DE BEERS
CANADA
GAHCHO KUÉ PROJECT

June 8, 2012 File: S110-01-09

Chuck Hubert
Senior Environmental Assessment Officer
Mackenzie Valley Environmental Impact Review Board
P.O. Box 938
Yellowknife NT X1A 2N7

Dear Mr. Hubert:

**Undertaking #1 - Response Changes in Kennady Lake for Gahcho Kué Project EIR0607-001 Environmental Impact Review Technical Sessions, May 22-25, 2012**

De Beers Canada Inc. (De Beers) is pleased to submit the attached Technical Memorandum in responses to Undertaking #1 to the McKenzie Valley Environmental Impact Review Board (MVEIRB). The undertaking was requested at the May 22-25, 2012 Technical Sessions held for the Gahcho Kué Project.

Specifically, Undertaking #1 requested that De Beers provide a summary list (approximately 5 pages) of all predicted changes to Kennady Lake related to the project, from baseline

We trust the response provided in the attached Technical Memorandum provides the information required to fulfill our requirements.

Sincerely,

Veronica Chisholm

Veronica Chisholm
Permitting Manager

Attachment

# TECHNICAL MEMORANDUM

**DATE** June 7, 2012 **PROJECT No.** 11-1365-0012/DCN-077

**TO** Veronica Chisholm, Andrew Williams, Stephen Lines
De Beers Canada Inc.

**CC** Amy Langhorne, John Faithful, Golder Associates Ltd.

**FROM** Kristine Mason, Golder Associates Ltd.

**GAHCHO KUÉ PROJECT TECHNICAL SESSIONS MAY 22 TO 25, 2012, UNDERTAKING #1**

As requested at the Gahcho Kué Project Technical Sessions on May 22 to 25, 2012, the following table summarizes the projected changes to Kennady Lake from baseline conditions to post-closure under long-term steady state conditions. The attached figures show Kennady Lake under baseline conditions (Figure 1), during mining operations (years 9 to 11, Figure 2), and at final reclamation (Figure 3).

| Kennady Lake Baseline Conditions | Kennady Lake Post-Closure (Long-term, steady state) |
|---|---|
| **Project Description** | |
| Kennady Lake at baseline conditions | • At completion of mine operations, the final Tuzo Pit will remain empty, while the Hearne Pit will have been partially backfilled with fine processed kimberlite (PK) and the 5034 pit will be completely backfilled with fine PK and mine rock.<br>• The 5034 pit is expected to be about 305 m deep and will be backfilled. The total depth of the Hearne Pit is expected to be 205 m, and is anticipated to be backfilled to approximately 100 m below the original lakebed. The Tuzo Pit, which is the last pit to be mined, will not be backfilled with material and will be about 305 m deep.<br>• Area 2 will be filled with fine PK and reclaimed with a coarse PK and mine rock cover overlying the fine PK. Dyke L will form the new shoreline with the completely infilled and reclaimed Fine PKC facility behind it.<br>• The planned within-lake reclamation activity will be completed, such as construction of in-lake fish compensation habitat and decommissioning of roads, diversion channels, and pipelines.<br>• The in-lake Dykes B, J, K, and N will be breached and lowered to a level below the expected restored lake surface elevation of 420.7 meters above sea level (masl).<br>• The diversion dykes (Dykes E, F, and G) will be removed to restore the baseline B, D, and E watershed boundaries of Kennady Lake; these watersheds will be returned to their natural drainage patterns. The A watershed will be connected to Area 3 of Kennady Lake.<br>• Once Areas 3 through 7 are refilled to the same elevation as Area 8, and the water quality within the refilled lake is acceptable, the in-lake portion of Dyke A will be removed.<br>• After Dyke A is removed, the hydrological regime is predicted to return to stable conditions and Kennady Lake will consist of five interconnected basins.<br>• The refilling of Kennady Lake, and its reconnection with the downstream watersheds, will then be completed.<br>• Water will once again flow from the A, B, D, and E watersheds through the refilled Kennady Lake (Areas 3 to 8), and downstream through Stream K5 into the L and M watersheds. |

