

TECHNICAL MEMORANDUM

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Project No. 20144940-814-TM-Rev0

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MELIADINE LAKE EFFLUENT—SUMMARY OF RATIONALE FOR EFFLUENT QUALITY CRITERION— MAXIMUM GRAB CONCENTRATION

In the Technical Meeting for the Water Licence 2AM-MEL1631 Amendment Application (Meliadine Mine) (30 November 2020), the topic of the rationale for the Effluent Quality Criteria (EQC), and specifically for the Maximum Grab Concentration (MGC) of total dissolved solids (TDS), was discussed. This memorandum provides a summary of how the MGC was developed (Section 1.0), followed by a synthesis of the recently acquired technical information considered in support of retaining the interim MGC for incorporation in the amended Water Licence (Section 2.0).

1.0 BACKGROUND FOR MAXIMUM GRAB CONCENTRATION

On 24 March 2020, Agnico Eagle Mines Limited (Agnico Eagle) submitted to the Nunavut Water Board (NWB) an Emergency Amendment to Type “A” Water Licence (No. 2AM-MEL1631) for effluent discharges associated with the Meliadine Mine; version 1 of the Water Quality Management and Optimization Plan (WQ-MOP) was included in this application. On 2 June 2020, the WQ-MOP Rev2 (Golder 2020a) was submitted to the NWB as a requirement under NWBs Reason for Decision (NWB 2020). The amendment, along with the WQ-MOP, was approved with Minister’s consent on 12 May 2020 and discharges to Meliadine Lake were initiated on 5 June 2020. The MGC of 5,000 mg/L (as calculated TDS) for the discharge of CP1 water to Meliadine Mine was incorporated into the WQ-MOP following intervenor review of the WQ-MOP Rev2. The following paragraphs summarize the path by which the MGC was developed and refined in advance of the Emergency Amendment Approval.

Under intervenor topic KivIA-1 (Maximum Allowable Effluent Concentration; MAEC) (submitted on 25 June 2020 [Agnico Eagle 2020a]), the Kivalliq Inuit Association recommended that Agnico Eagle include a TDS MAEC of 4,500 mg/L (i.e., 4,685 mg/L rounded down to nearest 500 mg/L increment) in the WQ-MOP as a final trigger in the adaptive management of the discharge. The 4,685 mg/L was sourced from Agnico Eagle’s Final Environmental Impact Statement (FEIS; Agnico Eagle 2014). This concentration for an end of pipe limit was sourced from the back calculation of meeting the drinking water aesthetic guideline (500 mg/L) at the edge of the mixing zone, assuming a background concentration of 35 mg/L and a dilution factor of 10:1. In response to the Environment and Climate Change Canada (ECCC) comment during the 30 November 2020 technical meeting, specifically that the MAEC was not used to assess effects of the discharge in Meliadine Lake and that a lower discharge concentration was used in the assessment of discharge to Meliadine Lake, ECCC is correct with respect to the far-field mixing model. The far field mixing model was developed to estimate the increase in concentration of water quality parameters as

a result of the potential accumulation of effluent in Meliadine Lake; the extent of the far field included the east basin of Meliadine Lake, which incorporated the mixing zone (see Section 4.3.3 of Appendix 7A Water and Sediment Quality Model, Meliadine Gold Project FEIS [Golder 2014]). However, the MAEC was assessed as a discharge concentration for the FEIS with the results of the near-field mixing model in Meliadine Lake (Agnico Eagle 2014 [SD 2-6 Surface Water Management Plan]) used to update the potential water quality conditions at the edge of the mixing zone at 100 metres (i.e., in Meliadine Lake). Based on this assessment, the FEIS concluded in Section 4.3.2 of Appendix 7A-4 that water quality guidelines for the protection of aquatic life and human health (CCME 2020; HC 2020) would be met at the edge of the mixing zone if effluent concentrations at the end of pipe are equal to or lower than the MAEC (Table 7.4-A24). The predicted maximum concentrations at the edge of the mixing zone (68 mg/L TDS) when an effluent discharge occurs are substantially lower than the MAEC.

