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**AQUATIC EFFECTS MONITORING PROGRAM ANNUAL 2021
REPORT – PLAIN LANGUAGE BRIEFING AND TECHNICAL
REVIEW COMMENTS**

Technical Memorandum # 367-22-03

Prepared for:

Environmental Monitoring Advisory Board (EMAB)
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PLAIN LANGUAGE SUMMARY

The Environmental Monitoring Advisory Board (EMAB) requested a technical review of the 2021 Aquatic Effects Monitoring Program (AEMP) Annual Report for the Diavik Diamond Mines (2012) Inc. (DDMI; “Diavik”) Project. This review included looking at:

- Diavik responses to previous North/South recommendations
- Appropriateness of sampling timing and frequency
- Quality of data collected
- Methods used to analyze data
- Adequacy of discussion of results
- Implications of results
- Defensibility of conclusions and recommendations
- Emerging issues that may indicate environmental change over time
- Potential project-related effects
- Action levels reached and adequacy of proposed follow-up
- Adaptive management responses
- Include recommendations on improvements to monitoring/management actions for EMAB’s consideration

Key comments and recommendations include:

- **Traditional Ecological Knowledge 2021 Study Report:** the report indicates camp participants expressed concerns about fish health and water quality in Lac de Gras. However, the report does not include the detailed results and discussion of the 2021 TK study. The 2021 AEMP report states that the 2021 TK report will be provided in the next annual AEMP report (i.e., in 2023);
 - **Recommendation:** provide the results and discussion of the 2021 TK program with sufficient time to allow for review of the report prior to undertaking the open-water season AEMP monitoring.
- **Phytoplankton Results:** the report notes that monitoring results from 2021 for the two measures of algal abundance differ. One measure (chlorophyll *a*) showed higher values across the sites sampled in the lake but the other (phytoplankton biomass) was mostly within the

normal range. Diavik notes that this suggests a problem with the chlorophyll *a* data. However, this disconnect could also be a result of issues with the other indicator (biomass);

- **Recommendation 1**: discuss potential data quality issues for phytoplankton biomass (as was done for chlorophyll *a*).
- **Recommendation 2**: look at the relationship between the two measures of algal abundance.
- **Phytoplankton Monitoring – Quality Assurance/Quality Control**: the report notes that duplicate samples for phytoplankton were not collected as part of the field program, as per the applicable Quality Assurance Project Plan (QAPP) Version 3.1. The QAPP v. 3.1 states that duplicate samples are to be collected at 10% of sites;
 - **Recommendation**: Include field duplicate samples in future monitoring programs.

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1.0 BACKGROUND AND SCOPE OF WORK

The Diavik Diamond Mines (2012) Inc. (DDMI) 2021 Aquatic Effects Monitoring Program (AEMP) Annual Report was submitted to the Wek'èezhii Land and Water Board (WLWB) in accordance with Part J, Item 8 of Water Licence W2015L2-0001 (Golder 2022a) and the report was distributed for review on May 31, 2021.

North/South Consultants Inc. (NSC) conducted a technical review of the 2021 AEMP Annual Report for the Environmental Monitoring Advisory Board (EMAB). As directed by EMAB in their Terms of Reference (ToR) for the review, the review focused on the following:

- Diavik responses to previous North/South recommendations
- Appropriateness of sampling timing and frequency
- Quality of data collected
- Methods used to analyze data
- Adequacy of discussion of results
- Implications of results
- Defensibility of conclusions and recommendations
- Emerging issues that may indicate environmental change over time
- Potential project-related effects
- Action levels reached and adequacy of proposed follow-up
- Adaptive management responses
- Include recommendations on improvements to monitoring/management actions for EMAB's consideration

The ToR indicated to identify the issues of most importance for EMAB. Section 2 provides a discussion of key review comments, along with recommendations for consideration by EMAB. Detailed technical review comments and recommendations are provided in Table 1 and in the Excel comments template as required for submission to the WLWB.

