REPORT

Water Quality Management and Optimization Plan Progress Update Rev4b

Phase 3: Meliadine Mine Effluent Discharge Benchmarks for Total Dissolved Solids

Submitted to:

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Distribution List

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REVISION HISTORY

Version	Date Issued	Purpose	Revisions
Rev1	24 March 2020	Development of a Plan to support the submission of the Emergency Amendment to the Type A Water Licence (2AM-MEL1631)	Establish a Plan to build from existing work performed on TDS benchmarks, including the following: ■ Evaluation of site-specific toxicity data. ■ Integration with the framework discussed with regulators for developing interim water quality targets for TDS at end of pipe and in the receiving environment that reflect the site-specific mixture of ions, confirmed through standardized toxicity tests (acute and chronic toxicity testing) and evaluation of assimilative capacity. ■ Establishment of a process (monitoring study design) for validation of interim targets in summer 2020.
Rev2	2 June 2020	Updated to address the NWB's approval of Emergency Amendment 1	Updates included: ■ Added clarification and additional scope to the Water Quality Validation Study—The NWB approval states that "the Licensee, in addition to the requirement as referred to in Part I, Item 6, during the 2020 discharge, shall undertake the Water Quality Program provided in Table 3 of Schedule I." The supplemental detail for this study is provided in Section 3.0 of the WQ-MOP (Conduct Validation Study). ■ Additional scope for the Plume Delineation Study—The NWB approval states that "the Licensee shall provide to the Board for review the 2020 Discharge Plume Delineation Study summary report as soon as all necessary data and results become available." A detailed study design for the 2020 Discharge Plume Delineation Study has been included in Appendix B of the WQ-MOP, and a summary of program sampling requirements is included in Section 3.3 of the WQ-MOP. ■ Incorporate a Response Plan—The WQ-MOP now includes adaptive management recommendations. This includes the addition of chemical and toxicological endpoint thresholds that monitoring data collected at the end of pipe or at the edge of the mixing zone can be compared, as well as a list of management actions or protocols that could be implemented in response to non-compliance. ■ Provide Field Contingencies—The WQ-MOP now includes contingency plans that could be implemented if logistical complications (e.g., safety concerns due to ice-cover or COVID-19) arise during the required 2020 water quality sampling program.
Rev2a	21 August 2020	Updated to address questions from ECCC and KivIA on 11 August 2020	■ Inclusion of the Maximum Grab Concentration (MGC) for TDS for the discharge of 5,000 mg/L ■ Inclusion of a paragraph in the adaptive management section (Section 3.5) to discuss thresholds and their application based on sample timing at the end of pipe and edge of mixing zone
Rev3	24 August 2020	Updated to include in the application package of the Type A Water Licence Amendment (2AM-MEL1631)	■ Included similar updates to Rev2a, but incorporated results of Phase 2 validation monitoring into Phase 1 to support the application of the discharge limits (EQCs) and edge of mixing zone (SSWQO) benchmark to provide for the ongoing long-term protection of Meliadine Lake from unacceptable effects ■ Inclusion of a new standalone Adaptive Management section (Section 5)

Version	Date Issued	Purpose	Revisions
Rev4	13 November 2020	Updated to support the Type A Water Licence Amendment (2AM-MEL1631) technical review process	▪ Incorporated the 2020 monitoring results for the discharge and from the receiving environment, including the supplemental testing studies, continuous in-lake monitoring, and plume delineation studies ▪ Included the Phase 3 component, which recommends the discharge limits (EQCs) and edge of mixing zone (SSWQO) benchmark for the long-term water management of CP1 discharge to Meliadine Lake so that Meliadine Lake is protected in the long-term from unacceptable effects
Rev4a	8 March 2021	Updated to incorporate monitoring data that were finalized following the Type A Water Licence Amendment (2AM-MEL1631) regulatory review process	▪ Incorporates the final water quality and toxicity testing results for CP1 discharge (MEL-14) and edge-of-mixing zone (MEL-13-01, MEL-13-07, and MEL-13-10) samples as part of the 2020 monitoring results. These results have been added to Appendix B, and represent the final set of monitoring data that were not available for Rev4
Rev4b	10 August 2021	Updated to incorporate the requirements of the approved Type A Water Licence (2AM-MEL1631) Amendment, June 23, 2021	▪ Inclusion of a new section (Section 5.0 – Development of a Chloride SSWQO), which incorporates the requirements of Part F, Item of 9 the Water Licence and includes a discussion of the Site-specific Water Quality Objectives for Chloride, specifically: *The Licensee shall implement the Water Quality Management and Optimization Plan as approved by the Board under Part B, Item 12. The Licensee shall, within sixty (60) days of approval of the Licence by the Minister, update this Plan to incorporate the requirements of Part F, Items 3 and a discussion on the Site-specific Water Quality Objectives for Chloride discussed during the technical review of the Application, and submit the updated Plan to the Board for approval in writing.*

PLAIN LANGUAGE SUMMARY

The Water Quality Management and Optimization Plan (WQ-MOP) was developed by Agnico Eagle Mines Limited (Agnico Eagle) to provide a procedure for determining acceptable discharge criteria and an in-lake monitoring benchmarks in Meliadine Lake. This process included three phases:

- Phase 1 – Develop total dissolved solids (TDS) discharge criteria and an in-lake monitoring benchmark for Meliadine Lake during the 2020 discharge season
- Phase 2 – Complete a detailed field study that included fish survival test with the discharge and aquatic organism growth and reproduction tests in the lake, and chemistry analysis of the discharge (one station) and the receiving environment (seven stations) on a regular basis
- Phase 3 – Develop long-term discharge criteria and an in-lake monitoring benchmark for Meliadine Lake that will be applicable to future operating conditions at the Meliadine Mine

Since March 2020, several versions of the WQ-MOP have been prepared. These versions allowed for updates to the WQ-MOP based on feedback and recommendations following review by the Nunavut Water Board (NWB or Board), Kivalliq Inuit Association (KivIA), Environment and Climate Change Canada (ECCC), and Crown Indigenous Relations Northern Affairs Canada (CIRNAC), and results of the detailed field study.

The Phase 1 of the WQ-MOP recommended TDS discharge criteria up to 3,500 mg/L and in-lake monitoring benchmark, located at 100m from the discharge point, of 1,000 mg/L during the 2020 discharge season.

The detailed field program conducted as Phase 2 of the WQ-MOP provided information on the quality of the discharge from Collection Pond 1 (CP1) in 2020 and the influence of the discharge on Meliadine Lake. In 2020, 1,031,177 m^3 of water was discharged from CP1 to Meliadine Lake. The daily discharge volume ranged from 15 m^3 to 17,518 m^3, with a daily average of 8,522 m^3. The TDS concentrations in the discharge ranged from 1,340 mg/L to 3,100 mg/L. Full chemical analyses were conducted and all regulated parameters in the Water Licence remained below regulated discharge limits. Throughout the duration of the discharge, the release of the water went as planned and testing and continuous monitoring showed that there was no occurrence of harmful effects on the environment, fish, and other aquatic life.

Meliadine Lake comprises several in-lake monitoring stations: three monitoring stations 100 m from the discharge point, a mid-field station (approximately 6 km downstream of the discharge point), and three reference stations downstream from the discharge point near the lake outlet. Sampling at these stations commenced immediately after the initiation of discharge of CP1 water to Meliadine Lake on July 3, 2020, which occurred during ice-cover conditions. Discharge continued on a regular basis until October 4, 2020 after discharge was ceased. Sampling was completed weekly at the edge of the mixing zone and monthly at the mid-field and reference stations, except when access to the lake was unsafe, such as during ice melt. Full chemical analyses were conducted on these samples. All in-lake measurements at 100 m from the discharge point remained well below the interim benchmark of 1,000 mg/L.

Over the discharge season, TDS concentrations measured at the in-lake monitoring stations ranged from 30 mg/L to 115 mg/L. All measured parameters over the discharge period were below guidelines, except for dissolved zinc at one edge of mixing zone station on August 2 and one reference station on July 27. This elevated concentration at the edge of the mixing zone was attributed to analytical variability as it was within five times the detection limit and not correlated with the MEL-14 discharge, with corresponding zinc concentrations in the discharge and at the other edge of mixing zone stations below guidelines. Concentrations of TDS at the mid-field and reference locations showed decreased further with distance from the diffuser. Throughout the duration of the discharge, water at the in-lake monitoring stations edge showed that harmful effects on the environment, fish, and other aquatic life were not occurring.

Additional monitoring under Phase 2 included the collection of measurements of water quality at different depths, collection of continuous conductivity measurements (using in-lake monitoring systems) from a single depth at three monitoring stations 100 m from the discharge point over the discharge season, and on two occasion (in early summer and late summer) the collection of measurements of conductivity at different depths at 22 sampling stations located up to a distance of 250 m from the discharge point to understand how the discharge water is mixing in Meliadine Lake. These monitoring components determined that:

- During ice-cover conditions, specific conductivity measurements in the lake near the discharge point were at their highest.
- Water monitoring at different depths near the discharge point showed that the discharge can be identified at low concentrations during ice cover conditions and during periods of higher discharge rates, and other times, the discharge was well mixed.
- The in-lake continuous monitoring stations showed that the discharge under ice moved predominantly from the discharge point in a west-north-east direction.
- During a higher discharge condition, higher conductivity was detected closer to the discharge point and at different water monitoring depths at all monitoring stations near the discharge point; under a lower discharge condition, a difference in conductivity across monitoring stations was not obvious.
- The submerged diffuser at the discharge point was able to effectively disperse the discharge into Meliadine Lake.

As a result of the water monitoring conducted under Phase 2, discharge under ice cover and open water conditions has been shown to remain within the TDS discharge criteria and the in-lake monitoring benchmark for Meliadine Lake, and showed that harmful effects on the environment, fish, and other aquatic life were not occurring. Monitoring confirmed that the submerged diffuser was able to effectively disperse the discharge into Meliadine Lake.

Based on the results of this detailed study, the following regulatory discharge limits and in-lake benchmark are therefore recommended for the long-term water management of CP1 discharge to Meliadine Lake:

- Water Licence regulatory limits: maximum average concentration (MAC) of TDS of 3,500 mg/L and the maximum grab concentration (MGC) of TDS of 4,500 mg/L for discharge from MEL-14 to Meliadine Lake (i.e., EQC); and
- An in-lake benchmark concentration of TDS of 1,000 mg/L to be achieved at the edge of the mixing zone in Meliadine Lake, which would also be consistent with the SSWQO for longer-term management of the receiving environment of Meliadine Lake.

As a condition of the approved Type A Water Licence (2AM-MEL1631) Amendment (June 23, 2021), Agnico Eagle will also monitor and evaluate the proportion of chloride concentrations within the calculated TDS concentration in the discharge at Monitoring Program Station MEL-14 and at the edge of the mixing zone in

Meliadine Lake at Monitoring Program Stations (MEL-13). Should the proportion of chloride concentration relative to that of calculated TDS in the discharge meet or exceed 60%, or exceed 75% of the long-term CCME Guidelines for the Protection of Aquatic Life Freshwater (i.e., 120 mg/L) at the edge of the mixing zone, based on annual average measurements, Agnico Eagle will develop a SSWQO for chloride for Meliadine Lake following CCME (2007) derivation procedures.

Table of Contents

TABLES

APPENDICES

APPENDIX A
WQ-MOP Rev2a

APPENDIX B
2020 Discharge Monitoring Results for Samples Collected Between 3 June 2020 and 26 October 2020

APPENDIX C
Plume Delineation Surveys Conducted on 21 July 2020 and 13 August 2020

APPENDIX D
Ceriodaphnia dubia Supplemental Toxicity Study

1.0 INTRODUCTION

The purpose of this Water Quality Management and Optimization Plan (WQ-MOP) update is to recommend discharge and receiving environment limits for total dissolved solids (TDS) as per Phase 3 of the WQ-MOP Rev2 for:

- the maximum average concentration (MAC) and maximum grab concentration (MGC) for discharge from CP1 to Meliadine Lake (i.e., effluent quality criteria; EQC); and
- the benchmark concentration to be achieved at the edge of the mixing zone in Meliadine Lake, which would also be consistent with the site-specific water quality objective (SSWQO) for longer-term management of the receiving environment of Meliadine Lake.

These recommendations are based on the results of the validation monitoring conducted in 2020 for the discharge and in the receiving environment (i.e., Meliadine Lake) as per Phase 2 of the approach detailed in the approved WQ-MOP Rev2 (Golder 2020b). As included in previous versions of the WQ-MOP (Rev1; Golder 2020a), this revision also describes the adaptive management thresholds associated with the management of water in CP1 that would trigger the implementation of measures to reduce the potential for the targets associated with discharge to Meliadine Lake to be exceeded.

On 2 June 2020, the WQ-MOP Rev2 (Golder 2020b) was submitted to the Nunavut Water Board (NWB) as a requirement under NWBs Reason for Decision (NWB 2020) to approve Agnico Eagle Mines (Agnico Eagle) Emergency Amendment to their Type “A” Water Licence (No. 2AM-MEL1631), submitted 24 March 2020, for effluent discharges associated with the Meliadine Mine located in the Kivalliq Region of Nunavut. This amendment, along with the WQ-MOP Rev2, was approved with Minister’s consent on 12 May 2020 and discharges to Meliadine Lake were initiated on 5 June 2020. The objective of the WQ-MOP was to formalize a procedure for management of effluent discharges that follows a systematic and science-based framework for determining acceptable discharge quality conditions.

The WQ-MOP Rev2a (Golder 2020c) was submitted to NWB on 24 August in response to questions from Environment and Climate Change Canada (ECCC) and the Kivalliq Inuit Association (KivIA) during a Water Management Working Group (WMWG) meeting for the 2020 discharge. As a result, a MGC for TDS for the discharge of 5,000 mg/L[1] was added, and further detail for adaptive management thresholds and activities was developed. The WQ-MOP Rev2a is provided in Appendix A.

The WQ-MOP Rev2a included a summary of the water management plan for the Mine associated with the Meliadine Lake discharge and proposed interim targets for TDS that were developed as per Phase 1 for the effluent discharge and for receiving environment conditions at the edge of the mixing zone during the emergency amendment. This plan also detailed monitoring studies to monitor discharge and receiving environment conditions of Meliadine Lake under the approved temporary (May to October 2020) amendment to Agnico Eagle’s Type “A” Water Licence (No. 2AM-MEL1631), which permitted the following:

- Authorization to temporarily discharge water from Containment Pond 1 (CP1) to Meliadine Lake that contains a maximum average concentration of TDS up to 3,500 mg/L, which exceeds the current limit described in Part F, Item 3 of the current Water Licence of 1,400 mg/L

[1] Since submission of the WQ-MOP Rev 2a, a MGC of 4,500 mg/L has been proposed.

Under the approved Water Licence Emergency Amendment, Meliadine Mine has been discharging from CP1 to Meliadine Lake since 5 June 2020. This discharge concluded on 4 October 2020. Water quality monitoring and toxicity testing described in detail in the approved WQ-MOP Rev 2a (Appendix A) was completed on 26 October 2020 (discharge terminated on 4 October 2020), with the sampling program operational for a period of just over 20 weeks. Results for the chemistry and toxicology components over the discharge period (between 3 June and 4 October 2020), including a post-discharge sample from MEL-14 collected on 26 October 2020, are summarized and interpreted in Appendix B. This post-discharge sample was collected for toxicity and limited chemistry testing because at this time the TDS concentration in MEL-14 was higher than the range of TDS concentrations tested during the 2020 discharge period; this testing provided additional evaluation of concentration response.

Within the WQ-MOP Rev2a (Appendix A), a three-phased approach was developed that included developing interim discharge and edge of mixing zone targets for TDS, designing and completing validation studies for the discharge and receiving environment, and finalizing the TDS benchmarks.

The WQ-MOP Rev 3 was completed on 24 August 2020 for inclusion in the application package for the Type A Water Licence Amendment (2AM-MEL1631) for Water Use and the Deposit of Waste. This version included the Rev2a updates, but incorporated results of Phase 2 validation monitoring into Phase 1 to support the application of the discharge limits (EQCs) and edge of mixing zone (SSWQO) benchmark. It also included an updated standalone Adaptive Management section (Section 5).

The WQ-MOP Rev4 was completed on 13 November 2020 and included updates to support the Type A Water Licence Amendment (2AM-MEL1631) technical review process. The updates included an incorporation of the 2020 monitoring results for the discharge and from the receiving environment, including the supplemental testing studies, continuous in-lake monitoring, and plume delineation studies. This version included the Phase 3 component, which recommends the discharge limits (EQCs) and edge of mixing zone (SSWQO) benchmark for the long-term water management of CP1 discharge to Meliadine Lake so that Meliadine Lake remains protected in the long-term from unacceptable effects.

The WQ-MOP Rev4a was issued on 8 March 2021 and included all remaining water quality and toxicity testing results for CP1 discharge (MEL-14) and edge-of-mixing zone (MEL-13-01, MEL-13-07, and MEL-13-10) samples as part of the 2020 monitoring results, which became available following the Type A Water Licence Amendment (2AM-MEL1631) regulatory review process.

At this time, all phases of the WQ-MOP have been completed (i.e., Phase 1 - Develop Interim Targets, Phase 2 – Conduct Validation Study, and Phase 3 - Finalize Meliadine Mine Benchmarks). The proposed TDS targets for the discharge have been ratified and have been incorporated as EQC for the discharge in the Type A Water Licence Amendment, including the site-specific TDS for Meliadine Lake at the edge of the mixing zone (NWB 2021):

- A MAC and a MGC of 3,500 mg/L TDS and 4,500 mg/L TDS, respectively, for the discharge
- An edge of mixing zone target of 1,000 mg/L TDS in the Meliadine Lake receiving environment at a radius of 100 m surrounding the in-lake diffuser

1.1 Report Structure

This updated WQ-MOP provided as part of the 2020 Water Licence Amendment application has been structured as follows:

- Benchmark Development (Section 2.0)

- Summary of Validation Study Components (Section 3.0)
- Finalization of Meliadine Mine Benchmarks for Longer-term Water Management (Section 4.0)
- Development of a Chloride Site-specific Water Quality Objective (Section 5.0)
- Adaptive Management (Section 6.0)
- Conclusions (Section 7.0)
- Appendix A: WQ-MOP Rev2a
- Appendix B: 2020 Discharge Monitoring Results for Samples Collected Between June 2020 and October 2020
- Appendix C: 2020 Plume Delineation Surveys Conducted on 21 July 2020 and 13 August 2020
- Appendix D: *Ceriodaphnia dubia* Supplemental Toxicity Study

1.1 Concordance

As part of the approval of the Request for the Minister's Consent to Process Amendment No. 1 to NWB Water Licence Type "A" No: 2AM-MEL1631, five conditions were required to be met. These are listed below, with reference to where they have been addressed in the WQ-MOP (Table 1). Additional conditions as part of Amendment No. 2 are provided in Table 2.

Table 1: Concordance Table for Conditions Required in Response to the Minister's Consent to Process Amendment No. 1 to NWB Water Licence Type "A" No: 2AM-MEL1631

<table>
<tr><th colspan="2">Licence Condition</th><th rowspan="2">Corresponding Section in WQ-MOP</th></tr>
<tr><th>Item</th><th>Condition</th></tr>
<tr><td>Item 21</td><td>The Discharge of Effluent from the Final Discharge Point at Monitoring Program Station MEL-14 shall be directed to Meliadine Lake through the Meliadine Lake Outfall Diffuser and shall not exceed the Effluent quality limits required under Part F, Item 3, except TDS that shall not exceed the following Effluent quality limits during the 2020 Discharge:
<table>
<tr><th>Parameter</th><th>Maximum Average Concentration</th><th>Maximum Concentration of Any Grab Sample</th></tr>
<tr><td>TDS (mg/L) (measured)</td><td>3,500</td><td>—</td></tr>
</table></td><td>Section 1;
Section 4;
Appendix B</td></tr>
<tr><td>Item 22</td><td>The Licensee shall implement the Plan entitled "Water Quality Management and Optimization Plan (WQMOP), Implementation Plan for Total Dissolved Solids", dated March 24, 2020, that was submitted as additional information with the March 24, 2020 Application for an amendment to Type "A" Water Licence No: 2AM-MEL-1631 to authorize the 2020 Discharge (the Amendment Application) that has been approved by the Board with the issuance of the Emergency Amendment No. 1.

The Licensee shall submit to the Board for review an updated Plan, prior to starting the 2020 Discharge, to reflect all commitments made during the review of the Amendment Application.</td><td>This document

Revision History;
Appendix A</td></tr>
<tr><td>Item 23</td><td>The Licensee, in addition to the requirements as referred to in Part I, Item 6, during the 2020 Discharge, shall undertake the Water Monitoring Program provided in Table 3 of Schedule I.</td><td>Section 3</td></tr>
</table>

Licence Condition		Corresponding Section in WQ-MOP
Item	**Condition**	
Item 24	The Licensee shall submit to the Board for approval, within the 2020 Annual Report, an updated Aquatic Effects Monitoring Program (AEMP) to take into account the results of the monitoring of the receiving environment during the 2020 Discharge.	Planned for Submission in 2022
Item 25	The Licensee shall provide to the Board for review the 2020 Discharge Plume Delineation Study summary report as soon as all necessary data and results become available.	Appendix C

Table 2: Concordance Table for Conditions Required in Response to the Minister's Consent to Amendment No. 2 to NWB Water Licence Type "A" No: 2AM-MEL1631

Licence Condition		Corresponding Section in WQ-MOP
Item	**Condition**	
Part F Item 9	The Licensee shall implement the Water Quality Management and Optimization Plan as approved by the Board under Part B, Item 12. The Licensee shall, within sixty (60) days of approval of the Licence by the Minister, update this Plan to incorporate the requirements of Part F, Items 3 and a discussion on the Site-specific Water Quality Objectives for Chloride discussed during the technical review of the Application, and submit the updated Plan to the Board for approval in writing.	This document Section 5.0

2.0 PHASE 1: BENCHMARK DEVELOPMENT

The guiding principle for Phase 1 outlined in the WQ-MOP was that site-specific water quality benchmarks be developed that satisfy the following conditions:

- protective of the environment
- satisfy regulatory requirements
- based on science (rather than strictly on considerations of policy or precedent)
- customized to the site-specific conditions of water quality and quantity

Adoption of fixed numerical benchmarks, either as static discharge limits or generic water quality guidelines, is unlikely to satisfy some parts of the above guiding principle. TDS benchmarks can, however, be developed using a toxicity-based approach that satisfies all the above conditions. TDS represent a “soup” of multiple component ions, and the behavior of this mixture in the environment is influenced by the relative toxicities of the component ions and the ability of some ions (e.g., calcium) to ameliorate the toxicity of others. For effective regulation of TDS, an approach is required that considers the toxicological potential of the mixture, and the point of compliance for different types of responses.

From communications with ECCC, the conceptual approach presented in the WQ-MOP Rev2a was consistent with guiding principles and had three main components in the development of numerical targets:

- Discharge must not result in acute toxicity at the point of release
- Discharge must not result in unacceptable chronic toxicity at the edge of the mixing zone (a regulated boundary located 100 m around the diffuser) following initial dilution
- Discharge must not exceed the capacity of the receiving environment to accommodate long-term loadings of constituents (i.e., assimilative capacity)

For broader management of TDS in Nunavut, instead of promulgating an uncertain numerical value for TDS or its individual component(s), Agnico Eagle developed interim targets for managing TDS in the discharge and receiving environment (to apply at the edge of the mixing zone) that reflect the site-specific mixture of ions, confirmed through standardized toxicity tests and evaluation of assimilative capacity. As detailed in the WQ-MOP Rev2, a validation monitoring program was designed and implemented with the onset of discharge on 5 June 2020 to validate interim targets developed as part of the WQ-MOP and to provide data to inform development of firm discharge limits and receiving environment benchmarks (or EQCs and SSWQOs) for long-term application. The discharge limit and SSWQO benchmarks were then be applied to guide an adaptive management approach for managing site water.

Since the approval of the emergency amendment and following consent from the Minister of Northern Affairs on 12 May 2020, monitoring data collected at the end of pipe and in the receiving environment (at the edge of the mixing zone) following the commencement of discharge on 5 June 2020 (i.e., Phase 2 of the validation framework) have been compared to interim discharge and edge of mixing zone limits applied at the end of pipe and in the receiving environment, respectively.

3.0 PHASE 2: Conduct Validation Study

In conjunction with the 2020 discharge to Meliadine Lake, as approved under Amendment 1 of the Mine's Type "A" Water Licence, supporting studies were conducted to monitor conditions and validate the science-based interim targets, as well as produce additional information on receiving environment assimilation (including plume delineation). This following section presents an overview of the monitoring studies completed as a condition under Amendment 1. A more detailed description of the discharge monitoring program is provided in the WQ-MOP Rev2a (Appendix A).

3.1 Validation during 2020 Discharge Event

The design of the approved validation study described in the WQ-MOP Rev2a (Appendix A) consisted of three components: water quality monitoring, toxicity testing, and plume delineation:

- **Water Quality Monitoring**—The surface water quality monitoring program was used to validate the near-field model predictions that TDS will be dispersed to less than 1,000 mg/L at the edge of the mixing zone, and to provide detailed chemical characterization of the effluent and receiving environment during the discharge, including an evaluation of the ionic composition of water used during the toxicity testing program. The water quality monitoring component was supplemented by the deployment of remote continuous logging sondes at the edge of the mixing zone stations 2 m above the lakebed. These sondes were used provide specific conductivity data at the edge of the mixing zone during the transition from ice cover to open water in Meliadine Lake when safe access to the lake was impossible.

- **Toxicity Testing**—The acute and chronic toxicity testing programs were conducted to confirm that the ionic composition measured in the discharge and the receiving environment during the surface water quality monitoring program were not at levels that would cause adverse biological effects. As described in detail in the WQ-MOP Rev2a (Appendix A) and summarized in Appendix B, Table B-1, the acute toxicity testing was conducted on the discharge to validate that the discharge is not acutely toxic. A suite of chronic toxicity tests was also conducted on discharge and receiving environment samples to validate that TDS concentrations measured at the edge of the mixing zone were not at levels that would cause chronic toxicity. As per commitments arising from responses to comments from ECCC and KivIA (Agnico Eagle 2020), as well as discussions through the WMWG, starting during the second monthly sampling event (see Appendix B; Table B-1 for details), chronic toxicity testing of the discharge was conducted monthly using a dilution series test design similar to that performed on the edge of mixing zone receiving environment stations.

- **Plume Delineation Study**—Plume delineation studies were conducted in mid and late summer (i.e., 21 July and 13 August 2020) to assess the vertical and horizontal extent of the effluent plume during seasonal periods that reflect the two distinct open water hydrological conditions in Meliadine Lake. The emphasis of these studies was on *in situ* specific conductivity profiling of the water column using a handheld meter with a sensor that will be lowered through the water column, with a subset of locations sampled for TDS. The relationship between field measured specific conductivity and laboratory measured TDS was established to validate the use of specific conductivity as a tracer of TDS in the receiving environment. The information retrieved confirmed model predictions related to effluent dilution and assimilation in the receiving environment, and that receiving environment monitoring stations were adequately characterizing conditions with respect to surface water chemistry and the potential for adverse biological effects.

An overview of the validation monitoring design that was conducted in 2020 is presented in Appendix B; Table B-1 and Figure B-1 depicts the locations of the selected monitoring stations. The plume delineation study is presented in Appendix C.

Starting in 2021, it is expected that the validation monitoring, with respect to discharge and edge of mixing zone locations and sampling frequency, will return to the monitoring design as required under the approved water licence.

3.2 Supplemental Toxicity Testing of CP1 Water

To supplement the toxicity testing completed for Phase 2 of the WQ-MOP, Agnico Eagle conducted complementary testing of water from CP1 in February 2020 to evaluate the potential for chronic toxicity of high TDS water.

The purpose of this CP1 supplemental testing was to:

- Evaluate the toxicity of CP1 water to a sensitive freshwater invertebrate (the crustacean, *C. dubia*) at concentrations higher than tested in 2019 chronic toxicity testing.
- Evaluate the concentration-response profile for both survival and reproduction endpoints to assist in the validation of the maximum average concentration for discharge from CP1 to Meliadine Lake (i.e., EQC) and the benchmark concentration to be achieved at the edge of the mixing zone in Meliadine Lake (i.e., SSWQO).
- Evaluate the sensitivity of TDS (and chloride) toxicity to manipulations of the original sample ionic composition, to provide insight into causation.

Additional details of the supplemental toxicity testing, including water chemistry measurements, raw toxicity test data and bench sheets, and statistical analyses are provided in Appendix D.

The *C. dubia* results from this supplemental testing confirm that mortality to a sensitive representative crustacean does not occur at or below the MAC 3,500 mg/L, despite the longer test duration relative to the standard 48-h *Daphnia magna* acute toxicity test commonly applied to evaluate acute toxicity. Additionally, *C. dubia* chronic toxicity (reproduction) did not occur in site-relevant mixtures until exposure concentrations of TDS are approximately double the SSWQO (i.e., double the 1,000 mg/L benchmark used to protect against chronic toxicity). The results are consistent with other testing of *C. dubia* reproduction in site water (conducted as part of the Phase 2 validation study) and confirm that the proposed EQC and SSWQO remain protective of their intended environmental protection goals.

The *C. dubia* survival endpoint is not routinely applied as a measure of acute toxicity under the MDMER or other effluent discharge regulations, as it is a chronic test, and more sensitive than the 96-h rainbow trout and 48-h *D. magna* tests commonly used to evaluate acute toxicity in undiluted effluent. As such, confirmation of the LC_{50} above 3,500 mg/L provides an additional margin of safety for the evaluation of acute toxicity.

4.0 PHASE 3: FINALIZE MELIADINE MINE BENCHMARKS

The Meliadine Mine discharged from CP1 to Meliadine Lake from 5 June 2020 to 4 October 2020, as approved under Amendment 1 of the Mine's Type "A" Water Licence. As such, water quality monitoring outlined in Appendix B; Table B-1 was completed on 26 October 2020, with the sampling program operational for a period of just over 20 weeks. Results reported for the chemistry and toxicology components over this period are summarized and interpreted in Appendix B.

Results represent the following monitoring as detailed in Table 3.

Table 3: Details of the Validation Monitoring conducted on the discharge and in the Receiving Environment during the 2020 Discharge associated with the Emergency Amendment

Validation Monitoring	Sampling Events / Duration
Water Chemistry	
MEL-14[(a)]	22 Sampling Events – 5, 7, 14, 15, 21, and 28 June; 5, 19, and 26 July; 2, 9, 13, 16, 23, 29 and 30 August; 5, 6, 13, 20, and 27 September; and 2 October 2020
Edge of Mixing Zone[(b)]	16 Sampling Events – 7[(d)] June; 12, 19, 22 and 29 July; 2, 9, 15, 19[(e)], 23, and 29 August; 5, 13, 20, and 27 September; and 4 October 2020
Mid-field Station[(c)]	7 Sampling Events – 7 June; 23 and 27 July; 18 and 22 August; and 7 and 12 September 2020
Reference Stations[(c)]	7 Sampling Events – 7 June; 22/25 and 27[(f)] July; 19[(g)] and 22/23 August; and 8[(f)] and 12 September 2020
Toxicity Testing	
MEL-14[(a)]	18 Acute Toxicity Tests – 7, 14, 21, and 28 June; 5, 12, 19, and 26 July; 2, 9, 16, 23, and 30 August; 6, 13, 20, and 27 September; and 2 October 2020 5 Chronic Toxicity Tests[(a)] – 20 July, 23 August, 12 September, and 3 October 2020
Edge of Mixing Zone	4 Chronic Toxicity Tests – 7[(d)] June, 23 July, 23 August, and 13 September
Mid-field Station[(c)]	4 Chronic Toxicity Tests – 6 June, 23 July, 22 August, and 12 September 2020
Reference Stations[(c)]	4 Chronic Toxicity Tests – 6 June, 25 July, 22/23 August, and 12 September 2020
Plume Delineation Studies	2 Events – 21 July 2020, and 13 August 2020
Remote Continuous Specific Conductivity and Temperature Monitoring	5 June 2020 to 4 October 2020[(h)]

(a) A post-discharge sample was collected from MEL-14 on 26 October 2020 to characterize elevated TDS; toxicity testing was conducted on this sample to address limitations in the TDS concentration exposure range tested in 2020.

(b) Due to melting ice conditions on Meliadine Lake (health and safety issue), weekly sampling events at the edge of the mixing zone during the weeks of 14 June, 21 June, 28 June, and 5 July were not conducted.

(c) Due to ice formation on Meliadine Lake (health and safety issue), the final monthly sampling event at the start of October was not conducted

(d) MEL-13-01 and MEL-13-07 only; edge of mixing zone station MEL-13-10 was not accessible due to unsafe local ice conditions during the first monthly sampling event (i.e., 7 June 2020)

(e) MEL-13-01 only

(f) MEL-03-02 only

(g) MEL-03-02 and MEL-04-05 only

(h) MEL-13-01 from 5 June to 29 August 2020

Detailed discussion of the results of this testing are provided in Appendix B.

The following represents the primary conclusions of this data analysis and interpretation of results:

- TDS concentrations measured in the discharge were less than the MAC of 3,500 mg/L in each of the weekly sampling events and ranged between 1,340 and 3,100 mg/L measured TDS (1,000 and 2,600 mg/L calculated TDS)
- The discharge was not found to be acutely toxic in 18 rounds of acute toxicity tests conducted with *D. magna* and Rainbow Trout, as the LC_{50} values were >100% discharge in each of the tests
- Sublethal toxicological effects were not identified during the chronic toxicity testing at MEL-14, except for low-level chronic effects to one species in the post-discharge sample collected in October. The MEL-14 post-discharge sample at a measured TDS concentration of 2,740 mg/L (2,500 mg/L calculated TDS) indicated some chronic effects to *Lemna minor* frond count when compared to the laboratory controls. Although results from this test do not align with the previous rounds of testing (i.e., IC_{50} greater than 97% at TDS concentrations ranging between 1,700 and 1,850 mg/L measured TDS [1,200 and 1,400 mg/L calculated TDS]), the results continue to support that the TDS SSQWO of 1,000 mg/L remains protective.
- TDS concentrations measured at the edge of mixing zone stations were consistently less than the interim target of 1,000 mg/L
- The plume delineation studies demonstrated that there was a high assimilation rate and that TDS concentrations rapidly decrease in the receiving environment to concentrations below which adverse effects on biological receptors would be expected. The results of these studies were consistent with the 2018 plume delineation study completed as part of the AEMP/EEM (Golder 2019) and aligned with the hydrodynamic modelling of the east basin of Meliadine Lake (Tetra Tech 2020a)
- Consistent with the low TDS concentration results reported in the receiving environment, adverse toxicological effects were not identified during the monthly chronic toxicity testing programs

Based on the agreed upon site-specific benchmark derivation procedure outlined in the WQ-MOP Rev2a (Appendix A) and summarized in Section 2.0, the validation monitoring conducted to date supports the interim EQC and edge of mixing zone (SSWQO) targets because:

- Discharge with TDS concentrations ranging between 1,340 and 3,100 mg/L measured TDS (1,000 and 2,600 mg/L calculated TDS) did not result in acute toxicity to *D. magna* and Rainbow Trout
- TDS concentrations in samples from MEL-14 ranging between 1,700 and 2,740 mg/L measured TDS (1,200 and 2,500 mg/L calculated TDS) did not result in chronic toxicity for fathead minnow, *Hyalella azteca*, or *D. magna.* Some chronic effects to *L. minor* frond count at MEL-14 relative to the laboratory controls were observed at a measured TDS concentration of 2,740 mg/L (2,500 mg/L calculated TDS), however, no effects to the biomass endpoint were identified, and the test results continue to support the SSWQO as being protective. Furthermore, the effects to frond count observed in this test do not align with the previous rounds of testing where no effects (i.e., IC_{50} greater than 97%) were noted at TDS concentrations ranging between 1,700 and 1,850 mg/L measured TDS (1,200 and 1,400 mg/L calculated TDS)
- Discharge did not result in chronic toxicity at the edge of the mixing zone following initial dilution (i.e., at a 100 m radius surrounding the diffuser in Meliadine Lake)

- Discharges do not show potential to exceed the capacity of the receiving environment to accommodate long-term loadings of constituents (i.e., assimilative capacity), as indicated by the observations that effluent rapidly diluted to less than the interim edge of mixing zone target of 1,000 mg/L TDS during the sampling events
- *C. dubia* results from supplemental testing conducted in February 2020 (Section 3.2) confirm that mortality to a sensitive representative crustacean does not occur at or below the MAC 3,500 mg/L, despite the longer test duration relative to the standard 48-h *D. magna* acute toxicity test commonly applied to evaluate acute toxicity
- *C. dubia* results from the supplemental testing conducted in February 2020 (Section 3.2) confirm that chronic toxicity to a sensitive species and endpoint (reproduction) does not occur until exposure concentrations of TDS are approximately double the SSWQO

Based on these observations, and the testing completed on site in 2018 and 2019, the MAC (3,500 mg/L) and a MGC of TDS of 4,500 mg/L can be adopted as benchmarks (i.e., as EQCs) for managing the discharge. Additionally, monitoring efforts in 2020 as outlined in Table B-1 of Appendix B completed for the duration of the permitted temporary discharge of CP1, a TDS concentration of 1,000 mg/L can be adopted for the mixing zone target as a firm benchmark (and SSWQO) in Meliadine Lake. These benchmarks are considered appropriate for the long-term water management at the Site, which will not result in adverse effects to the use of Meliadine Lake and for the on-going protection of aquatic life.

Results of the validation monitoring collected in 2020 have been available to the Board during the technical review process; following each monthly monitoring event, results from the validation monitoring were collated, reviewed, and presented to the WMWG, which was represented by the NWB, KivIA, ECCC, and Crown Indigenous Relations and Northern Affairs Canada (CIRNAC). Key messages to the WMWG during the meetings included that the monitoring data collected in 2020 confirmed that the diffuser was working as designed, the water being released in Meliadine Lake was safe to the environment, fish, and other aquatic life, and that there was no evidence of a build-up (accumulation) of TDS in Meliadine Lake beyond the localized area of the diffuser (i.e., near-field area) as a result of the discharge.

5.0 DEVELOPMENT OF A CHLORIDE SSWQO

5.1 Background

During the technical review process for the 2020 Water Licence Amendment application, the KivIA recommended (KIA-WL-TC-1; Agnico Eagle 2020b) that Agnico Eagle develop an SSWQO for chloride at the edge of the mixing zone (which would also apply within the receiving environment) because it is the largest contributing ion by mass to TDS in Meliadine effluent. This concern was based on the potential for chloride toxicity associated with the MAC and MGC effluent quality criteria for TDS. Agnico Eagle responded that due to the strong and consistent relationship between TDS and chloride in Meliadine effluent (Appendix A; Golder 2020c), an SSWQO for chloride at the edge of mixing zone and within the receiving environment was not necessary; a chloride SSWQO would be redundant with the existing TDS SSWQO. Further, the monitored TDS concentrations at the edge of mixing zone in Meliadine Lake in 2020 as part of the Emergency Amendment monitoring were well below the TDS SSWQO and the generic CCME long-term guideline for chloride (120 mg/L), indicating negligible risk. However, Agnico Eagle agreed to consider the development of an SSWQO for chloride.

As part of the Final Written Statement for the 2020 Water Licence Amendment application, ECCC recommended (ECCC-WL-FWS-3; Agnico Eagle 2021) that Agnico Eagle monitor the proportion by mass of chloride to the calculated TDS in the discharge and determine the need for an SSWQO if there were any changes in the composition of TDS. Agnico Eagle agreed to monitor the ionic composition of the discharge effluent composition (in particular, the proportion of major ions to TDS) and evaluate the need for SSWQO for chloride will based on these monitoring data for the discharge and/or at the edge of the mixing zone.

In the Reason for Decision report (NWB 2021), the Board required that Agnico Eagle note ECCC's recommendation and update the WQ-MOP to incorporate a discussion on thresholds for chloride. The following meets this requirement and the subsequent condition in Part F, Item 9 of the amended water licence.

5.2 Thresholds for Chloride

Chloride is one of the water quality parameters that Agnico Eagle regularly collects from monitoring in the receiving environment at the edge of mixing zone [MEL-13]), as well as at the mid-field [MEL02] and reference locations [MEL-03, MEL-04, and MEL-05]). As part of this commitment, Agnico Eagle will continue to monitor and evaluate chloride concentrations in the discharge and mixing zone, and develop an SSWQO for chloride if either the following thresholds are reached:

1) the proportion of chloride to TDS (calculated) by mass in the discharge reaches 60% or greater

   Monitoring of discharge through 2019 and 2020 indicates consistency in ionic composition, with approximately 50% of the TDS contributed by chloride (see Figure A-1; Appendix A; WQ-MOP Rev2a). If the proportion of chloride to TDS increases to 60% in the discharge, based on an annual average of discharge measurements, then the development of a chloride SSWQO would be warranted. If proportions of chloride remain stable or decrease over time, no SSWQO is necessary.

2) the concentration of chloride at the edge of the mixing zone (MEL-13) stations is greater than 75% of the generic CCME chloride guideline

   The generic long-term CCME guideline for chloride of 120 mg/L is currently used as a benchmark within the AEMP. Agnico Eagle will continue to monitor TDS composition at the edge of mixing zone, and if the generic chloride guideline of 120 mg/L is approached (i.e., the annual average chloride concentrations at edge of mixing zone are greater than 75% of the guideline) then a chloride SSWQO would be advanced.

The SSWQO derivation, if required, will follow the CCME (2007) derivation procedures, which entail screening of toxicity data for reliability and relevance, normalization of toxicity data to toxicity modifying factors in the receiving environment (e.g., water hardness), fitting of data using a species sensitivity distribution curve, and adoption of the HC_5 as the SSWQO. This approach is similar to that used for the derivation of the MAC EQC for TDS (calculated) in this WQ-MOP, and applied at other Northern mine sites (e.g., Ekati Mine, Gahcho Kué Mine, Giant Mine).

6.0 ADAPTIVE MANAGEMENT

The thresholds and management responses developed for the WQ-MOP as required by NWB's (2020) Reason for Decision and described in the WQ-MOP Rev2a will apply to discharges beyond 2020. The thresholds and management responses associated with adaptive management are detailed in Table 4. The table identifies an operating level ranging from Level 0 (green; normal operating condition) to Level 3 (red; high risk situation), the thresholds that trigger each level, and a list of management strategies and actions for consideration in response to mitigate and/or rectify the condition, if required.

Table 4: Surface Water Quality Adaptive Management Strategy for CP1 Discharge to Meliadine Lake

Adaptive Management Level	Threshold	Management Activity / Response /Action
Green (Level 0) Normal Operating Condition	Measured concentrations are less than the MAC discharge limit and the edge of mixing zone threshold level	■ Continue monitoring as per Water Licence requirements ■ Continue water management as per Water Management Plan
Yellow (Level 1)	Two consecutive end-of-pipe TDS concentrations equivalent to, or greater than, the MAC discharge limit, or Two consecutive edge-of-mixing-zone TDS concentrations equivalent to, or greater than, 75% of the edge of mixing zone threshold	■ Conduct a follow up sampling event to confirm trigger ■ Collect additional edge of the mixing zone sample(s) for chronic toxicity testing ■ Increase sampling frequency at end of pipe to twice weekly or at edge on mixing zone to bi-weekly
Orange (Level 2)	Three consecutive end-of-pipe TDS concentrations equivalent to, or greater than, the MAC discharge limit, or An end-of-pipe TDS measurement is equivalent to, or greater than the MGC discharge limit, or Three consecutive edge-of-mixing-zone TDS concentrations equivalent to, or greater than, 75% of the edge of mixing zone threshold	■ Conduct a follow up sampling event to confirm trigger ■ Decrease the rate of effluent discharge or temporarily cease pumping of the discharge ■ Consider alternative management of CP1 water (e.g., divert to waterline)
Red (Level 3)	Two consecutive end-of-pipe TDS concentrations greater than 4,500 mg/L	■ Cease pumping of the discharge to Meliadine Lake ■ Conduct a follow up sampling event to confirm trigger ■ Consider alternative management of CP1 water, such as diversion of CP1 water into the Waterline

Water quality (i.e., TDS) and toxicity testing monitoring data collected in CP1 (representing the discharge) and at the edge of the mixing zone will be compared to the benchmarks as determined by Phase 3 of the WQ-MOP.

These adaptive management measures will be implemented if the above referenced management thresholds are triggered. NWB will be notified promptly of any adaptive management measures that are implemented throughout the discharge period. Additional adaptive management responses or actions besides those listed in Table 4 may be considered on a case-by-case basis depending on the management level triggered, or if the results of on-going monitoring (such as the additional CP1 testing in October 2020) identifies a non-conformance. These include:

- Decreasing the rate of effluent discharge or temporary cessation of pumping of the discharge could be considered to increase dispersion and to decrease the overall size of the plume.
- Consideration given to collecting additional edge of the mixing zone sample(s) for exploratory chronic toxicity testing to confirm the threshold at the edge of the mixing zone. These additional samples could be amended with ionic salts in an ionic composition relevant to the edge of mixing zone and tested as a dilution series. The purpose would be to facilitate testing at concentrations both above and below the concentrations measured at the time of sampling, for the purpose of developing a concentration-response curve.
- Consideration given to additional targeted toxicity testing (e.g., validation test, or toxicity identification evaluation to explore the cause for an observed toxicological response), either in response to an acute toxicity outcome (e.g., mortality to the crustacean, *D. magna*) or for a moderate- to high-magnitude chronic toxicity response. Such toxicity is not anticipated to occur during the program (i.e., the thresholds have been set specifically to avoid such responses); however, if an anomalous response is observed, a TIE could help elucidate the cause.

An additional adaptive management strategy includes the utilization of an alternative to the water management plan; that is, use of the waterline as a supplemental option for water transfer from CP1. This alternative relates to the management of surface contact water and the potential opportunity to use the proposed waterline, which is new mine infrastructure provided in a Project Certificate Reconsideration Application currently before the NIRB for review. As described in the Type A Water Licence 2AM-MEL1631 Amendment (Main Application Document), Agnico Eagle is proposing to increase the currently approved discharge rate to 6,000 to 12,000 m^3 of water per day to Melvin Bay. Treated saline groundwater effluent will be conveyed through waterlines from the treatment plant to the discharge facility at the Itivia Fuel Storage Facility for discharge during the open water season (May to October). Surface contact water from CP1 can be directed to the waterline and co-mingled with the contact water from the underground mine prior to treatment and transfer to the waterline. This treated contact water from the underground mine and CP1 surface contact water will be discharged in a controlled manner to Melvin Bay through an engineered diffuser in compliance with the required discharge criteria. Treated final discharge quality will be required to meet MDMER criteria prior to discharge (GC 2020). The addition of the CP1 water to the contact water from the underground mine will not impact the ability of the discharge limits to be met. Further, supplemental assessments of the potential effects of redirecting CP1 water to the waterline were evaluated with respect to Meliadine Lake and Melvin Bay.

The redirection of CP1 water to the waterline instead of to Meliadine Lake shows that this will only result in a small reduction in overall flows in Meliadine Lake and negligible effects on the levels of Meliadine Lake (further details are provided in Appendix I of the Type A Water Licence 2AM-MEL1631, included as part of the 2020 Water Licence Application package).

Hydrodynamic modelling results indicate that effective dispersion of the waterline discharge over a range of salinities can be achieved over the planned four months of discharge during open water conditions; the minimum dilution factor is well above the target ratio of 11:1 as used in the previous Melvin Bay Diffuser Design Report (i.e., 3-D dispersion modelling assessment, Tetra Tech 2020b,c). Taking effluent accumulation over time into account, the minimum dilution factor (corresponding to the maximum concentration) at the edge of the 100 m mixing zone boundary ranges from about 40:1 to 90:1. Furthermore, hydrodynamic modelling indicates that the discharge is effectively dispersed in Melvin Bay and flushed out of the bay as there are no discernible areas of effluent stagnation or significant accumulation over the discharge period. As a result, the characteristics of the diffuser system and the operating conditions of the discharge (e.g., discharge volume, discharge rates, discharge timing) combined with the hydrodynamic conditions of the bay (primarily tidal regime) results in the efficient flushing of the entire bay. Once discharge ceases, and ice cover occurs on Melvin Bay, further dispersion of the remaining discharge in the bay is actively dispersed through ongoing tidal circulation. The effectiveness of the immediate discharge and the low proportion of discharge in Melvin Bay means that marine habitat and water quality in the Bay will remain protected.

Additional adaptive management strategies, if necessary, would be proposed to the regulatory authorities for discussion and agreement prior to implementation. For example, an adaptive management trigger could be based on the water volume having to be managed as a component of the waterline discharge and also reporting to CP1. In this scenario, normal operation would consist of diverting all the surface contact water and saline water to the waterline with no discharge to Meliadine Lake. In the event, however, that the waterline capacity was maximized (i.e., more site water requiring discharge than the waterline could accommodate), adaptive management activities would be initiated. In this case, some proportion of the surface contact water reporting to CP1 could be segregated, with the objective that lower TDS concentration water would be diverted to Meliadine Lake as long as the water to be discharged to Meliadine Lake remains within discharge limits and higher TDS concentration would remain transferred to the waterline.

7.0 CONCLUSIONS

This updated version of the WQ-MOP provides an evaluation of the water quality monitoring and toxicity testing data for discharge and the receiving environment (i.e., edge of mixing zone, and mid-field and reference locations) collected over the 2020 discharge period as per the Phase 2 (Conduct Validation Study) component of the WQ-MOP Rev2 and for the completion of Phase 3 (Finalize Meliadine Mine Benchmarks) to determine:

- the MAC and MGC for discharge from CP1 to Meliadine Lake (i.e., effluent quality criteria; EQC); and
- the benchmark concentration to be achieved at the edge of the mixing zone in Meliadine Lake, which would also be consistent with the SSWQO for longer-term management of the receiving environment of Meliadine Lake.

As a result of the comprehensive monitoring conducted under Phase 2, discharge under ice cover and open water conditions has been shown to remain within the interim EQC targets for TDS and not be acutely toxic or result in sub-lethal effects to aquatic biota. Further, the receiving environment has remained protected with no adverse effects identified to aquatic biota. Monitoring of the physico-chemical conditions and the water quality has confirmed the effectiveness of the diffuser in consistently dispersing the discharge, which has met edge of mixing zone requirements using the interim TDS target at the edge of the mixing zone and has further attenuated with distance from the diffuser. Therefore, Agnico Eagle recommends as per Phase 3 of the WQ-MOP, that the interim TDS targets for the discharge and receiving environment developed under Phase 1 be ratified as regulatory targets for TDS as EQC for discharge and SSWQO for the receiving environment that will be applicable to future operating conditions at the Meliadine Mine. Specifically:

- the MAC of TDS of 3,500 mg/L and the MGC of TDS of 4,500 mg/L for discharge from CP1 to Meliadine Lake (i.e., EQC); and
- the benchmark concentration of TDS of 1,000 mg/L to be achieved at the edge of the mixing zone in Meliadine Lake, which would also be consistent with the SSWQO for longer-term management of the receiving environment of Meliadine Lake.

As per Part F, Item 9 of the approved Water Licence (2AM-MEL1631) Amendment, Agnico Eagle was required to update the WQ-MOP to provide a discussion on the SSWQO for Chloride. As per the commitments made by Agnico Eagle during the technical review and public hearing, Agnico Eagle will continue to monitor and evaluate chloride concentrations in the discharge and at the edge of the mixing zone in Meliadine Lake during discharge conditions. If either of the following conditions are triggered, an SSWQO for chloride will be developed:

- the annual average composition of chloride to TDS (calculated) in the discharge reaches 60% or greater
- greater than 75% of the generic CCME chloride guideline.

The SSWQO derivation, if required, will follow the CCME (2007) derivation procedures

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APPENDIX A

WQ-MOP Rev2a

REPORT

Water Quality Management and Optimization Plan

Implementation Plan for Total Dissolved Solids

Submitted to:

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Table of Contents

TABLES

APPENDICES

1.0 INTRODUCTION

This report provides a Water Quality Management and Optimization Plan (WQ-MOP) for effluent discharges associated with the Meliadine Mine located in the Kivalliq Region of Nunavut. The objective is to formalize a procedure for management of effluent discharges that follows a systematic and science-based framework for determining acceptable effluent quality conditions.

