### Review Comment Table

<table>
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<th>Board:</th>
<th>WLWB</th>
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<tr>
<td>Review Item:</td>
<td>Diavik - 2014 to 2016 Aquatic Effects Re-evaluation Report and Version 5.0 of the AEMP Design (W2015L2-0001)</td>
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<td>File(s):</td>
<td>W2015L2-0001</td>
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Diavik - AEMP - 2014 to 2016 Aquatic Effects Re-evaluation Report - Part 2 - Apr 12_18 (1MB)  
Diavik - AEMP - 2014 to 2016 Aquatic Effects Re-evaluation Report - Appendices - Apr 12_18 (1MB)  
Diavik - AEMP - 2014 to 2016 Aquatic Effects Re-evaluation Report - Follow-up Correspondence - May 8_18 (1MB)  
Diavik - AEMP Design Version 5.0 - Apr 23_18 (1MB) |
| Item For Review Distributed On: | May 11 at 10:21 Distribution List |
| Reviewer Comments Due By: | July 19, 2018 |
| Proponent Responses Due By: | Aug 14, 2018 |
| Item Description: | Diavik Diamond Mines (2012) Inc. (DDMI) submitted the 2014 to 2016 Aquatic Effects Re-evaluation Report and Version 5.0 of the AEMP Design on March 14, 2018. These reports were submitted to the Wek’eezhii Land and Water Board (WLWB or the Board) for approval, under Part J, Conditions 9 and 3, respectively.  

#### 2014 to 2016 Aquatic Effects Re-evaluation Report

The cover letter for the 2014 to 2016 Aquatic Effects Re-evaluation Report includes a conformance table outlining the sections of the report addressing Board requirements and/or reviewer comments from previously considered Aquatic Effects Monitoring Program (AEMP)-related submissions. Reviewers are encouraged to review these topics and provide follow-up comments and recommendations to the Board regarding their earlier comments. DDMI is proposing some updates to the AEMP Design Plan, which are outlined in Section 14 of the 2014 to 2016 Aquatic Effect Re-evaluation Report. Subsequent to follow-up correspondence with DDMI, additional information was received from DDMI in order to further explain how two of the Board requirements were addressed. The responses provided by DDMI in this follow-up correspondence have been included as part of this review.  

#### AEMP Design – Version 5.0

Section 8 of the AEMP Design includes a concordance table outlining the sections of the report addressing Board requirements and/or reviewer comments from previously considered Aquatic Effects Monitoring Program (AEMP)-related submissions. Once again, reviewers are encouraged to review these topics and provide follow-up comments and recommendations to the Board regarding their earlier comments. The concordance table included in Section 8 of the AEMP Design also includes the changes proposed by DDMI as part of the 2014 to 2016 Aquatic Effects Re-evaluation Report. To assist reviewers with identifying the proposed changes to the AEMP Design, DDMI provided a track-changed copy of the AEMP Design, along with its submission of Version 5.0. Reviewers can access the track-changed copy here.
One of the Board requirements related to the submission of the 2014 to 2016 Aquatic Effects Re-evaluation Report was for DDMI to provide a memorandum to the Board outlining the results of a review of QA/QC issues related to implementation of the AEMP Design. This memorandum is not for approval, but a link is provided here for reviewer’s information in consideration of their review of the AEMP Design.

**General Review Instructions**

Reviewers are invited to submit comments and recommendations on the 2014 to 2016 Aquatic Effects Re-evaluation Report and Version 5.0 of the AEMP Design 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. If reviewers do, however, submit questions or are seeking clarification, they are asked to provide specific recommendations on how the Board should consider the proponent’s response in their decision.

All documents that have been uploaded to this review are also available on our public registry. If you have any questions or comments about the ORS or this review, please contact Board staff identified below.

**Contact Information:**

Anneli Jokela 867-765-4588  
Kassandra DeFrancis 867-765-4581  
Sarah Elsasser 867-446-5963

**Comment Summary**

### Diavik Diamond Mines (2012) Inc. (Proponent)

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<thead>
<tr>
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<tbody>
<tr>
<td>1</td>
<td>General File</td>
<td><strong>Comment</strong> (doc) Cover Letter - DDMI Response to Review Comments on the AEMP Re-evaluation and Design Reports</td>
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<tr>
<td>2</td>
<td>General File</td>
<td><strong>Comment</strong> (doc) Attachment-1: Figures 2-1 through 2-5</td>
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### Environment and Climate Change Canada: Bradley Summerfield

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<tr>
<td>1</td>
<td>General File</td>
<td><strong>Comment</strong> (doc) ECCC cover letter</td>
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<td>2</td>
<td>Overall</td>
<td><strong>Comment</strong> Due to the changes to the sampling design, statistical analysis, weight of evidence approach, and biological action levels, a workshop may be appropriate to gain clarity on rationale and justification for changes. <strong>Recommendation</strong> None</td>
<td><strong>Aug 14:</strong> DDMI expects that the WLWB will determine if a workshop would be valuable as a part of this review.</td>
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<td>3</td>
<td>AEMP Design Version 5.0 Table 3.5-1</td>
<td><strong>Comment</strong> The table identifies additional sampling that will be conducted under the Metal and Diamond Mining Effluent Regulations, and indicates that water quality monitoring will be</td>
<td><strong>Aug 14:</strong> DDMI will correct this to be 4 times per year but notes that if EEM applies, this sampling would not be required for several years.</td>
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completed twice during the open water period, not less than one month apart. **Recommendation**: ECCC notes that the Environmental Effects Monitoring Program under the MDMER requires water quality monitoring to be completed 4 times per year, not less than one month apart.

| 4 | AEMP Design Version 5.0 Section 4.3.4.9 - Gradient Analysis | **Comment**: A new approach for statistical analysis of the data is proposed based on the shift to a gradient study design. ECCC seeks additional clarity for the proposed approach.  
**Recommendation**: ECCC recommends that the proponent provide responses to the following questions: 1. What is the rationale for the proposed modelling approach? Could the proponent provide references from the literature for similar applications of these methods? 2. Is the ‘gradient’ variable a categorical variable for each transect (MF1, MF2, MF3), or a continuous variable (e.g., effluent concentration)? 3. Please provide equations for each proposed model. Why are multiplicative models proposed? Would linear models of log-transformed data be suitable? 4. How will non-detects be treated in the models? 5. Please provide further detail on how the effect of heteroscedasticity will be assessed, including equations for the models, and what additional information this will contribute to the gradient analysis | **Aug 14**: 1. The rationale is to account for the potential non-linearity of examined variables at the MF3 gradient, due to the greater length of the MF3 gradient relative to the MF1/MF2 gradients. The three models therefore provide a framework where if the data (transformed or not) are linear, model 1 is selected. However, if MF3 shows non-linear patterns, the combination of models 2 and 3 will be used, where MF1/MF2 are still linear, but MF3 is allowed a breakpoint. 2. This approach is simply an extension of the usual breakpoint vs. non-breakpoint model selection. Since the shorter MF1/MF2 gradients are not expected to have breakpoints, it was necessary to break the modelling process down to two constituents: linear and the piecewise. 3. The gradient variable is continuous (distance from diffuser). Equations will be added to the document. Multiplicative models are proposed to account for different slopes between different transects. Log-transformation will be attempted in the process of modeling to linearize data. 4. For discussion on treatment of non-detect values, please refer to GNWT-42 below. 5. Heteroscedasticity will be addressed using weighted model terms, as detailed in section 4.3.4.9 of the AEMP Design Plan. |

| 5 | AEMP Design Version 5.0 Section 4.6 - Plankton | **Comment**: While richness has been included as an overall data analysis method for plankton, it has been removed for use in the weight of evidence approach and the statistical analysis relating to action levels. The rationale provided states that the sensitivity of this endpoint to toxicity-related effects versus nutrient-related effects is not well known. Given that plankton richness is known to decrease under toxic conditions, this endpoint still provides valuable information for use in decision making and establishment of action levels within the response framework. Overall the assessment of richness will provide a more holistic view of any changes to the plankton community.  
**Recommendation**: ECCC recommends retaining the plankton richness endpoint within the response framework so that the plankton community and potential impacts due to mine effluent can be evaluated holistically. | **Aug 14**: Richness was removed from the plankton Action Level definitions, because although it is expected to decrease under toxic conditions, little is known about the relative sensitivity of this endpoint to toxicity-related effects versus nutrient-related effects, i.e., richness can also decrease under enrichment conditions. The non-directional nature of plankton richness presents a challenge in the plankton Action Level assessment, which is focussed on effects with distinct downward direction. This non-directional endpoint does not provide useful information to identify the direction of effect. However, it will be analyzed as part of the routine AEMP data analysis and weight-of-evidence assessment, and will be considered as supporting information when evaluating the ecological relevance of Action Level triggers and for developing response plans. The plankton Action Levels were therefore based on declines in biomass which are expected to respond predictably to toxic conditions, in a downward direction. |
Several benthic invertebrate community indices have been removed from the list of endpoints in the response framework, including: dominance, Simpson's Diversity Index, Simpson's Evenness Index, and the Bray Curtis Index. The rationale provided states that these endpoints are non directional and will respond in the same direction under nutrient enrichment or toxicological impairment. While this statement may be true, a change between the reference and exposure areas could signal a change in the receiving environment and can provide valuable information on potential mine effects. These endpoints should still be considered in the response framework to holistically assess changes in the benthic invertebrate community.

**Recommendation**
ECCC recommends retaining all benthic invertebrate community endpoints in the response framework so that the benthic community and potential impacts due to mine effluent can be evaluated holistically.

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**Environmental Monitoring Advisory Board: ... EMAB**

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<td>2</td>
<td>General File</td>
<td>Comment [doc] North-South Consultants Review of AEMP 3-year Summary Re-evaluation</td>
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<td>3</td>
<td>General File</td>
<td>Comment [doc] North-South Consultants Review of AEMP Re-Design Ver 5</td>
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<td>4</td>
<td>MAIN DOCUMENT, General Comment</td>
<td>Comment There are a number of instances where figures cited in the text are not presented (e.g., Fig 2-1 to 2-5 on p. 13), figures are presented with no reference in the text (e.g., Figures 9-11 to 9-18, Figures 9-27 to 9-32), and tables and figures (e.g., Table 9-11 on p. 570 should be 9-24) or sections (e.g., Section 9.3.2.1 on p. 583) are incorrectly cited in the text. <strong>Recommendation</strong> Complete a careful review of table, figure, and section referencing throughout the document.</td>
<td>Aug 14: Acknowledged, a thorough review of table, figure and section references will be completed. Figures 2-1 through 2-5 have also been included in this response as Attachment-1.</td>
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<td>5</td>
<td>MAIN DOCUMENT, General Comment on Temporal Trends (various sections)</td>
<td>Comment The report does not include a discussion of what significant year - area interactions mean for the Fixed Effect Model. <strong>Recommendation</strong> Provide an explanation of the results of statistical analyses in a more lay manner so readers can better understand the results.</td>
<td>Aug 14: Explanations of the meaning of statistical results were provided in the results sections. For example: Section 4.3.2.1.2: &quot;The results indicated that temporal trends were not significantly different among areas for the ice-cover or open-water season, as shown by non-significant interaction terms in Table 4-11. However, for the different areas evaluated (Figure 4-40), the slopes for the NF and FFA areas during ice-cover were significantly different from</td>
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<td>6</td>
<td>MAIN DOCUMENT, Various Sections</td>
<td>There are several instances throughout the document where the construction of the A21 dike is discussed as having had a potential effect on water quality and other components within the MF area. A map showing the location of the dike and other mine related infrastructure in relation to the sampling locations should be presented to assist in explaining why these effects would be seen within the MF areas and not elsewhere.</td>
<td>A map showing the location of the A21 dike in relation to the sampling sites should be added.</td>
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<td>7</td>
<td>MAIN DOCUMENT, AEMP Design Summary and Re-evaluation Methods, Section 2.2.2 Sampling Areas and Stations, page 13</td>
<td>The text references Figures 2-1 to 2-5 but figures are not included.</td>
<td>Add figures to the report.</td>
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<tr>
<td>8</td>
<td>MAIN DOCUMENT, Dust Deposition, Section 3.2, Methods, page 25</td>
<td>The report states: &quot;Analysis was undertaken to evaluate temporal or spatial trends in dust deposition rates, deposition of dustborne nutrients (i.e., total phosphorus [TP], orthophosphate [OP], nitrate plus nitrite [N+N], and ammonia), and deposition of two dust-borne metals indicative of metal deposition in general (i.e., aluminum and lead).&quot; It is not clear why the evaluation only included two metals (aluminum and lead).</td>
<td>Please provide a detailed rationale for focus on only two metals (aluminum and lead).</td>
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<td>9</td>
<td>MAIN DOCUMENT, Dust Deposition, Section 3.2.2, Data Handling, page 27</td>
<td>The report states: &quot;Snow water concentrations of some nutrients and metals were below the analytical DL. These data were included in the analysis by substituting values of half of the detection limit (DL) during the re-evaluation. However, in the snow chemistry data, there were different DLs from different testing laboratories and for different years. For example, three DLs were reported for the TP data (0.001 mg/L, 0.005 mg/L and 0.002 mg/L). Data with variable DLs were excluded from the analysis as per Table 3-2. The percentage zero, indicating a decreasing trend, while the slope for MF3-4 during the open-water season was significantly different from zero, indicating an increasing trend (Table 4-12).&quot;</td>
<td>The below detection limit data for TP and OP were removed from the analysis (i.e., analysis only included data above detection limits, and was thus conservative). In this particular case, nutrient and metal deposition are being conservatively estimated, because the results are used to predict potential effects to other valued parameters (e.g., TP and OP for water quality). Censored data (½ detection limit values) could be generated for individual samples and the statistics re-computed; however, this would be less...</td>
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<td>10</td>
<td>MAIN DOCUMENT, Dust Deposition, Section 3.2.2, Data Handling, page 27</td>
<td><strong>Comment</strong> It is indicated that outliers were identified as data points with Z-scores that were greater than 3. This differs from the Z-score value of 3.5 that was given in Section 2.4.2.3 (page 19) of the AEMP methods for identification of outliers. It is not clear why a different standard was applied to the dust data. <strong>Recommendation</strong> Please verify the Z-score applied and provide an explanation if a different standard was applied for outlier identification.</td>
<td>Aug 14: Section 2.4.2.3 refers to the identification of outliers in general. Outlier identification for dustfall and snow samples applied a slightly less strict criteria (i.e., $z &gt; 3.0$ versus $z &gt; 3.5$). Of the eight outliers identified in Table 3-3, four would no longer meet the $z = 3.5$ criteria, having values of 3.4, 3.4, 3.0 and 3.0. When propagated through the analysis, this results in changes to the &quot;deposition as function of distance&quot; (Figure 3-11) function. However, greatly reduced coefficients of determination ($r^2$) support the removal of the data. Changes also affect the &quot;Zone of Influence&quot; (Table 3-9). Effects are confined to the 2002-2005 and the 2010-2013 time periods only. The outlier identification approach used does not affect the broader conclusions of the analysis.</td>
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<td>11</td>
<td>MAIN DOCUMENT, Dust Deposition, Section 3.2.2, Data Handling, page 29, Table 3-4</td>
<td><strong>Comment</strong> The second last column in the Table 3-4 (lead, deposition, mg/m²/yr) requires correction of some values (some values reported as &quot;0.00&quot;). <strong>Recommendation</strong> Review and correct results presented in Table 3-4.</td>
<td>Aug 14: The table will be revised.</td>
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<td>12</td>
<td>MAIN DOCUMENT, Dust Deposition, Section 3.2.2, Methods, Data Handling, page 29, Table 3-4</td>
<td><strong>Comment</strong> The sample duplicate results are presented in Table 3-4 (page 29) for only a subset of parameters. The document should review all parameters to provide for an evaluation of QA/QC for the program as a whole. While annual reports discuss details for all parameters, the re-evaluation report is the location where data for numerous years are considered collectively. Issues with and/or patterns in data may not be readily apparent until data are reviewed for all years together. <strong>Recommendation</strong> Include duplicate sample results and discussion of these data for all parameters. A table presenting a summary of the analysis of the duplicate results (e.g., relative percent mean differences) could be provided in an appendix. This would also facilitate a thorough review of the QA/QC program as per the directive from the WLWB and assist with determining if any changes to the program are warranted.</td>
<td>Aug 14: The electronic data are impractically large to include in a written report (e.g., there are 16 years x 27 snow stations x 50+ analytes). The re-evaluation analyses took into account results of previous QC analyses, and were based on validated data. The QA/QC program for the AEMP is documented in the Quality Assurance Project Plan (QUAPP), which is reviewed separately from the 2014 to 2016 Aquatic Effects Re-evaluation Report.</td>
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<td>Page</td>
<td>MAIN DOCUMENT, Dust Deposition, Section 3.2.3.1, Methods, Data Analysis, Temporal Grouping, page 30</td>
<td><strong>Comment</strong> The report states: &quot;Dust deposition data and snow chemistry data were grouped into time periods to reflect changes in mining activities over time at the Mine. The time period groups were as follows: - 2002 to 2005: open pit mine construction and open pit mining - 2006 to 2009: underground mine construction and open pit mining - 2010 to 2013: open pit transition to underground mining - 2014 to 2016: underground mining with re-mining of the Waste Rock Storage Area - North Country Rock Pile&quot; While the principle of grouping according to major activities is a logical approach, grouping of years may mask short-term effects. Results for other components of the AEMP are presented by year in the report.</td>
<td><strong>Recommendation</strong> Please provide a discussion of whether more short-term effects have been observed for dust deposition, as it may pertain to pooling of multiple years of data. If short-term recent trends have been observed, these should be presented in the report.</td>
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<td>14</td>
<td>MAIN DOCUMENT, Dust deposition, Section 3.2.3.3, Methods, Data Analysis, Normal versus Log-Normally Distributed Data, page 31</td>
<td><strong>Comment</strong> The last line states &quot;In these instances, geometric means and SDs are more appropriate for computing statistics and comparing results (e.g., using Student's t-tests).&quot; This thought is incomplete; geometric means and SDs are more appropriate than what?</td>
<td><strong>Recommendation</strong> Please clarify.</td>
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<tr>
<td>15</td>
<td>MAIN DOCUMENT, Dust Deposition, Section 3.2.3.4, Methods, Data Analysis, Background Deposition Rates, page 31</td>
<td><strong>Comment</strong> For dust deposition &quot;background&quot; was defined as rates that were &quot;not significantly different from rates observed at the control stations.&quot; This assumes that the control sites were not affected by the mine. This assumption if incorrect could result in an underestimate of the impact of mine dust on Lac du Gras.</td>
<td><strong>Recommendation</strong> Please add a discussion of the validity of this assumption to the report.</td>
</tr>
<tr>
<td>16</td>
<td>MAIN DOCUMENT, Dust Deposition, Section 3.3.1.1, Results, Dustfall, pages 34-35</td>
<td><strong>Comment</strong> Dust deposition results for sites not significantly different from control sites were &quot;pooled to form a composite estimate of background dust deposition&quot; (page 34). While this approach may be reasonable for some of the sites, at least one site (SS5-4) has a notably high mean rate for the 2014-2016 pooled time period (i.e., more than four times the control sites). The lack of a statistically significant difference between this site and the formal &quot;control sites&quot; may reflect high variability in the data set and identifying this site as &quot;background&quot; does not seem to be appropriate based on the information presented. Inclusion of error bars on the figure (and other similar figures) would assist with review of these data. In addition, deposition rates for site SS5-4 reported in the 2014, 2015, and 2016 annual AEMP reports (Golder 2016a,b, and 2017) were 47, 43, and 38 mg/dm2/yr, respectively. The mean reported in Figure 3-4 Aug 14:** Error bars will be added to the relevant figures. The discrepancy related to SS5-4 will be reviewed and corrected if necessary. Sites SS5-2 and SS5-3 have 2014-2016 dust deposition rates that are lower than that at SS5-4 and SS5-5 and SSC-1, each station being progressively farther from the mine. Dust C1 is near SSC-1 and has values comparable to SS5-2 and SS5-3. If review indicates these values are valid, then this could be an example of spatial variability.</td>
<td><strong>Aug 14:</strong> Error bars will be added to the relevant figures. The discrepancy related to SS5-4 will be reviewed and corrected if necessary. Sites SS5-2 and SS5-3 have 2014-2016 dust deposition rates that are lower than that at SS5-4 and SS5-5 and SSC-1, each station being progressively farther from the mine. Dust C1 is near SSC-1 and has values comparable to SS5-2 and SS5-3. If review indicates these values are valid, then this could be an example of spatial variability.</td>
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and Table 3-5 (279 mg/dm²/yr) contradicts these values. **Recommendation** Include error bars on figures and provide clarification on the appropriateness of the approach for designating sites as "background". Please verify that the mean deposition rates presented for site SSS-4 are correct. If correct, suggest reconsidering designation of this site as "background".

<table>
<thead>
<tr>
<th>Comment</th>
<th>MAIN DOCUMENT, Dust Deposition, Section 3.3.1.1, Results, Dustfall, page 35, Figure 3-4 and Table 3-5</th>
<th>Aug 14: Figure 3-4, and Table 3-5 and similar tables will be updated in the revised version of the report, as suggested.</th>
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<td><strong>17</strong></td>
<td><strong>Comment</strong> Figure 3-4 and Table 3-5 present the mean dustfall deposition rates for control stations and stations where rates were not significantly different from the control sites. Both would benefit from inclusion of a measure of variability to assist the reviewer with understanding the variability of the pooled data sets. This is particularly important given that several years of data were pooled and that variability of the data sets would affect the statistical analyses and ultimately the treatment of data as &quot;background&quot;. Table 3-5 has a footnote that does not seem to apply to the table. &quot;N/D = no data; mean = temporal arithmetic mean; geomean = spatial geometric mean&quot;. Both the table and figure should indicate what the values presented represent (e.g., arithmetic mean). <strong>Recommendation</strong> Please include bars/values to illustrate variability with the data (confidence intervals or standard error depending on what the data are that are presented) on Figure 3-4 and Table 3-5 and subsequent similar tables and figures. Add additional explanatory information regarding the values presented.</td>
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<td><strong>18</strong></td>
<td><strong>Comment</strong> Figure 3-8 presents seasonal plots of dust deposition and includes point measurements and trend lines. Section 3.2.3.5 (page 31) indicates that the medians for each season are plotted for the trend analysis; trends were then visually assessed. Other figures and tables appear to present data as means rather than medians. There does not appear to be a discussion of why medians were used for the trend analysis and it is unclear if this is the most appropriate metric for this assessment. In addition, figures lack sufficient information to determine what is presented (e.g., means or medians) in this section. <strong>Recommendation</strong> Provide a discussion or rationale for the use of medians for trend analysis and add sufficient details to figures and tables to allow the reader to readily identify what is presented.</td>
<td>Aug 14: This will be reviewed and figures/tables updated if necessary in the revised version of the report.</td>
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| **19** | **Comment** It is indicated that background deposition rates of phosphorus and metals increased from 2010-2013 to 2014-2016 but no explanation is given as to why rates increased. This may be indicative of a mine-related influence in the latter period. **Recommendation** Include a discussion of possible explanations for the increase in background deposition rates. | Aug 14: This comment requires speculation. Relatively little is known about natural rates of atmospheric deposition in the sub-Arctic, let alone the deposition of nutrients. Variability in background concentrations could be attributed to changes in the flux of extraterrestrial dust (micrometeorites); or, long range transport of Asian air pollution and dust (e.g., McNaughton et al. 2011). Reference: McNaughton, C.S. et al. Absorbing aerosol in the
| 20 | MAIN DOCUMENT, Effluent and Water Quality, Section 4.2.4.2.2, Methods, Temporal Trends, page 84 and Section 4.3.2.1.1, Results, Temporal Trends, pages 130-133, Figures 4-35 to 4-38 | Comment | The report states: "Data are provided for DO, temperature, specific conductivity, and pH from 1996 to 2016, when available, at the following locations: NF; MF1-3; FF2-2; MF3-4; FF1; FFB; and FFA; these are the long-term monitoring stations that were selected for the detailed trend analysis." There is no discussion provided as to the rationale for why these sites were selected for trend analysis and it is not clear what individual sites are plotted in Figures 4-35 to 4-38 (pages 130-133). For example, Figure 4-35 (page 130) shows "NF" results but it is not clear what NF site is plotted. This also applies for the FFA, FFB, and FF1 "sites" referred to above. Recommendation Please clarify what data were presented and a rationale for selecting a sub-set of sites for analysis. | Aug 14: The rationale for including NF, FFB, FFA, and FF1 areas, and FF2-2, MF1-3, MF3-4 stations in the trend analysis is presented in Section 2.4.2. These areas and stations were selected for detailed analysis because of the availability of long-term data, and because they represent the range of exposure to effluent within Lac de Gras (i.e., NF, MF FF). |
| 21 | MAIN DOCUMENT, Effluent and Water Quality, Section 4.3.1.3, Results, Effluent and Mixing Zone, Effluent Toxicity, page 125 | Comment | Section 4.3.1.3 indicates six effluent samples showed sub-lethal toxicity; however Table 4-10 indicates only five samples showed sub-lethal toxicity, excluding the sample from June 2009 for which a re-test revealed the sample was non-toxic. The text further identifies five dates, including June 2009, for which sub-lethal effects occurred. There are inconsistencies between the text and table that should be corrected. Recommendation The text and table should be reviewed and updated as appropriate to clarify the findings. | Aug 14: This is a typographical error (five is correct) and will be addressed in the revised version of the report. |
| 22 | MAIN DOCUMENT, Effluent and Water Quality, Section 4.3.2.1.1, Results, Water Quality, Temporal Trends, Depth Profiles, page 129 | Comment | Paragraph 2 identifies "...DO concentrations during ice-cover that were at or below the Effects Benchmark of 6.5 mg/L for the protection of aquatic life (PAL) for "other" life stages (i.e., non-early life stages)." During the ice-cover season the CCME 9.5 mg/L benchmark for early life stages would be more appropriate for fall spawning species such as Lake Trout. In addition, there is no discussion of whether DO concentrations were above or below benchmarks for the open-water season. Recommendation The DO data should be compared to the appropriate benchmarks and the findings reported. Include a discussion comparing DO results for the open-water season to PAL guidelines. | Aug 14: A statement or paragraph detailing results of a comparison of DO data during open-water to benchmarks will be added in the version of the report. |
| 23 | MAIN DOCUMENT, Effluent and Water Quality, Section 4.3.2.1.1, Results, Water Quality, Temporal | Comment | Paragraph 3 discusses in situ pH data and the last line indicates that ".pH values below 5.0 or greater than 8.0 are anomalous." This is likely a valid statement as in situ pH data are prone to error due to equipment problems or poor calibrations; however it would be useful to include comparison to or discuss laboratory measured pH values if they are available to justify | Aug 14: A statement or paragraph detailing results of a comparison of laboratory pH to in-situ data to justify exclusion of data as "anomalous" will be added to the revised version of the report. |
Trends, Depth Profiles, page 129

<table>
<thead>
<tr>
<th>Exclusion of these data as &quot;anomalous&quot;.</th>
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<tbody>
<tr>
<td><strong>Recommendation</strong> If laboratory pH data are available, include a comparison to in situ data to justify exclusion of data as &quot;anomalous&quot;.</td>
</tr>
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<thead>
<tr>
<th><strong>24</strong></th>
<th>MAIN DOCUMENT, Effluent and Water Quality, Section 4.3.2.1.1, Results, Water Quality, Depth Profiles, page 130-133</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comment</strong></td>
<td>It is difficult to discern individual years in the depth profile figures presented on pages 130-133 (Figures 4-35 to 4-38). In particular, the figures do not clearly show results for pre-Project data making it difficult to assess whether any changes appear to have occurred post-Project. This confounds evaluation of the results that are presented. For example, it is noted that pH values frequently fell outside of the CCME PAL guideline range (6.5-9). To interpret the implications of this occurrence, it is important to consider baseline conditions in the lake; as the figures are presented, baseline results are not easily visualized in the figures.</td>
</tr>
<tr>
<td><strong>Recommendation</strong></td>
<td>Modifications to the figures would be beneficial to assist the reviewer with discriminating annual results and, in particular, distinguishing baseline from post-Project results. Suggest re-formatting figures to render them clearer. It would also be beneficial to include a brief discussion, where applicable, noting changes between the pre- and post-Project time periods. This would be notably useful for pH and DO results, where monitoring has shown exceedances of benchmarks. Consider examination of DO results as percent saturation values to evaluate trends over time.</td>
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| **Aug 14:** | A future version of the report could show pre-discharge data with a different colour scheme than the operational monitoring data. Different colours could be used for baseline sampling and for each version of the AEMP. |

<table>
<thead>
<tr>
<th><strong>25</strong></th>
<th>MAIN DOCUMENT, Effluent and Water Quality, Section 4.3.2.1.1, Results, Water Quality, Depth Profiles, page 130-131</th>
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<tbody>
<tr>
<td><strong>Comment</strong></td>
<td>While it is understood that water quality sites were relocated or replaced over time as part of the AEMP, several sites, as noted in Figures 4-35 and 4-36, were at deeper locations prior to 2007. For some of these sites, depth profile data indicate DO concentrations were relatively low near the bottom of the water column (at depths greater than those sampled after 2007). It is difficult to discern years in Figure 4-35, and therefore identify pre- vs. post-Project results. However, given that DO has been observed to drop to low levels at depth in previous years it would be relevant to monitor DO and temperature at deeper locations in the lake to monitor for changes over time. This is notably relevant given that nutrient enrichment, and increases in primary productivity (i.e., phytoplankton) have been observed post-Project; nutrient enrichment can lead to depletion of DO in aquatic ecosystems in winter due to accumulation and decay of organic materials.</td>
</tr>
<tr>
<td><strong>Recommendation</strong></td>
<td>While it is understood that modifications to the program design are outside of the scope of this document, it is noted here that the results presented in the Re-evaluation Report indicate a potential need to expand the DO monitoring in Lac de Gras. It is recommended that this modification be considered moving forward</td>
</tr>
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</table>

| **Aug 14:** | Modifications to the figures to improve the ability to distinguish between baseline and operational monitoring data could be included in a future version of the report (see response to previous comment). Based on the level of effect (mild enrichment), current trophic status of LDG (oligotrophic), and extensive spatial coverage of the AEMP, an expansion of DO monitoring in LDG doesn't appear warranted. |
and at a minimum, that an analysis of pre- vs. post-Project DO data be reviewed, focusing on deeper sites within the lake.

<table>
<thead>
<tr>
<th>26</th>
<th>MAIN DOCUMENT, Effluent and Water Quality, Section 4.3, Results, Water Quality, General</th>
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<tbody>
<tr>
<td>Comment</td>
<td>Trend analysis in the main report is based on data collected at mid-depth in the water column. While it is understood this approach renders it more feasible to compare across sites (as sites are not sampled in the same manner), this focus precludes consideration of effects on water quality near the bottom of the water column at the NF sites. Water quality is affected differently at depth at the NF sites due to the influence of the effluent discharge. For example, conductivity is notably elevated in the lower portion of the water column at these sites (see Figure 4-38, page 133 for example). A similar comment was made on the 2016 AEMP Report: &quot;Medians of water quality parameters in the NF area were calculated from data pooled across all sample depths, dates and stations (n = 15 samples; Appendix II, Section 3.4.1, page 64, Table 3-5). When water quality is relatively consistent across depth this approach is reasonable and appropriate. However, in instances where conditions vary across the water column such as in winter when the effluent plume is more evident near the bottom of the water column, it may be more conservative to examine data for each sampling depth separately. If effects are greatest near the bottom of the water column, potential effects on benthos would be better represented by the bottom water quality samples.&quot; (NSC 2017a).</td>
</tr>
<tr>
<td>Recommendation</td>
<td>Consider a more in-depth assessment for bottom samples, in particular for the NF sites.</td>
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</table>

<table>
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<tr>
<th>27</th>
<th>MAIN DOCUMENT, Effluent and Water Quality, Section 4.3.2.1.2, Results, Water Quality, Discrete Samples, page 133</th>
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<tr>
<td>Comment</td>
<td>The report states: &quot;Time series plots showing mid-depth concentrations of SOIs at AEMP stations in Lac de Gras and Lac du Sauvage, near the outlet to Lac de Gras, are presented in Figures 4-39 to 4-93. Mid-depth concentrations are presented herein, because that is the depth where the effluent plume is most likely to be present in a typical year considering the full period of record (see Section 4.3.2.1.1, Figure 4-38; Appendix 4C).&quot; It is acknowledged this is accurate for many years and that focus on the mid-depth data are the most appropriate given the information available. However, based on the conductivity depth profile results presented in Figure 4-38, this does not hold under all years. Caution should be taken when interpreting trends for the NF as the depth at which maximum effects on water quality appear (using conductivity depth profiles as a proxy for effluent influence) varies between years.</td>
</tr>
<tr>
<td>Recommendation</td>
<td>Consider evaluating a sub-set of parameters in the NF using data collected in bottom samples.</td>
</tr>
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</table>

Aug 14: The statistical trend analysis analyzed data collected at mid-depth; however, time series plots showing results for all depths (top, middle, bottom) and parameters over time are provided in Appendix 4C. A qualitative comparison of mid- and bottom-depth time series plots indicates that trends were comparable between the two depths, with the same variables generally showing increasing trends over time. Therefore, it is unlikely that conducting a statistical analysis on the bottom depth data would add new, or otherwise meaningful information to overall conclusions of the water quality chapter, considering the level of effort that would be required.

Aug 14: See response to previous comment.
<table>
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<th>Page</th>
<th>Source</th>
<th>Comment</th>
<th>Recommendation</th>
<th>Aug 14</th>
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<tbody>
<tr>
<td>28</td>
<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.2.1.4, Methods, Data Sources, page 248</td>
<td>The report states: &quot;Differences in the net dimensions were noted in 2017 among sampling years, which required adjustment of the data for some years. Re-measurement of the net diameter in 2016 determined that the zooplankton net used in 2014, 2015 and 2016 had a mouth diameter of 30.0 cm; therefore, recalculation of the zooplankton community biomass data was necessary for 2015 and 2016. The re-calculation increased the overall zooplankton biomass in 2015 and 2016 by 12.9% and 6.6%, respectively, as the volume of water actually sampled was smaller than that used in the 32 cm and 31.0 cm net diameter calculation (Table 5-3). These adjustments do not affect the conclusions reported in the respective annual reports. Additional discussion and results should be provided to backup the statement that conclusions were not affected.</td>
<td>Provide additional discussion to support the conclusion noted.</td>
<td>The 2015 and 2016 adjustments do not impact the results or conclusions of the 2015 and 2016 reports, because the annual reports generally analyze and interpret each year’s data separately, without comparisons to previous year’s data, with the exception of the comparisons of extent of effects. For extent of effects comparisons over time, the corrected area where zooplankton biomass was affected in 2015 remained &lt;0.6%, and the corrected 2016 area affected was 0.5%.</td>
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<tr>
<td>29</td>
<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.2.3.1, Methods, Data Analysis, page 249</td>
<td>The report states: “The WLWB requested that as part of the 2014 to 2016 Aquatic Effects Re-evaluation Report, an assessment of the reference conditions for the phytoplankton variables be examined (Table 1-1, Section 7). The assessment includes a comparison of the AEMP results to reference conditions as defined using the currently approved 2007 to 2010 reference area data (Golder 2017b), and the 2013 reference area data. Both normal ranges are presented herein.” There is no description provided for the &quot;2013 reference area data.&quot;</td>
<td>Provide a brief description of why normal ranges were derived using 2013 data and add a reference to the section of the report where this analysis is presented.</td>
<td>The description of the 2013 normal range is provided in detail in the Plankton Section (Section 7.2.3.1). The text points to Section 7 for details.</td>
</tr>
<tr>
<td>30</td>
<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.2.3.4, Methods, Data Analysis, page 251</td>
<td>&quot;The extent of eutrophication effects on phytoplankton biomass was not previously calculated or presented in the annual reports before 2016. As directed by the WLWB as part of the Board Directive and Reasons for Decisions re. W2015L2-001 Schedule 8 Update, and as part of EMAB commitment #5 from the Design Plan Version 4.0, and commitment #49 from the 2016 AEMP Annual Report (Table 1-1), the extent of effects on phytoplankton community biomass was estimated and presented to visually evaluate spatial trends for all years from 2007 to 2016.&quot; Addition of this analysis is a great improvement and addresses previous comments.</td>
<td>No action required.</td>
<td>Thank you for your comment. No response required.</td>
</tr>
<tr>
<td>31</td>
<td>MAIN DOCUMENT, Eutrophication Indicators, Section</td>
<td>&quot;To assess potential effects from dust emissions, phosphorus concentrations at stations within the estimated zone of influence from dust deposition were evaluated graphically and</td>
<td>A similar assessment for TN dust emissions is unnecessary, because Lac de Gras is phosphorus-limited. In addition, the analysis of dike-related effects in the 2016 and 2017 AEMP Annual Reports</td>
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<td>254</td>
<td>5.2.3.2, Methods, Data Analysis</td>
<td>compared to results at other nearby stations and to reference conditions for Lac de Gras (as defined in the AEMP Reference Conditions Report Version 1.2 [Golder 2017b]). An assessment for TN would also be beneficial. Also note that section heading numbering is repeated (two sets of headings beginning with 5.2.3)</td>
<td>Add discussion of potential effects on TN.</td>
<td>demonstrated low level effects, which have now ceased as the dike construction is completed. The section heading issue will be corrected.</td>
</tr>
<tr>
<td>258</td>
<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.1, Results, Summary of Effects, Extent of Effects</td>
<td>Paragraph 2, states that in years other than 2008, 2013 and 2009, &quot;the extent of effects on TP has extended northeast towards the Lac du Sauvage inflow and northwest along the NF-MF1-FF1 transect&quot;. However, based on the figure presented (Figure 5-1) the TP affected area extended southeast of the mine in 2016.</td>
<td>The text and figure should be reviewed and updated as appropriate.</td>
<td>Aug 14: Text will be updated as follows in the revised version of the report: &quot;The spatial extent of effects on TP concentrations was greatest in 2008, estimated as 112 km2 or 19.6% of the lake area, followed by 2013 (14%) and 2009 (9.3%). In other years, the extent of effects on TP has been low (&lt;0.6% to 6.5%), and has generally extended northeast towards the Lac du Sauvage inflow and northwest along the NF-MF1-FF1 transect (Figure 5-1; Table 5-7).&quot;</td>
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<td>261</td>
<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.1, Results, Summary of Effects, Extent of Effects, Figure 5-1</td>
<td>Figure 5-1 which presents the spatial extent of effects for TP is missing results for 2015. It is understood that the spatial extent of effects in that year was small (&lt;0.6 km2) which may preclude presentation in a map format. However, either a map should be added or at a minimum, an explanatory note/footnote should be included.</td>
<td>Please add an explanatory note for the omission of 2015 data from Figure 5-1.</td>
<td>Aug 14: An explanatory note explaining the omission of 2015 data from Figure 5-1 will be added.</td>
</tr>
<tr>
<td>263</td>
<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.1, Results, Summary of Effects, Extent of Effects, page 258, 261. and 263, Figure 5-2</td>
<td>Section 5.3.1.1 (Results, Summary of Effects, Extent of Effects, page 258) indicates: &quot;The boundary of effects on concentrations of TN generally extends to the northwest (to the end of the NF-MF1-FF1 transect) and to the northeast (towards the Lac du Sauvage inlet), with an exception in 2014 when the extent of effects appeared to be localized around the NF area.&quot; This statement appears to be based on incorrect results presented in Figure 5-2 (page 263) and is in disagreement with results presented in Table 5-7 (page 261) and those presented in the 2014 AEMP Annual Report (Golder 2016a). Table 5-7 indicates the affected area was equal to or greater than 40.1% of the lake area.</td>
<td>Please correct figure for the 2014 data and verify that data for other years are correctly presented. Modify text and data interpretation and conclusions accordingly.</td>
<td>Aug 14: The 2014 panel for Figure 5-2 is incorrect. The figure and text will be corrected.</td>
</tr>
<tr>
<td>266</td>
<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.1, Results, Summary of Effects, Extent of Effects, pages 262-266, Figures 5-1 to 5-2</td>
<td>Far-field areas were not sampled in 2014 or 2015, as noted in the report. However, as noted in previous review comments (NSC 2016), the lack of data for these sites in these years has limited the ability to accurately define the spatial extent of effects for TN and/or chlorophyll a as boundaries of the affected area(s) extended to the edge of MF sites. Without data for the FF sites in 2014 and 2015 it cannot be determined if the affected areas were in fact similar to</td>
<td>The annual data collected during interim years are sufficient to evaluate Action Level triggers, which is the main objective of the interim year AEMP reports (i.e., 2014 and 2015). Therefore, there is no reason to sample in the FF area more frequently and no need to include a discussion of the limitations of the lack of FF data in defining the spatial extent of effects. Figures will be modified to clearly indicate stations that were not sampled in a given year.</td>
<td>Aug 14: The annual data collected during interim years are sufficient to evaluate Action Level triggers, which is the main objective of the interim year AEMP reports (i.e., 2014 and 2015). Therefore, there is no reason to sample in the FF area more frequently and no need to include a discussion of the limitations of the lack of FF data in defining the spatial extent of effects. Figures will be modified to clearly indicate stations that were not sampled in a given year.</td>
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</table>
among the last three years of the program (i.e., 2014-2016) or what the actual spatial extent of effects were in those 2 years. This limitation should be noted in the text and considered in terms of interpretations presented regarding inter-annual differences and/or trends. For example, the text in Section 5.3.1.1 (page 258) reads: "Similarly, the greatest extent of effects on chlorophyll a concentrations was observed in 2016 (250.4 km², or 43.7% of lake area), closely followed by 2014 (=242.8 km², or =42.4% of lake area) (Figure 5-3; Table 5-7)." However, because the boundary for 2014 is actually undefinable due to the lack of data for the FF sites, the affected area may in fact have been larger in 2014 than 2016. This limitation must be clearly identified in the text. It is also suggested that all figures should be modified to clearly show that FF sites were not sampled in 2014 and 2015. Indicating the extent of effects boundaries with a dashed line to denote the boundary cannot be accurately defined would clarify this point.

**Recommendation** Please include discussion of the lack of FF data for 2014 and 2015 and the implications regarding limitations on defining the spatial extent of effects in those years. Modify figures to clearly indicate sites that weren't sampled in a given year.

| 36 | MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.1, Results, Extent of Effects, page 259 | **Comment** Similar to the previous comment, the statement on page 259 that reads: "The extent of effects on chlorophyll a concentrations along the NF-MF3-FFB-FFA transect did not extend beyond the MF3-7 station between 2007 and 2016." should be modified to reflect the lack of data for the FF sites in 2014. In that year, the extent of effects extended to MF3-7 to the west but due to the lack of data for the FFA and FFB site in that year, the western boundary cannot be defined accurately (it may have extended further).

**Recommendation** Please modify the text to incorporate the limitations of the 2014 data with respect to defining the spatial extent of effects on chlorophyll a.

| 37 | MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.1, Results, Extent of Effects, pages 263, Figure 5-2 and text page 258 | **Comment** In a review of the 2016 AEMP Annual Report, NSC (2017a) had commented on the exclusion of data for TN at site LDG-48 in the spatial extent analysis. This comment indicated: "Comment 1: Section 2.1.2 of Appendix XIII (page 5) indicates that no sample was collected from LDG-48 (the outlet of the lake) in the open-water season. As a result the spatial extent of effects on total nitrogen and cumulative effects were not assessed for the northwest area of the lake beyond sites FFA-4 and FFA-5..." While it is understood that sampling methods employed in the water quality monitoring program are not consistent with those for the eutrophication monitoring program, the TN concentration measured at LDG-48 in August, 2016 (174 µg/L) under the water quality program was above the normal range (122-
153 µg/L) for the open-water season. Based on this measurement, the spatial extent of effects extended through the northwest portion of the lake (i.e., effectively 100% of the lake area). It was recommended to incorporate data collected at site LDG-48 during the water quality monitoring program into the eutrophication analyses and reporting (i.e., spatial extent analysis) and update maps and spatial extent of effects estimates. This comment is re-iterated for consideration with respect to the current report.

**Recommendation** Add discussion in the report to note that the spatial extent of effects in 2016 could have extended through the entire lake. Include caveats respecting differences in sampling methods if appropriate.

<p>| 38 | MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.1, Results, Extent of Effects, page 258 | <strong>Comment</strong> The report indicates: &quot;Overall, the greatest extent of effects was observed on TN in 2016 (484.9 km², or 84.7% of lake area) (Figure 5-2; Table 5-7). The extent of effects on TN increased between 2007 and 2016, and has consistently shown an affected area &gt;20% since 2008, while the spatial extent of effects on other indicators of eutrophication (i.e., TP, phytoplankton and zooplankton biomass) has decreased. The lack of a relationship between areas where TN is greater and areas where biological effects were observed (chlorophyll a, phytoplankton and zooplankton biomass) is consistent with N not being the limiting nutrient in Lac de Gras.&quot; However, as noted above, this statement is based on erroneous TN information presented for 2014. With this correction made, spatial patterns for chlorophyll a and TN appear to be relatively similar in most years - notably in 2014. <strong>Recommendation</strong> Please review accuracy of results presented and modify text accordingly. | Aug 14: The error in Figure 5-2 will be corrected; it does not affect the interpretation of the relationship between TN and biological variables (Table 5-7). |
| 39 | MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.1, Results, Extent of Effects, pages 258, 261, and 263 | <strong>Comment</strong> The report indicates: &quot;The extent of effects on TN increased between 2007 and 2016, and has consistently shown an affected area &gt;20% since 2008, while the spatial extent of effects on other indicators of eutrophication (i.e., TP, phytoplankton and zooplankton biomass) has decreased.&quot; This statement does not apply for chlorophyll a where effects were greater in 2014 and 2016 than all other years (see Figure 5-3 and Table 5-7, pages 263 and 261, respectively). <strong>Recommendation</strong> Please review accuracy of results presented and modify text accordingly. | Aug 14: The quoted statement does not apply to chlorophyll a concentrations and was not intended to. Trends in chlorophyll a concentrations are discussed in other sentences within the section. |
| 40 | MAIN DOCUMENT, Eutrophication Indicators, Section | <strong>Comment</strong> The statement that reads: &quot;The area affected for phytoplankton biomass was greater from 2008 to 2011 compared to more recent years (i.e., 2014 to 2016; Figure 5-4; Table 5-7)&quot; should be modified to reflect the lack of data for 2014 and 2015. | Aug 14: The lack of FF data for 2014 and 2015 will be noted in the text associated with this statement. |</p>
<table>
<thead>
<tr>
<th>41</th>
<th>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.2, Results, Weight of Evidence Effect Ratings, page 267</th>
<th><strong>Comment</strong> The document indicates: &quot;The effects ratings for chlorophyll a fluctuated between moderate and high from 2007 to 2016 (Table 5-8). Chlorophyll a concentrations in the NF area were above the upper bound of the normal range from 2007 to 2016, but the affected area only exceeded 20% of the lake in 2009, 2013, and 2016.&quot; Table 5-7 (page 261) indicates that the affected area in 2014 was greater than or equal to 42.4%. <strong>Recommendation</strong> Please revise the statement (and other similar statements) to reflect the correct spatial extent of effects on chlorophyll a in 2014.</th>
<th><strong>Aug 14:</strong> Following AEMP Study Design Version 3.5, WOE assessments were not carried out in 2014 and 2015; therefore effect ratings were not calculated. The text here is referring to Table 5-8. In 2014 and 2015, a WOE assessment was not completed. Therefore, although it is true that the extent was &gt;20% in 2014, it was not commented on in the WOE-related section. A clarification will be added to the sentence in question to indicate that it is limited to the years when WOE was assessed.</th>
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<tr>
<td>42</td>
<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.2, Results, Weight of Evidence Effect Ratings, page 267, Table 5-8</td>
<td><strong>Comment</strong> Weight-of-evidence ratings are not presented for 2014 and 2015 in Table 5-8 (page 267). There is no explanation provided for the omission of results for these two years. Section 5.2.3.3 (page 255) indicates that &quot;The indicators of eutrophication data from 2014 and 2015 were not assessed following the AEMP Study Design Version 3.5 (Golder 2014a) because only NF and MF area data were collected in those years.&quot; However, Table 5-6 (page 255) that follows this text indicates that the effect rating for nutrients is based solely on comparison to normal ranges (and not to FF data). These results should therefore be incorporated into Table 5-8. <strong>Recommendation</strong> Please provide a discussion of the reason for the omission of 2014 and 2015 data in Table 5-8 and add ratings for TN and TP for 2014 and 2015.</td>
<td><strong>Aug 14:</strong> Following AEMP Study Design Version 3.5, WOE assessments were not carried out in 2014 and 2015; therefore effect ratings were not calculated.</td>
</tr>
<tr>
<td>43</td>
<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.3, Results, Action Levels, page 267</td>
<td><strong>Comment</strong> The report states: &quot;The percentage of the lake with concentrations greater than the normal range plus 25% of the Effects Benchmark (i.e., 1.74 µg/L) was also calculated for each year to determine if Action Level 3 was triggered. Results revealed that &lt;20% of Lac de Gras had concentrations greater than the normal range plus 25% of the Effects Benchmark (i.e., 1.74 µg/L). Because less than 20% of the lake area was above 1.74 µg/L, Action Level 3 was not triggered in any year.&quot; It would be useful to present a table showing the area of the lake above the normal range and the area above 1.74 µg/L. This information may illustrate whether the extent of higher concentrations of chlorophyll a are changing over time (i.e., evidence of trends). <strong>Recommendation</strong> Please provide a table presenting the area of the lake above the normal range and the area above 1.74 µg/L for each year.</td>
<td><strong>Aug 14:</strong> A table presenting the area of the lake above the normal range and the area above 1.74 µg/L for each year will be included.</td>
</tr>
<tr>
<td>44</td>
<td>Eutrophication Indicators, Section 5.3.3,</td>
<td><strong>Comment</strong> It is unclear what is being presented in Figure 5-13 and the conclusion based on the figure that &quot;.the elevated concentrations of</td>
<td><strong>Aug 14:</strong> The methods in Section 5.2.3.2 explain what is being presented in Figure 5-13; however, the figure will be annotated</td>
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<td>Page</td>
<td>Section</td>
<td>Comment</td>
<td>Recommendation</td>
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<tr>
<td>277</td>
<td>Results, Effects of Dust Deposition and Dike Construction</td>
<td>TP at the MF stations are most likely related to dike construction, rather than dust deposition&quot; is not discussed in sufficient detail to support this conclusion.</td>
<td><strong>Recommendation</strong> The text and figures should be reviewed and updated as appropriate.</td>
</tr>
<tr>
<td>279</td>
<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.4.2, Results, Temporal Trends, Nutrients</td>
<td>Section 5.3.4.2 states: &quot;Concentrations of TP in the NF area were slightly greater during the ice-cover season compared to the open-water season, while in the MF and NF areas, TP concentrations were generally similar between seasons.&quot; These trends are difficult to see in the figures as they are presented. It also appears that the sentence should read: &quot;while in the MF and FF areas, TP concentrations were generally similar between seasons.&quot;</td>
<td><strong>Recommendation</strong> The text and figures should be reviewed and updated as appropriate.</td>
</tr>
<tr>
<td>280</td>
<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.4.2, Results, Temporal Trends, Nutrients</td>
<td>Section 5.3.4.2 discusses ice-cover soluble reactive phosphorus concentrations and acknowledges that &quot;more exceedances [of the normal range] in the MF areas were observed in the samples taken at bottom depths. compared to those taken at the top or middle depths.&quot; If effects at the bottom are different (i.e., a greater effect is observed) than at mid-depth in the MF area, then the mid-depth may not be the most appropriate depth to use for this parameter and considerations of other depths may be warranted.</td>
<td><strong>Recommendation</strong> The data for all forms of phosphorus should be reviewed to determine if the mid-depth data are most appropriate to use in consideration of mine effects on phosphorus concentrations in Lac du Gras.</td>
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<td>286</td>
<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.4.2, Results, Temporal Trends, Nutrients</td>
<td>Section 5.3.4.2 indicates with respect to TN: &quot;In 2016, the NF area was not significantly different from the other areas in Lac de Gras (Table 5-14).&quot; This statement is somewhat misleading as it does not acknowledge that a large spatial extent of effects on TN occurred in that year.</td>
<td><strong>Recommendation</strong> Consider adding a statement indicating that while NF results were not statistically significantly different than other areas, TN was above the normal range throughout the lake in 2016.</td>
</tr>
<tr>
<td>286</td>
<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.4.2, Results, Temporal Trends, Nutrients</td>
<td>Paragraph 3 discusses trends in total dissolved nitrogen (TDN). TDN was not defined nor was an explanation of how it was determined provided in the document. Presumably it was calculated as the sum of ammonia-N and nitrate/nitrite-N. If this is the case, the trends in TDN that are discussed would be subject to the same problems as the ammonia data. This should be acknowledged.</td>
<td><strong>Recommendation</strong> Trends in TDN that are discussed in this section</td>
</tr>
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</table>
should be interpreted with caution unless it can be shown that the problems with the ammonia data do not affect the TDN values.

**Comment** Section 5.3.4.2 (page 286) indicates: "The more recent elevated concentrations at several NF, MF and FF area stations may in part reflect the change in labs from UofA to Maxxam that occurred in 2013 (Golder 2016a)." As this factor may have substantive implications with respect to tracking changes in nitrogenous parameters over time, there would be benefit to expanding this discussion to elaborate on potential implications of the laboratory change.

**Recommendation** Please provide additional discussion of the implications of laboratory changes on nitrogen monitoring results and trend analyses.

**Aug 14:** A detailed discussion of the implications of laboratory changes on nitrogen results was provided in the Effluent and Water Quality component of the 2013 report. The implication is greater variability and possibly biased results, which is discussed in Section 5.3.4.2.

**Comment** The nutrient summary states: "Nutrient concentrations remain low throughout Lac de Gras, within the oligotrophic ranges for both P and N." This is the first discussion of trophic status presented in the report. Some additional information should be presented here to qualify the statement. At a minimum, the trophic boundaries applied should be identified for TP and TN.

**Recommendation** Please identify the trophic boundaries applied.

**Aug 14:** Trophic boundaries will be provided as requested.

**Comment** Section 5.3.4.3 (page 301) indicates: "Chlorophyll a concentrations and plankton biomass displayed high variability in recent years, especially since 2014, without an obvious explanation in terms of nutrient concentrations that would account for this observation." The plots shown (Figure 5-28; page 295) indicate that data did not show especially high variability since 2014. Rather, the plots indicate that results for 2015 were somewhat anomalous. This also raises the general question as to why values were notably lower in 2015. Is there any potential explanation for these observations?

**Recommendation** Consider revising statement and expand if possible on potential reasons for low values in 2015.

**Aug 14:** The statement is correct; additional useful information is not available to allow speculation regarding the cause(s) of the lower values observed in 2015.

**Comment** The consideration of application of the CCME phosphorus management framework is well presented and the conclusions/recommendations provided by DDMI seem sound and reasonable. Based on the information provided, there does not appear to be any particular benefit to including this framework within the AEMP, particularly given that the primary concern (algal abundance) associated with nutrient enrichment is the foundation of the response framework.

**Recommendation** No action required.

**Aug 14:** No response required.

**Comment** "Secchi depths were deeper in the NF area compared to the MF and FF areas..." This statement contradicts results presented

**Aug 14:** The statement will be revised to "Secchi depths were generally shallower in the NF area."
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<tr>
<td>54</td>
<td>MAIN DOCUMENT, Sediment Quality, Section 6.2.1, Methods, Data Sources, page 336</td>
<td><strong>Comment</strong> The 2007 to 2016 AEMP samples were collected using a sediment gravity-corer, and the top 1 cm fraction was analyzed for nitrogen, phosphorus and metals. From 2007 to 2010, nitrogen, phosphorus and TOC were analyzed from the top 5 cm fraction of Ekman grab samples, from 2013 onwards, grain size analysis were conducted on top 10 to 15 cm samples, while TOC was analyzed in both the top 1 cm core samples and the top 10 to 15 cm Ekman grab samples.&quot; There appears to be a contradiction with respect to the depth of sediment analysed for nutrients in the excised text. It is unclear what sediment depths were analysed for what variables over the years. <strong>Recommendation</strong> Please clarify the methods description or modify if the text is in error. Inclusion of a table may assist with clarifying methods over the years.</td>
<td><strong>Aug 14:</strong> Text will be revised to remove contradicting sentences.</td>
</tr>
<tr>
<td>55</td>
<td>Sediment quality, Section 6.2.2.2, Methods, Data Handling, Censored Data, page 336</td>
<td><strong>Comment</strong> It is unclear how data for field duplicate samples were handled. The text simply indicates that the data were removed. It should be clarified how these data were removed. Were means of the duplicates calculated or were the first set of data retained and the second set (i.e., &quot;the duplicate&quot;) simply excluded? <strong>Recommendation</strong> The text should be clarified.</td>
<td><strong>Aug 14:</strong> Duplicates were used exclusively to assess the quality of the data. The first set of data were retained if quality criteria were met, and the duplicates were not included in the analysis. This is common practice for handling duplicate data.</td>
</tr>
<tr>
<td>56</td>
<td>MAIN DOCUMENT, Sediment Quality, Section 6.2.3.2, Methods, Weight-of-Evidence Effect Ratings, page 338, Table 6-3</td>
<td><strong>Comment</strong> Table 6-3 indicates a rating of &quot;No action&quot; if an ISQG is not exceeded and an &quot;early warning/low&quot; rating in the NF is statistically higher than the FF. It is unclear what occurs in the event that a statistically significant difference is observed between NF and FF results but the concentrations are below the ISQG. If this case would be ranked as &quot;No effect&quot; then the approach may be relatively insensitive in terms of the ability to identify early warnings of change. In addition, there are parameters without defined benchmarks. It is unclear how the ISQG comparison is applied in the framework. <strong>Recommendation</strong> Please clarify application of the WOE rankings.</td>
<td><strong>Aug 14:</strong> Table 6-3 is to be revised. &quot;No Response&quot; is to be set as &quot;No difference&quot;. ISQGs are considered only at Moderate effect level.</td>
</tr>
<tr>
<td>57</td>
<td>MAIN DOCUMENT, Sediment Quality, Section 6.2.3.4, Methods, Temporal Trends, page 339</td>
<td><strong>Comment</strong> Section 6.2.3.4 indicates: &quot;Trends in sediment chemistry over time were evaluated in relation to the normal range for Lac de Gras, which was calculated based on percentiles using reference area data (Golder 2017b). The normal ranges for SOIs were calculated using reference area data collected during the AEMP Study Design Version 2.0 (2007 to 2010; Table 6-4).&quot; Were the normal ranges used for comparisons also normalized to TOC or fines as was done for the monitoring dataset?</td>
<td><strong>Aug 14:</strong> Comparison to normal ranges and normal range calculation was based on raw/untransformed data.</td>
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<td>58</td>
<td>MAIN DOCUMENT, Sediment Quality, Section 6.3.1, Results, Summary of Effects, page 341</td>
<td>The text (page 341) indicates that the first low effect rating for strontium and vanadium in sediments occurred in 2016. This does not agree with the data presented in Table 6-5 (page 342) which indicates that a low effect rating was observed for strontium in 2008 and 2016, and for vanadium in 2007 and 2008 but not in 2016. Table 6-5 also indicates that 2016 was the first time TN received a low effect rating but it was not included in the previous list.</td>
<td>The text and table should be reviewed and updated as appropriate.</td>
</tr>
<tr>
<td>59</td>
<td>MAIN DOCUMENT, Sediment Quality, Section 6.3.1, Results, Summary of Effects, page 341</td>
<td>The report states (page 341): &quot;Chromium exceeded SQGs (i.e., lowest effects level and ISQG) frequently since 2007, while the PEL was exceeded once in 2008, and the severe effect level was never exceeded. Nevertheless, chromium exceeds guidelines in both NF and FF areas, therefore, these concentrations are likely to reflect elevated background levels for Lac de Gras.&quot; Since chromium was statistically higher in the NF area than the FF area in some years, the data suggest a mine-related effect and that the mine may have caused or contributed to exceedances. The magnitude by which the ISQG is exceeded would be useful to demonstrate in the figures (e.g., add ISQG of 37.3 mg/kg to Figure 6-12, page 358).</td>
<td>Please revise text and consider adding ISQGs to sediment quality scatter plot time series figures.</td>
</tr>
<tr>
<td>60</td>
<td>MAIN DOCUMENT, Sediment Quality, Section 6.3.3, Results, Temporal Trends, page 344</td>
<td>Trend analyses were performed following normalization of the data by TOC or percent fines, where applicable, and transformation of data using Box-Cox transformations.&quot; It is agreed that normalization of data for confounding variables (fines and TOC) is appropriate and provides a means to evaluate changes in metals and nutrients independent of changes/variability in these supporting variables. However, it would also be of interest to know if absolute concentrations (i.e., raw data) also show trends over time. This would be particularly pertinent if there have been mine-related changes in either supporting variable. For example, if there is a mine-related increase in TOC concentrations, the higher TOC may also result in higher metals and/or nutrients due to the affinity of these substances to organic matter. In addition, from a biological perspective, it is the absolute concentrations that are relevant.</td>
<td>Please clarify if trends were also evaluated on raw data for all of the SOIs. If this analysis has not been done, please provide a discussion of the rationale for excluding these analyses.</td>
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<td>61</td>
<td>Sediment Quality, Section 6.3.3, Results, Temporal Trends, Table 6-6, page 344</td>
<td><strong>Comment</strong> The table indicates that &quot;fines&quot; were selected as the normalizing variable for boron and tin, but that no normalizing variable was selected for lead. However, this would appear to contradict information presented in Table 6-6. The correlation analysis presented in Table 6-6 shows the following: boron was not significantly correlated with either TOC or fines; tin was significantly correlated with TOC but not fines; and, lead was significantly correlated with TOC. Based on the results presented in Table 6-6 and the methods that appear to have been applied to the other parameters, the following normalizing variables should have been applied: none for boron; TOC for tin; and TOC for lead. <strong>Recommendation</strong> The data should be reviewed and updated as appropriate. If necessary the models for boron, tin, and lead should be recreated and necessary changes made to the document.</td>
<td><strong>Aug 14:</strong> Table 6-6 and/or models for boron, tin and lead will be revised for consistency with the correlation analysis.</td>
</tr>
<tr>
<td>62</td>
<td>Sediment Quality, Section 6.3.3, Results, Temporal Trends, Table 6-9, page 346</td>
<td><strong>Comment</strong> The caption indicates that the data presented are for 2001 to 2016 when in fact the actual years of data used in the model for lithium were 2010, 2013 and 2016. <strong>Recommendation</strong> Update the caption to read &quot;Ã¢â€šâ‚ 2010 to 2016&quot;</td>
<td><strong>Aug 14:</strong> The caption will be revised as suggested.</td>
</tr>
<tr>
<td>63</td>
<td>Sediment Quality, Section 6.3.3.2, Results, Temporal Trends, Nutrients, page 350</td>
<td><strong>Comment</strong> In reference to data since 2006, but excluding 2013, the report indicates: &quot;TN concentrations were within the normal range for Lac de Gras.&quot; This is contrary to Figure 6-2 which shows that TN concentrations above the normal range occurred at MF3-7 from 2007 to 2016, and at several FF sites in 2016. <strong>Recommendation</strong> The text and table should be reviewed and updated as appropriate, including any conclusions made based on these results.</td>
<td><strong>Aug 14:</strong> Text will be revised to say that &quot;TN concentrations were within normal ranges at most stations.&quot;</td>
</tr>
<tr>
<td>64</td>
<td>Sediment Quality, Section 6.3.3.2, Results, Temporal Trends, Nutrients, page 350</td>
<td><strong>Comment</strong> &quot;Concentrations of TN were considered atypical in 2013, and inconsistent with other years' results, most likely due to a difference in laboratory methods in 2013 relative to other years (Golder 2017c).&quot; We agree that the 2013 TN data for sediments is anomalous (NSC had noted this in comments provided on the Reference Condition Report Supplement v. 1.2 supplement; NSC 2017b) and may indeed be related to changes in the laboratory method. Given this anomaly, it would be more appropriate to exclude the 2013 data from the trend analysis, or at a minimum, present a trend analysis with and without the 2013 data. It was noted in the report: &quot;These trends should be interpreted with caution, due to the uncertainty in the 2013 TN data noted above.&quot; <strong>Recommendation</strong> Conduct trend analysis excluding 2013 TN data</td>
<td><strong>Aug 14:</strong> The trend analysis will be re-run without the 2013 data.</td>
</tr>
<tr>
<td>65</td>
<td>Sediment Quality, Section 6.5 (Page 371) indicates: &quot;Concentrations of certain metals, such as arsenic and cadmium, in sediments</td>
<td><strong>Comment</strong> Section 6.5 (Page 371) indicates: &quot;Concentrations of certain metals, such as arsenic and cadmium, in sediments</td>
<td><strong>Aug 14:</strong> Where available, the SQG will be shown in sediment quality raw data plots.</td>
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<td>371</td>
<td>Section 6.5, Summary and Conclusions</td>
<td>Throughout Lac de Gras were above SQGs. These variables generally reflected patterns in TOC content of bottom sediments or background variation in sediment quality, and had no clear spatial trends related to the Mine. Since report figures presenting sediment quality results do not include SQGs, it is difficult to evaluate the occurrence and magnitude of exceedances of SQGs over time. For example, information as presented is inadequate to determine in what years, by what magnitude, and at which sites that cadmium and arsenic exceed SQGs. This visualization is important for critically reviewing the information and examining trends and identifying potential emerging trends. <strong>Recommendation</strong> Add benchmarks (i.e., SQGs) to sediment quality figures.</td>
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<td>377</td>
<td>MAIN DOCUMENT, Plankton, Section 7.2.1.1.2, AEMP Version 2.0 Data (2007 to 2011)</td>
<td><strong>Comment</strong> Different sampling methods were employed in 2007 than other years of the phytoplankton monitoring. It is stated that: &quot;...the phytoplankton sampling procedure was inadvertently changed to use the Secchi depth to determine the sampling depth (DDMI 2007). Since the 2007 AEMP plankton program used Secchi depth to determine sampling depth, instead of the top 10 m of the water column, sampling depths were approximately 2 m shallower than those between 2003 and 2006. From 2008 to 2016, the methods reverted back to the original sampling protocol of sampling the top 10 m of water column....Secchi depths in 2007 were approximately 8 m; phytoplankton are found within the euphotic zone (estimated as two times the Secchi depth); therefore, it is likely that the 2007 samples are comparable to the 2008 to 2016 samples.&quot; According to this text, the 2007 samples were collected at a depth of approximately 16 m which is notably different than 10 m. <strong>Recommendation</strong> Consider revising statement regarding comparability.</td>
<td>Aug 14: Samples were collected at 8 m depth in 2007. The remaining year's samples were collected within the top 10 m of the water column. The text describing the euphotic zone as two times the Secchi depth is used to demonstrate that in both cases in 2007 and in the remaining years the samples were collected within the euphotic zone.</td>
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<td>378</td>
<td>MAIN DOCUMENT, Plankton, Section 7.2.1.1.4, AEMP Version 3.5 Data (2013 to 2016)</td>
<td><strong>Comment</strong> The laboratory that performed taxonomic identifications and enumerations is not indicated for these sampling years. <strong>Recommendation</strong> Please add a statement identifying the laboratory that performed taxonomic identifications and enumerations for 2013-2016.</td>
<td>Aug 14: On page 378, paragraph 1 (Section 7.2.1.1.3), it is stated that from 2013 onward, taxonomic identifications and enumerations were performed by Eco Logic Ltd. Vancouver BC.</td>
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<td>392</td>
<td>MAIN DOCUMENT, Plankton, Section 7.3.1.1, Results, Summary of Effects, Weight-of-Evidence Effect Ratings</td>
<td><strong>Comment</strong> Table 7-9 indicates that based on a recalculation of affected area that was conducted in 2017 a high effect rating should now be applied to phytoplankton biomass in 2010. The text indicates that high effect ratings occurred in 2009 and 2011, but no mention is made of 2010. <strong>Recommendation</strong> The text should be updated to acknowledge this recent finding.</td>
<td>Aug 14: Text will be adjusted to &quot;Greater than 20% of the lake was affected in 2009, 2010 and 2011, which resulted in high effect ratings for these years.&quot;</td>
</tr>
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</table>
69  MAIN DOCUMENT,  
Plankton, Section  
7.3.2.1.2, Results,  
Temporal Trends,  
Biomass of Major  
Phytoplankton Groups,  
page 401

Comment The discussion of trends in cyanobacteria does not match the results presented in the tables and figures. The report indicates (page 401): "...a slight, non-significant decline was observed in the NF area between 2013 and 2016 (Figure 7-4 and Table 7-14)." However, Table 7-14 indicates that cyanobacteria biomass in the NF area was significantly different between 2013 and 2016. In addition, the report states: "Relative cyanobacteria biomass fluctuated with the normal range in all areas between 2007 and 2012 (Figure 7-9)." Figure 7-9 presents results for diatoms not cyanobacteria, and this statement describes trend in diatoms not trends in cyanobacteria. Figure 7-7, which shows cyanobacteria indicates that relative cyanobacteria biomass in both MF and FF areas was, at some locations, above the normal range from 2008-2012.

