AGNICO EAGLE

WHALE TAIL PIT PROJECT

Groundwater Monitoring Plan

In Accordance with:
Project Certificate No. 008, T&C 15 and 16

Prepared by:
Agnico Eagle Mines Limited – Meadowbank Division

Version 3_NWB
May 2019

EXECUTIVE SUMMARY

Agnico Eagle Mines Limited – Meadowbank Division (Agnico Eagle) received a Project Certificate No.008 from the Nunavut Impact Review Board for the development of the Whale Tail Pit, a satellite deposit located on the Amaruq Exploration property.

The deposit will be mined as an open pit (i.e., Whale Tail Pit), and ore will be hauled by truck to the approved infrastructure at Meadowbank Mine for milling. Approximately 8.3 million tonnes (Mt) of ore will be mined from the open pit and processed over a three to four-year mine life. The Approved Project supports mining ore from one open pit, the Whale Tail Pit, processed over a three to four-year mine life. Ore from Whale Tail Pit will be crushed on site after which it will be transported to Meadowbank Mine for milling. The mill rate will be approximately 9,000 to 12,000 tonnes per day. Agnico Eagle is proposing to expand and extend the Whale Tail Pit operations to include a larger Whale Tail open pit, development of the IVR open pit, and underground operations while continuing to operate and process ore at the Meadowbank Mine

During mining, groundwater will flow into the open pit. This water is naturally high in total dissolved solids and will not be directly discharged out of the active mine site without treatment. Water management during mine operations will involve a variety of activities, described in detail in the Water Management Plan (WMP) developed for the Project (Agnico Eagle 2019).

This Groundwater Management Plan (GWMP) reflects the commitments made with respect to submissions provided during the technical review of the FEIS, to comply with Terms and Conditions No. 15 and 16 included in the Project Certificate.

An update of the hydrogeological model was conducted in May 2019 for the Expansion Project since the submission of the FEIS addendum in December 2018. The updated hydrogeological model is presented in Appendix A. The model was updated based on results of the following items:

1. Sampling results of the multi-level Westbay well system, that were completed in November 2018;
2. Supplemental hydraulic conductivity (packer) testing in December 2018;
3. 2D thermal modelling and 3D block model thermal analyses completed in 2019 ;
4. Groundwater monitoring plan for horizontal and vertical groundwater flow; and,
5. Threshold and adaptive management plan related to the groundwater management.

The updated hydrogeological model was then used to provide revised predictions of groundwater inflow and total dissolved solids (TDS) concentrations during dewatering, mining, pit and underground flooding and long-term post-closure (reflooded) conditions.

The results of these studies indicated that arsenic release from the submerged pit wall (arsenic diffusion) would not affect water quality in the pit lake and mass transfer to water is very low even under the conservative assumptions of the calculations.

Results from these studies further indicate that the seepage into and out of the pit lake are negligible in volume, particularly compared to surface water exchanged annually during post-closure when flows are re-established based on average climate year watershed runoff. The combination of results corroborates to support that the hydrogeological regime around the pit lake is not critical to pit lake water quality.

Agnico Eagle considers that the uncertainty related to the arsenic-related water quality issues emanate from the Water Rock Storage Facility and the fill water in the proposed pit lake created after the excavation of the ore body, are addressed, and the NIRB Project Certificate No. 008 terms and conditions No. 15 and 16 has been fulfilled.

Agnico Eagle would like to clarify that the monitoring requirements related to the Waste Rock Storage Facility (WRSF) are addressed in the approved ARD-ML monitoring plan, Water Quality and Flow Monitoring Plan, Water Management Plan, Waste Management Plan, and the design report for the WRSF (60-day notice) approved by the NWB in December 2018. Any seepage emanating from the WRSF is considered as a surface water management issue. The groundwater monitoring plan focuses on the definition of the groundwater quality and flow reporting to the pit lake created before, during and after the excavation of the ore body.

The GWMP also includes monitoring commitments regarding the horizontal and vertical groundwater flow to validate the prediction of these studies during the operation of the Whale Tail pit. This plan was also updated in support of the Nunavut Impact Review Board (NIRB) review process and for the Expansion Project in support of the Nunavut Water Board (NWB) Type A Water License Amendment Process.

DISTRIBUTION LIST

AEM – Geology Superintendent

AEM – Engineering Superintendent

AEM – Geotechnical Coordinator

AEM – Environment Superintendent

AEM – Environmental Coordinator

DOCUMENT CONTROL

Version	Date (YMD)	Section	Revision
1	2018-05-30	All	To address Project Certificate No. 008. T&C 15 and 16
2	2018/11/8	1.1, 2.4, 2.5	To address ECCC and CIRNAC recommendations issued in October 2018
3_NIRB	2018-11-17	All	Updated for the Expansion Project in support of the Nunavut Impact Review Board review process
3_NWB	2019/05/09	All	Updated as a supporting document submitted to the Nunavut Water Board (NWB) for the Type A Water License amendment process

Prepared by:
Golder Associates & Agnico Eagle Mines Limited - Meadowbank Division

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1. INTRODUCTION

Agnico Eagle Mines Limited – Meadowbank Division (Agnico Eagle) received Project Certificate No.008 from the Nunavut Impact Review Board (NIRB) for the development of the Whale Tail Pit (the Project), a satellite deposit located on the Amaruq Exploration property. The Amaruq Exploration property is a 408 square kilometre (km^2) site located on Inuit Owned Land approximately 150 kilometres (km) north of the hamlet of Baker Lake and approximately 50 km northwest of the Meadowbank Mine in the Kivalliq region of Nunavut (Figure 1). The deposit will be mined as an open pit, and ore will be hauled by truck to the approved infrastructure at Meadowbank Mine for milling.

This document presents Groundwater Monitoring Plan (GWMP) for the Whale Tail Pit. Overall water management for operations, closure, and post-closure is described in the Agnico Eagle Water Management Plan (WMP) (Agnico Eagle 2018a). The WMP provides descriptions of the water control structures and associated design criteria.

1.1 CONCORDANCE

Meadowbank Mine is an approved mining operation and Agnico Eagle is planning to extend the life of the mine by constructing and operating the Project. The Project was subject to an environmental review established by Article 12, Part 5 of the Nunavut Agreement. In June 2016, Agnico Eagle submitted a Final Environmental Impact Statement (FEIS) seeking a reconsideration of the Meadowbank Mine Project Certificate (No. 004/File No. 03MN107) and Type A Water Licence Amendment (No. 2AM-MEA1525) from the NIRB.

On July 2016, the NIRB determined that the proposed Project required a separate screening assessment under the Nunavut Agreement and the *Nunavut Planning and Project Assessment Act* (NuPPAA). A separate Project Certificate (NIRB Project Certificate No. 008) was issued for the Project on March 15, 2018 by the NIRB. This GWMP reflects the commitments made with respect to submissions provided during the technical review of the FEIS, to comply with Terms and Conditions No. 15 and 16 included in the Project Certificate. An update of the hydrogeological model was conducted in May 2019 for the Expansion Project since the submission of the FEIS addendum in December 2018. The updated hydrogeological model is presented in Appendix A. The model was updated based on results of the following items

This version of the plan includes:

1. Sampling results of the multi-level Westbay well system, completed in November 2018;
2. Supplemental hydraulic conductivity (packer) testing in December 2018;
3. 2D thermal modelling and 3D block model thermal analyses completed in 2019;
4. Groundwater monitoring plan for horizontal and vertical groundwater flow; and,
5. Threshold and adaptive management plan related to the groundwater management.

An update of the hydrogeological model was conducted in May 2019 for the Expansion Project since the submission of the FEIS addendum in December 2018 (refer to Appendix A). The model was updated based on sampling results of the multi-level Westbay well system, that were completed in November 2018, supplemental hydraulic conductivity (packer) testing in December 2018, 2D thermal modelling and 3D block model thermal analyses completed in 2019. The updated hydrogeological model was then used to provide revised predictions of groundwater inflow and total dissolved solids (TDS) concentrations during dewatering, mining, pit and underground flooding and long-term post-closure (reflooded) conditions.

The results of these studies indicated that arsenic release from the submerged pit wall (arsenic diffusion) would not affect water quality in the pit lake; and, mass transfer to water is very low even under the conservative assumptions of the calculations. Results from these studies further indicate that the seepage into and out of the pit lake are negligible in volume, particularly compared to surface water exchanged annually during post-closure when flows are re-established based on average climate year watershed runoff. The combination of results corroborates to support that the hydrogeological regime around the pit lake is not critical to pit lake water quality.

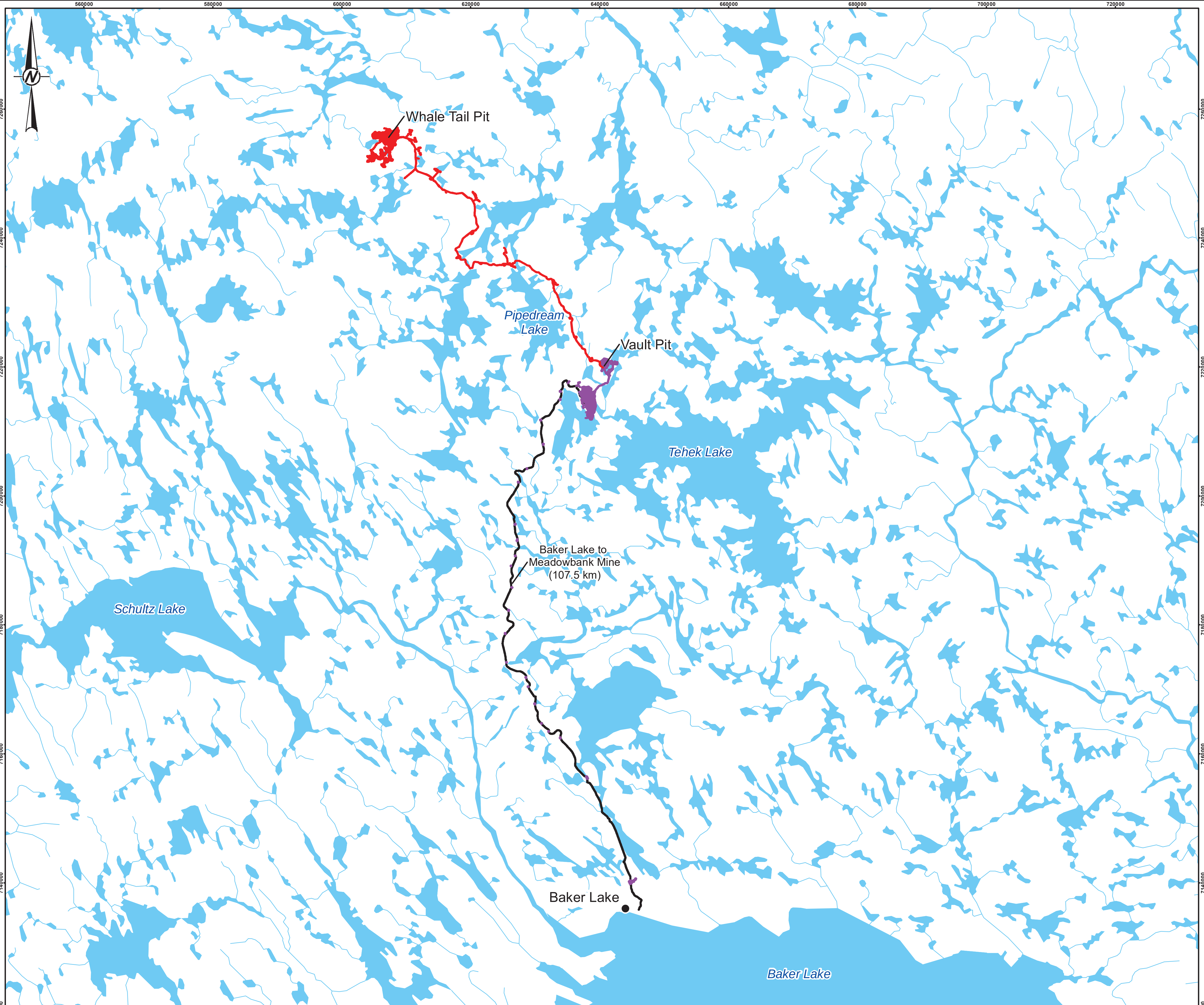
Agnico Eagle considers that the uncertainty related to the arsenic-related water quality issues emanate from the Water Rock Storage Facility and the fill water in the proposed pit lake created after the excavation of the ore body, are addressed, and the NIRB Project Certificate No. 008 terms and conditions No. 15 and 16 has been fulfilled. The GWMP was updated to include additional monitoring of the horizontal and vertical groundwater flow to validate the prediction of these studies during the operation of the Whale Tail pit.

Agnico Eagle would like to clarify the monitoring requirements related to the Waste Rock Storage Facility (WRSF) are addressed in the approved ARD-ML monitoring plan, Water Quality and Flow Monitoring Plan, Water Management Plan, Waste Management Plan and the design report for the WRSF, approved by the NWB in December 2018. Any seepage emanating from the WRSF is considered as a surface water management issue. The groundwater monitoring plan focus on the definition of the groundwater quality and flow reporting to the pit lake created before, during and after the excavation of the ore body.

1.2 OBJECTIVES

The objective of the GWMP is to provide consolidated information on groundwater management for the Project. The GWMP is divided into the following components:

- Introductory section (Section 1)
- A brief summary of the physical and hydrogeological setting at the mine site, the mine development plan and FEIS pit inflow predictions and updated predictions in 2019 (Section 2)
- A description of the groundwater monitoring program (Section 3)
- A summary of procedures for quality assurance and quality control (QA/QC) (Section 4)



LEGEND

- COMMUNITY
- HAUL ROAD
- ALL WEATHER ROAD
- WHALE TAIL PIT
- MEADOWBANK OPERATION AND INFRASTRUCTURE
- WATERCOURSE
- WATERBODY

0 12 24

1:600,000 KILOMETRES

REFERENCE(S)

1. HAUL ROAD OBTAINED FROM AGNICO EAGLE MINES LIMITED.
2. WATERCOURSE AND WATERBODY DATA OBTAINED FROM CANVEC © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
3. INSET MAP DATA OBTAINED FROM ESRI.

DATUM: NAD 83 CSRS PROJECTION: UTM ZONE 14

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED: MEADOWBANK DIVISION

PROJECT
WHALE TAIL PIT - EXPANSION PROJECT

TITLE
SITE LOCATION

CONSULTANT

GOLDER

YYYY-MM-DD	2018-11-22
DESIGNED	JR
PREPARED	CDB
REVIEWED	JR
APPROVED	DF

PROJECT NO.	CONTROL	REV.	FIGURE
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2. BACKGROUND

2.1 SITE CONDITIONS

The Project is located in Canada's Northern Arctic ecozone. This region includes most of Canada's Arctic Archipelago and northern regions of continental Nunavut and the Northwest Territories. This ecoregion is classified as a polar desert and is characterized by long cold winters and short cool summers. The mean air temperatures in June to September is approximately 7 degrees Celsius (°C) and -20.6 °C in October to May.

Average annual precipitation at Meadowbank Mine is 142.6 mm (1998 to 2004). The annual precipitation at site generally falls as rain between June and September, and snow between October and May. However, snowfall can occur at any time of the year.

Based on data for Baker Lake (120 km to the south), and from experience ice auguring within the Meadowbank Mine lakes in the winter, the mean maximum lake ice thickness over Whale Tail Lake is expected to be 2.25 m. During the winter collection of water quality baseline data in Whale Tail Lake in April 2016, ice thickness was confirmed to be 2 m.

The surficial geology of the Project area shows strong evidence of glacial activity and is dominated by veneers and blankets of till overlying undulating bedrock. Bedrock frequently outcrops in isolated exposures, elevated plateaus and elongated ridges. Lakes and ponds are abundant, occupying approximately 16% of the area.

The local overburden consists of till with a silty sand matrix and clasts that range from granule gravel to large boulders in size. Glaciofluvial deposits in the form of eskers and terraces are found in the northeast section of the satellite deposit and they continue in a southeast direction intersecting the haul road in several locations.

The bedrock geology in the Project area consists of Archean and Proterozoic super crustal sequences and plutonic rocks.

2.2 HYDROGEOLOGY SETTING

2.2.1 Conceptual Model

An updated thermal assessment for the Project was conducted in April 2019 to evaluate the existing permafrost characteristics in the Whale Tail Lake and Project area and to evaluate the existing talik conditions under the Whale Tail Lake adjacent to the Project site. The results of this work are documented in Golder (2019e). The report presents a review and summary of estimated permafrost condition based on available thermistor data to date, as well as the results of a thermal modelling exercise prepared to assess permafrost conditions and the extent of talik formations beneath the Whale Tail Lake.

Results from the thermal modelling were used to develop a 3D representation of the permafrost in the Whale Tail Lake area.

Based on the thermal modelling update and the available thermistor data, the permafrost characteristics in the Project area are summarized below:

- The depth of permafrost outside of the influence of lakes is estimated to be between 452 m and 522 m based on thermal gradients and ground temperatures at the lowest portions of the thermistor strings. The depth of permafrost increases with increasing distance from lakes with talik.

- Considering the 2D thermal modelling and 3D block model, the assessment indicated that:

    - Under the northern portion of the lake below Whale Tail Pit, there is likely a closed talik formation

    - Open talik conditions are probable in the southern portion of the lake where the Whale Tail Lake becomes wider

    - Permafrost depth is between 480 m and 550 m for ground away from the Whale Tail Lake, and between 350 m and 450 m below surface in portions beneath the Whale Tail Lake where a closed talik is present.

    - The cryopeg thickness is likely between 20 m to 30 m.

Review of the 2D thermal analysis and 3D block model indicates that the predicted closed and open talik is consistent with the conceptual hydrogeological conditions adopted in the FEIS Addendum.

The Project is in an area of continuous permafrost. In this region, the layer of permanently frozen subsoil and rock is generally deep and overlain by an active layer that thaws during summer. The depth of the active layer is typically expected to range between one and three metres. Depending on lake size, depth, and thermal storage capacity, the talik (unfrozen ground surrounded by permafrost) beneath lakes may fully penetrate the permafrost layer resulting in an open talik. Circular lakes with a radius greater than 300 m, or elongated lakes with a half-width of at least 150 m, are assumed to be connected to the deep groundwater flow regime through open taliks.

In areas of continuous permafrost, there are two groundwater flow regimes: a deep groundwater flow regime beneath permafrost, and a shallow groundwater flow regime located in the active (seasonally thawed) layer near the ground surface. With the exception of areas of taliks beneath lakes, the two groundwater regimes are isolated from one another by thick permafrost.

The shallow groundwater regime is active only seasonally during the summer months, and the magnitude of the flow in this layer is expected to be several times less than runoff from snowmelt. Groundwater in the active layer primarily flows to local depressions and ponds that drain to larger lakes; therefore, the total travel distance would generally extend only to the nearest pond, lake, or stream. Water in the active layer is stored in ground ice during the cold season and is then released with the ice thaws in late spring or early summer, thus providing flow to surface. During the warm season, groundwater in the active layer is recharged primarily by precipitation.

Permafrost reduces the hydraulic conductivity of the bedrock by several orders of magnitude (Burt and Williams 1976; McCauley et al. 2002). Consequently, the permafrost in the rock would be virtually impermeable to groundwater flow. The shallow groundwater flow regime, therefore, has little to no hydraulic connection with the deep groundwater regime which is overlain by massive and continuous permafrost.