The WQ-MOP presented herein is focussed on development of interim targets for total dissolved solids (TDS) for effluent discharge and receiving environment conditions at the edge of the mixing zone, but within a framework that can be extended to longer-term management of site water. Although currently specific to the Meliadine Mine, it is intended to align with a process that can be generalized to other Agnico Eagle Mines Limited (Agnico Eagle) projects in Nunavut.

On 24 March 2020, Agnico Eagle submitted an emergency request for an amendment to their Type "A" Water Licence (No. 2AM-MEL-1631), specifically seeking the following amendment:

- Authorization to temporarily discharge water from Containment Pond 1 (CP1) to Meliadine Lake that contains a maximum average TDS concentration up to 3,500 mg/L, which exceeds the current limit described in Part F, Item 3 of the current Water Licence of 1,400 mg/L

The emergency request issued by Agnico Eagle was based on the determination that the water storage capacity of CP1 would be exceeded if dewatering was not conducted prior to or in conjunction with the 2020 spring freshet. If the dewatering was not permitted, and the water storage capacity of CP1 was exceeded, this could represent a significant risk to site infrastructure, as well as human and environmental health. On 29 April 2020, the Nunavut Water Board (NWB 2020) recommended approval of Licence Amendment 1 for Agnico Eagle's Type "A" Water Licence, which permits the following:

- *The time-limited discharge (May 2020 – October 2020) of effluent from the Containment Pond 1 (CP1) into Meliadine Lake through the Meliadine Lake Diffuser (Monitoring Program Station MEL-14) and the Water discharge shall not exceed 3,500 mg/L for the Maximum Average Concentration (MAC) of the Total Dissolved Solids (TDS)*

The NWB's approval of Emergency Amendment 1 is contingent on conditions outlined in NWB's (2020) Reason for Decision. To respond to these conditions and requirements, the following have been addressed in this Updated WQ-MOP:

- **Water Quality Validation Study**—The NWB approval states that *"the Licensee, in addition to the requirement as referred to in Part I, Item 6, during the 2020 discharge, shall undertake the Water Quality Program provided in Table 3 of Schedule I.*" The scope for this study is provided in Section 3.0 of the WQ-MOP (Conduct Validation Study).
- **Plume Delineation Study**—The NWB approval states that "*the Licensee shall provide to the Board for review the 2020 Discharge Plume Delineation Study summary report as soon as all necessary data and results become available."* A detailed study design for the 2020 Discharge Plume Delineation Study has been included in Appendix B of the WQ-MOP, and a summary of program sampling requirements is included in Section 3.3 of the WQ-MOP.
- **Response Plan**—The WQ-MOP now includes adaptive management recommendations. This includes the addition of chemical and toxicological endpoint thresholds that monitoring data collected at the end of pipe or at the edge of the mixing zone can be compared, as well as a list of management actions or protocols that could be implemented in response to non-compliance.

- **Field Contingencies**—The WQ-MOP now includes contingency plans that could be implemented if logistical complications (e.g., safety concerns due to ice-cover or COVID-19) arise during the required 2020 water quality sampling program.

NWBs recommended approval of Amendment 1 received Minister's consent from the Honourable Daniel Vandal, Minister of Northern Affairs on 12 May 2020.

1.1 Site-Specific Benchmark Development Procedure

The guiding principle for the WQ-MOP is that water quality benchmarks should be developed that satisfy the following conditions:

- protective of the environment
- satisfy regulatory requirements
- based on science (rather than strictly on considerations of policy or precedent)
- customized to the site-specific conditions of water quality and quantity

Adoption of fixed numerical benchmarks, either as static discharge limits or generic water quality guidelines, is unlikely to satisfy some parts of the above guiding principle. TDS benchmarks can, however, be developed using a toxicity-based approach that satisfies all the above conditions. TDS represent a "soup" of multiple component ions, and the behavior of this mixture in the environment is influenced by the relative toxicities of the component ions and the ability of some ions (e.g., calcium) to ameliorate the toxicity of others. For effective regulation of TDS, an approach is required that considers the toxicological potential of the mixture, and the point of compliance for different types of responses.

From our communications with Environment and Climate Change Canada (ECCC), a conceptual approach has been developed that is consistent with the guiding principle, and that has three main components in the development of numerical targets:

- Effluent discharges must not result in acute toxicity at the point of release
- Effluent discharges must not result in unacceptable chronic toxicity at the edge of the mixing zone following initial dilution
- Effluent discharges must not exceed the capacity of the receiving environment to accommodate long-term loadings of constituents (i.e., assimilative capacity)

For broader management of TDS in Nunavut, instead of promulgating an uncertain numerical value for TDS or its individual component(s), we recommend development of interim targets for managing TDS in the effluent discharge and receiving environment (to apply at the edge of the mixing zone) that reflect the site-specific mixture of ions, confirmed through standardized toxicity tests and evaluation of assimilative capacity. Much of this information has already been collected for Meliadine Mine, and Agnico Eagle has designed a validation program to validate interim targets and provide data to inform development of effluent quality criterion (EQC) and site-specific water quality objective (SSWQO) benchmarks for long-term application (see Section 3.0). The EQC and site-specific water quality objectives (SSWQO) benchmarks can be applied to guide an adaptive management approach to processing of site water.

1.2 Phasing the Water Quality Management and Optimization Plan

As communicated to NWB by Agnico Eagle, the upcoming 2020 freshet season will result in accumulation of site water that exceeds the water storage capacity of the mine at CP1, requiring a managed release of site water to the environment. In anticipation of this condition, Amendment 1 was approved by NWB for Meliadine Mine's Type "A" Water Licence, allowing Meliadine Mine to dewater CP1 prior to or in conjunction with the 2020 freshet, avoiding "emergency" conditions. This decision received Minister's consent from the Honourable Daniel Vandal, Minister of Northern Affairs, on 12 May 2020.

The operational needs dictate a phased approach to the WQ-MOP, in which short-term needs for monitoring and validation are met, while remaining consistent with the overall WQ-MOP framework.

- **Phase 1: Develop Interim Targets**—Application of the general process described in Section 1.1, entailing review of literature and results of site-relevant toxicity testing, and subsequent establishment of science-based TDS targets, for use on an interim basis.
- **Phase 2: Conduct Validation Study**—In conjunction with the upcoming release of discharge from Meliadine Mine to Meliadine Lake commencing during freshet, Agnico Eagle will conduct supporting studies in 2020 to validate and/or refine the science-based interim targets and produce additional information on receiving environment assimilation. The scope for this study is provided in Section 3.0 of the WQ MOP (Conduct Validation Study).
- **Phase 3: Finalize Meliadine Mine Benchmarks**—Integrate the results of Phase 1 and Phase 2 to formalize the science-based interim targets as EQC and SSWQO benchmarks, with a framework for their implementation (e.g., adaptive management), that is applicable to future conditions at Meliadine Mine. Phase 3 will be submitted as part of the amendment application of the existing Meliadine Water Licence to the Nunavut Water Board.

This document emphasizes Phase 1 (Section 2.0) and Phase 2 (Section 3.0) of the WQ-MOP; sufficient detail is provided for the validation and plume delineation studies to indicate conformance with the Mine's monitoring requirements outlined in the NWB's (2020) Reason for Decision. Additional details of sample collection, handling, and chain-of-custody are being developed separately for use by the field crew and analytical laboratories.

2.0 PHASE 1: DEVELOP INTERIM TARGETS

2.1 Interim TDS Target for Effluent

This section presents the proposed interim target for effluent of 3,500 mg/L calculated TDS for the Meliadine Mine; the target is expressed as a Maximum Average Concentration (MAC). This target is proposed as an interim value, pending implementation of Phase 2 and Phase 3 of the WQ-MOP. The interim target of 3,500 mg/L calculated TDS was proposed following a review of site acute toxicity data collected for Meliadine Mine (Appendix A) and was approved (Amendment 1) on 4 May 2020 as the temporary (May 2020 to October 2020) TDS MAC permitted to be discharged from CP1 into Meliadine Lake at the Meliadine Mine Lake Outfall diffuser (Monitoring Program Station MEL-14).

As discussed in Appendix A, the toxicity of TDS across different site waters varies by ionic composition and the relative proportion of ions in the mixture. Low effect concentrations for acute endpoints (e.g., survival) have been reported in the literature for individual ions for select species, but these tests reflect exposure conditions accounting for a single ion, and not a balanced TDS mixture representative of most field conditions. Considering this, the proposal of an interim target focussed on review of site-specific acute toxicity data collected for site-relevant mixtures (e.g., treated effluent, influent, Collection Pond water; Appendix A, Section A2.0).

The approved interim TDS target for effluent of 3,500 mg/L is supported by:

- No acute toxicity to *D. magna* or Rainbow Trout was observed with influent and effluent TDS concentrations of equal to or less than 5,420 mg/L (measured TDS concentrations of equal to or less than 4,925 mg/L)—details are provided in Appendix A.
- No mortality to other organisms has been observed in tests using Fathead Minnows or *C. dubia* in chronic exposures; as of January 2020, these tests covered calculated TDS concentrations up to 2,357 mg/L (measured TDS concentrations of 2,490 mg/L). Chronic test endpoints are not used in a regulatory context to evaluate the acute toxicity of the effluent, but the lack of mortality in chronic tests provides encouraging information.
- The record of acute toxicity depicted in Appendix A (Table A-4) provides evidence of the lack of acute toxicity even at high TDS concentrations. As of March 2020, nine acute toxicity tests have been conducted with calculated TDS concentrations above 3,500 mg/L. For this reason, some caution is recommended in the development of the interim TDS target for effluent. The no-effect concentration of 5,420 mg/L calculated TDS was therefore reduced by 30% and rounded down to the value of 3,500 mg/L.

Validation of the interim TDS target to demonstrate that the effluent is consistently not acutely lethal will be conducted through monitoring during the discharge period as presented in Section 3.0. Sensitive species that form the basis for the validation would include test species *D. magna* and Rainbow Trout, as these are the species used to assess compliance for acute lethality under the Metal and Diamond Mining Effluent Regulations (MDMER; Government of Canada 2002).

2.2 Interim TDS Target at the Edge of the Mixing Zone

An interim target of 1,000 mg/L (as calculated TDS) to apply in the receiving environment at the edge of the mixing zone is proposed for the protection against chronic toxicity to representative aquatic species. This interim target is intended to evaluate the condition (from Section 1.1) that effluent discharges must not result in unacceptable chronic toxicity at the edge of the mixing zone following initial dilution. The target is proposed as an interim value for use in the short-term, pending implementation of Phase 2 and Phase 3 of the WQ-MOP. The interim target of 1,000 mg/L in the receiving environment at the edge of the mixing zone was supported by the NWB (2020) in their Reasons for Decision related to the approval of Amendment 1 of the Type “A” Water Licence.

The proposed interim target was derived using methods described in Appendix A and summarized below:

- Characterization of the Meliadine TDS profile (Section A1.1)—water chemistry data collected at the Meliadine Mine were used to profile the anticipated water quality in the receiving environment, including composition of major component ions in the TDS mixture.
- Review of water quality benchmarks (Section A1.2)—review of TDS benchmarks developed for locations with a similar TDS composition to Meliadine Mine.
- Literature review (Section A1.3)—review of peer-reviewed literature to determine the threshold for chronic toxicity with a focus on TDS mixtures of similar composition to Meliadine Mine (i.e., dominance of chloride, sodium, and calcium ions).

- Review of site-specific chronic toxicity data (Section A1.4)—review of site toxicity data and corresponding TDS and major ion chemistry of treated effluent and influent samples for Meliadine Mine, as collected during routine and regulatory compliance toxicity testing.
- Weight of Evidence (Section A1.5)—integration of the above information to justify the interim target of 1,000 mg/L TDS to apply at the edge of the mixing zone.

The interim TDS target includes the following assumptions:

- Ambient water hardness should remain within the current range to ameliorate potential chloride toxicity (i.e., through demonstration of non-toxicity of chloride under site-relevant ranges of hardness).
- Additional site-specific validation of the TDS threshold should be conducted to confirm that the mixture of ions represented by the effluent and near-field exposure conditions does not result in acute or chronic toxicity. Such studies are planned, as discussed in Section 3.0.
- Effluent chemistry profiles, particularly with respect to the proportions of major ions, will remain generally consistent in the future.

There is already strong scientific evidence to support the interim target as protective of the aquatic community. The results of toxicity testing do not indicate that an exceedance above 1,000 mg/L TDS will result in harm to aquatic life but provide reasonable certainty of no harm up to 1,000 mg/L. The key lines of evidence are presented in Appendix A, and are supported by the following considerations:

- The Meliadine Mine effluent contains a balance of major ions that is advantageous for limiting the toxic potency of the TDS mixture (Section A1.5.1).
- The Snap Lake site, which applies the same TDS concentration as a SSWQO, provides similar ionic mixtures and biological communities (Section A1.5.2).
- The chronic toxicity data set for Meliadine Mine site water, which includes a battery of four sensitive aquatic species, supports the interim TDS target as a defensible no-effect concentration (Section A1.5.3).
- The ionic balance has been stable in Meliadine Mine water, such that an interim TDS target can be developed without requiring development of targets for individual component ions (Section A1.5.4).

2.3 Assimilation Capacity Evaluation

The ability of the receiving environment to assimilate the concentrations and loading of constituents in effluent is the last component of the WQ-MOP implementation. Consideration of assimilation capacity provides confidence that constituents will not gradually accumulate to concentrations that would degrade the receiving environment.

The approach to TDS management set out in the WQ-MOP is not expected to affect the quality, quantity, or flow of the waters in Meliadine Lake. TDS levels during and after the 2020 discharge will continue to be managed to minimize adverse effects of the licenced deposit of effluent on the aquatic ecosystem of Meliadine Lake, and discharges would continue to meet the stringent requirements set by the MDMER. Confidence in this conclusion comes from plume delineation surveys, preliminary dilution estimates from dispersion models, and consideration of the Meliadine Lake hydrology.

The evidence for sufficient assimilation efficiency in Meliadine Lake to accommodate the interim TDS target for effluent of 3,500 mg/L comes from:

- **Consistency with Previous Impact Assessment Outcomes**—Based on the predictions included in the Final Environmental Impact Statement (FEIS) for the Meliadine Mine Gold Project (Golder 2014), the one-time release of mine wastewater to Meliadine Lake under this amendment would not be expected to result in potential additional project effects. That is, water quality in the receiver and downstream environment would remain within the predictions included in the FEIS. For the FEIS assessment, a Maximum Allowable Concentration (MAC; referred to as the Maximum Allowable Effluent Concentration [MAEC] in the FEIS) of TDS in the discharge of 4,685 mg/L was calculated based on the approach applied in the province of Quebec (MDDEP 2007), where the mixing ratio in a lake is set to a value of 10 to 1. The calculation of the MAC is dependent on the background concentrations (BG) in the lake, the water quality criteria (WQG; the guideline), and the mixing ratio (MR), as established by the following equation:

  $$MAC = MR \times (WQG - BG) + BG.$$

  Where for TDS:

  MR = 10 (as per MDDEP)

  WQG = 500 mg/L (Guidelines for Canadian Drinking Water Quality [GCDWQ; HC 2010], aesthetic objective)

  BG = 35 mg/L

  Therefore:

  $$MAC = 10 \times (500 - 35) + 35 = 4{,}685 \text{ mg/L}$$

  This MAC is well above the proposed interim target of 3,500 mg/L proposed in this amendment.

- **Plume Delineation Results**—Under operating conditions, a plume delineation survey based on specific conductivity results was conducted in 2018 in the near-field region of Meliadine Lake as part of the Environmental Effects Monitoring (EEM)/Aquatic Effects Monitoring Program (AEMP). The EEM plume delineation study used field surveys of specific conductivity to evaluate effluent dispersion with distance from the diffuser. The study evaluated dilution factors at a series of monitoring stations up to, and extending beyond, 250 m from the diffuser, based on the specific conductivity of the effluent and the measured field values through the water column at each the stations. To account for background values, two scenarios were used:

  - Scenario A: near-field average specific conductivity for 2015 to 2016; and
  - Scenario B: near-field average specific conductivity for 2017

  An observed slight increase in specific conductivity between 2015 to 2016 (pre-construction) and 2017 (construction) was the impetus for considering the two scenarios.

  Observations from the survey indicated a minimum dilution factor of 53 at 50 m away from the diffuser, and a minimum dilution factor range of 56 (Scenario A) and 85 (Scenario B) at the edge of the 100 m mixing zone boundary (Table 1). This study was also useful because it served to validate the performance of the submerged diffuser, which had previously been assessed by Tetra Tech as part of their design (Tetra Tech 2017) and re-assessed in 2018 (Tetra Tech 2018). As part of their reassessment in 2018, Tetra Tech concluded that the predicted minimum dilution of 23:1 was achieved at the edge of the 100 m mixing zone and that water quality criteria were met. The minimum dilution factor was more than twice the mixing ratio of

10:1 that was used to derive the MAC in the 2014 FEIS; it was based on a multi-year modelling scenario[1] where the minimum dilution at 100 m at the end of the first year of discharge was 72:1. The latter ratio is consistent with earlier modelling work to support a conceptual diffuser in 2015 (Agnico Eagle 2015), which indicated that the minimum dilution factor was 65:1.

In summary, the range of dilution factors observed at 100 m distance from the diffuser (representing the edge of the mixing zone) determined from the EEM plume delineation study are greater than the minimum dilution factor (23:1) developed in the performance assessment of the diffuser completed by Tetra Tech in 2018 based on multi-year simulations. The dilution factors remain in broad agreement with Tetra Tech's assessment for the first year of discharge (72:1) and the early work completed by Golder (65:1).

Table 1: Dilution Factors in the Near-field Exposure Area at Meliadine Lake[(a)]

Sampling Station	Maximum Specific Conductivity in 2018 (µS/cm)	Dilution Factor – Scenario A	Dilution Factor – Scenario B
50-01	99.8	63	104
50-03	105.5	53	79
100-01	93.4	80	159
100-03	104	56	85
100-04	102.6	58	90
100-05	98.9	65	109
100-06	88.5	101	266
100-08	96.6	71	125

(a) Listed data represent a portion of the data listed in Table 2.4-10 of Golder (2019)

µS/cm = microsiemens per centimetre

The 2018 EEM plume delineation results suggest that the effluent concentration observed at the 100 m mixing zone boundary was less than 2% of concentrations observed at end of pipe. Furthermore, the survey results showed that the plume remained at depths of roughly between 3 and 7 m, indicating that the receiving water and the effluent discharged had similar densities and/or intense mixing. The measured data from 2018 showed that at the time of the survey, the plume was more distinct to the south-west of the diffuser, which indicates a preferential direction of plume advection during the time of survey. Changes in wind speed and direction including current direction and speed are key factors determining the plume dispersion direction on any given day.

- **Mixing Ratio Calculations**—Preliminary calculations of the MAC have been completed based on standard industry practices as well as the results of the near-field modeling completed by Golder, as shown in Table 2.

[1] The multi-year simulation included annual diffuser discharge to Lake Meliadine over the 14 year construction and operations timeline (Year -3 to Year 11). This scenario was included to assess the effects of water quality constituent build-up in the lake on the dilution factor.

Table 2: Calculations of Maximum Average Concentrations for TDS

Report	Guideline for Canadian Drinking Water Quality for TDS (HC 2010) (mg/L)	Assumed Meliadine Lake Average Background TDS Concentration (mg/L)	Assumed Mixing Factor	Maximum Average Concentration (mg/L)
2014[(a)]	500 mg/L	35 mg/L	10:1	4,685
2015[(b)]			65:1	30,260[(c)]
2018[(d)]			23:1	10,730[(c)]
2019[(e)]			56:1	26,075[(c)]

Notes:

(a) Golder 2014. Water and Sediment Quality Model – Meliadine Mine Gold Project, Nunavut. Appendix 7.4-A.

(b) Agnico Eagle (2015) (see Appendix E, Water Management Plan).

(c) Concentration of maximum average effluent TDS is conceptual only; effluent would **not** be discharged at TDS concentrations of this magnitude as it could result in acute toxicity at the point of discharge.

(d) Tetra Tech (2018).

(e) Golder. 2019. Appendix G – Field Data in the Near-field Exposure Area at Meliadine Lake Under the Plume Delineation Study, 2018.

For the preliminary calculations, the mixing ratio (MR) was established as:

- 2014—reflects approach applied by the province of Quebec (MDDEP 2007), where the mixing ratio in a lake is set a value of 10:1.
- 2015—reflects minimum mixing factor predicted by near-field modeling.
- 2018—reflects minimum mixing factor as modelled for diffuser design (Tetra Tech 2017, 2018).
- 2019—reflects minimum mixing factor calculated from observations of plume delineation survey at edge of the 100 m mixing zone.

TDS = total dissolved solids; mg/L = milligrams per litre.

Based on the model calculations and the observation of the plume delineation study, it is likely that the discharge of effluent with a TDS concentration at 3,500 mg/L, even at the lowest measured mixing ratio of 72, would result in negligible risk of sublethal toxicity at the edge of the mixing zone. This mixing potential at the edge of the mixing zone boundary limits the potential for a sublethal response.

Beyond the mixing zone, into the near- and far-field in Meliadine Lake, effluent will be carried by currents within the lake and further mixed with ambient water. The location of the effluent outfall diffuser is also within the expected main flow channel of the lake, which will act to convey and further disperse the effluent toward the lake outlet.

The assimilative capacity of the 100 m mixing zone will be validated through a detailed monitoring program, for which a conceptual design is provided in Section 3.0.

3.0 PHASE 2: CONDUCT VALIDATION STUDY

In conjunction with the 2020 releases that are planned to occur prior to or in conjunction with the freshet at Meliadine Mine and that have been approved under Amendment 1 of the Mine's Type "A" Water Licence, supporting studies are required to be conducted in spring/summer 2020 to validate the science-based interim targets and produce additional information on receiving environment assimilation (including plume delineation). This section presents the general conceptual design for the spring/summer 2020 monitoring study required as a condition under Amendment 1. The monitoring study will be undertaken both to assess conditions experienced in Meliadine Lake during the discharge event, and for use as a validation component of the WQ-MOP.

A discharge event to dewater Collection Pond 1 (CP1) has been approved by NWB and will occur at the Mine site in the spring/summer of 2020. TDS concentrations in the effluent will be elevated relative to the receiving environment during this discharge event, presenting an opportunity to conduct site validation for the interim TDS targets for the effluent and for the receiving environment at the edge of the mixing zone. These studies also provide the opportunity to collect additional information for the potential development of TDS EQC and SSWQO benchmarks, for use in adaptive management. The conceptual design for the proposed validation would consist of three components: water quality monitoring (Section 3.1), toxicity testing (Section 3.2), and plume delineation (Section 3.3).

These three components are complimentary and will be conducted with the following primary objectives:

- **Water Quality Monitoring:** The surface water quality monitoring program will be conducted to validate the model predictions that TDS will be diluted to less than 1,000 mg/L at the edge of the mixing zone, to provide detailed chemical characterization of the effluent and receiving environment during the discharge, and to provide information on the ionic composition of water used during the toxicity testing program.
- **Toxicity Testing:** The acute and chronic toxicity testing programs will be conducted to confirm that the ionic composition measured in the effluent and the receiving environment during the surface water quality monitoring program are not at levels that would cause adverse biological effects. As described in detail in Section 3.2 and summarized in Table 3, acute toxicity tests will be conducted on the effluent and a suite of chronic toxicity tests will be conducted on receiving environment samples.
- **Plume Delineation Study**—The plume delineation study will be conducted to assess the vertical and horizontal extent of the effluent plume. This will primarily be assessed through *in situ* specific conductivity profiling of the water column using a handheld meter with a sensor that will be lowered through the water column, with a subset of locations sampled for TDS. The relationship between field measured specific conductivity and laboratory measured TDS will be established to validate the use of specific conductivity as a tracer of TDS in the receiving environment. The information retrieved will be used to confirm model predictions related to effluent dilution and assimilation in the receiving environment, and to confirm that receiving environment monitoring stations are adequately characterizing conditions with respect to surface water chemistry and the potential for adverse biological effects.

An overview of the conceptual design is presented in Table 3 and discussed in detail by component below.

Table 3: Conceptual Design for Proposed Validation of Interim TDS Limits for Effluent and Receiving Environment

Water Quality Monitoring Program			
Sampling Media	**Effluent**	**Mixing Zone**	**Receiving Environment** (beyond mixing zone)
Sample Timing	During effluent discharge and during collection of effluent samples for toxicity testing	During effluent discharge[(a)]	During effluent discharge[(a)]
Sampling Locations	MEL-14	3 stations at the edge of the mixing zone (MEL-01-01, MEL-01-07 and MEL-01-10)[(b)]	4 stations - 1 mid-field (MEL-02-05), 3 references (MEL-03-02, MEL-04-05, and MEL-05-04)
Number of Samples	Per regulatory and operational requirements	1 sample per station	1 sample per station
Frequency of Sampling	Weekly during discharge	Weekly during discharge or as per NWB's direction	Monthly during discharge or as per NWB's direction
Test Parameters	▪ Daily monitoring of effluent flow volumes ▪ Parameters as listed in Schedule I Group 2 of the 2AM-MEL1631 NWB Water Licence[(c)]	▪ Field physico-chemical water column profile measurements (temperature, specific conductivity, pH, DO) ▪ Parameters as listed in Schedule I Group 2 of the 2AM-MEL1631 NWB Water Licence[(c)]	▪ Field physico-chemical water column profile measurements (temperature, specific conductivity, pH, DO) ▪ Parameters as listed in Schedule I Group 2 of the 2AM-MEL1631 NWB Water Licence

Table 3: Conceptual Design for Proposed Validation of Interim TDS Limits for Effluent and Receiving Environment

Toxicity Testing Program			
Sampling Media	**Effluent**	**Mixing Zone**	**Receiving Environment** (beyond mixing zone)
Sample Timing	During effluent discharge	During effluent discharge[(a)]	During effluent discharge[(a)]
Sampling Locations	MEL-14	3 stations at the edge of the mixing zone (MEL-01-01, MEL-01-07 and MEL-01-10)[(b)]	4 stations - 1 mid-field (MEL-02-05), 3 references (MEL-03-02, MEL-04-05, and MEL-05-04)
Number of Samples	Per regulatory and operational requirements	1 composite sample per station	1 composite sample per station
Frequency of Sampling	Weekly during discharge	Monthly during discharge	Monthly during discharge or as per NWB direction
Test Parameters	Acute toxicity tests with: ▪ Rainbow Trout ▪ *Daphnia magna*	Chronic toxicity tests with: ▪ Pelagic crustacean (*Daphnia magna*) ▪ Epibenthic Invertebrate (*Hyalella azteca*) ▪ Macrophyte (duckweed) ▪ ELS fish (Fathead Minnow)	Chronic toxicity tests with: ▪ Pelagic crustacean (*Daphnia magna*) ▪ Epibenthic Invertebrate (*Hyalella azteca*) ▪ Macrophyte (duckweed) ▪ ELS fish (Fathead Minnow)
Plume Delineation Study			
Sampling Media	**Effluent**	**Receiving Environment** (within mixing zone and beyond)	
Sample Timing	During effluent discharge[(d)]	During effluent discharge[(d)]	
Sampling Locations	MEL-14	22 survey locations (see Appendix B) at distance intervals of 50 m from the diffuser, 100 m (i.e., edge of mixing zone), 175 m, and 250 m; potentially adjusted to include further afield samples if necessary[(e)]	
Frequency of Program	1 event during discharge	1 event during discharge	
Test Parameters	▪ TDS and major ions ▪ General parameters[(f)]	▪ Field physico-chemical water column profile measurements (temperature and specific conductivity) ▪ Water quality samples collected at a subset (a maximum of 10 stations) stations alongside profile measurements and analyzed for TDS, major ions, and general parameters[(f)]	

Notes:

(a) The timing of sampling for each program is expected to occur continuously during the discharge period as outlined in the sample frequencies listed above for each sample media and test type. However, sample timing will be dependent on safe access to the lake. The period of anticipated discharge will likely coincide with the transition period between ice covered and open water conditions on Meliadine Lake. If samples cannot be collected at the required time due to safety considerations, contingency measures may be implemented, as outlined in Section 3.4.

(b) Parameters as listed in Schedule I Group 2 of the 2AM-MEL1631 NWB Water Licence include Conventional Parameters (bicarbonate alkalinity, chloride, carbonate alkalinity, turbidity, conductivity, hardness, calcium, potassium, magnesium, sodium, sulphate, pH, total alkalinity, TDS, TSS, total cyanide, free cyanide, and weak acid dissociable [WAD] cyanide), Nutrients (ammonia-nitrogen, total Kjeldahl nitrogen, nitrate-nitrogen, nitrite-nitrogen, orthophosphate, total phosphorus, total organic carbon, dissolved organic carbon, and reactive silica), and Total and Dissolved Metals (aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, tin, titanium, uranium, vanadium, and zinc).

(c) Mixing zone stations MEL-01-01 and MEL-01-07 are routinely sampled by the mine during the EEM/AEMP programs. MEL-01-10 represents a new sampling station. Further details on the selected mixing zone sampling stations are provided in Section 3.1.

(d) Sample timing will be dependent on boat access to the lake. The period of anticipated discharge will likely coincide with the transition period between ice covered and open water conditions on Meliadine Lake. Access of the lake will occur as soon as open water conditions permit safe boat access.

(e) The maximum spatial extent of plume delineation monitoring may be extended past 250 m should the proportion of effluent be estimated to contribute >10% of TDS at 250 m (estimated based on field specific conductivity measurements).

(f) General parameters = total and bicarbonate/carbonate alkalinity, turbidity, laboratory specific conductivity, hardness, laboratory pH, and total suspended solids.

ELS = early life-stage; TDS = total dissolved solids.

3.1 Water Quality Sampling

Water quality samples will be collected and analyzed for a suite of parameters (conventional parameters, nutrients, and total and dissolved metals) to characterize water quality conditions of the effluent and the receiving environment of Meliadine Lake. The water quality results will also inform the ionic composition of effluent and receiving environment samples used during toxicity testing for site-specific validation of the interim target established for the edge of the mixing zone (see Section 3.2). The water quality data will also provide confirmation that TDS in water released at sampling station MEL-14 remains within permitted levels established through Amendment 1 (i.e., MAC is ≤3,500 mg/L TDS; edge of mixing zone ≤1,000 mg/L TDS). Samples of effluent for water chemistry analysis should, to the extent possible, be collected on the same day as edge of mixing zone and receiving environment (mid-field and reference locations) samples and analyzed for the same suite of parameters. As described in NWB's (2020) Reasons for Decision document, water quality samples within the discharge period will be collected as follows from monitoring stations routinely sampled during the mine's EEM/AEMP program:

- **Effluent samples:** The effluent (defined as sampling station MEL-14) will be sampled weekly during discharge for conventional parameters, nutrients, and total and dissolved metals.
- **Edge of mixing zone samples:** Three stations located at the edge of the mixing zone will initially be sampled weekly during the discharge for conventional parameters, nutrients, and total and dissolved metals. These edge of mixing zone sampling stations were selected following review of the 2018 plume delineation study results. The stations include MEL-01-01 and MEL-01-07, which are located approximately 100 m northwest and northeast of the diffuser, respectively. These stations are routinely sampled as part of the mine's EEM/AEMP program. To improve spatial coverage surrounding the diffuser, it was determined that a water quality sample should be collected at the edge of the mixing zone towards the southeast of the diffuser. MEL-01-06 represents a station located southeast of the diffuser that is currently monitored under the mine's EEM/AEMP program; however, this station is located outside of the 100 m mixing zone boundary (i.e., ~200 m from the diffuser). As a result, a new station, MEL-01-10, will be monitored at the edge of the mixing zone. MEL-01-10 was selected to provide spatial coverage at the edge of the mixing zone (i.e., 100 m radius surrounding the diffuser) and will correspond with the station 100-04 selected for the plume delineation study described in Appendix B. The UTM coordinates of this station (Easting 542861.3, Northing 6989059.1) are further described in Figure 2 and Table 1 of Appendix B. The specific water depths that will be sampled at each station will be determined in the field based on the specific conductivity profile observed at the time of sampling, to account for changes in plume conditions that could occur over time. As such, the depth sampled at each edge of mixing zone station may change between rounds of sampling. The sampling frequency may also be adjusted during the program based on results and conversations held during the Water Management Working Group review meetings.
- **Receiving environment – mid-field samples:** One mid-field station (MEL-02-05) will initially be sampled monthly during the discharge for conventional parameters, nutrients, and total and dissolved metals. The sampling frequency may be adjusted during the program based on results and conversations held during the Water Management Working Group review meetings.
- **Receiving environment – reference Samples:** Three reference stations (MEL-03-02, MEL-04-05, and MEL-05-04) will initially be sampled monthly during the discharge for conventional parameters, nutrients, and total and dissolved metals. The sampling frequency may be adjusted during the program based on results and conversations held during the Water Management Working Group review meetings.

Physico-chemical profiling of the lake water column will be measured *in situ* using water quality meters (e.g., Hanna, YSI, Eureka or equivalent) equipped with a 20 m or longer cable at each edge of mixing zone and receiving environment sample location. Samples for laboratory water quality analysis will be collected at each location based on the depth determined to have the highest specific conductivity.

Additionally, to facilitate the collection of *in situ* physico-chemical data (i.e., specific conductivity, dissolved oxygen concentrations, temperature, and pH) at the edge of the mixing zone during the period where ice cover transitions to open water across the lake, prohibiting safe lake access, Agnico Eagle will install remote monitoring stations at the edge of the mixing zone prior to the discharge event. This monitoring will collect and log specific conductivity and temperature data at several depths at these stations, which will be recovered once the lake can be safely accessed.

3.2 Sampling for Toxicity Testing

The 2020 discharge event provides an opportunity to evaluate TDS toxicity under site-relevant conditions. During discharge, representative water samples will be collected and tested for laboratory-based toxicity using standardized protocols for aquatic toxicity. The toxicity testing program will include separate test protocols for effluent and receiving water samples.

Effluent samples from sampling station MEL-14 will be collected and tested using the suite of toxicity test species and standard protocols conducted for acute lethality testing and EEM under the MDMER. As outlined in NWB's (2020) Reasons for Decision document, the effluent (sample ID: MEL-14) will be sampled weekly during the discharge and tested for acute toxicity using the following acute toxicity test protocols:

- 96-hour Rainbow Trout survival test using the Environment Canada (2007a) standard biological test method (EPS 1/RM/9)
- 48-hour *Daphnia magna* survival test using the Environment Canada (1996) standard biological test method (EPS 1/RM/11)

As outlined in NWB's (2020) Reasons for Decision document, receiving environment stations will be sampled monthly during the discharge and tested using a suite of chronic toxicity tests that were agreed upon following consultation with the Water Management Working Group. Edge of mixing zone and receiving environment (i.e., mid-field and refence locations) samples will be tested for chronic toxicity using a multi-species approach that uses standardized chronic toxicity test protocols:

- **21-day *Daphnia magna* survival and reproduction test using the ASTM (2007) standard biological test method (Method E1193-97)**—*D. magna* was selected as a chronic test species to evaluate receiving environment water quality, as it is well studied and sensitive pelagic crustacean, and found to be more ecologically relevant to northern lake communities relative to other crustaceans such as *Ceriodaphnia dubia*. The 21-d *D. magna* test was selected over the 7-d *Ceriodaphnia dubia* survival and reproduction test because the former is native to Meliadine Lake, and was recommended by stakeholders in the consultation stage to be preferred as a monitoring species.
- **14-day *Hyalella azteca* water-only survival and growth test using the Environment Canada (2017) standard biological test method (EPS 1/RM/33)**—*H. azteca* was selected as a chronic test species to evaluate receiving environment water quality, as it is a well studied and sensitive invertebrate species. *H. azteca* was selected over the freshwater midge, *Chironomus dilutus,* as *H. azteca* is considered an epibenthic species (i.e., inhabits the microenvironment at the sediment-water interface), whereas *C. dilutus* is a benthic infaunal species that burrows in sediment and would have less direct exposure to receiving

waters. The feeding strategy of *H. azteca*, which derives little nutrition from the sediments, and responds primarily to contaminants in the overlying water column (including water and food; Wang et al. 2004), is well suited to an evaluation of environmental responses associated with effluent discharges. Similarly, the other benthic invertebrate group considered, mayflies, were considered less relevant as the candidate test species tend to prefer either more flowing habitats (e.g., *Centroptilum* representative of Eastern North America streams and rivers), or temperate lakes and streams (e.g., *Hexagenia* representative of slow moving streams and ponds of the Great Lakes), which are less relevant for the northern lentic Meliadine Lake environment. Mayflies are less commonly tested and with lower degree of protocol standardization, such that obtaining representative, reliable, and repeatable results was considered a potential project risk.

- **7-day *Lemna minor* (duckweed) growth test using the Environment Canada (2007b) standard biological test method (EPS 1/RM/37)**—*L. minor* was selected as a chronic test species to evaluate receiving environment water quality, as it is a well studied and sensitive macrophyte species. NWB (2020) approved either the 7-day *Lemna minor* or the 72-h green alga (*Pseudokirchneriella subcapitata*) growth test for evaluating receiving environment water quality with respect to primary producers. *L. minor* was selected for testing as it was identified as the more sensitive of the two species during site-specific testing of CP1 water during the derivation of the proposed interim thresholds (Appendix A).
- **7-day larval Fathead Minnow (*Pimephales promelas*) survival and growth test using the Environment Canada (2011) standard biological test method (EPS 1/RM/22)**—Fathead Minnow were selected as a chronic test species to evaluate receiving environment water quality, as it is a well studied and sensitive early life-stage fish species. NWB (2020) approved either the 7-day Fathead Minnow survival and growth test or the 7-d Rainbow Trout embryo development test for evaluating receiving environment water quality with respect to early life-stage fish. Fathead minnows were selected for testing because the Rainbow Trout embryo development test is contingent on being able to secure viable embryos. Because the testing is expected to occur monthly during the discharge, it was identified that quality Rainbow Trout embryos may not be consistently available throughout the program, which would complicate temporal interpretation of chronic toxicity test results. As a result, the 7-day Fathead Minnow test was selected as the preferred option for early life-stage chronic fish testing.

Three types of samples will be collected from the receiving environment during each monthly sampling event for evaluation using the suite of chronic toxicity tests listed above. These samples include the following:

- **Edge of mixing zone samples**—Three stations located at the edge of the mixing zone (MEL-01-01, MEL-01-07, and MEL-01-10, as described in Section 3.1) will be sampled during each monthly sampling event for chronic toxicity testing. Prior to toxicity testing, physico-chemical water quality profiling of the water column at mixing zone sampling stations will be conducted to identify the samples with the highest specific conductivity (measured *in situ*). Samples will be collected at the depth with the highest conductivity for toxicity testing. Mixing zone stations will be tested for chronic toxicity using a standard dilution approach (i.e., 100%, 50%, 25%, 12.5% and 6.25% volume to volume dilutions) with the suite of chronic toxicity tests identified above. Dilutions will be conducted with laboratory water selected to provide broad comparability to Meliadine Lake.
- **Receiving environment – mid-field samples**—One mid-field station (MEL-02-05) will be sampled during each monthly sampling event for chronic toxicity testing. This mid-field sample will be tested for chronic toxicity using the full-strength sample with no dilution series (i.e., pass/fail test design).
- **Receiving environment – reference samples**—Three reference stations (MEL-03-02, MEL-04-05, and MEL-05-04) will be sampled during each monthly sampling event for chronic toxicity testing. These reference samples will be tested for chronic toxicity using the full-strength sample with no dilution series.

As the primary constituent of concern is TDS (including its component ions), concentrations would not be expected to decrease significantly during storage of a few weeks duration. As a result, a sufficient volume of sample for chronic toxicity testing will be collected at each station once per month. The samples will be collected with minimal headspace and transported under cool dark conditions to the respective toxicology laboratories. Upon arrival at the laboratories, samples will be stored in the dark at 4°C until test initiation. For chronic tests that call for renewals of test solutions during the exposure period, the refresh solution will be obtained from the bulk sample used to supply water at test initiation. The advantage to this approach is that the exposure concentration experienced by the organisms during the test will be held constant and will correspond directly with samples collected for detailed chemistry. The chronic toxicity test protocols require that conductivity be monitored during the tests, which should provide confirmation that TDS exposure concentrations remain relatively constant throughout the exposure duration.

Attempts will be made to conduct toxicity tests within the respective hold time requirements (i.e., 3 days for chronic tests) specified in the test protocols; however, slight deviations from hold time requirements may be unavoidable due to the mine's remote location and due to the current situation surrounding COVID-19. For the purposes of this study, hold time exceedances are not considered to represent a deviation from the test protocol because TDS concentrations are not expected to measurably change during storage. To validate this assumption, if samples are initiated outside the respective hold times, a subset of the stored toxicity samples will be tested for TDS so that comparisons can be made with the samples collected for analytical chemistry in the field.

3.3 Plume Delineation Study

A plume delineation study will be conducted in the near-field area of Meliadine Lake immediately outside of the mixing zone once it is safe to access the lake during effluent discharge to characterize the effluent plume configuration, validate model predictions related to effluent dilution and assimilation in the receiving environment, and to confirm that receiving environment monitoring stations are adequately characterizing edge of mixing zone conditions. Study timing will be dependent on safe lake access. Although discharge will likely commence during ice cover conditions and continue during the transition period between ice cover and open water conditions on Meliadine Lake, boat access to the lake is required to conduct the plume delineation study. Therefore, the plume delineation study will occur once open water conditions permit safe boat access.

Specific conductivity and temperature depth profiling at different spatial intervals from the effluent diffuser (i.e., collected at 50 m, 100 m, 175 m, and 250 m distances at 22 stations around the diffuser; potentially adjusted to include further afield samples if necessary) will be used to depict the dimensions and behaviour of the plume. A subset of the planned sampling stations (i.e., a maximum of 10 of the 22 identified locations) will be sampled for laboratory analysis of TDS, major ions, and other general parameters. Samples selected for more detailed analyses will be selected to encompass the range of specific conductivity measures observed surrounding the outfall. These data from the plume delineation study will provide:

- validation that the water quality at the edge of the mixing zone is consistent with predictions of TDS and major ion concentrations (as estimated using existing water quality from the effluent and modeling of the receiving environment)
- confirmation that the relationship between specific conductivity and water quality is sufficiently reliable for use in future plume delineation
- representation of the rate of effluent dispersion in the near-field region in Meliadine Lake, to address the assimilation capacity portion of the WQ-MOP.

This study would occur over one to two days during the effluent discharge once safe access to the lake is possible. A detailed study plan for the Plume Delineation Study is provided in Appendix B and is similar in scope to plume monitoring conducted during the 2018 Meliadine Mine EEM/AEMP.

3.4 Contingency Planning

Field monitoring and data collection will be conducted by Agnico Eagle Mine personnel, with support from Golder on an as-needed basis. Golder will provide the detailed study design for each component, specific work instructions, program coordination, data analysis, and reporting. Sample collection, chain-of-custody, and health and safety will be the responsibility of Mine staff. Due to the remote location of the Meliadine Mine site, the seasonal lake conditions during ice melt, and the current public health situation surrounding COVID-19, contingency planning for unforeseen complications related to the monitoring program are necessary to provide a framework that can be safely implemented in the event that certain aspects of the proposed monitoring program become unworkable. This section summarizes some of the factors that could influence the need to modify the sampling program, and the measures that will be undertaken to maintain program implementation within the practical and safety constraints.

Following discussions between Agnico Eagle and the Water Management Working Group, NWB (2020) has stipulated that the following contingency measures should be considered in case complications prohibit sampling and analysis as outlined in Table 3:

- *Use of specific conductivity or TDS field measurements as a surrogate for laboratory measured TDS and the contributing ions (development of a statistical relationship between field measurements of specific conductivity and laboratory TDS)*
- *Agnico Eagle should consult with the Water Management Working Group in respect of all monitoring and adaptive management measures* (see Section 3.5) *implemented by Agnico Eagle over the course of the CP1 discharges in 2020*

Where schedule allows, and where adaptations would result in a significant departure from the study design, input will be sought from the Working Group. Therefore, this section emphasizes circumstances that may require revisions to the program with a few days notice, and for which a formal consultation step is not feasible.

3.4.1 Ice Melt

Due to the timing of effluent discharge during freshet, safe access to Meliadine Lake may pose a challenge due to melting ice conditions. It is anticipated that effluent discharge will begin before the lake is completely ice-free to alleviate on-site water storage capacity limitations. Therefore, the edge of mixing zone and receiving environment monitoring conducted as part of this study may not be possible at certain times during the discharge due to safety concerns associated with ice melt. The following outlines contingency measures that could be implemented if the receiving environment is not accessible at the start of the discharge event:

- **Option 1—Delay open-water environment sampling (edge of mixing zone and receiving environment [mid-field and reference locations])**. Depending on the ice cover conditions and the long-term weather forecast at the time of initial discharge, it may be prudent to delay the first round of open-water sampling, to provide improvement in conditions and safety, without any other changes required to the sampling program.
- **Option 2—Temporary replacement of open water sampling with expanded effluent testing using dilutions**. The discharge monitoring station, MEL-14, is located on land and is therefore expected to be accessible when lake ice prohibits receiving environment sampling (both edge of mixing zone samples and receiving environment samples). As a result, if receiving environment samples cannot be sampled during the

first month due to unsafe sampling conditions caused by melting ice on Meliadine Lake, additional whole effluent samples from MEL-14 could be sent to the toxicology laboratory and tested using an extended dilution series that encompasses a larger range of TDS concentrations than would be expected in the receiving environment. These tests would be simulations of water quality and toxicological responses to approximate the field conditions, with a return to direct sampling of field conditions as soon as appropriate. Such chronic toxicity data could then be compared to *in situ* monitoring data that would be collected following ice-free conditions to validate the interim targets established at the edge of the mixing zone. Although this contingency would have uncertainty related to the estimation of effluent dilution in the mixing zone, it has the added benefit of providing site-specific chronic toxicity data at test concentrations greater than those expected at the edge of the mixing zone. These data would be informative for both the short-term monitoring needs, but also to validate longer-term benchmarks for TDS in the effluent (EQC-setting) and receiving environment (SSWQO). Such benchmarks would support a future application for a permanent amendment to these targets under the mine's water licence (i.e., support WQ-MOP Phase 3—long-term management of TDS).

3.4.2 Laboratory Testing

The study design has been developed to provide a high level of care and quality management, but laboratory testing always carries some risk of uncontrollable disruption:

- **Shipment Delay**—Due to the remote location of the site, and the multiple legs required for shipment from Nunavut to the Quebec transfer location, and subsequently to the analytical laboratories, there is a possibility of holding time exceedances for chemical or toxicological analyses (these times vary by test type but are generally a few days in duration). The potential for time delays increases during the Covid-19 condition due to the reduced options for alternate shipping routes. In the event of a minor holding time exceedance, we propose to continue with testing of the samples as promptly as can be accommodated by the laboratories, with associated documentation of the necessary protocol deviations. The contaminant types of primary interest in the samples (i.e., major ions and metals) are resistant to rapid sample degradation. Cancellation or rescheduling of the testing program would result in loss of information and associated uncertainty that far outweighs the consideration of holding time. Additional chemical analysis (e.g., both test initiation and termination) can be used to provide confidence in the stability of the chemical mixtures.

- **Test Failure**—A low percentage of toxicity tests result in test failures (i.e., unacceptable performance of negative control media, or other major disqualification, such as a prolonged power outage causing violation of rules for controlled environmental conditions). We have attempted to anticipate potential causes of control failures (e.g., fungal infestation of water samples, essential micronutrient levels of tests). If other unforeseeable factors result in a test failure, the default approach will be to proceed in order of:

  - Consult the laboratory to determine if the cause of failure can be identified
  - Restart the test using additional archived sample, if available
  - If test cannot be repeated with confidence, repeat test with fresh sample in the subsequent monitoring event (with additional water volume provided to support follow-up investigation of cause, if needed)
  - If multiple rounds of testing indicate a systematic problem with test quality, consider replacement testing (e.g., new laboratory, replacement test protocol)

- **Inadequate Sample Volumes**—In the event that water volumes are inadequate (e.g., sample containers compromised or lost in transit), attempts will be made to salvage the testing round through minor adjustments to the design, such as:
  - Replacement of site water with a synthetic water sample designed to mimic the ionic composition of the site water (e.g., laboratory preparation of a simulated Meliadine Lake ambient background water composition)
  - Modification of the dilution series to make efficient use of available sample

The contingency measures provided above represent an initial planning step and are not expected to address all potential complications that could arise during the monitoring program. As a result, these planning steps should be viewed as preliminary measures that are expected to evolve as the program progresses. Golder and Agnico Eagle will work together to identify additional contingency measures where necessary during the program and, where practical, will provide new contingency plans to the Water Management Working Group for comment and discussion prior to implementation.

3.5 Adaptive Management

As described in NWB's (2020) Reason for Decision, adaptive management measures related to the emergency discharge will be discussed on an ongoing basis throughout the discharge event during meetings with the Water Management Working Group comprised of the Kivalliq Inuit Association, Crown-Indigenous Relations and Northern Affairs Canada (CIRNAC), Environment and Climate Change Canada (ECCC), and NWB. However, prior to the first Water Management Working Group meeting, which is tentatively scheduled for two weeks following initiation of the discharge, NWB (2020) has stipulated that the following preliminary adaptive management thresholds and triggers be implemented during water quality monitoring of the discharge event:

- *If two consecutive end-of-pipe sampling events identify TDS concentrations equivalent to, or greater than, 3,500 mg/L, Agnico Eagle will increase sampling frequency*
- *If two consecutive edge-of-mixing-zone sampling events identify TDS concentrations equivalent to, or greater than, 75% of the interim target of 1,000 mg/L, Agnico Eagle will increase sampling frequency*

These thresholds and their application based on the respective sample timing at the end of pipe and edge of the mixing zone provides for a high level of responsiveness should monitoring data trigger adaptive management responses. The intent of the adaptive management thresholds and triggers is to initiate a response when there have been two consecutive measurements above the listed TDS thresholds.

The preliminary adaptive management measures (i.e., increase sampling frequency as required) will be implemented if the above referenced management targets are not achieved. NWB will be notified promptly of any adaptive management measures that are implemented throughout the discharge period. Additional adaptive management strategies that may be considered on a case-by-case basis if non-compliance with the above targets are observed, or if the results of the validation studies identify other non-conformances are:

- Decreasing the rate of effluent discharge or temporary cessation of pumping of the discharge could be considered to increase dilution and decrease the overall size of the plume.

- Consideration given to collecting additional edge of the mixing zone sample(s) for exploratory chronic toxicity testing to further validate the proposed interim target at the edge of the mixing zone. These additional samples could be amended with ionic salts in an ionic composition relevant to the edge of mixing zone and tested as a dilution series. The purpose would be to facilitate testing at concentrations both above and below the concentrations measured at the time of sampling, for the purpose of developing a concentration-response curve.
- Consideration given to additional targeted toxicity testing (e.g., validation test, or toxicity identification evaluation to explore the cause for an observed toxicological response), either in response to an acute toxicity outcome (e.g., mortality to crustacean *D. magna*) or for a moderate- to high-magnitude chronic toxicity response. Such toxicity is not anticipated to occur during the program (i.e., the thresholds have been set specifically to avoid such responses); however, if an anomalous response is observed, a TIE could help elucidate the cause.

If additional testing or analysis is conducted, per the second or third bullets above, the data would be useful both as a contingency measure and for longer-term management (i.e., WQ-MOP Step 3). These approaches have been applied at other northern mine sites to better understand the concentration-response and define the lower bound of where TDS may cause chronic toxicity in site-specific mixtures. Multiple chronic toxicity tests have already been conducted in recent years, and these support the proposed interim target at the edge of the mixing zone; additional tests would expand on that knowledge, clarifying the nature of TDS concentration-response, and the influence of modifying factors.

Additional adaptive management strategies, if necessary, would be proposed to the Water Management Working Group in advance of the next scheduled meeting to facilitate discussion and agreement prior to implementation.

