Snap Lake Environmental Monitoring Agency
Main Floor, Lahm Ridge Tower
4501 Franklin Avenue
P.O. Box 95, Yellowknife, NT X1A 2N1
Phone: 867-765-0961 FAX: 867-765-0963
Website: www.slema.ca

Dee McCallum
SHE Manager
De Beers Canada Inc.
Suite 300-5102 50th Ave.
Yellowknife, NT
X1A 3S8

October 22, 2010

Re: Predictions of Total Dissolved Solids, Calcium and Chloride Concentrations in Snap Lake

Dear Ms. McCallum,

In response to De Beers request dated September 9, 2010, Snap Lake Environmental Monitoring Agency (SLEMA) is pleased to provide the following information for the water quality modeling on the predictions of Total Dissolved Solids (TDS), Calcium and Chloride concentrations in Snap Lake.

1. SLEMA Model

In order to predict the lake water quality change in Snap Lake over the long-term, one model was initially developed for TDS. The conceptual model is shown in Figure 1.

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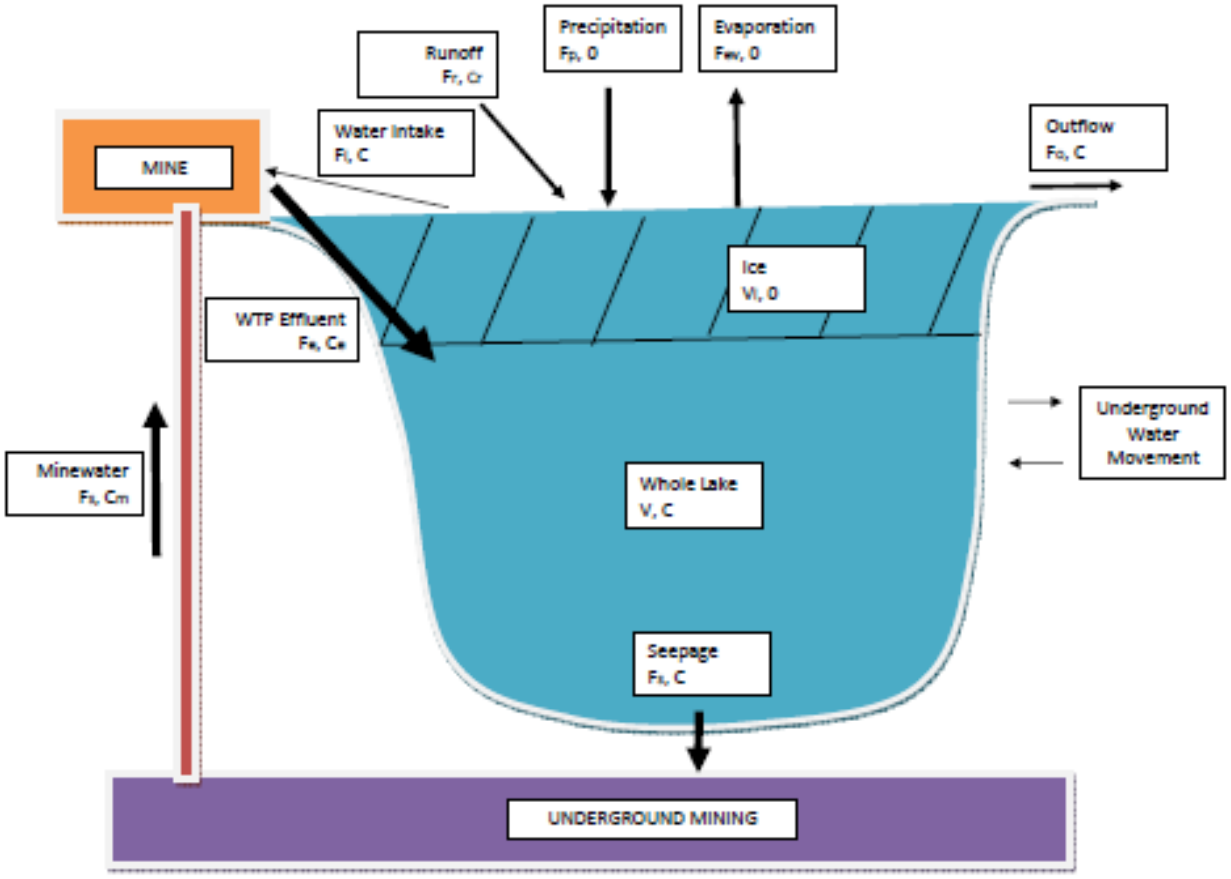

Figure 1. Conceptual Model for Snap Lake

The model is highly simplified. Based on Mass Balance and Water Balance, an equation is established.

$$C' = \frac{Fe \times Ce + Fr \times Cr + (V - Fo - Fi - Fs) \times C}{V - Vi}$$

Where,

- C' – simulated monthly whole-lake average TDS concentration, mg/L
- C – initial monthly whole-lake average TDS concentration, mg/L
- V – lake volume, m^3
- Vi – water volume of ice in the winter, m^3
- Fe – water treatment plant (WTP) effluent, m^3
- Ce – TDS concentration of WTP effluent, mg/L

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- Fr – watershed runoff, m^3
- Cr - TDS concentration of watershed runoff, mg/L
- Fo – lake outflow, m^3
- Fi – water intake, m^3
- Fs – seepage from the lake, m^3

The assumptions of the model include, but are not limited to

- Lake water level keeps constant (i.e. runoff from the lake catchment area is equal to outflow to downstream, precipitation and evaporation do not significantly change the water column of the lake);
- TDS is modeled conservatively (i.e., without any losses due to settling, chemical reaction, precipitation, etc.);
- Groundwater movement except minewater is not considered; and minewater is seeped from the lake;
- Water treatment plant does not change the TDS concentrations of the influent;
- The lake is fully mixed (the difference between the main water body and northwest arm is neglected).