2.0 KEY COMMENTS

The following sections present a brief overview of key comments in relation to the points identified by EMAB for evaluation during the review of the 2021 AEMP Annual Report, and any additional review comments and recommendations borne from this review.

The review considered the items identified in Section 1.0 with respect to the ToR. Diavik's responses (WLWB 2021) to NSC comments submitted on the 2020 AEMP Annual Report (NSC 2021a) were reviewed and any comments in relation to these responses were incorporated herein. It is noted that the WLWB (2022a,b) issued directives relating to NSC comments submitted on the 2020 AEMP Annual Report that are to be addressed in future reporting and, therefore, these comments are not reiterated here. For clarity, these include:

- “WLWB Decision #4: The Board requires DDMI to continue sampling at the control-assessment sites in 2022, as it committed to, and provide an assessment with rationale for why these sites should/should not be sampled in the future in the 2022 AEMP Annual Report” (WLWB 2022a). This directive relates to EMAB Comment #10 (NSC 2021a).
- “WLWB 2020 to 2022 Aquatic Effects Re-evaluation Report Requirement #2: The Board requires DDMI to include an analysis of whether differences between taxonomists are limiting the assessment of phytoplankton effects over time, and whether an adjustment to the normal ranges is necessary” (WLWB 2022b). This requirement relates to EMAB Comments #12 and 13 (NSC 2021a).

Additional comments relating to the ToR items on study design, methods, data analysis, data quality, reporting, action levels, and interpretation were submitted in relation to review of the 2017-19 AERER v. 1.0 (NSC 2021b), the 2017-19 AERER v. 1.0 Addendum (NSC 2022a), and the AEMP Design Plan v. 6.0 (NSC 2022b) in accordance with the WLWB review process and the reader is directed to these documents for additional information.

The following sections present key comments for discussion by EMAB members and refer to:

- Traditional Ecological Knowledge (TK) Study Report;
- Phytoplankton: Comparability of data;
- Phytoplankton: Duplicate Samples.

The technical review comments presented in Table 1 include additional detailed comments.

2.1 TRADITIONAL ECOLOGICAL KNOWLEDGE STUDY REPORT

The 2021 AEMP report excludes the results and discussion of the 2021 Traditional Knowledge Camp program and it is indicated they will be provided in the next AEMP Annual Report. The report notes: "Overall observations, however, made by participants during the camp indicated

concerns about fish health and water quality in Lac de Gras because of parasite loads observed in the fish sampled during the camp."

Based on the proposed schedule, results will not be made available until 2023 and after conduct of the 2022 AEMP monitoring program. The 2022 AEMP program is a comprehensive sampling year and will include sampling of fish, metals in fish tissue, sediment quality, and benthic invertebrates. The results of the 2021 TK program should be reviewed prior to undertaking of the biological monitoring program in 2022, notably in light of the reported concerns indicated by participants.

Recommendation: Provide the results and discussion of the 2021 TK program with sufficient time to facilitate review of the report prior to undertaking the open-water season AEMP monitoring.

2.2 PLANKTON AND EUTROPHICATION INDICATORS

2.2.1 Phytoplankton Data Comparability

The report notes differing effects were observed for the two measures of phytoplankton quantity. Chlorophyll *a* concentrations were above the normal range in all areas, whereas phytoplankton biomass was, with one exception, within the normal range in the lake. The report indicates: "It is not clear why chlorophyll *a* concentrations would be elevated without a corresponding increase in phytoplankton biomass, suggesting a potential data quality issue associated with the chlorophyll *a* dataset. Field procedures were reviewed and the analytical laboratory was contacted to verify the 2021 chlorophyll *a* results; this review identified no data quality issues."

The lack of correlation between the two indicators of algal quantities could also reflect data quality issues with the phytoplankton biomass data. This is suggested by the consistency in response and spatial gradient between chlorophyll *a* and zooplankton biomass.

Recommendation: Discuss potential data quality issues for phytoplankton biomass (as was done for chlorophyll *a*).

Conduct a correlation analysis between chlorophyll *a* and phytoplankton biomass results.

