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Yellowknife, NT X1A 2P6

File: Water Licence MV2011L2-0004

February 12, 2013

RE: AEMP Re-evaluation Report and AEMP Design Plan

Dear Mr. Casas,

Snap Lake Environmental Monitoring Agency (SLEMA) is pleased to provide Mackenzie Valley Land and Water Board (MVLWB) with the following comments and recommendations on the **AEMP Re-evaluation Report and AEMP Design Plan**.

The AEMP Re-evaluation Report presents detailed information and analysis of aquatic effects monitoring in Snap Lake, and provides input for the next stage of AEMP. The AEMP Re-evaluation Report is satisfactory.

The AEMP Design Plan proposes some changes, including a conceptual site model, a new reference lake, reorganization of monitoring stations, adjustment of sampling schedule, incorporation of a Weight of Evidence assessment of AEMP findings, and AEMP Response Framework.

SLEMA is concerned about the downsized sampling program. The proposed number of water quality and benthic invertebrate sample locations within the main basin of Snap Lake decreases by 53% for water quality and 36% for benthic invertebrate.

At this point in time the proposed reductions in sampling within the Snap Lake main basin have been insufficiently rationalized. Therefore the current AEMP design should be maintained until additional rationalization has been provided.

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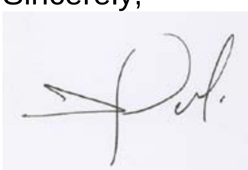
DeBeers should also discuss how the current AEMP addresses the spatial criteria in the MVEIRB (2003) impact definitions for water quality and benthic macroinvertebrates.

SLEMA engaged Barry Zajdlik of Zajdlik and Associates Inc. to review the AEMP Design Plan. Please find his comments attached.

If you have any questions whatsoever please feel free to contact the undersigned or David White at 867-765-0961 / dwhite@slema.ca.

Sincerely,



Johnny Weyallon
Chairperson

Attachment: **Review of Proposed Snap Lake AEMP Re-design**

Review of Proposed Snap Lake AEMP Re-design

Prepared by
Zajdlik & Associates Inc.
February, 2013

Prepared for
D. White
SLEMA

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Table 1: Acronym Definitions

Acronym	Definition
ANOVA	analysis of variance
EA	environmental assessment
FF	farfield
INAC	Indian and Northern Affairs Canada
MF	midfield
MVEIRB	Mackenzie Valley Environmental Impact Review Board
NF	nearfield
SNP	surveillance network program
TDS	total dissolved solids

1 Introduction

Zajdlik & Associates Inc. has been contracted to review the Snap Lake Aquatic Effects Monitoring Program (AEMP) Re-design of 2012. At the present time the review focuses on water quality within the main basin of Snap Lake. Some of the review findings may be applicable to other aspects of the AEMP. A brief chronology of relevant events provides context for the reports and data being reviewed.

1998-2001

- Baseline data collection

2002

- Additional water collection in Snap Lake

2003

- Additional water collection in Snap Lake

2004

- Begin construction
- June 2004 effluent discharge begins through temporary diffuser
- AEMP data collection begins May 2004 under an unapproved AEMP (DeBeers 2005a, pg. 12)
- Fisheries Authorization for the Snap Lake Project issued in August 2004

2005

- Phase II construction begins
- Snap Lake Working Group approves AEMP known as the July 2005 AEMP.

2006

- Permanent diffuser[1] operational May, 2006
- Water quality monitoring (but no sediment quality or benthic invertebrate community monitoring[2]) in reference lake (Northeast Lake) begins

2007

- Plume Characterization Special Study
- Sediment quality and benthic invertebrate community monitoring attempted in Northeast Lake but not completed for safety reasons.

2008

- Major construction activities (DeBeers, 2009).
- Picoplankton pilot study in Snap and Northeast Lakes.

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[1] Effluent comprised of treated minewater and domestic wastewater from sewage treatment system.
[2] Attempted but not possible due to safety and logistical challenges.

- Sediment quality and benthic invertebrate community monitoring begins in Northeast Lake.

2011

- Permanent diffuser replaced with new structure completed September 14, 2011.

1.1 Considerations

An effective AEMP is one that addresses the intended purposes. The Mackenzie Valley Environmental Impact Review Board (MVEIRB), (2003) states with respect to the AEMP that the purpose is:

- … "to verify the accuracy of EA predictions"; and,
- … "to identify unpredicted responses of the aquatic system to the project in a timely manner so that remedial or mitigative measures can be implemented to prevent a significant adverse environmental effect." (MVEIRB 2003, section 2.6.3.1).

The current Water Licence MV2011L2-0004 [Part G, Schedule 6, Item 1a,i states that the AEMP shall monitor "*for the purpose of measuring Project-related effects on the following components of the Receiving Environment: water quality"* (list follows).