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| Kennady Lake Baseline Conditions | Kennady Lake Post-Closure (Long-term, steady state) |
|---|---|
| **Hydrology** | |
| Total watershed area is 32.46 $km^2$. | ▪ Total watershed area in post-closure remains 32.46 $km^2$. |
| In the Kennady lake watershed, total land area is 21.17 $km^2$ and total lake area is 11.29 $km^2$. | ▪ There will be a small increase in the total land area (to 22.03 $km^2$) in the Kennady Lake watershed, due to the infilling of portions of Kennady Lake, partially offset by losses of land due to pit development. Total lake area at post-closure is 10.43 $km^2$. |
| Surface area of Kennady Lake is 8.15 $km^2$. | ▪ There will be a decrease in water surface area of Kennady Lake to 7.14 $km^2$ (decrease of 12.4%). This is due to infilling of the lake by the Fine PKC Facility, the Coarse PK Pile, and the South and West Mine Rock Piles, which will be slightly offset by the removal of land area during excavation of the 5034, Tuzo and Hearne mine pits.<br>▪ Changes to the Kennady Lake surface area will slightly increase post-closure flood peak discharges and water levels. |
| The mean annual water yield is approximately 147 mm. | ▪ Due to decreased lake evaporation from the reduced surface area of Kennady Lake, the mean annual water yield will slightly increase by 5.1% at post-closure, to 154 mm. |
| Mean annual discharge from Kennady Lake is 4,760 cubic decametres ($dam^3$). | ▪ Mean annual discharge from Kennady Lake will increase by 5% to 5,000 $dam^3$ (due to the changes in land to lake area in the watershed). |
| Summary | ▪ The changes to the Kennady Lake watershed will have a negligible effect on the post-closure hydrological regime in the closure phase of the Project.<br>▪ The changes were carried into the water quality model, as well as the fish and fish habitat assessment. |
| **Water Quality** | |
| Water quality at baseline | ▪ Based on the updated water quality modelling, the predicted water quality in Kennady Lake during post-closure compared to baseline conditions is presented in Table 8.2-12 of the 2012 EIS Supplement. The following provides a summary of the table. |
| Kennady Lake baseline Total Dissolved Solids (TDS) concentration is 13 mg/L. TDS is the concentration of all major dissolved materials, such as minerals and salts. | ▪ During operations, TDS concentrations will increase from management of saline groundwater inflows from the pits, natural runoff, and process water cycling within the Water Management Pond (WMP).<br>▪ During closure, TDS concentrations will decrease rapidly as a large proportion of high TDS water in the WMP is siphoned to Tuzo Pit and the lake is filled with low TDS waters from natural drainage and supplemental inflows from Lake N11. Following refilling, TDS concentrations are predicted to continue to decline as Dyke A is breached and water stored in Kennady Lake is replaced by additional fresh water inflows (i.e., natural drainage) from the upstream lakes and streams.<br>▪ Hydrodynamic modelling of the TDS concentrations for the Hearne and Tuzo Pits indicate that the pycnocline will form and become more stable over time. Pycnocline refers to the density gradient in TDS concentrations with the higher TDS water confined to the bottom of the pit and the freshwater on the surface. Therefore, the water with higher TDS will be isolated at the bottom of the pit and from the rest of Kennady Lake.<br>▪ The long-term steady state TDS concentration in Kennady Lake is projected to be 37 mg/L TDS.<br>▪ This was carried into the aquatic health assessment. |
| Baseline nitrate (generally below detection limits) and ammonia (0.032 mg/L) | ▪ Following closure, projected nitrate and ammonia concentrations decrease to steady state concentrations (0.024 mg/L for nitrate and 0.03 mg/L for ammonia) that are below CCME water quality guidelines and near background levels. CCME water quality guidelines are 13 mg/L for nitrate and 5.55 mg/L for ammonia (dependent on pH and temperature). |