2.2.2 Phytoplankton Duplicate Samples

The plankton report indicates: "Duplicate phytoplankton samples were not collected in 2021 per the Quality Assurance Project Plan Version 3.1 (QAPP; Golder 2017)." Similar statements appear in other sections of the report (e.g., Appendix XI, p. 4). However, QAPP v. 3.1 indicates that "The following additional QA/QC measures, specific to plankton, will be implemented to provide data integrity and relevance:

Duplicate samples of phytoplankton biomass, prepared from a separate sample collected from the same location as the original sample will be collected from 10% of the AEMP sampling stations. Duplicate samples will be prepared, labelled, and preserved individually and then submitted to the

appropriate taxonomist along with the original sample. These samples will be used to demonstrate consistency and precision in the sampling procedures used and homogeneity of the community being sampled" (Golder 2017, p. 27)."

It is unclear why duplicate samples were not collected in 2021. It is also noted that due to discrepancies between the chlorophyll *a* and phytoplankton biomass results for 2021, inclusion and review of QA/QC information for phytoplankton taxonomic composition and biomass such as duplicates is critical.

Recommendation: Include field duplicate samples in future monitoring programs.

3.0 REFERENCES

- Golder. 2022a. Diavik Diamond Mines (2012) Inc. Aquatic Effects Monitoring Program 2021 Annual Report. Submitted to Diavik Diamond Mines (2012) Inc. Yellowknife, NT, March 2022.
- Golder. 2022b. Diavik Diamond Mines (2012) Inc. Aquatic Effects Monitoring Program Study Design Version 6.0. Submitted to Diavik Diamond Mines (2012) Inc. Yellowknife, NT, April 2022.
- Golder. 2022c. Diavik Diamond Mines (2012) Inc. 2017 to 2019 Aquatic Effects Re-Evaluation Report v. 1.0 Addendum. Submitted to Wek'eezhii Land and Water Board, April 2022.
- Golder. 2021a. Diavik Diamond Mines (2012) Inc. Aquatic Effects Monitoring Program 2020 Annual Report. Submitted to Diavik Diamond Mines (2012) Inc. Yellowknife, NT, March 2021.
- Golder. 2021b. 2014 to 2019 AEMP Response Plan – Fish, Version 2.0. Submitted to Diavik Diamond Mines (2012) Inc. Yellowknife, NT, July 2021.
- Golder. 2020a. Diavik Diamond Mines (2012) Inc. Aquatic Effects Monitoring Program 2019 Annual Report. Submitted to Diavik Diamond Mines (2012) Inc. Yellowknife, NT, October 27, 2020.
- Golder. 2020b. Diavik Diamond Mines (2012) Inc. 2017 to 2019 Aquatic Effects Re-Evaluation Report for the Diavik Diamond Mine, Northwest Territories. Submitted to Diavik Diamond Mines (2012) Inc. Yellowknife, NT, December 2020.
- Golder. 2017. Diavik Diamond Mines (2012) Inc. Aquatic Effects Monitoring Program, Quality Assurance Project Plan Version 3.1. Submitted to Diavik Diamond Mines (2012) Inc. Yellowknife, NT, June 2017.
- North/South Consultants Inc. (NSC). 2022a. 2017-2019 Aquatic Effects Re-Evaluation Report v. 1.0 Addendum – Plain Language Briefing and Technical Review Comments. Prepared for the Environmental Monitoring Advisory Board. Technical Memorandum # 367-22-01. June 2022.
- NSC. 2022b. Aquatic Effects Monitoring Program Design Plan Version 6.0 – Plain language briefing and technical review comments. Technical Memorandum # 367-22-02. June 8, 2022.
- NSC. 2021a. Aquatic Effects Monitoring Program 2020 Annual Report – Plain language briefing and technical review comments. Prepared for the Environmental Monitoring Advisory Board. Technical Memorandum # 367-21-04. July 26, 2021.
- NSC. 2021b. 2017-2019 Aquatic Effects Re-Evaluation Report – Plain language briefing and technical review comments. Prepared for the Environmental Monitoring Advisory Board. Technical Memorandum # 367-21-03. July 19, 2021.
- Wek'eezhii Land and Water Board (WLWB). 2022a. Diavik – 2020 Aquatic Effects Monitoring Program (AEMP) Annual Report (W2015L2-0001): Reasons for Decision. January 31, 2022.
- WLWB. 2022b. Diavik - 2017 to 2019 Aquatic Effects Re-Evaluation Report and V. 4.0 of the Quality Assurance Project Plan (W2015L2-0001): Reasons for Decision. January 31, 2022.
- WLWB. 2021. Diavik – 2020 Aquatic Effects Monitoring Program (AEMP) Annual Report (W2015L2-0001): Review Summary and Attachments. August 13, 2021.