Groundwater flow within the deep groundwater flow regime is limited to the sub-permafrost zone. This deep groundwater flow regime is connected to the ground surface by open taliks underlying larger lakes. Talik exist beneath lakes that have enough depth so that they do not freeze to the bottom over the winter. If the lake is sufficiently large and deep, the talik can extend down to the deep groundwater regime. These taliks are referred to as open talik. If the talik does not extend down to the deep groundwater, it is referred to as a closed or an isolated talik. The width and shape of lakes in the Hydrogeology Baseline Study and FEIS area were reviewed to estimate if open taliks could be present below the lakes (Golder 2019e). Based on 1-D analytical solutions presented in Burn (2002), 2D thermal analysis and a 3D block model, Golder estimated that open taliks could be present for circular lakes with a radius of approximately 300 m and for elongated lakes with a half-width of approximately 150 m. Beneath smaller lakes that do not free to the bottom over the winter, a talik bulb may form; however, the talik bulb is not expected to extend to the deep groundwater flow system.

Generally, deep groundwater will flow from higher elevation lakes with open taliks to lower elevation lakes with open taliks. To a lesser degree, groundwater beneath the permafrost is influenced by density differences due to saline water conditions (density driven flow).

Below the active layer, permafrost underlies the land surrounding the lakes, which restricts the lateral or horizontal flow of groundwater and restricts the recharge of the sub-permafrost groundwater flow system by precipitation. Multiple thermistors in the land surrounding Whale Tail Lake, in combination with thermal modelling, indicate the permafrost extends to 452 m to 522 m below ground surface. In particular, thermistor data recorded at AMQ15-294, AMQ15-306, AMQ15-306, AMQ15-349A, AMQ15-421, AMQ15-452, AMQ17-1233, AMQ-1265A, AMQ17-1337 and AMQ17-1277A (Golder 2019c) indicates the presence of permafrost between Whale Tail Lake and Nemo lake, and therefore the absence of horizontal groundwater flow in the upper 452m to 522 m of bedrock.

Groundwater flow is controlled by surface water elevations in lakes with open talik; water moves vertically through the open talik to the underlying sub-permafrost groundwater flow system. The elevations of the lakes with expected talik in the baseline study area indicate that Whale Tail Lake is likely a groundwater discharge zone at the south end of the Lake (upward vertical hydraulic gradient); with flow from Lake A60 to Whale Tail Lake, and a groundwater recharge zone at the north end of the Lake (downward hydraulic gradient), with groundwater flow from Whale Tail Lake to Lake DS1 as presented on the Figure 2 showing the hydrogeology baseline study area.

Whale Tail Pit is located in the north basin and therefore a downward vertical hydraulic gradient is expected (Figure 3). This was verified by hydraulic head monitoring at the Westbay Well system in 2018, which had a measured downward hydraulic gradient of 0.008 m/m, which is equivalent to what would be expected based on the relative lake elevation of Whale Tail Lake and Lake DS1 (Golder 2019a).

FIGURE 2: HYDROGEOLOGY BASELINE STUDY AREA

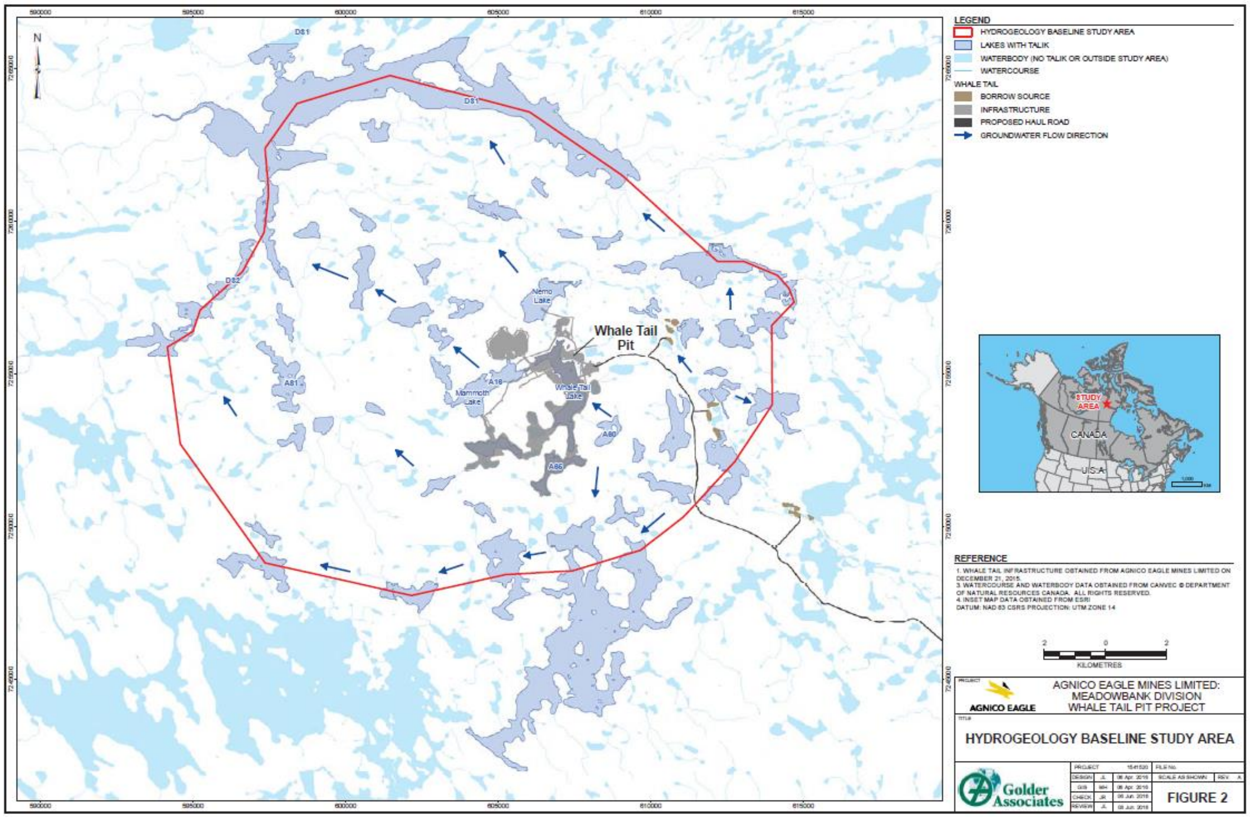
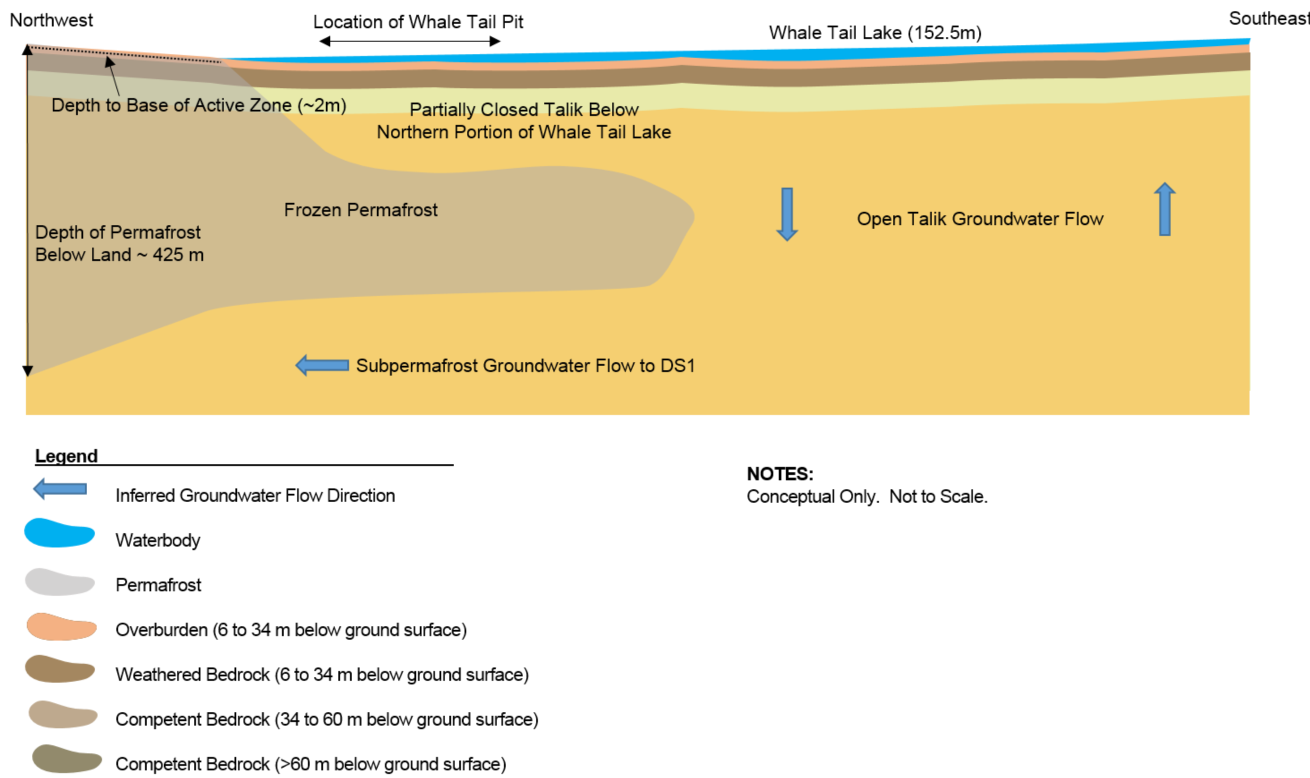
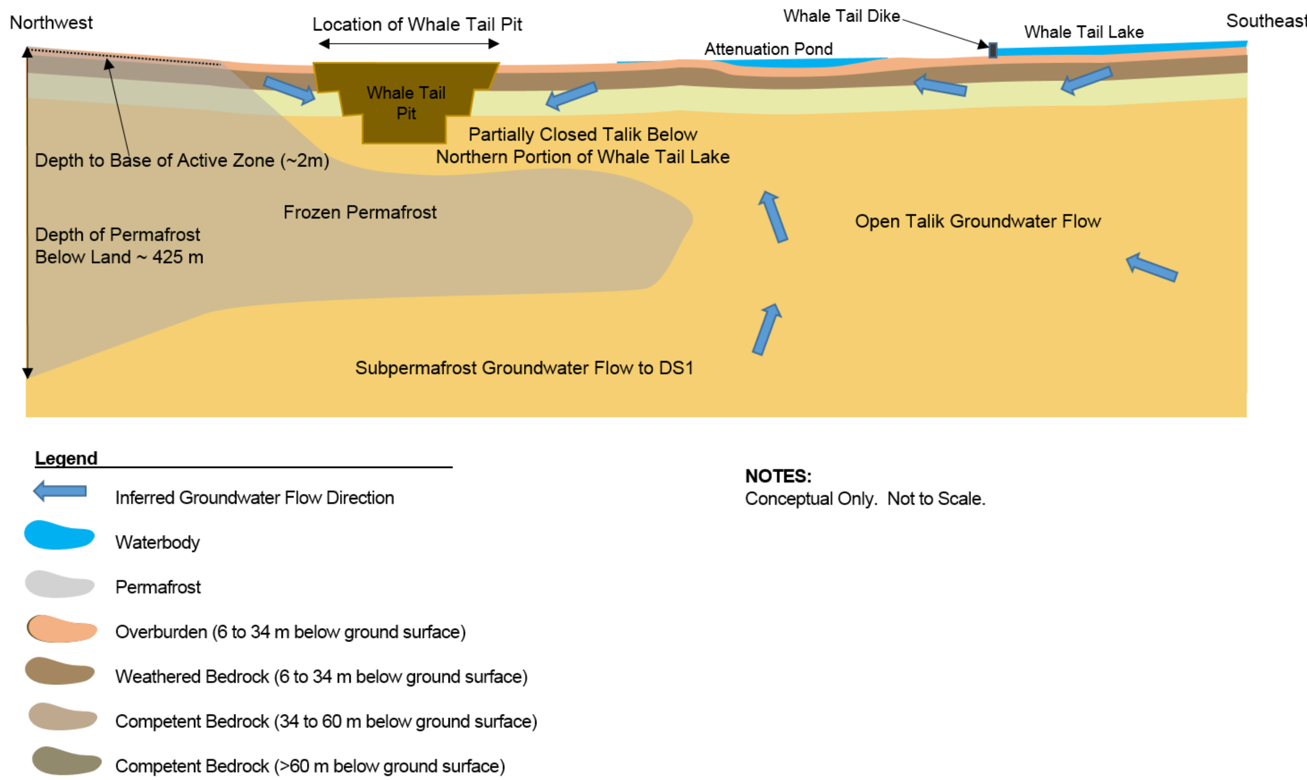


FIGURE 3: CONCEPTUAL MODEL OF PRE-MINING DEEP GROUNDWATER FLOW REGIME - CROSS-SECTION VIEW



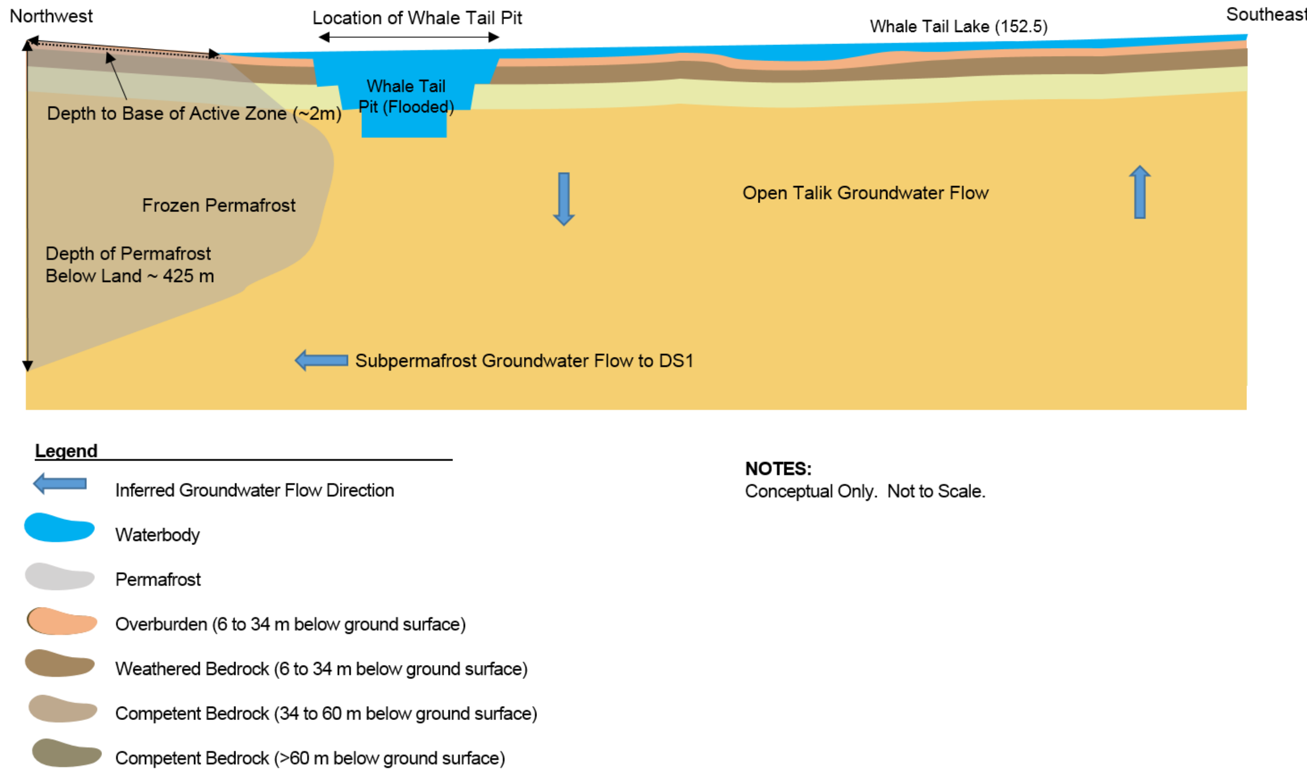
Below Whale Tail Lake, a talik is expected to form a continuous channel that is closed in the northern portion of Whale Tail Lake below the open pit and becomes open towards the south and central portion of the lake. As shown in Figure 4, during mining the open pit will act as a sink for groundwater flow, with seepage faces developing along the pit walls. In response to mining of the open pit, groundwater will be induced to flow through bedrock to the open pit. Mine inflow will primarily originate from Whale Tail Lake, the attenuation pond between the pit and Whale Tail dike, and deep bedrock. The quality of mine inflow will be a result of the mixing from each of these sources.

FIGURE 4: CONCEPTUAL MODEL OF DEEP GROUNDWATER FLOW REGIME DURING MINING - CROSS-SECTION VIEW



During closure (Figure 5), the open pit will be flooded with water from a variety of sources including: water pumped from the flooded South Whale Tail watershed until the original Whale Tail Lake level is reached (152.5 m), the north-east watershed following the breach of the North-East dike, groundwater originating from nearby lakes underlain by open taliks, connate water and water pumped from the attenuation pond. This process will dissipate the large hydraulic head differences established during mine operations in the vicinity of the mine workings. The rate of groundwater inflow will decrease as the water level in the open pit rises. From the start of closure and following the formation of the pit lake in post-closure, permafrost below the pit is expected to thaw slowly. The thermal regime in the vicinity of the pit will be monitored, as outlined in the Thermal Monitoring Plan for the Project (Agnico Eagle 2019).

FIGURE 5: CONCEPTUAL MODEL OF DEEP GROUNDWATER FLOW REGIME IN LONG-TERM POST-CLOSURE - CROSS-SECTION VIEW



2.2.2 Post-Closure Hydrogeological and Thermal Analysis

Hydrogeological analysis was conducted to assess the post-closure groundwater regime in the vicinity of the Whale Tail Pit (Golder 2019e). The intent of the study was to consider post-closure changes in the groundwater regime once the pit lake reaches its ultimate elevation and the influence, if any, that these changes may have on water quality in the flooded pit. As part of the analysis, the predicted changes in the permafrost regime, based on a post-closure thermal assessment, were incorporated in to the hydrogeological model. The results of the hydrogeological assessment provided input into a concurrent study that assessed water quality in the flooded pit (Golder 2019e). Overall, groundwater was found to be a minor component of the flooded pit lake water quality due to the small predicted seepage rates from the pit in relation to typical surface water exchanges.

Results of the post-closure thermal assessment (Golder, 2019e) included:

- During pit flooding, the warm pit lake temperature impacts mostly the upper portion of the permafrost under the pit, and a talik starts to form around the pit wall and floor.

- The permafrost under the pit lake continues to thaw during the long-term post-closure stage, and the open talik expands towards the northern edge of the pit lake (land side). The majority of the permafrost under the pit lake is thawed 300 years after closure.

- The steady-state model indicates the pit lake would thaw the permafrost in the long-term, and eventually somewhat reduce the permafrost depth to the northwest of the pit. A significantly longer time (in the order of 10,000 years) is likely required for the pit lake to reach the steady-state thermal conditions**.** Permafrost is still predicted to the north of the pit, restricting the horizontal flow of groundwater to towards Nemo Lake where the permafrost is present.

Result of the Post-closure hydrogeological model (Golder, 2018a) included:

- Initially, once the hydraulic heads return to near equilibrium shortly after mine flooding, groundwater inflow into the pit is greater than pit lake discharge into surrounding bedrock. This groundwater discharge to the pit lake decrease gradually over 100 years, at which time it reverses and the pit lake discharge into the bedrock is greater than the groundwater inflow. The relative difference in flow increases with time and as the permafrost layer beneath the pit lake thaws.

- Long-term, the pit lake establishes as a source of groundwater recharge, which is consistent with the current pre-development groundwater flow condition.