Recommendation Please review the text, tables and figures and make appropriate corrections.

Aug 14: Text will be reviewed and appropriate corrections will be made.

70  MAIN DOCUMENT,  
Plankton, Section  
7.3.2.1.3, Results,  
Temporal Trends,  
Phytoplankton Normal  
Range Evaluation, page 408

Comment The evaluation of the phytoplankton normal range presented in the report concluded: "Overall, based on the clear differences in the data sets produced by the two different taxonomists, the "adjusted" 2013 normal range (referred to going forward as the "2013 normal range") is recommended for comparisons from 2013 onwards." It would appear based on the information presented in this section that comparisons to the 2007 to 2010 normal ranges, which were based on data from a different taxonomist, moving forward would be inappropriate (i.e., there is evidence of a laboratory difference). However, as also noted in the report, the use of a single year of data to derive a normal range (2013) is also associated with issues (i.e., it does not incorporate inter-annual variability). Use of more than one year of data to derive normal ranges would be more scientifically appropriate.

Recommendation Please comment on the appropriateness of deriving updated normal ranges using one year of data and if the normal ranges will be recalculated in the future with additional data to account for inter-annual variability.

Aug 14: As stated in the text in Section 7.2.3.1, the 2013 normal range was adjusted to incorporate a similar level or inter-annual variability as was observed between 2007 and 2010. The adjusted 2013 normal range incorporates year-to-year variation, based on the 2007 to 2010 reference area dataset and assumes that the within-year variation between taxonomists is similar.

71  MAIN DOCUMENT,  
General Comments  
Regarding Fish Section 9

Comment A few terms are used inconsistently throughout the report, making it more difficult for the reader to follow. For example, age-2+ is used page 504, but the term adult seems to be used for the rest of the document. It is assumed that these are referring to the same stage. In addition, the sampling period for 2007, 2013, and 2016 is both called late summer and late fall (e.g., 3rd line of Section 9.2.1.3.4 late fall, but late summer in 6th line). Several different terms are used for the concept of CES - called "percent difference" in title of Table 9-12, called CES in footnote of this table, magnitude of difference in heading 9.2.1.3.7, and a critical effect size defined by

Aug 14: Terms will be reviewed and used consistently in the revised version of the report. The use of Age 2+ on page 504 will be updated to adult in the revised version of the report. All instances of late fall will be updated to late summer in the revised version of the report. Regarding the use of CES/magnitude of difference: The headings in both Sections 9.2.1.3.7 and 9.2.2.8 are titled Magnitude of Difference (CES). Magnitude of difference, or percent difference is the calculation as defined by EEM and Critical Effect Size (CES) is a threshold above which an effect may be indicative of a higher risk to the environment. For example, the magnitude of difference was
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<td>72</td>
<td>Section 9.2.1.3.3, Fish Health, Methods, Stage Re-classification, Table 9-2, page 505</td>
<td>There are potential errors in the data presented in Table 9-2 (page 505). It states 10 fish were reclassified from the 2007 dataset on page 505; however, Table 9-2 only shows 7 fish (2 age 1+ to YOY, 5 age 1+ to adult).</td>
<td>Review calculations and data tables.</td>
<td>Aug 14: The table and text are correct as shown. Ten fish were reclassified in 2007, as shown in Table 9-2. Two age 1+ fish were moved to YOY, five Age 1+ fish were re-classified as adults, and three adults were removed from the dataset due to missing GSI information, for a total of 10 fish.</td>
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<td>73</td>
<td>Section 9.2.1.3.5, Fish Health, Methods, Comparison to Normal Ranges, pages 507-508</td>
<td>There are some discrepancies in the methods described for the temporal trends analysis. It appears from the text that raw carcass weight was used as a covariate for Age-1+ condition, gonad, and liver weight trend analysis. However, it states on page 503 total body weight is more appropriate for this stage. It appears from Figure 9-18 that carcass weight was used.</td>
<td>Confirm appropriate analysis methods were used.</td>
<td>Aug 14: Section 9.2.1.2.2 is describing the descriptive statistics, and how to calculate indices for condition factor. This index was calculated using total body weight for Age 1+ fish, as presented in Table 9-9 where indices were used. The temporal trend method does not use an index for analysis, but rather looks at the total length and its covariate, total body weight. Figure 9-18 indicates that total weight was used as the response variable.</td>
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<tr>
<td>74</td>
<td>Section 9.2.1.3.7, Fish Health, Methods, Magnitude of Difference (Critical Effect Size), page 509</td>
<td>Section 9.2.1.3.7 (page 509) states: &quot;As per the MMER TGD (Environment Canada 2012), a Critical Effect Size (CES) is defined as &quot;a threshold above which an effect may be indicative of a higher risk to the environment&quot; (Environment Canada 2012). CES are defined for fish weight, relative liver size and relative gonad size as 25% of the reference area mean, and for condition as 10% of the reference area mean (Environment Canada 2012). The variables that triggered Action Level exceedances in 2016 were compared to the CES.&quot; It would seem appropriate to also compare Action Level exceedances from other years to the CES. In addition, there is no indication of what was defined as the &quot;reference area mean&quot; for making comparisons in the CES evaluation.</td>
<td>Include comparisons to CES for all years in which an Action Level exceedances occurred. Add description of how &quot;reference area mean&quot; was defined.</td>
<td>Aug 14: Comparison to the Critical Effect Size (CES) of a historical result does not provide anything meaningful to the interpretation of the results and the intent of a re-evaluation. What is relevant is the current re-evaluation period (i.e., 2014 to 2016) and where the current magnitude of difference sits relative to the CES. A clarification to this regard will be added to the text. The reference area mean was calculated using the same reference area data used to determine the normal range. This clarification will be added to the text in the revised version of the report.</td>
</tr>
<tr>
<td>75</td>
<td>Section 9.2.2, Fish Health, Results, general comment</td>
<td>The discussion of the results of the temporal trends is very difficult to follow. There is no discussion of the results of NF temporal trends for Total Length, Fresh Weight, or Carcass Weight even though Table 9-9 shows significant post-hoc results. There is discussion about large and small fish; however, the methods section (Section 9.2.1.3.5) does provide any explanation about how or why these categories were calculated.</td>
<td>Explain the results of statistical analysis in a more lay manner so readers can better understand the results.</td>
<td>Aug 14: This will be added to Section 9.2.1.3.5 in the revised version of the report.</td>
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<tr>
<td>76</td>
<td>Section 9.2.2.2, Fish</td>
<td>CPUE does not appear to be a variable included in the assessment of temporal trends as described in Section 9.2.1.3.5 and does not appear to be a variable included in the assessment of temporal trends as described in Section 9.2.1.3.5 and</td>
<td>CPUE is a method to standardize fish capture at each area, and can be used to provide an estimate of relative abundance</td>
<td>Aug 14:</td>
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normals were not calculated for this variable (Appendix 9A). It is unclear how the temporal evaluation of CPUE described in Section 9.2.2.2 was completed. Based on the text in this section and lack of statistical results, it does not appear that any statistical analysis was performed to support the conclusion of no change to CPUE attributable to the mine. There also appears to be errors in the text. For example, it is stated that mean CPUE at MF3 and F2 were higher than at other sites in 2010, 2013, and 2016; however it is clear from Figure 9-3 that values at FFA were higher, or at least very similar. The CPUE for the Age-1+ catch was not presented in Section 9.2.2.2 - but the abundance of Age-1+ is still listed as an endpoint for WOE in Table 9-5 and a rating of 0 is assigned to this endpoint in Tables 10A-11 to 10A-14. 

**Recommendation** Provide information on how the ratings and conclusions were derived.

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### Comment

There is a statement on page 512 that indicates "all sites except FF2 had increased parasite presence in 2013 and 2016 compared to 2007". This statement does not agree with the results presented in Table 9-7. The values are significantly similar between 2007, 2013, and 2016 as indicated by the same letter at NF and and FF2 sites, but are not the same as indicated by different letter for 2007, at the FFA and FF1 sites. The MF sites cannot be compared since due to lack of data for 2007. There also appear to be errors in the gray shading applied to Table 9-7. It states that grey shading indicates a decreasing trend; however, it is clear from Figure 9-4 that the cells highlighted are actually showing an increase in parasite occurrence. 

**Recommendation** Verify results and update report accordingly.

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### Comment

According to the text in Sections 9.2.1.3.5 and 9.3.2.1, Figures 9-5 to 9-10 (pages 514-519) and 9-19 to 9-26 (pages 548-555) are used to compare to normal ranges, but the graphs are titled Temporal Trend Plots. This is confusing to readers, as there is an almost identical series of graphs (Figures 9-11 to 9-14 [pages 521-524] and Figures 9-27 to 9-32 [pages 557-561]) that follows. Also, it is not clear from the figure titles or legends what exactly is plotted - are the circles values from individual sculpin? There is no information provided in the methods Section 9.2.1.3.4 and 9.3.1.3.1 explaining how data were compared to normal ranges (it indicates "results" are compared to background values). The methods also do not explain whether outliers were included in the calculation of the "mean". For example, Figure 9-11 (page 521) shows an outlier for Age-1+ at the FF site in 2016 but Figure 9-5 (page 514) does not indicate this point is anomalous. 

**Aug 14:** The statement on page 512 is valid. All areas except FF2 had increased parasite presence in 2013 and 2016. This sentence does not make any reference to statistical differences. However, it is acknowledged that there are no data from MF3 in 2007, and as such the statement of "all sites" is misleading. There is an error in the footnote of Table 9-7. The footnote should be corrected to read "Grey shading denotes significant increasing trend."

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### Comment

Temporal trend plots are the correct figure titles for Figures 9-5 to 9-10. Figures 9-19 to 9-26, and 9-27 to 9-32 are temporal trend analysis figures, which are different than temporal trend plots. It is acknowledged, however, that this may have been confusing, and the figure titles will be updated in the revised version of the report for clarity. The circles represent individual fish. Footnotes will be added to the figures so that this is clearer to the reader. In the results Section 9.2.2.4 it states that mean within-area values were compared to the normal ranges; however, we acknowledge that this could have also been included in the methods section. There are no outliers for the normal range comparisons (see Figures 9-5 to 10). The outlier referred to in Figure 9-11 is a statistical outlier, not an anomalous outlier, or a data outlier, and the individual points
<table>
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<th>Main Document, Fish, Section 9.2.2.6, Fish Health, Results, Weight-of-evidence Ratings, page 533</th>
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| 80   | **Comment** With respect to fish health analyses, according to Table 9-12 (page 535), CES values could not be calculated for LSI because of significant interaction ("Area-specific interpretation not possible due to significant interaction"). However, the report indicates there was a minimum of one significant interaction for the ANCOVAs for condition, LSI and GSI (page 519). It is unclear why CESs were derived for condition and GSI but not for LSI. Furthermore, it is unclear what the approach is, and will be in the future, in the event that CESs cannot be calculated for metrics with "significant interactions". If CESs cannot be assessed for this or other reasons, a metric can never trigger action level 3 or beyond since they cannot meet a requirement of action levels 2 or 3 according to Table 14-2 (page 617),which requires that "an effect size equal to or above the critical effect size defined by the EEM". **Recommendation** Please provide a discussion of how action level comparisons will be made in the event of "significant interaction" issues with data analysis. Revisit CES calculation for variables analyzed with ANCOVA with significant interaction. **Aug 14:** The analyses in question are two different analyses. Page 519 is determining ANCOVAs for trends over time (i.e., across all years, using year as the covariate). The magnitude of difference calculations are performed on an individual year basis (i.e., 2016 in Table 9-12). These two analyses cannot be compared, they are completely different. For future, in the event that Critical Effect Size (CES) cannot be calculated for metrics with significant interactions, additional guidance from the EEM Technical Guidance Document (Environment Canada 2012) will be applied to attempt to calculate the magnitude of effect on fish health endpoints with significant interactions. Reference: Environment Canada. 2012. Metal Mining Technical Guidance for Environmental Effects Monitoring. EEM/2012. Environment Canada, Ottawa, ON. 2012 |

<p>| 81   | <strong>Comment</strong> &quot;In 2007, 2010 and 2013 the samples consisted of fish bodies (i.e., carcass excluding gonads, otoliths, and stomachs). Gonads, otoliths and stomachs were not included, as they were required for separate analyses as part of the fish health assessment. In 2016, the samples consisted of carcass only. The livers were presented in the figure are the outcomes from the statistical models (as described in Section 9.2.1.3.5). <strong>Aug 14:</strong> &quot;Carcass only&quot; refers to carcass excluding viscera (i.e., excluding gonads, stomach, otoliths, liver). The difference in the tissue analyzed was the exclusion of the liver in 2016. |</p>
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<td>MAIN DOCUMENT, Fish, Section 9.3.1.1.2, Fish Tissue, Methods, Lake Trout</td>
<td>538</td>
<td>&quot;Concentrations in fish in 1996 were measured in composite samples, not individual fish. Because mercury bioaccumulates and biomagnifies in fish tissue and differences in mercury concentrations can be confounded by differences in fish body size, the 1996 data are not appropriate for use. Temporal and spatial comparisons were not conducted with this data.&quot; Section 9.3.1.3.2 (Temporal Trend Analysis, page 545) and Section 9.3.2.2 (Temporal Analysis, page 566) include data collected from 1996.</td>
<td>Please clarify or provide correction of text.</td>
<td>Aug 14: The text is correct as written; the 1996 data were not used for temporal and spatial comparisons. The 1996 data were only presented in Figure 9-34 for completeness, and as directed by previous reviewers in the annual reports. This is indicated in the footnote of Figure 9-34. The temporal analyses (Figure 9-35) and predicted mercury concentrations (Figure 9-36) do not include 1996 data.</td>
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<td>MAIN DOCUMENT, Fish, Section 9.3.1.1.2, Fish Tissue, Methods, Lake Trout</td>
<td>538</td>
<td>The report identifies various sources of Lake Trout mercury data included in the report and analyses. However, it is difficult for the reader to ascertain what data were included, what methods were employed, and what analytical laboratory and detection limits are associated with the data presented in the report. For example, page 538 indicates that samples were analysed at both ALS and Flett Research in 2008 but the report does not indicate which of the two datasets were incorporated into analyses and in the results presented in the report. The lack of clarity regarding these methods and metadata render it difficult for the reader to critically evaluate the approach taken and subsequent conclusions borne from the analyses presented in the report. For example, changes in analytical laboratories may affect conclusions.</td>
<td>The report would benefit from a summary table identifying, by year, analytical laboratories used and explicit identification of data incorporated in the analyses.</td>
<td>Aug 14: A summary table will be added in the revised version of the report. We agree with the reviewer that the various laboratories and collection methods render the interpretation of these data challenging. An effort was made to use as much of the data as possible. In previous years, reviewers have had concerns over not using all of the available data, and as such DDMI was directed to use all available data (including palatability data) in the 2014 to 2016 Aquatic Effects Re-evaluation Report.</td>
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<td>MAIN DOCUMENT, Fish, Section 9.3.1.1.2, Fish Tissue, Methods, Lake Trout</td>
<td>538</td>
<td>Section 9.3.1.1.2 indicates the following data sources for Lake Trout mercury: &quot;Mercury concentrations were measured in muscle, liver and kidney tissue from Lake Trout collected in Lac de Gras in 1996, 2002, 2003, 2004, 2005 and 2008, and Lac du Sauvage in 1996 and 2008. Mercury concentrations were also measured in muscle in 2011 and 2014 in both Lac de Gras and Lac du Sauvage. Additional mercury in muscle tissue data were collected as part of the Mine palatability studies in 2002, 2003, 2004, 2012, and 2015, and these data were incorporated into the analyses, where appropriate.&quot; However, Figure 9-34 (Section 9.3.2.2, page 567) presents results for 2009. There is no indication what these data represent. It is also unclear whether 2008 data represent results from ALS or Flett</td>
<td>The 2009 results were collected as part of the palatability studies. The 2008 results represent data from Flett research. Of note, there was no statistical difference between the Flett and ALS results in 2008 (Golder 2011).</td>
<td>Aug 14: The 2009 results were collected as part of the palatability studies. The 2008 results represent data from Flett research. Of note, there was no statistical difference between the Flett and ALS results in 2008 (Golder 2011).</td>
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<td>Page</td>
<td>Main Document, Fish, Section 9.3.1.3.1, Fish Tissue, Methods, Comparison to Normal Ranges, pages 542-544</td>
<td>Comment</td>
<td>Recommendation</td>
<td>Aug 14: The original purpose of the mercury in Lake Trout study was to evaluate a potential spike in mercury concentrations in Slimy Sculpin in 2007. Mercury is not discharged from the Diavik Diamond Mine. It remains undetected in Mine effluent (Golder 2016). The Board has not set effluent quality criteria for mercury, further emphasizing that development of a normal range as part of an Action Level assessment is not required.</td>
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<td>85</td>
<td>There is no discussion of normal ranges for mercury in Lake Trout provided in this section. If comparisons to normal ranges for Lake Trout are not part of the formal approved analysis approach, it would be beneficial to add a statement to that effect in the report. <strong>Recommendation</strong> Please provide a clarification as to why Lake Trout mercury data are not compared to a normal range.</td>
<td><strong>Main Document, Fish, Section 9.3.1.3.1, Fish Tissue, Methods, Comparison to Normal Ranges, Table 9-16, page 544</strong> Comment There appear to be two errors in the normal ranges presented for tissue analysis in Table 9-16. The values given for thorium are from 2010, as there are no values for 2007 or 2013 provided in the AEMP Reference Condition Report, Version 1.2/1.3. Likewise, the lower limit for tin is incorrectly presented in Table 9-16 as the value for 2010 rather than 2013. <strong>Recommendation</strong> Correct table and ensure error is not carried forward to future reports.</td>
<td><strong>Main Document, Fish, Section 9.3.1.3.2, Fish Tissue, Methods, Temporal Trends, Lake Trout (page 545) and Section 9.3.2.2, Fish Tissue, Results, Temporal Trends, Lake Trout, page 568, Figure 9-36</strong> Comment Section 9.3.1.3.2 (page 545) indicates: &quot;Since mercury concentration is length-dependent, to compare mercury between lakes, it was required to account for differences in Lake Trout lengths between lakes. Therefore, the model was used to conduct pairwise comparisons for year and lake, for a mean Lake Trout fork length of 620 mm to assess spatial and temporal differences in mercury concentrations.&quot; Figure 9-36 (Section 9.3.2.2, page 568) presents length-standardized mercury concentrations in Lake Trout. Data appear to have been standardized to a fork length of 620 mm. The report does not provide a discussion of the rationale for use of this length of trout for length standardization. <strong>Recommendation</strong> Please provide a discussion of the rationale for inclusion of the 620 mm length.</td>
<td><strong>Main Document, Fish, Section 9.3.1.3.3, Fish Tissue, Methods, Guideline Comparison, Fish Health page 546</strong> Comment The report applies a potential effects benchmark/tissue residue guideline for mercury of 1.0 µg/g wet weight from Jarvinen and Ankley (1998) for evaluating effects on fish (i.e., Lake Trout) health (Section 9.3.1.3.3, page 546). The report states: &quot;This is likely a very conservative benchmark; Environment and Climate Change Canada recently conducted a review of mercury in the Canadian environment and noted that the lowest adverse effect concentrations would be 0.5 to 1 mg/g wet weight in fish species such as Northern Pike and Walleye (ECCC 2016), many times higher than using the generic benchmark.&quot; The report incorrectly states the benchmark - or Lowest Observed Adverse Effect Level (LOAEL) - presented in the ECCC review; ECCC (2016) identifies an LOAEL of 0.5-1.0 µg/g as a conservative effect threshold/tissue guideline, and therefore remain valid.</td>
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1.0 µg/g. Section 9.3.1.3.3 indicates an incorrect unit of mg/g (a thousand fold difference). The conclusion presented in Section 9.3.2.3 (page 570) that "Lake Trout health is unlikely to be affected" and that "on the basis of the most recent mercury concentrations in Lake Trout from each lake (2014), no concerns to ......fish health are expected" is based on a misinterpreted benchmark. Mercury concentrations presented in Figure 9-34 (page 567) and Table 9-25 (page 572) indicate that mercury concentrations in individual Lake Trout from both lakes have frequently been in the range of 0.5-1.0 µg/g between 2005 and 2015.

**Recommendation** Reassess conclusions on potential effects of muscle mercury concentrations on fish health based on appropriate guidelines.

**Comment** Section 9.3.2.1, Figure 9-22 (page 551) indicates that mercury concentrations in Slimy Sculpin in the near field in 2007 were almost an order of magnitude higher than in 2013 and 2016 and concentrations in two samples were approaching the Canadian Food Inspection Agency (CFIA) and Health Canada guideline of 0.5 µg/g wet weight for human health consumption (CFIA 2015) applied in the report. Concentrations in sculpin from the far field in 2007 were also substantially higher than the results for 2013 and 2016. Section 9.3.2.2 (page 556) indicates that: "Many of the variables that had either a significant interaction or a significant year effect decreased over time and are, therefore, not considered further. These variables include arsenic, barium, magnesium, mercury, selenium, sodium, titanium, vanadium, and zinc (Table 9-19)." The notably high mercury concentrations reported for 2007 should be discussed and potential reasons for these differences should be identified. For example, it is noted in Section 9.3.1.1.1 (page 536) that although all samples for 2007, 2013, and 2016 were analysed at ALS Laboratories, the 2007 samples were analysed at the Edmonton, AB laboratory while samples from the latter two years were analysed at their Burnaby, BC laboratory. Has the change in laboratory been evaluated as a potential cause for the differences or are there environmental factors that may have caused or contributed to the high concentrations in 2007? The high concentrations observed in 2007 also result in a decreasing temporal trend; should there be issues with this dataset, these should be identified in order to avoid biasing trend analyses here and into the future.

**Recommendation** Include a discussion of the high mercury concentrations in Slimy Sculpin in 2007 and explore potential explanations for the relatively high concentrations observed in that year, notably for the near field area. If data are deemed to be
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<td>90</td>
<td>MAIN DOCUMENT, Fish, Section 9.3.2.1, Fish Tissue, Results, Comparison to Normal Ranges, Slimy Sculpin, Figures 9-19 to 9-26, pages 548-555</td>
<td>There are some issues with the presentation of normal ranges in Figures 9-19 to 9-26. The normal range does not appear for several elements that have low normal ranges (antimony, beryllium, and bismuth) - a footnote was provided for one element indicating why the normal range does not appear, but not for the other two. The normal range does not cover 2007 for some elements (boron, tellurium, thallium, and tin); a footnote explaining this would assist the reader.</td>
<td>Revise figures to include missing information.</td>
<td>Rationale for why normal ranges are not provided for some years (e.g., 2007 for boron, tellurium and tin) are provided in the Reference Conditions Report Version 1.2 (Golder 2017). Reference: Golder. 2017. AEMP Reference Conditions Report Version 1.2. Prepared for Diavik Diamond Mines (2012) Inc. Yellowknife, NT, Canada. June 2017.</td>
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<td>91</td>
<td>MAIN DOCUMENT, Fish, Section 9.3.2.2, Fish Tissue, Results, Temporal Trends, Lake Trout, page 566</td>
<td>Section 9.3.2.2 (page 566) indicates: &quot;In 2014, mercury was detected at near or below baseline concentrations in both Lac de Gras and Lac du Sauvage.&quot; There is no previous description of what constitutes &quot;baseline&quot; for mercury concentrations in Lake Trout.</td>
<td>Please include a description of what baseline mercury concentrations in Lake Trout are and how they were derived.</td>
<td>Baseline data refer to mercury concentrations measured in compositied Lake Trout muscle tissue in 1996.</td>
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<td>92</td>
<td>MAIN DOCUMENT, Fish, Section 9.3.2.2, Fish Tissue, Results, Temporal Trends, Slimy Sculpin, pages 556-565</td>
<td>There is no reason provided in Sections 9.3.2.2 or 9.3.1.3.2 (page 542) as to why some of the elements (chromium, lead, lithium, tellurium, zirconium) were not included in the temporal analysis (Figures 9-27 to 9-32, Tables 9-18 and 9-19). A footnote explaining why the 2007 data was omitted from the analysis for some elements (cesium, molybdenum, tin), as described on page 556, would be beneficial. The figures would also benefit from a Y-axis title.</td>
<td>Provide more information in figures/tables.</td>
<td>The rationale as to why some metals were not included in the temporal analyses is provided in Section 9.3.1.2.3, including descriptions of what years were included and why. Inclusion of this information as footnotes in tables/figures would be redundant.</td>
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<td>93</td>
<td>MAIN DOCUMENT, Fish, Section 9.3.2.2, Fish Tissue, Results, Temporal Trends, Lake Trout, pages 567-568</td>
<td>Figure 9-34 and the text indicates substantively lower concentrations of mercury in Lake Trout in 2014. The text indicates: &quot;Raw mercury concentrations in samples collected from Lac de Gras in 2015 were overall greater than those in samples collected in 2014 (Figure 9-34). However, when fish length was accounted for in the analysis, mercury concentrations were generally similar between the two years (see 2014 and 2015 values in Figure 9-35).&quot; It is difficult to discern inter-annual differences from Figure 9-35.</td>
<td>Please verify figure reference.</td>
<td>Figure reference should be Figure 9-36; this will be updated in the revised version of the report.</td>
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<td>94</td>
<td>MAIN DOCUMENT, Fish, Section 9.3.2.2, Fish Tissue, Results, Temporal Trends, Lake Trout, page 568</td>
<td>Section 9.3.2.2 indicates: &quot;Similar to the general pattern shown in Figure 9-34, the overall temporal trend in Lake Trout mercury concentration reflected the increase in adjusted mercury between 2002 and 2009/2011, and the decrease in mercury following 2011 (Figure 9-36).&quot; It is unclear what is meant by &quot;adjusted mercury&quot;. It is assumed this refers to length-standardized mean</td>
<td>Adjusted mercury is referring to when fish length was accounted for in the analysis of mercury concentrations.</td>
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**Aug 14:**
**Comment** The presentation of results for Lake Trout mercury concentrations is difficult to follow. The report switches between results for arithmetic data (sometimes inappropriately referred to as "raw" data and length-adjusted, modeled concentrations, and it remains unclear which analysis is being referred to in the discussion. The finding of a significant difference in Lake Trout mercury concentration between Lac de Gras and Lac du Sauvage in 2014 (but not in 2011) is counterintuitive to what is presented in Figure 9-36 (page 569).

**Recommendation** Suggest presenting results for length-adjusted concentrations to describe temporal trends and for spatial comparisons; arithmetic data should be used when discussing concentrations in the context of guidelines. Clearly address if significant difference in Lake Trout mercury concentrations existed between the two lakes and between each lake over time.

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**Comment** Figure 9-34 should indicate that it is arithmetic data being presented and a definition of what is meant by "pooled data" should be included. At the resolution chosen for Figure 9-35, it is very difficult to observe any differences or similarities between years. It is unclear why Figure 9-36 does not include results for 1996. It would be beneficial to present annual means (with confidence limits or standard error) and superscripts indicating the results of statistical comparisons between years (similar to Figure 3-4 in Appendix V of the 2014 annual report; Golder 2016a).

**Recommendation** Provide additional details in table and figure captions (and associated text) to adequately define the content of figures and tables. Consider including the results of statistical comparisons in Figure 9-36.

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**Comment** Many of the fish community endpoints shown in Tables 10-1 and 10-2 (pages 585-586) and Table 9-11 (page 533) no longer appear to be measured (e.g., Population structure - survival, Growth - size at age, Reproductive investment - age 1 abundance). It is unclear how these endpoints received Effect Level Ratings in Tables 10A-1, 10A-7, 10A-12, 10A-13). Since a few of these endpoints have been discontinued in more recent surveys as indicated by "n/s" in Appendix 10A tables (Population structure - survival, and -size [2016], and growth- size at age [2013]) - they should be omitted from earlier WOE analyses (i.e., 2007 and 2010).

**Aug 14:** The fish health endpoints were included to be generally consistent with AEMP Design Plan Version 4.1. Reproductive investment - age 1 abundance has been measured every year that fish health was assessed. Growth - size at age has been measured every year that fish health was assessed, with the exception of 2013. Growth - size at age was the key driver endpoint for the toxicological impairment hypothesis in 2016. Population structure - survival and Population structure - size were not key driver endpoints in any of the assessed years, so removing these endpoints would not affect the overall WOE scores for each year. Population Structure - Survival, Population Structure - Size, Growth - Size at Age,
**Recommendation** Update the WOE calculations to reflect the study design.

Reproductive Investment - Age 1+ Abundance, and Pathology - Occurrence [e.g., parasitism] have been recommended for removal from the AEMP Design Plan Version 5.0.

**Comment** Figures 10-2a to 10-2c are somewhat confusing since they seem to exclude some data; it is assumed that this is because the figures only present “key driver endpoints” (p. 589). For example, Figure 10-2c does not show any ratings for Water or Sediment Chemistry, despite showing increasing ratings in Figure 10-2a and b. There also appear to be some inconsistencies with the information presented in Figures 10-2a to 10-2c and 10-3a to 10-3c relative to results presented in earlier sections. For example, there is a grey diamond for 2010 for GSI in Figure 10-2c (indicating not measured), but none for LSI and body size, which also were excluded for 2010 due to methodological differences (see earlier comment and description of methods on page 502). Additional notes include: Figure 10-3c is not consistent with the text on page 592, which states that the key driver in 2010 was condition factor , but the figure shows an effect for LSI. Table 10A-8 shows moderate ratings for TP and chlorophyll a, but symbols for these do not appear in Figure 10-3c for 2010. Table 10A-12 shows high and moderate ratings for TN and TP, but no symbols appear in Figure 10-3c for 2013, and Table 10A-14 shows a high rating for TN that doesn't appear in Figure 10-3c for 2016. There is also an error in the footnote for Figure 10-3, where it states that * symbol does not indicate toxicity (should be nutrient enrichment). Since pathology - occurrence showed a low increase (see Figure 10-3c), should it have a * symbol in Figure 10-2c for 2016? **Recommendation** Review whether including only “Key Driver Endpoints” is the clearest way to illustrate the results of WOE analysis. Review and cross-check tables and figures against detailed results presented in earlier sections.

Aug 14: The intent of figures 10-2 and 10-3 are to present the key driver endpoints (i.e., the exposure and response endpoints with the highest weighted scores) for each ecosystem component for both the toxicological impairment and nutrient enrichment WOE analyses from 2007 to 2016, to illustrate whether there were any patterns in the types of exposure and responses observed over time. We agree that the figures are potentially confusing and therefore can be deleted, in favour of describing the key driver endpoints narratively in Section 10.4, and referring to individual endpoint ratings in the appendix tables.

**Comment** The report indicates: “Weight-of-evidence: The EA predicted that overall, Lac de Gras water would remain at a high quality for use as drinking water and by aquatic life. The main impact was expected to be the introduction of greater concentrations of nutrients, particularly phosphorus, with a concomitant increase in primary productivity over a portion of the lake. The WOE evaluation results are consistent with this prediction.” While it is acknowledged that some of the effects benchmarks for water quality were based on drinking water quality guidelines and that guidelines for the protection of aquatic life are typically more stringent than drinking water quality guidelines, the report does not include an explicit analysis of water quality in terms of drinking water quality. This statement may benefit from some additional explanation regarding

Aug 14: A brief summary related to drinking water quality will be added.
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| 100    | MAIN DOCUMENT, Proposed Updates to AEMP Design Plan, Section 14.2.1, Dust, page 606 | 606 | **Comment** Section 14.2.1 (page 606) provides a response to a WLWB directive: "The WLWB requested a critical review of the present sampling plan for dust, and requested DDMI consider revisions to the existing program based on the findings presented herein. Potential revisions requested by the WLWB (Table 1-1) included the following: - Consider the implementation of additional dustfall and/or snow water chemistry monitoring sites (W2015L2-0001 update, Commitment A)..." The response provided indicates: "The current number and location of the dustfall and snow water monitoring locations is sufficient to evaluate both the spatial and the temporal trends of dust deposition (e.g., Figure 3-10 and 3-17); nutrient deposition (Figure 3-11 to 3-14 and 3-18); and metal deposition (Figures 3-15, 3-16 and 3-19) in the vicinity of the Mine. Consequently, no additional monitoring locations are recommended at this time." There is no rationale provided for why no additional dust monitoring sites will be added. NSC (2017a) had noted in the review of the 2016 AEMP Report: "Given the relatively high dust deposition observed at sites south and southeast of the mine, it would be beneficial to add a site between the two monitoring axes (i.e., SSE in the vicinity of the water quality site MF3-3) and a dustfall monitoring station south of site Dust 10 (i.e., at or near one of the snow dust fall sites SS5-4 and SS5-5)."
**Recommendation** Provide a discussion and rationale for the proposal to not add dustfall monitoring sites. | Adding the suggested dustfall monitoring stations would add detail to the spatial analysis, but is unlikely to affect the general conclusions based on the entire dataset, which show that dust deposition rates are below the relevant guidelines. Therefore, additional dustfall monitoring stations are not warranted. Regarding the NSC (2017a) comment suggesting adding a station "at or near one of the snow dust fall sites SS5-4 and SS5-5", dustfall gauges must be placed on land so a potential new station would be ~1.5 km farther than SS5-5. |
| 101    | MAIN DOCUMENT, Proposed Updates to AEMP Design Plan, Section 14.2.1, Dust, page 606 | 606 | **Comment** Section 14.2.1 (page 606) provides a response to a WLWB directive: "The WLWB requested a critical review of the present sampling plan for dust, and requested DDMI consider revisions to the existing program based on the findings presented herein. Potential revisions requested by the WLWB (Table 1-1) included the following: ...Review the location and number of duplicate and blank samples for the dustfall and the snow water chemistry program (W2015L2-0001 update, Commitment B)." There is no discussion provided regarding a review of blank samples. **Recommendation** Include a discussion of blank samples included in the dust monitoring component. | There are no "travel blanks" or "field blanks" for dustfall or for snow cores. An "Equipment Blank" is prepared each year using de-ionized water and results show no sampling-equipment related contamination of snow samples. A short discussion of this can be added to the Re-evaluation Report. Duplicate samples were also collected as part of the QC program. Accuracy, precision and detection limits of the analysis are determined by the accredited 3rd party analytical labs. Analysis of duplicates enables an evaluation of repeatability among samples. |
| 102    | MAIN DOCUMENT, Proposed Updates to AEMP Design Plan, | | **Comment** Section 14.2.1 (page 606) provides a response to a WLWB directive: "The WLWB requested a critical review of the present sampling plan for dust, and requested DDMI consider revisions to the existing program based on the findings presented herein. Potential | There are 16 years of data and 50+ analytes for each duplicate sample. The full data set is impractically large to include in a written report. In addition, the QA/QC program for the AEMP is |
| Section 14.2.1, Dust, page 606 | revisions requested by the WLWB (Table 1-1) included the following: ...Review the location and number of duplicate and blank samples for the dustfall and the snow water chemistry program (W2015L2-0001 update, Commitment B)." The sample duplicate results are presented in Table 3-4 (page 29) for only a subset of parameters. The document should include a review of all parameters to provide for an evaluation of QA/QC for the program as a whole. While annual reports discuss details for all parameters, the re-evaluation report is the location where data for numerous years are considered collectively. Issues with and/or patterns in data may not be readily apparent until data are reviewed for all years together. **Recommendation** Include duplicate sample results and discussion of these data for all parameters. A table presenting a summary of the analysis of the duplicate results (e.g., relative percent mean differences) could be provided in an appendix. This would also inform on the need to modify the program. documented in the Quality Assurance Project Plan (QUAPP), which is reviewed separately from the Aquatic Effects Re-evaluation Report. |
| 103 MAIN DOCUMENT, Proposed Updates to AEMP Design Plan, Section 14.2.2.1, Fish, Non-lethal Slimy Sculpin Survey, page 607 | **Comment** It is unclear how the addition of a non-lethal sculpin survey, as described in Section 14.2.2.1 (page 607) will be incorporated into the assessment of effects. There will be no ability to compare the results of the first year of sampling to any previous data as the data collected and sampling strategy are different. Therefore, the first comparison could only be done after 6 years, since the sampling is recommended to occur every three years (Section 14.2.2.2). Furthermore, this dataset will lack baseline or early post-project data with which to compare. If normal ranges are utilized as per the lethal assessment, then the first two sampling years at a minimum will be needed to construct these ranges. If this is the case, then it would not be possible for these data to trigger an Action Level 3 for the first two sampling periods as, according to Table 9-4 (page 509), this requires data to be outside of the normal range. **Recommendation** Provide explanation of how this sampling program will be used within the existing effects assessment structure. |
| 104 MAIN DOCUMENT, Proposed Updates to AEMP Design Plan, Section 14.2.8, Weight-of-Evidence, page 611 | **Comment** Section 14.2.8 (page 611) indicates: "In their Reasons for Decision, WLWB (2017e; Section 3.12, Part 2e) recommends that benthic macroinvertebrate density be added as a nutrient enrichment exposure endpoint of the fish population health ecosystem component, or that rationale be provided for the omission (Table 1-1). Chlorophyll a is currently included as a nutrient enrichment exposure endpoint for the fish population health ecosystem, which is intended to be indicative of food supply. It is assumed that an increase in the biomass of algae as measured by chlorophyll a provides an early indication of an enrichment-related Aug 14: Benthic invertebrate density will be incorporated as an additional endpoint into the WOE for nutrient enrichment in the revised version of the AEMP Design Plan, with the cautions indicated in Section 14.2.8 (page 611) of the 2014 to 2016 Aquatic Effects Re-evaluation Report. |
| Aug 14: CPUE and Age-1+ abundance endpoints will still continue to be reported and discussed as part of the fish program annual AEMP results. CPUE is a method to standardize fish capture at each area, and can be used to provide an estimate of relative abundance among sampling areas. CPUE is not proposed to be included as part of the Action Level assessment. Changes in CPUE and abundance may be linked to causes external to a Mine related effect (e.g., mortality due to lethal fish health programs every three years, weather, wave action at the time of sampling), and therefore are not appropriate Action Level triggers. |
increase in zooplankton and/or benthic invertebrate food supply for fish. Adding benthic invertebrate abundance or density would be redundant considering there is already a conservative measurement of enrichment-related food supply in the WOE analysis. Moreover, the benthic invertebrate community samples are collected from deep-water stations and as such the abundance or density from these samples are not representative of food supply for shallow-water, shoreline-dwelling Slimy Sculpin. Because chlorophyll a is measured once per year and is inherently more variable in time and space than benthic invertebrate community metrics, the latter would provide a more integrative representation of effects related to nutrient enrichment. In addition, benthic invertebrates are the primary food source for slimy sculpin.

**Recommendation** Incorporate benthic invertebrate density in the WOE, as suggested by the WLWB.

| 105 | Appendix 10A, Updated Weight-of-Evidence Analyses | **Comment** There are inconsistencies among the years in the "A Posteriori Weighting" values. For example, in Table 10A-1 the endpoints for contaminant exposure were assigned a strength of linkage rating of 0.25, but this value is 0.5 in Tables 10A-7 and 10A-11, and 0.75 in 10A-13. Similarly, the a posteriori weighting factors do not match for the nutrient enrichment tables - pathology is rated 0.25 in Table 10A-14 (2016), but 0.75 in Table 10A-8 (2010). **Recommendation** Revise tables and verify WOE calculations. |
| Aug 14: A posteriori weighting factors are applied on a case-by-case basis and involve professional judgement. They are not intended to be equal for a given endpoint across years. Instead, they vary across years depending on the degree of concordance between endpoints in the exposure and biological response LOE groups, as well as the coherence of the response within the LOE group. So, for example, pathology is given more a posteriori weight in 2010 (Table 10A-8) compared to 2016 (Table 10A-14). In 2010, there were several biological response endpoints that indicated nutrient enrichment (population structure - size, condition factor, LSI, and pathology) so there was a coherent response among endpoints. In 2016, the only other observed biological response was growth - size at age and the direction of the growth response (i.e., reduction in growth) was not consistent with nutrient enrichment, and therefore the coherence of the response was weak for fish health endpoints. Moreover, there was a moderate increase in total phosphorus in 2010 whereas no increase was observed in 2016. Given that Lac de Gras is considered a phosphorus-limited lake, there was a higher strength of linkage between the exposure and the response in 2010 compared to 2016. Therefore, a higher a posteriori weighting was applied to 2010 compared to 2016. The lowest possible a posteriori weighting was applied to the fish community contaminant exposure endpoints in 2010 because there were no responses observed for the biological response endpoints. Therefore there can't be a coherence of response between the exposure and biological response LOE groups. Although higher a posteriori weighting could be applied for the strength of linkage weighting factor, it would have resulted in a
Comment: The Review of the 2016 AEMP report identified the exclusion of sculpin livers from tissue chemistry analysis in 2016 as an issue. The methods described in the memorandum to prevent future sampling errors are acceptable. However, the method to account for the omission of livers in tissue analyses in 2016 is imprecise. The concentration of elements in the livers of Slimy Sculpin has been estimated through extrapolation from two extremely dissimilar species (Lake Trout and Round Whitefish). It is assumed data for these species were used due to lack of similar data for sculpin. However, it is well established that the accumulation of elements in fish tissue is species-specific (see examples of references below). There is a precedent in the report regarding treatment of data with similar issues. Section 9.3.1.1.1 (pages 535-536) indicates that the 2004 samples were not included in the analysis as a result of the exclusion of livers (as well as most of the head and gas bladders) from the samples. Djikanovic, V., Skoric, S, and Gacic, Z. 2016. Concentrations of metals and trace elements in different tissues of nine fish species from Međuverye Reservoir (West Morava River Basin, Serbia). Archives of Biological Sciences 68(00): 69. Farkas, A., Salánki, J., Varanka, I. 2000. Heavy metal concentrations in fish of Lake Balaton. Lakes and Reservoirs: Research and Management 5(4): 271-279. Jordaan, L.J., Wepener, V., and Huizenga, J.M. 2016. The major trace element chemistry of fish and lake water within major South African catchments. Water SA 42(1): 112-128.

Recommendation: Unless it can be reasonably demonstrated that Lake Trout and Round Whitefish are a good model for Slimy Sculpin, it is recommended that the 2016 data be treated in the same manner as the 2004 samples, which also excluded liver tissue (i.e., omit them from future analyses).

Aug 14: "Predatory" will be removed, as suggested.
<table>
<thead>
<tr>
<th>Study Design, Section 3.2, Assessment and Measurement Endpoints, page 19, Table 3.2-1</th>
<th><strong>Comment</strong></th>
<th><strong>Recommendation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>108</td>
<td>Fish age has been removed from the assessment and measurement endpoints for fish health and there is no longer an indicator of survival identified in Table 3.2-1.</td>
<td>Recommend including a measurement endpoint for survival.</td>
</tr>
<tr>
<td>109</td>
<td>Table 3.2-1 indicates that catch-per-unit-effort (CPUE) is a measurement endpoint for the &quot;Fish Health and Abundance&quot; assessment. It is unclear how this endpoint factors into the Action Level evaluation as there is no reference condition (i.e., normal range) in either the Reference Condition Report Version 1.2 (Golder 2017) or Appendix 9A of the 2014-2016 Re-evaluation report (Golder 2018).</td>
<td>Provide additional information on how CPUE/abundance is to be used in the analysis of Slimy Sculpin monitoring results.</td>
</tr>
<tr>
<td>110</td>
<td>The text (page 25) provides an example that states &quot;at Action Level 1, the follow-up action for biological components is confirmation of effect&quot;; however, this does not agree with the revised action levels presented in Table 5.2-4 (page 91), that indicates the action for Action Level 1 is no action, and Action Level 2 is to confirm effects.</td>
<td>Review for conformity</td>
</tr>
<tr>
<td>111</td>
<td>Section 4.2.2.1 (page 34) identifies the number of duplicate samples to be incorporated into the QA/QC program for dust monitoring. However, there is no description of the numbers and types of blank QA/QC samples for the program.</td>
<td>Include a description of the numbers and types (e.g., field blank, equipment blank) of blank samples included in the dust monitoring program and identify if blank samples will be prepared (where applicable; e.g., preparation of equipment blanks) at sites where duplicate samples are collected.</td>
</tr>
<tr>
<td>112</td>
<td>Section 4.4.4 (page 54) indicates: &quot;Variables with strong correlations to TOC or percent fines will be normalized to the relevant physical variable before statistical analysis.&quot; As noted in comments on the Re-evaluation Report (NSC 2018), it is agreed that normalization of data for confounding variables (fines and TOC) is appropriate and provides a means to evaluate changes in metals and</td>
<td>Trend analysis on raw sediment quality data is not planned. Despite some fluctuations over time, there was no evident temporal trend in TOC and % fines. Mine-related effects were not expected or observed in these variables. Hence, trend analysis was focused on normalized data to minimize the effects of supporting variables fluctuating over time. Trend analysis on raw data would be</td>
</tr>
</tbody>
</table>
nutrients independent of changes/variability in these supporting variables. However, it would also be of interest to know if absolute concentrations (i.e., raw data) also show trends over time. This would be particularly pertinent if there have been mine-related changes in either supporting variable. For example, if there is a mine-related increase in TOC concentrations, the higher TOC may also result in higher metals and/or nutrients due to the affinity of these substances to organic matter.

**Recommendation** Please clarify if trends will also be evaluated on raw data for all of the SOIs. If this is not proposed, please provide a discussion of the rationale for excluding these analyses.

**Aug 14:** The recommendation can be modified to: "Please clarify if trends will also be evaluated on raw data for all of the SOIs. If this is not proposed, please provide a discussion of the rationale for excluding these analyses."
### Recommendation

Consider increasing the frequency of FF sampling for eutrophication metrics to annual sampling and/or provide a rationale for what actions would be taken in the event that the spatial extent of effects on eutrophication metrics extended up to the MF sites in years when FF sampling is not conducted.

Eutrophication metrics is expected to extend into the MF areas; therefore, unless an Action Level is triggered (based on effect magnitude combined with spatial extent), there is no action to be initiated upon observing effects on eutrophication metrics in the MF areas.

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### Description of AEMP Components, Section 4.6.2, Plankton, Field Methods, page 58

**Comment** The report indicates: "Sampling for the plankton component of the AEMP will occur at the same locations as the sampling for other AEMP components (see Section 3.4), with the exceptions of LDG-48 and LDS-4 which will not be sampled for plankton." Since eutrophication indicators will be sampled annually at this site as noted on page 56, collection of phytoplankton samples at this site annually would be consistent with the eutrophication monitoring component of the AEMP. It is further suggested that samples could be collected and archived pending review of results from other sampling sites (i.e., NF and MF sites).

**Recommendation** Collect phytoplankton samples at LDG-48 annually (samples could be archived).

**Aug 14:** As part of the Eutrophication Indicators component, chlorophyll a is sampled at LDG-48; therefore, there is already an indicator of phytoplankton biomass at LDG-48. Chlorophyll a has been found to be a more sensitive (i.e., triggering earlier) and robust (i.e., less variable) indicator of nutrient enrichment in Lac de Gras than phytoplankton biomass.

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### Description of AEMP Components, Section 4.8.1, Fish Health, Background, page 64

**Comment** The report states that a Lake Trout health study will only be conducted if the small-bodied fish (i.e., Slimy Sculpin) health assessment triggers an Action Level 3 (Section 4.8.1, page 64). This has been changed from an Action Level 2 in the previous Design Plan Version 4.1 (Golder 2016b). The revision has resulted in a much higher threshold to initiate a Lake Trout health assessment. In the control-effect sampling design (Version 4.1), a significant difference in a variable indicative of a toxicological effect at the MF area relative to the FF areas was sufficient to trigger a large-bodied fish survey; under the gradient sampling design (Version 5.0), the threshold for action level 3 is an exceedance of the critical effect size (CES) and the normal range and the effect is observed in two consecutive sampling periods. The requirement for exceeding the normal range alone is itself one action level higher than in the previous Version 4.1 AEMP design plan. Under this new action level trigger the small-bodied fish will have exceeded the critical threshold values recommended by the Environment Canada (EC) Metal Mining Environmental Effects Monitoring (EEM) Guidance Document (EC 2012) for 6 years before a large-bodied fish survey is even defined in an AEMP Response Plan. The other major limitation with this plan is that there will be no recent or baseline data with which to compare the Lake Trout health data collected should a study be triggered, limiting the value of such a survey. There is no information provided regarding how Lake Trout health monitoring would be conducted and how the data would be analysed. EMAB understands that the WLWB accepted Diavik’s proposal to use mercury levels in slimy sculpin as the trigger for lake

**Aug 14:** The inclusion of a potential study design for a large bodied fish health program is not appropriate at this time, as this would not follow the methods of the Response Framework. Action Levels triggers are evaluated on a case by case basis and then specific response plans are developed at that time in consultation with the WLWB and regulators. As per the approved Response Framework required by the WLWB, should an Action Level exceedance occur, an appropriate response will be developed as part of the Response Plan, and will require review and approval by the WLWB prior to implementation.
trout sampling in a previous decision, while recognizing that slimy
sculpin are not a good indicator of mercury-related risks in lake trout.
At the same time EMAB notes that mercury levels in trout in Lac de
Gras have been a concern since the mine was first proposed and
were raised by Affected Communities during the Comprehensive
Study of the proposal, and that Diavik made a prediction with respect
to mercury levels in lake trout that can only be verified by ongoing
monitoring. The only ongoing monitoring of mercury in lake trout
continues through the fish palatability studies. EMAB will continue to
take a keen interest in the results of the analysis of trout tissue from
these studies, and will take appropriate action if we deem a potential
risk is present, particularly for subsistence users.
**Recommendation** Review the Lake Trout health survey trigger and
provide a description of a conceptual study design.

| 117 | Description of AEMP Components, Section 4.8.2, Fish Health, Field Methods, page 64 | **Comment** The report indicates: "Backpack electrofishing will be used
to capture Slimy Sculpin. The first fish sampling done in a given year
would be a random field sampling effort at each of the study areas
documenting each fish captured, before moving to the targeted
lethal program." Additional details regarding the non-lethal survey
study design should be provided, including a description of the
sampling effort, target number of individuals captured,
randomization process, and number of sites etc.
**Recommendation** Please provide additional information regarding
the details of the non-lethal fish sampling program field methods. | Aug 14: Further details on the non-lethal fish sampling program will
be added in the revised version of the AEMP Design Plan. |

| 118 | Description of AEMP Components, Section 4.9.3, Fish Tissue Chemistry, Laboratory Methods, page 69 | **Comment** Section 4.9.3 (page 69) indicates that "five Slimy Sculpin
samples will be randomly selected after the initial analysis and sent
to Flett Research Ltd. (Winnipeg, MB) for QC of the mercury results."
It may be more meaningful to select five samples across a range of
concentrations (obtained from the primary analysis), including
minimum and maximum concentrations, rather than choosing five
samples randomly. Inter-laboratory comparison results for fish
mercury may vary substantively depending on the concentrations
encountered.
**Recommendation** Consider changing the approach on how to select
tissue samples for QC of mercury analysis. | Aug 14: The approach for selection of QC samples will be modified
as suggested in the revised version of the AEMP Design Plan;
however, it should be noted that sample selection for QA/QC is
often determined based on sample volumes available to meet the
minimum laboratory sample volume requirements. |

| 119 | Description of AEMP Components, Section 4.8.4, Fish Health, Data Analysis and Interpretation, page 67-68 | **Comment** The methodology for data analysis and statistical analysis
presented in Section 4.8.4 does not specify or differentiate what
data/endpoints will be calculated/analysed for each of the lethal and
non-lethal fish sampling programs. According to the 2014-2016 Re-
evaluation report (Golder 2018), a randomized, non-lethal survey is
intended to provide information on sculpin abundance and
reproductive success (Section 14.2.2.1, page 607). However the
Aug 14: These methods were described in Section 4.8.4; however,
 further clarification will be added. Action Level metrics for fish are
clearly defined in Section 5.2.4 and Table 5.2-4. The listed metrics
for Action Levels have corresponding normal ranges. Normal ranges
are not required for CPUE and abundance given that these data are
not standardized, and because they are appropriately not included
as part of the Action Levels for biological effects. Changes in CPUE
Version 5.0 Design Plan does not include any information on how the two non-lethal metrics recommended in the Re-evaluation report (i.e., CPUE and length-frequency histograms), are to be calculated and analysed or how they will be incorporated into the response framework (e.g., action level assessment). It is also unclear how the data will be analysed and interpreted due to the lack of reference conditions (i.e., normal ranges) for these endpoints. In addition, CPUE/abundance is not listed as a metric in Section 4.8.4 (page 68). **Recommendation** Provide a detailed description of the metrics that will be incorporated into reporting and the methods for analysing these metrics, including action levels where applicable.

<table>
<thead>
<tr>
<th>Comment</th>
<th>The reference conditions (i.e., normal ranges) for fish health were updated as part of the 2014-2016 Re-evaluation report (Appendix 9A; Golder 2018) due to a change in methods regarding the determination of stage (adult/age 1+). However, there is no methodology presented in Section 4.8 describing how sculpin will be sub-divided into the adult and &quot;juvenile&quot; categories indicated on page 67 or into the &quot;young/small&quot; categories for the length-frequency histograms described on page 68. It is unclear if the &quot;juvenile&quot; category differs from the Age 1+ category discussed in the 2014-2016 Re-evaluation report (Golder 2018). If these categories differ, then the normal ranges may need to be updated again to reflect the methodology used to separate adults from juveniles rather than Age1+ as was done in Appendix 9A of the Re-evaluation report. <strong>Recommendation</strong> Revise text in Section 4.8 to include methodology for stage determination. Review calculation of normal ranges for juvenile/adult categories and revise text as required.</th>
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<tr>
<td>Aug 14:</td>
<td>Methods for stage determination will be added to Section 4.8 in the revised version of the report, and will be the same as the methodology presented in the 2014 to 2016 Aquatic Effects Re-evaluation Report.</td>
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</table>

| Comment | As noted in NSC (2018), some of the weightings were not consistent across time (i.e., 2007, 2013, 2016) within the WOE evaluation presented in Appendix 10A of the 2014-2016 Re-evaluation report (Golder 2018). There is no information provided in the Design Plan Version 5.0 identifying the current weightings or how the rankings will be standardized among the sampling periods if the values have changed as part of the AEMP redesigns. There is also no discussion of whether the calculation of the WOE score is modified to account for endpoints that are missing results in a year (e.g., GSI in 2010). **Recommendation** Provide information on weighting factors and additional information on WOE scoring. |
| Aug 14: | A posteriori weighting factors are applied on a case-by-case basis and involve professional judgement. They are not intended to be equal for a given endpoint across years. Instead, they vary across years depending on the degree of concordance between endpoints in the exposure and biological response LOE groups, as well as the coherence of the response within the LOE group. So, for example, pathology is given more a posteriori weight in 2010 (Table 10A-8) compared to 2016 (Table 10A-14). In 2010, there were several biological response endpoints that indicated nutrient enrichment (population structure - size, condition factor, LSI, and pathology) so there was a coherent response among endpoints. In 2016, the only other observed biological response was growth - size at age and the direction of the growth response (i.e., reduction in growth) was not consistent with nutrient enrichment, and therefore the coherence of the response was weak for fish health endpoints. Moreover, there was a moderate increase in total phosphorus in 2010 whereas no |
increase was observed in 2016. Given that Lac de Gras is considered a phosphorus-limited lake, there was a higher strength of linkage between the exposure and the response in 2010 compared to 2016. Therefore, a higher a posteriori weighting was applied to 2010 compared to 2016. The lowest possible a posteriori weighting was applied to the fish community contaminant exposure endpoints in 2010, because there were no responses observed for the biological response endpoints. Therefore there can't be a coherence of response between the exposure and biological response LOE groups. Although higher a posteriori weighting could be applied for the strength of linkage weighting factor, it would have resulted in a higher total WOE score for the fish health community, which would be misleading because there were no biological responses observed.

Comment Section 14.2.8 (page 611) of the Re-evaluation Report (Golder 2018) indicates: "In their Reasons for Decision, WLWB (2017e; Section 3.12, Part 2e) recommends that benthic macroinvertebrate density be added as a nutrient enrichment exposure endpoint of the fish population health ecosystem component, or that rationale be provided for the omission (Table 1-1). Chlorophyll a is currently included as a nutrient enrichment exposure endpoint for the fish population health ecosystem, which is intended to be indicative of food supply. It is assumed that an increase in the biomass of algae as measured by chlorophyll a provides an early indication of an enrichment-related increase in zooplankton and/or benthic invertebrate food supply for fish. Adding benthic invertebrate abundance or density would be redundant considering there is already a conservative measurement of enrichment-related food supply in the WOE analysis. Moreover, the benthic invertebrate community samples are collected from deep-water stations and as such the abundance or density from these samples are not representative of food supply for shallow-water, shoreline-dwelling Slimy Sculpin." As noted in NSC (2018) comments on the Re-evaluation Report, because chlorophyll a is measured once per year and is inherently more variable in time and space than benthic invertebrate community metrics, the latter would provide a more integrative representation of effects related to nutrient enrichment. In addition, benthic invertebrates are the primary food source for Slimy Sculpin. This comment is re-iterated here for consideration within the design plan.

Recommendation Incorporate benthic invertebrate density in the WOE, as suggested by the WLWB.

Aug 14: Benthic invertebrate density will be incorporated as an additional endpoint into the WOE for nutrient enrichment in the revised version of the report, with the cautions indicated in Section 14.2.8 (page 611) of the 2014 to 2016 Aquatic Effects Re-evaluation Report.

