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MVEIRB file: EA1314-02

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RE: EA1314-02 - De Beers Canada Inc. - Snap Lake Mine – Closing Comments

Environment Canada (EC) participated in the review of the proposed Total Dissolved Solids (TDS) amendments to the Snap Lake Mine Environmental Assessment (the Project) in order to provide specialist advice, information and knowledge to the Mackenzie Valley Environmental Impact Review Board (MVEIRB). The specialist advice provided during this review was pursuant to EC's mandated responsibilities arising from the *Canadian Environmental Protection Act, 1999*, the pollution prevention provisions of the *Fisheries Act*, the *Migratory Birds Convention Act* and the *Species at Risk Act*.

Following the public hearings held June 5-6, 2014, interveners in the review process were given the opportunity to submit, in writing, closing comments and to request additional clarifications arising out of the hearings.

EC's comments and recommendations are in no way to be interpreted as any type of acknowledgement, compliance, permission, approval, authorization, or release of liability related to any requirements to comply with federal or territorial statutes and regulations. Responsibility for achieving regulatory compliance and cost effective risk and liability reduction lies solely with the project proponent.

EC provided four recommendations in its Intervention of May 21, 2014, which related to: the Proposed Site-Specific Water Quality Objectives (SSWQO) and Effluent Quality Criteria EQC for TDS, the Pilot Testing Program, Seepages in the North Pile and Water Management Pond, and the Potential Stratification of Snap Lake.

During the public hearings EC was asked whether or not EC has a definition of Best Available Technologies Economically Achievable (BATEA). EC does not have a standard definition for BATEA. EC would like to highlight that BATEA is not just technology but could also include techniques. EC would also like to clarify that the BATEA report referenced by De Beers Canada Inc. (the Proponent) during the Public Hearings is not an EC report. It is a Mine Environment Neutral Drainage (MEND) report.

The final draft of this report is expected to become available on the MEND website this autumn.

EC would like to make further clarifications with regards to the Proponent's letter dated June 27, 2014, regarding the additional* toxicity test data supporting the Snap Lake proposed SSWQO of 684 mg/L.

* *Daphnia magna* 21 day tests #3, 4, 5 and *Cyclops vernalis* 20 day test #1

The Proponent has proposed a SSWQO of 684 mg/L based on the lowest IC20 (20% inhibition concentration) from a single *Daphnia magna* 21 day toxicity test from 2013 (i.e., Test #1); however another test (Test #5 conducted in 2014) resulted in a lower IC20 in EC's opinion. The consultant, Golder Associates (Golder), disagrees with that lower IC20 estimate.

EC response to Golder's Point 2:

Re: Choice of statistical model for the *Daphnia magna* reproduction data.

It is clear from the means provided in Figure 1 of the response that the data is not monotonic using the definition provided in EPS 1/RM/46. Supporting Golder's definition of the term with the use of standard deviations is not appropriate; by the same line of reasoning (variability around the estimates), one would dismiss even the highest concentration as showing no effect, and EC can agree that there is indeed an effect at 1460 measured TDS mg/L. Perhaps the argument here is about the degree of non-monotonicity, which EC agrees is slight.

In this case, it is only one concentration (measured 629 TDS mg/L) which contributes to the non-monotonic trend. One useful thought experiment in this situation would be: what would the conclusions be if data from this problematic concentration were removed? EC would, with this hypothetical data set, agree that the models recommended in EC guidance would then be appropriate. Dropping data from this one concentration represents loss of information of a partial effect; however, in this case, two other concentrations (or even four, accepting the response at the lower concentrations) showed a partial effect. In this case, the 3P models would not converge (likely because of an ill-fitting model), but the 2P linear model did converge (Figure 1, left hand panel) and has a reasonable visual fit. The calculated IC20 would be 557 mg/L TDS (measured). Note this is similar to the 2P linear model IC20 previously calculated at 563 mg/L using all the data. Also graphed below are the mean values at each concentration, as supplied in the DeBeers response letter; where yellow shading has been inserted to cover the mean value at 629 TDS mg/L (Figure 1, right-hand panel).