In the response to KivIA-1 on 25 June 2020, Agnico Eagle accepted the recommendation, but noted there was relevant and current site-specific toxicity test data that indicated that a TDS concentration of 5,420 mg/L as measured TDS (or 4,925 mg/L as calculated TDS; collected on 20 March 20) did not result in acute lethality of *Daphnia magna* or Rainbow Trout (*Oncorhynchus mykiss*). Agnico Eagle stated that setting a maximum grab concentration TDS threshold of 4,500 mg/L (as measured TDS) provided a 20% buffer to the maximum measured TDS concentration that did not result in acute toxicity, which is a consistent approach to that used in the setting of the preliminary adaptive management triggers within the WQ-MOP. Agnico Eagle therefore proposed the supplemental adaptive management trigger for effluent quality for discharge be:

If the maximum allowable effluent concentration (MAEC) of TDS (as measured TDS) in effluent to be discharged to Meliadine Lake is equivalent to, or greater than, 5,000 mg/L, Agnico Eagle will temporarily decrease the rate of effluent discharges by up to 50% until TDS concentrations in the effluent are less than 5,000 mg/L.

This adaptive management trigger, without application of a 20% buffer, was incorporated into Rev3 of the WQ-MOP (Golder 2020b), which was prepared on 24 August 2020 and submitted with the 2020 Meliadine Mine Water Licence Amendment. In addition to incorporating this trigger in this WQ-MOP in the adaptive management plan, the trigger was also identified as the MGC. This MGC was also stated in the WQ-MOP Rev4 (Golder 2020c), which was submitted on 13 November 2020 with the responses to the Technical Responses as part of the amendment, with one confirmation. This confirmation was that the trigger reflected calculated TDS as per Agnico Eagle's response to KIA-WL-IR-3, which concluded that the use of calculated TDS concentrations is expected to provide more consistent and reliable results when tracking temporal and spatial trends and assessing conformity to thresholds.

Following responses to comments from ECCC and KivIA, and follow-up discussions through the Water Management Working Group (WMWG), the following interim targets for EQCs were subsequently agreed to for the discharge:

- A Maximum Average Concentration (MAC) and a MGC of 3,500 mg/L TDS and 5,000 mg/L TDS, respectively, for the discharge
- Both of the above targets to be calculated as a calculated sum of individual ions rather than the measured concentration

2.0 RATIONALE FOR RETAINING INTERIM MGC

The rationale for the suitability of the 5,000 mg/L TDS stems from a combination of:

- regulatory interpretation—specifically with respect to the use of acute lethality of *Rainbow Trout* and *Daphnia magna* as a basis for evaluating compliance with the *Fisheries Act* under applicable effluent regulations
- compilations of technical derivations—including literature reviews of chloride and TDS toxicity, as summarized in the WQ-MOP Rev2 (Golder 2020a)
- validation results from numerous toxicity tests conducted in 2020—including monitoring throughout the discharges to Meliadine Lake from June to October 2020

Through their legal counsel, Agnico Eagle has confirmed that the Metal and Diamond Mining Effluent Regulations (MDMER) provide a clear basis for assigning limits associated with discharge of effluent in compliance with section 36(3) of the *Fisheries Act*. Those arguments (submitted to the NWB and posted on the public registry on 1 December 2020; Agnico Eagle 2020b) are not repeated here, except to acknowledge that the MDMER has been recently amended to include a *Daphnia magna* mortality component within an updated definition of “acutely lethal” which comes into force on 1 June 2021.

With respect to the updated acute toxicity data set for Meliadine effluent, WQ-MOP Rev4 (Golder 2020c) provides a compilation of the recent acute toxicity testing results, including in the CP-1 water prior to discharge, and throughout the period of effluent discharge via MEL-14 in 2020. These results are presented in Appendix A (Table A4) of WQ-MOP Rev4, and include results of testing with *Daphnia magna*, Rainbow Trout (*Oncorhynchus mykiss*), and Threespine Stickleback (*Gasterosteus aculeatus*).

- Twelve rounds of acute toxicity tests have been conducted since September 2019 on samples containing more than 2,400 mg/L TDS (calculated)—none exhibited acute toxicity. Moreover, the number of mortalities observed across these tests was very low for both trout and daphnids, with 100% survival to both species in nearly all tests (i.e., no marginal results).
- Seven rounds of acute toxicity tests were conducted with TDS concentrations above 4,000 mg/L TDS (calculated), providing repeated confirmation of lack of acute toxicity at elevated TDS.
- The maximum concentrations tested included concentrations of 4,925 and 4,946 mg/L calculated TDS (both with 2,500 mg/L chloride), both collected in March 2020 prior to freshet. Neither of these samples elicited acute mortality in either trout or daphnid tests, validating the proposed MGC of 5,000 mg/L.