Table 1. Technical review comments and recommendations on the 2021 AEMP Annual Report.

TOPIC	COMMENT	RECOMMENDATION
<p>Main Report, Executive Summary, p. iv.; Traditional Knowledge Studies, Section 10.3, Results and Discussion, p. 60</p>	<p>The 2021 AEMP report excludes the results and discussion of the 2021 Traditional Knowledge Camp program and it is indicated they will be provided in the next AEMP Annual Report. The report notes: "Overall observations, however, made by participants during the camp indicated concerns about fish health and water quality in Lac de Gras because of parasite loads observed in the fish sampled during the camp."</p> <p>Based on the proposed schedule, results will not be made available until 2023 and after conduct of the 2022 AEMP monitoring program. The 2022 AEMP program is a comprehensive sampling year and will include sampling of fish, metals in fish tissue, sediment quality, and benthic invertebrates. The results of the 2021 TK program should be reviewed prior to undertaking of the biological monitoring program in 2022, notably in light of the reported concerns indicated by participants.</p>	<p>Provide the results and discussion of the 2021 TK program with sufficient time to facilitate review of the report prior to undertaking the open-water season AEMP monitoring.</p>
<p>Appendix I, Dust Deposition, Methodology, Section 2.3, Snow Water Chemistry, p. 2-8</p>	<p>Appendix I indicates that water volumes were not recorded for some snow chemistry stations and areal deposition rates were estimated using an average volume (3.419 L). "The snow chemistry concentrations (mg/L) were converted to an areal deposition rate in milligrams per square decimetre per year (mg/dm²/y) using Equation 1 multiplied by the collected volume of water (L). The water volume used for snow chemistry analysis was unknown for some stations; thus, an average was calculated (3.419 L) using the known volumes and applied to stations with unknown volumes."</p> <p>The report does not indicate which samples were affected. To be conservative, a range (minimum and maximum) of water volumes should be applied to the affected samples and the calculated areal deposition rates should be reviewed to determine what impact this has on the results and interpretation.</p>	<p>Identify which samples were affected by missing volume measurements.</p> <p>Calculate areal deposition rates using a range of water volumes and discuss potential implications on the interpretation of results.</p>

TOPIC	COMMENT	RECOMMENDATION
<p>Appendix I, Dust Deposition, Results, Section 3.1, Dustfall Gauges, p. 3-10, Figure 3.1-5</p>	<p>EMAB (Comment #3, Review comments on the 2020 AEMP) previously commented that it was unclear what data are presented in the boxplot (Figure 3.1-5) of dust deposition in previous annual reports. The WLWB issued the following directive in its Reasons for Decision regarding the 2020 AEMP Report: "Requirement #3b for future AEMP Annual Reports: The Board requires DDML to include additional details on what data is represented in the box-plots in Figure 3.1-5."</p> <p>It is still unclear what information is presented in the boxplot (i.e., what stations are included).</p>	<p>Clarify what data are used to generate the dust deposition box plot.</p>
<p>Appendix I, Dust Deposition, Results, Section 3.3, Snow Water Chemistry, p. 3-10, Figure 3.1-5</p>	<p>EMAB (EMAB Comments #4 and #8, 2020 AEMP Review and EMAB Comment #2, 2017-2019 AERER Review) previously recommended that reporting should present results of the snow chemistry monitoring for parameters that were identified as Substances of Interest (SOIs) in the water and sediment quality components, at a minimum those that were identified through Criterion 4 (water quality dust assessment effects).</p> <p>The WLWB in its Reasons for Decision on the 2020 AEMP Annual Report indicated: "...the Board will consider recommendations on this issue, if any, as part of its consideration of the 2017 to 2019 Aquatic Effects Re-evaluation Report Addendum."</p> <p>EMAB (Comment #2) recommended in its review of the 2017-19 AERER Addendum to Include an assessment of all parameters identified as SOIs in the water quality and/or sediment quality assessments or at a minimum those for which a determination of a linkage to the mine cannot be clearly established based on an evaluation of the effluent, water, or sediment quality data alone. The recommendation is reiterated here though it is acknowledged this issue will be addressed through the 2017-19 AERER Addendum review process.</p>	<p>See EMAB Comment #2 in the review of the 2017-19 AERER Addendum.</p>

