## Review Comment Table

<table>
<thead>
<tr>
<th>Board:</th>
<th>WLWB</th>
</tr>
</thead>
<tbody>
<tr>
<td>File(s):</td>
<td></td>
</tr>
<tr>
<td>Document(s):</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diavik - AEMP Annual Report - 2017 - Appendix XI - B and C - Plankton Community Data - Apr 27_18.zip (125 kB)</td>
</tr>
<tr>
<td></td>
<td>Diavik - AEMP Annual Report - 2017 - Appendix XII - D - WQ Raw Data - Apr 26_18.zip (275 kB)</td>
</tr>
<tr>
<td></td>
<td>Diavik - AEMP Annual Report - 2017 - Appendix XIII - E - Eutrophication Indicators Raw Data - Apr 26_18.zip (49 kB)</td>
</tr>
<tr>
<td>Item For Review Distributed On:</td>
<td>July 30 at 17:06 Distribution List</td>
</tr>
<tr>
<td>Reviewer Comments Due By:</td>
<td>Oct 31, 2018</td>
</tr>
<tr>
<td>Proponent Responses Due By:</td>
<td>Nov 21, 2018</td>
</tr>
</tbody>
</table>
| Item Description: | Diavik Diamond Mines (2012) Inc.'s (DDMI) submitted its 2017 Aquatic Effects Monitoring Program (AEMP) Annual Report (the Report) on April 13, 2018, in accordance with Part J, Condition 8 and Schedule 8, Condition 4 of DDMI's Water Licence (W2015L2-0001). The AEMP represents an extensive monitoring program, which includes the monitoring of water, sediment, and several types of living organisms around the Diavik site. In the cover letter with the Report, DDMI states that “sampling was carried out according to the requirements specified in the AEMP Study Design Version 4.1 for an interim monitoring year, which included sampling in the [near-field] NF and [mid-field] MF areas of the lake”.

DDMI also indicated in the cover letter letter that the Report includes revisions as required under the Board's decisions on the 2014, 2015 and 2016 (Version 1 and Version 1.1) AEMP Annual Reports and that Action Level exceedance reporting was required as per Part J, Condition 6 of the Licence.

Reviewers are invited to submit comments and recommendations on the 2017 AEMP Annual Report using the Online Review System (ORS) by the review comment deadline specified below. If reviewers seek clarification on the submission, they are encouraged to correspond directly with the proponent prior to submitting comments and recommendations. Reviewers may also wish to consider providing an indication of whether they are in support of the submission to provide context for comments and recommendations and to assist the Board with its decision. |
**UPDATE**: On November 5, 2018, the Proponent Response deadline was extended to November 21, 2018 in response to a request by DDMI.

Contact Information: Anneli Jokela 867-765-4588
Sarah Elsasser 867-446-5963

Comment Summary

<table>
<thead>
<tr>
<th>Diavik Diamond Mines (2012) Inc. (Proponent)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ID</strong></td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Environment and Climate Change Canada: Bradley Summerfield</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ID</strong></td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Environmental Monitoring Advisory Board: ... EMAB</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ID</strong></td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>26</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>Recommendation</td>
</tr>
<tr>
<td>---------------</td>
</tr>
<tr>
<td>Comment</td>
</tr>
<tr>
<td>Recommendation</td>
</tr>
</tbody>
</table>

**Nov 22:** The intent of the Annual AEMP Report for interim sampling years is to assess effects on water quality variables within the receiving area, by determining if an Action Level has been triggered. Temporal results are available in Section 4.3.2.1.1 of the 2014 to 2016 Aquatic Effects Re-evaluation Report. The primary concern related to pH in lakes of low buffering capacity, such as Lac de Gras, is a decline in pH, potentially resulting in acidification and subsequent effects on aquatic life. The median pH of DDMI’s effluent is approximately 7.5, which is close to the middle of the pH benchmark ranges for aquatic life (6.5 to 9.0) and drinking water (6.5 to 8.5). The pH range of Lac de Gras in all sampling areas is generally between 6.0 and 7.0 during the ice-cover season, and 6.0 to 7.5 during the open-water season. Values are therefore commonly below the lower benchmark value of 6.5 throughout Lac de Gras in both seasons at various depths. These results do not reflect Mine-related effects, which would more likely be exhibited as a slight increase in pH without a consequence to aquatic life, and without excursions from the benchmark ranges. Results for pH in the effluent are compared to the Effluent Quality Criteria in Section 3.2.4 of Appendix II. |

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Provide clarification of the in situ field instruments used over the 2017 monitoring program.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comment</td>
<td>The report indicates: &quot;Similarly, elevated values of field-measured turbidity were recorded using a YSI water quality meter at the mixing zone boundary in January 2017 (Appendix B). January 2017 was the only month of the sampling year when data were recorded with the YSI at the mixing zone.&quot; However, page 2 indicates that &quot;The in situ water column profile measurements were taken at AEMP stations using a multi-parameter water quality meter (YSI) following the methods described in DDMI's Standard Operating Procedure (SOP) ENVR-684-0317 &quot;SOP YSI ProDSS&quot;.&quot; It is unclear what in situ meters were used for the 2017 water quality monitoring program.</td>
</tr>
<tr>
<td>Recommendation</td>
<td>Provide clarification of the in situ field instruments used over the 2017 monitoring program.</td>
</tr>
</tbody>
</table>

**Nov 22:** A YSI ProDSS is used every month in which samples are obtained from Lac de Gras for the SNP and AEMP. |
<p>| APPENDIX II, Effluent and Water Chemistry Report, Section 3.2.3, Results, Trends in Effluent and at the Mixing Zone Boundary, Total Metals, page 36 and figures 3-10 to 3-19 | <strong>Comment</strong> | The report indicates: &quot;For most total metal SOIs, concentrations in the effluent were greater than the concentrations measured at the mixing zone boundary in 2017, indicating that the Mine effluent is a source of these variables to Lac de Gras. One exception was copper, where concentrations in the effluent were generally similar to or less than those recorded at the mixing zone boundary (Figure 3-13B/C). Lead and tin also had concentrations in the effluent that were generally similar to those at the mixing zone boundary (i.e., often below the DL), although sporadic elevated concentrations of these two variables occurred in the effluent which were greater than the measured concentrations at the mixing zone boundary (Figures 3-14B/C and 3-18B/C).&quot; The temporal pattern of effluent concentration and loading for several metals including antimony (Figure 3-11), molybdenum (Figure 3-15), and uranium (Figure 3-19) was not reflected in the mixing zone water quality results. Specifically, concentrations in the mixing zone decreased, and were notably lower than the effluent concentrations, in the open-water season despite increased concentrations in, and loading from, effluent. <strong>Recommendation</strong> Include a discussion of these observations in the report, including, where feasible potential or conceptual explanations. | <strong>Nov 22:</strong> The following sentence will be added to the discussion of total metals: &quot;For several metals, including antimony (Figure 3-11), molybdenum (Figure 3-15), and uranium (Figure 3-19), concentrations at the mixing zone boundary decreased in the open-water season despite increased concentrations in the effluent.&quot; There is no clear explanation why the temporal pattern of mixing zone concentrations does not directly mirror the trend in effluent concentrations. One potential explanation is that there is more immediate mixing in the open-water months, which reduces concentrations at the mixing zone boundary. Additionally, the effluent and mixing zone samples may have been collected on different days, resulting in some variability between the effluent and mixing zone results. All concentrations measured at the mixing zone were below AEMP Benchmarks with the exception of total aluminum on one occasion and field pH (Section 3.2.5 of Appendix II). |
| --- | --- | --- |
| APPENDIX II, Effluent and Water Chemistry Report, Section 3.3, Results, Depth Profiles, page 53 | <strong>Comment</strong> | Section 3.3 (page 53) only compares dissolved oxygen (DO) monitoring results to the 6.5 mg/L Canadian Council of Ministers of the Environment (CCME) protection of aquatic life (PAL) guideline (CCME 1999; updated to 2018). NSC had commented (NSC 2018) previously that DO results should be compared to both the 6.5 mg/L (early life stages absent) and the 9.5 mg/L (early life stages present) CCME PAL guidelines (CCME 1999; updated to 2018) where applicable. The CCME 9.5 mg/L benchmark for early life stages would be more appropriate for fall spawning species such as Lake Trout. Indications of these guidelines on the depth profile figures would also greatly improve the ability to readily assess where exceedances occurred (Note: this would also apply for pH). <strong>Recommendation</strong> Include a comparison of DO monitoring results to the appropriate benchmarks (i.e., 6.5 and 9.5 mg/L). Add 6.5 | <strong>Nov 22:</strong> The third sentence in the second paragraph of Section 3.3 should read: &quot;The greatest declines in DO near the lake bottom were measured at stations MF1-1, MF1-5, FF2-5, and MF3-6, where near-bottom DO concentrations were at or below the Effects Benchmark of 9.5 mg/L for the protection of aquatic life for early life stages. In addition, some concentrations measured at stations MF1-1, MF1-5, and FF2-5 were also below the Effects Benchmark of 6.5 mg/L for the protection of aquatic life for &quot;other&quot; life stages (i.e., non-early life stages). There is no evidence linking low near-bottom DO concentrations to Mine effects.&quot; The DO and pH benchmark values will be added to the depth profile plots in future AEMP annual reports and evidence will be evaluated to determine if there is a mine effect. |</p>
<table>
<thead>
<tr>
<th>Page</th>
<th>APPENDIX II, Effluent and Water Chemistry Report, Section 3.4.3, Results, Action Level Evaluation, Action Level 3, page 70, Figure 3-29</th>
<th>Comment</th>
<th>Nov 22: The Action Level 3 for dissolved sodium indicated on Figure 3-29 (51 mg/L; page 70) differs from what is presented in Table 3-8 (13.8 mg/L; page 64). Recommendation</th>
<th>Review and revise table/figure for Action Level 3 values for dissolved sodium.</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td><strong>Comment</strong> The Action Level 3 for dissolved sodium indicated on Figure 3-29 (51 mg/L; page 70) differs from what is presented in Table 3-8 (13.8 mg/L; page 64). <strong>Recommendation</strong> Review and revise table/figure for Action Level 3 values for dissolved sodium.</td>
<td></td>
<td>The value in the table is correct as it is calculated using the lower of the two effects benchmarks for dissolved sodium. The figure will be corrected in the revised report.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td><strong>Comment</strong> Action Level 3 values are not presented on all water quality Figures 3-24 to 3-42. See for example Figure 3-30 sulphate (page 71). <strong>Recommendation</strong> Add Action Level 3 values where missing to the figures.</td>
<td></td>
<td>Action Level 3 values are only presented on plots for variables that triggered Action Level 2. Therefore, Action Level 3 values are missing from two figures: sulphate (Figure 3-30) and total antimony (Figure 3-34). Action Level 3 values will be added to these figures in the revised report.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td><strong>Comment</strong> The report indicates: &quot;Concentrations in all other samples collected during the 2017 AEMP were below the relevant Effects Benchmarks for the protection of aquatic life and drinking water. This includes the sample collected at Station LDG-48, which is located at the Lac de Gras outflow to the Coppermine River (Appendix D).&quot; As noted in Section 3.3 (page 53) some DO measurements were below the CCME PAL guidelines. These occurrences should be included within this discussion. <strong>Recommendation</strong> Include discussion of DO monitoring results that were below CCME PAL benchmarks.</td>
<td></td>
<td>Action Level 3 values are only presented on plots for variables that triggered Action Level 2. Therefore, Action Level 3 values are missing from two figures: sulphate (Figure 3-30) and total antimony (Figure 3-34). Action Level 3 values will be added to these figures in the revised report.</td>
<td></td>
</tr>
</tbody>
</table>
| 10   | **Comment** The QA/QC Appendix B (page B-3) indicates that duplicate sample results were considered "notable" where the Relative Percent Difference (RPD) was greater than 40%. This criterion is higher than used in previous reports. For example, in the 2017 AEMP Annual Report (Golder 2017), the criterion was | | The RPD criterion of 40% is correct. Section 2.3.4 of the Quality Assurance Project Plan Version 3.1 states: "Field duplicate samples will be compared by calculating the relative percent difference (RPD) between the duplicate samples. If the RPD exceeds 40% when concentrations are greater than or equal to (=)
<table>
<thead>
<tr>
<th>Page</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-3</td>
<td>20% for evaluating duplicate sample results (Appendix II, Appendix C, page C-3). <strong>Recommendation</strong> Review the text and revise (if the value was reported in error) or provide a rationale for the change in the RPD criterion for evaluating duplicate sample results. 5 times the detection limit (DL), the data will be flagged and both sampling and analytical methods will be reviewed. This acceptance criterion is consistent with CCME (2016), which recommends that the criterion for field duplicates should be 1.5 to 2 times the criterion for laboratory duplicates, which is an RPD of =20% for most inorganic parameters analyzed in water.</td>
</tr>
<tr>
<td>C-9</td>
<td><strong>Comment</strong> A footnote to Figure C-6 (page C-9) indicates: &quot;Note: Anomalous data were recorded at the bottom depth of the MF3-6 profile during the ice-cover season of 2017 and were not included in the data presented in Section 3.3. It is likely that the measuring device encountered the bottom sediments and caused the anomalous measurements.&quot; The figure presents results of in situ depth profile measurements for a single site and sampling time. It is unclear what are the anomalous data referred to and what data were omitted from data presented in Section 3.3. <strong>Recommendation</strong> Provide a description of the anomalous data removed for this data set. <strong>Nov 22:</strong> The anomalous data removed had elevated parameters due to the sampling device coming into contact with, and stirring up the bottom sediments. This error was noted on the field sheet and the data were excluded as they were not representative of normal conditions.</td>
</tr>
<tr>
<td>A-4</td>
<td><strong>Comment</strong> Appendix B indicates three samples were collected at Site MF3-5. Footnotes in the table indicate sample MF3-5-QC(a) is a &quot;Field QC (duplicate) sample&quot; and sample MF-3-5-QC(b) is a &quot;Field QC (split) sample.&quot; The third sample (MF-3-5) is presumably the &quot;original&quot; sample (i.e., the other duplicate field sample). Table A-1 presents RPDs for duplicate phytoplankton samples and Table A-3 presents RPDs for the split sample. The results for these two comparisons appear to be reversed (based on the raw data provided in Appendix B). <strong>Recommendation</strong> Verify that duplicate and split sample QC results are presented in the correct tables and/or that the footnotes included in Appendix B are accurate. <strong>Nov 22:</strong> Acknowledged. The error will be corrected in Appendix A.</td>
</tr>
<tr>
<td>A-4</td>
<td><strong>Comment</strong> The QA/QC review of phytoplankton data considers results for counts (i.e., abundance) and not biomass. However, the plankton component of the AEMP is focussed on results for phytoplankton biomass and not abundance. It is recommended that an analysis and discussion of QA/QC results for biomass, in addition to abundance, be provided. Phytoplankton biomass is derived from two estimates: (1) counts of algal cells; and (2) ...</td>
</tr>
</tbody>
</table>
Appendix B - Raw Plankton Data

measures/estimates of cell biovolume. Phytoplankton biomass results are therefore affected by an additional source of variability (i.e., biovolume measurements) beyond measures of algal abundance. A similar comment was submitted in the review of the 2016 Annual AEMP Report (NSC 2017): "Comparison of duplicate phytoplankton samples should be done both for abundance (i.e., cell counts) as well as biomass. The latter is typically more variable than the former as it is derived from two measurements (cell counts and algal cell size). As biomass is the metric of concern for the AEMP QA/QC should focus on this metric."

**Recommendation** Provide an analysis and discussion of phytoplankton biomass QA/QC results.

<table>
<thead>
<tr>
<th>14</th>
<th>MAIN DOCUMENT, Section 4.3.3, Eutrophication Indicators, Results and Discussion, Nutrients and Water Chemistry in Lac de Gras, page 38</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comment</strong></td>
<td>As noted in previous comments (e.g., Section 2.4.3, NSC 2018 and row 35 in associated excel submission), comparisons of spatial extent of effects between years for eutrophication indicators should be done with caution and should include explanatory text identifying the limitations of inter-annual comparisons in light of the lack of sampling in the FF areas in interim years Section 4.3.3 reads: &quot;The boundary of effects on concentrations of TN to the northwest extended to at least Station MF1-5; however, the extent of effects along the MF1-FF1 transect could not be assessed further, because sampling in the FF1 area was not completed in 2017 as part of the interim program. The extent of effects to the northeast of the Mine extended to the end of the MF2-FF2 transect (Station FF2-5). The boundary of effects south of the Mine extended to between stations MF3-6 and MF3-7. The resulting affected area of the lake based on concentrations of TN was estimated as greater than or equal to 240 km2, or greater than or equal to 41.9% of lake area, which is less than reported in 2016, but comparable to the affected areas calculated for this variable in previous years.&quot; The last sentence should be modified to clearly state that direct comparisons to 2016 results are not possible due to the lack of sampling in FF areas in 2017. <strong>Recommendation</strong> Include a qualifying statement indicating that due to the lack of FF data for 2017 and the implications regarding limitations on defining the spatial extent of effects in those years, comparison to 2016 or other years is associated with uncertainty.</td>
</tr>
<tr>
<td>Nov 22: The last sentence in the third paragraph of Section 4.3.3 will be revised to &quot;The resulting affected area of the lake based on concentrations of TN was estimated as greater than or equal to 240 square km, or greater than or equal to 41.9% of the lake area. Although the values for spatial extent are comparable to the affected areas calculated for this variable in previous years, because the boundary of the affected area extends to the stations sampled this year, there is uncertainty as to whether the affected area of the lake extends past these stations into the FF areas.&quot;</td>
<td></td>
</tr>
</tbody>
</table>
**Comment** Similar to the comment above, comparisons of spatial extent of effects for chlorophyll a between years should be done with caution and should include explanatory text identifying the limitations of inter-annual comparisons in light of the lack of sampling in the FF areas in interim years. Section 4.3.3 reads: "Effects on chlorophyll a were observed in the NF area and along all three transects. The boundary of effects on concentrations of chlorophyll a to the northwest of the Mine extended to Station MF1-5 (Figure 4-10). The extent of effects to the northeast of the Mine extended to the end of the MF2-FF2 transect (Station FF2-5). The boundary of effects south of the Mine extended to Station MF3-4. The extent of effects on concentrations of chlorophyll a, based on the affected stations, was calculated to be 149.8 km². Compared to the total surface area of the lake (573 km²), the area demonstrating effects on chlorophyll a concentration represents 26.2% of the lake area, similar to the extent of effects observed in 2013 (Golder 2014)." The last sentence should be modified to clearly state that direct comparisons to 2013 results are not possible due to the lack of sampling in FF areas in 2017. As the boundary of the extent of effects along the northwest transect could not be accurately defined, the affected area may have been larger in 2017 than 2013.

**Recommendation** Include a qualifying statement indicating that due to the lack of FF data for 2017 and the implications regarding limitations on defining the spatial extent of effects in those years, comparison to 2013 or other years is associated with uncertainty.

---

**Comment** The report indicates: "The estimated total anthropogenic TP loading from the Mine in 2017 was 1.4 tonnes per year (t/yr), with 0.42 t/yr from effluent, 0.63 t/yr from direct dust deposited to the lake surface, and 0.34 t/yr from runoff from the surrounding watershed (excluding the Mine footprint). The anthropogenic TP loading (including both effluent and fugitive dust) presented a 7.3% increase relative to the natural background TP loading of the watershed." (page 23) It is unclear what the "natural background TP loading of the watershed" is that is referenced or how that value (not indicated) was estimated.

**Recommendation** Indicate the estimated "natural background TP loading of the watershed" and provide the source or calculation method.
loading of the watershed" and provide an explanation of how the estimate was derived. Clarify the method for estimating "anthropogenic loading" to Lac de Gras.

<table>
<thead>
<tr>
<th>Main Document, Section 4.3.2, Eutrophication Indicators, Results and Discussion, Nutrients and Water Chemistry in Lac de Gras, pages 34-35 and Appendix XIII, Eutrophication Indicators Report, Section 3.4, Results, Nutrients in Lac de Gras, pages 25-29</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comment</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Appendix XIII, Eutrophication Indicators Report, Section 3.5, Results, Chlorophyll a, and Phytoplankton and Zooplankton Biomass, pages 30-31 and Main Document,</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comment</strong></td>
</tr>
</tbody>
</table>

| Nov 22: | Concentrations of TP, TDP, SRP, TN, TDN, total ammonia, nitrate, nitrate+nitrite, and chlorophyll a at LDS-4 during the open-water season are shown on Figures 3-17 to 3-25 of Appendix XIII, Eutrophication Indicators Report. The influence of Lac du Sauvage inflow (as measured at LDS-4) on spatial trends in nutrients and chlorophyll a concentrations in Lac de Gras is included in Section 3.6 ("Spatial Analysis in Lac de Gras"). Results for LDS-4 will be added to Figures in future AEMP reports. |

<p>| Nov 22: | As stated in response to EMAB-17 (above), concentrations of chlorophyll a in LDS-4 during the open-water season are presented in Figure 3-25 of Appendix XIII, Eutrophication Indicators Report and the influence of Lac du Sauvage inflow (as measured at LDS-4) on spatial trends in chlorophyll a concentrations in Lac de Gras is included in Section 3.6 (&quot;Spatial Analysis in Lac de Gras&quot;). Results for LDS-4 will be added to figures in future AEMP reports. |</p>
<table>
<thead>
<tr>
<th>Section 4.3.2, Eutrophication Indicators, Results and Discussion, Nutrients and Water Chemistry in Lac de Gras, page 36</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
</tr>
<tr>
<td>Comment</td>
</tr>
<tr>
<td>Recommendation</td>
</tr>
<tr>
<td>Nov 22: The following sentence will be added to the discussion on TN: &quot;Significant positive trends were observed for the MF2-FF2 and MF3-FFB-FFA transects during the open-water season (Table 3-2). The higher TN concentrations along the MF2-FF2 transect may have been influenced by Lac du Sauvage inflow (as measured at LDS-4), as TN concentration at LDS-4 was elevated relative to areas of Lac de Gras other than the MF2-FF2 transect.&quot;</td>
</tr>
</tbody>
</table>

| 20 | APPENDIX XIII, Eutrophication Indicators Report, Section 3.7, Results, Action Level Evaluation, page 48 |
| Comment | The demarcation of Action Level 3 (i.e., Normal Range plus 25% Benchmark (AL3)) is not legible in Figure 3-28. |
| Recommendation | Revise figure. |
| Nov 22: We agree that the "Normal Range plus 25% Benchmark (AL3)" was not visible in the pdf version of the Appendix. This figure will be corrected in the revised report. |
| 21 | APPENDIX XIII, Eutrophication Indicators Report, Section 3.7, Results, Action Level Evaluation, page 48 | **Comment** There appears to be an erroneous figure reference or the referenced figure is not provided in relation to the following text: "In 2017, 26.2% of the lake area had chlorophyll a concentrations above the upper limit of the normal range (i.e., 0.82 µg/L) (Figures 3-28, 3-29 and 4-2; Table 3-3)." Figure 3-29 presents the area of the lake that exceeds the Action Level 3 criterion. | **Nov 22:** The revised text will read: "In 2017, 26.2% of the lake area had chlorophyll a concentrations above the upper limit of the normal range (i.e., 0.82 µg/L) (Figures 3-28 and 4-2; Table 3-4)."

| 22 | MAIN DOCUMENT, Section 4.3, Eutrophication Indicators, Summary and Discussion, pages 31-44, and APPENDIX XIII, Eutrophication Indicators Report, Section 4.1, Summary and Discussion, Nutrients in Effluent and the Mixing Zone, page 51 | **Comment** Section 4.3 of the main document (pages 31-44) and Section 4.1 of Appendix XIII (page 51) only present annual loading of total phosphorus (TP) to Lac de Gras for effluent. This underrepresents the total loading of TP to Lac de Gras associated with the mine. Estimates of loading from dust, presented in Appendix XIII Appendix D (Assessment of Total Phosphorus Deposition to Lac De Gras), should be presented and discussed within the main body of the report and the summary section of Appendix XIII. | **Recommendation** Incorporate discussion of all anthropogenic sources of TP to Lac de Gras within the main document and Appendix XIII. | **Nov 22:** The reviewer’s recommendation suggests that the estimated TP loading from dust is of comparable importance to the TP loading from effluent. This is a false assumption. The dust sampling program was not designed to be as precise as the AEMP for measuring TP loading to Lac de Gras. As discussed in Appendix D of Appendix XIII, the estimate of TP loading from dust is considered to have low precision with an order of magnitude variance and could be considered a worst-case estimate. Therefore, low confidence should be placed in the estimate of TP loading from dust and it should not be directly compared to the TP loading from effluent, which is based on direct and precise measurements of TP concentrations in effluent and effluent volume. For this reason, we have a high confidence in the estimate of TP loading from effluent. Further, TP and chl a concentrations in Lac de Gras were evaluated at stations with the highest potential impact from dust and at stations where discharge from the diffuser is the main influence on water quality. As stated in Section 4.3.4 of the main document and Section 3.2 in Appendix XIII, the lack of evidence for greater TP or chlorophyll a concentrations at stations with the highest potential to be influenced by dust, and the distinct overall declining trend in chlorophyll a concentrations with distance from the diffuser provides strong evidence that the TP in effluent (leading to increased chlorophyll a) is the driving factor for nutrient enrichment effects observed in Lac de Gras.