The above information provides confidence that concentrations up to the proposed MGC of 5,000 mg/L will not result in acute toxicity as defined under the applicable regulations.

Agnico Eagle also conducted a series of standard toxicity tests with the three brood *Ceriodaphnia dubia* survival and reproduction test, a protocol that is commonly applied for environmental compliance testing in receiving water. In other words, this is a chronic toxicity test more applicable to the receiving environment (edge of mixing zone), rather than discharge water. The demonstration that the LC₅₀ for *C. dubia* in CP-1 testing was greater than the MAC of 3,500 mg/L TDS provides additional confidence in the protectiveness of the MAC, but is not applicable as a formal requirement for application to the MGC.

Additional confidence in the proposed thresholds comes from comparison to similar acute testing conducted for the Con Mine in Yellowknife, NT (Golder 2018), where mine-related discharges contain very similar ionic composition of TDS (i.e., approximately 50% chloride in effluent, with balanced mixture of other major ions such as sodium, calcium, magnesium, and sulphate). At the Con Mine in 2018, a chloride acute toxicity study was conducted using several site-relevant mixtures to identify acute toxicity thresholds of chloride to rainbow trout and *D. magna*. The threshold for *D. magna* toxicity to chloride under site-relevant exposure conditions ranged between 2,900 and 3,090 mg/L (for survival and immobility). Rainbow trout were less sensitive to chloride toxicity, with a toxicity threshold of 4,975 mg/L chloride (for survival). These results for both species are in alignment with the range of expected values observed in the literature for acute chloride toxicity (2,565 to 3,630 mg/L chloride; Elphick et al. 2011; Mount et al. 1997; Biesinger and Christensen 1972). The study concluded that, “given the results of the present study, it is unlikely that chloride concentrations less than or equal to 2,500 mg/L will result in acute toxicity in *D. magna* or rainbow trout under current or predicted future conditions at Con Mine” (Golder 2018).

The 2,500 mg/L concentration of chloride cited in Golder (2018) is coincidentally equal to the maximum concentration measured in Meliadine CP1 water (two tests in March 2020), which also yielded no acute toxicity. Furthermore, the toxicity results from Golder (2018) were similar across three variants of site-specific TDS mixtures, including chloride composition ranging from 35% to 55%. Based on these findings, the 2,500 mg/L concentration of chloride (corresponding to approximately 5,000 mg/L TDS in the Con Mine effluent) was incorporated in the Aquatic Effects Monitoring Program (AEMP) Study Design for Con Mine, and also the Treated Effluent Acute Lethality Response Framework, as an Action Level threshold for chloride (Golder 2019). The Mackenzie Valley Land and Water Board (MVLWB) did not establish an effluent quality criterion for chloride (MVLWB 2019) but instead accepted the use of the Response Framework, which references the site-specific acute lethality threshold for chloride of 2,500 mg/L (Golder 2019; Table 1, footnote [a]) to fulfil the requirement of Water Licence (MV2017L8-0008) Part F, Condition 15.

3.0 CONCLUSION

In summary, several lines of evidence indicate that 5,000 mg/L TDS (approximately 2,500 mg/L chloride) is protective against acute toxicity as defined under MDMER (including amendments), and therefore an appropriate basis for setting a MGC of 5,000 mg/L TDS (as calculated TDS). Multiple samples of Meliadine CP1 water and mine-influenced water from other mine sites (with similar TDS composition) have consistently demonstrated lack of acute toxicity at these exposure levels. The confirmation of *C. dubia* acute toxicity at concentrations above the MAC of 3,500 mg/L provides an additional margin of safety relative to the MDMER requirements, but is based on a chronic test protocol and not pertinent to the regulatory acceptability of MGC. We recommend that the MGC of 5,000 mg/L calculated TDS be supported for the Water Licence 2AM-MEL1631 Amendment.

4.0 CLOSURE

We trust that the above is sufficient to meet your current needs. Should you wish to discuss further, or seek additional clarification or details, please contact us at your convenience.



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