4.0 CONCLUSIONS

The application of the WQ-MOP framework provides a basis for management of effluent discharges from Meliadine Mine to Meliadine Lake that:

- Is protective of the environment (both in the mixing zone and broader ecological condition of Meliadine Lake), as demonstrated in this memorandum, which provides Phase 1 and the conceptual elements of Phase 2 of the WQ-MOP
- Will satisfy regulatory requirements for the short-term (Phase 1 and 2) and long-term (Phase 3) management of TDS:
  - interim targets for TDS proposed herein satisfy short-term regulatory requirements for management of TDS during the 2020 discharge, subject to conditions outlined in Emergency Amendment 1, and endorsement of the interim targets for effluent and at the edge of the mixing zone
  - interim targets for TDS proposed herein form the basis for development of TDS targets for effluent (EQC) and receiving environment (SSWQO), following validation monitoring, for future application under an adaptive management framework
- Is based on science, including both site-specific evaluations of toxicity and comparison to other project approvals with similar composition of TDS
- Is customized to the site-specific conditions of water quality and quantity (with revisions as appropriate should these conditions change)

It is acknowledged that the aspects of the interim targets for TDS and, if required, future development of EQC and SSWQO, will benefit from additional confirmatory study. Our revised WQ-MOP provides the technical basis for these studies, and leverages the environmental monitoring of the 2020 discharge, which provides an opportunity to collect the data necessary for both short-term validation (i.e., Phase 2 of the WQ-MOP) and long-term management (i.e., Phase 3 of the WQ-MOP).

Signature Page

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APPENDIX A

Supporting Information for the Interim TDS Targets

APPENDIX A: SUPPORTING INFORMATION FOR INTERIM TDS TARGETS

This Appendix presents the supporting information and rationale for the proposed interim targets of: (a) 1,000 mg/L calculated TDS to apply at the edge of the mixing zone (Section A1.0) and (b) 3,500 mg/L calculated TDS to apply for effluent discharge (Section A2.0).

To prepare the interim targets, Golder Associates Ltd. (Golder) was requested to build from existing work performed on TDS benchmarks (i.e., Golder 2019), including the following:

- Incorporation of site-specific toxicity data.
- Integration with the framework discussed with regulators for developing interim water quality targets for TDS that reflect the site-specific mixture of ions, confirmed through standardized toxicity tests (acute and chronic toxicity testing) and evaluation of assimilative capacity.
- Establishment of a process for validation of interim targets in summer 2020.

The development of interim water quality targets for Agnico Eagle Nunavut operations was discussed with Environment and Climate Change Canada (ECCC) in several recent meetings and associated reviews:

- *Meeting on 9 December 2019 (Agnico Eagle 2019)*. This meeting discussed the technical approach to development of site-specific water quality objectives (SSWQO) for multiple projects (and constituents of interest) in Nunavut.
- *TDS Technical Memorandum (Golder 2019)*. This memorandum was prepared as a draft document to support a technical approach to development of SSWQOs for TDS.
- *Meeting on 9 January 2019 (Agnico Eagle 2020)*. This meeting discussed the technical approach to development of SSWQOs specific to TDS and its components, following from the ECCC review of Golder (2019).
- *Final Public Hearings for the Whale Tail Expansion Project, Baker Lake NU, February 13–14, 2020*. The hearings included contributions from ECCC (as Intervenors), and from Agnico Eagle (in the Proponent's concluding statements) and included areas of general agreement regarding a conceptual approach to regulation of TDS.

A1.0 INTERIM TDS TARGET AT THE EDGE OF THE MIXING ZONE

The benchmark of 1,000 mg/L calculated TDS is proposed as an interim value for use in the short-term, pending implementation of Phase 2 and Phase 3 of the WQ-MOP.

The proposed interim target was derived as summarized below and detailed in the subsequent sections:

- Characterization of the Meliadine TDS profile (Section A1.1)—water chemistry data collected at the Meliadine Mine were used to profile the anticipated water quality in the receiving environment, including composition of major component ions in the TDS mixture.
- Review of water quality benchmarks (Section A1.2)—review of TDS benchmarks developed for locations with a similar TDS composition to Meliadine Mine.
- Literature review (Section A1.3)—review of peer-reviewed literature to determine the threshold for chronic toxicity with a focus on TDS mixtures of similar composition to Meliadine (i.e., dominance of chloride, sodium, and calcium ions).

- Review of site-specific chronic toxicity data (Section A1.4)—review of site toxicity data and corresponding TDS and major ion chemistry for Meliadine treated effluent and influent samples, as collected during routine and regulatory compliance toxicity testing.
- Weight of Evidence (Section A1.5)—integration of the above information to justify an interim target TDS concentration of 1,000 mg/L to apply at the edge of the mixing zone.

A1.1 Characteristics of Total Dissolved Solids

A1.1.1 Definition

The TDS parameter is defined as the sum of the concentrations of all common dissolved ions in freshwaters (e.g., sodium [Na^+], calcium [Ca^{2+}], magnesium [Mg^+], potassium [K^+], sulphate [SO_4^{2-}], bicarbonate [HCO^{3-}], chloride [Cl^-], nitrate [NO^{3-}], fluoride [F^-], and silicate [SiO_3^{2-}]), and is essentially an expression of salinity. TDS can be calculated using the following equation (APHA 2005):

$$TDS_{calculated\ (mg/L)} = \sum[Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, F^-, SO_4^{2-}, SiO_3^{2-}, 4.42 \times NO_3^-\ (as\ N), 0.6 \times total\ alkalinity\ (as\ CaCO_3)]$$

Concentrations of TDS may also be measured gravimetrically by analytical laboratories. However, calculated TDS is used herein as the primary basis for derivation of interim targets for TDS and screening because:

- Laboratory interference can reduce the accuracy of measured TDS (Evaristo-Cordero 2011). In particular, waters with high calcium, magnesium, and chloride concentrations can form hydroscopic residues that absorb water under normal laboratory conditions, potentially biasing the measured TDS higher than actual concentrations (APHA 2005; Evaristo-Cordero 2011). In contrast, calculated TDS is based on the major ions that can measurably contribute to TDS and is therefore, not influenced by any changes that may occur from those ions being taken out of solution.
- Calculated TDS incorporates explicit consideration of the ionic composition, which is important for evaluating the toxicity of the TDS mixture (as discussed below).
- Calculated TDS is forecasted, using predictive modelling, to estimate potential TDS concentrations in effluent and receiving environment under future mine conditions; use of calculated TDS for the interim target provides an equivalence for comparison relative to modelled conditions.

In recent meetings, ECCC expressed a preference that concentrations of TDS be expressed on a measured concentration basis. Agnico Eagle has committed to presenting monitoring results using both methods (calculated and measured).

A1.1.2 General Fate and Effects

Dissolved solids occur naturally in water, with the composition and concentration of individual ion constituents varying by location based on natural factors, such as the geology and soil in the watershed, atmospheric precipitation and the water balance (evaporation-precipitation) (Weber-Scannell and Duffy 2007). Anthropogenic activities can alter the concentration of TDS in the aquatic environment, with effluent from mining or industrial treatment of water identified as common sources of elevated TDS (Soucek 2007; Weber-Scannell and Duffy 2007). Differences in the ratios of calcium to magnesium (Ca:Mg) or relative contribution of sulphate or chloride to the total TDS concentration are common indicators of anthropogenic influence.

The primary toxicity modifying factor for TDS is ionic composition, reflecting the fact that individual ionic components exhibit different potential to exert toxicity. For example, Mount et al. (1997) reported 48-hr LC_{50} values ranging from 390 to >5,610 mg/L in *C. dubia* and 96-hr LC_{50} values ranging from <510 to 7,960 mg/L in the Fathead Minnow exposed to various ion combinations, respectively. In general, a balanced mixture of ions results in lower toxicity than strong dominance by an individual ion, particularly dominance by an individual ion with relatively high toxicity. Mount et al. (1997) reported that the relative ion toxicity to freshwater biota was generally potassium > carbonate ≈ magnesium > chloride > sulphate, with calcium and sodium exhibiting relatively low toxicity. Therefore, the toxicity of a TDS mixture depends largely on the composition of ions within the mixture, rather than the total TDS concentration, which on its own is not an accurate predictor of toxicity. If the mixture is well characterized, and the composition of that mixture is similar to samples for which mixture-based toxicity testing has already been conducted, the confidence in predictions of toxicological potential increases substantially.

A1.1.3 Site-Specific Composition

Monitoring data for Meliadine effluent (MEL-14) were compiled for surface water samples collected between September 2017 and October 2019 and monitoring data for the near-field in Meliadine Lake (MEL-01; stations MEL-01-01 and MEL-01-06 to MEL-01-08) were compiled for surface water samples collected between July 2015 and September 2019. The date range selected for the effluent TDS data begins in 2017 because it coincides with period of increasing effluent TDS concentrations. The near-field TDS composition has been relatively stable over time; data were included for a broader time period to reflect the chronic exposure condition. Summary statistics for major ion chemistry, TDS, and water hardness are presented in Table A-1.

The interim target was developed considering that the ionic composition would fall within the bounds of the ionic composition of the effluent and near-field receiving water. In other words, the effluent and near-field receiving environment samples bracket the range of mixture types expected for future samples of water upon initial mixing. Average measured TDS in the effluent was approximately 930 mg/L and consisted predominantly of chloride (470 mg/L; 52% of TDS), sodium (167 mg/L; 18% of TDS), calcium (125 mg/L; 13% of TDS), sulphate (56 mg/L; 6% of TDS), carbonate (20 mg/L; 2% of TDS), and relatively low concentrations of magnesium, potassium, fluoride, nitrate, and reactive silica (combined 9% of TDS; Figure A-1). Average measured TDS in the near-field receiving environment (MEL-01) was lower (44 mg/L) with a broadly similar ionic composition to the effluent but with a higher overall proportion of carbonate and lower proportion of chloride, sodium, and calcium. TDS in the near-field consisted predominantly of chloride (12 mg/L; 28% of TDS), carbonate (18 mg/L; 24% of TDS), sodium (5.8 mg/L; 13% of TDS), calcium (7.7 mg/L; 18% of TDS), sulphate (4.5 mg/L; 10% of TDS), and relatively low concentrations of magnesium, potassium, fluoride, nitrate, and reactive silica (combined 6% of TDS; Figure A-2). On a site-wide basis, TDS composition relevant to the Meliadine interim TDS target is an ionic composition dominated by chloride, sodium, and calcium (from highest to lowest concentration), with lower contribution from carbonate. It is anticipated that, should TDS increase in the receiving environment relative to current conditions, the relative proportion of carbonate would decline as the relative proportions of chloride, sodium and calcium increase. Dominant ions of chloride, sodium, and calcium represent the lower range of toxicity potential relative to potassium, carbonate, and magnesium (Mount et al. 1997).

From November 2019 to March 2020, ten water quality samples were collected in Containment Pond 1 (CP1). The ionic composition of these samples were consistent with the ionic composition reported above for MEL-14 and MEL-01; average measured TDS in CP1 from November 2019 to March 2020 was approximately 4,403 mg/L and consisted predominantly of chloride (2,160 mg/L; 51% of TDS), sodium (806 mg/L; 19% of TDS), calcium

(483 mg/L; 11% of TDS), sulphate (349 mg/L; 8% of TDS), carbonate (87 mg/L; 2% of TDS), and relatively low concentrations of magnesium, potassium, fluoride, nitrate, and reactive silica (combined 9% of TDS).

Hardness may modify ion-specific toxicity, thereby ameliorating the toxicity of a mixture by reducing the toxicity of individual ions (Kennedy et al. 2005). For example, calcium has been identified as a specific component of hardness that ameliorates sulphate toxicity (Davies and Hall 2007; Mount et al. 2016). Hardness is not considered a toxicity modifying factor in the case of TDS, because hardness is a component of the TDS mixture and is therefore not an independent factor distinct from ionic composition. However, hardness can be considered for the evaluation of ion-specific toxicity, given that some ions (e.g., chloride, sulphate) are less toxic in hard water. Water hardness was calculated as calcium carbonate ($CaCO_3$) using the following equation:

$$[CaCO_3] = 2.5 \times [Ca^{2+}] + 4.1 \times [Mg^{2+}]$$

Average calculated water hardness in the effluent was 408 mg/L as $CaCO_3$ (i.e., very hard water), compared to 25 mg/L (i.e., soft water) in the near-field receiving environment.

Table A-1: Water chemistry results for TDS and associated constituents in Meliadine Mine effluent (MEL-14) collected between September 2017 to October 2019 and near-field (MEL-01) collected between July 2015 and September 2019

Parameter (mg/L)	MEL-14					MEL-01[(a)]				
	Median	Average	Maximum	Minimum	Sample Count	Median	Average	Maximum	Minimum	Sample Count
Calculated TDS	923	930	1,213	634	28	42	44	69	33	43
Measured TDS	1,185	1,203	1,760	860	28	52	54	94	25	43
Carbonate[(b)]	20	20	34	4	28	10	11	17	8	43
Chloride	470	487	660	300	28	12	12	19	8	43
Sodium	167	165	236	94	28	5.6	5.8	9.4	4.1	43
Calcium	125	122	220	17	28	7.3	7.7	13	5.8	43
Sulphate	53	56	90	7	28	4.3	4.5	6.6	3.4	43
Magnesium	26	25	36	4	28	1.3	1.4	2.4	1.0	43
Potassium	14	14	17	10	28	1.0	1.0	1.7	0.8	43
Fluoride	— [(c)]	— [(c)]	— [(c)]	— [(c)]	0	0.03	0.03	0.03	0.02	43
Nitrate (as N)	11	9	15	3	28	0.01	0.01	0.08	0.01	43
Reactive Silica	0.73	0.79	3.60	0.05	28	— [(d)]	— [(d)]	— [(d)]	— [(d)]	1
Calculated Water Hardness (as $CaCO_3$)[(e)]	407	408	698	59	28	24	25	41	19	43

Notes:

All concentrations expressed in milligrams per litre.

(a) MEL-01 measurements are from near-field stations MEL-01-01, MEL-01-06, MEL-01-07, MEL-01-08, and MEL-01-09.

(b) Calculated from total alkalinity as total alkalinity (as $CaCO_3$) × 0.6

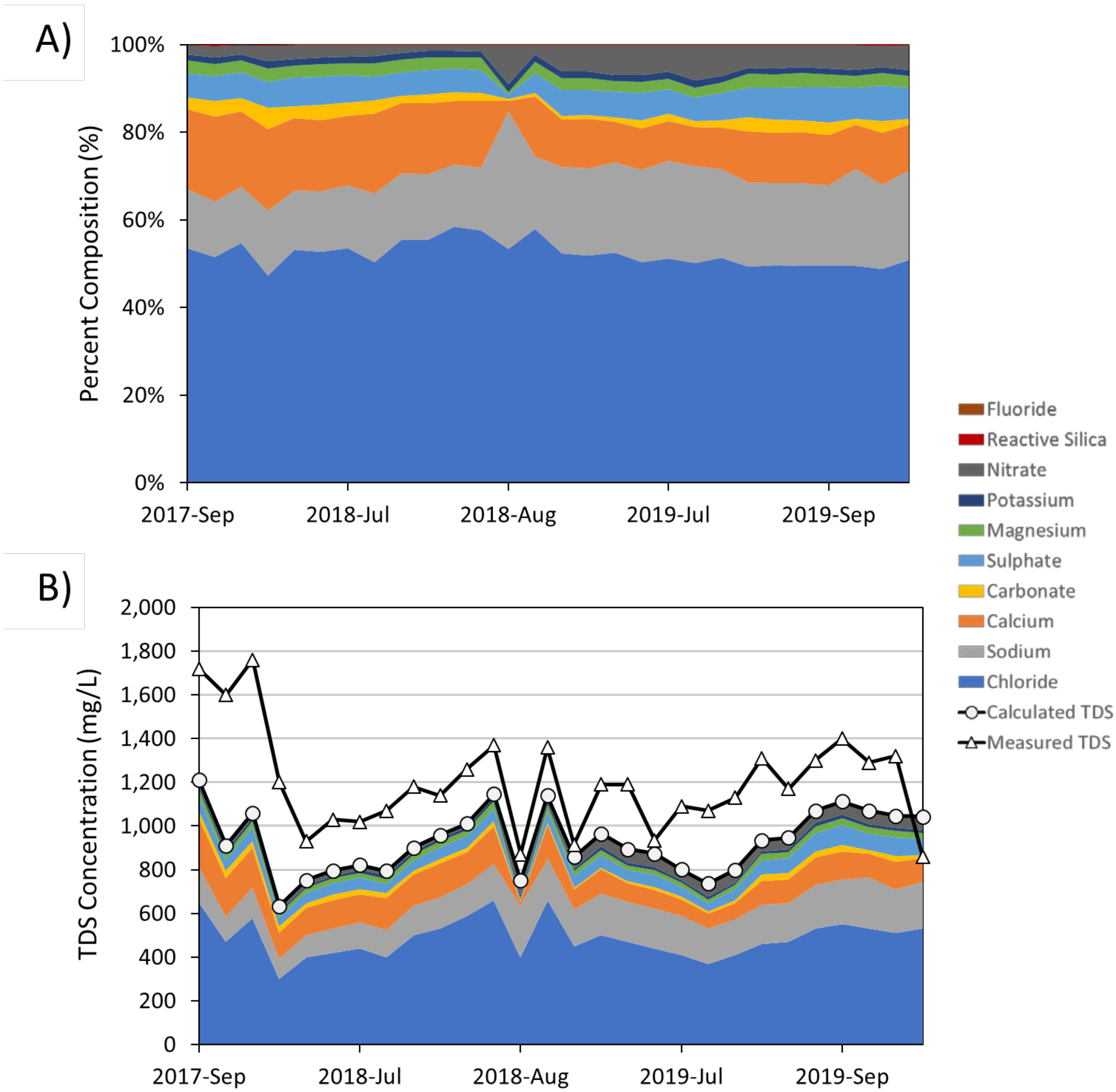
(c) Fluoride was not measured for data collected between September 2017 and October 2019, which precluded the calculation of summary statistics. However, these data would not result in significant changes to the understanding of ionic composition, given that fluoride provides only a trace component of both halides and TDS in Meliadine water samples.

(d) Reactive silica was only measured in one sample for data collected between September 2017 and October 2019, which precluded the calculation of summary statistics.

(e) Calculated as $(2.5 \times [Ca^{2+}]) + (4.1 \times [Mg^{2+}])$

mg/L = milligrams per litre; $CaCO_3$ = calcium carbonate; N = Nitrogen; — = not measured.

Figure A-1: Percent composition of TDS (%) (Panel A) and TDS concentration (mg/L) (Panel B) at station MEL-14 (treated effluent) for samples collected between September 2017 and October 2019 at Meliadine Mine.

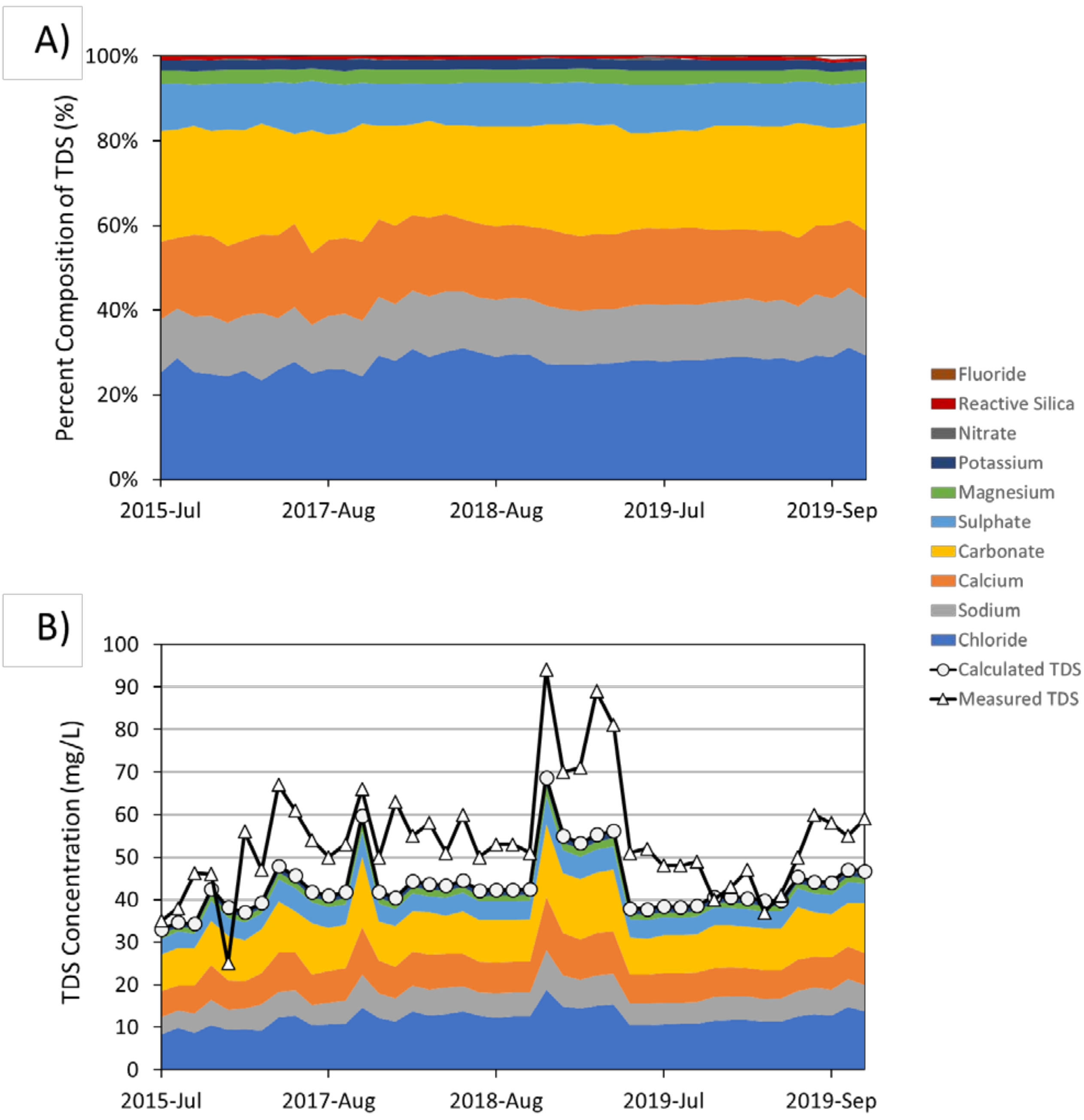


Notes:

Ionic composition was calculated as: $TDS_{calculated\ (mg/L)} = \sum[Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, F^-, SO_4^{2-}, SiO_3^{2-}, 4.42 \times NO_3^- \ (as\ N), 0.6 \times total\ alkalinity\ (as\ CaCO_3)]$.

Data for ionic composition from effluent (MEL-14) was collected between September 2017 and October 2019.

Figure A-2: Percent composition of TDS (%) (Panel A) and TDS concentration (mg/L) (Panel B) at station MEL-01 (near-field) for samples collected between July 2015 and September 2019 at Meliadine Mine.



Notes:

Ionic composition was calculated as: $TDS_{calculated\ (mg/L)} = \sum[Na^{+}, K^{+}, Ca^{2+}, Mg^{2+}, Cl^{-}, F^{-}, SO_4^{2-}, SiO_3^{2-}, 4.42 \times NO_3^{-}\ (as\ N), 0.6 \times total\ alkalinity\ (as\ CaCO_3)]$.

Data for ionic composition from near-field (MEL-01) was collected from stations MEL-01-01, MEL-01-06, MEL-01-07, and MEL-01-08 between July 2015 and September 2019.

A1.2 Benchmarks from Other Sites

Currently, there is no federal, Provincial or Territorial water quality guideline for TDS in Canada. Several US States have developed state or site-specific TDS criteria focussed on the protection of aquatic life. In Alaska, TDS criteria range from 500 to 1,500 mg/L (ADEC 2009), depending on the TDS composition and whether the receiving environment is potential salmon spawning habitat. Permits are required for discharges to receiving water that result in an increase in TDS concentration in the waterbody between 500 and 1,000 mg/L. Chapman et al. (2000) reported that studies conducted for Coeur Alaska's Kensington Mine site resulted in the first site-specific TDS permit in Alaska. The permit states that TDS may not exceed 1,000 mg/L in Sherman Creek, the receiving waterbody of Kensington Mine effluent (ADEC 2017). Alaska also granted a site-specific permit for Red Dog Mine effluent (ADEC 2013; Brix et al. 2010). Concentrations of TDS up to 1,500 mg/L are permitted during periods when salmonids are not spawning, provided calcium is greater than 50% by weight of the total cations (ADEC 2013; Brix et al. 2010). During spawning periods, the limit was set at 500 mg/L (Brix et al. 2010). However, the studies used to establish the Alaskan TDS water quality criterion were based on ionic compositions dominated by calcium sulphate, whereas the Meliadine effluent and near-field TDS is predominantly sodium chloride and calcium chloride (Chapman et al. 2000; Brix et al. 2010). Therefore, these benchmarks are not directly applicable to Meliadine Mine.

In 2004, the Iowa Department of Natural Resources (IDNR) adopted an interim TDS standard of 1,000 mg/L in receiving streams; the standard was used as a screening value to determine whether site-specific toxicity testing was required (IDNR 2009). However, IDNR since recommended replacing the TDS standard with numerical sulphate and chloride criteria (IDNR 2009) under the assumption that the individual ions provide a more defensible basis for evaluating toxicity relative to the sum of the ions.

The Snap Lake Mine in the Northwest Territories currently has a site-specific water quality objective (SSWQO) for TDS of 1,000 mg/L (Golder 2014; Chapman and McPherson 2015). The SSWQO was derived following toxicity testing with multiple receptor groups (fish, invertebrates, and plants) using a TDS ionic composition specific to Snap Lake Mine dominated by chloride, calcium, and sodium. The typical composition of Snap Lake water includes ~45% to 47% chloride, 20% to 21% calcium, 10% to 11% sodium, 9% sulphate, 5% to 7% carbonate, 4% nitrate, and 2% to 3% magnesium, with minor contributions from potassium and fluoride. This composition is broadly similar to that of Meliadine effluent. The test species and effects endpoints for the TDS SSWQO dataset, as reported by Chapman and McPherson (2015) and discussed in detail in Golder (2014), are presented in Table A-2. Additional testing was also conducted with the non-resident water flea, *Ceriodaphnia dubia*. As discussed by Chapman (2014a) the results from multiple rounds of testing with *C. dubia* were highly variable (potentially confounded by laboratory artifacts) and could not be relied upon to derive a protective SSWQO for Snap Lake Mine. Because species of the genus *Ceriodaphnia* do not reside in Snap Lake, species of the genus *Daphnia* are observed in Snap Lake, the chronic reproduction *D. magna* results were considered more representative of daphnids in Snap Lake. Following a resident taxa approach for deriving a SSWQO using the dataset in Table A-2, the TDS SSWQO for Snap Lake was set as 1,000 mg/L. The SSWQO was considered protective of aquatic life, and "if not exceeded, will avoid harm to the Snap Lake ecosystem" (Chapman 2014a, p.5). As discussed by Chapman (2014c), the results of toxicity testing do not indicate that an exceedance above 1,000 mg/L TDS will result in harm to aquatic life but provide "reasonable certainty of no harm up to 1,000 mg/L" (Chapman 2014a, p.5).

Table A-2: Chronic toxicity testing dataset for Snap Lake TDS SSWQO as summarized by Chapman and McPherson (2015)

Test Species	Common Name	Life stage	Test Duration	Endpoint	Test Statistic[a]	Result (mg/L TDS)	Reference
Salvelinus namaycush	Lake Trout	early life-stage		dry fertilization survival	LC_{20}	990	Baker et al. 2015
				dry fertilization growth	IC_{20}	>1,490	
				wet fertilization survival	LC_{20}	>1,480	
				wet fertilization growth	IC_{20}	>1,480	
Daphnia magna	water flea	<24 hr	21-d	reproduction	IC_{20}	>1,100	Chapman 2014b
Brachionus calyciflorus	rotifer		48-hr	population	IC_{10}	>1,330	Chapman 2014c
Chironomus dilutus	chironomid		10-d	growth	IC_{10}	>1,390	Chapman 2014c
Thymallus arcticus	Arctic Grayling	early life-stage		dry fertilization survival	LC_{20}	>1,420	Baker et al. 2015
				dry fertilization growth	IC_{20}	>1,420	
				wet fertilization survival	LC_{20}	>1,410	
				wet fertilization growth	IC_{20}	>1,410	
Pseudokirchneriella subcapitata	green alga	population	72-h	growth	IC_{10}	>1,470	Chapman 2014c
Navicula pelliculosa	diatom	population	120-h	growth	IC_{10}	>1,490	Chapman 2014c
Cyclops vernalis	copepod		20-d	growth	IC_{20}	>1,510	Marus et al. 2015; Chapman 2014c; Chapman 2014a
Pimephales promelas	Fathead Minnow	early life-stage	32-d	hatching, survival and growth	IC_{20}	>2,200	Chapman 2014c

Notes:

(a) As reported in Chapman and McPherson (2015) for the "*lowest reliable, technically defensible endpoint for each test*." A discussion of the selection of endpoints is provided in Golder (2014).

mg/L = milligrams per litre; TDS = total dissolved solids; LC_X = lethal concentration causing a lethal effect to x% of the test population; IC_X = inhibitory concentration that causes an x% inhibitory effect in the sublethal endpoint being measured.

The Snap Lake SSWQO validation excluded test results for the water flea, *C. dubia,* because multiple rounds of testing produced highly variable effect concentrations that were not reliable. Variability in the reproductive endpoint for *C. dubia* was attributed to confounding factors associated with the testing laboratory (e.g., dilution and acclimation water), and such variations have also been reported elsewhere (Lasier et al. 2006; Pacholski et al. 2016; Mount et al. 2016). Golder (2011; 2014) and Chapman and McPherson (2015) concluded that *D. magna* are more relevant surrogate for resident cladoceran species in Snap Lake mine because zooplankton surveys in Snap Lake reported the genus *Daphnia* but not the genus *Ceriodaphnia*. The same logic would apply for Meliadine Lake, where zooplankton surveys conducted as part of Aquatic Effects Monitoring in 2015, 2016, and 2017 reported *Daphnia* presence but not *Ceriodaphnia* (Golder 2019).

A1.3 Review of Chronic Toxicity Literature

Golder (2011; 2014) conducted an extensive literature review for total dissolved solids that was updated by Chapman and McPherson (2015); the literature review is presented in Appendix A of Golder (2011; 2014) and summarized in Chapman and McPherson (2015). This literature is separate from the values derived from site-specific toxicity testing at Snap Lake Mine as reported in Table A-2. Golder (2011; 2014) and Chapman and McPherson (2015) concluded that the toxicity of TDS was highly dependent on the ionic composition, the species tested, and the life stage; they identified the following trends for generic TDS mixtures:

- Phytoplankton—overall high tolerance of phytoplankton to TDS toxicity with effect concentrations higher than 1,000 mg/L.
- Benthic invertebrates—in general, adverse effect concentrations were above 1,000 mg/L, with the following exceptions. Relatively high sensitivity was reported for oligochaete worms (96-hour immobilization EC_{50} of 281 mg/L calcium chloride to the oligochaete worm *Tubifex*; Khangarot 1991), and the glochidia of a freshwater mussel (48-hour EC_{50} of 560 mg/L sodium chloride to glochidia of *Lampsilis fasciola*; Bringolf et al. 2007). Lower effect concentrations were also reported for the fingernail clam (*Sphaerium simile*; 96-hour survival LC_{50} of 740 mg/L; GLEC and INHS 2008; Soucek et al. 2011) but these represented individual ion exposure, which may not accurately predict chloride toxicity under mixture conditions.
- Zooplankton—cladoceran species were generally the most sensitive to TDS. Effect concentrations for calcium chloride salts ranged from 600 to 7,000 mg/L. A review of the chronic dataset presented by Golder (2011; 2014) indicated that effect concentrations for sodium chloride generally ranged from 750 mg/L (7-d reproduction no-effect concentration (NOEC) for *C. dubia*; Cooney et al. 1992) to 2,400 mg/L (7-d survival lowest effect concentration for *C. dubia*; Cooney et al. 1992).
- Fish—the sensitivity of fish to TDS toxicity varied by life-stage, with fertilization and egg-hardening life stages identified as the most sensitive toxicological endpoints. Fish were also generally less sensitive to TDS toxicity than zooplankton, with effect concentrations for calcium chloride ranging from 4,600 mg/L to greater than 15,000 mg/L. A review of the chronic dataset presented by Golder (2011; 2014) indicated that effect concentrations for sodium chloride generally ranged from 800 mg/L (8-d NOEC *Oncorhynchus mykiss*; Camargo and Tarazona 1991) to 8,000 mg/L (7-d NOEC *Pimephales promelas*; Pickering et al. 1996).

Lower effect concentrations have been reported for individual ions for select species, but these tests reflect exposure conditions accounting for a single ion, and not a balanced TDS mixture representative of most field conditions. A review of the literature indicates that when accounting for toxicity for TDS the following observations apply as summarized by Chapman and McPherson (2015):

- TDS toxicity is lower with the presence of more than one cation.
- Hardness may ameliorate TDS toxicity and the toxicity of individual ions (e.g., chloride and sulphate).
- The relative ratios of ions within the TDS mixture may affect TDS toxicity (e.g., Ca^{2+}:Mg^{2+}).

More recent research by Mount et al. (2016) support the conclusions by Chapman and McPherson (2015). Following extensive toxicity testing exposing *C. dubia* to different salt mixtures, Mount et al. (2016) concluded that inferring toxicity from individual ions is difficult due in part to interdependence among ions. Buchwalter et al. (2013) concluded that TDS toxicity is complicated by the findings that:

1) individual ions vary in toxicity;

2) some ions in solution can modify the toxicity of other ions; and

3) relative toxicities of ions are not consistent across species.

The results from Mount et al. (2016) also support the conclusion that toxicity of TDS mixtures varies by ionic composition, and that the characteristics of the TDS mixture influence the toxicity of other ions in the mixture.

A1.4 Site-Specific Chronic Toxicity Data

The information from the literature discussed in Section A1.3, particularly for Snap Lake, provides an indication of chronic exposure levels for TDS that are protective of aquatic life in a northern freshwater ecosystem. However, the identified importance of ionic composition means that site-specific results should carry the greatest weight in the interpretation of biological and ecological significance.

Chronic toxicity testing data and corresponding water chemistry data have been collected by Agnico Eagle as part of routine and regulatory monitoring at stations MEL-14 (treated effluent), and MEL-12 (influent from the water treatment plant). Chronic toxicity tests performed (all standard Environment Canada test protocols commonly applied in the Canadian environmental effects monitoring framework) were:

- Biological Test Method: Test of Reproduction and Survival Using the Cladoceran, *Ceriodaphnia dubia* (EC 2007a)
- Biological Test Method: Test of Larval Growth and Survival Using Fathead Minnows (EC 2011)
- Biological Test Method: Growth Inhibition Test Using a Freshwater Alga (EC 2007b)
- Biological Test Method: Test for Measuring the Inhibition of Growth Using the Freshwater Macrophyte, *Lemna minor* (EC 2007c)

Chronic toxicity test results and corresponding water chemistry data for calculated TDS (and measured) and chloride are presented in Table A-3. The results of the chronic testing indicate:

- No effects to *C. dubia* survival at TDS concentrations up to and including 2,357 mg/L (measured TDS of 2,450 mg/L). Reduced *C. dubia* reproduction was observed at TDS concentrations between 1,140 mg/L to 2,202 mg/L (measured TDS of 1,360 to 2,490 mg/L).
- No effects to Fathead Minnow survival or growth at TDS concentrations up to and including 2,357 mg/L (measured TDS of 2,450 mg/L).
- Growth inhibition to *P. subcapitata* was observed in two samples collected in September and October 2019 at TDS concentrations of 2,202 mg/L and 2,357 mg/L, respectively (measured TDS of 2,490 mg/L and 2,450 mg/L, respectively). However, follow up testing conducted in October indicated no effect to growth inhibition at a TDS concentration of 2,350 mg/L (measured TDS of 2,370 mg/L). No effect to growth inhibition was observed in remaining samples at TDS concentrations up to and including 1,140 mg/L (measured TDS of 1,360 mg/L).
- Effects to *L. minor* frond count were observed at TDS concentrations between 2,202 mg/L to 2,357 mg/L (measured TDS of 2,490 mg/L to 2,450 mg/L). Although effects to *L. minor* frond count were occasionally observed at TDS concentrations of approximately 1,000 mg/L the effect was not consistently observed. For example, no effect to frond count (IC_{25} >97% vol/vol) was observed on three occasions at TDS

concentrations ranging between 800 to 1,140 mg/L (measured TDS of 1,130 to 1,360 mg/L). Effects to *L. minor* biomass were observed in two of eight samples at TDS concentrations of 1,011 mg/L and 2,357 mg/L (measured TDS 1,260 mg/L to 2,450 mg/L). No effects to *L. minor* biomass were observed in six of eight samples at TDS concentrations of 800 to 2,350 mg/L (measured TDS of 1,130 mg/L to 2,370 mg/L).

In summary, multiple rounds of chronic toxicity testing indicate no effects to survival of fish or crustaceans across a wide range of TDS concentrations (i.e., unbounded no-effect level of 2,357 mg/L), and no reliable indications of sublethal toxicity have been observed at 1,000 mg/L. Moderate to high magnitude sublethal responses to *C. dubia* and aquatic plants/algae are evident at calculated TDS concentrations that exceed 2,000 mg/L. Collectively, these results provide evidence that the interim TDS target for Snap Lake of 1,000 mg/L remains protective for Meliadine Lake. A higher threshold TDS concentration protective of aquatic life may be supportable once the validation study (Phase 2 of WQ-MOP) is complete.

Table A-3: Chronic toxicity data for MEL-14 and MEL-12 samples collected between 2018 to 2019 with corresponding total dissolved solids and chloride concentrations

Sample Location	Sample Date	Chronic Toxicity							Water Chemistry (mg/L)		
		Water flea *Ceriodaphnia dubia*		Fathead minnow *Pimephales promelas*		Green alga *P. subcapitata*	Duckweed *Lemna minor*				
		3-brood Survival LC_{50} (% vol/vol)	3-brood Reproduction IC_{25} (% vol/vol)	7-d Survival LC_{50} (% vol/vol)	7-d Growth IC_{25} (% vol/vol)	72-hr Cell Inhibition IC_{25} (% vol/vol)	7-d Frond Count IC_{25} (% vol/vol)	7-d Biomass IC_{25} (% vol/vol)	Measured TDS	Calculated TDS	Chloride
MEL-14	07 August 2018	>100	>100	>100	>100	>90.9	72.3	>97	1,140[(a)]	958[(a)]	530[(a)]
	13 August 2018	—	—	>100	>100	>90.9	38.2	42	1,260	1,011	590
	3 September 2018	>100	90.1	>100	>100	>90.9	>97	>97	1,360	1,140	660
	9 July 2019	—	—	—	—	—	>97	>97	1,190	965	500
	13 August 2019	—	—	—	—	—	>97	>97	1,130	800	410
MEL-12	24 September 2019	>100	24.3	>100	>100	60.8	26.3	>97	2,490	2,202	1,100
	1 October 2019	>100	58.8	>100	>100	88.2	29.4	66.2	2,450	2,357	1,200
	8 October 2019	>100	20.1	>100	>100	>90.9	59	>97	2,370	2,350	1,200

Notes:

(a) Corresponding water chemistry data was not collected for this sample. However, a sample collected on 5 August 2018 from the same location is reported here for comparison.

mg/L = milligrams per litre; vol/vol = volume per volume; TDS = total dissolved solids; LC_X = lethal concentration causing a lethal effect to x% of the test population; IC_X = inhibitory concentration that causes a x% inhibitory effect in the sublethal endpoint being measured.

A1.5 Weight of Evidence Summary for Proposed Site-Specific Water Quality Objective

An interim TDS target of 1,000 mg/L to apply at the edge of the mixing zone was proposed following integration of information obtained through characterization of the Meliadine TDS profile (Section A1.1), review of water quality benchmarks for TDS developed for similar mixtures (Section A1.2), a literature review of TDS toxicity (Section A1.3), and a review of site-specific chronic toxicity data for Meliadine treated effluent and influent samples (Section A1.4). Sections A1.5.1 to 1.5.4 summarize the weight of evidence behind the proposed interim TDS target.

Several considerations, summarized in Sections A1.5.1 through A1.5.4, provide confidence in the application of the interim TDS target and also bode well for outcomes of the Phase 2 validation studies. The literature and site-specific data review provide a basis to propose an interim target for TDS; implementation of Phase 2 validation studies will provide increased precision and reliability in the interim target.

A1.5.1 Ionic Balance is Favorable

Effect concentrations reported in the Snap Lake dataset were derived from exposures using a balanced TDS mixture, whereas effect concentrations from the literature are generally derived from exposures using single salt mixtures (e.g., sodium chloride or calcium chloride) that do not consider TDS mixture effects. Meliadine TDS ionic composition resembles the ionic composition evaluated during the validation of the Snap Lake TDS SSWQO of 1,000 mg/L. As indicated in Section A1.0, Meliadine TDS contains a high relative proportion of calcium and sodium ions (on average 31% of TDS); these dominant ions are among the least toxic according to Mount et al. (1997), and have been identified as key components of TDS that ameliorate toxicity of other ions (Davies and Hall 2007, Mount et al. 2016, Soucek et al. 2018, Scheibener et al. 2017). Concentrations of the relatively toxic potassium and magnesium ions are predicted to remain low in Meliadine effluent; potassium and magnesium ions make up approximately 4% to 5% of TDS in effluent and the near-field. The information from the ionic composition analysis (Section A1.0), and comparison to the Snap Lake TDS SSWQO dataset (Section A2.0), although not conclusive, suggests that the Meliadine TDS mixture would not exhibit chronic toxicity from TDS components at concentrations of TDS below approximately 1,000 mg/L. Some literature studies indicate toxicity to select invertebrate species at concentrations below 1,000 mg/L TDS, but these toxicity tests are limited to test solutions that contain predominantly one or two ions, which do not apply to the complex mixture conditions of Meliadine TDS, nor incorporate the beneficial effect of calcium and sodium for ameliorating toxicity of other ions in these mixtures.

A1.5.2 Comparability to Well-Validated Snap Lake

Effect concentrations derived from extensive validation of the SSWQO at Snap Lake mine indicated no effects to site-resident or relevant surrogate species below 1,100 mg/L TDS. The effect concentration for *D. magna*, the most sensitive species in the dataset, was unbounded indicating no effects at the highest tested TDS concentration. Unbounded effect concentrations were also reported for all other test species in the Snap Lake dataset. Therefore, concentrations of TDS above 1,000 mg/L may pose no risk to aquatic life but there is uncertainty in proposing an interim TDS target to apply at the edge of the mixing zone of higher than 1,000 mg/L because exposure concentrations used in the Snap Lake dataset did not reach toxicity thresholds for the species tested.

A1.5.3 Available Site-Specific Toxicity Data Support the Benchmark

The chronic toxicity data tested with Meliadine mixtures supports the proposed interim target to apply at the edge of the mixing zone of 1,000 mg/L (Section A4.0). During routine and regulatory chronic toxicity testing with

MEL-14 and MEL-12 samples, no chronic effects to *C. dubia* survival, early life-stage Fathead Minnow survival or growth, or growth of the green alga *P. subcapitata* were observed at TDS concentrations of approximately 1,140 mg/L (measured TDS of 1,360 mg/L). The reduction of *C. dubia* reproduction at 1,140 mg/L (measured TDS of 1,360 mg/L) was not large (IC_{25} for reproduction of 90.1% vol/vol at TDS concentrations of 1,140 mg/L). Overall, these results support the proposed interim TDS target of 1,000 mg/L to apply at the edge of the mixing zone, but site-specific validation is necessary to verify these results and develop a TDS SSWQO for long-term application.

A1.5.4 Ionic Balance is Stable

The stable ionic balance over several years of monitoring (Figure 2) is suited to development of a single benchmark for TDS, without requiring development of individual benchmarks for component ions. The TDS interim target incorporates contributions from chloride and sulphate (along with other ionic components) and it is not recommended at this time that separate benchmarks be developed for chloride and sulphate as individual ions. However, the concentrations of individuals ions can be prorated from the recommended TDS interim target of 1,000 mg/L. For Meliadine TDS, the relative proportion of chloride at the recommended interim target of 1,000 mg/L would range between 280 to 520 mg/L, depending on the ionic composition. The upper bound of chloride proportion is based on an ionic composition derived from TDS in the effluent; it is anticipated that the ionic composition for TDS in the receiving environment would not have as high a proportion of chloride as effluent. For comparison, Snap Lake TDS including chloride of up to approximately 450 to 470 mg/L demonstrated negligible toxicity.

The proposed TDS interim target to apply at the edge of the mixing zone was derived from the anticipated ion composition for Meliadine based on monitoring data for effluent and near-field. Modelled chemistry data are not available for the ionic composition anticipated under future discharge conditions at Meliadine, requiring confirmation that ionic mixtures are expected to remain consistent in terms of proportions of major ions. If future effluent quality with respect to TDS constituents is markedly different, then re-evaluation of the proposed TDS threshold may be warranted.

A2.0 INTERIM TDS TARGET FOR EFFLUENT—SITE-SPECIFIC ACUTE TOXICITY RESULTS

Acute toxicity testing data and corresponding water chemistry data were collected by Agnico Eagle as part of routine and regulatory monitoring at stations MEL-14 (treated effluent), MEL-12 (influent from the water treatment plant), and CP1 (Collection Pond 1). Acute toxicity tests performed were:

- Biological Test Method: Reference Method for Determining Acute Lethality of Effluent to *Daphnia magna* (EC 2000a).
- Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Rainbow Trout (EC 2000b).
- Biological Test Method: Acute Lethality Test Using Threespine Stickleback (*Gastrosteus aculeatus*) (ECCC 2017).

Acute toxicity test species include the standard protocols (*D. magna* and Rainbow Trout) used to assess compliance for acute lethality under the Metal and Diamond Mining Effluent Regulations (Government of Canada 2002). Two additional tests were conducted with Threespine Stickleback in November and December 2019. The Threespine Stickleback results were included for comparative purposes, although this species is currently not a required standard test species for regulatory testing related to discharge of effluent to Meliadine Lake. Acute toxicity test results and corresponding water chemistry data for TDS (measured and calculated) and chloride are presented in Table A-4.

Acute toxicity testing conducted between 2017 to 2020 with influent (MEL-12 and CP1) and effluent (MEL-14) has indicated no acute toxicity (i.e., LC_{50} >100% vol/vol) to *D. magna* or Rainbow Trout survival with TDS concentrations of up to and including 5,420 mg/L (measured TDS concentrations of up to 4,925 mg/L). Reduced survival (60% in full-strength sample) in Rainbow Trout was observed in a CP1 sample collected 17 December 2017 at TDS concentration of 3,150 mg/L. However, mortality did not exceed 50%, and since 2017 several samples have been tested with measured and TDS concentrations greater than 3,150 mg/L, all of which indicated no acutely toxic effects to Rainbow Trout.

Threespine Stickleback were tested on two occasions in November and December 2019 with CP1 sample. Measured TDS concentrations of up to and including 3,410 mg/L did not result in acutely toxic effects in Threespine Stickleback.

Table A-4: Acute toxicity data for MEL-14, MEL-12, and CP1 samples collected between 2017 to 2020 with corresponding total dissolved solids and chloride concentrations

Sample Location	Sample Date	Acute Toxicity			Water Chemistry (mg/L)		
		Daphnia magna	Rainbow Trout *Oncorhynchus mykiss*	Threespine Stickleback *Gastrosteus aculeatus*	Measured TDS	Calculated TDS	Chloride
		48-hour Survival LC_{50} (% vol/vol)	96-hour Survival LC_{50} (% vol/vol)	96-hour Survival LC_{50} (% vol/vol)			
MEL-14	9 August 2017	>100	>100	—	1,600	911	470
	27 August 2017	>100	>100	—	1,760	1,061	580
	24 June 2018	>100	>100	—	1,200	634	300
	1 July 2018	>100	>100	—	930	752	400
	5 August 2018	>100	>100	—	1,140	958	530
	3 September 2018	>100	>100	—	1,360	1,140	660
	24 June 2019	>100	>100	—	915	859	450
	9 July 2019	>100	>100	—	1,190	965	500
	3 September 2019	>100	>100	—	1,300	1,070	530
CP1	21 June 2017	>100	>100	—	1,190	575	290
	12 July 2017	>100	>100	—	908	707	350
	05 November 2017	—	>100	—	2,230	— (b)	— (b)
	11 November 2017	>100	>100	—	2,791	— (b)	— (b)
	19 November 2017	>100	>100	—	— (c)	— (b)	— (b)
	17 December 2017	>100	NC (60% survival)(d)	—	3,150	— (b)	— (b)
	10 June 2018	>100	>100	—	685	477	210
	17 June 2018	>100	>100	—	540	281	180
	25 November 2019	—	—	>100	2,960	3,055	1,500
	15 December 2019	—	—	>100	3,410	— (b)	— (b)
	05 January 2020	>100	>100	—	4,830	4,465	2,400
	12 January 2020	>100	>100	—	4,150	3,815	1,900

Sample Location	Sample Date	Acute Toxicity			Water Chemistry (mg/L)		
		Daphnia magna	Rainbow Trout *Oncorhynchus mykiss*	Threespine Stickleback *Gastrosteus aculeatus*	Measured TDS	Calculated TDS	Chloride
		48-hour Survival LC_{50} (% vol/vol)	96-hour Survival LC_{50} (% vol/vol)	96-hour Survival LC_{50} (% vol/vol)			
	26 January 2020	>100	>100	—	4,160	3,659	1,900
	02 February 2020	>100	>100	—	4,080	4,263	2,100
	09 February 2020	>100	>100	—	4,330	4,219	2,100
	16 February 2020	>100	>100	—	4,880	4,352	2,300
	01 March 2020	>100	>100	—	5,350	4,946	2,500
	08 March 2020	>100	>100	—	4,870	4,816	2,400
	15 March 2020	>100	>100	—	5,420	4,925	2,500
MEL-12	24 September 2019	>100	>100	—	2,490	2,202	1,100
	01 October 2019	— (e)	>100	—	2,450	2,357	1200
	08 October 2019	>100	>100	—	2,370	2,350	1,200

Notes:

(a) Test was conducted with full-strength sample (100% vol/vol) and laboratory control.

(b) Corresponding major ion chemistry data were not measured in this sample; therefore, calculated TDS could not be determined.

(c) Corresponding water chemistry data were not collected for this sample.

(d) A 96-hour LC_{50} could not be calculated because this test was conducted as a screening (pass/fail) test, whereby full-strength (100% vol/vol effluent) sample was tested with a laboratory control. To estimate the LC_{50} a multi-concentration dilution series must be conducted. The result reported here in brackets is percent survival in the full-strength effluent sample.

(e) Due to a laboratory error during testing with *Daphnia magna* the results of the 1 October 2019 test were invalidated and were not reported by the laboratory.

TDS = total dissolved solids; MEL-14 = treated effluent; MEL-12 = untreated influent; CP1 = Containment Pond 1; mg/L = milligrams per litre; LC_X = lethal concentration causing a lethal effect to x% of the test population; vol/vol = volume per volume; NC = not calculable.

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APPENDIX B

Plume Delineation Study Design

B.1 INTRODUCTION

The Meliadine Gold Mine (Mine) is located in the Kivalliq District of Nunavut near the western shore of Hudson Bay, in Northern Canada (Figure 1). The nearest community is Rankin Inlet (coordinates: 62°48’35’’N;092°05’58’’W), approximately 25 km south of the Tiriganiaq deposit (coordinates: 63°01’03’’N, 92°12’03’’W). The Mine is located within the Meliadine Lake watershed of the Wilson Water Management Area (Nunavut Water Regulations Schedule 4).

