

DE BEERS

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June 27, 2014

File:L020

Simon Toogood
Environmental Assessment Officer
Mackenzie Valley Review Board
Box 938, #200 Scotia Centre 5102-50th Avenue
Yellowknife, NT, X1A 2N7

Dear Mr. Toogood

Re: De Beers Canada Inc.'s Response to Environment Canada's Review of New Evidence (EA1314-02)

De Beers Canada Inc. ("De Beers") provides the following response to Environment Canada's letter of June 25, 2014 regarding new evidence submitted by De Beers on June 10 in response to undertakings from the Public Hearings. Specifically, parties were asked to comment on laboratory reports of toxicity testing for three tests of *Daphnia magna* and one copepod, *Cyclops vernalis*, as well as interpretation of these results as it relates to an appropriate site-specific water quality objective (SSWQO) for Snap Lake. No other parties provided specific comments on the test results, although the Government of the Northwest Territories (GNWT) – Department of Lands noted that the derivation of appropriate site-specific water quality objectives should be led by the Mackenzie Valley Land and Water Board during the licence review process.

De Beers' detailed response is represented in the attached Technical Memorandum. Generally, De Beers disagrees with Environment Canada's review and maintains that the new evidence continues to fully support its proposal to rescind the current TDS limit of 350 mg/L for Snap Lake, and to replace it with a SSWQO of at least 684 mg/L, on the basis that there will be no significant impacts to the environment. De Beers agrees with the GNWT that the Mackenzie Valley Land and Water Board is the appropriate body to set numeric SSWQOs and associated Effluent Quality Criteria.

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De Beers will provide final comments in its submission July 8.

Sincerely,

DE BEERS CANADA INC.



Erica Bonhomme
Environment Manager
Snap Lake Mine

Attachment

cc. Sarah-Lacey McMillan
Lorraine Seale

EC
GNWT-Lands

DATE June 27, 2014**PROJECT No.** 14-1349-0003/1500/1503**TO** Erica Bonhomme, Snap Lake Environmental Manager
De Beers Canada Inc.**CC** James Elphick (Nautilus), Cathy McPherson (Golder); Alexandra Hood (De Beers)**FROM** Peter M. Chapman**EMAIL** pmchapman@golder.com**RE: EA1314-02 – DE BEERS CANADA INC. – SNAP LAKE MINE – RESPONSE TO NEW EVIDENCE**

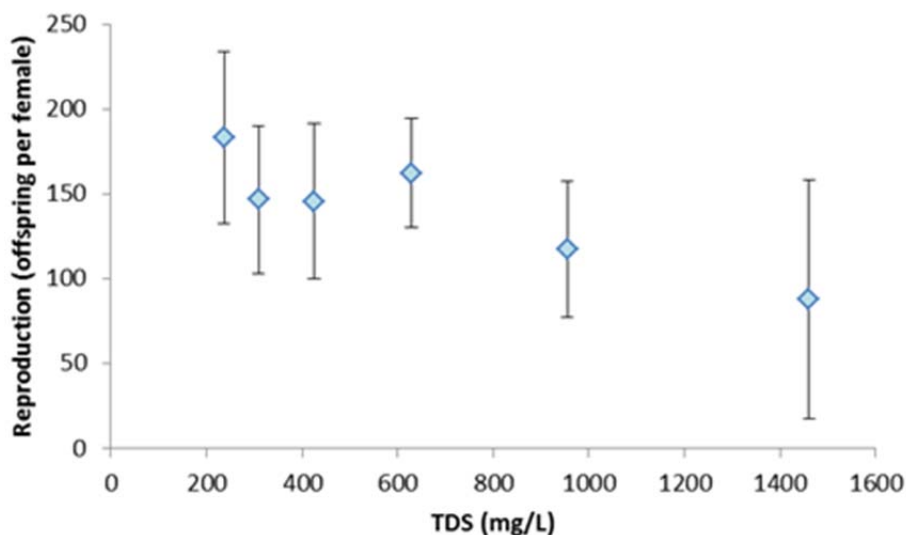
This Technical Memorandum provides the combined Golder Associates Ltd. (Golder) and Nautilus Environmental (Nautilus) technical response to Environment Canada's letter to Simon Toogood (MVEIRB) dated June 25, 2014. That letter constituted Environment Canada's Response to new evidence presented to the MVEIRB related to the Snap Lake Mine Water Licence Amendment process. Specifically, Environment Canada provided comments on additional TDS toxicity testing with the waterflea, *Daphnia magna*, and the copepod, *Cyclops vernalis*, exposed to synthetic lake water intended to simulate Snap Lake TDS conditions. We provide and respond below to specific issues raised by Environment Canada.