As summarized above, with the exception of deep sub-permafrost groundwater flow, groundwater flow during closure will be similar to pre-development conditions and limited to the area of talik below Whale Tail Lake and the developed pit lake during closure. Horizontal flow beneath land will be restricted by the presence of permafrost below the active layer. Thermal analysis indicates that although permafrost degradation below the pit footprint will occur, permafrost will be present below the land outside of the pit lake and other lakes with talik (i.e., including between the pit and Nemo Lake).

Predictions from the hydrogeological modelling were an input into a concurrent study that assesses overall water quality in the flooded pit (Golder, 2018c). Arsenic loading rate from the Whale Tail pit north wall has been determined from the completion of the Arsenic diffusion model (Golder, 2018d) and integrated to the Whale Tail Pit hydrodynamic model (Golder, 2018c). Result of the hydrodynamic model are:

- The concentration of TDS will remain below site specific water quality objectives at all times. TDS will peak at just below 25mg/L in year 2025, and thereafter decrease over time. Concentration of TDS will stabilize at approximately 11mg/L by 2055.

- The concentration of arsenic will remain below site specific water quality objectives at all times. Arsenic will peak at just below 0.025mg/L in year 2025, and thereafter decrease over time. Concentration of arsenic will stabilize at approximately 0.0025mg/L by 2055.

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

The pit lake in the long-term is expected to be a source of groundwater recharge, with a seepage loss rates to groundwater of approximately 1.7 m^3/day (620 m^3/year), which is negligible relative to the 3,000,000+ m^3 of surface water exchanged annually post-closure when surface water flows are re-established, based on average climate year watershed runoff. This groundwater loss rate is representing 0.02% of the total surface water exchanged annually. This indicates that uncertainty in the hydraulic gradient and groundwater flow is not critical to the long-term assessment of pit lake water quality. As presented in Golder (2018) recent monitoring of the hydraulic gradient, and calculated fluxes based on this gradient suggest that the predicted post-closure seepage rates are reasonable based on the measured data.

2.2.3 Groundwater Volumes and Quality

Updated predictions for dewatering of Whale Tail Lake and the mining and reflooding of the pits and underground for the Expansion Project were conducted in May 2019. The model update incorporates a reduction in deep bedrock hydraulic conductivity based on additional packer testing in December 2018, and the results of the thermal modelling, which overall support the permafrost interpretation in the FEIS Addendum. Minor adjustments were made in the permafrost depth along the margins of Whale Tail Lake but overall, changes to the permafrost extent were minor and did not conceptually alter the interpretation of where open and closed talik were present in Whale Tail Lake.

Updated predictions of groundwater inflow (quantity and TDS quality) are provided for the Base Case and EA Scenario. Quantity and TDS quality is consistent with previous modelling in the FEIS Addendum, TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources accounted for in Site Wide Water Quality analysis. The Base Case Scenario represents the best estimate of groundwater inflow and groundwater TDS based on the measured data. The EA Scenario is designed to be a reasonable, yet more conservative, assessment of potential groundwater inflow quantity and TDS quality than values that might be adopted for mine operation planning. (i.e., Base Case Scenario). Results from the more conservative EA Scenario are used in the Updated Site-Wide Water Balance and Water Quality model (Golder 2019).

A summary of these updated predictions is presented in the section below.

2.2.3.1 Base Case Scenario

Dewatering

Table 1 presents a summary of the predicted discharge to the North Basin of Whale Tail lake during dewatering for the base case. The predicted discharge of 1320 m3/day is within 20 m3/day of the FEIS predictions (1340 m3/day) and no change in TDS concentration was predicted. The minor variation in predicted discharge from the FEIS reflects the small adjustments made to permafrost extent along the margins of Whale Tail Lake.

Table. 1 Predicted Groundwater Discharge to North Basin of Whale Tail Lake during Dewatering – Base Case Scenario

Phase	Base Case Scenario	
	Groundwater Discharge (m3/day)	**TDS Concentration (mg/L)**
Lake Dewatering (Q1-Q3 2019)	1320	80

Mining

Table 2 presents a summary of the updated predicted groundwater flow rates and groundwater TDS concentrations to the mine development areas for the Base Case Scenario during mining of the open pits and underground. The predictions include: predicted groundwater inflow to Whale Tail Pit, predicted groundwater inflow to the Underground, predicted flow to and from the Whale Tail Attenuation Pond, and predicted discharge to the dewatered North Base of Whale Tail Lake (i.e., the flow of water below the Whale Tail Lake Dike to the dewatered lake bottom). Groundwater inflow to the IVR Pit during mining is not included as the pit is in permafrost (groundwater inflow will be negligible). Some interception of surface water runoff and direct precipitation by the IVR Pit is excepted, but this is not a flow component derived from the groundwater modelling. It is addressed in the Updated Site-Wide Water Balance and Water Quality Model (Golder 2019d).

- **Whale Tail Open Pit**

In the last quarter of 2019, following dewatering of the North Basin of Whale Tail Lake, mining is expected to intersect unfrozen rock, and groundwater inflow to the pit is predicted to be 970 m3/day. The groundwater inflow to the open pit was predicted to increase from 970 m3/day in 2019 to 1,340 m3/day in 2022 to 2025. The overall inflow to the pit does not increase significantly as the pit deepens because the flow of water is primary through the permeable shallow (weathered) bedrock and the lower portion of the pit is in permafrost. The predicted quantity of groundwater inflow into the open pit during mining for the Base Case Scenario is close to what was predicted in the FEIS Addendum as no changes were made to the shallow bedrock hydraulic conductivity based on the recent packer test data.

Groundwater inflow predictions during mining conservatively assumes that no freeze-back will occur in the pit walls. This assumption was adopted for Whale Tail Pit to be conservative and because during the first few years of mining, the pit will be both widened and deepened, resulting in the continual exposure of unfrozen bedrock. During the later years of mining; however, the pit development will be entirely within the permafrost and significant freeze back in the pit walls is considered possible and has been observed at Meadowbank. Although not simulated, if freeze back does occur as is the case at Meadowbank, actual groundwater inflow to the pit could be substantively lower than the predicted (i.e., reduce to zero during periods of full freeze back).

Table. 2 Predicted Groundwater Inflow and Groundwater Quality during Mining – Base Case Scenario – Whale Tail Pit and Underground

Phase	Time Period	Whale Tail Pit		Underground		Whale Tail Attenuation Pond			North Basin of Whale Tail Lake (within the diked area)[3]	
		Groundwater Inflow (m^3/day)	TDS Concentration[2] (mg/L)	Groundwater Inflow (m^3/day)	TDS Concentration[2] (mg/L)	Groundwater Inflow (m^3/day)	Inflow TDS Concentration (mg/L)	Surface Water Outflow (m^3/day)	Groundwater Discharge to Surface (m^3/day)	Inflow TDS Concentration (mg/L)
Mining	August-December 2019[1]	970	120	NA	NA	350	110	180	650	70
	2020	1160	50	20	3880	120	170	860	720	30
	2021	1310	20	30	4080	90	150	1040	730	20
	2022	1340	20	110	5630	90	130	1080	720	10
	2023	1340	10	180	6890	90	110	1080	720	10
	2024	1340	10	170	7430	90	80	1080	720	10
	2025	1340	10	130	7760	90	40	1080	720	10

Notes:

IVR Pit is located in permafrost and was therefore not modelled. Interception of runoff / direct precipitation accounted for in Site Wide Water Balance.
Mining prior to Q4 2019 is within permafrost and groundwater inflow will be negligible.
TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources to be accounted for in Site Wide Water Quality analysis.
NA = not applicable; TDS = total dissolved solids; m3/day = cubic metres per day; mg/L = milligrams per litre; % = percent.

TDS concentration in the groundwater inflow to the pit was predicted to decrease during mining from approximately 120 mg/L (2019) to 10 mg/L (2023 to 2025). These TDS concentrations are identical to the predicted TDS concentrations in the FEIS Addendum. The relatively low TDS concentration and decrease in TDS over time reflects the minimal upwelling of higher salinity waters at depth due to the presence of the permafrost at the base of the pit and the high contribution of lake water from the South Base of Whale Lake and from the Whale Tail Attenuation Pond water. Consistent with the FEIS Addendum, the predicted TDS concentrations in this model only account for TDS loading from groundwater. TDS loading from the Whale Tail Attenuation Pond and South Basin of Whale Tail Lake is accounted for in the water quality model (Golder 2019d).

- **Underground**

For the Underground, groundwater inflow was predicted to increase from 20 m3/day in 2020, which is the first year the Underground development will be within unfrozen bedrock, up to 180 m3/day in 2023, which is when the underground reaches its maximum depth of -505 masl. By the final year of mining, the groundwater inflow decreases to 130 m3/day. This decrease reflects that the underground is no longer being deepened and flow to the underground is likely near steady state conditions (reduced drainage from storage). The predicted flows based on the updated model is approximately 13% lower than the predicted values in the FEIS Addendum at the end of mining (150 m3/day). The reduction in groundwater inflow reflects the small decrease in hydraulic conductivity in the deep sub-permafrost bedrock due to the additional packer testing data.

TDS concentrations in the groundwater inflow to the Underground were predicted to increase from 3,880 mg/L in 2020 to 7,760 mg/l in 2025. The predicted increase in TDS concentration is the result of the interception of higher salinity groundwater as the mine is deepened, and the upwelling of higher TDS water from beneath the Underground. The predicted TDS concentrations are within 30 mg/L of the predicted values in the FEIS Addendum for the Base Case Scenario.

Reflooding Of Pits and Underground

Table 3 and Table 4 respectively presents a summary of the predicted groundwater inflow rates and groundwater TDS concentration to the mine development areas for the Base Case Scenario during reflooding of the pits and underground. The predictions presented in tables 3 and 4 include: predicted groundwater inflow to Whale Tail Pit Lake, predicted groundwater flow to the Underground, predicted flow to and from the Whale Tail Attenuation Pond, and predicted discharge to the dewatered North Base of Whale Tail Lake (i.e., the flow of water below the Whale Tail Lake Dike to the dewatered lake bottom surface). Groundwater inflow to the IVR Pit during refilling was not included as the pit is in permafrost (groundwater inflow will be negligible).

The predictions presented for the reflooding phase utilize a conceptual filling schedule for the Whale Tail Pit and the Underground, based on initial water balance predictions. Fine tuning of the flooding sequence was conducted after the conceptual filing schedule was developed; however, these adjustments will not have a significant impact on the predicted flow rates and salinity for a given elevation range.

For the prediction of pit reflooding, the pit walls were assumed to be frozen at the start of closure / end of mining, which restricted the inflow of groundwater to the pit lake until the pit lake rises and thaws the pit walls. This is considered reasonable as during the later years of mining, the pit development is limited to within the permafrost below Whale Tail Lake. If the pit walls do not remain frozen or melts seasonally, higher inflows than what is predicted could occur resulting in a shorter pit-filling period.

Considering the assumption of freeze-back in the pit walls, groundwater inflow to the Whale Tail Pit was not predicted to occur until 2030, when the pit lake level rises above the top of permafrost elevation near the pit (approximately 40 masl). When the water elevation in the pit lake rises above the permafrost, the freeze back is assumed to dissipate below the lake level and groundwater inflow to the pit was predicted to resume. The groundwater inflow to the pit lake was predicted to increase from 10 m^3/day in 2030 to approximately 1,160 m^3/day in 2036 as the pit walls progressively become unfrozen and connected to the permeable weathered bedrock. As the pit lake rises further in elevation, the groundwater inflows decrease and eventually the pit lake switches to a groundwater recharge boundary (i.e., the pit lake starts to recharge the sub-permafrost groundwater flow system). These groundwater inflow rates are similar to predictions in the FEIS Addendum and reflect that no changes were made to the shallow bedrock hydraulic conductivity.

The refilling of the Underground is expected to occur over a very short period (i.e. the bottom 500 m will be refilled in the first year). The water level in the Underground is therefore almost immediately higher then the hydraulic heads in bedrock near the Underground, resulting in a small but generally consistent flux of water from the Underground to bedrock. At the end of the reflooding period (2041) the Underground remains a source of groundwater recharge. with a predicted discharge of -10 m3/day. These flow rates are slightly lower (by 0 to 5 m3/day) of the predicted groundwater recharge rates predicted in the FEIS Addendum.

Table. 3 Predicted Groundwater Inflow and Groundwater Salinity during Reflooding - Base Case Scenario – Whale Tail Pit, Whale Tail Attenuation Pond, North Basin of Whale Tail Lake

Phase	Approximate Time Period	Water Level in Pit (masl)		Whale Tail Pit		Whale Tail Attenuation Pond			Dewatered North Basin of Whale Tail Lake (within the diked area)	
		From	To	Net Groundwater Inflow/Outflow[1] (m^3/day)	TDS Concentration[2] (mg/L)	Groundwater Inflow (m^3/day)	Inflow TDS Concentration (mg/L)[2]	Surface Water Outflow	Net Groundwater Discharge to Surface[1] (m^3/day)	Inflow TDS Concentration[2] (mg/L)
Flooding	2026	-130	-76	NA	NA	145	30	<5	340	<10
	2027	-76	-39	NA	NA	170	24	<5	340	<10
	2028	-39	3	NA	NA	180	21	<5	345	<10
	2029	3	26	NA	NA	185	19	<5	345	<10
	2030	26	43	10	24	190	18	<5	345	<10
	2031	43	61	60	24	180	17	10	345	<10
	2032	61	73	90	21	170	17	30	345	<10
	2033	73	87	120	19	160	17	45	340	<10
	2034	87	101	130	17	155	17	50	340	<10
	2035	101	111	700	<10	125	25	505	330	<10
	2036	111	124	1160	<10	85	29	940	300	<10
	2037	124	133	910	<10	90	22	740	300	<10
	2038	133	142	360	<10	115	16	315	315	<10
	2039	142	149	-30	NA	70	22	135	370	<10
	2040	149	153.5	-10	NA	0	NA	5	155	<10
	2041	153.5	153.5	0	NA	0	NA	0	-10	<10

Notes:
IVR Pit is located in permafrost and was therefore not modelled. Interception of runoff / direct precipitation accounted for in Site Wide Water Balance.
Positive values indicate flow to the pit/pond and negative values indicate flow to bedrock.
TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources to be accounted for in Site Wide Water Quality analysis.
NA = not applicable; TDS = total dissolved solids; m3/day = cubic metres per day; mg/L = milligrams per litre; % = percent.

Table. 4 Predicted Groundwater Inflow and Groundwater Salinity during Refilling – Base Case Scenario – Underground

Phase	Approximate Time Period	Water Level in Underground (masl)		Underground	
		From	To	Net Groundwater Inflow/Outflow[1] (m^3/day)	TDS Concentration[2] (mg/L)
Flooding	2026	-505	-76	-30	NA
	2027	-76	-39	<-5	NA
	2028	-39	3	<-5	NA
	2029	3	26	<-5	NA
	2030	26	43	<-5	NA
	2031	43	61	<-5	NA
	2032	61	73	<-5	NA
	2033	73	87	-5	NA
	2034	87	101	-10	NA
	2035	101	111	-10	NA
	2036	111	124	-10	NA
	2037	124	133	-10	NA
	2038	133	142	-25	NA
	2039	142	149	-15	NA
	2040	149	152.5	-10	NA
	2041	153	152.5	-10	NA

Notes:
Positive values indicate flow to the underground and negative values indicate flow to bedrock.
TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources to be accounted for in Site Wide Water Quality analysis.
NA = not applicable; TDS = total dissolved solids; m3/day = cubic metres per day; mg/L = milligrams per litre; % = percent

2.2.3.1 EA scenario

The Base Case predictions discussed in the preceding section provides the most likely estimates of groundwater inflow quantity and quality for the Expansion Project based on the available hydraulic conductivity data. Considering the number of tests; however, and in consideration of the sensitivity analysis conducted in the FEIS Addendum, an EA Scenario was developed as part of the FEIS addendum. This scenario provides a reasonable yet conservative estimate of groundwater inflow such that there is a high level of confidence that the potential effects of the Expansion Project on groundwater inflow quantity and salinity have not been underestimated. Results from the EA Scenario are used in the Site-Wide Water Balance and Water Quality Models for the Expansion Project.

Dewatering

Table 5 presents a summary of the predicted discharge to the North Basin of Whale Tail lake during dewatering. The predicted discharge of 1330 m3/day is within 20 m3/day of the FEIS Addendum predictions (1350 m3/day) and no change in TDS concentration was predicted. The minor variation in predicted discharge from the FEIS reflects the small adjustments made to permafrost extent along the margins of Whale Tail Lake.

Table. 5 Predicted Groundwater Discharge to North Basin of Whale Tail Lake during Dewatering – EA Scenario

Phase	EA Scenario	
	Groundwater Discharge (m3/day)	TDS Concentration (mg/L)
Lake Dewatering (Q1-Q3 2019)	1330	80

Mining

Table 6 and Table 7 presents a summary of the updated predicted groundwater flow rates and groundwater TDS concentrations to the mine development areas for the EA Scenario during mining of the open pits and underground. The predictions presented include: predicted groundwater inflow to Whale Tail Pit, predicted groundwater inflow to the Underground, predicted flow to and from the Whale Tail Attenuation Pond, and predicted discharge to the dewatered North Base of Whale Tail Lake (i.e., the flow of water below the Whale Tail Lake Dike to the dewatered lake bottom). Groundwater inflow to the IVR Pit during mining is not included as the pit is in permafrost (groundwater inflow will be negligible). Some interception of surface water runoff and direct precipitation by the IVR Pit is excepted, but this is not a flow component derived from the groundwater modelling. It is addressed in the Updated Site-Wide Water Balance and Water Quality Model (Golder 2019d).

- **Whale Tail Open Pit**

The predicted quantity and TDS concentration of groundwater inflow into the open pit during mining for the EA Scenario is similar to what was predicted in the Base Case and assumes no freeze-back in the pit walls. For the EA Scenario, the groundwater inflow to the open pit was predicted to increase from 970 m3/day in 2019 to 1,350 m3/day in 2025 and the TDS concentration was predicted to decrease from 120 mg/L in 2019 to 10 mg/L in 2025. Groundwater inflow is controlled by the shallow bedrock hydraulic conductivity, which was not modified between the Base Case and EA Scenario due to the high number of tests in this unit and the conservatism used in the Base Case Scenario. The shallow bedrock hydraulic conductivity is also unchanged from the FEIS Addendum; therefore, predicted inflows to the open pit are similar to the predictions in the FEIS Addendum.

- **Underground**

For the EA Scenario, the updated groundwater inflow to the Underground was predicted to increase from 60 m3/day in 2020 to a maximum of 420 m3/day in 2023. In the final year of mining, the groundwater inflow decreases slightly to 340 m3/day. These groundwater inflows are approximately 2 to 3 times higher than the Base Case values for the same period of mining. Predicted TDS concentrations for the EA scenario are 30% higher than the Base Case at the end of mining and reflect more upwelling of deeper more saline groundwater beneath the Underground.

The predicted inflows based on the updated model is approximately 20% lower than the predicted values at the end of mining in the FEIS Addendum (430 m3/day). The reduction in groundwater inflow reflects the small decrease in hydraulic conductivity in the deep sub-permafrost bedrock due to the additional packer testing data. The predicted TDS concentrations are approximately 2 to 9 % lower than the predicted values in the FEIS Addendum.

