Aboriginal Affairs and Northern Development Canada
Affaires autochtones et Développement du Nord Canada

Box 1500
YELLOWKNIFE NT X1A 2R3

January 18, 2012

MVEIRB File Number: EIR 0607-001
Chuck Hubert
Panel Manager
Mackenzie Valley Environmental Impact Review Board
P.O. BOX 938
YELLOWKNIFE NT X1A 2N7

BY EMAIL: chubert@reviewboard.ca

Re: Gahcho Kue Diamond Mine Environmental Impact Review for DeBeers Canada Inc. – Information Requests

Dear Mr. Hubert

Aboriginal Affairs and Northern Development Canada (AANDC) is providing the following information requests (IRs) for the Gahcho Kue Environmental Impact Review Panel. AANDC believes that this information is necessary in assessing the potential impacts of the – Gahcho Kue Diamond Project (EIR 0607-001).

AANDC staff, and its technical consultants John Brodie, Hatfield Consultants, Lorax, Dr. Chris Burn and BGC Engineering Inc., are available to discuss these IR's and their associated rationale with the Gahcho Kue Environmental Review Panel, staff and the proponent.

Thank you for the opportunity to provide information requests. If you have any questions, please contact Lionel Marcinkoski at 669-2591 or via email at Lionel.Marcinkoski@aandc-aadnc.gc.ca

Yours sincerely,

Teresa Joudrie
Director
Renewable Resources and Environment Directorate- NT Region

IR Number: AANDC 1
Source: Section 8: KLOI Water Quality and Fish in Kennady Lake; Section 9: KLOI Downstream Water Effects
To: DeBeers Canada Inc.
Subject: Water Quality Objectives for Kennady Lake and the Downstream Receiving Environment

Preamble:
Water Quality Objectives (WQOs) are determined to ensure that the aquatic environment will not be significantly impacted by the project (terms used to describe WQOs in other Northern projects include EA Threshold and Water Quality Benchmarks).

AANDC notes that if the project impairs water quality to a point that it exceeds WQOs, the project is considered to have the potential to cause significant long-term impacts to the environment.

WQOs can be established based on local environmental sensitivities, generic water quality guidelines and background conditions. AANDC notes that DeBeers Canada Inc. (DCI) has compared water quality in Kennady Lake and the downstream environment to baseline conditions, water quality guidelines (CCME Water Quality Guidelines for the Protection of Aquatic Life) and Chronic Effects Benchmarks in Section 8.4.

The Gahcho Kue project is unique as it utilizes an existing waterbody (Kennady Lake) as a Water Management Pond and it requires that the waterbody be reopened at the end of operations. Consequently, the conditions within the Water Management Pond during operation are key to having the pond reopened at the end of mine.

The EIS document outlines changes/impacts from the project on Kennady Lake and the downstream receiving environment including: a change in trophic status within Kennady Lake, temporary or long term increases in metal and ion parameters in Kennady Lake and the downstream receiving environment, changes in species distributions within Kennady Lake and the downstream receiving environment. DCI concludes that the predicted effects are not significant and/or mitigable.

Request:
1. Please propose water quality objectives for Kennady Lake during operations and post-closure.
2. Please propose water quality objectives for the downstream receiving environment (e.g. N11) during operations and post-closure.
3. Relate the proposed post-closure Kennady Lake objectives and downstream water quality objectives to long-term chronic toxicity benchmarks to support acceptability.

IR Number: AANDC 2
Source: Section 8: KLOI Water Quality and Fish in Kennady Lake; Section 9: KLOI Downstream Water Effects
To: DeBeers Canada Inc.
Subject: Acceptable Levels of Change for Kennady Lake and the Downstream Receiving Environment

Preamble:
Sections 8 and 9 of the EIR predict a range of effects from the project. DCI concludes that the predicted effects are not significant and/or mitigable.

AANDC recognizes that the EA prediction and effects/impacts discussed in the EIR are predictions. Once the project is in operation, the extent of the effects may be greater or less than predicted. Understanding the level of change in the receiving environment that would be considered unacceptable is valuable when assessing potential impacts from a project, given that there is always a level of uncertainty inherent in EA predictions and effects assessments. Furthermore, understanding the acceptable/unacceptable level of change directly contributes to the development of; i) an appropriate and focused Aquatic Effects Monitoring Plan; ii) appropriate Effects Levels that 'trigger' Adaptive Management; and, iii) appropriate management response actions within an Adaptive Management Plan.

These plans rely on outcomes of the EA even though they are ultimately required of the project in the regulatory phase. As such, the EA and regulatory phase of the process are directly linked. Consequently, an incomplete EA can lead to complications in the regulatory process during initial water licence issuance, as well as, during operations and closure (i.e. unanticipated changes to the project, mining conditions or effluent quality).