Figure 1: *Daphnia magna* reproduction, with data from 629 mg/L TDS removed; this establishes monotonicity in the data set. At left, the data is presented as a scatterplot; at right, the data is presented as group means.

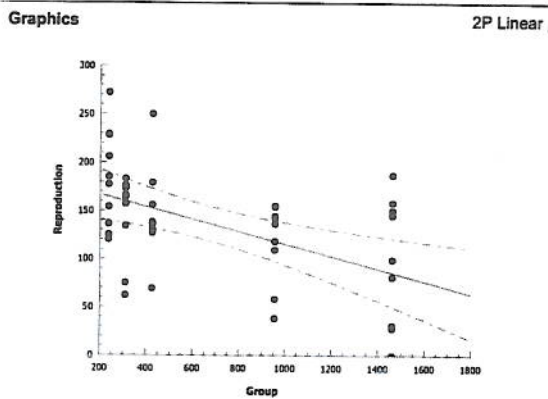
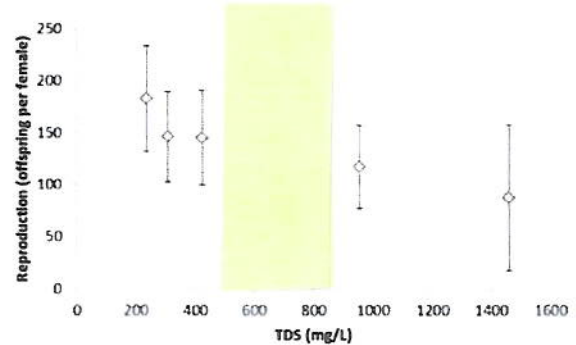


Figure 1 *Daphnia magna* Reproduction in Test 5 Showing Standard Deviation arc



The next question to be addressed is which model to use, 2P straight line or a 3P sigmoidal model. EC agrees with many of the comments made by Golder. Sigmoidal-shaped (S-shaped) responses are very common in ecotoxicity data and should the S-shaped curve fit the data, the upper asymptote is crucial. Also true, the $y=mx+c$ model is not the one that best describes the majority of ecotoxicity data; however, there are exceptions. Unusual in this case, the 3P log-Gompertz model did not present the usual S-shaped curve, as seen in the original report (reproduced below as Figure 2). For comparison, a more representative Gompertz curve with a separate data set is shown (Figure 3). In fact, it was the lack of S-shape to the curve that first “raised a flag”; the 3P Gompertz “curve” in the *Daphnia magna* experiment was almost indistinguishable from a straight line, a strong visual suggestion that a 2P linear model would be a better choice (Figure 4). There is no apparent upper asymptote, a defining feature of the Gompertz (or other common 3P) models (Figure 2). The straight-line trend in this data is readily apparent when conducting the thought experiment of removing the data at 629 mg/L (which caused the non-monotonicity).

Figure 2: Reproduction of the original model (3P log-gompertz) fitted to the data

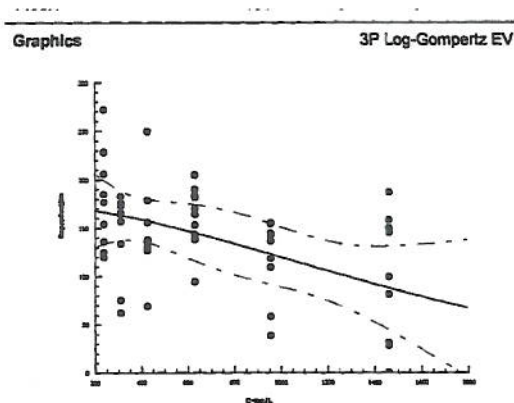


Figure 3: A data set (unrelated to this project) showing the typical S-shape of the Gompertz curve