There is seasonal change of the whole-lake average TDS concentrations, because lake ice in the winter reduces the water column, and then makes TDS concentrations increase in the winter.

Microsoft Office Excel 2007 was chosen as the calculation platform. Data sources include monthly reports of Surveillance Network Program (SNP), annual reports of Aquatic Effects Monitoring Program, Air Quality and Emissions Monitoring and Management Plan, and Hydrological Monitoring Program. Due to lack in data of ice thickness in Snap Lake, limited literature review was carried out to estimate the ice profile.

2. Correlations between TDS, Calcium and Chloride

Calcium and chloride are the most important components of TDS. Data analysis revealed strong correlations between Calcium concentrations and TDS concentrations and between Chloride concentrations and TDS concentrations, in both WTP effluent and Snap Lake (see Figure 2 and Table 1).

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Figure 2. TDS, Calcium and Chloride in WTP Effluent and Snap Lake

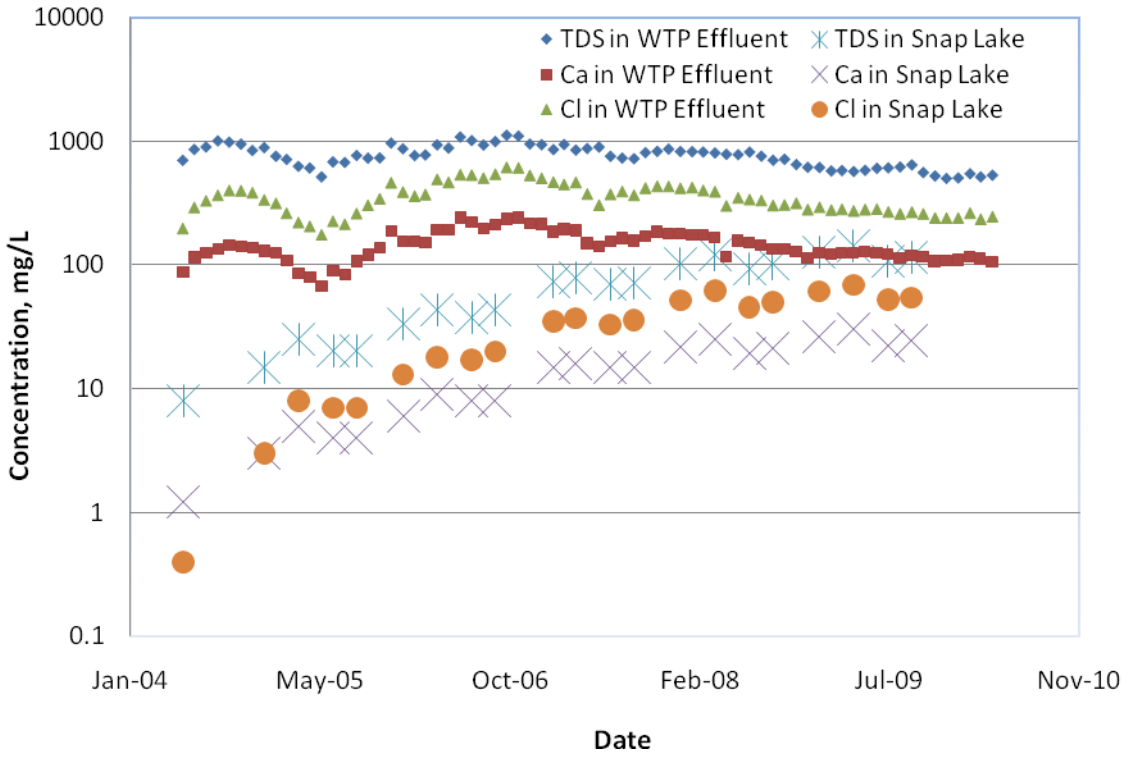

Table 1. Correlation between TDS, Calcium and Chloride

	Calcium vs. TDS		Chloride vs. TDS	
	Correlation	Co-efficient	Correlation	Co-efficient
WTP Effluent	[Ca]=0.202[TDS]	0.790	[Cl]=0.557[TDS]	0.861
Snap Lake	[Ca]=0.211[TDS]	0.999	[Cl]=0.523[TDS]	0.998

[Ca], [Cl] and [TDS] in Table 1 represent concentration of Calcium, Chloride and TDS, respectively. It is noticed that the equation of Calcium vs. TDS in WTP effluent is similar to the equation of Calcium vs. TDS in Snap Lake, and so for the equations of Chloride vs. TDS in WTP effluent and Snap Lake.

The above correlation equations demonstrate one of statements claimed in the Aquatic Effect Monitoring Program 2009 Annual Report - **the major ion composition in Snap Lake closely reflect the ionic composition of the treated effluent**.

Due to the strong correlations, it is believed that the SLEMA water quality model could be applied not only to TDS, but also to Calcium and Chloride.

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The assumptions of loadings for Calcium and Chloride follow Scenario #2 of TDS modeling (see details in SLEMA letter dated September 2, 2010).

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

Sincerely,

(original signed by)

Johnny Weyallon
Chairperson