

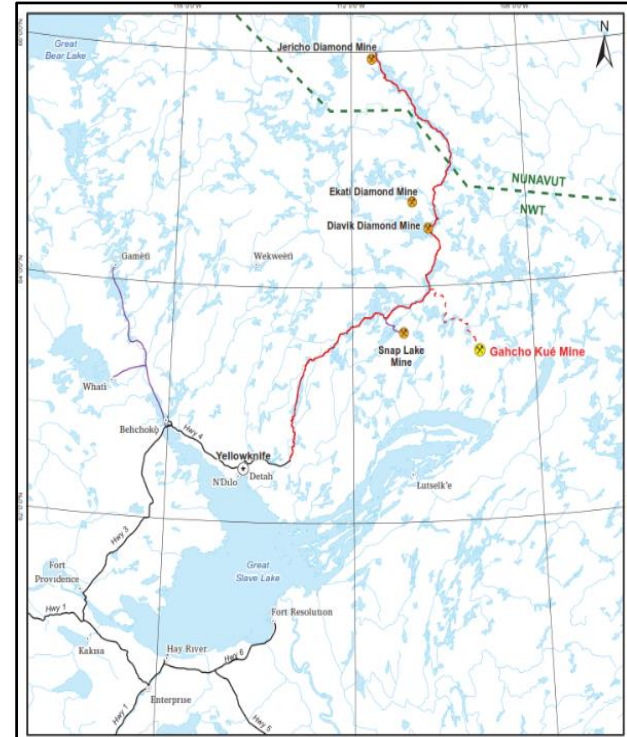
GAHCHO KUÉ MINE TECHNICAL WORKSHOP INTERIM CLOSURE AND RECLAMATION PLAN V3 - UPDATED CRITERIA

December 14, 2017

Sarah McLean, Regulatory Specialist

GAHCHO KUÉ MINE

- Operations Phase: 11+ years
- Closure
 - Active closure and monitoring: 2 years
 - Refilling of Kennady Lake and monitoring: 12-20 years (19-30 years worst case scenario)
- Post closure monitoring
 - Excluding Kennady Lake - until closure criteria are achieved
 - For Kennady Lake – up to 5 years following reconnection to downstream waterbodies



AGENDA

- Overview of the Gahcho Kué Mine and closure goals.
- Summary of closure and reclamation plan development and next steps.
- Presentation of updated criteria for each closure objective category:
 - Side-Wide (SW)
 - Open Pit (OP)
 - Kennady Lake (KL)
 - Mine Rock (MR)
 - Processed Kimberlite (PK)
 - Infrastructure (I)
- Conclusions



CLOSURE AND RECLAMATION PLANNING

- Closure and reclamation plan development
 - Version 1 - Conceptual closure and reclamation plan submitted November 2013 to MVLWB
 - Version 2 – Draft interim closure and reclamation (ICRP) plan submitted February 2016 to stakeholders
 - Version 3 – ICRP submitted July 2016 to MVLWB. Reviewer comments and De Beers response completed in November, 2016.
- In January 2017, the MVLWB outlined a work plan to revised the ICRP to Version 4.
 - Closure objectives review and response – January to March, 2017
 - Objectives approved by MLVWB
 - Closure options and research plan review and response – March to September, 2017
 - Options and reclamation research plan approved by MVLWB
 - Closure criteria review and response – current step commenced September, 2017
 - Criteria updated based on reviewer comments in October, 2017
 - Criteria workshop
- Submit ICRP version 4 to MVLWB for approval – Timing TBD

OBJECTIVE CATEGORIES AND MAJOR MINE COMPONENTS

Site Wide (SW):

- Includes everything on site

Open Pits (OP):

- 5034 pit
- Hearne pit
- Tuzo pit

Kennady Lake (KL)

- Water drainage basin of Kennady Lake

Mine Rock Piles (MR)