As communicated to the Nunavut Water Board (NWB) by Agnico Eagle Mines Limited (Agnico Eagle), the 2020 freshet season will result in accumulation of site water that exceeds the water storage capacity of the mine at containment pond 1 (CP1), requiring a managed release of site water to the environment. In anticipation of this condition, Amendment 1 was approved by NWB for the Meliadine Mine Type “A” Water Licence (No. 2AM-MEL-1631), allowing Meliadine to dewater CP1 prior to freshet, avoiding “emergency” conditions. Specifically, Amendment 1 permits the following:

- *The time-limited discharge (May 2020 – October 2020) of effluent from the Containment Pond 1 (CP1) into Meliadine Lake through the Meliadine Lake Diffuser (Monitoring Program Station MEL-14) and the Water discharge shall not exceed 3,500 mg/L for the Maximum Average Concentration (MAC) of the Total Dissolved Solids (TDS)*

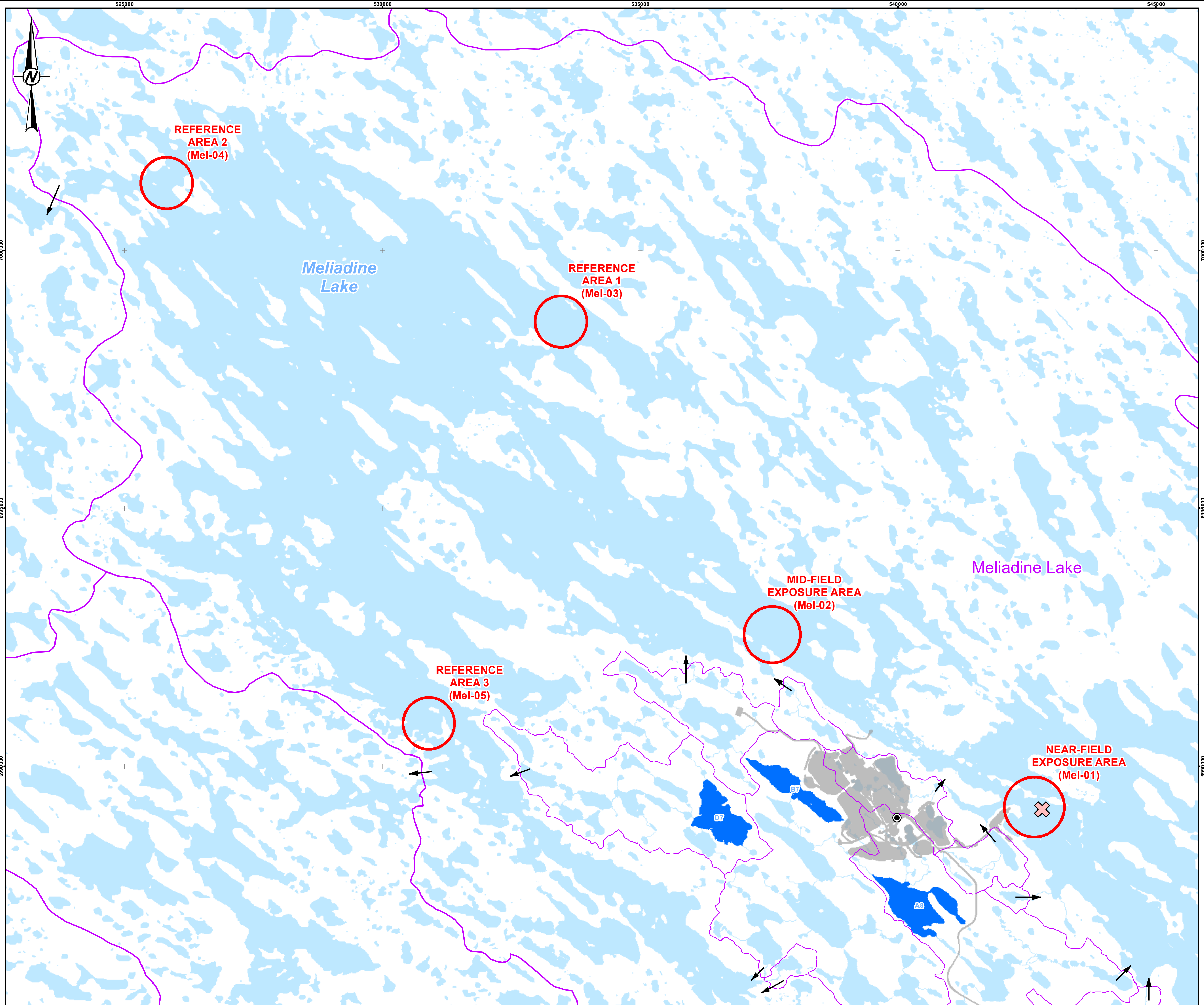
The NWB approval is contingent on several conditions outlined in NWB’s (2020) Reason for Decision. Among these conditions is the requirement for Agnico Eagle to conduct a Plume Delineation Study during the discharge event to characterize plume dispersion in the receiving environment of Meliadine Lake. The purpose of the Plume Delineation Study is to provide confidence that the dispersion of the CP1 discharge will follow the anticipated pattern of flow and mixing in the receiving environment, such that environmental protection objectives at the edge of the mixing zone will be satisfied.

A submerged diffuser was installed in Meliadine Lake in August 2017 to disperse the water discharged from containment ponds 1 and 5 (CP1 and CP5). The diffuser is 30 m long, 400 mm diameter, with a nearly north-south orientation, and connected to the pipelines through a T-connection. Ten 51 mm ports are evenly spaced at every 3 m along the diffuser (Tetra Tech 2017).

This document provides details on the proposed plume delineation study (e.g., sampling design and methods) to evaluate plume dispersion dynamics during the planned release of effluent from CP1. This plan has been designed to address reporting requirements under Amendment 1 for a Plume Delineation Study, as outlined in Insert Item 25, Part I of NWB’s (2020) Reasons for Decision. The period of anticipated discharge is expected to commence during ice cover on Lake Meliadine and continue through the transition period between ice cover and open water conditions, and into open water conditions on Meliadine Lake. Safe boat access to the lake is required to successfully conduct the plume delineation study. Therefore, the detailed plume delineation study will be conducted over 1 to 2 days as soon as open water conditions permit safe boat access.

B.2 BACKGROUND INFORMATION

Turbulent mixing caused by the diffusers results in an initial effluent plume adjacent to the diffusers. The term “plume” in this report refers to the mixture of effluent and lake water that is chemically distinguishable from the surrounding ambient lake water.



LEGEND

- DIFFUSER
- MINE FOOTPRINT
- WATERSHED BOUNDARY
- WATERCOURSE
- WATERBODY

DRAFT

0 1.5 3

1:75,000 KILOMETRES

REFERENCE(S)
1. BASE DATA OBTAINED FROM AGNICO EAGLE MINES LIMITED.
2. DATUM: NAD83 PROJECTION UTM ZONE 15

CLIENT
AGNICO EAGLE MINES LIMITED

PROJECT
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
SITE LOCATION

CONSULTANT
GOLDER

YYYY-MM-DD	2018-07-04
DESIGNED	ER
PREPARED	MH
REVIEWED	
APPROVED	

PROJECT NO.	CONTROL	REV.	FIGURE
1787610	5000/5010	A	1

The diffuser in Meliadine Lake is oriented on a nearly north-south alignment, forming a “T” at the end of the pipe (Tetra Tech 2018; Figure 1). The constructed diffuser differed from the original project design (see Tetra Tech 2017) in terms of its horizontal position and depth of diffuser system at T-connection (42 m horizontal shift and a 3.2 m shallower depth). Therefore, the performance of the diffuser system was reassessed by Tetra Tech (2018). Despite the deviations from the original design, the predicted minimum dilution of 23:1 was achieved at the edge of the mixing zone, and water quality criteria were met (Tetra Tech 2018).

Based on previous experience in low conductivity sub-arctic lakes, specific conductivity was considered an appropriate tracer to delineate the effluent plume in Meliadine Lake, because effluent conductivity (i.e., specific conductance, temperature-corrected to 25°C) is higher than the specific conductivity of natural lake water. Specific conductivity measurements are a rapid, inexpensive, and reliable way of measuring the ionic content in a solution; the main constituents of interest in Meliadine Lake discharge are ionic parameters (e.g., chloride and other components of total dissolved solids). Specific conductivity in CP1 ranged from 5,300 to 9,000 microsiemens per litre (µS/cm) between November 2019 and March 2020 (Appendix A), whereas specific conductivity in Meliadine Lake (Near-field exposure area) ranged from 49 to 99 µS/cm in 2017 (Golder 2018c). This gradient in specific conductivity provides a reliable basis for tracing the direction and intensity of the plume during the release event, with chemical measurements from samples collected at select monitoring stations used to confirm the water quality details.

B.3 METHODS

B.3.1 Sampling Design

The sampling design selected for the plume delineation in Meliadine Lake is a nearly radial model that allows measurement of plume dispersion in all directions. According to the *MVLWB/GNWT Guidelines for Effluent Mixing Zones* (GNWT 2017), the regulated mixing zone is defined as an area where concentrations of some substances may not comply with site-specific water quality objectives for the receiving environment, but is nevertheless suitable for reducing constituent concentrations from full strength discharges to those that provide protection against chronic effects to aquatic life. For lakes in the Mackenzie Valley, regulated mixing zones commonly have a maximum of 100 m radius from the discharge point (GNWT 2017). In contrast, site characterization under the MDMER/MMER (GC 2017) requires a description of the manner in which the effluent mixes within the exposure area at 250 m from each final discharge point. Using these distances as a basis for monitoring design, a modified radial grid containing 22 sampling stations was developed (Figure 2). Coordinates of sampling stations are provided in Table 1.

Table 1: Coordinates of plume delineation study sampling stations

Sample ID	UTM Coordinates (NAD 83, Zone 15V)	
	Easting	Northing
50-01	542803.3	6989212.3
50-02	542847.2	6989144.7
50-03	542792.6	6989085.7
50-04	542748.4	6989153.2
100-01	542807.5	6989262.1
100-02	542875.5	6989226.9
100-03	542897.3	6989140.6
100-04	542861.3	6989059.1

Sample ID	UTM Coordinates (NAD 83, Zone 15V)	
	Easting	Northing
100-05	542788.4	6989035.9
100-06	542719.9	6989070.2
100-07	542699.0	6989157.3
100-08	542728.6	6989233.4
175-01	542813.8	6989336.8
175-02	542971.8	6989134.3
175-03	542782.1	6988961.1
175-04	542624.1	6989163.6
250-01	543046.7	6989128.0
250-02	542958.1	6988944.5
250-03	542775.8	6988886.4
250-04	542605.4	6988972.9
250-05	542549.2	6989170.0
250-06	542622.9	6989339.8

Two central markers are depicted in Figure 2 that outline the north and south ends of the diffuser, which is approximately 30 m in length. From each of these central markers, semicircles of 50, 100, 175, and 250 m were drawn, and within each arc, sampling stations have been placed along up to eight transects radiating from the diffuser (Figure 2). The number of stations at each distance varied, with the larger station numbers applied to the 100 m and 250 m distances. Some of the candidate sampling stations along transects were removed from the design as they were located on islands or shallow areas of Meliadine Lake.

The distances from sampling stations to central markers (i.e., diffuser ends) were selected to provide higher resolution close to the diffusers and to characterize the edge of the mixing zone per the GNWT and MDMER frameworks.

B.3.2 Field Work Instructions

As described by Golder (2018a), the method selected for plume delineation relies on vertical profiles of specific conductivity in near-field exposure areas of Meliadine Lake. Vertical profiles of the lake water column will be measured using water quality meters (e.g., Hanna, YSI, Eureka, or equivalent) equipped with a 20 m or longer cable. Before commencing the profile, the water quality sensor will be placed in lake water for at least one minute to allow readings to stabilize. If, following extended submersion (beyond one minute if necessary), the equipment is not providing stable readings, measurements will be taken using a different meter.

At each sampling station, profile measurements will be taken from surface (i.e., 0.3 m) and at 1-m water depth intervals, starting from 1 m below surface to 1 m above the lake bottom. Temperature and specific conductivity (and if possible, dissolved oxygen concentration, dissolved oxygen saturation, and pH) will be entered on field data sheets. If possible, wind direction and speed will be estimated and recorded.

A maximum of ten water samples will be collected from a subset of the planned sampling stations for laboratory analysis of TDS, major ions, and general parameters (i.e., total and bicarbonate/carbonate alkalinity, turbidity, laboratory specific conductivity, hardness, laboratory pH, and total suspended solids). These samples will be collected from the depth of highest specific conductivity through the water volume at these stations, as determined from the specific conductivity water column profile. Samples identified for more detailed analyses will be selected to encompass the range of specific conductivity measures observed surrounding the diffuser. These data will be used to validate the assumption that TDS concentrations in the receiving environment can be adequately traced using specific conductivity.

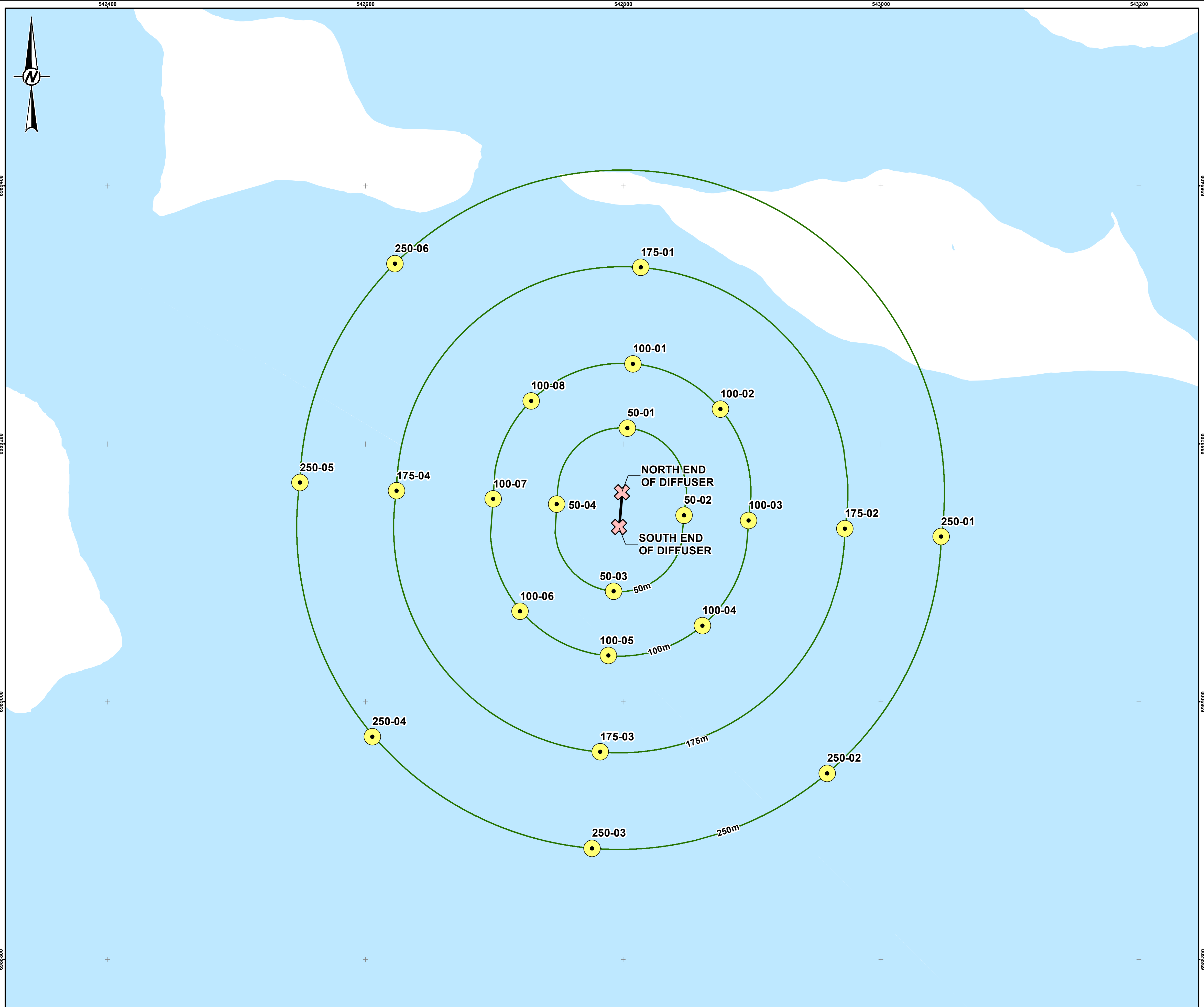
Field work for this study will commence as soon as open water conditions are present on Meliadine Lake, and there is safe access to the sampling locations by boat. Field work will be completed within a timely manner to avoid influence of confounding factors associated with weather conditions and discharge variability. Although it is expected that it will take one full day of work for a two-person field crew to complete the field program, additional days might be required depending on weather conditions. The program will be conducted during discharge to satisfy reporting requirement under Amendment 1 for a plume delineation study, as outlined in Insert Item 25, Part I of NWB's (2020) Reasons for Decision. In addition, a corresponding sample of the discharge from MEL-14 is required to be collected for the program. Therefore, the timing of the field work for this study should be planned around the weekly MEL-14 sampling schedule.

Quality assurance and quality control (QA/QC) procedures will be undertaken to obtain accurate data. QA/QC will include field staff training, routine calibration of field equipment, and documentation. Meter calibration will be re-checked at least once during each day of field work. In case the field staff notice that results are deviating from the expected range of values, a new check with calibration standards will be performed at a sampling station and, if necessary, the probe will be recalibrated. Calibration checks or re-calibration will be documented in the field book.

B.3.3. Data Analysis and Reporting

Following field work, data will be reviewed, and summary tables and figures will be prepared for presentation and discussion during the next available Water Management Working Group meeting. The plume will be described in terms of its size, shape, and vertical distribution. The relationship between field measured specific conductivity and laboratory measured TDS and calculated TDS (from the sum of major ions, where these data are available for each of the selected substations) will be established to validate the use of specific conductivity as a tracer of TDS in the receiving environment. The information retrieved will be used to confirm model predictions related to effluent dilution and assimilation in the receiving environment, and to confirm that receiving environment monitoring stations are adequately characterizing conditions with respect to surface water chemistry and toxicity testing (Sections 3.1 and 3.2 of the main body of the report, respectively).

Results from the plume delineation study will be presented as a stand-alone report, including spatial delineation of the plume and estimated dilution factors at each sampling station. This report will be submitted for review by the Water Management Working Group.



LEGEND

DIFFUSER

SAMPLING LOCATION

FINAL DISCHARGE BUFFER

AS-BUILT DIFFUSER

0 60 120

1:3,000 METRES

REFERENCE(S)

1. BASE DATA OBTAINED FROM AGNICO EAGLE MINES LIMITED.
2. DATUM: NAD83 PROJECTION UTM ZONE 15

CLIENT

AGNICO EAGLE MINES LIMITED

PROJECT

MELIADINE GOLD PROJECT
NUNAVUT

TITLE

SAMPLING DESIGN FOR PLUME DELINEATION STUDY AT MELIADINE LAKE NEAR-FIELD EXPOSURE AREA

CONSULTANT

GOLDER

YYYY-MM-DD	2018-07-04
DESIGNED	ER
PREPARED	MH
REVIEWED	
APPROVED	

PROJECT NO.	CONTROL	REV.	FIGURE
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GOLDER

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APPENDIX B

2020 Discharge Monitoring Results for Samples Collected Between 3 June 2020 and 26 October 2020

OVERVIEW

This Appendix presents the 2020 Meliadine Mine emergency discharge validation monitoring program results, including testing during active discharge plus the results of a post-discharge sample to test the chronic toxicity at a higher TDS concentration. These monitoring results have been collected to support regulatory requirements and commitments outlined in Amendment 1 to the Meliadine Mine Type "A" Water Licence (No. 2AM-MEL1631). As outlined in the Golder (2020) Water Quality Monitoring and Optimization Plan (WQ-MOP Rev2a; Appendix A), the monitoring program assesses and validates the interim total dissolved solid (TDS) targets established for the discharge (a maximum average concentration of 3,500 mg/L calculated TDS) and the receiving environment at the edge of the mixing zone (1,000 mg/L calculated TDS at a 100 m radius surrounding the outfall diffuser). A detailed description of the study design, including analytical testing performed as part of the 2020 Meliadine Mine emergency discharge monitoring program, is outlined in Section 3.0 of the WQ-MOP Rev2a (Appendix A). The sampling stations assessed during this monitoring program are shown in Figure B-1 and described in Table B-1.

The purpose of this Appendix is to provide a high-level summary of key water quality indicators (e.g., specific conductivity, calculated TDS, and chloride concentrations in the discharge and receiving environment, results of acute and chronic toxicity tests) collected to date, to assess these measures relative to predictions and targets established in the Golder (2020) WQ-MOP. This evaluation of monitoring results is organized as follows:

- Summary of key analytical chemistry results related to TDS in the discharge and receiving environment (Section B1.0)
- Summary of acute toxicity testing with the MEL-14 discharge (Section B2.0)
- Summary of chronic toxicity testing with the MEL-14 discharge and Meliadine Lake receiving environment water samples (Section B3.0)
- Uncertainties (Section B4.0)
- Conclusions for the monitoring program, as they relate to predictions and targets established in the Golder (2020) WQ-MOP (Section B5.0)

Table B-1: Conceptual Design for Validation of Interim Total Dissolved Solids Limits for Discharge and Receiving Environment Conducted in 2020 as Part of the Emergency Amendment to Agnico Eagle Mine's Type "A" Water Licence (No. 2AM-MEL1631)

Water Quality Monitoring Program			
Sampling Media	**Discharge**	**Mixing Zone Surface Water**[a]	**Receiving Environment Surface Water**[a] (beyond mixing zone)
Sample Timing	During discharge and during collection of samples for toxicity testing	During discharge[b]	During discharge[b]
Sampling Locations	MEL-14	3 stations at the edge of the mixing zone (MEL-13-01, MEL-13-07 and MEL-13-10)[c]	4 stations—1 mid-field (MEL-02-05), 3 references (MEL-03-02, MEL-04-05, and MEL-05-04)
Number of Samples	Per regulatory and operational requirements[d]	1 sample per station	1 sample per station
Frequency of Sampling	Weekly during discharge[d]	Weekly during discharge or as per NWB's direction	Monthly during discharge or as per NWB's direction
Test Parameters	■ Daily monitoring of discharge flow volumes ■ Parameters as listed in Schedule I Group 2 of the 2AM-MEL1631 NWB Water Licence[e]	■ Field physico-chemical water column profile measurements (temperature, specific conductivity, pH, DO) ■ Parameters as listed in Schedule I Group 2 of the 2AM-MEL1631 NWB Water Licence[e]	■ Field physico-chemical water column profile measurements (temperature, specific conductivity, pH, DO) ■ Parameters as listed in Schedule I Group 2 of the 2AM-MEL1631 NWB Water Licence[e]
Toxicity Testing Program			
Sampling Media	**Discharge**	**Mixing Zone Surface Water**[a]	**Receiving Environment Surface Water**[a] (beyond mixing zone)
Sample Timing	During discharge	During discharge[b]	During discharge[b]
Sampling Locations	MEL-14	3 stations at the edge of the mixing zone (MEL-13-01, MEL-13-07 and MEL-13-10)[c]	4 stations—1 mid-field (MEL-02-05), 3 references (MEL-03-02, MEL-04-05, and MEL-05-04)
Number of Samples	Per regulatory and operational requirements[d]	1 composite sample per station	1 composite sample per station
Frequency of Sampling	Weekly acute tests during discharge; monthly chronic toxicity tests beginning during the second monthly event[d,f]	Monthly during discharge	Monthly during discharge or as per NWB direction
Test Parameters	Acute toxicity tests with: ■ Rainbow Trout ■ *Daphnia magna* Chronic toxicity tests[e] with: ■ Pelagic crustacean (*Daphnia magna*) ■ Epibenthic Invertebrate (*Hyalella azteca*) ■ Macrophyte (*Lemna minor* [duckweed]) ■ Larval fish (*Pimephales promelas* [Fathead Minnow])	Chronic toxicity tests with: ■ Pelagic crustacean (*Daphnia magna*) ■ Epibenthic Invertebrate (*Hyalella azteca*) ■ Macrophyte (*Lemna minor* [duckweed]) ■ Larval fish (*Pimephales promelas* [Fathead Minnow])	Chronic toxicity tests with: ■ Pelagic crustacean (*Daphnia magna*) ■ Epibenthic Invertebrate (*Hyalella azteca*) ■ Macrophyte (*Lemna minor* [duckweed]) ■ Larval fish (*Pimephales promelas* [Fathead Minnow])

Table B-1: Conceptual Design for Validation of Interim Total Dissolved Solids Limits for Discharge and Receiving Environment Conducted in 2020 as Part of the Emergency Amendment to Agnico Eagle Mine's Type "A" Water Licence (No. 2AM-MEL1631)

Plume Delineation Study		
Sampling Media	**Discharge**	**Receiving Environment** (within mixing zone and beyond)
Sample Timing	During discharge[g]	During discharge[g]
Sampling Locations	MEL-14	22 survey locations (see Appendix B) at distance intervals of 50 m from the diffuser, 100 m (i.e., edge of mixing zone), 175 m, and 250 m; potentially adjusted to include more distant samples if necessary[h]
Frequency of Program	2 events during discharge (early and late summer)	2 events during discharge (early and late summer)
Test Parameters	■ TDS and major ions ■ General parameters[i]	■ Field physico-chemical water column profile measurements (temperature and specific conductivity) ■ Water quality samples collected at a subset (a maximum of 10 stations) stations alongside profile measurements and analyzed for TDS, major ions, and general parameters[g]

Notes:

(a) "Surface Water" means near surface water, plus the selected sample depth for testing was the depth with the highest conductivity from the vertical profile (unless the highest specific conductivity was measured in the last profile reading above the lakebed. If so, the sample was collected at the depth 1 m above the bottom reading).

(b) The timing of sampling for each program occurs continuously during the discharge period as outlined in the sample frequencies listed above for each sample media and test type. However, sample timing is dependent on safe access to the lake. The period of anticipated discharge coincides with the transition period between ice covered and open water conditions on Meliadine Lake. Where samples cannot be collected at the required time due to safety considerations, contingency measures are implemented.

(c) Mixing zone stations MEL-13-01 and MEL-13-07 are routinely sampled by the mine during the EEM/AEMP programs. MEL-13-10 represents a new sampling station.

(d) A post-discharge sample was collected from MEL-14 on 26 October 2020 for water chemistry and chronic toxicity testing; this sample was collected to test the chronic toxicity at a higher TDS concentration than evaluated during the discharge period.

(e) Parameters as listed in Schedule I Group 2 of the 2AM-MEL1631 NWB Water Licence include Conventional Parameters (bicarbonate alkalinity, chloride, carbonate alkalinity, turbidity, conductivity, hardness, calcium, potassium, magnesium, sodium, sulphate, pH, total alkalinity, TDS, TSS, total cyanide, free cyanide, and weak acid dissociable [WAD] cyanide), Nutrients (ammonia-nitrogen, total Kjeldahl nitrogen, nitrate-nitrogen, nitrite-nitrogen, orthophosphate, total phosphorus, total organic carbon, dissolved organic carbon, and reactive silica), and Total and Dissolved Metals (aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, copper, iron, lead, lithium, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, tin, titanium, uranium, vanadium, and zinc).

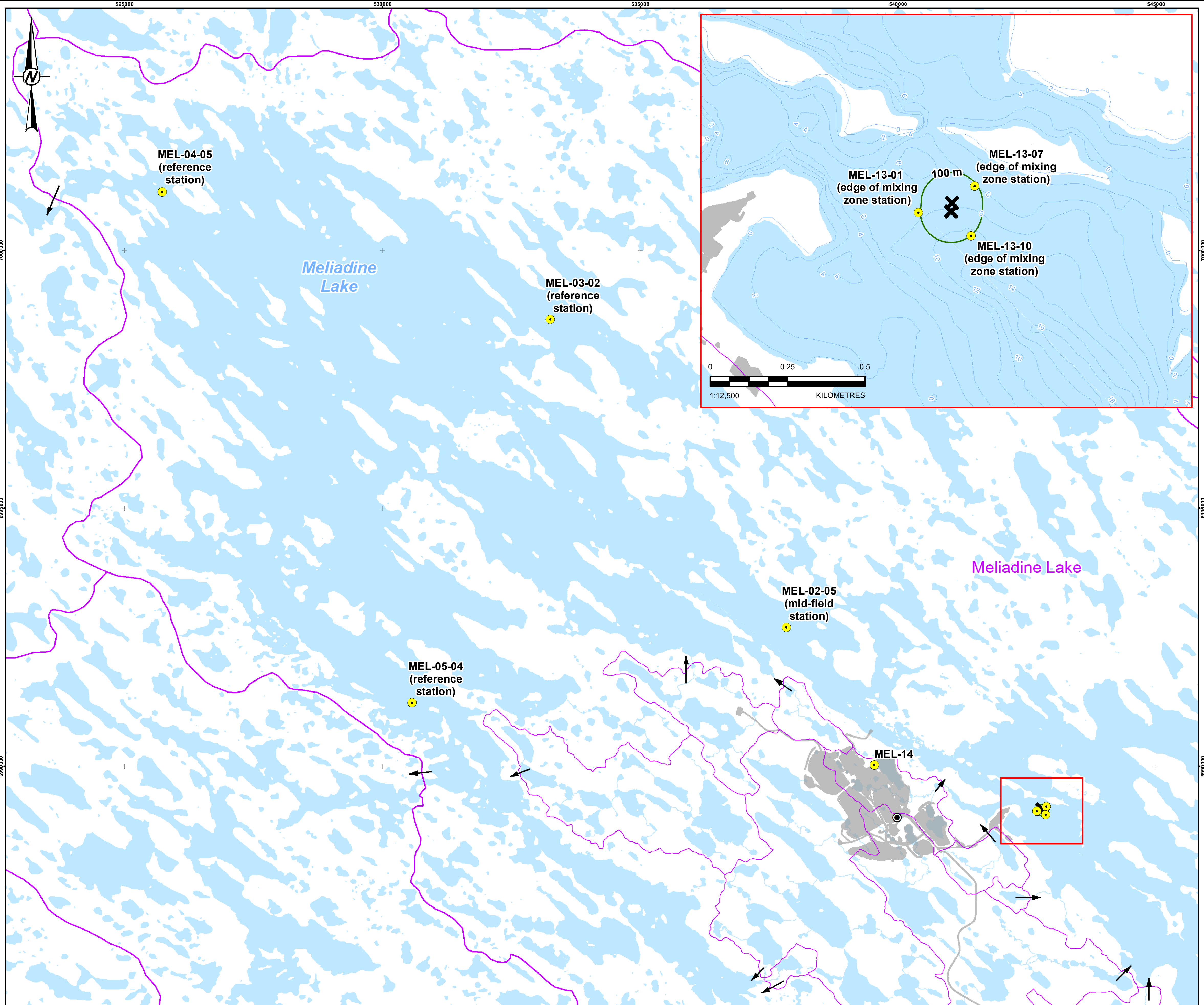
(f) Per commitments arising from responses to comments from ECCC and KivIA and discussions through the WMWG following the first monthly sampling event, chronic toxicity testing of the MEL-14 discharge is conducted monthly beginning on the second monthly sampling event.

(g) Sample timing is dependent on boat access to the lake. The period of anticipated discharge coincides with the transition period between ice covered and open water conditions on Meliadine Lake. Access of the lake occurs as soon as open water conditions permit safe boat access.

(h) The maximum spatial extent of plume delineation monitoring may be extended past 250 m should the proportion of discharge be estimated to contribute >10% of TDS at 250 m (estimated based on field specific conductivity measurements).

(i) General parameters = total and bicarbonate/carbonate alkalinity, turbidity, laboratory specific conductivity, hardness, laboratory pH, and total suspended solids.

TDS = total dissolved solids.



LEGEND

- SAMPLING STATION
- DIFFUSER
- FINAL DISCHARGE BUFFER
- MINE FOOTPRINT
- WATERSHED BOUNDARY
- WATERCOURSE
- WATERBODY

0 1.5 3
1:75,000 KILOMETRES

REFERENCE(S)
1. BASE DATA OBTAINED FROM AGNICO EAGLE MINES LIMITED.
2. DATUM: NAD83 PROJECTION UTM ZONE 15

CLIENT
AGNICO EAGLE
AGNICO EAGLE MINES LIMITED

PROJECT
MELIADINE GOLD PROJECT
NUNAVUT

TITLE
WQ-MOP SAMPLING STATIONS

CONSULTANT
GOLDER

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B1.0 SUMMARY OF ANALYTICAL CHEMISTRY RESULTS

B1.1 Water Chemistry during the 2020 Discharge Period

Water chemistry monitoring results were compiled from the WQ-MOP validation monitoring program for the discharge and in the receiving environment performed between 5 June 2020 (commencement of discharge) and 4 October 2020 (termination of sampling; termination of discharge occurred on 3 October 2020). Additionally, a post-discharge sample from MEL-14 was collected on 26 October 2020 to test the chronic toxicity at a higher TDS concentration than evaluated during the discharge period; the latter are not compiled with the discharge chemistry presented below but are presented separately (Section B1.2).

Tabulated results were provided to Golder from Agnico Eagle (see Attachment B1) for the following monitoring events in 2020 (Table B-2).

Table B-2: Details of the Validation Monitoring conducted on the discharge and in the Receiving Environment during the 2020 Discharge associated with the Emergency Amendment

Validation Monitoring	Sampling Events / Duration
Water Chemistry	
MEL-14[a]	22 Sampling Events – 5, 7, 14, 15, 21, and 28 June; 5, 19, and 26 July; 2, 9, 13, 16, 23, 29 and 30 August; 5, 6, 13, 20, and 27 September; and 2 October 2020
Edge of Mixing Zone[a]	16 Sampling Events – 7[c] June; 12, 19, 22 and 29 July; 2, 9, 15, 19[d], 23, and 29 August; 5, 13, 20, and 27 September; and 4 October 2020
Mid-field Station[b]	7 Sampling Events – 7 June; 23 and 27 July; 18 and 22 August; and 7 and 12 September 2020
Reference Stations[b]	7 Sampling Events – 7 June; 22/25 and 27[e] July; 19[f] and 22/23 August; and 8[e] and 12 September 2020
Toxicity Testing	
MEL-14[a]	18 Acute Toxicity Tests – 7, 14, 21, and 28 June; 5, 12, 19, and 26 July; 2, 9, 16, 23, and 30 August; 6, 13, 20, and 27 September; and 2 October 2020 5 Chronic Toxicity Tests[a] – 20 July, 23 August, 12 September, and 3 October 2020
Edge of Mixing Zone	4 Chronic Toxicity Tests – 7[c] June, 23 July, 23 August, and 13 September
Mid-field Station[b]	4 Chronic Toxicity Tests – 6 June, 23 July, 22 August, and 12 September 2020
Reference Stations [b]	4 Chronic Toxicity Tests – 6 June, 25 July, 22/23 August, and 12 September 2020
Plume Delineation Studies	2 Events – 21 July 2020, and 13 August 2020
Remote Continuous Specific Conductivity and Temperature Monitoring	5 June 2020 to 4 October 2020[g]

[a] A post-discharge sample was collected from MEL-14 on 26 October 2020 for water chemistry and chronic toxicity testing; this sample is addressed independently of collections presented in this table.

[b] Due to melting ice conditions on Meliadine Lake (health and safety concerns), weekly sampling events at the edge of the mixing zone during the weeks of 14 June, 21 June, 28 June, and 5 July were not conducted.

[c] Due to ice formation on Meliadine Lake (health and safety concerns), the final monthly sampling event at the start of October was not conducted.

[d] MEL-13-01 and MEL-13-07 only; edge of mixing zone station MEL-13-10 was not accessible due to unsafe local ice conditions during the first monthly sampling event (i.e., 7 June 2020).

[e] MEL-13-01 only.

[f] MEL-03-02 only.

[g] MEL-03-02 and MEL-04-05 only.

[h] MEL-13-01 from 5 June to 29 August 2020.

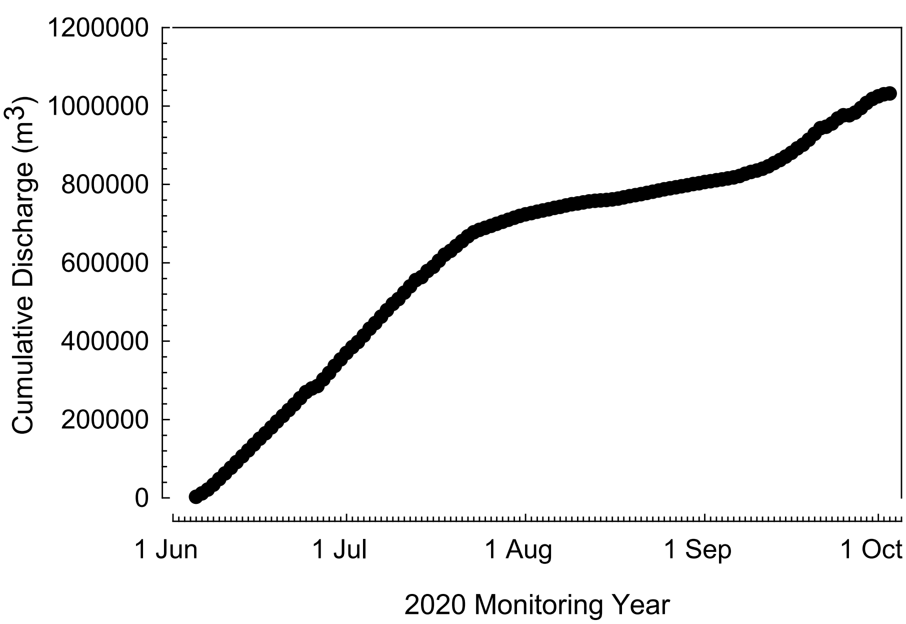
In total, 1,031,177 m^3 of CP1 water was discharged to Meliadine Lake between 5 June and 3 October 2020 (Figure B-2). Daily discharge rates ranged from 15 m^3/day to 17,518 m^3/day (Figure B-3). The discharge was characterized by three distinct discharge periods:

- Elevated discharge from June 9 to July 22 at approximately 16,000 m^3/day, which occurred at the tail end of under-ice conditions through to shortly after full open water conditions in the East basin of Meliadine Lake
- Reduced discharge from July 23 to September 5 at approximately 4,000 m^3/day
- A short-term ramp up in discharge from September 6 that peaked on September 15 at approximately 15,000 m^3/day followed by a reduction through to the end of discharge

Daily specific conductivity trends at MEL-14 showed elevated measurements during under-ice conditions of around 5,000 µS/cm, a reduction during ice melt and corresponding freshet inputs to around 2,000 µS/cm, followed by a steady minor gradual increase through the summer months to the end of discharge of approximately 4,000 µS/cm (Figure B-3).

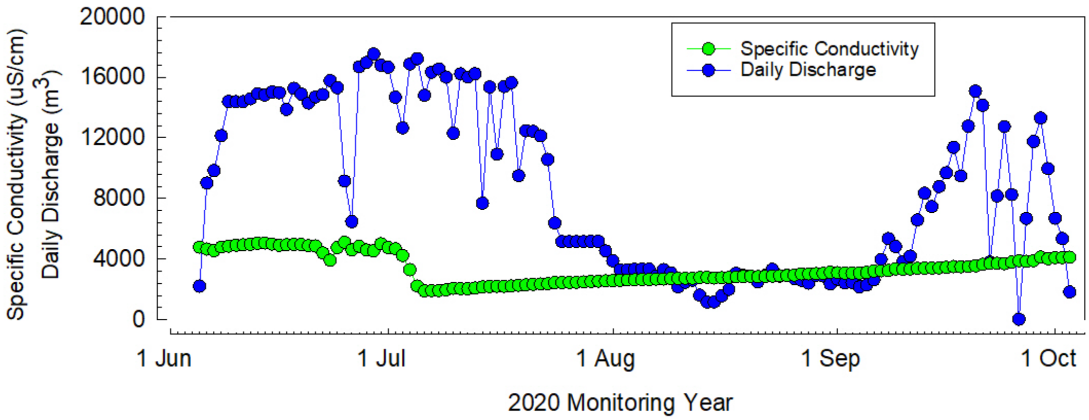
Discharge samples from MEL-14 were collected weekly and submitted to BV Labs or ALS Environmental for analyses; reported data are presented in Attachment B1. The discharge water quality data were screened against the interim MAC and MGC TDS limits and applicable water licence discharge limits (discharge quality).

Figure B-2: Cumulative CP1 Water Discharge to Meliadine Lake between 5 June 2020 and 3 October 2020



m^3 = cubic metres. The last day of discharge to Meliadine Lake was October 3, 2020.

Figure B-3: MEL-14 Daily Discharge Rates and Specific Conductivity Measurements between 5 June 2020 and 3 October 2020



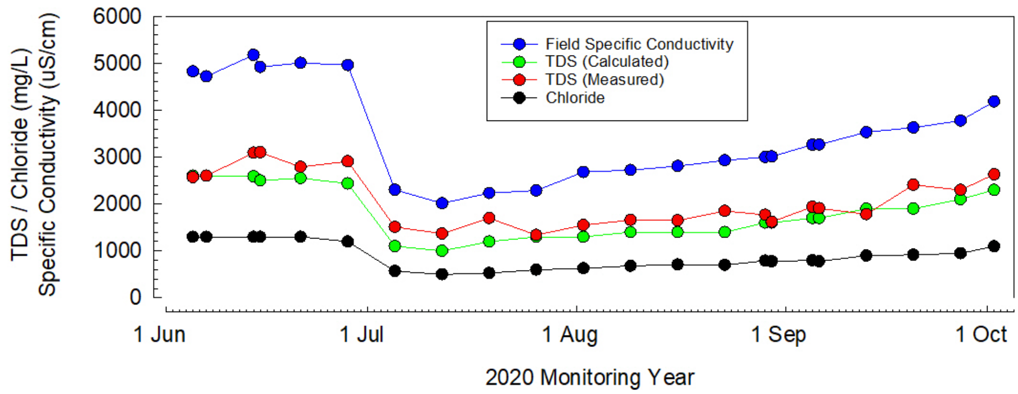
Notes: Complete open-water conditions in Meliadine Lake achieved on 15 July 2020
m^3 = cubic metres; µS/cm = microsiemens per centimetre.

Concentrations of calculated TDS in the discharge, determined from weekly samples submitted for laboratory analysis, ranged from 1,030 mg/L to 2,675 mg/L (Figure B-4). The discharge also remained within all applicable Water Licence discharge limits and the 3,500 mg/L MAC TDS limit permitted under Amendment B1.

The ionic composition of the discharge remained consistent over the 2020 discharge period, as determined from the relatively consistent proportion of chloride in the TDS. Chloride was the dominant anion in the discharge and the largest ionic constituent of TDS, contributing 49% of the TDS by mass on average. The secondary components of TDS comprised sodium, calcium, and sulphate (i.e., average of 19%, 12%, and 11%, respectively). The remaining minor contributors of the TDS comprised magnesium, potassium, bicarbonate, silica, and nitrate.

The relationship between chloride and TDS varies as a function of dilution and distance from the diffuser (Table B-3). This occurs because the receiving waters contain a lower proportion of chloride relative to the full-strength discharge. At the edge of the mixing zone, the median chloride proportion decreases to appropriately one-third, and further decreases in the mid-field and reference locations, to 27% and 24%, respectively. This chloride composition is consistent with the near-field median for data collected between July 2015 and September 2019 from MEL-01, which was estimated at 29% (see Table A-1 in WQ-MOP Rev2a).

Figure B-4: MEL-14 Total Dissolved Solids (Calculated and Measured), Laboratory Specific Conductivity and Chloride Measurements between 5 June 2020 and 2 October 2020



mg/L = milligrams per litre; µS/cm = microsiemens per centimetre.

Table B-3: Summary of Key Water Quality Indicators in Discharge and Receiving Environment Samples Collected during the 2020 Discharge Period, including Hardness and the Ratio between Chloride and Calculated Total Dissolved Solids

Monitoring Stations	Units	Median	Mean	Min	Max	SD	Count
MEL-14							
Total dissolved solids	mg/L	1,880	2,093	1,340	3,100	572	22
Total dissolved solids (calculated)	mg/L	1,700	1,826	1,000	2,600	546	22
Chloride	mg/L	795	893	500	1,300	282	22
Hardness, as $CaCO_3$	mg/L	696	767	426	1,090	220	22
$Cl:TDS_{Calc}$	—	0.49	0.49	0.44	0.52	0.02	22
MEL-13							
Total dissolved solids	mg/L	70	68	30	115	21	45
Total dissolved solids (calculated)	mg/L	54	56	49	78	6.6	44
Chloride	mg/L	18	19	9	28	3.3	45
Hardness, as $CaCO_3$	mg/L	30	31	22	39	3.0	45
$Cl:TDS_{Calc}$	—	0.33	0.34	0.28	0.37	0.02	44
MEL-02							
Total dissolved solids	mg/L	49	49	35	80	15	7
Total dissolved solids (calculated)	mg/L	44	45	40	60	7.0	7
Chloride	mg/L	12	12	11	16	1.7	7
Hardness, as $CaCO_3$	mg/L	24	26	24	35	4.0	7
$Cl:TDS_{Calc}$	—	0.27	0.27	0.26	0.29	0.01	7

Table B-3: Summary of Key Water Quality Indicators in Discharge and Receiving Environment Samples Collected during the 2020 Discharge Period, including Hardness and the Ratio between Chloride and Calculated Total Dissolved Solids

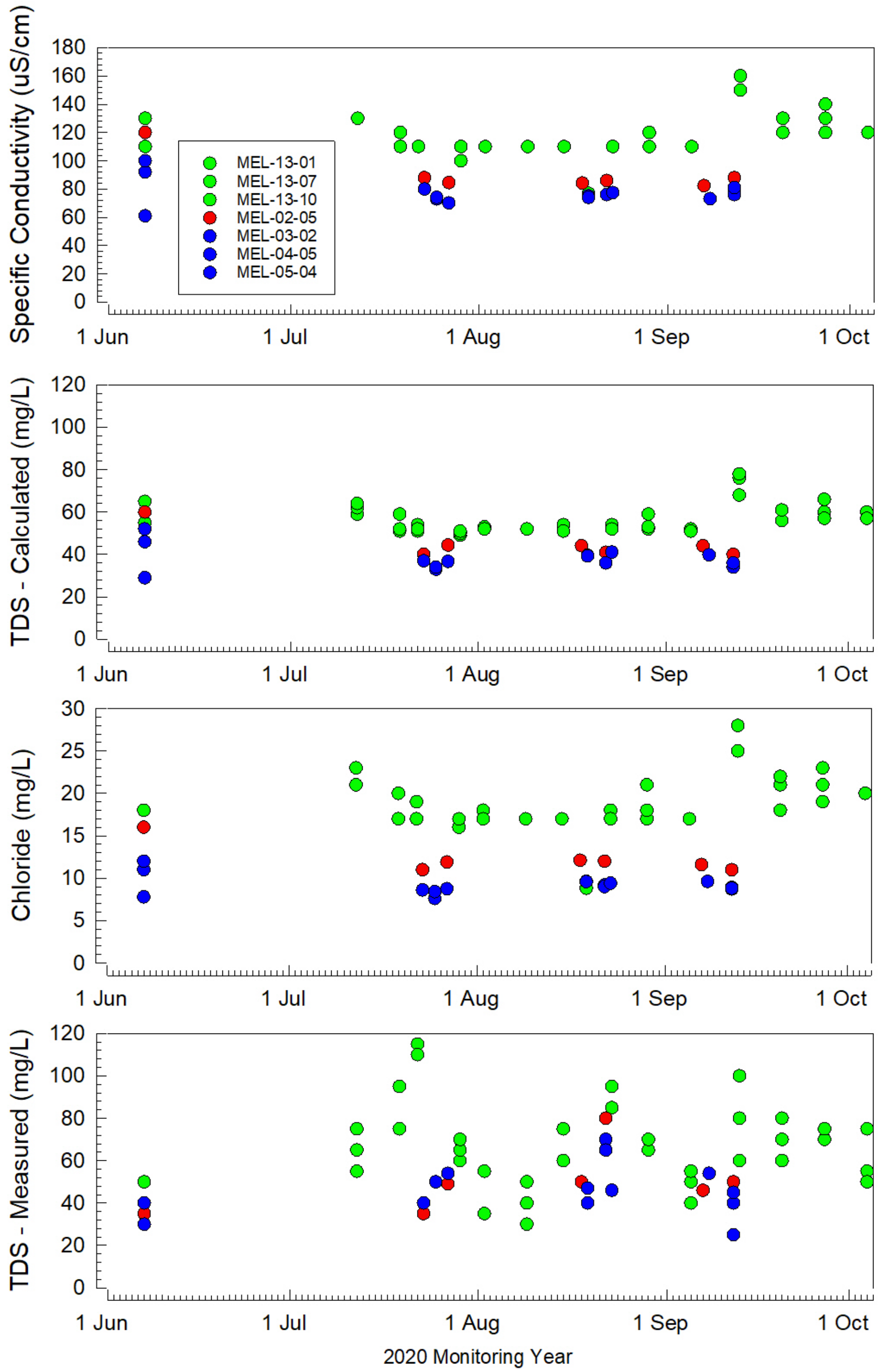
Monitoring Stations	Units	Median	Mean	Min	Max	SD	Count
Reference							
Total dissolved solids	mg/L	46	46	25	70	11	16
Total dissolved solids (calculated)	mg/L	36	38	29	52	5.4	16
Chloride	mg/L	9.0	9.2	7.6	12	1.1	16
Hardness, as $CaCO_3$	mg/L	22	23	19	31	2.7	16
$Cl:TDS_{Calc}$	—	0.24	0.24	0.23	0.27	0.01	16

$CaCO_3$ = calcium carbonate; $Cl:TDS_{Calc}$ = mass ratio of chloride to calculated total dissolved solids; mg/L = milligrams per litre; min = minimum; max = maximum; SD = standard deviation; — = unitless.

Calculated TDS, specific conductivity, and measured TDS in discharge were maintained in consistent proportions throughout the validation monitoring program; however, there was larger variability in the measured TDS relative to the calculated TDS, and measured TDS was typically biased high (i.e., higher than the corresponding calculated TDS and specific conductivity comparisons). For this reason, calculated TDS has been preferred to measured TDS in this assessment.

Water quality in the receiving environment (i.e., edge of the mixing zone, mid-field, and reference stations) can be characterized through review of the same water quality indicators used for the discharge (i.e., specific conductivity, calculated TDS, and chloride) (Figure B-5). Relative to the discharge, concentrations of calculated TDS were low at each monitoring station, ranging from 49 to 78 mg/L, indicating that the submerged diffuser effectively dispersed the pumped discharge into Meliadine Lake. The edge of mixing zone calculated TDS concentrations were less than the interim edge of mixing zone (and SSWQO) target of 1,000 mg/L, demonstrating a high assimilation rate that reduced TDS concentrations to well below concentrations of potential concern. Field parameters (e.g., pH, dissolved oxygen, temperature) were similar between the discharge and the receiving environment with the exception of specific conductivity, which was approximately 28 times lower at the edge of mixing zone stations (Attachment B1). Although some nutrients and metals showed slight decreases at the edge of the mixing zone compared to the discharge (e.g., turbidity, TOC, total phosphorus, copper, and iron within a factor of three), others showed concentration decreases greater than 50-fold (e.g., nitrate, nitrite, ammonia, aluminum, lithium, manganese, and strontium). All of the above observations are consistent with the pattern expected for well-mixed discharge in the receiving environment.

Figure B-5: Total Dissolved Solids (Calculated and Measured), Laboratory Specific Conductivity and Chloride Measurements for the Receiving Environment Stations in Meliadine Lake between 5 June 2020 and 4 October 2020



Notes: Complete open-water conditions in Meliadine Lake achieved on 15 July 2020

TDS = total dissolved solids; mg/L = milligrams per litre; µS/cm = microsiemens per centimetre.

Water quality data collected in the receiving environment were screened against CCME water quality guidelines for the protection of freshwater aquatic life (Attachment B1). Calculated TDS concentrations at the edge of the mixing zone remained within the proposed 1,000 mg/L SSWQO benchmark. Water quality at all receiving environment stations during the discharge period remained within CCME PAL guidelines except for dissolved zinc in two samples. These elevated zinc concentrations are not attributed to discharge but due to natural variability or variability in the analytical measurements:

- At MEL-13-10 on 2 August 2020, dissolved zinc (16 µg/L) was above the CCME long-term water quality guideline of 9.2 µg/L; however, total zinc was below the detection limit of 5 µg/L (the chronic dissolved zinc guideline valued is determined based on pH, hardness, and dissolved organic carbon measurements). This discrepancy between total and dissolved zinc suggests there is some uncertainty in measurements for zinc in these samples. Further, total and dissolved zinc measurements in the discharge were <5 µg/L, well below the permitted discharge limits of 400 µg/L for the Maximum Average Concentration (MAC) and 800 µg/L for the Maximum Grab Concentration (MGC). As a result, the dissolved zinc value at MEL-13-10 appears anomalous and not correlated with the MEL-14 discharge, but rather to variability in the analytical measurements within five times the detection limit.
- At reference station MEL-03-02 on 27 July 2020, dissolved zinc was 5.7 µg/L (above the calculated guideline) but total zinc was measured at 0.84 µg/L; this suggests there is some uncertainty in measurements for zinc.