| Kennady Lake Baseline Conditions | Kennady Lake Post-Closure (Long-term, steady state) |
|---|---|
| Baseline total phosphorus concentration in Kennady Lake is 0.0057 mg/L, with the trophic status of the lake being oligotrophic (low productivity). | ▪ The long-term steady state concentration of phosphorus in Kennady Lake during post-closure is projected to be 0.009 mg/L, with the trophic status of the lake remaining oligotrophic in the long-term.<br>▪ Dissolved oxygen modelling indicates that a large volume of Kennady Lake at post-closure will have sufficient under-ice dissolved oxygen for fish overwintering. For example, 74 to 92% of the total volume of Kennady Lake will have a dissolved oxygen concentration above 5 mg/L (acute guideline for the protection of cold water species excluding the larval stages; AENV 1999), and 51 to 89% of the total volume will have a dissolved oxygen concentration above 6.5 mg/L (chronic guideline for the protection of aquatic life for cold water species excluding the larval stages; CCME 1999).<br>▪ In post-closure, the projected volumes of water with dissolved oxygen concentrations greater than 5 and 6.5 mg/L are approximately 47 and 45 million cubic metres ($Mm^3$), respectively (compared to ~ 35 $Mm^3$ in pre-development). Therefore, the volume of Kennady Lake with a projected dissolved oxygen concentration higher than 6.5 mg/L is higher than the pre-development volume of Kennady Lake.<br>▪ These results were carried into the fish and fish habitat assessment. |
| Baseline total metals: cadmium (0.00002 mg/L) and copper (0.0012 mg/L) have been measured in Kennady Lake above guideline concentrations under existing (baseline) environment conditions. | ▪ Based on the updated water quality modelling, maximum total concentrations for only two metals (cadmium and copper) are projected to be higher than Canadian Water Quality Guidelines for the Protection of Aquatic Life (CCME 1999) during the post-closure period (cadmium 0.000041 mg/L and copper 0.002 mg/L).<br>▪ At baseline, both cadmium and copper have been measured in Kennady Lake to be above guideline concentrations, with concentrations of 0.00002 mg/L for cadmium and 0.0012 mg/L for copper under baseline conditions. Furthermore, the CCME water quality guideline for cadmium is currently under review, with the proposed guideline value being higher than the current guideline value; it is expected that the Kennady Lake projected cadmium concentrations will be less than the proposed guideline value.<br>▪ Cadmium and copper, along with other metals, were carried into the aquatic health assessment to assess the potential for effects to the health of aquatic life in Kennady Lake resulting from modelled changes in water quality. |
| Other water quality parameters | ▪ All other water quality parameters are expected to be below CCME water quality guidelines and so will have a negligible effect on surface water quality. |
| Summary | ▪ Water quality in the refilled lake will return to conditions suitable to support aquatic life. |
| **Aquatic Health** | |
| TDS | ▪ Using the results from the water quality model, the predicted maximum TDS concentrations are below concentrations associated with adverse effects to freshwater aquatic life.<br>▪ Thus, predicted changes in TDS concentrations will have negligible residual effects on aquatic health. |
| Other parameters (other than copper) | ▪ With the exception of copper, maximum concentrations are predicted to remain below the chronic effect benchmark (CEB) identified for each substance of potential concern (SOPC) (including cadmium).<br>▪ The chronic effects benchmark (CEB) is the water concentration above which changes to aquatic health could occur on the scale of individual organisms.<br>▪ As a result, the predicted increases in the concentrations of these SOPCs are expected to have a negligible residual effect on the aquatic health in Kennady Lake. |
| Copper | ▪ Maximum concentrations of total copper are predicted to be above CEBs in Kennady Lake during closure conditions. However, the predicted concentrations only marginally exceeded the CEBs: maximum total copper concentration was predicted to be 0.0020 mg/L during long-term conditions, which is slightly higher than the corresponding CEB of 0.0019 mg/L.<br>▪ Despite the predicted exceedance of the CEBs, the potential for copper to cause adverse residual effects to aquatic life in Kennady Lake is considered to be low (see Section 8.2.6.2 and Appendix 8.VI of the EIS Supplement for more details). |