- South Mine Rock Pile
- West Mine Rock Pile

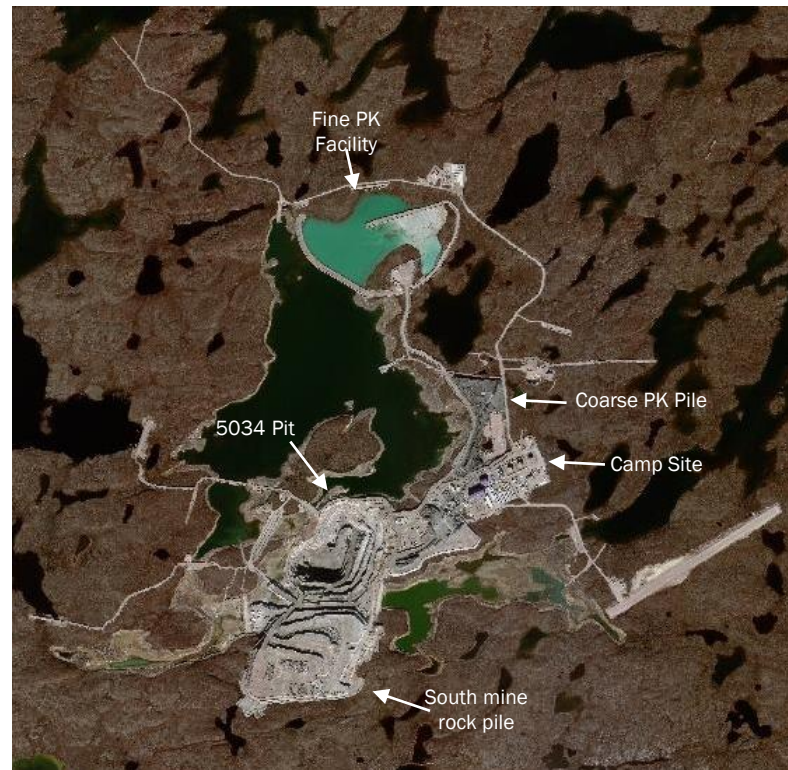
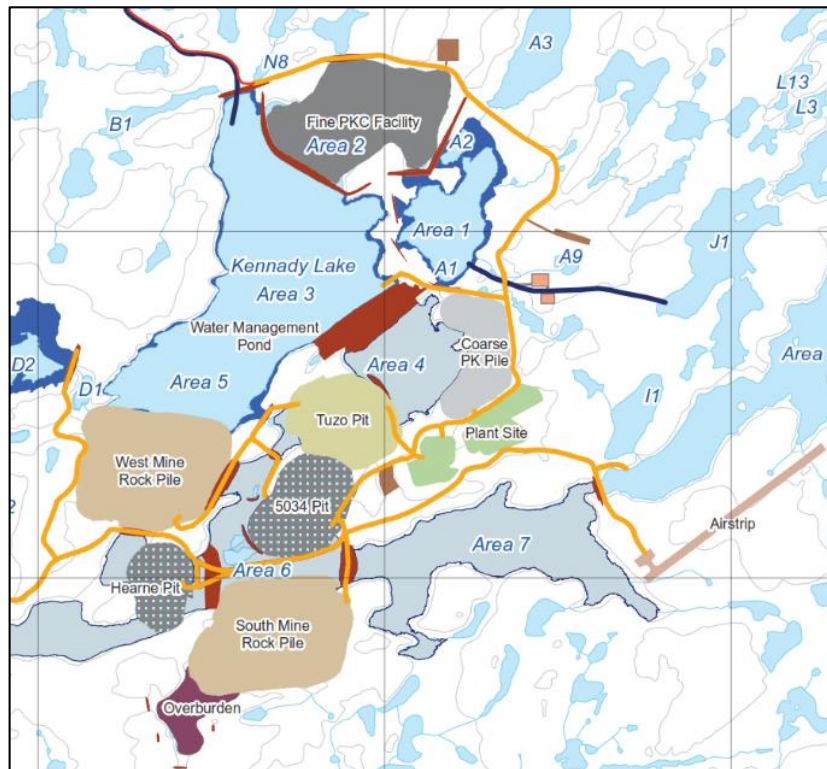
PK Disposal Areas (PK)