| 23 | APPENDIX XIII, Eutrophication Indicators Report, Section 4.3, | **Comment** Although concentrations of TN were generally higher in Lac de Gras in winter, use of the 2017 open-water season monitoring data for delineation of the spatial extent of effects (i.e., the area of Lac de Gras above the normal range) would result in a | **Nov 22:** The purpose of the figures are to show the extent of the effects in the lake due to effluent discharge. The TN concentrations in the near-field area were lower during the open-water season compared to the ice-cover season and trends with distance from
| **Summary and Discussion, Extent of Effects, pages 53-59, Figure 4-2 and Appendix XIII - E, Eutrophication Indicators Raw Data** | larger calculated affected area. Specifically, results for the most western site (MF3-7) along transect MF3 exceeded the normal range in the summer but not the winter. Use of the open-water season data would result in an affected area that extended to the full extent of the monitoring site boundaries. The TN concentration for site MF3-7 in winter is 0.159 mg/L (mean of bottom samples; raw data presented in Appendix XIII - E), which is within the normal range for this season (0.138 - 0.173 mg/L), whereas the concentration for the open-water season is 0.186 mg/L (mean of raw data presented in Appendix XIII - E), which is above the upper boundary of the normal range (0.153 mg/L). **Recommendation** Recommend presenting spatial extent of effects for either the worst case (i.e., the largest spatial extent of effects) or present both the ice-cover and open-water season results in two figures. The latter would also provide for direct comparison of chlorophyll a and nutrient results for the same time period.** the diffuser were not significant (MF1-FF1 transect), slightly positive (MF3-FFB-FFA), or positive (increasing with distance from diffuser; MF2-FF2). It is agreed that TN concentrations in open-water were greater than normal range in 2017, but there is no indication that the concentrations were related to effluent discharge. In addition, TN concentrations at LDG-48 and LDS-4 were also above normal range but at similar concentrations relative to those in the NF area. |

| **APPENDIX XIII, Eutrophication Indicators Report, Appendix C, Quality Assurance and Quality Control, page C-3** | **Comment** Similar to a previous comment, the QA/QC appendix C (page C-3) indicates that duplicate sample results were considered notable where the Relative Percent Difference (RPD) was greater than 40%. This criterion is higher than used in previous reports. For example, in the 2017 AEMP Annual Report (Golder 2017), the criterion was 20% for evaluating duplicate sample results (Appendix XIII, Appendix B, page B-3). **Recommendation** Review the text and revise (if the value was reported in error) or provide a rationale for the change in the RPD criterion for evaluating duplicate sample results. Nov 22: The data quality assessment followed the approved Quality Assurance Project Plan (QAPP) Version 3.1 (Golder 2017c), which has a data quality objective of 40% for field duplicates. |

| **APPENDIX XIII, Eutrophication Indicators Report, Appendix C, Quality Assurance and Quality Control, page C-3** | **Comment** For review of QA/QC results, the percent of flagged duplicate nutrient samples (i.e., those failing data quality objectives) was expressed based on the total number of duplicate sample pairs collected (e.g., total of 190 duplicate sample pairs for the open-water season). However, of the total 190 duplicate pairs, RPDs for many samples could not be reliably assessed due to data values being less than 5 times the analytical detection limit. It would be more appropriate to evaluate the overall percent of flagged samples based on the total number of duplicate pair results where the RPD could be reliably calculated (i.e., for those total number of paired samples that exceeded 5 times the number of flagged duplicate RPDs was based on the total number of paired samples to give an accurate sense of data quality for the overall dataset. The data quality assessment included consideration of whether the target detection limits were achieved and the impact of any deviations on the interpretation of results. Assessing the achieved detection limits and number of flagged duplicate RPDs allows a more robust assessment of data quality than limiting the assessment to only results with more than 5x the detection limit. Assessing duplicate samples included evaluating patterns in flagged samples among stations and stations. |

| **APPENDIX XIII, Eutrophication Indicators Report, Appendix C, Quality Assurance and Quality Control, page C-3** | **Comment** Nov 22: The number of flagged duplicate RPDs was based on the total number of paired samples to give an accurate sense of data quality for the overall dataset. The data quality assessment included consideration of whether the target detection limits were achieved and the impact of any deviations on the interpretation of results. Assessing the achieved detection limits and number of flagged duplicate RPDs allows a more robust assessment of data quality than limiting the assessment to only results with more than 5x the detection limit. Assessing duplicate samples included evaluating patterns in flagged samples among stations and stations. |
detection limit). This approach also does not consider QA/QC results on a parameter by parameter basis and thus may not adequately assess potential issues with specific analytes.

**Recommendation** Recommend expressing the percent of flagged duplicate RPDs based on the total number of paired samples where one or more values exceeded 5 times the analytical detection limit. Also recommend expressing percentages of flagged values by water quality parameter in order to evaluate issues that may be present with specific analytes.

### Fisheries and Oceans Canada: Angie McLellan

<table>
<thead>
<tr>
<th>ID</th>
<th>Topic</th>
<th>Reviewer Comment/Recommendation</th>
<th>Proponent Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>General</td>
<td><strong>Comment</strong> Fisheries and Oceans Canada has reviewed the AEMP Annual Report - 2017. Although there are sections that relate to our mandate, we have no comments after reviewing the report. <strong>Recommendation</strong> N/A</td>
<td>Nov 22: N/A</td>
</tr>
</tbody>
</table>

### GNWT - ENR: Central Email GNWT

<table>
<thead>
<tr>
<th>ID</th>
<th>Topic</th>
<th>Reviewer Comment/Recommendation</th>
<th>Proponent Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>General File</td>
<td><strong>Comment</strong> (doc) ENR Letter with Comments, Recommendations and Attached Memo <strong>Recommendation</strong></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>General File</td>
<td><strong>Comment</strong> (doc) Attachment: Zajdlik &amp; Associates Inc. – October 2018 – Review of Diavik Diamond Mine 2017 AEMP <strong>Recommendation</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Topic 1: General</td>
<td><strong>Comment</strong> ENR retained Zajdlik and Associates to provide review and comment of the Diavik Diamond Mines (2012) Inc. (DDMI) 2017 Aquatic Effects Monitoring Program (AEMP) Annual Report. As part of the review, Dr. Zajdlik focused on previous WLWB Board Directives and Reasons for Decision for the prior AEMPs. ENR has extracted and summarized his comments and recommendations from this memorandum and provided them below. ENR has also included Dr. Zajdlik’s review memorandum which provides additional background, technical figures, and context for the comments and recommendations. <strong>Recommendation</strong> 1) ENR recommends the Board refer to the</td>
<td>Nov 22: No response required.</td>
</tr>
</tbody>
</table>
| Topic 2: WLWB 2014 AEMP Directives | **Comment** | All the Directives in WLWB’s Reasons for Decisions (WLWB 2016) that refer to comments by GNWT ENR on the 2014 AEMP review pertain either to the AEMP design or the AEMP 3-Year Re-Evaluation. ENR notes that DDMI (Golder 2018a, Table 2) did consider WLWB (2016), Directive 2A: "DDMI is to consider a more explicit analysis of the role of nitrogen in explaining variation and the spatial extent of chlorophyll a effect", within the 2017 AEMP. According to, DDMI (Golder 2018a, Table 2) this consideration is presented in Appendix XIII, Section 3.0 of the 2017 AEMP report. The spatial distributions of total ammonia, total nitrogen, total dissolved nitrogen, nitrate and nitrate + nitrite are discussed by DDMI (Golder 2018a, Appendix XIII, Section 3.6.2). The spatial distribution of chlorophyll a is also discussed by DDMI (Golder 2018a, Appendix XIII, Section 3.6.3). However, the relationship between nitrogen species and chlorophyll a is not considered by DDMI (Golder 2018a, Section 3) as stated. In a review of the 3-Year AEMP re-evaluation (Golder, 2018b) Dr. Zajdlik (2018) concluded that "The 'role of nitrogen in explaining the spatial extent of chlorophyll a effect' does not appear to be discussed explicitly" and recommended that: "DDMI should follow the spatial extent portion of the WLWB (2016b, Directive 2) to 'consider a more explicit analysis of the role of nitrogen in explaining variation and the spatial extent of chlorophyll a effects.' That is, DDMI should consider the role of nitrogen in the spatial extent of chlorophyll a effects."

**Recommendation** 1) ENR recommends DDMI clarify if the 2016 WLWB Directive 2A has been addressed as required in the 2017 AEMP report, or in a previously submitted report/plan. If not, DDMI should adequately respond to the Directive by providing a discussion for public review (e.g., in a technical memo) on the relationship between nitrogen species and chlorophyll a that was recommended by GNWT-ENR during the 2014 AEMP review and AEMP 3-Year Re-Evaluation. |
| --- | --- | --- |

Nov 22: The 2016 WLWB Directive 2A was addressed in Section 5.3.5.3 of the 2014 to 2016 AEMP Re-evaluation Report using data available for all AEMP monitoring years up to 2016. The evaluation indicated that although moderate to strong relationships were detected between TN and chlorophyll a in 2007 to 2013, similarly strong relationships were found between TDS and chlorophyll a, and TDS and TN were also correlated. Given the strong P limitation expected in Lac de Gras based on the TN:TP ratio, it was considered unlikely that N would be the limiting nutrient; rather, the strong correlation between chlorophyll a concentration and TDS suggested a Mine-related nutrient enrichment effect related to an increase in micronutrients associated with TDS. To address this recommendation, relationships among these variables were evaluated in the 2017 open-water data set by calculating Pearson correlation coefficients. Results indicate a strong, significant correlation between TDS and chlorophyll a (r=0.815, P<0.001, n=20), a weak relationship between TP and chlorophyll a (r=0.489, P=0.029, n=20), and no relationship between TN and chlorophyll a (r=0.123, P=0.605, n=20). These results are consistent with N not being the limiting nutrient in Lac de Gras, and also imply a potential Mine-related eutrophication effect related to an increase in micronutrients associated with TDS and potentially TP. These results will be added to the updated 2017 AEMP Annual Report as a new section in Appendix XIII, Section 3.0. |

<table>
<thead>
<tr>
<th>Topic 3: Appendix XIII</th>
<th><strong>Comment</strong></th>
<th>ENR notes that some of the Section numbers in the AEMP report Appendix XIII are incorrect.</th>
</tr>
</thead>
<tbody>
<tr>
<td>---</td>
<td>---</td>
<td>Nov 22: Acknowledged. Any errors in section numbering will be corrected in Appendix XIII, Section 2.3.</td>
</tr>
</tbody>
</table>
| Topic 4: WLWB 2015 AEMP Directives and DDMI Commitments | **Comment** WLWB’s Reasons for Decision on the 2015 AEMP Annual Report (2017a) reports that Directive 2C pertains to AEMPs stating: "DDMI is to clarify the meaning of 'slight increase in trophic status' in all future AEMP-related reports". DDMI (Golder 2018a, Table 2) points to Appendix XIII, Section 4.2 of the 2017 AEMP report as the section where WLWB (2017a) Directive 2C is addressed. In that section DDMI (Golder 2018a) states: "A slight increase in nutrient enrichment suggests that nutrients are increasing in Lac de Gras, but a change in trophic status from oligotrophic to mesotrophic has not been observed." The statement puts a boundary on the change in trophic status but is not definitive. Trophic status is a continuum that is defined using a variety of metrics with some debate regarding choice of metrics. ENR has previously commented to the Board on the continuum in trophic status and what defines a change in trophic status as it relates to Lac de Gras. DDMI (Golder 2018a Appendix XIII, Section 3.4 Figures 3-10, 3-12 inclusive and Figures 3-13, 3-15) present boxplots of nutrients and plankton metrics by area for the 2017 sampling season. These informative graphics should be summarized in a table that contains the percent increase in the median eutrophication metric (nutrient or chlorophyll a concentration or plankton biomass) relative to the baseline median by area. This allows readers to rapidly assess how each eutrophication metric has changed relative to the baseline and allows the authors to unequivocally present the degree of change. **Recommendation** 1) ENR recommends that the informative graphics discussed above should be summarized into a table that contains the percent increase in the median eutrophication metric (nutrient or chlorophyll a concentration or plankton biomass) relative to the baseline median by area by DDMI.

**Nov 22:** DDMI does not agree with the recommendation to include the requested summary table as it would not provide additional useful information for evaluating mine-related effects in Lac de Gras. There are no generally applicable criteria for northern lakes for percentage changes to use when evaluating effects on eutrophication indicators. The requested table would reduce complex results best shown as plots to single values per variable that are substantially less informative. In addition, percentage changes in median values can be misleading, because they ignore variation around the median value, and can substantially inflate the perception of magnitude of change when concentrations are low. |
<p>| Topic 5: WLWB 2015 AEMP Directives and DDMI | <strong>Comment</strong> WLWB (2017a) notes that &quot;the GNWT-ENR recommended that DDMI provide the raw toxicity test data as part of the AEMP reports (GNWT-ENR comment 9). In its response, DDMI stated that they would consider including these results as an | <strong>Nov 22:</strong> DDMI will include this requirement when the AEMP Design is next updated. |</p>
<table>
<thead>
<tr>
<th>Commitments - Raw Toxicity Data</th>
<th>appendix to the annual AEMP reports. Although the raw toxicity test data were not included, the toxicity test methods are introduced in the report (Golder 2018a, Appendix II, Section 2.3.4.4), test results are presented by DDMI (Golder 2018a, Appendix II, Section 3.2.6) and the specific sampling months are listed. The inclusion of a result summary is in this case, helpful as it highlights the absence of acute or chronic toxicity based on the pass/fail criterion. Highlighting the hormetic effect for Pseudokirchneriella subcapitata for each of the four sampling times at the surveillance network program monitoring locations is also helpful. That said, detecting the increased but statistically insignificant exposure immobility and mortality in <em>Daphnia magna</em> and exposure rainbow trout egg and embryo mortality in the September sample required retrieval of Surveillance Network Program documents. <strong>Recommendation 1)</strong> ENR recommends that the raw toxicity data should be provided by DDMI as part of the AEMP report.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 Topic 6: WLWB 2016 AEMP Directives and DDMI Commitments - 2.3.1 Ammonia Contamination</td>
<td><strong>Comment</strong> WLWB (2017b) Directive 2 pertains to AEMPs stating: &quot;DDMI is to include as part of the 2017 AEMP Annual Report, the results of its investigation and proposed recommendations regarding ammonia contamination issues&quot;. DDMI (Golder 2018a, Table 2) points to Appendix II Section 2.4.1 and Appendix B as the sections where WLWB (2017b) Directive 2 is addressed. In that section DDMI (Golder 2018a) describes improvements made to sample handling by Maxxam Analytics (Maxxam). In an ammonia quality control study, 124 samples duplicate samples were submitted to both Maxxam and ELS (Golder, 2018b, Appendix 4B, Attachment A ALS/Maxxam Total Ammonia Interlab Comparison). Of those samples, 71 Maxxam and 69 ALS results were less than the detection limit (0.005 mg/L) and a fixed value of 0.003 mg/L was substituted. This very large proportion of censored observations biases the variance term used in the paired t-test downward, artificially increasing the power of the paired t-test. Dr. Zajdlik, in his review, notes that this likely had the effect of making the conclusion &quot;no systematic bias in ammonia measurements between analytical laboratories&quot; more defensible. Although Maxxam analytical procedures have been improved, DDMI (Golder Nov 22: DDMI has an ongoing commitment to making improvements to the quality of the ammonia data for low level measurements, and continues to be engaged with ongoing efforts for improvement with the commercial laboratory.</td>
</tr>
</tbody>
</table>
2018a) states that ammonia results from the ALS laboratories will be used as the data quality is better and so that potential laboratory effects are obviated. Table B1, Appendix B (Golder, 2018a, Appendix II) shows that ammonia was detectable in 50% (2/4) of equipment blanks (at high concentrations), 33% (1/3) of field blanks and 50% (1/2) of trip blanks in the 2017 samples submitted to Maxxam. Table B1, Appendix B (Golder, 2018a, Appendix II) also shows that ammonia was detectable in 50% (1/2) of equipment blanks (at high concentrations), 50% (2/4) of field blanks and 25% (1/4) of trip blanks in the 2017 samples submitted to ALS. The maximum recorded quality assurance ammonia concentration was 42 µg/L measured in a field blank submitted to Maxxam. Under the assumption that the entry "ALS (Maxxam)" in Table B2, Appendix B (Golder, 2018a, Appendix II) pertains to ammonia, relative percent differences for duplicate samples are 47.8 and 14.8% (Maxxam) and 7 and 20% (ALS). Given the data quality objective of a 40% limit on the relative percent difference (Golder, 2018a, Appendix II, Appendix B) 50% (1/2) Maxxam samples "fail". The detection of ammonia in a large proportion of the ALS quality assurance blanks suggests that low level detection of ammonia remains problematic. The maximum ammonia concentration recorded in a blank by ALS was 12 µg/L. Assuming that this is a random as opposed to systematic event, ammonia concentrations that could be biased more than 50% are any that are reported as lower than 24 µg/L. Such ammonia concentrations are reported for the August through October samples collected at the mixing zone boundary by DDMI (Golder 2018a, Appendix II, Figure 3-8), most of the open water samples (aside from nearfield samples) and all but one of the under-ice samples (Golder 2018a, Appendix II, Figure 3-50). Note that this is a worst-case scenario but, there is also the possibility of a lesser extent of bias such as 25%. The results presented in the 2017 AEMP Annual Report (Golder 2018a, Appendix II, Figure 3-50) make sense in a general fashion; ammonia concentrations decrease with distance from the source and concentrations are lower in the open water season. Given that Action Level 1 tests for a two-fold difference between the nearfield area median concentrations that are high or non-
detectable (30.0 and < 0.5 µg/L for the under ice and open water seasons; respectively) and reference dataset median concentrations of 17.8 µg/L under ice and 5 µg/L in the open water (this is the detection limit) (Golder, 2017b) there is some cause for concern if the reference median dataset is suspect due to quality control issues. A visual examination of the data presented in the AEMP Reference Conditions Report Version 1.2 (Golder 2017b) shows four aberrant observations on the high side. These four observations are not sufficient to bias estimation of the median of that dataset. Action Levels 2 and 3 use the 5th percentile ammonia concentrations in the nearfield area and the 75th percentile ammonia concentration at the mixing zone boundary, respectively as exposure measurements. Given current observed concentrations in the nearfield it is unlikely that ammonia quality assurance issues will adversely affect comparison with action levels. The ALS ammonia data quality remains of concern and further efforts should be made to improve the quality of the ammonia data for low level measurement. From a practical management perspective based on current use of Action Levels, the ammonia data quality concern is only of moderate concern. **Recommendation** 1) ENR recommends DDMI review the ammonia data quality and commit to making improvements to the quality of the ammonia data for low level measurements.

<table>
<thead>
<tr>
<th>7</th>
<th>None</th>
<th><strong>Comment</strong> None</th>
<th><strong>Nov 22:</strong> This label should read &quot;Ammonia (Maxxam)&quot;. This entry will be corrected in the revised report.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recommendation</strong> 2) ENR recommends that DDMI should clarify that the entry &quot;ALS (Maxxam)&quot; in Table B2, Appendix B (Golder, 2018a) pertains to ammonia.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 8 | Topic 7: Nutrient Loadings | **Comment** DDMI states in the 2017 AEMP report (Golder 2018a, Appendix XIII, Appendix D): "Lac de Gras is an oligotrophic lake characterized by very low concentrations of nutrients, including total phosphorus (TP). The median background concentration of TP in Lac de Gras is 3.6 micrograms per litre (µg/L) during the ice-cover season (with a normal range of 2.0 to 5.0 µg/L), and 3.3 µg/L during the open water season (with a normal range of 2.0 to 5.3 µg/L) (Table 3.2-12; Golder 2017a)". Environment Canada (2004) with respect to phosphorus in freshwater states that: "If the increase from the baseline is greater than 50%, the risk of |
|---|---|---|---|
| **Nov 22:** The 2014 and 2015 chlorophyll a data will be provided in an electronic (i.e. Microsoft Excel) format, if not already available on the WLWB public registry. |
observable effects is considered to be high, and further assessment is recommended". Median background concentrations for total phosphorus in Lac de Gras are 3.6 and 3.3 µg/L during the ice-cover and the open water seasons, respectively (Golder 2018a, Appendix XIII, Appendix D). Using those values and data provided on the public registry, the proportion of samples exceeding a 50% increase in the season-specific baseline median is plotted for the last four years. "To provide the most conservative view of effluent effects, the season and depth with the greatest extent of effects was selected for this evaluation" following Golder (2018b). Dr. Zajdlik shows in his review for ENR (Figures 1 and 2) that on a conservative basis a very large proportion of samples exceed the Environment Canada (2004) recommended 50% increase in TP. The figures show the proportion of samples exceeding a 50% increase in season-specific TP baseline for the years examined, varies between 2 and 24%. More samples exceed a 50% increase in the season-specific TP baseline in the open water season than under ice. Dr. Zajdlik also demonstrates that a 50% increase over the baseline occurs most frequently in the nearfield and that the proportion of samples higher than 50% of the baseline is increasing since 2015. It is not clear whether conclusions reached using the figures presented would compare with those reached using Golder (2018b, Figure 5-1) if the 2015 data were included. That figure shows the affected area (as defined by) exceedance of the natural range and using "the season and depth with the greatest extent of effects" (Golder, 2018b., Section 5.2.3.4). However, the overall message is that large portions of Lac de Gras exceed the Environment Canada (2004) 50% increase in baseline criterion for TP who state: "If the increase from the baseline is greater than 50%, the risk of observable effects is considered to be high, and further assessment is recommended". ENR encourages the Board and DDMI to further review Dr. Zajdlik’s memo included in this response, including the figures discussed above.

**Recommendation 1** ENR recommends that DDMI should provide the 2014 and 2015 chlorophyll a data in an electronic (i.e. Microsoft excel or similar) format.
Recommendation 2) ENR recommends that DDMI should use the current chlorophyll a extent of effects paradigm and estimate the spatial extent of exceedances of a 50% increase in the season-specific total phosphorus baseline median following Environment Canada (2004) to allow regulators to decide whether further investigation of the Environment Canada (2004) criterion is warranted.