Contributions to the inflow to the Whale Tail Pit and the Underground from the Whale Tail Attenuation Pond and the South Basin of Whale Tail Lake were evaluated for the EA Scenario to support the update to the Site-Wide Water Quality Model. TDS concentrations from these sources are accounted for in the Site-wide Water Quality model through a feedback loop. The quantity contributions predicted by the hydrogeological model are presented in Table 6 and Table 7. In 2020, approximately 64% of groundwater inflow to the pit is originating from the Whale Tail Attenuation Pond. The pond represents the major contributor to groundwater inflow to the pit due to its connection to the pit through the permeable shallow bedrock. The contribution from the pond was predicted to increase to 82% at the end of mining. The contribution from the South Basin of Whale Tail Lake is also predicted to increase from 3% in 2021 to 15% at the end of mining in 2025. In the Underground, the source of groundwater inflow is attributed only to water from the deep bedrock flow system

Table. 6 Predicted Groundwater Inflow and Groundwater Quality during Mining - EA Scenario – Whale Tail Pit and Underground

Phase	Time Period	Whale Tail Pit				Underground			
		Groundwater Inflow (m^3/day)[3]	Inflow TDS Concentration (mg/L)[2]	Portion of Inflow from Attenuation Pond (%)	Portion of Inflow from South Basin of Whale Tail Lake (%)	Net Groundwater Inflow (m^3/day)	Inflow TDS Concentration (mg/L)[2]	Portion of Inflow from Attenuation Pond (%)	Portion of Inflow from South Basin of Whale Tail Lake (%)
Mining	August-December 2019[1]	970	120	1%	<1%	NA	NA	NA	NA
	2020	1170	50	64%	<1%	60	4120	<1%	<1%
	2021	1320	30	79%	3%	70	4580	<1%	<1%
	2022	1360	20	81%	9%	250	6230	<1%	<1%
	2023	1360	20	82%	12%	420	7850	<1%	<1%
	2024	1350	10	82%	14%	410	9090	<1%	<1%
	2025	1350	10	82%	15%	340	10180	<1%	<1%

Notes:

IVR Pit is located in permafrost and was therefore not modelled. Interception of runoff / direct precipitation accounted for in Site Wide Water Balance.
Mining prior to Q4 2019 is within permafrost and groundwater inflow will be negligible.
TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources to be accounted for in Site Wide Water Quality analysis. NA = not applicable; TDS = total dissolved solids; m3/day = cubic metres per day; mg/L = milligrams per litre; % = percent.

Table. 7 Predicted Groundwater Inflow and Groundwater Salinity during Dewatering and Mining - EA Scenario – Whale Tail Attenuation Pond and Whale Tail Lake (North Basin)

Phase	Time Period	Whale Tail Attenuation Pond				North Basin of Whale Tail Lake (within the diked)[1]		
		Groundwater Inflow (m^3/day)	Inflow TDS Concentration (mg/L) [2]	Portion of Inflow from South Basin of Whale Tail Lake (%)	Pond Outflow (m^3/day)	Net Groundwater Inflow (m^3/day)[3]	TDS Concentration (mg/L) [2]	Portion of Inflow from South Basin of Whale Tail Lake (%)
Mining	August-December 2019	350	110	<1%	180	650	70	39%
	2020	120	170	<1%	860	720	30	85%
	2021	90	160	5%	1050	730	20	98%
	2022	90	140	23%	1090	720	10	99%
	2023	90	110	49%	1090	720	10	99%
	2024	90	90	74%	1090	720	10	>99%
	2025	90	70	94%	1090	720	10	>99%

Notes:

IVR Pit is located in permafrost and was therefore not modelled. Interception of runoff / direct precipitation accounted for in Site Wide Water Balance.
Predictions of groundwater inflow to North Basin of Whale Tail lake represents the discharge of groundwater to the lake basin during dewatering and mining. This excludes discharges to the pit and Whale Tail Attenuation Pond, which are within the North Basin of Whale Tail Lake.
TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources are accounted for in the Site Wide Water Quality model.
NA = not applicable; TDS = total dissolved solids; m3/day = cubic metres per day; mg/L = milligrams per litre; % = percent.

Reflooding of Pits and Underground

Table 8 and Table 9 respectively presents a summary of the predicted groundwater inflow rates and groundwater TDS concentration to the mine development areas for the EA Scenario during reflooding of the pits and underground. The predictions presented in Table 8 and Table 9 include: predicted groundwater inflow to Whale Tail Pit Lake, predicted groundwater flow to the Underground, predicted flow to and from the Whale Tail Attenuation Pond, and predicted discharge to the dewatered North Base of Whale Tail Lake (i.e., the flow of water below the Whale Tail Lake Dike to the dewatered lake bottom surface). Again, it should be noted that TDS concentrations do not account for loading from nearby lakes and the Whale Tail Attenuation Pond. TDS from these sources are taken in to account by a feedback loop in the Site Wide Water Quality model. Groundwater inflow to the IVR Pit during refilling was not included as the pit is in permafrost (groundwater inflow will be negligible).

The predictions presented for the reflooding phase utilize a conceptual filling schedule for the Whale Tail Pit and the Underground, based on initial water balance predictions. Fine tuning of the flooding sequence was conducted after the conceptual filing schedule was developed; however, these adjustments will not have a significant impact on the predicted flow rates and salinity for a given elevation range.

Similar to the Base Case, the pit walls were assumed to be frozen at the start of closure / end of mining, which restricted the inflow of groundwater to the pit lake until the pit lake rises and thaws the pit walls. Considering the assumption of freeze-back in the pit walls, groundwater inflow to the Whale Tail Pit was not predicted to occur until 2030, when the pit lake level rises above the top of permafrost elevation near the pit (approximately 40 masl). When the water elevation in the pit lake rises above the permafrost, the freeze back is assumed to dissipate below the lake level and groundwater inflow to the pit was predicted to resume. The groundwater inflow to the pit lake was predicted to increase from 20 m^3/day in 2030 to approximately 1,170 m^3/day in 2036 as the pit walls progressively become unfrozen and connected to the permeable weathered bedrock. As the pit lake rises further in elevation, the groundwater inflows decrease and eventually the pit lake switches to a groundwater recharge boundary (i.e., the pit lake starts to recharge the sub-permafrost groundwater flow system). These groundwater inflow rates are similar to predictions in the FEIS Addendum and reflect that no changes were made to the shallow bedrock hydraulic conductivity.

At the start of reflooding, a small flux of groundwater inflow is predicted to discharge to the Underground. Over time, as hydraulic gradients near the Underground dissipate, the Underground switches to a groundwater recharge boundary. At the end of the filling period (2041) the Underground remains a source of groundwater recharge to the sub-permafrost groundwater regime. These predicted inflows are similar to or lower than those predicted in the FEIS Addendum, which ranged from 50 m^3/day inflow at the start of reflooding to -25 m^3/day (positive values indicate flow to the pit/pond; negative values indicate flow to bedrock) discharge at the end of reflooding (0 to 70 % lower than the FEIS values depending on the pit lake elevation).

Table. 8 Predicted Groundwater Inflow and Groundwater Salinity during Reflooding - EA Scenario – Whale Tail Pit, Whale Tail Attenuation Pond, North Basin of Whale Tail Lake

Phase	Approximate Time Period	Water Level in Pit (masl)		Whale Tail Pit				Whale Tail Attenuation Pond				North Basin of Whale Tail Lake (within the diked area)		
		From	To	Net Groundwater Inflow/Outflow[1] (m^3/day)	Inflow TDS Concentration [2] (mg/L)	Portion of Inflow from Attenuation Pond (%)	Portion of Inflow from South Basin of Whale Tail Lake (%)	Groundwater Inflow (m^3/day)	Inflow TDS Concentration (mg/L) [2]	Portion of Inflow from South Basin of Whale Tail Lake (%)	Pond Outflow (m^3/day)	Net Groundwater Inflow/Outflow[1] (m^3/day)	TDS Concentration (mg/L) [2]	Portion of Inflow from South Basin of Whale Tail Lake (%)
Flooding	2026	-130	-76	NA	NA	NA	NA	150	35	76%	<5	345	<10	>99%
	2027	-76	-39	NA	NA	NA	NA	170	30	84%	<5	345	<10	>99%
	2028	-39	3	NA	NA	NA	NA	180	25	89%	<5	345	<10	>99%
	2029	3	26	NA	NA	NA	NA	180	25	91%	<5	345	<10	>99%
	2030	26	43	20	24	47%	41%	185	20	93%	<5	345	<10	>99%
	2031	43	61	90	24	47%	41%	170	20	96%	25	345	<10	>99%
	2032	61	73	130	19	44%	50%	160	20	97%	55	340	<10	>99%
	2033	73	87	170	15	46%	53%	150	20	98%	80	340	<10	>99%
	2034	87	101	170	13	50%	50%	145	20	98%	90	335	<10	>99%
	2035	101	111	730	<10	71%	29%	120	25	99%	530	330	<10	>99%
	2036	111	124	1170	<10	81%	19%	85	30	99%	950	300	<10	>99%
	2037	124	133	910	<10	82%	18%	90	20	99%	745	300	<10	>99%
	2038	133	142	360	<10	82%	18%	115	15	99%	315	315	<10	>99%
	2039	142	149	-30	NA	NA	NA	70	20	98%	140	370	<10	>99%
	2040	149	153.5	-10	NA	NA	NA	0	NA	NA	10	155	<10	>99%
	2041	153.5	153.5	0 to -5	NA	NA	NA	0	NA	NA	5	-10	NA	NA

Notes:
IVR Pit is located in permafrost and was therefore not modelled. Interception of runoff / direct precipitation accounted for in Site Wide Water Balance.
Positive values indicate flow to the pit/pond and negative values indicate flow to bedrock.
TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources to be accounted for in Site Wide Water Quality analysis.
NA = not applicable; TDS = total dissolved solids; m3/day = cubic metres per day; mg/L = milligrams per litre; % = percent.

Table. 9 Predicted Groundwater Inflow and Groundwater Salinity during Refilling - EA Scenario – Underground

Phase	Time Period	Water Level in Underground (masl)		Underground			
		From	To	Net Groundwater Inflow/Outflow[1] (m^3/day)	Inflow TDS Concentration[2] (mg/L)	Portion of Inflow from Attenuation Pond (%)	Portion of Inflow from South Basin of Whale Tail Lake (%)
Flooding	2026	-505	-76	10	9800	<1%	<1%
	2027	-76	-39	30	12100	<1%	<1%
	2028	-39	3	20	12700	<1%	<1%
	2029	3	26	10	13200	<1%	<1%
	2030	26	43	10	13600	<1%	<1%
	2031	43	61	5	13800	<1%	<1%
	2032	61	73	5	14000	<1%	<1%
	2033	73	87	-5	NA	<1%	<1%
	2034	87	101	-5	NA	NA	NA
	2035	101	111	-10	NA	NA	NA
	2036	111	124	-15	NA	NA	NA
	2037	124	133	-20	NA	NA	NA
	2038	133	142	-35	NA	NA	NA
	2039	142	149	-25	NA	NA	NA
	2040	149	152.5	-25	NA	NA	NA
	2041	153	152.5	-20	NA	NA	NA

Notes:

IVR Pit is located in permafrost and was therefore not modelled. Interception of runoff / direct precipitation accounted for in Site Wide Water Balance.
Positive values indicate flow to the underground and negative values indicate flow to bedrock.
TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources to be accounted for in Site Wide Water Quality analysis. NA = not applicable; TDS = total dissolved solids; m3/day = cubic metres per day; mg/L = milligrams per litre; % = percent.

2.2.3.2 Model Predictions - Fully Flooded Open Pits

The following section provides updated groundwater model predictions for the IVR Pit and Whale Tail pit following flooding of the mine development and North Basin of Whale Tail Lake. This data may be used in the future to support updated hydrodynamic modelling of the pit lakes, if required, to evaluate long-term pit lake water quality. Updated predictions are provided for the pit lakes to evaluate if the changes made to the model (estimated hydraulic conductivity of the deep sub-permafrost bedrock) affect previous predictions in the FEIS addendum.The model predictions were provided for the EA Scenario, and utilizes the same model as the dewatering, mining and reflooding phases. As discussed in the modelling report of the FEIS Addendum (Golder 2018), density- dependent transport of solutes was not considered for the assessment of groundwater conditions as the buoyancy effects were considered negligible in relation to the regional hydraulic head gradient.

Although the two pit lakes are connected following filling, the groundwater flow conditions surrounding the pit lakes are initially very different. As presented in the FEIS Addendum, the Whale Tail Pit lake is predicted by thermal analysis to be connected to the deep sub-permafrost groundwater 11 years into filling and for the permafrost below the pit lake to fully degrade over 50 years. The IVR Pit lake is predicted to be within permafrost during mining and flooding and the permafrost below the pit lake to fully degrade over 1000 years.

- **Whale Tail Pit**

Table 10 presents predicted outflow from the Whale Tail Pit lake following full reflooding of the pit. The pit lake was predicted to recharge the regional sub-permafrost groundwater system from the first year after full flooding and over the following 300 years. Over time, as the groundwater flow system near the flooded mine workings re-equilibrates and the shallow bedrock re-saturates and/or re-pressurizes, the amount of recharge to the sub-permafrost flow system decreases from 3.3 m3/day in Year 1 to 1.4 m3/day after 200 years. The long-term predicted pit lake discharge to the sub-permafrost groundwater flow system is predicted to be 1.2 m3/day, which is 20% less than the long-term pit lake discharge in the FEIS Addendum (1.5 m3/day) as a result of the slight reduction in deep bedrock hydraulic conductivity. No significant groundwater inflows to the pit lake were predicted.

Table. 10 Predicted Whale Tail Pit Lake outflow following Flooding of the Mine Development

Time (Years after Reflooding)	Pit Lake Outflow to Groundwater (m^3/day)
1	3.3
50	2.1
1 0	1
2 0	1
3 0	1

Considering the hydraulic conductivity assigned to the deep bedrock for the FEIS scenario (3 x 10-9 m/s) based on packer testing data, the approximate area of the pit (0.5 km2), and the measured pre-development downward hydraulic gradient at the Westbay Well (0.008 m/m), the calculated steady-state discharge from the pit is 1 m3/day. This value is in good agreement with the predicted value from the model after 300 years (1.2 m3/day).

- **IVR PIT**

The IVR Pit is in an area of regional permafrost; therefore, during mining and flooding, groundwater inflows to the pit were assumed to be negligible. Following flooding and the formation of the IVR Pit lake, the permafrost is expected to melt and connect the IVR Pit lake to the sub-permafrost groundwater flow system.

In consideration of the long timeline associated with the melting of the permafrost, the fully flooded analysis of the IVR Pit was limited to a prediction of the long-term steady-state groundwater flow environment that would develop near the pit lake following the full melting of permafrost below the pit footprint. Model results confirmed the assumption that the IVR Pit lake would act as recharge boundary to the regional groundwater system once the permafrost layer beneath the lake melts. The long-term predicted discharge from the IVR Pit lake to the sub- permafrost groundwater flow system was approximately 0.5 m^3/day, which is 30% lower than the predicted discharge in the FEIS Addendum (0.7 m^3/day) as result of the slight reduction in the deep bedrock hydraulic conductivity.

Because the IVR Pit Lake and Whale Pit lakes will be maintained at the same elevation and directly connected following reflooding of the pit lakes and the North Basin of Whale Tail Lake, lateral movement between the two pit lakes is expected to be negligible.

2.2.4 Additional Data Collection

Project Certificate Term and Condition No. 15 indicates the need to collect additional site-specific hydraulic data in key areas of the Project during the pre-development, construction and operational phases. Agnico Eagle has commenced with the collection and documentation of this data, and a summary of the results is presented below.

2.2.4.1 Groundwater Quality

At the time of the FEIS, a representative sample of deep groundwater had not been collected and data collected at the Meadowbank Mine was used to infer the TDS profile at the project. A Westbay well system was installed on site between March and April in 2016. The borehole was drilled to a depth of 499 m. The well was installed to monitor hydraulic heads, test hydraulic conductivity, and collect groundwater samples from multiple intervals (Golder 2016c). The groundwater samples collected from the Westbay system at depths from 276 m to 392 m indicate that the TDS content in the groundwater was between 3,198 mg/L and 4,042 mg/L. This range is slightly higher than the groundwater TDS measured at Meadowbank from shallower depths (less than 200m vertical depth).

Groundwater samples were also collected from the Westbay in November 2018, along with the measurement of vertical hydraulic gradient (Golder 2018). The 2018 program estimated groundwater quality were in the same range as previously estimated. The calculated groundwater TDS were slightly higher in 2018 which was attributed to the higher proportion of residual drilling water in the sample. The concentrations of metals and arsenic were low. Given that the arsenic concentrations are similar to the assumptions adopted in the geochemical models (low arsenic in formation groundwater), groundwater arsenic content is still not likely to have a significant effect on mine surface water quality.

Data collected from the Westbay will be used in future updates to the water quality forecast in support of the Project. At this time, it is expected that the water treatment system planned for the project can handle groundwater with the measured water quality observed in 2016 and 2018.

2.2.4.2 Hydraulic Conductivity Testing

Hydrogeological investigations were undertaken between 2015 and 2017 to characterize the hydraulic conductivity of the bedrock in the vicinity of the Whale Tail Pit. These investigations were documented in reports by Knight Piesold (2016), Golder (2016a, 2017), and SNC (2017). These investigations included the completion of 49 packer tests in unfrozen areas of bedrock (i.e., within the talik or below the regional permafrost).

Data collected from these four investigations indicated the bulk hydraulic conductivity of the bedrock ranges on the order of 1 x 10^{-5} m/s near surface (i.e., up to depths of 40 m) to approximately 1 x 10^{-9} m/s at greater depths.

As part of the FEIS, the hydraulic conductivity was estimated to be between 1 x 10^{-8} and 2 x 10^{-7} m/s. Evaluation of the refined estimates of hydraulic conductivity from the supplemental testing with respect to groundwater flows indicate that the inflow to the pit could be up to five times higher (up to 1,400 m^3/day) during mining due to the groundwater flow rates to the pit being controlled by the shallow bedrock hydraulic conductivity (connection of the pit to the south whale tail basin). This higher flow rate is within the limits of the water treatment system and water management infrastructure and adaptive management of these flows is not required at this time.

A hydrological testing program was conducted between 7 and 9 December 2018 by Golder to collect data near the underground below IVR pit (refer to appendix C). The testing was conducted in deep bedrock in the sub-permafrost zone over a depth interval of about 375 to 626 meters below the ground surface (mbgs). A total of three (3) packer test were performed. Each of the three test conducted within this interval resulted in estimated hydraulic conductivities of less than 1 x10^{-10} m/s. With addition of these tests to historical measurements of bedrock hydraulic conductivity, the hydraulic conductivity of the deep bedrock is inferred to be slightly lower than what was assumed in the previous hydrogeologic model and presented in the FEIS Addendum in 2018. With the additional measurements from December 2018, the calculated geometric average of the test data below 200 mbgs decreased from 1 x10^{-9} m/s to 8 x10^{-10} m/s. Table 11 presents a tabular summary of the bedrock hydraulic conductivity used in the EA Scenario for the FEIS Addendum compared to the bedrock hydraulic conductivity used in the updated hydrogelogical assessment.

Table. 11 Hydraulic Conductivity of the Hydrostratigraphic Units

Hydrostratigraphic Unit	Depth Interval (m)	Hydraulic Conductivity (m/s)		Hydraulic Conductivity (m/s)	
		FEIS Base Case Scenario	2019 Updated Base Case Scenario	FEIS EA Scenario	2019 Updated EA Scenario
Overburden	0 to 6	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}
Weathered bedrock	6 to 40	1×10^{-5}	1×10^{-5}	1×10^{-5}	1×10^{-5}
Competent bedrock	40 to 100	7×10^{-8}	7×10^{-8}	1×10^{-7}	1×10^{-7}
Competent bedrock	100 to 200	9×10^{-9}	9×10^{-9}	3×10^{-8}	3×10^{-8}
Competent bedrock	>200	1×10^{-9}	$\underline{\mathbf{8 \times 10^{-10}}}$	4×10^{-9}	$\underline{\mathbf{3 \times 10^{-9}}}$

Note: Parameters which have changed since the FEIS Addendum are shown in bold and underlined.