B1.2 Post-Discharge Water Chemistry

A post-discharge sample from MEL-14 was collected on 26 October 2020 to evaluate the chronic toxicity at a higher TDS concentration than tested during the discharge period. The results have been presented separately to distinguish between conditions associated with discharge linked to the Emergency Amendment and the broader program of benchmark validation under the WQ-MOP.

Chloride remained the dominant anion in the MEL-14 sample and the largest ionic constituent of TDS, contributing 48% of the TDS by mass, which is consistent with the water chemistry during discharge (Table B-4). TDS and chloride remained within the overall range of concentrations reported during discharge; however, the TDS and chloride concentrations for the 26 October event were higher than measured in the samples collected for the four previous rounds of chronic toxicity testing. During the four rounds of chronic tests, the MEL-14 discharge was measured at TDS concentrations ranging between 1,700 and 1,850 mg/L measured TDS (1,200 and 1,400 mg/L calculated TDS). As such, the 26 October 2020 sample expanded the testing range of constituents and helped to further validate benchmarks.

Table B-4: Summary of Key Water Quality Indicators in the MEL-14 Post-Discharge Sample Collected on 26 October 2020, including Hardness and the Ratio between Chloride and Calculated Total Dissolved Solids

Monitoring Stations	Units	Value
Total dissolved solids	mg/L	2,740
Total dissolved solids (calculated)	mg/L	2,500
Chloride	mg/L	1,200
Hardness, as $CaCO_3$	mg/L	1,120
$Cl:TDS_{Calc}$	—	0.48

B1.3 Remote Monitoring of Specific Conductivity

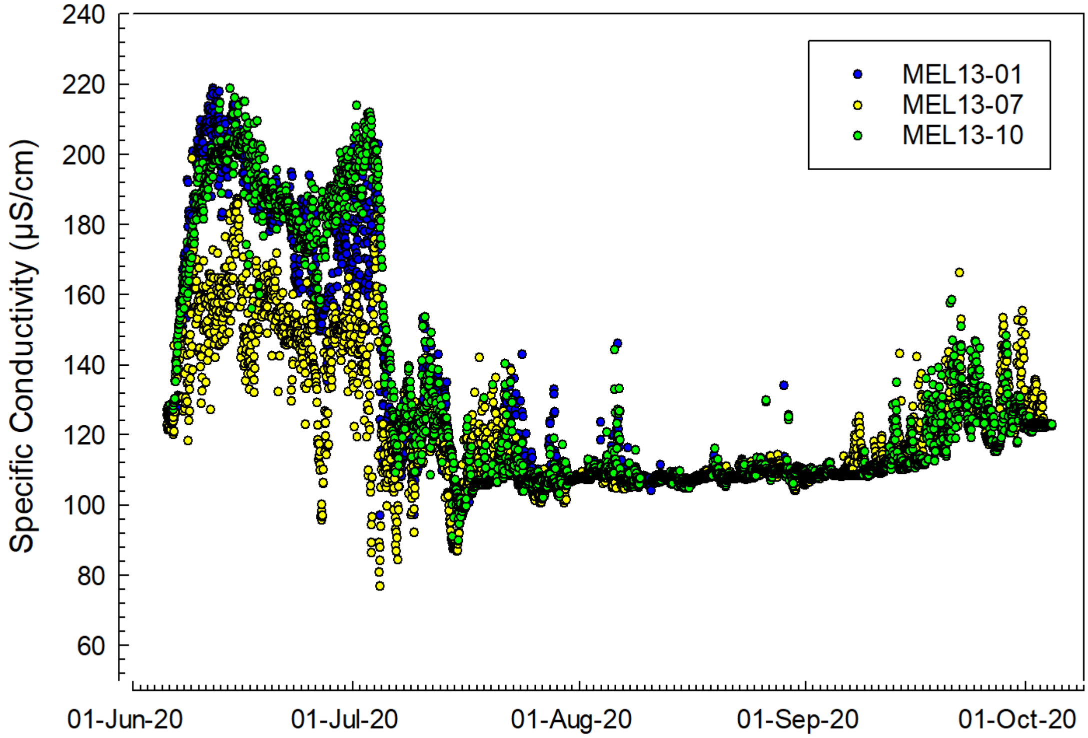
Remote data loggers (Eureka Trimeter Water Conductivity Probes) to measure specific conductivity were deployed in the water column at MEL-13-01, MEL-13-07, and MEL-13-10. These loggers were anchored at the edge of the mixing zone stations and attached to buoys in the water column that placed them approximately 2 m above the lakebed. Loggers at MEL-13-07 and MEL-13-10 were deployed from 5 June 2020 to 4 October 2020, and the logger at MEL-13-01 were deployed 5 June 2020 to 29 August 2020 (Figure B-6). They were recovered on July 15, the data downloaded, and the calibration checked and updated, with redeployment for the remaining period up to October 4. The monitoring frequency was set to an hourly basis.

The primary purpose of this monitoring approach was to provide specific conductivity data at the edge of the mixing zone stations during the transition from ice-cover to open water conditions. This provided an opportunity to monitor high-resolution specific conductivity as a surrogate for other water quality parameters (including TDS) that are strongly associated with specific conductivity (e.g., major ions). As the lake transitioned from ice cover to open water, safe access to the receiving environment stations was not feasible, until mid-July, almost 5 weeks after the initial sampling at the commencement of discharge. These logging stations were maintained at the edge of the mixing zone for the remainder of the discharge period.

The logged specific conductivity measurements at the edge of the mixing zone stations show a relatively similar conductivity among the stations (Figure B-6). The data indicate peak specific conductivity (approximately 220 µS/cm) during under-ice conditions, with slightly higher values at MEL-13-01 and MEL-13-10 compared to MEL-13-07 (e.g., peak of approximately 190 µS/cm) (Figure B-6). The data indicate that the plume under ice extended throughout the mixing zone, with a slightly more pronounced W-N-E lateral spread. This plume spread is in contrast with a previous plume delineation study (i.e., Golder 2018) that the plume moved in a predominant north-east to south-east direction (the Golder (2018) findings were based on open water season monitoring). With the onset of ice melt and freshet (early- to mid-July) changes in hydrological conditions and progression into open water conditions (also associated with the reduction in daily discharge rates), the plume direction appeared to be similar throughout the mixing zone. During the summer months, variations among specific conductivity measurements at the three edge of mixing zone stations narrowed (Figure B-6).

The pattern in specific conductivity at the edge of the mixing zone followed a similar pattern to the daily discharge rates irrespective of season. Higher specific conductivity values at the mixing zone boundary stations corresponded with periods of higher daily discharge (i.e., June through July and mid-September). This pattern was also evident in the specific conductivity water column profiles at the edge of mixing zone stations (Figure B-7).

Figure B-6: Continuous Specific Conductivity Measurements at the Edge of Mixing Zone Stations Collected 2 m above the Lakebed from 5 June 2020 to 4 October 2020



Notes: Complete open-water conditions in Meliadine Lake achieved on 15 July 2020
µS/cm = microsiemens per centimetre.

B1.4 Water Column Profiles

In addition to the sample collections for water quality, physico-chemical water quality measurements were collected from the water column at each sampling station. These data provided specific conductivity, pH, temperature, and dissolved oxygen concentration data through the water column at the stations. The specific conductivity data were used to identify the depth in the water column where samples were preferentially collected. Sampling was conducted at the depth of maximum specific conductivity, unless it was measured at the depth nearest to the lakebed, in which case the sampling depth was adjusted to 1 m above the last measurement.

The water column specific conductivity profiles indicated four clear trends:

- Specific conductivity at all stations was elevated during ice cover, which is attributed to cryo-concentration increases in the water column below the ice
- The discharge plume, as defined by higher specific conductivity measurements, was evident at and below mid-depth at the edge of the mixing zone (Figure B-7), which indicated that the placement of the logging sondes was appropriate for identification and monitoring of daily variations at the mixing zone boundary

- Between the transition from ice cover to open water (i.e., up to July 22) and the short ramp up in discharge at the end of September (after September 23), specific conductivity was equilibrated through the water column
- The discharge plume in open water was identified at the edge of the mixing zone under higher discharge rates (i.e., in September); however, at lower daily discharge rates, the plume was not discernible due to a low magnitude of influence relative to background variation

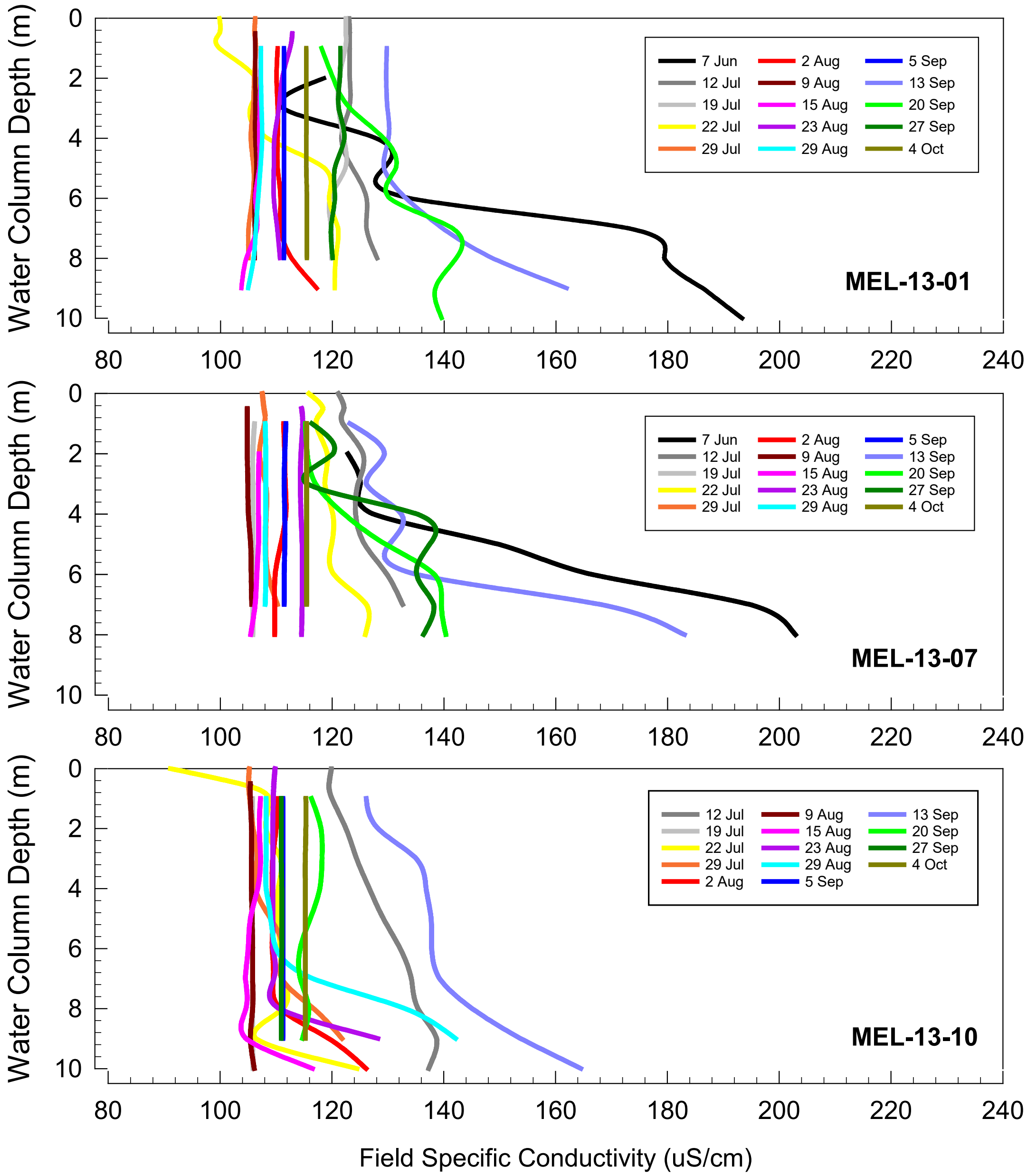
The lake was generally well oxygenated during ice-cover and open water with most dissolved oxygen measurements greater than 8 mg/L throughout the water column at the edge of mixing zone, mid-field, and reference stations.

Water column temperature profiles were generally consistent throughout the water column and between stations. However, during ice-cover conditions and in the month following freshet, temperature increased slightly with depth, and in the month following freshet, minor temperature decreases were measured at depth. Throughout the discharge period, temperature was dependent on season with a minimum near zero during ice-cover, a maximum of 16.5°C at the edge of mixing zone during open water, and a maximum of 14.6°C in the reference area during open-water.

Open-water pH ranged from 6.88 to 8.20 at the edge of the mixing zone, whereas ice-cover pH ranged from 5.96 to 6.98. Mid-field pH profiles ranged from 6.86 to 6.95 in ice-cover conditions and 7.29 to 7.74 in open-water conditions. Ice-cover pH at the reference stations was variable with pH ranging from 6.64 to 6.83 at MEL-04-05 to 7.43 to 7.56 at MEL-05-04; however, open-water pH profiles were similar ranging from 7.55 to 8.15. At all stations, ice-cover and open-water pH were relatively constant throughout the water column.

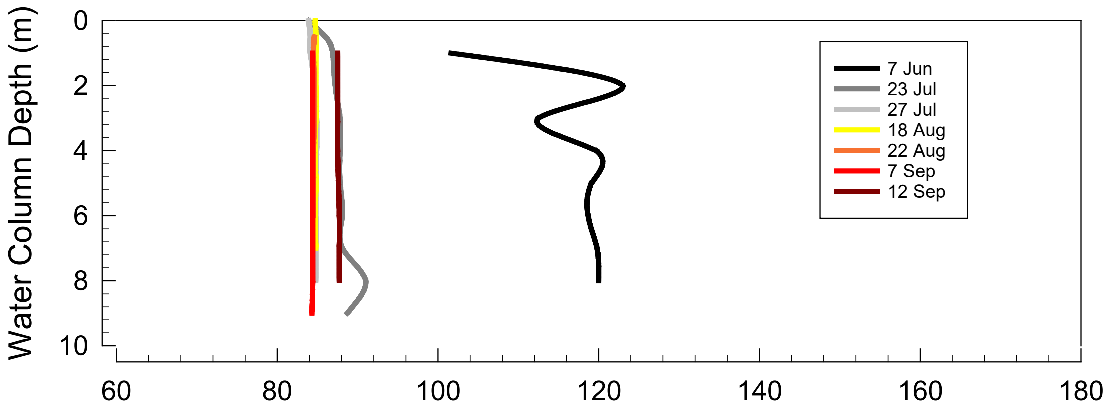
At the mid-field and reference stations (Figure B-8 and Figure B-9), there was no evidence of influence of any discharge plume through the water column, either under ice or in open water. The water column was typically well mixed on each occasion. A transition in decreasing specific conductivity from the edge of the mixing zone, through the mid-field, and to the reference stations was evident (as identified from the water chemistry analyses). This pattern indicates that discharge quickly dispersed in the mixing zone and assimilated broadly throughout in the lake with distance from the diffuser. During periods of lower daily discharge volumes, the specific conductivity profiles show well-mixed water column conditions due to the similarity in field-measured parameters throughout the water column.

Figure B-7: Specific Conductivity Water Column Profiles for the Edge of the Mixing Zone Stations from 7 June 2020 to 4 October 2020.



m = metre; µS/cm = microsiemens per centimetre.

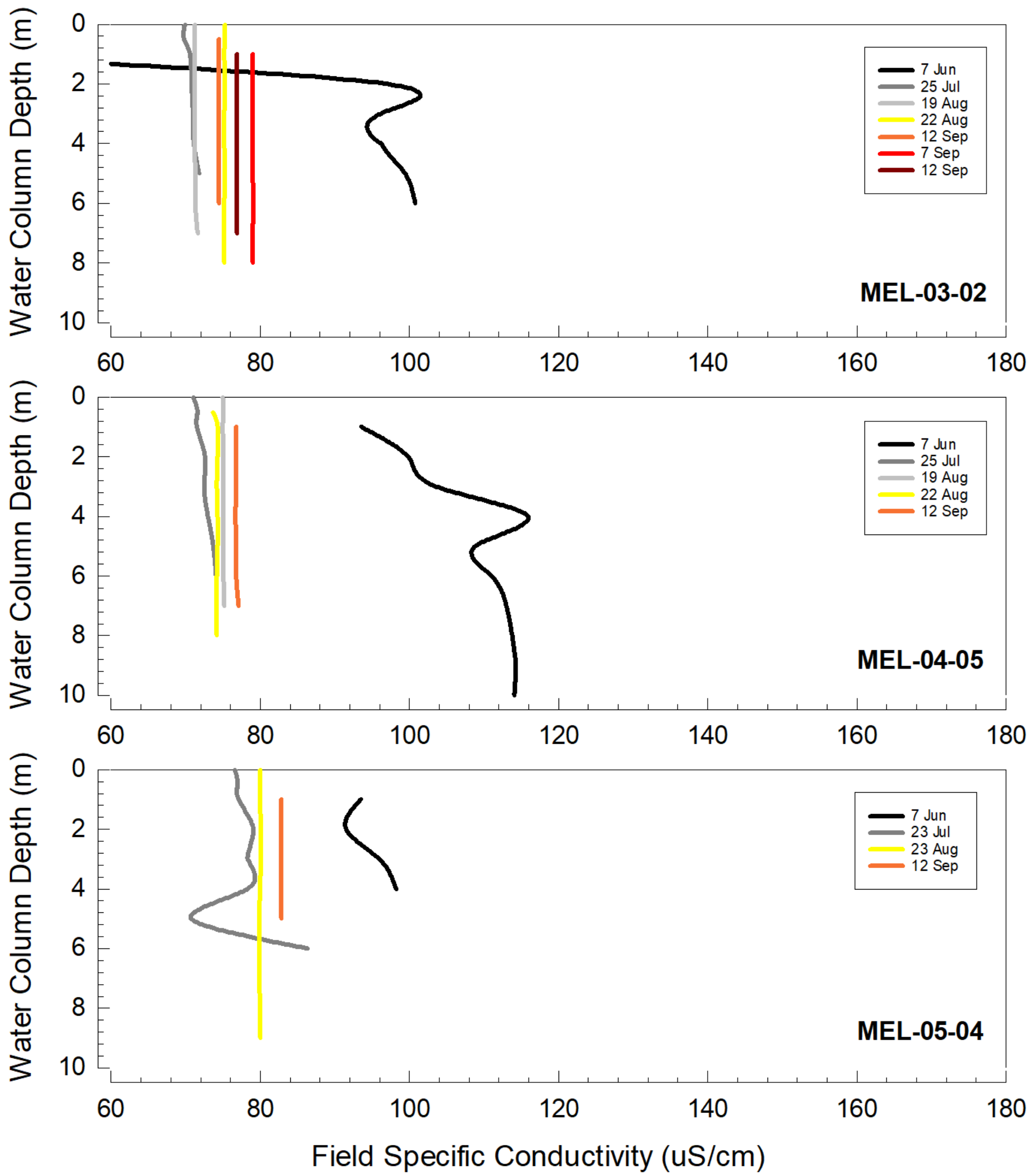
Figure B-8: Specific Conductivity Water Column Profiles for the Mid-field Station from 7 June 2020 to 4 October 2020.



Notes: Complete open-water conditions in Meliadine Lake achieved on 15 July 2020

m = metres; µS/cm = microsiemens per centimetre.

Figure B-9: Specific Conductivity Water Column Profiles for the Reference Stations from 7 June 2020 to 4 October 2020.



Notes: Complete open-water conditions in Meliadine Lake achieved on 15 July 2020

m = metres; µS/cm = microsiemens per centimetre.

B1.5 Water Quality Summary

Based on the water chemistry results obtained during the WQ-MOP validation monitoring program between 5 June 2020 and 4 October 2020, primary conclusions are:

- Measured TDS concentrations in the full-strength discharge were consistently less than permitted levels of 3,500 mg/L, and dispersed discharge remained below 1,000 mg/L at the edge of mixing zone stations during each of the sampling events
- Discharge was effectively assimilated in the receiving environment, as TDS concentrations measured at the edge of the mixing zone have not exceeded 115 mg/L. TDS concentrations showed additional attenuation through the mid-field, with levels at the far-field reference stations consistent with background concentrations in Meliadine Lake.
- The receiving environment showed evidence of rapid recovery from high volume discharge following under-ice and early September periods.

B2.0 SUMMARY OF ACUTE TOXICITY TEST RESULTS

Acute toxicity tests were conducted on the MEL-14 discharge weekly throughout the discharge period from 5 June 2020 to 4 October 2020. Results for 18 rounds of weekly acute toxicity testing programs were reported using the 96-hour Rainbow Trout and 48-hour *Daphnia magna* survival tests (Environment Canada 2016a,b). Table B-5 summarizes the results of these tests; detailed laboratory reports and bench sheets from each of the tests can be provided upon request.

Acute toxicity tests indicate that the discharge has not been acutely toxic to Rainbow Trout or *Daphnia magna* across the range of TDS concentrations tested (i.e., between 1,340 and 3,090 mg/L measured TDS; Table B-5). The LC_{50} values (lethal concentration effecting 50% of organisms) were >100% (full-strength) discharge in each of the tests. Furthermore, with one exception (90% survival in one test) in each species, 100% of organisms have survived in the undiluted full-strength samples. These findings corroborate with acute toxicity testing of CP1 water collected throughout 2019 and early 2020, which have consistently indicated a lack of acute toxicity at concentrations similar to, and exceeding, those observed in the weekly samples during discharge release. The occasional observance of 10% mortality throughout a long period of monitoring is typical of a no-effect response, as occasional mortalities are within the natural background response for clear water, including negative control laboratory water.

The results of these tests were confirmed as valid by the testing laboratory (Aquatox Laboratories, Guelph, ON); tests met control and test acceptability requirements from the respective test methods.

Table B-5: Weekly acute toxicity test results from MEL-14 during the emergency discharge monitoring program (5 June 2020 to 4 October 2020).

Sample Date	TDS Concentration (mg/L as Measured)	96-hour Rainbow Trout Survival Results		48-hour *Daphnia magna* Survival Results	
		LC50 Value (% Discharge)	Survival in 100% Full Strength Discharge (%)	LC_{50} Value (% Discharge)	Survival in 100% Full Strength Discharge (%)
7 June 2020	2,570	>100	100	>100	100
14 June 2020	3,090	>100	100	>100	100
21 June 2020	2,790	>100	100	>100	100
28 June 2020	2,910	>100	100	>100	100
5 July 2020	1,510	>100	100	>100	100
12 July 2020	1,370	>100	100	>100	100
19 July 2020	1,430	>100	100	>100	100
26 July 2020	1,340	>100	100	>100	100
2 August 2020	1,550	>100	100	>100	100
9 August 2020	1,660	>100	100	>100	100
16 August 2020	1,650	>100	100	>100	100
23 August 2020	1,850	>100	100	>100	90
30 August 2020	1,620	>100	90	>100	100
6 September 2020	1,910	>100	100	>100	100
13 September 2020	1,780	>100	100	>100	100
20 September 2020	2,410	>100	100	>100	100
27 September 2020	2,300	>100	100	>100	100
2 October 2020	2,630	>100	100	>100	100

Notes: TDS = total dissolved solids; mg/L = milligrams per litre; % = percent; LC_{50} = lethal concentration effecting 50% of organisms.

B3.0 SUMMARY OF CHRONIC TOXICITY TEST RESULTS

One component of the WQ-MOP monitoring program entails chronic toxicity testing of monthly receiving environment samples from Meliadine Lake. The goal of the testing is to assess the potential for chronic effects to aquatic receptors at, and beyond, the edge of the mixing zone (i.e., a 100 m radius surrounding the diffuser in Meliadine Lake). As outlined in the WQ-MOP Rev2 (Golder 2020), chronic effects were not anticipated at the edge of the mixing zone based on earlier chronic toxicity tests of CP1 water and predicted exposure concentrations. As a validation and confirmation step, four chronic toxicity test species were identified to monitor conditions in the receiving environment during the monthly toxicity testing program. These tests include:

- 7-day Fathead Minnow (freshwater fish) survival and growth test using early life-stages (Environment Canada 2011)
- 7-day *Lemna minor* (Duckweed; aquatic macrophyte) survival and growth test (Environment Canada 2007)
- 14-day *Hyalella azteca* (benthic invertebrate) survival and growth test (Environment Canada 2017)
- 21-day *Daphnia magna* (freshwater crustacean) survival and reproduction test (ASTM International 2012)

The low hardness receiving environment of Meliadine Lake (ranging between approximately 20 and 40 mg/L hardness; 2019 AEMP[1]) posed a complication for implementation and interpretation of chronic toxicity testing, as the organisms used in the selected tests are typically cultured in higher hardness waters (i.e., 80–110 mg/L for *Daphnia magna*; ~140 mg/L *Hyalella azteca*; ~100 mg/L for *Lemna minor*, 130–140 mg/L for Fathead Minnow). This was identified as a potential confounding factor during conversations with Bureau Veritas Laboratories (BV Labs; chronic toxicity laboratory), as the transfer of organisms from the higher hardness culture waters to the lower hardness test waters could elicit osmotic stress to the organisms and, therefore, bias the results of the test. In conversations with the laboratory, it was concluded that potential for osmotic stress would be less of a concern for Fathead Minnows and Duckweed, as these species tend to have a larger range of tolerance to different water types. However, hardness concentrations in the Meliadine Lake receiving environment are more consequential for crustacean testing, as site water hardness is at lower end of the tolerance range for the two crustacean species (*Daphnia magna* and *Hyalella azteca*). To reduce the potential for a confounding effect of osmotic stress, it was considered necessary to acclimate organism cultures prior to testing, and to account for hardness adjustment in the data interpretation.

The chronic toxicity testing for Meliadine Lake is further complicated by the fact that the primary contaminant group of concern being investigated in the MEL-14 discharge is the mixed of ions represented by TDS, requiring consideration of the influence of dilution water on the concentrations and ratios of major ions. Toxicity associated with TDS is typically caused by osmotic stress and is influenced by the specific ratios of the component major ions (i.e., calcium, magnesium, sodium, potassium, chloride, sulphate, and alkalinity). Chronic toxicity tests are commonly performed using dilution series tests on the discharge being investigated and, therefore, ionic concentrations in full strength discharge samples tend to be greater than control/dilution water used in the tests. The standard control/dilution water used during testing is typically the same water that the organisms are cultured in. However, for tests conducted in receiving environment samples (Meliadine Lake), the ambient TDS is low relative to the culture media, such that standard dilution waters may increase TDS in receiving environment samples at higher dilutions. Therefore, a site-specific test design was required to avoid confounding of results:

1. Control for the low hardness conditions in Meliadine Lake and assess normal organism response in lower hardness waters

2. Select relevant references to compare against organism responses in exposure areas

3. Set-up the test design so that the test acceptability (e.g., organism health and validity of the tests) can be properly assessed, while also accounting for the non-standard (low hardness) exposure conditions of site media

To address these site-specific complications, a modified test design was developed and applied during the chronic toxicity testing associated with each of the four test species. Additional controls were implemented so that organism responses potentially resulting from low conductivity waters of the receiving environment, rather than an adverse toxicological response to TDS, could be discerned. The following represents the various components of the modified chronic toxicity test design:

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[1] Azimuth Consulting Group Partnership. 2020. Aquatic Effects Monitoring Program, 2019 Annual Report, Meliadine Gold Project. Prepared for Agnico Eagle Mines Limited. Project No. AEM-19-04 / MEL AEMP 2019.

- **Controls**—Three types of control water are used during the testing:
  - **Laboratory control**—standard culture water used for each species during regular testing at the laboratory. This control is used to assess test validity per standard protocol requirements; it is intended to facilitate comparison of organism response to a normal performance range for cultured organisms in non-contaminated media. Laboratory control responses are not preferable for comparison to site-water responses.
  - **Soft water control**—standard culture water used for each species during regular testing was diluted down to a hardness of ~40 mg/L, while keeping ionic ratios intact. This control was used to assess organism response in low hardness waters, but at typical ratios of major ions used during standard testing. This control serves as a baseline for the receiving environment tests because endpoints such as growth or reproduction could be compared across similar lower ionic strength waters, including those under suboptimal exposure conditions for the cultured organisms. This control was compared to the response in the laboratory control to assess the likelihood and magnitude of differences in organism performance that were independent of the influence of the discharge.
  - **Site Control**—synthetic dilution water prepared as simulated reference water. The site control is a synthetic water recipe developed based on ionic ratios reported in the 2019 AEMP [Azimuth 2020] and based on the pooled reference conditions in Meliadine Lake. The difference between the soft water control and the site control is that the former used a standard recipe of ions used for organism culturing, whereas the latter is a customized recipe adjusted to ambient site conditions. The site control is used to evaluate organism response in clean test water using ionic ratios that are representative of Meliadine Lake reference sites, as identified during the most recent AEMP. This water was also used as the dilution water in the dilution series tests outlined below, as such provided a more realistic and site-relevant assessment of how the discharge is expected to be diluted within the receiving environment. The site control was used to assess how well organisms responded to the synthetic dilution water. Results were compared to the soft water control to assess how organisms responded to differences in the ionic recipes (i.e., water with a similar hardness but with different ionic ratios).
- **Meliadine Lake Receiving Environment Monitoring Samples**—Two types of tests were conducted using receiving environment samples during the discharge event:
  - **Full strength tests**—full strength tests (sometimes called “pass/fail” tests) were performed with samples of undiluted Meliadine Lake water, including samples from the mid-field station MEL-02-05 and the three reference stations (MEL-03-02, MEL-04-05, and MEL-05-04). The reference station results were compared statistically to the mid-field results, as well as to the dilution series test results (next bullet) to investigate whether significant differences are apparent, and whether any identified differences are related to the influence of the discharge.
  - **Dilution series tests**—Meliadine Lake edge of mixing zone stations (MEL-13-01, MEL-13-07, and MEL-13-10) are tested using a standard volumetric dilution series (e.g., 100%, 50%, 25%, 12.5%, 6.25%, 3.13%, and 1.56% volume/volume sample). Due to the larger test set-up for these dilution series (i.e., greater number of test vessels), dedicated controls are specified for each station to control for subtle temperature or light differences in the test chambers that may influence survival, growth, or reproduction endpoints in the tests. The chronic toxicity test results

in the 100% undiluted edge of mixing zone samples were compared statistically to the results in the reference stations (MEL-03-02, MEL-04-05, and MEL-05-04) to assess whether edge of mixing zone stations show statistically significant reductions in survival, growth, or reproduction. The statistical assessment included comparison to each individual reference station, as well as the pooled average of the reference station results. Where statistical differences were identified, the dilution series test design facilitated the investigation of any concentration-response relationships. The concentration-response analysis culminated in the calculation of relevant IC/EC_X values (inhibitory / effect concentrations influencing X% of the population). These analyses are useful for confirming: 1) whether effects are apparent and not simply reflective of confounding factors (e.g., subtle temperature, light, or feeding differences); and 2) determining at what level of dilution the observed effects decrease to ambient levels.

Chronic toxicity test results were assessed using the following tiered approach:

1. Compare results of the undiluted edge of mixing zone and mid-field stations (separately) to the range in response observed at the reference stations—There is natural variability in sub-lethal endpoints such as growth and reproduction and, therefore, it is necessary to evaluate the range in response observed in reference water relative to the range observed at exposure sites.

2. Evaluate the concentration-response relationship observed along the dilution series for edge of mixing zone stations—Consider the pattern of response as a function of dilution to determine whether the pattern suggests that a higher percentage of site water causes a larger decrease in organism performance.

3. Assess the response in the laboratory controls to determine the potential confounding influence of low hardness—The controls, both standard negative control and low hardness controls, are not compared directly to organism response in site water, as the laboratory culture water is not necessarily consistent in character with the receiving environment (e.g., micronutrients, DOC). These controls were instead used to assess test validity and potential for confounding. In the case of the site water control (also the dilution water), the results of 100% site water were included as a treatment along the dilution series test design (0% sample [site control], 1.56% sample, 3.13% sample, …, 100% sample).

Following responses to comments from ECCC and KivIA (Agnico Eagle 2020) and discussions through the WMWG, additional testing was incorporated into the overall program that entailed expanded testing of full-strength discharge. Accordingly, monthly chronic toxicity testing of the MEL-14 discharge (full-strength discharge plus volumetric dilutions) was initiated during the second monthly sampling event (i.e., July). Testing at higher TDS concentrations is important for validating the interim benchmark of 1,000 mg/L at the edge of mixing zone and for providing recommendations for a final water quality objective for long-term management of Meliadine Lake. The low concentrations of TDS and other exposure indicators identified at in the edge of mixing zone stations (i.e., concentrations well below the 1,000 mg/L TDS benchmark) limit the degree to which the receiving environment water quality benchmarks can be validated. However, the MEL-14 testing program encompassed exposures both above and below the proposed target of 1,000 mg/L calculated TDS.

The following sections discuss the results of the four rounds of monthly chronic toxicity testing conducted during discharge, including the additional sample collected at MEL-14 after cessation of discharge for the year to limit the uncertainty around the TDS exposure range. The composition of the all samples were similar. Results are discussed in the following sections:

- **Section B3.1:** 7-day Fathead Minnow (freshwater fish) survival and growth test
- **Section B3.2:** 7-day *Lemna minor* (Duckweed; aquatic macrophyte) survival and growth test
- **Section B3.3:** 14-day *Hyalella azteca* (benthic invertebrate) survival and growth test
- **Section B3.4:** 21-day *Daphnia magna* (freshwater crustacean) survival and reproduction test

Detailed laboratory reports can be provided upon request. Due to the shipping time from the site to the laboratory, most tests were initiated past the recommended hold time for the respective tests. However, the delay in test initiation would not have affected the chemical composition of the water samples nor their potential to elicit toxicity.

B3.1 Fathead Minnow Results

The 7-day Fathead Minnow larval survival and growth tests conducted on receiving environment samples collected in June and July 2020 did not indicate impairment of survival or growth endpoints relative to organism response observed at the reference stations. This was true for organisms exposed to both discharge and edge of mixing zone samples. Survival and growth endpoints measured in undiluted 100% samples from the discharge, edge of mixing zone, and mid-field stations encompassed a similar range of response as the reference stations (Table B-6 to Table B-8).

Results from August, September, and October 2020 indicated impairment of survival or growth endpoints in discharge, edge of mixing zone, mid-field, and reference stations. The discharge, edge of mixing zone and mid-field stations showed higher variability than what was seen in previous testing; however, similar variability was apparent in the reference stations. As depicted in Table B-8, survival was strong in lab water controls (86.7–100%); however, survival in site water was variable, ranging from 0% to 100% in site water replicates including all types of water including discharge, edge of mixing zone, mid-field, and reference stations. The observation of mortality, particularly for reference water, is anomalous, and indicative of interference by an effect that is not attributable to TDS or other water quality factor linked to discharge.

The presence of, and high variability of, mortality in the August, September, and October sampling events is likely attributable to sporadic mortality phenomenon linked to bacterial and fungal growth in collected samples. As described in Downey et al. (2000), sporadic mortality in samples collected from control/reference water is a relatively common complication in larval fathead minnow tests and can confound test results. The Department of Natural Resources, Wisconsin, USA identified this issue in 26% of fathead minnow tests performed with field collected controls (n = 1,496), compared to a 2.9% occurrence in laboratory control water. Consistent with the laboratory observations of “fuzzy” organisms (i.e., visual evidence of fungal coating), the sporadic mortality appears to be caused by pathogenic bacteria or fungal infections. Sporadic mortality phenomenon is also often accompanied by high replicate variation in survival response, and a concentration of adverse effects approximately 5–6 days into the exposure duration.

Re-testing using an ultraviolet (UV) filtration pre-treatment was recommended to differentiate between chemical effects of site water versus artifacts caused by pathogens. Overall, these tests strongly supported the identification of pathogens, rather than water quality factors, as the cause for the observed responses. Results for MEL-14 from the August UV-filtered re-test resulted in a mean survival of 96.7%; this result differed from two tests where pathogens were not controlled, including the re-run untreated discharge of 73.3% and original result of 20% survival (Table B-6 to Table B-8). This increase in survival was also demonstrated in the reference and mid-field samples, each of which had 100% survival when pathogens were controlled. These results support the hypothesis that the higher variability in mortality may be due to bacterial and fungal growth. The hypothesis was further supported by the September results for MEL-14 from the UV-filtered re-test, which resulted in 100% survival compared to the uncontrolled tests with a mean survival of 30% and 23.3%. Once again, this increase in survival was also demonstrated in the reference, mid-field, and edge of mixing zone samples, each of which had 96.7% to 100% survival when pathogens were controlled. Although the October results did not undergo the UV treatment, untreated results were similar to the uncontrolled August and September results including some mortality (10%) in the laboratory negative control. Therefore, it was anticipated that UV treatment would yield similar results to August and September and would not provide additional information. Side by side (i.e., untreated and treated) testing is recommended especially during the summer and fall when pathogens appear to be a confounding factor in the test results.

The following outcomes of statistical comparisons ($p < 0.05$) were observed for the Fathead minnow endpoints:

- No statistically significant effects on survival or growth ($p < 0.05$) were identified in samples collected in June.
- No statistically significant effects on survival ($p < 0.05$) were identified in samples collected in July.
- No statistically significant effects on survival or growth ($p < 0.05$) were identified at the MEL-13-07 station collected in August.
- Significant effects ($p < 0.05$) for the biomass (growth) endpoint were observed at MEL-13-10 in July relative to responses observed in MEL-04-05 and MEL-05-04, but not to MEL-03-02 or the pooled reference station responses. However, these significant differences appear to be artifacts of the test design (i.e., variation due to factors other than discharge influence). The concentration-response relationship observed along the dilution series for MEL-13-10 did not suggest an association between exposure magnitude and toxicological response. The calculated IC values for the survival and growth endpoints were both determined by the toxicology laboratory (Bureau Veritas Laboratories, Burnaby, BC) to be greater than the full-strength sample (>100%).
- Significant effects ($p < 0.05$) for the survival endpoint were observed at the MEL-13-01 and MEL-02-05 stations in August relative to responses observed in MEL-04-05 and the pooled reference, but not to MEL-03-02 or MEL-05-04 station responses. Significant effects ($p < 0.05$) for the survival endpoint were observed at the MEL-13-10 station relative to responses observed in all reference stations and the pooled reference responses. However, ultraviolet (UV) filtration pre-treatment of the samples for MEL-14, MEL-13, MEL-02-05, and the reference stations demonstrate that the higher variability in mortality was due to bacterial or fungal growth.

- Significant effects ($p < 0.05$) for the biomass (growth) endpoint were observed at the MEL-13-01 and MEL-02-05 stations in August relative to responses observed in MEL-04-05, but not to MEL-03-02, MEL-05-04 or the pooled reference station responses. Significant effects ($p < 0.05$) for the biomass (growth) endpoint were observed at the MEL-13-10 station relative to responses observed in all reference stations and the pooled reference responses except MEL-05-04. However, ultraviolet (UV) filtration pre-treatment of the samples from MEL-14, MEL-13, MEL-02-05, and the reference stations demonstrate that the higher variability in mortality was due to bacterial or fungal growth.

- Significant effects ($p < 0.05$) for the survival and biomass endpoints were observed at the MEL-13-01, MEL-13-07, and MEL-02-05 stations in September relative to responses observed in MEL-04-05 and MEL-05-04, but not to MEL-03-02 or the pooled reference station responses. Significant effects ($p < 0.05$) for the survival and biomass endpoints were observed at the MEL-13-10 station relative to responses observed in MEL-05-04, but not to MEL-03-02, MEL-04-05, or the pooled reference responses. However, ultraviolet (UV) filtration pre-treatment of MEL-14, MEL-13, MEL-02-05, and the reference stations demonstrate that the higher variability in mortality was due to bacterial or fungal growth in some of the samples.

Test observations and outliers are noted in the respective test data summary section of the report. The results of these tests were considered valid by the testing laboratory (Bureau Veritas, Burnaby, BC), as the tests met control and test acceptability requirements outlined in the respective test methods (detailed laboratory reports can be provided upon request).

Table B-6: Discharge and edge of mixing zone fathead minnow dilution series results from MEL-14, MEL-13-01, MEL-13-07, and MEL-13-10 from the June to October 2020 sampling events

Sample Date	MEL-14		MEL-13-01		MEL-13-07		MEL-13-10	
	Survival LC_{50} Value (95% CI; %)	Growth IC_{25} Value (95% CI; %)	Survival LC_{50} Value (95% CI; %)	Growth IC_{25} Value (95% CI; %)	Survival LC_{50} Value (95% CI; %)	Growth IC_{25} Value (95% CI; %)	Survival LC_{50} Value (95% CI; %)	Growth IC_{25} Value (95% CI; %)
7 June 2020	—	—	>100	>100	>100	>100	—	—
20–25 July 2020	>100	>100	>100	>100	>100	>100	>100	>100*
22–23 August 2020	13.5 (8.9, 20.5)	8.7 (2.2, 21.9)	15.2 (11.8, 19.6)*	5.6 (2.8, 24.8)*	N/C	N/C	37.6 (30.1, 47.0)*	34.9 (18.4, 47.4)*
22–23 August 2020 UV-Filtered	>100	>100	—	—	—	—	—	—
12–13 September 2020	43.2 (30.1, 62.0)	24.2 (13.7, 36.4)	>100*	>100 (53.0, >100)*	100 (N/A, N/A)*	53.9 (27.3, 86.6)*	>100*	>100*
12–13 September 2020 UV-Filtered	>100	>100	—	—	—	—	—	—
26 October 2020	25.4 (15.9, 40.7)	15.9 (3.1, 46.2)	—	—	—	—	—	—

Notes: % = percent; > = greater than; CI = confidence interval; LC_{50} = lethal concentration effecting 50% of organisms; IC_{25} = inhibitory concentration affecting 25% of organisms; N/C = Not Calculable: The LC_{50} for survival and IC_{25} for biomass were not able to be calculated due to an interrupted dose response; UV = ultraviolet; * = significant effect vs MEL-03-02, MEL-04-05, MEL-05-04, or Pooled references; — = not applicable.

Table B-7: Discharge and edge of mixing zone fathead minnow full strength results from MEL-14, MEL-13-01, MEL-13-07, and MEL-13-10 from the June to October 2020 sampling events

Sample Date	MEL-14		MEL-13-01		MEL-13-07		MEL-13-10	
	Mean Survival ± SD (%)	Mean Biomass ± SD (mg)	Mean Survival ± SD (%)	Mean Biomass ± SD (mg)	Mean Survival ± SD (%)	Mean Biomass ± SD (mg)	Mean Survival ± SD (%)	Mean Biomass ± SD (mg)
7 June 2020	—	—	100 ± 0.0	0.579 ± 0.03	100 ± 0.0	0.493 ± 0.07	—	—
20–25 July 2020	93.3 ± 5.8	0.330 ± 0.01	96.7 ± 5.8	0.459 ± 0.01	100 ± 0.0	0.393 ± 0.10	96.7 ± 5.8	0.402 ± 0.01*
22–23 August 2020	20 ± 10	0.154 ± 0.06	20 ± 10*	0.133 ± 0.05*	86.7 ± 15.3	0.300 ± 0.05	0.0 ± 0.0*	0.000 ± 0.00*
22–23 August 2020 UV-Filtered	96.7 ± 5.8	0.405 ± 0.01	100 ± 0.0	0.405 ± 0.01	100 ± 0.0	0.415 ± 0.01	100 ± 0.0	0.369 ± 0.02
22–23 August 2020 No UV Re-run	73.3 ± 11.5 $^{\times}$	0.309 ± 0.08	—	—	—	—	—	—
12–13 September 2020	30 ± 30	0.142 ± 0.12	63.3 ± 32.1*	0.291 ± 0.07*	50 ± 40*	0.237 ± 0.14*	80 ± 17.3*	0.329 ± 0.07*
12–13 September 2020 UV-Filtered	100 ± 0.0	0.363 ± 0.02	96.7 ± 5.8	0.349 ± 0.03	100 ± 0.0	0.329 ± 0.03	96.7 ± 5.8	0.312 ± 0.05
12–13 September 2020 No UV Re-run	23.3 ± 11.5 $^{\times}$	0.137 ± 0.06 $^{\times}$	—	—	—	—	—	—
26 October 2020	23.3 ± 15.3	0.134 ± 0.04	—	—	—	—	—	—

Notes: % = percent; mg = milligrams; SD = standard deviation; UV = ultraviolet; $^{\times}$ = significant effect vs UV-Filtered test; * = significant effect vs MEL-03-02, MEL-04-05, MEL-05-04, or Pooled references; — = no testing completed (no results).

Table B-8: Site control, soft-water control, mid-field and reference fathead minnow full strength results from MEL-02-05, MEL-03-02, MEL-04-05, and MEL-05-04 from the June to October 2020 sampling events

Sample Date	Laboratory Negative Control		Site Control / Synthetic Control		Lab Soft-water Control		MEL-02-05		MEL-03-02		MEL-04-05		MEL-05-04	
	Mean Survival ± SD (%)	Mean Biomass ± SD (mg)	Mean Survival ± SD (%)	Mean Biomass ± SD (mg)	Mean Survival ± SD (%)	Mean Biomass ± SD (mg)	Mean Survival ± SD (%)	Mean Biomass ± SD (mg)	Mean Survival ± SD (%)	Mean Biomass ± SD (mg)	Mean Survival ± SD (%)	Mean Biomass ± SD (mg)	Mean Survival ± SD (%)	Mean Biomass ± SD (mg)
7 June 2020	100 ± 0.0	0.554 ± 0.04	100 ± 0.0	0.512 ± 0.01	100 ± 0.0	0.566 ± 0.03	90 ± 0.0	0.540 ± 0.04	96.7 ± 5.8	0.508 ± 0.04	100 ± 0.0	0.553 ± 0.04	93.3 ± 5.8	0.525 ± 0.02
22–25 July 2020	100 ± 0.0	0.475 ± 0.00	100 ± 0.0	0.447 ± 0.01	100 ± 0.0	0.437 ± 0.00	100 ± 0.0	0.448 ± 0.03	66.7 ± 35.1	0.309 ± 0.19	100 ± 0.0	0.457 ± 0.02	100 ± 0.0	0.436 ± 0.02
22–23 August 2020	93.3 ± 5.8	0.458 ± 0.03	100 ± 0.0	0.454 ± 0.01	100 ± 0.0	0.436 ± 0.03	13.3 ± 15.3*	0.108 ± 0.10*	23.3 ± 15.3	0.164 ± 0.08	80 ± 26.5	0.355 ± 0.05	20 ± 20	0.123 ± 0.11
22–23 August 2020 UV-Filtered	100 ± 0.0	0.440 ± 0.01	100 ± 0.0	0.426 ± 0.02	93.3 ± 5.8	0.368 ± 0.03	100 ± 0.0	0.369 ± 0.02	100 ± 0.0	0.362 ± 0.02	100 ± 0.0	0.376 ± 0.01	100 ± 0.0	0.395 ± 0.02
12–13 September 2020	100 ± 0.0	0.401 ± 0.02	100 ± 0.0	0.371 ± 0.03	96.7 ± 5.8	0.391 ± 0.03	50 ± 34.6*	0.228 ± 0.10*	3.3 ± 5.8	0.025 ± 0.04	96.7 ± 5.8	0.416 ± 0.03	100 ± 0.0	0.436 ± 0.04*
12–13 September 2020 UV-Filtered	86.7 ± 11.5	0.297 ± 0.03	100 ± 0.0	0.293 ± 0.06	96.7 ± 5.8	0.286 ± 0.05	96.7 ± 5.8	0.302 ± 0.06	96.7 ± 5.8	0.287 ± 0.01	100 ± 0.0	0.303 ± 0.03	100 ± 0.0	0.302 ± 0.03
26 October 2020	90 ± 0.0	0.341 ± 0.01	100 ± 0.0	0.316 ± 0.02	—	—	—	—	—	—	—	—	—	—

Notes: % = percent; mg = milligrams; SD = standard deviation; UV = ultraviolet; * = significant effect vs reference stations or pooled references (for MEL-02-05) or vs Site/Synthetic control (for reference stations); — = no testing completed (no results).

B3.2 *Lemna minor* (Duckweed) Results

The results of the 7-day Duckweed growth tests conducted on receiving environment samples collected in June, July, August, and September 2020 did not indicate impairment of frond count or growth endpoints relative to organism response observed at the reference stations. This was true for organisms exposed to discharge, water at edge of mixing zone, and near-field samples (Table B-9 to Table B-11).

Testing in July, August, and September of the full-strength discharge (MEL-14) did not result in effects to biomass and frond count, as response in the full-strength sample was generally within the range observed in the synthetic site control (i.e., lab water designed to mimic background concentrations).

In October, testing at MEL-14 resulted in some effects to frond count (IC_{50} 40.4%) indicating some impairment at measured TDS concentrations of 2,740 mg/L (calculated TDS of 2,500 mg/L).

Consistent with the results identified with the full-strength samples from July to September, frond count and biomass in undiluted 100% samples at the edge of mixing zone and mid-field stations encompassed a similar range of responses to the reference stations, with the exception of MEL-13-07, which was variable, suggesting that effects to Duckweed were not present.

Differences were observed between lab control and site control due to the higher ionic composition in the laboratory control, but the site control has been developed synthetically to match receiving environment conditions.

The following outcomes of statistical comparisons ($p < 0.05$) were observed for the Duckweed endpoints:

- For cases where statistically significant responses were observed, these were more commonly due to a stimulative response (i.e., increased biomass or frond count) relative to the site control. Inhibition responses were rare and limited to Station MEL-13-07 (discussed further below).
- No significant effects on frond count or growth of organisms were evident at the MEL-13-01 edge of mixing zone station in June, July, August, or September 2020; this conclusion applied relative to responses observed in each of the three reference stations, as well as the pooled reference station response.
- No significant effects on frond count or growth of organisms were evident at the MEL-13-10 edge of mixing zone station in July or August 2020; this conclusion applied relative to responses observed in each of the three reference stations, as well as the pooled reference station response.
- No significant effects on frond count and growth of organisms were evident at the MEL-02-05 mid-field station in June or July 2020; this conclusion applied relative to responses observed in each of the three reference stations, as well as the pooled reference station response.
- Significant effects (inhibition) for the frond count endpoint were observed at the MEL-13-07 station in June 2020 relative to responses observed in each of the three reference stations, as well as the pooled reference station response. Significant effects (inhibition) were also observed on organism growth (dry weight) at the MEL-13-07 station relative to the MEL-04-05 and MEL-05-04 reference stations, as well as the pooled reference response. However, these significant differences appear to be anomalous (i.e., variation due to factors other than discharge influence). The concentration-response relationship observed along the dilution series of the MEL-13-07 edge of mixing zone station did not suggest an association between exposure magnitude and toxicological response. The

calculated IC_{25} values for the frond count and growth endpoints were both determined by the toxicology laboratory (Bureau Veritas Laboratories, Burnaby, BC) to be >97% discharge (the maximum dilution series concentration of 97% rather than 100% is due to the dilution of the 100% sample by a nutrient formulation required by the standard test protocol; Environment Canada 2007).