Request:

1. Please describe levels of change (Early Warning Low, Moderate and High) within the aquatic receiving environment that would be considered unacceptable/significantly adverse (e.g. water quality, sediment, benthic and aquatic community, fish, etc.).
2. Describe how these Effect Levels would 'trigger' adaptive management for the project.

IR Number: AANDC 3
Source: Section 8: KLOI Water Quality and Fish in Kennady Lake; Section 9: KLOI Downstream Water Effects; Section 10: KLOI: Long-term Biophysical Effects, Closure and Reclamation; Terms of Reference
To: DeBeers Canada Inc.
Subject: Aquatic Effects Monitoring Plan, Adaptive Management Plan

Preamble:
Section 3.2.7 of the ToR for the EIS requires that the:

> "EIS must include a description of any follow up programs, contingency plans, or adaptive management programs the developer proposes to employ before, during, and after the proposed development, for the purpose of recognizing and managing unpredicted problems."

DCI requested clarification on the intent of this requirement to the MVEIRB, and the MVEIRB responded in a January 24, 2008 letter that

> "The intention of this section in the ToR was 1) to ensure that impact prediction and mitigation is undertaken in an adaptive management context and 2) that a comprehensive description of the monitoring process be provided with emphasis on follow up programs. These programs will assist in future critical evaluation of both specific and cumulative impact predictions made for Gahcho Kue Project."

The MVEIRB recognized that comments from the regulators, once the EIS was reviewed, would be used to refine the content of the EIS with respect to monitoring programs.

AANDC has developed the "Guidelines for Designing and Implementing Aquatic Effects Monitoring Programs for Development Projects in the Northwest Territories, 2009" which outline the requirements for an Aquatic Effects Monitoring Program (AEMP). AEMP design should be initiated during the Environmental Impact Review of a project.

Section 10.10 of the EIS briefly describes follow-up monitoring that will be conducted, but little detail is provided.

Request:
1. Please provide a draft AEMP Framework.
2. Please include consideration of Adaptive Management in the AEMP, with reference to levels of acceptable change per AANDC IR #2.

IR Number: AANDC 4
Source: EIS and Conformity Responses
To: Debeers Canada Inc.
Subject: Water Quality

Preamble:
The water quality of the area in both the short and long term is an important part of understanding the effect of the project. In addition to the current and predicted water quality, mitigation strategies need to anticipate a range of assumptions and predictions.

Request:
1. What is the capacity of the partially dewatered Kennedy Lake?
2. What is the anticipated short and long term water quality of PK, Areas 2, WMP, off of the rock piles and Hearne Pit. How were the effect levels determined? What are the parameters of concern?
3. The western edge of the coarse PK waste rock pile will likely be in contact with water. This will prevent ARD if the material is underwater but what is preventing ML? What are the effects in association with annual fluctuating water levels -"rinsing".
4. What is the water quality of the water above the PK in the Hearne Pit? What is the water quality of the Tuzo Pit? What is the expected schedule of water quality over the life of the mine and variations seasonally, how will DCI deal with it over the mine life and into the closure period?
5. What are the plans if the groundwater conditions and water quality conditions are not favourable for discharge?
6. What is the anticipated water treatment option for the water that does not meet objectives for TSS and TDS?
7. For Dyke A, how will the water in this area be handled if it does not meet discharge criteria to allow dyke to be breached?
8. What is the anticipated effect of the phosphorous (groundwater) on the environment?

IR Number: AANDC 5
Source: Section 3: Project Description, Section 8: KLOI: Water Quality and Fish in Kennady Lake, Section 10: KLOI Long-term Biophysical Effects, Closure and Reclamation
To: Debeers Canada Inc.
Subject: Reclamation and Closure

Preamble:
In order to adequately close a site, a clear understanding of the issues is required. Once the solutions have been determined adequate support infrastructure needs to be available. The solutions have to sufficiently cover a range of conditions and be viable options.

Request:

1. The surface inflow into the pits - Is this volume of water to be pumped to the partially dewatered Kennedy Lake? What is the volume of water expected and the quality of it?
2. Is the drainage directly to the environment from the waste rock piles and PKC during operation and into closure? What are the contingencies to intercept seepage prior to going into the NW portion of Kennedy Lake?
3. Is the outflow from Area 8 directly to the environment?
4. What is the strategy if the long term water quality of the partially dewatered Kennedy Lake does not permit discharge to Lake N11?
5. What is the level of permafrost in the waste rock piles? At what elevations within the waste rock piles is the PAG rock and when is it in permafrost conditions? There is no detailed information or evaluation of the reclamation cover and rate of convection. What consideration was given to heat input from lake water on permafrost development?
6. Is the unfrozen area near the filter dyke L a concern for the PK facility? Should something be done to mitigate this unfrozen area?
7. The coarse PK will have 1 m cover. Is this sufficient to ensure permafrost conditions and what are the performance expectations of this cover long term (i.e. post-closure)?
8. Has the thermal evolution of the fine or coarse PK been evaluated?