Except for the refinement of the hydraulic conductivity for the deep sub-permafrost bedrock, field data collected in 2018 is consistent with the conceptual model presented in the FEIS Addendum and no changes were made to the interpreted flow conditions. The conceptual model is presented in Appendix 6-B of the FEIS Addendum (Golder 2018).

Hydraulic head monitoring conducted in November 2018 (Westbay sampling) confirmed the downward direction of the vertical hydraulic gradient predicted by the model below Whale Tail Lake. Review of the 2D thermal analysis and 3D block model indicates that predicted closed and open taliks are consistent with the conceptual hydrogeological conditions adopted in the FEIS Addendum (closed talik in the northern portion of Whale Tail lake and open talik in the southern portion). The 3D block model was compared to the permafrost in the numerical model, and minor adjustments were made in the simulated permafrost depth along the margins of Whale Tail Lake (slightly smaller in extent).

2.2.4.3 Verification of Horizontal and Vertical Groundwater Flow Direction

Thermal data continues to be collected at the Project to verify assumptions in the permafrost conditions. Thermistors have been installed at ten locations, of which four are located to the north of the Whale Tail Pit, between Nemo Lake and Whale Tail Pit (Golder 2018b). These thermistors verify the presence of permafrost below the active layer and that the deep-sub permafrost groundwater flow system will only be connected/recharged by vertical flow through talik present below lakes of sufficient size, such as Whale Tail lake. The four thermistors between Nemo Lake and Whale Tail Pit (AMQ17-1337, AMQ17-1233, AMQ17-1277A and AMQ15-452) each indicate permafrost below the land and that horizontal flow below the active layer is restricted by permafrost in the upper 425 to 495 m of bedrock.

The vertical movement of groundwater flow through the open talik is being monitored using the Westbay Well system (AMQ16-626) to measure the vertical hydraulic gradient. This monitoring verified the direction of groundwater flow and can be used in combination with the measured bedrock hydraulic conductivity to estimate the groundwater flux near Whale Tail Pit.

The hydraulic head data collected at AMQ16-626 (Golder 2018), in November 2018 (Westbay sampling) confirmed the downward direction of the vertical hydraulic gradient predicted by the model below Whale Tail Lake. Assuming the measured hydraulic head is representative of the midpoint of the measurement interval, the downward gradient is 0.008 m/m. This gradient is consistent with the estimated gradient derived from looking at the relative elevation of Whale Tail Lake and DS1 (0.008 m/m), as reported in Agnico Eagles response to TC15 (Agnico Eagle 2018). DS1 is the predicted receptor from water in the area of Whale Tail Pit and Underground (Golder 2016c).

For the depth interval over which the hydraulic head was measured (326 to 456 mbgs), the estimated hydraulic conductivity of the bedrock for the FEIS for the Whale Tail Pit Project was 1 $x10^{-8}$ to 3 x 10^{-8} m/s (Golder 2016c). As discussed, in support of TC15 and the development of the Project, additional packer testing was conducted subsequent to the FEIS and the data indicate the hydraulic conductivity of bedrock over this depth interval is likely lower (1 x 10^{-9} m/s based on the geometric average of the test data) (Golder 2018a). Considering the measured gradient (0.008), the historical range of bedrock hydraulic conductivity adopted in the FEIS (1 $x10^{-8}$ to 3 x 10^{-8}) and the now refined hydraulic conductivity (1 x 10^{-9} m/s) and an assumed effective porosity of 0.001 (Maidment 1992; Stober and Bucher 2007), the estimated downward groundwater flow velocity is between approximately 0.25 m/yr and 8 m/yr. The lower bound of this range is considered more reasonable, as it uses the refined hydraulic conductivity data discussed above, which is based on the geometric mean of all the packer test measurements (pre- and post-FEIS).

Gradients measured during this monitoring program are considered a reasonable interpretation of what long-term gradients could be post-closure following the formation of the pit lake.

Recharge and discharge from the base of Whale Tail Lake or a flooded pit lake will be controlled by the vertical hydraulic gradients and the bedrock hydraulic conductivity near the base of the permafrost. Considering the approximate area of the Whale Tail Pit (0.5 km2), the range in bedrock hydraulic conductivity (1 x 10-9 to 3 x 10-8 m/s), and the measured downward gradient (0.008), the data would indicate long-term groundwater flux would be approximately 0.3 m3/day to 11 m3/day. Similar to the estimated groundwater velocity, the lower bound of this range is considered more reasonable, as it uses the refined estimate of hydraulic conductivity. Overall, the estimated flux is similar to the long-term predicted discharge from the pit lake at post-closure (1.7 m3/day; Golder 2016c) and supports the conclusion in the FEIS that long-term predicted flows from the pit lake to the groundwater flow system will be negligible relative to the surface water exchange into the pit lake (Golder 2018c).

3. GROUNDWATER MONITORING PLAN

Water quantity and quality monitoring data will be used to verify the predicted water quality and quantity trends and to conduct adaptive management should differing trends be observed. Monitoring will be initiated at the start of mining and continue during operations and closure.

The GWMP will be further defined as the open pit is developed and will be conducted in agreement with the WMP for the Project.

3.1 HORIZONTAL AND VERTICAL GROUNDWATER FLOW MONITORING

Thermal monitoring will continue at each of the installed thermistors to monitor the presence of permafrost below the active layer during construction and operations phases. The monitoring will continue until such time as a thermistor is destroyed by active mining.

Two thermistors, AMQ17-1233 and AMQ17-337, are located outside of the pit footprint and will be used to monitor permafrost conditions between Nemo Lake and Whale Tail Pit. The thermistor data will be used to verify the presence of permafrost and the restricted horizontal movement of groundwater below the active layer due to permafrost in the upper 425 to 495 m of bedrock.

Agnico Eagle is planning to install an additional thermistor between Nemo Lake and IVR pit prior to Q4 of 2020.

As part of the Whale Tail Dike Operation Maintenance and Surveillance manual, performance of the Whale Tail dike will be monitored with different instruments (e.g. piezometers) located in the principal horizontal groundwater flow pathway between Whale Tail South Basin and the Whale Tail pit. Piezometer readings and water level in the Whale Tail South Basin and the Attenuation Pond will be available to calibrate the hydrogeological model during operation if deemed necessary.

Vertical groundwater flow conditions in the area of Whale Tail Pit will be monitored by the Westbay Well system. Agnico Eagle will be sampling the Westbay Well system commencing in March 2019 and will continue to sample and report on an annual basis during the Construction and Operations Phases. The monitoring will include the measurement of the vertical hydraulic gradient and the collection of groundwater samples. During operations, this data will be supplemented by the direct measurement of groundwater quality in the seepage inflow to the pit. Water sampling parameters will be consistent with the sump sampling and seepage surface parameters planned for the pit. Data collected during construction and operations phases will be used to develop an appropriate monitoring for closure and will be documented in the Interim Closure and Reclamation Plan.

4. GROUNDWATER QUANTITY AND QUALITY MONITORING

4.1 WATER QUANTITY

Groundwater inflow to the open pit will be collected in sumps prior to being pumped to surface. Water collected in the sumps represents the bulk, or combined inflow to the open pit, and may include other sources of water, such as precipitation. During construction and operations, groundwater inflow to the pit will be evaluated four time per calendar year as per Water Licence 2AM-WTP1826 requirements. Management of the pumped-out water is described in the WMP.

The above flow monitoring will be supplemented by periodic seepage surveys to be conducted twice during the first year of mining and once a year thereafter. In the first year of pit development, one of the seepage surveys will be conducted in early summer, following snow melt and thawing of any ice in the pit walls, and then again in late August. In the following years of mining, one survey will be conducted in August of each year. The objective of the seepage surveys is to identify preferential groundwater flow paths in the walls of the open pit, if present, and to determine their relative contribution to the groundwater inflow to the pit with respect to water quantity and quality.

4.2 WATER QUALITY

During the operations phase, the quality of water from the sumps (either at the sump or at end of pipe at the surface) will be monitored four time per calendar year as per Water Licence 2AM-WTP1826 requirements.

Water samples will also be collected from seeps in the pit walls if there is sufficient water for analysis and if access to the seep is possible.

For each sample, field parameters will be recorded (pH, turbidity, salinity and electrical conductivity). Analytical parameters will include:

Total and Dissolved Metals: aluminium, antimony, arsenic, boron, barium, beryllium, cadmium, copper, chromium, iron, lithium, manganese, mercury, molybdenum, nickel, lead, selenium, tin, strontium, titanium, thallium, uranium, vanadium and zinc.

Nutrients: ammonia-nitrogen, total kjeldahl nitrogen, nitrate nitrogen, nitrite-nitrogen, ortho-phosphate, total phosphorous, total organic carbon, total dissolved organic carbon and reactive silica.

Conventional Parameters: bicarbonate alkalinity, chloride, carbonate alkalinity, conductivity, hardness, calcium, potassium, magnesium, sodium, sulphte, pH, total alkalinity, total dissolved solids, total suspended solids and turbidity.

Total cyanide and free cyanide. If total cyanide is detected above 0.05 mg/L at a monitoring station in receiving environment; further analysis of Weak Acid Dissociable Cyanide will be triggered.

Additional chemical analyses may be required to more completely characterize the chemical loading from the mine water. The additional analyses will be dependent on monitoring results.

5. DATA COMPILATION AND UPDATES TO GROUNDWATER MODEL

Groundwater monitoring data will be compiled into a Project-specific database and evaluated for trends in groundwater data with respect to pit and underground inflow quantity and quality.

Measured groundwater inflow rates will be compared to model predictions on an annual basis. If significant variations from model predictions are observed, the assumptions behind the data will be reviewed and the analysis updated if required. In addition, updates to the groundwater model will be made if operational changes occur as the open pit advances which could significantly alter groundwater inflow or quality.

Variations that would be considered significant and would be triggers for review of the data include:

- Groundwater inflow quantity to the mine, based on rolling monthly average of inflow over six consecutive months, is 20% higher than predicted groundwater inflow. The six-month averaging period of observation is based on observed seasonal variations in inflow quantities in mines situated in continuous permafrost regions, where half the year there is virtually no surface water component of flow to the pit.

- Collected water samples that indicate that the TDS is more than 25% higher than the estimated water quality, based on a 6-month rolling average.

- Temperature profiles observed in the sentinel thermistors (AMQ17-1233 and AMQ17-337) located between Nemo Lake and Whale Tail Lake are showing sign of permafrost degradation below the active layer.

- Observed inflow quantity and quality is lower than expected would not be of concern and/or effect water management plans on-site. Model updates or analysis would therefore not be conducted if predicted inflow quantity and quality is higher than observed conditions.

If the first three variations are triggered, the groundwater and/ or permafrost data would be assessed to evaluate trends, the potential causes of the triggers and the potential for long-term effects associated with the variation. If for example, the greater than predicted inflows were correlated to a short-term effect such as freezing in the pit walls, changes in mining rate, freshet or transient drainage of a high storage feature, then further reassessment of groundwater inflows may not be required, and the adaptive management of these short-term effects would be evaluated under the Water Management Plan (WMP). However, if the effects of these variations is found to be potentially long term, this may warrant review of the model and/or permafrost calibration and predictions.

Table 12 presents the adaptive management plan with respect to groundwater monitoring. The design of the water management infrastructure includes contingencies in case of unplanned events. The Whale Tail attenuation pond can handle higher groundwater inflows and the Operation Water Treatment Plan (O-WTP) is designed to handle total flow rates 60% higher than planned (including surface and groundwater inflows reporting to the Attenuation Pond). O-WTP has the capacity to treat more than a five times increase in groundwater inflows from the one predicted during operation. Moreover, if the inflows are greater than this then there is the capacity to store water within the pit and adjust the mining plan to deal with extra inflows. In any case, all contact water will be managed within the pit area.

The groundwater management strategies: the ponds, sumps and water conveyance strategies around the pit can be modified to mitigate the effect of additional groundwater volume or salinity prior to treatment and discharge. The water conveyance strategy will be evaluated and optimized during operations and closure to maintain post-closure commitments. Other engineering solutions such as depressurization wells, grouting and thermosiphons may be considered, if warranted.

If one of the thresholds in Table 12 is triggered and it is found to be a potentially long-term effect, then hydrogeological and thermal analyses will be required to define the best solution to address the exceedance. Agnico Eagle considers that adaptive management must be based on well informed decisions and may include re-calibration of the thermal and hydrogeological models, predictions based on these re-calibrations, and revised Site-Wide water balance and Site-Wide water quality forecasts.

Table. 12. Groundwater Adaptive Management Plan

Threshold	Consequence	Likelihood	Adaptive Management
Groundwater inflows to the mine, based on rolling monthly average of inflow over six consecutive months, is 20% higher than predicted groundwater inflow	• Higher water volume to treat during operation • Potential to compromise storage capacity of the attenuation pond • Impact on mining sequence	Low	O-WTP have 60% contingency to manage higher inflow to attenuation pond (forecasted peak operation flow in the water balance is 1,300m^3/h during 12h a day vs treatment capacity of 1,800 m^3/h during 24h per day); O-WTP have the capacity to treat more than five times increase in groundwater inflows from the one predicted during operation; Attenuation pond has 50% contingency to manage higher groundwater inflow; Assess situation by performing additional inspection, monitoring and field investigation; Review hydrogeological model, Site-wide water balance and Site-wide water quality forecast with updated data; Review water management strategy (e.g. temporary storing water in the pit); Evaluate potential long-term mitigations (e.g., grouting); Review water management strategy.
Collected groundwater samples that indicate that the TDS is more than 25% higher than the estimated groundwater quality, Based on rolling monthly average over 6 consecutive months	• Higher TDS water quality to treat during operation • Compromise storage capacity of the attenuation pond • Potential to reduce water treatment efficiency and management plan if not meeting Metal and Diamond Mining Effluent Regulations • Impact on mining sequence	Low	O-WTP have 60% contingency to manage higher inflow to attenuation (forecasted peak operation flow in the water balance is 1,300m3/h during 12h a day vs treatment capacity of 1,800m3/h during 24h per day); O-WTP have the capacity to treat more than five times increase in groundwater inflows from the one predicted during operation; Flow to the pit is dominated by seepage loss from the Attenuation Pond and seepage from the South Basin of Whale Tail Lake. As the groundwater inflow to the pit is representing a small ratio of the overall water inflows in the attenuation pond, water treatment efficiency should not be impacted significantly by uncertainty in the groundwater TDS; Assess situation by performing additional inspection, monitoring and field investigation; Review hydrogeological model, Site-wide water balance and site-wide water quality forecast with updated data; Evaluate additional treatment and storage

			capacity required to manage flow in operation (e.g. storing water in the pit); Evaluate potential long term mitigations (e.g. grouting, thermosiphon); Review water management strategy.
Temperature profile observed in the sentinel thermistors (AMQ17-1233 and AMQ17-337) located between Nemo Lake and Whale Tail Lake are showing sign of permafrost degradation below the active layer.	• Horizontal groundwater flow observed between Whale Tail Pit north wall and Nemo Lake. • Potential for groundwater seepage to pit sump/pit lake. • Increased water treatment requirement.	Unlikely	Assess situation by performing additional inspection, monitoring and field investigation; Review thermal model, hydrogeological model, Site-wide water balance and site-wide water quality forecast with updated data; Install new thermistor(s) to evaluate the extent of the permafrost degradation; Evaluate additional treatment and storage capacity required to manage flow in operation (e.g. storing water in the pit); Evaluate potential long-term mitigations as depressurization wells, grouting, thermosiphon Review water management strategy.

6. QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

Quality Assurance (QA) refers to plans or programs that encompass a wide range of internal and external management and technical practices designed to ensure the collection of data of known quality that matches the intended use of the data. Quality Control (QC) is a specific aspect of QA that refers to the internal techniques used to measure and assess data quality. Specific QA and QC procedures that will be followed during sampling performed for the GWMP are described in Section 4.1 and 4.2.

6.1 QUALITY ASSURANCE

Quality assurance protocols will be diligently followed so data are of known, acceptable, and defensible quality. There are three areas of internal and external management, which are outlined in more detail below.

6.1.1 Field Staff Training and Operations

To make certain that field data collected are of known, acceptable, and defensible quality, field staff will be trained to be proficient in standardized field groundwater sampling procedures, data recording, and equipment operations applicable to the GWMP. All field work will be completed according to specified instructions and established technical procedures for standard sample collection, preservation, handling, storage and shipping protocols.

6.1.2 Laboratory

To make sure that high quality data are generated, accredited laboratories that will be selected for sample analysis. Accreditation programs are utilised by the laboratories so that performance evaluation assessments are conducted routinely for laboratory procedures, methods, and internal quality control.

6.1.3 Office Operations

A data management system will be utilized so that an organized consistent system of data control, data analysis, and filing will be applied to the GWMP. Relevant elements will include, but are not limited to the following:

- all required samples are collected;
- chain-of-custody and analytical request forms are completed and correct;
- proper labelling and documentation procedures are followed, and samples will be delivered to the appropriate locations in a timely manner;
- laboratory data will be promptly reviewed once they are received to validate data quality;
- sample data entered into a Mine-specific groundwater quality database will be compared to final laboratory reports to confirm data accuracy; and
- appropriate logic checks will be completed to ensure the accuracy of the calculations.

6.2 QUALITY CONTROL

The QC component will consist of applicable field and sample handling procedures, and the preparation and submission of two types of QC samples to the various laboratories involved in the program. The QC samples include blanks (e.g., travel, field, equipment) and duplicate/split samples.

Sample bottle preparation, field measurement and sampling handling QC procedures include the following:

- Sample bottles will be kept in a clean environment, capped at all times, and stored in clean shipping containers. Samplers will keep their hands clean, wear gloves, and refrain from eating or smoking while sampling.
- Where sampling equipment must be reused at multiple sampling locations, sampling equipment will be cleaned appropriately between locations.
- Temperature, pH, and specific conductivity will be measured in the field using hand held meters (e.g., YSI water quality sondes).
- Samples will be cooled to between 4°C and 10˚C as soon as possible after collection. Care will be taken when packaging samples for transport to the laboratory to maintain the appropriate temperature (between 4°C and 10˚C) and minimize the possibility of rupture. Where appropriate, samples will be treated with preservatives to minimize physical, chemical, biological processes that may alter the chemistry of the sample between sample collection and analysis.
- Samples will be shipped to the laboratory as soon as reasonably possible to minimize sample hold times. If for any reason, samples do not reach the laboratory within the maximum sample hold time for individual parameters, the results of the specific parameters will be qualified, or the samples will not be analysed for the specific parameters.
- Chain of custody sample submission forms will be completed by field sampling staff and will be submitted with the samples to the laboratory.
- Only staff with the appropriate training in the applicable sampling techniques will conduct water sampling.

Quality control procedures implemented will consist of the preparation and submission of QA/QC samples, such as field blanks, trip blanks, and split/duplicate water samples. These are defined as follows:

- Field Blank: A sample will be prepared in the field using laboratory-provided deionized water to fill a set of sample containers, which will then be submitted to the laboratory for the same analysis as the field water samples. Field blanks will be used to detect potential sample contamination during collection, shipping and analysis.
- Travel Blank: A sample will be prepared and preserved at the analytical laboratory prior to the sampling trip using laboratory-provided deionized water. The sample will remain unopened throughout the duration of the sampling trip. Travel blanks will be used to detect potential sample contamination during transport and storage.
- Duplicate Sample: Two samples will be collected from a sampling location using identical sampling procedures. They will be labelled, preserved individually and submitted for identical

analyses. Duplicate samples will be used to assess variability in water quality at the sampling site. Duplicate will be collected and submitted for analyses at approximately, 10% of sampling locations. For smaller batches of samples (less than 10), at least one duplicate will be collected and submitted for analysis.