- Significant effects (inhibition) for the frond count endpoint were observed at the MEL-13-07 station in July 2020 relative to responses observed in the MEL-03-02 and MEL-05-04 reference stations, as well as the pooled reference station response. However, this response is attributable to high reference biomass production rather than impairment of the MEL-13-07 response. The reference stations MEL-03-02 and MEL-05-04 in July 2020 had a significant stimulation effect on frond count and growth endpoints relative to the site control (synthetic control) during this sampling event. In comparison to the site control, no significant effects on frond count or growth of organisms were evident. Furthermore, the concentration-response relationship observed along the dilution series of the MEL-13-07 edge of mixing zone station did not suggest an association between exposure magnitude and toxicological response. The calculated IC_{25} values for the frond count and growth endpoints were both determined by the toxicology laboratory (Bureau Veritas Laboratories, Burnaby, BC) to be >97% discharge.
- Significant effects (stimulation) for the frond count endpoint were observed at the MEL-13-07 station in August 2020 relative to responses observed in the MEL-03-02 reference station and the pooled reference station response. Additionally, significant effects (stimulation) for the growth endpoint were observed relative to responses observed in the pooled reference station response.
- Significant effects (stimulation) for the frond count and weight endpoints were observed at the MEL-13-07 station in September 2020 relative to responses observed in the MEL-03-02 and MEL-05-04 reference stations and the pooled reference station response.
- Significant effects (stimulation) for the growth endpoint were observed at the MEL-13-10 station in September 2020 relative to responses observed in the MEL-03-02 and MEL-05-04 reference stations and the pooled reference station response. Additionally, significant effects (stimulation) for the frond count were observed in the MEL-03-02 and MEL-05-04 reference stations.
- Significant effects (stimulation) for the frond count and growth endpoints were observed at the MEL-02-05 station in August 2020 relative to responses observed in the three reference stations and the pooled reference station response.
- Significant effects (stimulation) for the frond count endpoint were observed at the MEL-02-05 station in September 2020 relative to responses observed in the MEL-03-02 and MEL-05-04 reference stations.
- Significant effects (stimulation) for the frond count and growth endpoints were observed at the MEL-03-04, MEL-04-05, and MEL-05-04 stations in August 2020 relative to responses observed in the site/synthetic control response.
- Significant effects (stimulation) for the frond count and growth endpoints were observed at the MEL-04-05 station in September 2020 relative to responses observed in the site/synthetic control response. Additionally, significant effects (stimulation) for the frond count endpoint were observed at the MEL-05-04 station relative to responses observed in the site/synthetic control response.

Results reported for the edge of mixing zone dilution series testing (Table B-9) indicated that frond count and growth EC_{25} values were both >97% discharge in each of the edge of mixing zone stations. These results indicate that water collected at the edge of the mixing zone in Meliadine Lake did not result in chronic effects on growth to Duckweed.

Possible chronic effects to frond count (i.e., reductions in frond increase), but not biomass, were observed at a measured TDS concentration of 2,740 mg/L (calculated TDS of 2,500 mg/L) at MEL-14 in October. Statistically significant effects were also noted in the 48.5% and 24.2% concentrations; however, effects at these lower concentrations do not align with the previous rounds of testing (i.e., discharges have not resulted in unacceptable chronic toxicity [i.e., IC_{50} >97%] at TDS concentrations ranging between 1,700 and 1,850 mg/L measured TDS [1,200 and 1,400 mg/L calculated TDS]).

Test observations and outliers are noted in the respective test data summary section of the report. The results of these tests were considered valid by the testing laboratory (Bureau Veritas, Burnaby, BC), as the tests met control and test acceptability requirements outlined in the respective test methods (detailed laboratory reports can be provided upon request).

Table B-9: Discharge and edge of mixing zone *Lemna minor* (duckweed) dilution series results from MEL-14, MEL-13-01, MEL-13-07, and MEL-13-10 from the June to October 2020 sampling events

Sample Date	MEL-14		MEL-13-01		MEL-13-07		MEL-13-10	
	Frond Count IC_{50} Value (95% CI; %)	Growth IC_{25} Value (95% CI; %)	Frond Count IC_{50} Value (95% CI; %)	Growth IC_{25} Value (95% CI; %)	Frond Count IC_{50} Value (95% CI; %)	Growth IC_{25} Value (95% CI; %)	Frond Count IC_{50} Value (95% CI; %)	Growth IC_{25} Value (95% CI; %)
7 June 2020	—	—	>97	>97	>97*(I)	>97*(I)	—	—
20–25 July 2020	>97	>97	>97	>97	>97*(I)	>97	>97	>97
22–23 August 2020	>97	>97	>97	>97	>97*(S)	>97*(S)	>97	>97
12–13 September 2020	>97	>97	>97	>97	>97*(S)	>97*(S)	>97*(S)	>97*(S)
26 October 2020	40.4 (26, 69)	>97	—	—	—	—	—	—

Notes: % = percent; > = greater than; LC_{50} = lethal concentration effecting 50% of organisms; IC_{25} = inhibitory concentration affecting 25% of organisms; (I) = sample inhibition; (S) = sample stimulation; * = significant effect vs MEL-03-02, MEL-04-05, MEL-05-04, or Pooled references; — = not applicable/no testing completed (no results).

Table B-10: Discharge and edge of mixing zone *Lemna minor* (duckweed) full strength results from MEL-14, MEL-13-01, MEL-13-07, and MEL-13-10 from the June to October 2020 sampling events

Sample Date	MEL-14		MEL-13-01		MEL-13-07		MEL-13-10	
	Mean Increase in Fronds[a] ± SD (#)	Mean Biomass ± SD (mg)	Mean Increase in Fronds[a] ± SD (#)	Mean Biomass ± SD (mg)	Mean Increase in Fronds[a] ± SD (#)	Mean Biomass ± SD (mg)	Mean Increase in Fronds[a] ± SD (#)	Mean Biomass ± SD (mg)
7 June 2020	—	—	71.5 ± 7.0	7.82 ± 0.68	52.3 ± 2.9*(I)	6.65 ± 0.30*(I)	—	—
20–25 July 2020	35.3 ± 7.1	5.65 ± 1.48	58.8 ± 11.3	7.68 ± 1.42	55.0 ± 7.2*(I)	6.97 ± 1.11	61.5 ± 7.9	8.11 ± 1.58
22–23 August 2020	37.5 ± 2.9	6.51 ± 0.18	84.3 ± 14.1	8.79 ± 1.39	102.5 ± 12.7*(S)	10.34 ± 1.32*(S)	92.5 ± 18.7	10.20 ± 2.34
12–13 September 2020	35.3 ± 5.1	7.50 ± 1.64	73.0 ± 21.6	6.51 ± 1.98	85.0 ± 7.0*(S)	8.90 ± 0.75*(S)	73.5 ± 6.2*(S)	9.04 ± 0.39*(S)
26 October 2020	25.3 ± 2.1	7.16 ± 1.43	—	—	—	—	—	—

Notes: mg = milligrams; # = number; SD = standard deviation; (I) = sample inhibition; (S) = sample stimulation; * = significant effect vs MEL-03-02, MEL-04-05, MEL-05-04, or Pooled references; — = no testing completed (no results).

(a) Mean increase in fronds is the mean of the final frond count in each test vessel minus the number of fronds added to the test vessel at test initiation.

Table B-11: Site control, soft-water control, mid-field and reference *Lemna minor* (duckweed) full strength results from MEL-02-05, MEL-03-02, MEL-04-05, and MEL-05-04 from the June to October 2020 sampling events

Sample Date	Lab Negative Control		Site Control / Synthetic Control		Lab Soft-water Control		MEL-02-05		MEL-03-02		MEL-04-05		MEL-05-04	
	Mean Increase in Fronds[a] ± SD (#)	Mean Biomass ± SD (mg)	Mean Increase in Fronds[a] ± SD (#)	Mean Biomass ± SD (mg)	Mean Increase in Fronds[a] ± SD (#)	Mean Biomass ± SD (mg)	Mean Increase in Fronds[a] ± SD (#)	Mean Biomass ± SD (mg)	Mean Increase in Fronds[a] ± SD (#)	Mean Biomass ± SD (mg)	Mean Increase in Fronds[a] ± SD (#)	Mean Biomass ± SD (mg)	Mean Increase in Fronds[a] ± SD (#)	Mean Biomass ± SD (mg)
7 June 2020	64.5 ± 4.8	6.95 ± 0.19	73.5 ± 3.1	7.66 ± 0.66	75.3 ± 12.3	7.92 ± 0.97	86.0 ± 9.8	8.73 ± 0.50	72.8 ± 9.2	7.55 ± 0.85	78.3 ± 12.1	8.42 ± 1.20	75.0 ± 7.6	8.50 ± 0.94
22–25 July 2020	46.8 ± 2.2	5.26 ± 0.19	46.5 ± 4.1	5.63 ± 0.41	73.3 ± 13.2	7.37 ± 1.06	76.5 ± 12.2	7.20 ± 1.48	69.3 ± 4.2*(S)	7.09 ± 0.53*(S)	58.0 ± 21.5	5.88 ± 1.74	70.5 ± 5.3*(S)	6.84 ± 0.66*(S)
22–23 August 2020	70.5 ± 6.2	7.75 ± 0.67	36.0 ± 1.4	5.20 ± 0.23	79.3 ± 11.1	8.83 ± 1.14	109.3 ± 12.8*(S)	11.58 ± 1.48*(S)	77.3 ± 15.9*(S)	8.85 ± 0.56*(S)	86.3 ± 12.3*(S)	8.99 ± 0.76*(S)	86.3 ± 12.4*(S)	8.60 ± 0.70*(S)
12–13 September 2020	60.5 ± 5.8	6.35 ± 0.79	51.3 ± 3.8	6.69 ± 0.55	69.0 ± 3.6	7.75 ± 0.48	77.0 ± 9.1*(S)	7.59 ± 0.88	58.5 ± 8.1	6.37 ± 1.00	79.3 ± 7.5*(I)	7.98 ± 0.81*(I)	64.3 ± 3.6*(I)	6.94 ± 0.54
26 October 2020	69.3 ± 15.1	7.91 ± 1.02	73.8 ± 8.6	8.81 ± 1.13	—	—	—	—	—	—	—	—	—	—

Notes: mg = milligrams; # = number; SD = standard deviation; (I) = sample inhibition; (S) = sample stimulation; * = significant effect vs reference stations or pooled references (for MEL-02-05) or vs Site/Synthetic control (for reference stations).

(a) Mean increase in fronds is the mean of the final frond count in each test vessel minus the number of fronds added to the test vessel at test initiation.

B3.3 *Hyalella azteca* Results

The results of the 14-day *Hyalella azteca* tests conducted on receiving environment samples collected in June, July, August, September, and October 2020 did not indicate impairment of survival endpoints relative to organism response observed at the reference stations (Table B-12 to Table B-14). This conclusion applies for organisms exposed to both discharge and edge of mixing zone samples. Testing of the undiluted discharge (MEL-14) does not result in adverse effects to survival, as responses in the undiluted sample were within the range observed in the laboratory, synthetic site, and soft-water controls. Apart from MEL-13-01 in June and August, receiving environment results did not indicate impairment of growth endpoints relative to organism response observed at the reference stations.

Survival results from August 2020 indicate some reduced survival in the edge of mixing zone, mid-field, and reference stations samples relative to reference stations or pooled references (for edge of mixing zone and mid-field) or relative to Site/Synthetic control (for reference stations) but not in the discharge sample. Mean survival in the mixing zone and mid-field samples encompassed a similar range of response as that in the reference stations, suggesting that the effects observed were not due to influence of the discharge. The variability in survival in the edge of mixing zone stations is likely an artifact of the test design (e.g., confounding effect of the low conductivity receiving environment relative to *Hyalella azteca* optimal conditions) and requires further review of other lines of evidence (e.g., test WQ data, growth data, results of reference toxicant tests) to properly interpret, particularly as the survival in the undiluted discharge (MEL-14) ranged from 90–100%. As the discharge was not found to be toxic at MEL-14, the variability observed in edge of mixing zone stations does not appear to be the result of TDS, as concentrations are more than eight times lower than the undiluted discharge.

The following outcomes of statistical comparisons ($p < 0.05$) were observed for the *Hyalella azteca* endpoints:

- No significant effects on survival and growth of organisms were evident at the MEL-13-07 (June or July), MEL-13-10 (July or September), or MEL-13-01 (July or September) edge of mixing zone stations; this conclusion applied relative to responses observed in each of the three reference stations, as well as the pooled reference station response.
- No significant effects on survival of organisms were evident in August at the MEL-13-07 edge of mixing zone station; this conclusion applied relative to responses observed in each of the three reference stations, as well as the pooled reference station response.
- No significant effects on survival and growth of organisms were evident at the MEL-02-05 mid-field station in June or July 2020; this conclusion applied relative to responses observed in each of the three reference stations, as well as the pooled reference station response.
- No significant effects on survival and growth of organisms were evident at the MEL-03-02, MEL-04-05, or MEL-05-04 reference stations in June or July 2020; this conclusion applied relative to responses observed in site synthetic control response.
- No significant effects on survival of organisms were evident at the MEL-03-02, MEL-04-05, or MEL-05-04 reference stations in August 2020; this conclusion applied relative to responses observed in site synthetic control response.

- A significant effect for the growth endpoint was observed at the MEL-13-01 station in June 2020 relative to responses observed in the MEL-05-04 reference station. Additionally, the calculated IC_{25} value for the growth endpoint was 2.3% v/v. However, this significant difference and associated IC_{25} appear to be artifacts of the test design (i.e., variation due to factors other than discharge influence). The concentration-response relationship observed along the dilution series of the MEL-13-01 edge of mixing zone station did not suggest an association between exposure magnitude and toxicological response, but rather to variability. The average growth in MEL-13-01 was within the broad range of response observed at the reference stations.
- A significant effect for the survival endpoint was observed at the MEL-13-01 station in August 2020 relative to responses observed in the MEL-04-05 reference station. A significant effect for the survival endpoint was observed at the MEL-13-10 station in August 2020 relative to responses observed in the three reference stations and the pooled references. However, survival and reproduction results from the discharge (MEL-14) did not suggest an association between the discharge exposure and toxicological response.
- A significant effect for the growth endpoint was observed at the MEL-13-01, MEL-13-07, and MEL-13-10 stations in August 2020 relative to responses observed in the MEL-05-04 reference station. However, the growth endpoint at the reference station MEL-05-04 was significantly greater than the site control (synthetic control) during this sampling event confounding the results.
- A significant effect for the survival endpoint was observed at the MEL-13-07 station in September 2020 relative to responses observed in the three reference stations and the pooled references. Additionally, a significant effect for the growth endpoint was observed relative to responses observed in the MEL-05-04 reference station and the pooled references. However, survival and reproduction results from the discharge (MEL-14) did not suggest an association between the discharge exposure and toxicological response.
- A significant effect for the survival endpoint was observed at the MEL-02-05 station in September 2020 relative to responses observed in the three reference stations and the pooled references. However, survival results from the discharge (MEL-14) did not suggest an association between the discharge exposure and toxicological response.
- Significant effects for the growth endpoint were observed at the MEL-04-05 and MEL-05-04 reference stations in September 2020 relative to the response observed in the synthetic control.

With the exception of MEL-13-01 growth in June and August, results reported for the edge of mixing zone dilution series testing (Table B-12) indicated that both the survival and growth EC_{25} values were >97% discharge in each of the edge of mixing zone stations and discharge station. These results indicate that water collected at the edge of the mixing zone in Meliadine Lake did not result in chronic effects on survival or growth to *Hyalella azteca*.

Test observations and outliers are noted in the respective test data summary section of the report. Although organism cultures were acclimated in a lower hardness environment prior to testing, testing often did not meet test method validity criteria, as mean dry weight *Hyalella azteca* in the control replicates were less than 0.10 mg. Due to the lower hardness in the site/synthetic control and soft-water control, this was anticipated in these controls; however, it was not in the laboratory control. The testing laboratory (Bureau Veritas, Burnaby, BC) indicated that the low weight was likely due to the culture supplier feeding the organisms strictly a diet of Tetramin slurry, whereas the laboratory uses a yeast, cereal grass media, and trout chow (YCT) mixture in addition to the Tetramin slurry. The quality of the YCT mixture was also being questioned independently by the testing laboratory. A new YCT mixture from a new supplier was received in early August; however, the new mixture was not used on the July tests. Upon changing suppliers and a slow introducing the YCT mixture to the cultures diet, the testing laboratory has noted systematic improvement in the growth of the *Hyalella azteca.* Another possibility for the lower growth observed in the summer testing was that the organisms themselves were on the smaller end of the size range for their age. Although the testing laboratory did confirm the age, size, and acclimation with the supplier and did not note any inconsistencies, the laboratory noted that the organism size was a possible contributor to the lower growth observed. Although weights did not meet the test method validity criteria in controls, the results were compared across samples. Test acceptability requirements and test control results are outlined in the respective test methods (detailed laboratory reports can be provided upon request).

Table B-12: Discharge and edge of mixing zone *Hyalella azteca* dilution series results from MEL-14, MEL-13-01, MEL-13-07, and MEL-13-10 from the June to October 2020 sampling events

Sample Date	MEL-14		MEL-13-01		MEL-13-07		MEL-13-10	
	Survival LC_{50} Value (95% CI; %)	Growth IC_{25} Value (95% CI; %)	Survival LC_{50} Value (95% CI; %)	Growth IC_{25} Value (95% CI; %)	Survival LC_{50} Value (95% CI; %)	Growth IC_{25} Value (95% CI; %)	Survival LC_{50} Value (95% CI; %)	Growth IC_{25} Value (95% CI; %)
7 June 2020	—	—	>100	2.3 (<1.6, N/A)	>100	>100	—	—
20–25 July 2020	>100	>100	>100	>100	>100	>100	>100	>100
22–23 August 2020	>100	>100	>100*	61.0 (N/A, N/A)*	>100	>100*	>100*	>100*
12–13 September 2020	>100	>100	>100	>100	>100*	>100*	>100	>100
26 October 2020	>100	>100	—	—	—	—	—	—

Notes: % = percent; > = greater than; CI = confidence interval; LC_{50} = lethal concentration effecting 50% of organisms; IC_{25} = inhibitory concentration affecting 25% of organisms; * = significant effect vs MEL-03-02, MEL-04-05, MEL-05-04, or Pooled references; N/A = Not Available, above highest test concentration; — = not applicable/no testing completed (no results).

Table B-13: Discharge and edge of mixing zone *Hyalella azteca* full strength results from MEL-14, MEL-13-01, MEL-13-07, and MEL-13-10 from the June to October 2020 sampling events

Sample Date	MEL-14		MEL-13-01		MEL-13-07		MEL-13-10	
	Survival ± SD (%)	Mean Dry Weight ± SD (mg)	Survival ± SD (%)	Mean Dry Weight ± SD (mg)	Survival ± SD (%)	Mean Dry Weight ± SD (mg)	Survival ± SD (%)	Mean Dry Weight ± SD (mg)
6–7 June 2020	—	—	90 ± 0	0.03 ± 0.01*	86 ± 15	0.05 ± 0.01	—	—
22–25 July 2020	96 ± 5	0.13 ± 0.1	98 ± 4	0.03 ± 0.01	100 ± 0	0.11 ± 0.02	100 ± 0	0.09 ± 0.03
22–23 August 2020	100 ± 0	0.17 ± 0.02	76 ± 39*	0.05 ± 0.04*	96 ± 9	0.06 ± 0.01*	50 ± 34*	0.06 ± 0.01*
12–13 September 2020	98 ± 4	0.16 ± 0.02	94.2 ± 5	0.11 ± 0.02	84 ± 21*	0.07 ± 0.02*	98 ± 4	0.09 ± 0.02
26 October 2020	98 ± 4	0.16 ± 0.01	—	—	—	—	—	—

Notes: % = percent; mg = milligrams; SD = standard deviation; * = significant effect vs MEL-03-02, MEL-04-05, MEL-05-04, or Pooled references; — = no testing completed (no results).

Table B-14: Site control, soft-water control, mid-field, and reference *Hyalella azteca* full strength results from MEL-02-05, MEL-03-02, MEL-04-05, and MEL-05-04 from the June to October 2020 sampling events

Sample Date	Laboratory Negative Control		Site Control / Synthetic Control		Lab Soft-water Control		MEL-02-05		MEL-03-02		MEL-04-05		MEL-05-04	
	Survival ± SD (%)	Mean Dry Weight ± SD (mg)	Survival ± SD (%)	Mean Dry Weight ± SD (mg)	Survival ± SD (%)	Mean Dry Weight ± SD (mg)	Survival ± SD (%)	Mean Dry Weight ± SD (mg)	Survival ± SD (%)	Mean Dry Weight ± SD (mg)	Survival ± SD (%)	Mean Dry Weight ± SD (mg)	Survival ± SD (%)	Mean Dry Weight ± SD (mg)
6–7 June 2020	94 ± 9	0.04 ± 0.01	90 ± 7	0.03 ± 0.01	88 ± 4	0.04 ± 0.01	88 ± 11	0.04 ± 0.02	88 ± 4	0.03 ± 0.01	90 ± 7	0.03 ± 0.00	80 ± 12	0.05 ± 0.01
22–25 July 2020	96 ± 5	0.03 ± 0.00	96 ± 9	0.04 ± 0.01	94 ± 9	0.04 ± 0.01	98 ± 4	0.04 ± 0.01	90 ± 10	0.04 ± 0.02	96 ± 5	0.04 ± 0.02	92 ± 8	0.03 ± 0.01
22–23 August 2020	100 ± 0	0.14 ± 0.02	100 ± 0	0.07 ± 0.01	92 ± 8	0.05 ± 0.02	80.2 ± 17*	0.07 ± 0.01*	86.2 ± 9	0.06 ± 0.02	96 ± 5	0.06 ± 0.02	77.5 ± 39	0.09 ± 0.02*
12–13 September 2020	100 ± 0	0.07 ± 0.01	92 ± 8	0.07 ± 0.02	98 ± 4	0.12 ± 0.01	86 ± 21*	0.10 ± 0.02	100 ± 0	0.08 ± 0.02	98 ± 4	0.09 ± 0.01*	98 ± 4	0.10 ± 0.01*
26 October 2020	100 ± 0	0.15 ± 0.02	98 ± 4	0.12 ± 0.03	—	—	—	—	—	—	—	—	—	—

Notes: % = percent; mg = milligrams; SD = standard deviation; * = significant effect vs reference stations or pooled references (for MEL-02-05) or vs Site/Synthetic control (for reference stations); — = no testing completed (no results).

B3.4 *Daphnia magna* Results

The 21-day *Daphnia magna* survival, reproduction, and growth tests conducted on discharge and receiving environment samples collected from June to July 2020 did not indicate impairment of survival endpoints relative to organism response observed at the reference stations (Table B-15 to Table B-17). This conclusion was true for organisms exposed to discharge, edge of mixing zone, and mid-field water samples. Testing of the undiluted discharge (MEL-14) does not appear to result in effects to survival or growth, as responses in the undiluted sample were within the range observed in controls.

Survival and growth results from August to October 2020 do not indicate impairment of the endpoints in the discharge, edge of mixing zone, mid-field, and reference stations. However, reproduction was reduced in the MEL-14 station in comparison to its laboratory negative control resulting in IC_{25} values for three sampling events of 37.6% (95% confidence interval [CI] from 4.9% to >100%), 93.8% (CI 4.6% to >100%), and 61.6% (CI 10.2% to >100%). The mean reproduction endpoint in the discharge, edge of mixing zone, and mid-field stations from June to August encompassed a similar range of responses as the reference stations, suggesting that the variability observed in the MEL-14 reproduction results was not due to the discharge. In September, the reproduction at the edge of mixing zone and mid-field stations encompassed a similar range of responses as the reference stations; however, reproduction at MEL-14 in September and October was lower than those observed in the laboratory controls.

The following outcomes of statistical comparisons ($p < 0.05$) were observed for the *Daphnia magna* endpoints:

- No significant effects on survival and reproduction of organisms were evident at the MEL-13-07 (June or July), MEL-13-10 (July), or MEL-13-01 (June or July) edge of mixing zone stations; this conclusion applied relative to responses observed in each of the three reference stations, as well as the pooled reference station response.
- No significant effects on survival of organisms were evident at the MEL-13-01, MEL-13-07, or MEL-13-10 edge of mixing zone stations in August or September 2020; this conclusion applied relative to responses observed in each of the three reference stations, as well as the pooled reference station response.
- No significant effects on growth of organisms were evident at the MEL-13-07 or MEL-13-10 edge of mixing zone stations in August or September 2020; this conclusion applied relative to responses observed in each of the three reference stations, as well as the pooled reference station response.
- No significant effects on the reproduction of organisms were evident at the MEL-13-10 edge of mixing zone station in September 2020; this conclusion applied relative to responses observed in each of the three reference stations, as well as the pooled reference station response.
- No significant effects on survival and reproduction of organisms were evident at the MEL-02-05 mid-field station in June or July 2020; this conclusion applied relative to responses observed in each of the three reference stations, as well as the pooled reference station response.
- No significant effects on survival and growth of organisms were evident at the MEL-02-05 mid-field station in August or September 2020; this conclusion applied relative to responses observed in each of the three reference stations, as well as the pooled reference station response.

- No significant effects on survival, reproduction, and growth of organisms were evident at the MEL-03-02, MEL-04-05, or MEL-05-04 reference stations in June or July 2020; this conclusion applied relative to responses observed in site synthetic control response.
- No significant effects on survival, reproduction, and growth of organisms were evident at the MEL-03-02 or MEL-04-05 reference stations in September 2020; this conclusion applied relative to responses observed in site synthetic control response.
- No significant effects on survival and reproduction of organisms were evident at the MEL-03-02, MEL-04-05, or MEL-05-04 reference stations in August 2020; this conclusion applied relative to responses observed in site synthetic control response.
- No significant effects on survival and growth of organisms were evident at the MEL-05-04 reference stations in September 2020; this conclusion applied relative to responses observed in site synthetic control response.
- Significant effects for the growth endpoint were observed at the MEL-13-01 and MEL-13-07 stations in June 2020 relative to responses observed in each of the three reference stations, as well as the pooled reference station response. However, these differences appear to result from variation due to factors other than discharge influence. The concentration-response relationships observed along the dilution series of the MEL-13-01 and MEL-13-07 edge of mixing zone stations do not suggest an association between exposure magnitude and toxicological response.
- Significant effects for the growth endpoint were observed at the MEL-13-07 and MEL-13-10 stations in July 2020 relative to responses observed in the MEL-03-02 and MEL-05-04 reference stations, as well as the pooled reference station response.
- Significant effects for the growth endpoint were observed at the MEL-02-05 station in June 2020 relative to responses observed in the MEL-04-05 reference station, but not to the pooled reference station response.
- Significant stimulation effects for the growth endpoint were observed at the MEL-13-01 station in August and September 2020 relative to responses observed in the three reference stations and the pooled reference station response.
- Significant stimulation effects for the reproduction endpoint were observed at the MEL-13-01, MEL-13-07, MEL-13-10, and MEL-02-05 stations in August 2020 relative to responses observed in the MEL-04-05 reference station. Similarly, MEL-13-07 showed significant stimulation effects for the reproduction endpoint relative to responses observed in the MEL-05-04 reference station and pooled references.
- Significant inhibition effects for the reproduction endpoint were observed at the MEL-13-01 station in September 2020 relative to responses observed in the three reference stations and the pool references. Similarly, MEL-13-07 showed significant inhibition effects for the reproduction endpoint relative to responses observed in the MEL-03-02 and MEL-05-04 reference stations and the pooled references.
- Significant effects for the reproduction endpoint were observed at the MEL-02-05 station in September 2020 relative to responses observed in the MEL-05-04 reference station, but not to MEL-03-02, MEL-04-05, or the pooled reference station response.

- Significant effects for the reproduction endpoint were observed at the MEL-05-04 reference station in September 2020 relative to response observed in the synthetic control.

Results reported for the edge of mixing zone dilution series testing (Table B-15) indicated that the survival, reproduction, and growth EC_{25} values were >100% discharge in each of the edge of mixing zone stations. These results indicate that water collected at the edge of the mixing zone in Meliadine Lake did not result in chronic effects on survival, reproduction, or growth to *Daphnia magna*.

Test observations and outliers are noted in the respective test data summary section of the report. Although organism cultures were acclimatized prior to testing in a lower hardness environment, the test method validity criteria for reproduction in controls was below the required average of 60 young in most tests. The laboratory noted that the site water and soft water were not appropriate for maintaining satisfactory daphnia reproduction during the June testing. The low reproduction in the laboratory control in the July samples is likely due to the quality of the YCT mixture noted in Section B3.3. The new YCT mixture from a new supplier was received in early August; however, the new mixture was not used on the July tests. The testing laboratory has noted improvement in the *Daphnia magna* following the switch to the new YCT mixture. Although reproduction did not meet the test method validity criteria in controls, the results were able to be compared across samples. Other minor deviations from the test method and standard practices occurred; however, they had negligible impacts on the test results. Test acceptability requirements and test control results are outlined in the respective test methods.

Table B-15: Discharge and edge of mixing zone *Daphnia magna* dilution series results from MEL-14, MEL-13-01, MEL-13-07, and MEL-13-10 from the June to October 2020 sampling events

Sample Date	MEL-14			MEL-13-01			MEL-13-07			MEL-13-10		
	Survival LC_{50} Value (95% CI; %)	Reproduction IC_{25} Value (95% CI; %)	Growth IC_{25} Value (95% CI; %)	Survival LC_{50} Value (95% CI; %)	Reproduction IC_{25} Value (95% CI; %)	Growth IC_{25} Value (95% CI; %)	Survival LC_{50} Value (95% CI; %)	Reproduction IC_{25} Value (95% CI; %)	Growth IC_{25} Value (95% CI; %)	Survival LC_{50} Value (95% CI; %)	Reproduction IC_{25} Value (95% CI; %)	Growth IC_{25} Value (95% CI; %)
6–7 June 2020	—	—	—	>100	>100	>100*	N/C	>100	>100*	—	—	—
20–25 July 2020	>100	>100	>100	>100	>100	>100	>100	>100	>100*	>100	>100	>100*
22–23 August 2020	>100	37.6 (4.9, N/A)	>100	>100	>100*(S)	>100*(S)	>100	>100*(S)	>100	>100	>100*(S)	>100
12–13 September 2020	90.3 (30.0, >100)	93.8 (4.6, N/A)	>100	>100	>100*	>100*	>100	>100*	>100	>100	>100	>100
26 October 2020	>100	61.6 (10.2, N/A)	>100	—	—	—	—	—	—	—	—	—

Notes: % = percent; CI = confidence interval; LC_{50} = lethal concentration effecting 50% of organisms; IC_{25} = inhibitory concentration affecting 25% of organisms; N/A = not available; N/C = not calculable – The LC_{50} for survival was not able to be calculated due to an interrupted dose response; (S) = sample stimulation; * = significant effect vs MEL-03-02, MEL-04-05, MEL-05-04, or Pooled references; — = not applicable/no testing completed (no results).

Table B-16: Discharge and edge of mixing zone *Daphnia magna* full strength results from MEL-14, MEL-13-01, MEL-13-07, and MEL-13-10 from the June to October 2020 sampling events

Sample Date	MEL-14			MEL-13-01			MEL-13-07			MEL-13-10		
	Survival ± SD (%)	Mean Neonates ± SD	Mean Dry Weight ± SD (mg)	Survival ± SD (%)	Mean Neonates ± SD	Mean Dry Weight ± SD (mg)	Survival ± SD (%)	Mean Neonates ± SD	Mean Dry Weight ± SD (mg)	Survival ± SD (%)	Mean Neonates ± SD	Mean Dry Weight ± SD (mg)
6–7 June 2020	—	—	—	100 ± 0.0	40.5 ± 42.8	0.27 ± 0.07*	100 ± 0.0	50.3 ± 44.2	0.27 ± 0.07*	—	—	—
22–25 July 2020	100 ± 0.0	50.4 ± 43.7	0.48 ± 0.08	100 ± 0.0	43.2 ± 7.6	0.32 ± 0.06	80 ± 42.0	46.2 ± 15.6	0.37 ± 0.05*	80 ± 42.0	26.7 ± 19.6	0.38 ± 0.07*
22–23 August 2020	60 ± 52.0	49.8 ± 29.9	0.48 ± 0.05	90 ± 32.0	58.8 ± 21.7*(S)	0.53 ± 0.11*(S)	90 ± 32.0	65.6 ± 14.8*(S)	0.44 ± 0.09	70 ± 48.0	57.4 ± 21.3*(S)	0.36 ± 0.09
12–13 September 2020	40 ± 52.0	35.1 ± 23.9	0.42 ± 0.08	100 ± 0.0	55.0 ± 14.3*(I)	0.64 ± 0.11*(S)	90 ± 32.0	54.2 ± 21.4*(I)	0.43 ± 0.07	100 ± 0.0	69.8 ± 13.2	0.44 ± 0.09
26 October 2020	50 ± 53.0	58.4 ± 39.9	0.63 ± 0.11	—	—	—	—	—	—	—	—	—

Notes: % = percent; (S) = sample stimulation; (I) = sample inhibition; mg = milligrams; SD = standard deviation; * = significant effect vs MEL-03-02, MEL-04-05, MEL-05-04, or Pooled references; — = not applicable/no testing completed (no results).

Table B-17: Site control, soft-water control, mid-field and reference *Daphnia magna* full strength results from MEL-02-05, MEL-03-02, MEL-04-05, and MEL-05-04 from the June to October 2020 sampling events

Sample Date	Laboratory Negative Control			Site Control / Synthetic Control			Lab Soft-water Control			MEL-02-05			MEL-03-02			MEL-04-05			MEL-05-04		
	Survival ± SD (%)	Mean Neonates ± SD	Mean Dry Weight ± SD (mg)	Survival ± SD (%)	Mean Neonates ± SD	Mean Dry Weight ± SD (mg)	Survival ± SD (%)	Mean Neonates ± SD	Mean Dry Weight ± SD (mg)	Survival ± SD (%)	Mean Neonates ± SD	Mean Dry Weight ± SD (mg)	Survival ± SD (%)	Mean Neonates ± SD	Mean Dry Weight ± SD (mg)	Survival ± SD (%)	Mean Neonates ± SD	Mean Dry Weight ± SD (mg)	Survival ± SD (%)	Mean Neonates ± SD	Mean Dry Weight ± SD (mg)
6–7 June 2020	100 ± 0.0	81.4 ± 14.9	0.29 ± 0.07	80 ± 42.0	31.4 ± 32.2	0.14 ± 0.07	90 ± 32.0	59.8 ± 35.3	0.30 ± 0.06	100 ± 0.0	40.7 ± 44.4	0.16 ± 0.05*	90 ± 32.0	59.5 ± 42.3	0.16 ± 0.07	100 ± 0.0	66.1 ± 47.1	0.11 ± 0.04	100 ± 0.0	40.0 ± 46.4	0.12 ± 0.04
22–25 July 2020	100 ± 0.0	41.6 ± 23.4	0.27 ± 0.07	70 ± 48.0	27.6 ± 20.6	0.26 ± 0.04	100 ± 0.0	47.7 ± 19.4	0.27 ± 0.06	90 ± 32.0	35.1 ± 19.0	0.30 ± 0.07	90 ± 32.0	37.0 ± 21.9	0.29 ± 0.06	80 ± 42.0	34.4 ± 16.3	0.32 ± 0.10	100 ± 0.0	31.5 ± 18.4	0.30 ± 0.06
22–23 August 2020	80 ± 42.2	59.3 ± 33.4	0.44 ± 0.04	90 ± 32.0	47.6 ± 18.9	0.47 ± 0.04	100 ± 0.0	59.9 ± 19.9	0.41 ± 0.07	90 ± 32.0	55.0 ± 21.4*(S)	0.45 ± 0.07	90 ± 32.0	56.6 ± 22.6	0.41 ± 0.09	100 ± 0.0	33.9 ± 23.3	0.38 ± 0.11*	70 ± 48.0	41.7 ± 27.4	0.43 ± 0.08
12–13 September 2020	80 ± 42.2	69.3 ± 26.8	0.40 ± 0.08	90 ± 32.0	62.2 ± 25.6	0.43 ± 0.06	90 ± 32.0	67.9 ± 11.9	0.39 ± 0.07	80 ± 42.0	63.4 ± 24.3*(I)	0.40 ± 0.11	100 ± 0.0	73.9 ± 11.1	0.44 ± 0.06	90 ± 32.0	72.0 ± 17.4	0.41 ± 0.10	100 ± 0.0	82.0 ± 13.3*(I)	0.48 ± 0.04
26 October 2020	100 ± 0.0	109.7 ± 10.0	0.74 ± 0.10	90 ± 32	89.5 ± 27.9	0.71 ± 0.06	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Notes: % = percent; mg = milligrams; SD = standard deviation; (S) = sample stimulation; (I) = sample inhibition; * = significant effect vs reference stations or pooled references (for MEL-02-05) or vs Site/Synthetic control (for reference stations); — = not applicable/no testing completed (no results).

B4.0 UNCERTAINTY ANALYSIS

All monitoring programs are subject to uncertainty because the environmental monitoring components cannot assess every location, biological condition, or ecological factor. Typical sources of uncertainty in an environmental monitoring programs include how representative sampling stations are for assessing potential impacts, the timing of sample collection, the potential effect of cumulative exposures, extrapolating effects between species, and extrapolating between observations in the laboratory to field conditions. These uncertainties are common to all monitoring programs and are compensated for by using appropriately conservative approaches (e.g., choice of sensitive indictor test organisms). Specific uncertainties of the current program include the following:

- Limited exposure range—Low concentrations of TDS and other exposure indicators, although desirable outcomes for demonstrating the effective dilution of discharge, limit the degree to which the receiving environment water quality benchmarks can be validated. Testing at higher TDS concentrations is important for validating the benchmark and for the final water quality objective at the edge of the mixing zone for long-term management of Meliadine Lake. The supplemental chronic testing at MEL-14 initiated during the second monthly sampling event and repeated at the end of October 2020 helped to address this limitation. Chronic toxicity testing of the full-strength discharge plus volumetric dilutions was useful for validation of the interim target of 1,000 mg/L at the edge of mixing zone—discharge was measured at TDS concentrations ranging between 1,700 and 1,850 mg/L measured TDS (1,200 and 1,400 mg/L measured TDS) in the MEL-14 chronic tests.

- Ecological significance of frond count reductions—The additional round of chronic toxicity testing of MEL-14 initiated at the end of October 2020 on each of the four selected chronic test species at a measured TDS concentration of 2,740 mg/L (calculated TDS of 2,500 mg/L) did not indicate impairment on fathead minnow, *Hyalella azteca*, or *Daphnia magna*. However, possible chronic effects to *Lemna minor* frond count were noted when compared to the laboratory controls at a measured TDS concentration of 2,740 mg/L (calculated TDS of 2,500 mg/L). Responses to the *Lemna minor* biomass endpoint were not observed in this test, and biomass is a more reliable indicator of biological response. In any case, the potential responses to an aquatic macrophyte in a chronic test do not result in a change to the conclusions of the testing program for validating the EQC. Chronic test endpoints help to characterize the nature of the effluent, but acute toxicity is the primary tool for evaluating the acceptability of full-strength discharges. Furthermore, the significant effects at lower concentrations (48.5% and 24.2%) during this test do not align with the previous rounds of testing as unacceptable chronic toxicity (i.e., IC_{50} >97%) in discharges at TDS concentrations ranging between 1,700 and 1,850 mg/L measured TDS (1,200 and 1,400 mg/L calculated TDS) were not observed. Although these results are anomalous, they remain protective of a TDS concentration of 1,000 mg/L.

- Low hardness influence on *Daphnia magna*—The application of a test protocol that is best suited for moderately hard water has some uncertainty when applied to testing of soft water typical of Meliadine Lake reference conditions. This uncertainty was partly addressed through study design (e.g., multiple control waters, and acclimation of organisms to site-relevant hardness). However, uncertainty is elevated relative to other chronic toxicity test endpoints, particularly for the *Hyalella* growth endpoint, which yielded low growth values for most site waters relative to common test outcomes. The available data do not indicate that growth suppression is attributable to discharge influence, but the variance in the growth data is high, and the confounding effects of other factors (e.g., food quality) is not fully understood.

B5.0 CONCLUSIONS

Based on the results of the WQ-MOP monitoring program, the following conclusions are reached from combined assessment of analytical chemistry and toxicology testing programs:

- TDS concentrations measured in the discharge were consistently below the MAC of 3,500 mg/L in each of the weekly sampling events and ranged between 1,340 and 3,100 mg/L measured TDS (1,000 and 2,600 mg/L calculated TDS).
- The discharge was not acutely toxic in 18 rounds of acute toxicity tests conducted with *Daphnia magna* and Rainbow Trout, as the LC_{50} values were >100% discharge in each of the tests. No survival data for either species indicate that full strength discharge is approaching concentrations causing mortality.
- Calculated TDS concentrations measured at the edge of mixing zone stations were less than the proposed interim target of 1,000 mg/L during the June to October 2020 sampling events, indicating that the discharge has a high assimilation rate and that TDS concentrations (along with other exposure parameters strongly associated with TDS) rapidly decrease in the receiving environment to concentrations below which adverse effects on biological receptors would be expected.
- The receiving environment was able to recover rapidly from the high volume of discharge under-ice.
- Adverse toxicological effects were not identified during the chronic toxicity testing at MEL-14 from July to September. The additional round of chronic toxicity testing of MEL-14 in October at a measured TDS concentration of 2,740 mg/L (2,500 mg/L calculated TDS) did not indicate impairment on fathead minnow, *Hyalella azteca*, or *Daphnia magna*. However, chronic effects to *Lemna minor* frond count were noted in full strength effluent as well as the 48.5% and 24.2% concentrations when compared to the laboratory controls. The October *Lemna minor* frond count result does not align with the previous rounds of testing with IC_{50} greater than 97% at TDS concentrations ranging between 1,700 and 1,850 mg/L measured TDS (1,200 and 1,400 mg/L calculated TDS). Although this test result was anomalous, it remains protective of a TDS concentration of 1,000 mg/L.
- Consistent with the low TDS concentration results reported in the receiving environment, adverse toxicological effects were not identified during the monthly chronic toxicity testing programs of the receiving environment. In the few cases where statistically significant differences were identified, they were found not to be linked to degree of discharge influence, but rather to other sources of variance.

Based on the agreed upon site-specific benchmark derivation procedure outlined in Section 1.1 of the Golder (2020) WQ-MOP Rev2 (Appendix A), the validation monitoring conducted to date support the proposed interim targets because:

- Discharges were measured at TDS concentrations ranging between 1,340 and 3,100 mg/L measured TDS (1,000 and 2,600 mg/L calculated TDS), which did not result in acute toxicity at the point of release
- Discharges have not resulted in unacceptable chronic toxicity for fathead minnow, *Hyalella azteca*, or *Daphnia magna* at TDS concentrations ranging between 1,700 and 2,740 mg/L measured TDS (1,200 and 2,500 mg/L calculated TDS)
- One sample collected at MEL-14 post-discharge at a measured TDS concentration of 2,740 mg/L (2,500 mg/L calculated TDS) indicated some chronic effects to *Lemna minor* frond count when compared to the laboratory controls. Although this test result did not align with the previous rounds of testing, it remained protective at a TDS concentration of 1,000 mg/L.
- Discharges have not resulted in unacceptable chronic toxicity at the edge of the mixing zone following initial dilution (i.e., at a 100 m radius surrounding the diffuser in Meliadine Lake)
- Discharges do not appear to be exceeding the capacity of the receiving environment to accommodate long-term loadings of constituents (i.e., assimilative capacity), as indicated by the observations the discharge rapidly diluted to below the proposed edge of mixing zone target of 1,000 mg/L TDS during the sampling events

These observations are consistent with the results of other lines of evidence that are complementary to the 2020 monitoring program, including literature and site-specific toxicity tests with multiple species (both acute and chronic tests) and additional validation of *Ceriodaphnia dubia* toxicity summarized in Appendix D.

Based on these observations, Agnico Eagle recommends as per Phase 3 of the WQ-MOP, that the interim TDS targets for the discharge and receiving environment developed under Phase 1 be ratified as regulatory targets for TDS as EQC for discharge and SSWQO for the receiving environment that will be applicable to future operating conditions at the Meliadine Mine. Specifically:

- the MAC of TDS of 3,500 mg/L and the maximum grab concentration (MGC) of TDS of 4,500 mg/L for discharge from CP1 to Meliadine Lake (i.e., EQC); and
- the benchmark concentration of TDS of 1,000 mg/L to be achieved at the edge of the mixing zone in Meliadine Lake, which would also be consistent with the SSWQO for longer-term management of the receiving environment of Meliadine Lake.

APPENDIX C

Plume Delineation Surveys Conducted on 21 July 2020 and 13 August 2020

REPORT

Appendix C: Plume Delineation Study Results

Updated Water Quality Management and Optimization Plan

Submitted to:

Agnico Eagle Mining Limited
Meliadine Mine Operations

Submitted by:

Golder Associates Ltd.

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20143949-802-RPT-Rev0

13 November 2020

Distribution List

1 eCopy: Agnico Eagle Mines Limited

1 eCopy: Golder Associate Ltd.

Table of Contents

TABLES

FIGURES

ATTACHMENTS

C-1 INTRODUCTION

The Meliadine Gold Mine (Mine) is located in the Kivalliq District of Nunavut near the western shore of Hudson Bay, in Northern Canada (Figure 1). The nearest community is Rankin Inlet (coordinates: 62°48’35’’N; 092°05’58’’W), approximately 25 km south of the Tiriganiaq deposit (coordinates: 63°01’03’’N; 92°12’03’’W). The Mine is located within the Meliadine Lake watershed of the Wilson Water Management Area (Nunavut Water Regulations Schedule 4).

As communicated to the Nunavut Water Board (NWB) by Agnico Eagle Mines Limited (Agnico Eagle), the 2020 freshet season will result in accumulation of site water that exceeds the water storage capacity of the mine at containment pond 1 (CP1), requiring a managed release of site water to the environment. In anticipation of this condition, Amendment 1 was approved by NWB for the Meliadine Mine Type “A” Water Licence (No. 2AM-MEL-1631), allowing Meliadine to dewater CP1 prior to freshet, avoiding “emergency” conditions. Specifically, Amendment 1 permits the following:

- *The time-limited discharge (May 2020 – October 2020) of effluent from the Containment Pond 1 (CP1) into Meliadine Lake through the Meliadine Lake Diffuser (Monitoring Program Station MEL-14) and the Water discharge shall not exceed 3,500 mg/L for the Maximum Average Concentration (MAC) of the Total Dissolved Solids (TDS)*

The NWB approval is contingent on several conditions outlined in NWB’s (2020) Reason for Decision. Among these conditions is the requirement for Agnico Eagle to conduct Plume Delineation Studies during the discharge event to characterize plume dispersion in the receiving environment of Meliadine Lake. The purpose of the Plume Delineation Studies is to provide confidence that the dispersion of the CP1 discharge will follow the anticipated pattern of flow and mixing in the receiving environment, such that environmental protection objectives at the edge of the mixing zone will be satisfied.

A submerged diffuser was installed in Meliadine Lake in August 2017 to disperse the water discharged from containment pond 1 (CP1) at station MEL-14. The diffuser is 30 m long, 400 mm diameter, with a nearly north-south orientation, and connected to the pipelines through a T-connection. Ten 51 mm ports are evenly spaced at every 3 m along the diffuser, with the ports discharging to the water column approximately 1 m above the lakebed (Tetra Tech 2017).

This document presents the results of the plume delineation studies conducted on July 21 and August 13, 2020. This study has been designed to address reporting requirements under Amendment 1 for a Plume Delineation Study, as outlined in Insert Item 25, Part I of NWB’s (2020) Reasons for Decision.

C-1.1 Background Information

Turbulent mixing caused by the diffusers results in an initial discharge plume adjacent to the diffusers. The term “plume” in this report refers to the mixture of CP1 discharge and lake water that is chemically distinguishable from the surrounding ambient lake water.

The diffuser in Meliadine Lake is oriented on a nearly north-south alignment, forming a “T” at the end of the pipe (Tetra Tech 2018; Figure 1). The constructed diffuser differed from the original project design (see Tetra Tech 2017) in terms of its horizontal position and depth of diffuser system at T-connection (42 m horizontal shift and a 3.2 m shallower depth).

LEGEND

- DIFFUSER
- SAMPLING LOCATION
- DIRECTION OF FLOW AT WATERSHED OUTLET
- MINE FOOTPRINT
- WATERSHED BOUNDARY
- WATERCOURSE
- WATERBODY

0 400 800

1:20,000 KILOMETRES

REFERENCE(S)

1. BASE DATA OBTAINED FROM AGNICO EAGLE MINES LIMITED.
2. DATUM: NAD83 PROJECTION UTM ZONE 15

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED

PROJECT

MELIADINE GOLD PROJECT
NUNAVUT

TITLE

SITE LOCATION

CONSULTANT

GOLDER

YYYY-MM-DD	2020-11-12
DESIGNED	ER
PREPARED	MH
REVIEWED	
APPROVED	

PROJECT NO.	CONTROL	REV.	FIGURE
20143949	1000/1500	A	1

Based on previous experience in low conductivity sub-arctic lakes, conductivity (i.e., specific conductance, temperature-corrected to 25°C; hereafter referred to as just conductivity) was considered an appropriate tracer to delineate the effluent plume in Meliadine Lake, because the conductivity of the CP1 discharge is higher than the conductivity of natural lake water. Conductivity measurements are a rapid, inexpensive, and reliable way of measuring the ionic content in a solution; the main constituents of interest in Meliadine Lake discharge are ionic parameters (e.g., chloride and other components of total dissolved solids). Conductivity in the water that was at Station MEL-14 [Agnico Eagle 2015]) ranged from 1,883 to 5,090 microsiemens per centimetre (µS/cm) between June 5 and October 3 2020 (Attachment A), whereas conductivity in Meliadine Lake (near-field exposure area; out to the 250 m zone of the plume delineation boundary) ranged from 102 to 142 µS/cm in 2020. Similarly, calculated TDS concentrations at MEL-14 ranged from 1,030 to 2,687 mg/L, while the concentrations in the near-field area ranged between 50 and 60 mg/L. This gradient in conductivity and calculated TDS provides a reliable basis for tracing the direction and intensity of the plume during the release event, with chemical measurements from samples collected at select monitoring stations used to confirm the water quality details.

The ability of the receiving environment to assimilate the concentrations and loading of constituents in effluent is a component of the WQ-MOP implementation. Consideration of assimilation capacity provides confidence that constituents will not gradually accumulate to concentrations that would degrade the receiving environment.

The approach to TDS management set out in the WQ-MOP is not expected to affect the quality, quantity, or flow of the waters in Meliadine Lake. TDS concentrations during and after the 2020 discharge will continue to be managed to minimize adverse effects of the licenced deposit of effluent on the aquatic ecosystem of Meliadine Lake, and discharges would continue to meet the stringent requirements set by the Nunavut Water Board through the Type A Water Licence (2AM-MEL1631) and the MDMER (GC 2018). Confidence in this conclusion comes from plume delineation surveys, preliminary dilution estimates from dispersion models, and consideration of the Meliadine Lake hydrology.

A plume delineation study was conducted in 2018 in the near-field region of Meliadine Lake as part of the Environmental Effects Monitoring (EEM) / Aquatic Effects Monitoring Program (AEMP) (Golder 2019). The plume delineation study used field surveys of conductivity to evaluate effluent dispersion with distance from the diffuser. The study evaluated dilution factors at a series of monitoring stations up to and extending beyond 250 m from the diffuser, based on the conductivity of the CP1 discharge and the measured field values through the water column at each of the monitoring stations. To account for background values, two scenarios were used:

- Scenario A: near-field average conductivity for 2015 to 2016
- Scenario B: near-field average conductivity for 2017

An observed slight increase in conductivity between 2015 to 2016 (pre-construction) and 2017 (construction) was the impetus for considering the two ambient condition scenarios.

Observations from the study indicated a minimum dilution factor of 53 at 50 m away from the diffuser, and a minimum dilution factor range of 56 (Scenario A) and 85 (Scenario B) at the edge of the 100 m mixing zone boundary (Table 1). This study was also useful because it served to validate the performance of the submerged diffuser, which had previously been assessed by Tetra Tech as part of their design (Tetra Tech 2017) and re-assessed in 2018 (Tetra Tech 2018). As part of their reassessment in 2018, Tetra Tech concluded that the predicted minimum dilution of 23:1, based on life of mine discharge to Meliadine Lake[1], was achieved at the edge of the 100 m mixing zone and that water quality criteria were met. Under the same study, the minimum dilution at the end of the first year of discharge (at 100 m from the diffuser) was 72:1. The latter ratio is consistent with earlier modelling work to support a conceptual diffuser in 2015 (Agnico Eagle 2015), which indicated that the minimum dilution factor was 65:1.