IR Number: AANDC 6
Source: EIS and Conformity Responses
To: Debeers Canada Inc.
Subject: General Mining Plan

Preamble:
The proposed mine development plan generally follows standard mining practices. The large number of dykes and the amount of water required to be moved to access the mineralized zones is definitely atypical of most mines in Northern Canada.

Request:

1. Why has DCI limited the footprint to a single watershed?
2. Can DCI outline all potential impacts (physical controls such as Till Cover, Permafrost and Rock/Water interface and their linkage to effects to local surface water) from the Waste Rock and PKC storage?
3. Please provide contingencies for closure if aspects of the mine do not perform adequately or the mine does not develop according to plan (i.e. technical, operational or practical/feasible complications)?

IR Number: AANDC 7
Source: Section 8: KLOI Water Quality and Fish in Kennady Lake
To: Debeers Canada Inc.
Subject: Water Quality – toxicity testing

Preamble:

The EIS provided predicted water chemistry for both water pumped into lake N11 during operations, and within Kennady Lake post-closure. The predicted water chemistries indicated that concentrations of several substances of potential concern may exceed the CCME and/or the derived Chronic Effects Benchmarks. Discussion in the EIS has argued that the concentrations are unlikely to result in chronic effects to aquatic organisms. A short-coming of comparing measured (or predicted) water chemistry against toxicity-based numeric benchmarks is that there is no consideration of the following: (1) the potential for additive or synergistic effects arising from the combined exposure of more than one substance of potential concern; and (2) that there may be chemical entities that are not accounted for in standard chemical analysis. Examples of the latter can include process/treatment chemicals, or minor/secondary natural substances in the rock being processed.

Consequently, at this time, there is insufficient information to assess the potential for chronic/sub acute toxicity to resident aquatic organisms. One way to assess a complex water sample for potential effects is to subject the sample to toxicity testing. This testing should be done with representative species of different kingdoms (i.e., fish, invertebrate, plant). The testing should also favor chronic or sub lethal tests as these are more sensitive, and representative of possible effects within the receiving environment.

If toxicity is observed at concentrations expected to be either pumped to Lake N11 during operations or found within Kennady Lake post-closure, then a toxicity identification evaluation (TIE) would be appropriate. A TIE would help De Beers identify the contaminant most likely resulting in the toxicity. De Beers could then consider mitigative approaches.

Request:

1. Please provide the results of sub-lethal and chronic toxicity tests on simulated water samples as outlined above. If this is not practical, please provide a reason why toxicity testing should not be done.

IR Number: AANDC 8
Source: Section 8: KLOI Water Quality and Fish in Kennady Lake; Section 9: KLOI Downstream Water Effects
To: Debeers Canada Inc.
Subject: Water Quality – P and potential enrichment

Preamble:

Sections 8 and 9 of the EIS discuss potential effects to Kennady Lake and downstream water bodies as a result of increased P loading to Kennady Lake during operations and post closure. The EIS indicates that these water bodies will likely shift from being oligotrophic to becoming mesotrophic. Furthermore, a number of changes (both potentially beneficial and negative) were outlined. One of the negative changes was a likely reduction in overwintering dissolved oxygen concentration in Kennady Lake post–closure. And consequently "over wintering habitat in Kennady Lake at post-closure may become more limited for cold-water fish species, such as lake trout and round whitefish than under baseline conditions" (Bottom P8-503). A concern is that periodic dissolved oxygen concentrations in Kennady Lake (and lakes downstream that currently provide over-wintering habitat [M2, M3 and M4]) may not be sufficient to support any large bodied fish.

Request:

1. Discuss the potential for periodic die-offs of non-cold-water fish species (including forage fish) in Kennady Lake and downstream lakes post closure. If possible please put this discussion in context with existing mesotrophic lakes nearby to the Gahcho Kue site.

2. Please also discuss the likelihood that a maximum total P concentration (18mg/L) in Kennady Lake post-closure (proposed by De Beers as a possible commitment) would avoid the periodic die-off of large non-cold-water fish species (P8-494).

IR Number: AANDC 9
Source: Section 8: KLOI Water Quality and Fish in Kennady Lake;
To: Debeers Canada Inc.
Subject: Water Quality - Copper

Preamble:

The EIS indicates that possible effects of copper in water may be mitigated by a predicted increase of dissolved organic carbon (page 8-496). A biotic ligand model provided by USEPA (USEPA 2003) provides a convenient way to assess copper toxicity in the context of hardness, alkalinity and dissolved organic carbon.

Request:

1. Please test this hypothesis using a biotic ligand model or similar approach. If this is not practical, please provide a compelling reason why a biotic ligand model (or similar) could not be used.