Comment Information on both internal and external abnormalities, including wounds, lacerations, and tumours, is being collected as part of the assessment. However, it is not appropriate to include fish abnormalities in the WOE assessment. It is not a valid line of evidence, as measured, to
<table>
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<th>Section</th>
<th>Description</th>
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<th>Recommendation</th>
<th>Aug 14</th>
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<tbody>
<tr>
<td><strong>4.10.2.1, Weight-of-Evidence, Lines of Evidence and Measurement Endpoints, page 74, Table 4.10-2</strong></td>
<td>of the fish health assessment. However, this information is not incorporated into the WOE evaluation (i.e., as defined in Table 4.10-2, page 74) and parasitism has been deleted from the WOE evaluation. The report indicates (page 72) that the Standard Operating Procedures for the internal and external examinations of sculpin have been followed for all surveys; these data could be used to generate normal ranges and could be analysed for previous years and added to the WOE evaluation (i.e., a replacement for the parasitism metric that was deleted). <strong>Recommendation</strong> Consider adding the results of fish abnormalities to the WOE assessment to strengthen the WOE analysis.</td>
<td>directly determine if there is a toxicological or nutrient-related Mine effect. These endpoints will continue to be reported and discussed as part of the fish program.</td>
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<tr>
<td><strong>124</strong></td>
<td>Description of AEMP Components, Section 4.10.2.1, Weight-of-Evidence, Lines of Evidence and Measurement Endpoints, pages 73-74, Tables 4.10-1 and 4.10-2</td>
<td><strong>Comment</strong> The removal of biological variables from the endpoints and lines of evidence (Tables 4.10-1 and 4.10-2) leaves no measure of survival for fish. The rationale provided in Golder (2018) for these deletions is: &quot;Total length, fresh weight, and/or carcass weight should be added as endpoints to the WOE analysis instead of size at age, which cannot be determined because age data are not available for Slimy Sculpin (due to the difficulties of interpreting ages using otoliths with this species). Survival, and Reproductive Investment - Age-1+ Abundance should both be removed from the WOE endpoints for fish population health. Neither of these endpoints can be accurately determined due to difficulties in capturing the smallest size classes (e.g., fishing gear bias), and while length-frequency and presence/absence analysis for the smallest size class may be considered as a surrogate for Age-1+ abundance, they should not be included as part of the WOE.&quot; It would be beneficial if the two metrics recommended to be collected as part of the randomized, non-lethal survey identified in the Re-evaluation report (i.e., abundance and length-frequency histograms; Section 14.2.2.1; Golder 2018) could be added to the WOE; however, it is recognized that this is complicated by the absence of data from previous surveys. <strong>Recommendation</strong> Consider inclusion of non-lethal fish population endpoints (abundance and length-frequency histograms) in the WOE.</td>
<td>Aug 14: Inclusion of these endpoints in the WOE assessment will be considered following the first attempt at completing the randomized field sampling effort (i.e., 2019 fish program). At this time, it is unknown if the random sampling effort will yield sufficient information, so we have refrained from making commitments to use these data in the WOE assessment.</td>
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<td><strong>125</strong></td>
<td>Response Framework, Section 5.2.4, Biological Components, pages 89-90, Table 5.2-4</td>
<td><strong>Comment</strong> Section 5.2.4 (pages 89-90, Table 5.2-4) states that the reference conditions for fish health are contained in the Reference Conditions Report Version 1.2 (Golder 2017). However, the normal ranges were recalculated for all of the health variables as part of the 2014-2016 Re-evaluation Report (Appendix 9A; Golder 2018) due to a change in how age/stage was calculated. <strong>Recommendation</strong> Correct citation to reference condition, if appropriate and clarify what normal ranges will be used moving forward.</td>
<td>Aug 14: The normal ranges presented in Appendix 9A of the 2014 to 2016 Aquatic Effects Re-evaluation Report will be used going forward. The reference citation in the text will be corrected in the revised version of the report.</td>
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<tr>
<td>ID</td>
<td>Topic</td>
<td>Reviewer Comment/Recommendation</td>
<td>Proponent Response</td>
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<td>53</td>
<td>General File</td>
<td><strong>Comment</strong> (<a href="doc">doc</a>) 2018-07-19 - Adobe - ENR Letter to Board - DDMI Diavik - W2015L2-0001 - ENR Comments</td>
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<td>54</td>
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<td><strong>Comment</strong> (<a href="doc">doc</a>) Zajdlik Associates Inc - DDMI AEMP 3 Year Re-Evaluation Review July 10</td>
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<td>55</td>
<td>General File</td>
<td><strong>Comment</strong> (<a href="doc">doc</a>) Zajdlik Associates Inc - DDMI AEMP Design 5 Review July 6</td>
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<tr>
<td>1</td>
<td>2014 to 2016 Aquatic Effects Re-evaluation Report 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) 2014 to 2016 Aquatic Effects Re-evaluation Report. As part of the review, Dr. Zajdlik focused on the 2017 WLWB Board Directives and Reasons for Decision for the 2016 AEMP and Schedule 8 update. ENR has extracted and summarized some of his comments and recommendations from this memo and provided them below. ENR has also included Dr. Zajdlik's review memo which provides additional background and context for the comments and recommendations. <strong>Recommendation</strong> 1) ENR recommends the Board refer to the attached memo for additional background and context supporting ENR's comments and recommendations.</td>
<td><strong>Aug 14:</strong> No response required.</td>
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<tr>
<td>2</td>
<td>Topic 2: Phytoplankton Taxonomy in Eastern Lac de Gras</td>
<td><strong>Comment</strong> ENR has previously provided recommendations to the WLWB on including phytoplankton taxonomy to be done annually at all MF and FF-2 locations as well as LDS-4 (WLWB 2017a, Section 3.12, part 2 h). ENR's comment and recommendation was as follows: &quot;Comment Golder (2016, Table 3.5-1) proposes to measure indicators of eutrophication annually at nearfield, MF, FF2, LDS-4 and LDG-48. This list of eutrophication indicators includes zooplankton biomass but does not include phytoplankton taxonomy. Phytoplankton taxonomy is currently measured annually at nearfield locations. Given concerns with potential eutrophication in the eastern end of Lac de Gras due to construction of the Jay Pit, phytoplankton taxonomy should be included in the list of eutrophication indicators that are measured on an annual basis at MF, FF2 and LDS-4 locations in addition to nearfield locations. This more complete time series of data will aid in detecting and understanding potential cumulative impacts. Note that currently, DDMI does not propose to measure phytoplankton taxonomy at LDS-4 at all. Recommendation 1) ENR recommends that phytoplankton taxonomy should be included in the</td>
<td><strong>Aug 14:</strong> DDMI addressed the directive in Section 14.2.5, and recommended that plankton sampling at LDS-4 (the Narrows) be discontinued, because this location is shallow with flowing water, and not appropriate for collection of representative phytoplankton samples. However, the updated AEMP study design will result in collecting sufficient data on water quality and eutrophication indicators to evaluate potential cumulative effects related to the Dominion Diamond Jay Project planned in Lac du Sauvage, for the following reasons: Annual water quality sampling (including nutrients and chlorophyll a) will continue at Station LDS-4. Four stations in the MF2-FF2 area, extending along a transect form the NF area to an approximately 2 km distance downstream of the Narrows, will be sampled for plankton annually under the updated study design. Phytoplankton samples will also be collected for taxonomy at LDS-1, LDS-2, and LDS-3 in Lac du Sauvage, immediately upstream of the Narrows, during comprehensive years.</td>
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list of eutrophication indicators that are measured on an annual basis at MF, FF2 and LDS-4 locations in addition to nearfield locations." The Board noted that DDMI has already committed to including this annually at all MF stations in response to a Board Directive which requires: "DDMI is to incorporate annual sampling for plankton variables at the MF stations as part of its updates to the AEMP Design that are to be submitted along with the 2014 to 2016 Aquatic Effects Re-evaluation Report" (WLWB 2017a). The Proponent response was that "Recommendations relating to changes to the AEMP sampling design or analytical methods is outside the scope of the Annual Report and should be addressed during the next update to the AEMP Design." Despite that statement, DDMI (DDMI/Golder 2018a, Table 1-1) notes that the recommendation pertains to "Plankton" and the specific Proponent response in the AEMP design plan is presented in Plankton - Section 7.7 therein. However, DDMI (DDMI/Golder 2018a) also states that "The 2014 to 2016 Aquatic Effects Re-evaluation Report has been prepared under Water Licence W2015L2-0001 and AEMP Study Design Version 3.5." Because a recommendation to augment sampling made in 2017 cannot be implemented retroactively, this recommendation will only appear in subsequent AEMPs and a revision to the AEMP design. DDMI (DDMI/Golder 2018b, Table 8-1) points to AEMP Design Plan Version 4.1 for a response to this recommendation. There is no discussion of phytoplankton taxonomy in AEMP Design Plan Version 4.1. DDMI (DDMI/Golder 2018b, §4.6.2) does state that "sampling in the NF and MF areas of Lac de Gras will occur on an annual basis" but there is no discussion regarding ENR’s comment, despite a commitment to do so (WLWB, 2017b, Comment Summary ID #18).

**Recommendation 1** As the WLWB (2017a) directive to address ENR’s comment was not addressed in the document indicated by Golder (DDMI/Golder 2018a Table 8-1), ENR recommends that DDMI should address the WLWB (2017a) directive with respect to conducting phytoplankton taxonomy at the FF2 and LDS-4 locations. It is acknowledged that DDMI is now evaluating phytoplankton taxonomy at midfield locations.

### 3 Topic 3: Capturing Slimy Sculpin

**Comment** ENR has previously provided comments regarding sampling for slimy sculpin: "DDMI suggests that very few young of year (YOY) were captured possibly due to their size being too small to be captured and from the presence of slimy sculpin in a range of sizes in the exposure areas, similar reproductive success is likely across sites. ENR notes that few captured YOY may also be an indicator for poor reproductive success. The presence of a range of sizes at the exposure areas does not necessarily indicate successful reproduction.

**Aug 14:** The concordance Table reference will be updated to 14.2.2.1 in the revised version of the report, which is the correct section reference to where alternative methods to examine reproductive success are discussed within the report. DDMI interpreted ENR’s comments to review alternative methods to examine reproductive success to mean statistical methods, not field methods, given that alternative field methods were extensively examined in the early years of developing the Slimy Sculpin fish.
and is insufficient rationale to dismiss the absence of YOY. Recommendation 1) ENR recommends DDMI consider reviewing the methods used to determine reproductive success and consider additional methods such as minnow traps or jar traps in future AEMPs that have been successfully deployed to capture YOY (Arciszewski et al. 2010)". DDMI's response is noted in the Board 2017 reasons for decision, where Section 3.1.3, 2h states: "DDMI has stated that alternative methods to examine reproductive success of Slimy Sculpin will be reviewed and considered (Responses to EMAB comment 80; GNWT-ENR comment 29)" (WLWB, 2017a Section 3.1.3, 2 j). DDMI (DDMI/Golder 2018a, Table 1-1) notes that the recommendation is addressed in Section 13.4, therein. ENR notes that the section 13.4 noted in the concordance table (Golder 2018a, Table 1-1) does not exist in the report. However, DDMI (DDMI/Golder 2018a Section 9.2.1.2.2) states that individual ages "could not be determined with sufficient accuracy" citing CRI (2014). DDMI (DDMI/Golder 2018a Section 9.2.1.2.3) discusses a procedure to classify fish by ages using a variety of methods. DDMI (DDMI/Golder 2018a, Section 14.2.2.3, Population Structure) recommends removing Reproductive Investment - Age-1+ Abundance as a weight of evidence endpoint due to the difficulties in capturing the smallest size classes (e.g., fishing gear bias). DDMI (DDMI/Golder 2018a Section 14.2.2.1) discusses a small addition to the field program that comprises random field sampling within an area to better understand effects on abundance (catch per unit effort) and overall reproductive success. DDMI (Golder 2018a) notes that "There are limitations inherent in the use of any type of fish gear, however, and for electrofishing small fish in boulder-cobble lake habitat, it is likely the smallest size of fish (i.e., YOY and short juveniles) will still be under-represented by this sampling method." This leads to the recommendation that smaller size classes be examined for presence / absence but not used in the weight of evidence approach. It is not clear whether the within-area random sampling area will be conducted. The review of alternative methods recommended by ENR does not appear to have been conducted.

**Recommendation 1)** DDMI should conduct a review of methods to capture young of the year and discuss any potential biases induced by specific methodologies. The outcome will determine whether young of year size classes will be used in the weight of evidence.

**Aug 14**: Table 1-1 in the 14 March, 2018 submission references the correct section (5.3.8) for this topic. Additional topics covered in the comments for this recommendation are addressed under the individual recommendations below.
consideration to include a discussion of observed phosphorus concentrations and how they relate to the phosphorus management framework. DDMI (Golder 2018a, Table 1-1) points to the Eutrophication Indicators section and Section 5.2.8 for the response to this directive. ENR notes that this appears to be a typographical error, and this topic is discussed by DDMI (DDMI/Golder 2018a, §5.3.8.3) and summarized in section 5.3.8 entitled "Inclusion of Phosphorus Concentration in the Response Framework". DDMI presents three arguments. 1. DDMI (Golder 2018a, Section 5.3.8.3) states: "Chlorophyll a concentration has proven to be a simple and robust indicator of the biological response to nutrient additions to Lac de Gras. It is a more reliable indicator of trophic status than TP, which is an exposure variable rather than a response variable". This statement, with the exception of total phosphorous being an exposure variable, is comprised of a series of subjective assertions. What can be said objectively about chlorophyll a in Lac de Gras is that: . it exhibits a general gradient in response with increasing distance from the Mine (Golder 2016, Appendix XIII, Figure 3-19; Golder 2017, Appendix XIII, Figure 3-19); . it is weakly correlated with total P (DDMI/Golder, 2018a Section 5.3.5.3); . it is moderately to strongly correlated with total N (DDMI/Golder, 2018a Section 5.3.5.3); . it is moderately to strongly correlated with total dissolved solids (DDMI/Golder, 2018a Section 5.3.5.3); and, . it is poorly correlated with N:P ratios (DDMI/Golder, 2018a Section 5.3.5.3). When nutrients are limited it is assumed that addition of nutrients leads to increases in phytoplankton biomass. Chlorophyll a as a surrogate measure of phytoplankton biomass should also increase with phytoplankton biomass. As stated by Golder (2011) "An evaluation of the relationship between chlorophyll a and phytoplankton biomass provides an understanding of the utility of chlorophyll a as a phytoplankton biomass indicator". That relationship is weak when evaluating the relationship by sampling area (Golder 2011, Figure 3.4-41; DDMI/Golder 2018a, Figure 5-35) but is "moderate to strong" when evaluating the relationship by year rather than sampling area (DDMI/Golder, 2018a Section 5.3.5.1). Other authors discuss the limited correspondence between chlorophyll a and phytoplankton biovolume (Dolan et al. 1978; Felip and Catalan, 2000) or biomass (El-Shaarawi and Munawar, 1978; Jónasson et al. 1992). 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 of the chlorophyll a
concentration to biomass ratio with changes in trophic status, with size of organism and with temporal changes in phytoplankton taxonomic composition. The overall message is that the utility of chlorophyll a as a phytoplankton biomass indicator, which is arguably the most appropriate biological measurement to nutrient enrichment, is subject to debate. The first argument includes a statement that chlorophyll a is "a sensitive and robust measure of biological response to nutrient inputs from the Mine". Sensitivity is a relative term and reflects the relative degree of change in a biological response to nutrient inputs. The only contextual comment regarding chlorophyll a appearing by DDMI (DDMI/Golder 2018a, Section 5.3.6) states: "the plankton component results generally support the conclusions of the eutrophication indicators analysis". A discussion of whether chlorophyll a is more (or less) sensitive than say phytoplankton biomass was not found. Robustness is defined as a change that occurs only in association with changes in nutrient input. That is changes in chlorophyll a are only attributable to nutrients. Aside from nutrient concentrations, chlorophyll a is known to vary with community structure (El-Shaarawi and Munawar, 1978). In a review of community structure, DDMI (DDMI/Golder 2018a, Section 7.3.2.1.5) states: "The phytoplankton multidimensional scaling results indicate that changes over time in phytoplankton community structure have been occurring in the near field area of Lac de Gras, especially between 2003 to 2007, and that conditions in 2016 differed from conditions in 2013 throughout the lake, but the near field and far field areas in these two years were more similar than observed in previous years". It is not clear to what extent changes in chlorophyll a reflect changes in the community rather than a general biological response to nutrient addition. The conclusion that chlorophyll a is "a sensitive and robust measure of biological response to nutrient inputs from the Mine" does not appear to be supported. The last idea in the first argument above is that that chlorophyll a is a response variable rather than an exposure variable which is correct inasmuch as chlorophyll a solely reflects nutrient exposure. This is in fact not an argument for excluding exposure variables because CCME (2016), in a discussion of types of variables relevant for nutrient guideline development, states unequivocally: "Nutrient concentrations are the most practical variables for nutrient guidelines as they can be managed directly." The second argument presented by DDMI (Golder 2018a) regarding inclusion of P as an action level is: 2. "Increases in TP in Lac de Gras have been small and sporadic, without strong spatial trends, while clear increases in chlorophyll a concentrations have been observed in the NF and MF
areas, indicating a gradient-type response to nutrient addition. "Golder (2018a, Section 5.3.8.3) Although strong spatial gradients in total P are not apparent, Appendix XIII and Figure 3-8 (Golder 2016); and Appendix XIII and Figure 3-18 (Golder 2017) show evidence of higher total P concentrations within 10 km of the diffuser versus further sites. The absence of strong and distinct spatial gradients may be due to the uptake of nutrients noted by Golder (2011) who state: "Increases in chlorophyll a concentrations over time may be limited by nutrient availability, as inorganic phosphorus and nitrogen are essentially depleted at some stations by the end of the growing season". Finally, ENR notes that "annual loads of total phosphorous from the North Inlet Water Treatment Plant have increased between 2002 and 2016" (Golder 2018a, Section 5.5) suggesting that managing total P may be or become necessary. The third argument presented by DDMI (Golder 2018a) regarding inclusion of P as an action level is: 3. "The Significance Threshold is recommended to continue to be based on biological response (chlorophyll a), rather than nutrient concentrations. The Response Framework "builds up" to the Significance Threshold and, therefore, must be based on a matching variable, which is chlorophyll a". The first idea is a recommendation and not an argument regarding use of P as an action level and is therefore not discussed in this section. The second idea is that "the Response Framework "builds up" to the Significance Threshold" and therefore must be based on a matching variable is correct. But that argument does not preclude the use of additional significance thresholds such as the original 1999 significance threshold for eutrophication that pertains to total P. Since that time (1999), scientific knowledge has evolved and guidance on managing nutrients to limit eutrophication have been published (CCME 2004, 2006, 2016; Environment Canada 2004, US EPA 2015). ENR's opinion, after consideration of the above points presented by DDMI (DDMI/Golder 2018a) regarding inclusion of total P as an Action Level is that total P should be included as an action level. Specific rationale include: 1. Trophic status is a multi-faceted concept. This multifaceted nature is reflected in definition of trophic status by authorities that use several indicators to define trophic status, e.g. Vollenweider (1968) and Section 5.2.3.5 (DDMI/Golder 2018a) which uses total P to estimate the trophic state index following Carlson (1977); OECD (1982); Clark and Hutchinson (1992); CCME (2004) and US EPA (2015). 2. The weak relationship between total P and chlorophyll a in Lac de Gras and in general (Zajdlik 2017, Section 2.4.2), suggests chlorophyll a should not be used as a surrogate for total P in defining trophic status. 3. The utility of chlorophyll a in indicating an unequivocal eutrophication
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<td>5</td>
<td>None</td>
<td>Recommendation 1) ENR recommends that DDMI should correct the reference to section 5.2.8 in Golder (DDMI/2018a, Table 1-1) as that section does not exist.</td>
<td>Aug 14: The model predictions are provided as figures for each biological variable. While Golder agrees that the coefficient estimates supplement these visual outputs, the provision of the tables would essentially duplicate the provided information. The visualized predictions (predicted means with their associated 95% CIs) allow for an easy identification of differences in temporal trends between transects (i.e., the area:year interaction).</td>
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<td>None</td>
<td>Recommendation 2) ENR recommends that it would be helpful by DDMI to see the estimated model coefficients and Wald statistics for the models presented in Golder (DDMI/2018a, Table 5-16) to understand the area: year interaction terms. Those terms define the spatio-temporal variability of the biological indicator variables.</td>
<td>Aug 14: Although changes in community composition will occur in Lac de Gras in response to nutrient inputs, the key endpoint for evaluating biological effects related to nutrient inputs is phytoplankton biomass, for which chlorophyll a is used as an indicator variable. Chlorophyll a is moderately to strongly related to phytoplankton biomass in Lac de Gras and is commonly used to classify trophic status of lakes. Therefore, it represents a reasonable indicator for use as the basis of the Action Level criterion for eutrophication indicators.</td>
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<td>7</td>
<td>None</td>
<td>Recommendation 3) ENR recommends that DDMI should assess how chlorophyll a is driven by the demonstrated changes in community composition in order to demonstrate the robustness of chlorophyll a as the sole criterion for eutrophication related action levels.</td>
<td>Aug 14: DDMI has demonstrated (Golder 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017) that chlorophyll a is a sensitive and robust variable for tracking eutrophication in Lac de Gras. Chlorophyll a is directly tied to trophic status, while phytoplankton biomass is not; this is desirable, because protecting trophic status is important to manage effects in Lac de Gras by the AEMP Response Framework. In addition, total phytoplankton biomass is highly variable among stations and is subject to taxonomy-related (subsampling) variation, whereas chlorophyll a can be directly measured and is more consistent among stations. Community level biological indicators (i.e., phytoplankton and zooplankton biomass) are typically subject to large spatial and temporal variability due to habitat variation and clumped spatial distribution, which may be further increased by variation introduced during field sampling and laboratory analysis. Zooplankton are secondary producers and do not directly respond to changes in nutrient concentrations. Zooplankton biomass is highly variable both spatially and vertically. As well, zooplankton did not respond when other biological indicators (i.e., chlorophyll a and phytoplankton biomass) did.</td>
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<td>Recommendation 4) In combination with the preceding recommendation, ENR recommends that DDMI should demonstrate the sensitivity of chlorophyll a relative to other biological responses to eutrophication in order to demonstrate the sensitivity of chlorophyll a as the sole criterion for eutrophication related action levels.</td>
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**Recommendation 5** ENR recommends that DDMI should discuss why the relationship between chlorophyll a and phytoplankton biomass by area is "weak" but the relationship between chlorophyll a and phytoplankton biomass by year is "moderate to strong".

**Aug 14**: The relationship between chlorophyll a and phytoplankton biomass by area is "weak" compared to the relationship between chlorophyll a and phytoplankton biomass by year, which is "moderate to strong", because there is more data (larger sample size) included in the "by year" correlation, and there is a greater range in the data values when data for all years/areas are included in the correlation.

**Recommendation 6** ENR recommends that DDMI adopt Total Phosphorous as an Action Level.

**Aug 14**: Given the information presented in the 2014 to 2016 Aquatic Effects Re-evaluation Report (Section 5.3.8), DDMI has demonstrated that developing a total phosphorus Action Level is inappropriate. Chlorophyll a has proven to be a simple and robust response variable, and is a more reliable indicator of trophic status than TP. TP changes in Lac de Gras have been small and sporadic, without strong spatial trends (Table 5-7). Therefore, use of chlorophyll a in the response framework provides a more appropriate and conservative approach for managing Mine-related eutrophication effects in Lac de Gras, rendering a TP Action Level unnecessary.

**Comment** In ENR's previous recommendations on DDMI's 2014 AEMP Annual Report, ENR recommended that the eutrophication significance threshold for each of the three eutrophication-related metrics should be as follows: 1. The mean of the five Farfield A depth integrated chlorophyll a concentration does not exceed 4.5 µg/L; or, 2. The mean of the five Farfield A total P concentrations does not exceed 10 µg/L; or, 3. The mean of the five Farfield A total N concentrations does not exceed 700 µg/L. DDMI (DDMI/Golder 2018a, Table 1-1) points to Golder (2018a, Section 5.3.8) for a response to these recommendations. The response to the first significance threshold appears in Section 5.3.8.5. It is agreed that the concentration was chosen to protect the oligotrophic status of Lac de Gras, the mean is lower than the maximum used in the current threshold and that the "suggested threshold represents a departure from the definition of significance by the Comprehensive Study Report (Government of Canada 1999), which is based on a high effect magnitude as defined in the EA (i.e., benchmark+20%)". However, as noted by DDMI (DDMI/Golder 2018a, Section 5.3.8.5) "it (the proposed significance threshold) would be expected to be triggered at about the same level of effect as the current Significance Threshold". This is due to the offsetting effect of using a mean without the addition of a 20% buffer. There does not appear to be significant disagreement. The response to the second significance threshold appears in Section 5.3.8.5. DDMI is correct in asserting that total P and biological responses are only poorly correlated. It is that

**Aug 14**: The quoted statements do not contradict one another. The first statement points to TP and TDS being the most likely key drivers of phytoplankton biomass, while the second statement discusses the fact that TN and TDS are strongly correlated (i.e., although TN is correlated with TDS, other evidence suggests that TN is less likely to be a driver for primary productivity than TDS or TP in Lac de Gras).
poor correlation and the idea that assessing trophic status is multifaceted (Vollenweider, 1968; Carlson, 1977; OECD, 1982; Clark and Hutchinson, 1992; CCME, 2004; Dodds, 2007; US EPA 2015) that suggests that reliance on a single measure of trophic status is imprudent. In a review of 29 methods to measure trophic status Lambou et al. (1983) concluded that "Most methods were much more effective in ranking the lakes against the total phosphorus standard than the chlorophyll a standard" suggesting that total P (at least on a weight of evidence basis) is a more important variable in defining trophic status than chlorophyll a. DDMI is also correct that total P is an exposure variable. It is for that reason that total P should be managed. CCME (2016) in a discussion of types of variables relevant for nutrient guideline development states unequivocally: "Nutrient concentrations are the most practical variables for nutrient guidelines as they can be managed directly. Disagreement remains regarding how to manage potential project effects. DDMI asserts that the response to nutrient enrichment should be managed whereas CCME (2016) states that nutrients should be managed. The second point of disagreement is that chlorophyll a is "a sensitive and robust measure of biological response to nutrient inputs from the Mine" Golder (2018a, Section 5.3.8.5) is discussed in Section 7 of Dr. Zadjlik's memo. Limitations of chlorophyll a as a biological response to nutrient inputs are: 1. Chlorophyll a is only weakly correlated with phytoplankton biomass / biovolume (which is likely a more meaningful biological response to nutrient input than chlorophyll a (Carlson, 1984). 2. Chlorophyll a is only one facet of the multifaceted trophic status concept 3. Chlorophyll a has not been demonstrated to either a sensitive or robust measure of biological response to nutrient inputs from the Mine. The response to the third significance threshold appears in Section 5.3.8.5. DDMI (DDMI/Golder 2018a, Section 5.3.8.5) states: "Despite poor relationships observed with phytoplankton biomass, total phosphorous or micronutrients associated with increased total dissolved solids (Section 5.3.5) are the most likely key drivers of phytoplankton biomass in Lac de Gras." This contrasts with the statement: "In addition, the strong correlations between total dissolved solids and total nitrogen suggest that biological effects related to total nitrogen or components of between total dissolved solids (i.e., micronutrients) may not be separated by a correlational approach" (DDMI/Golder 2018a, Section 5.3.5.2). The inability to disentangle the effects of total nitrogen and total dissolved solid using correlation is the correct conclusion. The second point made by Golder (2018a) with respect to a Significance Threshold for total N is that "there is a high level of uncertainty
around a definitive and appropriate trophic threshold for N”. There is little question that an appropriate threshold is the oligotrophic - mesotrophic boundary as is used for chlorophyll a. What remains of the argument is that there is a high level of uncertainty regarding that boundary. There is considerable uncertainty in the oligotrophic - mesotrophic boundary for chlorophyll a concentrations. Golder (2014, Table 5.4-2) shows that the factor between the range of maximum oligotrophic and minimum mesotrophic boundaries is 3.2. As presented in Section 5.3.8.5, the worst-case scenario for total nitrogen averages results in a factor of 5.3 (=1,630/310). Another way of quantifying uncertainty is to estimate the coefficient of variation. Using Wetzel (2001) who references Vollenweider (1979), the boundary conditions of total N for oligotrophic lakes is a mean of 661 µg/L, with a range of 307 to 1,630 µg/L, and Nürnberg (1996, cited in Smith, 2009) has the oligotrophic boundary total N as <350 µg/L.

Jones and Knowlton (1993) present a total N oligotrophic - mesotrophic boundary for lakes of 300 µg total N/L. Using the mean of 661 µg/L and the Nürnberg (1996) and Jones and Knowlton (1993) recommended boundaries. The coefficient of variation among the three boundary conditions is less than a modest 45%. DDMI dealt with the uncertainty in the chlorophyll a boundary values by using the average of the average of maximum chlorophyll a concentrations for oligotrophic waters and the average of minimum chlorophyll a concentrations for mesotrophic waters (Golder, 2014). A similar approach could be used for total N. Carlson (1996) discusses the use of an N index in addition to a P index and "suggests that a nitrogen index value might be a more universally applicable nutrient index than a phosphorus index". The recommendation to use total N as an eutrophication limit/trigger follows recent initiatives in Alberta (ESRD, 2014) and ongoing efforts across the United States (US EPA, 2015, 2016). US EPA (2015) discusses reasons why total N should be part of a dual criterion (the other criterion is total P) for preventing eutrophication. These reasons are summarized herein; readers are encouraged to read the paper for details and supporting scientific literature. - trophic status can vary both spatially and temporally; - a single element nutrient limitation hypothesis ignores variation in nutritional needs; - N fixation does not fully offset N deficiency; - N loads can serve as sources further downstream; and, - controlling only P may not effectively prevent the occurrence of harmful algal blooms in freshwaters. Finally, the recommendation to manage total N is consistent with the CCME (2016) recommendation to manage nutrient concentrations as opposed to response variables.

**Recommendation 1)** ENR recommends that DDMI should reconcile
the two contrasting statements: o “Despite poor relationships observed with phytoplankton biomass, total phosphorous or micronutrients associated with increased total dissolved solids (Section 5.3.5) are the most likely key drivers of phytoplankton biomass in Lac de Gras” Golder (2018a, Section 5.3.8.5). o “In addition, the strong correlations between total dissolved solids and total nitrogen suggest that biological effects related to TN or components of TDS (i.e., micronutrients) may not be separated by a correlational approach” Golder (2018a, Section 5.3.5.2).

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<td>11</td>
<td>None</td>
<td>2) ENR recommends that DDMI should conduct a literature review for total N conditions defining the oligotrophic – mesotrophic boundary and using the same methodology used for chlorophyll a (Golder, 2014), estimate a total N eutrophication limit.</td>
<td><strong>Aug 14:</strong> DDMI has reviewed the literature on trophic classifications based on P and N. The N threshold for a transition from an oligotrophic lake to a mesotrophic lake is wide, with no clear cut-off. For example, the Wetzel (2001) oligotrophic range is 0.307 to 1.630 mg/L, the mesotrophic range is 0.361 to 1.387 mg/L, and the eutrophic range is 0.393 to 6.100 mg/L. There are large overlaps among these ranges, as illustrated by the overlap between the oligotrophic and eutrophic ranges which span a large range in primary productivity. The method used for estimating the mesotrophic boundary was reasonable for chlorophyll a, which has a limited range among sources (3 fold difference and 3 to 8 µg/L range) for the upper limit of oligotrophic. The large range for TN is problematic for the determination of a single threshold value, especially when a single source (Wetzel 2001) reports a &gt;5 fold range for oligotrophic status. Wetzel RG. 2001. Limnology, Lake and River Ecosystems. Third Ed. Academic Press, New York, NY.</td>
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<td>12</td>
<td>None</td>
<td>3) The recommendation to use total N as an eutrophication limit/trigger follows recent initiatives in Alberta (ESRD, 2014) and ongoing efforts across the United States (US EPA, 2015, 2016). US EPA (2015) discusses reasons why total N should be part of a dual criterion (the other criterion is total P). ENR recommends that DDMI should discuss reasons for their disagreement with these authorities.</td>
<td><strong>Aug 14:</strong> DDMI agrees that eutrophication management could consider both N and P, if monitoring results suggests that such an approach is warranted. Through a decade monitoring of eutrophication indicators in Lac de Gras under the AEMP, DDMI has demonstrated that the current approach is working and provides sufficient information to allow tracking and management of nutrient-related effects in Lac de Gras. The US EPA suggests the dual criterion because of the highly variable nature of nutrient limitation in aquatic ecosystems and the different nutritional needs of aquatic flora and fauna; however, if the limiting nutrient is clearly identified, which is the case in Lac de Gras, which shows clear P-limitation, then P management is a reasonable approach to eutrophication management. Both the US EPA (2015) and Alberta (ESRD 2014) initiatives are based on waterbodies in temperate regions representing a wide range of chemical and biological conditions (neither consider subarctic lakes); therefore, by necessity, they need to cover a greater range of potential nutrient limitation scenarios.</td>
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<td><strong>Topic 6: Role of Nitrogen in Explaining Changes in Chlorophyll a</strong></td>
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<td><strong>Comment</strong></td>
<td>The WLWB (2016b, Directive 2 A) states that: &quot;With regards to the 2014 to 2016 Aquatic Effects Re-evaluation Report, the Board has decided that DDMI is to consider a more explicit analysis of the role of nitrogen in explaining variation and the spatial extent of chlorophyll a effects.&quot; DDMI (DDMI/Golder 2018a, Table 1-1) points to the Eutrophication Indicator in Section 5.3.3, 5.3.5 and Plankton Section 7. However, Section 5.3.3 discusses effects of dike deposition and dike construction and not chlorophyll a or nitrogen. Section 5.3.5.3 discusses the relationship between nutrients and chlorophyll a concentrations. The relationship is assessed by tabulating the year-specific Pearson product moment correlations between chlorophyll a and total N. Section 5.3.5.3 summarizes the correlations stating: &quot;The relationship between concentrations of chlorophyll a and TN was moderate to strong, ranging between r = 0.52 and 0.92 between 2007 and 2013, while in 2016 the relationship was poor (r &lt;0.2) (Figure 5-38; Table 5-22)&quot;. The &quot;role of nitrogen in explaining the spatial extent of chlorophyll a effect&quot; does not appear to be discussed explicitly.</td>
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<td><strong>Recommendation</strong></td>
<td>1) ENR recommends that DDMI should correct the cross-reference where Table 1-1 (DDMI/Golder 2018a) incorrectly points to Eutrophication Indicator Section 5.3.3 for a discussion of the role of nitrogen in chlorophyll a spatial extent.</td>
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<td><strong>Aug 14:</strong></td>
<td>No change needed. Table 1-1 correctly points to Section 5.3.5 which examines the relationship between biological variables and nutrient variables. Within Section 5.3.5, the relationship between nutrients and chlorophyll a concentrations can be found in sub-section 5.3.5.3.</td>
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<tr>
<th>14</th>
<th>None</th>
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<tr>
<td><strong>Comment</strong></td>
<td>None</td>
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<tr>
<td><strong>Recommendation</strong></td>
<td>2) ENR recommends that DDMI should follow the spatial extent portion of the WLWB (2016b, Directive 2) to &quot;consider a more explicit analysis of the role of nitrogen in explaining variation and the spatial extent of chlorophyll a effects.&quot; That is, DDMI should consider the role of nitrogen in the spatial extent of chlorophyll a effects.</td>
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<tr>
<td><strong>Aug 14:</strong></td>
<td>DDMI explored the role of nitrogen in explaining variation in chlorophyll a concentrations in Section 5.3.5.3. It was also shown that N and TDS effects could not be separated and the moderate to strong relationships between TN and chlorophyll a concentrations, and TN and phytoplankton biomass, may be the result of the strong correlation between TN and TDS. Since N and TDS effects cannot be separated (i.e., N analysis is confounded by TDS and vice versa), the use of chlorophyll a, which is a response variable that incorporates the effects of all nutrients (TP, TN, micronutrients associated with TDS), is the most robust approach to monitoring Mine-related eutrophication effects.</td>
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<th>15</th>
<th><strong>Topic 7: AEMP Response Plan Action Levels</strong></th>
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<tr>
<td><strong>Comment</strong></td>
<td>The WLWB (2018, Directive 3) states: &quot;DDMI is to address GNWT-ENR recommendations 10 and 11, with regards to changes to Action Levels for effluent and water chemistry, as part of the 2014 to 2016 Aquatic Effects Re-evaluation Report.&quot; The first GNWT ENR recommendation states: &quot;1) ENR recommends the increasing temporal trends in the mixing zone, nearfield and midfield 1 and midfield 2 should trigger an early warning level or Action Level 1. A temporal trend that will lead to the predicted mean exceeding two times the reference condition median within 3 years should trigger Action Level. The recommended Action Level additional criteria</td>
</tr>
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<td><strong>Aug 14:</strong></td>
<td>The section reference given in Table 1-1 (Section 13.2) is incorrect. The WLWB 2018, Directive 3 (&quot;DDMI is to address GNWT-ENR recommendations 10 and 11, with regards to changes to Action Levels for effluent and water chemistry, as part of the 2014 to 2016 Aquatic Effects Re-evaluation Report.&quot;) is addressed in Section 14.3 of the 2014 to 2016 Aquatic Effects Re-evaluation Report. This will be updated in the revised version of the report.</td>
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</table>
should be linked to existing criteria with the logical operator "OR". The second GNWT ENR recommendation states: "ENR recommends the Action Level 2 criterion used in the DDMI AEMP Design 3.5 should be used and the suggestion made by EMAB (Environmental Monitoring and Advisory Board) to modify Action Level 1 to specify EITHER an exceedance of 2 x the median reference condition OR an exceedance of the normal range of reference conditions should be investigated by DDMI using the last three years of AEMP data and the results should be submitted for public review". DDMI (DDMI/Golder 2018a, Table 1-1) points to (Golder 2018a) Effluent and Water Quality Section 13.2 for a response to these directives. Section 13.2 does not exist. The section entitled "Effluent and Water Quality" was examined for a discussion of inclusion of temporal trends as an action level and sequential action level assessment. The following locations were searched with outcomes as described. . Golder (2018a, Table 4-6) which presents Action Levels does not include such a discussion. . Golder (2018a, Section 4.2.4.2.2) which discusses temporal trends does not link trends with Action Levels. . Golder (2018a, Section 4.3.2.1) presents temporal trend results for water quality. . Golder (2018a, Section 4.3.2.2.1) discusses Action Levels without reference to temporal trends. . Golder (2018a, Table 4-27) summarizes trends in water quality Substances of Interest but does not link trends with Action Levels. It is not clear whether WLWB (2018, Directive 3) stating: "DDMI is to address GNWT-ENR recommendations 10 and 11, with regards to changes to Action Levels for effluent and water chemistry, as part of the 2014 to 2016 Aquatic Effects Re-evaluation Report" was addressed, as the specific location referred to in Golder (2018a, Table 1-1) does not exist and the general location referred to in Golder (2018a, Table 1-1) does not appear to discuss the topics.

**Recommendation 1)** ENR recommends that DDMI address WLWB (2018, Directive 3) with respect to addressing GNWT-ENR recommendations 10 and 11.

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**16 Topic 8: Figure 5-41**

**Comment** DDMI (DDMI/Golder 2018a, Figure 5-41) presents Carlson trophic status index ratios on a bivariate plot. Ratios for each location in Lac de Gras within a year are plotted using the same colour. Given that spatial patterns in some of these indices have been observed, DDMI should improve this useful graphic by the use of symbols representing at least some of the 8 areas. Certainly, the NF and MF locations at least could be identified to aid in interpretation.

**Recommendation 1)** ENR recommends that DDMI should improve Figure 5-41 by the use of symbols representing at least some of the 8 areas. Additionally, DDMI should use a colour gradient for years improving the ability to detect temporal changes.

**Aug 14:** Figures 5-41 presents the Carlson trophic index ratios by year and Figure 5-42 presents it by area. Including this information onto one plot makes interpretation of the plot difficult and makes the presentation of the plot confusing. The key information can be read from these plots as they are presented.
<table>
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<tr>
<th>Topic</th>
<th>Comment</th>
<th>Recommendation</th>
<th>Aug 14</th>
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<tr>
<td>9</td>
<td>Logistic regression is correctly used to deal with censored data. A limitation of logistic regression is that due to the binary nature of the dependent variable, the magnitude of detectable concentration changes is not used. DDMI should consider the use of multinomial models, possibly using baseline upper percentiles such as the 90th as an additional cut-point for detectable concentrations. This may improve the ability of the logistic regression models (notably for nutrients) to detect change.</td>
<td><strong>Recommendation</strong> 1) ENR recommends that DDMI should consider the use of multinomial models, possibly using baseline upper percentiles such as the 90th as an additional cut-point for detectable concentrations.</td>
<td><strong>This approach will be considered for future AEMP work.</strong> At the time the 2014 to 2016 Aquatic Effects Re-evaluation Report was prepared, it was deemed that logistic regression was the more robust approach, considering the sample size and distribution of data. As more data become available, it will be possible to break down the datasets into several bins using percentiles, as suggested in the comment.</td>
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<td>10</td>
<td>Golder (2018a, Section 9.2.1.3.8) refers to Appendix A, but this appendix does not exist in Golder (2018a).</td>
<td><strong>Recommendation</strong> 1) ENR recommends that DDMI should clarify this reference.</td>
<td><strong>Acknowledged and will be corrected.</strong></td>
</tr>
<tr>
<td>11</td>
<td>ENR notes that section 5.2.3 (Golder 2018a) subsections are duplicated.</td>
<td><strong>Recommendation</strong> 1) DDMI should correct these duplications.</td>
<td><strong>Acknowledged and will be corrected.</strong></td>
</tr>
<tr>
<td>12</td>
<td>The caption for Figure 7-15 (Golder, 2018a) entitled &quot;Metric Multidimensional Scaling of Phytoplankton in the Near-field and Far-field&quot; is incomplete and should be corrected as this graphic likely pertains to phytoplankton biomass.</td>
<td><strong>Recommendation</strong> 1) ENR recommends DDMI correct the figure title.</td>
<td><strong>Acknowledged and will be corrected.</strong></td>
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<td>1) ENR notes that the above references are provided in support of ENR comments.</td>
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<tr>
<td>AEMP 3 Year Re-Evaluation</td>
<td><strong>Recommendation</strong> 1) ENR notes this attachment is included in support of the submitted comments and recommendations as applicable.</td>
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| 23 | **Comment** GNWT-ENR and ECCC are currently in a process to assess existing Territorial legislation against Federal legislation (i.e. Fisheries Act) in an effort to reach 'equivalency in effect'. Equivalency in effect would stand down the federal statute and regulations. Thus, any requirements of MMER and EEM would not apply in the NWT. Initial meetings have occurred and both Governments are committed to an expedited process to reach such an agreement.  
**Recommendation** 1) ENR recommends that any changes to the AEMP design as a result of the MDMER are not required. Only improvements to the existing design should be considered by the Board if sufficient rational is provided by DDMI. | **Aug 14:** No response required. |
| 24 | **Comment** ENR retained Zajdlik and Associates to provide review and comment of the Diavik Diamond Mines (2012) Inc. (DDMI) Version 5.0 AEMP Design. ENR has extracted and summarized comments and recommendations from this memo and provided them below. ENR has also included Dr. Zajdlik's review memo which provides additional background and context for the comments and recommendations.  
**Recommendation** 1) ENR recommends the Board refer to the attached memo for additional background and context supporting ENRâ€™s comments and recommendations. | **Aug 14:** No response required. |
| 25 | **Comment** ENR notes that the AEMP Design Plan Version 5.0 (the Plan) is considerably different than its predecessor Plan Version 4.1. The most significant change is the change from a gradient comparison design to a reference condition design. The proposed change in design is stated to be due to the cumulative effects of the Ekati and Diavik Mines on water chemistry in the Far Field (FF) A area that precludes the use of FFA as a reference area. Thus, the nearfield (NF) - FF comparisons used previously to assess change can no longer be made for water chemistry. Additionally, some of the key changes from the AEMP Design 4.1 include in this postposed design are:  
- Changed from a near field - far field comparison to a near field - reference condition comparison for biological action levels.  
- Changed number of locations and site locations in the far field.  
- A change in statistical analytical protocols.  
- Biological action levels have been changed. Biological effect sizes for statistical hypothesis testing have been added as have criteria for consecutive differences. ENR is concerned that the changes proposed by DDMI will not result in a stronger AEMP. The new design will impede continuation of analyses over time while not presenting any significant improvements to the... | **Aug 14:** DDMI disagrees with the GNWT-ENR comment, on the basis that the changes to the AEMP study design reflected in Version 5.0 reflect recommendations made by reviewers during previous review cycles of AEMP Annual Reports, and are consistent with the type of effect observed on water quality in Lac de Gras, and with EEM guidance. |
AEMP. Retaining locations that have been monitored since the implementation of AEMP design 2.0 allows for assessing long term changes. ENR notes that following the Board Directed AEMP Cumulative effects meeting (Rio Tinto, 2016) Dominion Diamond Ekati ULC (Dominion) and DDMI espoused the same idea stating: "No operator is suggesting changes to their individual AEMP programs. Data collected through each program must remain consistent to allow continued analysis" (Rio Tinto, 2016). The proposed change in design impairs the ability to conduct the temporal trend analyses conducted in the AEMP re-evaluation since 8 of 15 farfield stations will be lost (see comments below). Although the design proposes adding three sampling locations in the farfield, the intent is to sample along a proposed gradient. Consequently, the stations cannot simultaneously be used to replace stations representing distinct farfield areas. As discussed by Dr. Zajdlik in his attached memo, DDMI (Golder 2018a, Section 1.2.1) states that updates to the AEMP sampling stations to allow gradient analysis as the key method to analyze Mine-related effects. The only statistical analysis that relates to gradients is the breakpoint analysis - and that analysis does not use the farfield locations. Thus, the proposed change is unnecessary at least for this reason. Overall ENR does not believe there is as yet, a compelling scientific or management-based reason to change the sampling design as proposed. Retention of the current design (Version 4.1) with an emphasis on gradient analyses offer the advantages over the proposed change in design that will be further discussed below, and is discussed in greater detail in Dr. Zajdlik’s memo. However, ENR has reviewed the design plan to provide constructive feedback on the design in order to assist DDMI with a resubmittal if direct by the Board to do so.

**Recommendation**

1) ENR recommends that the Board not approve the proposed AEMP design Plan (Version 5.0) by DDMI. ENR encourages DDMI to review the succeeding comments and recommendations and include them in an updated AEMP design Plan for public review.

2) ENR recommends that in the event that DDMI determines that the proposed augmentation of stations in the farfield is valuable, consideration should be given to adding those stations to the current program design (Version 4.1).

*Aug 14:* Filling gaps in the spatial coverage in the FF areas is valuable, because it allows more accurate tracking of the extent of effects in Lac de Gras, which is a key objective of the AEMP. It is not useful to add the new FF stations to Version 4.1, because the last sampling under that version will be done before the WLWB can provide direction. Therefore, it is logical to make changes to Version 5, to be first applied in 2019, following WLWB approval of the redesigned AEMP.
Comment

The previous design plan followed Environment Canada (2012) Environmental Effects monitoring program sampling requirements with five sites within an area. That recommendation was based on an ability to detect biological changes thought to be ecologically significant when using a reference - exposure analysis (not a gradient analysis). It is important to note the emphasis on biological effects rather than changes in water chemistry. The proposed changes in sampling effort are presented below. Table 2: Changes in Sampling Effort in AEMP Design 5.0 (Golder 2018a, Table 3.4-1) versus AEMP Design 4.1 (Golder 2017a, Table 3.4-1) change FF1 FFA FFB removed 3 2 3 added 1 2 remaining stations 3 3 4 Table 2 shows that a net loss of 5 sampling locations or a 33% reduction in the farfield areas A, B and 1 is proposed. The proposal to reduce sampling effort due to a change in experimental design requires the following recommendations discussed herein to be addressed with results to be assessed by reviewers prior to further consideration. The spatial extent of changes in the FF1 area has been investigated for eutrophication metrics by DDMI (Golder, 2018b, Figures 5-1 through 5-5). Prior to accepting the removal of locations FF1-1, FF1-3 and FF1-5 proposed by DDMI (Golder 2018a), the spatial extent of all substances of interest should be presented. An absence of spatio-temporal trends in FF1 that may indicate past, current or future water quality issues would suggest that these locations add little value in assessing potential impacts to water quality and again, in the absence of effects, suggest that some or even all FF1 locations are of little use in evaluating a chemical gradient. The Plan also proposes to remove three FFB locations and two FFA locations while adding two FFB locations (FFB-7, FFB-8). A limited comparison of removed versus retained water chemistry locations by exposure area (FFA and FFB) suggests that (as expected) there is no difference among the two groups of stations. However, further information is warranted to confirm the absence of spatial effects.

Recommendation 1) ENR recommends DDMI should provide further discussion on the spatial extent of all substances of interest prior to accepting the removal of locations FF1-1, FF1-3 and FF1-5 as proposed. As part of the discussion, DDMI should produce such maps and make them available to reviewers.

Aug 14: DDMI does not support ENR’s recommendation to produce maps of the spatial extent of all substances of interest in the FF1 area prior to accepting the removal of locations FF1-1, FF1-3 and FF1-5 as proposed. This assessment is based on the following considerations: Under previous versions of the AEMP design plan (Versions 4.1 and earlier), the stations located within each of the three FF area represented individual replicates to be used in statistical comparisons between the NF and FF areas. As such, they were not considered to be exposed to varying amounts of effluent. The proposed changes to the FF area stations under AEMP Design Plan Version 5.0 were made to adjust the sampling design to a gradient design that extended through the FF areas. To accomplish this, the number and locations of stations were adjusted to better delineate the extent of effects in the FF areas of the lake and eliminate redundant stations (i.e., stations that were previously sampled as statistical replicates to be used in the control-impact comparisons). The level of effort required to create maps of the spatial extent of all substances of interest in the FF1 area over multiple sampling events would be substantial. If data from the last two comprehensive sampling events were considered (2013 and 2016), for two sampling seasons (ice-cover and open-water), this would require more than 120 maps to be generated based on the 31 substances of interest identified for the 2014 to 2016 Aquatic Effects Re-evaluation Report. The presence of an effluent exposure gradient in Lac de Gras is well established. It is unclear to DDMI how a detailed analysis of trends in the FF areas would provide additional meaningful information that would substantially improve upon the changes already recommended in AEMP Design Plan Version 5.0.

Comment

None

Recommendation 2) ENR recommends DDMI should conduct comparisons of retained versus proposed deleted locations for all substances of interest in each of the FFA and FFB areas on a year-by-year basis using data from 2012 -2017 inclusive to confirm the absence of spatial effects.

Aug 14: Please see response to comment GNWT -ENR 27. The same rationale applies to not preparing the requested maps for the FFA and FFB areas.
|   | Topic 5: Temporal Trend Analyses | **Comment** | As noted by DDMI, temporal trend analyses are conducted during an AEMP re-evaluation "to summarize AEMP data collected to date in an accessible format and evaluate temporal trends" (Golder, 2018b, Section 2.4.1). Temporal trend analytical methods for data collected under AEMP Design 5.0 are discussed in Section 4.3.4.10 of the Plan (Golder 2018a). Linear mixed effects models are used with the variance among stations in the nearfield and farfield areas being ascribed to random effects. As noted in the Plan (Golder 2018a, Section 4.3.4.10), "The use of random variables will allow for variability in the different data components to be correctly assigned (i.e., to stations within areas, instead of to areas)." The proposed loss of 40% of FFA locations and 60% of FFB locations effectively precludes the meaningful estimation of variance components when conducting temporal trend analyses because the proposed design orders locations along a presumed gradient such that assignment of locations to either of the western farfield areas does not make sense. This will almost certainly result in an inflation of variability for the trend term(s) and a reduction in ability to detect temporal trends. Interpretations that could be affected include water and sediment quality, eutrophication indicators, various phytoplankton, zooplankton and benthic macroinvertebrate metrics. **Recommendation** 1) ENR recommends that DDMI should discuss how locations along a spatial gradient will be used to estimate the within-area variance components described if the proposed design is adopted. | **Aug 14:** Previous AEMP data analyses have shown that variability within each FF area has been low for most variables, reflecting minimal variation due to effluent exposure, and primarily showing background variation, the extent of which has been illustrated through a number of years of monitoring since 2007. Although reducing the number of FF stations may slightly influence the trend analyses run every three years, the proposed changes are appropriate to facilitate an efficient monitoring program by reducing the number of redundant stations in these areas, from the perspective of the gradient analysis. |
|---|---|---|---|
|   | None | **Comment** | None |
|   | None | **Recommendation** 2) ENR recommends that DDMI should discuss how the ability to detect temporal trends in far field areas 1, A and B, will be affected if the proposed design is adopted. | **Aug 14:** The effect of the changes in sampling design in the FF area on the ability to detect temporal trends is expected to be minor, since the within-area variation in the FF is relatively low, as shown by a number of years of monitoring. Therefore, fewer stations in these areas can provide representative data. |
|   | Topic 6: Comprehensive Year Dataset | **Comment** | DDMI (Golder 2018a, Section 4.3.4.10) makes the following statement: "For the Aquatic Effects Re-evaluation Report, time series plots will be generated for each SOI for each season using available data from 1996 to the latest available comprehensive year dataset." It is not clear whether FF1, FFA and FFB data will be "comprehensive" if the proposed AEMP design is implemented as 53% (8/15) of the locations in these areas will no longer be sampled. Furthermore, DDMI (Golder 2018a, Section 4.3.4.10) in reference to the Aquatic Effects Re-evaluation Report states that "Linear mixed models will be used to analyze spatial and temporal trends" and further that "the results will be used to interpret temporal and spatial trends". In these models distance is not included as a random variable but rather distance is implied by the area/station fixed effect. It is not clear |
|   | None | **Aug 14:** The term "comprehensive" follows the AEMP Design Plan's definition of comprehensive sampling every third year, rather than referring to the comprehensive nature of data. Clarification on the use of distance in modeling will be added to the revised version of the report in Section 4.3.4.10. |
| 32 | Topic 7: Gradient Analyses | Comment | Under the current AEMP design (Version 4.1), visual assessments of gradients have been used to identify trends in concentrations of substances of interest along defined spatial gradients in Lac de Gras, delineate the extent of effects and define gradients along transects for eutrophication indicators, assess cumulative effects from the Ekati and Diavik Mines, and identify environmental gradients that may be associated with the phytoplankton community (Golder 2017b, 2018b). DDMI (Golder 2018a, Section 4.3.4.9) states that "the main objective of the spatial gradient analysis will be to evaluate trends in SOI concentrations along the effluent exposure gradients". Segmented regression models that use distance as an explanatory variable are proposed to estimate gradients but only using stations from the midfield. The only difference between AEMP Design 4.1 and 5.0 with respect to gradient analyses is that segmented regression will be used instead of linear regression. The regression analyses in AEMP Design 4.1 and AEMP Design 5.0 use only midfield stations. Consequently, statistical analyses of gradients do not require any changes to the current AEMP design. The multidimensional scaling discussed in the DDMI 2014 to 2016 Aquatic Effects Re-Evaluation Report (Golder 2018b, Section 7.2.3.3) in response to Board directive (WLWB, 2017a) uses historical data to identify environmental gradients that may be associated with the phytoplankton community. It is not clear how samples collected along a gradient would be used to scale data prior to multidimensional scaling due to the arbitrariness in assigning locations to an area. This issue also affects scaling of benthic invertebrate community data (Golder 2018b, Section 8.2.3.3), assessing significance of the Analysis of Similarity R-statistic (Golder 2018b, Section 8.2.3.3) and, estimation of random effects. Recommendation 1) ENR recommends that DDMI should discuss how samples collected along a gradient would be used to scale data prior to multidimensional scaling due to the arbitrariness in assigning locations to an area. | Aug 14: The comment is unclear; the data were not scaled before running MDS. The data are log(x+1) transformed as a pre-treatment for multidimensional scaling to avoid undue bias on the ordination plot (Clarke et al. 2014). |
| 33 | Topic 8: Weight of Evidence | Comment | The weight of evidence approach presented in the 2016 AEMP report (Golder 2017b, Appendix XV, Section 2.3.2.2.1) uses a statistical comparison of NF and FF for the following lines of evidence: . Substances of interest for water quality; . Nutrients; . Substances of potential toxicological concern for sediment quality; . Sculpin tissue chemistry; . Biological productivity (chlorophyll a and | Aug 14: The decision criteria to be used under the AEMP Design Plan Version 5.0 will remain the same as those used in 2016 AEMP Annual Report, with the exception that NF to FF comparisons will be replaced by NF to FF reference dataset (as described in the Reference Conditions Report) comparisons. This change will be |
zooplankton and phytoplankton biomass); benthic community (total invertebrate density, density of dominant invertebrates, richness, Simpson's diversity index, dominance, evenness, Bray-Curtis distance); and, fish population health (energy stores, reproductive investment, tapeworm parasitism). These comparisons follow the previous AEMP design (Golder, 2017a). Although DDMI (Golder 2018a, 4.10-1, 4.10-2) proposes to change some of the measurement endpoints in the lines of evidence presented above, measurement endpoints corresponding to key lines of evidence regarding exposure have remained the same or have been augmented. As examples of decision criteria, DDMI (Golder 2016, Figure 4.10-1) includes examples of "negligible" and "early warning - low" decision criteria that use statistical comparisons of nearfield and farfield measurement endpoints. The "moderate" decision criterion uses an estimate of variability from farfield measurements. DDMI (Golder 2018a, Section 4.10.2.2) refers to decision criteria but does not provide examples to replace the criteria that will no longer be possible under the proposed AEMP Version 5.0 design. DDMI (Golder 2018a, Section 4.10.2.2) states that "The decision criteria used to assign an effect level rating for exposure endpoints and for biological response endpoints will be based on the categories (Action Levels) in Section 5.2". Although Action Levels for water chemistry (Golder, 2018a, Table 5.2-1), sediment quality (Golder, 2018a, Section 5.2.2), and eutrophication indicators (Golder, 2018a, Section 5.2.3), have remained unchanged from AEMP Design 4.1, substantive changes in biological action levels have been proposed.

**Recommendation**

1) ENR recommends that DDMI should provide a set of decision criteria for the weight of evidence approach that can be used under the proposed AEMP (Version 5.0). Note that DDMI (Golder 2018b, Section 8.2.3.5) argues that nearfield – farfield statistical comparisons should be used for evaluating biological Action Level exceedances.

**Aug 14:** Modifications to the biological Action Levels were required because DDMI was directed by the WLWB to address statistical comparisons for Action Levels 1 and 2 for biological components (WLWB 2017). Some of the changes made to Action Levels reflect the key reason for changing the study design: the FF areas are affected by mine effluent and therefore are inappropriate as the basis for evaluating differences from the reference condition. Further, given the recent addition of Diamond Mines to the MDMER, DDMI updated the Action Levels to align with the EEM program. Both the WLWB directive and the addition of diamond mines to the MDMER support the necessity of modifications to the Action Levels.
comparison (historic reference data set versus farfield A) proposed changes to the experimental design are irrelevant to evaluation of Action Level 1 for biological effects. Action Level 2 for biological effects (Golder, 2018a, Table 5.2-4) is similar to Action Level 1 with respect to extent (nearfield) but varies by the addition of a criterion for two consecutive years (plankton) or a criterion that effect sizes defined by Environment Canada (2012) be exceeded (benthic invertebrates and fish metrics). This is a departure from AEMP Design 4.1 (Golder, 2017a) where comparisons use data collected from the midfield and data from farfield A. Again, in light of the changes to the basis for comparison (historic reference data set versus farfield A) proposed changes to the experimental design are irrelevant to evaluation of Action Level 2 for biological effects. Action Level 3 for biological effects (Golder, 2018a, Table 5.2-4) is similar to Action Level 2 with respect to extent (nearfield) but varies by the addition of a criterion for changes to occur consecutively for a period of sampling events (3 for plankton and 2 for benthic invertebrates and fish) and a criterion that measurement endpoints fall below the normal range. Again, commenting only on the implications of the proposed changes in sampling design, the proposed changes to the experimental design are irrelevant to evaluation of Action Level 3 for biological effects. Overall, the proposed changes to the experimental design are irrelevant to evaluation of Action Levels 1 through 3 for biological effects. If Action Levels under AEMP design 4.1 were retained, the proposed changes in experimental design would have adverse consequences with respect to interpretation due to changes in centroids of sampling locations (see discussion in Sections 2.1 and 2.3 of the Zajdlik and Associates memo) and the difficulty of estimating an appropriate variance term.

**Recommendation** 1) ENR recommends DDMI further evaluate and provide additional rationale to support the necessity of modifications to biological action levels in the proposed plan.

**References:** WLWB 2017b. Decision from Wek’éezhii Land and Water Board Meeting of 22 September 2017: Version 4.1 of the AEMP Design Plan. Wek’éezhii Land and Water Board, File W2015L2-0001 (Type "A").
decision making (Golder 2018a, Section 3.5); critical biological effect sizes (Golder 2018a, Section 5.2.4); and, selection of biological effect indicators (Golder 2018a, Section 5.2.4). However, the consistency does not apply to recommended experimental designs when making inferences for action levels. Environment Canada (2012) recommended designs include: 1) Control-impact design (C-I); 2) Multiple control-impact design (MC-I); 3) Before/after control-impact (BACI); 4) Simple gradient (SG) design; 5) Radial gradient (RG) design; 6) Multiple gradient design (MG); and, 7) Reference condition approach (RCA). Although a gradient design is discussed and implemented, the proposed de facto design for assessing biological action levels is most closely related to the Environment Canada (2012) reference condition approach. That approach establishes a reference condition through "an initial standardized sampling program at a wide variety of geographic scales. The same benthic invertebrate community sampling protocol is used in as many ecoregions and stream orders or lakes as are available in a catchment", (Environment Canada, 2012). The intent is to capture the extent of regional variability and using multivariate techniques, determine whether benthic communities from the exposure site(s) are similar to the reference condition. The proposed design uses a reference area (Golder, 2018c) that while not capturing regional variability, likely provides a reasonable estimate of spatial variability in the downstream exposure area of Lac de Gras. This reference condition may not adequately describe natural variability in the eastern end of Lac de Gras which is subject to the influence of discharge from Lac du Sauvage. It is not clear whether temporal scales of variability are adequate because scales vary from 1 to 4 years. Certainly, samples collected in only one year cannot capture temporal variability. More importantly the temporal scales for a variety of reasons, represent on an analyte/measurement endpoint-specific basis, different times. The analyte/measurement endpoint-specific selection process used results in a reference condition representing varying temporal scales with very different levels of sampling effort, particularly if indexed by specific far field area. The de facto experimental design for assessing biological action levels could also loosely be defined as before-after design as the reference condition ostensibly represents the pre-impact condition in Lac de Gras. However, the reference areas are not the exposure areas and hence the comparison is confounded by using areas that may or may not be comparable. Even if this were a true before and after design, such designs are typically not recommended as there is often natural drift in biological communities over time. This is in fact the rationale extent, but does not provide information on magnitude relative to the reference condition, because all AEMP stations in Lac de Gras have now been exposed to the mine effluent. Therefore, the current approach of evaluating biological Action Levels by comparisons to historical FF/reference area data is preferred. The issues ENR identified with the reference data set used for the Action Level evaluation have been considered in the past, at the time of the preparation and regulatory review of the Reference Conditions Report. The reference condition and associated normal ranges represent best estimates based on available data. Although some shallow trends related to exposure to mine effluent have been demonstrated in the FF areas through the period of 2007-2010 (e.g., for major ions, molybdenum, strontium), the magnitudes of increases in concentrations of parameters with trends were negligible in terms of biological effects, and no trends in the biological data are apparent during this period. Therefore, use of historical FF/reference area dataset is considered reasonable for the AEMP Action level evaluation. ENR's concerns related to spatial differences between the reference areas (western Lac de Gras) and the exposure areas (eastern Lac de Gras) are valid, but data to verify potential background differences between these areas are very limited. Historical water quality data suggest no background spatial gradients or at most very slight gradients. Similarly, biological data from the early years of monitoring do not suggest notable gradients across the lake. Normal ranges developed based on the historical FF dataset represent a reasonable fit to exposure area data from the early monitoring years. Therefore, the current approach of using historical reference area data as the basis of the Action Level assessment is considered reasonable.
for the use of consecutive differences in biological measurement endpoints when moving through the biological action level hierarchy (Action Levels 1 through 3). The latter concern led to the recommendation of BACI designs by Environment Canada (2012). Other issues associated with a limited reference condition definition are discussed in Environment Canada (2012). In his analysis of the Plan, Dr. Zajdlik has assessed which one of the Environment Canada (2012) recommended experimental designs for assessing biological action levels would be best suited for the program. As such, Dr. Zadjlik found that the gradient design using the segmented regression models described by DDMI (Golder 2018a, Section 4.3.4.9) to be a strong candidate. Advantages of this method are that: 1) All the issues regarding the reference condition definition are sidestepped. 2) Synoptic data are used avoiding issues with natural changes over time. 3) The issue of confounding for plankton metrics discussed by DDMI (Golder 2018a, Section 4.6.4) is avoided. 4) A consistent data analytical method is used throughout the AEMP. 5) It is likely that the achieved statistical power for detecting trends will be higher than that achieved by a comparison of nearfield data with the reference condition data. A challenge, but possible advantage is that biological effects levels would be expressed in terms of spatial gradients contextualized by critical effect sizes with a reduced emphasis on the reference dataset.

**Recommendation** 1) ENR recommends that given the limitations of the reference dataset discussed in the preceding comment, DDMI should consider using one of the Environment Canada (2012) recommended experimental designs for assessing biological action levels. The gradient design using the segmented regression models described in Golder (2018a, Section 4.3.4.9) is a strong candidate as described in the comment.