In summary, the range of dilution factors observed at a 100 m distance from the diffuser (representing the edge of the mixing zone) determined from the EEM plume delineation study were greater than the minimum dilution factor (23:1) developed in the performance assessment of the diffuser completed by Tetra Tech in 2018 based on multi-year simulations. The dilution factors remain in broad agreement with Tetra Tech's assessment for the first year of discharge (72:1) and the early work completed by Golder (65:1).

Work completed by Tetra Tech also indicated prevailing currents within the east basin of Meliadine Lake, where the diffuser is located, transport water at the surface layer towards the E-SE. This direction is also consistent with predominant wind directions from the NW. Surface currents in Meliadine Lake follow this general path, but can be variable and highly responsive to wind conditions. A returning current heading NW near the lakebed is also present (Tetra Tech 2018).

Table 1: Dilution Factors in the Near-field Exposure Area at Meliadine Lake[(a)]

Sampling Station	Maximum Conductivity in 2018 (µS/cm)	Dilution Factor – Scenario A	Dilution Factor – Scenario B
50-01	99.8	63	104
50-03	105.5	53	79
100-01	93.4	80	159
100-03	104.0	56	85
100-04	102.6	58	90
100-05	98.9	65	109
100-06	88.5	101	266
100-08	96.6	71	125

(a) Listed data represent a portion of the data listed in Table 2.4-10 of Golder (2019)

µS/cm = microsiemens per centimetre

C-2 OBJECTIVES

Plume delineation studies were conducted in Meliadine Lake in mid and late summer 2020 in the near-field area of Meliadine Lake immediately outside of the mixing zone to validate model predictions related to the dilution and assimilation of CP1 discharge in the receiving environment, to confirm edge of mixing zone conditions, and to characterize the receiving environment at the edge of the mixing zone. Although discharge will likely commence during ice cover conditions and continue during the transition period between ice cover and open water conditions on Meliadine Lake, boat access to the lake is required to conduct the plume delineation studies. Therefore, the plume delineation studies were constrained to open water conditions that permitted safe boat access.

The data obtained from the plume delineation studies will provide:

[1] The multi-year simulation included annual diffuser discharge to Lake Meliadine over the 14-year construction and operations timeline (Year -3 to Year 11). This scenario was included to assess the effects of water quality constituent build-up in the lake on the dilution factor.

- validation that the water quality at the edge of the mixing zone is consistent with predictions of TDS and major ion concentrations (as estimated using existing water quality from the effluent and modeling of the receiving environment)
- confirmation that the relationship between conductivity and water quality is sufficiently reliable for use in future plume delineation studies
- representation of the rate of effluent dispersion in the near-field region in Meliadine Lake, to address the assimilation capacity portion of the WQ-MOP.

C-3 METHODS

C-3.1 Sampling Design

The sampling design selected for the plume delineation in Meliadine Lake is a nearly radial model that allows measurement of plume dispersion in all directions. According to the *MVLWB/GNWT Guidelines for Effluent Mixing Zones* (GNWT 2017), the regulated mixing zone is defined as an area where concentrations of some substances may not comply with site-specific water quality objectives for the receiving environment, but is nevertheless suitable for reducing constituent concentrations from full strength discharges to those that provide protection against chronic effects to aquatic life. For lakes in the Mackenzie Valley, regulated mixing zones commonly have a maximum of 100 m radius from the discharge point (GNWT 2017). In contrast, site characterization under the MDMER/MMER (GC 2020) requires a description of the way discharge mixes within the exposure area at 250 m from each final discharge point. Using these distances as a basis for monitoring design, a modified radial grid containing 22 sampling stations was developed (Figure 2). Coordinates of sampling stations are provided in Table 2.

Table 2: Coordinates of Plume Delineation Study Sampling Stations

Sample ID	UTM Coordinates (NAD 83, Zone 15V)	
	Easting	Northing
50-01	542803.3	6989212.3
50-02	542847.2	6989144.7
50-03	542792.6	6989085.7
50-04	542748.4	6989153.2
100-01	542807.5	6989262.1
100-02	542875.5	6989226.9
100-03	542897.3	6989140.6
100-04	542861.3	6989059.1
100-05	542788.4	6989035.9
100-06	542719.9	6989070.2
100-07	542699.0	6989157.3
100-08	542728.6	6989233.4
175-01	542813.8	6989336.8
175-02	542971.8	6989134.3
175-03	542782.1	6988961.1
175-04	542624.1	6989163.6
250-01	543046.7	6989128.0

Sample ID	UTM Coordinates (NAD 83, Zone 15V)	
	Easting	Northing
250-02	542958.1	6988944.5
250-03	542775.8	6988886.4
250-04	542605.4	6988972.9
250-05	542549.2	6989170.0
250-06	542622.9	6989339.8

Two central markers are depicted in Figure 2 that outline the north and south ends of the diffuser, which is approximately 30 m in length. From each of these central markers, semicircles of 50, 100, 175, and 250 m were drawn, and within each arc, sampling stations were placed along up to eight transects radiating from the diffuser (Figure 2). The number of stations with each arc varied, but the highest number of stations were placed on the 100 m and 250 m arc from the diffuser. Some of the sampling stations along transects were removed from the design as they were located on islands or shallow areas of Meliadine Lake.

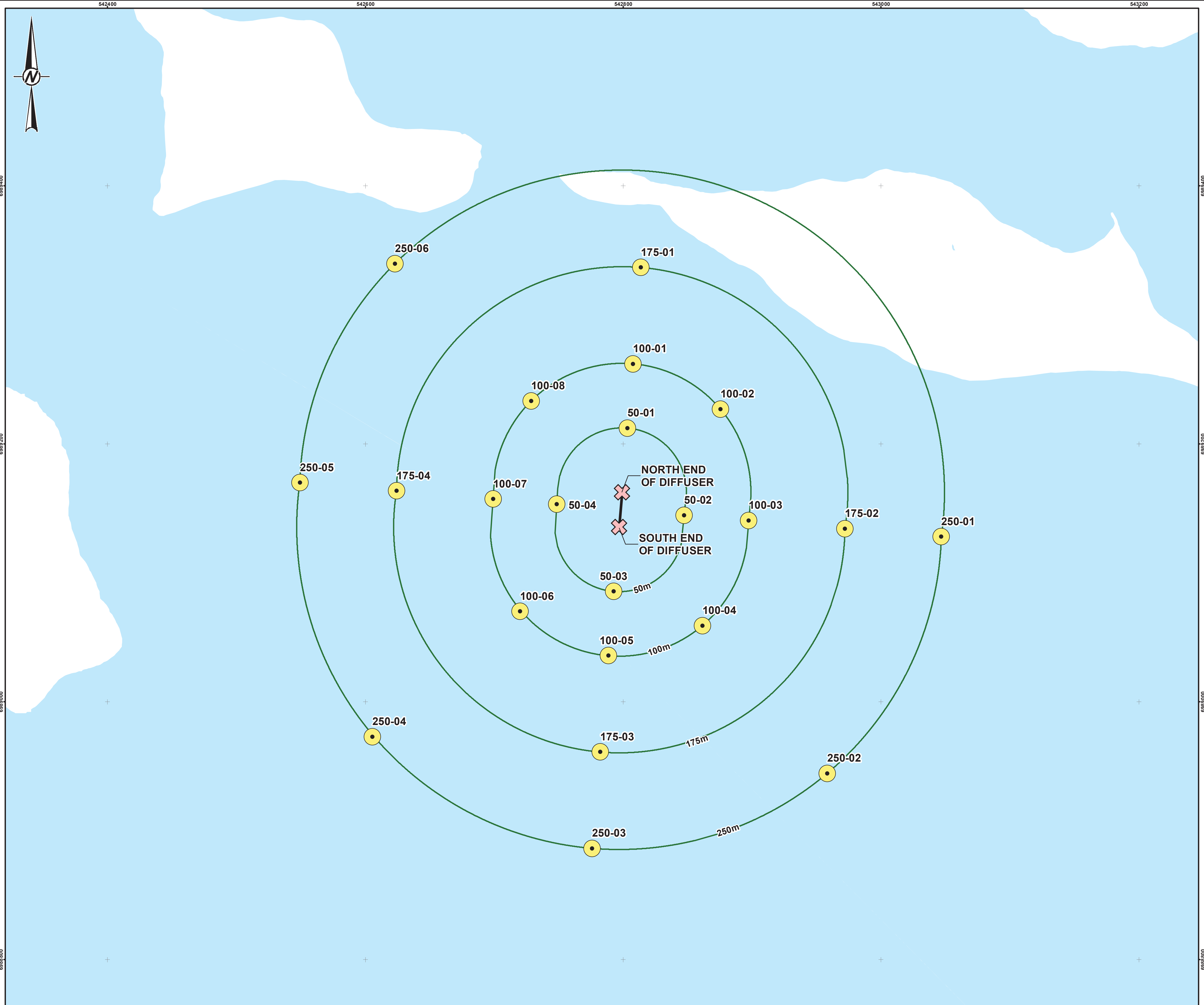
The distances from sampling stations to central markers (i.e., diffuser ends) were selected to provide higher resolution close to the diffusers and to characterize the edge of the mixing zone as per GNWT and MDMER frameworks.

C-3.2 Field Work

As described by Golder (2019), the method selected for plume delineation relies on vertical profiles of conductivity in near-field exposure areas of Meliadine Lake. Vertical profiles of the lake water column were measured using water quality meters (e.g., Hanna, YSI, Eureka, or equivalent) equipped with a 20 m or longer cable in mid and late summer 2020. Before commencing the profile, the water quality sensor was placed in lake water for at least one minute to allow readings to stabilize. If, following extended submersion (beyond one minute if necessary), the equipment was not providing stable readings, measurements were taken using a different sensor and meter.

At each sampling station, profile measurements were taken from the water surface (i.e., 0.3 m) and at 1 m water depth intervals through the water column, starting from 1 m below surface to 1 m above the lake bottom. Temperature and conductivity data were measured and recorded on field data sheets (if available, dissolved oxygen [concentration and percent saturation] and pH were also recorded).

Field work for the mid summer sampling event took place on July 21, 2020 as soon as fully open water conditions occurred in Meliadine Lake, which coincided with safe access to the sampling locations by boat. The late summer sampling was conducted on August 13, 2020. Field work was completed within a timely manner (i.e., within a single day) to avoid influence of confounding factors associated with weather conditions and potential for discharge variability. Each round of plume delineation was completed in 8 to 10 hours. The program was conducted during discharge to satisfy reporting requirement under Amendment 1 for a plume delineation study, as outlined in Insert Item 25, Part I of NWB's (2020) Reasons for Decision. In addition, a corresponding sample of the discharge from MEL-14 was required to be collected for the program. The timing of the field work for these studies was planned around the weekly MEL-14 sampling schedule.



LEGEND

DIFFUSER

SAMPLING LOCATION

FINAL DISCHARGE BUFFER

AS-BUILT DIFFUSER

0 60 120

1:3,000 METRES

REFERENCE(S)

1. BASE DATA OBTAINED FROM AGNICO EAGLE MINES LIMITED.
2. DATUM: NAD83 PROJECTION UTM ZONE 15

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED

PROJECT

MELIADINE GOLD PROJECT
NUNAVUT

TITLE

SAMPLING DESIGN FOR PLUME DELINEATION STUDY AT MELIADINE LAKE NEAR-FIELD EXPOSURE AREA

CONSULTANT

GOLDER

YYYY-MM-DD	2018-07-04
DESIGNED	ER
PREPARED	MH
REVIEWED	
APPROVED	

PROJECT NO.	CONTROL	REV.	FIGURE
20143949	1000/1500	A	2

Quality assurance and quality control (QA/QC) procedures were undertaken to obtain reliable data, which were representative of the discharge quality and receiving environment quality at the time of sample collection. QA/QC included field staff training, routine calibration of field equipment, and documentation. Meter calibration was re-checked at least once during each day of field work. In case the field staff noticed results were deviating from the expected range of values, a new check with calibration standards was immediately performed and, if necessary, the probe was recalibrated. Calibration checks or re-calibration were documented in the field book.

C-3.3 Data Analysis

Following field work, all field data and laboratory analysis results (when available) were reviewed. The spatial extent and water column field conductivity data was examined to provide an estimate of the discharge plume in a three-dimensional configuration, which was described in terms of its size, shape, and vertical distribution. Additionally, the relationship between field measured conductivity and calculated TDS (derived from the sum of major ions, where these data were available from selected substations, as per the formula [Equation 3-1] adapted from Method 1030E in Standard Methods for the Examination of Water and Wastewater APHA [2012]) was established to validate the use of conductivity as a tracer of TDS in the receiving environment.

$$Calculated\ TDS = (0.6 \text{ x Total Alkalinity as } CaCO_3) + Na^{+} + Mg^{+} + K^{+} + Ca^{2+} + SO_4{}^{2-} + Cl- + (NO_3{}^{-} - \text{N x } 4.427) + F^{-} + (SiO_3{}^{2-} - SiO_2 \text{ x } 1.266) \qquad \text{[Equation 3-1]}$$

Conductivity data were plotted using R v.3.6.3 environment (R Core Team 2020) and presented in vertical profile plots. Because of the high number of sampling stations (twenty-two), profile plots were grouped based on their distances from the diffuser (50, 100, 175, and 250 m). This approach improved data presentation while retaining the information on the extent of the plume and its behaviour through the water column.

Dilution factors were derived from the conductivity or calculated TDS data to provide an estimate of the mixing characteristics of the discharge at the edge of the mixing zone (i.e., 100 m); a higher dilution factor typically indicates a larger degree of dilution or mixing of the discharge in the receiving lake environment within the mixing zone. Following a conservative approach, the dilution factors were calculated according to the Equation 3-2. Corresponding lower bound data from the mid-field area in 2020 were used to represent ambient conditions for the derivation because these measurements throughout the 2020 monitoring period during open water conditions have remained consistent with data measured at the far-field (or lake outlet) stations.

$$DF = \frac{[C_{eff}] - [C_{amb}]}{[MC_{dif}] - [C_{amb}]} \qquad \text{[Equation 3-2]}$$

where:

DF = dilution factor

$[C_{eff}]$ = average conductivity in the treated effluent (MEL-14) at same day of the plume delineation study

$[MC_{dif}]$ = maximum conductivity or calculated TDS at a given plume delineation sampling station

$[C_{amb}]$ = average conductivity or average calculated TDS in the mid-field area characterizing ambient conditions during open-water of 2020

C-4 RESULTS

C-4.1 Supporting Data

Data obtained during the daily and weekly effluent monitoring and the results obtained from the mid-field area (MEL-02-05) are presented in Table 3. On the days when the plume delineation studies were completed, the conductivity of the discharge (i.e., MEL-14) was 2,326 µS/cm (July 21, 2020) and 2,765 µS/cm (August 13, 2020), Calculated TDS concentrations were 1,230 mg/L on July 21, 2020 and 1,446 mg/L on August 13, 2020.

Table 3: MEL-14 and MEL-02-05 Samples Collected between June and August 2020 with Corresponding Total Dissolved Solids Concentrations and Daily Average Conductivity Values

Sampling Station	Sample Date	Water Chemistry		
		Daily Average Specific Conductivity[(a)] (µS/cm)	Calculated TDS (mg/L)	Measured TDS (mg/L)
MEL-14	2020-06-05	4,780	2,615	2,570
	2020-06-07	4,548	2,595	2,600
	2020-06-14	5,054	2,687	3,090
	2020-06-15	4,967	2,597	3,100
	2020-06-21	4,851	2,675	2,790
	2020-06-28	4,588	2,548	2,910
	2020-07-05	2,206	1,158	1,510
	2020-07-12	2,027	1,030	1,370
	2020-07-21	2,326	1,230	1,700
	2020-07-26	2,441	1,146	1,430
	2020-07-26	2,441	1,262	1,340
	2020-08-02	2,582	1,322	1,550
	2020-08-09	2,708	1,413	1,660
	2020-08-13	2,765	1,446	1,670
	2020-08-16	2,757	1,438	1,650
	2020-08-23	2,864	1,438	1,850
	2020-08-29	3,017	1,603	1,770
	2020-08-30	3,038	1,584	1,620
	2020-09-05	3,100	1,652	1,940
	2020-09-06	3,196	1,659	1,910
	2020-09-13	3,387	1,879	1,780
	2020-09-20	3,538	1,918	2,410
	2020-09-27	3,833	2,046	2,300

Sampling Station	Sample Date	Water Chemistry		
		Daily Average Specific Conductivity[a] (µS/cm)	Calculated TDS (mg/L)	Measured TDS (mg/L)
MEL-02-05	2020-06-07	117	60	35[b]
	2020-07-23	88	41	35[b]
	2020-08-22	85	42	80[b]

Notes:

(a) Daily average conductivity measurements for MEL-14, and water column average conductivity measurements for MEL-02-05

(b) Measured TDS results considered inconsistent when compared to calculated TDS and conductivity

TDS = total dissolved solids; MEL-14 = treated effluent; MEL-02-05 = mid-field area; mg/L = milligrams per litre; µS/cm = microsiemens per litre.

C-4.2 Daily Discharge Volumes

Daily discharge volumes were recorded by Agnico Eagle. Discharge from CP1 to Meliadine Lake was initiated on June 5, 2020 and ceased on October 3, 2020. A total of 1,031,177 m^3 of CP1 water was discharged to Meliadine Lake through a submerged diffuser during the 2020 open-water season. Over the course of the open water discharge period, the range of daily average discharge was 2,197 m^3 on June 5, 2020 to 17,518 m^3 recorded on June 29, with a daily average discharge of 8,522 m^3. On the days when the plume delineation studies were conducted the daily discharge volume was 12,404 m^3 (July 21, 2020), which was preceded by a discharge of 12,456 m^3 on the previous day. For the second plume delineation study, the total discharge volume was 1,601 m^3, which was preceded by a discharge of 2,599 m^3 on the previous day. A plot showing the daily discharge over the discharge period (June 5 to October 3, 2020) is provided in Appendix B of the WQ-MOP Rev4.

C-4.3 Relationship between Conductivity and Total Dissolved Solids

To validate the assumption that field conductivity can be used adequately to trace TDS concentrations in the receiving environment a regression analysis was performed using laboratory and field data for all twenty-four samples collected (i.e. twelve at each survey). A detailed analysis of the ionic composition of the effluent is provided in Appendix A of the WQ-MOP Rev4; analytical results for the discharge and receiving environment samples collected in 2020 are provided in Appendix B of the WQ-MOP Rev4.

The initial regression used all data available and yielded a coefficient of 0.63, with *p-value* <0.001; however, visual assessment of the regression (Figure 3, left panel) determined that the data with highest conductivity (i.e., 50-02 from July 21) was an outlier. Hence, it was decided that the analysis should be run for a second time excluding the 50-02 data. The result obtained indicated a stronger relation between field conductivity and calculated TDS (R = 0.89 and *p-value* <0.000001).

Therefore, conductivity was deemed a reliable tracer for TDS in Meliadine Lake. With the inclusion of previous or future additional data, the regression may be strengthened and thus increase its accuracy. This has implications for future plume delineation studies and may reduce analytical costs and limitations associated with discrete sampling.

The relationship obtained in the right panel of Figure 3 was used to derive calculated TDS for sampling depths where discrete samples were not obtained and thus allow the calculation of dilution factors for calculated TDS at all depths.

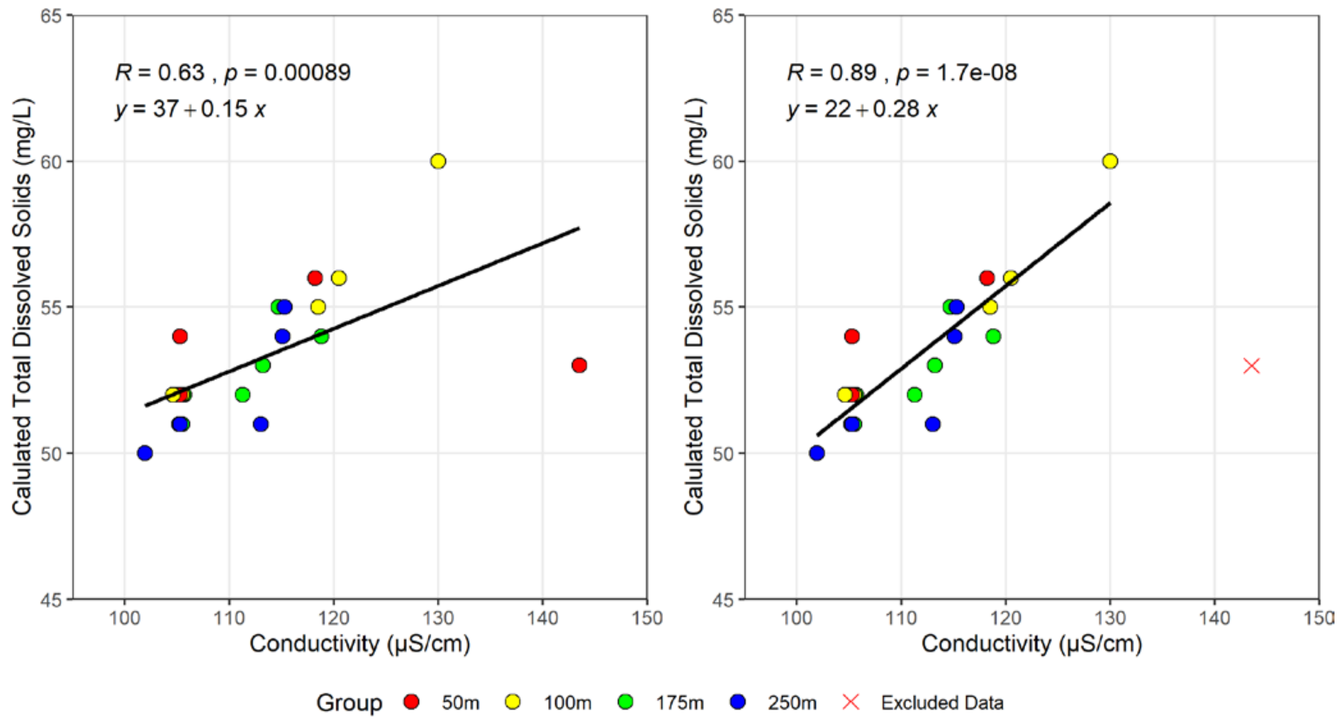


Figure 3: Linear Relationship Between Calculated Total Dissolved Solids and Conductivity at Meliadine Lake with (Left) and Without (Right) Extreme Conductivity Result

C-4.4 Plume Delineation Data

The complete field measurements and water chemistry dataset from the plume delineation surveys conducted on July 21 and August 13, 2020 are presented in Attachments A and B.

Weather conditions during the field surveys were typical summer conditions. On July 21, average air temperature was 16.5°C and average wind speed was 12.5 km/hour from the north-northwest over the course of the sampling event; in the preceding week, average air temperature was 12.6°C and winds ranged from 10.9 to 28.9 km/hour. On August 13, average air temperature was 15.7°C and average wind speed was 6.5 km/hour from the south southeast over the course of the sampling event; in the preceding week, average air temperature was 14.7°C and winds ranged from 8.4 to 21.1 km/hour.

On both sampling events, thermal stratification was not observed through the water column at any of the monitoring stations. On 21 July 2020, the water column ranged between 11 and 12 °C throughout the water column and between stations. On 13 August 2020, the water column temperature ranged between 15 and 16 °C.

Field conductivity, and estimated and calculated TDS, data are presented below in vertical profiles for each sampling station and each plume delineation study (Figure 4 and Figure 5).

During the plume delineation study on July 21, 2020 some variability in conductivity was observed spatially and throughout the water column; field conductivity varied between 104 and 144 µS/cm. Concentrations of estimated and measured calculated TDS on 21 July ranged between 52 and 62 mg/L. A similar level of variability in concentrations compared to conductivity was discernible between stations and with water column depth. With respect to water column profile variability, the field conductivity profile at sampling station 50-02, where the maximum conductivity wand calculated TDS as measured, showed an arc-shaped profile indicating greater conductivity at intermediate depths between 2 and 8 m, which provides a visual estimate of the position of the plume within the water column. This is consistent with the diffuser depth, located 2 m off the lakebed in approximately 6 m of water. Nevertheless, the July 21, 2020 conductivity profiles suggested that the discharge was discernible to varying degrees at all sampling stations depending on the proximity and direction from diffuser.

During the August 13, 2020 plume delineation study, there was limited variability in conductivity within and across locations. Results ranged from 102 to 106 µS/cm and no discernible plume could be identified. Corresponding calculated TDS concentrations ranged from 50 to 52.5 mg/L. Water column profile conductivity measurements on August 13 were similar to the lowest conductivity values measured on July 21. Furthermore, conductivity was relatively low despite more than two months of continuous discharge into Meliadine Lake, highlighting the assimilation capacity of the receiving environment.

The comparison of both sampling events strongly suggests the prevalence of well mixed conditions in the vicinity of the diffuser in August 13 despite the slightly higher conductivity and calculated TDS of the discharge on that day. On the other hand, the discharge plume was more discernible on July 21 at sampling stations between 50 m and 100 m from the diffuser but dispersed with increasing distance from the source. This is attributed to the large difference in daily discharge volumes on each day. Discharge into Meliadine Lake on July 21 was nearly eight times greater than discharge on August 13, in fact, the small discharge volume recorded on that day was over 5 times lower than the average discharge recorded between June 5 and October 3.

The vertical profile plots highlight the difference in conditions observed on the two events and the ability of Meliadine Lake to assimilate the effluent in close proximity to the diffuser.

Figure 6 and Figure 7 illustrate the horizontal and vertical distribution of conductivity and calculated TDS at four depths (i.e., surface, 3 m, 6 m, or bottom, if shallower and bottom) during the July 21 study. The surface extent of the discharge plume had a slightly larger northern emphasis extending from the location of the diffuser. However, with depth, plume dispersion showed a more lateral spread throughout the mixing zone (a greater range of green, yellow, and red colours throughout the mixing zone). As shown by the vertical profile plots, higher conductivity and maximum concentrations of calculated TDS were more associated with intermediate and bottom depths (i.e., at 3 m to bottom depths). At deeper depths, the presence of the plume to the east of the diffuser is less obvious, which may be associated with the prevailing pattern of NW currents near the lakebed (Tetra Tech 2018).

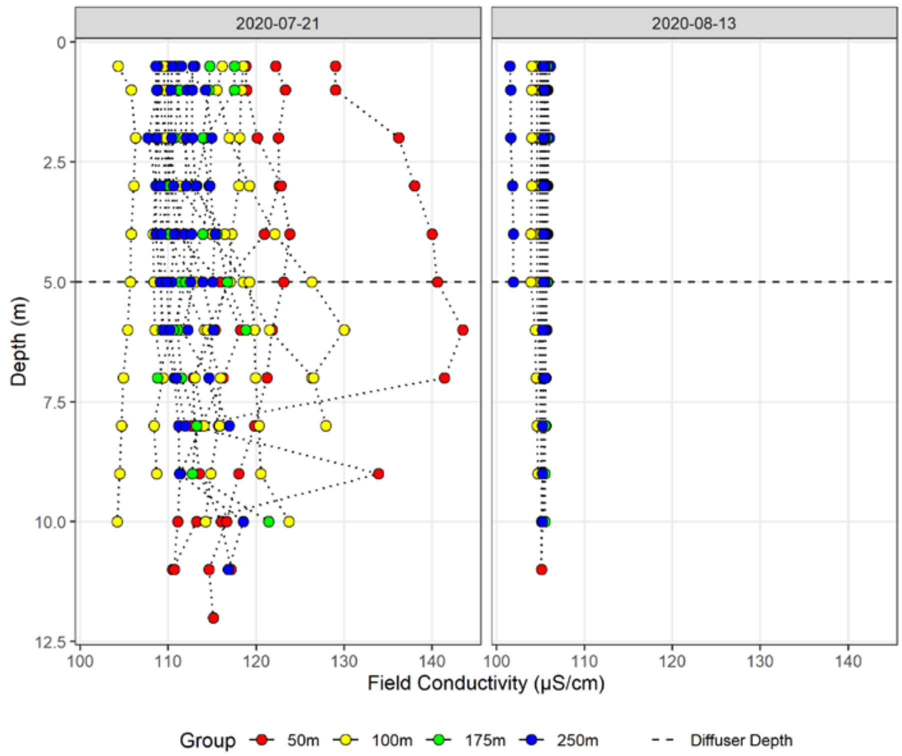


Figure 4: Field Conductivity Profiles in Meliadine Lake at the Plume Delineation Study Locations on July 21 (Left) and August 13, 2020 (Right)

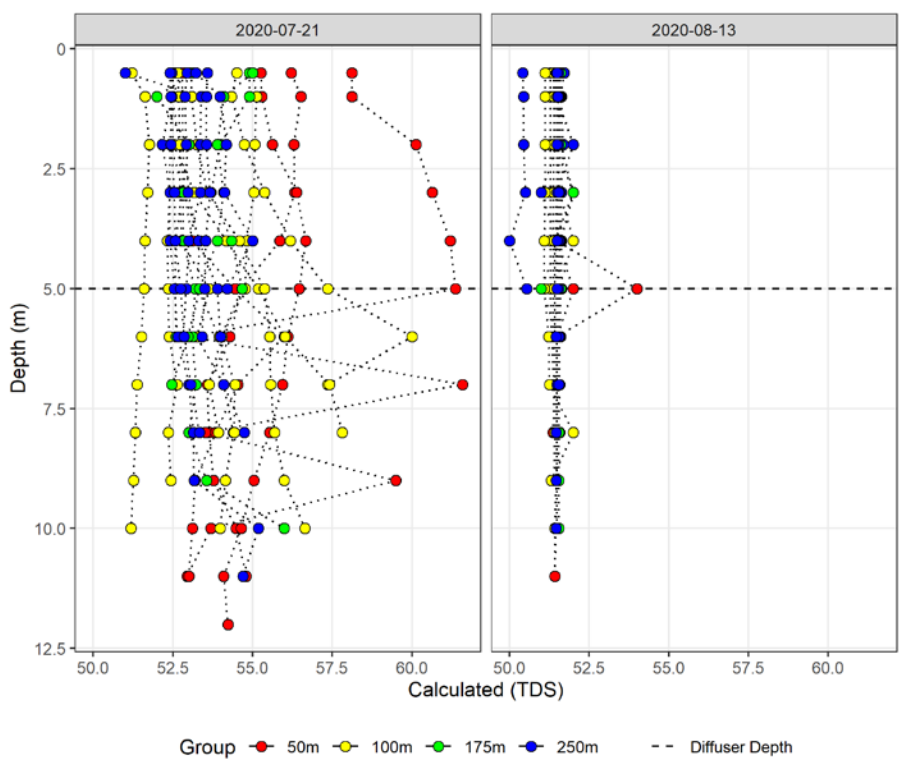
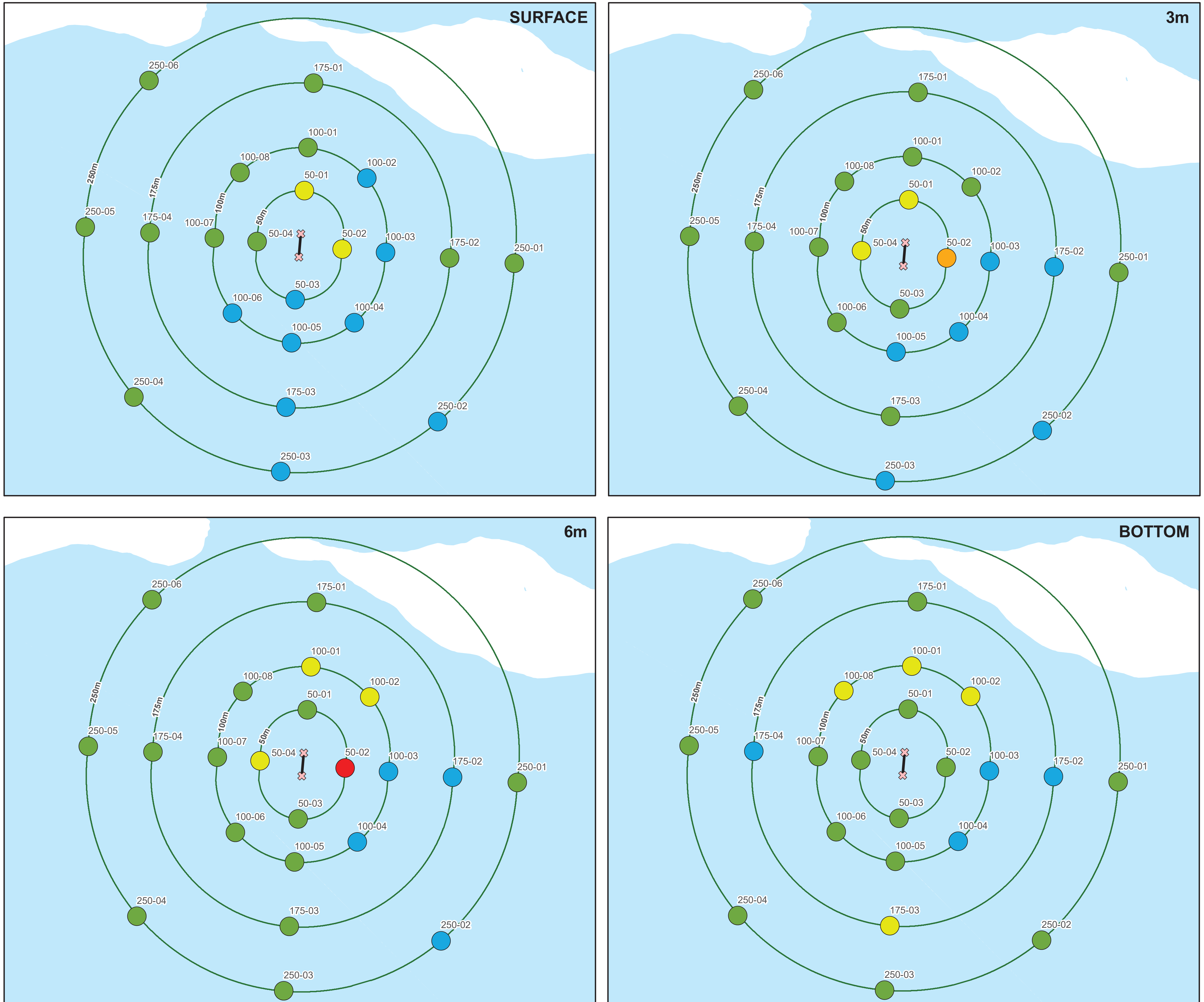


Figure 5: Calculated Total Dissolved Solids Profiles in Meliadine Lake at the Plume Delineation Study Locations on July 21 (Left) and August 13, 2020 (Right)



LEGEND

DIFFUSER

CONDUCTIVITY (µS/cm)

150

100

0 90 180

1:4,500 METRES

REFERENCE(S)

1. BASE DATA OBTAINED FROM AGNICO EAGLE MINES LIMITED.
2. DATUM: NAD83 PROJECTION UTM ZONE 15

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED

PROJECT

MELIADINE GOLD PROJECT
NUNAVUT

TITLE

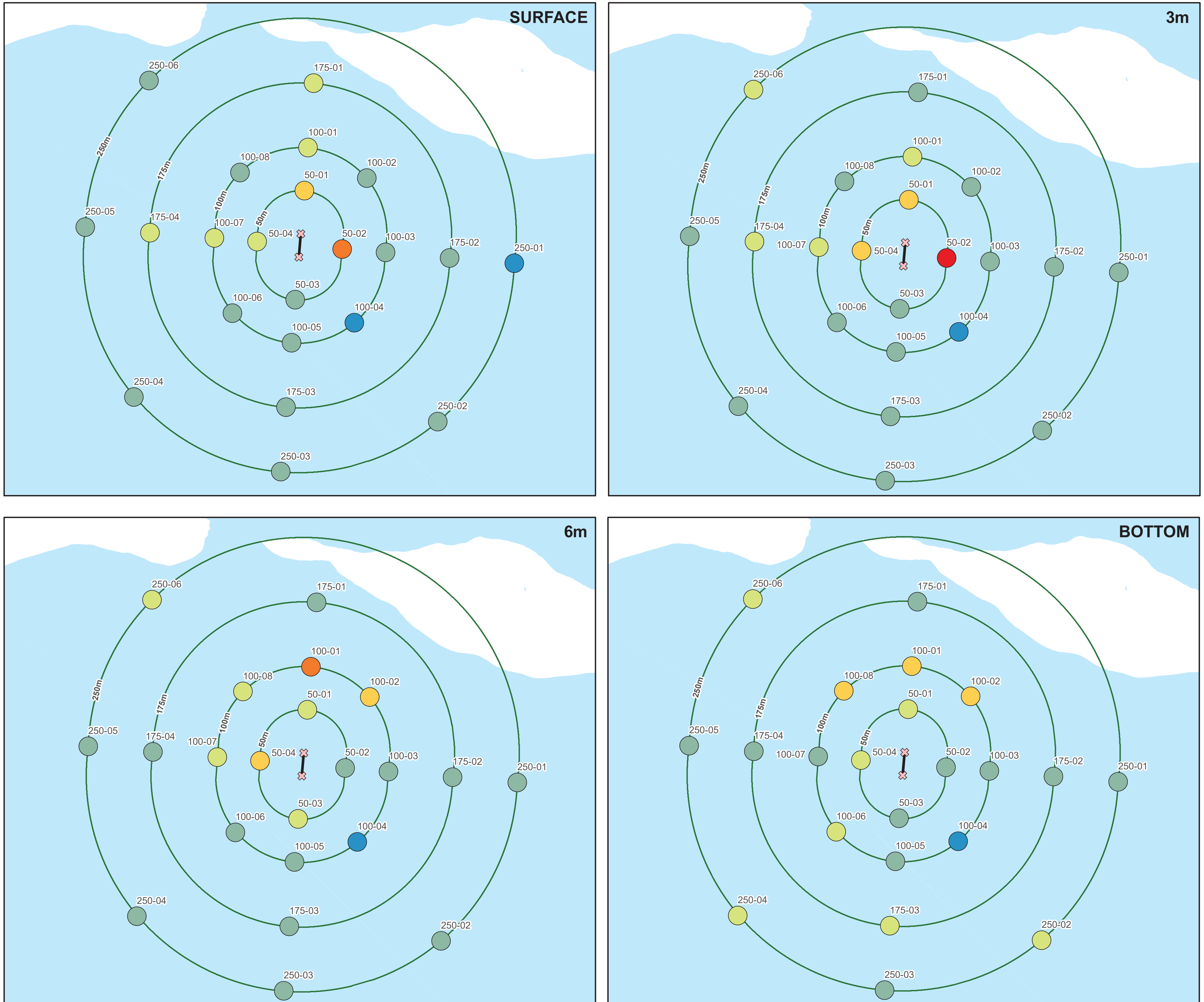
HORIZONTAL AND VERTICAL DISTRIBUTION FOR CONDUCTIVITY (µS/cm) IN THE NEAR-FIELD IN MELIADINE LAKE

CONSULTANT

GOLDER

YYYY-MM-DD	2020-11-12
DESIGNED	ER
PREPARED	MH
REVIEWED	
APPROVED	

PROJECT NO.	CONTROL	REV.	FIGURE
20143949	1000/1500	A	6



LEGEND

DIFFUSER

CALCULATED TDS (mg/L)

62

50

0 90 180

1:4,500 METRES

REFERENCE(S)

1. BASE DATA OBTAINED FROM AGNICO EAGLE MINES LIMITED.
2. DATUM: NAD83 PROJECTION UTM ZONE 15

CLIENT

AGNICO EAGLE

AGNICO EAGLE MINES LIMITED

PROJECT

MELIADINE GOLD PROJECT
NUNAVUT

TITLE

HORIZONTAL AND VERTICAL DISTRIBUTION OF CALCULATED TDS (mg/L) IN THE NEAR-FIELD IN MELIADINE LAKE

CONSULTANT

GOLDER

YYYY-MM-DD	2020-11-12
DESIGNED	ER
PREPARED	MH
REVIEWED	
APPROVED	

PROJECT NO.	CONTROL	REV.	FIGURE
20143949	1000/1500	A	7

C-4.5 Dilution Factor

The calculation of dilution factors for each plume delineation study was based on discrete samples collected on both sampling events at depths corresponding to the maximum observed field conductivity and calculated TDS. Thus, those samples were intended to represent the highest effluent concentrations and are considered a conservative approach for the evaluation of discharge mixing within Meliadine Lake.

The dilution factors are presented below in Table 4. The results were obtained using the CP1 discharge data from the same day. The average conductivity and TDS concentrations obtained during the open-water season of 2020 from the mid-field area were used as representative of ambient concentrations for the open-water season under current conditions. This approach can also be considered conservative as the current ambient concentrations in the near-field have greater concentrations of TDS and thus greater conductivity. The dilution factors are wide-ranging, which reflect the lake bathymetry within the 250 m boundary of the plume delineation study, ambient water quality conditions, the dispersion of the discharge plume, and prevailing currents through the water column.

At the edge of the mixing zone (i.e. 100 m from the diffuser) the results indicate a minimum dilution factor of 57 for maximum conductivity and minimum of 97 for calculated TDS considering the mid-field area ambient results in 2020. As suggested by field conductivity and calculated TDS profiles, the dilution factors indicate lower dilution potential during the July 21 event, with dilution factors approximately two times greater in August 13.

These results indicate the ability of the receiving environment to effectively assimilate the discharge in the immediate receiving environment of Meliadine Lake. These results are in broad agreement with the modelling results presented in the FEIS, which predicted dilution factors of 23:1 to 65:1 (Agnico Eagle 2015; Tetra Tech 2018), and consistent with a previous plume delineation conducted as part of the AEMP/EEM study in 2018 (Golder 2019).

Table 4: Maximum Conductivity and Calculated Total Dissolved Solids and Estimated Dilution Factors in the Near-field in Meliadine Lake during the Plume Delineation Studies on 21 July and 13 August 2020

Date	Sampling Station	Maximum Conductivity (µS/cm)	Calculated Total Dissolved Solids (mg/L) [(a)]	Dilution Factor for Maximum Conductivity [(b)]	Dilution Factor for Calculated TDS [(b)]
2020-07-21	50-01	123	57[(c)]	69	136
	50-02	144	53	43	227
	50-03	118	56	82	144
	50-04	124	57[(c)]	68	133
	100-01	130	60	**57**	**97**
	100-02	128	58[(c)]	61	118
	100-03	109	53[(c)]	122	245
	100-04	106	52[(c)]	147	298
	100-05	116	54[(c)]	91	179
	100-06	116	54[(c)]	90	178
	100-07	119	55	81	164
	100-08	124	56	68	144
	175-01	119	54	81	191
	175-02	111	52	110	281
	175-03	121	53	74	227
	175-04	115	55	95	164
	250-01	113	51	102	369

Date	Sampling Station	Maximum Conductivity (µS/cm)	Calculated Total Dissolved Solids (mg/L) (a)	Dilution Factor for Maximum Conductivity (b)	Dilution Factor for Calculated TDS (b)
	250-02	119	55(c)	81	160
	250-03	112	53(c)	107	214
	250-04	117	54	87	191
	250-05	113	54(c)	101	201
	250-06	115	55	92	164
2020-08-13	50-01	105	51(c)	192	388
	50-02	105	54	188	226
	50-03	105	52	188	333
	50-04	106	52(c)	184	371
	100-01	105	51	188	437
	100-02	105	51(c)	192	388
	100-03	105	52(c)	187	377
	100-04	105	51(c)	191	385
	100-05	105	52(c)	187	377
	100-06	106	52(c)	184	371
	100-07	106	52	184	333
	100-08	105	52	196	333
	175-01	105	52	191	333
	175-02	105	52	189	333
	175-03	106	51	185	437
	175-04	106	52	183	333
	250-01	105	52	188	333
	250-02	105	51(c)	188	380
	250-03	106	52(c)	185	374
	250-04	105	51	187	437
	250-05	106	52(c)	178	358
	250-06	102	50	247	636

(a) Column includes Calculated TDS as measured from discrete samples collected at a sub-set of the monitoring stations, and Calculated TDS estimated for the remaining sampling stations using the linear relationship provided in Figure 3 (right plot - TDSCalc = 22 + 0.28*Conductivity)

(b) Dilution factors were calculated based on MEL-14 results for the same day and ambient concentration from average open-water for the mid-field station MEL-02-05 in 2020.

(c) Discrete sample was not collected at this depth; therefore, the presented calculated TDS was estimated using the conductivity v. Calculated TDS relationship (see footnote a).

- = not available or not calculated; TDS = total dissolved solids; MEL-14 = treated effluent; MEL-02-05 = md-field area; mg/L = milligrams per litre; µS/cm = microsiemens per litre

Cells highlighted in grey indicate the 100 m edge of mixing zone boundary.

Cells highlighted in yellow indicate lowest dilution factors overall and text in **bold** indicates lowest dilution for the edge of the mixing zone (i.e. 100 m from diffuser).

C-5 CONCLUSIONS

The two plume delineation studies conducted on July 21 and August 13, 2020 were able to describe the mixing of CP1 discharge into Meliadine Lake under two different discharge scenarios. Overall, results indicate that:

- the influence of discharge was more discernible closer to the diffuser and throughout the water column at all monitoring stations under the higher discharge rate during the July 21 discharge, with evidence of a mid-depth plume at 50 m from the diffuser; under the lower discharge rate on August 13, despite the discharge possessing a similar range of conductivity, the discharge was not as prevalent
- the relationship between field conductivity and calculated TDS was strong and deemed reliable
- even at the greater discharge rate, the function of the submerged diffuser was able to effectively disperse the discharge into Meliadine Lake
- the plume on July 21 was more evident at depth, primarily due to its higher discharge rate compared to the discharge on August 13 (despite the discharges having similar TDS concentrations), and showed that the extent of its spread was generally throughout the mixing zone
- considering a conservative approach using ambient conditions based on mid-field monitoring results, the minimum dilution factor at the edge of mixing zone was 57 for maximum conductivity and 97 for calculated total dissolved solids
- dilution achieved at the 100 m edge of the mixing zone boundary under both plume delineation studies was in agreement with the 2018 plume delineation study and near-field effluent dispersion modelling predictions, including the recent hydrodynamic evaluation of plume dispersion in the east basin of Meliadine Lake.