Nov 22: The DDMI AEMP employs a Response Framework to manage Mine-related effects in Lac de Gras, consistent with guidance provided by the WLWB. Annual AEMP reports evaluate nutrient enrichment effects based on multiple indicator variables, and tiered Action Levels based on chlorophyll a concentration are used to trigger management actions. The general intent of the AEMP Response Framework is to maintain a healthy, diverse and functioning aquatic ecosystem, remaining within the oligotrophic range, which is consistent with the goals of the CCME Phosphorus Management Framework (PMF; CCME 2004). The AEMP uses chlorophyll a concentration as the key evaluated variable to trigger management actions, whereas under the PMF, exceeding the baseline plus 50% value for TP indicates that "the risk of observable effects is considered to be high, and further assessment is recommended". It is worth noting that nutrient enrichment effects have been observed in Lac de Gras since 2007 and further assessment is conducted annually as part of the AEMP. The 2014 to 2016 AEMP Re-evaluation Report (Golder 2018, Section 5.3.8.3) provided an evaluation of the applicability of the 50% increase in TP criterion to manage Mine-related nutrient enrichment in Lac de Gras. Golder (2018) concluded that this criterion is unlikely to be of value, in part because it was triggered by reference area data due to low and variable TP concentrations in Lac de Gras. In addition, while the TP criterion was only occasionally triggered in the Near-field area (representing the likely worst-case effects from the Mine) during 2007 to 2016, Action Level 1 or 2 triggers were observed for chlorophyll a during each year. DDMI therefore does not agree with this recommendation as evaluation of the application of the PMF elements suggested by GNWT-ENR has shown that adopting the baseline plus 50% TP value to evaluate annual AEMP results would not result in a useful addition to the management of effects related to nutrient inputs to Lac de Gras from the Mine. The current approach to managing P inputs, which consists of (1) the EQC under the Water Licence, (2) annual monitoring and assessment of nutrient concentrations and biological response variables under the AEMP, and (3) focusing on biological effects to
| Topic 8: Phosphorus Contaminant Loadings from Dust and Effluent | **Comment** This comment discusses the contributions of phosphorus from dust and effluent in the context of the Water Licence limit for TP loadings via effluent to Lac de Gras. Approximate calculations regarding the relative loads of ammonia from effluent and dust to Lac de Gras are also presented to explore whether dust should be considered as a contaminant source when discussing loadings to Lac de Gras. DDMI (Golder 2018a, Appendix II) reports that the TP loadings from the Mine "in 2017 was 1,400 kilograms/year (kg/y), with 420 kg/y from effluent, 630 kg/y from direct dust deposited to the lake surface, and 340 kg/y from runoff from the surrounding watershed (excluding the Mine footprint)". Although the combined current Mine-associated loadings exceed the TP loading limit for the Water Licence, the Licence is specific to "all treatment facilities discharging to Lac de Gras" (WLWB, 2018) and therefore the 420 kg deposited by DDMI in 2017 falls well below this limit. Due to the uncertainty of when the mine will cease operations, ENR is unable to estimate the annual average loading as stipulated in DDMI’s Water Licence (Part H, Item 32) and therefore uncertain if the annual average would approach the 1000 kg per year limit for any given year (see subsequent comment and recommendations for more discussion on this topic). An annual loading limit for TP was not included in the original Water Licence for the Diavik Diamond Mine (Northwest Territories Water Board, 2000). The annual loading limit was added following a request by DDMI as the mine was occasionally out of compliance using a concentration-based limit (DDMI, 2002a). Considerable trigger response actions, is adequate and has functioned well to date. The PMF allows for site-specific management of P, which is the preferred approach for Lac de Gras. References: CCME 2004. Canadian Water Quality Guidelines for the Protection of Aquatic Life: Phosphorus: Canadian guidance framework for the management of freshwater systems. In: Canadian Environmental Quality Guidelines, 2004, Canadian Council of Ministers of the Environment. Winnipeg, MB. Golder Associates Ltd. 2018. 2014 to 2016 Aquatic Effects Re-evaluation Report for the Diavik Diamond Mine, Northwest Territories. Prepared for Diavik Diamond Mines (2012) Inc. Yellowknife, NT. | **Nov 22:** Appendix XIII, Section 3.2 text will be updated to reference Appendix D of Appendix XIII and the 2014 to 2016 AEMP Re-Evaluation report, both of which include discussion of the spatial interpolation methods used to compute background and anthropogenic loadings of TP to the Lac de Gras watershed. Please also refer to the response to EMAB-16. |
discussion ensued (DDMI, 2002b), with an apparent outcome that if the (then) newly updated predicted TP loads were lower than those used in the environmental assessment, that a loadings-based limit (using the updated, lower limits) for TP was reasonable. The phosphorous loadings used in the original environmental assessment (DDMI, 2002a) may be 1657 kg/y for all facilities with a maximum of 2,321 kg/y for all facilities. It is not clear whether those figures include the construction sewage load of 292 kg/y. As the 2017 loadings fall well below the loadings used in the original environmental assessment that concluded that "there would be no significant adverse residual effects of nutrient enrichment (that is based on phosphorous) on Lac de Gras during operations and post-closure" (Canada, 1999) action based on the original environmental assessment is not warranted. That said, previous recommendations regarding nutrient management (Zajdlik, 2016) in the context of more recent Environment Canada (2004) and CCME (2006) guidance are still relevant. DDMI (Golder 2017c) presents methods for estimating TP loadings to Lac de Gras via dust. These use TP concentrations in snow water as the basis for the loading estimates. DDMI (Golder 2018a, Appendix I, Figure 3.3-4) presents phosphorus concentration in snow water that diminish from approximately 50 µg/L in 0-100m distance from Mine footprint range to background deposition rates. Concentrations of ammonia are greater than approximately 100 µg/L in the 101-250 m range (0-100m range data are not presented) (Golder 2018a, Appendix I, Figure 3.3-1). Ammonia concentrations in snow water are approximately double the phosphorus concentrations in snow water.

**Recommendation** 1) ENR recommends that the methods used to estimate total phosphorus loadings from dust, presented in Golder (2017c) should either be referenced in future AEMPs or the methods should be included in the AEMP by DDMI.

| 11 | Topic 9: Phosphorus Loading | Comment | The current Water Licence that DDMI operates under (WLWB, 2018 Part H, Item 32) contains a clause regarding the total annual phosphorus loadings from effluent that discusses total average annual loading of 1,000 kg per year during the life of the mine. The average annual loading of total phosphorus is defined |
| Nov 22 | DDMI considers this recommendation by ENR as beyond the scope of the AEMP review. |
therein as follows: "Average Annual Loading of Total Phosphorus" means the sum of annual loads divided by the number of annual loads summed. As defined the average annual loading of the mine is a running average and the "average annual loading of 1,000 kg per year during the life of the mine" cannot be known until the mine ceases operating. Although loads from "all treatment facilities discharging to Lac de Gras" as stated in the Water Licence are well below the prescribed limit, the wording of the Water Licence should be corrected.

Recommendation 1) ENR recommends that the wording of the Water Licence should be corrected. This may take the form of a 3 year average as originally envisioned (DDMI, 2000b).

12 Topic 10: Loadings from Dust and Action Levels

Comment The following paragraphs discuss how dust and effluent loadings are combining in the near and mid field areas to challenge interpretation of loadings. This requires that dust and effluent loadings be considered simultaneously when assessing effects in Lac de Gras. The linkage between loadings and effluent quality criteria (EQC) is discussed leading to a recommendation that if substantive dust loads occur, EQCs should be reconsidered in the context of combined (dust and effluent) loadings so that effects benchmarks are not exceeded. Because Action Levels define actions that follow exceedance of an action, consideration of dust loads following exceedance of specific Action Levels is also discussed. The interpretation of potential dust deposition effects with respect to other analytes is contingent upon an assessment of spatial patterns with respect to the dust zone of influence. DDMI (Golder 2018a, Section 4) concluded that "the increases at the MF stations may not be solely related to effluent" (Increases refer to ammonia, lead and tin). Of the 10 substances of interest that were greater than 2 x the median of the reference dataset in one or more of the midfield stations, 7 also triggered Action Level 1 in the nearfield. DDMI (Golder 2018a, Section 4) concludes that "exceedances at the MF stations were at least partly caused by dispersion of Mine effluent into the lake". The 2017 AEMP was carried out following AEMP Design Plan Version 4.1 (Golder 2017a). Under that design, for water quality variables, Action Level 3 requires derivation of EQC. Effluent based EQCs are back-

Nov 22: Effects on water quality and aquatic life are being monitored by the AEMP from all mine-related sources in Lac de Gras, with an emphasis on effluent-related effects, because monitoring has shown that the effluent is the main contributor to mine-related effects. Effects from dust deposition under the AEMP are evaluated in relation to phosphorus (P) deposition in Section 3.2 of Appendix XIII, and for all variables in Section 3.6 of Appendix II. This analysis is of interest in relation to P deposition, because effects related to nutrient enrichment have been observed in Lac de Gras, and dustfall is known to contribute P to the lake. Results indicate that P deposited from dust is unlikely to account for the observed enrichment effect in Lac de Gras, and that overall, a dust-related effect on water quality is not apparent. The recommended loading calculation is not done for variables other than P as part of routine annual AEMP data analysis, as per the currently approved AEMP Design Plan. Considering the effects on water quality observed in Lac de Gras, which can be characterized as mild nutrient enrichment and increased concentrations of ions and metals related to the effluent discharge, without an apparent dust-related effect on water quality, additional evaluation of loadings from dust deposition is not warranted. Please also refer to the response to EMAB-22.
calculated from effects benchmarks. As the water quality effects benchmarks "represent levels of water quality variables below which a body of water is expected to be suitable for its designated use" (Golder, 2017a), the benchmark applies regardless of the waste source. If dust loadings comprise a substantive proportion of waste loads being deposited to Lac de Gras by the Proponent, then EQCs should reflect that loading to ensure that the water quality benchmark is not exceeded. At this point in time, the relative contribution of TP from dust, to the deposition of waste in Lac de Gras is not known. Monthly ammonia loading rates from the North Inlet Water Treatment Plant are presented in the AEMP report (Golder 2018a, Appendix II, Figure 3-8). Using that figure, 200 kg is a crude estimate of an average ammonia monthly loading rate, leading to an annual ammonia loading rate of 2,400 kg/y. Using a conservative 2:1 ratio of ammonia: TP in snow water and the reported 630 kg TP contribution from dust to Lac de Gras in 2017 (Golder (2018a, Appendix II), the ammonia loading from dust may be very approximately, 1,260 kg/y (=2 x 630 kg/y total P from dust) or a contribution of approximately 50% of the loading from the North Inlet water treatment plant. These "back-of-the-envelope" calculations by Dr. Zajdlik suggest that loadings of nutrients and substances of interest attributable to dust deposition from the Mine site can add significantly to the amount of waste deposited via effluent that is permitted under the current Water Licence. Dust deposition may explain the concentrations of total nitrogen at the MF2-FF2 transect, that were elevated relative to the NF area (Golder, 2018a Section 4.3.2). Under AEMP Design Plan Version 4.1, exceedance of Action Level 4 requires an investigation of mitigation options. Mitigation options could consider improved dust management as part of the action plan. However, the extent to which reductions in dust losses would enable the Proponent to meaningfully manage losses is not currently known as the relative loadings are not known. Finally, given general concerns with eutrophication following increased awareness of eutrophication and provision of Federal Guidance (CCME, 2006; Environment Canada, 2004) subsequent to the environmental assessment, a recommendation regarding
measuring nutrient loads is provided below.

**Recommendation 1** ENR recommends that DDMI should provide a table of the loadings from dust and effluent for all analytes triggering Action Level 1.


**Recommendation** None.

<table>
<thead>
<tr>
<th>ID</th>
<th>Topic</th>
<th>Reviewer Comment/Recommendation</th>
<th>Proponent Response</th>
</tr>
</thead>
</table>
| 1  | Appendix 1 Table 2-1; Sampling dates | **Comment** Table 2-1 presents the 2017 sampling locations. The third column's heading indicates "2016 Sampling dates". On the second page of the table, this column is labelled "2015 sampling dates".  
**Recommendation** Please clarify if the sampling locations are from the 2017 season. If so, please confirm that the information in this table is also from 2017. | Nov 22: The sampling information is from 2017. The table headings will be corrected. |
| 2  | Appendix 1: Dustfall gauge methodology | **Comment** Table 2-1 indicates that all dust stations, except for Dust 11 and 12 which were only deployed once, were sampled 4 times in the year. The methodology described in Section 2.1 states "once the mass of collected dustfall at a station was measured, the mean daily dustfall rate over the collection period was calculated as D =M/A*T, where T is the number of days of dustfall collection. Then, | Nov 22: a) Annual deposition rate was weighted quarterly based on the days of deployment during that quarter. b) To calculate annual dust deposition rate, the mean daily rate (see above) was multiplied by 365 to get an annual rate. |
mean daily dustfall rate was multiplied by 365 days to estimate mean annual dustfall rate. According to this methodology, there should be 4 mean daily dustfall rates for each sampling station (one for each of the sampling periods).

**Recommendation**

A) How were differences in deployment time for each sampling period adjusted for in annual deposition rate calculations?  
B) Please explain the calculations that DDMI used to go from mean daily rates to one annual rate for all stations.

### Appendix 1: Dust deposition results

**Comment**  
Section 3 states that, for Dust 1, highest recorded dustfall occurred during the summer months (936 mg/dm/yr) compared to winter months (230 mg/dm/yr). Section 3.1 states that annual dustfall rate at Dust 1 is 480 mg/dm/yr.

**Recommendation**  
For all dustfall sampling locations, please identify what deployment period was used to calculate summer/winter deposition rates.

**Nov 22:** The March to July and July to September/October 2017 deployments constituted summer and the previous year to March 2017 and September/October to December 2017/January 2018 deployments constituted winter for all dustfall sampling locations, with the exception of Dust 11 and 12 which were only sampled once in January 2018 after installation in October 2017 (winter). Raw data indicating deployment periods is shown in Appendix B.

### Appendix 1: Snow water chemistry results- Ammonia

**Comment**  
Snow water chemistry data for ammonia (figure 3.3-1) is missing from the 0-100m site from 2013-2017. The data from 2017 is also missing from Table 3.1-1. Additionally, no ammonia data is presented from any distance for 2016. No explanation is provided for this omission.

**Recommendation**  
Provide rationale for the omission of this data from both Figure 3.3-1 (ammonia data from 2013-2017) and Table 3.3-1 (ammonia data from 2017).

**Nov 22:** There was a transcription error that caused the ammonia result in the 0-100 m zone to be excluded in 2017. The correct value for location SS3-6 was 120 ug/L. In previous years there was only one measurement taken so no median value was able to be calculated. An updated figure showing the single value for all available years of ammonia measurements is included as Attachment-1.

### Directives

**2015 AEMP Annual report RFD Directive 2D**

**Comment**  
Directive 2D from the WLWB’s RFD on the 2015 AEMP Report required that DDMI "Include a footnote to Figures 3.1-1 to 3.3-1 explaining the absence of any medians from the 0-100m zone". In its conformity table for the 2017 AEMP, DDMI indicates

**Nov 22:** The referenced figures show snow water quality as a result of the effects of dust deposition. As noted by DDMI and stated in the 2014 AEMP Annual Report Reasons for Decision (RfD), "The May 26, 2016 Directive from the WLWB instructs DDMI
<table>
<thead>
<tr>
<th>Section</th>
<th>Comment</th>
<th>Recommendation</th>
<th>Nov 22</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.2.3</td>
<td>that this section is addressed in the water quality section, in Appendix 2 Section 3.2.1 to 3.2.3. However, the Board's directive refers to dust deposition not water quality. <strong>Recommendation</strong> Please describe how this directive was addressed in the 2017 AEMP report as it relates to dust deposition or clarify the location in the concordance table.</td>
<td>to address the effect of nutrient loading from dust deposition in the Version 4 AEMP Design Plan. Therefore, DDMI plans to present the method for evaluating the effect of dust deposition on water quality in the Design Plan for approval by the Board, and then include the required subsection in the Water Quality sections of subsequent AEMP annual reports.&quot; The RfD go on to state that, &quot;...the Board will consider the proposed method for evaluating the effect of dust on the water quality of Lac de Gras during its consideration of the AEMP Design Version 4.0. The Board is also directing DDMI to include the required subsection starting with the 2016 AEMP Annual Report.&quot; DDMI therefore considers the location of this discussion within the report to be appropriate and consistent with Board directives. The required updates to the footnotes for Figures 3.1-1 to 3.3-1 have been included as Attachment-1.</td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>Several of the results paragraphs in this section (e.g. 3.3.4, 3.3.5, 3.3.8) refer to results from 2016. It is unclear if this is an error or if DDMI intended to discuss 2016 data, rather than 2017 data. <strong>Recommendation</strong> Please clarify if subsections in Section 3.3 of Appendix 1 report data from 2017 or 2016.</td>
<td></td>
<td>Acknowledged. Sections 3.3.4 and 3.3.8 contained typographical errors which noted 2016 instead of 2017, however the results discussed are for 2017.</td>
</tr>
<tr>
<td>3.4</td>
<td>The goal for liquid water RPD is 20% when the average concentration is &gt;5x DL. RPD for dustfall was between 25-47% and was called &quot;moderate&quot;. It is not clear what &quot;moderate&quot; means with respect to the dustfall collection program and how this may influence the interpretation of results. <strong>Recommendation</strong> A) Is there a dust RPD goal? B) Is a 39% RPD for dustfall samples acceptable? C) Has DDMI considered adding QAQC standards for dustfall measurements?</td>
<td>A) Is there a dust RPD goal? B) Is a 39% RPD for dustfall samples acceptable? C) Has DDMI considered adding QAQC standards for dustfall measurements?</td>
<td>DDMI would first like to clarify that the water quality RPD goal is 40% (please also refer to the response to EMAB-10). Dust samples are inherently highly variable so RPDs of 25-47% are considered acceptable for interpretation. The BC Field Sampling manual suggests RPDs between 20-50% indicate there may be a problem with sampling, however, due to the previously stated highly variable nature of dustfall samples the RPD values found are not a cause for concern. DDMI will consider adding QA/QC standards for dustfall when the AEMP Design is next updated.</td>
</tr>
<tr>
<td>3.4</td>
<td>Table 3.4-1 summarizes duplicate analysis results and RPDs for snow survey and snow water chemistry samples. For SS1-1, RPD is calculated as 39%. However, from the data presented it appears that the actual RPD may be greater than 100%. <strong>Recommendation</strong> Please verify and confirm the RPDs reported in Table 3.4-1. If any values need to be updated, please describe</td>
<td></td>
<td>Acknowledged. There was a typographical error in the first column of Table 3.4-1. It should read 1662/1118 for SS1-1 which gives a RPD of 39%, as stated in the table.</td>
</tr>
</tbody>
</table>
10 Appendix VIII: Gill net deployment time  
**Comment** The A21 fish out program yielded approximately 10% of the fish biomass expected to be removed from the A21 pit area. During the CPUE phase, short gill net deployments were used (i.e. 2 hrs) to minimize fish mortality. However, the DFO guidance indicates that nets should be moved daily to minimize disturbance behaviour.  
**Recommendation** Has DDMI considered if the short duration of net deployments impacted fish recovery rates?

| Nov 22: Golder and DDMI worked closely with DFO to develop an A21 De-fishing Execution Plan. Short duration gill netting was conducted during Phase 1 of the program in an effort to reduce fish mortality, as the primary focus of the program was fish transfer. Fish transfer was required under DDMI's Fisheries Act Authorization. Overnight gill net sets in Phase 2 showed a minimal increase in fish catch rates; therefore, the selected methodology was assumed effective. For the short duration and overnight sets, the nets were moved continually throughout the day and were not set in the same place from day to day. |

11 Appendix VIII: Dewatering during phase 2 of fish out  
**Comment** According to DFO guidance, dewatering activities can and should occur during phase 2 of the fish out. This aids in concentrating the remaining fish in the deeper areas, thus increasing the likelihood of successful catch and transfer. However, DDMI did not commence dewatering activities during phase 2 of the fish out program.  
**Recommendation** A) Please provide rationale for why dewatering activities did not take place during phase 2 of the fish out. B) Discuss if this had the potential to impact fish out success.

| Nov 22: Golder and DDMI worked closely with DFO to develop an A21 De-fishing Execution Plan where dewatering was an option, if required, to facilitate the de-fishing. Due to low fish catch rates during Phase 1 and 2, dewatering was not required to meet the de-fishing objectives and DFO provided approval to Golder and DDMI to cease fishing effort. The fish-out was deemed successful and complete by DFO and dewatering was not suggested as a means to increase the already very low catch results. |

12 Appendix VIII: Data collected from individual fish  
**Comment** DFO guidance indicates that ageing structures and biological tissue samples should be collected from all larger, older fish and a subsection of smaller, younger fish during a fish out. This information does not appear to be included in the Report.  
**Recommendation** A) Did DDMI collect data for ageing structures and biological tissue samples as per DFO guidance? B) If yes, please indicate where this data is reported. C) If not, please describe if this affects DDMI’s ability to meet the objectives of the fish-out.

| Nov 22: Golder and DDMI worked closely with DFO to develop an A21 De-fishing Execution Plan that included primarily fish transfer rather than sacrificing individual fish, as per DDMI’s Fisheries Act Authorization. As part of the execution plan approved by DFO, the collection of ageing structures and biological tissue samples was not required. The objectives of the fish-out were met as outlined in the Execution Plan. DFO provided approval of the plan and signed off that the fish-out was completed. |

13 Appendix VIII: Fish out Report Table 3-6  
**Comment** The title of this table is "Fish catch and weight by Species for Lynx Lake Fish-Out.  
**Recommendation** Please confirm that the data contained in this table is from the A21 fish out program.

<p>| Nov 22: Acknowledged. This will be corrected in the final version of the report. |</p>
<table>
<thead>
<tr>
<th>14</th>
<th>Appendix VIII: Fish out follow up</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comment</strong></td>
<td>The A21 fish-out yielded only 10% of the expected biomass. DDMI indicated that this discrepancy is likely due to the timing of construction activities for the dike, which allowed fish to avoid and escape the diked area prior to fish-out.</td>
</tr>
<tr>
<td><strong>Recommendation</strong></td>
<td>Does DDMI have any plans for follow-up monitoring or actions to verify the success of the fish out?</td>
</tr>
<tr>
<td><strong>Nov 22</strong></td>
<td>The pit lake has been dewatered and no remaining fish were identified; no further monitoring or follow up actions are possible.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>15</th>
<th>Nitrogen contamination issues (Appendix II, Appendix B and XIII)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comment</strong></td>
<td>Appendix II Section 2.4 indicates that there were QAQC issues with ammonia contamination and abnormal results for turbidity. Appendix B of Appendix II indicates that there were potential contamination issues with Ammonia, total dissolved kjedahl nitrogen, total dissolved nitrogen and dissolved molybdenum. Appendix C of Appendix XIII states that there were potential issues for total dissolved nitrogen and dissolved kjedahl nitrogen. These various sections of the report seem to convey different information. It is also unclear if the contamination issues have been remedied to a degree that is acceptable to DDMI for the purposes of meeting the requirements of its AEMP.</td>
</tr>
<tr>
<td><strong>Recommendation</strong></td>
<td>A) Please provide a summary of all potential contamination issues in the 2017 dataset with respect to nitrogen species and how this has influenced conclusions with respect to mine effects related to nitrogen. B) Please describe what data has been omitted from analysis, or has been used with caution, in the 2017 AEMP report. C) Please describe if any additional work is planned to address outstanding QAQC issues, especially with respect to TDN and TKN.</td>
</tr>
<tr>
<td><strong>Nov 22</strong></td>
<td>A) The Effluent and Water Chemistry Report (Appendix II) includes results for nitrate, nitrite, and ammonia. No contamination issues were noted for nitrate and nitrite. The ALS ammonia data were used instead of the Maxxam ammonia data. The Eutrophication Indicators Report (Appendix XIII) noted the issues with Maxxam ammonia data as discussed by Appendix II and also used the ALS ammonia data for the Eutrophication Indicators effects assessment. As stated in Section 2.3.6 of Appendix XIII, under-ice TDN data were considered to be suspect and were only presented as graphs in the report to provide transparency and to allow for comparisons of spatial trends to other nutrient results. As discussed in Appendix C to Appendix XIII, dissolved Kjeldahl nitrogen (DKN) data collected during the ice-cover season had the same data quality issues as total dissolved nitrogen (TDN). As DKN is not a variable evaluated in the Eutrophication Indicators report, it was not analyzed and did not affect the interpretation of results. Data quality issues were resolved prior to the open-water season, such that no data quality issues with TDN were observed in the open-water dataset. B) With regards to Appendix II, the ammonia data measured by Maxxam were omitted from analysis. TDN data were used with caution as described above. C) DDMI is working with the analytical...</td>
</tr>
</tbody>
</table>
| Appendix XIII: Eutrophication Indicators Report | Figure 3-8 | **Comment** The title of this graph is “Concentrations of Total Phosphorous and Chlorophyll a in Lac de Gras in relation to dust deposition during the open-water season, 2017”. However, it is not clear how the data presented relates to the area potentially affected by dust. It is also unclear if this data represents concentrations of TP and chl a in Lac de Gras because of dust deposition, or in general.  
**Recommendation** A) Please explain how Figure 3-8 describes the relationship between dust deposition and concentrations of TP and chl a in Lac de Gras. B) Has DDMI considered including a visual representation of the dustfall on this graph to assist with interpretation? For example, ZOI demarcated with a dashed vertical line or dustfall on a secondary y-axis? | **Nov 22:** A) Figure 3-8 of Appendix XIII identifies the stations within the zone of influence (ZOI) for dust deposition. The figure illustrates how TP and chlorophyll a concentrations are not elevated at stations that are expected to be the most impacted by dust deposition (i.e., those within an approximately 1 km distance from the mine footprint). Instead, chlorophyll a concentrations decline with increasing distance from the diffuser, indicating that effluent is the primary driver of nutrient enrichment in Lac de Gras. B) The four stations within the ZOI for dust deposition are marked on the figure. Not all stations within 5 km of the diffuser are within the ZOI; therefore, marking the ZOI with a dashed vertical line is not practical. The methods for calculating dust deposition rates are explained in Appendix D of Appendix XIII. It is not possible to develop precise dustfall estimates at each lake monitoring station to plot dustfall estimates on a secondary axis. |
| --- | --- | --- | --- |
| Appendix XIII: Eutrophication Indicators Report | Figures 3-14 and 3-15 | **Comment** Phytoplankton and zooplankton biomass for LDG-48 appear to be missing from the Report. This is a requirement of annual sampling as per the AEMP Design Plan Version 4.1.  
**Recommendation** Please indicate where this data can be found or provide rationale for the omission of this data. | **Nov 22:** Section 3.4.2 of the AEMP Design Plan Version 4.1 (Golder 2016) states that water quality, nutrients, and chlorophyll a will be measured at LDG-48. Although Table 3.5-1 of the AEMP Design Plan Version 4.1 includes zooplankton biomass as one of the eutrophication indicators, and lists LDG-48 as one of the stations/sampling areas, phytoplankton and zooplankton are not sampled at LDG-48 as indicated in the rows for phytoplankton and zooplankton (i.e., LDG-48 is not listed as a station to be sampled for these parameters). The depth of station LDG-48 is very shallow, limiting the possibility of plankton net sampling. Future AEMP Design Plans will include a footnote explaining that plankton are not collected at LDG-48, but that nutrient and chlorophyll a are collected at LDG-48 and are included in the Eutrophication Indicators assessment. Phytoplankton and zooplankton were not sampled at LDG-48 in 2017. |
| Appendix XIII: Eutrophication Indicators Report | Fig 3-28 (and | **Comment** The AL3 line does not appear in the legend box or on the figure.  
**Recommendation** Can DDMI please explain if the AL3 line is within the range of the y-axis of this figure? | **Nov 22:** The Action Level 3 benchmark is within the y-axis range. As noted in EMAB-20, the demarcation of Action Level 3 (i.e., Normal Range plus 25% Benchmark (AL3) = 1.74 mg/L) is not |
19 Appendix XIII: Section 4.3 Extent of Effects  
**Comment** This section discusses the extent of effects for eutrophication indicators in 2017. The second paragraph indicates that Figure 4-1 shows how sampling locations along various transects relate to the normal range. However, Figure 4.1 is a map of the estimated area of effect and does not provide data from individual transects. Additionally, this section states, "there was no affected area to the northeast of the Mine, as only the most distant station (FF2-5) had a TP concentration greater than the normal range" and indicates that rationale for this statement can be found in Section 2.3.5, however, there is no rationale provided to justify this statement in Section 2.3. (or elsewhere in the appendix).