**Aug 14:** The biological Action Level 1 comparisons are similar to the EEM design-based statistical comparisons completed to detect biological effects during the AEMP Versions 2 to 4, with the difference being the inclusion of more years of FF area data in the Action Level 1 comparisons. The power of the Action Level 1 comparison is expected to be similar to those achieved by the biological effect comparisons run during previous AEMP versions, which was already documented in the AEMP Study Design Version 2.

**Recommendation** 2) ENR recommends that the statistical power of the proposed biological action level 1 comparison should be estimated by DDMI using data from the latest AEMP cycle to understand the ability of the proposed comparisons to detect change.

**Aug 14:** Please refer to GNWT-36.

**Recommendation** 3) ENR recommends that the statistical power of the current biological action levels comparison should be estimated by DDMI using data from the latest AEMP cycle as a point of reference for the proposed changes to biological action levels.
<table>
<thead>
<tr>
<th>Page</th>
<th>Comment</th>
<th>Recommendation</th>
<th>Aug 14:</th>
<th>Recommendation 4) ENR recommends that DDMI should discuss the proposed change in basis for comparison for biological action levels (Golder, 2018a) with the statement made in Golder (2018b, Section 8.2.3.5): “Therefore, from the perspective of evaluating the potential for aquatic toxicity in the NF and MF areas, the FF areas were considered suitable as ‘minimally affected’ sampling areas in the statistical comparisons for evaluating Action Level exceedances.”</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td>None</td>
<td><strong>None</strong></td>
<td></td>
<td>Aug 14: The quoted statement appears sufficiently clear, and applies to the proposed Action Levels the same way as it did to the previous Action Levels.</td>
</tr>
<tr>
<td>39</td>
<td>Topic 11: Action levels for FFB</td>
<td><strong>None</strong></td>
<td></td>
<td>Aug 14:</td>
</tr>
<tr>
<td>40</td>
<td>Topic 12: Action Levels Percentile</td>
<td><strong>None</strong></td>
<td></td>
<td>Aug 14:</td>
</tr>
</tbody>
</table>
areas should be estimated. Assuming for the moment that location labels are used to categorize locations along the gradient as belong to farfield A or B, the proposed reduction in sampling effort in the farfield areas reduces the precision of the estimated 95th percentile used in action levels 8 and 9 (Golder 2018a, Table 5.2-1 and for chlorophyll a). In order to offset the reduced precision a percentile closer to the median should be used as precision (of estimated percentiles) improves with proximity to the median. The 80th percentile is subjectively, recommended for this purpose. Alternatives to adopting this recommendation are to demonstrate what reduction in percentiles is necessary to achieve a similar precision of the estimated 95th percentile using five sampling locations, or, to retain five FFA sampling locations.

**Recommendation** 1) ENR recommends that DDMI use the 80th percentile in action levels 8 and 9. DDMI should also discuss the implications of estimating within-area variability (which somewhat loosely is what the 95th percentile estimates) using samples collected along a known gradient.

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**41 Topic 13: Change in Program Design Clarification**

**Comment** DDMI (Golder 2018a Section 3.4.1) states: "Changes were made to adjust the sampling design to a gradient design, while maintaining the ability to continue statistical comparisons of NF area data to the reference condition dataset for Action Level evaluation". As there are no changes to proposed sampling in the nearfield and comparisons with the reference condition dataset are not impacted by the proposed changes in design; and 2) statistical comparisons with the farfield for the purpose of AL evaluation are not made, DDMI should adjust this statement as follows: "Changes were made to adjust the sampling design to a gradient design".

**Recommendation** 1) ENR recommends DDMI update the statement presented in the associated comment.

**Aug 14:** The statement is sufficiently clear as currently worded.

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**42 Topic 14: Response to Previous ENR Comments**

**Comment** ENR has previously provided recommendations regarding the AEMP design in the 2016 AEMP Annual Report and Update to Schedule 8, Condition 3 review. The WLWB (2017b) directed DDMI to address GNWT-ENR comments 6, 7, and 9 to 13 provide various recommendations about potential improvements that could be made to the statistical analyses. DDMI (Golder 2018a, Table 8-1) points to AEMP Design Plan Version 5.0 - Sections 4.3.4.9, 4.3.4.10, 4.6.4, 4.7.4 as locations where responses were provided. Those sections were reviewed with the following outcomes: . ENR comment 6: The details that the ENR comments addressed were not included; consequently, this recommendation was not addressed. . ENR comment 7: A discussion of censoring is not found; consequently, this recommendation was not addressed. . ENR Comment 9: There is no

**Aug 14:** ENR Comment 6: This comment recommended that DDMI address a number of specific comments about the statistical procedures used for the 2016 AEMP annual report. Please see the following responses. ENR Comment 7: DDMI agrees that insufficient detail was provided in the AEMP Design Plan Version 5.0 on the topic of censored data. The report provided details on the approach used for data handling for non-detect results (i.e., replacement of non-detect values with half the detection limit [see Section 4.3.4.2]), but did not include consideration of handling of censored data in the statistical analyses. The following text will be added to the report (as a newly added Section 4.3.4.11): "Observations below the analytical DL are considered censored data. Censored data can potentially bias summary statistics calculated using parametric statistics, because of
violation of underlying assumptions. Based on USEPA guidance, a screening value of greater than 15% censoring will be used to flag data sets that may require an alternative data analysis method (USEPA 2000). The decision of how to analyze the datasets, however, will be determined on a variable-by-variable basis during data analysis. The intent of this process will be to select the appropriate method for each variable and season, based on the amount of censoring within each dataset." This approach is consistent with that applied in the 2016 and 2017 AEMP annual reports and in the 2014 to 2016 Aquatic Effects Re-evaluation Report. ENR Comment 9: As the reviewer points out, this comment was addressed in the DDMI responses to comments on the 2016 AEMP Annual Report. The comment pertained to sample sizes considered in the among area (NF/FF) comparisons used in previous versions of the AEMP design. This comment is not relevant to the current version of the design because the statistical approach has shifted to a gradient analysis. ENR Comment 10: As the reviewer points out, this comment was addressed in the DDMI responses to comments on the 2016 AEMP Annual Report. The comment pertained to the P-value used to flag data sets that have violations of the assumption of normality in the among area comparisons. Under the AEMP Design Plan Version 5.0, normality of the models used in the gradient and temporal trend analyses will be evaluated using the procedures discussed in sections 4.3.4.9 and 4.3.4.10, respectively. ENR Comment 11: As the reviewer points out, this comment was addressed in the DDMI responses to comments on the 2016 AEMP Annual Report. The comment pertained to the P-value used to flag data sets that have violations of the assumption of equality of variances for the among area comparisons. Under the updated AEMP Design Plan Version 5.0, heteroscedasticity of the models in the gradient and temporal trend analyses will be evaluated using the procedures discussed in sections 4.3.4.9 and 4.3.4.10. ENR Comment 12: See response provided above to ENR Comment 11. ENR Comment 13: See response provided above to ENR Comment 7. ENR Comment 17: This appears to be an oversight in the DDMI responses to comments on the 2016 AEMP Annual Report. The reviewer is correct that sampling of phytoplankton in the NF and MF on an annual basis was not mentioned in the AEMP Design Plan Version 4.1, as indicated in the comment response. However, the commitment has been addressed in the AEMP Design Plan Version 5.0 (see Table 3.5-1 and Section 4.6.2). Regarding phytoplankton taxonomy at Station LDS-4, please see the response to GNWT-ENR #2.
<table>
<thead>
<tr>
<th>Topic 15: Benthic Macroinvertebrate Metrics</th>
<th><strong>Comment</strong> In a discussion regarding benthic macroinvertebrate metrics, DDMI (Golder 2018a, Section 4.10.2.1) states: &quot;These endpoints will be assessed for gradients with effluent exposure and or for statistical differences among sampling areas of Lac de Gras. It is not clear how samples in the far field that are intended to represent a gradient may be arbitrarily grouped to conduct the Analyses of Variance conducted under AEMP Design 4.1. <strong>Recommendation</strong> 1) ENR recommends DDMI should discuss how statistical differences among sampling areas of Lac de Gras will be estimated and tested.</th>
<th><strong>Aug 14:</strong> The text will be clarified to reflect the following: &quot;These endpoints will be assessed for gradients with effluent exposure in Lac de Gras, and in statistical comparisons as part of Action Level assessment.&quot; The main analysis approach for annual AEMP data analysis is a gradient analysis, because the former reference areas are now exposed to effluent. For the Action Level analysis, the current year’s near-field area are statistically compared to the 2007 to 2010 far-field area data which are considered representative of the reference condition.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topic 16: Clarification on Number of FF Stations</td>
<td><strong>Comment</strong> Table 3.4-1 of the Plan lists 10 FF stations (excluding the two FF2 stations) yet Table 3.5-1 lists only 8 FF stations (again, excluding the two FF2 stations) for effluent plume, water quality, eutrophication indicators, phytoplankton, etc. components of the AEMP. <strong>Recommendation</strong> 1) ENR recommends that DDMI should clarify this discrepancy.</td>
<td><strong>Aug 14:</strong> Golder to respond Table 3.5-1 should be corrected to 10 stations at the far field areas.</td>
</tr>
<tr>
<td>Topic 17: Analytical Method</td>
<td><strong>Comment</strong> Section 4.8.4 (Golder 2018a) states: &quot;The statistical comparisons among areas and the test for assumptions of normality and homogeneity of variance for parametric statistics will be conducted as described for water quality (Section 4.3.4.9.2)&quot;. This section does not exist in the current report. <strong>Recommendation</strong> 1) ENR recommends that DDMI should confirm that the intended analytical method is that described in Golder 2018a, Section 4.3.4.9.</td>
<td><strong>Aug 14:</strong> The referenced section will be updated in the revised version of the report.</td>
</tr>
<tr>
<td>Page</td>
<td>Topic</td>
<td>Comment</td>
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<tr>
<td>47</td>
<td>Topic 18: Clarification on Number of FF Stations</td>
<td>Section 4.3.4.9 of the Plan states: &quot;Following data transformation (if required), the selected models will be fitted to the data. Statistical outliers will be identified using studentized residuals with absolute values of 3.5 or higher, or due to consideration of leverage (where a single point could strongly influence the overall fit of the model). All values removed from analysis will be retained in the model prediction plots, where they will be shown as a different symbol to identify them as statistical outliers from the rest of the data.&quot; Outliers and observations are often similar (high leverage points are extremes in the predictor space). If conclusions change due to the removal of observations DDMI should present both analyses in the main body of the report to allow readers to form their own conclusions.</td>
</tr>
<tr>
<td>48</td>
<td>Topic 19: General</td>
<td>Dr. Zajdlik notes that the proposed reduction in sampling locations in the farfield will reduce the number of Trophic State Index ratios (Golder 2018b, Section5.3.7.2) by area.</td>
</tr>
<tr>
<td>49</td>
<td>None</td>
<td>None</td>
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<tr>
<td>ID</td>
<td>Topic</td>
<td>Comment</td>
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<tr>
<td>51</td>
<td>Topic 21: Memo - Zajdlik Associates Inc â€” AEMP Design Version 5</td>
<td>Comment ENR has included an attachment: &quot;July, 2018 - Memo - Zajdlik Associates Inc - DDMI AEMP Design 5 Review July 6 with this submission. Recommendation 1) ENR notes this attachment is included in support of the submitted comments and recommendations as applicable.</td>
</tr>
<tr>
<td>52</td>
<td>Topic 22: Table in Topic 4</td>
<td>Comment The ORS sometimes does not accept table formats. Recommendation 1) ENR recommends that the Board and the proponent reference ENR's submitted letter to view the table if necessary.</td>
</tr>
</tbody>
</table>

**WLWB: Anneli Jokela**

<table>
<thead>
<tr>
<th>ID</th>
<th>Topic</th>
<th>Comment</th>
<th>Proponent Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Background Dust Deposition Rates – Re-evaluation Report, Section 3.3.1</td>
<td>In the Board's Reasons for Decision for the 2011 to 2013 Aquatic Effects Re-evaluation Report, the Board required Diavik to consider the inclusion of monitoring data from the Ekati Diamond Mine as an estimate of regional dust deposition rates in the 2014 to 2016 Aquatic Effects Re-evaluation Report. The sampling locations used for calculating background deposition rates appears to be the same as those used in the 2011 to 2013 Re-evaluation and do not incorporate Ekati data. Recommendation Provide details on how DDMI considered existing data from the Ekati Diamond Mine and include rationale as to why it did not incorporate any of that data into its estimates of background dust deposition.</td>
<td>Aug 14: The Ekati Mine's 2012 (2009 - 2011) and 2015 (2012-2014) 3-yr AEMP Re-evaluation Reports reported background dust deposition rates of 36.5 to 146 mg/dm^2/yr (0.1 to 0.4 mg/dm^2/day). These values are consistent with the geometric mean (62 mg/dm^2/yr) and 95% confidence interval (31 to 124 mg/dm^2/year) background dust deposition rates calculated from the Diavik Mine data. As these data are consistent, the inclusion of the Ekati data in the Diavik mine calculations would not alter the interpretation of the results.</td>
</tr>
<tr>
<td>2</td>
<td>Maps of AEMP Water Quality Sampling Locations – Re-</td>
<td>The first sentence of this section indicates that water quality has been sampled at various locations over time and references Figure 2-1 to 2-5. Figures 2-1 to 2-5 do not, however,</td>
<td>Aug 14: Figures have been provided with this response as Attachment-1 and were omitted from the report in error. They will be added to the revised version of the report.</td>
</tr>
</tbody>
</table>
**Evaluation Report, Section 4.2.1.2**

Recommendation Did DDMI intend to include these figures in this 2014 to 2016 Aquatic Effects Re-evaluation Report? If yes, please provide them now and explain whether they differ from figures previously provided in other reports. If not, please provide an updated reference to what report these figures can be found in.

---

**Data Screening Methods for Water Quality – Re-evaluation Report, Section 4.2.3.1**

Comment The second paragraph of this section states that “Details on this data screening approach are provided in Section 2.5.1 of this report.”; however, there is no Section 2.5.1 in this Report.

Recommendation Did DDMI intend to include a Section 2.5.1 in this 2014 to 2016 Aquatic Effects Re-evaluation Report? If yes, please provide this section now and explain whether content in this section differs from that provided in previous reports. If not, please provide an updated reference to what report this information can be found in.

---

**Normal Ranges for Eutrophication Indicators – Re-evaluation Report, Section 5.2.3.1**

Comment Table 5-4 provides the normal ranges for the various eutrophication indicators. Included in the table are normal range values for phytoplankton biomass based on data from the year 2013 (lower limit = 79 mg/m³ and upper limit = 326 mg/m³). The last time normal range values for phytoplankton biomass were presented based on 2013 data was within Version 1.0 of the AEMP Reference Conditions Report. In Version 1.0 of the AEMP Reference Conditions Report, the lower and upper limits were 79 and 326 mg/m³, respectively. It is not clear why there is a difference in the upper limit reported here.

Recommendation Please clarify why the upper limit for the phytoplankton biomass normal range based on 2013 presented here differs from the one previously calculated as part of Version 1.0 of the AEMP Reference Conditions Report.

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**Total Phosphorus Concentrations – Re-evaluation Report, Section 5.3.3**

Comment This paragraph explains that total phosphorus (TP) concentrations during the open-water season of 2016 were greater than the normal range at one station (i.e., MF3-1); however, Figure 5-13 shows a second station with TP concentrations greater than the normal range (i.e., one station along the MF1 to FF1 transect).

Recommendation Please identify which station this data point represents and provide an explanation of whether this exceedance of the normal range is more likely linked to mine effluent, dust deposition, or dike construction.

---

**EA Threshold for Phosphorus – Re-evaluation Report, Section 5.4**

Comment The first paragraph in the section discusses the EA threshold of 5ug/L that was established for phosphorus and how calculations of the normal range via the AEMP have shown that phosphorus concentrations of 5ug/L were within the normal range.

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Aug 14: This is a typographical error. The methods used for the anomalous data screening are summarized in the QAPP, which is referenced in the report. The reference to Section 2.5.1 will be removed from the report.

Aug 14: DDMI acknowledges that the 2013 normal range presented in the 2014 to 2016 Aquatic Effects Re-evaluation Report differs from that presented in Version 1.0 of the Reference Conditions Report, which was not approved. DDMI presents an assessment in the 2014 to 2016 Aquatic Effects Re-evaluation Report Section 7.2.3.1, following the Board directive to conduct an assessment of the reference conditions for phytoplankton variables, given the change in taxonomist that occurred in 2013. In Section 7.2.3.1, DDMI recommended that an adjusted 2013 normal range be established, which also incorporates year-to-year variation based on the 2007 to 2010 reference area data. As expected, the adjusted 2013 normal range is wider than that reported in the Version 1.0 Reference Conditions Report.

Aug 14: The statement identified in the comment referred to one station in relation to the preceding sentence, which identified a subset of nine stations evaluated for potential dike construction effects. This will be clarified in the revised version of the report. The second station with TP concentrations above the normal range is FF1-5, which is outside the zone of elevated dust deposition, and away from the A21 dike. The reason for the elevated TP concentration at this station is unknown.

Aug 14: The wording of the sentence in question in Section 5.4 requires clarification; it was intended to convey that the normal range was approved, rather than a new EA threshold. The sentence
This paragraph then states: "Therefore, a new threshold based on the upper limit of the normal range (i.e., 5 µg/L for ice-cover and 5.3 µg/L for open-water) has been employed and approved." It is unclear why DDMI believes that a new EA threshold has been approved.

**Recommendation** Please provide support and rationale for why DDMI believes a new EA threshold for phosphorus has been approved?

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<table>
<thead>
<tr>
<th></th>
<th>7 Total Phosphorus in Sediments – Re-evaluation Report, Section 6.3.3.2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comment</strong></td>
<td>This section explains that the methods for sampling nutrients in sediments changed starting in 2013, whereby nutrients were analyzed in the top 5 cm prior to 2013 and in the top 1 cm since 2013. The results in this section indicate that samples collected in 2013 and 2016 had lower TP concentrations compared to historical values and that the NF area had significantly different concentrations from the FF1 area in 2013 and 2016. The potential influence of the change in sampling methodology on these results does not appear to be addressed.</td>
</tr>
<tr>
<td><strong>Recommendation</strong></td>
<td>Please explain the potential influence and implication of the change in sampling methodology on the interpretation of potential mine-related effects for TP in sediment.</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th></th>
<th>8 Sediment Quality Conclusions – Re-evaluation Report, Section 6.5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comment</strong></td>
<td>The first summary point in this section states: &quot;The current approach of collecting single composite samples at each station is considered adequate to detect Mine-related effects on sediment quality variables.&quot; It is not clear what results DDMI is basing this conclusion on.</td>
</tr>
<tr>
<td><strong>Recommendation</strong></td>
<td>Please elaborate on the supporting rationale for this conclusion.</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th></th>
<th>9 Normal Ranges for Phytoplankton – Re-evaluation Report, Section 7.2.3.1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Comment</strong></td>
<td>Table 7.5 provides a comparison of normal ranges calculated for phytoplankton variables, with the last column providing an adjusted normal range. Values in this column generally seem to be close to those presented for the non-adjusted normal ranges, with the exception of the lower bound for total phytoplankton biomass. In this case, the non-adjusted lower bound is 75 mg/m³ whereas the adjusted lower bound is 19 mg/m³.</td>
</tr>
<tr>
<td><strong>Recommendation</strong></td>
<td>Is the lower bound value of the adjusted normal range for total phytoplankton biomass correct? If yes, can DDMI explain why there is such a large difference between the two values?</td>
</tr>
</tbody>
</table>

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**Aug 14:** The sampling strategy of analyzing the top 1 cm of sediments provides a more accurate assessment of recently deposited sediments. Therefore, it is expected that mine-related effects to TP in bottom sediments is more likely to be captured in the more recent data. The comparison of data from before and after 2013 is sensitive to the methodological differences mentioned above and must be evaluated carefully. In light of the improvement in the ability to evaluate mine-related effects on TP in the data collected since 2013, the more recent data should be considered more accurate for evaluating effects. It is also relevant to note that bottom sediments in Lac de Gras contain a large amount of phosphorus (e.g., normal range of 681 to 1,650 mg/kg dw), which, given the dissolved oxygen (DO) regime of the lake, has a minimal influence on lake water TP concentrations. Therefore, TP in bottom sediments is unlikely to be a useful variable for evaluating ecologically relevant effects related to mine-related nutrient inputs, unless a change in DO regime occurs.

**Aug 14:** The conclusion is based on DDMI AEMP results, which have indicated that effects in sediment quality are being detected using the current approach of collecting single composite sediment sample at each station. The sampling approach used was able to capture mine-related effects on sediments and follows the same practices of a number of environmental monitoring programs for diamond mines in Northern Canada.

**Aug 14:** The adjusted 2013 normal range is the result of increased year-to-year variation based on the variation observed in the original 2007 to 2010 reference area data, which causes a "widening" of the normal range (i.e., a lower lower bound and a higher upper bound). The approach is detailed in Section 7.2.3.1.
<table>
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<tr>
<th>Page</th>
<th>Title</th>
<th>Comment</th>
<th>Recommendation</th>
<th>Aug 14:</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Normal Ranges for Fish Tissue Chemistry – Re-evaluation Report, Section 9.3.1.3.1</td>
<td>Table 9-16 presents the normal ranges for fish tissue chemistry. The upper limit presented for tellurium differs from the value reported in the AEMP Reference Conditions Report (RCR). The value in Table 9-16 is 0.004 ug/g wwt whereas the value in the RCR is 0.04 ug/g wwt.</td>
<td>Please confirm if the value reported in Table 9-16 for the upper limit of tellurium should be 0.04 ug/g wwt.</td>
<td>The upper limit of Tellurium in Table 9-16 should be corrected to 0.04 ug/g wwt. The correct upper limit value of tellurium was used in Figure 9-25.</td>
</tr>
<tr>
<td>11</td>
<td>EA Prediction for Mercury in Fish – Re-evaluation Report, Sections 9.4.</td>
<td>Section 9.4 indicates that the EA prediction for mercury concentration in sport and subsistence fisheries (i.e., that it would remain below a mean of 0.2 ug/g wwt) has been exceeded in Lac de Gras in six of the years it was sampled (i.e., 2004, 2008, 2009, 2011, 2012, and 2015).</td>
<td>Can DDMI explain why the EA prediction appears to have underestimated mean mercury concentrations in sport and subsistence fisheries?</td>
<td>A possible explanation for why the EA prediction underestimated mean mercury concentrations in Lake Trout may be related to a different size range of fish being captured at the time when the EA prediction was set. Because mercury biomagnifies, fish size is directly related to mercury concentration, and thus the EA prediction. The prediction is not based on an adjusted mean, and if a different size range of fish are captured in a given year, the mean concentration may vary as well. To further complicate the interpretation, the EA prediction was based on different field methods. Captured fish were composited, so mercury concentration cannot be correlated with individual fish length.</td>
</tr>
<tr>
<td>12</td>
<td>Relative Percent Difference for Snow Water Chemistry Duplicates – Re-evaluation Report, Section 14.2.1</td>
<td>The last paragraph of this section explains why the Relative Percent Difference (RPD) between snow water chemistry duplicates can be high in some cases and why additional replication may not be warranted. This section does not, however, address whether it would be possible and/or beneficial to establish a data quality objective for the snow water chemistry duplicates. Directive 3F from the Board’s Reasons for Decision for the 2015 AEMP Annual Report required DDMI to consider the establishment of data quality objectives for snow water chemistry data as part of the 2014 to 2016 Aquatic Effects Re-evaluation Report.</td>
<td>Please comment on the possibility and potential benefit of having a data quality objective established for snow water chemistry data collected as part of the Dust component of the AEMP.</td>
<td>While it is possible to create a data quality objective (DQO) for snow water chemistry duplicates, they would be arbitrary and likely to be of limited benefit. For example, issues include: Snow samples are analyzed for numerous water quality parameters (i.e., nutrients and 50+ metals); will DQOs be required for each compound? What metric will be used to determine acceptable range in RPDs that will be used to set a DQO for each individual compound? If only one compound in a sample exceeds its DQO, will the entire sample be flagged as low-quality or invalid? As discussed in the document, natural sample-to-sample variability in snow composition is expected to exceed analytical accuracy and precision by a wide margin. Table 3-4 for the duplicate at SS3-7 in 2014 is a good example. Ammonia RPD = 108%; N+N RPD = 10% and Orthophosphate RPD = &lt;0.5%. Professional judgment suggests these differences are real (i.e., inherent to the samples), and not an analytical artifact related to sampling handling, aggregation or analysis.</td>
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<td>13</td>
<td>Method for Calculating Adjusted Normal Range for Phytoplankton Variables – Re-evaluation Report, Section 14.2.6</td>
<td>This section recommends that the 2013 normal range for phytoplankton variables be used for comparisons moving forward and explains that an adjustment to this normal range will be required to account for year-to-year variability. This section describes three ways in which this data could be adjusted and states that it will be done using one or a combination of these methods. It is also stated that the adjustment procedure will be documented in the 2017 AEMP.</td>
<td>Text in Section 14.2.6 will be updated to reflect the decision to use the approach detailed in Section 7.2.3.1, in which the adjusted 2013 normal range is based on the variation observed in the original 2007 to 2010 reference area dataset.</td>
<td>Text in Section 14.2.6 will be updated to reflect the decision to use the approach detailed in Section 7.2.3.1, in which the adjusted 2013 normal range is based on the variation observed in the original 2007 to 2010 reference area dataset.</td>
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<td>Page</td>
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<td>14</td>
<td>Analysis of Lake Trout Tissue Metal Concentrations – Re-evaluation Report, Section 14.2.9; AEMP Design, Section 4.9; and Follow-up Correspondence, DDMI Response 1</td>
<td><strong>Comment</strong> In the Board's Reasons for Decision for the 2015 AEMP Annual Report, there was a requirement for DDMI to present, as part of the 2014 to 2016 Aquatic Effects Re-evaluation Report, the analyses for fish tissue metal concentration as described in the AEMP Design (i.e., Version 3.5). Alternatively, DDMI could explain if, and why, the analysis described in the Design should be considered differently and to provide rationale for a change to the AEMP Design. This direction was related to the fish tissue samples collected as part of the TK component of the AEMP. In follow-up correspondence following the submission of the 2014 to 2016 Aquatic Effects Re-evaluation Report and the AEMP Design Version 5.0, DDMI explained why it believed that statistical analysis of the fish tissue chemistry data collected as part of the TK component was not required or appropriate. In Section 14.2.9 of the Re-evaluation Report, DDMI states that no changes are recommended with respect to the fish tissue chemistry analyses of the TK component. Version 5.0 of the Design, however, still appears to suggest that analyses of all metals from Lake Trout tissue samples are required (see Sections 4.9.2, 4.9.3, and 4.9.4). These sections suggest that all metals from Lake Trout tissue samples will be analyzed in the laboratory and that summary statistics for all these metals will be reported. Based on the response provided by DDMI in the follow-up correspondence, it appears that the plan is to report on mercury data only. <strong>Recommendation</strong> Can DDMI confirm if it means to provide summary statistics for all metals analyzed in Lake Trout tissue collected as part of the TK component of the AEMP? If not, can DDMI provide a possible clarification for Section 4.9 of the AEMP Design?</td>
<td><strong>Aug 14:</strong> For the TK component, all metals analyzed as part of the standard tissue metals scan will be provided in the TK report. Summary statistics, including sample size, percentage of metal concentrations greater than the DL, minimum, median, maximum, and SD values will be included in the TK report. However, as previously indicated, the fish palatability results are not suitable as an early warning trigger for conducting a larger mercury in Lake Trout program as the sampling protocols, sample size, fishing locations, and size of fish are not consistent between years. As such, statistical analyses of the fish tissue chemistry collected as part of the TK program is not appropriate.</td>
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<td>15</td>
<td>Timing of Snow Core Surveys – AEMP Design, Plain Language Summary and Section 4.2.2.1</td>
<td><strong>Comment</strong> The Plain Language Summary of the AEMP Design indicates that snow core surveys &quot;will continue to take place every year during November&quot; whereas Section 4.2.2.1 states that &quot;as in previous years, snow samples will be collected in April of each year.&quot; <strong>Recommendation</strong> Please confirm the timing of the snow core surveys.</td>
<td><strong>Aug 14:</strong> The timing of the snow core surveys is April, this correction will be made in the revised version of the report.</td>
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<tr>
<td>16</td>
<td>Sediment Quality Sampling Stations – AEMP Design, Plain Language Summary</td>
<td><strong>Comment</strong> In the Plain Language Summary section for Sediment Quality, it is stated that &quot;The AEMP sediment quality survey will continue to occur every three years at the same stations sampled during the AEMP Version 5.0.&quot; The currently-approved AEMP Design is Version 4.1.</td>
<td><strong>Aug 14:</strong> AEMP Design Version 4.1 will be referenced in the revised version of the report.</td>
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</table>
### Recommendation
Can DDMI confirm the AEMP Design reference for this section given that Version 5.0 has not yet been implemented?

<table>
<thead>
<tr>
<th>No.</th>
<th>Section/Design, Section</th>
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<tbody>
<tr>
<td>17</td>
<td>Collection Ponds – AEMP Design, Section 2.3.1</td>
</tr>
<tr>
<td>18</td>
<td>Trophic Status in Assessment Endpoints – AEMP Design, Section 3.2</td>
</tr>
<tr>
<td>19</td>
<td>Sources of Potential Mine-related Effects – AEMP Design, Section 3.4.1</td>
</tr>
<tr>
<td>20</td>
<td>Lake Trout Health Survey – AEMP Design, Section 3.5</td>
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</table>

**Comment**

**Section 2.3.1** briefly outlines the different components of the water management systems at Diavik. Table 2.3-1 outlines a summary of the collection ponds. The information presented in Table 2.3-1 was compared to the most recently-approved version of the Water Management Plan (i.e., Table 3-1 in Version 14.1). This comparison identified some discrepancies between the information presented here in Table 2.3-1 and in Table 3-1 of Version 14.1 of the Water Management Plan (i.e., see columns for Drainage Area and Design Capacity).

**Recommendation**
Provide an explanation for the apparent discrepancies between Table 2.3-1 of the AEMP Design and Table 3-1 of Version 14.1 of the Water Management Plan.

**Aug 14:** The Water Management Plan Version 14.1 contains the correct information and Table 2.3-1 of the AEMP Design will be updated in the revised version of the report.

**Comment**

Table 3.2-1 outlines the Valued Ecosystem Components (VECs), the Assessment Endpoints, the Measurement Endpoints, and the Supporting Lines of Evidence associated with the AEMP. The assessment endpoints for the lake productivity VEC (i.e., phyto- and zooplankton) involve maintenance of an oligotrophic plankton community whereas the assessment endpoints for the additional aquatic community components VEC include maintenance of a benthic invertebrate community characteristic of an ultra-oligotrophic lake.

**Recommendation**
Is there a reason for the distinction between the maintenance of an oligotrophic community for plankton and an ultra-oligotrophic community for benthic invertebrates? Please explain.

**Aug 14:** The term "ultra-oligotrophic" will be changed to "oligotrophic" in this table.

**Comment**

Section 3.4.1 discusses the potential sources of Mine-related effects on the aquatic ecosystem of Lac de Gras. DDMI indicates that Mine effluent is the most important source, but also lists other potential stressors (e.g., dust deposition and dike construction). As compared to the currently-approved AEMP Design, "seepage" has been removed from the list of other potential stressors.

**Recommendation**
Please provide rationale for the removal of seepage from the list of other stressors that may have effects on Lac de Gras.

**Aug 14:** This revision was made in accordance with the AEMP Design V4 Reasons for Decision, Table 2, Comment #3, which instructed DDMI that "The word 'seepage' should be removed from the last sentence of this section.", referring to Section 2.3.1 (Water Management). The edited sentence was: "Water outflows include treated water to Lac de Gras, surface runoff, seepage and evaporation." DDMI agrees that seepage waters do not directly reach Lac de Gras, but rather report to the North Inlet and are treated in the North Inlet Water Treatment Plant (NIWTP) before being released to Lac de Gras.

**Comment**

Section 3.5 of the AEMP Design Version 5.0 includes a change to the sampling schedule for the Lake Trout fish health survey. Under the previously-approved Design, a fish health survey would be completed if triggered by the results of the Slimy Sculpin fish health survey (i.e., if Action Level 2 was triggered). Version 5.0 of the Design indicates that a Lake Trout fish health survey would be

**Aug 14:** The triggers that lead to the development of a Response Plan for a large-bodied fish health program are similar between the two study designs. However, the large-bodied fish health program falls under Action Level 3 in Version 5.0 as opposed to Action Level 2 in Version 4.1, as the intent of this current update was to better align the Action Levels with the EEM program. Action Level 1 is an...
triggered if an Action Level 3 for Slimy Sculpin is triggered. This proposed change to the sampling schedule was not identified in the 2014 to 2016 Aquatic Effects Re-evaluation Report, thus the rationale for this proposed change is not clear. Also, the document indicates that the Lake Trout survey would be conducted, if appropriate. It is not clear what factors would be considered when determining whether a Lake Trout survey would be or would not be appropriate. **Recommendation** (1) Please provide detailed rationale for this proposed change or identify where in the submissions (i.e., the Re-evaluation or the Design) the rationale was provided. (2) Please elaborate on the factors that would be considered when determining whether a Lake Trout health survey would be conducted following an Action Level 3 exceedance for Slimy Sculpin.

### Timing of the 2017 to 2019 Aquatic Effects Re-evaluation Report – AEMP Design, Section 3.5

**Comment** The second last paragraph of this section indicates that the Aquatic Effects Re-evaluation Report will be “submitted six months following approval of the comprehensive AEMP Annual Report.” The Water Licence does not include specific information on the timing of this submission with respect to other AEMP Annual Reports. It is not clear why DDMI requires six months following approval of the next comprehensive AEMP Annual Report.

**Recommendation** Provide rationale for why six months following approval of the next comprehensive AEMP Annual Report is required by DDMI to complete the 2017 to 2019 Aquatic Effects Re-evaluation.

**Aug 14:** The recommended timeline allows for incorporation of recommendations and/or directives following approval of the next comprehensive AEMP annual report to the 2017 to 2019 Aquatic Effects Re-evaluation Report. A shorter timeline would not allow for inclusion of new recommendations and/or directives to the re-evaluation report that resulted from the most recent comprehensive AEMP year, and would create a discontinuity in the process of aligning and improving the document with WLWB directives and proponent recommendations as they are received.

### Gradient Analysis – Re-evaluation Report, Section 14.1 and AEMP Design, Section 4.3.4.1

**Comment** Version 5.0 of the AEMP Design proposes that the design be modified from "a 'hybrid' program that allowed both control-impact and gradient analysis and gradient analysis of effects" to a gradient design only. Section 4.3.4.1 of the Design explains that this gradient analysis will examine Substance of Interest (SOI) concentrations along the NF to FF gradients. The FF sites, however, are not sampled on an annual basis, thus it is not clear how the gradient analysis will be conducted during interim years.

**Recommendation** Please clarify how the proposed gradient analysis will be conducted during interim years, when FF area sites are not sampled.

**Aug 14:** The interim year data analysis will continue to focus on evaluating Action Level triggers to facilitate managing mine-related effects in Lac de Gras, and will include a level of spatial analysis consistent with that applied during interim years under the previous version of the AEMP. Interim year data analysis does not incorporate a statistical gradient analysis.

### Action Levels for Biological Components –

**Comment** In this section, DDMI proposed a number of changes to Action Levels for the biological components of the AEMP. Among these proposed changes is the inclusion of an effect size requirement.

**Aug 14:** The previous Action Level 2 for benthic invertebrates incorporated statistical testing based on a study design that incorporated a Critical Effect Size (CES) of 2 SD, which was based on...
<table>
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<tr>
<th>Action Levels for Biological Components – AEMP Design, Section 5.2.4</th>
<th><strong>Comment</strong> Table 5.2-4 outlines the new proposed Action Levels for the biological components of the AEMP. Action Level 3 for all biological components include three requirements. The first requirement involves a statistically significant difference between the variable of interest and the mean of the reference dataset and the third requirement is for a difference from the normal range (in the same direction than the statistical difference noted in requirement 1). It is not clear how these two requirements differ from each other, given that the reference dataset is the normal range. For example, in the case of phytoplankton, requirement 1 is that mean phytoplankton biomass is statistically significantly less than the reference dataset and requirement 3 is that mean phytoplankton biomass is below the normal range. If mean phytoplankton biomass is statistically significantly less than the reference dataset (i.e., the normal range), isn't it also below the normal range? <strong>Recommendation</strong> Please clarify how these two requirements differ.</th>
</tr>
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<tr>
<td>Aug 14: A statistically significant difference in the NF area from the mean of the reference dataset is a different criterion than the NF mean being outside the normal range. An NF area mean may be significantly lower than the reference dataset mean, but remain within the normal range. The normal range criterion was added to Action Level 3 to ensure that the difference detected by statistical testing is sufficiently large to be meaningful.</td>
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<td>Aug 14: Rationale for the changes to the biological Action Levels is provided in Section 5.2.4 of the AEMP Design Plan Version 5.0. Action Level 1 is an early-warning indication of a potential effect, but with a magnitude below the Critical Effect Size (CES) and with an NF area mean within the normal range. Therefore, a management action is not necessary to respond to this Action Level. However, confirmation of the effect is an appropriate follow-up action. Therefore, &quot;No action&quot; will be replaced with &quot;Confirm effect&quot; for Action Level 1 in the last column of Table 5.2-4. Action Level 2 represents a potential effect that also requires confirmation (i.e., it is of sufficiently large magnitude for follow-up), with the action being consistent with the confirmation step of EEM. &quot;No action&quot; will be removed from the in the last column of Table 5.2-4. This will result in the same action (Confirm effect) for both Action Levels 1 and 2 triggers, which is appropriate given these triggers represent small differences in magnitude of effect. Action Level 3 is intended to...</td>
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</table>
July 19, 2018

Via online submission

Anneli Jokela
Senior Technical Advisor
Wek’eezhii Land and Water Board
1-4905 48th Street
Yellowknife, NT X1A 3S3

Dear Ms. Jokela:


Environment and Climate Change Canada (ECCC) has reviewed the information submitted to the Wek'eezhii Land and Water Board (WLWB) regarding the above-mentioned documents and is submitting comments via the online review system. ECCC’s specialist advice is provided based on our mandate, in the context of the Canadian Environmental Protection Act and the pollution prevention provisions of the Fisheries Act.

Should you require further information, please do not hesitate to contact me at (867) 669-4707 or Bradley.Summerfield@canada.ca

Sincerely,

[original signed by]

Bradley Summerfield
Senior Environmental Assessment Coordinator

Attachment(s): ECCC Comments Excel Sheet

cc: Georgina Williston, Head, Environmental Assessment North (NT and NU)
July 19, 2018

Ryan Fequet
Executive Director
Wek’èezhìi Land and Water Board
1 - 4905 48 St.
Yellowknife, NT X1A 3S3

Joseph Mackenzie
Chair
Wek’èezhìi Land and Water Board
1 - 4905 48 St.
Yellowknife, NT X1A 3S3

Re: Review of 2014-16 AEMP Summary Report and AEMP Re-design Version 5

Dear Joseph 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’ 2014-16 Aquatic Effects Monitoring Program (AEMP) Summary Report and AEMP Re-design Version 5 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 have also reviewed the documents internally.

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

EMAB draws your attention to the following:

Proposed Change to Gradient Design
EMAB accepts that now that Diavik’s effluent is affecting the “far-field” area at the western part of Lac de Gras, it is appropriate to change the original control-impact design of the AEMP to a gradient design.

Eutrophication Indicators and Sampling Frequency
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 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 – 25% of LdG
- 2014 – 42.4%
- 2015 – 10.3%
- 2016 – 43.7%

Diavik has noted a correlation between Chlorophyll $a$ and Total Dissolved Solids, and suggested TDS may be providing micro-nutrients for the Chlorophyll $a$.

EMAB has also observed that total Nitrogen (TN) has been increasing in extent so that it now appears the entire lake is experiencing TN above the normal range.
As noted in previous comments, the higher levels of chlorophyll $a$ in 2014 and 2016 have reached the extent of the mid-field sampling stations. If the affected area of LdG increases beyond the mid-field this will not be detectable except in “comprehensive” monitoring years i.e. every third year. This situation will continue with the proposed gradient sampling design. The area of LdG 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, and there is wide variation between years. 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 annual geographic extent of the area affected by chlorophyll $a$ above the normal range. Diavik should also include a summary of data on conditions that affect phytoplankton, including light, temperature, water clarity and other nutrients in the discussion of phytoplankton results.

**Mercury in Lake Trout**
EMAB understands that the WLWB has accepted Diavik’s proposal to use mercury levels in slimy sculpin as the trigger for lake trout sampling while recognizing that slimy sculpin are not a good indicator of mercury-related risks in lake trout. At the same time EMAB notes that mercury levels in trout in Lac de Gras have been a concern since the mine was first proposed and were raised by Affected Communities during the Comprehensive Study of the proposal, and that Diavik made a prediction with respect to mercury levels in lake trout which can only be verified by ongoing monitoring.

The only ongoing monitoring of mercury in lake trout continues through the fish palatability studies. EMAB will continue to take a keen interest in the results of the analysis of trout tissue from these studies, and will take appropriate action if we deem a potential risk is present, particularly for subsistence users.

**Dust Monitoring**
With the increase in dust levels in the area of A21 dike construction, and the expected ongoing activity around the A21 pit, EMAB has recommended that Diavik add dust monitoring stations in the south and southwest areas of the mine. Diavik has not proposed any new dust monitoring stations in the re-design and has not presented a rationale for this decision.

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)
    Anneli Jokela, Regulatory Specialist, WLWB (by email)
    Kassandra DeFrancis, Regulatory Specialist (by email)
2014 TO 2016 AQUATIC EFFECTS RE-EVALUATION REPORT

PLAIN LANGUAGE BRIEFING AND TECHNICAL REVIEW COMMENTS

Technical Memorandum # 367-18-01

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

Prepared by:
North/South Consultants Inc.

July 18, 2018
1.0 BACKGROUND AND SCOPE OF WORK


DDMI is required to produce and submit an integrated Aquatic Effects Monitoring Plan (AEMP) report to the WLWB every three years. The goal of this report, referred to as the Aquatic Effects Re-Evaluation Report (previously the Three Year Summary Report), is “to meet the requirements of Water Licence W2015L2-0001 Part J Item 9, which has the following three objectives:

a) To describe the Project-related effects on the receiving environment compared against Environmental Assessment (EA) predictions;

b) To update predictions of Project-related effects on the Receiving Environment based on monitoring results obtained since project inception; and

c) To provide supporting evidence, if necessary, for proposed revisions to the AEMP Design Plan.

The report also must satisfy the requirements of Water Licence W2015L2-0001 Schedule 8 Item 5, which are:

a) a review and summary of AEMP data collected to date including a description of overall trends in the data and other key findings of the monitoring program

b) an analysis that integrates the results of individual monitoring components (e.g., water quality, fish health, etc.) to date and describes the overall ecological significance of the results

c) a comparison of measured Project-related aquatic effects to predictions made during the Environmental Assessment and an evaluation of any differences and lessons learned

d) updated predictions of Project-related aquatic effects or impacts from the time of writing to the end of mine life based on AEMP results to date and any other relevant operational monitoring data

e) a plain language summary of the major results of the above analyses and a plain language interpretation of the significance of those results

f) recommendations, with rationale, for changes to Action Levels as set in the AEMP Design Plan

g) recommendations, with rationale, for changes to any other aspect of the AEMP Design Plan; and,
h) any other information required as requested by the Board.”

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

- How well previous EMAB comments and recommendations were addressed and incorporated;
- Quality of data collected, including Diavik review of quality assurance/quality control (QA/QC) issues;
- Methods used to analyze trends in data;
- Adequacy of discussion of results;
- Defensibility of conclusions and recommendations, including recommendations for changes to the AEMP Design Plan;
- Emerging issues, and year-to-year variation in parameters that may indicate environmental change over time;
- Unanticipated project-related effects; and
- Action levels reached, assessment of response framework.

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 Re-evaluation Report represents a large undertaking and presents a large amount of data and information. Given the extent of the report, some errors or discrepancies would be expected. Although a comprehensive documentation of minor errors was not undertaken for this review, it is noted that there were a number of instances where there either figures referenced in the text that are not presented in the report and various instances of incorrect references to tables, figures, and sections. It was also noted that many table and figure captions did not provide sufficient information to determine what is presented. We have noted such discrepancies and other minor editorial comments observed during the technical review in Table 1 to assist the authors with revisions to the document.

The following sections present a plain language briefing of NSC’s key comments on the Technical Review, with a focus on the points identified by EMAB for evaluation during the review of AERR Version 1.0 (Section 1.0). Due to the size and complexity of the report, the following comments have been organized according to the report structure (i.e., by monitoring component or major report heading).

2.1 INCORPORATION AND CONSIDERATION OF PREVIOUS EMAB COMMENTS AND WLWB DIRECTIVES

With two exceptions, the report appears to have adequately addressed previous EMAB comments and WLWB directives. The exceptions are described below.

2.1.1 WLWB Directive: Consideration of Additional Dustfall and/or Snow Chemistry Monitoring sites

Section 14.2.1 (page 606) provides a response to a WLWB directive: “The WLWB requested a critical review of the present sampling plan for dust, and requested DDMI consider revisions to the existing program based on the findings presented herein. Potential revisions requested by the WLWB (Table 1-1) included the following:

- Consider the implementation of additional dustfall and/or snow water chemistry monitoring sites (W2015L2-0001 update, Commitment A)..."

The response provided indicates: “The current number and location of the dustfall and snow water monitoring locations is sufficient to evaluate both the spatial and the temporal trends of dust deposition (e.g., Figure 3-10 and 3-17); nutrient deposition (Figure 3-11 to 3-14 and 3-18); and metal deposition (Figures 3-15, 3-16 and 3-19) in the vicinity of the Mine. Consequently, no additional monitoring locations are recommended at this time.”

There is no rationale provided for why no additional dust monitoring sites will be added. NSC (2017a) had noted in the review of the 2016 AEMP Report: “Given the relatively high dust
deposition observed at sites south and southeast of the mine, it would be beneficial to add a site between the two monitoring axes (i.e., SSE in the vicinity of the water quality site MF3-3) and a dustfall monitoring station south of site Dust 10 (i.e., at or near one of the snow dust fall sites SS5-4 and SS5-5).”

**Recommendation:** Provide a discussion and rationale for the proposal to not add dustfall monitoring sites.

### 2.1.2 WLWB Directive: Review of Duplicate and Blank Samples for Dustfall and/or Snow Chemistry Program

Section 14.2.1 (page 606) provides a response to a WLWB directive: “The WLWB requested a critical review of the present sampling plan for dust, and requested DDMI consider revisions to the existing program based on the findings presented herein. Potential revisions requested by the WLWB (Table 1-1) included the following:

...Review the location and number of duplicate and blank samples for the dustfall and the snow water chemistry program (W2015L2-0001 update, Commitment B).”

There is no discussion provided regarding a review of blank samples.

**Recommendation 1:** Include a discussion of blank samples included in the dust monitoring component.

Section 14.2.1 (page 606) indicates: “The relative percent differences among sample duplicates are occasionally high for the snow water chemistry data. This is commonly observed for variables related to dust due to the episodic nature of dust deposition, and the discrete but stochastic nature of particle deposition. Geometric averaging of samples plus their duplicates in the 2014 to 2016 re-analysis effectively accounted for occasionally high RPD [relative percent difference] values observed between duplicate snow chemistry samples collected at the same location. Potential outliers were effectively screened using the Z-score approach, and consequently no additional sample duplicates are proposed.”

The sample duplicate results are presented in Table 3-4 (page 29) for only a subset of parameters. The document should include a review of all parameters to provide for an evaluation of QA/QC for the program as a whole. While annual reports discuss details for all parameters, the re-evaluation report is the location where data for numerous years are considered collectively. Issues with and/or patterns in data may not be readily apparent until data are reviewed for all years together.

**Recommendation 2:** Include duplicate sample results and discussion of these data for all parameters. A table presenting a summary of the analysis of the duplicate results (e.g., relative
percent mean differences) could be provided in an appendix. This would also inform on the need to modify the program.

2.2 DUST DEPOSITION

2.2.1 Parameters Evaluated

The report states (Dust Deposition, Section 3.2.2, Data Handling, page 27): “Analysis was undertaken to evaluate temporal or spatial trends in dust deposition rates, deposition of dustborne nutrients (i.e., total phosphorus [TP], orthophosphate [OP], nitrate plus nitrite [N+N], and ammonia), and deposition of two dust-borne metals indicative of metal deposition in general (i.e., aluminum and lead).”

It is not clear why the evaluation only included two metals (aluminum and lead).

Recommendation: Please provide a detailed rationale for focus on only two metals (aluminum and lead).

2.2.2 Grouping Of Data Sets

In Section 3.2.3.1 (Methods, Data Analysis, Temporal Grouping, page 30), the report states: “Dust deposition data and snow chemistry data were grouped into time periods to reflect changes in mining activities over time at the Mine. The time period groups were as follows:

- 2002 to 2005: open pit mine construction and open pit mining
- 2006 to 2009: underground mine construction and open pit mining
- 2010 to 2013: open pit transition to underground mining

While the principle of grouping according to major activities is a logical approach, grouping of years may mask short-term effects. Results for other components of the AEMP are presented by year in the report.

Recommendation: Please provide a discussion of whether more short-term effects have been observed for dust deposition, as it may pertain to pooling of multiple years of data. If short-term recent trends have been observed, these should be presented in the report.

2.2.3 Definition Of Background Data

Dust deposition results for sites not significantly different from control sites were "pooled to form a composite estimate of background dust deposition" (Dust Deposition, Section 3.3.1.1, Results,
Dustfall, page 35). While this approach may be reasonable for some of the sites, at least one site (SS5-4) has a notably high mean rate for the 2014-2016 pooled time period (i.e., more than four times the control sites). The lack of a statistically significant difference between this site and the formal “control sites” may reflect high variability in the data set and identifying this site as "background" does not seem to be appropriate based on the information presented. Inclusion of error bars on the figure (and other similar figures) would assist with review of these data.

In addition, deposition rates for site SS5-4 reported in the 2014, 2015, and 2016 annual AEMP reports (Golder 2016a,b, and 2017) were 47, 43, and 38 mg/dm²/year, respectively. The mean reported in Figure 3-4 and Table 3-5 (279 mg/dm²/yr; page 35) contradicts these values.

**Recommendation:** Include error bars on figures and provide clarification on the appropriateness of the approach for designating sites as "background".

Please verify that the mean deposition rates presented for site SS5-4 are correct. If correct, suggest reconsidering designation of this site as "background".

### 2.2.4 Temporal Changes

It is indicated that background deposition rates of phosphorus and metals increased from 2010-2013 to 2014-2016 but no explanation is given as to why rates increased (Dust Deposition, Section 3.3.4, Results, Spatial Distribution of Environmental Loadings, pages 53 to 56). This may be indicative of a mine-related influence in the latter period.

**Recommendation:** Possible explanations for the increase in background deposition rates should be discussed.

### 2.3 WATER QUALITY

#### 2.3.1 Dissolved Oxygen (DO) Results and Discussion

Section 4.3.2.1.1 (Effluent and Water Quality, Results, Water Quality, Temporal Trends, Depth Profiles, page 129) identifies "...DO concentrations during ice-cover that were at or below the Effects Benchmark of 6.5 mg/L for the protection of aquatic life (PAL) for "other" life stages (i.e., non-early life stages)." During the ice-cover season the Canadian Council of Ministers of the Environment (CCME 1999; updated to 2018) 9.5 mg/L benchmark for early life stages would be more appropriate for fall spawning species such as Lake Trout. In addition, there is no discussion of whether DO concentrations were above or below benchmarks for the open-water season.

**Recommendation:** The DO data should be compared to the appropriate benchmarks and the findings reported. Include a discussion comparing DO results for the open-water season to PAL guidelines.
2.3.2 Depth Profile Results and Discussion

It is difficult to discern individual years in the depth profile figures presented in Figures 4-35 to 4-38 (pages 130-133). In particular, the figures do not clearly show results for pre-Project data making it difficult to assess whether any changes appear to have occurred post-Project. This confounds evaluation of the results that are presented. For example, it is noted that pH values frequently fell outside of the CCME PAL guideline range (6.5-9). To interpret the implications of this occurrence, it is important to consider baseline conditions in the lake; as the figures are presented, baseline results are not easily visualized in the figures.

Recommendation: Modifications to the figures would be beneficial to assist the reviewer with discriminating annual results and, in particular, distinguishing baseline from post-Project results. Suggest re-formatting figures to render them clearer.

It would also be beneficial to include a brief discussion, where applicable, noting changes between the pre- and post-Project time periods. This would be notably useful for pH and DO results, where monitoring has shown exceedances of benchmarks.

Consider examination of DO results as percent saturation values to evaluate trends over time.

2.4 EUTROPHICATION INDICATORS

2.4.1 Spatial Extent Of Effects – Total Nitrogen

Comment 1:

Section 5.3.1.1 (Results, Summary of Effects, Extent of Effects, page 258) indicates: “The boundary of effects on concentrations of total nitrogen (TN) generally extends to the northwest (to the end of the NF-MF1-FF1 transect) and to the northeast (towards the Lac du Sauvage inlet), with an exception in 2014 when the extent of effects appeared to be localized around the NF area.” This statement appears to be based on incorrect results presented in Figure 5-2 (page 263) and is in disagreement with results presented in Table 5-7 (page 261) and those presented in the 2014 AEMP Annual Report (Golder 2016a). Table 5-7 indicates the affected area was equal to or greater than 40.1% of the lake area.

Section 5.3.1.1 (page 258) further indicates: "Overall, the greatest extent of effects was observed on TN in 2016 (484.9 km², or 84.7% of lake area) (Figure 5-2; Table 5-7). The extent of effects on TN increased between 2007 and 2016, and has consistently shown an affected area >20% since 2008, while the spatial extent of effects on other indicators of eutrophication (i.e., TP, phytoplankton and zooplankton biomass) has decreased. The lack of a relationship between areas where TN is greater and areas where biological effects were observed (chlorophyll a, phytoplankton and zooplankton biomass) is consistent with N not being the limiting nutrient in Lac de Gras."
However, as noted above, this statement is based on erroneous TN information presented for 2014. With this correction made, spatial patterns for chlorophyll \(a\) and TN appear to be relatively similar in most years - notably in 2014.

**Recommendation 1:** Please correct Figure 5-2 for the 2014 data and verify that data for other years are correctly presented. Modify text and data interpretation and conclusions accordingly.

**Comment 2:**

In a review of the 2016 AEMP Annual Report, NSC (2017a) had commented on the exclusion of data for TN at site LDG-48 in the spatial extent analysis. This comment indicated: "Comment 1: Section 2.1.2 of Appendix XIII (page 5) indicates that no sample was collected from LDG-48 (the outlet of the lake) in the open-water season. As a result the spatial extent of effects on total nitrogen and cumulative effects were not assessed for the northwest area of the lake beyond sites FFA-4 and FFA-5..."

While it is understood that sampling methods employed in the water quality monitoring program are not consistent with those for the eutrophication monitoring program, the TN concentration measured at LDG-48 in August, 2016 (174 µg/L) under the water quality program was above the normal range (122-153 µg/L) for the open-water season. Based on this measurement, the spatial extent of effects extended through the northwest portion of the lake (i.e., effectively 100% of the lake area).

It was recommended to incorporate data collected at site LDG-48 during the water quality monitoring program into the eutrophication analyses and reporting (i.e., spatial extent analysis) and update maps and spatial extent of effects estimates.

This comment is re-iterated for consideration with respect to the current report.

**Recommendation 2:** Add discussion in the report to note that the spatial extent of effects in 2016 could have extended through the entire lake. Include caveats respecting differences in sampling methods if appropriate.

### 2.4.2 Spatial Extent Of Effects – Chlorophyll A

Section 5.3.1.1 (page 258) indicates: "The extent of effects on TN increased between 2007 and 2016, and has consistently shown an affected area >20% since 2008, while the spatial extent of effects on other indicators of eutrophication (i.e., TP, phytoplankton and zooplankton biomass) has decreased."

This statement does not apply for chlorophyll \(a\) where effects were greater in 2014 and 2016 than all other years (see Figure 5-3 and Table 5-7, pages 263 and 261, respectively).
Recommendation: Please review accuracy of results presented and modify text accordingly.

2.4.3 Spatial Extent Of Effects Discussion

Far-field areas were not sampled in 2014 or 2015, as noted in the report. However, as noted in previous review comments (NSC 2016), the lack of data for these sites in these years has limited the ability to accurately define the spatial extent of effects for TN and/or chlorophyll $a$ as boundaries of the affected area(s) extended to the edge of MF sites. Without data for the FF sites in 2014 and 2015 it cannot be determined if the affected areas were in fact similar among the last three years of the program (i.e., 2014-2016) or what the actual spatial extent of effects were in those 2 years.

This limitation should be noted in the text and considered in terms of interpretations presented regarding inter-annual differences and/or trends. For example, the text in Section 5.3.1.1 (page 258) reads: “Similarly, the greatest extent of effects on chlorophyll $a$ concentrations was observed in 2016 (250.4 km$^2$, or 43.7% of lake area), closely followed by 2014 (≥242.8 km$^2$, or ≥42.4% of lake area) (Figure 5-3; Table 5-7).” However, because the boundary for 2014 is actually undefinable due to the lack of data for the FF sites, the affected area may in fact have been larger in 2014 than 2016. This limitation must be clearly identified in the text.

Similarly, the statement on page 259 that reads: “The extent of effects on chlorophyll $a$ concentrations along the NF-MF3-FFB-FFA transect did not extend beyond the MF3-7 station between 2007 and 2016…” should be modified to reflect the lack of data for the FF sites in 2014. In that year, the extent of effects extended to MF3-7 to the west but due to the lack of data for the FFA and FFB site in that year, the western boundary cannot be defined accurately (it may have extended further).

It is also suggested that all figures should be modified to clearly show that FF sites were not sampled in 2014 and 2015. Indicating the extent of effects boundaries with a dashed line to denote the boundary cannot be accurately defined would clarify this point.

Recommendation: Please include discussion of the lack of FF data for 2014 and 2015 and the implications regarding limitations on defining the spatial extent of effects in those years. Modify figures to clearly indicate sites that weren't sampled in a given year.

2.4.4 Weight-Of-Evidence (WOE)

Weight-of-evidence ratings for eutrophication indicators are not presented for 2014 and 2015 in Table 5-8 (page 267). There is no explanation provided for the omission of results for these two years.

Section 5.2.3.3 (page 255) indicates that "The indicators of eutrophication data from 2014 and 2015 were not assessed following the AEMP Study Design Version 3.5 (Golder 2014a) because
only NF and MF area data were collected in those years." However, Table 5-6 (page 255) that follows this text indicates that the effect rating for nutrients is based solely on comparison to normal ranges (and not to FF data). These results should therefore be incorporated into Table 5-8.

**Recommendation:** Please provide a discussion of the reason for the omission of 2014 and 2015 data in Table 5-8 and add ratings for TN and TP for 2014 and 2015.

### 2.4.5 Temporal Trends – Total Nitrogen

Section 5.3.4.2 (page 286) indicates: "The more recent elevated concentrations at several NF, MF and FF area stations may in part reflect the change in labs from UofA to Maxxam that occurred in 2013 (Golder 2016a)."

As this factor may have substantive implications with respect to tracking changes in nitrogenous parameters over time, there would be benefit to expanding this discussion to elaborate on potential implications of the laboratory change.

**Recommendation:** Please provide additional discussion of the implications of laboratory changes on nitrogen monitoring results and trend analyses.

### 2.5 SEDIMENT QUALITY

#### 2.5.1 Weight-Of-Evidence Effect Ratings Methods

Table 6-3 (Section 6.2.3.2, page 338) indicates a rating of "No action" if an interim sediment quality guideline (ISQG) is not exceeded and an "early warning/low" rating in the NF is statistically higher than the FF for the WOE assessment for sediment quality.

It is unclear what occurs in the event that a statistically significant difference is observed between NF and FF results but the concentrations are below the ISQG. In addition, there are parameters without defined benchmarks. It is unclear how the ISQG comparison is applied in the framework.

**Recommendation:** Please clarify application of the WOE rankings.
Table 6-3  Effect Level Rations Applied for Sediment Quality the normal range

<table>
<thead>
<tr>
<th>LOE Group</th>
<th>Measurement Endpoint Analysis</th>
<th>No Response</th>
<th>Early Warning/Low</th>
<th>Moderate</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment Quality (substances of potential toxicological concern)</td>
<td>Comparison to FF Areas, Normal Range, and Guidelines(a)</td>
<td>&lt;ISQG</td>
<td>Statistically significant increase, NF vs FF areas</td>
<td>Low + NF &gt;[(ISQG+PEL)/2 (or other appropriate guideline)] AND NF area median &gt;normal range</td>
<td>MF &gt;[(ISQG+PEL)/2 (or other appropriate guideline)] AND MF area median &gt;normal range OR NF &gt;PEL AND NF area median &gt;normal range</td>
</tr>
</tbody>
</table>

Notes: NF = near-field; MF = mid-field; FF = far-field; LEL = lowest effect level; PEL = probable effect level, SEL = severe effect level; SOI = substance of interest; ISQG = interim sediment quality guideline; >= greater than; <= less than. Normal ranges for each LOE group and measurement endpoint are defined and provided in the AEMP Reference Conditions Report Version 1.2 (Golder 2017b).

(a) Applied separately for each variable.

(b) For example, the OMOEE (1993) [LEL+SEL]/2.

2.5.2  Trend Analysis Methods

Section 6.3.3 (page 344) indicates: "Trend analyses were performed following normalization of the data by TOC [total organic carbon] or percent fines, where applicable, and transformation of data using Box-Cox transformations."

It is agreed that normalization of data for confounding variables (fines and TOC) is appropriate and provides a means to evaluate changes in metals and nutrients independent of changes/variability in these supporting variables (i.e., standardization of data). However, it would also be of interest to know if absolute concentrations (i.e., raw data) also show trends over time. This would be particularly pertinent if there have been mine-related changes in either supporting variable. For example, if there is a mine-related increase in TOC concentrations, the higher TOC may also result in higher metals and/or nutrients due to the affinity of these substances to organic matter. In addition, from a biological perspective, it is the absolute concentrations that are relevant.

**Recommendation:** Please clarify if trends were also evaluated on raw data for all of the substances of interest (SOIs). If this analysis has not been done, please provide a discussion of the rationale for excluding these analyses.

2.5.3  Trend Analysis Results - Nutrients

Section 6.3.3.2 (page 350) indicates: “Concentrations of TN were considered atypical in 2013, and inconsistent with other years’ results, most likely due to a difference in laboratory methods in 2013 relative to other years (Golder 2017c).”
We agree that the 2013 TN data for sediments is anomalous (NSC had noted this in comments provided on the Reference Condition Report Supplement v. 1.2 supplement; NSC 2017b) and may indeed be related to changes in the laboratory method. Given this anomaly, it would be more appropriate to exclude the 2013 data from the trend analysis, or at a minimum, present a trend analysis with and without the 2013 data. It was noted in the report: “These trends should be interpreted with caution, due to the uncertainty in the 2013 TN data noted above.”

**Recommendation**: Conduct trend analysis excluding 2013 TN data.

### 2.5.4 Trend Analysis Results – Data Presentation

Section 6.5 (Page 371) indicates: "Concentrations of certain metals, such as arsenic and cadmium, in sediments throughout Lac de Gras were above SQGs [sediment quality guidelines]. These variables generally reflected patterns in TOC content of bottom sediments or background variation in sediment quality, and had no clear spatial trends related to the Mine."

Since report figures presenting sediment quality results do not include SQGs, it is difficult to evaluate the occurrence and magnitude of exceedances of SQGs over time. For example, information as presented is inadequate to determine in what years, by what magnitude, and at which sites that cadmium and arsenic exceed SQGs. This visualization is important for critically reviewing the information and examining trends and identifying potential emerging trends.