TOPIC	COMMENT	RECOMMENDATION
<p>Appendix II, Effluent and Water Chemistry Report, Excel Data File "AppII_WQ_AttD1-2_SNP_RawData"</p>	<p>EMAB (Comment #10; 2020 AEMP Review) previously recommended including effluent and mixing zone SNP temperature data and assessing/discussing potential effects of effluent discharge on water temperature in the receiving environment. It was further recommended that if data are insufficient to assess potential effects, collect additional information in future monitoring. In a review of the 2017-2019 AERER NSC provided a recommendation to examine the effects of effluent on water temperature in the NF; differences in fish health metrics have been attributed to habitat differences, including differences in water temperature in previous reports (EMAB Comment #36).</p> <p>In its Reasons for Decision on the 2020 AEMP, the WLWB issued the following Directive: "Requirement #3d for future AEMP Annual Reports: The Board requires DDMI to include the temperature data in the raw data files for the SNP stations associated with the AEMP."</p> <p>DDMI included temperature data for the effluent and SNP mixing zone stations in raw format as directed by the WLWB in the 2021 AEMP Annual Report. These results were not, however, presented or discussed in the 2021 AEMP Annual Report. DDMI's response to EMAB Comment #10 is noted and in response, we acknowledge that a statistical analysis is not necessarily warranted for the annual report for interim monitoring years. However, it is reiterated that an analysis of temperature data should be included at a minimum in the Re-evaluation Reports and ideally in years in which fish and invertebrate monitoring are conducted, notably because past reports have identified temperature differences as causing or contributing to observed differences in fish health metrics.</p>	<p>Assess/discuss potential effects of effluent discharge on water temperature in the receiving environment in AERER and annual AEMP reports in years when fish and invertebrate monitoring is conducted. If data are insufficient to assess potential effects, recommend collecting additional information in future monitoring.</p>
<p>Eutrophication Indicators, Results and Discussion, Section 4.3.2, Lac de Gras, p. 35</p>	<p>The report notes differing effects were observed for the two measures of phytoplankton quantity. Chlorophyll <i>a</i> concentrations were above the normal range in all areas, whereas phytoplankton biomass was, with one exception, within the normal range in the lake. The report indicates: "It is not clear why chlorophyll <i>a</i> concentrations would be elevated without a corresponding increase in phytoplankton biomass, suggesting a potential data quality issue associated with the chlorophyll <i>a</i> dataset. Field procedures were reviewed and the analytical laboratory was contacted to verify the 2021 chlorophyll <i>a</i> results; this review identified no data quality issues."</p> <p>The lack of correlation between the two indicators of algal quantities could also reflect data quality issues with the phytoplankton biomass data. This is suggested by the consistency in response and spatial gradient between chlorophyll <i>a</i> and zooplankton biomass.</p>	<p>Discuss potential data quality issues for phytoplankton biomass (as was done for chlorophyll <i>a</i>).</p> <p>Conduct a correlation analysis between chlorophyll <i>a</i> and phytoplankton biomass results.</p>