**Recommendation** A) Please confirm that Figure 4.1 is the correct reference graph for this discussion. B) Please provide the location for the rationale that justifies the conclusions reached by DDMI with respect to the spatial extent of TP effects.

**Nov 22:** A) Figure 4-1 is the correct reference graph for this discussion. It shows which stations are within the area affected (which is indicated by pink shading). B) The rationale is found in Section 2.3.3. During the review of results done to prepare a response to this recommendation, an error was discovered in the calculations for Figures 4-1 and 4-2, which may affect the discussion of the extent of effects of TN and TP. These figures will be revised and the relevant text will be updated in the revised report.

20 Appendix 13: Eutrophication Indicators Report Table 4-1  
**Comment** Table 4-1 describes the spatial extent of effects of eutrophication indicators in Lac de Gras over the past 10 years. For each indicator, the total lake area effects varies widely and increases and decreases from year to year. For both TP and TN, DDMI states that the extent of effect is comparable to the affected areas calculated in previous years.

**Recommendation** Please define "comparable" in this context, given the wide range of spatial and temporal variability observed for eutrophication indicators.

**Nov 22:** "Comparable" in this context means that the 2017 results fall within the range of values observed within the last 10 years.

21 Appendix XIII: Section 3.2 Effects of dust deposition  
**Comment** Total estimated anthropogenic TP loading from the mine in 2017 was estimated to be 1.4 t/yr, with contributions of 0.42 t/yr, 0.63 t/yr and 0.34 t/yr from effluent, dust deposition and runoff, respectively. Based on these values, dust deposition appears to be responsible for ~45% of the total TP loads to LDG from the mine. However, DDMI reaches the conclusion that "2017 AEMP results provided no clear evidence that dust deposition had an additional measurable effect on concentrations of TP or chlorophyll a in Lac de Gras, on top of the effect apparent from the

**Nov 22:** A) Spatial interpolation and the calculation of TP loads is discussed in Appendix D of Appendix XIII and is illustrated graphically in Figure D-2. B) Dust is preferentially blown to the southeast of the mining area (see wind rose in Figure 2-1 and Appendix XIII, Appendix D, Figure D-2) and will be a diffuse areal source to LDG during the open-water season. TP from the effluent is concentrated as a point source. Dust deposited during the ice-cover season cannot affect the concentration of TP in LDG until spring break-up because TP contained in dust is released as an
| Appendix XIII: Section 3.4 Nutrients in Lac de Gras | **Comment** | It is noted that TDN values should be used with caution due to possible contamination issues. However, TDN was measured to be higher than the normal range at all sampling locations (including LDG 48) and during both open water and ice-covered seasons. DDMI states "based on subtracting the magnitude of laboratory bias from the ice cover TDN concentrations, it is likely that TDN concentration was within the normal range at LDG-48".

**Recommendation** A) What is the estimated magnitude of laboratory bias for TDN? B) Please provide rationale for why the estimated corrected TDN values for ice-cover data based on this correction were not included in the Report. C) Please provide an explanation for the open water season results that demonstrate that TDN concentrations during this time were also above the normal range at all stations and were highest at LDG-48.

| Nov 22: | A) The under-ice TDN concentrations appeared to be approximately 150 µg-N/L higher than TN within the same sample. B) It is not acceptable best practice to "correct" data by subtracting the field blank results (BC MOE 2013 - BC Field Sampling Manual - Part A Quality Assurance and Quality Control, https://www2.gov.bc.ca/assets/gov/environment/research-monitoring-and-reporting/monitoring/emre/bc_field_sampling_manual_part_a.pdf). The statement that "based on subtracting the magnitude of laboratory bias from the ice cover TDN concentrations, it is likely that TDN concentration was within the normal range at LDG-48" was a qualitative narrative statement to provide some indication of relative TDN concentration, but as stated in Section 2.3.6 and Appendix C of Appendix XIII, the ice-cover data for TDN should be used with caution. C) As stated in Appendix C of Appendix XIII, no data quality issues were observed for open-water TDN data. As stated in Section 3.6.2 of Appendix XIII and shown in Figure 3-21, TDN concentrations measured during the open-water season were generally above the normal range, with the exception of those along the MF3 transect. The observation of TDN concentrations during open-water season above the normal range is consistent with other nitrogen parameters that also had concentrations above their normal ranges, such as total nitrogen (Figure 3-20) and total ammonia (Figure 3-21). Nitrate and nitrite were generally not detected during the open-water season. The TDN concentration at LDG-48 is higher than other TDN measurements in the 2017 open-
The reason for this higher concentration at this station is not clear. The TDN concentration of 188 µg/L is based on one sample collected at LDG-48 during the open-water season (Appendix E of Appendix XIII), and as all measured concentrations, is subject to analytical uncertainty. Although the TDN concentration (188 µg/L) for this sample is higher than the corresponding TN concentration (168 µg/L), the magnitude of the difference (11%) is within the data quality objective (i.e., RPD of 20%; Appendix C, Table C-7) and was therefore not identified as anomalous (Appendix B). TDN concentrations at LDG-48 will be evaluated in 2018 to determine if the value measured in 2017 is representative of typical concentrations at this station.

<table>
<thead>
<tr>
<th>Appendix XIII: Role of N in eutrophication</th>
<th>Comment</th>
<th>Nov 22: Please see the response to ENR-2.</th>
</tr>
</thead>
<tbody>
<tr>
<td>As per WLWB's reason for decision on the 2014 AEMP report, and as reported in the 2017 AEMP concordance table, DDMI was to &quot;consider a more explicit analysis of the role of nitrogen in explaining variation and the spatial extent of chlorophyll a effects&quot;. The concordance table indicates that this consideration is in Appendix VIII, Section 3. This section, and the appendix in general, contains results, including for N but there does not appear to be a discussion or further consideration of these results and how they relate to other indicators of eutrophication. <strong>Recommendation</strong> Please indicate where in the Report the consideration of the role of N in explaining variation in chlorophyll a effects can be found.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Appendix XIII Section 4.2: Summary of nutrient data trends</th>
<th>Comment</th>
<th>Nov 22: Table 3-2 shows that significant declining trends were observed for: TP, DP, SRP, TN, TDN, total ammonia, nitrate, and nitrate+nitrite in at least one season and along at least one transect. This list is inclusive of most of the nutrients.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 4.2 of the Eutrophication Indicators Report states that &quot;significant trends in decreasing concentrations with distance from the effluent diffuser were observed for almost all nutrients, and particularly along the MF3 transect&quot;. However, in Table 3-2, only slightly over half (21/39) of the trend lines assessed had p-values of &lt;0.05 (the threshold for statistical significance). One of these significant trends (TN from MF2) was positive, indicating increasing concentration with distance from the diffuser. <strong>Recommendation</strong> Please provide further rationale for the conclusion that &quot;significant trends in decreasing concentrations with distance from the effluent diffuser were observed for almost all nutrients, and particularly along the MF3 transect. This list is inclusive of most of the nutrients.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Appendix XIII: Figure 3-12 | **Comment** DDMI did not provide a normal range for Figures 3-12 A or B, but this information is provided (for nitrate) in Appendix II Figures 3-32.  
**Recommendation** Please provide rationale for why this information is not provided. | Nov 22: The normal ranges for nitrate and nitrite as used in the Appendix II will be applied to the appropriate figures in Appendix XIII. |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2016 AEMP DDMI Commitments: Consideration of seasonal differences in dust deposition</td>
<td><strong>Comment</strong> The concordance table identifies DDMI’s commitment 1d to &quot;consider seasonal dust deposition data&quot; in its Eutrophication Indicators report. DDMI indicates this was done in Appendix XIII, Section 3.2. DDMI’s consideration of seasonal differences is as follows: &quot;Analysis of multiple years of dustfall data from dust gauges during the open water season and snow cores during the ice core season indicated that the amount of dust deposition was similar between the two seasons (i.e. no measurable seasonality in dust deposition was identified&quot;. However, the Dust Deposition Report (Appendix I of the 2017 AEMP) states &quot;fugitive dust generation is expected to be greatest during snow-free periods where and when there is site activity” (p 3-1). This expectation was reported to be observed, as Appendix 1 states that Dust 1 had dustfall rates of 936 mg/dm²/yr during the summer and 230 mg/dm²/yr during the winter. Additionally, the 2014-2016 AEMP Re-evaluation report present the most definitive assessment of potential seasonal trends in dust (Figure 3-8) and nutrient deposition (Figure 3-9) as a function of distance from the mine. As indicated in these figures, a weak seasonal trend may be evident but the uncertainties are very large because dust deposition values vary over two to three orders of magnitude for the same locations during the same seasons (i.e., deposition is highly variable). Observations that indicate higher dust deposition at a single location (Dust 1) for a single year are insufficient to conclude that there is a robust, long-term trend of seasonality in dust deposition. The seasonal trends in Appendix 1 referenced one single dust station (out of 14) right next to the runway (Dust 1) which is not representative of a seasonal trend everywhere. It is expected that there would be more dust at the runway in the summer when it is exposed gravel (and snow covered in the winter). The seasonality found at Dust 1 is not a general trend for the site where there is no strong seasonal signal.</td>
<td>Nov 22: Dust deposition outside the mine boundary is a stochastic process that varies with on-site activities as well as seasonal meteorology. Dust production is predicted to be highest under dry windy conditions most commonly observed during the snow-free periods. Figure 3-8 and 3-9 of the 2014 to 2016 AEMP Re-evaluation report present the most definitive assessment of potential seasonal trends in dust (Figure 3-8) and nutrient deposition (Figure 3-9) as a function of distance from the mine. As indicated in these figures, a weak seasonal trend may be evident but the uncertainties are very large because dust deposition values vary over two to three orders of magnitude for the same locations during the same seasons (i.e., deposition is highly variable). Observations that indicate higher dust deposition at a single location (Dust 1) for a single year are insufficient to conclude that there is a robust, long-term trend of seasonality in dust deposition. The seasonal trends in Appendix 1 referenced one single dust station (out of 14) right next to the runway (Dust 1) which is not representative of a seasonal trend everywhere. It is expected that there would be more dust at the runway in the summer when it is exposed gravel (and snow covered in the winter). The seasonality found at Dust 1 is not a general trend for the site where there is no strong seasonal signal.</td>
</tr>
<tr>
<td>Appendix II: Figures 3-1B and 3-2C to 3-19C</td>
<td><strong>Comment</strong> Many of these figures show the concentrations at the mixing zone boundary decreasing in March and most of the concentrations at the mixing zone boundary declined dramatically during the open water season even though the volume of effluent</td>
<td>Nov 22: There is no clear explanation why the temporal pattern of mixing zone concentrations does not directly mirror the trend in effluent concentrations. All concentrations measured at the mixing zone were below AEMP Benchmarks with the exception of total</td>
</tr>
</tbody>
</table>
and the concentration in the effluent increased (pages 27-32, 34-35, 37-46).

**Recommendation**

A) What factors may contribute to the decrease in concentrations that was detected for many variables in March?

B) What may cause the concentrations of the variables to decrease at the mixing zone boundary during the open water season?

C) Why might the decrease in concentration of some variables (e.g., potassium and sulphate) at the mixing zone boundary be less pronounced than the decrease in concentration of other variables?

<table>
<thead>
<tr>
<th>28</th>
<th>Appendix II: 3.2.2 Nitrogen Variables AND Appendix II: 3.2.3 Total Metals</th>
</tr>
</thead>
</table>
| **Comment** | Several figures in Section 3.2.2 and 3.2.3 show high variability at certain times of year. For example, the ammonia concentrations at the mixing zone boundary show a wide range in March, May, and October that does not appear to correspond to increases in effluent flow or ammonia concentration in effluent (figure 3-8, page 34). Similarly lead, aluminum, copper, and antimony concentrations show high variability in March. Although Section 3.2.5 explains that the March aluminum concentration may be anomalous, the variability in the other metals remains.  
**Recommendation** A) What may contribute to the variability in ammonia concentrations during March, May, and October? B) What may contribute to the high variability in metal concentrations at the mixing zone boundary (e.g., lead, copper, and antimony in March)? |
| **Nov 22:** | There is no clear explanation why the temporal pattern of mixing zone concentrations does not directly mirror the trend in effluent concentrations. All concentrations measured at the mixing zone were below AEMP Benchmarks with the exception of total aluminum on one occasion and field pH (Section 3.2.5 of Appendix II). See response to EMAB-5. |

<table>
<thead>
<tr>
<th>29</th>
<th>Appendix II: 3.2.2 Nitrogen Variables</th>
</tr>
</thead>
</table>
| **Comment** | The text points out that the nitrate concentration at the mixing zone boundary is greater and more variable during the ice cover season, which is the opposite to the trend in effluent concentration (page 33).  
**Recommendation** What might cause this opposite trend in mixing zone concentration compared to effluent concentration for nitrate? |
| **Nov 22:** | There is no clear explanation why the temporal pattern of mixing zone concentrations does not directly mirror the trend in effluent concentrations. Nitrate concentrations measured at the mixing zone were below AEMP Benchmarks (Section 3.2.5 of Appendix II). See response to EMAB-5. |

<table>
<thead>
<tr>
<th>30</th>
<th>Appendix II: 3.2.3 Total Metals</th>
</tr>
</thead>
</table>
| **Comment** | The text states that concentrations of lead in effluent "generally remained within a similar range throughout the 2017 reporting period". Figure 3-14 shows two distinctly higher concentrations in January and August (pages 36, 41).  
**Recommendation** Please provide an explanation for what may |
<p>| <strong>Nov 22:</strong> | There is no clear explanation for these higher concentrations. Both values are below the Effluent Quality Criteria. |</p>
<table>
<thead>
<tr>
<th>Appendix II</th>
<th>Section</th>
<th>Comment</th>
<th>Recommendation</th>
<th>Nov 22:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action Level 3</td>
<td>3.4.3</td>
<td>DDMI included dissolved calcium, dissolved potassium, and dissolved sodium as SOIs even though both the dissolved and the total forms of those variables triggered Action Level 1 (Table 3-6, page 60). DDMI explained that the most representative form was chosen to avoid duplication. <strong>Recommendation</strong> A) DDMI indicated that the dissolved forms of these variables were chosen as SOIs because they were the most representative. Please explain what is meant by this statement (i.e., what are they most representative of?). B) How might the conclusions or results change if the total forms were considered?</td>
<td>A) The dissolved form of these metals was chosen to be consistent with the convention used in previous reports. Generally, if the dissolved form triggers an action level then the total fraction has probably triggered or is close to triggering the action level as well (and vice versa). Calcium, potassium and sodium are typically major ions in surface waters, are highly soluble, and are usually reported in the dissolved form in water quality evaluations. B) Although the total concentrations are generally greater than the dissolved concentrations, the concentration of the two fractions are highly correlated. Therefore, similar temporal and spatial trends would be expected.</td>
<td></td>
</tr>
<tr>
<td>Figure 3-27</td>
<td>3.6</td>
<td>This section discusses a ‘visual evaluation’ of the potential effects of dust deposition (page 112). <strong>Recommendation</strong> Which figures, trends, or other information were considered in this evaluation, and how were conclusions reached?</td>
<td>Reference to &quot;visual evaluation&quot; of potential effects from dust and &quot;effect not apparent&quot; relate to the following. During the open water season, if effects of dust deposition were present in the NH3, Sb or Pb surface water data, these should manifest as increases in the concentrations of these compounds at the following stations: MF3-1, -2, -3 and -4. Figures for ammonia (Fig. 3-50), tin (Fig. 3-56 and 3-65b) and lead (Fig. 3-60 and 3-68b) show no readily apparent enhancements at these locations. Consequently, the effects of dust were deemed &quot;not apparent&quot;.</td>
<td></td>
</tr>
<tr>
<td>Comparison of AEMP Data to Effects Benchmarks</td>
<td>3.7</td>
<td>This section mentions that one sample of total manganese during the ice-covered season exceeded the AEMP drinking water effects benchmark (page 124). A brief discussion is provided for a similar occurrence with pH values, but not for manganese. <strong>Recommendation</strong> Please discuss this exceedance in the context of the normal range of variability in LDG and describe possible explanations for the exceedance.</td>
<td>The total manganese concentration that exceeded the AEMP aesthetic drinking water effects benchmark was identified as an anomalous value in Appendix C of Appendix II; the reported value was outside the normal range, and was not retained in the dataset for subsequent analysis. The following will be added to the first paragraph of Section 3.7: &quot;This value was identified as an anomalous value in Appendix C of Appendix II and was removed...&quot;</td>
<td></td>
</tr>
</tbody>
</table>
from the analysis. All other total manganese values were below the effects benchmark."

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Appendix XI: 2.1 Field Sampling</td>
<td><strong>Comment</strong> In Appendix XI, the field sampling methods for the zooplankton samples indicate that each sample consists of three vertical hauls through the entire water column (page 2). The Diavik AEMP Design Plan Version 4.1 Section 4.6.2 states that zooplankton samples will consist of a single vertical haul taken from a depth of 1 m above the lake bottom (AEMP 4.1 page 55). The eutrophication methods state that samples will consist of three vertical hauls through the entire water column (AEMP 4.1 page 53).</td>
<td><strong>Recommendation</strong> A) Please confirm which field methods were used for 2017 zooplankton sampling conducted as part of the Plankton component (not the Eutrophication component). B) Whichever methods were used, did DDMI use the same zooplankton sampling methods in 2017 that it used in past years? C) If different zooplankton sampling methods were used in 2017, please comment on DDMI’s ability to interpret results and discern temporal trends.</td>
<td><strong>Nov 22:</strong> Zooplankton taxonomy samples were collected using the same methods as in previous years (i.e., a single vertical haul). The error in the text will be corrected.</td>
</tr>
<tr>
<td></td>
<td>Appendix XI: 2.2.1 Phytoplankton Community</td>
<td><strong>Comment</strong> In Appendix XI, the described lab methods for phytoplankton sample analysis differ from the methods described in the AEMP Design Plan Version 4.1 Section 4.6.3.1 (page 56). For example, the methods described in Appendix XI say that aliquots of 25 ml were used and that a minimum of 250 and maximum of 300 units were counted. However, the AEMP Design Plan version 4.1 states that 7 ml aliquots should be used and that a minimum of 400 units will be counted.</td>
<td><strong>Recommendation</strong> A) Why do the lab methods described for 2017 phytoplankton analysis differ from the AEMP Design Plan? B) How could the use of larger aliquots and smaller minimum sample units affect the results? C) Did DDMI use the same phytoplankton lab methods in 2017 that it used in past years? D) If different phytoplankton lab methods were used in 2017, please comment on DDMI’s ability to interpret results and discern temporal trends.</td>
<td><strong>Nov 22:</strong> The method in 2017 has not changed. The amount subsampled and units counted will differ from year to year; however the calculation methods to determine the number of cells present in a subsample account for these year to year differences. The design plan should not have included details of the exact amount to be subsampled/units counted.</td>
</tr>
</tbody>
</table>
| Page | Appendix XI: 2.2.1 Phytoplankton Community | Comment | According to the first sentence of this section, 19 composite phytoplankton samples were taken and include samples in NF, MF1, MF-FF2, and MF3 stations as well as three duplicate samples and a single split sample (page 4). 

**Recommendation** Please confirm whether the three duplicate samples and single split sample are included in the count of 19 composite samples or are in addition to the 19 samples. |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov 22:</td>
<td>The three duplicate samples (NF4, MF1-5, MF3-5) and the one split sample (MF3-5) are in addition to the 19 samples collected in the NF (5), MF1 (3), MF2-FF2 (4) and MF3 (7) areas.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Appendix XI: 3.1.1 Phytoplankton Taxonomic Richness and Biomass | Comment | Phytoplankton biomass was above the normal range in the near field stations and some of the mid-field stations in 2017 and therefore did not trigger Action Level 1. However, the biomass of cyanobacteria at all sampling locations was below the normal range established from 2007 to 2010 (page 9) 

**Recommendation** A) Discuss potential explanations for the observation that cyanobacteria biomass is below the normal range despite total phytoplankton biomass being above normal range. B) Has DDMI considered the possibility that cyanobacteria may exhibit a unique toxicological response to changes in water quality variables? C) Identify potential effects to the lake ecosystem because of the lowered cyanobacteria biomass, including consideration of edibility. |
| Nov 22: | The purpose of the Annual AEMP Reports for interim sampling years is to assess Mine effects on water quality, indicators of eutrophication, and plankton, by determining if an Action Level has been triggered. The approved AEMP Design identifies Action Levels and an associated response to be undertaken when such Action Levels are reached. We appreciate that likely explanations are helpful to provide for reviewers and the Board in instances where an Action Level has not been reached, and we generally include this information in annual reports if such explanations are readily apparent from the results. However, DDMI is of the opinion that it is not appropriate to speculate to explain results that may reflect complex ecosystem interactions beyond the explanatory scope of the AEMP, where a prescribed Action Level and associated response have not been triggered. High level responses are provided below. A) A possible explanation for the low cyanobacteria biomass (below normal range) compared to high overall phytoplankton biomass (above normal range) is that there is higher biomass of the other major groups of phytoplankton present (i.e., microflagellates and diatoms), which are driving the higher total phytoplankton biomass. B) DDMI did not consider this possibility because low cyanobacteria biomass is not of concern, and the water quality and toxicity datasets did not indicate a potential for toxicity to aquatic life in Lac de Gras. C) It is possible that the lower cyanobacteria biomass in the phytoplankton community has the potential to increase palatability of the algae for herbivores in the lake ecosystem. Lac de Gras remains oligotrophic, which is the desired state of this lake. |
| Appendix XI: 3.2.1 Zooplankton | Comment | Zooplankton biomass was within the normal range at most sampling locations in 2017 and therefore did not trigger |
| Nov 22: | Please see the response to WLWB-38 regarding explanations of potential effects in interim monitoring years when |
### Biomass and Taxonomic Richness

**Action Level 1.** However, the biomass of calanoid copepods was below the normal range established from 2007 to 2010 at all but one sampling location (page 16).