One of the key EA predictions made by DeBeers is that impacts will range from "low" to "negligible" (MVEIRB, 2003). This review assess whether that prediction can be verified given the proposed modifications to the AEMP. In order to do so, the definitions of "impacts" are presented below. Impacts are:

- "Negligible if the water quality change would affect less than 5% of the aquatic community throughout Snap Lake or would affect more than 20% of the aquatic community in less than 1% of Snap Lake";

- "Low if the water quality change would affect less than 10% of the aquatic community or would affect more than 10% of the aquatic community in less than 10% of Snap Lake";

- "Moderate if the water quality change would affect more than 10% of the aquatic community in more than 10% of Snap Lake"; and,

- "High if the water quality change would affect more than 20% of the aquatic community in more than 20% of Snap Lake."

Specific numerical values for water quality variables for effluent and within Snap Lake are presented in DeBeers, (2002). Criteria for determining the impact of mining on benthic macroinvertebrates are defined in DeBeers (2002, section 9.5.2.2.3 Impact Analysis). These are presented below.

- Negligible magnitude: maximum predicted concentrations less than chronic effect value (or LOEC if chronic effect value not available) in less than 1% of the lake; seasonal changes in water quality only;

- Low magnitude: maximum predicted concentrations that exceed the chronic effect value (or LOEC) in less than 10% of the lake; seasonal changes in water quality only;

- Moderate magnitude: maximum predicted concentrations that exceed one chronic effect value (or LOEC) in less than 20% of the lake; seasonal changes in water quality; and,

- High magnitude: maximum predicted concentrations that exceed the chronic effect value (or LOEC) in 20% or more than 20% of the lake; year round effects on water quality.

DeBeers conclusion after assessing predictions of effluent discharge and other losses to the receiving environment and using the criteria above are that:

"*The magnitude of the impacts to the water quality and the organisms ranges from negligible to low. The geographic extent of all impacts is local, as it is limited to Snap Lake and all impacts are reversible…. The overall environmental consequence of the project was assessed as low for water quality and each of the communities and organisms at Snap Lake.*"

It is important to note that with respect to benthic organisms at least, the conclusions were predicated upon an effluent that was confined to deep water, non-productive portions of Snap Lake for a seasonal versus year-round exposure. It is clear that exposure in Snap Lake occurs over the depth of the water column and not "deep basin areas *that* are unlikely to represent critical fish feeding habitat" as the water is reasonably well mixed and does not appear to stratify. It is also clear that exposure to TDS (total dissolved solids) at least, is continuous over the course of a year, with higher concentrations observed in winter (Figure 1**Error! Reference source not found.**).

2 Methods

Statistical analyses were conducted using R (R Development Core Team, 2012). Investigations of specific aspects of the AEMP design are presented as "Results" along with results of statistical analyses.

2.1 Available Data

This section tabulates the data collected that are the focus of this review. These include water and sediment quality and benthic macroinvertebrates. Other data, even data of the same type may also have been collected.

Table 2: Tabulation of Sampling Locations[3]

	Water Quality 2008 AEMP[4]	Water Quality – Proposed 2013	Benthos Quality 2008 AEMP[5]	Benthos Quality – Proposed 2013	Sediment Quality 2008 AEMP[6]	Sediment Quality – Proposed 2013
Mixing Zone	3	3			1	
NF	7	3	5	4	7	4
MF	5	2	5	2	5	2
FF	4	1	1	1	2	1
Northwest Arm	5	4	3	3	3	3
wetlands (contingency receiving environment for treated sewage)	1					
outflow of Snap Lake, upstream of King Lake	1	1				
inflow to Snap Lake	1	2				
Northeast Lake	5	6	5	5	5	
Inland Lake		3				
Total	32	25				

The table above shows that:

- The proposed number of water quality sample locations within the main basin of Snap Lake decreases by 53% (1-9/19).
- Overall, and excluding the additional lake, the proposed number of AEMP water quality sample locations decreases by 31% (1-22/32).
- The proposed number of benthic invertebrate sample locations within the main basin of Snap Lake decreases by 36% (1-7/11).
- Overall, and excluding the additional lake, the proposed number of AEMP benthic invertebrate sample locations decreases by 21% (1-15/19).

[3] A cell that is empty should not be construed as representing zero as it is not necessary to populate all cells for the purpose of this review.
[4] Main basin and northwest arm sampling stations presented in Figure 2-1 of Golder (2009).
[5] Figure 5-1 of Golder (2009)
[6] Figure 5-1 of Golder (2009)

Table 3: Tabulation of Sampling Frequencies[7]

<table>
<tr><th></th><th>Water Quality 2008 AEMP</th><th>Water Quality – Proposed 2013</th><th>Benthos Quality 2008 AEMP</th><th>Benthos Quality – Proposed 2013</th><th>Sediment Quality 2008 AEMP</th><th>Sediment Quality – Proposed 2013</th></tr>
<tr><td>Mixing Zone</td><td>monthly</td><td>monthly</td><td rowspan="5">1 ice cover</td><td rowspan="5">1 open water</td><td rowspan="5">1 ice cover</td><td>1 ice cover</td></tr>
<tr><td>NF</td><td rowspan="4">quarterly</td><td rowspan="4">1 ice cover,
3 open water</td><td rowspan="4">1 open water</td></tr>
<tr><td>MF</td></tr>
<tr><td>FF</td></tr>
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<tr><td>Northeast Lake</td><td>quarterly</td><td></td><td>1 ice cover</td><td></td><td>1 ice cover</td><td>1 open water (and since 2009)</td></tr>
<tr><td>Inland Lake</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Total</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

An important proposed change is that sampling for sediment at AEMP (not surveillance network program (SNP)) station and benthic invertebrates is to sample every three years instead of every year. At this point in time the rationalization for the switch from one to three years was not examined.