- Fine Processed Kimberlite Containment Facility
- Coarse Processed Kimberlite Pile

Infrastructure (I):

- Mine site
- Airstrip
- Water management structures
- Accommodations
- Roads
- Processing plant

MINE SITE



CLOSURE OBJECTIVE AND CRITERIA

SITE WIDE (SW)

Objective

SW1 – Air quality levels safe for people, vegetation, aquatic life, and wildlife.

SW2 – Drainage pathways for surface runoff are physically stable.

SW3 – Surface runoff and seepage water quality that is safe for people, vegetation, aquatic life, and wildlife.

SW4 – Mine areas are physically stable for use by people and wildlife.

SW5 – Safe passage and other use for caribou and other wildlife

Criteria

- Ambient air quality shall not exceed the NWT Ambient Air Quality Standards for total suspended particulate (TSP), fine Particulate Matter (PM_{2.5}), and Nitrogen Dioxide (NO₂). As of September 2017:
 - Annual NO₂ – 60 µg/m³a
 - 24 hour TSP – 120 µg/m³
 - Annual TSP – 60 µg/m³
 - 24 hour PM_{2.5} - 28 µg/m³
- Site-specific criteria may be developed if site-specific factors differ from what was assumed for the generic guideline values therefore affecting the applicability of the generic criteria.

CLOSURE OBJECTIVE AND CRITERIA

SITE WIDE (SW)

Objective

SW1 – Air quality levels safe for people, vegetation, aquatic life, and wildlife.

SW2 – Drainage pathways for surface runoff are physically stable.

SW3 – Surface runoff and seepage water quality that is safe for people, vegetation, aquatic life, and wildlife.

SW4 – Mine areas are physically stable for use by people and wildlife.

SW5 – Safe passage and other use for caribou and other wildlife

Criteria

- No significant signs of deformation, degradation and/or erosion and sedimentation which could contribute to physically unstable conditions as visually observed during geotechnical inspections by a qualified professional engineer on a minimum of two geotechnical inspections occurring over a duration of at least two years.
- Natural drainage conforms to the final site plan, as determined by a qualified professional engineer.

CLOSURE OBJECTIVE AND CRITERIA

SITE WIDE (SW)

Objective

SW1 – Air quality levels safe for people, vegetation, aquatic life, and wildlife.

SW2 – Drainage pathways for surface runoff are physically stable.

SW3 – Surface runoff and seepage water quality that is safe for people, vegetation, aquatic life, and wildlife.

SW4 – Mine areas are physically stable for use by people and wildlife.

SW5 – Safe passage and other use for caribou and other wildlife

Criteria

- Closure water quality that meets territorial/federal guidelines and/or site-specific risk-based criteria to be specified in the Final Closure Plan.
 - Surface runoff and seepage water that is within the catchment basin of Kennady Lake are addressed more specifically within KL1. The Mine Rock Piles and PK Facilities are within the Kennady Lake catchment basin

CLOSURE OBJECTIVE AND CRITERIA

SITE WIDE (SW)

Objective

SW1 – Air quality levels safe for people, vegetation, aquatic life, and wildlife.

SW2 – Drainage pathways for surface runoff are physically stable.

SW3 – Surface runoff and seepage water quality that is safe for people, vegetation, aquatic life, and wildlife.

SW4 – Mine areas are physically stable for use by people and wildlife.