C-6 REFERENCES

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ATTACHMENT A

Field Data Collected from the Sampling Locations in Meliadine Lake during the Plume Delineation Studies on July 21 and August 13, 2020

Attachment A: Field Data Collected from the Sampling Locations in Meliadine Lake during the Plume Delineation Studies on July 21 and August 13, 2020

Date	Sampling Station	Sample Depth	pH	Specific Conductivity (uS/cm)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
2020-07-21	50-01	0.5-1 m	7.6	122	11.6	11.30	104.2
2020-07-21	50-01	1-2 m	7.6	123	11.6	11.38	104.6
2020-07-21	50-01	2-3 m	7.6	123	11.6	11.39	104.6
2020-07-21	50-01	3-4 m	7.6	123	11.6	11.39	104.6
2020-07-21	50-01	4-5 m	7.5	121	11.5	11.39	104.5
2020-07-21	50-01	5-6 m	7.6	117	11.4	11.39	104.4
2020-07-21	50-01	6-7 m	7.6	115	11.4	11.39	104.2
2020-07-21	50-01	7-8 m	7.6	113	11.3	11.37	103.8
2020-07-21	50-01	8-9 m	7.6	113	11.2	11.35	103.6
2020-07-21	50-01	9-10 m	7.6	114	11.2	11.35	103.4
2020-07-21	50-01	10-11 m	7.6	116	11.1	11.34	103.2
2020-07-21	50-01	11-12 m	7.6	117	11.1	11.33	102.9
2020-07-21	50-02	0.5-1 m	7.5	129	11.4	11.18	102.1
2020-07-21	50-02	1-2 m	7.5	129	11.4	11.31	103.5
2020-07-21	50-02	2-3 m	7.5	136	11.3	11.35	103.6
2020-07-21	50-02	3-4 m	7.5	138	11.3	11.35	103.7
2020-07-21	50-02	4-5 m	7.5	140	11.3	11.35	103.7
2020-07-21	50-02	5-6 m	7.5	141	11.3	11.36	103.8
2020-07-21	50-02	6-7 m	7.5	144	11.3	11.36	103.8
2020-07-21	50-02	7-8 m	7.5	141	11.3	11.36	103.8
2020-07-21	50-02	8-9 m	7.6	113	11.3	11.36	103.8
2020-07-21	50-02	9-10 m	7.6	134	11.2	11.37	103.7
2020-07-21	50-02	10-11 m	7.6	113	11.2	11.36	103.6
2020-07-21	50-02	11-12 m	7.3	111	11.1	11.31	101.1
2020-07-21	50-03	0.5-1 m	7.4	110	11.7	11.37	104.6
2020-07-21	50-03	1-2 m	7.4	110	11.6	11.40	104.9
2020-07-21	50-03	2-3 m	7.4	110	11.7	11.40	105.0
2020-07-21	50-03	3-4 m	7.4	110	11.6	11.41	105.0
2020-07-21	50-03	4-5 m	7.5	111	11.6	11.41	104.9
2020-07-21	50-03	5-6 m	7.5	116	11.6	11.40	104.7
2020-07-21	50-03	6-7 m	7.5	118	11.5	11.39	104.6
2020-07-21	50-03	7-8 m	7.5	116	11.5	11.37	104.3
2020-07-21	50-03	8-9 m	7.5	114	11.4	11.36	103.9
2020-07-21	50-03	9-10 m	7.5	111	11.3	11.34	103.4
2020-07-21	50-03	10-11 m	7.5	111	11.2	11.32	103.3
2020-07-21	50-03	11-12 m	7.5	111	11.2	11.18	102.1
2020-07-21	50-04	0.5-1 m	7.6	119	11.3	11.18	101.9
2020-07-21	50-04	1-2 m	7.6	119	11.3	11.34	103.6
2020-07-21	50-04	2-3 m	7.6	120	11.2	11.36	103.6
2020-07-21	50-04	3-4 m	7.6	123	11.3	11.36	103.7
2020-07-21	50-04	4-5 m	7.5	124	11.2	11.37	103.6
2020-07-21	50-04	5-6 m	7.5	123	11.2	11.36	103.5
2020-07-21	50-04	6-7 m	7.6	122	11.1	11.35	103.3
2020-07-21	50-04	7-8 m	7.5	121	11.2	11.35	103.5
2020-07-21	50-04	8-9 m	7.6	120	11.1	11.35	103.2
2020-07-21	50-04	9-10 m	7.5	118	11.2	11.33	103.1
2020-07-21	50-04	10-11 m	7.6	117	11	11.32	102.7
2020-07-21	50-04	11-12 m	7.5	115	11	11.30	102.4
2020-07-21	50-04	12-13 m	7.1	115	10.9	7.55	73.0
2020-07-21	100-01	0.5-1 m	7.5	116	11.6	11.31	104.0
2020-07-21	100-01	1-2 m	7.5	116	11.5	11.36	104.3
2020-07-21	100-01	2-3 m	7.5	117	11.6	11.37	104.4
2020-07-21	100-01	3-4 m	7.5	119	11.5	11.37	104.4
2020-07-21	100-01	4-5 m	7.5	122	11.5	11.38	104.4
2020-07-21	100-01	5-6 m	7.5	126	11.5	11.37	104.4
2020-07-21	100-01	6-7 m	7.5	130	11.5	11.37	104.2
2020-07-21	100-01	7-8 m	7.5	126	11.3	11.34	103.7
2020-07-21	100-02	0.5-1 m	7.5	109	11.9	11.43	105.7
2020-07-21	100-02	1-2 m	7.5	109	11.9	11.47	106.2
2020-07-21	100-02	2-3 m	7.6	109	11.9	11.48	106.2
2020-07-21	100-02	3-4 m	7.6	111	11.8	11.49	106.0
2020-07-21	100-02	4-5 m	7.6	115	11.6	11.48	105.7
2020-07-21	100-02	5-6 m	7.6	119	11.6	11.48	105.5
2020-07-21	100-02	6-7 m	7.6	122	11.5	11.47	105.3
2020-07-21	100-02	7-8 m	7.6	127	11.5	11.45	104.8
2020-07-21	100-02	8-9 m	7.6	128	11.4	11.40	104.3

Attachment A: Field Data Collected from the Sampling Locations in Meliadine Lake during the Plume Delineation Studies on July 21 and August 13, 2020

Date	Sampling Station	Sample Depth	pH	Specific Conductivity (uS/cm)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
2020-07-21	100-03	0.5-1 m	7.6	109	11.55	11.04	100.6
2020-07-21	100-03	1-2 m	7.6	109	11.5	11.39	104.5
2020-07-21	100-03	2-3 m	7.6	109	11.5	11.42	104.8
2020-07-21	100-03	3-4 m	7.6	109	11.5	11.42	104.8
2020-07-21	100-03	4-5 m	7.6	108	11.4	11.41	104.4
2020-07-21	100-03	5-6 m	7.6	108	11.3	11.40	104.2
2020-07-21	100-03	6-7 m	7.6	109	11.3	11.39	104.0
2020-07-21	100-03	7-8 m	7.6	109	11.3	11.39	104.0
2020-07-21	100-03	8-9 m	7.6	108	11.3	11.38	103.9
2020-07-21	100-03	9-10 m	7.6	109	11.3	11.36	103.8
2020-07-21	100-04	0.5-1 m	7.6	104	12	11.28	104.3
2020-07-21	100-04	1-2 m	7.6	106	12	11.41	105.8
2020-07-21	100-04	2-3 m	7.6	106	11.9	11.47	106.3
2020-07-21	100-04	3-4 m	7.6	106	11.9	11.47	106.1
2020-07-21	100-04	4-5 m	7.6	106	11.8	11.46	105.8
2020-07-21	100-04	5-6 m	7.6	106	11.7	11.45	105.7
2020-07-21	100-04	6-7 m	7.6	105	11.7	11.44	105.4
2020-07-21	100-04	7-8 m	7.6	105	11.6	11.43	104.9
2020-07-21	100-04	8-9 m	7.5	105	11.5	11.41	104.7
2020-07-21	100-04	9-10 m	7.6	105	11.5	11.40	104.5
2020-07-21	100-04	10-11 m	7.6	104	11.4	11.39	104.2
2020-07-21	100-05	0.5-1 m	7.3	110	11.7	11.38	104.9
2020-07-21	100-05	1-2 m	7.3	110	11.7	11.41	105.2
2020-07-21	100-05	2-3 m	7.4	110	11.7	11.42	105.3
2020-07-21	100-05	3-4 m	7.4	110	11.7	11.43	105.3
2020-07-21	100-05	4-5 m	7.4	110	11.7	11.43	105.2
2020-07-21	100-05	5-6 m	7.4	113	11.6	11.43	105.1
2020-07-21	100-05	6-7 m	7.4	112	11.6	11.42	105.0
2020-07-21	100-05	7-8 m	7.5	115	11.6	11.41	104.9
2020-07-21	100-05	8-9 m	7.5	116	11.6	11.40	104.8
2020-07-21	100-05	9-10 m	7.5	115	11.6	11.39	104.7
2020-07-21	100-05	10-11 m	7.5	114	11.5	11.39	104.5
2020-07-21	100-06	0.5-1 m	7.2	109	11.9	11.39	105.4
2020-07-21	100-06	1-2 m	7.3	109	11.9	11.42	105.7
2020-07-21	100-06	2-3 m	7.3	110	11.8	11.44	105.7
2020-07-21	100-06	3-4 m	7.4	110	11.8	11.45	105.7
2020-07-21	100-06	4-5 m	7.4	112	11.7	11.45	105.5
2020-07-21	100-06	5-6 m	7.4	112	11.7	11.44	105.4
2020-07-21	100-06	6-7 m	7.4	114	11.6	11.43	105.2
2020-07-21	100-06	7-8 m	7.4	116	11.6	11.42	105.1
2020-07-21	100-06	8-9 m	7.5	116	11.3	11.40	103.9
2020-07-21	100-07	0.5-1 m	7.6	119	11.2	11.37	103.8
2020-07-21	100-07	1-2 m	7.6	118	11.2	11.39	103.8
2020-07-21	100-07	2-3 m	7.6	118	11.2	11.39	103.7
2020-07-21	100-07	3-4 m	7.6	118	11.2	11.38	103.7
2020-07-21	100-07	4-5 m	7.6	117	11.1	11.38	103.6
2020-07-21	100-07	5-6 m	7.5	117	11.2	11.38	103.3
2020-07-21	100-07	6-7 m	7.6	114	11.2	11.37	103.5
2020-07-21	100-07	7-8 m	7.6	113	11.1	11.38	103.5
2020-07-21	100-07	8-9 m	7.6	114	11.1	11.36	103.4
2020-07-21	100-08	0.5-1 m	7.5	111	11.7	11.43	105.3
2020-07-21	100-08	1-2 m	7.6	111	11.7	11.46	105.7
2020-07-21	100-08	2-3 m	7.6	112	11.7	11.46	105.7
2020-07-21	100-08	3-4 m	7.6	113	11.7	11.46	105.6
2020-07-21	100-08	4-5 m	7.6	116	11.7	11.46	105.5
2020-07-21	100-08	5-6 m	7.6	119	11.6	11.45	105.3
2020-07-21	100-08	6-7 m	7.6	120	11.6	11.45	105.2
2020-07-21	100-08	7-8 m	7.6	120	11.6	11.40	105.1
2020-07-21	100-08	8-9 m	7.6	120	11.5	11.44	105.0
2020-07-21	100-08	9-10 m	7.6	121	11.5	11.44	105.0
2020-07-21	100-08	10-11 m	7.6	124	11.4	11.44	104.6
2020-07-21	175-01	0.5-1 m	7.5	118	11.5	11.43	104.8
2020-07-21	175-01	1-2 m	7.5	118	11.5	11.46	105.1
2020-07-21	175-01	2-3 m	7.5	114	11.4	11.47	105.0
2020-07-21	175-01	3-4 m	7.5	113	11.4	11.47	105.0
2020-07-21	175-01	4-5 m	7.5	116	11.4	11.46	104.8

Attachment A: Field Data Collected from the Sampling Locations in Meliadine Lake during the Plume Delineation Studies on July 21 and August 13, 2020

Date	Sampling Station	Sample Depth	pH	Specific Conductivity (uS/cm)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
2020-07-21	175-01	5-6 m	7.5	117	11.3	11.47	104.7
2020-07-21	175-01	6-7 m	7.5	119	11.3	11.47	104.6
2020-07-21	175-02	0.5-1 m	7.6	111	11.6	11.43	n/a
2020-07-21	175-02	1-2 m	7.6	111	11.5	11.43	n/a
2020-07-21	175-02	2-3 m	7.6	111	11.5	11.43	n/a
2020-07-21	175-02	3-4 m	7.6	110	11.5	11.43	n/a
2020-07-21	175-02	4-5 m	7.6	109	11.4	11.44	n/a
2020-07-21	175-02	5-6 m	7.6	109	11.4	11.44	n/a
2020-07-21	175-02	6-7 m	7.6	109	11.3	11.43	n/a
2020-07-21	175-03	0.5-1 m	7.4	109	11.8	11.42	n/a
2020-07-21	175-03	1-2 m	7.4	109	11.8	11.43	n/a
2020-07-21	175-03	2-3 m	7.5	109	11.8	11.44	n/a
2020-07-21	175-03	3-4 m	7.5	110	11.7	11.44	n/a
2020-07-21	175-03	4-5 m	7.5	110	11.7	11.44	n/a
2020-07-21	175-03	5-6 m	7.5	111	11.7	11.44	n/a
2020-07-21	175-03	6-7 m	7.5	111	11.7	11.43	n/a
2020-07-21	175-03	7-8 m	7.5	112	11.7	11.43	n/a
2020-07-21	175-03	8-9 m	7.5	113	11.7	11.42	n/a
2020-07-21	175-03	9-10 m	7.5	113	11.6	11.41	n/a
2020-07-21	175-03	10-11 m	7.5	121	11.2	11.29	n/a
2020-07-21	175-04	0.5-1 m	7.5	115	11.25	11.58	107.2
2020-07-21	175-04	1-2 m	7.5	115	11.22	11.60	107.4
2020-07-21	175-04	2-3 m	7.5	114	11.19	11.61	107.4
2020-07-21	175-04	3-4 m	7.5	115	11.22	11.60	107.4
2020-07-21	175-04	4-5 m	7.5	114	11.14	11.62	107.5
2020-07-21	175-04	5-6 m	7.5	112	11.13	11.65	107.6
2020-07-21	175-04	6-7 m	7.5	111	11.05	11.69	107.5
2020-07-21	175-04	7-8 m	7.5	109	10.83	11.64	106.7
2020-07-21	250-01	0.5-1 m	7.6	113	11.6	11.44	105.2
2020-07-21	250-01	1-2 m	7.6	112	11.6	11.30	103.8
2020-07-21	250-01	2-3 m	7.6	112	11.5	11.41	104.8
2020-07-21	250-01	3-4 m	7.6	112	11.6	11.41	104.9
2020-07-21	250-01	4-5 m	7.6	111	11.5	11.43	104.8
2020-07-21	250-01	5-6 m	7.6	110	11.5	11.43	104.8
2020-07-21	250-01	6-7 m	7.6	110	11.3	11.45	104.6
2020-07-21	250-02	0.5-1 m	7.6	109	12	11.16	103.3
2020-07-21	250-02	1-2 m	7.6	109	12	11.39	105.6
2020-07-21	250-02	2-3 m	7.6	108	12	11.45	106.2
2020-07-21	250-02	3-4 m	7.6	109	12	11.46	106.3
2020-07-21	250-02	4-5 m	7.6	109	12	11.46	106.3
2020-07-21	250-02	5-6 m	7.6	109	11.9	11.46	106.1
2020-07-21	250-02	6-7 m	7.6	110	11.9	11.46	106.0
2020-07-21	250-02	7-8 m	7.6	111	11.8	11.45	105.9
2020-07-21	250-02	8-9 m	7.6	111	11.8	11.45	105.8
2020-07-21	250-02	9-10 m	7.6	111	11.8	11.44	105.5
2020-07-21	250-02	10-11 m	7.6	119	11.7	11.43	105.4
2020-07-21	250-02	11-12 m	7.6	117	11.7	11.32	104.2
2020-07-21	250-03	0.5-1 m	7.6	109	11.9	11.46	106.0
2020-07-21	250-03	1-2 m	7.6	109	11.8	11.47	106.0
2020-07-21	250-03	2-3 m	7.6	109	11.8	11.46	106.0
2020-07-21	250-03	3-4 m	7.6	109	11.8	11.46	105.9
2020-07-21	250-03	4-5 m	7.6	109	11.8	11.46	105.8
2020-07-21	250-03	5-6 m	7.6	110	11.8	11.45	105.7
2020-07-21	250-03	6-7 m	7.6	110	11.7	11.45	105.7
2020-07-21	250-03	7-8 m	7.6	111	11.7	11.44	105.6
2020-07-21	250-03	8-9 m	7.6	112	11.7	11.43	105.4
2020-07-21	250-04	0.5-1 m	n/a	111	11.9	11.43	105.8
2020-07-21	250-04	1-2 m	n/a	110	11.9	11.46	106.0
2020-07-21	250-04	2-3 m	n/a	110	11.9	11.48	106.2
2020-07-21	250-04	3-4 m	n/a	111	11.9	11.47	106.2
2020-07-21	250-04	4-5 m	n/a	112	11.8	11.47	105.9
2020-07-21	250-04	5-6 m	n/a	114	11.7	11.46	105.6
2020-07-21	250-04	6-7 m	n/a	115	11.7	11.44	105.4
2020-07-21	250-04	7-8 m	n/a	115	11.7	11.43	105.3
2020-07-21	250-04	8-9 m	n/a	117	11.6	11.22	104.3
2020-07-21	250-05	0.5-1 m	7.5	113	11.42	11.46	106.5

Attachment A: Field Data Collected from the Sampling Locations in Meliadine Lake during the Plume Delineation Studies on July 21 and August 13, 2020

Date	Sampling Station	Sample Depth	pH	Specific Conductivity (uS/cm)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
2020-07-21	250-05	1-2 m	7.5	113	11.49	11.55	107.3
2020-07-21	250-05	2-3 m	7.5	113	11.38	11.60	107.7
2020-07-21	250-05	3-4 m	7.5	113	11.33	11.61	107.7
2020-07-21	250-05	4-5 m	7.5	113	11.28	11.60	107.6
2020-07-21	250-05	5-6 m	7.5	113	11.28	11.61	107.6
2020-07-21	250-05	6-7 m	7.5	112	11.26	11.63	107.7
2020-07-21	250-06	0.5-1 m	7.5	112	12.1	11.34	105.5
2020-07-21	250-06	1-2 m	7.5	114	11.8	11.43	105.5
2020-07-21	250-06	2-3 m	7.5	115	11.9	11.40	105.6
2020-07-21	250-06	3-4 m	7.5	115	11.7	11.44	105.4
2020-07-21	250-06	4-5 m	7.5	115	11.6	11.45	105.2
2020-07-21	250-06	5-6 m	7.5	115	11.6	11.44	105.2
2020-08-13	250-05	0.5-1 m	7.6	106	15.7	9.80	98.6
2020-08-13	250-05	1-2 m	7.6	106	15.7	9.80	98.6
2020-08-13	250-05	2-3 m	7.6	106	15.6	9.79	98.5
2020-08-13	250-05	3-4 m	7.5	106	15.6	9.79	98.5
2020-08-13	250-05	4-5 m	7.5	106	15.6	9.79	98.4
2020-08-13	250-05	5-6 m	7.5	106	15.6	9.78	98.4
2020-08-13	250-05	6-7 m	7.5	n/a	n/a	9.77	98.3
2020-08-13	175-04	0.5-1 m	7.5	106	15.6	9.73	97.9
2020-08-13	175-04	1-2 m	7.5	106	15.6	9.79	98.4
2020-08-13	175-04	2-3 m	7.6	106	15.6	9.80	98.5
2020-08-13	175-04	3-4 m	7.6	106	15.6	9.79	98.5
2020-08-13	175-04	4-5 m	7.6	106	15.6	9.79	98.5
2020-08-13	175-04	5-6 m	7.6	106	15.6	9.79	98.4
2020-08-13	175-04	6-7 m	7.6	106	15.6	9.76	98.1
2020-08-13	100-07	0.5-1 m	7.6	106	15.7	9.84	99.1
2020-08-13	100-07	1-2 m	7.6	106	15.7	9.84	99.0
2020-08-13	100-07	2-3 m	7.6	106	15.7	9.83	98.9
2020-08-13	100-07	3-4 m	7.6	106	15.7	9.82	98.8
2020-08-13	100-07	4-5 m	7.6	106	15.7	9.82	98.8
2020-08-13	100-07	5-6 m	7.6	106	15.7	9.82	98.8
2020-08-13	100-07	6-7 m	7.6	106	15.7	9.80	98.6
2020-08-13	100-07	7-8 m	7.6	106	15.7	9.79	98.5
2020-08-13	100-07	8-9 m	7.6	106	16.6	9.79	98.5
2020-08-13	50-04	0.5-1 m	7.6	105	15.7	9.90	99.6
2020-08-13	50-04	1-2 m	7.6	105	15.7	9.87	99.3
2020-08-13	50-04	2-3 m	7.6	105	15.7	9.86	99.1
2020-08-13	50-04	3-4 m	7.6	105	15.7	9.85	98.9
2020-08-13	50-04	4-5 m	7.6	106	15.7	9.84	98.9
2020-08-13	50-04	5-6 m	7.6	105	15.7	9.83	98.9
2020-08-13	50-04	6-7 m	7.6	105	15.7	9.82	98.8
2020-08-13	50-04	7-8 m	7.6	105	15.6	9.81	98.7
2020-08-13	50-04	8-9 m	7.6	106	15.6	9.81	98.6
2020-08-13	50-04	9-10 m	7.6	105	15.6	9.80	98.5
2020-08-13	50-04	10-11 m	7.6	105	15.6	9.78	98.2
2020-08-13	50-04	11-12 m	7.6	105	15.6	9.75	97.8
2020-08-13	50-02	0.5-1 m	7.5	105	15.7	9.85	99.1
2020-08-13	50-02	1-2 m	7.5	105	15.7	9.84	99.0
2020-08-13	50-02	2-3 m	7.5	105	15.7	9.83	98.9
2020-08-13	50-02	3-4 m	7.5	105	15.7	9.83	98.9
2020-08-13	50-02	4-5 m	7.5	105	15.7	9.82	98.8
2020-08-13	50-02	5-6 m	7.5	105	15.7	9.82	98.8
2020-08-13	50-02	6-7 m	7.5	105	15.7	9.81	98.7
2020-08-13	50-02	7-8 m	7.5	105	15.6	9.81	98.6
2020-08-13	50-02	8-9 m	7.5	105	15.6	9.80	98.6
2020-08-13	50-02	9-10 m	7.5	105	15.6	9.80	98.5
2020-08-13	50-02	10-11 m	7.5	105	15.6	9.80	98.5
2020-08-13	100-03	0.5-1 m	7.6	105	15.7	9.90	99.7
2020-08-13	100-03	1-2 m	7.6	105	15.7	9.90	99.5
2020-08-13	100-03	2-3 m	7.6	105	15.7	9.98	99.4
2020-08-13	100-03	3-4 m	7.6	105	15.7	9.87	99.3
2020-08-13	100-03	4-5 m	7.6	105	15.7	9.86	99.2
2020-08-13	100-03	5-6 m	7.6	105	15.7	9.85	99.1
2020-08-13	100-03	6-7 m	7.6	105	15.7	9.84	99.1
2020-08-13	100-03	7-8 m	7.6	105	15.7	9.84	99.0

Attachment A: Field Data Collected from the Sampling Locations in Meliadine Lake during the Plume Delineation Studies on July 21 and August 13, 2020

Date	Sampling Station	Sample Depth	pH	Specific Conductivity (uS/cm)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
2020-08-13	100-03	8-9 m	7.6	105	15.7	9.84	98.9
2020-08-13	100-03	9-10 m	7.6	105	15.6	9.76	98.3
2020-08-13	175-02	0.5-1 m	7.6	105	15.7	9.90	99.7
2020-08-13	175-02	1-2 m	7.6	105	15.7	9.89	99.6
2020-08-13	175-02	2-3 m	7.6	105	15.7	9.88	99.6
2020-08-13	175-02	3-4 m	7.6	105	15.7	9.88	99.5
2020-08-13	175-02	4-5 m	7.6	105	15.7	9.87	99.7
2020-08-13	175-02	5-6 m	7.6	105	15.7	9.87	99.4
2020-08-13	250-01	0.5-1 m	7.6	105	15.8	9.91	99.9
2020-08-13	250-01	1-2 m	7.6	105	15.8	9.93	99.8
2020-08-13	250-01	2-3 m	7.6	105	15.8	9.89	99.7
2020-08-13	250-01	3-4 m	7.6	105	15.8	9.88	99.7
2020-08-13	250-01	4-5 m	7.6	105	15.8	9.88	99.6
2020-08-13	250-01	5-6 m	7.6	105	15.8	9.87	99.6
2020-08-13	175-01	0.5-1 m	7.6	105	15.8	9.96	100.4
2020-08-13	175-01	1-2 m	7.6	105	15.8	9.95	100.3
2020-08-13	175-01	2-3 m	7.6	105	15.8	9.94	100.2
2020-08-13	175-01	3-4 m	7.6	105	15.8	9.94	100.2
2020-08-13	175-01	4-5 m	7.6	105	15.8	9.93	100.1
2020-08-13	175-01	5-6 m	7.6	105	15.8	9.93	100.1
2020-08-13	175-01	6-7 m	7.6	105	15.8	9.92	100.0
2020-08-13	100-01	0.5-1 m	7.6	105	15.7	9.91	n/a
2020-08-13	100-01	1-2 m	7.6	105	15.7	9.90	n/a
2020-08-13	100-01	2-3 m	7.6	105	15.7	9.89	n/a
2020-08-13	100-01	3-4 m	7.6	105	15.7	9.90	n/a
2020-08-13	100-01	4-5 m	7.6	105	15.7	9.89	n/a
2020-08-13	100-01	5-6 m	7.6	105	15.7	9.88	n/a
2020-08-13	100-01	6-7 m	7.6	105	15.7	9.89	n/a
2020-08-13	50-01	0.5-1 m	7.6	105	15.7	9.92	100.0
2020-08-13	50-01	1-2 m	7.6	105	15.7	9.92	99.9
2020-08-13	50-01	2-3 m	7.6	105	15.7	9.91	99.8
2020-08-13	50-01	3-4 m	7.6	105	15.7	9.90	99.7
2020-08-13	50-01	4-5 m	7.6	105	15.7	9.90	99.7
2020-08-13	50-01	5-6 m	7.6	105	15.7	9.89	99.6
2020-08-13	50-01	6-7 m	7.6	105	15.7	9.88	99.5
2020-08-13	50-01	7-8 m	7.6	105	15.7	9.87	99.4
2020-08-13	50-01	8-9 m	7.6	105	15.7	9.87	99.4
2020-08-13	50-03	0.5-1 m	7.6	105	15.8	9.94	n/a
2020-08-13	50-03	1-2 m	7.6	105	15.8	9.96	n/a
2020-08-13	50-03	2-3 m	7.6	105	15.8	9.95	n/a
2020-08-13	50-03	3-4 m	7.6	105	15.8	9.94	n/a
2020-08-13	50-03	4-5 m	7.6	105	15.8	9.93	n/a
2020-08-13	50-03	5-6 m	7.6	105	15.8	9.92	n/a
2020-08-13	50-03	6-7 m	7.6	105	15.8	9.91	n/a
2020-08-13	50-03	7-8 m	7.6	105	15.7	9.90	n/a
2020-08-13	50-03	8-9 m	7.6	105	15.7	9.89	n/a
2020-08-13	50-03	9-10 m	7.6	105	15.7	9.88	n/a
2020-08-13	50-03	10-11 m	7.6	105	15.7	9.86	n/a
2020-08-13	50-03	11-12 m	7.6	105	15.7	9.85	n/a
2020-08-13	100-05	0.5-1 m	7.6	105	15.8	9.93	100.2
2020-08-13	100-05	1-2 m	7.6	105	15.8	9.92	100.1
2020-08-13	100-05	2-3 m	7.6	105	15.8	9.91	100.0
2020-08-13	100-05	3-4 m	7.6	105	15.8	9.90	99.9
2020-08-13	100-05	4-5 m	7.6	105	15.8	9.90	99.9
2020-08-13	100-05	5-6 m	7.6	105	15.8	9.91	99.9
2020-08-13	100-05	6-7 m	7.6	105	15.8	9.91	99.9
2020-08-13	100-05	7-8 m	7.6	105	15.8	9.90	99.9
2020-08-13	100-05	8-9 m	7.6	105	15.8	9.90	99.8
2020-08-13	100-05	9-10 m	7.6	105	15.7	9.89	99.6
2020-08-13	100-05	10-11 m	7.6	105	15.7	9.88	99.5
2020-08-13	100-02	0.5-1 m	7.6	105	15.8	10.01	101.1
2020-08-13	100-02	1-2 m	7.6	105	15.8	10.00	101.0
2020-08-13	100-02	2-3 m	7.6	105	15.8	9.99	100.9
2020-08-13	100-02	3-4 m	7.7	105	15.8	9.98	100.8
2020-08-13	100-02	4-5 m	7.7	105	15.8	9.98	100.7
2020-08-13	100-02	5-6 m	7.7	105	15.8	9.98	100.7

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Date	Sampling Station	Sample Depth	pH	Specific Conductivity (uS/cm)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
2020-08-13	100-02	6-7 m	7.6	105	15.8	9.97	100.7
2020-08-13	100-02	7-8 m	7.6	105	15.8	9.96	100.5
2020-08-13	100-04	0.5-1 m	7.7	105	15.9	10.18	102.8
2020-08-13	100-04	1-2 m	7.7	105	15.9	10.13	102.3
2020-08-13	100-04	2-3 m	7.7	105	15.9	10.10	102.1
2020-08-13	100-04	3-4 m	7.7	105	15.9	10.09	102.0
2020-08-13	100-04	4-5 m	7.7	105	15.9	10.07	101.8
2020-08-13	100-04	5-6 m	7.7	105	15.9	10.05	101.6
2020-08-13	100-04	6-7 m	7.7	105	15.9	10.04	101.4
2020-08-13	100-04	7-8 m	7.7	105	15.9	10.03	101.3
2020-08-13	100-04	8-9 m	7.7	105	15.9	10.01	101.2
2020-08-13	100-04	9-10 m	7.7	105	15.9	10.01	101.2
2020-08-13	100-06	0.5-1 m	7.7	106	15.9	10.07	101.6
2020-08-13	100-06	1-2 m	7.7	106	15.9	10.02	101.2
2020-08-13	100-06	2-3 m	7.6	105	15.9	10.01	101.1
2020-08-13	100-06	3-4 m	7.6	106	15.9	10.00	101.0
2020-08-13	100-06	4-5 m	7.6	106	15.9	9.99	101.0
2020-08-13	100-06	5-6 m	7.6	105	15.9	9.99	101.0
2020-08-13	100-06	6-7 m	7.6	105	15.9	9.99	101.0
2020-08-13	100-06	7-8 m	7.6	105	15.9	9.99	100.9
2020-08-13	100-06	8-9 m	7.6	105	15.9	9.98	100.8
2020-08-13	100-08	0.5-1 m	7.6	104	15.9	10.05	101.6
2020-08-13	100-08	1-2 m	7.6	104	15.9	10.05	101.6
2020-08-13	100-08	2-3 m	7.6	104	15.9	10.04	101.5
2020-08-13	100-08	3-4 m	7.6	104	15.9	10.03	101.4
2020-08-13	100-08	4-5 m	7.6	104	15.9	10.03	101.4
2020-08-13	100-08	5-6 m	7.6	104	15.9	10.02	101.3
2020-08-13	100-08	6-7 m	7.6	104	15.9	9.99	100.9
2020-08-13	100-08	7-8 m	7.6	105	15.8	9.99	100.8
2020-08-13	100-08	8-9 m	7.6	105	15.8	9.98	100.8
2020-08-13	100-08	9-10 m	7.6	105	15.8	9.96	100.6
2020-08-13	175-03	0.5-1 m	7.6	105	15.8	9.89	99.8
2020-08-13	175-03	1-2 m	7.6	105	15.8	9.89	99.7
2020-08-13	175-03	2-3 m	7.6	106	15.8	9.88	99.6
2020-08-13	175-03	3-4 m	7.6	106	15.8	9.87	99.5
2020-08-13	175-03	4-5 m	7.6	106	15.8	9.86	99.4
2020-08-13	175-03	5-6 m	7.6	106	15.8	9.85	99.3
2020-08-13	175-03	6-7 m	7.6	106	15.8	9.84	99.2
2020-08-13	175-03	7-8 m	7.6	106	15.8	9.83	99.1
2020-08-13	175-03	8-9 m	7.6	106	15.8	9.83	99.1
2020-08-13	175-03	9-10 m	7.6	106	15.8	9.82	99.0
2020-08-13	175-03	10-11 m	7.6	106	15.8	9.82	98.9
2020-08-13	250-02	0.5-1 m	7.6	105	15.8	9.97	100.6
2020-08-13	250-02	1-2 m	7.6	105	15.8	9.96	100.5
2020-08-13	250-02	2-3 m	7.6	105	15.8	9.95	100.4
2020-08-13	250-02	3-4 m	7.6	105	15.8	9.95	100.3
2020-08-13	250-02	4-5 m	7.6	105	15.8	9.93	100.2
2020-08-13	250-02	5-6 m	7.6	105	15.8	9.93	100.2
2020-08-13	250-02	6-7 m	7.6	105	15.8	9.93	100.1
2020-08-13	250-02	7-8 m	7.6	105	15.8	9.92	100.1
2020-08-13	250-02	8-9 m	7.6	105	15.8	9.92	100.0
2020-08-13	250-02	9-10 m	7.6	105	15.8	9.90	99.9
2020-08-13	250-02	10-11 m	7.6	105	15.8	9.89	99.7
2020-08-13	250-03	0.5-1 m	7.6	106	15.8	9.90	99.8
2020-08-13	250-03	1-2 m	7.6	106	15.8	9.89	99.8
2020-08-13	250-03	2-3 m	7.6	106	15.8	9.89	99.8
2020-08-13	250-03	3-4 m	7.6	106	15.8	9.88	99.7
2020-08-13	250-03	4-5 m	7.6	106	15.8	9.88	99.6
2020-08-13	250-03	5-6 m	7.6	106	15.8	9.88	99.6
2020-08-13	250-03	6-7 m	7.6	106	15.8	9.87	99.5
2020-08-13	250-03	7-8 m	7.6	106	15.8	9.85	99.2
2020-08-13	250-04	0.5-1 m	7.7	105	16	10.13	102.5
2020-08-13	250-04	1-2 m	7.7	105	15.9	10.12	102.4
2020-08-13	250-04	2-3 m	7.7	105	15.9	10.11	102.4
2020-08-13	250-04	3-4 m	7.7	105	16	10.11	102.4
2020-08-13	250-04	4-5 m	7.7	105	16	10.11	102.3

Attachment A: Field Data Collected from the Sampling Locations in Meliadine Lake during the Plume Delineation Studies on July 21 and August 13, 2020

Date	Sampling Station	Sample Depth	pH	Specific Conductivity (uS/cm)	Temperature (°C)	Dissolved Oxygen (mg/L)	Dissolved Oxygen Saturation (%)
2020-08-13	250-04	5-6 m	7.7	105	15.9	10.09	102.1
2020-08-13	250-04	6-7 m	7.7	105	15.9	10.06	101.6
2020-08-13	250-06	0.5-1 m	7.6	102	15.9	10.18	102.8
2020-08-13	250-06	1-2 m	7.6	102	15.9	10.12	102.4
2020-08-13	250-06	2-3 m	7.6	102	15.9	10.10	102.2
2020-08-13	250-06	3-4 m	7.7	102	15.9	10.09	102.1
2020-08-13	250-06	4-5 m	7.7	102	15.9	10.00	102.0
2020-08-13	250-06	5-6 m	7.7	102	15.9	10.07	101.9

Notes:

n/a = not analyzed or measured; m = metre; µS/cm = microsiemens per centimetre; mg/L = milligrams per litre

ATTACHMENT B

Laboratory Data for Samples Collected at Select Sampling Locations in Meliadine Lake for the Plume Delineation Studies on July 21 and August 13, 2020

Attachment B: Laboratory Data for Samples Collected at Select Sampling Locations in Meliadine Lake for the Plume Delineation Studies on July 21 and August 13, 2020

Date	Sampling Station	Sample Depth (m)	pH	Specific conductivity (µS/cm)	Hardness, as $CaCO_3$ (mg/L)	Total alkalinity, as $CaCO_3$ (mg/L)	Calculated Total dissolved Solids (mg/L)	Total dissolved solids (mg/L)	Total suspended solids (mg/L)	Turbidity (NTU)	Bicarbonate, as $CaCO_3$ (mg/L)	Calcium (mg/L)	Carbonate, as $CaCO_3$ (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)	Sulphate (mg/L)	Silica (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Nitrate + nitrite (mg/L)
2020-07-21	50-02	6	7.4	110	28.9	16	53	85	1.0	0.5	16	8.77	<1	19	<0.1	1.69	1.11	7.48	5.1	0.52	0.15	<0.01	0.15
2020-07-21	50-03	6	7.4	120	30.0	16	56	85	1.0	0.4	16	9.12	<1	20	<0.1	1.76	1.15	7.87	5.3	0.51	0.17	<0.01	0.17
2020-07-21	100-01	6	7.4	130	31.9	16	60	120	2.0	0.5	16	9.59	<1	22	<0.1	1.92	1.20	8.86	5.9	0.57	0.22	<0.01	0.22
2020-07-21	100-07	0.5	7.4	120	29.7	17	55	95	1.0	0.4	17	9.00	<1	20	<0.1	1.75	1.11	7.90	5.3	0.5	0.17	<0.01	0.17
2020-07-21	100-08	9	7.4	120	30.1	16	56	120	1.0	0.4	16	9.13	<1	20	<0.1	1.76	1.15	8.07	5.3	0.45	0.2	<0.01	0.2
2020-07-21	175-01	6	7.4	120	29.4	16	54	120	1.0	0.4	16	8.95	<1	19	<0.1	1.71	1.12	7.74	5.3	0.46	0.16	<0.01	0.16
2020-07-21	175-02	1	7.4	110	28.7	16	52	95	1.0	0.4	16	8.70	<1	18	<0.1	1.69	1.08	7.37	4.8	0.46	0.14	<0.01	0.14
2020-07-21	175-03	8	7.4	110	28.7	17	53	90	<1	0.4	17	8.69	<1	18	<0.1	1.70	1.11	7.50	5.0	0.46	0.15	<0.01	0.15
2020-07-21	175-04	0.5	7.4	120	29.4	16	55	95	1.0	0.3	16	8.89	<1	20	<0.1	1.74	1.11	7.82	5.2	0.45	0.18	<0.01	0.18
2020-07-21	250-01	0.5	7.4	110	28.0	16	51	100	2.0	0.5	16	8.46	<1	17	<0.1	1.68	1.11	7.39	4.8	0.46	0.14	<0.01	0.14
2020-07-21	250-04	6	7.4	110	29.1	16	54	85	2.0	0.4	16	8.87	<1	19	<0.1	1.69	1.10	7.59	5.3	0.45	0.15	<0.01	0.15
2020-07-21	250-06	4	7.4	120	29.1	17	55	95	1.0	0.4	17	8.82	<1	20	<0.1	1.71	1.14	7.66	5.1	0.45	0.16	<0.01	0.16
2020-08-13	50-02	5	7.3	110	28.7	20	54	55	<1	0.4	20	8.75	<1	17	<0.1	1.67	1.08	7.13	5.5	n/a	<0.1	<0.01	<0.1
2020-08-13	50-03	5	7.4	110	28.6	18	52	45	<1	0.3	18	8.70	<1	17	<0.1	1.68	1.07	7.11	5.4	n/a	<0.1	<0.01	<0.1
2020-08-13	100-01	3	7.4	110	28.4	17	51	55	2.0	0.3	17	8.64	<1	17	<0.1	1.66	1.06	7.08	5.5	n/a	<0.1	<0.01	<0.1
2020-08-13	100-07	4	7.4	110	28.2	18	52	40	1.0	0.3	18	8.59	<1	17	<0.1	1.65	1.07	7.20	5.5	n/a	<0.1	<0.01	<0.1
2020-08-13	100-08	8	7.4	110	28.3	18	52	40	1.0	0.4	18	8.56	<1	17	<0.1	1.67	1.06	7.12	5.5	n/a	<0.1	<0.01	<0.1
2020-08-13	175-01	3	7.4	110	28.4	18	52	50	1.0	0.4	18	8.63	<1	17	<0.1	1.67	1.07	7.16	5.7	n/a	<0.1	<0.01	<0.1
2020-08-13	175-02	2	7.4	110	28.4	16	52	55	2.0	0.3	16	8.66	<1	17	<0.1	1.65	1.07	7.28	5.7	n/a	<0.1	<0.01	<0.1
2020-08-13	175-03	5	7.3	110	28.4	16	51	55	1.0	0.4	16	8.58	<1	17	<0.1	1.69	1.08	7.23	5.6	n/a	<0.1	<0.01	<0.1
2020-08-13	175-04	3	7.4	110	28.6	17	52	60	1.0	0.3	17	8.71	<1	17	<0.1	1.66	1.07	7.24	5.5	n/a	<0.1	<0.01	<0.1
2020-08-13	250-01	2	7.4	110	28.4	17	52	70	1.0	0.3	17	8.65	<1	17	<0.1	1.66	1.07	7.11	5.6	n/a	<0.1	<0.01	<0.1
2020-08-13	250-04	3	7.3	110	28.4	18	51	55	2.0	0.3	18	8.65	<1	17	<0.1	1.64	1.06	7.04	5.4	n/a	<0.1	<0.01	<0.1
2020-08-13	250-06	4	7.4	110	28.2	17	50	30	1.0	0.4	17	8.52	<1	16	<0.1	1.67	1.07	6.97	5.3	n/a	<0.1	<0.01	<0.1

Notes:

n/a = not analyzed or measured; m = metre; µS/cm = microsiemens per centimetre; mg/L = milligrams per litre; NTU = nephelometric turbidity units; $CaCO_3$ = calcium carbonate

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APPENDIX D

Ceriodaphnia dubia Supplemental Toxicity Study

D-1 INTRODUCTION

This appendix summarizes the findings of a supplemental investigation of toxicity of Containment Pond 1 (CP1) water. The study was undertaken by Agnico Eagle in 2020 to provide increased confidence in the suitability of interim water quality benchmarks established prior to the discharge of water to Meliadine Lake. Specifically, the work provides a partial validation of both the interim effluent quality criterion (EQC) for total dissolved solids (TDS) of 3,500 mg/L and the interim site-specific water quality objective for TDS of 1,000 mg/L. These studies, in combination with other site-specific toxicity testing data described in the WQ-MOP, were requested by Agnico Eagle to better understand the potential impact of the discharge on aquatic life.

This study focussed on a single test species (*Ceriodaphnia dubia*) to emphasize an organism previously demonstrated to be sensitive to TDS in site-specific tests. As documented in the Water Quality Management and Optimization Plan (WQ-MOP), chronic testing of CP1 and MEL-14 water in 2019 identified chronic sublethal toxicity to *C. dubia*, but did not identify responses to the survival endpoint over the range of concentrations tested. Given that CP1 water and effluent discharges in 2020 had the potential to exceed the previous tested ranges of TDS and chloride concentrations (due to concentration over the under-ice season in 2019/2020), this provided an opportunity to expand the range of tested conditions, possibly including the range at which survival responses occur to *C. dubia*.

The three-brood survival and reproduction test (Environment Canada protocol EPS 1/RM/21) is not one of the standard tests specified under the Metal and Diamond Mining Effluent Regulations (MDMER) to identify acute lethality to effluent. However, identification of the concentration causing survival responses to *C. dubia* was considered complementary to the test results for *Daphnia magna*. The latter species, using a 48-h test duration and LC_{50} endpoint (concentration causing greater than 50% mortality), is part of the MDMER framework for determining acute toxicity. The longer test duration for *C. dubia* provides an additional margin of safety in the evaluation of potential short-term toxicity responses, and should not be viewed as a regulatory driver for establishment of effluent quality criteria or limits.

D-1.1 Purpose

The purpose of the CP1 supplemental testing was to:

- Evaluate the toxicity of CP1 water to a sensitive freshwater invertebrate (the crustacean, *Ceriodaphnia dubia*) at concentrations higher than were tested in 2019 chronic toxicity testing.
- Evaluate the concentration-response profile for both survival and reproduction endpoints to assist in the validation of the maximum average concentration for discharge from CP1 to Meliadine Lake (i.e., EQC); and the benchmark concentration to be achieved at the edge of the mixing zone in Meliadine Lake (i.e., site-specific water quality objective; SSWQO).
- Evaluate the sensitivity of TDS (and chloride) toxicity to manipulations of the original sample ionic composition, to provide insight into causation.

The supplemental toxicity testing was conducted in two stages:

- Stage 1 (Range Finder)—a wide range of TDS (and associated chloride) concentrations, extending from close to the SSWQO to well above the EQC, was tested using the standard *C. dubia* three brood survival and reproduction test protocol (Environment Canada [2007], EPS 1/RM/21).

- Stage 2 (Refinement)—a narrower range of TDS (and associated chloride) concentrations was tested to provide increased precision in the acute toxicity threshold for *C. dubia* survival, including further tests of CP1 site water, synthetic preparations to mimic CP1 chemistry, and synthetic preparations to simulate modified ionic composition. The modified samples were not conducted to directly assess CP1 or Meliadine discharge toxicity, but rather to explore sensitivity to changes in ionic composition, analogous to a toxicity identification evaluation (TIE) approach.

This document summarizes the main findings of the test results, which have been finalized by the laboratory are in the process of being compiled for submission to Agnico Eagle. All TDS concentrations reported herein represent the calculated concentrations from summation of the individual ions, either as target (nominal concentrations) during study design or as confirmed (measured) concentrations from an analytical laboratory.

D-2 STAGE 1 TESTS

Stage 1 entailed testing of CP1 water collected during winter, and was collected to represent TDS concentrations in excess of 4,000 mg/L; the sample was collected during under-ice conditions and was intentionally sampled to exceed concentrations anticipated for Meliadine discharge during freshet. The CP1 sample identified as Sample A was collected on 10 February 2020, and delivered to the Nautilus Environmental laboratory in Calgary, Alberta, on 14 February 2020. The sample was tested in the following treatments, in order to capture a range of nominal (target) concentrations ranging from 1,049 mg/L TDS (measured sum of ions) to 5,000 mg/L TDS (measured sum of ions), and corresponding chloride concentrations ranging from 522 mg/L TDS (measured sum of ions) to 2,500 mg/L:

- Treatments 1 to 5 were prepared by diluting Sample A using laboratory dilution water.
- Treatment 6 was undiluted Sample A.
- Treatment 7 was prepared by amending Sample A with reagent grade NaCl, $CaSO_4{\bullet}2H_2O$, $MgSO_4{\bullet}7H2O$, $MgCl_2{\bullet}6H_2O$, and $Na_2SO_4CaCl_2{\bullet}2H_2O$ to increase the TDS and chloride concentrations while maintaining ratios of calcium, magnesium, and sodium constant and in a site-relevant ionic composition.
- A laboratory control was also tested along with the seven treatments above.

The concentrations of constituents were confirmed in analytical measurements made at the beginning (test initiation) at end (test termination) of the exposure (Table D-1). These measurements confirmed that the nominal concentrations were well represented in the experiment, and that the concentrations remained stable throughout the test duration (i.e., the variance between initiation and termination was within the range of analytical error).

Table D-1: Measured water quality in treatments used for the Stage 1 study design

Treatment Level	Chloride (mg/L)		TDS (mg/L)	
	Initiation	Termination	Initiation	Termination
Treatment 1	535	557	1,080	1,110
Treatment 2	720	666	1,440	1,430
Treatment 3	934	979	1,870	2,020
Treatment 4	1,230	1,270	2,470	2,610
Treatment 5	1,660	1,730	3,310	3,540
Treatment 6 (Site Water)	2,210	-	4,420	-
Treatment 7	2,510	2,470	4,970	5,020

Notes: Measurements of TDS are for the calculated measurement of TDS from measured individual ions

The toxicity tests were conducted using two versions of the *C. dubia* protocol, including the standard Environment Canada protocol (which was completed in six days based on observation of three broods in the negative control in at least 60% of replicates) and an extended duration test that covered eight days of exposure. As the results were very similar between these two versions, this section discusses only the results from the standard protocol.

The results of the range finder test (Table D-2) indicated a clear concentration-response, with a calculated lethal toxicity value (LC_{50}) of 3,785 mg/L TDS and LC_{50} of 1,881 mg/L chloride, and a calculated chronic toxicity value (IC_{25}) of 2,053 mg/L TDS and IC_{25} of 1,010 mg/L chloride. These concentrations were calculated using exposures calculated as the average TDS and chloride concentrations between test initiation and test termination.

The results of Stage 1 are consistent with other recent testing of *C. dubia* reproduction in site water and confirm that the proposed EQC and SSWQO remain protective. The calculated IC_{25} for TDS was two times higher than the interim chronic SSWQO of 1,000 mg/L, and the LC_{50} for TDS exceeds the proposed EQC of 3,500 mg/L for maximum average concentration for discharge from CP1 to Meliadine Lake.

It is important to acknowledge that the *C. dubia* survival endpoint is not routinely applied as a measure of acute toxicity under the MDMER or other effluent discharge regulations, as it is a chronic test, and more sensitive than the standard tests used to evaluate acute toxicity in undiluted effluent (i.e., 96-h rainbow trout and 48-h *Daphnia magna* tests). As such, confirmation of the LC_{50} above 3,500 mg/L, for a sensitive aquatic species, provides an additional margin of safety for the evaluation of acute toxicity.

Table D-2: Results of *Ceriodaphnia dubia* Phase 1 rangefinder tests for Sample A, including treatment data (top pane) and summary statistics (bottom pane)

Sample A Treatment	Average Treatment Concentration (mg/L)		Mean Survival (%)	Mean Reproduction (%) (± SD)
	Chloride	TDS		
Laboratory negative control	trace	trace	100	20.8 ± 2.2
Treatment 1 (Diluted Sample A)	546	1,095	100	32.9 ± 2.2
Treatment 2 (Diluted Sample A)	693	1,435	100	31.5 ± 2.6
Treatment 3 (Diluted Sample A)	957	1,945	100	26.6 ± 3.7‡
Treatment 4 (Diluted Sample A)	1,250	2,540	100	17.1 ± 5.8‡
Treatment 5 (Diluted Sample A)	1,695	3,425	90	2.9 ± 2.8*‡
Treatment 6 (Unadjusted Sample A)	2,210	4,420	0*	0.0 ± 0.0*‡
Treatment 7 (Supplemented Sample A)	2,490	4,995	0*	0.0 ± 0.0*‡

SD = standard deviation

* Result was significantly lower than laboratory negative control

‡ Result was significantly lower than the Treatment 1 response (lowest concentration site water treatment)

Endpoint	Sample A	
	Chloride (mg/L)	TDS (mg/L)
C. dubia – Day 6		
Survival LC50 (95% CL)	1,881 (1,782-1,986) [a,b]	3,785 (3,591-3,989) [a,b]
Reproduction IC25 (95% CL)	1,111 (1,051-1,190)[a] 1,010 (937-1,074)[b]	2,257 (2,154-2,412)[a] 2,053 (1,886-2,183)[b]
C. dubia – Day 8		
Survival LC50 (95% CL)	1,881 (1,782-1,986) [a,b]	3,785 (3,591-3,989) [a,b]
Reproduction IC25 (95% CL)	1,196 (1,134-1,277)[a] 1,078 (1,014-1,144)[b]	2,430 (2,291-2,579)[a] 2,190 (2,048-2,307)[b]

SD = Standard Deviation, LC = Lethal Concentration, IC = Inhibition Concentration, CL = Confidence Limits

[a] Test endpoint calculated using the lab control as the negative control.

[b] Test endpoint calculated using the lowest concentration as the negative control

D-3 STAGE 2 TESTS

The Stage 2 study was conducted as a follow up to Stage 1, to further determine the effect of chloride and TDS in the site water, as well as in three synthetic waters, to *C. dubia*. For Stage 2, emphasis was placed on the survival endpoint (i.e., LC_{50}) because previous testing (both in 2019 tests and in Stage 1 of this study) adequately described the concentration-response profile for the reproduction endpoint (i.e., IC_{25}). Prior to testing, Sample A was submitted for chemical analysis to confirm the original results as 31 days had elapsed between sample collection and follow-up testing. The results confirmed that neither sample degradation nor chemical composition changes occurred. The exposure range was narrowed to 3,250–4,250 mg/L TDS for Stage 2 (Table D-3), and was deliberately constrained to provide improved resolution (precision) near the predicted LC_{50}. Chloride concentrations were manipulated in two of the tests.

To complete the study objectives for Stage 2, Nautilus prepared four series (Table D-3). The series were labelled as TIE treatments as follows:

- **TIE 1**—repeat testing of CP-1 Water (Sample A) from February 2020 collection—this series was applied to confirm that toxicity had not changed with sample storage over one month, to provide improved precision in the LC_{50}, and to provide a baseline evaluating responses in the remaining series.
- **TIE 2**—Water quality data from analysis of the Sample A was used to synthesize lab water to achieve the targeted TDS and chloride concentrations while maintaining ratios of calcium, magnesium and sodium and their contribution to TDS composition.
- **TIE 3**—Reduced chloride proportion from TIE 2 (TDS maintained stable)—this series was applied to test whether chloride removal would reduce toxicity under conditions of stable ionic composition for other component ions.
- **TIE 4**—Increased chloride proportion from TIE 2 (TDS maintained stable)—this series was a companion to TIE 3, but with an increase in chloride proportion.

Table D-3: Study design showing nominal (target) concentrations for Phase 2 *Ceriodaphnia dubia* tests for Sample A

TIE 1		TIE 2		TIE 3		TIE 4	
TDS (mg/L)	Cl (mg/L)	TDS (mg/L)	Cl (mg/L)	TDS (mg/L)	Cl (mg/L)	TDS (mg/L)	Cl (mg/L)
3,250	1,649	3,250	1,623	3,250	780	3,250	1,924
3,500	1,776	3,500	1,748	3,500	840	3,500	2,072
3,750	1,902	3,750	1,873	3,750	900	3,750	2,220
4,000	2,029	4,000	1,998	4,000	960	4,000	2,368
4,250	2,156	4,250	2,123	4,250	1,020	4,250	2,516

TDS = Total Dissolved Solids, Cl = Chloride

Table D-4 summarizes the findings of the Stage 2 program, which included:

- The LC_{50} for Sample A in Stage 2 (3,581 mg/L TDS) was similar to the original test, with high degree of overlap in the confidence limits for the two stages of testing.
- Reproduction was low in all tested treatments, which was expected given the high concentration range tested; again, the magnitude of response for the reproduction endpoint was consistent with Phase 1 testing.
- The LC_{50} values for both the site water (Sample A; TIE 1) and synthetic water (TIE 2) were very similar for both TDS and chloride.
- Manipulation of the synthetic samples to decrease or increase chloride content (TIE 3 and TIE 4) resulted in strong changes to the concentration-response profile.
  - Observed toxicity increased in the exaggerated high chloride treatments.
  - There was no observed toxicity in the low chloride treatments. provides evidence in support of chloride being implicated as a key component of toxicity within the TDS mixtures studied.

Table D-4: Results of Phase 2 *Ceriodaphnia dubia* tests for Sample A

Sample ID	*C dubia* - Survival LC50 (95% CL)	
	Chloride (mg/L)	TDS (mg/L)
TIE 1	1,817 (1,775-1,860)	3,581 (3,499 – 3,666)
TIE 2	1,789 (1,697-1,885)	3,581 (3,398-3,774)
TIE 3	>1,020	>4,250
TIE 4	<1,924	<3,250

SD = Standard Deviation, LC = Lethal Concentration, CL = Confidence Limits, TDS = Total Dissolved Solids, TIE = Toxicity Identification Evaluation

D-4 CONCLUSIONS

The testing of *C. dubia* in this supplemental study provided data in support of the interim water quality benchmarks for TDS used as interim values within the WQ-MOP. The data indicate, with a high degree of confidence, that chronic toxicity of CP1 water to a sensitive freshwater invertebrate is in agreement with the data used in the WQ-MOP (i.e., from 2019 site-specific testing, and from literature compilations of other investigations of TDS toxicity at similar northern mines).

- The maximum average concentration for discharge from CP1 to Meliadine Lake (i.e., EQC of 3,500 mg/L TDS) is supported by the calculated LC_{50} estimates for *C. dubia*, which exceeded 3,500 mg/L TDS in both Stage 1 and Stage 2. The precision as indicated by the confidence limits around the LC_{50} estimates, also support the conclusion that the EQC is protective.

- The benchmark concentration to be achieved at the edge of the mixing zone in Meliadine Lake (i.e., SSWQO of 1,000 mg/L TDS) is supported by the calculated estimates for *C. dubia* reproduction. The IC_{25} of 2,053 mg/L TDS is twice the SSWQO. Use of an alternate statistic, such as the IC_{20} or the maximum acceptable toxicant concentration (MATC; the geometric mean on the no adverse effect level and lowest adverse effect concentration), does not change the conclusion that the SSWQO remains protective.

The above conclusions are based on the assumption that the contribution of chloride to the TDS mixture will remain close to 50% (or be lower than 50%); this proportion is typical of ionic composition in CP1 water and MEL-14 discharge in recent years, and seasonal variation in this proportion has been low. Furthermore, the proportion of chloride in effluent-influenced water decreases as water is dispersed into Meliadine Lake. Given the stability of chloride within the effluent stream, chloride EQC and SSWQO values are not necessary at this time (i.e., redundant with TDS). Should chloride proportion be projected to increase under future management scenarios, identification of chloride benchmarks would be appropriate.

D-5 REFERENCES

Environment Canada. 2007. Biological Test Method: Test for Reproduction and Survival Using the Cladoceran *Ceriodaphnia dubia*. EPS 1/RM/21, Second Edition, February 2007.

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