**Recommendation**: Add benchmarks (i.e., SQGs) to sediment quality figures.

### 2.6 PHYTOPLANKTON

#### 2.6.1 Phytoplankton Normal Range Evaluation

The evaluation of the phytoplankton normal range presented in the report concluded (Section 7.3.2.1.3, page 408): "Overall, based on the clear differences in the data sets produced by the two different taxonomists, the “adjusted” 2013 normal range (referred to going forward as the “2013 normal range”) is recommended for comparisons from 2013 onwards."

It would appear based on the information presented in this section, that comparisons to the 2007 to 2010 normal ranges, which were based on data from a different taxonomist, moving forward would be inappropriate (i.e., there is evidence of a laboratory difference). However, as also noted in the report, the use of a single year of data to derive a normal range (2013) is also associated with issues (i.e., it does not incorporate inter-annual variability). Use of more than one year of data to derive normal ranges would be more scientifically appropriate.

**Recommendation**: Please comment on the appropriateness of deriving updated normal ranges using one year of data and if the normal ranges will be recalculated in the future with additional data to account for inter-annual variability.
2.7 FISH HEALTH

2.7.1 Comparisons To Critical Effect Sizes

Section 9.2.1.3.7 (page 509) states: "As per the MMER TGD (Environment Canada 2012), a Critical Effect Size (CES) is defined as “a threshold above which an effect may be indicative of a higher risk to the environment” (Environment Canada 2012). CES are defined for fish weight, relative liver size and relative gonad size as 25% of the reference area mean, and for condition as 10% of the reference area mean (Environment Canada 2012). The variables that triggered Action Level exceedances in 2016 were compared to the CES."

It would seem appropriate to also compare Action Level exceedances from other years to the CES. In addition, there is no indication of what was defined as the "reference area mean" for making comparisons in the CES evaluation.

**Recommendation**: Include comparisons to CES for all years in which an Action Level exceedances occurred. Add description of how "reference area mean" was defined.

2.7.2 Magnitude Of Effect - CES Comparisons

With respect to fish health analyses, according to Table 9-12 (page 535), CES values could not be calculated for LSI because of significant interaction ("Area-specific interpretation not possible due to significant interaction"). However, the report indicates there was a minimum of one significant interaction for the ANCOVAs for condition, liver somatic index (LSI) and gonadosomatic index (GSI; page 519). It is unclear why CESs were derived for condition and GSI but not for LSI.

Furthermore, it is unclear what the approach is, and will be in the future, in the event that CESs cannot be calculated for metrics with “significant interactions”. If CESs cannot be assessed for this or other reasons, a metric can never trigger Action Level 3 or beyond since they cannot meet a requirement of Action Levels 2 or 3 according to Table 14-2 (page 6-17), which requires that "an effect size equal to or above the critical effect size defined by the EEM [environmental effects monitoring]."

**Recommendation**: Please provide a discussion of how action level comparisons will be made in the event of "significant interaction" issues with data analysis.

2.7.3 Weight-Of-Evidence Ratings

Section 9.3.2.4 indicates that the 2010 results were included in the WOE ratings. However, Section 9.2.1.1 (pages 501-502) indicates that 2010 was excluded from the analysis for most variables due to seasonal effects associated with the change in sampling time (i.e., spring versus fall). The report states (page 502) that growth and organ weight were expected to be different due to seasonal effects. Therefore, it is unclear why 2010 has been included in the WOE analysis. It is
more likely the change in endpoints listed in Table 9-11 (growth, condition, and LSI) were related to seasonal effects rather than enrichment.

**Recommendation**: Update the WOE analysis to exclude 2010 due to methodological differences or provide an explanation for inclusion on 2010 data in this analysis.

### 2.7.4 Exceedance Of Action Levels And Assessment Of Response Framework

With respect to fish health analyses, according to Table 9-12 (page 535), CES values could not be calculated for LSI because of significant interaction (“Area-specific interpretation not possible due to significant interaction”). However, page 519 indicates there was a minimum of one significant interaction for the ANCOVAs for condition, LSI and GSI (page 519). It is unclear why CESs were derived for condition and GSI but not for LSI.

Furthermore, it is unclear what the approach is and will be in the future in the event that CESs cannot be calculated for metrics with “significant interactions”. If CESs cannot be assessed for this or other reasons, a metric can never trigger action level 3 or beyond since they cannot meet a requirement of action levels 2 or 3 according to Table 14-2 (page 617), which requires that "an effect size equal to or above the critical effect size defined by the EEM".

**Recommendation**: Please provide a discussion of how action level comparisons will be made in the event of "significant interaction" issues encountered in data analysis.

Revisit CES calculation for variables analyzed with ANCOVA with significant interaction.

### 2.8 FISH TISSUES

#### 2.8.1 Methods – Lake Trout

Section 9.3.1.1.2 (page 538) of the report identifies various sources of Lake Trout mercury data included in the report and analyses: “Tissue mercury samples in 2005 and 2008 were analyzed by ALS with a DL of 0.01 \( \mu g/g \) wwt [wet weight]. The 2008 mercury samples were also analyzed by Flett (Flett Research Ltd.), Winnipeg, Manitoba, with a DL 0.0004 \( \mu g/g \) wwt. The 2011 and 2014 mercury samples were analyzed by Flett. The palatability study samples (i.e., 2002, 2003, 2004, 2012 and 2015) were analysed by ALS with a DL of 0.01 \( \mu g/g \) wwt.”

However, it is difficult for the reader to ascertain what data were included, what methods were employed, and what analytical laboratory and detection limits are associated with the data presented in the report. For example, page 538 indicates that samples were analysed at both ALS Laboratories and Flett Research in 2008 but the report does not indicate which of the two datasets were incorporated into analyses and the results presented in the report.

The lack of clarity regarding these methods and metadata render it difficult for the reader to critically evaluate the approach taken and subsequent conclusions borne from the analyses.
presented in the report. For example, changes in analytical laboratories may affect conclusions and/or interpretation of data, including trend analyses.

**Recommendation**: Please add a summary table identifying, by year, analytical laboratories used and explicit identification of data incorporated in the analyses.

### 2.8.2 Lake Trout Mercury Benchmark

The report applies a potential effects benchmark/tissue residue guideline for mercury of 1.0 μg/g wet weight from Jarvinen and Ankley (1998) for evaluating effects on fish (i.e., Lake Trout) health (Section 9.3.1.3.3, page 546). The report states: “This is likely a very conservative benchmark; Environment and Climate Change Canada [ECCC] recently conducted a review of mercury in the Canadian environment and noted that the lowest adverse effect concentrations would be 0.5 to 1 mg/g wet weight in fish species such as Northern Pike and Walleye (ECCC 2016), many times higher than using the generic benchmark.”

The report incorrectly states the benchmark - or Lowest Observed Adverse Effect Level (LOAEL) – presented in the ECCC review; ECCC (2016) identifies an LOAEL of 0.5-1.0 μg/g. Section 9.3.1.3.3 indicates an incorrect unit of mg/g (a thousand fold difference).

The conclusion presented in Section 9.3.2.3 (page 570) that “Lake Trout health is unlikely to be affected” and that “on the basis of the most recent mercury concentrations in Lake Trout from each lake (2014), no concerns to ......fish health are expected” is based on a misinterpreted benchmark. Mercury concentrations presented in Figure 9-34 (page 567) and Table 9-25 (page 572) indicate that mercury concentrations in individual Lake Trout from both lakes have frequently been in the range of 0.5-1.0 μg/g between 2005 and 2015.

**Recommendation**: Reassess conclusions on potential effects of muscle mercury concentrations on fish health based on appropriate guidelines.

### 2.8.3 Slimy Sculpin Mercury Comparison To Normal Ranges

Section 9.3.2.1, Figure 9-22 (page 551) indicates that mercury concentrations in Slimy Sculpin in the NF in 2007 were almost an order of magnitude higher than in 2013 and 2016 and concentrations in two samples were approaching the Canadian Food Inspection Agency (CFIA) and Health Canada guideline of 0.5 μg/g wet weight for human health consumption (CFIA 2015) applied in the report. Concentrations in sculpin from the far field in 2007 were also substantially higher than the results for 2013 and 2016.

Section 9.3.2.2 (page 556) indicates that: “Many of the variables that had either a significant interaction or a significant year effect decreased over time and are, therefore, not considered further. These variables include arsenic, barium, magnesium, mercury, selenium, sodium, titanium, vanadium, and zinc (Table 9-19).”
The notably high mercury concentrations reported for 2007 should be discussed and potential reasons for these differences should be identified. For example, it is noted in Section 9.3.1.1.1 (page 536) that although all samples for 2007, 2013, and 2016 were analysed at ALS Laboratories, the 2007 samples were analysed at the Edmonton, AB laboratory while samples from the latter two years were analysed at their Burnaby, BC laboratory. Has the change in laboratory been evaluated as a potential cause for the differences or are there environmental factors that may have caused or contributed to the high concentrations in 2007? The high concentrations observed in 2007 also result in a decreasing temporal trend; should there be issues with this dataset, these should be identified in order to avoid biasing trend analyses here and into the future.

**Recommendation:** Include a discussion of the high mercury concentrations in Slimy Sculpin in 2007 and explore potential explanations for the relatively high concentrations observed in that year, notably for the near field area. If data are deemed to be suspect, trend analysis should be revisited. This is particularly critical given that the results of the trend analysis are the foundation for determining if a Lake Trout mercury survey is to be conducted.

### 2.8.4 Lake Trout Mercury Temporal Trends

Section 9.3.2.2 (page 566) indicates: "In 2014, mercury was detected at near or below baseline concentrations in both Lac de Gras and Lac du Sauvage."

There is no previous description of what constitutes "baseline" for mercury concentrations in Lake Trout.

**Recommendation:** Please include a description of what baseline mercury concentrations in Lake Trout are and how they were derived.

### 2.9 PROPOSED UPDATES TO AEMP DESIGN PLAN

#### 2.9.1 Non-Lethal Fish Survey

It is unclear how the addition of a non-lethal sculpin survey, as described in Section 14.2.2.1 (page 607) will be incorporated into the assessment of effects. There will be no ability to compare the results of the first year of sampling to any previous data as the data collected and sampling strategy are different. Therefore, the first comparison could only be done after 6 years, since the sampling is recommended to occur every three years (Section 14.2.2.2). Furthermore, this dataset will lack baseline or early post-project data with which to compare. If normal ranges are utilized as per the lethal assessment, then the first two sampling years at a minimum will be needed to construct these ranges. If this is the case, then it would not be possible for these data to trigger an Action Level 3 for the first two sampling periods as, according to Table 9-4 (page 509), this requires data to be outside of the normal range.
**Recommendation**: Provide explanation of how this sampling program will be used within the existing effects assessment structure.

### 2.9.2 Weight-Of-Evidence

Section 14.2.8 (page 611) indicates: "In their Reasons for Decision, WLWB (2017e; Section 3.12, Part 2e) recommends that benthic macroinvertebrate density be added as a nutrient enrichment exposure endpoint of the fish population health ecosystem component, or that rationale be provided for the omission (Table 1-1). Chlorophyll a is currently included as a nutrient enrichment exposure endpoint for the fish population health ecosystem, which is intended to be indicative of food supply. It is assumed that an increase in the biomass of algae as measured by chlorophyll a provides an early indication of an enrichment-related increase in zooplankton and/or benthic invertebrate food supply for fish. Adding benthic invertebrate abundance or density would be redundant considering there is already a conservative measurement of enrichment-related food supply in the WOE analysis. Moreover, the benthic invertebrate community samples are collected from deep-water stations and as such the abundance or density from these samples are not representative of food supply for shallow-water, shoreline-dwelling Slimy Sculpin."

Because chlorophyll $a$ is measured once per year and is inherently more variable in time and space than benthic invertebrate community metrics, the latter would provide a more integrative representation of effects related to nutrient enrichment.

**Recommendation**: Incorporate benthic invertebrate density in the WOE, as suggested by the WLWB.

### 2.10 QUALITY ASSURANCE/QUALITY CONTROL MEMORANDUM:

#### 2.10.1 Slimy Sculpin Liver Correction Factors

The Review of the 2016 AEMP report identified the exclusion of sculpin livers from tissue chemistry analysis in 2016 as an issue (NSC 2017a). The methods described in the report and QA/QC memorandum to prevent future sampling errors are acceptable. However, the method to account for the omission of livers in tissue analyses in 2016 is imprecise.

The concentration of elements in the livers of Slimy Sculpin has been estimated through extrapolation from two extremely dissimilar species (Lake Trout and Round Whitefish). It is assumed data for these species were used due to lack of similar data for sculpin. However, it is well established that the accumulation of elements in fish tissue is species-specific (e.g., Djikanovic et al. 2016; Farkas et al. 2000; Jordaan et al. 2016).
There is a precedent in the report regarding treatment of data with similar issues. Section 9.3.1.1.1 (pages 535-536) indicates that the 2004 samples were not included in the analysis as a result of the exclusion of livers (as well as most of the head and gas bladders) from the samples.

**Recommendation:** Unless it can be reasonably demonstrated that Lake Trout and Round Whitefish are a good model for Slimy Sculpin, it is recommended that the 2016 data be treated in the same manner as the 2004 samples, which also excluded liver tissue (i.e., omit them from future analyses).

### 2.11 SPECIFIC AEMP COMPONENT REVIEWS

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 AERR.

<table>
<thead>
<tr>
<th>TOPIC</th>
<th>COMMENT</th>
<th>RECOMMENDATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MAIN DOCUMENT, General Comment</strong></td>
<td>There are a number of instances where figures cited in the text are not presented (e.g., Fig 2-1 to 2-5 on p. 13), figures are presented with no reference in the text (e.g., Figures 9-11 to 9-18, Figures 9-27 to 9-32), and tables and figures (e.g., Table 9-11 on p. 570 should be 9-24) or sections (e.g., Section 9.3.2.1 on p. 583) are incorrectly cited in the text.</td>
<td>Complete a careful review of table, figure, and section referencing throughout the document.</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, General Comment on Temporal Trends (various sections)</strong></td>
<td>The report does not include a discussion of what significant year - area interactions mean for the Fixed Effect Model.</td>
<td>Provide an explanation of the results of statistical analyses in a more lay manner so readers can better understand the results.</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, Various Sections</strong></td>
<td>There are several instances throughout the document where the construction of the A21 dike is discussed as having had a potential effect on water quality and other components within the MF area. A map showing the location of the dike and other mine related infrastructure in relation to the sampling locations should be presented to assist in explaining why these effects would be seen within the MF areas and not elsewhere.</td>
<td>A map showing the location of the A21 dike in relation to the sampling sites should be added.</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, AEMP Design Summary and Re-evaluation Methods, Section 2.2.2 Sampling Areas and Stations, page 13</strong></td>
<td>The text references Figures 2-1 to 2-5 but figures are not included.</td>
<td>Add figures to the report.</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, Dust Deposition, Section 3.2, Methods, page 25</strong></td>
<td>The report states: &quot;Analysis was undertaken to evaluate temporal or spatial trends in dust deposition rates, deposition of dustborne nutrients (i.e., total phosphorus [TP], orthophosphate [OP], nitrate plus nitrite [N+N], and ammonia), and deposition of two dust-borne metals indicative of metal deposition in general (i.e., aluminum and lead).&quot; It is not clear why the evaluation only included two metals (aluminum and lead).</td>
<td>Please provide a detailed rationale for focus on only two metals (aluminum and lead).</td>
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<td><strong>MAIN DOCUMENT, Dust Deposition, Section 3.2.2, Data Handling, page 27</strong></td>
<td>The report states: &quot;Snow water concentrations of some nutrients and metals were below the analytical DL. These data were included in the analysis by substituting values of half of the detection limit (DL) during the re-evaluation. However, in the snow chemistry data, there were different DLs from different testing laboratories and for different years. For example, three DLs were reported for the TP data (0.001 mg/L, 0.005 mg/L and 0.002 mg/L). Data with variable DLs were excluded from the analysis as per Table 3-2. The percentage of below DL data ranged from 1.6% for aluminum to 27.0% for OP.&quot; However, the remainder of the section seems to imply that values below the DL were removed (e.g., last line page 28 states &quot;Following the removal of data below DLs and outliers, duplicates were averaged to obtain a representative value&quot;). It is unclear what specific data points were omitted from the analysis.</td>
<td>Text should be reviewed and adjusted as needed to clarify what data were removed and what were retained. Censored values should be retained when possible and not removed unless absolutely necessary.</td>
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<tr>
<td><strong>MAIN DOCUMENT, Dust Deposition, Section 3.2.2, Data Handling, page 27</strong></td>
<td>It is indicated that outliers were identified as data points with Z-scores that were greater than 3. This differs from the Z-score value of 3.5 that was given in Section 2.4.2.3 (page 19) of the AEMP methods for identification of outliers. It is not clear why a different standard was applied to the dust data.</td>
<td>Please verify the Z-score applied and provide an explanation if a different standard was applied for outlier identification.</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, Dust Deposition, Section 3.2.2, Data Handling, page 29, Table 3-4</strong></td>
<td>The second last column in the Table 3-4 (lead, deposition, mg/m2/yr) requires correction of some values (some values reported as &quot;0.00&quot;).</td>
<td>Review and correct results presented in Table 3-4.</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, Dust Deposition, Section 3.2.2, Methods, Data Handling, page 29, Table 3-4</strong></td>
<td>The sample duplicate results are presented in Table 3-4 (page 29) for only a subset of parameters. The document should review all parameters to provide for an evaluation of QA/QC for the program as a whole. While annual reports discuss details for all parameters, the re-evaluation report is the location where data for numerous years are considered collectively. Issues with and/or patterns in data may not be readily apparent until data are reviewed for all years together.</td>
<td>Include duplicate sample results and discussion of these data for all parameters. A table presenting a summary of the analysis of the duplicate results (e.g., relative percent mean differences) could be provided in an appendix. This would also facilitate a thorough review of the QA/QC program as per the directive from the WLWB and assist with determining if any changes to the program are warranted.</td>
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<td><strong>MAIN DOCUMENT, Dust Deposition, Section 3.2.3.1, Methods, Data Analysis, Temporal Grouping, page 30</strong></td>
<td>The report states: &quot;Dust deposition data and snow chemistry data were grouped into time periods to reflect changes in mining activities over time at the Mine. The time period groups were as follows: - 2002 to 2005: open pit mine construction and open pit mining - 2006 to 2009: underground mine construction and open pit mining - 2010 to 2013: open pit transition to underground mining - 2014 to 2016: underground mining with re-mining of the Waste Rock Storage Area – North Country Rock Pile&quot;</td>
<td>Please provide a discussion of whether more short-term effects have been observed for dust deposition, as it may pertain to pooling of multiple years of data. If short-term recent trends have been observed, these should be presented in the report.</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, Dust deposition, Section 3.2.3.3, Methods, Data Analysis, Normal versus Log-Normally Distributed Data, page 31</strong></td>
<td>The last line states &quot;In these instances, geometric means and SDs are more appropriate for computing statistics and comparing results (e.g., using Student’s $t$-tests).&quot; This thought is incomplete; geometric means and SDs are more appropriate than what?</td>
<td>Please clarify.</td>
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<tr>
<td><strong>MAIN DOCUMENT, Dust Deposition, Section 3.2.3.4, Methods, Data Analysis, Background Deposition Rates, page 31</strong></td>
<td>For dust deposition &quot;background&quot; was defined as rates that were &quot;not significantly different from rates observed at the control stations.&quot; This assumes that the control sites were not affected by the mine. This assumption if incorrect could result in an underestimate of the impact of mine dust on Lac du Gras.</td>
<td>Please add a discussion of the validity of this assumption to the report.</td>
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<tr>
<td><strong>MAIN DOCUMENT, Dust Deposition, Section 3.3.1.1, Results, Dustfall, pages 34-35</strong></td>
<td>Dust deposition results for sites not significantly different from control sites were &quot;pooled to form a composite estimate of background dust deposition&quot; (page 34). While this approach may be reasonable for some of the sites, at least one site (SS5-4) has a notably high mean rate for the 2014-2016 pooled time period (i.e., more than four times the control sites). The lack of a statistically significant difference between this site and the formal “control sites” may reflect high variability in the data set and identifying this site as &quot;background&quot; does not seem to be appropriate based on the information presented. Inclusion of error bars on the figure (and other similar figures) would assist with review of these data.</td>
<td>Include error bars on figures and provide clarification on the appropriateness of the approach for designating sites as &quot;background&quot;.</td>
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<td>In addition, deposition rates for site SS5-4 reported in the 2014, 2015, and 2016 annual AEMP reports (Golder 2016a,b, and 2017) were 47, 43, and 38 mg/dm2/yr, respectively. The mean reported in Figure 3-4 and Table 3-5 (279 mg/dm2/yr) contradicts these values.</td>
<td>Please verify that the mean deposition rates presented for site SS5-4 are correct. If correct, suggest reconsidering designation of this site as &quot;background&quot;.</td>
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<td>MAIN DOCUMENT, Dust Deposition, Section 3.3.1.1, Results, Dustfall, page 35, Figure 3-4 and Table 3-5</td>
<td>Figure 3-4 and Table 3-5 present the mean dustfall deposition rates for control stations and stations where rates were not significantly different from the control sites. Both would benefit from inclusion of a measure of variability to assist the reviewer with understanding the variability of the pooled data sets. This is particularly important given that several years of data were pooled and that variability of the data sets would affect the statistical analyses and ultimately the treatment of data as &quot;background&quot;. Table 3-5 has a footnote that does not seem to apply to the table. &quot;N/D = no data; mean = temporal arithmetic mean; geomean = spatial geometric mean&quot;. Both the table and figure should indicate what the values presented represent (e.g., arithmetic mean).</td>
<td>Please include bars/values to illustrate variability with the data (confidence intervals or standard error depending on what the data are that are presented) on Figure 3-4 and Table 3-5 and subsequent similar tables and figures. Add additional explanatory information regarding the values presented.</td>
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<tr>
<td>MAIN DOCUMENT, Dust Deposition, Section 3.3.2, Results, Annual and Seasonal Trends, page 41, Figure 3-8</td>
<td>Figure 3-8 presents seasonal plots of dust deposition and includes point measurements and trend lines. Section 3.2.3.5 (page 31) indicates that the medians for each season are plotted for the trend analysis; trends were then visually assessed. Other figures and tables appear to present data as means rather than medians. There does not appear to be a discussion of why medians were used for the trend analysis and it is unclear if this is the most appropriate metric for this assessment. In addition, figures lack sufficient information to determine what is presented (e.g., means or medians) in this section.</td>
<td>Provide a discussion or rationale for the use of medians for trend analysis and add sufficient details to figures and tables to allow the reader to readily identify what is presented.</td>
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<tr>
<td>MAIN DOCUMENT, Dust Deposition, Section 3.3.4, Results, Spatial Distribution of Environmental Loadings, pages 53 to 56</td>
<td>It is indicated that background deposition rates of phosphorus and metals increased from 2010-2013 to 2014-2016 but no explanation is given as to why rates increased. This may be indicative of a mine-related influence in the latter period.</td>
<td>Include a discussion of possible explanations for the increase in background deposition rates.</td>
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<td>MAIN DOCUMENT, Effluent and Water Quality, Section 4.2.4.2.2, Methods, Temporal Trends, page 84 and Section 4.3.2.1.1, Results, Temporal Trends, pages 130-133, Figures 4-35 to 4-38</td>
<td>The report states: &quot;Data are provided for DO, temperature, specific conductivity, and pH from 1996 to 2016, when available, at the following locations: NF; MF1-3; FF2-2; MF3-4; FF1; FFB; and FFA; these are the long-term monitoring stations that were selected for the detailed trend analysis.&quot; There is no discussion provided as to the rationale for why these sites were selected for trend analysis and it is not clear what individual sites are plotted in Figures 4-35 to 4-38 (pages 130-133). For example, Figure 4-35 (page 130) shows &quot;NF&quot; results but it is not clear what NF site is plotted. This also applies for the FFA, FFB, and FF1 &quot;sites&quot; referred to above.</td>
<td>Please clarify what data were presented and a rationale for selecting a sub-set of sites for analysis.</td>
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<tr>
<td>MAIN DOCUMENT, Effluent and Water Quality, Section 4.3.1.3, Results, Effluent and Mixing Zone, Effluent Toxicity, page 125</td>
<td>Section 4.3.1.3 indicates six effluent samples showed sub-lethal toxicity; however Table 4-10 indicates only five samples showed sub-lethal toxicity, excluding the sample from June 2009 for which a re-test revealed the sample was non-toxic. The text further identifies five dates, including June 2009, for which sub-lethal effects occurred. There are inconsistencies between the text and table that should be corrected.</td>
<td>The text and table should be reviewed and updated as appropriate to clarify the findings.</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Effluent and Water Quality, Section 4.3.2.1.1, Results, Water Quality, Temporal Trends, Depth Profiles, page 129</td>
<td>Paragraph 2 identifies &quot;...DO concentrations during ice-cover that were at or below the Effects Benchmark of 6.5 mg/L for the protection of aquatic life (PAL) for &quot;other&quot; life stages (i.e., non-early life stages).&quot; During the ice-cover season the CCME 9.5 mg/L benchmark for early life stages would be more appropriate for fall spawning species such as Lake Trout. In addition, there is no discussion of whether DO concentrations were above or below benchmarks for the open-water season.</td>
<td>The DO data should be compared to the appropriate benchmarks and the findings reported. Include a discussion comparing DO results for the open-water season to PAL guidelines.</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Effluent and Water Quality, Section 4.3.2.1.1, Results, Water Quality, Temporal Trends, Depth Profiles, page 129</td>
<td>Paragraph 3 discusses in situ pH data and the last line indicates that &quot;...pH values below 5.0 or greater than 8.0 are anomalous.&quot; This is likely a valid statement as in situ pH data are prone to error due to equipment problems or poor calibrations; however it would be useful to include comparison to or discuss laboratory measured pH values if they are available to justify exclusion of these data as &quot;anomalous&quot;.</td>
<td>If laboratory pH data are available, include a comparison to in situ data to justify exclusion of data as &quot;anomalous&quot;.</td>
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<td><strong>MAIN DOCUMENT, Effluent and Water Quality, Section 4.3.2.1.1, Results, Water Quality, Depth Profiles, page 130-133</strong>&lt;br&gt;It is difficult to discern individual years in the depth profile figures presented on pages 130-133 (Figures 4-35 to 4-38). In particular, the figures do not clearly show results for pre-Project data making it difficult to assess whether any changes appear to have occurred post-Project. This confounds evaluation of the results that are presented. For example, it is noted that pH values frequently fell outside of the CCME PAL guideline range (6.5-9). To interpret the implications of this occurrence, it is important to consider baseline conditions in the lake; as the figures are presented, baseline results are not easily visualized in the figures.</td>
<td>Modifications to the figures would be beneficial to assist the reviewer with discriminating annual results and, in particular, distinguishing baseline from post-Project results. Suggest re-formatting figures to render them clearer. It would also be beneficial to include a brief discussion, where applicable, noting changes between the pre- and post-Project time periods. This would be notably useful for pH and DO results, where monitoring has shown exceedances of benchmarks. Consider examination of DO results as percent saturation values to evaluate trends over time.</td>
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<td><strong>MAIN DOCUMENT, Effluent and Water Quality, Section 4.3.2.1.1, Results, Water Quality, Depth Profiles, page 130-131</strong>&lt;br&gt;While it is understood that water quality sites were relocated or replaced over time as part of the AEMP, several sites, as noted in Figures 4-35 and 4-36, were at deeper locations prior to 2007. For some of these sites, depth profile data indicate DO concentrations were relatively low near the bottom of the water column (at depths greater than those sampled after 2007). It is difficult to discern years in Figure 4-35, and therefore identify pre- vs. post-Project results. However, given that DO has been observed to drop to low levels at depth in previous years it would be relevant to monitor DO and temperature at deeper locations in the lake to monitor for changes over time. This is notably relevant given that nutrient enrichment, and increases in primary productivity (i.e., phytoplankton) have been observed post-Project; nutrient enrichment can lead to depletion of DO in aquatic ecosystems in winter due to accumulation and decay of organic materials.</td>
<td>While it is understood that modifications to the program design are outside of the scope of this document, it is noted here that the results presented in the Re-evaluation Report indicate a potential need to expand the DO monitoring in Lac de Gras. It is recommended that this modification be considered moving forward and at a minimum, that an analysis of pre- vs. post-Project DO data be reviewed, focusing on deeper sites within the lake.</td>
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<td><strong>MAIN DOCUMENT, Effluent and Water Quality, Section 4.3, Results, Water Quality, General</strong></td>
<td>Trend analysis in the main report is based on data collected at mid-depth in the water column. While it is understood this approach renders it more feasible to compare across sites (as sites are not sampled in the same manner), this focus precludes consideration of effects on water quality near the bottom of the water column at the NF sites. Water quality is affected differently at depth at the NF sites due to the influence of the effluent discharge. For example, conductivity is notably elevated in the lower portion of the water column at these sites (see Figure 4-38, page 133 for example). A similar comment was made on the 2016 AEMP Report: &quot;Medians of water quality parameters in the NF area were calculated from data pooled across all sample depths, dates and stations (n = 15 samples; Appendix II, Section 3.4.1, page 64, Table 3-5). When water quality is relatively consistent across depth this approach is reasonable and appropriate. However, in instances where conditions vary across the water column such as in winter when the effluent plume is more evident near the bottom of the water column, it may be more conservative to examine data for each sampling depth separately. If effects are greatest near the bottom of the water column, potential effects on benthos would be better represented by the bottom water quality samples.&quot; (NSC 2017a).</td>
<td>Consider a more in-depth assessment for bottom samples, in particular for the NF sites.</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, Effluent and Water Quality, Section 4.3.2.1.2, Results, Water Quality, Discrete Samples, page 133</strong></td>
<td>The report states: &quot;Time series plots showing mid-depth concentrations of SOIs at AEMP stations in Lac de Gras and Lac du Sauvage, near the outlet to Lac de Gras, are presented in Figures 4-39 to 4-93. Mid-depth concentrations are presented herein, because that is the depth where the effluent plume is most likely to be present in a typical year considering the full period of record (see Section 4.3.2.1.1, Figure 4-38; Appendix 4C).&quot; It is acknowledged this is accurate for many years and that focus on the mid-depth data are the most appropriate given the information available. However, based on the conductivity depth profile results presented in Figure 4-38, this does not hold under all years. Caution should be taken when interpreting trends for the NF as the depth at which maximum effects on water quality appear (using conductivity depth profiles as a proxy for effluent influence) varies between years.</td>
<td>Consider evaluating a sub-set of parameters in the NF using data collected in bottom samples.</td>
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### TOPIC

**MAIN DOCUMENT, Eutrophication Indicators, Section 5.2.1.4, Methods, Data Sources, page 248**

The report states: "Differences in the net dimensions were noted in 2017 among sampling years, which required adjustment of the data for some years. Re-measurement of the net diameter in 2016 determined that the zooplankton net used in 2014, 2015 and 2016 had a mouth diameter of 30.0 cm; therefore, recalculation of the zooplankton community biomass data was necessary for 2015 and 2016. The re-calculation increased the overall zooplankton biomass in 2015 and 2016 by 12.9% and 6.6%, respectively, as the volume of water actually sampled was smaller than that used in the 32 cm and 31.0 cm net diameter calculation (Table 5-3). These adjustments do not affect the conclusions reported in the respective annual reports.

Additional discussion and results should be provided to back up the statement that conclusions were not affected.

**RECOMMENDATION**

Provide additional discussion to support the conclusion noted.

---

**MAIN DOCUMENT, Eutrophication Indicators, Section 5.2.3.1, Methods, Data Analysis, page 249**

The report states: "The WLWB requested that as part of the 2014 to 2016 Aquatic Effects Re-evaluation Report, an assessment of the reference conditions for the phytoplankton variables be examined (Table 1-1, Section 7). The assessment includes a comparison of the AEMP results to reference conditions as defined using the currently approved 2007 to 2010 reference area data (Golder 2017b), and the 2013 reference area data. Both normal ranges are presented herein."

There is no description provided for the "2013 reference area data."

**RECOMMENDATION**

Provide a brief description of why normal ranges were derived using 2013 data and add a reference to the section of the report where this analysis is presented.

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**MAIN DOCUMENT, Eutrophication Indicators, Section 5.2.3.4, Methods, Data Analysis, page 251**

"The extent of eutrophication effects on phytoplankton biomass was not previously calculated or presented in the annual reports before 2016. As directed by the WLWB as part of the Board Directive and Reasons for Decisions re. W2015L2-001 Schedule 8 Update, and as part of EMAB commitment #5 from the Design Plan Version 4.0, and commitment #49 from the 2016 AEMP Annual Report (Table 1-1), the extent of effects on phytoplankton community biomass was estimated and presented to visually evaluate spatial trends for all years from 2007 to 2016."

Addition of this analysis is a great improvement and addresses previous comments.

**RECOMMENDATION**

No action required.
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<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.2.3.2, Methods, Data Analysis, page 254</td>
<td>&quot;To assess potential effects from dust emissions, phosphorus concentrations at stations within the estimated zone of influence from dust deposition were evaluated graphically and compared to results at other nearby stations and to reference conditions for Lac de Gras (as defined in the AEMP Reference Conditions Report Version 1.2 [Golder 2017b]).&quot; An assessment for TN would also be beneficial. Also note that section heading numbering is repeated (two sets of headings beginning with 5.2.3)</td>
<td>Add discussion of potential effects on TN.</td>
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<tr>
<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.1, Results, Summary of Effects, Extent of Effects, page 258</td>
<td>Paragraph 2, states that in years other than 2008, 2013 and 2009, &quot;the extent of effects on TP... has extended northeast towards the Lac du Sauvage inflow and northwest along the NF-MF1-FF1 transect&quot;. However, based on the figure presented (Figure 5-1) the TP affected area extended southeast of the mine in 2016.</td>
<td>The text and figure should be reviewed and updated as appropriate.</td>
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<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.1, Results, Summary of Effects, Extent of Effects, page 262, Figure 5-1</td>
<td>Figure 5-1 which presents the spatial extent of effects for TP is missing results for 2015. It is understood that the spatial extent of effects in that year was small (&lt;0.6 km2) which may preclude presentation in a map format. However, either a map should be added or at a minimum, an explanatory note/footnote should be included.</td>
<td>Please add an explanatory note for the omission of 2015 data from Figure 5-1.</td>
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<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.1, Results, Summary of Effects, Extent of Effects, pages 258, 261, and 263, Figure 5-2</td>
<td>Section 5.3.1.1 (Results, Summary of Effects, Extent of Effects, page 258) indicates: &quot;The boundary of effects on concentrations of TN generally extends to the northwest (to the end of the NF-MF1-FF1 transect) and to the northeast (towards the Lac du Sauvage inlet), with an exception in 2014 when the extent of effects appeared to be localized around the NF area.&quot; This statement appears to be based on incorrect results presented in Figure 5-2 (page 263) and is in disagreement with results presented in Table 5-7 (page 261) and those presented in the 2014 AEMP Annual Report (Golder 2016a). Table 5-7 indicates the affected area was equal to or greater than 40.1% of the lake area.</td>
<td>Please correct figure for the 2014 data and verify that data for other years are correctly presented. Modify text and data interpretation and conclusions accordingly.</td>
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<td>Far-field areas were not sampled in 2014 or 2015, as noted in the report. However, as noted in previous review comments (NSC 2016), the lack of data for these sites in these years has limited the ability to accurately define the spatial extent of effects for TN and/or chlorophyll a as boundaries of the affected area(s) extended to the edge of MF sites. Without data for the FF sites in 2014 and 2015 it cannot be determined if the affected areas were in fact similar among the last three years of the program (i.e., 2014-2016) or what the actual spatial extent of effects were in those 2 years.</td>
<td>This limitation should be noted in the text and considered in terms of interpretations presented regarding inter-annual differences and/or trends. For example, the text in Section 5.3.1.1 (page 258) reads: &quot;Similarly, the greatest extent of effects on chlorophyll a concentrations was observed in 2016 (250.4 km², or 43.7% of lake area), closely followed by 2014 (≥242.8 km², or ≥42.4% of lake area) (Figure 5-3; Table 5-7).&quot; However, because the boundary for 2014 is actually undefinable due to the lack of data for the FF sites, the affected area may in fact have been larger in 2014 than 2016. This limitation must be clearly identified in the text.</td>
<td>Please include discussion of the lack of FF data for 2014 and 2015 and the implications regarding limitations on defining the spatial extent of effects in those years. Modify figures to clearly indicate sites that weren't sampled in a given year.</td>
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<td>It is also suggested that all figures should be modified to clearly show that FF sites were not sampled in 2014 and 2015. Indicating the extent of effects boundaries with a dashed line to denote the boundary cannot be accurately defined would clarify this point.</td>
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<td>Similar to the previous comment, the statement on page 259 that reads: &quot;The extent of effects on chlorophyll a concentrations along the NF-MF3-FFB-FFA transect did not extend beyond the MF3-7 station between 2007 and 2016...&quot; should be modified to reflect the lack of data for the FF sites in 2014. In that year, the extent of effects extended to MF3-7 to the west but due to the lack of data for the FFA and FFB site in that year, the western boundary cannot be defined accurately (it may have extended further).</td>
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<td>Please modify the text to incorporate the limitations of the 2014 data with respect to defining the spatial extent of effects on chlorophyll a.</td>
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<td><strong>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.1, Results, Extent of Effects, pages 263, Figure 5-2 and text page 258</strong></td>
<td>In a review of the 2016 AEMP Annual Report, NSC (2017a) had commented on the exclusion of data for TN at site LDG-48 in the spatial extent analysis. This comment indicated: &quot;Comment 1: Section 2.1.2 of Appendix XIII (page 5) indicates that no sample was collected from LDG-48 (the outlet of the lake) in the open-water season. As a result the spatial extent of effects on total nitrogen and cumulative effects were not assessed for the northwest area of the lake beyond sites FFA-4 and FFA-5...&quot; While it is understood that sampling methods employed in the water quality monitoring program are not consistent with those for the eutrophication monitoring program, the TN concentration measured at LDG-48 in August, 2016 (174 µg/L) under the water quality program was above the normal range (122-153 µg/L) for the open-water season. Based on this measurement, the spatial extent of effects extended through the northwest portion of the lake (i.e., effectively 100% of the lake area). It was recommended to incorporate data collected at site LDG-48 during the water quality monitoring program into the eutrophication analyses and reporting (i.e., spatial extent analysis) and update maps and spatial extent of effects estimates. This comment is re-iterated for consideration with respect to the current report.</td>
<td>Add discussion in the report to note that the spatial extent of effects in 2016 could have extended through the entire lake. Include caveats respecting differences in sampling methods if appropriate.</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.1, Results, Extent of Effects, page 258</strong></td>
<td>The report indicates: &quot;Overall, the greatest extent of effects was observed on TN in 2016 (484.9 km2, or 84.7% of lake area) (Figure 5-2; Table 5-7). The extent of effects on TN increased between 2007 and 2016, and has consistently shown an affected area &gt;20% since 2008, while the spatial extent of effects on other indicators of eutrophication (i.e., TP, phytoplankton and zooplankton biomass) has decreased. The lack of a relationship between areas where TN is greater and areas where biological effects were observed (chlorophyll a, phytoplankton and zooplankton biomass) is consistent with N not being the limiting nutrient in Lac de Gras.&quot; However, as noted above, this statement is based on erroneous TN information presented for 2014. With this correction made, spatial patterns for chlorophyll a and TN appear to be relatively similar in most years - notably in 2014.</td>
<td>Please review accuracy of results presented and modify text accordingly.</td>
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<tr>
<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.1, Results, Extent of Effects, pages 258, 261, and 263</td>
<td>The report indicates: &quot;The extent of effects on TN increased between 2007 and 2016, and has consistently shown an affected area &gt;20% since 2008, while the spatial extent of effects on other indicators of eutrophication (i.e., TP, phytoplankton and zooplankton biomass) has decreased.&quot; This statement does not apply for chlorophyll a where effects were greater in 2014 and 2016 than all other years (see Figure 5-3 and Table 5-7, pages 263 and 261, respectively).</td>
<td>Please review accuracy of results presented and modify text accordingly.</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.1, Results, Extent of Effects, page 259</td>
<td>The statement that reads: &quot;The area affected for phytoplankton biomass was greater from 2008 to 2011 compared to more recent years (i.e., 2014 to 2016; Figure 5-4; Table 5-7)&quot; should be modified to reflect the lack of data for 2014 and 2015.</td>
<td>Please modify the text to reflect the lack of data for 2014 and 2015.</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.2, Results, Weight of Evidence Effect Ratings, page 267</td>
<td>The document indicates: &quot;The effects ratings for chlorophyll a fluctuated between moderate and high from 2007 to 2016 (Table 5-8). Chlorophyll a concentrations in the NF area were above the upper bound of the normal range from 2007 to 2016, but the affected area only exceeded 20% of the lake in 2009, 2013, and 2016.&quot; Table 5-7 (page 261) indicates that the affected area in 2014 was greater than or equal to 42.4%.</td>
<td>Please revise the statement (and other similar statements) to reflect the correct spatial extent of effects on chlorophyll a in 2014.</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.2, Results, Weight of Evidence Effect Ratings, page 267, Table 5-8</td>
<td>Weight-of-evidence ratings are not presented for 2014 and 2015 in Table 5-8 (page 267). There is no explanation provided for the omission of results for these two years. Section 5.2.3.3 (page 255) indicates that &quot;The indicators of eutrophication data from 2014 and 2015 were not assessed following the AEMP Study Design Version 3.5 (Goldier 2014a) because only NF and MF area data were collected in those years.&quot; However, Table 5-6 (page 255) that follows this text indicates that the effect rating for nutrients is based solely on comparison to normal ranges (and not to FF data). These results should therefore be incorporated into Table 5-8.</td>
<td>Please provide a discussion of the reason for the omission of 2014 and 2015 data in Table 5-8 and add ratings for TN and TP for 2014 and 2015.</td>
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<td><strong>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.1.3, Results, Action Levels, page 267</strong></td>
<td>The report states: &quot;The percentage of the lake with concentrations greater than the normal range plus 25% of the Effects Benchmark (i.e., 1.74 µg/L) was also calculated for each year to determine if Action Level 3 was triggered. Results revealed that &lt;20% of Lac de Gras had concentrations greater than the normal range plus 25% of the Effects Benchmark (i.e., 1.74 µg/L). Because less than 20% of the lake area was above 1.74 µg/L, Action Level 3 was not triggered in any year.&quot;</td>
<td>It would be useful to present a table showing the area of the lake above the normal range and the area above 1.74 µg/L. This information may illustrate whether the extent of higher concentrations of chlorophyll a are changing over time (i.e., evidence of trends). Please provide a table presenting the area of the lake above the normal range and the area above 1.74 µg/L for each year.</td>
</tr>
<tr>
<td><strong>Eutrophication Indicators, Section 5.3.3, Results, Effects of Dust Deposition and Dike Construction, page 277</strong></td>
<td>It is unclear what is being presented in Figure 5-13 and the conclusion based on the figure that &quot;...the elevated concentrations of TP at the MF stations are most likely related to dike construction, rather than dust deposition&quot; is not discussed in sufficient detail to support this conclusion.</td>
<td>The text and figures should be reviewed and updated as appropriate.</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.4.2, Results, Temporal Trends, Nutrients, page 279</strong></td>
<td>Section 5.3.4.2 states: &quot;Concentrations of TP in the NF area were slightly greater during the ice-cover season compared to the open-water season, while in the MF and NF areas, TP concentrations were generally similar between seasons...&quot; These trends are difficult to see in the figures as they are presented. It also appears that the sentence should read: &quot;while in the MF and FF areas, TP concentrations were generally similar between seasons.&quot;</td>
<td>The text and figures should be reviewed and updated as appropriate.</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.4.2, Results, Temporal Trends, Nutrients, page 280</strong></td>
<td>Section 5.3.4.2 discusses ice-cover soluble reactive phosphorus concentrations and acknowledges that &quot;more exceedances [of the normal range] in the MF areas were observed in the samples taken at bottom depths... compared to those taken at the top or middle depths.&quot; If effects at the bottom are different (i.e., a greater effect is observed) than at mid-depth in the MF area, then the mid-depth may not be the most appropriate depth to use for this parameter and considerations of other depths may be warranted.</td>
<td>The data for all forms of phosphorus should be reviewed to determine if the mid-depth data are most appropriate to use in consideration of mine effects on phosphorus concentrations in Lac du Gras.</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.4.2, Results, Temporal Trends, Nutrients, page 286</strong></td>
<td>Section 5.3.4.2 indicates with respect to TN: &quot;In 2016, the NF area was not significantly different from the other areas in Lac de Gras (Table 5-14).&quot; This statement is somewhat misleading as it does not acknowledge that a large spatial extent of effects on TN occurred in that year.</td>
<td>Consider adding a statement indicating that while NF results were not statistically significantly different than other areas, TN was above the normal range throughout the lake in 2016.</td>
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<td><strong>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.4.2, Results, Temporal Trends, Nutrients, page 286</strong></td>
<td>Paragraph 3 discusses trends in total dissolved nitrogen (TDN). TDN was not defined nor was an explanation of how it was determined provided in the document. Presumably it was calculated as the sum of ammonia-N and nitrate/nitrite-N. If this is the case, the trends in TDN that are discussed would be subject to the same problems as the ammonia data. This should be acknowledged.</td>
<td>Trends in TDN that are discussed in this section should be interpreted with caution unless it can be shown that the problems with the ammonia data do not affect the TDN values.</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.4.2, Results, Temporal Trends, Nutrients, pages 286</strong></td>
<td>Section 5.3.4.2 (page 286) indicates: &quot;The more recent elevated concentrations at several NF, MF and FF area stations may in part reflect the change in labs from UofA to Maxxam that occurred in 2013 (Golder 2016a).&quot; As this factor may have substantive implications with respect to tracking changes in nitrogenous parameters over time, there would be benefit to expanding this discussion to elaborate on potential implications of the laboratory change.</td>
<td>Please provide additional discussion of the implications of laboratory changes on nitrogen monitoring results and trend analyses.</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.4.2, Results, Temporal Trends, Nutrients, page 293</strong></td>
<td>The nutrient summary states: &quot;Nutrient concentrations remain low throughout Lac de Gras, within the oligotrophic ranges for both P and N.&quot; This is the first discussion of trophic status presented in the report. Some additional information should be presented here to qualify the statement. At a minimum, the trophic boundaries applied should be identified for TP and TN.</td>
<td>Please identify the trophic boundaries applied.</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.4.3, Results, Chlorophyll a Concentrations, and Phytoplankton and Zooplankton Biomass, page 301</strong></td>
<td>Section 5.3.4.3 (page 301) indicates: &quot;Chlorophyll a concentrations and plankton biomass displayed high variability in recent years, especially since 2014, without an obvious explanation in terms of nutrient concentrations that would account for this observation.&quot; The plots shown (Figure 5-28; page 295) indicate that data did not show especially high variability since 2014. Rather, the plots indicate that results for 2015 were somewhat anomalous. This also raises the general question as to why values were notably lower in 2015. Is there any potential explanation for these observations?</td>
<td>Consider revising statement and expand if possible on potential reasons for low values in 2015.</td>
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<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.3.8.3, Results, Phosphorus Management Framework, pages 318-321</td>
<td>The consideration of application of the CCME phosphorus management framework is well presented and the conclusions/recommendations provided by DDMI seem sound and reasonable. Based on the information provided, there does not appear to be any particular benefit to including this framework within the AEMP, particularly given that the primary concern (algal abundance) associated with nutrient enrichment is the foundation of the response framework.</td>
<td>No action required.</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Eutrophication Indicators, Section 5.5, Summary and Conclusions, page 329</td>
<td>&quot;Secchi depths were deeper in the NF area compared to the MF and FF areas...&quot; This statement contradicts results presented earlier in Section 5.3.4.1 (page 277) and Figure 5-14 (page 278). Secchi disk depths are generally lower in the NF area - notably compared to the FF areas.</td>
<td>Revise statement.</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Sediment Quality, Section 6.2.1, Methods, Data Sources, page 336</td>
<td>&quot;The 2007 to 2016 AEMP samples were collected using a sediment gravity-corer, and the top 1 cm fraction was analyzed for nitrogen, phosphorus and metals. From 2007 to 2010, nitrogen, phosphorus and TOC were analyzed from the top 5 cm fraction of Ekman grab samples, from 2013 onwards, grain size analysis were conducted on top 10 to 15 cm samples, while TOC was analyzed in both the top 1 cm core samples and the top 10 to 15 cm Ekman grab samples.&quot; There appears to be a contradiction with respect to the depth of sediment analysed for nutrients in the excised text. It is unclear what sediment depths were analysed for what variables over the years.</td>
<td>Please clarify the methods description or modify if the text is in error. Inclusion of a table may assist with clarifying methods over the years.</td>
</tr>
<tr>
<td>Sediment quality, Section 6.2.2.2, Methods, Data Handling, Censored Data, page 336</td>
<td>It is unclear how data for field duplicate samples were handled. The text simply indicates that the data were removed. It should be clarified how these data were removed. Were means of the duplicates calculated or were the first set of data retained and the second set (i.e., &quot;the duplicate&quot;) simply excluded?</td>
<td>The text should be clarified.</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Sediment Quality, Section 6.2.3.2, Methods, Weight-of-Evidence Effect Ratings, page 338, Table 6-3</td>
<td>Table 6-3 indicates a rating of &quot;No action&quot; if an ISQG is not exceeded and an &quot;early warning/low&quot; rating in the NF is statistically higher than the FF. It is unclear what occurs in the event that a statistically significant difference is observed between NF and FF results but the concentrations are below the ISQG. If this case would be ranked as &quot;No effect&quot; then the approach may be relatively insensitive in terms of the ability to identify early warnings of change. In addition, there are parameters without defined benchmarks. It is unclear how the ISQG comparison is applied in the framework.</td>
<td>Please clarify application of the WOE rankings.</td>
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<td>MAIN DOCUMENT, Sediment Quality, Section 6.2.3.4, Methods, Temporal Trends, page 339</td>
<td>Section 6.2.3.4 indicates: &quot;Trends in sediment chemistry over time were evaluated in relation to the normal range for Lac de Gras, which was calculated based on percentiles using reference area data (Golder 2017b). The normal ranges for SOIs were calculated using reference area data collected during the AEMP Study Design Version 2.0 (2007 to 2010; Table 6-4).” Were the normal ranges used for comparisons also normalized to TOC or fines as was done for the monitoring dataset?</td>
<td>Please provide a clarification on normal ranges used.</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Sediment Quality, Section 6.3.1, Results, Summary of Effects, page 341</td>
<td>The text (page 341) indicates that the first low effect rating for strontium and vanadium in sediments occurred in 2016. This does not agree with the data presented in Table 6-5 (page 342) which indicates that a low effect rating was observed for strontium in 2008 and 2016, and for vanadium in 2007 and 2008 but not in 2016. Table 6-5 also indicates that 2016 was the first time TN received a low effect rating but it was not included in the previous list.</td>
<td>The text and table should be reviewed and updated as appropriate.</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Sediment Quality, Section 6.3.1, Results, Summary of Effects, page 341</td>
<td>The report states (page 341): &quot;Chromium exceeded SQGs (i.e., lowest effects level and ISQG) frequently since 2007, while the PEL was exceeded once in 2008, and the severe effect level was never exceeded. Nevertheless, chromium exceeds guidelines in both NF and FF areas, therefore, these concentrations are likely to reflect elevated background levels for Lac de Gras.” Since chromium was statistically higher in the NF area than the FF area in some years, the data suggest a mine-related effect and that the mine may have caused or contributed to exceedances. The magnitude by which the ISQG is exceeded would be useful to demonstrate in the figures (e.g., add ISQG of 37.3 mg/kg to Figure 6-12, page 358).</td>
<td>Please revise text and consider adding ISQGs to sediment quality scatter plot time series figures.</td>
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<td>MAIN DOCUMENT, Sediment Quality, Section 6.3.3, Results, Temporal Trends, page 344</td>
<td>Section 6.3.3 (page 344) indicates: &quot;Trend analyses were performed following normalization of the data by TOC or percent fines, where applicable, and transformation of data using Box-Cox transformations.&quot; It is agreed that normalization of data for confounding variables (fines and TOC) is appropriate and provides a means to evaluate changes in metals and nutrients independent of changes/variability in these supporting variables. However, it would also be of interest to know if absolute concentrations (i.e., raw data) also show trends over time. This would be particularly pertinent if there have been mine-related changes in either supporting variable. For example, if there is a mine-related increase in TOC concentrations, the higher TOC may also result in higher metals and/or nutrients due to the affinity of these substances to organic matter. In addition, from a biological perspective, it is the absolute concentrations that are relevant.</td>
<td>Please clarify if trends were also evaluated on raw data for all of the SOIs. If this analysis has not been done, please provide a discussion of the rationale for excluding these analyses.</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Sediment Quality, Section 6.3.3, Results, Temporal Trends, Table 6-6, page 344</td>
<td>The table indicates that &quot;fines&quot; were selected as the normalizing variable for boron and tin, but that no normalizing variable was selected for lead. However, this would appear to contradict information presented in Table 6-6. The correlation analysis presented in Table 6-6 shows the following: boron was not significantly correlated with either TOC or fines; tin was significantly correlated with TOC but not fines; and, lead was significantly correlated with TOC. Based on the results presented in Table 6-6 and the methods that appear to have been applied to the other parameters, the following normalizing variables should have been applied: none for boron; TOC for tin; and TOC for lead.</td>
<td>The data should be reviewed and updated as appropriate. If necessary the models for boron, tin, and lead should be recreated and necessary changes made to the document.</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Sediment Quality, Section 6.3.3, Results, Temporal Trends, Table 6-9, page 346</td>
<td>The caption indicates that the data presented are for 2001 to 2016 when in fact the actual years of data used in the model for lithium were 2010, 2013 and 2016.</td>
<td>Update the caption to read &quot;... 2010 to 2016&quot;</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Sediment Quality, Section 6.3.3.2, Results, Temporal Trends, Nutrients, page 350</td>
<td>In reference to data since 2006, but excluding 2013, the report indicates: &quot;TN concentrations were within the normal range for Lac de Gras.&quot; This is contrary to Figure 6-2 which shows that TN concentrations above the normal range occurred at MF3-7 from 2007 to 2016, and at several FF sites in 2016.</td>
<td>The text and table should be reviewed and updated as appropriate, including any conclusions made based on these results.</td>
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<td><strong>MAIN DOCUMENT, Sediment Quality, Section 6.3.3.2, Results, Temporal Trends, Nutrients, page 350</strong></td>
<td>&quot;Concentrations of TN were considered atypical in 2013, and inconsistent with other years’ results, most likely due to a difference in laboratory methods in 2013 relative to other years (Golder 2017c).&quot; We agree that the 2013 TN data for sediments is anomalous (NSC had noted this in comments provided on the Reference Condition Report Supplement v. 1.2 supplement; NSC 2017b) and may indeed be related to changes in the laboratory method. Given this anomaly, it would be more appropriate to exclude the 2013 data from the trend analysis, or at a minimum, present a trend analysis with and without the 2013 data. It was noted in the report: &quot;These trends should be interpreted with caution, due to the uncertainty in the 2013 TN data noted above.&quot;</td>
<td>Conduct trend analysis excluding 2013 TN data</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, Sediment Quality, Section 6.5, Summary and Conclusions, page 371</strong></td>
<td>Section 6.5 (Page 371) indicates: &quot;Concentrations of certain metals, such as arsenic and cadmium, in sediments throughout Lac de Gras were above SQGs. These variables generally reflected patterns in TOC content of bottom sediments or background variation in sediment quality, and had no clear spatial trends related to the Mine.&quot; Since report figures presenting sediment quality results do not include SQGs, it is difficult to evaluate the occurrence and magnitude of exceedances of SQGs over time. For example, information as presented is inadequate to determine in what years, by what magnitude, and at which sites that cadmium and arsenic exceed SQGs. This visualization is important for critically reviewing the information and examining trends and identifying potential emerging trends.</td>
<td>Add benchmarks (i.e., SQGs) to sediment quality figures.</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, Plankton, Section 7.2.1.1.2, AEMP Version 2.0 Data (2007 to 2011), page 377</strong></td>
<td>Different sampling methods were employed in 2007 than other years of the phytoplankton monitoring. It is stated that: &quot;...the phytoplankton sampling procedure was inadvertently changed to use the Secchi depth to determine the sampling depth (DDMI 2007). Since the 2007 AEMP plankton program used Secchi depth to determine sampling depth, instead of the top 10 m of the water column, sampling depths were approximately 2 m shallower than those between 2003 and 2006. From 2008 to 2016, the methods reverted back to the original sampling protocol of sampling the top 10 m of water column....Secchi depths in 2007 were approximately 8 m; phytoplankton are found within the euphotic zone (estimated as two times the Secchi depth); therefore, it is likely that the 2007 samples are comparable to the 2008 to 2016 samples.&quot; According to this text, the 2007 samples were collected at a depth of approximately 16 m which is notably different than 10 m.</td>
<td>Consider revising statement regarding comparability.</td>
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<tr>
<td>MAIN DOCUMENT, Plankton, Section 7.2.1.1.4, AEMP Version 3.5 Data (2013 to 2016), page 378</td>
<td>The laboratory that performed taxonomic identifications and enumerations is not indicated for these sampling years.</td>
<td>Please add a statement identifying the laboratory that performed taxonomic identifications and enumerations for 2013-2016.</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Plankton, Section 7.3.1.1, Results, Summary of Effects, Weight-of-Evidence Effect Ratings, page 392</td>
<td>Table 7-9 indicates that based on a recalculation of affected area that was conducted in 2017 a high effect rating should now be applied to phytoplankton biomass in 2010. The text indicates that high effect ratings occurred in 2009 and 2011, but no mention is made of 2010.</td>
<td>The text should be updated to acknowledge this recent finding.</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Plankton, Section 7.3.2.1.2, Results, Temporal Trends, Biomass of Major Phytoplankton Groups, page 401</td>
<td>The discussion of trends in cyanobacteria does not match the results presented in the tables and figures. The report indicates (page 401): &quot;...a slight, non-significant decline was observed in the NF area between 2013 and 2016 (Figure 7-4 and Table 7-14).&quot; However, Table 7-14 indicates that cyanobacteria biomass in the NF area was significantly different between 2013 and 2016. In addition, the report states: &quot;Relative cyanobacteria biomass fluctuated with the normal range in all areas between 2007 and 2012 (Figure 7-9).&quot; Figure 7-9 presents results for diatoms not cyanobacteria, and this statement describes trend in diatoms not trends in cyanobacteria. Figure 7-7, which shows cyanobacteria indicates that relative cyanobacteria biomass in both MF and FF areas was, at some locations, above the normal range from 2008-2012.</td>
<td>Please review the text, tables and figures and make appropriate corrections.</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Plankton, Section 7.3.2.1.3, Results, Temporal Trends, Phytoplankton Normal Range Evaluation, page 408</td>
<td>The evaluation of the phytoplankton normal range presented in the report concluded: &quot;Overall, based on the clear differences in the data sets produced by the two different taxonomists, the &quot;adjusted&quot; 2013 normal range (referred to going forward as the &quot; 2013 normal range&quot;) is recommended for comparisons from 2013 onwards.&quot; It would appear based on the information presented in this section that comparisons to the 2007 to 2010 normal ranges, which were based on data from a different taxonomist, moving forward would be inappropriate (i.e., there is evidence of a laboratory difference). However, as also noted in the report, the use of a single year of data to derive a normal range (2013) is also associated with issues (i.e., it does not incorporate inter-annual variability). Use of more than one year of data to derive normal ranges would be more scientifically appropriate.</td>
<td>Please comment on the appropriateness of deriving updated normal ranges using one year of data and if the normal ranges will be recalculated in the future with additional data to account for inter-annual variability.</td>
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<td><strong>MAIN DOCUMENT, General Comments Regarding Fish Section 9</strong></td>
<td>A few terms are used inconsistently throughout the report, making it more difficult for the reader to follow. For example, age-2+ is used page 504, but the term adult seems to be used for the rest of the document. It is assumed that these are referring to the same stage. In addition, the sampling period for 2007, 2013, and 2016 is both called late summer and late fall (e.g., 3rd line of Section 9.2.1.3.4 late fall, but late summer in 6th line). Several different terms are used for the concept of CES - called &quot;percent difference&quot; in title of Table 9-12, called CES in footnote of this table, magnitude of difference in heading 9.2.1.3.7, and a critical effect size defined by EEM in Table 14-2.</td>
<td>Use terms consistently throughout document.</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, Fish, Section 9.2.1.2.3, Fish Health, Methods, Stage Re-classification, Table 9-2, page 505</strong></td>
<td>There are potential errors in the data presented in Table 9-2 (page 505). It states 10 fish were reclassified from the 2007 dataset on page 505; however, Table 9-2 only shows 7 fish (2 age 1+ to YOY, 5 age 1+ to adult).</td>
<td>Review calculations and data tables.</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, Fish, Section 9.2.1.3.5, Fish Health, Methods, Comparison to Normal Ranges, pages 507-508</strong></td>
<td>There are some discrepancies in the methods described for the temporal trends analysis. It appears from the text that raw carcass weight was used as a covariate for Age-1+ condition, gonad, and liver weight trend analysis. However, it states on page 503 total body weight is more appropriate for this stage. It appears from Figure 9-18 that carcass weight was used.</td>
<td>Confirm appropriate analysis methods were used.</td>
</tr>
<tr>
<td><strong>MAIN DOCUMENT, Fish, Section 9.2.1.3.7, Fish Health, Methods, Magnitude of Difference (Critical Effect Size), page 509</strong></td>
<td>Section 9.2.1.3.7 (page 509) states: &quot;As per the MMER TGD (Environment Canada 2012), a Critical Effect Size (CES) is defined as “a threshold above which an effect may be indicative of a higher risk to the environment” (Environment Canada 2012). CES are defined for fish weight, relative liver size and relative gonad size as 25% of the reference area mean, and for condition as 10% of the reference area mean (Environment Canada 2012). The variables that triggered Action Level exceedances in 2016 were compared to the CES.&quot; It would seem appropriate to also compare Action Level exceedances from other years to the CES. In addition, there is no indication of what was defined as the &quot;reference area mean&quot; for making comparisons in the CES evaluation.</td>
<td>Include comparisons to CES for all years in which an Action Level exceedances occurred. Add description of how &quot;reference area mean&quot; was defined.</td>
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<td>MAIN DOCUMENT, Fish, Section 9.2.2, Fish Health, Results, general comment</td>
<td>The discussion of the results of the temporal trends is very difficult to follow. There is no discussion of the results of NF temporal trends for Total Length, Fresh Weight, or Carcass Weight even though Table 9-9 shows significant post-hoc results. There is discussion about large and small fish; however, the methods section (Section 9.2.1.3.5) does provide any explanation about how or why these categories were calculated.</td>
<td>Explain the results of statistical analysis in a more lay manner so readers can better understand the results.</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Fish, Section 9.2.2.2, Fish Health, Results, CPUE, page 512</td>
<td>CPUE does not appear to be a variable included in the assessment of temporal trends as described in Section 9.2.1.3.5 and normals were not calculated for this variable (Appendix 9A). It is unclear how the temporal evaluation of CPUE described in Section 9.2.2.2 was completed. Based on the text in this section and lack of statistical results, it does not appear that any statistical analysis was performed to support the conclusion of no change to CPUE attributable to the mine. There also appears to be errors in the text. For example, it is stated that mean CPUE at MF3 and F2 were higher than at other sites in 2010, 2013, and 2016; however it is clear from Figure 9-3 that values at FFA were higher, or at least very similar. The CPUE for the Age-1+ catch was not presented in Section 9.2.2.2 - but the abundance of Age-1+ is still listed as an endpoint for WOE in Table 9-5 and a rating of 0 is assigned to this endpoint in Tables 10A-11 to 10A-14.</td>
<td>Provide information on how the ratings and conclusions were derived.</td>
</tr>
<tr>
<td>MAIN DOCUMENT, Fish, Section 9.2.2.3, Fish Health, Results, Parasitism, pages 512-513</td>
<td>There is a statement on page 512 that indicates &quot;all sites except FF2 had increased parasite presence in 2013 and 2016 compared to 2007&quot;. This statement does not agree with the results presented in Table 9-7. The values are significantly similar between 2007, 2013, and 2016 as indicated by the same letter at NF and and FF2 sites, but are not the same as indicated by different letter for 2007, at the FFA and FF1 sites. The MF sites cannot be compared since due to lack of data for 2007. There also appear to be errors in the gray shading applied to Table 9-7. It states that grey shading indicates a decreasing trend; however, it is clear from Figure 9-4 that the cells highlighted are actually showing an increase in parasite occurrence.</td>
<td>Verify results and update report accordingly.</td>
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<td>MAIN DOCUMENT, Fish, Results, Sections 9.2.2 and 9.3.2, various sub-sections and pages</td>
<td>According to the text in Sections 9.2.1.3.5 and 9.3.2.1, Figures 9-5 to 9-10 (pages 514-519) and 9-19 to 9-26 (pages 548-555) are used to compare to normal ranges, but the graphs are titled Temporal Trend Plots. This is confusing to readers, as there is an almost identical series of graphs (Figures 9-11 to 9-14 [pages 521-524] and Figures 9-27 to 9-32 [pages 557-561]) that follows. Also, it is not clear from the figure titles or legends what exactly is plotted - are the circles values from individual sculpin?</td>
<td>Revise figures to make more clear and update figure captions and text.</td>
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<tr>
<td>MAIN DOCUMENT, Fish, Section 9.2.2.6, Fish Health, Results, Weight-of-evidence Ratings, page 533</td>
<td>There is no information provided in the methods Section 9.2.1.3.4 and 9.3.1.3.1 explaining how data were compared to normal ranges (it indicates &quot;results&quot; are compared to background values). The methods also do not explain whether outliers were included in the calculation of the &quot;mean&quot;. For example, Figure 9-11 (page 521) shows an outlier for Age-1+ at the FF site in 2016 but Figure 9-5 (page 514) does not indicate this point is an outlier.</td>
<td>Provide explanation of how ratings were obtained.</td>
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<tr>
<td>MAIN DOCUMENT, Fish, Section 9.2.2.7, Fish Health, Results, Action Levels, Table 9-12, page 535 and Section 14.3.2.2, pages 616-617</td>
<td>With respect to fish health analyses, according to Table 9-12 (page 535), CES values could not be calculated for LSI because of significant interaction (&quot;Area-specific interpretation not possible due to significant interaction&quot;). However, the report indicates there was a minimum of one significant interaction for the ANCOVAs for condition, LSI and GSI (page 519). It is unclear why CESs were derived for condition and GSI but not for LSI. Furthermore, it is unclear what the approach is, and will be in the future, in the event that CESs cannot be calculated for metrics with &quot;significant interactions&quot;. If CESs cannot be assessed for this or other reasons, a metric can never trigger action level 3 or beyond since they cannot meet a requirement of action levels 2 or 3 according to Table 14-2 (page 617), which requires that &quot;an effect size equal to or above the critical effect size defined by the EEM&quot;.</td>
<td>Please provide a discussion of how action level comparisons will be made in the event of &quot;significant interaction&quot; issues with data analysis. Revisit CES calculation for variables analyzed with ANCOVA with significant interaction.</td>
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<td>MAIN DOCUMENT, Fish, Section 9.3.1.1.1, Fish Tissue, Methods, Slimy Sculpin, page 536</td>
<td>&quot;In 2007, 2010 and 2013 the samples consisted of fish bodies (i.e., carcass excluding gonads, otoliths, and stomachs). Gonads, otoliths and stomachs were not included, as they were required for separate analyses as part of the fish health assessment. In 2016, the samples consisted of carcass only. The livers were excluded from the samples in 2016 due to a field error.” Please clarify what is meant by &quot;carcass only&quot; in 2016.</td>
<td>Provide clarification on what tissues were included in the carcass analysed in 2016.</td>
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<tr>
<td>MAIN DOCUMENT, Fish, Section 9.3.1.1.2, Fish Tissue, Methods, Lake Trout, page 538</td>
<td>&quot;Concentrations in fish in 1996 were measured in composite samples, not individual fish. Because mercury bioaccumulates and biomagnifies in fish tissue and differences in mercury concentrations can be confounded by differences in fish body size, the 1996 data are not appropriate for use. Temporal and spatial comparisons were not conducted with this data.&quot; Section 9.3.1.3.2 (Temporal Trend Analysis, page 545) and Section 9.3.2.2 (Temporal Analysis, page 566) include data collected from 1996.</td>
<td>Please clarify or provide correction of text.</td>
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<tr>
<td>MAIN DOCUMENT, Fish, Section 9.3.1.1.2, Fish Tissue, Methods, Lake Trout, page 538</td>
<td>The report identifies various sources of Lake Trout mercury data included in the report and analyses. However, it is difficult for the reader to ascertain what data were included, what methods were employed, and what analytical laboratory and detection limits are associated with the data presented in the report. For example, page 538 indicates that samples were analysed at both ALS and Flett Research in 2008 but the report does not indicate which of the two datasets were incorporated into analyses and in the results presented in the report. The lack of clarity regarding these methods and metadata render it difficult for the reader to critically evaluate the approach taken and subsequent conclusions borne from the analyses presented in the report. For example, changes in analytical laboratories may affect conclusions.</td>
<td>The report would benefit from a summary table identifying, by year, analytical laboratories used and explicit identification of data incorporated in the analyses.</td>
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<td><strong>MAIN DOCUMENT, Fish, Section 9.3.1.1.2, Fish Tissue, Methods, Lake Trout, page 538</strong></td>
<td>Section 9.3.1.1.2 indicates the following data sources for Lake Trout mercury: &quot;Mercury concentrations were measured in muscle, liver and kidney tissue from Lake Trout collected in Lac de Gras in 1996, 2002, 2003, 2004, 2005 and 2008, and Lac du Sauvage in 1996 and 2008. Mercury concentrations were also measured in muscle in 2011 and 2014 in both Lac de Gras and Lac du Sauvage. Additional mercury in muscle tissue data were collected as part of the Mine palatability studies in 2002, 2003, 2004, 2012, and 2015, and these data were incorporated into the analyses, where appropriate.&quot;</td>
<td>Please clarify or correct text and figures.</td>
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<td><strong>MAIN DOCUMENT, Fish, Section 9.3.1.3.1, Fish Tissue, Methods, Comparison to Normal Ranges, pages 542-544</strong></td>
<td>However, Figure 9-34 (Section 9.3.2.2, page 567) presents results for 2009. There is no indication what these data represent. It is also unclear whether 2008 data represent results from ALS or Flett Research.</td>
<td>Please provide a clarification as to why Lake Trout mercury data are not compared to a normal range.</td>
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<td><strong>MAIN DOCUMENT, Fish, Section 9.3.1.3.1, Fish Tissue, Methods, Comparison to Normal Ranges, Table 9-16, page 544</strong></td>
<td>There appear to be two errors in the normal ranges presented for tissue analysis in Table 9-16. The values given for thorium are from 2010, as there are no values for 2007 or 2013 provided in the AEMP Reference Condition Report, Version 1.2/1.3. Likewise, the lower limit for tin is incorrectly presented in Table 9-16 as the value for 2010 rather than 2013.</td>
<td>Correct table and ensure error is not carried forward to future reports.</td>
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<td><strong>MAIN DOCUMENT, Fish, Section 9.3.1.3.2, Fish Tissue, Methods, Temporal Trends, Lake Trout (page 545) and Section 9.3.2.2, Fish Tissue, Results, Temporal Trends, Lake Trout, page 568, Figure 9-36</strong></td>
<td>Section 9.3.1.3.2 (page 545) indicates: &quot;Since mercury concentration is length-dependent, to compare mercury between lakes, it was required to account for differences in Lake Trout lengths between lakes. Therefore, the model was used to conduct pairwise comparisons for year and lake, for a mean Lake Trout fork length of 620 mm to assess spatial and temporal differences in mercury concentrations.&quot;</td>
<td>Please provide a discussion of the rationale for use of this length of trout for length standardization.</td>
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<td><strong>MAIN DOCUMENT, Fish, Section 9.3.2.2, Fish Tissue, Methods, Temporal Trends, Lake Trout (page 545) and Section 9.3.2.2, Fish Tissue, Results, Temporal Trends, Lake Trout, page 568, Figure 9-36</strong></td>
<td>Figure 9-36 (Section 9.3.2.2, page 568) presents length-standardized mercury concentrations in Lake Trout. Data appear to have been standardized to a fork length of 620 mm.</td>
<td>Please provide a discussion of the rationale for inclusion of the 620 mm length.</td>
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<td><strong>MAIN DOCUMENT, Fish, Section 9.3.1.3.3, Fish Tissue, Methods, Guideline Comparison, Fish Health page 546</strong></td>
<td>The report applies a potential effects benchmark/tissue residue guideline for mercury of 1.0 μg/g wet weight from Jarvinen and Ankley (1998) for evaluating effects on fish (i.e., Lake Trout) health (Section 9.3.1.3.3, page 546). The report states: “This is likely a very conservative benchmark; Environment and Climate Change Canada recently conducted a review of mercury in the Canadian environment and noted that the lowest adverse effect concentrations would be 0.5 to 1 mg/g wet weight in fish species such as Northern Pike and Walleye (ECCC 2016), many times higher than using the generic benchmark.”</td>
<td>The report incorrectly states the benchmark - or Lowest Observed Adverse Effect Level (LOAEL) – presented in the ECCC review; ECCC (2016) identifies an LOAEL of 0.5-1.0 μg/g. Section 9.3.1.3.3 indicates an incorrect unit of mg/g (a thousand fold difference). The conclusion presented in Section 9.3.2.3 (page 570) that &quot;Lake Trout health is unlikely to be affected&quot; and that &quot;on the basis of the most recent mercury concentrations in Lake Trout from each lake (2014), no concerns to ...fish health are expected&quot; is based on a misinterpreted benchmark. Mercury concentrations presented in Figure 9-34 (page 567) and Table 9-25 (page 572) indicate that mercury concentrations in individual Lake Trout from both lakes have frequently been in the range of 0.5-1.0 μg/g between 2005 and 2015. Reassess conclusions on potential effects of muscle mercury concentrations on fish health based on appropriate guidelines.</td>
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<td>SECTION 9.3.2.1, Figure 9-22 (page 551) indicates that mercury concentrations in Slimy Sculpin in the near field in 2007 were almost an order of magnitude higher than in 2013 and 2016 and concentrations in two samples were approaching the Canadian Food Inspection Agency (CFIA) and Health Canada guideline of 0.5 µg/g wwt for human health consumption (CFIA 2015) applied in the report. Concentrations in sculpin from the far field in 2007 were also substantially higher than the results for 2013 and 2016.</td>
<td>Include a discussion of the high mercury concentrations in Slimy Sculpin in 2007 and explore potential explanations for the relatively high concentrations observed in that year, notably for the near field area. If data are deemed to be suspect, trend analysis should be revisited. This is particularly critical given that the results of the trend analysis are the foundation for determining if a Lake Trout mercury survey is to be conducted.</td>
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<td>SECTION 9.3.2.2 (page 556) indicates that: “Many of the variables that had either a significant interaction or a significant year effect decreased over time and are, therefore, not considered further. These variables include arsenic, barium, magnesium, mercury, selenium, sodium, titanium, vanadium, and zinc (Table 9-19).”</td>
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<td>The notably high mercury concentrations reported for 2007 should be discussed and potential reasons for these differences should be identified. For example, it is noted in Section 9.3.1.1.1 (page 536) that although all samples for 2007, 2013, and 2016 were analysed at ALS Laboratories, the 2007 samples were analysed at the Edmonton, AB laboratory while samples from the latter two years were analysed at their Burnaby, BC laboratory. Has the change in laboratory been evaluated as a potential cause for the differences or are there environmental factors that may have caused or contributed to the high concentrations in 2007? The high concentrations observed in 2007 also result in a decreasing temporal trend; should there be issues with this dataset, these should be identified in order to avoid biasing trend analyses here and into the future.</td>
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<td>There are some issues with the presentation of normal ranges in Figures 9-19 to 9-26. The normal range does not appear for several elements that have low normal ranges (antimony, beryllium, and bismuth) - a footnote was provided for one element indicating why the normal range does not appear, but not for the other two. The normal range does not cover 2007 for some elements (boron, tellurium, thallium, and tin); a footnote explaining this would assist the reader.</td>
<td>Revise figures to include missing information.</td>
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<td>SECTION 9.3.2.2 (page 566) indicates: &quot;In 2014, mercury was detected at near or below baseline concentrations in both Lac de Gras and Lac du Sauvage.&quot; There is no previous description of what constitutes &quot;baseline&quot; for mercury concentrations in Lake Trout.</td>
<td>Please include a description of what baseline mercury concentrations in Lake Trout are and how they were derived.</td>
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<td><strong>MAIN DOCUMENT, Fish, Section 9.3.2.2, Fish Tissue, Results, Temporal Trends, Slimy Sculpin, pages 556-565</strong></td>
<td>There is no reason provided in Sections 9.3.2.2 or 9.3.1.3.2 (page 542) as to why some of the elements (chromium, lead, lithium, tellurium, zirconium) were not included in the temporal analysis (Figures 9-27 to 9-32, Tables 9-18 and 9-19). A footnote explaining why the 2007 data was omitted from the analysis for some elements (cesium, molybdenum, tin), as described on page 556, would be beneficial. The figures would also benefit from a Y-axis title.</td>
<td>Provide more information in figures/tables.</td>
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<td><strong>MAIN DOCUMENT, Fish, Section 9.3.2.2, Fish Tissue, Results, Temporal Trends, Lake Trout, pages 567-568</strong></td>
<td>Figure 9-34 and the text indicates substantively lower concentrations of mercury in Lake Trout in 2014. The text indicates: &quot;Raw mercury concentrations in samples collected from Lac de Gras in 2015 were overall greater than those in samples collected in 2014 (Figure 9-34). However, when fish length was accounted for in the analysis, mercury concentrations were generally similar between the two years (see 2014 and 2015 values in Figure 9-35).&quot; It is difficult to discern inter-annual differences from Figure 9-35.</td>
<td>Please verify figure reference.</td>
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<tr>
<td><strong>MAIN DOCUMENT, Fish, Section 9.3.2.2, Fish Tissue, Results, Temporal Trends, Lake Trout, page 568</strong></td>
<td>Section 9.3.2.2 indicates: &quot;Similar to the general pattern shown in Figure 9-34, the overall temporal trend in Lake Trout mercury concentration reflected the increase in adjusted mercury between 2002 and 2009/2011, and the decrease in mercury following 2011 (Figure 9-36).&quot; It is unclear what is meant by &quot;adjusted mercury&quot;. It is assumed this refers to length-standardized mean mercury concentrations.</td>
<td>Please provide clarification of adjusted mercury (methods and discussion) in the report.</td>
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<td><strong>MAIN DOCUMENT, Fish, Section 9.3.2.2, Fish Tissue, Results, Temporal Trends, Lake Trout, general comment</strong></td>
<td>The presentation of results for Lake Trout mercury concentrations is difficult to follow. The report switches between results for arithmetic data (sometimes inappropriately referred to as &quot;raw&quot; data and length-adjusted, modeled concentrations, and it remains unclear which analysis is being referred to in the discussion. The finding of a significant difference in Lake Trout mercury concentration between Lac de Gras and Lac du Sauvage in 2014 (but not in 2011) is counterintuitive to what is presented in Figure 9-36 (page 569).</td>
<td>Suggest presenting results for length-adjusted concentrations to describe temporal trends and for spatial comparisons; arithmetic data should be used when discussing concentrations in the context of guidelines. Clearly address if significant difference in Lake Trout mercury concentrations existed between the two lakes and between each lake over time.</td>
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| **MAIN DOCUMENT, Fish, Section 9.3.2.2, Fish Tissue, Results, Temporal Trends, Lake Trout, Figures 9-34 to 9-36, pages 567-569** | Figure 9-34 should indicate that it is arithmetic data being presented and a definition of what is meant by 'pooled data" should be included.  
At the resolution chosen for Figure 9-35, it is very difficult to observe any differences or similarities between years.  
It is unclear why Figure 9-36 does not include results for 1996. It would be beneficial to present annual means (with confidence limits or standard error) and superscripts indicating the results of statistical comparisons between years (similar to Figure 3-4 in Appendix V of the 2014 annual report; Golder 2016a). | Provide additional details in table and figure captions (and associated text) to adequately define the content of figures and tables.  
Consider including the results of statistical comparisons in Figure 9-36. |
<p>| <strong>MAIN DOCUMENT, Weight-of-Evidence Section 10.2, Approach, pages 585-586, Appendix 10A</strong> | Many of the fish community endpoints shown in Tables 10-1 and 10-2 (pages 585-586) and Table 9-11 (page 533) no longer appear to be measured (e.g., Population structure - survival, Growth - size at age, Reproductive investment - age 1 abundance). It is unclear how these endpoints received Effect Level Ratings in Tables 10A-1, 10A-7, 10A-12, 10A-13). Since a few of these endpoints have been discontinued in more recent surveys as indicated by &quot;n/s&quot; in Appendix 10A tables (Population structure - survival, and -size [2016], and growth- size at age [2013]) - they should be omitted from earlier WOE analyses (i.e., 2007 and 2010). | Update the WOE calculations to reflect the study design. |</p>
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<td>Figures 10-2a to 10-2c are somewhat confusing since they seem to exclude some data; it is assumed that this is because the figures only present &quot;key driver endpoints&quot; (p. 589). For example, Figure 10-2c does not show any ratings for Water or Sediment Chemistry, despite showing increasing ratings in Figure 10-2a and b.</td>
<td>REVIEW whether including only &quot;Key Driver Endpoints&quot; is the clearest way to illustrate the results of WOE analysis. Review and cross-check tables and figures against detailed results presented in earlier sections.</td>
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<td>There also appear to be some inconsistencies with the information presented in Figures 10-2a to 10-2c and 10-3a to 10-3c relative to results presented in earlier sections. For example, there is a grey diamond for 2010 for GSI in Figure 10-2c (indicating not measured), but none for LSI and body size, which also were excluded for 2010 due to methodological differences (see earlier comment and description of methods on page 502).</td>
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<td>Additional notes include: Figure 10-3c is not consistent with the text on page 592, which states that the key driver in 2010 was condition factor, but the figure shows an effect for LSI.</td>
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<td>Table 10A-8 shows moderate ratings for TP and chlorophyll a, but symbols for these do not appear in Figure 10-3c for 2010.</td>
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<td>Table 10A-12 shows high and moderate ratings for TN and TP, but no symbols appear in Figure 10-3c for 2013, and Table 10A-14 shows a high rating for TN that doesn't appear in Figure 10-3c for 2016.</td>
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<td>There is also an error in the footnote for Figure 10-3, where it states that * symbol does not indicate toxicity (should be nutrient enrichment).</td>
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<td>Since pathology - occurrence showed a low increase (see Figure 10-3c), should it have a * symbol in Figure 10-2c for 2016?</td>
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<td><strong>MAIN DOCUMENT, AEMP</strong>&lt;br&gt;Summary of Effects, Section 12.2, Toxicological Impairment, page 602</td>
<td>The report indicates: &quot;Weight-of-evidence: The EA predicted that overall, Lac de Gras water would remain at a high quality for use as drinking water and by aquatic life. The main impact was expected to be the introduction of greater concentrations of nutrients, particularly phosphorus, with a concomitant increase in primary productivity over a portion of the lake. The WOE evaluation results are consistent with this prediction.&quot; While it is acknowledged that some of the effects benchmarks for water quality were based on drinking water quality guidelines and that guidelines for the protection of aquatic life are typically more stringent than drinking water quality guidelines, the report does not include an explicit analysis of water quality in terms of drinking water quality. This statement may benefit from some additional explanation regarding effects on drinking water quality as this is not the focus of the report.</td>
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<td><strong>MAIN DOCUMENT, Proposed Updates to AEMP Design Plan, Section 14.2.1, Dust, page 606</strong></td>
<td>Section 14.2.1 (page 606) provides a response to a WLWB directive: &quot;The WLWB requested a critical review of the present sampling plan for dust, and requested DDMI consider revisions to the existing program based on the findings presented herein. Potential revisions requested by the WLWB (Table 1-1) included the following:&lt;br&gt;- Consider the implementation of additional dustfall and/or snow water chemistry monitoring sites (W2015L2-0001 update, Commitment A)...&quot; The response provided indicates: &quot;The current number and location of the dustfall and snow water monitoring locations is sufficient to evaluate both the spatial and the temporal trends of dust deposition (e.g., Figure 3-10 and 3-17); nutrient deposition (Figure 3-11 to 3-14 and 3-18); and metal deposition (Figures 3-15, 3-16 and 3-19) in the vicinity of the Mine. Consequently, no additional monitoring locations are recommended at this time.&quot; There is no rationale provided for why no additional dust monitoring sites will be added. NSC (2017a) had noted in the review of the 2016 AEMP Report: &quot;Given the relatively high dust deposition observed at sites south and southeast of the mine, it would be beneficial to add a site between the two monitoring axes (i.e., SSE in the vicinity of the water quality site MF3-3) and a dustfall monitoring station south of site Dust 10 (i.e., at or near one of the snow dust fall sites SSS-4 and SSS-5).&quot;</td>
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<td>MAIN DOCUMENT, Proposed Updates to AEMP Design Plan, Section 14.2.1, Dust, page 606</td>
<td>Section 14.2.1 (page 606) provides a response to a WLWB directive: &quot;The WLWB requested a critical review of the present sampling plan for dust, and requested DDMI consider revisions to the existing program based on the findings presented herein. Potential revisions requested by the WLWB (Table 1-1) included the following: ...Review the location and number of duplicate and blank samples for the dustfall and the snow water chemistry program (W2015L2-0001 update, Commitment B).&quot; There is no discussion provided regarding a review of blank samples.</td>
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<td>MAIN DOCUMENT, Proposed Updates to AEMP Design Plan, Section 14.2.1, Dust, page 606</td>
<td>The sample duplicate results are presented in Table 3-4 (page 29) for only a subset of parameters. The document should include a review of all parameters to provide for an evaluation of QA/QC for the program as a whole. While annual reports discuss details for all parameters, the re-evaluation report is the location where data for numerous years are considered collectively. Issues with and/or patterns in data may not be readily apparent until data are reviewed for all years together.</td>
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<td><strong>MAIN DOCUMENT, Proposed Updates to AEMP Design Plan, Section 14.2.2.1, Fish, Non-lethal Slimy Sculpin Survey, page 607</strong></td>
<td>It is unclear how the addition of a non-lethal sculpin survey, as described in Section 14.2.2.1 (page 607) will be incorporated into the assessment of effects. There will be no ability to compare the results of the first year of sampling to any previous data as the data collected and sampling strategy are different. Therefore, the first comparison could only be done after 6 years, since the sampling is recommended to occur every three years (Section 14.2.2.2). Furthermore, this dataset will lack baseline or early post-project data with which to compare. If normal ranges are utilized as per the lethal assessment, then the first two sampling years at a minimum will be needed to construct these ranges. If this is the case, then it would not be possible for these data to trigger an Action Level 3 for the first two sampling periods as, according to Table 9-4 (page 509), this requires data to be outside of the normal range.</td>
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| **MAIN DOCUMENT, Proposed Updates to AEMP Design Plan, Section 14.2.8, Weight-of-Evidence, page 611** | Section 14.2.8 (page 611) indicates: "In their Reasons for Decision, WLWB (2017e; Section 3.12, Part 2e) recommends that benthic macroinvertebrate density be added as a nutrient enrichment exposure endpoint of the fish population health ecosystem component, or that rationale be provided for the omission (Table 1-1). Chlorophyll a is currently included as a nutrient enrichment exposure endpoint for the fish population health ecosystem, which is intended to be indicative of food supply. It is assumed that an increase in the biomass of algae as measured by chlorophyll a provides an early indication of an enrichment-related increase in zooplankton and/or benthic invertebrate food supply for fish. Adding benthic invertebrate abundance or density would be redundant considering there is already a conservative measurement of enrichment-related food supply in the WOE analysis. Moreover, the benthic invertebrate community samples are collected from deep-water stations and as such the abundance or density from these samples are not representative of food supply for shallow-water, shoreline-dwelling Slimy Sculpin."