As the proposed frequency of sampling water quality within Snap Lake decreases under ice cover the ability to detect maxima during the ice cover period is decreased (it was already poor with only two samples collected during this time period). The effect of collecting only a single

[7] A cell that is empty should not be construed as representing zero as it is not necessary to populate all cells for the purpose of this review.

sample during winter may be mitigated by the observation that water quality is worse later in the winter and also because maximum under ice concentrations proposed during the EA pertain to SNP stations, not AEMP stations. However the criterion for whole lake averages applies to the main Snap Lake basin. A reduced frequency of sampling during the winter when TDS concentrations are higher (See Figure 1) may reduce the ability to detect whole lake averages that exceed the 350 mg/L criterion.

3 Results

3.1 Homogeneity of Water Quality in Main Basin of Snap Lake

In this section the homogeneity of water quality in the main basin of Snap Lake is examined as this comprises a fundamental reason for reducing sampling within Snap Lake.

Examination of field conductivity profiles (Figure 2-22, Golder 2012a) for April 2011 show a clear gradient in conductivity with generally highest conductivities observed at SNP stations followed by NF stations a mixture of MF and FF stations and finally by stations in the Northwest Arm. The vertical variation is considerably less. As a whole the data suggest a gradient in concentration with distance from the diffuser that does not support the assertion that the lake is sufficiently mixed to ignore this spatial aspect. The homogeneity of TDS among areas of the lake designated as SNP, nearfied, midfield and farfield are visually assessed below.