SW5 – Safe passage and other use for caribou and other wildlife

Criteria

- No significant deformation and degradation, and/or erosion and sedimentation is indicated at drainage pathways, Mine Rock Piles, PK areas, and/or any other remaining engineered structures confirmed by visual monitoring as part of site geotechnical inspections completed by a professional engineer on a minimum of two geotechnical inspections occurring over a duration of at least two years.
 - Criteria to satisfy physically stable Mine areas are also addressed during the following objectives:
 - SW2 – Drainage Pathways
 - MR1 – Mine rock facility side slopes
 - PK2 – PK facility side slopes
 - I1 – Disturbed areas of the Mine
- Grading/contouring conforms to the final site plan, as determined by a qualified professional engineer.

CLOSURE OBJECTIVE AND CRITERIA

SITE WIDE (SW)

Objective

SW1 – Air quality levels safe for people, vegetation, aquatic life, and wildlife.

SW2 – Drainage pathways for surface runoff are physically stable.

SW3 – Surface runoff and seepage water quality that is safe for people, vegetation, aquatic life, and wildlife.

SW4 – Mine areas are physically stable for use by people and wildlife.

SW5 – Safe passage and other use for caribou and other wildlife

Criteria

- No buildings or equipment remain above surface grade following final closure.
- Confirmation by the engineer of record that the grading/contouring conforms to the final site plan.
- Satisfactory results of post-closure wildlife risk assessment completed by a qualified professional with input from Aboriginal representatives.
- Use of the site by wildlife (i.e. birds, mammals) as documented through a minimum two years of post-closure monitoring.

CLOSURE OBJECTIVE AND CRITERIA

OPEN PITS (OP)

Objective

OP1 – The backfilled and/or flooded pits will not adversely impact establishment of sustainable aquatic ecosystems and life in the overlying Kennady Lake and downstream waterbodies.

OP2 – Physically stable pit walls to limit risk of a failure impacting people and aquatic life

Criteria

- Water and sediment quality in the flooded/backfilled pits will not adversely affect Kennady Lake water quality such that it prevents re-establishment of the aquatic ecosystem in Kennady Lake.
- Establishment and maintenance of meromictic conditions within the flooded Tuzo pit.
- Additional criteria may be developed in the Final Closure Plan consistent with the outcomes of the reclamation research program.

CLOSURE OBJECTIVE AND CRITERIA

OPEN PITS (OP)

Objective

OP1 – The backfilled and/or flooded pits will not adversely impact establishment of sustainable aquatic ecosystems and life in the overlying Kennady Lake and downstream waterbodies.

OP2 – Physically stable pit walls to limit risk of a failure impacting people and aquatic life

Criteria

- Final conditions of the open pit walls confirmed to be within approved design constraints by a professional engineer.
 - No visual indications of significant deformation and degradation is observed during a final inspection by a professional engineer
- Confirmation by the WSCC NWT Mines Act Inspector that access conditions meet the NWT Mines Act requirements prior to final closure of the pits.

CLOSURE OBJECTIVE AND CRITERIA

KENNADY LAKE (KL)

Objective

KL1 – Return Kennedy Lake to a state that will support a functioning aquatic ecosystem and traditional uses.

KL2 – Physically stable constructed banks of Kennedy Lake to limit risk of failure that would impact aquatic life, wildlife, and people.

KL3 – Kennedy Lake is reconnected with the upstream and downstream and small craft navigation is possible within the Kennedy Lake basin through the dyke and pit areas.

Criteria

- Complete all agreed upon fish habitat compensation in accordance with DFO authorization(s) (03-HCAA-CA66-00057.1)
- Water quality that meets territorial/federal (Health Canada's Guidelines for Canadian Drinking Water Quality (August 2012 edition)) or site-specific risk-based criteria for use as a source of drinking water; criteria linked to health-based targets, not aesthetic.
- Water quality that meets the water quality criteria for the reconnection of Kennedy Lake to the surrounding waters as stipulated in the Final Closure Plan.
- The return of lake trout, northern pike and arctic grayling to Kennedy Lake documented through a minimum of two years of monitoring.
- Aquatic biota monitoring indicates ecosystem recovery is occurring on a trajectory consistent with EIS or updated predictions.