IR Number: AANDC 10
Source: Section 8: KLOI Water Quality and Fish in Kennady Lake;
To: Debeers Canada Inc.
Subject: Fish Tissue – potential for Hg Biomagnification

Preamble:

The EIS indicated that the baseline concentrations of mercury in fish tissue for fish caught from Kennady Lake exceed USEPA risk-based screening criteria for human consumption. The accumulation of mercury is generally strongly correlated with the rate of methylation in water bodies. Methylation tends to be greater in water bodies that have a higher trophic status. The higher trophic status leads to more organic carbon in sediments and anoxic zones that provide substrate for bacteria responsible for methylation.

Given (1) that an active mine may result in an incremental input of mercury, (2) that an increase in P loadings may cause a shift from oligotrophic to mesotrophic conditions, and (3) that these conditions could result in increased uptake of mercury (via methylation), some predictions regarding future concentrations of mercury in fish tissue should be made.

Request:

1. Please estimate the mercury concentrations in the tissues of large bodied fish in lake N11 (and downstream) during operation, and in Kennady Lake post-closure;

2. Please also discuss the potential for increased accumulation of other metals due to a trophic shift in Kennady Lake; and

3. Discuss long-term management options if a problem occurs (and is irreversible).

IR Number: AANDC 11
Source: Section 3: Project Description
To: Debeers Canada Inc.
Subject: Managing PAG mine rock/barren kimberlite

Preamble:

It is reported (3.7.3.3) that PAG mine rock as well as barren kimberlite will be sequestered within the interior of the mine rock piles in areas that will allow permafrost to develop or will be underwater when Kennady Lake is refilled. Although these long term solutions for handling PAG materials are identified, the day to day activities to be undertaken with respect to the management of PAG materials at the site during construction and operation of the mine (i.e., prior to implementing these long term solutions) require more detailed discussion.

Request:

Please describe the day to day activities that will take place at the mine site recognizing that some materials encountered during development and operation of the mine will be acid generating or at least potentially acid generating.

Items that should be discussed include:

1. De Beers on-site PAG sampling and analysis capabilities as they relate to effective decision making with respect to materials handling on a day to day basis;

2. Procedures in place to ensure that PAG materials are not inadvertently used for construction of roads, airstrips, dykes, berms, etc.; and

3. Interim measures to be employed (e.g., storage location, duration, management and monitoring practices, etc) regarding the handling and storage of PAG materials (i.e., prior to encapsulation and/or underwater storage).

IR Number: AANDC 12
Source: Section 8: KLOI Water Quality and Fish in Kennady Lake, Section 10: KLOI Long-term Biophysical Effects, Closure and Reclamation
To: Debeers Canada Inc.
Subject: Water Quality – Possible treatment options

Preamble:

During operations, water from the WMP will be discharged to Lake N11, provided that discharge criteria are achieved. Similarly the reclaimed portions of Kennady Lake will be re-connected with Area 8 post-closure, once appropriate water quality has been achieved. Contingency options will be required in the event the discharge criteria cannot be met or appropriate water quality has not been achieved.

Request:

1. Please identify and evaluate contingency options available to DCI in the event water cannot be discharged from the WMP during operations.

2. Please identify and evaluate contingency options available to DCI in the event water in Kennady Lake does not meet water quality objectives post-closure.

IR Number: AANDC 13
Source: Section 8: KLOI Water Quality and Fish in Kennady Lake
To: Debeers Canada Inc.
Subject: Limnology – potential for vertical mixing post-closure

Preamble:

Two models were used to evaluate the stratification in the Tuzo Pit: CE-QUAL-W2 for the first 100 years; and a long-term "vertical slice spreadsheet model" for 15,000 years. Insufficient information about these models, the inputs to them, and the results obtained from them, is provided to assess their effectiveness in predicting the water quality in Tuzo Pit and the restored Kennady Lake.

The conclusions drawn from the hydrodynamic modeling are given in 8.8.4.2.1:

> "The hydrodynamic results indicate that the rate of drop in pycnocline elevation will decline with time, which has two implications for water quality in Kennady Lake. First, it indicates that influences of Tuzo Pit water on Kennady Lake water quality will diminish with time, because the relative amounts of upward flux water will decrease accordingly. Secondly, it indicates a strengthening of the stratification as the pycnocline becomes deeper."

and from the long-term modeling given in 8.8.4.2.2:

> "it may be concluded with some confidence from this modeling that stratification in Tuzo pit will strengthen in time."