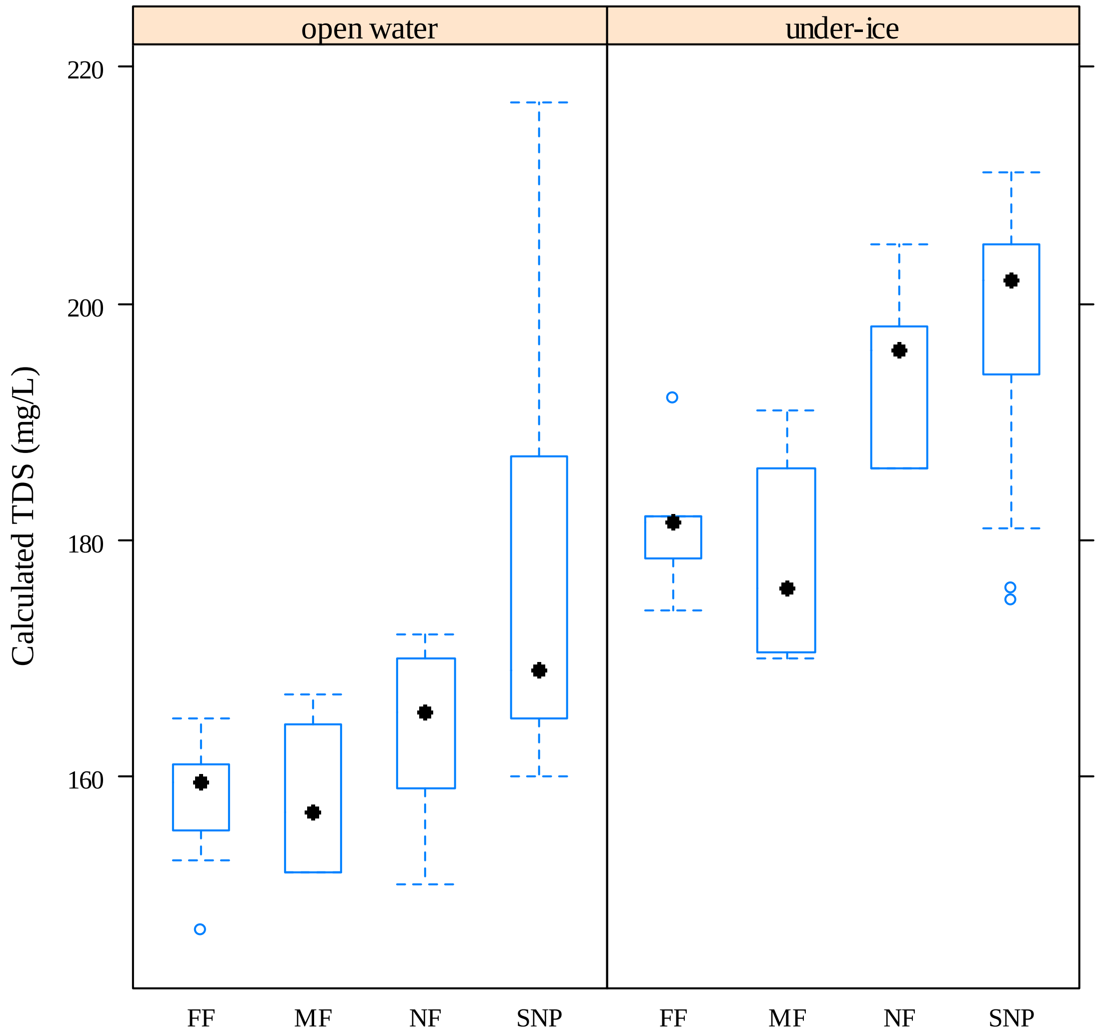

Figure 1: Box and Whisker Plots[8] Showing Calculated TDS by Area and Season

There are visually apparent differences in the median TDS concentrations within the main basin of Snap Lake in 2011. The null hypothesis that the median TDS concentrations are equal across areas is tested below. As data are markedly non-normal the distribution free, Kruskal-Wallis test is used.

[8] Box and Whisker plots present the 25th and 75th percentiles of a data set as the lower and upper boundaries of the box; respectively. The mean is indicated as a black dot. Whiskers extend to the nearest observation that is less than the median ± 1.5 (75th percentile – 25th percentile). Any observations beyond this are identified as circles.

Table 4: Summary of Kruskal - Wallis Tests

Season	Degrees of freedom	Test Statistic	P-value
Under Ice	3	19.598	0.0002056
Open Water	3	22.7943	4.457e-05

The table above shows that the null hypothesis of homogeneity of calculated TDS concentration across areas is rejected for both the open water and under ice seasons. The results demonstrate that Snap Lake is not well mixed with respect to calculated TDS.

3.2 Water Quality Objectives

In this section water quality objectives and the point at which they should be met are examined as AEMP sampling locations must be selected with this in mind.

DeBeers (2002) predicted that only Cd, Cu, Cr (III, VI) would exceed proposed water quality benchmarks outside the mixing zone[9]. The extent of Snap Lake so affected was expected to be < 1% (by surface area). DeBeers committed to ensuring that conditions in Snap Lake met the EA predictions (MVEIRB, 2003 pg 69).

The WQOs agreed to should be applied at the edge of the mixing zone. This is consistent with MVLWB (2011). The only exceptions to the application of WQOs to the edge of the mixing zone should be for TDS, calcium and chloride as discussed in the Surveillance Network Program.

3.3 TDS

In this section various aspects of TDS are investigated as TDS is the primary contaminant of concern.

3.3.1 Data Quality

Calculated TDS rather than measured TDS is used to confirm EA predictions and assess impacts for reasons discussed in Golder (2008). However, 53% of the measured TDS samples collected in the main basin of Snap Lake are labeled “warning, hold time was substantially exceeded and may have an effect on results” and 9% of are labeled “data invalidated because holding time was exceeded” (Appendix A3, Table A3-1 footnotes, Golder, 2012a). The implications of hold times being exceeded on measured TDS for calculated TDS if any are not clear. DeBeers should discuss whether there are any implications.

[9] Mixing zone defined as “the mixing zone around the diffuser (3 stations, called SNP 02-20d, e and f, located in a radius of 120 degrees at 200 metres from the diffuser” – current water licence.

3.3.2 Sampling Plan

TDS is sampled following DeBeers (2005) who state:

"The TDS, Calcium and Chloride Sampling Plan include field conductivity measurements at 1 m intervals at each sampling station. If there is no conductivity gradient, then a middepth water sample is analyzed for TDS. If there is a conductivity gradient, then samples are collected from near the surface, near the bottom and at the depth of maximum conductivity. If the maximum conductivity occurs near the bottom or top, then the third sample is collected from mid-depth."

The following figure shows the relationship between specific conductivity and calculated[10] TDS for sampling locations in the main basin of Snap Lake. Samples are collected during 2011 and are presented in Appendix A2 (Golder, 2012a).

[10] TDS is calculated for the reasons presented in DeBeers (2005). The calculation methods is presented therein but may have been updated since 2005.