Because chlorophyll a is measured once per year and is inherently more variable in time and space than benthic invertebrate community metrics, the latter would provide a more integrative representation of effects related to nutrient enrichment. In addition, benthic invertebrates are the primary food source for slimy sculpin. | Incorporate benthic invertebrate density in the WOE, as suggested by the WLWB. |
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<tr>
<td>Appendix 10A, Updated Weight-of-Evidence Analyses</td>
<td>There are inconsistencies among the years in the &quot;A Posteriori Weighting&quot; values. For example, in Table 10A-1 the endpoints for contaminant exposure were assigned a strength of linkage rating of 0.25, but this value is 0.5 in Tables 10A-7 and 10A-11, and 0.75 in 10A-13. Similarly, the a posteriori weighting factors do not match for the nutrient enrichment tables - pathology is rated 0.25 in Table 10A-14 (2016), but 0.75 in Table 10A-8 (2010).</td>
<td>Revise tables and verify WOE calculations.</td>
</tr>
<tr>
<td>Memorandum: Review of AEMP QA/QC issues, Section 2.2.2, Fish Liver Tissue Exclusion from Carcass Chemistry Analysis, page 6</td>
<td>The Review of the 2016 AEMP report identified the exclusion of sculpin livers from tissue chemistry analysis in 2016 as an issue. The methods described in the memorandum to prevent future sampling errors are acceptable. However, the method to account for the omission of livers in tissue analyses in 2016 is imprecise. The concentration of elements in the livers of Slimy Sculpin has been estimated through extrapolation from two extremely dissimilar species (Lake Trout and Round Whitefish). It is assumed data for these species were used due to lack of similar data for sculpin. However, it is well established that the accumulation of elements in fish tissue is species-specific (see examples of references below). There is a precedent in the report regarding treatment of data with similar issues. Section 9.3.1.1.1 (pages 535-536) indicates that the 2004 samples were not included in the analysis as a result of the exclusion of livers (as well as most of the head and gas bladders) from the samples.</td>
<td>Unless it can be reasonably demonstrated that Lake Trout and Round Whitefish are a good model for Slimy Sculpin, it is recommended that the 2016 data be treated in the same manner as the 2004 samples, which also excluded liver tissue (i.e., omit them from future analyses).</td>
</tr>
</tbody>
</table>

Djikanovic, V., Skorić, S, and Gaćić, Z. 2016. Concentrations of metals and trace elements in different tissues of nine fish species from Meduvršje Reservoir (West Morava River Basin, Serbia). Archives of Biological Sciences 68(00): 69.


3.0 SUPPORTING MATERIALS FOR REVIEW


AQUATIC EFFECTS MONITORING PROGRAM DESIGN PLAN VERSION 5.0 – PLAIN LANGUAGE BRIEFING AND TECHNICAL REVIEW COMMENTS

Technical Memorandum # 367-18-02

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

Prepared by:
North/South Consultants Inc.

July 18, 2018
1.0 BACKGROUND AND SCOPE OF WORK


North/South Consultants Inc. (NSC) conducted a technical review of the AEMP Design Plan Report Version 5.0 for the Environmental Monitoring Advisory Board (EMAB). As directed by EMAB in their Terms of Reference for the review, the review focused on the following:

- How well the Design Plan Report addresses EMAB recommendations since the previous re-design;
- The proposed gradient design to measure mine-related effects and compatibility with existing data;
- Ability to detect inputs/effects from other sources (i.e., Ekati Mine);
- Location and number of new far-field and mid-field stations;
- Appropriateness of proposed statistical analysis methods;
- Updates to the Biological Action Levels;
- Appropriateness of updates made to the list of variables analyzed;
- Changes to the plankton sampling schedule;
- Data handling and analyses methods; and
- Rationale for all other proposed changes to the AEMP Design Plan.

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 AEMP Design Plan Version 5.0 is well written and organized and the submission of a version with revisions identified as track changes was particularly useful for conducting a technical review.

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 AEMP Design Plan Version 5.0 (Section 1.0), and any additional review comments and recommendations borne from this review. The following is organized according to the scope of work identified in Section 1.0.

2.1 INCORPORATION AND CONSIDERATION OF PREVIOUS COMMENTS AND WLWB DIRECTIVES

2.1.1 Addition of Benthic Macroinvertebrates to the Nutrient Enrichment Weight-of-Evidence (WOE) Analysis

Section 14.2.8 (page 611) of the Re-evaluation Report (Golder 2018) indicates: “In their Reasons for Decision, WLWB (2017e; Section 3.12, Part 2e) recommends that benthic macroinvertebrate density be added as a nutrient enrichment exposure endpoint of the fish population health ecosystem component, or that rationale be provided for the omission (Table 1-1). Chlorophyll $a$ is currently included as a nutrient enrichment exposure endpoint for the fish population health ecosystem, which is intended to be indicative of food supply. It is assumed that an increase in the biomass of algae as measured by chlorophyll $a$ provides an early indication of an enrichment-related increase in zooplankton and/or benthic invertebrate food supply for fish. Adding benthic invertebrate abundance or density would be redundant considering there is already a conservative measurement of enrichment-related food supply in the WOE [weight-of-evidence] analysis. Moreover, the benthic invertebrate community samples are collected from deep-water stations and as such the abundance or density from these samples are not representative of food supply for shallow-water, shoreline-dwelling Slimy Sculpin.”

As noted in NSC (2018) comments on the 2014-2016 Re-evaluation Report, because chlorophyll $a$ is measured once per year and is inherently more variable in time and space than benthic invertebrate community metrics, the latter would provide a more integrative representation of effects related to nutrient enrichment. In addition, benthic invertebrates are the primary food source for Slimy Sculpin. This comment is re-iterated here for consideration within the design plan.

**Recommendation:** Incorporate benthic invertebrate density in the WOE, as suggested by the WLWB.
2.1.2 Potential Addition of Dustfall and/or Snow Water Chemistry Sites

As noted in NSC (2018), reiterated here for continuity, the 2014-16 Re-evaluation Report (Section 14.2.1, page 606) provides a response to a WLWB directive: “The WLWB requested a critical review of the present sampling plan for dust, and requested DDMI consider revisions to the existing program based on the findings presented herein. Potential revisions requested by the WLWB (Table 1-1) included the following:

- Consider the implementation of additional dustfall and/or snow water chemistry monitoring sites (W2015L2-0001 update, Commitment A)...

The response provided indicates: “The current number and location of the dustfall and snow water monitoring locations is sufficient to evaluate both the spatial and the temporal trends of dust deposition (e.g., Figure 3-10 and 3-17); nutrient deposition (Figure 3-11 to 3-14 and 3-18); and metal deposition (Figures 3-15, 3-16 and 3-19) in the vicinity of the Mine. Consequently, no additional monitoring locations are recommended at this time.”

There is no rationale provided for why no additional dust monitoring sites will be added. NSC (2017) had noted in the review of the 2016 AEMP Report: “Given the relatively high dust deposition observed at sites south and southeast of the mine, it would be beneficial to add a site between the two monitoring axes (i.e., SSE in the vicinity of the water quality site MF3-3) and a dustfall monitoring station south of site Dust 10 (i.e., at or near one of the snow dust fall sites SS5-4 and SS5-5).”

**Recommendation:** Provide a discussion and rationale for the proposal to not add dustfall monitoring sites.

2.2 PROPOSED GRADIENT DESIGN

The proposed change in monitoring design (i.e., switch to a gradient design) appears reasonable and appropriate; this change is a response to issues identified over the years of monitoring and the observation of effluent influence extending to far-field areas.

**Recommendation:** N/A.

2.3 CUMULATIVE EFFECTS

Inclusion of monitoring sites at the inflow and outflow of Lac de Gras allows for an assessment of potential cumulative effects associated with the Ekati and Diavik mines. Monitoring for eutrophication indicators at these sites annually and inclusion of these results in spatial analyses in annual reports will provide for a more comprehensive analysis of upstream and downstream activities that may act cumulatively with effects from the Diavik mine.

**Recommendation:** N/A.
2.4 CHANGES TO FAR-FIELD STATIONS

The proposed changes to the far-field stations appears appropriate given the change in sampling design (i.e., change to a gradient design). While several stations have been omitted from the program, additional sites were added to fill in spatial gaps along the gradient axes (Section 3.4.1, page 21).

**Recommendation:** N/A.

2.5 PROPOSED STATISTICAL METHODS

The proposed statistical analyses appear to be appropriate and are described in detail.

**Recommendation:** N/A.

2.6 UPDATED BIOLOGICAL ACTION LEVELS

The report states that a Lake Trout health study will only be conducted if the small-bodied fish (i.e., Slimy Sculpin) health assessment triggers an Action Level 3 (Section 4.8.1, page 64). This has been changed from an Action Level 2 in the previous Design Plan Version 4.1 (Golder 2016a). The revision has resulted in a much higher threshold to initiate a Lake Trout health assessment. In the control-effect sampling design (Version 4.1), a significant difference in a variable indicative of a toxicological effect at the MF area relative to the FF areas was sufficient to trigger a large-bodied fish survey; under the gradient sampling design (Version 5.0), the threshold for action level 3 is an exceedance of the critical effect size (CES) and the normal range and the effect is observed in two consecutive sampling periods.

The requirement for exceeding the normal range alone is itself one action level higher than in the previous Version 4.1 AEMP design plan. Under this new action level trigger the small-bodied fish will have exceeded the critical threshold values recommended by the Environment Canada (EC) Metal Mining Environmental Effects Monitoring (EEM) Guidance Document (EC 2012) for 6 years before a large-bodied study is even defined in an AEMP Response Plan. The other major limitation with this plan is that there will be no recent or baseline data with which to compare the Lake Trout health data collected should a study be triggered, limiting the value of such a survey. There is no information provided regarding how Lake Trout health monitoring would be conducted and how the data would be analysed.

**Recommendation:** Review the Lake Trout health survey trigger and provide a description of a potential study design.
2.7 MODIFICATIONS TO LIST OF VARIABLES AND SAMPLING PROGRAM

2.7.1 Fish Health Endpoints

Table 3.2-1 indicates that catch-per-unit-effort (CPUE) is a measurement endpoint for the "Fish Health and Abundance" assessment. It is unclear how this endpoint factors into the Action Level evaluation as there is no reference condition (i.e., normal range) in either the Reference Condition Report Version 1.2 (Golder 2017) or Appendix 9A of the 2014-2016 Re-evaluation Report (Golder 2018).

Recommendation: Provide additional information on how CPUE/abundance is to be used in the analysis of Slimy Sculpin monitoring results.

2.7.2 Addition of Non-Lethal Fish Survey

The report indicates: “Backpack electrofishing will be used to capture Slimy Sculpin. The first fish sampling done in a given year would be a random field sampling effort at each of the study areas documenting each fish captured, before moving to the targeted lethal program” (Section 4.8.2, page 64).

Additional details regarding the non-lethal survey study design should be provided, including a description of the sampling effort, target number of individuals captured, randomization process, and number of sites.

Recommendation: Provide additional information regarding the details of the non-lethal fish sampling program field methods.

2.8 CHANGES TO THE PLANKTON SAMPLING SCHEDULE

One of the proposed changes to the study design is the change in the sampling frequency for phytoplankton. At the mid-field sites, phytoplankton would be sampled every year, as opposed to every three years. DDMI notes: “This change gives the AEMP the ability to look at potential effects on plankton in the main body of the lake on an annual basis” (page PLS-3).

We agree with this addition but would also suggest expanding the program to include annual sampling for eutrophication variables, including nutrients, chlorophyll $a$, and potentially plankton, at FF sites. As noted in previous review comments (e.g., NSC 2016, 2018), the lack of sampling at FF sites 2 out of 3 years has meant that the spatial extent of effects on eutrophication indicators has not been adequately defined in some years. For example, both TN and chlorophyll $a$ spatial extent of effects extended to the edge of MF sites in 2014 (Golder 2016b).

The report also indicates: “Sampling for the plankton component of the AEMP will occur at the same locations as the sampling for other AEMP components (see Section 3.4), with the
exceptions of LDG-48 and LDS-4 which will not be sampled for plankton” (Section 4.6.2, page 58).

Since eutrophication indicators will be sampled annually at this site as noted on page 56, collection of phytoplankton samples at this site annually would be consistent with the eutrophication monitoring component of the AEMP. It is further suggested that samples could be collected and archived pending review of results from other sampling sites (i.e., NF and MF sites).

**Recommendation 1:** Consider increasing the frequency of FF sampling for eutrophication metrics to annual sampling and/or provide a rationale for what actions would be taken in the event that the spatial extent of effects on eutrophication metrics extended up to the MF sites in years when FF sampling is not conducted.

**Recommendation 2:** Collect phytoplankton samples at LDG-48 annually (samples could be archived).

### 2.9 DATA HANDLING AND ANALYSIS METHODS

#### 2.9.1 Inclusion of Results from the Inflow and Outflow in Spatial Analyses of Effects

The report indicates that: “During interim years, station LDG-48, located at the outlet of Lac de Gras into the Coppermine River, and LDS-4, located in the narrows between Lac du Sauvage and Lac de Gras, will also be included in the spatial analysis” (Section 4.5.4, page 56).

As noted in Section 2.3, this addition to the program will provide valuable information on the assessment of the spatial extent of effects, notably towards the northwest axis of the lake.

Assuming the intent for defining the spatial extent of effects will include the site at the lake outflow for defining boundaries for eutrophication metrics in the NW direction, a substantive area of the lake will be defined based on the results of a single sample (i.e., LDG-48). Similar to a previous comment, it is suggested that inclusion of additional FF sites in "interim sampling years" would provide valuable information for defining spatial extents of effects for eutrophication indicators.

**Recommendation:** Could DDMI clarify that spatial extent of effects will include the site at the lake outflow for defining boundaries in the NW direction?

Consider sampling at additional FF sites in interim years for eutrophication metrics to assist with defining spatial extent of effects across the lake.
2.9.2 Analysis of Non-Lethal Fish Survey Data

The methodology for data analysis and statistical analysis presented in Section 4.8.4 does not specify or differentiate what data/endpoints will be calculated/analysed for each of the lethal and non-lethal fish sampling programs. According to the 2014-2016 Re-evaluation Report (Golder 2018), a randomized, non-lethal survey is intended to provide information on sculpin abundance and reproductive success (Section 14.2.2.1, page 607). However, the Version 5.0 Design Plan does not include any information on how the two non-lethal metrics recommended in the Re-evaluation Report (i.e., CPUE and length-frequency histograms), are to be calculated and analysed or how they will be incorporated into the response framework (e.g., action level assessment). It is also unclear how the data will be analysed and interpreted due to the lack of reference conditions (i.e., normal ranges) for these endpoints. In addition, CPUE/abundance is not listed as a metric in Section 4.8.4 (page 68).

Recommendation: Provide a detailed description of the metrics that will be incorporated into reporting and the methods for analysing these metrics, including action levels where applicable.

2.9.3 Analysis of Fish Health Data: Stage Determination and Normal Ranges

The reference conditions (i.e., normal ranges) for fish health were updated as part of the 2014-2016 Re-evaluation Report (Appendix 9A; Golder 2018) due to a change in methods regarding the determination of stage (adult/age 1+). However, there is no methodology presented in Section 4.8 describing how sculpin will be sub-divided into the adult and “juvenile” categories indicated on page 67 or into the “young/small” categories for the length-frequency histograms described on page 68. It is unclear if the “juvenile” category differs from the Age 1+ category discussed in the 2014-2016 Re-evaluation Report (Golder 2018). If these categories differ, then the normal ranges may need to be updated again to reflect the methodology used to separate adults from juveniles rather than Age1+ as was done in Appendix 9A of the Re-evaluation Report.

Recommendation: Revise text in Section 4.8 to include methodology for stage determination. Review calculation of normal ranges for juvenile/adult categories and revise text as required.

2.9.4 WOE Analysis of Fish Health Data: Inclusion of External Abnormalities

Information on both internal and external abnormalities, including wounds, lacerations, and tumours, is being collected as part of the fish health assessment. However, this information is not incorporated into the WOE evaluation (i.e., as defined in Table 4.10-2, page 74) and parasitism has been deleted from the WOE evaluation. The report indicates (page 72) that the Standard Operating Procedures for the internal and external examinations of sculpin have been followed for all surveys; these data could be used to generate normal ranges and could be analysed for previous years and added to the WOE evaluation (i.e., a replacement for the parasitism metric that was deleted).
**Recommendation:** Consider adding the results of fish abnormalities to the WOE assessment to strengthen the WOE analysis.

### 2.9.5 Fish Health Normal Ranges

Section 5.2.4 (pages 89-90, Table 5.2-4) states that the reference conditions for fish health are contained in the Reference Conditions Report Version 1.2 (Golder 2017). However, the normal ranges were recalculated for all of the health variables as part of the 2014-2016 Re-evaluation Report (Appendix 9A; Golder 2018) due to a change in how age/stage was calculated.

**Recommendation:** Correct citation to reference condition if appropriate and clarify what normal ranges will be used moving forward.

### 2.10 RATIONALE FOR PROPOSED CHANGES

#### 2.10.1 Fish Endpoints

As discussed in a review of the 2014-2016 Re-evaluation Report (NSC 2018), the removal of the biological variables from the endpoints and lines of evidence (Tables 4.10-1 and 4.10-2) leaves no measure of survival for fish. The rationale provided in Golder (2018) for these deletions is:

“Total length, fresh weight, and/or carcass weight should be added as endpoints to the WOE analysis instead of size at age, which cannot be determined because age data are not available for Slimy Sculpin (due to the difficulties of interpreting ages using otoliths with this species).…Survival, and Reproductive Investment – Age-1+ Abundance should both be removed from the WOE endpoints for fish population health. Neither of these endpoints can be accurately determined due to difficulties in capturing the smallest size classes (e.g., fishing gear bias), and while length-frequency and presence/absence analysis for the smallest size class may be considered as a surrogate for Age-1+ abundance, they should not be included as part of the WOE.”

It would be beneficial if the two metrics recommended to be collected as part of the randomized, non-lethal survey identified in the Re-evaluation Report (i.e., abundance and length-frequency histograms; Section 14.2.2.1; Golder 2018) could be added to the WOE; however, it is recognized that this is complicated by the absence of data from previous surveys.

**Recommendation:** Recommend inclusion of non-lethal fish population endpoints (abundance and length-frequency histograms) in the WOE.
2.11 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 AEMP Design Plan v. 5.0.

<table>
<thead>
<tr>
<th>TOPIC</th>
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<tr>
<td>Study Design, Section 3.2, Assessment and Measurement Endpoints, page 19, Table 3.2-1</td>
<td>Table 3.2-1 (page 19) Valued Ecosystem Components and Measurement Endpoints Associated with the AEMP identifies &quot;Maintenance of fish tissue metal concentrations that do not pose a risk to predatory fish&quot; as an assessment endpoint and &quot;Slimy Sculpin tissue chemistry&quot; as the measurement endpoint. Previous AEMP reports have not included an assessment of potential risks to predatory fish associated with metals in Slimy Sculpin. While it is acknowledged this information may be lacking for a number of metals, some scientific literature is available to assist with assessing potential risks to piscivorous fish for some metals. For example, comparisons could be made to the BCMOE interim dietary guideline for selenium of 4 μg/g DW for aquatic-dependent wildlife and fish (BCMOE 2014a,b, 2018).</td>
<td>The assessment endpoint should either be revised to remove &quot;predatory&quot; or the AEMP assessment framework should be expanded to include an explicit assessment of the risks posed by metals in Slimy Sculpin to predatory fish (e.g., Lake Trout).</td>
</tr>
<tr>
<td>Study Design, Section 3.2, Assessment and Measurement Endpoints, page 19, Table 3.2-1</td>
<td>Fish age has been removed from the assessment and measurement endpoints for fish health and there is no longer an indicator of survival identified in Table 3.2-1.</td>
<td>Recommend including a measurement endpoint for survival.</td>
</tr>
<tr>
<td>Study Design, Section 3.2, Assessment and Measurement Endpoints, page 19, Table 3.2-1</td>
<td>Table 3.2-1 indicates that catch-per-unit-effort (CPUE) is a measurement endpoint for the &quot;Fish Health and Abundance&quot; assessment. It is unclear how this endpoint factors into the Action Level evaluation as there is no reference condition (i.e., normal range) in either the Reference Condition Report Version 1.2 (Golder 2017) or Appendix 9A of the 2014-2016 Re-evaluation report (Golder 2018).</td>
<td>Provide additional information on how CPUE/abundance is to be used in the analysis of Slimy Sculpin monitoring results.</td>
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<tr>
<td>Study Design, Section 3.5, Sampling Schedule, page 25 and Response Framework, Section 5.2.4, Biological Components, page 91, Table 5.2-4</td>
<td>The text (page 25) provides an example that states &quot;at Action Level 1, the follow-up action for biological components is confirmation of effect&quot;; however, this does not agree with the revised action levels presented in Table 5.2-4 (page 91), that indicates the action for Action Level 1 is no action, and Action Level 2 is to confirm effects.</td>
<td>Review for conformity</td>
</tr>
<tr>
<td>Description of AEMP Components, Section 4.2.2.1, Dust Deposition, Snow Cores, page 34</td>
<td>Section 4.2.2.1 (page 34) identifies the number of duplicate samples to be incorporated into the QA/QC program for dust monitoring. However, there is no description of the numbers and types of blank QA/QC samples for the program.</td>
<td>Include a description of the numbers and types (e.g., field blank, equipment blank) of blank samples included in the dust monitoring program and identify if blank samples will be prepared (where applicable; e.g., preparation of equipment blanks) at sites where duplicate samples are collected.</td>
</tr>
<tr>
<td>Description of AEMP Components, Section 4.4.4, Sediment quality, Data Analysis and Interpretation, page 54</td>
<td>Section 4.4.4 (page 54) indicates: &quot;Variables with strong correlations to TOC or percent fines will be normalized to the relevant physical variable before statistical analysis.&quot;</td>
<td>Please clarify if trends will also be evaluated on raw data for all of the SOIs. If this is not proposed, please provide a discussion of the rationale for excluding these analyses.</td>
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| Description of AEMP Components, Section 4.5.4, Eutrophication Indicators, Data Analysis and Interpretation, page 56 | The report indicates that: "During interim years, station LDG-48, located at the outlet of Lac de Gras into the Coppermine River, and LDS-4, located in the narrows between Lac du Sauvage and Lac de Gras, will also be included in the spatial analysis."

This addition to the program will provide valuable information on the assessment of the spatial extent of effects, notably towards the northwest axis of the lake.

Assuming the intent for defining the spatial extent of effects will include the site at the lake outflow for defining boundaries in the NW direction, a substantive area of the lake will be defined based on the results of a single sample (i.e., LDG-48). Similar to a previous comment, it is suggested that inclusion of additional FF sites in "interim sampling years" would provide valuable information for defining spatial extents of effects for eutrophication indicators. | Could DDMI clarify that spatial extent of effects will include the site at the lake outflow for defining boundaries in the NW direction?
Consider sampling at additional FF sites in interim years for eutrophication metrics to assist with defining spatial extent of effects across the lake. |
| Plain Language Summary (page PLS-3) and Description of AEMP Components, Section 4.6.2, Plankton, Field Methods, page 58 | One of the proposed changes to the study design is the change in the sampling frequency for phytoplankton. At the mid-field sites, phytoplankton would be sampled every year, as opposed to every three years. DDMI notes: “This change gives the AEMP the ability to look at potential effects on plankton in the main body of the lake on an annual basis” (page PLS-3).

We agree with this addition but would also suggest expanding the program to include annual sampling for eutrophication variables, including nutrients, chlorophyll a, and potentially plankton, at FF sites. As noted in previous review comments (e.g., NSC 2016, 2018), the lack of sampling at FF sites 2 out of 3 years has meant that the spatial extent of effects on eutrophication indicators has not been adequately defined in some years. For example, both TN and chlorophyll a spatial extent of effects extended to the edge of MF sites in 2014 (Golder 2016a). | Consider increasing the frequency of FF sampling for eutrophication metrics to annual sampling and/or provide a rationale for what actions would be taken in the event that the spatial extent of effects on eutrophication indicators extended up to the MF sites in years when FF sampling is not conducted. |
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<td>Collect phytoplankton samples at LDG-48 annually (samples could be archived).</td>
</tr>
<tr>
<td>Description of AEMP Components, Section 4.8.1, Fish Health, Background, page 64</td>
<td>The report states that a Lake Trout health study will only be conducted if the small-bodied fish (i.e., Slimy Sculpin) health assessment triggers an Action Level 3 (Section 4.8.1, page 64). This has been changed from an Action Level 2 in the previous Design Plan Version 4.1 (Golder 2016b). The revision has resulted in a much higher threshold to initiate a Lake Trout health assessment. In the control-effect sampling design (Version 4.1), a significant difference in a variable indicative of a toxicological effect at the MF area relative to the FF areas was sufficient to trigger a large-bodied fish survey; under the gradient sampling design (Version 5.0), the threshold for action level 3 is an exceedance of the critical effect size (CES) and the normal range and the effect is observed in two consecutive sampling periods. The requirement for exceeding the normal range alone is itself one action level higher than in the previous Version 4.1 AEMP design plan. Under this new action level trigger the small-bodied fish will have exceeded the critical threshold values recommended by the Environment Canada (EC) Metal Mining Environmental Effects Monitoring (EEM) Guidance Document (EC 2012) for 6 years before a large-bodied study is even defined in an AEMP Response Plan. The other major limitation with this plan is that there will be no recent or baseline data with which to compare the Lake Trout health data collected should a study be triggered, limiting the value of such a survey. There is no information provided regarding how Lake Trout health monitoring would be conducted and how the data would be analysed.</td>
<td>Review the Lake Trout health survey trigger and provide a description of a conceptual study design.</td>
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<td>Please provide additional information regarding the details of the non-lethal fish sampling program field methods.</td>
</tr>
<tr>
<td>Description of AEMP Components, Section 4.9.3, Fish Tissue Chemistry, Laboratory Methods, page 69</td>
<td>Section 4.9.3 (page 69) indicates that &quot;five Slimy Sculpin samples will be randomly selected after the initial analysis and sent to Flett Research Ltd. (Winnipeg, MB) for QC of the mercury results.&quot; It may be more meaningful to select five samples across a range of concentrations (obtained from the primary analysis), including minimum and maximum concentrations, rather than choosing five samples randomly. Inter-laboratory comparison results for fish mercury may vary substantively depending on the concentrations encountered.</td>
<td>Consider changing the approach on how to select tissue samples for QC of mercury analysis.</td>
</tr>
<tr>
<td>Description of AEMP Components, Section 4.8.4, Fish Health, Data Analysis and Interpretation, page 67-68</td>
<td>The methodology for data analysis and statistical analysis presented in Section 4.8.4 does not specify or differentiate what data/endpoints will be calculated/analysed for each of the lethal and non-lethal fish sampling programs. According to the 2014-2016 Re-evaluation report (Golder 2018), a randomized, non-lethal survey is intended to provide information on sculpin abundance and reproductive success (Section 14.2.2.1, page 607). However the Version 5.0 Design Plan does not include any information on how the two non-lethal metrics recommended in the Re-evaluation report (i.e., CPUE and length-frequency histograms), are to be calculated and analysed or how they will be incorporated into the response framework (e.g., action level assessment). It is also unclear how the data will be analysed and interpreted due to the lack of reference conditions (i.e., normal ranges) for these endpoints. In addition, CPUE/abundance is not listed as a metric in Section 4.8.4 (page 68).</td>
<td>Provide a detailed description of the metrics that will be incorporated into reporting and the methods for analysing these metrics, including action levels where applicable.</td>
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<tr>
<td>TOPIC</td>
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<tr>
<td>Description of AEMP Components, Section 4.8.4, Fish Health, Data Analysis and Interpretation, page 67-68</td>
<td>The reference conditions (i.e., normal ranges) for fish health were updated as part of the 2014-2016 Re-evaluation report (Appendix 9A; Golder 2018) due to a change in methods regarding the determination of stage (adult/age 1+). However, there is no methodology presented in Section 4.8 describing how sculpin will be sub-divided into the adult and &quot;juvenile&quot; categories indicated on page 67 or into the &quot;young/small&quot; categories for the length-frequency histograms described on page 68. It is unclear if the &quot;juvenile&quot; category differs from the Age 1+ category discussed in the 2014-2016 Re-evaluation report (Golder 2018). If these categories differ, then the normal ranges may need to be updated again to reflect the methodology used to separate adults from juveniles rather than Age1+ as was done in Appendix 9A of the Re-evaluation report.</td>
<td>Revise text in Section 4.8 to include methodology for stage determination. Review calculation of normal ranges for juvenile/adult categories and revise text as required.</td>
</tr>
<tr>
<td>Description of AEMP Components, Section 4.10.2., Weight-of-Evidence Framework, pages 72-80</td>
<td>As noted in NSC (2018), some of the weightings were not consistent across time (i.e., 2007, 2013, 2016) within the WOE evaluation presented in Appendix 10A of the 2014-2016 Re-evaluation report (Golder 2018). There is no information provided in the Design Plan Version 5.0 identifying the current weightings or how the rankings will be standardized among the sampling periods if the values have changed as part of the AEMP redesigns. There is also no discussion of whether the calculation of the WOE score is modified to account for endpoints that are missing results in a year (e.g., GSI in 2010).</td>
<td>Provide information on weighting factors and additional information on WOE scoring.</td>
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<td>TOPIC</td>
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<td>Weight-of-Evidence, Section 4.10.2.1, Lines of Evidence and Measurement Endpoints, page 73, Table 4.10-1</td>
<td>Section 14.2.8 (page 611) of the Re-evaluation Report (Golder 2018) indicates: &quot;In their Reasons for Decision, WLWB (2017e; Section 3.12, Part 2e) recommends that benthic macroinvertebrate density be added as a nutrient enrichment exposure endpoint of the fish population health ecosystem component, or that rationale be provided for the omission (Table 1-1). Chlorophyll a is currently included as a nutrient enrichment exposure endpoint for the fish population health ecosystem, which is intended to be indicative of food supply. It is assumed that an increase in the biomass of algae as measured by chlorophyll a provides an early indication of an enrichment-related increase in zooplankton and/or benthic invertebrate food supply for fish. Adding benthic invertebrate abundance or density would be redundant considering there is already a conservative measurement of enrichment-related food supply in the WOE analysis. Moreover, the benthic invertebrate community samples are collected from deep-water stations and as such the abundance or density from these samples are not representative of food supply for shallow-water, shoreline-dwelling Slimy Sculpin.&quot; As noted in NSC (2018) comments on the Re-evaluation Report, because chlorophyll a is measured once per year and is inherently more variable in time and space than benthic invertebrate community metrics, the latter would provide a more integrative representation of effects related to nutrient enrichment. In addition, benthic invertebrates are the primary food source for Slimy Sculpin. This comment is re-iterated here for consideration within the design plan.</td>
<td>Incorporate benthic invertebrate density in the WOE, as suggested by the WLWB.</td>
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<tr>
<td>Description of AEMP Components, Section 4.10.2.1, Weight-of-Evidence, Lines of Evidence and Measurement Endpoints, page 74, Table 4.10-2</td>
<td>Information on both internal and external abnormalities, including wounds, lacerations, and tumours, is being collected as part of the fish health assessment. However, this information is not incorporated into the WOE evaluation (i.e., as defined in Table 4.10-2, page 74) and parasitism has been deleted from the WOE evaluation. The report indicates (page 72) that the Standard Operating Procedures for the internal and external examinations of sculpin have been followed for all surveys; these data could be used to generate normal ranges and could be analysed for previous years and added to the WOE evaluation (i.e., a replacement for the parasitism metric that was deleted).</td>
<td>Consider adding the results of fish abnormalities to the WOE assessment to strengthen the WOE analysis.</td>
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<tr>
<td>TOPIC</td>
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<td>Description of AEMP Components, Section 4.10.2.1, Weight-of-Evidence, Lines of Evidence and Measurement Endpoints, pages 73-74, Tables 4.10-1 and 4.10-2</td>
<td>The removal of biological variables from the endpoints and lines of evidence (Tables 4.10-1 and 4.10-2) leaves no measure of survival for fish. The rationale provided in Golder (2018) for these deletions is: “Total length, fresh weight, and/or carcass weight should be added as endpoints to the WOE analysis instead of size at age, which cannot be determined because age data are not available for Slimy Sculpin (due to the difficulties of interpreting ages using otoliths with this species)....Survival, and Reproductive Investment – Age-1+ Abundance should both be removed from the WOE endpoints for fish population health. Neither of these endpoints can be accurately determined due to difficulties in capturing the smallest size classes (e.g., fishing gear bias), and while length-frequency and presence/absence analysis for the smallest size class may be considered as a surrogate for Age-1+ abundance, they should not be included as part of the WOE.” It would be beneficial if the two metrics recommended to be collected as part of the randomized, non-lethal survey identified in the Re-evaluation report (i.e., abundance and length-frequency histograms; Section 14.2.2.1; Golder 2018) could be added to the WOE; however, it is recognized that this is complicated by the absence of data from previous surveys.</td>
<td>Consider inclusion of non-lethal fish population endpoints (abundance and length-frequency histograms) in the WOE.</td>
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<tr>
<td>Response Framework, Section 5.2.4, Biological Components, pages 89-90, Table 5.2-4</td>
<td>Section 5.2.4 (pages 89-90, Table 5.2-4) states that the reference conditions for fish health are contained in the Reference Conditions Report Version 1.2 (Golder 2017). However, the normal ranges were recalculated for all of the health variables as part of the 2014-2016 Re-evaluation Report (Appendix 9A; Golder 2018) due to a change in how age/stage was calculated.</td>
<td>Correct citation to reference condition, if appropriate and clarify what normal ranges will be used moving forward.</td>
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3.0 SUPPORTING MATERIALS FOR REVIEW


July 19, 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  
2014 to 2016 Aquatic Effects Re-evaluation Report and Version 5.0 of the AEMP Design  
Request for Comment

The Department of Environment and Natural Resources (ENR), Government of the Northwest Territories has reviewed the information 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.

2014 to 2016 Aquatic Effects Re-evaluation Report

Topic 1: General

Comment(s):

ENR retained Zajdlik and Associates to provide review and comment of the Diavik Diamond Mines (2012) Inc. (DDMI) 2014 to 2016 Aquatic Effects Re-evaluation Report. As part of the review, Dr. Zajdlik focused on the 2017 WLWB Board Directives and Reasons for Decision for the 2016 AEMP and Schedule 8 update. ENR has extracted and summarized some of his comments and recommendations from this memo and provided them below. ENR has also included Dr. Zajdlik’s review memo which provides additional background 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: Phytoplankton Taxonomy in Eastern Lac de Gras

Comment(s):

ENR has previously provided recommendations to the WLWB on including phytoplankton taxonomy to be done annually at all MF and FF-2 locations as well as LDS-4 (WLWB 2017a, Section 3.12, part 2 h). ENR’s comment and recommendation was as follows:

“Comment Golder (2016, Table 3.5-1) proposes to measure indicators of eutrophication annually at nearfield, MF, FF2, LDS-4 and LDG-48. This list of eutrophication indicators includes zooplankton biomass but does not include phytoplankton taxonomy. Phytoplankton taxonomy is currently measured annually at nearfield locations. Given concerns with potential eutrophication in the eastern end of Lac de Gras due to construction of the Jay Pit, phytoplankton taxonomy should be included in the list of eutrophication indicators that are measured on an annual basis at MF, FF2 and LDS-4 locations in addition to nearfield locations. This more complete time series of data will aid in detecting and understanding potential cumulative impacts. Note that currently, DDMI does not propose to measure phytoplankton taxonomy at LDS-4 at all.

Recommendation 1) ENR recommends that phytoplankton taxonomy should be included in the list of eutrophication indicators that are measured on an annual basis at MF, FF2 and LDS-4 locations in addition to nearfield locations.”

The Board noted that DDMI has already committed to including this annually at all MF stations in response to a Board Directive which requires: “DDMI is to incorporate annual sampling for plankton variables at the MF stations as part of its updates to the AEMP Design that are to be submitted along with the 2014 to 2016 Aquatic Effects Re-evaluation Report” (WLWB 2017a).

The Proponent response was that “Recommendations relating to changes to the AEMP sampling design or analytical methods is outside the scope of the Annual Report and should be addressed during the next update to the AEMP Design.” Despite that statement, DDMI (DDMI/Golder 2018a, Table 1-1) notes that the recommendation pertains to “Plankton” and the specific Proponent response in the AEMP design plan is presented in Plankton - Section 7.7 therein. However, DDMI (DDMI/Golder 2018a) also states that “The 2014 to 2016 Aquatic Effects Re-evaluation Report has been prepared under Water Licence W2015L2-0001 and
AEMP Study Design Version 3.5.” Because a recommendation to augment sampling made in 2017 cannot be implemented retroactively, this recommendation will only appear in subsequent AEMPs and a revision to the AEMP design.

DDMI (DDMI/Golder 2018b, Table 8-1) points to AEMP Design Plan Version 4.1 for a response to this recommendation. There is no discussion of phytoplankton taxonomy in AEMP Design Plan Version 4.1. DDMI (DDMI/Golder 2018b, §4.6.2) does state that “sampling in the NF and MF areas of Lac de Gras will occur on an annual basis” but there is no discussion regarding ENR’s comment, despite a commitment to do so (WLWB, 2017b, Comment Summary ID #18).

**Recommendation(s):**

1) As the WLWB (2017a) directive to address ENR’s comment was not addressed in the document indicated by Golder (DDMI/Golder 2018a Table 8-1), ENR recommends that DDMI should address the WLWB (2017a) directive with respect to conducting phytoplankton taxonomy at the FF2 and LDS-4 locations. It is acknowledged that DDMI is now evaluating phytoplankton taxonomy at midfield locations.

**Topic 3: Capturing Slimy Sculpin**

**Comment(s):**

ENR has previously provided comments regarding sampling for slimy sculpin:

“DDMI suggests that very few young of year (YOY) were captured possibly due to their size being too small to be captured and from the presence of slimy sculpin in a range of sizes in the exposure areas, similar reproductive success is likely across sites. ENR notes that few captured YOY may also be an indicator for poor reproductive success. The presence of a range of sizes at the exposure areas does not necessarily indicate successful reproduction and is insufficient rationale to dismiss the absence of YOY.

*Recommendation 1) ENR recommends DDMI consider reviewing the methods used to determine reproductive success and consider additional methods such as minnow traps or jar traps in future AEMPs that have been successfully deployed to capture YOY (Arciszewski et al. 2010)*”.

DDMI’s response is noted in the Board 2017 reasons for decision, where Section 3.1.3, 2h states: “DDMI has stated that alternative methods to examine reproductive success of Slimy Sculpin will be reviewed and considered (Responses to EMAB comment 80; GNWT-ENR comment 29)” (WLWB, 2017a Section 3.1.3, 2 j). DDMI (DDMI/Golder 2018a, Table 1-1) notes that the recommendation is addressed in Section 13.4, therein.
ENR notes that the section 13.4 noted in the concordance table (Golder 2018a, Table 1-1) does not exist in the report. However, DDMI (DDMI/Golder 2018a Section 9.2.1.2.2) states that individual ages “could not be determined with sufficient accuracy” citing CRI (2014). DDMI (DDMI/Golder 2018a Section 9.2.1.2.3) discusses a procedure to classify fish by ages using a variety of methods. DDMI (DDMI/Golder 2018a, Section 14.2.2.3, Population Structure) recommends removing Reproductive Investment – Age-1+ Abundance as a weight of evidence endpoint due to the difficulties in capturing the smallest size classes (e.g., fishing gear bias).

DDMI (DDMI/Golder 2018a Section 14.2.2.1) discusses a small addition to the field program that comprises random field sampling within an area to better understand effects on abundance (catch per unit effort) and overall reproductive success. DDMI (Golder 2018a) notes that “There are limitations inherent in the use of any type of fish gear, however, and for electrofishing small fish in boulder-cobble lake habitat, it is likely the smallest size of fish (i.e., YOY and short juveniles) will still be under-represented by this sampling method.” This leads to the recommendation that smaller size classes be examined for presence / absence but not used in the weight of evidence approach.

It is not clear whether the within-area random sampling area will be conducted. The review of alternative methods recommended by ENR does not appear to have been conducted.

Recommendation(s):

1) DDMI should conduct a review of methods to capture young of the year and discuss any potential biases induced by specific methodologies. The outcome will determine whether young of year size classes will be used in the weight of evidence.