**Recommendation** A) Discuss potential explanations for the observation that calanoid copepod biomass is below the normal range despite total zooplankton biomass being above or within normal range. B) Has DDMI considered the possibility that calanoid copepods may exhibit a unique toxicological response to changes in water quality variables? C) Identify potential effects to the lake ecosystem because of the lowered calanoid copepod biomass.

### Appendix XI - 3.1.2 Phytoplankton Community Structure

**Comment** These sections describe differences to the phytoplankton community in 2017 in comparison to the 2007 to 2010 reference conditions. This includes greater relative abundance and biomass of microflagellates and diatoms, and lower relative abundance and biomass of chlorophytes and cyanobacteria.

**Recommendation** How might changes in phytoplankton community composition affect the lake ecosystem?

**Nov 22:** Please see the response to WLWB-38 regarding explanations of potential effects in interim monitoring years when Action Levels are not triggered. A high level response is provided below. It is possible that the changes in phytoplankton community composition can affect the edibility of the algae for herbivores in the lake. The changes observed to date have been towards a more palatable phytoplankton assemblage.

### Appendix XI - 4.1 Phytoplankton Community

**Comment** This section describes differences to the zooplankton community in 2017 in comparison to the 2008 to 2010 reference conditions. This includes greater relative abundance of rotifers and less relative abundance of copepods in 2017. Regarding biomass, there was an increase in cladocerans and cyclopoid copepods in 2017, compared to the reference conditions where there were more calanoid copepods.

**Nov 22:** Please see the response to WLWB-38 regarding explanations of potential effects in interim monitoring years when Action Levels are not triggered. A high level response is provided below. It is possible that the changes in community composition can affect the quality of food for fish, especially if the community shifts towards larger taxa like cladocerans, which fish prefer. In the NF area in 2017, cladocerans were above the upper bound of the
| Recommendation | How might changes in zooplankton community composition affect the lake ecosystem? | normal range indicating that a shift to these more palatable taxa may be occurring in this area, representing a potential increase in food for fish. |
Re: Review of 2017 AEMP Annual Report

Dear Joe and Ryan,

The Environmental Monitoring Advisory Board (EMAB) wishes to thank the Wek’èezhìi Land and Water Board (WLWB) for the opportunity to review Diavik Diamond Mines’ 2017 Aquatic Effects Monitoring Program (AEMP) Annual Report and respectfully submit the following comments and attached Excel table.

We contracted North-South Consultants (N-S) to provide technical review and advice and we also reviewed the documents internally.

The N-S technical review is attached for your consideration. We agree with N-S’ general assessment that the report is mostly well-written and comprehensive.

EMAB draws your attention to the following:

**Eutrophication Indicators – extent of effect**

One of the main predictions made during the environmental assessment was that nutrient levels in Lac de Gras would increase. Originally these predictions were based on phosphorus loadings; however phosphorus levels are not a good indicator of nutrient enrichment on their own because they are consumed by phytoplankton. Chlorophyll $a$ and biomass of algae were added to the parameters measured to account for this.

Since these parameters were added to the AEMP there have been wide fluctuations in the extent of Lac de Gras (LdG) with levels of chlorophyll $a$ above the normal range:

- 2013 – 24.9% of LdG
- 2014 – 42.4% or greater
- 2015 – 10.3%
- 2016 – 43.7%
- 2017 – 26.2% or greater

Diavik has indicated that they don’t know why these fluctuations are occurring.

EMAB also observed in 2016 that total nitrogen (TN) has been increasing in extent so that it appeared the entire lake was experiencing TN above the normal range. Diavik compared the 2017 results, where the area of the lake affected was 41.9% or greater, to 2016. However Diavik did not sample the far-field sites in 2017, so the 2016 and 2017 data are not comparable.

When the affected area of LdG increases beyond the mid-field the full extent will not be detectable except in “comprehensive” monitoring years i.e. every third year. Since the extent of LdG area affected has reached the extent of the mid-field stations two different years, and TN above the normal range extends well beyond the mid-
field, EMAB is recommending that Diavik sample all AEMP stations for eutrophication indicators annually to allow tracking of the extent of affected area throughout the lake as well as any increases in concentration.

EMAB is also recommending that Diavik investigate additional data collection that would allow them to better explain the reasons for the widely fluctuating geographic extent of the area affected by chlorophyll a above the normal range. Diavik should also include a summary of conditions that affect phytoplankton, including light, temperature, water clarity and other nutrients in the discussion of phytoplankton results.

**Dust Monitoring and Phosphorus Loading**

EMAB was pleased that Diavik added two new dust gauges on the SW part of East Island to assist with monitoring additional dust from A21 operation.

EMAB notes that while Diavik has identified mine-generated dust as an airborne source of substantial quantities of phosphorus loading to LdG, only loadings from effluent were included in the discussion on phosphorus loadings in the main report. Diavik should include all of its phosphorus contribution to LdG when discussing loadings.

**Fish Health**

EMAB continues to be concerned about mercury levels in lake trout in LdG. We understand that the WLWB has made its decision on how these will be monitored through the AEMP; however we believe it is important to keep track of these levels over time. EMAB will be initiating our own review of the existing data on mercury in lake trout and will be considering making a recommendation on monitoring of mercury in lake trout directly to Diavik, as provided for in the Environmental Agreement.

We trust that these comments are useful and encourage you to give them full consideration. If you require further information, please contact John McCullum at the EMAB office.

Sincerely

Napoleon Mackenzie
Chair

Cc  EMAB members (by email)
    Parties to the Environmental Agreement (by email)
    Sarah Elsasser, Regulatory Manager, WLWB (by email)
    Anita Ogaa, Regulatory Specialist, WLWB (by email)
AQUATIC EFFECTS MONITORING PROGRAM ANNUAL 2017
REPORT – PLAIN LANGUAGE BRIEFING AND TECHNICAL
REVIEW COMMENTS

Technical Memorandum # 367-18-04

Prepared for:
Environmental Monitoring Advisory Board (EMAB)
P.O. Box 2577
Yellowknife, NT
X1A 2P9

Prepared by:
North/South Consultants Inc.

October 1, 2018
1.0 BACKGROUND AND SCOPE OF WORK


The Wek’eezhii Land and Water Board (WLWB) noted the following for the review of the 2017 AEMP (the Report):

“The AEMP represents an extensive monitoring program, which includes the monitoring of water, sediment, and several types of living organisms around the Diavik site. In the cover letter with the Report, DDMI states that “sampling was carried out according to the requirements specified in the AEMP Study Design Version 4.1 for an interim monitoring year, which included sampling in the [near-field] NF and [mid-field] MF areas of the lake”.

DDMI also indicated in the cover letter that the Report includes revisions as required under the Board's decisions on the 2014, 2015 and 2016 (Version 1 and Version 1.1) AEMP Annual Reports and that Action Level exceedance reporting was required as per Part J, Condition 6 of the Licence.”

North/South Consultants Inc. (NSC) conducted a technical review of the 2017 AEMP Annual Report for the Environmental Monitoring Advisory Board (EMAB). The following aquatic environment components were reviewed by NSC personnel with technical knowledge and expertise in each of the areas: dust; effluent and water chemistry; plankton; and eutrophication indicators. As directed by EMAB in their Scope of Work for the review, the following points were considered:

- Diavik responses to previous North/South recommendations, if applicable;
- 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;
- Unanticipated project-related effects;
- Action levels reached and adequacy of proposed follow-up;
- Adaptive management responses; and
- Include recommendations on improvements to monitoring/management actions for EMAB’s consideration.

Section 2 provides a plain language briefing of the 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 PLAIN LANGUAGE BRIEFING

The following sections present a plain language briefing of NSC’s comments in relation to the points identified by EMAB for evaluation during the review of the 2017 AEMP Annual Report, and any additional review comments and recommendations borne from this review. The following sections present key comments for discussion by EMAB members and refer to:

- presentation and discussion of pH monitoring results;
- discussion of temporal patterns for several metals in the mixing zone;
- dissolved oxygen (DO) results and discussion;
- effluent and water quality assurance/quality control (QA/QC) sample results;
- phytoplankton QA/QC results and discussion;
- spatial extent of effects for eutrophication indicators discussion;
- inclusion of results for LDS-4;
- increasing Trend for total nitrogen (TN) along transect MF2-FF2
- discussion of anthropogenic loading of total phosphorus (TP);
- methods for estimating the spatial extent of effects on nutrients; and
- review of QA/QC duplicate sample results for nutrients.

To aid in this discussion, useful figures (and corresponding numbering and captions) are included from the 2017 AEMP Annual Report.

The technical review comments (Table 1) include additional detailed comments that recommend various revisions to clarify either the presentation of results and/or their interpretation to improve the overall quality of the report; these comments are excluded from the discussion below.

2.1 EFFLUENT AND WATER QUALITY

2.1.1 Discussion of pH Results

Section 3.3.1 (Results and Discussion, Effluent and Mixing Zone Water Quality) of the Main Report (page 22) indicates: "Field pH values measured at the mixing zone boundary in 2017, particularly during the ice-cover season, were below the Effects Benchmark value of 6.5; however, pH throughout Lac de Gras was often measured below this Effects Benchmark, in both ice-cover and open-water seasons, at various depths, and over time (i.e., 2002 to 2016)."
It is understood that pH is not considered within the Substance of Interest (SOI) identification process. However, it would be beneficial to include some discussion of pH in the effluent for comparison to the lake monitoring results within this section of the report. This would assist with an overall presentation of potential mine-related effects on pH.

It would also be beneficial to provide baseline information on pH in Lac de Gras (i.e., prior to 2002) in the discussion as normal ranges have not been derived for this metric.

**Recommendation 1**: Include results for pH in effluent and incorporate into the discussion of pH monitoring results for Lac de Gras.

**Recommendation 2**: Include baseline pH results for Lac de Gras to facilitate an evaluation of potential changes to this metric over time.

### 2.1.2 Temporal Patterns in Antimony, Molybdenum, and Uranium in the Mixing Zone

Appendix II, Effluent and Water Chemistry Report, Section 3.2.3 (Results, Trends in Effluent and at the Mixing Zone Boundary, Total Metals; page 36) indicates: "For most total metal SOIs, concentrations in the effluent were greater than the concentrations measured at the mixing zone boundary in 2017, indicating that the Mine effluent is a source of these variables to Lac de Gras. One exception was copper, where concentrations in the effluent were generally similar to or less than those recorded at the mixing zone boundary (Figure 3-13B/C). Lead and tin also had concentrations in the effluent that were generally similar to those at the mixing zone boundary (i.e., often below the DL), although sporadic elevated concentrations of these two variables occurred in the effluent which were greater than the measured concentrations at the mixing zone boundary (Figures 3-14B/C and 3-18B/C)."

The temporal pattern of effluent concentration and loading for several metals including antimony (Figure 3-11; page 38), molybdenum (Figure 3-15; page 42), and uranium (Figure 3-19; page 46) was not reflected in the mixing zone water quality results. Specifically, concentrations in the mixing zone decreased, and were notably lower than the effluent concentrations, in the open-water season despite increased concentrations in, and loading from, effluent.
Figure 3-15. Molybdenum: A) Monthly Loading Rate from the North Inlet Water Treatment Plant and Concentration in B) Effluent and at C) the Mixing Zone Boundary (after Golder 2018).

**Recommendation**: Include a discussion of these observations in the report, including where feasible, potential or conceptual explanations.

### 2.1.3 Dissolved Oxygen Results and Discussion

Section 3.3 (page 53) only compares DO monitoring results to the 6.5 mg/L Canadian Council of Ministers of the Environment (CCME) protection of aquatic life (PAL) guideline (CCME 1999; updated to 2018). NSC had commented (NSC 2018) previously that DO results should be compared to both the 6.5 mg/L (early life stages absent) and the 9.5 mg/L (early life stages present) CCME PAL guidelines (CCME 1999; updated to 2018) where applicable.

The CCME 9.5 mg/L benchmark for early life stages would be more appropriate for fall spawning species such as Lake Trout. Indications of these guidelines on the depth profile figures would also greatly improve the ability to readily assess where exceedances occurred (Note: this would also apply for pH).
Recommendation 1: Include a comparison of DO monitoring results to the appropriate benchmarks (i.e., 6.5 and 9.5 mg/L).

Recommendation 2: Add 6.5 and 9.5 mg/L benchmarks for DO and pH benchmarks to depth profile figures.

2.1.4 Quality Assurance/Quality Control Sample Results

The Effluent and Water Chemistry Report Appendix B (QA/QC Methods and Results; page B-3) indicates that duplicate sample results were considered “notable” where the Relative Percent Difference (RPD) was greater than 40%. This criterion is higher than used in previous reports. For example, in the 2017 AEMP Annual Report (Golder 2017), the criterion was 20% for evaluating duplicate sample results (Appendix II, Appendix C, page C-3). The same criterion (40%) is also identified in Appendix XIII, Eutrophication Indicators Report, Appendix C (Quality Assurance and Quality Control; page C-3).

Recommendation: Review the text and revise (if the value was reported in error) or provide a rationale for the change in the RPD criterion for evaluating duplicate sample results.

2.2 PLANKTON

2.2.1 Phytoplankton QA/QC Results and Discussion

The QA/QC review of phytoplankton data considers results for counts (i.e., abundance) and not biomass (Appendix XI, Plankton Report, Appendix A, Quality Assurance and Quality Control, page A-4, Table A-1, and Appendix B - Raw Plankton Data). However, the plankton component of the AEMP is focused on results for phytoplankton biomass and not abundance. It is recommended that an analysis and discussion of QA/QC results for biomass, in addition to abundance, be provided. Phytoplankton biomass is derived from two estimates: (1) counts of algal cells; and (2) measures/estimates of cell biovolume. Phytoplankton biomass results are therefore affected by an additional source of variability (i.e., biovolume measurements) beyond measures of algal abundance.

A similar comment was submitted in the review of the 2016 Annual AEMP Report (NSC 2017): "Comparison of duplicate phytoplankton samples should be done both for abundance (i.e., cell counts) as well as biomass. The latter is typically more variable than the former as it is derived from two measurements (cell counts and algal cell size). As biomass is the metric of concern for the AEMP QA/QC should focus on this metric."

Recommendation: Provide an analysis and discussion of phytoplankton biomass QA/QC results.
2.3 EUTROPHICATION INDICATORS

2.3.1 Spatial Extent of Effects Discussion

Section 4.3.3 reads: "The boundary of effects on concentrations of TN to the northwest extended to at least Station MF1-5; however, the extent of effects along the MF1-FF1 transect could not be assessed further, because sampling in the FF1 area was not completed in 2017 as part of the interim program. The extent of effects to the northeast of the Mine extended to the end of the MF2-FF2 transect (Station FF2-5). The boundary of effects south of the Mine extended to between stations MF3-6 and MF3-7. The resulting affected area of the lake based on concentrations of TN was estimated as greater than or equal to 240 km², or greater than or equal to 41.9% of lake area, which is less than reported in 2016, but comparable to the affected areas calculated for this variable in previous years."

The last sentence should be modified to clearly state that direct comparisons to 2016 results are not possible due to the lack of sampling in far-field (FF) areas in 2017.

As noted in previous comments (e.g., Section 2.4.3, NSC 2018 and row 35 in associated excel submission), comparisons of spatial extent of effects between years for eutrophication indicators should be done with caution and should include explanatory text identifying the limitations of inter-annual comparisons in light of the lack of sampling in the FF areas in interim years.

Note that although this comment and the recommendation below refer specifically to TN, both are intended to apply to all discussions of eutrophication indicators. It is noted that a similar issue occurs in the discussion of chlorophyll a results.

**Recommendation:** Include a qualifying statement indicating that due to the lack of FF data for 2017 and the implications regarding limitations on defining the spatial extent of effects in those years, comparison to 2016 or other years is associated with uncertainty.

2.3.2 Inclusion of Results for LDS-4

The discussion and graphical plots of results for nutrients in Lac de Gras within the eutrophication indicators section (Main Document, Section 4.3.2, Eutrophication Indicators, Results and Discussion, Nutrients and Water Chemistry in Lac de Gras, pages 34-35) does not include results for the inflow to Lac de Gras (i.e., Site LDS-4), though it is noted that some discussion of results for this site are provided in Appendix XIII (e.g., pages 34-43).

Inclusion of monitoring results for site LDS-4 within the Main Report would assist with interpretation of results. For example, TN concentrations were notably higher in the MF2-FF2 transect in the open-water season (Main Document, Figure 4-4, page 25); it would be of interest to compare these results to the upstream site at the lake inflow to evaluate the potential influence of upstream conditions on this transect. Qualitative review of the raw data files suggest that the
inflow of Lac de Gras contained a higher concentration of TN than the MF1, MF3, and NF areas and may have contributed to the relatively higher concentrations of TN observed along transect MF2-FF2 in the open-water season (the report notes that no sample was collected from LDS-4 in winter).

![Box plot showing concentrations of Total Nitrogen in Lac de Gras during the Ice-Cover and Open-Water Seasons, 2017 (after Golder 2018).](image)

**Figure 4-4.** Concentrations of Total Nitrogen in Lac de Gras during the Ice-Cover and Open-Water Seasons, 2017 (after Golder 2018).

**Recommendation:** Add results for LDS-4 to figures and include discussion of results for LDS-4 within the discussion of nutrients in Lac de Gras in the main document (Section 4.3.2) and Appendix XIII (Section 3.4).

### 2.3.3 Increasing Trend for TN along Transect MF2-FF2

Appendix XIII, Eutrophication Indicators Report, Section 3.6.2 indicates: "Concentrations of TN were generally greater than the normal range during both ice-cover and open-water seasons (Figure 3-20). **Strong decreasing trends in TN concentrations were observed along all transects during both seasons**, with the exception of the MF1 transect during the open-water season (Table 3-2). Concentrations of TN at LDG-48 were similar to concentrations observed in the MF2-FF2 area during the open-water season. The concentration of TN at LDS-4 was slightly greater than those measured in the NF area during the open-water season." (page 38).¹

¹ Text underlined and bolded for emphasis.
Figure 3-20 (page 39) indicates a trendline for the MF2 transect for TN that increases with distance from the effluent diffuser (see blue circle in figure below). As noted above in Section 2.3.2, the concentration of TN measured at LDS-4 may have contributed to the higher TN concentrations observed along transect MF2-FF2.

**Figure 3-20. Concentrations of Total Nitrogen According to Distance from the Effluent Discharge, 2017 (after Golder 2018).**

**Recommendation 1**: Correct the text to reflect positive trend in TN at transect MF2-FF2 in the open-water season.

**Recommendation 2**: Provide additional discussion of potential effects of water quality at the Lac du Sauvage outflow on nutrients in Lac de Gras, notably at transect MF2-FF2.

### 2.3.4 Discussion of Anthropogenic Loading of TP

Section 4.3 of the main document (Eutrophication Indicators, Summary and Discussion, pages 31-44) and Section 4.1 of Appendix XIII (Summary and Discussion, Nutrients in Effluent and the Mixing Zone; page 51) only present annual loading of total phosphorus (TP) to Lac de Gras for effluent. This underrepresents the total loading of TP to Lac de Gras associated with the mine.
Estimates of loading from dust, presented in Appendix XIII Appendix D (Assessment of Total Phosphorus Deposition to Lac De Gras), should be presented and discussed within the main body of the report and the summary section of Appendix XIII.

**Recommendation:** Incorporate discussion of all anthropogenic sources of TP to Lac de Gras within the main document and Appendix XIII.

### 2.3.5 Methods for Estimating Spatial Extent of Effects

Although concentrations of TN were generally higher in Lac de Gras in winter, use of the 2017 open-water season monitoring data for delineation of the spatial extent of effects (i.e., the area of Lac de Gras above the normal range) would result in a larger calculated affected area. Specifically, results for the most western site (MF3-7) along transect MF3 exceeded the normal range in the summer but not the winter (see Figure 4-2 reproduced below). Use of the open-water season data would result in an affected area that extended to the full extent of the monitoring site boundaries. The TN concentration for site MF3-7 in winter is 0.159 mg/L (mean of bottom samples; raw data presented in Appendix XIII - E), which is within the normal range for this season (0.138 - 0.173 mg/L), whereas the concentration for the open-water season is 0.186 mg/L (mean of raw data presented in Appendix XIII - E), which is above the upper boundary of the normal range (0.153 mg/L).
2.3.6 Review of QA/QC Duplicate Sample Results

In Appendix XIII (Eutrophication Indicators Report, Appendix C, Quality Assurance and Quality Control; page C-3), the percent of flagged duplicate nutrient samples for 2017 was expressed based on the total number of duplicate samples for the year (e.g., total of 190 duplicate sample pairs for the open-water season). However, of the total 190 duplicate pairs, RPDs (measure of precision of duplicate results) for many samples could not be reliably assessed due to data values being less than five times the analytical detection limit. It would be more appropriate to evaluate the overall percent of flagged samples based on the total number of duplicate pair results where the RPD could be reliably calculated (i.e., for those total number of paired samples that exceeded five times the detection limit). This approach also does not consider QA/QC results on a parameter by parameter basis and thus may not adequately assess potential issues with specific analytes.

**Recommendation 1**: Recommend expressing the percent of flagged duplicate RPDs based on the total number of paired samples where one or more values exceeded 5 times the analytical detection limit (i.e., those data pairs that could be reliably assessed for RPDs).

**Recommendation 2**: Recommend expressing percentages of flagged values by water quality parameter in order to evaluate issues that may be present with specific analytes.

2.4 DETAILED TECHNICAL REVIEW COMMENTS

Detailed technical review comments and recommendations are provided in the following Table 1; these are also provided in the Excel comments template as required for submission to the WLWB.
Table 1. Technical review comments and recommendations on the 2017 AEMP Annual Report.