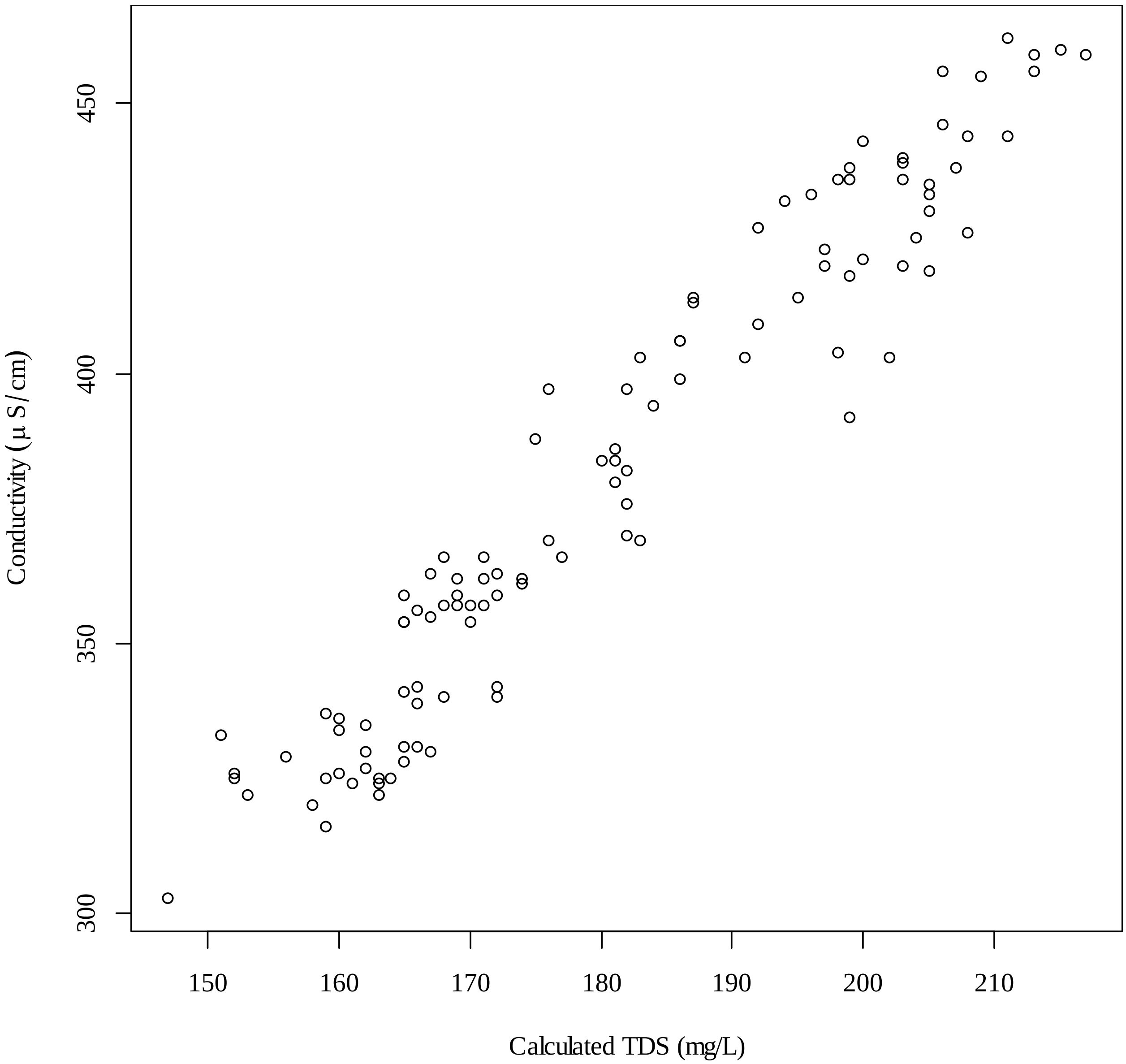

Figure 2: Conductivity versus Calculated TDS

The figure above shows a strong correlation between conductivity and calculated TDS for sampling locations in the main basin of Snap Lake collected during 2011. A simple linear regression confirms the visually strong correlation. Regression diagnostics indicate that the requisite assumptions are met. Thus the relationship between conductivity and calculated TDS appears to be sufficient for the intended purposes.

The data collected are used in *ad hoc* manner with two variants for estimating the whole lake average concentration for TDS, Ca and Cl in Snap Lake (DeBeers, 2005, section 2.4.1). In the following, TDS is referred to specifically but the comments apply to all three analytes. Both strategies use a regression analysis with depth to estimate a single location-specific TDS concentration.

Then another regression between the depth-averaged concentration and the minimum flow distance from the discharge will be calculated and tested for TDS, Ca, and Cl. If that regression is statistically significant "the relationship between concentration and distance from the diffuser outfall will be considered when calculating the whole lake average concentration". Predicted concentrations at midpoints in a yet to be determined grid will be used to estimate a whole lake average.

The proposed procedure reduces variability at several steps. These are:

- Using conductivity – TDS relationships;
- Using depth –averaged concentrations; and,
- Using flow distance – TDS regressions.

The net effect is to artificially reduce variability in the whole lake average thus obscuring high TDS concentrations that would be measured if the *ad hoc* procedure were not employed. This can have the effect of inducing a false positive or negative result as described in Zajdlik (2011).

To illustrate the importance of understanding the average AND the variability around it, the empirical cumulative density function for the 2011, Snap Lake main basin AEMP data were examined to estimate how high TDS concentrations might become if a whole lake average of 350 mg/L occurs. In the graphic below <u>the median of the distribution of the calculated 2011 TDS concentrations is shifted to 350 mg/L</u>.