| Kennady Lake Baseline Conditions | Kennady Lake Post-Closure (Long-term, steady state) |
|---|---|
| Fish tissue concentrations | ▪ With the exception of aluminum, nickel, and silver, predicted increases in fish tissue concentrations for substances of interest (SOIs) considered in the assessment were below toxicological benchmarks and therefore, are expected to have negligible effects on fish tissue quality in Kennady Lake.<br>▪ For aluminum, nickel, and silver, based on a review of the toxicological benchmarks, the concentrations predicted, and the potential for bioaccumulation, the potential for adverse effects to aquatic health in Kennady Lake from aluminum, nickel, and silver was considered to be low, and residual effects to aquatic communities were considered to be negligible. |
| Summary | ▪ Changes to water quality are predicted to have negligible residual effects to aquatic communities in the Kennady Lake in post-closure under the assessed conditions. |
| **Fish and Fish Habitat** | |
| Fish habitat in Kennady Lake | ▪ There will be permanent losses of fish habitat in Kennady Lake associated with Fine PKC Facility, the Coarse PK Pile, the West and South Mine Rock Piles, and permanent dykes. The permanent losses of fish habitat within Kennady Lake are estimated to be approximately 157 ha in area.<br>▪ These losses to fish habitat in Kennady Lake will be included in the fish habitat compensation plan which will be developed to achieve no net loss of fish habitat.<br>▪ The fish habitat compensation plan will be developed in consultation with DFO and with input from local communities. There are plans to review and seek input on habitat compensation options with community members during site visits in August 2012, as well as community visits in the fall of 2012.<br>▪ The placement of habitat enhancement features in Kennady Lake is proposed as part of the compensation plan.<br>▪ Although Kennady Lake will be smaller than at baseline conditions, fish habitat for spawning, rearing, and overwintering will be present in Kennady Lake post-closure. |
| Baseline total phosphorus concentration in Kennady Lake is 0.0057 mg/L, with the trophic status of the lake being oligotrophic. | ▪ Nutrient concentrations in Kennady Lake will increase (projected to 0.009 mg/L) within the oligotrophic range, with corresponding changes in productivity and lower trophic communities.<br>▪ Increased productivity is expected at all lower trophic levels, reflected in increases in biomass of phytoplankton, zooplankton, and benthic invertebrates.<br>▪ As a result of the increases in the food base for fish, there may also be increased growth and production in the fish species of Kennady Lake.<br>▪ Kennady Lake during post-closure is expected to retain sufficient levels of dissolved oxygen during winter to support fish, including sensitive species, such as lake trout. The volume of Kennady Lake at post-closure with a projected dissolved oxygen concentration higher than 6.5 mg/L is higher than the pre-development volume of Kennady Lake.<br>▪ As the shallow littoral zone is expected to remain well oxygenated through the period of egg incubation, it is expected that suitable spawning and egg incubation habitat for lake trout and round whitefish will continue to be present in the refilled Kennady Lake, and that natural recruitment will occur.<br>▪ Based on the availability of large volumes of water with under-ice dissolved oxygen levels greater than 5 mg/L, overwintering habitat in Kennady Lake at post-closure is expected to suitable for all fish species currently in the lake, including lake trout. |

| Kennady Lake Baseline Conditions | Kennady Lake Post-Closure (Long-term, steady state) |
|---|---|
| Eight species of fish are present in Kennady Lake, including five large-bodied species (lake trout, Arctic grayling, northern pike, round whitefish, burbot) and three forage fish species (lake chub, ninespine stickleback and slimy sculpin).<br>The fish population in Kennady Lake is estimated to be ~19,000 fish (fish > 18 cm). The lake trout population of is estimated to be ~ 11,000 fish. | ▪ The fish species within Kennady Lake during post-closure are expected to be similar to baseline conditions, including the re-establishment of large-bodied fish populations (including lake trout). |
| Summary | ▪ Habitat conditions in the refilled lake will be suitable for all species currently within the lake to return and re-establish. |

**Recovery of Kennady Lake**

- The time frame for recovery of the phytoplankton community (i.e., the microscopic plants in the water column) is expected to be approximately five years after refilling is complete, taking into account that the community will begin to develop during the refilling period.
- Zooplankton community (i.e., the microscopic animals in the water column) development is predicted to follow recovery of the phytoplankton community (i.e., likely within five to ten years of Kennady Lake being completely refilled).
- Recovery of the benthic invertebrate community (i.e., the small, bottom-dwelling animals) in Kennady Lake is expected to be slower than that of the plankton communities, with an estimated time for recovery of about ten years after refilling is complete.
- Water quality is expected to be suitable for aquatic life when the refilling process is complete. At this point, small- and large-bodied fish would enter the lake and re-establish within the lake.
- The small-bodied fish would be expected to establish a forage fish base relatively quickly. The large-bodied fish species would be expected to recolonize the lake shortly after refilling to feed on the forage base. These large-bodied fish would be expected to reside in the lake, or use the lake to complete some aspect of their life history, with their populations increasing over time.
- Northern pike is expected to re-establish a stable, self-sustaining population in Kennady Lake later than Arctic grayling or burbot (i.e., approximately 50 to 60 years following the complete refilling of Kennady Lake).
- Lake trout would also require a long time to re-establish a stable, self-sustaining population (i.e., approximately 60 to 75 years following the complete refilling of Kennady Lake).
- The estimation for the re-establishment of these large-bodied predatory species is a conservative estimate for a healthy, self-sustaining fish population to be established at stable levels of abundance, and takes into account at least two life cycles of these slower-growing fish species.
- The lake would provide suitable habitat for fish to live year-round (i.e., rearing/feeding, overwintering, spawning).

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