CLOSURE OBJECTIVE AND CRITERIA

KENNADY LAKE (KL)

Objective

KL1 – Return Kennedy Lake to a state that will support a functioning aquatic ecosystem and traditional uses.

KL2 – Physically stable constructed banks of Kennedy Lake to limit risk of failure that would impact aquatic life, wildlife, and people.

KL3 – Kennedy Lake is reconnected with the upstream and downstream and small craft navigation is possible within the Kennedy Lake basin through the dyke and pit areas.

Criteria

- No significant deformation and degradation, erosion, or sedimentation indicated at constructed banks, confirmed by visual monitoring as part of site geotechnical inspections completed by an professional engineer.
 - Criteria to satisfy physically stable Mine areas are also addressed through the following objectives:
 - SW2 – Drainage pathways
 - MR1 – Mine rock facility side slopes
 - PK2 – PK facility side slopes
 - I1 – Disturbed areas of the Mine
- Constructed banks conform to the final design as determined by the engineer of record.

CLOSURE OBJECTIVE AND CRITERIA

KENNADY LAKE (KL)

Objective

KL1 – Return Kennedy Lake to a state that will support a functioning aquatic ecosystem and traditional uses.

KL2 – Physically stable constructed banks of Kennedy Lake to limit risk of failure that would impact aquatic life, wildlife, and people.

KL3 – Kennedy Lake is reconnected with the upstream and downstream and small craft navigation is possible within the Kennedy Lake basin through the dyke and pit areas.

Criteria

- External dykes (e.g. A,E,F,G) are breached connecting Kennedy Lake with the upstream and downstream.
- Internal dykes (B,J,K,N) are breached to 418 masl to allow for small craft navigation within Kennedy Lake

CLOSURE OBJECTIVE AND CRITERIA

MINE ROCK PILES (MR)

Objective

MR1 – Physically stable slopes to limit risk of failure that would impact the people or wildlife.

MR2 – Contaminated rock and non-hazardous waste disposal areas within piles do not pose an unacceptable risk to aquatic life, people, or wildlife.

MR3 – Chemically stable mine rock piles that are safe for aquatic life, humans, and wildlife.

Criteria

- No significant deformation, degradation, and/or erosion is indicated at Mine Rock Piles by visual monitoring as part of site geotechnical inspections completed by a professional engineer for a minimum of two geotechnical inspections occurring over a duration of at least two years.
 - Criteria to satisfy physically stable Mine areas are also addressed through the following objectives:
 - SW2 – Drainage pathways
 - MR1 – Mine rock facility side slopes
 - PK2 – PK facility side slopes
 - I1 – Disturbed areas of the mine
- Mine rock pile and cover constructed as per the approved design, and QA/QC plan as determined by the engineer of record, or other professional engineer.
- Construction documented in an as built report completed by a professional engineer

CLOSURE OBJECTIVE AND CRITERIA

MINE ROCK PILES (MR)

Objective

MR1 – Physically stable slopes to limit risk of failure that would impact the people or wildlife.

MR2 – Contaminated rock and non-hazardous waste disposal areas within piles do not pose an unacceptable risk to aquatic life, people, or wildlife.

MR3 – Chemically stable mine rock piles that are safe for aquatic life, humans, and wildlife.

Criteria

- Management of contaminated rock and nonhazardous waste during mining is completed as per approved management plans (De Beers, 2016b) and confirmed annually in the water licence report.
- Results of a post-closure risk assessment completed by a qualified person indicate that chemical risks at site are consistent, or less than, EIS impact predictions.

CLOSURE OBJECTIVE AND CRITERIA

MINE ROCK PILES (MR)

Objective

MR1 – Physically stable slopes to limit risk of failure that would impact the people or wildlife.

MR2 – Contaminated rock and non-hazardous waste disposal areas within piles do not pose an unacceptable risk to aquatic life, people, or wildlife.