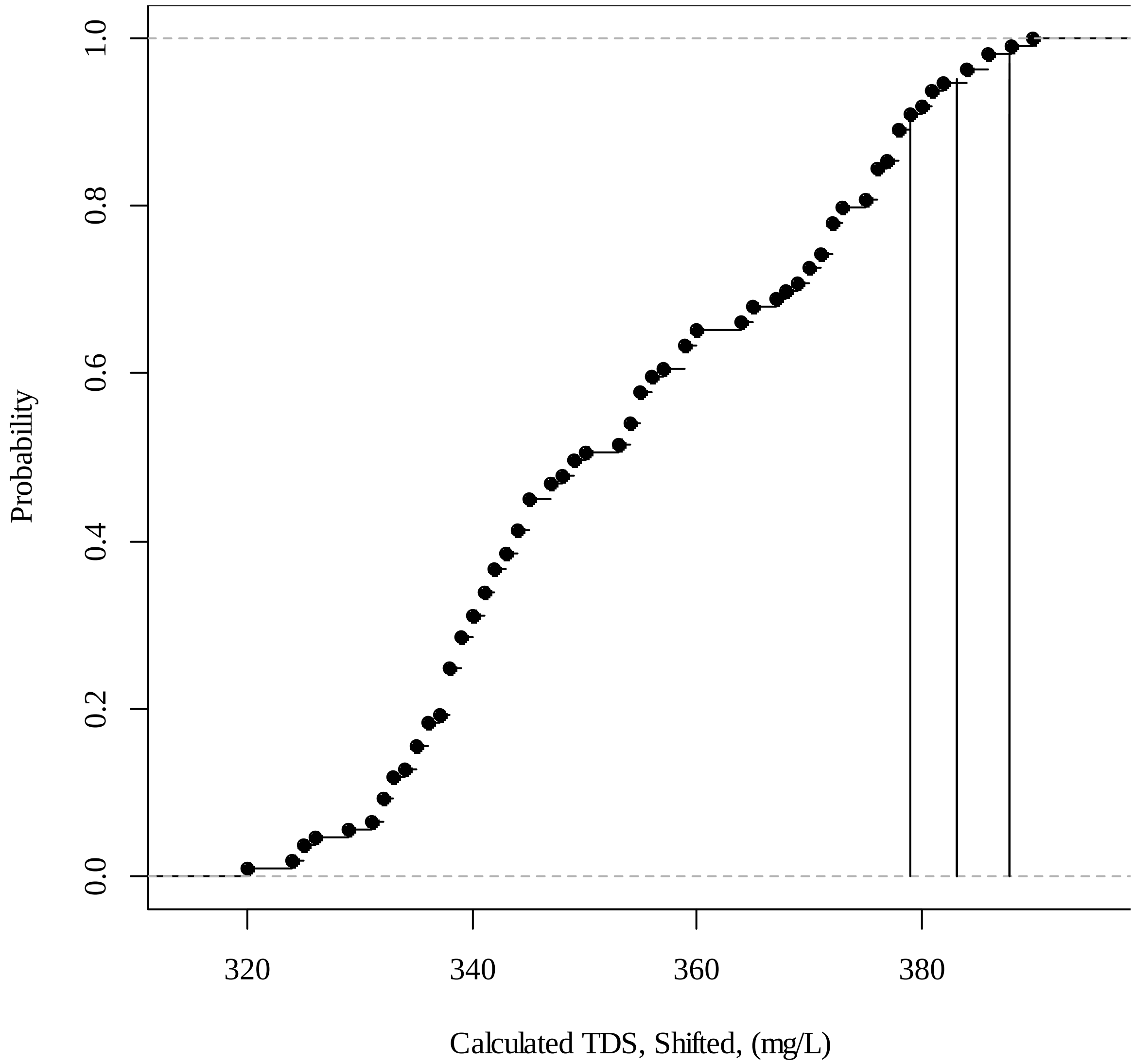

Figure 3: Projected Calculated TDS Percentiles when Median = 350 mg/L

The 90th, 95th and 99th percentiles are presented below as drop lines from the shifted empirical cumulative distribution. These percentiles correspond to 379, 383 and 388 mg/L. Note that these percentiles likely underpredict the extreme percentiles that will be observed as the variance of calculated TDS concentrations is almost certain to increase as the mean/median increases. Similar calculations for chloride and calcium were not conducted at this time.

3.3.3 Recommendation

The whole lake averaging procedure presented by DeBeers should be reviewed in the near future as TDS concentrations are continuing to increase. As the whole lake TDS average is part of the

Fisheries Authorization and current water licence a defensible estimate is necessary. This is discussed in section 5.2 along with a recommendation in Zajdlik (2011) that is also relevant.

4 Conclusions

4.1 AEMP Key Questions

One objective of the AEMP is to confirm EA predictions ((MVEIRB 2003, section 2.6.3.1). One of these predictions is that "the magnitude of the impacts to the water quality and the organisms range from negligible to low. An impact is defined as negligible "if the water quality change would affect less than 5% of the aquatic community throughout Snap Lake or would affect more than 20% of the aquatic community in less than 1% of Snap Lake" (MVEIRB, 2003). Spatial extent is a portion of the criterion for assessing negligible (and other) impacts.

Key question 1 on water quality posed by Golder (2012b) is "Are concentrations or loads of key water quality parameters in discharges to Snap Lake consistent with EAR predictions and below Water Licence limits?

Effluent concentrations and total P loads are compared to water licence limits to address the second aspect of key question 1. As EAR predictions are lower than License Limits concentrations are also compared to EAR predictions. Golder (2012b) used flow-weighted concentrations for this comparison stating that such concentrations are "more reflective of average conditions, rather than instantaneous concentrations".