In both cases it is concluded that the stratification will strengthen with time, and the implication is that because the stratification is strong then the good quality surface water will be "isolated" from the poor quality deep water. AANDC is concerned that while a strong pycnocline will inhibit exchange of deep water with shallow water, it will never prevent it entirely. From Fick's Law the vertical mass transport of a solute per unit area is given by:

$$q = -\varepsilon_v \frac{\partial C}{\partial z}$$

where ε_v is the vertical diffusivity, C is the concentration of solute, and z is the vertical direction· In general, the vertical diffusivity cannot be predicted with any confidence. In the case of the Tuzo Pit/Kennady Lake its estimation is particularly problematic given the unusual shape of the pit, the extreme climatic conditions and the absence of data from analogous systems. An appreciation for the range of possible values of vertical diffusivity is given by Powell Lake, which has been meromictic for at least 11,000 years. Estimates of the vertical diffusivity range from 474 m^2/yr (1.5×10^{-5} m^2/s) near the surface down to 0.55

m^2/yr (1.7 x 10^{-8} m^2/s) near the bottom (Sanderson et al. 1986). The latter value is just 3.7 times the vertical diffusivity of salt. As a result, there is a wide range to the potential flux of water from the Tuzo Pit. This range should be used to bound the predicted water quality.

Once solute has moved from Tuzo Pit into Kennady Lake the next level of uncertainty is what proportion of that material will be flushed from the lake due to fresh water inflows each season. It is difficult to predict how effectively the spring freshet will mix with the water in Kennady Lake. One important factor to consider is the effect of ice cover. When ice forms it excludes most of the salt present in the water. The effects of this exclusion are not well understood, and not incorporated into CE-QUAL-W2. This may be important in that the volume of ice cover is a significant proportion of the volume of the mixolimnion of the lake. After ice melt a fresh layer will be present on the surface of the lake, overlying a more saline layer. Thus, during spring freshet there are basically three water masses to consider in Kennady Lake: the fresh ice-melt, the more saline water below it (containing solute that originated in Tuzo Pit) and the spring freshet. The manner in which these water masses mix together governs the quality of the water flowing out of the lake each year and, ultimately, the water quality within the lake. The complexities of this mixing process are not likely to be captured by CE-QUAL-W2. Rather than trying to achieve accurate predictions, it is more realistic to run the model with a range of input conditions, and assumptions, to determine bounds on the potential water quality.

Request:

1. Please summarize the data that were used as input to the models including:

   a) the flow rate of water to fill the pit and lake
   b) the time it will take to fill the pit and lake
   c) groundwater flow rates, before, during and after filling
   d) groundwater quality – summarize the parameters of concern and give the relevant concentrations
   e) the annual volume of freshwater inflow to Kennady Lake after filling, including:
      i) typical ice and snow thickness
      ii) volume and area of the section of the lake modeled

   *Note that much of this information is already provided but not summarized in one area. The requested data should provide enough information for the reader to evaluate the results.

2. Please provide simple calculations to bound the uncertainty in the water quality. What would the water quality be?

a) if the entire pit and lake were well mixed
b) if the largest flux of deep water (obtained using an upper bound estimate of ε_v), mixed into a smaller volume of Kennady Lake (due to stratification as described above)

3. Please provide details of the vertical slice spreadsheet model. In particular provide details of the value(s) used for the vertical diffusivity and how they were determined. Please provide a plot of the predicted vertical flux of TDS versus time. Please provide an additional plot of the predicted vertical flux of TDS versus time if the vertical diffusivity is increased by a factor of 10. What effect would such an increase in the estimate of vertical diffusivity have of the predicted water quality in Kennady Lake?

4. Please provide details of how CE-QUAL-W2 is able to predict the water quality in Kennady Lake. Please provide estimates of the inaccuracy of the modeling process.

References:

Sanderson, B., K. Perry, and T. Pedersen (1986), Vertical Diffusion in Meromictic Powell Lake, British Columbia, J. Geophys. Res., 91(C6), 7647–7655, doi:10.1029/JC091iC06p07647.

USEPA 2003. The Biotic Ligand Model: Technical Support Document for Its Application to the Evaluation of Water Quality Criteria for Copper. Accessed on line at http://yosemite.epa.gov/water/owrccatalog.nsf/0/e693bcf79893c3e085256e23005fcd3b?OpenDocument on 10Jan12.

IR Number: AANDC 14
Source: Section 3: Project Description
To: Debeers Canada Inc.
Subject: Permafrost

Preamble:

Reference. p. 3-104. "The upper portion of the thick cover of clean mine rock over the waste depository will be subject to annual freeze and thaw cycles, but the PK and PAG rock sequestered below are predicted to remain permanently frozen"

Request:

1. Please describe the method of prediction and the numerical basis that led to this result. Please supply details of such prediction, including:

   a) The model of the thermal regime of the rock pile.
   b) The effect of the lake on the constructed pile's thermal regime.
   c) The physical processes of heat transfer in the coarse rock pile.
   d) Thermal properties of the coarse rock required to model the thermal regime.
   e) Effect of climate change on temperatures within the rock piles.
   f) Time scale over which permafrost is expected to develop in the rock pile, and the time scale of which it is anticipated to be maintained, given the prospect of climate change in the region.