Topic 4: Inclusion of Phosphorus as an Action Level

Comment(s):

WLWB (2017c, Directive 3) states that “With regards to the 2014 to 2016 Aquatic Effects Re-evaluation Report, the Board has decided that DDMI is to consider the inclusion of phosphorus concentrations in the Response Framework. The Board requires this consideration to include a discussion of observed phosphorus concentrations and how they relate to the phosphorus management framework”. DDMI (Golder 2018a, Table 1-1) points to the Eutrophication Indicators section and Section 5.2.8 for the response to this directive. ENR notes that this appears to be a typographical error, and this topic is discussed by DDMI (DDMI/Golder 2018a, §5.3.8.3) and summarized in section 5.3.8 entitled “Inclusion of Phosphorus Concentration in the Response Framework”. DDMI presents three arguments.
1. DDMI (Golder 2018a, Section 5.3.8.3) states: “Chlorophyll a concentration has proven to be a simple and robust indicator of the biological response to nutrient additions to Lac de Gras. It is a more reliable indicator of trophic status than TP, which is an exposure variable rather than a response variable”.

This statement, with the exception of total phosphorous being an exposure variable, is comprised of a series of subjective assertions. What can be said objectively about chlorophyll a in Lac de Gras is that:

- it exhibits a general gradient in response with increasing distance from the Mine (Golder 2016, Appendix XIII, Figure 3-19; Golder 2017, Appendix XIII, Figure 3-19);
- it is weakly correlated with total P (DDMI/Golder, 2018a Section 5.3.5.3);
- it is moderately to strongly correlated with total N (DDMI/Golder, 2018a Section 5.3.5.3);
- it is poorly correlated with N:P ratios (DDMI/Golder, 2018a Section 5.3.5.3).

When nutrients are limited it is assumed that addition of nutrients leads to increases in phytoplankton biomass. Chlorophyll a as a surrogate measure of phytoplankton biomass should also increase with phytoplankton biomass. As stated by Golder (2011) “An evaluation of the relationship between chlorophyll a and phytoplankton biomass provides an understanding of the utility of chlorophyll a as a phytoplankton biomass indicator”. That relationship is weak when evaluating the relationship by sampling area (Golder 2011, Figure 3.4-41; DDMI/Golder 2018a, Figure 5-35) but is “moderate to strong” when evaluating the relationship by year rather than sampling area (DDMI;/Golder, 2018a Section 5.3.5.1).

Other authors discuss the limited correspondence between chlorophyll a and phytoplankton biovolume (Dolan et al. 1978; Felip and Catalan, 2000) or biomass (El-Shaarawi and Munawar, 1978; Jónasson et al. 1992). 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 of the chlorophyll a concentration to biomass ratio with changes in trophic status, with size of organism and with temporal changes in phytoplankton taxonomic composition. The overall message is that the utility of chlorophyll a as a phytoplankton biomass indicator, which is arguably the most appropriate biological measurement to nutrient enrichment, is subject to debate.
The first argument includes a statement that chlorophyll a is “a sensitive and robust measure of biological response to nutrient inputs from the Mine”. Sensitivity is a relative term and reflects the relative degree of change in a biological response to nutrient inputs. The only contextual comment regarding chlorophyll a appearing by DDMI (DDMI/Golder 2018a, Section 5.3.6) states: “the plankton component results generally support the conclusions of the eutrophication indicators analysis”. A discussion of whether chlorophyll a is more (or less) sensitive than say phytoplankton biomass was not found. Robustness is defined as a change that occurs only in association with changes in nutrient input. That is changes in chlorophyll a are only attributable to nutrients. Aside from nutrient concentrations, chlorophyll a is known to vary with community structure (El-Shaarawi and Munawar, 1978). In a review of community structure, DDMI (DDMI/Golder 2018a, Section 7.3.2.1.5) states: “The phytoplankton multidimensional scaling results indicate that changes over time in phytoplankton community structure have been occurring in the near field area of Lac de Gras, especially between 2003 to 2007, and that conditions in 2016 differed from conditions in 2013 throughout the lake, but the near field and far field areas in these two years were more similar than observed in previous years”. It is not clear to what extent changes in chlorophyll a reflect changes in the community rather than a general biological response to nutrient addition. The conclusion that chlorophyll a is “a sensitive and robust measure of biological response to nutrient inputs from the Mine” does not appear to be supported.

The last idea in the first argument above is that that chlorophyll a is a response variable rather than an exposure variable which is correct inasmuch as chlorophyll a solely reflects nutrient exposure. This is in fact not an argument for excluding exposure variables because CCME (2016), in a discussion of types of variables relevant for nutrient guideline development¹, states unequivocally: “Nutrient concentrations are the most practical variables for nutrient guidelines as they can be managed directly.” The second argument presented by DDMI (Golder 2018a) regarding inclusion of P as an action level is:

2. “Increases in TP in Lac de Gras have been small and sporadic, without strong spatial trends, while clear increases in chlorophyll a concentrations have been observed in the NF and MF areas, indicating a gradient-type response to nutrient addition. “Golder (2018a, Section 5.3.8.3)

Although strong spatial gradients in total P are not apparent, Appendix XIII and Figure 3-8 (Golder 2016); and Appendix XIII and Figure 3-18 (Golder 2017) show evidence of higher total P concentrations within 10 km of the diffuser versus further sites. The absence of strong and distinct spatial gradients may be due to the uptake of nutrients noted by Golder (2011) who state: “Increases in chlorophyll a concentrations over time may be limited by nutrient availability, as inorganic
phosphorus and nitrogen are essentially depleted at some stations by the end of the growing season. Finally, ENR notes that “annual loads of total phosphorous from the North Inlet Water Treatment Plant have increased between 2002 and 2016” (Golder 2018a, Section 5.5) suggesting that managing total P may be or become necessary.

The third argument presented by DDMI (Golder 2018a) regarding inclusion of P as an action level is:

3. “The Significance Threshold is recommended to continue to be based on biological response (chlorophyll a), rather than nutrient concentrations. The Response Framework “builds up” to the Significance Threshold and, therefore, must be based on a matching variable, which is chlorophyll a”.

The first idea is a recommendation and not an argument regarding use of P as an action level and is therefore not discussed in this section. The second idea is that “the Response Framework “builds up” to the Significance Threshold” and therefore must be based on a matching variable is correct. But that argument does not preclude the use of additional significance thresholds such as the original 1999 significance threshold for eutrophication that pertains to total P. Since that time (1999), scientific knowledge has evolved and guidance on managing nutrients to limit eutrophication have been published (CCME 2004, 2006, 2016; Environment Canada 2004, US EPA 2015).

ENR’s opinion, after consideration of the above points presented by DDMI (DDMI/Golder 2018a) regarding inclusion of total P as an Action Level is that total P should be included as an action level. Specific rationale include:

1. Trophic status is a multi-faceted concept. This multifaceted nature is reflected in definition of trophic status by authorities that use several indicators to define trophic status, e.g. Vollenweider (1968) and Section 5.2.3.5 (DDMI/Golder 2018a) which uses total P to estimate the trophic state index following Carlson (1977); OECD (1982); Clark and Hutchinson (1992); CCME (2004) and US EPA (2015).

2. The weak relationship between total P and chlorophyll a in Lac de Gras and in general (Zajdlik 2017, Section 2.4.2), suggests chlorophyll a should not be used as a surrogate for total P in defining trophic status.

3. The utility of chlorophyll a in indicating an unequivocal eutrophication response (phytoplankton biomass) is subject to debate.

Nutrients can be managed directly whereas responses to nutrients cannot.
Recommendation(s):

1) ENR recommends that DDMI should correct the reference to section 5.2.8 in Golder (DDMI/2018a, Table 1-1) as that section does not exist.

2) ENR recommends that it would be helpful by DDMI to see the estimated model coefficients and Wald statistics for the models presented in Golder (DDMI/2018a, Table 5-16) to understand the area: year interaction terms. Those terms define the spatio-temporal variability of the biological indicator variables.

3) ENR recommends that DDMI should assess how chlorophyll a is driven by the demonstrated changes in community composition in order to demonstrate the robustness of chlorophyll a as the sole criterion for eutrophication related action levels.

4) In combination with the preceding recommendation, ENR recommends that DDMI should demonstrate the sensitivity of chlorophyll a relative to other biological responses to eutrophication in order to demonstrate the sensitivity of chlorophyll a as the sole criterion for eutrophication related action levels.

5) ENR recommends that DDMI should discuss why the relationship between chlorophyll a and phytoplankton biomass by area is “weak” but the relationship between chlorophyll a and phytoplankton biomass by year is “moderate to strong”.

6) ENR recommends that DDMI adopt Total Phosphorous as an Action Level.

Topic 5: Significance Thresholds for Nutrients

Comment(s):

In ENR’s previous recommendations on DDMI’s 2014 AEMP Annual Report, ENR recommended that the eutrophication significance threshold for each of the three eutrophication-related metrics should be as follows:

1. The mean of the five Farfield A depth integrated chlorophyll a concentration does not exceed 4.5 μg/L; or,
2. The mean of the five Farfield A total P concentrations does not exceed 10 μg/L; or,
3. The mean of the five Farfield A total N concentrations does not exceed 700 μg/L.

DDMI (DDMI/Golder 2018a, Table 1-1) points to Golder (2018a, Section 5.3.8) for a response to these recommendations. The response to the first significance threshold
appears in Section 5.3.8.5. It is agreed that the concentration was chosen to protect the oligotrophic status of Lac de Gras, the mean is lower than the maximum used in the current threshold and that the “suggested threshold represents a departure from the definition of significance by the Comprehensive Study Report (Government of Canada 1999), which is based on a high effect magnitude as defined in the EA (i.e., benchmark+20%)”. However, as noted by DDMI (DDMI/Golder 2018a, Section 5.3.8.5) “it (the proposed significance threshold) would be expected to be triggered at about the same level of effect as the current Significance Threshold”. This is due to the offsetting effect of using a mean without the addition of a 20% buffer. There does not appear to be significant disagreement.

The response to the second significance threshold appears in Section 5.3.8.5. DDMI is correct in asserting that total P and biological responses are only poorly correlated. It is that poor correlation and the idea that assessing trophic status is multifaceted (Vollenweider, 1968; Carlson, 1977; OECD, 1982; Clark and Hutchinson, 1992; CCME, 2004; Dodds, 2007; US EPA 2015) that suggests that reliance on a single measure of trophic status is imprudent. In a review of 29 methods to measure trophic status Lambou et al. (1983) concluded that “Most methods were much more effective in ranking the lakes against the total phosphorus standard than the chlorophyll a standard” suggesting that total P (at least on a weight of evidence basis) is a more important variable in defining trophic status than chlorophyll a. DDMI is also correct that total P is an exposure variable. It is for that reason that total P should be managed. CCME (2016) in a discussion of types of variables relevant for nutrient guideline development states unequivocally: “Nutrient concentrations are the most practical variables for nutrient guidelines as they can be managed directly. Disagreement remains regarding how to manage potential project effects. DDMI asserts that the response to nutrient enrichment should be managed whereas CCME (2016) states that nutrients should be managed. The second point of disagreement is that chlorophyll a is “a sensitive and robust measure of biological response to nutrient inputs from the Mine” Golder (2018a, Section 5.3.8.5) is discussed in Section 7 of Dr. Zadlik’s memo. Limitations of chlorophyll a as a biological response to nutrient inputs are:

1. Chlorophyll a is only weakly correlated with phytoplankton biomass / biovolume (which is likely a more meaningful biological response to nutrient input than chlorophyll a (Carlson, 1984).

2. Chlorophyll a is only one facet of the multifaceted trophic status concept

3. Chlorophyll a has not been demonstrated to either a sensitive or robust measure of biological response to nutrient inputs from the Mine.

The response to the third significance threshold appears in Section 5.3.8.5. DDMI (DDMI/Golder 2018a, Section 5.3.8.5) states: “Despite poor relationships observed with phytoplankton biomass, total phosphorous or micronutrients associated with
increased total dissolved solids (Section 5.3.5) are the most likely key drivers of phytoplankton biomass in Lac de Gras.” This contrasts with the statement: “In addition, the strong correlations between total dissolved solids and total nitrogen suggest that biological effects related to total nitrogen or components of between total dissolved solids (i.e., micronutrients) may not be separated by a correlative approach” (DDMI/Golder 2018a, Section 5.3.5.2). The inability to disentangle the effects of total nitrogen and total dissolved solid using correlation is the correct conclusion. The second point made by Golder (2018a) with respect to a Significance Threshold for total N is that “there is a high level of uncertainty around a definitive and appropriate trophic threshold for N”. There is little question that an appropriate threshold is the oligotrophic – mesotrophic boundary as is used for chlorophyll a. What remains of the argument is that there is a high level of uncertainty regarding that boundary.

There is considerable uncertainty in the oligotrophic – mesotrophic boundary for chlorophyll a concentrations. Golder (2014, Table 5.4-2) shows that the factor between the range of maximum oligotrophic and minimum mesotrophic boundaries is 3.2. As presented in Section 5.3.8.5, the worst-case scenario for total nitrogen averages results in a factor of 5.3 (=1,630/310). Another way of quantifying uncertainty is to estimate the coefficient of variation. Using Wetzel (2001) who references Vollenweider (1979), the boundary conditions of total N for oligotrophic lakes is a mean of 661 μg/L, with a range of 307 to 1,630 μg/L, and Nurnberg (1996, cited in Smith, 2009) has the oligotrophic boundary total N as <350 μg/L.” Jones and Knowlton (1993) present a total N oligotrophic – mesotrophic boundary for lakes of 300 μg total N/L. Using the mean of 661 μg/L and the Nürnberg (1996) and Jones and Knowlton (1993) recommended boundaries. The coefficient of variation among the three boundary conditions is less than a modest 45%. DDMI dealt with the uncertainty in the chlorophyll a boundary values by using the average of the average of maximum chlorophyll a concentrations for oligotrophic waters and the average of minimum chlorophyll a concentrations for mesotrophic waters (Golder, 2014). A similar approach could be used for total N.

Carlson (1996) discusses the use of an N index in addition to a P index and “suggests that a nitrogen index value might be a more universally applicable nutrient index than a phosphorus index”. The recommendation to use total N as an eutrophication limit/trigger follows recent initiatives in Alberta (ESRD, 2014) and ongoing efforts across the United States (US EPA, 2015, 2016). US EPA (2015) discusses reasons why total N should be part of a dual criterion (the other criterion is total P) for preventing eutrophication. These reasons are summarized herein; readers are encouraged to read the paper for details and supporting scientific literature.

- trophic status can vary both spatially and temporally;
- a single element nutrient limitation hypothesis ignores variation in nutritional needs;
- N fixation does not fully offset N deficiency;
• N loads can serve as sources further downstream; and,
• controlling only P may not effectively prevent the occurrence of harmful algal blooms in freshwaters.

Finally, the recommendation to manage total N is consistent with the CCME (2016) recommendation to manage nutrient concentrations as opposed to response variables.

Recommendation(s):

1) ENR recommends that DDMI should reconcile the two contrasting statements:

   o “Despite poor relationships observed with phytoplankton biomass, total phosphorous or micronutrients associated with increased total dissolved solids (Section 5.3.5) are the most likely key drivers of phytoplankton biomass in Lac de Gras” Golder (2018a, Section 5.3.5).

   o “In addition, the strong correlations between total dissolved solids and total nitrogen suggest that biological effects related to TN or components of TDS (i.e., micronutrients) may not be separated by a correlational approach” Golder (2018a, Section 5.3.5.2).

2) ENR recommends that DDMI should conduct a literature review for total N conditions defining the oligotrophic – mesotrophic boundary and using the same methodology used for chlorophyll a (Golder, 2014), estimate a total N eutrophication limit.

3) The recommendation to use total N as an eutrophication limit/trigger follows recent initiatives in Alberta (ESRD, 2014) and ongoing efforts across the United States (US EPA, 2015, 2016). US EPA (2015) discusses reasons why total N should be part of a dual criterion (the other criterion is total P). ENR recommends that DDMI should discuss reasons for their disagreement with these authorities.

Topic 6: Role of Nitrogen in Explaining Changes in Chlorophyll a

Comment(s):

The WLWB (2016b, Directive 2 A) states that: “With regards to the 2014 to 2016 Aquatic Effects Re-evaluation Report, the Board has decided that DDMI is to consider a more explicit analysis of the role of nitrogen in explaining variation and the spatial extent of chlorophyll a effects.”
DDMI (DDMI/Golder 2018a, Table 1-1) points to the Eutrophication Indicator in Section 5.3.3, 5.3.5 and Plankton Section 7. However, Section 5.3.3 discusses effects of dike deposition and dike construction and not chlorophyll a or nitrogen. Section 5.3.5.3 discusses the relationship between nutrients and chlorophyll a concentrations. The relationship is assessed by tabulating the year-specific Pearson product moment correlations between chlorophyll a and total N. Section 5.3.5.3 summarizes the correlations stating: “The relationship between concentrations of chlorophyll a and TN was moderate to strong, ranging between r = 0.52 and 0.92 between 2007 and 2013, while in 2016 the relationship was poor (r < 0.2) (Figure 5-38; Table 5-22).” The “role of nitrogen in explaining the spatial extent of chlorophyll a effect” does not appear to be discussed explicitly.

Recommendation(s):

1) ENR recommends that DDMI should correct the cross-reference where Table 1-1 (DDMI/Golder 2018a) incorrectly points to Eutrophication Indicator Section 5.3.3 for a discussion of the role of nitrogen in chlorophyll a spatial extent.

2) ENR recommends 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.

Topic 7: AEMP Response Plan Action Levels

Comment(s):

The WLWB (2018, Directive 3) states: “DDMI is to address GNWT-ENR recommendations 10 and 11, with regards to changes to Action Levels for effluent and water chemistry, as part of the 2014 to 2016 Aquatic Effects Re-evaluation Report.”

The first GNWT ENR recommendation states: “1) ENR recommends the increasing temporal trends in the mixing zone, nearfield and midfield 1 and midfield 2 should trigger an early warning level or Action Level 1. A temporal trend that will lead to the predicted mean exceeding two times the reference condition median within 3 years should trigger Action Level. The recommended Action Level additional criteria should be linked to existing criteria with the logical operator “OR”.

The second GNWT ENR recommendation states: “ENR recommends the Action Level 2 criterion used in the DDMI AEMP Design 3.5 should be used and the suggestion made by EMAB (Environmental Monitoring and Advisory Board) to modify Action Level 1 to specify EITHER an exceedance of 2 x the median reference condition OR
an exceedance of the normal range of reference conditions should be investigated by DDMI using the last three years of AEMP data and the results should be submitted for public review”.

DDMI (DDMI/Golder 2018a, Table 1-1) points to (Golder 2018a) Effluent and Water Quality Section 13.2 for a response to these directives. Section 13.2 does not exist. The section entitled “Effluent and Water Quality” was examined for a discussion of inclusion of temporal trends as an action level and sequential action level assessment. The following locations were searched with outcomes as described.

- Golder (2018a, Table 4-6) which presents Action Levels does not include such a discussion.
- Golder (2018a, Section 4.2.4.2.2) which discusses temporal trends does not link trends with Action Levels.
- Golder (2018a, Section 4.3.2.1) presents temporal trend results for water quality.
- Golder (2018a, Section 4.3.2.2.1) discusses Action Levels without reference to temporal trends.
- Golder (2018a, Table 4-27) summarizes trends in water quality Substances of Interest but does not link trends with Action Levels.

It is not clear whether WLWB (2018, Directive 3) stating: “DDMI is to address GNWT-ENR recommendations 10 and 11, with regards to changes to Action Levels for effluent and water chemistry, as part of the 2014 to 2016 Aquatic Effects Re-evaluation Report” was addressed, as the specific location referred to in Golder (2018a, Table 1-1) does not exist and the general location referred to in Golder (2018a, Table 1-1) does not appear to discuss the topics.

**Recommendation(s):**

1) ENR recommends that DDMI address WLWB (2018, Directive 3) with respect to addressing GNWT-ENR recommendations 10 and 11.

**Topic 8: Figure 5-41**

**Comment(s):**

DDMI (DDMI/Golder 2018a, Figure 5-41) presents Carlson trophic status index ratios on a bivariate plot. Ratios for each location in Lac de Gras within a year are plotted using the same colour. Given that spatial patterns in some of these indices
have been observed, DDMI should improve this useful graphic by the use of symbols representing at least some of the 8 areas. Certainly, the NF and MF locations at least could be identified to aid in interpretation.

**Recommendation(s):**

1) ENR recommends that DDMI should improve Figure 5-41 by the use of symbols representing at least some of the 8 areas. Additionally, DDMI should use a colour gradient for years improving the ability to detect temporal changes.

**Topic 9: Censored Data**

**Comment(s):**

Logistic regression is correctly used to deal with censored data. A limitation of logistic regression is that due to the binary nature of the dependent variable, the magnitude of detectable concentration changes is not used. DDMI should consider the use of multinomial models, possibly using baseline upper percentiles such as the 90th as an additional cut-point for detectable concentrations. This may improve the ability of the logistic regression models (notably for nutrients) to detect change.

**Recommendation(s):**

1) ENR recommends that DDMI should consider the use of multinomial models, possibly using baseline upper percentiles such as the 90th as an additional cut-point for detectable concentrations.

**Topic 10: Appendix A**

**Comment(s):**

Golder (2018a, Section 9.2.1.3.8) refers to Appendix A, but this appendix does not exist in Golder (2018a).

**Recommendation(s):**

1) ENR recommends that DDMI should clarify this reference.

**Topic 11: Section 5.3.2**

**Comment(s):**

ENR notes that section 5.2.3 (Golder 2018a) subsections are duplicated.
Recommendation(s):

1) DDMI should correct these duplications.

Topic 12: Figure 7-15

Comment(s):

The caption for Figure 7-15 (Golder, 2018a) entitled “Metric Multidimensional Scaling of Phytoplankton in the Near-field and Far-field” is incomplete and should be corrected as this graphic likely pertains to phytoplankton biomass.

Recommendation(s):

1) ENR recommends DDMI correct the figure title.

Topic 13: References

Comment(s):


Recommendation(s):

1) ENR notes that the above references are provided in support of ENR comments.

Topic 14: Memo - Zajdlik Associates Inc - DDMI AEMP 3 Year Re-Evaluation

Comment(s):

ENR has included an attachment: “July 19, 2018 - Memo - Zajdlik Associates Inc - DDMI AEMP 3 Year Re-Evaluation” with this submission.

Recommendation(s):

1) ENR notes this attachment is included in support of the submitted comments and recommendations as applicable.

Version 5.0 of the AEMP Design

Topic 1: MDMER Equivalency
Comment(s):

GNWT-ENR and ECCC are currently in a process to assess existing Territorial legislation against Federal legislation (i.e. Fisheries Act) in an effort to reach ‘equivalency in effect’. Equivalency in effect would stand down the federal statute and regulations. Thus, any requirements of MMER and EEM would not apply in the NWT. Initial meetings have occurred and both Governments are committed to an expedited process to reach such an agreement.

Recommendation:

1) ENR recommends that any changes to the AEMP design as a result of the MDMER are not required. Only improvements to the existing design should be considered by the Board if sufficient rational is provided by DDMI.

Topic 2: General

Comment(s):

ENR retained Zajdlik and Associates to provide review and comment of the Diavik Diamond Mines (2012) Inc. (DDMI) Version 5.0 AEMP Design. ENR has extracted and summarized comments and recommendations from this memo and provided them below. ENR has also included Dr. Zajdlik's review memo which provides additional background 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 3: Overall Program Design

Comment(s):

ENR notes that the AEMP Design Plan Version 5.0 (the Plan) is considerably different than its predecessor Plan Version 4.1. The most significant change is the change from a gradient comparison design to a reference condition design. The proposed change in design is stated to be due to the cumulative effects of the Ekati and Diavik Mines on water chemistry in the Far Field (FF) A area that precludes the use of FFA as a reference area. Thus, the nearfield (NF) – FF comparisons used previously to assess change can no longer be made for water chemistry.

Additionally, some of the key changes from the AEMP Design 4.1 include in this postposed design are:
• Changed from a near field - far field comparison to a near field – reference condition comparison for biological action levels.
• Changed number of locations and site locations in the far field.
• A change in statistical analytical protocols.
• Biological action levels have been changed. Biological effect sizes for statistical hypothesis testing have been added as have criteria for consecutive differences.

ENR is concerned that the changes proposed by DDMI will not result in a stronger AEMP. The new design will impede continuation of analyses over time while not presenting any significant improvements to the AEMP. Retaining locations that have been monitored since the implementation of AEMP design 2.0 allows for assessing long term changes. ENR notes that following the Board Directed AEMP Cumulative effects meeting (Rio Tinto, 2016) Dominion Diamond Ekati ULC (Dominion) and DDMI espoused the same idea stating: “No operator is suggesting changes to their individual AEMP programs. Data collected through each program must remain consistent to allow continued analysis” (Rio Tinto, 2016).

The proposed change in design impairs the ability to conduct the temporal trend analyses conducted in the AEMP re-evaluation since 8 of 15 farfield stations will be lost (see comments below). Although the design proposes adding three sampling locations in the farfield, the intent is to sample along a proposed gradient. Consequently, the stations cannot simultaneously be used to replace stations representing distinct farfield areas.

As discussed by Dr. Zajdlik in his attached memo, DDMI (Golder 2018a, Section 1.2.1) states that updates to the AEMP sampling stations to allow gradient analysis as the key method to analyze Mine-related effects. The only statistical analysis that relates to gradients is the breakpoint analysis – and that analysis does not use the farfield locations. Thus, the proposed change is unnecessary at least for this reason.

Overall ENR does not believe there is as yet, a compelling scientific or management-based reason to change the sampling design as proposed. Retention of the current design (Version 4.1) with an emphasis on gradient analyses offer the advantages over the proposed change in design that will be further discussed below, and is discussed in greater detail in Dr. Zajdlik’s memo. However, ENR has reviewed the design plan to provide constructive feedback on the design in order to assist DDMI with a resubmittal if direct by the Board to do so.

**Recommendation(s):**

1) ENR recommends that the Board not approve the proposed AEMP design Plan (Version 5.0) by DDMI. ENR encourages DDMI to review the succeeding comments and recommendations and include them in an updated AEMP design Plan for public review.
2) ENR recommends that in the event that DDMI determines that the proposed augmentation of stations in the farfield is valuable, consideration should be given to adding those stations to the current program design (Version 4.1).

**Topic 4: Change in Sampling Effort**

**Comment(s):**

The previous design plan followed Environment Canada (2012) Environmental Effects monitoring program sampling requirements with five sites within an area. That recommendation was based on an ability to detect biological changes thought to be ecologically significant when using a reference – exposure analysis (not a gradient analysis). It is important to note the emphasis on biological effects rather than changes in water chemistry. The proposed changes in sampling effort are presented below.

**Table 1: Changes in Sampling Effort in AEMP Design 5.0 (Golder 2018a, Table 3.4-1) versus AEMP Design 4.1 (Golder 2017a, Table 3.4-1)**

<table>
<thead>
<tr>
<th>change</th>
<th>FF1</th>
<th>FFA</th>
<th>FFB</th>
</tr>
</thead>
<tbody>
<tr>
<td>removed</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>added</td>
<td>1</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>remaining stations</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 2 shows that a net loss of 5 sampling locations or a 33% reduction in the farfield areas A, B and 1 is proposed.

The proposal to reduce sampling effort due to a change in experimental design requires the following recommendations discussed herein to be addressed with results to be assessed by reviewers prior to further consideration.

The spatial extent of changes in the FF1 area has been investigated for eutrophication metrics by DDMI (Golder, 2018b, Figures 5-1 through 5-5). Prior to accepting the removal of locations FF1-1, FF1-3 and FF1-5 proposed by DDMI (Golder 2018a), the spatial extent of all substances of interest should be presented. An absence of spatio-temporal trends in FF1 that may indicate past, current or future water quality issues would suggest that these locations add little value in assessing potential impacts to water quality and again, in the absence of effects, suggest that some or even all FF1 locations are of little use in evaluating a chemical gradient.

The Plan also proposes to remove three FFB locations and two FFA locations while adding two FFB locations (FFB-7, FFB-8). A limited comparison of removed versus
retained water chemistry locations by exposure area (FFA and FFB) suggests that (as expected) there is no difference among the two groups of stations. However, further information is warranted to confirm the absence of spatial effects.

**Recommendation(s):**

1) ENR recommends DDMI should provide further discussion on the spatial extent of all substances of interest prior to accepting the removal of locations FF1-1, FF1-3 and FF1-5 as proposed. As part of the discussion, DDMI should produce such maps and make them available to reviewers.

2) ENR recommends DDMI should conduct comparisons of retained versus proposed deleted locations for all substances of interest in each of the FFA and FFB areas on a year-by-year basis using data from 2012 - 2017 inclusive to confirm the absence of spatial effects.

**Topic 5: Temporal Trend Analyses**

**Comment(s):**

As noted by DDMI, temporal trend analyses are conducted during an AEMP reevaluation “to summarize AEMP data collected to date in an accessible format and evaluate temporal trends” (Golder, 2018b, Section 2.4.1). Temporal trend analytical methods for data collected under AEMP Design 5.0 are discussed in Section 4.3.4.10 of the Plan (Golder 2018a). Linear mixed effects models are used with the variance among stations in the nearfield and farfield areas being ascribed to random effects. As noted in the Plan (Golder 2018a, Section 4.3.4.10), “The use of random variables will allow for variability in the different data components to be correctly assigned (i.e., to stations within areas, instead of to areas).” The proposed loss of 40% of FFA locations and 60% of FFB locations effectively precludes the meaningful estimation of variance components when conducting temporal trend analyses because the proposed design orders locations along a presumed gradient such that assignment of locations to either of the western farfield areas does not make sense. This will almost certainly result in an inflation of variability for the trend term(s) and a reduction in ability to detect temporal trends. Interpretations that could be affected include water and sediment quality, eutrophication indicators, various phytoplankton, zooplankton and benthic macroinvertebrate metrics.

**Recommendation(s):**

1) ENR recommends that DDMI should discuss how locations along a spatial gradient will be used to estimate the within-area variance components described if the proposed design is adopted.
2) ENR recommends that DDMI should discuss how the ability to detect temporal trends in far field areas 1, A and B, will be affected if the proposed design is adopted.

**Topic 6: Comprehensive Year Dataset**

**Comment(s):**

DDMI (Golder 2018a, Section 4.3.4.10) makes the following statement: “For the Aquatic Effects Re-evaluation Report, time series plots will be generated for each SOI for each season using available data from 1996 to the latest available comprehensive year dataset.” It is not clear whether FF1, FFA and FFB data will be “comprehensive” if the proposed AEMP design is implemented as 53% (8/15) of the locations in these areas will no longer be sampled.

Furthermore, DDMI (Golder 2018a, Section 4.3.4.10) in reference to the Aquatic Effects Re-evaluation Report states that “Linear mixed models will be used to analyze spatial and temporal trends” and further that “the results will be used to interpret temporal and spatial trends”. In these models distance is not included as a random variable but rather distance is implied by the area/station fixed effect. It is not clear whether the ordinality (ordering) of the area/station fixed effects will be considered in the mixed effects models.

**Recommendation(s):**

1) ENR recommends DDMI clarify the wording for both these sections.

**Topic 7: Gradient Analyses**

**Comment(s):**

Under the current AEMP design (Version 4.1), visual assessments of gradients have been used to identify trends in concentrations of substances of interest along defined spatial gradients in Lac de Gras, delineate the extent of effects and define gradients along transects for eutrophication indicators, assess cumulative effects from the Ekati and Diavik Mines, and identify environmental gradients that may be associated with the phytoplankton community (Golder 2017b, 2018b).

DDMI (Golder 2018a, Section 4.3.4.9) states that “the main objective of the spatial gradient analysis will be to evaluate trends in SOI concentrations along the effluent exposure gradients”. Segmented regression models that use distance as an explanatory variable are proposed to estimate gradients but only using stations from the midfield. The only difference between AEMP Design 4.1 and 5.0 with respect to gradient analyses is that segmented regression will be used instead of linear regression. The regression analyses in AEMP Design 4.1 and AEMP Design 5.0
use only midfield stations. Consequently, statistical analyses of gradients do not require any changes to the current AEMP design.

The multidimensional scaling discussed in the DDMI 2014 to 2016 Aquatic Effects Re-Evaluation Report (Golder 2018b, Section 7.2.3.3) in response to Board directive (WLWB, 2017a) uses historical data to identify environmental gradients that may be associated with the phytoplankton community. It is not clear how samples collected along a gradient would be used to scale data prior to multidimensional scaling due to the arbitrariness in assigning locations to an area. This issue also affects scaling of benthic invertebrate community data (Golder 2018b, Section 8.2.3.3), assessing significance of the Analysis of Similarity R-statistic (Golder 2018b, Section 8.2.3.3) and, estimation of random effects.

**Recommendation(s):**

1) ENR recommends that DDMI should discuss how samples collected along a gradient would be used to scale data prior to multidimensional scaling due to the arbitrariness in assigning locations to an area.

**Topic 8: Weight of Evidence**

**Comment(s):**

The weight of evidence approach presented in the 2016 AEMP report (Golder 2017b, Appendix XV, Section 2.3.2.2.1) uses a statistical comparison of NF and FF for the following lines of evidence:

- Substances of interest for water quality;
- Nutrients;
- Substances of potential toxicological concern for sediment quality;
- Sculpin tissue chemistry;
- Biological productivity (chlorophyll a and zooplankton and phytoplankton biomass);
- Benthic community (total invertebrate density, density of dominant invertebrates, richness, Simpson’s diversity index, dominance, evenness, Bray-Curtis distance); and,
- Fish population health (energy stores, reproductive investment, tapeworm parasitism).

These comparisons follow the previous AEMP design (Golder, 2017a). Although DDMI (Golder 2018a, 4.10-1, 4.10-2) proposes to change some of the measurement endpoints in the lines of evidence presented above, measurement endpoints corresponding to key lines of evidence regarding exposure have remained the same or have been augmented. As examples of decision criteria, DDMI (Golder 2016, Figure 4.10-1) includes examples of “negligible” and “early warning – low” decision
criteria that use statistical comparisons of nearfield and farfield measurement endpoints. The “moderate” decision criterion uses an estimate of variability from farfield measurements. DDMI (Golder 2018a, Section 4.10.2.2) refers to decision criteria but does not provide examples to replace the criteria that will no longer be possible under the proposed AEMP Version 5.0 design.

DDMI (Golder 2018a, Section 4.10.2.2) states that “The decision criteria used to assign an effect level rating for exposure endpoints and for biological response endpoints will be based on the categories (Action Levels) in Section 5.2”. Although Action Levels for water chemistry (Golder, 2018a, Table 5.2-1), sediment quality (Golder, 2018a, Section 5.2.2), and eutrophication indicators (Golder, 2018a, Section 5.2.3), have remained unchanged from AEMP Design 4.1, substantive changes in biological action levels have been proposed.

**Recommendation(s):**

1) ENR recommends that DDMI should provide a set of decision criteria for the weight of evidence approach that can be used under the proposed AEMP (Version 5.0). Note that DDMI (Golder 2018b, Section 8.2.3.5) argues that nearfield – farfield statistical comparisons should be used for evaluating biological Action Level exceedances.

**Topic 9: Changes in Biological Action Levels**

**Comment(s):**

It should be noted that at this time, changes in biological action levels are assessed only from the perspectives of changes to the experimental design and bases for comparison. The proposed changes in metrics, degree of change (effect sizes) or additional criteria in Action Levels 2 and 3 have not been reviewed by ENR or Dr. Zajdlik.

The proposed action Level 1 for biological effects (Golder, 2018a, Table 5.2-4) involves comparisons of nearfield data with means of the historic reference data set. This is a departure from AEMP Design 4.1 (Golder, 2017a) where comparisons are with means from data from farfield A. Some of the measurement endpoints have changed in AEMP Design 5.0. In light of the changes to the basis for comparison (historic reference data set versus farfield A) proposed changes to the experimental design are irrelevant to evaluation of Action Level 1 for biological effects.

Action Level 2 for biological effects (Golder, 2018a, Table 5.2-4) is similar to Action Level 1 with respect to extent (nearfield) but varies by the addition of a criterion for two consecutive years (plankton) or a criterion that effect sizes defined by Environment Canada (2012) be exceeded (benthic invertebrates and fish metrics). This is a departure from AEMP Design 4.1 (Golder, 2017a) where comparisons use
data collected from the midfield and data from farfield A. Again, in light of the changes to the basis for comparison (historic reference data set versus farfield A) proposed changes to the experimental design are irrelevant to evaluation of Action Level 2 for biological effects.

Action Level 3 for biological effects (Golder, 2018a, Table 5.2-4) is similar to Action Level 2 with respect to extent (nearfield) but varies by the addition of a criterion for changes to occur consecutively for a period of sampling events (3 for plankton and 2 for benthic invertebrates and fish) and a criterion that measurement endpoints fall below the normal range. Again, commenting only on the implications of the proposed changes in sampling design, the proposed changes to the experimental design are irrelevant to evaluation of Action Level 3 for biological effects.

Overall, the proposed changes to the experimental design are irrelevant to evaluation of Action Levels 1 through 3 for biological effects. If Action Levels under AEMP design 4.1 were retained, the proposed changes in experimental design would have adverse consequences with respect to interpretation due to changes in centroids of sampling locations (see discussion in Sections 2.1 and 2.3 of the Zajdlik and Associates memo) and the difficulty of estimating an appropriate variance term.

Recommendation(s):

1) ENR recommends DDMI further evaluate and provide additional rationale to support the necessity of modifications to biological action levels in the proposed plan.

Topic 10: Implications of Proposed Design Change

Concerns regarding the use of the reference data set were expressed in Zajdlik (2015) due to the use of sites with a demonstrable effluent effect, which contravenes the definition of a reference area. Those concerns are still relevant and now due to the emphasis on comparing biological effects with the reference dataset to define action levels, as the ultimate purpose for the AEMP, additional concerns are raised. The AEMP Design 5.0 discusses consistency with the federal Environmental Effects Monitoring program for metal mines (Environment Canada, 2012) in the context of:

- schedule for sampling slimy sculpin (Golder 2018a, Section 3.5);
- a tiered, three-year cycle approach for environmental management decision making (Golder 2018a, Section 3.5);
- critical biological effect sizes (Golder 2018a, Section 5.2.4); and,
- selection of biological effect indicators (Golder 2018a, Section 5.2.4).
However, the consistency does not apply to recommended experimental designs when making inferences for action levels. Environment Canada (2012) recommended designs include:

1) Control-impact design (C-I);
2) Multiple control-impact design (MC-I);
3) Before/after control-impact (BACI);
4) Simple gradient (SG) design;
5) Radial gradient (RG) design;
6) Multiple gradient design (MG); and,
7) Reference condition approach (RCA).

Although a gradient design is discussed and implemented, the proposed *de facto* design for assessing biological action levels is most closely related to the Environment Canada (2012) reference condition approach. That approach establishes a reference condition through “an initial standardized sampling program at a wide variety of geographic scales. The same benthic invertebrate community sampling protocol is used in as many ecoregions and stream orders or lakes as are available in a catchment”, (Environment Canada, 2012). The intent is to capture the extent of regional variability and using multivariate techniques, determine whether benthic communities from the exposure site(s) are similar to the reference condition. The proposed design uses a reference area (Golder, 2018c) that while not capturing regional variability, likely provides a reasonable estimate of spatial variability in the downstream exposure area of Lac de Gras. This reference condition may not adequately describe natural variability in the eastern end of Lac de Gras which is subject to the influence of discharge from Lac du Sauvage. It is not clear whether temporal scales of variability are adequate because scales vary from 1 to 4 years. Certainly, samples collected in only one year cannot capture temporal variability. More importantly the temporal scales for a variety of reasons, represent on an analyte/measurement endpoint-specific basis, different times. The analyte/measurement endpoint-specific selection process used results in a reference condition representing varying temporal scales with very different levels of sampling effort, particularly if indexed by specific far field area.

The *de facto* experimental design for assessing biological action levels could also loosely be defined as before-after design as the reference condition ostensibly represents the pre-impact condition in Lac de Gras. However, the reference areas are not the exposure areas and hence the comparison is confounded by using areas that may or may not be comparable. Even if this were a true before and after design, such designs are typically not recommended as there is often natural drift in biological communities over time. This is in fact the rationale for the use of consecutive differences in biological measurement endpoints when moving through the biological action level hierarchy (Action Levels 1 through 3). The latter concern led to the recommendation of BACI designs by Environment Canada (2012). Other
issues associated with a limited reference condition definition are discussed in Environment Canada (2012).

In his analysis of the Plan, Dr. Zajdlik has assessed which one of the Environment Canada (2012) recommended experimental designs for assessing biological action levels would be best suited for the program. As such, Dr. Zadjlik found that the gradient design using the segmented regression models described by DDMI (Golder 2018a, Section 4.3.4.9) to be a strong candidate. Advantages of this method are that:

1) All the issues regarding the reference condition definition are sidestepped.
2) Synoptic data are used avoiding issues with natural changes over time.
3) The issue of confounding for plankton metrics discussed by DDMI (Golder 2018a, Section 4.6.4) is avoided.
4) A consistent data analytical method is used throughout the AEMP.
5) It is likely that the achieved statistical power for detecting trends will be higher than that achieved by a comparison of nearfield data with the reference condition data.

A challenge, but possible advantage is that biological effects levels would be expressed in terms of spatial gradients contextualized by critical effect sizes with a reduced emphasis on the reference dataset.

Recommendation(s):

1) ENR recommends that given the limitations of the reference dataset discussed in the preceding comment, DDMI should consider using one of the Environment Canada (2012) recommended experimental designs for assessing biological action levels. The gradient design using the segmented regression models described in Golder (2018a, Section 4.3.4.9) is a strong candidate as described in the comment.

2) ENR recommends that the statistical power of the proposed biological action level 1 comparison should be estimated by DDMI using data from the latest AEMP cycle to understand the ability of the proposed comparisons to detect change.

3) ENR recommends that the statistical power of the current biological action levels comparison should be estimated by DDMI using data from the latest AEMP cycle as a point of reference for the proposed changes to biological action levels.

4) ENR recommends that DDMI should discuss the proposed change in basis for comparison for biological action levels (Golder, 2018a) with the statement made in Golder (2018b, Section 8.2.3.5): “Therefore, from the perspective of evaluating the potential for aquatic toxicity in the NF and MF areas, the FF areas were
considered suitable as “minimally affected” sampling areas in the statistical comparisons for evaluating Action Level exceedances.”

**Topic 11: Action Levels for FFB**

**Comment(s):**

DDMI (Golder 2018a) presents action levels in Table 5.2-1. The proposed inclusion of locations FFB-6 and FFB-7 shifts the FFB area centroid much further west, thus affecting the spatial extent of changes in water chemistry under action level 8.

**Recommendation(s):**

1) In order to retain the same approximate FFB centroid, ENR recommends that DDMI should use FFB-6, FFB-5, FFB-2, MF3-7 and FF1-6 to assess Action Level 8.

**Topic 12: Action Levels Percentile**

**Comment(s):**

Action levels 8 and 9 (water quality and chlorophyll a) use percentiles estimated using the five locations within each of farfield areas A and B. The proposed design places locations on a dilution gradient such that it is not clear how variability within these farfield areas should be estimated. Assuming for the moment that location labels are used to categorize locations along the gradient as belong to farfield A or B, the proposed reduction in sampling effort in the farfield areas reduces the precision of the estimated 95th percentile used in action levels 8 and 9 (Golder 2018a, Table 5.2-1 and for chlorophyll a). In order to offset the reduced precision a percentile closer to the median should be used as precision (of estimated percentiles) improves with proximity to the median. The 80th percentile is subjectively, recommended for this purpose. Alternatives to adopting this recommendation are to demonstrate what reduction in percentiles is necessary to achieve a similar precision of the estimated 95th percentile using five sampling locations, or, to retain five FFA sampling locations.

**Recommendation(s):**

1) ENR recommends that DDMI use the 80th percentile in action levels 8 and 9. DDMI should also discuss the implications of estimating within-area variability (which somewhat loosely is what the 95th percentile estimates) using samples collected along a known gradient.
Topic 13: Change in Program Design Clarification

Comment(s):

DDMI (Golder 2018a Section 3.4.1) states: “Changes were made to adjust the sampling design to a gradient design, while maintaining the ability to continue statistical comparisons of NF area data to the reference condition dataset for Action Level evaluation”. As there are no changes to proposed sampling in the nearfield and comparisons with the reference condition dataset are not impacted by the proposed changes in design; and 2) statistical comparisons with the farfield for the purpose of AL evaluation are not made, DDMI should adjust this statement as follows: “Changes were made to adjust the sampling design to a gradient design”.

Recommendation(s):

1) ENR recommends DDMI update the statement presented in the associated comment.

Topic 14: Response to Previous ENR Comments

Comment(s):

ENR has previously provided recommendations regarding the AEMP design in the 2016 AEMP Annual Report and Update to Schedule 8, Condition 3 review. The WLWB (2017b) directed DDMI to address GNWT-ENR comments 6, 7, and 9 to 13 provide various recommendations about potential improvements that could be made to the statistical analyses. DDMI (Golder 2018a, Table 8-1) points to AEMP Design Plan Version 5.0 – Sections 4.3.4.9, 4.3.4.10, 4.6.4, 4.7.4 as locations where responses were provided. Those sections were reviewed with the following outcomes:

- ENR comment 6: The details that the ENR comments addressed were not included; consequently, this recommendation was not addressed.
- ENR comment 7: A discussion of censoring is not found; consequently, this recommendation was not addressed.
- ENR Comment 9: There is no reference to Sokal and Rolf nor is there a discussion of “large” and “small” datasets. However, this comment was addressed in (WLWB, 2017c, Comment Summary ID #10).
- ENR Comment 10: No discussion of non-normality is provided; however, this comment was addressed in (WLWB, 2017c, Comment Summary ID #11).
- ENR Comment 11: The significance of deviations from equal variance were not discussed; however, this comment was addressed in (WLWB, 2017c, Comment Summary ID #12).
ENR Comment 12: No discussion of assessing normality was included; consequently, this recommendation was not addressed.

ENR Comment 13: No discussion regarding treatment of censored data was included; consequently, this recommendation was not addressed.

ENR notes during review of the AEMP Re-Evaluation (Golder, 2018c) it became coincidentally apparent that some at least of the GNWT-ENR comments have been addressed but the reference to those responses is incorrect. No systematic attempt has been made to find responses provided by DDMI in documents other than those cited by Golder (2018, Table 8-1).

The WLWB (2017b) directed DDMI to address GNWT-ENR comment 17; a recommendation for the inclusion of phytoplankton taxonomy to be done annually at all MF and FF-2 locations, as well as LDS-4. The Board notes that DDMI has already committed to including this annually at all MF stations (see Section 3.5 of these Reasons for Decision). DDMI (2018a, Table 8-1) points to AEMP Design Plan Version 4.1 for a response to this recommendation. There is no discussion of phytoplankton taxonomy in AEMP Design Plan Version 4.1. DDMI (Golder 2018a, Section 4.6.2) does state that “sampling in the NF and MF areas of Lac de Gras will occur on an annual basis” but there is no discussion regarding GNWT-ENR comment 17, despite a commitment to do so (WLWB, 2017c, Comment Summary ID #18).

Recommendation(s):

1) The WLWB (2017b) directive to address ENR comments 6, 7, and 9 to 13 were not addressed in the sections indicated by Golder (2018a Table 8-1). However, comment #9 and #10, were addressed in (WLWB, 2017c, Comment Summary ID #10, 11). ENR recommends that DDMI should either point to where the remaining comments have been addressed or follow the remainder of the WLWB (2017b) directive.

2) The WLWB (2017b) directive to address ENR comment 17 was not addressed in the document indicated by Golder (2018a Table 8-1). ENR recommends DDMI should address the WLWB (2017b) directive with respect to FF2 locations as well as LDS-4.

Topic 15: Benthic Macroinvertebrate Metrics

Comment(s):

In a discussion regarding benthic macroinvertebrate metrics, DDMI (Golder 2018a, Section 4.10.2.1) states: “These endpoints will be assessed for gradients with effluent exposure and or for statistical differences among sampling areas of Lac de Gras. It is not clear how samples in the far field that are intended to represent a
gradient may be arbitrarily grouped to conduct the Analyses of Variance conducted under AEMP Design 4.1.

**Recommendation(s):**

1) ENR recommends DDMI should discuss how statistical differences among sampling areas of Lac de Gras will be estimated and tested.

**Topic 16: Clarification on Number of FF Stations**

**Comment(s):**

Table 3.4-1 of the Plan lists 10 FF stations (excluding the two FF2 stations) yet Table 3.5-1 lists only 8 FF stations (again, excluding the two FF2 stations) for effluent plume, water quality, eutrophication indicators, phytoplankton, etc. components of the AEMP.

**Recommendation(s):**

1) ENR recommends that DDMI should clarify this discrepancy.

**Topic 17: Analytical Method**

**Comment(s):**

Section 4.8.4 (Golder 2018a) states: “The statistical comparisons among areas and the test for assumptions of normality and homogeneity of variance for parametric statistics will be conducted as described for water quality (Section 4.3.4.9.2)”. This section does not exist in the current report.

**Recommendation(s):**

1) ENR recommends that DDMI should confirm that the intended analytical method is that described in Golder 2018a, Section 4.3.4.9.

**Topic 18: Clarification on Number of FF Stations**

**Comment(s):**

Section 4.3.4.9 of the Plan states:

“Following data transformation (if required), the selected models will be fitted to the data. Statistical outliers will be identified using studentized residuals with absolute values of 3.5 or higher, or due to consideration of leverage (where a single point could strongly influence the overall fit of the
All values removed from analysis will be retained in the model prediction plots, where they will be shown as a different symbol to identify them as statistical outliers from the rest of the data.”

Outliers and observations are often similar (high leverage points are extremes in the predictor space). If conclusions change due to the removal of observations DDMI should present both analyses in the main body of the report to allow readers to form their own conclusions. Sensitivity of conclusions to aberrant observations often raises interesting questions regarding the experimental design and/or the population of interest.

**Recommendation(s):**

1) ENR recommends that DDMI should present both analyses in the main body of the report to allow readers to form their own conclusions.

**Topic 19: General**

**Comment(s):**

Dr. Zajdlik notes that the proposed reduction in sampling locations in the farfield will reduce the number of Trophic State Index ratios (Golder 2018b, Section 5.3.7.2) by area.

**Recommendation(s):**

1) ENR recommends that DDMI should discuss the implications with respect to trophic status classification.

2) ENR recommends that when testing normality, the Shapiro-Wilks test should be used instead of the Kolmogorov-Smirnov test that has been used in previous analyses.

**Topic 20: References**

**Comment(s):**


Recommendation(s):

1) ENR notes that the above references are provided in support of ENR comments.


Comment(s):

ENR has included an attachment: “July, 2018 - Memo - Zajdlik Associates Inc - DDMI AEMP Design 5 Review July 6 with this submission.”
Recommendation(s):

1) ENR notes this attachment is included in support of the submitted comments and recommendations as applicable.

Topic 22: Table in Topic 4

Comment(s):

The ORS sometimes does not accept table formats.

Recommendation(s):

1) ENR recommends that the Board and the proponent reference ENR's submitted letter to view the table if necessary.

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

DRAFT

Review of DDMI AEMP Re-Evaluation

Prepared for:

B. Pain, P Green
Government of the Northwest Territories

Prepared by:

Zajdlik & Associates Inc.
July, 2018
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Table 1: Acronym Definitions

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<th>Acronym</th>
<th>Definition</th>
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<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>AEMP</td>
<td>Aquatic Effects Monitoring Program</td>
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<tr>
<td>CRI</td>
<td>Canadian Rivers Institute</td>
</tr>
<tr>
<td>CCME</td>
<td>Canadian Council of Ministers of the Environment</td>
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<tr>
<td>DDMI</td>
<td>Diavik Diamond Mine Inc.</td>
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<tr>
<td>EMAB</td>
<td>Environmental Monitoring and Advisory Board</td>
</tr>
<tr>
<td>GNWT ENR</td>
<td>Government of the Northwest Territories, Department of Environment and Natural Resources</td>
</tr>
<tr>
<td>OECD</td>
<td>Organisation for Economic Cooperation and Development</td>
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<tr>
<td>WLWB</td>
<td>Wekèezhii Land and Water Board</td>
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<td>YOY</td>
<td>young of the year</td>
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1 Introduction

Zajdlik & Associates Inc. was retained by the Government of the Northwest Territories Department of Environment and Natural Resources (GNWT ENR) to review various aspects of the Diavik Diamond Mines Inc. (DDMI) Aquatic Effects Monitoring Program (AEMP) 3 Year Re-Evaluation. The Re-Evaluation considers substantive input from reviewers and direction from the Wékèezhii Land and Water Board (WLWB) with respect to the following documents:

- AEMP Design Version 4.0 and Version 4.1
- 2011 to 2013 Aquatic Effects Re-evaluation Report
- AEMP Reference Conditions Report
- 2014-2016 AEMP Annual Reports
- 2016 AEMP Response Plans and 2016 AEMP Fish Response Plan – Supplemental Report
- Water Licence Schedule 8 update

Golder (2018a, Table 1-1) presents a concordance table of the recommendations and directives that points to the locations in the report where these items are addressed. Note that some of the references to locations within Golder (2018a) either do not exist or do not correspond to the subject of discussion. As the report is 631 pages long it is difficult to be sure that responses to directives are not addressed in sections of the report other than those that were referenced. Although a recommendation to address this has been provided there is some concern that in this review, not all of DDMI’s reasoning with respect to various Directives has been considered at this time.
2 WLWB (2017a, §3.12, part 2 g) – Various Statistical Recommendations

The first set of recommendations is made in the context of WLWB (2017a, §3.12, part 2 g) which states: “GNWT-ENR comments 6, 7, and 9 to 13 all appear to provide various recommendations about potential improvements that could be made to the statistical analyses.” These recommendations are presented in WLWB (2017b). The recommendations and Proponent responses are presented below. Review responses are provided in the last column of Table 2, herein. Golder (2018a, Table 1-1) notes that the recommendations pertain to “all” sections of the design plan and the specific Proponent response in the AEMP design plan is presented in §14 therein.
Table 2: GNWT Recommendations and Proponent Responses - WLWB (2017a, §3.12, part 2 g)

<table>
<thead>
<tr>
<th>Topic Label</th>
<th>GNWR ENR Comment and Recommendation</th>
<th>Proponent Response</th>
<th>Review Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topic 6: Statistical Analyses</td>
<td><strong>Comment</strong> ENR is providing comments specific to the statistical analysis presented in Appendix II, Section 2.3.9. However, ENR notes that nearly identical analyses are presented in the other Appendices as well. As such, these specific comments on the analysis also generally apply to the other Appendices as well. <strong>Recommendation 1</strong> ENR recommends that the specific comments on the statistical analysis presented in Appendix II, Section 2.3.9 apply to all the other Appendices as well.</td>
<td><strong>June 15:</strong> The 2016 AEMP Annual Report provides a summary of the sample design, methods and analysis approved within the AEMP Study Design Version 3.5. Recommendations relating to changes to the AEMP sampling design or analytical methods is outside the scope of the Annual Report and should be addressed during the next update to the AEMP Design.</td>
<td>The recommendations provided under this topic were not addressed in AEMP Design 5.0 (Golder, 2018b).</td>
</tr>
<tr>
<td>Topic 7: USEPA Citation</td>
<td><strong>Comment</strong> USEPA guidance on censoring is cited in § 2.3.9.1 but a citation is not provided. Also, assertions regarding robustness of ANOVA to non-normality are made in §2.3.9.2 without providing citations. <strong>Recommendation 1</strong> ENR recommends that the relevant USEPA guidance source be provided.</td>
<td><strong>June 15:</strong> The citation (US EPA 2000) is provided in Section 2.3.3 (methods section relating to handling of censored data) and is included in the references section (Section 7). It is reproduced below.</td>
<td>Provision of citation is noted.</td>
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<table>
<thead>
<tr>
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</table>
| Topic 8: ANOVA Residuals | **Comment** The comment in §2.3.9.2 that means of samples with "small to moderate deviations from normality are approximately normally distributed even when the population is not normal" is irrelevant with respect to the assumptions for the ANOVA conducted as the assumption pertains to residuals and not means.  
**Recommendation**  
1) ENR recommends that this comment be removed. | **June 15:** The statement is relevant to the assumption of normality (Sokal and Rohlf, 1995). The intent of the comment is to explain that the consequences of non-normality are not necessarily serious because the population means will follow a normal distribution more closely than the distribution of the individual variates (Sokal and Rohlf, 1995).  

<p>| Topic 9: Identification of Sample Size | <strong>Comment</strong> The quotation in §2.3.9.2 from Sokal and Rolf mentions &quot;large&quot; samples. In the hypothesis tests conducted there are 22 (5 nearfield and 17 farfield) locations. Typically, a large sample comprises at least 30, if not 60 distinct replicates (not subsamples). ENR notes that the available data set would be considered | <strong>June 15:</strong> The statistical approach used for the Diavik AEMP was developed based on procedures recommended in the MMER Technical Guidance Document (EC 2012), which states that most univariate normal distribution based statistical methods are robust to violations of assumptions. As this is a matter of professional judgment, the available data set is considered sufficient for the hypothesis tests. | <strong>The response circumvents the recommendation but does not provide discussion of robustness of methods to violations of assumptions.</strong> |</p>
<table>
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<th>GNWR ENR Comment and Recommendation</th>
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<th>Review Response</th>
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<tbody>
<tr>
<td>small to moderate, and the Sokal and Rolf quotation would not apply. <strong>Recommendation</strong> 1) ENR recommends the Sokal and Rolf quotation not be applied to the small to moderate dataset available and should be removed.</td>
<td>are quite robust and can support moderate violations of the assumptions. As recommended by EC (2012), in cases where serious violations of the ANOVA assumptions were encountered, non-parametric statistics were used. This approach is further substantiated by Green (1979), who states that &quot;two-tailed tests with F and t statistics will generally be valid, even on extremely non-normal populations. The ratio of the largest to the smallest sample variance should not exceed 20, and the ratio of the largest to the smallest sample size should not exceed 4.&quot;</td>
<td>disagreement, no further responses are necessary.</td>
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**Topic 10:** Justification for **Comment** The p-value used in §2.3.9.2 to determine whether the conclusion that non-normality could be ignored is provided without justification. **June 15:** Because most univariate statistical methods are robust under moderate violations of assumptions. **Please see preceding comment.**
<table>
<thead>
<tr>
<th>WLWB (2017b)</th>
<th>Use of Specific p-value</th>
<th><strong>Recommendation</strong></th>
<th><strong>Proponent Response</strong></th>
<th><strong>Review Response</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Topic Label</td>
<td>1) ENR recommends that justification for the p-value should be provided.</td>
<td>(EC 2012), the intent of setting α for the Kolmogorov-Smirnov test to 0.01 was to flag datasets that have serious violations of the ANOVA assumption of normality. In cases where serious violations of ANOVA assumptions were present, non-parametric statistics were used. <strong>Reference:</strong> Environment Canada. 2012. Metal Mining Guidance Document for Aquatic Environmental Effects Monitoring. Environment Canada, Ottawa, Ontario.</td>
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<td>Topic 11: Significance of Deviation from Equal Variance</td>
<td><strong>Comment</strong> The comment in §2.3.9.2 &quot;As with normality, small to moderate deviations from the assumption of equal variances do not compromise the overall test of significance by ANOVA&quot; is made without reference to an authority. ENR notes that references defining the effects of this violation and defining &quot;small to moderate deviations&quot; have not been provided. <strong>Recommendation</strong> 1) ENR recommends that appropriate references defining the effects of this violation and defining &quot;small to moderate deviations&quot; be provided.</td>
<td>June 15: The reference is Sokal and Rohlf (1995). <strong>Reference:</strong> Sokal RR, Rohlf FJ. 1995. Biometry, Third Edition. W.H. Freeman and Co., New York, NY, USA. 887p.</td>
<td>Provision of citation is noted.</td>
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<tr>
<td>WLWB (2017b)</td>
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<td><strong>Topic 12:</strong> Statistical Analysis - Test for Normality</td>
<td><strong>Comment</strong> The analysis consists of contrasts among areas within a general linear model framework under the assumption of Gaussian or &quot;normally distributed&quot; errors. It is very likely that at least some substances of interest will not be normally distributed. The Kolmogorov-Smirnov test is intended to be used for normality testing. However, this test is poorly regarded by subject matter experts in this area, including D'Agostino and Stephens, (1986) who state: &quot;For testing normality, the Kolmogorov-Smirnov test is only a historical curiosity. It should never be used. It has poor power in comparison to the above procedures&quot;. Alternative tests are available and should be used instead.</td>
<td>June 15: The 2016 AEMP Annual Report provides a summary of the sample design, methods and analysis approved within the AEMP Study Design Version 3.5. Recommendations relating to changes to the AEMP sampling design or analytical methods is outside the scope of the Annual Report and should be addressed during the next update to the AEMP Design.</td>
<td>This recommendation was not addressed within the AEMP re-evaluation but as noted by DDEC, it may be addressed in AEMP Design 5.0 (Golder, 2018b). This latter document was reviewed and while testing for normality is discussed, a specific test is not mentioned. A recommendation on this topic is presented in a review of Golder, 2018b.</td>
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<td><strong>Recommendation</strong> 1) ENR recommends the Shapiro-Wilks test should be used instead of the Kolmogorov-Smirnov test to test normality.</td>
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<td><strong>Topic 13:</strong> Treatment of Censored Data</td>
<td><strong>Comment</strong> One of the conditions for use of the one-tailed t-test discussed in Golder (2017, § 2.3.9.5) is that the censoring proportion be less than 40%. Given this large degree of possible censoring it is not clear what the estimated variance represents.</td>
<td>June 15: Noted. In future analyses, DDMI will consider using a non-parametric alternative to the one-sample t-test in cases where non-detect values occur in the NF area.</td>
<td>The AEMP re-evaluation only analyzes trends and therefore addressing this recommendation within the re-evaluation is not relevant.</td>
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<tr>
<td>WLWB (2017b)</td>
<td>GNWR ENR Comment and Recommendation</td>
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<td>Topic Label</td>
<td><strong>Recommendation</strong> 1) ENR recommends the criterion be modified to approximately 10% censoring or, the test should be replaced by a nonparametric equivalent and the degree of acceptable censoring may be increased to 49%.</td>
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### 2.1 Recommendation

The recommendations this directive points to are very specific and are concerned with details of statistical analyses. It is not clear whether details at this level should be included in an overall design report or in the methodological sections of an AEMP annual report. That said, only topics 6 and 12 in Table 2 have yet to be addressed. A commitment was made to address those comments within Golder (2018b). That document was reviewed and recommendations on this directive were provided therein (Zajdlik, 2018).
3  **WLWB (2017a, §3.12, part 2 h) – Phytoplankton Taxonomy in Eastern Lac de Gras**

The second set of recommendations is made in the context of WLWB (2017a, §3.12, part 2 h) which states: “GNWT-ENR comment 18 includes a recommendation for the inclusion of phytoplankton taxonomy to be done annually at all MF and FF-2 locations, as well as LDS-4. The Board notes that DDMI has already committed to including this annually at all MF stations (see Section 3.5 of these Reasons for Decision).” This is due to Board Directive 3C that states: “DDMI is to incorporate annual sampling for plankton variables at the MF stations as part of its updates to the AEMP Design that are to be submitted along with the 2014 to 2016 Aquatic Effects Re-evaluation Report” WLWB (2017a). The GNWT-ENR recommendation was presented in WLWB (2017b). The specific recommendation is:

“Comment Golder (2016, Table 3.5-1) proposes to measure indicators of eutrophication annually at nearfield, MF, FF2, LDS-4 and LDG-48. This list of eutrophication indicators includes zooplankton biomass but does not include phytoplankton taxonomy. Phytoplankton taxonomy is currently measured annually at nearfield locations. Given concerns with potential eutrophication in the eastern end of Lac de Gras due to construction of the Jay Pit, phytoplankton taxonomy should be included in the list of eutrophication indicators that are measured on an annual basis at MF, FF2 and LDS-4 locations in addition to nearfield locations. This more complete time series of data will aid in detecting and understanding potential cumulative impacts. Note that currently, DDMI does not propose to measure phytoplankton taxonomy at LDS-4 at all.