Additional QA/QC procedures that will be applied to the seepage survey component of the GWMP will include:

- Location – Universal Transverse Mercator (UTM) coordinates of seepage will be defined through the use of a hand-held Global Positioning System (GPS) unit and will be recorded in the field log book with a photograph of each pit wall.
- Sample Labels – appropriate sample nomenclature will be assigned to the sample labels that will define sample locations, sample type, year, and designation. These labels will distinguish between samples collected from seeps versus samples collected from sumps.

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APPENDIX A – UPDATED HYDROGEOLOGICAL ASSESSMENT, WHALE TAIL PIT, EXPANSION PROJECT

TECHNICAL MEMORANDUM

DATE 6 May 2019

Project No. 18108905-291-TM-Rev0

TO Michel Groleau
Agnico Eagle Mines Limited - Meadowbank Division

CC Jennifer Range

FROM Jennifer Levenick, Don Chorley

EMAIL jlevenick@golder.com

UPDATED HYDROGEOLOGICAL ASSESSMENT, WHALE TAIL PIT, EXPANSION PROJECT

1.0 INTRODUCTION

Agnico Eagle Mines Limited: Meadowbank Division (Agnico Eagle) is proposing to develop the Whale Tail Pit, IVR Pit and Underground operations on the Amaruq property (Expansion Project), in continuation of mine operations and milling of the Meadowbank Mine. The Approved Project supports mining ore from one open pit, the Whale Tail Pit, processed over a three to four-year mine life. The Expansion Project proposes mining additional ore from the expanded Whale Tail Pit, the IVR Pit, and Underground operations.

This report presents the results of updated hydrogeological modelling completed for the Expansion Project since submission of the FEIS addendum in December 2018. The model was updated based on results of monitoring at the Westbay system in November 2018, supplemental packer testing in December 2018, and additional thermal analysis in 2019. The updated hydrogeological model was then used to provide revised predictions of groundwater inflow and total dissolved solids (TDS) concentrations during dewatering, mining, pit and underground flooding, and long-term post-closure (reflooded) conditions.

The technical memorandum is organized as follows:

- Section 2.0 provides a summary of hydrogeological data and thermal modelling results available since last hydrogeological assessment completed for the Expansion Project (Golder 2018).
- Section 3.0 and 4.0 provides a description of the changes made to the conceptual and numerical model based on the additional data collected.
- Section 5.0 provides a summary of the updated groundwater model predictions during dewatering, mining and filling phases of the Expansion Project.
- Section 6.0 provides a summary of the updated groundwater model predictions after the pits are fully flooded.

2.0 DATA REVIEW

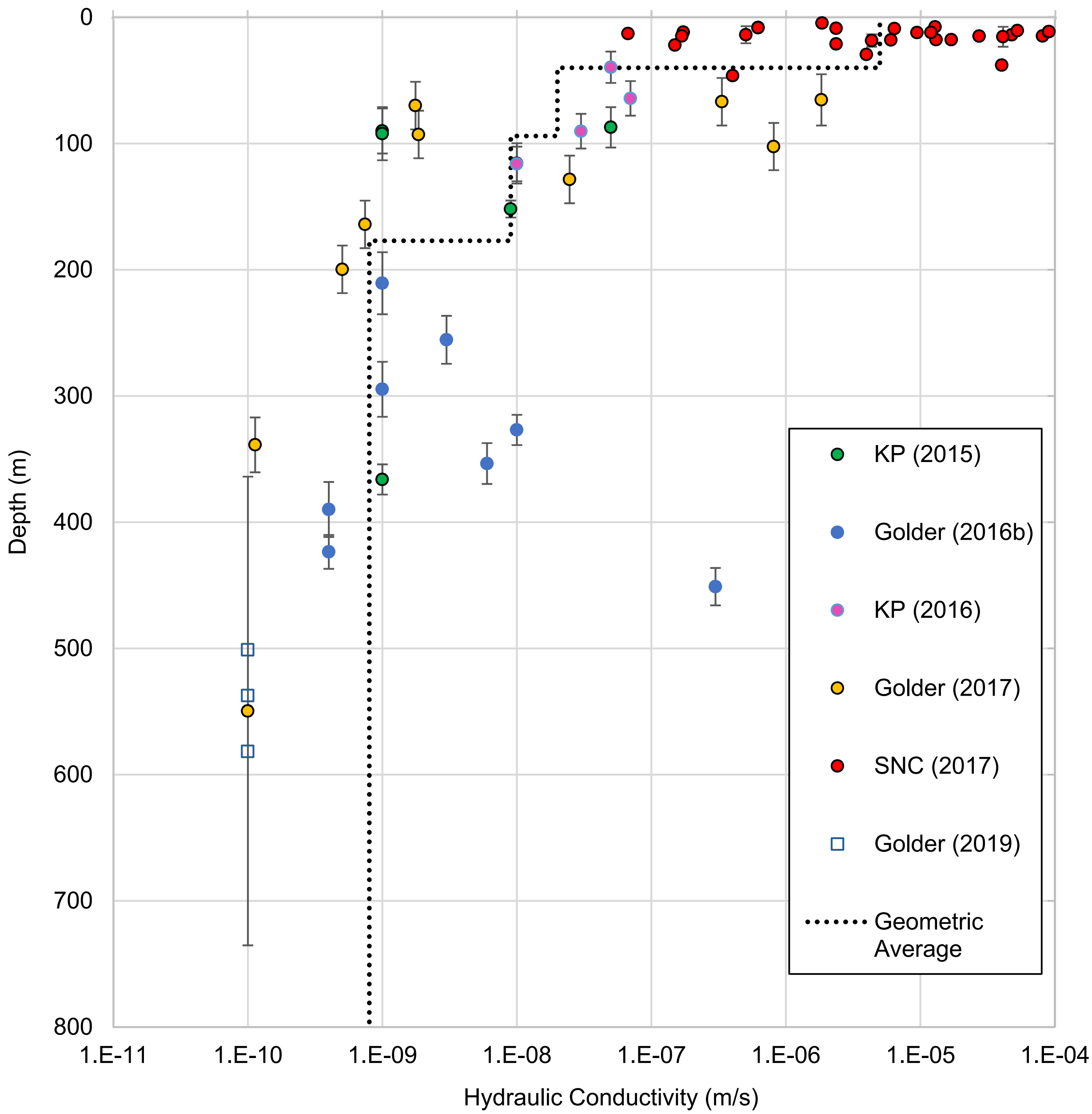
Since the completion of the FEIS hydrogeological assessment for the Expansion Project (Golder 2018), investigations have been carried out to collect additional site-specific data, as requested in the Project Certificate No. 008, Term and Condition No. 15 for the Approved Project. A summary of the results of these investigations is presented below.

2.1 Hydrogeological Testing

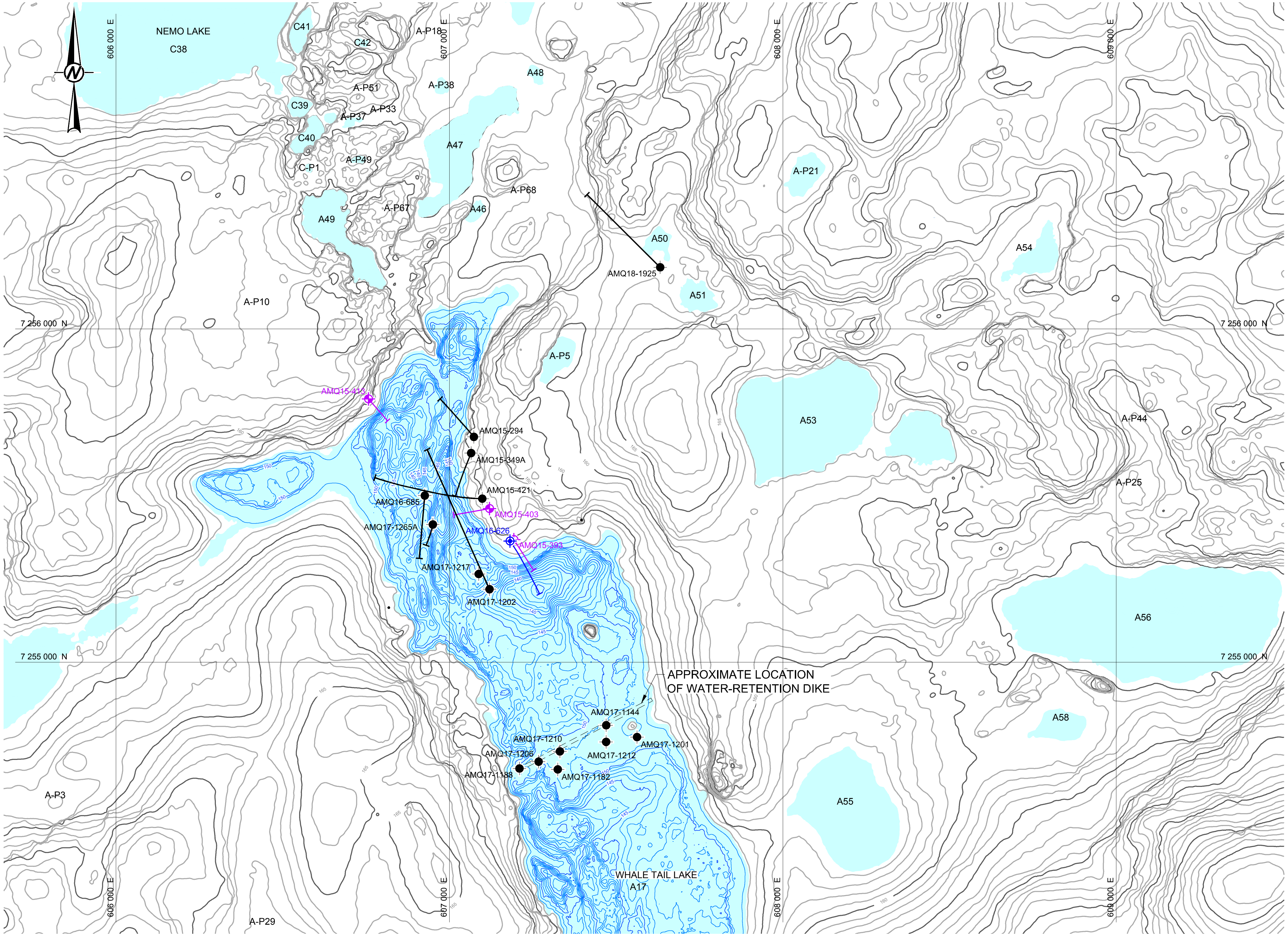
A hydrogeological testing program was conducted between 7 and 9 of December 2018 (Golder 2019b) to collect data near the underground below IVR pit. The testing was conducted in deep bedrock in the sub-permafrost zone over a depth interval of about 375 to 626 metres below ground surface (mbgs). Each of the three tests conducted within this interval resulted in estimated hydraulic conductivities of less than 1 x 10^{-10} m/s (due to limitations of the testing equipment, hydraulic conductivities of less than 1 x 10^{-10} m/s could not be quantified).

With the addition of these tests to historical measurements of bedrock hydraulic conductivity (Figure 1), the hydraulic conductivity of the deep bedrock is inferred to be slightly lower than what was assumed in the previous hydrogeologic modelling. These packer test data also provide a higher level of confidence that the one high value of hydraulic conductivity over a 30 m zone from a depth of about 436 m to 466 m in deep bedrock that was measured during the drilling of the borehole for the Westbay multi-level well is likely an isolated zone of jointing near the test interval and is not a large-scale enhanced permeability zone.

Figure 1 presents an updated summary of the hydraulic conductivity measurements completed for the area of the two pits and Underground, including the 2018 measurements and historical data. Figure 2 presents the location of the borehole locations tested. With the additional measurements from December 2018, the calculated geometric average of the test data below 200 mbgs decreased from 1 x 10^{-9} m/s to 8 x 10^{-10} m/s.



CLIENT AGNICO EAGLE MINES LIMITED		PROJECT AMARUQ PROPERTY – EXPANSION PROJECT	
CONSULTANT GOLDER	YYYY-MM-DD	2019-05-01	TITLE **SUMMARY OF HYDRAULIC CONDUCTIVITY TEST RESULTS**
	PREPARED	JL	
	DESIGN	JL	
	REVIEW	DC	PROJECT No. **18108905** — Rev. **0** — FIGURE **1**
	APPROVED	JL	



LEGEND

- EXISTING GROUND SURVEY
- EXISTING BATHYMETRY
- WATER BODY
- WESTBAY SYSTEM
- BOREHOLE
- MONITORING WELL

NOTE(S)

1. ALL UNITS ARE IN METERS UNLESS NOTED OTHERWISE.
2. CONTOUR INTERVAL 1m MINOR AND 5m MAJOR.

REFERENCE

BASE PLAN AND BATHYMETRY DATA RECEIVED FROM AGNICO EAGLE MINES LTD. DATE RECEIVED NOVEMBER 25, 2016.
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CAD FILE: 1665858-2100B-CM-0002.DWG
CAD FILE: 61-000-142-001_R0BLOC.DWG

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CLIENT	AGNICO EAGLE MINES LIMITED	PROJECT	AMARUQ PROJECT PROPERTY - EXPANSION PROJECT
CONSULTANT	YYYY-MM-DD 2019-02-12	TITLE	**LOCATION OF PACKER TEST BOREHOLES AND INSTALLED MONITORING WELLS**
	DESIGNED CM		
	PREPARED MSH/JEM		
	REVIEWED JL	PROJECT NO. 18108905	CONTROL 291
	APPROVED DH	REV. 0	FIGURE 2

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2.2 Permafrost Assessment

Golder was recently retained to carry out an updated thermal assessment for the Project to:

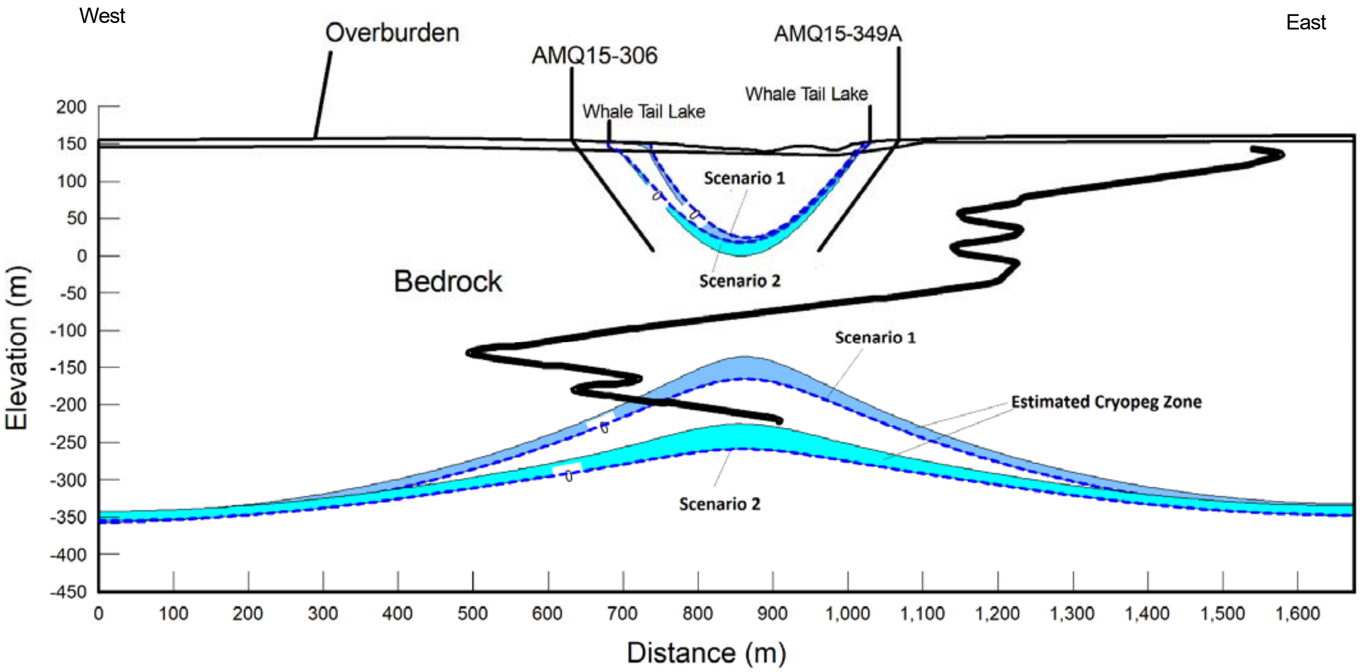
- Evaluate existing permafrost characteristics in the Whale Tail Lake and Project area.
- Evaluate existing talik conditions under the Whale Tail Lake adjacent to the Project site.

The results of this work are documented in Golder (2019c). The report presents a review and summary of estimated permafrost condition based on available thermistor data to date, as well as the results of a thermal modelling exercise prepared to assess permafrost conditions and the extent of talik formations beneath the Whale Tail Lake. Results from the thermal modelling were used to develop a 3D representation of the permafrost in the Whale Tail Lake area.

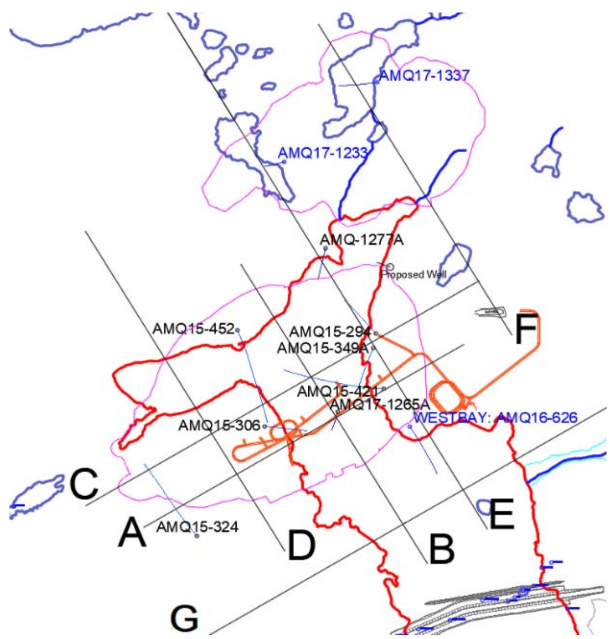
Based on the thermal modelling and the available thermistor data, the permafrost characteristics in the Project area are summarized below:

- The depth of permafrost outside of the influence of lakes is estimated to be between 452 m and 522 m based on thermal gradients and ground temperatures at the lowest portions of the thermistor strings. The depth of permafrost increases with increasing distance from lakes with talik.
- Considering the 2D thermal modelling and 3D block model, the assessment indicated that:
  - Under the northern portion of the lake below Whale Tail Pit, there is likely a closed talik formation (Section C of the thermal modelling report, reproduced on Figure 3 of this report).
  - Open talik conditions are probable in the southern portion of the lake where the Whale Tail Lake becomes wider (Section G of the thermal modelling report, reproduced on Figure 4 of this report).
  - Permafrost depth is between 480 m and 550 m for ground away from the Whale Tail Lake, and between 350 m and 450 m below surface in portions beneath the Whale Tail Lake where a closed talik is present.
  - The cryopeg thickness is likely between 20 m to 30 m.

Review of the 2D thermal analysis and 3D block model indicates that the predicted closed and open talik is consistent with the conceptual hydrogeological conditions adopted in the FEIS Addendum.