IR Number: AANDC 15
Source: Section 3: Project Description
To: Debeers Canada Inc.
Subject: Permafrost

Preamble:

Reference. p. 3-104. "Permafrost development in the Fine PKC Facility and underlying talik is expected to occur over time."

Request:

1. Please indicate whether any quantitative assessment of this process has been completed. Please supply details of such assessment for both Fine and Coarse PK storage facilities, including:

   a) Numerical modeling method
   b) Explicit statement of all assumptions used in modeling
   c) Statement of all thermal properties used in modeling
   d) Method for calculation of surface temperature of the fine PK
   e) Effect of climate change on the thermal regime of the fine PK
   f) Time required to establish permafrost in the PK and underlying talik
   g) Rate of annual freezing during period of permafrost aggradation

IR Number: AANDC 16
Source: Section 3: Project Description
To: Debeers Canada Inc.
Subject: Site Drainage

Preamble:

Reference 3 – 67 “If water quality of runoff from the mine rock piles to the west and south of Kennady Lake, the Coarse PK pile, or the Fine PKC Facility is unsuitable for direct discharge into Kennady Lake, this water will be collected and treated to achieve acceptable discharge quality”

Request:

1. Please indicate the time over which water quality is going to be monitored, and the relation between this number and the expected time for permafrost establishment throughout these facilities, for both the Fine and Coarse PK facilities.

2. Please indicate how direct discharge is going to be monitored and the water quality levels that would initiate water collection.

3. Please indicate how unsatisfactory water is to be collected after mine closure.

IR Number: AANDC 17
Source: Section 8: KLOI Water Quality and Fish in Kennady Lake
To: Debeers Canada Inc.
Subject: General Hydrogeology

Preamble:

Apparent Inconsistencies were identified during the review of EIS Sections 8.3 and 8.4.

Request:

1. Please confirm the location of MPV-04-165 on Figure 8.3-7.
2. Please clarify the flow direction on Figure 8.4-5. This figure shows mine water flowing from 5034 pit to Hearne pit.
3. Please confirm whether Table 8.4-6 on p. 8-165 should be labelled Table 8.4-7.

IR Number: AANDC 18
Source: EIS and Conformity Responses
To: Debeers Canada Inc.
Subject: Case study results of Diavik and Snap Lake Hydrogeological Characterization Reports (Pre-mining and operational)

Preamble:

Reference to Snap Lake and Diavik mine hydrogeological conditions and water management challenges during operations are made through the developer's EIS.

Request:

1. Provide copies of the pertinent sections related to hydrogeological characterization and water quality (groundwater and surface water) from the following reports:

   De Beers (De Beers Canada Mining Inc.). 2002. Snap Lake Diamond Project Environmental Assessment Report. Prepared for De Beers Canada Mining Inc. by Golder Associates Ltd. Yellowknife, N.W.T. February 2002.

   Diavik, EIS (Rio Tinto) Specifically the hydrogeological characterization components and groundwater management plans

2. Provide copies of the following paper:

   Kuchling, K., D. Chorley and W. Zawadzki. 2000. Hydrogeological modelling of mining operations at the Diavik Diamonds Project. In Proceedings of the Sixth International Symposium on Environmental Issues and Waste Management in Energy and Mineral Production, University of Calgary, Calgary AB.

3. Provide copies of any publications relating to fracture flow within the regional study area.

IR Number: AANDC 19
Source: Section 11.6: SON: Permafrost, Groundwater and Hydrogeology
To: Debeers Canada Inc.
Subject: Water Quantity

Preamble:

This request deals with the uncertainty in predicted inflows during dewatering operations.

The groundwater model described in Section APPENDIX 11.6.I HYDROGEOLOGICAL MODELS PRE-MINING, DURING MINING AND CLOSURE utilizes specified head boundaries (Layer 1 of the model) to represent all lakes assumed to have open taliks connected to the deep groundwater flow regime. Each of these boundaries was set to the surveyed lake elevation shown in Figure 11.6.I-1. Simulations show drawdown of these water levels during dewatering; however Areas 3 and 5 will remain flooded as part of the WMP. A constant head boundary equal to the operational level of the WMP should have been set as the boundary condition. As the combined surface area of Areas 3 and 5 is substantial and the water level in this pond managed, an endless supply of water to the open pit through the shallow sediments and underlying exfoliated bed rock toward dewater pits will occur. This will result in higher than anticipated inflow rates, and lead to transport of constituents in WMP water deeper into the underlying lake bed.