MR3 – Chemically stable mine rock piles that are safe for aquatic life, humans, and wildlife.

Criteria

- Results of a post-closure risk assessment completed by a qualified professional geologist indicate that chemical risks at site are consistent, or less than, EIS impact predictions. Confirmation of placement of PAG rock in the designated PAG rock placement zones, confirmed annually in the annual water licence report.

CLOSURE OBJECTIVE AND CRITERIA

MINE ROCK PILES (MR)

Objective

PK1 – Prevent PK from entering the surrounding terrestrial and aquatic environment.

PK2 – Physically stable PK disposal areas to limit risk of facility failure.

PK3 – Chemically stable Processed Kimberlie Facilities (piles) that do not endanger human, wildlife, or environmental health and safety.

Criteria

- Performance monitoring results and final inspection of rock covers and dykes by a professional engineer indicate the engineered structures are performing as per design; no significant deformation and degradation indicated at PK facilities, confirmed by visual monitoring as part of site geotechnical inspections completed by a professional engineer.
- PK facility cover conforms to the design as determined by the engineer of record.

CLOSURE OBJECTIVE AND CRITERIA

MINE ROCK PILES (MR)

Objective

PK1 – Prevent PK from entering the surrounding terrestrial and aquatic environment.

PK2 – Physically stable PK disposal areas to limit risk of facility failure.

PK3 – Chemically stable Processed Kimberlie Facilities (piles) that do not endanger human, wildlife, or environmental health and safety.

Criteria

- Geotechnical stability analysis completed as part of the detailed design of rock covers by a professional engineer for the Fine PKC Facility and Coarse PK Pile; performance monitoring results and final inspection of rock covers and dykes by a professional engineer indicate the engineered structures are performing as per design.

CLOSURE OBJECTIVE AND CRITERIA

MINE ROCK PILES (MR)

Objective

PK1 – Prevent PK from entering the surrounding terrestrial and aquatic environment.

PK2 – Physically stable PK disposal areas to limit risk of facility failure.

PK3 – Chemically stable Processed Kimberlie Facilities (piles) that do not endanger human, wildlife, or environmental health and safety.

Criteria

- Satisfactory results of a post-closure risk assessment completed by a qualified person indicate that chemical risks at site are consistent, or less than, EIS impact predictions.

CLOSURE OBJECTIVE AND CRITERIA

INFRASTRUCTURE (I)

Objective

I1 – Disturbed areas will be safe for people, wildlife, and vegetation.

I2 – Re-vegetation targeted to priority areas.

I3 – Aesthetic conditions of the infrastructure areas are similar to surrounding natural conditions.

Criteria

- Final site inspection by a professional engineer or qualified professional to confirm removal of all potentially hazardous materials.
- Disturbed areas at the Mine are remediated to applicable federal/territorial soil quality guidelines or site-specific risk-based criteria as required.
- Soil that exceeds criteria (assumed to be the agricultural land use criteria at this time) is either removed or managed to the satisfaction of a qualified engineer to achieve protection of environmental and human health.

CLOSURE OBJECTIVE AND CRITERIA

INFRASTRUCTURE (I)

Objective

I1 – Disturbed areas will be safe for people, wildlife, and vegetation.

I2 – Re-vegetation targeted to priority areas.

I3 – Aesthetic conditions of the infrastructure areas are similar to surrounding natural conditions.

Criteria

- Available surface materials have been salvaged and applied as a growth substrate; compacted soil surfaces (e.g., roads, pads) have been scarified; and native species have been applied to disturbed areas.
- Conformance of the site to the revegetation plan, as determined by a qualified professional.
- Specific criteria will be selected based on achievable coverage of vegetation for the environmental setting at the Mine as determined following completion of the revegetation research and will be included in the Final Closure Plan.

CLOSURE OBJECTIVE AND CRITERIA

INFRASTRUCTURE (I)

Objective

I1 – Disturbed areas will be safe for people, wildlife, and vegetation.