TOPIC	COMMENT	RECOMMENDATION
<p>Conclusions and Recommendations, Section 13.2, Recommendations, p. 66</p>	<p>DDMI recommended that the analysis used to evaluate potential effects from dust emissions on water quality in Lac de Gras be discontinued in future AEMP reports.</p> <p>The WLWB indicated in its Reasons for Decision with respect to the 2020 AEMP Annual Report "To not approve removal of the following from future AEMP Annual Reports, as proposed in Section 13.2 of the Report: the analysis to evaluate potential effects from dust emissions on water quality." The WLWB also indicated that any recommended changes should be included with an updated AEMP Design Plan. Design Plan v. 6.0 did not include a recommendation to discontinue this analysis.</p>	<p>Recommend retaining the analysis of potential effects of dust emissions on water quality.</p>
<p>Appendix II, Effluent and Water Chemistry Report, Results, Section 3.1, Substances of Interest, p. 22-23 and Section 3.7, Effects from Dust Deposition, p. 100</p>	<p>Section 3.1 indicates that three variables (boron, lithium, and zinc) were elevated in the MF area and triggered Criterion 4 but were not elevated in the NF area, potentially indicating effects related in part to dust deposition. The discussion of potential dust effects presented in Section 3.7 identifies four variables (i.e., turbidity, boron, chromium, and lithium), which appears to be an error.</p> <p>The discussion includes consideration of the results of effluent and dust (snow chemistry) monitoring for boron and lithium but no discussion is provided for zinc.</p>	<p>Provide a discussion of the potential linkage between dust and zinc.</p>
<p>Appendix XI, Plankton Report, Attachment A, Quality Assurance Quality Control, p. A-2</p>	<p>The plankton report indicates: "Duplicate phytoplankton samples were not collected in 2021 per the Quality Assurance Project Plan Version 3.1 (QAPP; Golder 2017)." Similar statements appear in other sections of the report (e.g., Appendix XI, p. 4). However, QAPP v. 3.1 indicates that "The following additional QA/QC measures, specific to plankton, will be implemented to provide data integrity and relevance: Duplicate samples of phytoplankton biomass, prepared from a separate sample collected from the same location as the original sample will be collected from 10% of the AEMP sampling stations. Duplicate samples will be prepared, labelled, and preserved individually and then submitted to the appropriate taxonomist along with the original sample. These samples will be used to demonstrate consistency and precision in the sampling procedures used and homogeneity of the community being sampled" (Golder 2017, p. 27)."</p> <p>It is unclear why duplicate samples were not collected in 2021. It is also noted that due to discrepancies between the chlorophyll <i>a</i> and phytoplankton biomass results for 2021, inclusion and review of QA/QC information for phytoplankton taxonomic composition and biomass such as duplicates is critical.</p>	<p>Include field duplicate samples in future monitoring programs.</p>

TOPIC	COMMENT	RECOMMENDATION
Appendix XI, Plankton Report, Attachment A, Quality Assurance Quality Control, p. A-2	The plankton program included analysis of two split phytoplankton samples. Could Diavik clarify how the split sample is prepared (e.g., separate aliquots removed from the sample or same aliquot examined but from different microscope fields) and whether phytoplankton are both counted and measured (for biomass calculation) in both the split samples?	Clarify how the split sample is prepared (e.g., separate aliquots removed from the sample or same aliquot examined but from different microscope fields) and whether phytoplankton are both counted and measured (for biomass calculation) in both the split samples.
Appendix XIII, Eutrophication Indicators, Section 5, Response Framework, p. 76	Section 5 of Appendix XIII indicates: "Action Level 3 was not triggered in 2021 because concentrations of chlorophyll a remained below the normal range upper bound plus 25% of the Effects Benchmark of 1.74 µg/L at all stations except NF area stations, MF1-1 and MF1-2, which represents less than 20% of the lake." This statement conflicts with the text presented in Section 3.3 which indicates NF, MF1-1 and MF1-3, and all sites in the MF2-FF2 area exceeded this concentration.	Review text relating to assessment of Action Levels for Eutrophication Indicators and correct as required.