1. Environment Canada identified no concerns with 4 of the 5 *D. magna* tests (Tests 1 to 4)
 - **Response:** Golder and Nautilus agree that these tests were conducted properly and that the data are technically defensible.
2. Environment Canada focused their comments on Test 5, for which they agreed that Environment Canada (2005) statistical guidance for toxicity tests was followed; however, they recommended a different model (of those recommended in the Environment Canada (2005) guidance document) for analyzing the data. For the *D. magna* Test 5, Environment Canada stated the IC20 could be either 310 mg/L or 563 mg/L, the latter based on the model they recommend, and the former based on eyeballing the data.
 - **Response:** Golder and Nautilus disagree with Environment Canada's conclusions, which are not well founded. Environment Canada (2005) guidance on statistical methods for toxicity tests indicates that linear or non-linear regression is appropriate for analyzing continuous variables, such as reproduction, and that the model should incorporate logarithmic transformation of the data, which can be accomplished by using a log-based model, or log transforming the data prior to analysis. These models are used because they evaluate the entire data set, rather than restricting the analysis to data for specific concentrations, and incorporation of log transformation is a fundamental principle of toxicology.
 - By suggesting that 310 mg/L be used as the IC20 for Test 5, Environment Canada violates the Environment Canada (2005) guidance since the toxicity result assessment would be based on a single test concentration, not on the concentration-response. Moreover, this suggestion is unnecessary since



the data do not violate the assumption of monotonicity, despite Environment Canada's suggestion otherwise. Although the mean reproduction values are non-monotonic when observed in isolation, when considered in the context of the standard deviation around those means (Figure 1), there is no significant deviation from monotonicity. In other words, variability within the dataset may produce an appearance of non-monotonicity in mean values by chance alone, but context provided by the standard deviation around those mean values indicates that this appearance occurred by chance alone.

Figure 1 *Daphnia magna* Reproduction in Test 5 Showing Standard Deviation around the Means



- Environment Canada's use of a 2-P linear model, which produced an IC20 of 563 mg/L, also violates the recommendations of the Environment Canada (2005) guidance document because this approach does not incorporate log-transformation of the data. Furthermore, a concentration-response that is characterized by an equation of $y = mx+c$ is not typical of toxicological data, and is also inconsistent with the larger body of available information on effects of TDS on aquatic species.
 - There is no reason to anticipate that TDS would produce a non-monotonic concentration-response, and no reason to anticipate that the concentration-response curve would not have sigmoidal characteristics, notwithstanding the results of the AICc test for this particular data set.
 - In summary, neither Golder nor Nautilus consider the model proposed by Environment Canada to be appropriate or technically defensible. In general, 3-P models that are available in CETIS are more appropriate for analyzing aquatic toxicological data for quantitative variables, since these models incorporate an upper asymptote, which is a reasonable assumption for aquatic toxicity test data, particularly for essential nutrients such as those associated with TDS.
 - However, note that even using the technically incorrect suggestion by EC of an IC20 of 563 mg/L TDS for Test 5, the geomean of the 5 *Daphnia magna* tests remains >1,000 mg/L TDS.
3. In the case of the copepod test, Environment Canada identified a 20% decrease in survival at 1,008 mg/L and 1,508 mg/L but then noted these data are suspect due to possible cannibalism.