Zero Temperature Isoline



From Golder 2019.

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CONSULTANT

GOLDER

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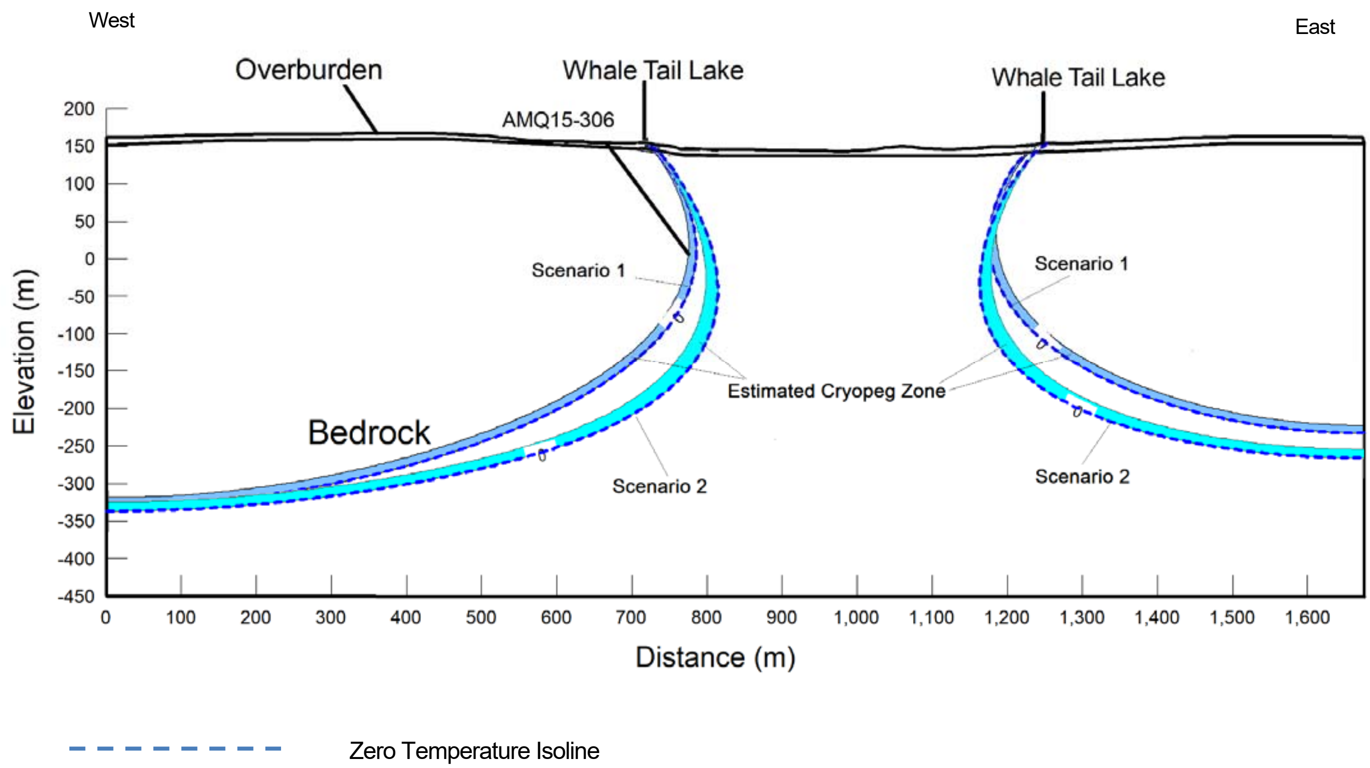
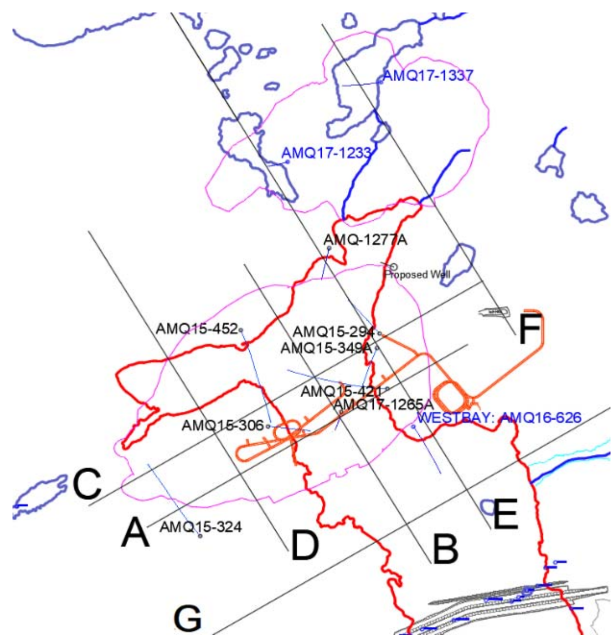
PREPARED	JL
DESIGN	JL
REVIEW	DC
APPROVED	JL

TITLE
THERMAL MODEL CALIBRATION RESULTS – SECTION C

PROJECT No.	Rev.	FIGURE
18108905	**0**	**3**





From Golder 2019.

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GOLDER

YYYY-MM-DD	2019-05-01
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DESIGN	JL
REVIEW	DC
APPROVED	JL

TITLE
THERMAL MODEL CALIBRATION RESULTS – SECTION G

PROJECT No.	Rev.	FIGURE
18108905	**0**	**4**

2.3 Westbay Sampling and Hydraulic Head Measurements

Groundwater sampling and hydraulic head measurements of the Westbay multi-level system was undertaken in November 2018 (Golder 2019a) and are described below. The 2018 sampling data supplements previous data collected from the Westbay multi-level system in 2016.

Groundwater samples were collected from ports 2, 3, 4, and 6 of the Westbay multi-level well in November 2018. During drilling and installation of the Westbay, the drilling fluid was tagged with fluorescein. During collection of the water samples, the fluorescein concentration was measured to estimate the proportion of the sample that could be attributed to drilling fluid.

Groundwater quality of each water sample was estimated using a mass balance calculation to remove the proportion of residual drill fluid from the collected samples. The 2018 program estimated groundwater quality at Ports 6, 4, and 3 are in the same range as previously estimated. The calculated groundwater TDS were slightly higher in 2018 relative to 2016. The variation is attributed to the higher proportion of residual drilling water in the sample, which produces greater uncertainty in the TDS of the formation water. Therefore, the 2018 values are not considered to represent an actual increase in groundwater TDS and the assumptions for the FEIS Addendum conceptual model, which are based on the more reliable and applicable 2016 data, are still considered to be appropriate.

The concentrations of metals and arsenic were low. The maximum calculated arsenic concentration remains similar to what was calculated for Port 6 in 2016. Given that the arsenic concentrations are similar to assumptions adopted in the geochemical models for the FEIS (low arsenic in Formation groundwater), groundwater arsenic content is still not likely to have a significant effect on mine surface water quality.

Hydraulic heads measurements were recorded at the sampling ports prior to any sampling or development. The measurements indicate a downward hydraulic gradient was present (magnitude of 0.008 m/m), which is consistent with the conceptual understanding of pre-development groundwater flow directions and predicted conditions post-closure following the formation of the Whale Tail Pit Lake (Golder 2018). Gradients measured pre-development are considered a reasonable interpretation of what long-term gradients could be post-closure following the formation of the pit lake.

Considering the approximate area of Whale Tail Pit (0.5 km^2), the updated geometric average of the deep sub-permafrost bedrock (8×10^{-10} m/s), and the measured downward gradient (0.008 m/m), the data would indicate long term groundwater flux from the pit lake would be approximately 0.3 m^3/day. This value is lower than discharge measurements predicted in the FEIS addendum for the Environmental Assessment (EA) Scenario of 1.5 m^3/day (Golder 2018).

3.0 CONCEPTUAL MODEL AND REFINEMENT OF BEDROCK HYDRAULIC CONDUCTIVITY

Except for the refinement of the hydraulic conductivity for the deep sub-permafrost bedrock, field data collected in 2018 is consistent with the conceptual model presented in the FEIS Addendum and no changes were made to the interpreted flow conditions. The conceptual model is presented in Appendix 6-B of the FEIS Addendum (Golder 2018).

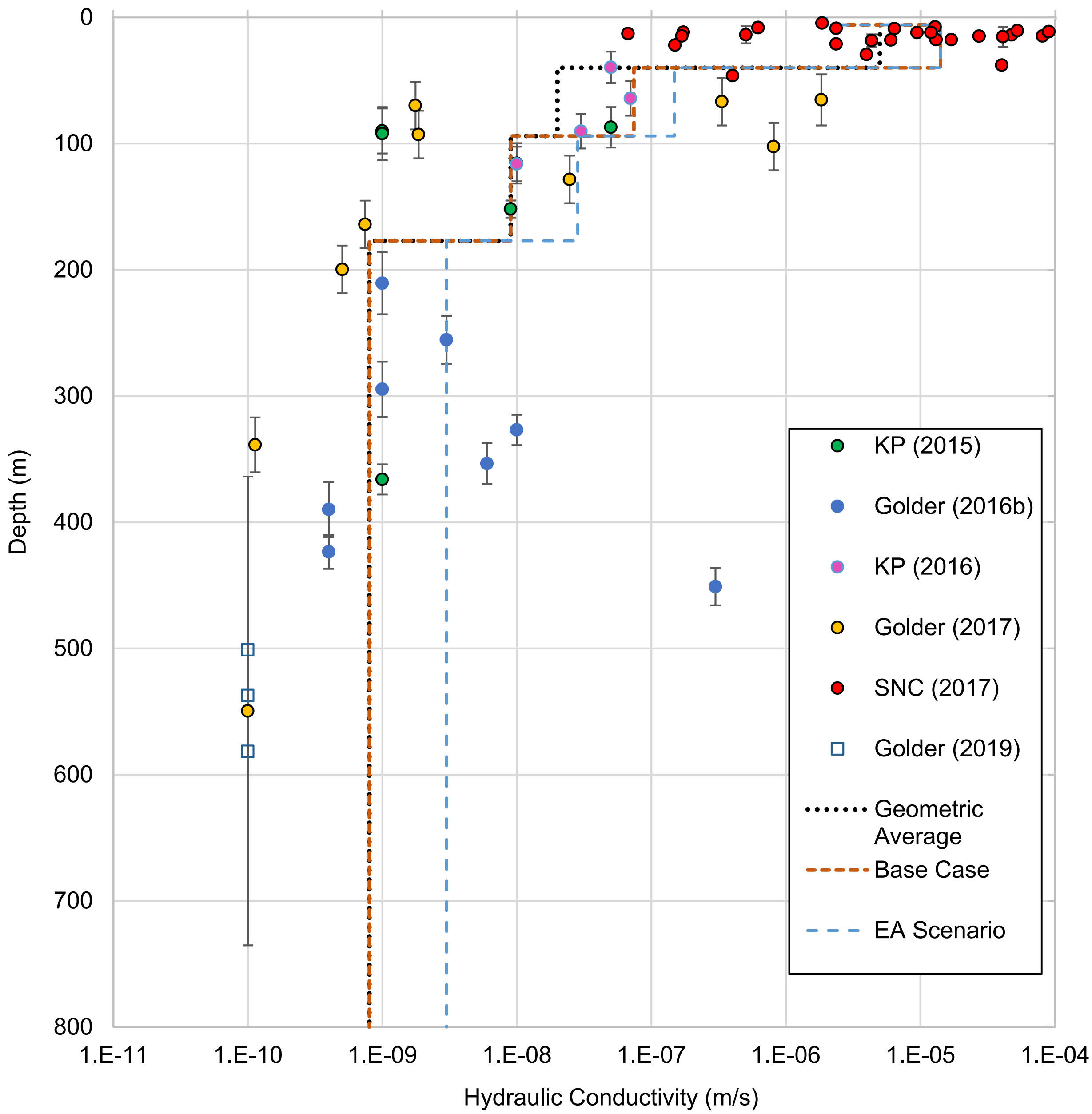
Hydraulic head monitoring conducted in November 2018 confirmed the downward direction of the vertical hydraulic gradient predicted by the model below Whale Tail Lake. Review of the 2D thermal analysis and 3D block model indicates that predicted closed and open taliks are consistent with the conceptual hydrogeological conditions adopted in the FEIS Addendum (closed talik in the northern portion of Whale Tail lake and open talik in the southern portion). The 3D block model was compared to the permafrost in the numerical model, and minor adjustments were made in the simulated permafrost depth along the margins of Whale Tail Lake (slightly smaller in extent).

Considering the packer test results, the hydraulic conductivity of the deep sub-permafrost bedrock was lowered from what was used in the FEIS addendum. For the Base Case, the hydraulic conductivity was decreased from 1 x 10^{-9} m/s to 8 x 10^{-10} m/s, which is equivalent to the geometric average of the test values. For the EA Scenario, the hydraulic conductivity was decreased from 4 x 10^{-9} m/s to 3 x 10^{-9} m/s, which is approximately 3 times higher than the geometric average of the data values. As described in the FEIS modelling report (Golder 2018), the Base Case Scenario represents reasonable estimates of hydraulic conductivity based on measured data; whereas, the EA Scenario incorporates conservatively higher estimates of hydraulic conductivity. Figure 5 presents the updated hydraulic conductivity profile for the bedrock that was assigned in this assessment of groundwater inflows and quality for the EA and Base Case Scenarios. Table 1 presents a tabular summary of the bedrock hydraulic conductivity used in the EA Scenario for the FEIS Addendum compared to the bedrock hydraulic conductivity used in this updated assessment.

Table 1: Hydraulic Conductivity of the Hydrostratigraphic Units

Hydrostratigraphic Unit	Depth Interval (m)	Hydraulic Conductivity (m/s)		Hydraulic Conductivity (m/s)	
		FEIS Base Case Scenario	2019 Updated Base Case Scenario	FEIS EA Scenario	2019 Updated EA Scenario
Overburden	0 to 6	2×10^{-6}	2×10^{-6}	2×10^{-6}	2×10^{-6}
Weathered bedrock	6 to 40	1×10^{-5}	1×10^{-5}	1×10^{-5}	1×10^{-5}
Competent bedrock	40 to 100	7×10^{-8}	7×10^{-8}	1×10^{-7}	1×10^{-7}
Competent bedrock	100 to 200	9×10^{-9}	9×10^{-9}	3×10^{-8}	3×10^{-8}
Competent bedrock	>200	1×10^{-9}	**$\underline{8 \times 10^{-10}}$**	4×10^{-9}	**$\underline{3 \times 10^{-9}}$**

Note: Parameters which have changed since the FEIS Addendum are shown in bold and underlined.



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REVIEW	DC
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TITLE
UPDATED HYDRAULIC CONDUCTIVITY VALUES – BASE CASE AND EA SCENARIO

PROJECT No. **18108905**
Rev. **0**
FIGURE **5**

4.0 3D NUMERICAL HYDROGEOLOGICAL MODEL

To complete the updated hydrogeological assessment for the Expansion Project, the numerical hydrogeological model developed for the Expansion Project in FEFLOW was updated to incorporate the minor changes in hydraulic conductivity at depth and permafrost extent identified in Sections 2.0 and 3.0:

- The 3D block model was compared to the permafrost in the numerical model, and minor adjustments were made in the permafrost depth along the margins of Whale Tail Lake. Overall, changes to the permafrost extent were minor and did not conceptually alter the interpretation of where open and closed talik were present in Whale Tail Lake.
- The hydraulic conductivity of the competent bedrock below a depth of 200 m was decreased based on the updated packer test data collected in December 2018 (Table 1).

Except for the above two changes, no other modifications were made to the numerical model prior to predicting updated groundwater inflow quantity and quality for the Base Case and EA Scenarios. The development and construction of the numerical model is presented in Appendix 6-B of the FEIS Addendum (Golder 2018).

5.0 UPDATED MODEL PREDICTIONS – PRE-DEVELOPMENT, DEWATERING, MINING AND FILLING PHASES

The following section of the report provides updated predictions for dewatering of Whale Tail Lake and the mining and reflooding of the pits and underground for the Expansion Project. As discussed in Section 4.0, this model incorporates a reduction in deep bedrock hydraulic conductivity based on additional packer testing in December 2018, and the results of the thermal modelling, which overall support the permafrost interpretation in the FEIS Addendum. Minor adjustments were made in the permafrost depth along the margins of Whale Tail Lake but overall, changes to the permafrost extent were minor and did not conceptually alter the interpretation of where open and closed talik were present in Whale Tail Lake.

Updated predictions of groundwater inflow (quantity and TDS quality[1]) are provided for the Base Case and EA Scenario. The Base Case Scenario represents the best estimate of groundwater inflow and groundwater TDS based on the measured data. The EA Scenario is designed to be a reasonable, yet more conservative, assessment of potential groundwater inflow quantity and TDS quality than values that might be adopted for mine operation planning (i.e., Base Case Scenario). Results from the more conservative EA Scenario are used in the Updated Site-Wide Water Balance and Water Quality model.

[1] Consistent with previous modelling in the FEIS Addendum, TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources accounted for in Site Wide Water Quality analysis.

5.1 Base Case Scenario

5.1.1 Dewatering

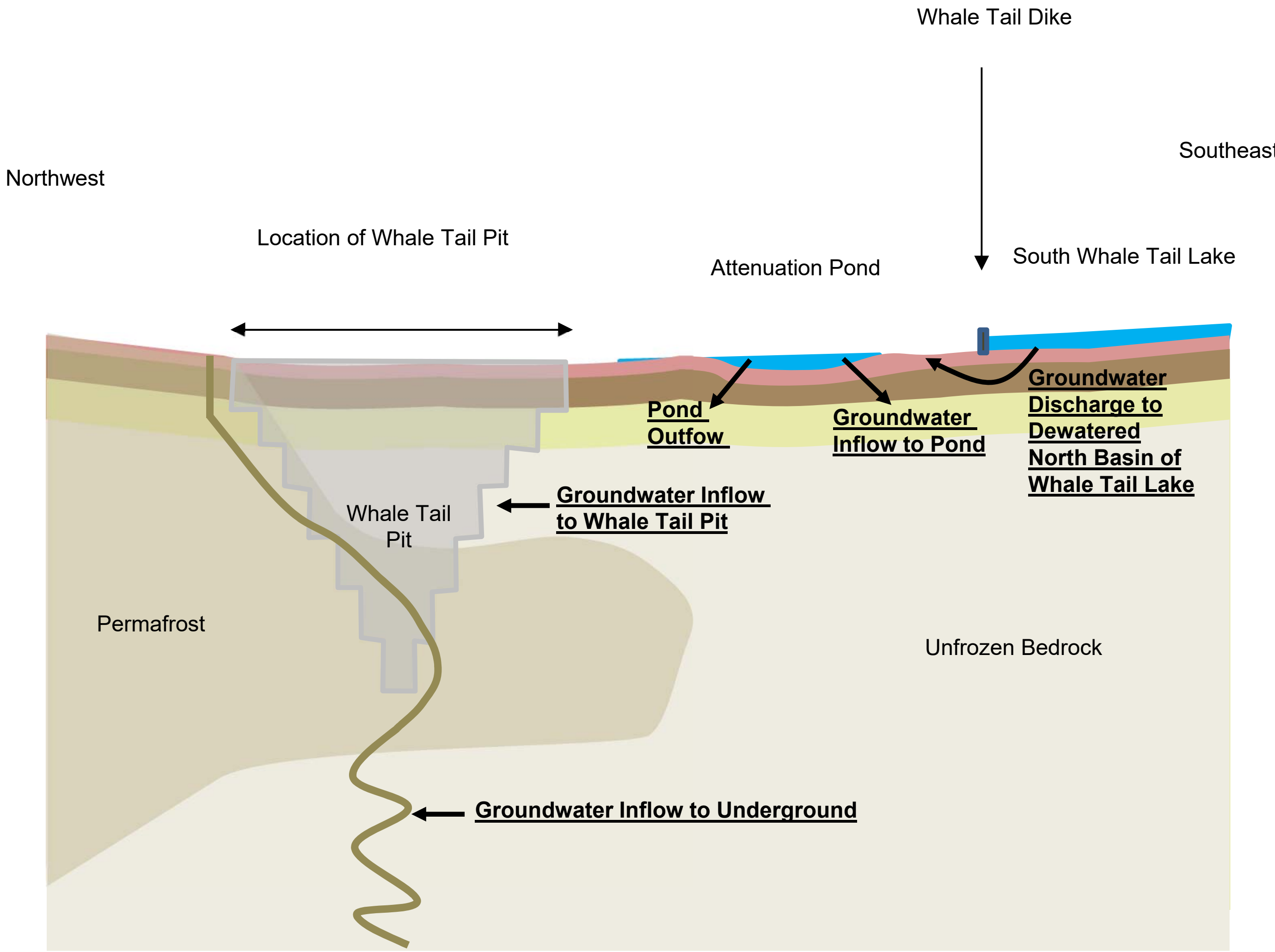
Table 2 presents a summary of the predicted discharge to the North Basin of Whale Tail lake during dewatering. The predicted discharge of 1320 m^3/day is within 20 m^3/day of the FEIS predictions (1340 m^3/day) and no change in TDS concentration was predicted. The minor variation in predicted discharge from the FEIS reflects the small adjustments made to permafrost extent along the margins of Whale Tail Lake.