Further, the sensitivity analysis conducted on the model is not clearly understood with respect to how it demonstrates that the physical parameters in the base case scenario are a reasonable upper bound. Throughout the EIS, the developer states that a conservative estimate of permeability should be applied to the fault zones, lessons learned from operations at Snap Lake and Diavik.

Request:

1. With the presence of the WMP overlying the open talik during operational phases of the project how much of an increase in inflow would be expected?
2. What is the range of permeability observed at Snap Lake and Diavik for the major faults?
3. What would be the inflow rate to the pits if the maximum observed permeability of faults at Diavik or Snap Lake were realized at Gahcho Kué, and how would DBCMI manage this increase in flow and TDS loadings?

IR Number: AANDC 20
Source: Section 11.6: SON: Permafrost, Groundwater and Hydrogeology
To: Debeers Canada Inc.
Subject: Water Quantity

Preamble:

This request deals with the uncertainty in predicted inflows during dewatering operations.

DBCMI developed a three-dimensional groundwater flow model of the site using MODFLOW and a solute transport model using MT3D. Calibration results of the model were not provided in the write up (Section 11.6 Subject of Note: Permafrost, Groundwater and Hydrogeology, specifically Appendix 11.6.I Hydrogeological models pre-mining, during mining and closure).

Furthermore, sensitivity analyses conducted on the model does not include an evaluation of enhanced permeability. The authors conclude that the base case scenario provides a reasonable upper bound of mass loading to the pits over the mine life. Throughout the EIS, the developer states that a conservative estimate of permeability should be applied to the fault zones, lessons learned from operations at Snap Lake and Diavik.

Request:

1. Provide calibration results and supporting discussion.
2. Run simulations on a calibrated model that includes best, worst and likely scenarios using the range of TDS concentrations in groundwater observed at the site, and using the range of permeability observed for faulting in the regional study area (i.e., values from Diavik and Snap Lake mines).
3. The model should also incorporate a constant head boundary condition overlying the WMP.

IR Number: AANDC 21
Source: EIS and Conformity Responses
To: Debeers Canada Inc.
Subject: Water Quality – Taliks

Preamble:

The open pits (TDS during dewatering), WMP, the fine PK and the western edge of the coarse PK of the pile will be situated over the talik and in contact with water and all three are considered point sources of contaminants

Request:

1. If groundwater conditions with respect to TDS concentrations have been underestimated how will DCI deal with managing the increase in loadings?
2. How would treatment of TDS take place to meet discharge objectives?
3. If discharge criteria (with respect to TDS) are not achieved and discharge to Lake N11 is not permitted how will DBCMI manage water on site?

4. With respect to the presence of the WMP lying over an open talik:
   a) How will the water quality of the WMP vary during operations and at closure?
   b) With the WMP being situated over a talik in connection with an active dewatering system during operations, what will be the predicted short term and long term concentrations in lake bed sediments and the underlying exfoliated bedrock, and what would be the potential impacts to benthic community and water column quality?
5. Permafrost establishment within the fine PKC Facility is anticipated to take an appreciably longer time (i.e., to the end of the reclamation phase) than the mine rock piles, particularly Area 2 because a portion of this area is located on the lake bed, under which a talik existed. If this pile is not covered and rinsing of the material occurs then metal leaching from this pile could be an issue. Please provide the following information related to this issue:
   a) Will there be a loading to the underlying groundwater system?
   b) If so can you predict the magnitude of the impact to groundwater quality and potentially down gradient receptors (groundwater discharge sites)?

6. The Coarse PK Pile will be built entirely on land to a maximum height of 30 m and will have side slopes of 4H:1V. Permafrost conditions are expected to develop within the pile; however by the end of operations, the western edge of the pile will have reached the Area 4 of the re-flooded Kennady Lake and will likely be in contact with lake water. This scenario could act as a source for metal leaching. Please provide the following information related to this scenario:
   a) As with the fine PK scenario will there be a loading to the underlying groundwater system or Kennady Lake considering the western edge will lie over an open talik?
   b) If so can you predict the magnitude of the impact to groundwater quality and potentially down gradient receptors (groundwater discharge sites)?

IR Number: AANDC 22
Source: Section 11.6: SON: Permafrost, Groundwater and Hydrogeology, Annex D.
To: Debeers Canada Inc.
Subject: Adequacy of Permafrost Baseline Information

Preamble:

One of the stated objectives of the baseline program was *"... to describe near-surface permafrost conditions as part of the terrain survey ..."* (De Beers 2010c, pg. D1-2) *"Permafrost investigations ... were carried out ... in 2004 and 2005. The objective ... was to obtain and provide baseline permafrost data for the design and operation of the Project facilities, and for predicting effects from the project."* (De Beers 2010c, pg. D7-1,) However, the thermistors installed in the winter of 2004 were only read between April and August 2004, between 1 and 6 times (De Beers 2010c, Appendices D.II, D.III and D.IV). The monitoring period is far short of that needed to interpret the baseline ground thermal regime. Indeed, the data reported indicate ongoing stabilization of ground temperatures in response to drilling disturbance.