However this is only correct if the formula and data collection to produce unbiased estimates. In order for equation 2 (Golder 2012b) to produce the correct average: 1) The sample collection timing must be such that no bias is imparted. Systematic sampling (collecting at the same frequency over time), random sampling or purposive sampling with appropriate weighting may all be used to address this issue of bias. 2) The number of samples collected from the permanent and temporary WTP discharges must be the same OR be weighted by the number of samples from each location.

Key question 2 on water quality differentiates between discharge to Snap Lake and concentrations within Snap Lake. Key Question # 2 posed by Golder (2012b) is "Are concentrations of key water quality parameters in Snap Lake below AEMP benchmarks and Water Licence limits?"

Key question 3 on water quality assesses temporal trends in water quality parameters and compares water quality parameters to EA predictions. The EA predictions (DeBeers, 2002, Table 9.4-19) pertain to maximum ice-covered concentration after initial mixing made at the edge of the mixing zone and maximum ice-free concentration within 1% of Snap Lake. It is not clear what stations (SNP or AEMP) correspond to a zone around the diffuser that comprises 1% of Snap Lake. As EA predictions pertain to specific portions of Snap Lake (maximum ice-covered concentration after initial mixing and maximum ice-free concentration within 1% of

Snap Lake) the spatial resolution of sampling should be such to ensure that Key Question 3 can answer the question “Are concentrations of key water quality parameters in Snap Lake below EA predictions?”

Key question 1on benthos posed by Golder (2012b) is “Is the benthic invertebrate community affected by changes in water and sediment quality in Snap Lake?” The EA impact analysis by (DeBeers, 2002) uses both expected chemical concentrations compared to toxicity-based effects concentrations and spatial extent of areas so affected to assess impacts. As the AEMP is intended to assess EA predictions (as well as other purposes) on benthos, the area over which changes occur must be assessed. Given that the proposed number of benthic invertebrate sample locations within the main basin of Snap Lake will decrease by 36% (See Table 2) the ability of the AEMP to confirm EA predictions may be compromised.

4.2 AEMP Design

The reduction in sampling effort within the main body of Snap Lake may be reasonable if the only goal of the AEMP is to make comparisons between the Snap Lake main basin and other reference lakes. It is premature to state what reduction is reasonable for this purpose, until such time as the variability within and among the reference lakes is understood.

The proposed reduction in sampling effort is discussed in section 5.1.3, Design Rationale, (Golder, 2012 b) stating: “Fewer stations will be sampled in Snap Lake between 2012 and 2014 compared to 2004 because the main basin of Snap Lake is well mixed, and the spatial resolution required in 2004 (12 stations) is no longer necessary.” Golder (2012b) thus suggests more than a 50% reduction in sampling effort.

With respect to the statement that the main basin of Snap Lake is well mixed, the analyses conducted in section 3.1 present overwhelming evidence of differences in calculated TDS concentrations among pre-defined areas of the main basin. With respect to the statement that spatial resolution required in 2004 (12 stations) is no longer necessary it is important to consider how AEMP data will be used. If AEMP data are used only to make comparisons between the Snap Lake main basin and other reference lakes the reduction in sampling effort might be reasonable but as noted above there is demonstrable structure in the within basin TDS data. However AEMP data should also be used to assess effects consistent with the percentage of areas used to define the spatial portion of “low”, “moderate” and “high” changes as defined by MVEIRB (2003). It is not clear that a 50% reduction of sampling effort within the main basin of the lake will provide sufficient data to corroborate/refute changes in the aquatic community in 1, 10 and 20% of the lake.

The current Water Licence (MV2011 L2-0004) Schedule 6, Part G: Conditions Applying to Aquatic Effects Monitoring, part 2b, ii refers to statistical design criteria. Statistical design criteria include type I and II errors for statistical decision making. These are discussed in Indian and Northern Affairs Canada (INAC), (2009) and Environment Canada (2012). Both documents state that Type I and II errors should be equal so as to afford both the environment and proponent the same risks. A maximum error rate of 20% is recommended and INAC (2009) notes that 10%

error rates are being used in the Canadian North. Finally, Mapstone (1995) suggests that the choice of effect size should be a primary driver of a monitoring program design. The effect sizes of interest are those presented in MVEIRB (2003) rather than generic environmental effects monitoring criteria.

4.1 Overall

An explicit objective of the AEMP is to validate EA predictions. Validation of predictions for water quality and benthos requires spatial sampling within the main body of Snap Lake to address the impact criteria which have spatial indices (as well as magnitude of effect criteria).

The redesigned AEMP changes focus from within lake comparisons to among lake comparisons and proposes a marked reduction in sampling within Snap Lake (for water and benthos at least). The proposed reduction in sampling effort precludes validation of EA predictions with spatial indices because there will be insufficient samples within the prescribed proportions of Snap Lake (1, 10 and 20%) to differentiate between impacts ranging from negligible to high. Additionally, the proposed reduction in sampling within the main basin of Snap Lake is rationalized by stating "the main basin of Snap Lake is well mixed" which for TDS at least is demonstrably incorrect.