I2 – Re-vegetation targeted to priority areas.

I3 – Aesthetic conditions of the infrastructure areas are similar to surrounding natural conditions.

Criteria

- No visible buildings, equipment or non-local materials on surface.
- Final grading/contouring reflects surrounding topography (e.g. steep edges of roadways and pads flattened) and natural drainage patterns reestablished where possible, native vegetation species established at final closure using methods informed by the research findings

ENR QUESTIONS

1) There are several areas where De Beers proposes that closure criteria are to be to the “satisfaction” of the engineer related to visual inspections. There are various areas of the site where the above is proposed including drainage pathways, rock piles, dams, confirmation of geotech stability, etc.. ENR remains concerned about how this will be measured and/or reported back to parties with the intent of demonstrating performance post-closure. ENR expects that the engineer would have specific criteria to develop the closure design. These criteria are then measured post-closure to ensure the design meets the closure objectives. These criteria are to be the “closure criteria”. **What are the closure design criteria for the various components of the mine site and what research is to occur to inform these closure design criteria?**

De Beers Response:

- The engineer’s inspection reports will be provided to the MVLWB and therefore to all parties
- The Closure Design Criteria are set against the final design of each feature. For this reason it is not possible to list them all at this early stage of mine development.

ENR QUESTIONS

2) As previously discussed, ENR has some concern with the methodology proposed for closure water quality criteria related to Kennady Lake. While ENR supports De Beers position that site-specific criteria may be developed for Kennady Lake, De Beers continues to propose that this criteria will be driven by water quality predictions and the water quality results once the lake begins to refill. ENR notes that acceptable closure criteria must be developed now based on the closure objectives (and intent) for Kennady Lake post-closure. These criteria should not be dependent on the water that is observed after refilling. ENR believes that this approach will ensure that the closure objectives and criteria will dictate closure options and actions and would allow for a more proactive approach in managing water on site to ensure post-closure water quality meets expectations of stakeholders. **As such, ENR requests De Beers commit to a process and timeline for the establishment of water and sediment closure criteria**

De Beers response:

- The process and timeline for water quality criteria are already articulated the RRP. The RRP (Section 5, Task 2) commits to completing updated predictions of Kennady Lake Water Quality and Water Management Options prior to lake refilling. The schedule for completion of this task is between years 2020 to 2024. Criteria would be developed thereafter. It is important to note that water quality will continue to be monitored during refilling and that these data may be used to inform final closure criteria.
- Like water quality, the sediment quality guidelines for the protection of freshwater aquatic life are provided in the AEMP V.5 (Table 9.3-2). These guidelines, together with the normal ranges of background concentrations of these parameters and monitoring data collected during the re-filling process, will be considered for the development of specific closure criteria for sediment quality in Kennady Lake.

ENR QUESTIONS

3) The Board had requested additional information related to closure criteria for the stability of the meromixis. In response, De Beer mentioned reclamation research will be completed to establish numerical closure criteria for the mixolimnion. ENR does not believe this is an adequate response to the Board's inquiry. If meromixis is the proposed closure strategy, then criteria to determine stability is required. The criteria need to be measurable and must demonstrate some form of stability (e.g. X% change in water quality over Xyrs). Further, should meromixis occur the mixolimnion will be the top layer, as such ENR does agree that this area requires separate closure criteria as this area will be representative of the aquatic environment and must be similar to lake-wide closure criteria to support aquatic life. Current understanding suggests that the stability of the meromictic layer is dependant on the ratio of the mixolimnion to the monimolimnion, i.e. the higher the ratio of the monimolimnion to mixolimnion, the less likely that the layers will mix. Reclamation research should be focused on defining the ratio of the layers. De Beers has noted that additional metrics will be developed to confirm meromixis. **ENR would be interested in a brief overview of what these metrics would be.**

De Beers response:

- Section 4, Task 4 of the RRP provides discussion and two example stability formula that will be considered in the selection of criteria. De Beers agreed criteria would need to be developed and informed by research, as well as by the experience at other mine sites that will undergo pit re-filling processes ahead of Gahcho Kué. De Beers considers this an acceptable response to the Board to address perceived gaps in defining criteria at this time.