**Recommendation 1) ENR recommends that phytoplankton taxonomy should be included in the list of eutrophication indicators that are measured on an annual basis at MF, FF2 and LDS-4 locations in addition to nearfield locations.”**

The Proponent response was that “Recommendations relating to changes to the AEMP sampling design or analytical methods is outside the scope of the Annual Report and should be addressed during the next update to the AEMP Design.” Despite that statement, Golder (2018a, Table 1-1)
notes that the recommendation pertains to “Plankton” and the specific Proponent response in the AEMP design plan is presented in Plankton - Section 7.7 therein. However, Golder (2018a) also states that “The 2014 to 2016 Aquatic Effects Re-evaluation Report has been prepared under Water Licence W2015L2-0001 and AEMP Study Design Version 3.5.” Because a recommendation to augment sampling made in 2017 cannot be implemented retroactively, this recommendation will only appear in subsequent AEMPs and a revision to the AEMP design.

DDMI (2018b, Table 8-1) points to AEMP Design Plan Version 4.1 for a response to this recommendation. There is no discussion of phytoplankton taxonomy in AEMP Design Plan Version 4.1. DDMI (2018b, §4.6.2) does state that “sampling in the NF and MF areas of Lac de Gras will occur on an annual basis” but there is no discussion regarding GNWT-ENR comment 17, despite a commitment to do so (WLWB, 2017b, Comment Summary ID #18).

3.1 Recommendation

- The WLWB (2017a) directive to address ENR comment 17 was not addressed in the document indicated by Golder (2018a Table 8-1). DDMI should address the WLWB (2017a) directive with respect to conducting phytoplankton taxonomy at the FF2 and LDS-4 locations. It is acknowledged that DDMI is now evaluating phytoplankton taxonomy at midfield locations.

4 WLWB (2017a §3.1.3, 2 g) – Historical Parasitism

“DDMI has stated that it will consider historical occurrences of parasites (GNWT-ENR comment 26)”, (WLWB, 2017a §3.1.3, 2 g). Golder (2018a, Table 1-1) notes that the recommendation is addressed in Section 9.2.2.3, therein. Because parasites (tapeworms) were reported differently in 2007 and 2010 relative to 2013 and 2016, only presence of external parasites was consistently recorded. Logistic regression was used to model the proportion of fish with and without external parasites as a function of “area, year (as factor), and their interaction. The model was used to estimate mean probability of tapeworm infection and the associated 95% confidence interval for
each area and year, and to perform multiple comparisons between years within area. P-values were corrected using the Tukey method (Tukey1977). All analyses were performed in R v. 3.4.2 (R 2017). This is a thorough and well considered response to the GNWT ENR recommendation.

5 WLWB (2017a §3.1.3, 2 h) - Capturing Slimy Sculpin

“DDMI has stated that alternative methods to examine reproductive success of Slimy Sculpin will be reviewed and considered (EMAB comment 80; GNWT-ENR comment 29)” (WLWB, 2017a §3.1.3, 2 j). Golder (2018a, Table 1-1) notes that the recommendation is addressed in Section 13.4, therein. The GNWT ENR recommendation states: “DDMI suggests that very few young of year (YOY) were captured possibly due to their size being too small to be captured and from the presence of slimy sculpin in a range of sizes in the exposure areas, similar reproductive success is likely across sites. ENR notes that few captured YOY may also be an indicator for poor reproductive success. The presence of a range of sizes at the exposure areas does not necessarily indicate successful reproduction and is insufficient rationale to dismiss the absence of YOY.

Recommendation 1) ENR recommends DDMI consider reviewing the methods used to determine reproductive success and consider additional methods such as minnow traps or jar traps in future AEMPs that have been successfully deployed to capture YOY (Arciszewski et al. 2010).”

The section 13.4 noted in the concordance table (Golder 2018a, Table 1-1) does not exist in the report. However, Golder (2018a §9.2.1.2.2) states that individual ages “could not be determined with sufficient accuracy” citing CRI (2014). Golder (2018a §9.2.1.2.3) discusses a procedure to classify fish by ages using a variety of methods. Golder (2018a, §14.2.2.3, Population Structure) recommends removing Reproductive Investment – Age-1+ Abundance as a weight of evidence endpoint due to the difficulties in capturing the smallest size classes (e.g., fishing gear bias). Golder (2018a §14.2.2.1) discusses a small addition to the field program that comprises random field sampling within an area to better understand effects on abundance (catch per unit effort).
and overall reproductive success. Golder (2018a) notes that “There are limitations inherent in the use of any type of fish gear, however, and for electrofishing small fish in boulder-cobble lake habitat, it is likely the smallest size of fish (i.e., YOY and short juveniles) will still be under-represented by this sampling method.” This leads to the recommendation that smaller size classes be examined for presence / absence but not used in the weight of evidence approach. It is not clear whether the within-area random sampling area will be conducted. The review of alternative methods recommended by GNWT ENR does not appear to have been conducted.

5.1 Recommendation

- Although alternative methods to examine reproductive success were reviewed and considered in the Aquatic Effects Re-evaluation Report. DDMI did not review alternative sampling methods as recommended by GNWT ENR. DDMI should conduct such a review of methods to capture young of the year and discuss any potential biases induced by specific methodologies. The outcome will determine whether young of year size classes will be used in the weight of evidence.

6  WLWB (2016a, Comment ID #7) - Assessment of Toxicological Impairment

GNWT ENR recommended that: “DDMI update the AEMP design to include the presence/absence of toxic agents and any effect of toxins on planktonic organisms by incorporating the results of toxicological testing of plankton into the Plankton Report” (WLWB 2016, Comment ID #7). The response provided by DDMI is a general agreement that toxicological impairment needs to be evaluated based on the full weight of evidence provided by the AEMP data set, including exposure indicators, toxicity test results, field-measured biological response variables, and potentially other lines of evidence.”
In 2015, Action Level 1 was triggered for total phytoplankton biomass and cyanobacteria biomass but not other plankton metrics. The response from DDMI was that “Action Level 1 exceedances for phytoplankton provide an early-warning indication of potential Mine related changes, and are not of immediate concern regarding toxicity to the plankton community in Lac de Gras” and concluded that “the appropriate action is to confirm the 2015 results based on the 2016 monitoring data” (Golder, 2016). In 2016, Action Levels 1 and 2 were triggered for total zooplankton biomass. The response from DDMI was that “The Action Level 1 and Action Level 2 exceedances for zooplankton biomass provide an early-warning indication of potential Mine-related changes and are not of immediate concern regarding toxicity to the plankton community in Lac de Gras.” Reasons were provided for this statement that included comparison with another metric, the degree of change found, the absence of effluent toxicity and that no AEMP effects benchmarks were exceeded. Golder (2018a, §7.3.4.2) presents an integrative environmental assessment of plankton responses that includes toxicological exposure indicators as well as nutrient enrichment. Consequently, the ENR recommendation has been addressed.

7 WLWB (2017c, Directive 3) - Inclusion of P as an Action Level

WLWB (2017c, Directive 3) states that “With regards to the 2014 to 2016 Aquatic Effects Re-evaluation Report, the Board has decided that DDMI is to consider the inclusion of phosphorus concentrations in the Response Framework. The Board requires this consideration to include a discussion of observed phosphorus concentrations and how they relate to the phosphorus management framework”. Golder (2018a, Table 1-1) points to the Eutrophication Indicators section and §5.2.8 for the response to this directive. Although Golder (2018a, §5.2.8) does not exist, this topic is discussed in Golder (2018a, §5.3.8.3) and summarized in the section entitled “Inclusion of Phosphorus Concentration in the Response Framework”. The three arguments presented are considered below.

1. Golder (2018a, §5.3.8.3) states: “Chlorophyll a concentration has proven to be a simple and robust indicator of the biological response to nutrient additions to Lac de Gras. It is a more reliable indicator of trophic status than TP, which is an exposure variable rather than a response variable”.
The statement, with the exception of total phosphorous being an exposure variable, is comprised of a series of subjective assertions. What can be said objectively about chlorophyll a in Lac de Gras is that:

- it exhibits a general gradient in response with increasing distance from the Mine (Golder 2016, Appendix XIII, Figure 3-19; Golder 2017, Appendix XIII, Figure 3-19);
- it is weakly correlated with total P (Golder, 2018a § 5.3.5.3);
- it is moderately to strongly correlated with total N (Golder, 2018a § 5.3.5.3);
- it is moderately to strongly correlated with total dissolved solids (Golder, 2018a § 5.3.5.3); and,
- it is poorly correlated with N:P ratios (Golder, 2018a § 5.3.5.3).

When nutrients are limited it is a given that addition of nutrients leads to increases in phytoplankton biomass. Chlorophyll a as a surrogate measure of phytoplankton biomass should also increase with phytoplankton biomass. As stated by Golder (2011) “An evaluation of the relationship between chlorophyll a and phytoplankton biomass provides an understanding of the utility of chlorophyll a as a phytoplankton biomass indicator”. That relationship is weak when evaluating the relationship by sampling area (Golder 2011, Figure 3.4-41; Golder 2018a, Figure 5-35) but is “moderate to strong” when evaluating the relationship by year rather than sampling area (Golder, 2018a § 5.3.5.1). Other authors discuss the limited correspondence between chlorophyll a and phytoplankton biovolume (Dolan et al. 1978; Felip and Catalan, 2000) or biomass (El-Shaarawi and Munawar, 1978; Jónasson et al. 1992). 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 of the chlorophyll $a$ concentration to biomass ratio with changes in trophic status, with size of organism and with temporal changes in phytoplankton taxonomic composition. The overall message is that the utility of chlorophyll $a$ as a phytoplankton biomass indicator which is arguably the most appropriate biological measurement to nutrient enrichment, is subject to debate.
The first argument includes a statement that chlorophyll a is “a sensitive and robust measure of biological response to nutrient inputs from the Mine”. Sensitivity is a relative term and reflects the relative degree of change in a biological response to nutrient inputs. The only contextual comment regarding chlorophyll a appearing in Golder (2018a, §5.3.6) states: “the plankton component results generally support the conclusions of the eutrophication indicators analysis”. A discussion of whether chlorophyll a is more (or less) sensitive than say phytoplankton biomass was not found. Robustness is defined as a change that occurs only in association with changes in nutrient input. That is changes in chlorophyll a are only attributable to nutrients. Aside from nutrient concentrations, chlorophyll a is known to vary with community structure (El-Shaarawi and Munawar, 1978). In a review of community structure, Golder (2018a, § 7.3.2.1.5) states: “The phytoplankton multidimensional scaling results indicate that changes over time in phytoplankton community structure have been occurring in the near field area of Lac de Gras, especially between 2003 to 2007, and that conditions in 2016 differed from conditions in 2013 throughout the lake, but the near field and far field areas in these two years were more similar than observed in previous years”. It is not clear to what extent changes in chlorophyll a reflect changes in the community rather than a general biological response to nutrient addition. The conclusion that chlorophyll a is “a sensitive and robust measure of biological response to nutrient inputs from the Mine” does not appear to be supported.

The last idea in the first argument above is that that chlorophyll a is a response variable rather than an exposure variable which is correct inasmuch as chlorophyll a solely reflects nutrient exposure. This is in fact not an argument for excluding exposure variables because CCME (2016), in a discussion of types of variables relevant for nutrient guideline development¹, states unequivocally: “Nutrient concentrations are the most practical variables for nutrient guidelines as they can be managed directly².” The second argument presented by Golder (2018a) regarding inclusion of P as an action level is:

¹ Applies to rivers and streams.
² Note that CCME (2016) also states that “Any of the biotic response variables are candidates for nutrient guidelines as long as their importance and applicability for a region can be demonstrated.” The implication is that biotic response variables can also be used as management variables if the conditions described are met. The discussion presented in §8 regarding chlorophyll a concludes that chlorophyll a does not meet those conditions.
2. “Increases in TP in Lac de Gras have been small and sporadic, without strong spatial
trends, while clear increases in chlorophyll a concentrations have been observed in the
NF and MF areas, indicating a gradient-type response to nutrient addition. “Golder
(2018a, §5.3.8.3)

Although strong spatial gradients in total P are not apparent (Golder 2016, Appendix XIII, Figure
3-8; Golder 2017, Appendix XIII, Figure 3-18) show evidence of higher total P concentrations
within 10 km of the diffuser versus further sites. The absence of strong and distinct spatial
gradients may be due to the uptake of nutrients noted by Golder (2011) who state: “Increases in
chlorophyll a concentrations over time may be limited by nutrient availability, as inorganic
phosphorus and nitrogen are essentially depleted at some stations by the end of the growing
season”. Finally, note that “annual loads of total phosphorous from the North Inlet Water
Treatment Plant have increased between 2002 and 2016” (Golder 2018a, §5.5) suggesting that
managing total P may be or become necessary. The third argument presented by Golder (2018a)
regarding inclusion of P as an action level is:

3. “The Significance Threshold is recommended to continue to be based on biological response
(chlorophyll a), rather than nutrient concentrations. The Response Framework “builds up” to
the Significance Threshold and, therefore, must be based on a matching variable, which is
chlorophyll a”.

The first idea is a recommendation and not an argument regarding use of P as an action level
and is therefore not discussed in this section. The second idea is that “the Response
Framework “builds up” to the Significance Threshold” and therefore must be based on a
matching variable is correct. But that argument does not preclude the use of additional
significance thresholds such as the original 1999 significance threshold for eutrophication
that pertains to total P. Since that time (1999) scientific knowledge has evolved and
guidance on managing nutrients to limit eutrophication have been published (CCME 2004,
7.1 **Recommendations**

- DDMI should correct the reference to section 5.2.8 in Golder (2018a, Table 1-1) as that section does not exist.

- It would be helpful to see the estimated model coefficients and Wald statistics for the models presented in Golder (2018a, Table 5-16) to understand the area: year interaction terms. Those terms define the spatio-temporal variability of the biological indicator variables.

- DDMI should assess how chlorophyll a is driven by the demonstrated changes in community composition in order to demonstrate the robustness of chlorophyll a as the sole criterion for eutrophication related action levels.

- In combination with the preceding recommendation, DDMI should demonstrate the sensitivity of chlorophyll a relative to other biological responses to eutrophication in order to demonstrate the sensitivity of chlorophyll a as the sole criterion for eutrophication related action levels.

- DDMI should discuss why the relationship between chlorophyll a and phytoplankton biomass by area is “weak” but the relationship between chlorophyll a and phytoplankton biomass by year is “moderate to strong”.

- After consideration of the arguments presented in Golder (2018a) regarding inclusion of total P as an Action Level it is recommended that total P be included as an action level. Reasons for doing so are:

1. Trophic status is a multi-faceted concept. This multifaceted nature is reflected in definition of trophic status by authorities that use several indicators to define trophic status Vollenweider (1968); Golder 2018a, §5.2.3.5 which uses total P to estimate the

2. The weak relationship between total P and chlorophyll a in Lac de Gras and in general (Zajdlik 2017, §2.4.2), suggests chlorophyll a should not be used as a surrogate for total P in defining trophic status.

3. The utility of chlorophyll a in indicating an unequivocal eutrophication response (phytoplankton biomass) is subject to debate.

4. Nutrients can be managed directly whereas responses to nutrients cannot.

8 WLWB (2016a, Comment ID #11) - Significance Thresholds for Nutrients

GNWT ENR recommended that the eutrophication significance threshold for each of the three eutrophication-related metrics should be as follows:

1. The mean of the five Farfield A depth integrated chlorophyll a concentration does not exceed 4.5 μg/L; or,
2. The mean of the five Farfield A total P concentrations does not exceed 10 μg/L; or,
3. The mean of the five Farfield A total N concentrations does not exceed 700 μg/L.

Golder (2018a, Table 1-1) points to Golder (2018a, §5.3.8) for a response to these recommendations. The response to the first significance threshold appears in Golder (2018a, §5.3.8.5). It is agreed that the concentration was chosen to protect the oligotrophic status of Lac de Gras, the mean is lower than the maximum used in the current threshold and that the “suggested threshold represents a departure from the definition of significance by the Comprehensive Study Report (Government of Canada 1999), which is based on a high effect magnitude as defined in the EA (i.e., benchmark+20%)”. However, as noted by Golder (2018a,
§5.3.8.5) “it (the proposed significance threshold) would be expected to be triggered at about the same level of effect as the current Significance Threshold”. This is due to the offsetting effect of using a mean without the addition of a 20% buffer. There does not appear to be significant disagreement.

The response to the second significance threshold appears in Golder (2018a, §5.3.8.5). DDMI is correct in asserting that total P and biological responses are only poorly correlated. It is that poor correlation and the idea that assessing trophic status is multifaceted (Vollenweider, 1968; Carlson, 1977; OECD, 1982; Clark and Hutchinson, 1992; CCME, 2004; Dodds, 2007; US EPA 2015) that suggests that reliance on a single measure of trophic status is imprudent. In a review of 29 methods to measure trophic status Lambou et al. (1983) concluded that “Most methods were much more effective in ranking the lakes against the total phosphorus standard than the chlorophyll a standard” suggesting that total P (at least on a weight of evidence basis) is a more important variable in defining trophic status than chlorophyll a. DDMI is also correct that total P is an exposure variable. It is for that reason that total P should be managed. CCME (2016) in a discussion of types of variables relevant for nutrient guideline development states unequivocally: “Nutrient concentrations are the most practical variables for nutrient guidelines as they can be managed directly. Disagreement remains regarding how to manage potential project effects. DDMI asserts that the response to nutrient enrichment should be managed whereas CCME (2016) states that nutrients should be managed. The second point of disagreement is that chlorophyll a is “a sensitive and robust measure of biological response to nutrient inputs from the Mine” Golder (2018a, §5.3.8.5) is discussed in §7, herein. Limitations of chlorophyll a as a biological response to nutrient inputs are:

1. Chlorophyll a is only weakly correlated with phytoplankton biomass / biovolume (discussed in §7, herein) which is likely a more meaningful biological response to nutrient input than chlorophyll a (Carlson, 1984).

2. Chlorophyll a is only one facet of the multifaceted trophic status concept (discussed in §7.1, point 1, herein).
3. Chlorophyll a has not been demonstrated to either a sensitive or robust measure of biological response to nutrient inputs from the Mine (discussed in §7.1, herein).

The response to the third significance threshold appears in Golder (2018a, §5.3.8.5). Golder (2018a, §5.3.8.5) states: “Despite poor relationships observed with phytoplankton biomass, total phosphorous or micronutrients associated with increased total dissolved solids (Section 5.3.5) are the most likely key drivers of phytoplankton biomass in Lac de Gras.” This contrasts with the statement: “In addition, the strong correlations between total dissolved solids and total nitrogen suggest that biological effects related to total nitrogen or components of between total dissolved solids (i.e., micronutrients) may not be separated by a correlational approach” Golder (2018a, §5.3.5.2). The inability to disentangle the effects of total nitrogen and total dissolved solid using correlation is the correct conclusion. The second point made by Golder (2018a) with respect to a Significance Threshold for total N is that “there is a high level of uncertainty around a definitive and appropriate trophic threshold for N”. There is little question that an appropriate threshold is the oligotrophic – mesotrophic boundary as is used for chlorophyll a. What remains of the argument is that there is a high level of uncertainty regarding that boundary.

There is considerable uncertainty in the oligotrophic – mesotrophic boundary for chlorophyll a concentrations. Golder (2014, Table 5.4-2) shows that the factor between the range of maximum oligotrophic and minimum mesotrophic boundaries is 3.2. As presented in (2018a, §5.3.8.5), the worst-case scenario for total nitrogen averages results in a factor of 5.3 (=1,630/310). Another way of quantifying uncertainty is to estimate the coefficient of variation. Using Wetzel (2001) who references Vollenweider (1979), the boundary conditions of total N for oligotrophic lakes is a mean of 661 μg/L, with a range of 307 to 1,630 μg/L, and Nurnberg (1996, cited in Smith, 2009) has the oligotrophic boundary total N as <350 μg/L.” Jones and Knowlton (1993) present a total N oligotrophic – mesotrophic boundary for lakes of 300 μg total N/L. Using the mean3 of 661 μg/L and the Nürnberg (1996) and Jones and Knowlton (1993) recommended boundaries, the coefficient of variation among the three boundary conditions is less than a modest 45%.

DDMI dealt with the uncertainty in the chlorophyll a boundary values by using the average of

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3 Using the raw data cited in Wetzel (2001) would result in a higher coefficient of variation. Unfortunately, the document cited (Vollenweider, 1979) could not be retrieved.
the average of maximum chlorophyll a concentrations for oligotrophic waters and the average of minimum chlorophyll a concentrations for mesotrophic waters (Golder, 2014). A similar approach could be used for total N.

Carlson (1996) discusses the use of a N index in addition to a P index and “suggests that a nitrogen index value might be a more universally applicable nutrient index than a phosphorus index”. The recommendation to use total N as a eutrophication limit/trigger follows recent initiatives in Alberta (ESRD, 2014) and ongoing efforts across the United States (US EPA, 2015, 2016). US EPA (2015) discusses reasons why total N should be part of a dual criterion (the other criterion is total P) for preventing eutrophication. These reasons are summarized herein; readers are encouraged to read the paper for details and supporting scientific literature.

- trophic status can vary both spatially and temporally;
- a single element nutrient limitation hypothesis ignores variation in nutritional needs;
- N fixation does not fully offset N deficiency;
- N loads can serve as sources further downstream; and,
- controlling only P may not effectively prevent the occurrence of harmful algal blooms in freshwaters.

Finally, the recommendation to manage total N is consistent with the CCME (2016) recommendation to manage nutrient concentrations as opposed to response variables.

### 8.1 Recommendations

- DDMI should reconcile the two contrasting statements:
  - “Despite poor relationships observed with phytoplankton biomass, total phosphorous or micronutrients associated with increased total dissolved solids (Section 5.3.5) are the most likely key drivers of phytoplankton biomass in Lac de Gras” Golder (2018a, §5.3.8.5).
“In addition, the strong correlations between total dissolved solids and total nitrogen suggest that biological effects related to TN or components of TDS (i.e., micronutrients) may not be separated by a correlational approach” Golder (2018a, §5.3.5.2).

DDMI should conduct a literature review for total N conditions defining the oligotrophic – mesotrophic boundary and using the same methodology used for chlorophyll a (Golder, 2014), estimate a total N eutrophication limit.

The recommendation to use total N as a eutrophication limit/trigger follows recent initiatives in Alberta (ESRD, 2014) and ongoing efforts across the United States (US EPA, 2015, 2016). US EPA (2015) discusses reasons why total N should be part of a dual criterion (the other criterion is total P). DDMI should discuss reasons for their disagreement with these authorities.

9 WLWB (2016b, Directive 2a) - Role of Nitrogen in Explaining Changes in Chlorophyll a

WLWB (2016b, Directive 2 A) states that: “With regards to the 2014 to 2016 Aquatic Effects Re-evaluation Report, the Board has decided that DDMI is to consider a more explicit analysis of the role of nitrogen in explaining variation and the spatial extent of chlorophyll a effects.”

Golder (2018a, Table 1-1) points to Golder (2018a) Eutrophication Indicator §5.3.3, 5.3.5 and Plankton §7. However, Golder (2018a, §5.3.3) discusses effects of dike deposition and dike construction and not chlorophyll a or nitrogen. Golder (2018a, §5.3.5.3) discusses the relationship between nutrients and chlorophyll a concentrations. The relationship is assessed by tabulating the year-specific Pearson product moment correlations between chlorophyll a and total N. Golder (2018a, §5.3.5.3) summarizes the correlations stating: “The relationship between concentrations of chlorophyll a and TN was moderate to strong, ranging between r = 0.52 and 0.92 between 2007 and 2013, while in 2016 the relationship was poor (r <0.2) (Figure 5-38;
Table 5-22). The “role of nitrogen in explaining the spatial extent of chlorophyll a effect” does not appear to be discussed explicitly.

9.1 Recommendations

- Golder (2018a, Table 1-1) incorrectly points to Golder (2018a) Eutrophication Indicator §5.3.3) for a discussion of the role of nitrogen in chlorophyll a spatial extent. DDMI should correct this cross-reference.

- 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.


WLWB (2018, Directive 3) states: “DDMI is to address GNWT-ENR recommendations 10 and 11, with regards to changes to Action Levels for effluent and water chemistry, as part of the 2014 to 2016 Aquatic Effects Re-evaluation Report.”

The first GNWT ENR recommendation states: “1) ENR recommends the increasing temporal trends in the mixing zone, nearfield and midfield 1 and midfield 2 should trigger an early warning level or Action Level 1. A temporal trend that will lead to the predicted mean exceeding two times the reference condition median within 3 years should trigger Action Level. The recommended Action Level additional criteria should be linked to existing criteria with the logical operator “OR”.

The second GNWT ENR recommendation states: “ENR recommends the Action Level 2 criterion used in the DDMI AEMP Design 3.5 should be used and the suggestion made by EMAB (Environmental Monitoring and Advisory Board) to modify Action Level 1 to specify
Either an exceedance of 2 x the median reference condition OR an exceedance of the normal range of reference conditions should be investigated by DDMI using the last three years of AEMP data and the results should be submitted for public review”.

Golder (2018a, Table 1-1) points to Golder (2018a) Effluent and Water Quality §13.2 for a response to these directives. Golder (2018a, §13.2) does not exist. The section of Golder (2018a) entitled “Effluent and Water Quality” was examined for a discussion of inclusion of temporal trends as an action level and sequential action level assessment. The following locations were searched with outcomes as described.

- Golder (2018a, Table 4-6) which presents Action Levels does not include such a discussion.
- Golder (2018a, §4.2.4.2.2) which discusses temporal trends does not link trends with Action Levels.
- Golder (2018a, §4.3.2.1) presents temporal trend results for water quality
- Golder (2018a, §4.3.2.2.1) discusses Action Levels without reference to temporal trends.
- Golder (2018a, Table 4-27) summarizes trends in water quality Substances of Interest but does not link trends with Action Levels.

10.1 Recommendation

- It is not clear whether WLWB (2018, Directive 3) stating: “DDMI is to address GNWT-ENR recommendations 10 and 11, with regards to changes to Action Levels for effluent and water chemistry, as part of the 2014 to 2016 Aquatic Effects Re-evaluation Report” was addressed, as the specific location referred to in Golder (2018a, Table 1-1) does not exist and the general location referred to in Golder (2018a, Table 1-1) does not appear to
discuss the topics. DDMI should either direct the reader to the appropriate section(s) within Golder (2018a) or, address WLWB (2018, Directive 3) with respect to addressing GNWT-ENR recommendations 10 and 11.

11 Additional Recommendations

This set of recommendations follows a general review of the re-evaluation report that is distinct from reviewing DDMI’s response to previous reviewer recommendations and/or Board directives. Aside from the first recommendation, remaining recommendations are provided in no particular order.

• Some of the references to locations within Golder (2018a) either do not exist or do not correspond to the subject of discussion. As the report is 631 pages long it is difficult to be sure that responses to directives are not addressed in sections of the report other than those that were referenced. DDMI should consider submitting a revised 3 Year Re-Evaluation Report to ensure that reviewers consider all of DDMI’s reasoning with respect to various Directives.

• Golder (2018a, Figure 5-41) presents Carlson trophic status index ratios on a bivariate plot. Ratios for each location in Lac de Gras within a year are plotted using the same colour. Given that spatial patterns in some of these indices have been observed DDMI should improve this useful graphic by the use of symbols representing at least some of the 8 areas. Certainly, the NF and MF locations at least could be identified to aid in interpretation. Additionally, DDMI should use a colour gradient for years improving the ability to detect temporal changes.

4 “Generally, large particles predominated in the NF, MF2-FF2, and MF1 areas, while smaller particles predominated (i.e., dissolved colour and clay particles) in the MF3 and FF areas (Figure 5-42)”, (Golder, 2018).
• Golder (2018a, §9.2.1.3.8) refers to Appendix A, but this appendix does not exist in Golder (2018a). DDMI should clarify this reference.

• Golder (2018a, §5.2.3) subsections are duplicated. DDMI should correct these duplications.

• Logistic regression is correctly used to deal with censored data. A limitation of logistic regression is that due to the binary nature of the dependent variable, the magnitude of detectable concentration changes is not used. DDMI should consider the use of multinomial models, possibly using baseline upper percentiles such as the 90th as an additional cut-point for detectable concentrations. This may improve the ability of the logistic regression models (notably for nutrients) to detect change.

• The caption for Figure 7-15 (Golder, 2018a) entitled “Metric Multidimensional Scaling of Phytoplankton in the Near-field and Far-field” is incomplete and should be corrected as this graphic likely pertains to phytoplankton biomass.
12 References


DRAFT
Review of DDMI AEMP Design 5.0

Prepared for:
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July, 2018
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1 Introduction

Zajdlik & Associates Inc. was retained by the Government of the Northwest Territories to review various aspects of the Diavik Diamond Mines Inc. (DDMI) Aquatic Effects Monitoring Program (AEMP) Design Plan Version 5.

Some of the key changes from the AEMP Design 4.1 are presented below:

- Changed from a near field - far field comparison to a near field – reference condition comparison for biological action levels.

- Changed number of locations and site locations in the far field.

- A change in statistical analytical protocols.

- Biological action levels have been changed. Biological effect sizes for statistical hypothesis testing have been added as have criteria for consecutive differences.

These topics are addressed in greater detail below.
2 Review Outcomes

2.1 Change in Design

The proposed change in design is stated to be due to the cumulative effects of the Ekati and Diavik Mines on water chemistry in the Far Field (FF) A area that precludes the use of FFA as a reference area. Thus, the nearfield (NF) – FF comparisons used previously to assess change can no longer be made for water chemistry. The proposed changes in sampling effort are discussed in §2.2, herein. In the discussion of the design change, the rationalization for removing locations is that from a gradient analysis perspective, such locations are “redundant” (Golder, 2018a§ 3.4.1). The word redundant implies that these locations are superfluous or not needed and as such is an oversimplification. Replicates within an area are useful in a gradient analysis as they can be used to improve the precision of slope estimates leading to improved statistical power and aid in detecting abrupt changes such as may occur due to inflows from subcatchments. Retaining locations that have been monitored since the implementation of AEMP design 2.0 allows for assessing long term changes. An overall recommendation regarding the proposed change in design is presented in §2.3.5, herein.

2.1.1 Recommendations

The following recommendations associated with the change in experimental design are presented in no particular order unless otherwise stated. Although some of the recommendations assume that proposed design is accepted, an overall recommendation regarding adoption of the proposed changes is presented in §2.3.5.2.3, herein.

- Golder (2018a, Table 5.2-1) presents action levels. The proposed inclusion of locations FFB-6 and FFB-7 shifts the FFB area centroid much further west, thus affecting the

1 Note that DDMI states that biological changes in the FFA have not yet been detected and in theory at least, FFA could still be used as a biological reference area.

2 Note that with respect to environmental monitoring such replicates are known as “field replicates” as they are not true replicates in the somewhat abstract world of laboratory experiments.
spatial extent of changes in water chemistry under action level 8. In order to retain the same approximate FFB centroid, DDMI should use FFB-6, FFB-5, FFB-2, MF3-7 and FF1-6 to assess Action Level 8.

- Action levels 8 and 9 (water quality and chlorophyll a) use percentiles estimated using the 5 locations within each of farfield areas A and B. The proposed design places locations on a dilution gradient such that it is not clear how variability within these farfield areas should be estimated. Assuming for the moment that location labels are used to categorize locations along the gradient as belong to farfield A or B, the proposed reduction in sampling effort in the farfield areas reduces the precision of the estimated 95th percentile used in action levels 8 and 9 (Golder 2018a, Table 5.2-1 and for chlorophyll a\(^3\)). In order to offset the reduced precision a percentile closer to the median should be used as precision (of estimated percentiles) improves with proximity to the median. The 80th percentile is subjectively, recommended for this purpose. Alternatives to adopting this recommendation are to demonstrate what reduction in percentiles is necessary to achieve a similar precision of the estimated 95th percentile using 5 sampling locations, or, to retain 5 FFA sampling locations. DDMI should also discuss the implications of estimating within-area variability (which somewhat loosely is what the 95th percentile estimates) using samples collected along a known gradient.

- Golder (2018a §3.4.1) states: “Changes were made to adjust the sampling design to a gradient design, while maintaining the ability to continue statistical comparisons of NF area data to the reference condition dataset for Action Level evaluation”. As there are no changes to proposed sampling in the nearfield and comparisons with the reference condition dataset are not impacted by the proposed changes in design; and 2) statistical comparisons with the farfield for the purpose of AL evaluation are not made, DDMI should adjust this statement as follows: “Changes were made to adjust the sampling design to a gradient design”.

\(^3\) Not presented in the “track changes” version of Golder 2018a as there were no changes to the text from the same section in AEMP Design 4.1.
2.2 Change in Sampling Effort

The previous plan followed Environment Canada (2012) Environmental Effects monitoring program sampling requirements with 5 sites within an area. That recommendation was based on an ability to detect biological changes thought to be ecologically significant when using a reference – exposure analysis (not a gradient analysis). It is important to note the emphasis on biological effects rather than changes in water chemistry. The proposed changes in sampling effort are presented below.

Table 2: Changes in Sampling Effort in AEMP Design 5.0 (Golder 2018a, Table 3.4-1) versus AEMP Design 4.1 (Golder 2017a, Table 3.4-1)

<table>
<thead>
<tr>
<th>change</th>
<th>FF1</th>
<th>FFA</th>
<th>FFB</th>
</tr>
</thead>
<tbody>
<tr>
<td>removed</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>added</td>
<td>1</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>remaining stations</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 2 shows that a net loss of 5 sampling locations or a 33% reduction in the farfield areas A, B and 1 is proposed.

2.2.1 Recommendations

The proposal to reduce sampling effort due to a change in experimental design requires the following recommendations to be addressed with results to be assessed by reviewers prior to further consideration. Note that an overall recommendation regarding the proposed sampling design is presented in 2.3.5, herein. Recommendations are provided in no particular order.

- The spatial extent of changes in the FF1 area has been investigated for eutrophication metrics (Golder, 2018b, Figures 5-1 through 5-5). Prior to accepting the removal of locations FF1-1, FF1-3 and FF1-5 proposed in Golder (2018a), the spatial extent of all substances of interest should be presented. An absence of spatio-temporal trends in FF1 that may indicate past, current or future water quality issues would suggest that these
locations add little value\(^4\) in assessing potential impacts to water quality and again, in the absence of effects, suggest that some or even all FF1 locations are of little use in evaluating a chemical gradient. DDMI should produce such maps and make them available to reviewers.

- Golder (2018a) proposes to remove 3 FFB locations and 2 FFA locations while adding two FFB locations (FFB-7, FFB-8). A limited comparison of removed versus retained water chemistry locations by exposure area (FFA and FFB) suggests that (as expected) there is no difference among the two groups of stations. DDMI should conduct comparisons of retained versus proposed deleted locations for all substances of interest in each of the FFA and FFB areas on a year-by-year basis using data from 2012 -2017 inclusive to confirm the absence of spatial effects.

### 2.3 Should the Current AEMP Design be Retained?

Proposed changes to the AEMP affect various elements of the AEMP. These elements are discussed below.

#### 2.3.1 Temporal Trend Analyses

Temporal trend analyses are conducted during an AEMP re-evaluation “to summarize AEMP data collected to date in an accessible format and evaluate temporal trends” (Golder, 2018b, §2.4.1). Temporal trend analytical methods for data collected under AEMP design 5 are discussed in Golder (2018a, §4.3.4.10). Linear mixed effects models are used with the variance among stations in the nearfield and farfield areas being ascribed to random effects. As noted in Golder (2018a, §4.3.4.10), “The use of random variables will allow for variability in the different data components to be correctly assigned (i.e., to stations within areas, instead of to areas).” The proposed loss of 40% of FFA locations and 60% of FFB locations effectively precludes the

\(^4\) Golder (2017b, Table 3-4) shows that the range of barium and total dissolved solids under ice in 2016 was low relative to the nearfield but large relative to locations from FFB and FFA.
meaningful estimation of variance components when conducting temporal trend analyses because the proposed design orders locations along a presumed gradient such that assignment of locations to either of the western farfield areas does not make sense. This will almost certainly result in an inflation of variability for the trend term(s) and a reduction in ability to detect temporal trends. Interpretations that could be affected include water and sediment quality, eutrophication indicators, various phytoplankton, zooplankton and benthic macroinvertebrate metrics. A recommendation on this topic is provided in §2.3.1.1, herein.

2.3.1.1 Recommendations

Recommendations are provided in no particular order.

- DDMI should discuss how locations along a spatial gradient will be used to estimate the within-area variance components described if the proposed design is adopted.

- DDMI should discuss how the ability to detect temporal trends in far field areas 1, A and B, will be affected if the proposed design is adopted.

- Golder (2018a, §4.3.4.10) makes the following statement: “For the Aquatic Effects Re-evaluation Report, time series plots will be generated for each SOI for each season using available data from 1996 to the latest available comprehensive year dataset.” It is not clear whether FF1, FFA and FFB data will be “comprehensive” if the proposed AEMP design is implemented as 53% (8/15) of the locations in these areas will no longer be sampled. DDMI should clarify this wording.

- Golder (2018a, §4.3.4.10) in reference to the Aquatic Effects Re-evaluation Report states that “Linear mixed models will be used to analyze spatial and temporal trends” and further that “the results will be used to interpret temporal and spatial trends”. In these models distance is not included as a random variable but rather distance is implied by the

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5 This issue also affects estimation of random effects as discussed in §2.3.2, herein.
area/station\textsuperscript{6} fixed effect. It is not clear whether the ordinality (ordering) of the area/station fixed effects will be considered in the mixed effects models. DDMI should clarify this wording.

2.3.2 Gradient Analyses

Under the current AEMP design, visual assessments of gradients have been used to identify trends in concentrations of substances of interest along defined spatial gradients in Lac de Gras, delineate the extent of effects and define gradients along transects for eutrophication indicators, assess cumulative effects from the Ekati and Diavik Mines, identify environmental gradients that may be associated with the phytoplankton community Golder (2017b, 2018b).

Golder (2018a, §4.3.4.9) states that “the main objective of the spatial gradient analysis will be to evaluate trends in SOI concentrations\textsuperscript{7} along the effluent exposure gradients”. Segmented regression models that use distance as an explanatory variable are proposed to estimate gradients but only using stations from the midfield. The only difference between AEMP Design 4.0 and 5.01 with respect to gradient analyses is that segmented regression will be used instead of linear regression. The regression analyses in AEMP Design 4.0 and AEMP Design 5.0 use only midfield stations. Consequently, statistical analyses of gradients do not require any changes to the current AEMP design.

The multidimensional scaling discussed in Golder (2018b, §7.2.3.3) in response to Board directive (WLWB, 2017a) uses historical data to identify environmental gradients that may be associated with the phytoplankton community. It is not clear how samples collected along a gradient would be used to scale data prior to multidimensional scaling due to the arbitrariness in assigning locations to an area. This issue also affects scaling of benthic invertebrate community

\textsuperscript{6} Labelling varies among areas with farfield areas being labelled as such due to expected similarity of exposure concentrations within each of the farfield areas whereas midfield areas are labelled as a combination of the midfield area and location due to the presence of an exposure gradient.

\textsuperscript{7} Golder (2018a, §4.5.4, 4.6.4 and 4.7.4) states these gradient analyses will also be applied to nutrients, plankton and benthic macroinvertebrate metrics, respectively.
data (Golder 2018b, §8.2.3.3), assessing significance of the Analysis of Similarity R-statistic (Golder 2018b, §8.2.3.3) and, estimation of random effects as discussed in §2.3.1, herein.

2.3.2.1 Recommendations

- DDMI should discuss how samples collected along a gradient would be used to scale data prior to multidimensional scaling due to the arbitrariness in assigning locations to an area.

2.3.3 Weight of Evidence

The weight of evidence approach presented in Golder (2017b, Appendix XV, § 2.3.2.2.1) AEMP uses a statistical comparison of NF and FF for the following lines of evidence:

- Substances of interest for water quality;
- Nutrients;
- Substances of potential toxicological concern for sediment quality;
- Sculpin tissue chemistry;
- Biological productivity (chlorophyll a and zooplankton and phytoplankton biomass);
- Benthic community (total invertebrate density, density of dominant invertebrates, richness, Simpson’s diversity index, dominance, evenness, Bray-Curtis distance); and,
- Fish population health (energy stores, reproductive investment, tapeworm parasitism).

These comparisons follow the previous AEMP design (Golder, 2017a). Although Golder (2018a, 4.10-1, 4.10-2) proposes to change some of the measurement endpoints presented in the lines of evidence presented above, measurement endpoints corresponding to key lines of evidence regarding exposure have remained the same or have been augmented. As examples of decision criteria, Golder (2016, Figure 4.10-1) includes examples of “negligible” and “early warning – low” decision criteria that use statistical comparisons of nearfield and farfield measurement endpoints. The “moderate” decision criterion uses an estimate of variability from farfield
measurements\textsuperscript{8}. Golder (2018a, §4.10.2.2) refers to decision criteria but does not provide examples to replace the criteria that will no longer be possible under the proposed AEMP design.

2.3.3.1 Recommendations

- Golder (2018a, §4.10.2.2) states that “The decision criteria used to assign an effect level rating for exposure endpoints and for biological response endpoints will be based on the categories (Action Levels) in Section 5.2”. Although Action Levels for water chemistry (Golder, 2018a, Table 5.2-1), sediment quality (Golder, 2018a, §5.2.2), and eutrophication indicators (Golder, 2018a, §5.2.3), have remained unchanged from AEMP Design 4.1, substantive changes in biological action levels have been proposed (discussed in §2.3.4, herein). DDMI should provide a set of decision criteria for the weight of evidence approach that can be used under the proposed AEMP. Note that Golder (2018b, §8.2.3.5) argues that nearfield – farfield statistical comparisons should be used for evaluating biological Action Level exceedances.

2.3.4 Changes in Biological Action Levels

At this time, changes in biological action levels are assessed only from the perspectives of changes to the experimental design and bases for comparison. The proposed changes in metrics, degree of change (effect sizes) or additional criteria in Action Levels 2 and 3 are not reviewed.

2.3.4.1 Implications of Proposed Design Change

Within this section, changes in biological action levels are examined only from the perspective of the implications of the proposed changes in sampling design.

The proposed action Level 1 for biological effects (Golder, 2018a, Table 5.2-4) involves comparisons of nearfield data with means of the historic reference data set. This is a departure

\textsuperscript{8} Refer to estimation of variance components discussed in §2.3.1, herein regarding measures of variability in the farfield under the proposed AEMP design.
from AEMP Design 4.1 (Golder, 2017a) where comparisons are with means from data from farfield A. Some of the measurement endpoints have changed in AEMP Design 5.0. In light of the changes to the basis for comparison (historic reference data set versus farfield A) proposed changes to the experimental design are irrelevant to evaluation of Action Level 1 for biological effects.

Action Level 2 for biological effects (Golder, 2018a, Table 5.2-4) is similar to Action Level 1 with respect to extent (nearfield) but varies by the addition of a criterion for two consecutive years (plankton) or a criterion that effect sizes defined by Environment Canada (2012) be exceeded (benthic invertebrates and fish metrics). This is a departure from AEMP Design 4.1 (Golder, 2017a) where comparisons use data collected from the midfield and data from farfield A. Again, in light of the changes to the basis for comparison (historic reference data set versus farfield A) proposed changes to the experimental design are irrelevant to evaluation of Action Level 2 for biological effects.

Action Level 3 for biological effects (Golder, 2018a, Table 5.2-4) is similar to Action Level 2 with respect to extent (nearfield) but varies by the addition of a criterion for changes to occur consecutively for a period of sampling events (3 for plankton and 2 for benthic invertebrates and fish) and a criterion that measurement endpoints fall below the normal range. Again, commenting only on the implications of the proposed changes in sampling design, the proposed changes to the experimental design are irrelevant to evaluation of Action Level 3 for biological effects.

Overall, the proposed changes to the experimental design are irrelevant to evaluation of Action Levels 1 through 3 for biological effects. If Action Levels under AEMP design 4.1 were retained, the proposed changes in experimental design would have adverse consequences with respect to interpretation due to changes in centroids of sampling locations (see discussion in §2.1, herein) and the difficulty of estimating an appropriate variance term (see discussion in §2.3.1, herein).
2.3.4.2 Implications of Proposed Changes in Bases for Comparison

Concerns regarding the use of the reference data set were expressed in Zajdlik (2015) due to the use of sites with a demonstrable effluent effect, which contravenes the definition of a reference area. Those concerns are still relevant and now due to the emphasis on comparing biological effects with the reference dataset to define action levels, the raison d'etre for the AEMP, additional concerns are raised. The AEMP Design 5.0 discusses consistency with the federal Environmental Effects Monitoring program for metal mines (Environment Canada, 2012) in the context of:

- schedule for sampling slimy sculpin (Golder 2018a, §3.5);
- a tiered, three-year cycle approach for environmental management decision making (Golder 2018a, §3.5);
- critical biological effect sizes (Golder 2018a, §5.2.4); and,
- selection of biological effect indicators (Golder 2018a, §5.2.4).

However, the consistency does not apply to recommended experimental designs when making inferences for action levels. Environment Canada (2012) recommended designs include:

1. Control-impact design (C-I);
2. Multiple control-impact design (MC-I);
3. Before/after control-impact (BACI);
4. Simple gradient (SG) design;
5. Radial gradient (RG) design;
6. Multiple gradient design (MG); and,
7. Reference condition approach (RCA).

Although a gradient design is discussed and implemented, the proposed *de facto* design for assessing biological action levels is most closely related to the Environment Canada (2012) reference condition approach. That approach establishes a reference condition through “an initial standardized sampling program at a wide variety of geographic scales. The same benthic
invertebrate community sampling protocol is used in as many ecoregions and stream orders or lakes as are available in a catchment”, (Environment Canada, 2012). The intent is to capture the extent of regional variability and using multivariate techniques, determine whether benthic communities from the exposure site(s) are similar to the reference condition. The proposed design uses a reference area (Golder, 2018c) that while not capturing regional variability, likely provides a reasonable estimate of spatial variability in the downstream exposure area of Lac de Gras. This reference condition may not adequately describe natural variability in the eastern end of Lac de Gras which is subject to the influence of discharge from Lac du Sauvage. It is not clear whether temporal scales of variability are adequate because scales vary from 1 to 4 years. Certainly, samples collected in only one year cannot capture temporal variability. More importantly the temporal scales for a variety of reasons, represent on an analyte/measurement endpoint-specific basis, different times. The analyte/measurement endpoint-specific selection process used results in a reference condition representing varying temporal scales with very different levels of sampling effort, particularly if indexed by specific far field area.

The de facto experimental design for assessing biological action levels could also loosely be defined as before-after design as the reference condition ostensibly represents the pre-impact condition in Lac de Gras. However, the reference areas are not the exposure areas and hence the comparison is confounded by using areas that may or may not be comparable. Even if this were a true before and after design, such designs are typically not recommended as there is often natural drift in biological communities over time. This is in fact the rationale for the use of consecutive differences in biological measurement endpoints when moving through the biological action level hierarchy (Action Levels 1 through 3). The latter concern led to the recommendation of BACI designs by Environment Canada (2012). Other issues associated with a limited reference condition definition are discussed in Environment Canada (2012).

2.3.4.3 Recommendations

The following recommendations associated with biological action levels are presented in no particular order unless otherwise stated. Although some of the recommendations assume that proposed design is accepted, an overall recommendation regarding adoption of the proposed changes is presented in §2.3.52.3, herein.
• Given the limitations of the reference dataset discussed in §2.3.4.2, herein, DDMI should consider using one of the Environment Canada (2012) recommended experimental designs for assessing biological action levels. The gradient design using the segmented regression models described in Golder (2018a, §4.3.4.9) is a strong candidate. Advantages of this approach are that:

1. All the issues regarding the reference condition definition are sidestepped.
2. Synoptic data are used avoiding issues with natural changes over time.
3. The issue of confounding for plankton metrics discussed in Golder (2018a, §4.6.4) is avoided.
4. A consistent data analytical method is used throughout the AEMP.
5. It is likely that the achieved statistical power for detecting trends will be higher than that achieved by a comparison of nearfield data with the reference condition data.

A challenge, but possible advantage is that biological effects levels would be expressed in terms of spatial gradients contextualized by critical effect sizes with a reduced emphasis on the reference dataset.

• The statistical power of the proposed biological action level 1 comparison should be estimated using data from the latest AEMP cycle to understand the ability of the proposed comparisons to detect change.

• The statistical power of the current biological action levels comparison should be estimated using data from the latest AEMP cycle as a point of reference for the proposed changes to biological action levels.

• DDMI should discuss the proposed change in basis for comparison for biological action levels (Golder, 2018a) with the statement made in Golder (2018b, §8.2.3.5): “Therefore, from the perspective of evaluating the potential for aquatic toxicity in the NF and MF
areas, the FF areas were considered suitable as “minimally affected” sampling areas in
the statistical comparisons for evaluating Action Level exceedances.

2.3.5 Conclusion

One reason for retaining an experimental design is allow for continuation of analyses over time.
Following the Board Directed AEMP Cumulative effects meeting (Rio Tinto, 2016) DDEC and
DDMI espoused the same idea stating: “No operator is suggesting changes to their individual
AEMP programs. Data collected through each program must remain consistent to allow
continued analysis.” (Rio Tinto, 2016). The proposed change in design impairs the ability to
conduct the temporal trend analyses conducted in the AEMP re-evaluation since 8 of 15 farfield
stations will be lost. Although the design proposes adding 3 sampling locations in the farfield
the intent is to sample along a proposed gradient. Consequently, the stations cannot
simultaneously be used to replace stations representing distinct farfield areas.

Golder (2018a, §1.2.1) states: updates to the AEMP sampling stations to allow gradient analysis
as the key method to analyze Mine-related effects. The only statistical analysis that relates to
gradients is the breakpoint analysis – and that analysis does not use the farfield locations. Thus,
the proposed change is unnecessary at least for this reason.

Overall there is as yet, no compelling scientific or management-based reason to change the
sampling design as proposed. Retention of the current design with an emphasis on gradient
analyses offer the following advantages over the proposed change in design:

• The 5 reasons presented in 2.3.4.3, herein;

• Avoiding adverse consequences when estimating percentiles of water quality analytes
  and chlorophyll a for farfield areas A and B when evaluating Action levels 8 and 9;

In the event that DDMI is convicted that the proposed augmentation of stations in the farfield is
valuable, consideration should be given to adding those stations to the current program.
3 Response to Previous ENR Comments

The Government of Northwest Territories, Department of Environment and Natural Resources (ENR) has provided recommendations regarding the AEMP design. The responses to these recommendations pertaining to AEMP design are evaluated herein.

WLWB (2017b) directed DDMI to address GNWT-ENR comments 6, 7, and 9 to 13 provide various recommendations about potential improvements that could be made to the statistical analyses. Golder (2018a, Table 8-1) points to AEMP Design Plan Version 5.0 – Sections 4.3.4.9, 4.3.4.10, 4.6.4, 4.7.4 as locations where responses were provided. Those sections were reviewed with the following outcomes:\(^9\):

- ENR comment 6: The details that the ENR comments addressed were not included\(^9\); consequently, this recommendation was not addressed.

- ENR comment 7: A discussion of censoring is not found\(^9\); consequently, this recommendation was not addressed.

- ENR Comment 9: There is no reference to Sokal and Rolf nor is there a discussion of “large” and “small” datasets. However, this comment was addressed in (WLWB, 2017c, Comment Summary ID #10).

- ENR Comment 10: No discussion of non-normality is provided; however, this comment was addressed in (WLWB, 2017c, Comment Summary ID #11).

\(^9\) Note during review of the AEMP Re-Evaluation (Golder, 2018c) it became coincidentally apparent that some at least of the GNWT-ENR comments have been addressed but the reference to those responses is incorrect. No systematic attempt has been made to find responses provided by DDMI in documents other than those cited by Golder (2018, Table 8-1).
• ENR Comment 11: The significance of deviations from equal variance were not discussed; however, this comment was addressed in (WLWB, 2017c, Comment Summary ID #12).

• ENR Comment 12: No discussion of assessing normality was included; consequently, this recommendation was not addressed.

• ENR Comment 13: No discussion regarding treatment of censored data was included; consequently, this recommendation was not addressed.

WLWB (2017b) directed DDMI to address GNWT-ENR comment 17; a recommendation for the inclusion of phytoplankton taxonomy to be done annually at all MF and FF-2 locations, as well as LDS-4. The Board notes that DDMI has already committed to including this annually at all MF stations (see Section 3.5 of these Reasons for Decision). DDMI (2018a, Table 8-1) points to AEMP Design Plan Version 4.1 for a response to this recommendation. There is no discussion of phytoplankton taxonomy in AEMP Design Plan Version 4.1. DDMI (2018a, §4.6.2) does state that “sampling in the NF and MF areas of Lac de Gras will occur on an annual basis” but there is no discussion regarding GNWT-ENR comment 17, despite a commitment to do so (WLWB, 2017c, Comment Summary ID #18).

### 3.1 Recommendations

• The WLWB (2017b) directive to address ENR comments 6, 7, and 9 to 13 were not addressed in the sections indicated by Golder (2018a Table 8-1). However, comment #9 and #10, were addressed in (WLWB, 2017c, Comment Summary ID #10, 11). DDMI should either point to where the remaining comments have been addressed or follow the remainder of the WLWB (2017b) directive.

• The WLWB (2017b) directive to address ENR comment 17 was not addressed in the document indicated by Golder (2018a Table 8-1). DDMI should address the WLWB (2017b) directive with respect to FF2 locations as well as LDS-4.
4 General Recommendations

Recommendations are provided in no particular order and unless otherwise stated pertain to Golder (2018a).

- In a discussion regarding benthic macroinvertebrate metrics, Golder (2018a, §4.10.2.1) states: “These endpoints will be assessed for gradients with effluent exposure and or for statistical differences among sampling areas of Lac de Gras. It is not clear how samples in the far field that are intended to represent a gradient may be arbitrarily grouped to conduct the Analyses of Variance conducted under AEMP Design 4.1. DDMI should discuss how statistical differences among sampling areas of Lac de Gras will be estimated and tested.

- Golder 2018a, Table 3.4-1 lists 10 FF stations (excluding the two FF2 stations) yet Golder 2018a, Table 3.5-1 lists only 8 FF stations (again, excluding the two FF2 stations) for effluent plume, water quality, eutrophication indicators, phytoplankton, etc. components of the AEMP. DDMI should clarify this discrepancy.

- Golder 2018a, §4.8.4 states: “The statistical comparisons among areas and the test for assumptions of normality and homogeneity of variance for parametric statistics will be conducted as described for water quality (Section 4.3.4.9.2)”. This section does not exist in the current report. DDMI should confirm that the intended analytical method is that described in Golder 2018a, §4.3.4.9.

- Golder 2018a, §4.3.4.9 states: “Following data transformation (if required), the selected models will be fitted to the data. Statistical outliers will be identified using studentized residuals with absolute values of 3.5 or higher, or due to consideration of leverage (where a single point could strongly influence the overall fit of the model). All values removed from analysis will be retained in the model prediction plots, where they will be shown as
a different symbol to identify them as statistical outliers from the rest of the data.”
Outliers and observations are often similar (high leverage points are extremes in the
predictor space). If conclusions change due to the removal of observations DDMI should
present both analyses in the main body of the report to allow readers to form their own
conclusions. Sensitivity of conclusions to aberrant observations often raises interesting
questions regarding the experimental design and/or the population of interest.

- The proposed reduction in sampling locations in the farfield will reduce the number of
  Trophic State Index ratios (Golder (2018b, §5.3.7.2) by area. DDMI should discuss the
  implications with respect to trophic status classification.

- When testing normality, the Shapiro-Wilks test should be used instead of the
  Kolmogorov-Smirnov test that has been used in previous analyses.
5 References


Dear Mr. Mackenzie:

Subject: Responses to Diavik - 2014 to 2016 Aquatic Effects Re-evaluation Report and Version 5.0 of the AEMP Design (W2015L2-0001)

The Wek’eezhii Land and Water Board (WLWB) provided a complete list of proponent review comments and Recommendations to Diavik Diamond Mines (2012) Inc. (DDMI) for the Diavik - 2014 to 2016 Aquatic Effects Re-evaluation Report and Version 5.0 of the AEMP Design (W2015L2-0001) on 20 July 2018. Responses to these comments are attached.

DDMI plans to submit a revised version of the AEMP Re-evaluation Report and Design to address reviewer comments, as noted in our attached response, once a decision by the WLWB is received. In an oversight, Figures 2-1 through 2-5 were initially omitted from the report. These figures have been provided as Attachment-1 to our response.

If you have any questions regarding the above, please contact the undersigned at your convenience.

Yours sincerely,

Sean Sinclair, Superintendent
Environment

CC: Kassandra DeFrancis, WLWB
Anneli Jokela, WLWB
Sarah Elsasser, WLWB

Attachments: DDMI Response to Reviewer Comments on the 2014 to 2016 Aquatic Effects Re-evaluation Report and Version 5.0 of the AEMP Design
Attachment-1: Figures 2-1 through 2-5
HYDROGRAPHY DATA OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.

PROJECTION: UTM ZONE 12   DATUM: NAD 83

DIFFUSERS
STATION LOCATION
NEAR-FIELD
MID-FIELD 1
MID-FIELD 2
PAR-FIELD 2; MID-FIELD 2
PAR-FIELD 1
PAR-FIELD
PAR-FIELD B

SURVEILLANCE NETWORK PROGRAM
 SAMPLING SITES FOR SLIMY SCULPIN
 NEAR-FIELD
NEAR-FIELD 1
NEAR-FIELD 2
FAR-FIELD 1
FAR-FIELD 2
FAR-FIELD

FLOW DIRECTION
DIAVIK FOOTPRINT (CURRENT TO 2016)
WATERBODY

LEGEND

Scale 1:175,000
Scale 1:25,000

DRAFT

REFERENCE

SUBMISSION DATA OBTAINED FROM DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED.
AEMP VERSION 3.0 (2011-2013)
SAMPLING STATIONS

FIGURE: 2-4

DIFFUSERS
STATION LOCATION
SAMPLE SITES FOR SLIMY
SCULPIN

FLOW DIRECTION
DIAMOND FOOTPRINT
CURRENT TO 2016
WATERBODY

REFERENCE
LEGEND

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PROJECTION: UTM 19N 15 (DATUM NAD 83)
Hi Anneli,

Please see DDMI responses below in blue text. Give me a call if you have any questions or need further clarification.

Regards,

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From: Anneli Jokela <ajokela@wlwb.ca>
Sent: Tuesday, February 19, 2019 11:39 AM
To: Sinclair, Sean (DDMI) <Sean.Sinclair@riotinto.com>
Subject: Follow-up Questions to DDMI Responses to WLWB Follow-up IR for the AEMP Re-evaluation and Design Plan.
Importance: High

Hello Sean,

We have two follow-up questions regarding DDMI’s February 14th response to the February 5th WLWB Follow-up IR for the 2014 to 2016 Aquatic Effects Re-evaluation and AEMP Design Plan Version 5.0.

1. In response to Question #1 (re: EMAB comment 28), DDMI stated the following: “The adjustments to zooplankton biomass did not affect the Action Level classification in these years, as the Action Levels were assessed against the 2015 and 2016 FF (far-field) data, respectively.” According to the AEMP Design, FF areas are not sampled in interim years (i.e., 2015). Also, the 2015 and 2016 AEMP Annual Reports indicate that Action Level comparisons were made to the normal ranges and the 2008-2010 reference area means. Thus, it is not clear whether the 2015 and 2016 biomass adjustments would have influenced the Action Level comparisons for these two years. Please confirm if the adjusted zooplankton biomass influences the Action Level comparisons for the 2015 and 2016 season (a table illustrating each of the updated comparisons would be helpful). If any of the Action Level evaluations change, a discussion of how this influences conclusions for the Re-evaluation Report should be included.

Action Level comparisons were made to the normal ranges, and 2008 to 2010 reference area mean in 2014, 2015 and 2016. In 2016 (the comprehensive year) comparisons were also made to the far-field area mean. The Action Level assessment involves statistically comparing plankton biomass and richness between the NF area (and potentially MF areas) and the FF areas (when data are available), and comparing NF area results to the
normal range (Table 1). Action Level 1 is triggered when significantly lower biomass or richness is observed in the NF area compared to the FF areas (Table 1). Action Level 2 is triggered when the effect observed in the NF area expands to the nearest MF stations (i.e., MF1-1, MF2-1, MF3-1), and Action Level 3 is triggered when NF area results fall below the normal range.

The adjustments to zooplankton biomass are shown in Table 2. Since the adjustments to zooplankton biomass resulted in increases in biomass in the exposure areas, they do not influence the Action Level evaluation. Zooplankton biomass is showing enrichment (i.e., increased biomass) and not toxicological impairment (i.e., decreased biomass), which is evaluated in the Action Level assessment for plankton.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Action Levels for Plankton Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Action Level</strong></td>
<td><strong>Magnitude of Effect</strong></td>
</tr>
<tr>
<td>1</td>
<td>Mean biomass or richness significantly less than reference area(a) means</td>
</tr>
<tr>
<td>2</td>
<td>Mean biomass or richness significantly less than reference area(a) means</td>
</tr>
<tr>
<td>3</td>
<td>Mean richness less than normal range(b)</td>
</tr>
<tr>
<td>4</td>
<td>TBD(c)</td>
</tr>
<tr>
<td>5</td>
<td>Decline in biomass or richness likely to cause a &gt;20% change in fish population(s)</td>
</tr>
</tbody>
</table>

(a) Action Levels were assessed by comparing NF and MF areas to the FF1, FFA and FFB areas, which formerly served as reference areas.

(b) Normal ranges were obtained from the AEMP Reference Conditions Report Version 1.1 (Golder 2015a).

c) To be determined if Action Level 3 is triggered.

d) Although the Significance Threshold is not an Action Level, it is shown as the highest Action Level to demonstrate escalation of effects towards the Significance Threshold.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Adjusted Zooplankton Biomass Values for 2014 and 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variable</strong></td>
<td><strong>Unit</strong></td>
</tr>
<tr>
<td>2014 unadjusted total zooplankton biomass</td>
<td>mg/m³</td>
</tr>
<tr>
<td>2014 adjusted total zooplankton biomass</td>
<td>mg/m³</td>
</tr>
<tr>
<td>2015 zooplankton biomass (no adjustment needed)</td>
<td>mg/m³</td>
</tr>
<tr>
<td>2016 unadjusted total zooplankton biomass</td>
<td>mg/m³</td>
</tr>
<tr>
<td>2016 adjusted total zooplankton biomass</td>
<td>mg/m³</td>
</tr>
</tbody>
</table>

n/a = not applicable.
2. In response to Question #6 (re; EMAB comment 69), DDMI provided the following revised text:

“Cyanobacteria biomass increased significantly in the NF, FFA and FFB areas, and at the MF1-3, FF2-2 and MF3-4 stations between 2002 and 2012 (Figure 7-8 and Table 7-15), and between 2013 and 2016 in the NF area (Figure 7-3 and Table 7-14)...”. According to the original text, there appeared to be a “decrease” in cyanobacteria between 2013 and 2016; the discrepancy noted by EMAB related to the Re-evaluation Report stating the decrease was “not-significant” when Table 7-14 identified a significant difference. Results from Figure 7-3 suggest that cyanobacteria decreased between 2013 and 2016. Can DDMI clarify why the revised text now indicates that cyanobacteria significantly "increased" between 2013 and 2016?

The text should be revised again to say “Cyanobacteria biomass increased significantly in the NF, FFA and FFB areas, and at the MF1-3, FF2-2 and MF3-4 stations between 2002 and 2012 (Figure 7-8 and Table 7-15), but decreased between 2013 and 2016 in the NF area (Figure 7-3 and Table 7-14).”

It would be greatly appreciated if these responses could be provided by end-of-day. We recommend that a quick phone call take place prior to finalizing the responses to ensure that the questions being asked are clear to DDMI and to avoid the need to follow-up again.

Masi,
Anneli

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