<table>
<thead>
<tr>
<th>TOPIC</th>
<th>COMMENT</th>
<th>RECOMMENDATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>APPENDIX I, Dust Deposition, Section 2.3, Methodology, Snow Water Chemistry, page 2-7 and Table 3.4-2, page 3-20</td>
<td>The methods description indicates: &quot;For quality assurance and control purposes, duplicate samples were collected at stations SS3-5 and SS5-5, and an equipment blank sample was collected at station SS3-6. Snow water chemistry sampling methodology is detailed in SOP ENVR-512-0213 (see Appendix F).&quot; Table 3.4-2 (page 3-20) presents results for a &quot;Control 1 Blank Sample&quot;. It is unclear if this represents the results of the equipment blank referred to earlier.</td>
<td>Clarify what type of blank sample is presented in Table 3.4-2.</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Effluent and Water Chemistry, Section 3.3.1, Results and Discussion, Effluent and Mixing Zone Water Quality, page 22</td>
<td>The Report indicates: &quot;Field pH values measured at the mixing zone boundary in 2017, particularly during the ice-cover season, were below the Effects Benchmark value of 6.5; however, pH throughout Lac de Gras was often measured below this Effects Benchmark, in both ice-cover and open-water seasons, at various depths, and over time (i.e., 2002 to 2016).&quot; It is understood that pH is not considered within the Substance of Interest (SOI) identification process. However, it would be beneficial to include some discussion of pH in the effluent for comparison to the lake monitoring results within the report. This would assist with an overall presentation of potential mine-related effects on pH. It would also be beneficial to provide baseline information on pH in Lac de Gras (i.e., prior to 2002) in the discussion as normal ranges have not been derived for this metric.</td>
<td>Include results for pH in effluent and incorporate into the discussion of pH monitoring results for Lac de Gras. Include baseline pH results for Lac de Gras to facilitate an evaluation of potential changes to this metric over time.</td>
</tr>
<tr>
<td>APPENDIX II, Effluent and Water Chemistry Report, Section 2.4.2, Methods, Quality Assurance/Quality Control, Abnormal Results for Turbidity, page 23</td>
<td>The report indicates: &quot;Similarly, elevated values of field-measured turbidity were recorded using a YSI water quality meter at the mixing zone boundary in January 2017 (Appendix B). January 2017 was the only month of the sampling year when data were recorded with the YSI at the mixing zone.&quot; However, page 2 indicates that &quot;The in situ water column profile measurements were taken at AEMP stations using a multi-parameter water quality meter (YSI) following the methods described in DDMI’s Standard Operating Procedure (SOP) ENVR-684-0317 “SOP YSI ProDSS”.&quot; It is unclear what in situ meters were used for the 2017 water quality monitoring program.</td>
<td>Provide clarification of the in situ field instruments used over the 2017 monitoring program.</td>
</tr>
<tr>
<td>TOPIC</td>
<td>COMMENT</td>
<td>RECOMMENDATION</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>APPENDIX II, Effluent and Water Chemistry Report, Section 3.2.3, Results, Trends in Effluent and at the Mixing Zone Boundary, Total Metals, page 36 and figures 3-10 to 3-19</td>
<td>The report indicates: &quot;For most total metal SOIs, concentrations in the effluent were greater than the concentrations measured at the mixing zone boundary in 2017, indicating that the Mine effluent is a source of these variables to Lac de Gras. One exception was copper, where concentrations in the effluent were generally similar to or less than those recorded at the mixing zone boundary (Figure 3-13B/C). Lead and tin also had concentrations in the effluent that were generally similar to those at the mixing zone boundary (i.e., often below the DL), although sporadic elevated concentrations of these two variables occurred in the effluent which were greater than the measured concentrations at the mixing zone boundary (Figures 3-14B/C and 3-18B/C).&quot; The temporal pattern of effluent concentration and loading for several metals including antimony (Figure 3-11), molybdenum (Figure 3-15), and uranium (Figure 3-19) was not reflected in the mixing zone water quality results. Specifically, concentrations in the mixing zone decreased, and were notably lower than the effluent concentrations, in the open-water season despite increased concentrations in, and loading from, effluent.</td>
<td>Include a discussion of these observations in the report, including, where feasible potential or conceptual explanations.</td>
</tr>
<tr>
<td>APPENDIX II, Effluent and Water Chemistry Report, Section 3.3, Results, Depth Profiles, page 53</td>
<td>Section 3.3 (page 53) only compares dissolved oxygen (DO) monitoring results to the 6.5 mg/L Canadian Council of Ministers of the Environment (CCME) protection of aquatic life (PAL) guideline (CCME 1999; updated to 2018). NSC had commented (NSC 2018) previously that DO results should be compared to both the 6.5 mg/L (early life stages absent) and the 9.5 mg/L (early life stages present) CCME PAL guidelines (CCME 1999; updated to 2018) where applicable. The CCME 9.5 mg/L benchmark for early life stages would be more appropriate for fall spawning species such as Lake Trout. Indications of these guidelines on the depth profile figures would also greatly improve the ability to readily assess where exceedances occurred (Note: this would also apply for pH).</td>
<td>Include a comparison of DO monitoring results to the appropriate benchmarks (i.e., 6.5 and 9.5 mg/L). Add 6.5 and 9.5 mg/L benchmarks for DO and pH benchmarks to depth profile figures.</td>
</tr>
<tr>
<td>APPENDIX II, Effluent and Water Chemistry Report, Section 3.4.3, Results, Action Level Evaluation, Action Level 3, page 70, Figure 3-29</td>
<td>The Action Level 3 for dissolved sodium indicated on Figure 3-29 (51 mg/L; page 70) differs from what is presented in Table 3-8 (13.8 mg/L; page 64).</td>
<td>Review and revise table/figure for Action Level 3 values for dissolved sodium.</td>
</tr>
<tr>
<td>TOPIC</td>
<td>COMMENT</td>
<td>RECOMMENDATION</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>APPENDIX II, Effluent and Water Chemistry Report, Section 3.4.3, Results, Action Level Evaluation, Action Level 3, pages 65-83. Figures 3-24 to 3-42</td>
<td>Action Level 3 values are not presented on all water quality Figures 3-24 to 3-42. See for example Figure 3-30 sulphate (page 71).</td>
<td>Add Action Level 3 values where missing to the figures.</td>
</tr>
<tr>
<td>APPENDIX II, Effluent and Water Chemistry Report, Section 3.7, Results, Comparison of AEMP Data to Effects Benchmarks, page 124</td>
<td>The report indicates: &quot;Concentrations in all other samples collected during the 2017 AEMP were below the relevant Effects Benchmarks for the protection of aquatic life and drinking water. This includes the sample collected at Station LDG-48, which is located at the Lac de Gras outflow to the Coppermine River (Appendix D).&quot; As noted in Section 3.3 (page 53) some DO measurements were below the CCME PAL guidelines. These occurrences should be included within this discussion.</td>
<td>Include discussion of DO monitoring results that were below CCME PAL benchmarks.</td>
</tr>
<tr>
<td>APPENDIX II, Effluent and Water Chemistry Report, Appendix B, Quality Assurance and Quality Control Methods and Results, page B-3</td>
<td>The QA/QC Appendix B (page B-3) indicates that duplicate sample results were considered &quot;notable&quot; where the Relative Percent Difference (RPD) was greater than 40%. This criterion is higher than used in previous reports. For example, in the 2017 AEMP Annual Report (Golder 2017), the criterion was 20% for evaluating duplicate sample results (Appendix II, Appendix C, page C-3).</td>
<td>Review the text and revise (if the value was reported in error) or provide a rationale for the change in the RPD criterion for evaluating duplicate sample results.</td>
</tr>
<tr>
<td>APPENDIX II, Effluent and Water Chemistry Report, Appendix C, Initial Effluent and Water Quality Data Screening, page C-9, Figure C-6</td>
<td>A footnote to Figure C-6 (page C-9) indicates: &quot;Note: Anomalous data were recorded at the bottom depth of the MF3-6 profile during the ice-cover season of 2017 and were not included in the data presented in Section 3.3. It is likely that the measuring device encountered the bottom sediments and caused the anomalous measurements.&quot; The figure presents results of in situ depth profile measurements for a single site and sampling time. It is unclear what are the anomalous data referred to and what data were omitted from data presented in Section 3.3.</td>
<td>Provide a description of the anomalous data removed for this data set.</td>
</tr>
<tr>
<td>APPENDIX XI, Plankton Report, Appendix A, Quality Assurance and Quality Control, page A-4, Table A-1, and Appendix B - Raw Plankton Data</td>
<td>Appendix B indicates three samples were collected at Site MF3-5. Footnotes in the table indicate sample MF3-5-QC(a) is a &quot;Field QC (duplicate) sample&quot; and sample MF-3-5-QC(b) is a &quot;Field QC (split) sample.&quot; The third sample (MF-3-5) is presumably the &quot;original&quot; sample (i.e., the other duplicate field sample). Table A-1 presents RPDs for duplicate phytoplankton samples and Table A-3 presents RPDs for the split sample. The results for these two comparisons appear to be reversed (based on the raw data provided in Appendix B).</td>
<td>Verify that duplicate and split sample QC results are presented in the correct tables and/or that the footnotes included in Appendix B are accurate.</td>
</tr>
</tbody>
</table>
The QA/QC review of phytoplankton data considers results for counts (i.e., abundance) and not biomass. However, the plankton component of the AEMP is focused on results for phytoplankton biomass and not abundance. It is recommended that an analysis and discussion of QA/QC results for biomass, in addition to abundance, be provided. Phytoplankton biomass is derived from two estimates: (1) counts of algal cells; and (2) measures/estimates of cell biovolume. Phytoplankton biomass results are therefore affected by an additional source of variability (i.e., biovolume measurements) beyond measures of algal abundance.

A similar comment was submitted in the review of the 2016 Annual AEMP Report (NSC 2017): "Comparison of duplicate phytoplankton samples should be done both for abundance (i.e., cell counts) as well as biomass. The latter is typically more variable than the former as it is derived from two measurements (cell counts and algal cell size). As biomass is the metric of concern for the AEMP QA/QC should focus on this metric."

Provide an analysis and discussion of phytoplankton biomass QA/QC results.

As noted in previous comments (e.g., Section 2.4.3, NSC 2018 and row 35 in associated excel submission), comparisons of spatial extent of effects between years for eutrophication indicators should be done with caution and should include explanatory text identifying the limitations of inter-annual comparisons in light of the lack of sampling in the FF areas in interim years.

Section 4.3.3 reads: "The boundary of effects on concentrations of TN to the northwest extended to at least Station MF1-5; however, the extent of effects along the MF1-FF1 transect could not be assessed further, because sampling in the FF1 area was not completed in 2017 as part of the interim program. The extent of effects to the northeast of the Mine extended to the end of the MF2-FF2 transect (Station FF2-5). The boundary of effects south of the Mine extended to between stations MF3-6 and MF3-7. The resulting affected area of the lake based on concentrations of TN was estimated as greater than or equal to 240 km², or greater than or equal to 41.9% of lake area, which is less than reported in 2016, but comparable to the affected areas calculated for this variable in previous years."

Include a qualifying statement indicating that due to the lack of FF data for 2017 and the implications regarding limitations on defining the spatial extent of effects in those years, comparison to 2016 or other years is associated with uncertainty.

The last sentence should be modified to clearly state that direct comparisons to 2016 results are not possible due to the lack of sampling in FF areas in 2017.
<table>
<thead>
<tr>
<th>TOPIC</th>
<th>COMMENT</th>
<th>RECOMMENDATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Similar to the comment above, comparisons of spatial extent of effects for chlorophyll a between years should be done with caution and should include explanatory text identifying the limitations of inter-annual comparisons in light of the lack of sampling in the FF areas in interim years.</td>
<td>Include a qualifying statement indicating that due to the lack of FF data for 2017 and the implications regarding limitations on defining the spatial extent of effects in those years, comparison to 2013 or other years is associated with uncertainty.</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Section 4.3.3, Eutrophication Indicators, Results and Discussion, Nutrients and Water Chemistry in Lac de Gras, page 41</td>
<td>Section 4.3.3 reads: &quot;Effects on chlorophyll a were observed in the NF area and along all three transects. The boundary of effects on concentrations of chlorophyll a to the northwest of the Mine extended to Station MF1-5 (Figure 4-10). The extent of effects to the northeast of the Mine extended to the end of the MF2-FF2 transect (Station FF2-5). The boundary of effects south of the Mine extended to Station MF3-4. The extent of effects on concentrations of chlorophyll a, based on the affected stations, was calculated to be 149.8 km². Compared to the total surface area of the lake (573 km²), the area demonstrating effects on chlorophyll a concentration represents 26.2% of the lake area, similar to the extent of effects observed in 2013 (Golder 2014).&quot;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The last sentence should be modified to clearly state that direct comparisons to 2013 results are not possible due to the lack of sampling in FF areas in 2017. As the boundary of the extent of effects along the northwest transect could not be accurately defined, the affected area may have been larger in 2017 than 2013.</td>
<td></td>
</tr>
<tr>
<td>APPENDIX XIII, Eutrophication Indicators Report, Section 3.2, Results, Effects of Dust Deposition, page 23</td>
<td>The report indicates: &quot;The estimated total anthropogenic TP loading from the Mine in 2017 was 1.4 tonnes per year (t/yr), with 0.42 t/yr from effluent, 0.63 t/yr from direct dust deposited to the lake surface, and 0.34 t/yr from runoff from the surrounding watershed (excluding the Mine footprint). The anthropogenic TP loading (including both effluent and fugitive dust) presented a 7.3% increase relative to the natural background TP loading of the watershed.&quot; (page 23)</td>
<td>Indicate the estimated &quot;natural background TP loading of the watershed&quot; and provide an explanation of how the estimate was derived.</td>
</tr>
<tr>
<td></td>
<td>It is unclear what the &quot;natural background TP loading of the watershed&quot; is that is referenced or how that value (not indicated) was estimated.</td>
<td>Clarify the method for estimating &quot;anthropogenic loading&quot; to Lac de Gras.</td>
</tr>
<tr>
<td>TOPIC</td>
<td>COMMENT</td>
<td>RECOMMENDATION</td>
</tr>
<tr>
<td>-------</td>
<td>---------</td>
<td>----------------</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, Section 4.3.2, Eutrophication Indicators, Results and Discussion, Nutrients and Water Chemistry in Lac de Gras, pages 34-35</strong></td>
<td>The discussion and graphical plots of results for nutrients in Lac de Gras within the Eutrophication Indicators section (Main Document, Section 4.3.2, Eutrophication Indicators, Results and Discussion, Nutrients and Water Chemistry in Lac de Gras, pages 34-35) does not include results for the inflow to Lac de Gras (i.e., Site LDS-4), though it is noted that some discussion of results for this site are provided in Appendix XIII (e.g., pages 34-43). Inclusion of monitoring results for site LDS-4 within the Main Report would assist with interpretation of results. For example, TN concentrations were notably higher in the MF2-FF2 transect in the open-water season (Main Document, Figure 4-5, page 25); it would be of interest to compare these results to the upstream site at the lake inflow to evaluate the potential influence of upstream conditions on this transect. Qualitative review of the raw data files suggest that the inflow of Lac de Gras contained a higher concentration of TN than the MF1, MF3, and NF areas and may have contributed to the relatively higher concentrations of TN observed along transect MF2-FF2 in the open-water season (the report notes that no sample was collected from LDS-4 in winter).</td>
<td>Add results for LDS-4 to figures and include discussion of results for LDS-4 within the discussion of nutrients in Lac de Gras in the main document (Section 4.3.2) and Appendix XIII (Section 3.4).</td>
</tr>
<tr>
<td><strong>APPENDIX XIII, Eutrophication Indicators Report, Section 3.5, Results, Chlorophyll a, and Phytoplankton and Zooplankton Biomass, pages 30-31 and MAIN DOCUMENT, Section 4.3.2, Eutrophication Indicators, Results and Discussion, Nutrients and Water Chemistry in Lac de Gras, page 36</strong></td>
<td>As noted for nutrients, it would be of benefit to include the LDS-4 results for chlorophyll a within the discussion and Figure 3-13 presented in Section 3.5 of Appendix XIII (page 31) and Figure 4-5, Section 4.3.2 in the main document (page 36).</td>
<td>Add results for LDS-4 to Figure 3-13 and include discussion of results for LDS-4 within the discussion of chlorophyll a in Lac de Gras.</td>
</tr>
<tr>
<td>TOPIC</td>
<td>COMMENT</td>
<td>RECOMMENDATION</td>
</tr>
<tr>
<td>-------</td>
<td>---------</td>
<td>----------------</td>
</tr>
<tr>
<td>APPENDIX XIII, Eutrophication Indicators Report, Section 3.6.2, Results, Spatial Analysis in Lac de Gras, Nutrients, page 38</td>
<td>The report indicates: &quot;Concentrations of TN were generally greater than the normal range during both ice-cover and open-water seasons (Figure 3-20). Strong decreasing trends in TN concentrations were observed along all transects during both seasons, with the exception of the MF1 transect during the open-water season (Table 3-2). Concentrations of TN at LDG-48 were similar to concentrations observed in the MF2-FF2 area during the open-water season. The concentration of TN at LDS-4 was slightly greater than those measured in the NF area during the open-water season.&quot; (page 38). Figure 3-20 (page 39) indicates a trendline for MF2 for TN that increases with distance from the effluent diffuser. As noted above, the concentration of TN measured at LDS-4 may have contributed to the higher TN concentrations observed along transect MF2-FF2.</td>
<td>Correct the text to reflect positive trend in TN at transect MF2-FF2 in the open-water season. Provide additional discussion of potential effects of water quality at the Lac du Sauvage outflow on nutrients in Lac de Gras, notably at transect MF2-FF2.</td>
</tr>
<tr>
<td>APPENDIX XIII, Eutrophication Indicators Report, Section 3.7, Results, Action Level Evaluation, page 48</td>
<td>The demarcation of Action Level 3 (i.e., Normal Range plus 25% Benchmark (AL3)) is not legible in Figure 3-28.</td>
<td>Revise figure.</td>
</tr>
<tr>
<td>APPENDIX XIII, Eutrophication Indicators Report, Section 3.7, Results, Action Level Evaluation, page 48</td>
<td>There appears to be an erroneous figure reference or the referenced figure is not provided in relation to the following text: &quot;In 2017, 26.2% of the lake area had chlorophyll a concentrations above the upper limit of the normal range (i.e., 0.82 μg/L) (Figures 3-28, 3-29 and 4-2; Table 3-3).&quot; Figure 3-29 presents the area of the lake that exceeds the Action Level 3 criterion.</td>
<td>Review text and figures and revise where required.</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Section 4.3, Eutrophication Indicators, Summary and Discussion, pages 31-44, and APPENDIX XIII, Eutrophication Indicators Report, Section 4.1, Summary and Discussion, Nutrients in Effluent and the Mixing Zone, page 51</td>
<td>Section 4.3 of the main document (pages 31-44) and Section 4.1 of Appendix XIII (page 51) only present annual loading of total phosphorus (TP) to Lac de Gras for effluent. This underrepresents the total loading of TP to Lac de Gras associated with the mine. Estimates of loading from dust, presented in Appendix XIII Appendix D (Assessment of Total Phosphorus Deposition to Lac De Gras), should be presented and discussed within the main body of the report and the summary section of Appendix XIII.</td>
<td>Incorporate discussion of all anthropogenic sources of TP to Lac de Gras within the main document and Appendix XIII.</td>
</tr>
<tr>
<td>TOPIC</td>
<td>COMMENT</td>
<td>RECOMMENDATION</td>
</tr>
<tr>
<td>-------</td>
<td>---------</td>
<td>----------------</td>
</tr>
<tr>
<td>APPENDIX XIII, Eutrophication Indicators Report, Section 4.3, Summary and Discussion, Extent of Effects, pages 53-59, Figure 4-2 and Appendix XIII - E, Eutrophication Indicators Raw Data</td>
<td>Although concentrations of TN were generally higher in Lac de Gras in winter, use of the 2017 open-water season monitoring data for delineation of the spatial extent of effects (i.e., the area of Lac de Gras above the normal range) would result in a larger calculated affected area. Specifically, results for the most western site (MF3-7) along transect MF3 exceeded the normal range in the summer but not the winter. Use of the open-water season data would result in an affected area that extended to the full extent of the monitoring site boundaries. The TN concentration for site MF3-7 in winter is 0.159 mg/L (mean of bottom samples; raw data presented in Appendix XIII - E), which is within the normal range for this season (0.138 - 0.173 mg/L), whereas the concentration for the open-water season is 0.186 mg/L (mean of raw data presented in Appendix XIII - E), which is above the upper boundary of the normal range (0.153 mg/L).</td>
<td>Recommend presenting spatial extent of effects for either the worst case (i.e., the largest spatial extent of effects) or present both the ice-cover and open-water season results in two figures. The latter would also provide for direct comparison of chlorophyll a and nutrient results for the same time period.</td>
</tr>
<tr>
<td>APPENDIX XIII, Eutrophication Indicators Report, Appendix C, Quality Assurance and Quality Control, page C-3</td>
<td>Similar to a previous comment, the QA/QC appendix C (page C-3) indicates that duplicate sample results were considered notable where the Relative Percent Difference (RPD) was greater than 40%. This criterion is higher than used in previous reports. For example, in the 2017 AEMP Annual Report (Golder 2017), the criterion was 20% for evaluating duplicate sample results (Appendix XIII, Appendix B, page B-3).</td>
<td>Review the text and revise (if the value was reported in error) or provide a rationale for the change in the RPD criterion for evaluating duplicate sample results.</td>
</tr>
<tr>
<td>APPENDIX XIII, Eutrophication Indicators Report, Appendix C, Quality Assurance and Quality Control, page C-3</td>
<td>For review of QA/QC results, the percent of flagged duplicate nutrient samples (i.e., those failing data quality objectives) was expressed based on the total number of duplicate sample pairs collected (e.g., total of 190 duplicate sample pairs for the open-water season). However, of the total 190 duplicate pairs, RPDs for many samples could not be reliably assessed due to data values being less than 5 times the analytical detection limit.</td>
<td>Recommend expressing the percent of flagged duplicate RPDs based on the total number of paired samples where one or more values exceeded 5 times the analytical detection limit. Also recommend expressing percentages of flagged values by water quality parameter in order to evaluate issues that may be present with specific analytes.</td>
</tr>
<tr>
<td>APPENDIX XIII, Eutrophication Indicators Report, Appendix C, Quality Assurance and Quality Control, page C-3</td>
<td>It would be more appropriate to evaluate the overall percent of flagged samples based on the total number of duplicate pair results where the RPD could be reliably calculated (i.e., for those total number of paired samples that exceeded 5 times the detection limit). This approach also does not consider QA/QC results on a parameter by parameter basis and thus may not adequately assess potential issues with specific analytes.</td>
<td></td>
</tr>
</tbody>
</table>
3.0 SUPPORTING MATERIALS FOR REVIEW


October 31, 2018

Sarah Elsasser
Regulatory Manager
Wekeezhii Land and Water Board
#1-4905 48th Street
Yellowknife, NT
X1A 3S3

Dear Ms. Elsasser,

Re:   DDMI Diavik
       Water Licence – W2015L2-0001
       2017 AEMP Annual Report
       Request for Comment

The Department of Environment and Natural Resources (ENR), Government of the Northwest Territories has reviewed the report at reference based on its mandated responsibilities under the Environmental Protection Act, the Forest Management Act, the Forest Protection Act, the Species at Risk (NWT) Act, the Waters Act and the Wildlife Act and provides the following comments and recommendations for the consideration of the Board.

Topic 1: General

Comment(s):

ENR retained Zajdlik and Associates to provide review and comment of the Diavik Diamond Mines (2012) Inc. (DDMI) 2017 Aquatic Effects Monitoring Program (AEMP) Annual Report. As part of the review, Dr. Zajdlik focused on previous WLWB Board Directives and Reasons for Decision for the prior AEMPs. ENR has extracted and summarized his comments and recommendations from this memorandum and provided them below. ENR has also included Dr. Zajdlik’s review memorandum which provides additional background, technical figures, and context for the comments and recommendations.
Recommendation(s):

1) ENR recommends the Board refer to the attached memo for additional background and context supporting ENR’s comments and recommendations.

Topic 2: WLWB 2014 AEMP Directives

Comment(s):

All the Directives in WLWB’s Reasons for Decisions (WLWB 2016) that refer to comments by GNWT ENR on the 2014 AEMP review pertain either to the AEMP design or the AEMP 3-Year Re-Evaluation. ENR notes that DDMI (Golder 2018a, Table 2) did consider WLWB (2016), Directive 2A: “DDMI is to consider a more explicit analysis of the role of nitrogen in explaining variation and the spatial extent of chlorophyll a effect”, within the 2017 AEMP. According to, DDMI (Golder 2018a, Table 2) this consideration is presented in Appendix XIII, Section 3.0 of the 2017 AEMP report.

The spatial distributions of total ammonia, total nitrogen, total dissolved nitrogen, nitrate and nitrate + nitrite are discussed by DDMI (Golder 2018a, Appendix XIII, Section 3.6.2). The spatial distribution of chlorophyll a is also discussed by DDMI (Golder 2018a, Appendix XIII, Section 3.6.3). However, the relationship between nitrogen species and chlorophyll a is not considered by DDMI (Golder 2018a, Section 3) as stated. In a review of the 3-Year AEMP re-evaluation (Golder, 2018b) Dr. Zajdlik (2018) concluded that “The ‘role of nitrogen in explaining the spatial extent of chlorophyll a effect’ does not appear to be discussed explicitly” and recommended that: “DDMI should follow the spatial extent portion of the WLWB (2016b, Directive 2) to ‘consider a more explicit analysis of the role of nitrogen in explaining variation and the spatial extent of chlorophyll a effects.’ That is, DDMI should consider the role of nitrogen in the spatial extent of chlorophyll a effects.”

Recommendation(s):

1) ENR recommends DDMI clarify if the 2016 WLWB Directive (2A) has been addressed as required in the 2017 AEMP report, or in a previously submitted report/plan. If not, DDMI should adequately respond to the Directive by providing a discussion for public review (e.g., in a technical memo) on the relationship between nitrogen species and chlorophyll a that was recommended by GNWT-ENR during the 2014 AEMP review and AEMP 3-Year Re-Evaluation.
**Topic 3: Appendix XIII**

**Comment(s):**

ENR notes that some of the Section numbers in the AEMP report Appendix XIII are incorrect.