Attempts to probe the active layer thickness were hampered by the coarse soil texture, with success limited to areas of organic soil (De Beers 2010c, pg. D7-17).

Further, *"Due to the absence of actual data on the mean annual soil temperatures for the majority of the identified terrain units, this important permafrost parameter was calculated ..."* (De Beers 2010c, pg. D7-10, Tables D7.3-2 and D7.3-3)

The Proponent concludes: *"Results suggest that the calculated mean annual permafrost temperatures are generally in close agreement with the measured mean annual permafrost temperatures in moraine blanket and organic veneer. This suggests also that the input parameters for calculating mean annual permafrost temperatures correspond to actual climate and vegetation conditions within the study area."* (De Beers 2010c, pg. D7-27; also EBA 2011b, pg. 6)

AANDC considers the reported permafrost data are minimal. If the field data are sparse and potentially not in equilibrium, then the confidence in any assumptions made using this data base is low.

Request:

1. Please describe and evaluate the risks to the project assumptions due to using calculated data and data collected over a short monitoring period.

2. Please provide an evaluation of additional data sources that could be used to supplement the existing ground thermal regime database

3. Please describe any uncertainties in the geothermal modelling outputs resulting from use of the existing ground thermal regime database.

IR Number: AANDC 23
Source: Section 11.6: SON: Permafrost, Groundwater and Hydrogeology, Section 11.7: SON Vegetation, Annex D
To: Debeers Canada Inc.
Subject: Borrow Materials – Quantities Available & Engineering Properties

Preamble:

The stated objectives of the baseline program included:

- *"... to complete a local and regional terrain (surficial material and landform) survey ..."* (De Beers 2010c, pg. D1-2) and
- *"... to collect soil samples for laboratory analysis of ... texture ..."* (De Beers 2010c, pg. D1-3)

Surficial materials are predominantly sandy, gravelly till with variable boulder content, which is described as a discontinuous veneer (<1 m thick) and occasionally thicker (1 to 4 m). Eskers are *"... of limited extent and unknown thickness."* (De Beers 2010c, pg. D5-3).

The till materials *"... commonly occur in association with other materials, especially with organic materials of peatlands."* (De Beers 2010c, esp. pgs. D5-5; also pg. D5-11 and Table D5.3-1).

"Permafrost features are common throughout the LSA. Piping, "boiling", and heaving of the active layer, thermokarst and thermo-erosion, and pingo development are of primary importance." (De Beers 2010c, pg D5-13 and Figures D7.3-1 to D7.3-7). Cryoturbation associated with these processes has the effect of mixing deleterious materials into the near-surface till deposits.

Field reconnaissance was undertaken to *"... verify the terrain units identified in the aerial photographs and assess the surficial soil composition."* (De Beers 2010c, pg. D7-10)

75 drill holes were completed to install 42 thermistors and, in part, *"... to retrieve good quality samples of ... moraine, for boulder counts and geotechnical characterization."* (De Beers 2010c, pg. D7-4). *"Representative samples were tested for grain size distribution, hydrometer, and Atterberg limits tests."* (De Beers 2010c, pg. D7-5)

Interpretations as to erosion risk, acidification, sensitivity, and reclamation suitability (e.g. De Beers 2010e, Tables 11.7.I-9 and 11.7.I-11) and interpretations regarding performance of the materials as part of dyke and berm designs (EBA 2011a and b) are provided, yet none of the laboratory data are disclosed either as discrete test results or aggregate results. What are disclosed are generalized (e.g. De Beers 2010c, Table D7.2-6). These are inadequate to assess the suitability of the interpretations reported.

The construction quantities required (EBA 2011, Tables 6 and 7) are sizeable and it is unclear how much local borrow will be required until other "overburden" sources become available ((De Beers 2010b, pg. 3-32)

Request:

1. The Proponent should provide the following:
   a) Grain size curves for all laboratory testing completed on borrow materials.
   b) Assessment of the percentage of inventoried borrow materials that will be useable when deleterious material content, recovery challenges (i.e. irregular bedrock surface configuration, wet nature of lake-bed sources, frozen condition of stock piles, etc.) are accounted for.
   c) If processing is required to eliminate deleterious materials (e.g. EBA 2011a, pg. 7) and/or to achieve suitable gradation (e.g. EBA 2011a, pgs. 7 to 9), where will this be located, what is the water-use requirement, and how will wash-water be managed?
   d) Schedule as to where the materials will be recovered from (time and location) as required for construction of roads, air strip, pads, dykes, berms and for use in concrete aggregate.
   e) Re-confirmation that a quarry and related processing will not be required for construction materials.