DeBeers should ensure that the AEMP can validate EA predictions based on impact criteria that have spatial attributes. This will enable management triggers to be set within the delimited areas so that DeBeers conclusions regarding stated impacts restated below are not exceeded.

> "*The magnitude of the impacts to the water quality and the organisms ranges from negligible to low. The geographic extent of all impacts is local, as it is limited to Snap Lake and all impacts are reversible…. The overall environmental consequence of the project was assessed as low for water quality and each of the communities and organisms at Snap Lake.*" (MVEIRB, 2003).

At this point in time the proposed reductions in sampling within the Snap Lake main basin have been insufficiently rationalized. Therefore the current AEMP design should be maintained until additional rationalization has been provided. DeBeers should also discuss how the current AEMP addresses the spatial criteria in the MVEIRB (2003) impact definitions for water quality and benthic macroinvertebrates. The recommendations below may be used to augment the reasons for reducing sampling effort within the main basin of Snap Lake. .

5 Recommendations

5.1 Augmenting Reasons for Reducing Sampling Program

- DeBeers should demonstrate that the ability of the proposed reduction in sampling of water quality and benthos within Snap Lake (53% and 36% reductions, respectively as presented in Table 2) will not compromise the ability of the AEMP to confirm the EA predictions regarding benthos as the MVEIRB (2003) impact criteria have spatial attributes.

- The question "Please provide a worked example of the calculations described in Section 2.0, Appendix B, Pg 3/26" posed prior to the AEMP technical meeting held on January 24th was not answered. This question should be answered to better understand DeBeer's reasoning for reducing water quality sampling and prior to modifying terms of the water licence (Annex A, section D) that requires 15 TDS sampling locations.

- The reduction in water quality sampling frequency during the winter reduces the likelihood of detecting a whole lake average TDS concentration that exceeds the 350 mg/L criterion. DeBeers should demonstrate how the reduced sampling program will affect the ability to detect the maximum whole lake TDS average over the winter prior to reducing the sampling frequency for water quality.

- Reductions in sampling programs should ensure that statistical design criteria are applied at the scale of interest (zones corresponding to impact criteria stated in the EA rather than between exposure and reference lakes) for differences of interest (magnitude of effects agreed to in the EA rather than generic environmental effects monitoring program effect sizes).

5.2 Additional Recommendations

The following additional recommendations are provided in no particular order:

- Apply SSWQOs at the edge of the mixing zone. Particularly, apply the SSWQO for TDS (i.e. 444 mg/L) at the edge of the mixing zone following (DeBeers, 2002, Table 9.4-19 and Figure 9.4-13).

- EQCs should be estimated on the basis of SSWQOs being met at the edge of the mixing zone not at the outlet of Snap Lake. This is consistent with CCME (2003) guidance on mixing zones factors 1: "*The dimensions of an IDZ should be restricted to avoid adverse effects on the designated uses of the receiving water system (i.e., the IDZ should be as small as possible).*"

- If the effluent plume is expected to substantively extend beyond Snap Lake, sufficient baseline data must be collected to answer questions regarding degree of change. The definitions of impact presented in MVEIRB (2003) pertaining to magnitude of effect should be used as guidance for designing these baseline studies. Design criteria presented in INAC (2009) should also be considered.

- Section 4.8.3 of DeBeers (2102b) suggests increasing the frequency of fish tissue sampling from every 5 years to every 3 years. This suggestion should be adopted if fish populations will not be adversely affected.

- Calculated TDS rather than measured TDS is used to confirm EA predictions and assess impacts for reasons discussed in Golder (2008). However, 53% of the measured TDS samples collected in the main basin of Snap Lake are labeled “warning, hold time was substantially exceeded and may have an effect on results” and 9% of are labeled “data invalidated because holding time was exceeded” (Appendix A3, Table A3-1 footnotes, Golder, 2012a). The implications of hold times being exceeded on measured TDS for calculated TDS if any, are not and should be discussed.

- The whole lake averaging procedure presented by DeBeers should be reviewed in the near future as TDS concentrations are continuing to increase. As the whole lake TDS average is part of the Fisheries Authorization and current water licence a defensible estimate is necessary. It is important to note that estimating the average of three dimensional objects is routinely conducted by geostatisticians. DeBeers should consult a geostatistician to replace the *ad hoc* method described in DeBeers (2005) with a theoretically defensible method of estimating whole lake averages.

- The following recommendation was provided in Zajdlik (2011). “Repeat power calculations as TDS means approach the FA TDS limit. It is imprudent to specify at what point the analyses should be repeated as it is not clear how the mean-variance relationship (which will drive the achieved power estimates) will change as TDS concentrations increase. In the unlikely event that the current variance reflects means in the vicinity of the FA TDS limit. the AEMP sample sizes or interpretation paradigm should be revisited when mean TDS concentrations approach approximately 320-340 mg/L. However it is likely that TDS measurements will become more variable and hence the AEMP will need be modified at lower mean TDS concentrations to maintain acceptable Type I and II error rates. Guidance on choosing these rates is provided in INAC (2009)”.

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