**Recommendation(s):**

1) ENR recommends that the Section numbers in the report (Golder 2018a), Appendix XIII, Section 2.3 should be corrected

**Topic 4: WLWB 2015 AEMP Directives and DDMI Commitments – Trophic Status**

**Comment(s):**

WLWB’s Reasons for Decision on the 2015 AEMP Annual Report (2017a) reports that Directive 2C pertains to AEMPs stating: “DDMI is to clarify the meaning of ‘slight increase in trophic status’ in all future AEMP-related reports”. DDMI (Golder 2018a, Table 2) points to Appendix XIII, Section 4.2 of the 2017 AEMP report as the section where WLWB (2017a) Directive 2C is addressed. In that section DDMI (Golder 2018a) states: “A slight increase in nutrient enrichment suggests that nutrients are increasing in Lac de Gras, but a change in trophic status from oligotrophic to mesotrophic has not been observed.” The statement puts a boundary on the change in trophic status but is not definitive. Trophic status is a continuum that is defined using a variety of metrics with some debate regarding choice of metrics. ENR has previously commented to the Board on the continuum in trophic status and what defines a change in trophic status as it relates to Lac de Gras.

DDMI (Golder 2018a Appendix XIII, Section 3.4 Figures 3-10, 3-12 inclusive and Figures 3-13, 3-15) present boxplots of nutrients and plankton metrics by area for the 2017 sampling season. These informative graphics should be summarized in a table that contains the percent increase in the median eutrophication metric (nutrient or chlorophyll a concentration or plankton biomass) relative to the baseline median by area. This allows readers to rapidly assess how each eutrophication metric has changed relative to the baseline and allows the authors to unequivocally present the degree of change.

**Recommendation(s):**

1) ENR recommends that the informative graphics discussed above should be summarized into a table that contains the percent increase in the median
eutrophication metric (nutrient or chlorophyll a concentration or plankton biomass) relative to the baseline median by area by DDMI.

**Topic 5: Topic: WLWB 2015 AEMP Directives and DDMI Commitments - Raw Toxicity Data**

**Comment(s):**

WLWB (2017a) notes that “the GNWT-ENR recommended that DDMI provide the raw toxicity test data as part of the AEMP reports (GNWT-ENR comment 9). In its response, DDMI stated that they would consider including these results as an appendix to the annual AEMP reports”. Although the raw toxicity test data were not included, the toxicity test methods are introduced in the report (Golder 2018a, Appendix II, Section 2.3.4.4), test results are presented by DDMI (Golder 2018a, Appendix II, Section 3.2.6) and the specific sampling months are listed. The inclusion of a result summary is in this case, helpful as it highlights the absence of acute or chronic toxicity based on the pass/fail criterion. Highlighting the hormetic effect for *Pseudokirchneriella subcapitata* for each of the four sampling times at the surveillance network program monitoring locations is also helpful. That said, detecting the increased but statistically insignificant exposure immobility and mortality in *Daphnia magna* and exposure rainbow trout egg and embryo mortality in the September sample required retrieval of Surveillance Network Program documents.

**Recommendation(s):**

1) ENR recommends that the raw toxicity data should be provided by DDMI as part of the AEMP report.

**Topic 6: WLWB 2016 AEMP Directives and DDMI Commitments - 2.3.1 Ammonia Contamination**

**Comment(s):**

WLWB (2017b) Directive 2 pertains to AEMPs stating: “DDMI is to include as part of the 2017 AEMP Annual Report, the results of its investigation and proposed recommendations regarding ammonia contamination issues”. DDMI (Golder 2018a, Table 2) points to Appendix II Section 2.4.1 and Appendix B as the sections where WLWB (2017b) Directive 2 is addressed. In that section DDMI (Golder 2018a) describes improvements made to sample handling by Maxxam Analytics (Maxxam). In an ammonia quality control study, 124 samples duplicate samples were submitted to both Maxxam and ELS (Golder, 2018b, Appendix 4B, Attachment A ALS/Maxxam Total Ammonia Interlab Comparison). Of those samples, 71 Maxxam and 69 ALS results were less than the detection limit (0.005 mg/L) and a fixed value of 0.003 mg/L was substituted. This very large proportion of censored observations
biases the variance term used in the paired t-test downward, artificially increasing the power of the paired t-test. Dr. Zajdlik, in his review, notes that this likely had the effect of making the conclusion “no systematic bias in ammonia measurements between analytical laboratories” more defensible.

Although Maxxam analytical procedures have been improved, DDMI (Golder 2018a) states that ammonia results from the ALS laboratories will be used as the data quality is better and so that potential laboratory effects are obviated.

Table B1, Appendix B (Golder, 2018a, Appendix II) shows that ammonia was detectable in 50% (2/4) of equipment blanks (at high concentrations), 33% (1/3) of field blanks and 50% (1/2) of trip blanks in the 2017 samples submitted to Maxxam. Table B1, Appendix B (Golder, 2018a, Appendix II) also shows that ammonia was detectable in 50% (1/2) of equipment blanks (at high concentrations), 50% (2/4) of field blanks and 25% (1/4) of trip blanks in the 2017 samples submitted to ALS. The maximum recorded quality assurance ammonia concentration was 42 µg/L measured in a field blank submitted to Maxxam. Under the assumption that the entry “ALS (Maxxam)” in Table B2, Appendix B (Golder, 2018a, Appendix II) pertains to ammonia, relative percent differences for duplicate samples are 47.8 and 14.8% (Maxxam) and 7 and 20% (ALS). Given the data quality objective of a 40% limit on the relative percent difference (Golder, 2018a, Appendix II, Appendix B) 50% (1/2) Maxxam samples “fail”. The detection of ammonia in a large proportion of the ALS quality assurance blanks suggests that low level detection of ammonia remains problematic.

The maximum ammonia concentration recorded in a blank by ALS was 12 µg/L. Assuming that this is a random as opposed to systematic event, ammonia concentrations that could be biased more than 50% are any that are reported as lower than 24 µg/L. Such ammonia concentrations are reported for the August through October samples collected at the mixing zone boundary by DDMI (Golder 2018a, Appendix II, Figure 3-8), most of the open water samples (aside from nearfield samples) and all but one of the under-ice samples (Golder 2018a, Appendix II, Figure 3-50). Note that this is a worst-case scenario but, there is also the possibility of a lesser extent of bias such as 25%. The results presented in the 2017 AEMP Annual Report (Golder 2018a, Appendix II, Figure 3-50) make sense in a general fashion; ammonia concentrations decrease with distance from the source and concentrations are lower in the open water season. Given that Action Level 1 tests for a two-fold difference between the nearfield area median concentrations that are high or non-detectable (30.0 and < 0.5 µg/L for the under ice and open water seasons; respectively) and reference dataset median concentrations of 17.8 µg/L under ice and 5 µg/L in the open water (this is the detection limit) (Golder, 2017b) there is some cause for concern if the reference median dataset is suspect due to quality control issues. A visual examination of the data presented in the AEMP Reference Conditions Report Version 1.2 (Golder 2017b) shows four aberrant observations on the high side. These four observations are not sufficient to bias
estimation of the median of that dataset. Action Levels 2 and 3 use the 5th percentile ammonia concentrations in the nearfield area and the 75th percentile ammonia concentration at the mixing zone boundary, respectively as exposure measurements. Given current observed concentrations in the nearfield it is unlikely that ammonia quality assurance issues will adversely affect comparison with action levels.

The ALS ammonia data quality remains of concern and further efforts should be made to improve the quality of the ammonia data for low level measurement. From a practical management perspective based on current use of Action Levels, the ammonia data quality concern is only of moderate concern.

**Recommendation(s):**

1) ENR recommends DDMI review the ammonia data quality and commit to making improvements to the quality of the ammonia data for low level measurements.

2) ENR recommends that DDMI should clarify that the entry “ALS (Maxxam)” in Table B2, Appendix B (Golder, 2018a) pertains to ammonia.

**Topic 7: Nutrient Loadings**

**Comment(s):**

DDMI states in the 2017 AEMP report (Golder 2018a, Appendix XIII, Appendix D): “Lac de Gras is an oligotrophic lake characterized by very low concentrations of nutrients, including total phosphorus (TP). The median background concentration of TP in Lac de Gras is 3.6 micrograms per litre (μg/L) during the ice-cover season (with a normal range of 2.0 to 5.0 μg/L), and 3.3 μg/L during the open water season (with a normal range of 2.0 to 5.3 μg/L) (Table 3.2-12; Golder 2017a).”

Environment Canada (2004) with respect to phosphorus in freshwater states that: “If the increase from the baseline is greater than 50%, the risk of observable effects is considered to be high, and further assessment is recommended”. Median background concentrations for total phosphorus in Lac de Gras are 3.6 and 3.3 μg/L during the ice-cover and the open water seasons, respectively (Golder 2018a, Appendix XIII, Appendix D). Using those values and data provided on the public registry, the proportion of samples exceeding a 50% increase in the season-specific baseline median is plotted for the last four years. “To provide the most conservative view of effluent effects, the season and depth with the greatest extent of effects was selected for this evaluation” following Golder (2018b).

Dr. Zajdlik shows in his review for ENR (Figures 1 and 2) that on a conservative basis a very large proportion of samples exceed the Environment Canada (2004) recommended 50% increase in TP. The figures show the proportion of samples
exceeding a 50% increase in season-specific TP baseline for the years examined, varies between 2 and 24%. More samples exceed a 50% increase in the season-specific TP baseline in the open water season than under ice.

Dr. Zajdlik also demonstrates that a 50% increase over the baseline occurs most frequently in the nearfield and that the proportion of samples higher than 50% of the baseline is increasing since 2015. It is not clear whether conclusions reached using the figures presented would compare with those reached using Golder (2018b, Figure 5–1) if the 2015 data were included. That figure shows the affected area (as defined by) exceedance of the natural range and using “the season and depth with the greatest extent of effects” (Golder, 2018b, Section 5.2.3.4). However, the overall message is that large portions of Lac de Gras exceed the Environment Canada (2004) 50% increase in baseline criterion for TP who state: “If the increase from the baseline is greater than 50%, the risk of observable effects is considered to be high, and further assessment is recommended”. ENR encourages the Board and DDMI to further review Dr. Zajdlik’s memo included in this response, including the figures discussed above.

**Recommendation(s):**

1) ENR recommends that DDMI should provide the 2014 and 2015 chlorophyll a data in an electronic (i.e. Microsoft excel or similar) format.

2) ENR recommends that DDMI should use the current chlorophyll a extent of effects paradigm and estimate the spatial extent of exceedances of a 50% increase in the season-specific total phosphorus baseline median following Environment Canada (2004) to allow regulators to decide whether further investigation of the Environment Canada (2004) criterion is warranted.

**Topic 8: Phosphorus Contaminant Loadings from Dust and Effluent**

**Comment(s):**

This comment discusses the contributions of phosphorus from dust and effluent in the context of the Water Licence limit for TP loadings via effluent to Lac de Gras. Approximate calculations regarding the relative loads of ammonia from effluent and dust to Lac de Gras are also presented to explore whether dust should be considered as a contaminant source when discussing loadings to Lac de Gras.

DDMI (Golder 2018a, Appendix II) reports that the TP loadings from the Mine “in 2017 was 1,400 kilograms/year (kg/y), with 420 kg/y from effluent, 630 kg/y from direct dust deposited to the lake surface, and 340 kg/y from runoff from the surrounding watershed (excluding the Mine footprint)”. Although the combined current Mine-associated loadings exceed the TP loading limit for the Water Licence,
the Licence is specific to “all treatment facilities discharging to Lac de Gras” (WLWB, 2018) and therefore the 420 kg deposited by DDMI in 2017 falls well below this limit. Due to the uncertainty of when the mine will cease operations, ENR is unable to estimate the annual average loading as stipulated in DDMI’s Water Licence (Part H, Item 32) and therefore uncertain if the annual average would approach the 1000 kg per year limit for any given year (see subsequent comment and recommendations for more discussion on this topic).

An annual loading limit for TP was not included in the original Water Licence for the Diavik Diamond Mine (Northwest Territories Water Board, 2000). The annual loading limit was added following a request by DDMI as the mine was occasionally out of compliance using a concentration-based limit (DDMI, 2002a). Considerable discussion ensued (DDMI, 2002b), with an apparent outcome that if the (then) newly updated predicted TP loads were lower than those used in the environmental assessment, that a loadings-based limit (using the updated, lower limits) for TP was reasonable. The phosphorous loadings used in the original environmental assessment (DDMI, 2002a) may be 1657 kg/y for all facilities with a maximum of 2,321 kg/y for all facilities. It is not clear whether those figures include the construction sewage load of 292 kg/y. As the 2017 loadings fall well below the loadings used in the original environmental assessment that concluded that “there would be no significant adverse residual effects of nutrient enrichment (that is based on phosphorous) on Lac de Gras during operations and post-closure” (Canada, 1999) action based on the original environmental assessment is not warranted. That said, previous recommendations regarding nutrient management (Zajdlik, 2016) in the context of more recent Environment Canada (2004) and CCME (2006) guidance are still relevant.

DDMI (Golder 2017c) presents methods for estimating TP loadings to Lac de Gras via dust. These use TP concentrations in snow water as the basis for the loading estimates. DDMI (Golder 2018a, Appendix I, Figure 3.3-4) presents phosphorus concentration in snow water that diminish from approximately 50 µg/L in 0-100m distance from Mine footprint range to background deposition rates. Concentrations of ammonia are greater than approximately 100 µg/L in the 101-250 m range (0-100m range data are not presented) (Golder 2018a, Appendix I, Figure 3.3-1). Ammonia concentrations in snow water are approximately double the phosphorus concentrations in snow water.

**Recommendation(s):**

1) ENR recommends that the methods used to estimate total phosphorus loadings from dust, presented in Golder (2017c) should either be referenced in future AEMPs or the methods should be included in the AEMP by DDMI.
**Topic 9: Phosphorus Loading**

**Comment(s):**

The current Water Licence that DDMI operates under (WLWB, 2018 Part H, Item 32) contains a clause regarding the total annual phosphorus loadings from effluent that discusses total average annual loading of 1,000 kg per year during the life of the mine. The average annual loading of total phosphorous is defined therein as follows: "Average Annual Loading of Total Phosphorus" means the sum of annual loads divided by the number of annual loads summed.

As defined the average annual loading of the mine is a running average and the "average annual loading of 1,000 kg per year during the life of the mine" cannot be known until the mine ceases operating. Although loads from "all treatment facilities discharging to Lac de Gras" as stated in the Water Licence are well below the prescribed limit, the wording of the Water Licence should be corrected.

**Recommendation(s):**

1) ENR recommends that the wording of the Water Licence should be corrected. This may take the form of a 3 year average as originally envisioned (DDMI, 2000b).

**Topic 10: Loadings from Dust and Action Levels**

The following paragraphs discuss how dust and effluent loadings are combining in the near and mid field areas to challenge interpretation of loadings. This requires that dust and effluent loadings be considered simultaneously when assessing effects in Lac de Gras. The linkage between loadings and effluent quality criteria (EQC) is discussed leading to a recommendation that if substantive dust loads occur, EQCs should be reconsidered in the context of combined (dust and effluent) loadings so that effects benchmarks are not exceeded. Because Action Levels define actions that follow exceedance of an action, consideration of dust loads following exceedance of specific Action Levels is also discussed.

The interpretation of potential dust deposition effects with respect to other analytes is contingent upon an assessment of spatial patterns with respect to the dust zone of influence. DDMI (Golder 2018a, Section 4) concluded that “the increases at the MF stations may not be solely related to effluent” (Increases refer to ammonia, lead and tin). Of the 10 substances of interest that were greater than 2 x the median of the reference dataset in one or more of the midfield stations, 7 also triggered Action Level 1 in the nearfield. DDMI (Golder 2018a, Section 4) concludes that “exceedances at the MF stations were at least partly caused by dispersion of Mine effluent into the lake”.

The 2017 AEMP was carried out following AEMP Design Plan Version 4.1 (Golder 2017a). Under that design, for water quality variables, Action Level 3 requires derivation of EQC. Effluent based EQCs are back-calculated from effects benchmarks. As the water quality effects benchmarks “represent levels of water quality variables below which a body of water is expected to be suitable for its designated use” (Golder, 2017a), the benchmark applies regardless of the waste source. If dust loadings comprise a substantive proportion of waste loads being deposited to Lac de Gras by the Proponent, then EQCs should reflect that loading to ensure that the water quality benchmark is not exceeded. At this point in time, the relative contribution of TP from dust, to the deposition of waste in Lac de Gras is not known.

Monthly ammonia loading rates from the North Inlet Water Treatment Plant are presented in the AEMP report (Golder 2018a, Appendix II, Figure 3-8). Using that figure, 200 kg is a crude estimate of an average ammonia monthly loading rate, leading to an annual ammonia loading rate of 2,400 kg/y. Using a conservative 2:1 ratio of ammonia: TP in snow water and the reported 630 kg TP contribution from dust to Lac de Gras in 2017 (Golder (2018a, Appendix II), the ammonia loading from dust may be very approximately, 1,260 kg /y (=2 x 630 kg/y total P from dust) or a contribution of approximately 50% of the loading from the North Inlet water treatment plant. These “back-of-the-envelope” calculations by Dr. Zajdlik suggest that loadings of nutrients and substances of interest attributable to dust deposition from the Mine site can add significantly to the amount of waste deposited via effluent that is permitted under the current Water Licence. Dust deposition may explain the concentrations of total nitrogen at the MF2-FF2 transect, that were elevated relative to the NF area (Golder, 2018a Section 4.3.2).

Under AEMP Design Plan Version 4.1, exceedance of Action Level 4 requires an investigation of mitigation options. Mitigation options could consider improved dust management as part of the action plan. However, the extent to which reductions in dust losses would enable the Proponent to meaningfully manage losses is not currently known as the relative loadings are not known. Finally, given general concerns with eutrophication following increased awareness of eutrophication and provision of Federal Guidance (CCME, 2006; Environment Canada, 2004) subsequent to the environmental assessment, a recommendation regarding measuring nutrient loads is provided below.

Recommendation(s):

1) ENR recommends that DDMI should provide a table of the loadings from dust and effluent for all analytes triggering Action Level 1.
**Topic 11: References**

**Comment(s):**

The following references are submitted in support of ENR comments:


Recommendation(s):

None.

Comments and recommendations were provided by ENR technical experts in the Water Resources Division and the North Slave Region and were coordinated and collated by the Environmental Assessment and Monitoring Section (EAM), Conservation, Assessment and Monitoring Division (CAM).
Should you have any questions or concerns, please do not hesitate to contact Patrick Clancy, Environmental Regulatory Analyst at (867) 767-9233 Ext: 53096 or email patrick_clancy@gov.nt.ca.

Sincerely,

Patrick Clancy  
Environmental Regulatory Analyst  
Environmental Assessment and Monitoring Section  
Conservation, Assessment and Monitoring Division  
Department of Environment and Natural Resources  
Government of the Northwest Territories

Review of Diavik Diamond Mine 2017 AEMP

Prepared for:

B. Pain
Government of the Northwest Territories

Prepared by:

Zajdlik & Associates Inc.
October, 2018
Table of Contents

1 Introduction ........................................................................................................................................... 1
2 Review of Wekèezhii Land and Water Board Directives .............................................................. 1
   2.1 WLWB 2014 AEMP Directives .................................................................................................... 1
   2.1.1 Recommendations .................................................................................................................. 2
   2.2 WLWB 2015 AEMP Directives and DDMI Commitments ....................................................... 2
   2.2.1 Recommendations .................................................................................................................. 3
   2.3 WLWB 2016 AEMP Directives and DDMI Commitments ....................................................... 4
      2.3.1 Ammonia Contamination ....................................................................................................... 4
      2.3.2 Provision of Raw Data ........................................................................................................... 6
      2.3.3 Recommendations ................................................................................................................ 6
3 Nutrient Loadings .................................................................................................................................. 7
   3.1 Recommendations ....................................................................................................................... 13
4 Loadings from Dust ............................................................................................................................... 13
   4.1 Recommendations ....................................................................................................................... 16
5 References .............................................................................................................................................. 17
Appendix 1 Chlorophyll a as a Measure of Primary Productivity .................................................... 20

List of Tables

Table 1: Acronym Definitions ................................................................................................................ ii
List of Figures

Figure 1: Conservative Proportion of Samples Exceeding a 50% Increase over the Total P Baseline in Lac de Gras ................................................................. 8
Figure 2: Proportion of Samples Exceeding a 50% Increase in Season-Specific Total P Baseline in Lac de Gras ................................................................. 9
Figure 3: Conservative Proportion of Samples Exceeding a 50% Increase in Total P Baseline in Lac de Gras by Sampling Area ....................................................... 10
Figure 4: Proportion of Samples Exceeding a 50% Increase in Total P Baseline in Lac de Gras by Sampling Area ................................................................. 12

Table 1: Acronym Definitions

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>AEMP</td>
<td>Aquatic Effects Monitoring Program</td>
</tr>
<tr>
<td>CCME</td>
<td>Canadian Council of Ministers of the Environment</td>
</tr>
<tr>
<td>DDMI</td>
<td>Diavik Diamond Mine Inc.</td>
</tr>
<tr>
<td>EQC</td>
<td>effluent quality criteria</td>
</tr>
<tr>
<td>GNWT ENR</td>
<td>Government of the Northwest Territories, Environment and Natural Resources</td>
</tr>
<tr>
<td>WLWB</td>
<td>Wekèezhii Land and Water Board</td>
</tr>
</tbody>
</table>
1 Introduction

Zajdlik & Associates Inc. was retained by the Government of the Northwest Territories, Environment and Natural Resources (GNWT ENR) to review various aspects of the Diavik Diamond Mine Inc. (DDMI) Aquatic Effects Monitoring Program (AEMP). The AEMP is presented in Golder (2018a) and was carried out following AEMP Design Plan Version 4.1 (Golder 2017a).

CAVEAT: Review comments are provided that mention normal ranges presented in Golder (2015) but these comments should not be construed as in any way endorsing the use of data collected during 2007-2009 (and likely much earlier) for the purpose of estimating ranges of natural variability for water quality parameters or the use of the 2.5th and 97.5th percentiles to delimit the range of natural variability. Review comments also mention Substances of Interest (SOIs) but again, comments should not be construed as endorsing the current methodology for defining water quality analytes as SOIs.

2 Review of Wekèezhii Land and Water Board Directives

Responses to the Wekèezhii Land and Water Board (WLWB) directives initiated by GNWT-ENR pertaining to AEMPs (unless otherwise stated) are reviewed in this section.

2.1 WLWB 2014 AEMP Directives

All the Directives initiated by GNWT ENR in WLWB (2016) pertain either to the AEMP design or the AEMP 3-Year Re-Evaluation. However, Golder (2018a, Table 2) did consider WLWB (2016), Directive 2A: “DDMI is to consider a more explicit analysis of the role of nitrogen in explaining variation and the spatial extent of chlorophyll a effect”, within the 2017 AEMP. According to, Golder (2018a, Table 2) this consideration is presented in Appendix XIII, Section 3.0.
The spatial distributions of total ammonia, total N, total dissolved N, nitrate and nitrate + nitrite are discussed in Golder (2018a, Appendix XIII, §3.6.2). The spatial distribution of chlorophyll \( a \) is discussed in Golder (2018a, Appendix XIII, §3.6.3). The relationship between nitrogen species and chlorophyll \( a \) is not considered in Golder (2018a, §3) as stated. In a review of the 3-Year AEMP re-evaluation (Golder, 2018b) Zajdlik (2018) concluded that “The “role of nitrogen in explaining the spatial extent of chlorophyll a effect” does not appear to be discussed explicitly” and recommended that: “DDMI should follow the spatial extent portion of the WLWB (2016b, Directive 2) to “consider a more explicit analysis of the role of nitrogen in explaining variation and the spatial extent of chlorophyll a effects.” That is, DDMI should consider the role of nitrogen in the spatial extent of chlorophyll a effects.”

### 2.1.1 Recommendations

The following recommendations are presented in no particular order.