SECTION 4, TASK 4 OF THE RRP

Task 4: Development of Numerical Closure Criteria

Utilizing the updated predictive model from Task 3, numerical closure criteria for the mixolimnion, or surface water zone, will be developed for water quality in the flooded pits, which will satisfy the Open Pit closure objective OP1.

Additional metrics will be developed to confirm meromictic conditions and its stability and resistance to mixing. For example, equations that quantitatively describe the stability of two water layers on the basis of their density, incorporating other physical conditions (e.g. temperature, wind, etc.) will be evaluated to inform the closure condition. Such examples are Schmidt Stability (Schmidt, 1928) and Lake Number (Imberger and Patterson, 1990).

The research findings will be summarized in a report and submitted with the Annual Closure and Reclamation Plan Progress Report (Part J, Item 4 of the Project water licence).

ENR QUESTIONS

4) De Beers has provided additional information regarding closure criteria for returning Kennady Lake to a state that will support functioning habitat. Of note, there is significant overlap with requirements of the *Fisheries Act* Authorization. For example, De Beers notes that the Authorization references return of fish “populations” while the closure criteria references “the return of lake trout, northern pike, Arctic grayling through a minimum of two years.” The Authorization also references “sufficient number of fish.” ENR requests clarification on how sufficient numbers of fish may be determined (e.g. population ratio, number of total fish, etc). **If there are specific requirements from the Fisheries Act authorization these should be brought forward.**

De Beers response:

- ENR is correct that the process for monitoring the return of fish to Kennady Lake has been established in the Federal DFO Fisheries Authorization.
- The process involves submission and approval by DFO of a Fish Habitat Validation Plan ahead of final construction of habitat features and re-filling of the lake. Upon reconnection of Kennady Lake to the downstream watershed, the use of those habitat features by fish will be monitored for two successive years to confirm the fish have returned to Kennady Lake in sufficient numbers. It is De Beers understanding that determination of the sufficient number of fish will be made by DFO following provision of information by De Beers.

ENR QUESTIONS

5) Regarding OP1, De Beers notes that aquatic monitoring will include sediment quality, water quality and lower trophic levels. As mentioned previously, there are requirements for the establishment of fisheries populations under the Fisheries Act Authorization. **Can De Beers confirm that fisheries monitoring will also be included as a component of aquatic monitoring and be a closure criteria for Kennady Lake ?**

De Beers response:

- De Beers can confirm that fish populations will be monitored as part of the aquatic monitoring and are included in the closure criteria for the KL1.

ENR QUESTIONS

6) Regarding chemical stability of mine rock and processed kimberlite areas, De Beers references that water quality criteria for these areas falls under the objective of KL1. ENR disagrees as KL1 refers to closure water criteria from a lake-wide perspective related to the return of Kennady Lake to functioning habitat. **Localized closure criteria related to mine rock and processed kimberlite storage areas should be developed to ensure that impacts related to seepage water from these areas are minimized within Kennady Lake and avoid these areas from contaminating and degrading the quality of Kennady Lake post-closure.**

De Beers response:

- Water quality criteria will be measured in Kennady Lake. The objective (KL1) is to return Kennady Lake to a state that will support a functioning aquatic ecosystem and traditional uses. The measuring of water quality in the lake is consistent with our mine plan, operations, and our water license (see SNP stations).
- At closure all runoff waters, including from all of the mine features, will report to Kennady Lake. Developing closure criteria for the lake accounts for these inputs.

CLOSING

- Any questions?
- Feedback regarding closure and reclamation is welcome at all times. Please feel free to contact your inquires to:

Sarah McLean

Sarah.mclean@debeersgroup.com

867.688.9227

- Thank you for your participation