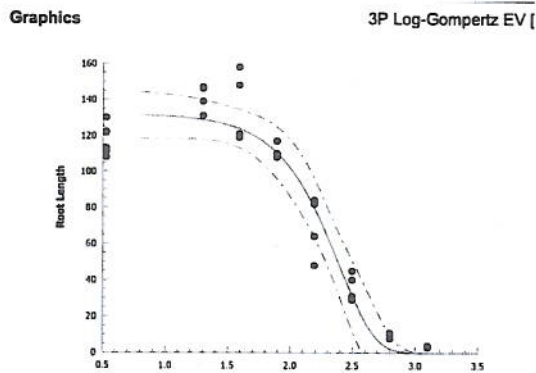
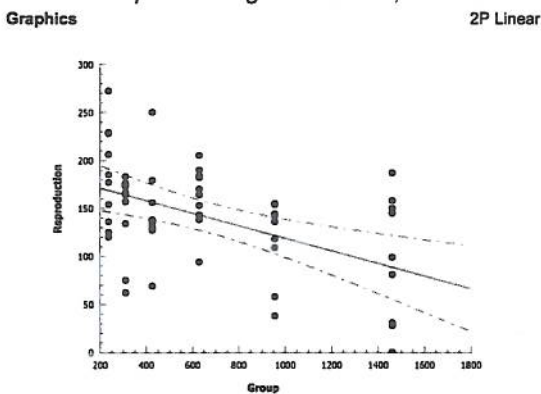


Figure 4: The *Daphnia magna* data set, identical to Figure 2, fit with a 2P linear model



In summary, with data sets that are unusual (e.g., non-monotonic), the usual tools (e.g., EC statistical guidance) cannot be expected to work well. Scientific judgement is needed, tempered by margin of safety required, other non-scientific factors and the need for consistency throughout the risk assessment process. EC continues to suggest that 310 mg/L *may be* one option and it is one that, in EC's opinion, offers a large margin of safety. Other estimates derived using regression approaches *may be* used, such as a 2P linear model, which capitalizes on the strength of the entire data set.

EC response to Golder's Point 3:

EC is pleased that there is agreement that the copepod survival data is suspect if the observation of cannibalism is real. However, EC disagrees with the *assumption* that the growth data is more sensitive than survival data for this experiment, given the lack of evidence to support this conclusion. Playing out this assumption, one would expect Golder to have tried calculating differences in growth using biomass instead of correcting for survival. The biomass endpoint is described using weight in EPS 1/RM/22 and could be extended to this test by substituting length (and would involve dividing the total length of the surviving copepods by the original number of organisms placed in the test vessel at the start of the test; 10 in this case). The biomass endpoint has the potential to show a greater sensitivity and it may in fact be a more appropriate endpoint for this test, given the presence of partial mortality. EC also questions why the laboratory did not consider whether the cannibalism confounded the growth endpoint. One could speculate that the growth of the predator organisms would increase. EC requires more information on the

cannibalism hypothesis to determine if the copepod data should be reconsidered given that in EC's opinion the mortality data displays a dose response to TDS.

EC response to Golder's Points 4, 6, and 7:

EC does accept data from non-standardized tests; despite, in Golder's words, tests are "conducted by applying best practices". EC argues that best practices, in this case, would mean demonstrating that the method is valid and fit for the intended purpose. The laboratory is a Canadian Association for Laboratory Accreditation (CALA) accredited facility. CALA sets out minimum criteria to address when validating in-house test methods. It is EC's opinion that these minimum criteria have not been met. Without method validation, it is difficult to have confidence in the generated data.

This concludes EC's closing arguments. EC would like to thank the MVEIRB for the opportunity to comment on the Proponent's Project application and hopes that the technical comments and recommendations provided throughout the process are useful in the decision-making process. Should you have any questions or wish clarification on any aspect of this letter, contact me at (867) 669-4724 or sarah-lacey.mcmillan@ec.gc.ca.

Sincerely,



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cc: Carey Ogilvie Head Environmental Assessment North (NT & NU), EPOD-PNR
EC Review Team