- Golder (2018a, Table 2) points to Appendix XIII, Section 3.0 as the section where WLWB (2016) Directive 2A is addressed. No discussion of the relationship between nitrogen species and chlorophyll \( a \) was found. The recommendation to address WLWB (2016) Directive 2A made in Zajdlik (2018) is reiterated here: “**DDMI should follow the spatial extent portion of the WLWB (2016b, Directive 2) to “consider a more explicit analysis of the role of nitrogen in explaining variation and the spatial extent of chlorophyll a effects.”** That is, DDMI should consider the role of nitrogen in the spatial extent of chlorophyll a effects”.

- The section numbers in Golder 2018a, Appendix XIII, §2.3 should be corrected.

### 2.2 WLWB 2015 AEMP Directives and DDMI Commitments

WLWB (2017a) Directive 2C pertains to AEMPs stating: “DDMI is to clarify the meaning of ‘slight increase in trophic status’ in all future AEMP-related reports”. Golder (2018a, Table 2)
points to Appendix XIII, Section 4.2 as the section where WLWB (2017a) Directive 2C is addressed. In that section Golder (2018) states: “A slight increase in nutrient enrichment suggests that nutrients are increasing in Lac de Gras, but a change in trophic status from oligotrophic to mesotrophic has not been observed.” The statement puts a boundary on the change in trophic status but is not definitive. Trophic status is a continuum that is defined using a variety of metrics with some debate regarding choice of metrics. The continuum in trophic status has been discretized into categories whose breakpoints are again, subject to debate. Rather than debating what degree of change in metrics defines a ‘slight increase in trophic status’ a recommendation is presented in §2.2.1 below.

WLWB (2017a) notes that “the GNWT-ENR recommended that DDMI provide the raw toxicity test data as part of the AEMP reports (GNWT-ENR comment 9). In its response, DDMI stated that they would consider including these results as an appendix to the annual AEMP reports”. Although the raw toxicity test data were not included, the toxicity test methods are introduced in Golder (2018a, Appendix II, §2.3.4.4), results are presented in Golder (2018a, Appendix II, §3.2.6) and the specific sampling months are listed. The inclusion of a result summary is in this case, helpful as it highlights the absence of acute or chronic toxicity based on the pass/fail criterion. Highlighting the hormetic effect for *Pseudokirchneriella subcapitata* for each of the four sampling times at the surveillance network program monitoring locations is also helpful. That said, detecting the increased but statistically insignificant exposure immobility and mortality in *Daphnia magna* and exposure rainbow trout egg and embryo mortality in the September sample required retrieval of surveillance network program documents.

### 2.2.1 Recommendations

The following recommendations are presented in no particular order.

- Golder 2018a, Appendix XIII, §3.4 Figures 3-10, 3-12 inclusive and Figures 3-13, 3-15) present boxplots of nutrients and plankton metrics by area for the 2017 sampling season. These informative graphics should be summarized in a table that contains the percent increase in the median eutrophication metric (nutrient or chlorophyll a concentration or plankton biomass) relative to the baseline median by area. This allows readers to rapidly
assess how each eutrophication metric has changed relative to the baseline and allows the authors to unequivocally present the degree of change.

- The raw toxicity data should be provided as part of the AEMP report.

### 2.3 WLWB 2016 AEMP Directives and DDMI Commitments

#### 2.3.1 Ammonia Contamination

WLWB (2017b) Directive 2 pertains to AEMPs stating: “DDMI is to include as part of the 2017 AEMP Annual Report, the results of its investigation and proposed recommendations regarding ammonia contamination issues”. Golder (2018a, Table 2) points to Appendix II Section 2.4.1 and Appendix B as the sections where WLWB (2017b) Directive 2 is addressed. In that section Golder (2018) describes improvements made to sample handling by Maxxam. In an ammonia quality control study, 124 samples duplicate samples were submitted to both Maxxam and ELS (Golder, 2018b, Appendix 4B, Attachment A ALS/Maxxam Total Ammonia Interlab Comparison). Of those samples, 71 Maxxam and 69 ALS results were less than the detection limit (0.005 mg/L) and a fixed value of 0.003 mg/L was substituted. This very large proportion of censored observations biases the variance term used in the paired t-test downward, artificially increasing the power of the paired t-test. This likely had the effect of making the conclusion “no systematic bias in ammonia measurements between analytical laboratories” more defensible.

Although Maxxam analytical procedures have been improved, Golder (2018a) states that ammonia results from the ALS laboratories will be used as the data quality is better and so that potential laboratory effects are obviated.

---

1 Two opposing factors must be considered. The first is the (artificial) reduction in the variance estimate but the second is the suitability of the normal (or t-distribution) for the highly censored dataset. A more defensible analysis would be to use a non-parametric test.
Table B1, Appendix B (Golder, 2018a, Appendix II) shows that ammonia was detectable in 50% (2/4) of equipment blanks (at high concentrations), 33% (1/3) of field blanks and 50% (1/2) of trip blanks in the 2017 samples submitted to Maxxam. Table B1, Appendix B (Golder, 2018a, Appendix II) also shows that ammonia was detectable in 50% (1/2) of equipment blanks (at high concentrations), 50% (2/4) of field blanks and 25% (1/4) of trip blanks in the 2017 samples submitted to ALS. The maximum recorded quality assurance ammonia concentration was 42 µg/L measured in a field blank submitted to Maxxam. Under the assumption that the entry “ALS (Maxxam)” in Table B2, Appendix B (Golder, 2018a, Appendix II) pertains to ammonia, relative percent differences for duplicate samples are 47.8 and 14.8% (Maxxam) and 7 and 20% (ALS). Given the data quality objective of a 40% limit on the relative percent difference (Golder, 2018a, Appendix II, Appendix B) 50% (1/2) Maxxam samples “fail”. The detection of ammonia in a large proportion of the ALS quality assurance blanks suggests that low level detection of ammonia remains problematic.

The maximum ammonia concentration recorded in a blank by ALS was 12 µg/L. Assuming that this a random as opposed to systematic event, ammonia concentrations that could be biased more than 50% are any that are reported as lower than 24 µg/L. Such ammonia concentrations are reported for the August through October samples collected at the mixing zone boundary Golder (2018a, Appendix II, Figure 3-8), most of the open water samples (aside from nearfield samples) and all but one of the under-ice samples (Golder 2018a, Appendix II, Figure 3-50). Note that this is a worst-case scenario but, there is also the possibility of a lesser extent of bias such as 25%. The results presented in (Golder 2018a, Appendix II, Figure 3-50) make sense in a general fashion; ammonia concentrations decrease with distance from the source and concentrations are lower in the open water season. Given that Action Level 1 tests for a two-fold difference between the nearfield area median concentrations that are high or non-detectable (30.0 and < 0.5 µg/L for the under ice and open water seasons; respectively) and reference dataset\(^2\) median concentrations of 17.8 µg/L under ice and 5 µg/L in the open water (this is the detection limit)

---

\(^2\) Severe concerns about this use of the reference dataset have been expressed previously and will not be reiterated here.
(Golder, 2017b) there is some cause for concern if the reference median dataset is suspect due to quality control issues. A visual examination of the data presented in Golder (2017b) shows 4 aberrant observations on the high side. These 4 observations are not sufficient to bias estimation of the median of that dataset. Action Levels 2 and 3 use the 5th percentile ammonia concentrations in the nearfield area and the 75th percentile ammonia concentration at the mixing zone boundary, respectively as exposure measurements. Given current observed concentrations in the nearfield it is unlikely that ammonia quality assurance issues will adversely affect comparison with action levels.

2.3.2 Provision of Raw Data

WLWB (2017b) Directive 4B pertains to AEMPs stating: “4B. DDMI is to provide all raw data for all variables monitored as part of the AEMP in Excel spreadsheet format as part of its submission for all future AEMP Annual Reports”. This directive followed comments from the Environmental Monitoring Advisory Board and GNWT with respect to chlorophyll a data. Chlorophyll a data are provided in Tab “E.3 2017 Chl a” of spreadsheet “Diavik - AEMP Annual Report - 2017 - Appendix XIII - E - Eutrophication Indicators Raw Data - Apr 26_18.xlsx” posted on the WLWB public registry. No further action is necessary with respect to the current AEMP. However, see recommendations in §3.1, herein.

2.3.3 Recommendations

The following recommendations are presented in no particular order.

- The ALS ammonia data quality remains of concern and further efforts should be made to improve the quality of the ammonia data for low level measurement. From a practical management perspective based on current use of Action Levels, the ammonia data quality concern is only of moderate concern.

---

3 Golder (2018b, Appendix II Table 3-7) points to the AEMP Reference Conditions Report, Version 1.2 as opposed to a later version.
• DDMI should clarify that the entry “ALS (Maxxam)” in Table B2, Appendix B (Golder, 2018a) pertains to ammonia.

3 Nutrient Loadings

Golder (2018a, Appendix XIII, Appendix D) states: “Lac de Gras is an oligotrophic lake characterized by very low concentrations of nutrients, including total phosphorus (TP). The median background concentration of TP in Lac de Gras is 3.6 micrograms per litre (μg/L) during the ice-cover season (with a normal range of 2.0 to 5.0 μg/L), and 3.3 μg/L during the open water season (with a normal range of 2.0 to 5.3 μg/L) (Table 3.2-12; Golder 2017a)”.

Environment Canada (2004) with respect to phosphorus in freshwater states that: “If the increase from the baseline is greater than 50%, the risk of observable effects is considered to be high, and further assessment is recommended”. Median background concentrations for total phosphorus in Lac de Gras are 3.6 and 3.3 μg/L during the ice-cover and the open water seasons, respectively (Golder 2018a, Appendix XIII, Appendix D). Using those values and data provided on the public registry, the proportion of samples exceeding 50% of the season-specific baseline median is plotted for the last four years. “To provide the most conservative view of effluent effects, the season and depth with the greatest extent of effects was selected for this evaluation” following Golder (2018b).
Figure 1: Conservative Proportion of Samples Exceeding a 50% Increase over the Total P Baseline in Lac de Gras

The preceding figure shows that on a conservative basis a very large proportion of samples exceed the Environment Canada (2004) recommended 50% increase in total P. The data are replotted in a less conservative fashion by using all depth-specific samples and on a season-specific basis rather than the highest concentration for a location without consideration of season or depth.
Figure 2: Proportion of Samples Exceeding a 50% Increase in Season-Specific Total P Baseline in Lac de Gras

The preceding figure shows that proportion of samples exceeding a 50% increase in season-specific total P baseline is for the years examined, varies between 2 and 24%. More samples exceed 150% of the season-specific total P baseline in the open water season than under ice. The data are replotted by sampling area below.
Figure 3: Conservative Proportion of Samples Exceeding a 50% Increase in Total P Baseline in Lac de Gras by Sampling Area

Due to the choice of using the highest total P concentration for a location regardless of depth and season, and presenting data separately by year, Figure 3 merely identifies whether a concentration exceeded 150% of the season-specific baseline or not. The graphic shows that 50% or more of the samples collected in the nearfield, midfield and farfield 2 exceeded 150% of
the season-specific baseline from 2014 onward\textsuperscript{4}. The single sample collected at farfield 1 exceeded the season-specific baseline whereas the single sample collected at farfield A or B did not. The data are replotted using all samples (i.e. not using the conservative method used by Golder 2018b).

\textsuperscript{4} This examination only considered the most recent years and is not an exhaustive examination of exceedances of the Environment Canada (2004) 150\% criterion.
The preceding figure shows that a 50% increase over the baseline occurs most frequently in the nearfield and that the proportion of samples higher than 50% of the baseline is increasing since 2015. It is not clear whether conclusions reached using this figure would compare with those reached using Golder, 2018b (Figure 5–1) if the 2015 data were included. That figure shows the affected area (as defined by) exceedance of the natural range and using “the season and depth
with the greatest extent of effects” (Golder, 2018b.§ 5.2.3.4). The overall message is that large portions of Lac de Gras exceed the Environment Canada (2004) 150% baseline criterion for total \( P \) who state: “If the increase from the baseline is greater than 50%, the risk of observable effects is considered to be high, and further assessment is recommended”.

3.1 Recommendations

The following recommendations are presented in no particular order.

- DDMI should provide the 2014 and 2015 chlorophyll a data in an electronic format.

- DDMI should use the current chlorophyll a extent of effects paradigm and estimate the spatial extent of exceedances of 150% of the season-specific total P baseline median following Environment Canada (2004) to allow Regulators to decide whether further investigation of the Environment Canada (2004) criterion is warranted.

4 Loadings from Dust

Golder (2018a, Appendix II) reports that the total P loadings from the Mine “in 2017 was 1.4 tonnes per year (t/y), with 0.42 t/y from effluent, 0.63 t/y from direct dust deposited to the lake surface, and 0.34 t/y from runoff from the surrounding watershed (excluding the Mine footprint)”.

Although the combined current Mine-associated loadings exceed the limit for the water licence, the water licence is specific to “all treatment facilities discharging to Lac de Gras” (WLWB, 2018) and therefore the 420 kg deposited by DDMI in 2017 falls well below this limit.

An annual loading limit for total P was not in the original water licence for Diavik Diamond Mine Inc. (Northwest Territories Water Board, 2000). The annual loading limit was added following a request by DDMI as the mine was occasionally out of compliance using a concentration-based limit (DDMI, 2002a). Considerable discussion ensued (DDMI, 2002b), with an apparent outcome that if the (then) newly updated predicted total P loads were lower
than those used in the environmental assessment, that a loadings-based limit (using the updated, lower limits) for total P was reasonable. The phosphorous loadings used in the original environmental assessment (DDMI, 2002a) may be $5 \times 1657$ kg/y for all facilities with a maximum of 2,321 kg/y for all facilities. It is not clear whether those figures include the construction sewage load of 292 kg/y. As the 2017 loadings fall well below the loadings used in the original environmental assessment that concluded that “there would be no significant adverse residual effects of nutrient enrichment (that is based on phosphorous) on Lac de Gras during operations and post-closure” (Canada, 1999) action based on the original environmental assessment is not warranted. That said, previous recommendations regarding nutrient management (Zajdlik, 2016) in the context of more recent Environment Canada (2004) and CCME (2006) guidance are still relevant.

Golder (2017c) presents methods for estimating total P loadings to Lac de Gras via dust. These use total P concentrations in snow water as the basis for the loading estimates. Golder (2018a, Appendix I, Figure 3.3-4) presents P concentration in snow water that diminish from approximately 50 µg/L in 0-100m range to background deposition rates. Concentrations of ammonia are greater than approximately 100 µg/L in the 101-250 m range (0-100m range data are not presented) (Golder 2018a, Appendix I, Figure 3.3-1). Ammonia concentrations in snow water are approximately double the P concentrations in snow water.

Monthly ammonia loading rates from the North Inlet Water Treatment Plant are presented in in Golder (2018a, Appendix II, Figure 3-8). Using that figure, 200 kg is a crude estimate of an average ammonia monthly loading rate, leading to an annual ammonia loading rate of 2,400 kg/y. Using a conservative 2:1 ratio of ammonia: total P in snow water and the reported 630 kg total P contribution from dust to Lac de Gras in 2017 (Golder (2018a, Appendix II), the ammonia loading from dust may be very approximately, 1,260 kg/y (=2 x 630 kg/y total P from dust) or a contribution of approximately 50% of the loading from the North Inlet water treatment plant. These “back-of-the-envelope” calculations suggest that loadings of nutrients and substances of interest attributable to dust deposition from the Mine site can add significantly to the amount of waste deposited via effluent that is permitted under the current water licence. Dust deposition

---

$^5$ The original EA prediction documents were not reviewed at this time.
may explain the concentrations of total nitrogen at the MF2-FF2 transect, that were elevated relative to the NF area (Golder, 2018a § 4.3.2).

The interpretation of potential dust deposition effects with respect to other analytes is contingent upon an assessment of spatial patterns with respect to the dust zone of influence. Golder (2018a, §4) concluded that “the increases at the MF stations may not be solely related to effluent” (Increases refer to ammonia, lead and tin). Of the 10 substances of interest that were greater than 2 x the median of the reference dataset in one or more of the midfield stations, 7 also triggered Action Level 1 in the nearfield. Golder (2018a, §4) concludes that “exceedances at the MF stations were at least partly caused by dispersion of Mine effluent into the lake”.

The 2017 AEMP was carried out following AEMP Design Plan Version 4.1 (Golder 2017a). Under that design, for water quality variables, Action Level 3 requires derivation of effluent quality criteria (EQC). Effluent based EQCs are back-calculated from effects benchmark. As the water quality effects benchmarks “represent levels of water quality variables below which a body of water is expected to be suitable for its designated use” (Golder, 2017a), the benchmark applies regardless of the waste source. If dust loadings comprise a substantive proportion of waste loads being deposited to Lac de Gras by the Proponent, then EQCs should reflect that loading to ensure that the water quality benchmark is not exceeded. At this point in time, the relative contribution of total P from dust, to the deposition of waste in Lac de Gras is not known.

Under AEMP Design Plan Version 4.1, exceedance of Action Level 4 requires an investigation of mitigation options. Mitigation options could consider improved dust management as part of the action plan. However, the extent to which reductions in dust losses would enable the Proponent to meaningfully manage losses is not currently known as the relative loadings are not known. Finally, given general concerns with eutrophication following increased awareness of eutrophication and provision of Federal Guidance (CCME, 2006; Environment Canada, 2004) subsequent to the environmental assessment, a recommendation regarding measuring nutrient loads is provided below.
4.1 Recommendations

The following recommendations are presented in no particular order.

- DDMI should provide a table of the loadings from dust and effluent for “nutrients” as defined by WLWB (2018). This may require adding total Kjeldahl nitrogen to the list of analytes measured in snow water.

- DDMI should provide a table of the loadings from dust and effluent for all analytes triggering Action Level 1.

- The current water licence that DDMI operates under (WLWB, 2018 Part H, Item 32) contains a clause regarding the total annual that discusses total average annual loading of 1,000 kg per year during the life of the mine. The average annual loading of total phosphorous is defined therein as follows: "Average Annual Loading of Total Phosphorus" means the sum of annual loads divided by the number of annual loads summed.

As defined the average annual loading of the mine is a running average and the “average annual loading of 1,000 kg per year during the life of the mine” cannot be known until the mine ceases operating. Although loads from “all treatment facilities discharging to Lac de Gras” as stated in the water licence are well below the prescribed limit, the wording of the water licence should be corrected. This may take the form of a 3 year average as originally envisioned (DDMI, 2000b).

- The methods used to estimate total P loadings from dust, presented in Golder (2017c) should either be referenced in future AEMPs or the methods should be included in the AEMP.
5 References


Appendix 1  Chlorophyll a as a Measure of Primary Productivity

This material is extracted from Zajdlik (2016).

Golder (2014) states that “eutrophication responses are difficult to link to nutrient concentrations. As demonstrated by years of monitoring in Lac de Gras, concentrations of phosphorus do not predict the actual biological response to nutrient enrichment (Section 4.4).” In Snap Lake, Golder (2009) found that the relationship between lake wide mean chlorophyll $a$ concentration and mean total phytoplankton biomass was not statistically significant. They concluded that chlorophyll $a$ may not be an accurate surrogate for the Snap Lake phytoplankton community. It is difficult to reconcile those statements with the following statement by Golder (2014): “Rather, the increase in the biomass of algae as measured by chlorophyll $a$ has been a very good measure of the effects of nutrient enrichment.” This topic is explored with data collected in Lac de Gras within §Error! Reference source not found. and Error! Reference source not found., herein.

The literature on chlorophyll $a$ – phytoplankton production is very briefly reviewed with an emphasis of oligotrophic waters.

- Chlorophyll $a$ may not be the dominant photopigment (Bowman et al., 2005).

- Dolan et al. (1978) found that “chlorophyll $a$ concentrations were inconsistent with phytoplankton cell volume concentrations” in Saginaw Bay of Lake Michigan. (Note that biovolume is a new eutrophication indicator in the AEMP Design 4.0, (Golder, 2016a)

- El-Shaarawi and Munawar (1978) found a significant but seasonally varying relationship between phytoplankton biomass and chlorophyll $a$. They found that variability in chlorophyll $a$ concentration varied with taxonomic composition.

- Jónasson et al (1992) state that 5 to 10-fold differences in the chlorophyll $a$/ biomass ratio are not uncommon.
Finally, in a comprehensive review of chlorophyll $a$ – phytoplanktonic biomass relationship as a function of trophic status Kasprzak et al. (2008) conclude that: “chlorophyll $a$ concentration might be used with caution as a predictor of phytoplankton biomass”. Reasons for cautions include variation chlorophyll $a$ concentration to biomass ratio with changes in trophic status, with size of organism and with temporal changes in phytoplankton taxonomic composition.

This topic was discussed in WLWB (2017a) In that document the EMAB (Environmental Monitoring Advisory Board) comment 9 suggests that “DDMI assess the relationship between chlorophyll a and phytoplankton abundance to determine if chlorophyll a is “a sufficient indicator of assessing eutrophication effects on phytoplankton””. The response from DDMI was that relationship was “weak” due to the limited range of observed concentrations/mass, a switch in taxonomists and/or the variation in chlorophyll a concentration among species. In conclusion, the data examined suggest that within Lac de Gras, chlorophyll $a$ is not strongly related to phytoplankton abundance.

References


Dear Mr. Mackenzie:

Subject: DDMI Submission – Response to Review Comments on the 2017 AEMP Annual Report

Please find attached Diavik Diamond Mines (2012) Inc. (DDMI) response to the 77 comments received on the 2017 Aquatic Effects Monitoring Program (AEMP) Annual Report. As noted in our responses, DDMI anticipates submitting an updated version of the 2017 AEMP Annual Report to address the relevant recommendations and directives received in the Wek’eezhii Land and Water Board’s (WLWB or the 'Board') Reasons for Decision. Additionally, DDMI has provided an attachment with corrected Figures 3.3-1 through 3.3-4.

In our review of the comments and recommendations provided by reviewers, DDMI identified a number of results that suggested that DDMI provide a ‘possible explanation’ as to why a particular effect may be occurring. The purpose of the Annual AEMP Reports for interim sampling years are to assess effects on water quality variables, indicators of eutrophication, and plankton, by determining if an Action Level has been triggered. The approved AEMP Design identifies Action Levels and an associated response to be undertaken when such Action Levels are reached. We appreciate that likely explanations or understandings are helpful to provide for reviewers and the Board in instances where an Action Level has not been reached, and we generally try to include this information in the annual report. In instances where a reviewer identifies that a likely explanation/understanding of the results may have been missed or inadequately described, we are pleased to provide this information directly, or request a response from our consultants. However, DDMI is of the opinion that it is not appropriate for us or our consultants to speculate or provide ‘possible explanations’ for results that are not 'likely', or where a prescribed Action Level and associated response have not been triggered. Therefore, we have provided a response where we or our consultants have determined that an explanation is likely; in those instances where DDMI or its consultants do not have a likely explanation and an Action Level has not been reached, we have noted this in our response.

These responses and attachments have also been uploaded to the WLWB’s Online Review System (ORS). Please do not hesitate to contact the undersigned if you have any questions related to this submission.
Yours sincerely,

Sean Sinclair
Superintendent, Environment

cc: Anita Ooga, WLWB
    Anneli Jokela, WLWB

Attach: DDMI Response to Review Comments on the 2017 AEMP Annual Report
       Attachment-1: Revised Figures 3.3-1 through 3.3-4
Figure 3.3-1
Snow Water Chemistry Results:
Aluminum, Ammonia and Arsenic, 2001 to 2017

Note: The values used for the 0-100 m zone from 2014-2017 represent one sample rather than the median.
Figure 3.3-2
Snow Water Chemistry Results:
Cadmium, Chromium and Copper, 2001 to 2017

**Cadmium**

- Median Concentration (µg/L)
- Note: The values used for the 0-100 m zone from 2014-2017 represent one sample rather than the median.

**Chromium**

- Median Concentration (µg/L)

**Copper**

- Median Concentration (µg/L)

Note: The values used for the 0-100 m zone from 2014-2017 represent one sample rather than the median.
Figure 3.3-3
Snow Water Chemistry Results:
Lead, Nickel and Nitrite, 2001 to 2017

Note: The values used for the 0-100 m zone from 2014-2017 represent one sample rather than the median.
**Figure 3.3-4**

Snow Water Chemistry Results: Phosphorus and Zinc, 2001 to 2017

**Phosphorus**

*Note: The values used for the 0-100 m zone from 2014-2017 represent one sample rather than the median.*

**Zinc**

*Note: The values used for the 0-100 m zone from 2014-2017 represent one sample rather than the median.*