- **Response:** Golder and Nautilus agree with Environment Canada's assessment of the copepod mortality data including possible cannibalism that rendered the survival data suspect and unreliable. This is the reason that reliance was placed on the growth data (a chronic response that is typically more sensitive than the acute response of survival).
4. Environment Canada agreed that the copepod test was a new test and then pointed out that there was no test validation (such as would be typical of a more established test).
- **Response:** The copepod test method is not a standardized test. The method was developed specifically for the purpose of its application to the development of a benchmark for Snap Lake, and not as a standardized test methodology. Such was also the case for testing conducted with Lake Trout and Arctic Grayling. Such testing was developed to improve environmental realism and reduce uncertainty by testing organisms that are actually found in Snap Lake, not standardized laboratory test organisms that are not found in Snap Lake. The copepod species, *Cyclops vernalis*, was chosen because it is closely related to other species of *Cyclops* that occur in Snap Lake (i.e., *C. bicuspidatus thomasi* and *C. scutifer*) and because a culture of this species was available from a commercial supplier. Test temperature was chosen to fall within the range of conditions used by that supplier (room temperature). The test duration was selected based on the goal of initiating the test with recently hatched nauplii, and continuing until they had reached an adult stage, determined on the basis of reproduction occurring in the test. This resulted in a five-fold increase in the size of the female copepods through the test, which provided a substantial change in size that would be expected to produce measurable differences between test concentrations. We consider this to be a proactive, innovative, and acceptable means to investigate the specific problem.
 - Non-standardized tests such as those conducted for this project, including the copepod test, provide the most important and site-specific information for determining appropriately protective site-specific water quality objectives (SSWQOs). Such non-standardized tests, given their value, should be encouraged. Note in this regard that a significant portion of the data used in national water quality guideline development by the Canadian Council of Ministers of the Environment (CCME) is derived from studies conducted using non-standardized test methods for which there is no information from performance of cultures, reference toxicant tests, etc. Indeed, it is rare for published studies to report such information.
 - In an ideal world, standardized tests would be available for all potential species; however, in reality toxicity testing is, of necessity, often conducted by applying best practices. The quality of data produced is assessed on the basis of the available information, as was the case for the copepod test. We note that the method itself is currently being prepared for peer-reviewed publication as noted during the June 2014 Hearing.
5. Environment Canada questioned why length was measured rather than weight in the copepod test.
- **Response:** The copepods used in the test were very small; it would not have been possible to accurately measure dry weight, particularly since male and female copepods differ in size and would have had to have been separated prior to weighing, further reducing the biomass available for measurement in each replicate. Consequently, length was the most appropriate measure of growth. Length measurements allowed growth rates of male and female copepods to be assessed separately and produced a consistent and reliable indication of growth.
6. Environment Canada indicated that no information on acclimation conditions was provided for the copepod test.

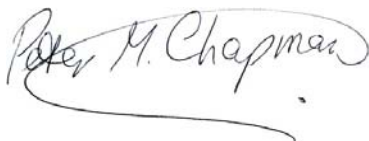
- **Response:** Environment Canada is incorrect. In fact, the Nautilus report provides details of the temperature ($22 \pm 1^\circ\text{C}$), photoperiod (16 h light : 8 h dark), duration (~ 7 weeks), feeding regime, and water type used during the acclimation period. Since the copepod test is not a standardized test method, reference toxicant data (positive controls) were not available. Also, since the copepods reproduce sexually and produce offspring that are practically microscopic, monitoring culture performance is considerably more complicated than, for instance, a *Daphnia magna* culture.
 - Note that the copepod test produced a very clear growth response in differing test concentrations with an exceptionally low degree of between-replicate variability, as well as highly consistent responses of male and female copepods to the test solutions.
 - Golder and Nautilus have a very high degree of confidence in the data from the copepod test.
7. Environment Canada stated that the information from the copepod test “does not add to the weight of evidence approach in determining a SSWQO for TDS at Snap Lake”.
- **Response:** Environment Canada’s conclusion is not supported. Copepods are a very important component of the zooplankton community in Snap Lake. The data from the copepod toxicity test are technically defensible and provide important information on the sensitivity of copepods to Snap Lake TDS.
8. Environment Canada noted what they believed was a minor error in the figure plot for the copepod test but did not indicate any substantive effects to the test results.
- **Response:** Golder and Nautilus agree that this apparent typographical error is a non-issue. The figure was provided to show the data. The control data point of 0 mg/L was 0 mg/L of the Snap Lake TDS blend, which should have been noted on the figure for clarity.

In summary, Golder and Nautilus appreciate the effort that Environment Canada has put into trying to understand the new evidence. We hope that our responses to their comments provide a firm basis for Environment Canada to accept the technical defensibility of the testing conducted. Further, we hope that, based on the technically defensible benchmarks generated, and the explanations provided above, Environment Canada now agrees that the conclusions drawn from the test results not only support the proposed SSWQO of 684 mg/L for Snap Lake but in fact would also support a SSWQO of up to 1,000 mg/L, or possibly higher for Snap Lake.

We trust that this technical memorandum provide you with the information you require at this time. Should you have any questions, or require further information, please contact the undersigned.

GOLDER ASSOCIATES LTD.

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PMC/CAM/me

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