Table 2: Predicted Groundwater Discharge to North Basin of Whale Tail Lake during Dewatering – Base Case Scenario

Phase	Base Case Scenario	
	Groundwater Discharge (m^3/day)	TDS Concentration (mg/L)
Lake Dewatering (Q1-Q3 2019)	1320	80

5.1.2 Mining

Table 3 presents a summary of the updated predicted groundwater flow rates and groundwater TDS concentrations to the mine development areas for the Base Case Scenario during mining of the open pits and underground. The predictions presented on these tables are conceptually shown on Figure 6 and include: predicted groundwater inflow to Whale Tail Pit, predicted groundwater inflow to the Underground, predicted flow to and from the Whale Tail Attenuation Pond, and predicted discharge to the dewatered North Base of Whale Tail Lake (i.e., the flow of water below the Whale Tail Lake Dike to the dewatered lake bottom). Groundwater inflow to the IVR Pit during mining is not included as the pit is in permafrost (groundwater inflow will be negligible). Some interception of surface water runoff and direct precipitation by the IVR Pit is excepted, but this is not a flow component derived from the groundwater modelling. It is addressed in the Updated Site-Wide Water Balance and Water Quality Model (Golder 2019d).



Legend

- Flow Component with predictions of Water Quantity and TDS Water Quality
- Waterbody
- Permafrost
- Overburden (0 to 6 m below ground surface)
- Weathered Bedrock (6 to 40 m below ground surface)
- Competent Bedrock (40 to 100 m below ground surface)
- Competent Bedrock (>100 m below ground surface)

NOTES:
Conceptual Only. Not to Scale.

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PREPARED	JL
DESIGN	JL
REVIEW	DC
APPROVED	JL

TITLE
CONCEPTUAL SCHEMATIC SHOWING LOCATION OF FLOW COMPONENTS WITH PREDICTIONS OF GROUNDWATER INFLOW

PROJECT No. **18108905** Rev. **0** FIGURE **6**

Table 3: Predicted Groundwater Inflow and Groundwater Quality during Mining – Base Case Scenario – Whale Tail Pit and Underground

Phase	Time Period	Whale Tail Pit		Underground		Whale Tail Attenuation Pond			North Basin of Whale Tail Lake (within the diked area) [3]	
		Groundwater Inflow (m^3/day)	TDS Concentration[2] (mg/L)	Groundwater Inflow (m^3/day)	TDS Concentration[2] (mg/L)	Groundwater Inflow (m^3/day)	Inflow TDS Concentration (mg/L)	Surface Water Outflow (m^3/day)	Groundwater Discharge to Surface (m^3/day)	Inflow TDS Concentration (mg/L)
Mining	August-December 2019[1]	970	120	NA	NA	350	110	180	650	70
	2020	1160	50	20	3880	120	170	860	720	30
	2021	1310	20	30	4080	90	150	1040	730	20
	2022	1340	20	110	5630	90	130	1080	720	10
	2023	1340	10	180	6890	90	110	1080	720	10
	2024	1340	10	170	7430	90	80	1080	720	10
	2025	1340	10	130	7760	90	40	1080	720	10

Notes:
Pictorial representation of Flow Locations Components shown on Figure 6.
IVR Pit is located in permafrost and was therefore not modelled. Interception of runoff / direct precipitation accounted for in Site Wide Water Balance.
[1] Mining prior to Q4 2019 is within permafrost and groundwater inflow will be negligible.
[2] TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources to be accounted for in Site Wide Water Quality analysis.
NA = not applicable; TDS = total dissolved solids; m^3/day = cubic metres per day; mg/L = milligrams per litre; % = percent.

Whale Tail Open Pit

In the last quarter of 2019, following dewatering of the North Basin of Whale Tail Lake, mining is expected to intersect unfrozen rock, and groundwater inflow to the pit is predicted to be 970 m^3/day. The groundwater inflow to the open pit was predicted to increase from 970 m^3/day in 2019 to 1,340 m^3/day in 2022 to 2025. The overall inflow to the pit does not increase significantly as the pit deepens because the flow of water is primary through the permeable shallow (weathered) bedrock and the lower portion of the pit is in permafrost. The predicted quantity of groundwater inflow into the open pit during mining for the Base Case Scenario is close to what was predicted in the FEIS Addendum as no changes were made to the shallow bedrock hydraulic conductivity based on the recent packer test data.

Groundwater inflow predictions during mining conservatively assumes that no freeze-back will occur in the pit walls. This assumption was adopted for Whale Tail Pit to be conservative and because during the first few years of mining, the pit will be both widened and deepened, resulting in the continual exposure of unfrozen bedrock. During the later years of mining; however, the pit development will be entirely within the permafrost and significant freeze back in the pit walls is considered possible and has been observed at Meadowbank. Although not simulated, if freeze back does occur as is the case at Meadowbank, actual groundwater inflow to the pit could be substantively lower than the predicted values in Table 3 and Table 4 (i.e., reduce to zero during periods of full freeze back).

TDS concentration in the groundwater inflow to the pit was predicted to decrease during mining from approximately 120 mg/L (2019) to 10 mg/L (2023 to 2025). These TDS concentrations are identical to the predicted TDS concentrations in the FEIS Addendum. The relatively low TDS concentration and decrease in TDS over time reflects the minimal upwelling of higher salinity waters at depth due to the presence of the permafrost at the base of the pit and the high contribution of lake water from the South Base of Whale Lake and from the Whale Tail Attenuation Pond water. Consistent with the FEIS Addendum, the predicted TDS concentrations in this model only account for TDS loading from groundwater. TDS loading from the Whale Tail Attenuation Pond and South Basin of Whale Tail Lake is accounted for in the water quality model (Golder 2019d).

Underground

For the Underground, groundwater inflow was predicted to increase from 20 m^3/day in 2020, which is the first year the Underground development will be within unfrozen bedrock, up to 180 m^3/day in 2023, which is when the underground reaches its maximum depth of -505 masl. By the final year of mining, the groundwater inflow decreases to 130 m^3/day. This decrease reflects that the underground is no longer being deepened and flow to the underground is likely near steady state conditions (reduced drainage from storage). The predicted flows based on the updated model is approximately 13% lower than the predicted values in the FEIS Addendum at the end of mining (150 m^3/day). The reduction in groundwater inflow reflects the small decrease in hydraulic conductivity in the deep sub-permafrost bedrock due to the additional packer testing data.

TDS concentrations in the groundwater inflow to the Underground were predicted to increase from 3,880 mg/L in 2020 to 7,760 mg/l in 2025. The predicted increase in TDS concentration is the result of the interception of higher salinity groundwater as the mine is deepened, and the upwelling of higher TDS water from beneath the Underground. The predicted TDS concentrations are within 30 mg/L of the predicted values in the FEIS Addendum for the Base Case Scenario.

5.1.3 Reflooding of Pits and Underground

Table 4 and Table 5 respectively presents a summary of the predicted groundwater inflow rates and groundwater TDS concentration to the mine development areas for the Base Case Scenario during reflooding of the pits and underground. The predictions presented in Table 4 and Table 5 include: predicted groundwater inflow to Whale Tail Pit Lake, predicted groundwater flow to the Underground, predicted flow to and from the Whale Tail Attenuation Pond, and predicted discharge to the dewatered North Base of Whale Tail Lake (i.e., the flow of water below the Whale Tail Lake Dike to the dewatered lake bottom surface). Groundwater inflow to the IVR Pit during refilling was not included as the pit is in permafrost (groundwater inflow will be negligible).

The predictions presented for the reflooding phase utilize a conceptual filling schedule for the Whale Tail Pit and the Underground, based on initial water balance predictions. Fine tuning of the flooding sequence was conducted after the conceptual filing schedule was developed; however, these adjustments will not have a significant impact on the predicted flow rates and salinity for a given elevation range.

For the prediction of pit reflooding, the pit walls were assumed to be frozen at the start of closure / end of mining, which restricted the inflow of groundwater to the pit lake until the pit lake rises and thaws the pit walls. This is considered reasonable as during the later years of mining, the pit development is limited to within the permafrost below Whale Tail Lake. If the pit walls do not remain frozen or melts seasonally, higher inflows than what is predicted could occur resulting in a shorter pit-filling period.

Considering the assumption of freeze-back in the pit walls, groundwater inflow to the Whale Tail Pit was not predicted to occur until 2030, when the pit lake level rises above the top of permafrost elevation near the pit (approximately 40 masl). When the water elevation in the pit lake rises above the permafrost, the freeze back is assumed to dissipate below the lake level and groundwater inflow to the pit was predicted to resume. The groundwater inflow to the pit lake was predicted to increase from 10 m^3/day in 2030 to approximately 1,160 m^3/day in 2036 as the pit walls progressively become unfrozen and connected to the permeable weathered bedrock. As the pit lake rises further in elevation, the groundwater inflows decrease and eventually the pit lake switches to a groundwater recharge boundary (i.e., the pit lake starts to recharge the sub-permafrost groundwater flow system). These groundwater inflow rates are similar to predictions in the FEIS Addendum and reflect that no changes were made to the shallow bedrock hydraulic conductivity.

The refilling of the Underground is expected to occur over a very short period (i.e. the bottom 500 m will be refilled in the first year). The water level in the Underground is therefore almost immediately higher then the hydraulic heads in bedrock near the Underground, resulting in a small but generally consistent flux of water from the Underground to bedrock. At the end of the reflooding period (2041) the Underground remains a source of groundwater recharge. with a predicted discharge of -10 m^3/day. These flow rates are slightly lower (by 0 to 5 m^3/day) of the predicted groundwater recharge rates predicted in the FEIS Addendum.

Table 4: Predicted Groundwater Inflow and Groundwater Salinity during Reflooding - Base Case Scenario – Whale Tail Pit, Whale Tail Attenuation Pond, North Basin of Whale Tail Lake

Phase	Approximate Time Period	Water Level in Pit (masl)		Whale Tail Pit		Whale Tail Attenuation Pond			Dewatered North Basin of Whale Tail Lake (within the diked area)	
		From	To	Net Groundwater Inflow/Outflow[1] (m^3/day)	TDS Concentration[2] (mg/L)	Groundwater Inflow (m^3/day)	Inflow TDS Concentration (mg/L)[2]	Surface Water Outflow (m^3/day)	Net Groundwater Discharge to Surface[1] (m^3/day)	Inflow TDS Concentration[2] (mg/L)
Flooding	2026	-130	-76	NA	NA	145	30	<5	340	<10
	2027	-76	-39	NA	NA	170	24	<5	340	<10
	2028	-39	3	NA	NA	180	21	<5	345	<10
	2029	3	26	NA	NA	185	19	<5	345	<10
	2030	26	43	10	24	190	18	<5	345	<10
	2031	43	61	60	24	180	17	10	345	<10
	2032	61	73	90	21	170	17	30	345	<10
	2033	73	87	120	19	160	17	45	340	<10
	2034	87	101	130	17	155	17	50	340	<10
	2035	101	111	700	<10	125	25	505	330	<10
	2036	111	124	1160	<10	85	29	940	300	<10
	2037	124	133	910	<10	90	22	740	300	<10
	2038	133	142	360	<10	115	16	315	315	<10
	2039	142	149	-30	NA	70	22	135	370	<10
	2040	149	153.5	-10	NA	0	NA	5	155	<10
	2041	153.5	153.5	0	NA	0	NA	0	-10	<10

Notes:
Pictorial representation of Flow Locations Components shown on Figure 6.
IVR Pit is located in permafrost and was therefore not modelled. Interception of runoff / direct precipitation accounted for in Site Wide Water Balance.
[1] Positive values indicate flow to the pit/pond and negative values indicate flow to bedrock.
[2] TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources to be accounted for in Site Wide Water Quality analysis.
NA = not applicable; TDS = total dissolved solids; m^3/day = cubic metres per day; mg/L = milligrams per litre; % = percent.

Table 5: Predicted Groundwater Inflow and Groundwater Salinity during Refilling – Base Case Scenario – Underground

Phase	Approximate Time Period	Water Level in Underground (masl)		Underground	
		From	To	Net Groundwater Inflow/Outflow[1] (m^3/day)	TDS Concentration[2] (mg/L)
Flooding	2026	-505	-76	-30	NA
	2027	-76	-39	<-5	NA
	2028	-39	3	<-5	NA
	2029	3	26	<-5	NA
	2030	26	43	<-5	NA
	2031	43	61	<-5	NA
	2032	61	73	<-5	NA
	2033	73	87	-5	NA
	2034	87	101	-10	NA
	2035	101	111	-10	NA
	2036	111	124	-10	NA
	2037	124	133	-10	NA
	2038	133	142	-25	NA
	2039	142	149	-15	NA
	2040	149	152.5	-10	NA
	2041	153	152.5	-10	NA

Notes:
Pictorial representation of Flow Locations Components shown on Figure 6.
[1] Positive values indicate flow to the underground and negative values indicate flow to bedrock.
[2] TDS concentrations do not account for loading from lakes and Whale Tail Attenuation Pond. TDS from these sources to be accounted for in Site Wide Water Quality analysis.
NA = not applicable; TDS = total dissolved solids; m^3/day = cubic metres per day; mg/L = milligrams per litre; % = percent.

5.2 EA Scenario

The Base Case predictions discussed in the preceding section provides the most likely estimates of groundwater inflow quantity and quality for the Expansion Project based on the available hydraulic conductivity data (Section 2 Table 1). Considering the number of tests; however, and in consideration of the sensitivity analysis conducted in the FEIS Addendum, an EA Scenario was developed as part of the FEIS Addendum. This scenario provides a reasonable yet conservative estimate of groundwater inflow such that there is a high level of confidence that the potential effects of the Expansion Project on groundwater inflow quantity and salinity have not been underestimated. Results from the EA Scenario are used in the Site-Wide Water Balance and Water Quality Models for the Expansion Project. Hydraulic conductivity values adopted in the EA Scenario relative to the Base Case are presented in Section 3.0 and take in to account the recent packer testing data collected in December 2018.

5.2.1 Dewatering

Table 6 presents a summary of the predicted discharge to the North Basin of Whale Tail lake during dewatering. The predicted discharge of 1330 m^3/day is within 20 m^3/day of the FEIS Addendum predictions (1350 m^3/day) and no change in TDS concentration was predicted. The minor variation in predicted discharge from the FEIS reflects the small adjustments made to permafrost extent along the margins of Whale Tail Lake.

Table 6: Predicted Groundwater Discharge to North Basin of Whale Tail Lake during Dewatering – EA Scenario

Phase	EA Scenario	
	Groundwater Discharge (m^3/day)	TDS Concentration (mg/L)
Lake Dewatering (Q1-Q3 2019)	1330	80

5.2.2 Mining

Table 7 and Table 8 presents a summary of the updated predicted groundwater flow rates and groundwater TDS concentrations to the mine development areas for the EA Scenario during mining of the open pits and underground. The predictions presented on these tables are conceptually shown on Figure 5 and include: predicted groundwater inflow to Whale Tail Pit, predicted groundwater inflow to the Underground, predicted flow to and from the Whale Tail Attenuation Pond, and predicted discharge to the dewatered North Base of Whale Tail Lake (i.e., the flow of water below the Whale Tail Lake Dike to the dewatered lake bottom). Groundwater inflow to the IVR Pit during mining is not included as the pit is in permafrost (groundwater inflow will be negligible). Some interception of surface water runoff and direct precipitation by the IVR Pit is excepted, but this is not a flow component derived from the groundwater modelling. It is addressed in the Updated Site-Wide Water Balance and Water Quality Model (Golder 2019d).

Whale Tail Open Pit

The predicted quantity and TDS concentration of groundwater inflow into the open pit during mining for the EA Scenario is similar to what was predicted in the Base Case and assumes no freeze-back in the pit walls. For the EA Scenario, the groundwater inflow to the open pit was predicted to increase from 970 m^3/day in 2019 to 1,350 m^3/day in 2025 and the TDS concentration was predicted to decrease from 120 mg/L in 2019 to 10 mg/L in 2025. Groundwater inflow is controlled by the shallow bedrock hydraulic conductivity, which was not modified between the Base Case and EA Scenario due to the high number of tests in this unit and the conservatism used in the Base Case Scenario. The shallow bedrock hydraulic conductivity is also unchanged from the FEIS Addendum; therefore, predicted inflows to the open pit are similar to the predictions in the FEIS Addendum.

Underground

For the EA Scenario, the updated groundwater inflow to the Underground was predicted to increase from 60 m^3/day in 2020 to a maximum of 420 m^3/day in 2023. In the final year of mining, the groundwater inflow decreases slightly to 340 m^3/day. These groundwater inflows are approximately 2 to 3 times higher than the Base Case values for the same period of mining. Predicted TDS concentrations for the EA scenario are 30% higher than the Base Case at the end of mining and reflect more upwelling of deeper more saline groundwater beneath the Underground.

The predicted inflows based on the updated model is approximately 20% lower than the predicted values at the end of mining in the FEIS Addendum (430 m^3/day). The reduction in groundwater inflow reflects the small decrease in hydraulic conductivity in the deep sub-permafrost bedrock due to the additional packer testing data. The predicted TDS concentrations are approximately 2 to 9 % lower than the predicted values in the FEIS Addendum.

Contributions to the inflow to the Whale Tail Pit and the Underground from the Whale Tail Attenuation Pond and the South Basin of Whale Tail Lake were evaluated for the EA Scenario to support the update to the Site-Wide Water Quality Model. TDS concentrations from these sources are accounted for in the Site-wide Water Quality model through a feedback loop. The quantity contributions predicted by the hydrogeological model are presented in Table 7 and Table 8. In 2020, approximately 64% of groundwater inflow to the pit is originating from the Whale Tail Attenuation Pond. The pond represents the major contributor to groundwater inflow to the pit due to its connection to the pit through the permeable shallow bedrock. The contribution from the pond was predicted to increase to 82% at the end of mining. The contribution from the South Basin of Whale Tail Lake is also predicted to increase from 3% in 2021 to 15% at the end of mining in 2025. In the Underground, the source of groundwater inflow is attributed only to water from the deep bedrock flow system.