



# Technical Review-Snap Lake Interim Closure and Reclamation Plan

Version 3.2 dated July 2013

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## OVERVIEW

De Beers submitted Version 3.2 of the Interim Closure and Reclamation Plan (ICRP) in July 2013. The plan is typical of mine closure plans and contains generalized details of how the mine would be reclaimed at closure. The plan also addresses the works that would be implemented under a scenario where the mine was placed in Temporary Closure.

At the time of preparation of the ICRP, it was envisaged that the mine would operate for an additional 15 years until 2028. This timing is reflected in the schedule for implementation of the Reclamation Research programs which are required to flesh out details of the closure design. These aspects include the final design for the cover on the North Pile and implementation of the vegetation programs for restoration of the site.

In December 2015, De Beers announced the mine operations would be suspended and placed the site under Care and Maintenance. The company indicated there were three options under evaluation for the future of the site: 1) Reopening the mine; 2) An extended Care and Maintenance period; or 3) Permanent Mine Closure. Given the uncertain future, advances toward the development of a complete and defensible closure plan would appear to be a high priority.

De Beers is proposing to submit Version 4 of the plan in early 2017. This plan will include the following changes and additions: adoption of the new format in conformance with the current guidelines; incorporation of relevant information collected from community and stakeholder engagement, with particular focus on feedback regarding closure criteria; updating to include closure criteria for MVLWB approval; updating of the reclamation research plan based on monitoring and research completed; updating to address the amended Environmental Assessment and current Water Licence; updating of current site conditions; and, updated to address the current Extended Care and Maintenance Plan. It is also expected that the Version 4 plan will include updated designs for the cover for the North Pile; an improved description on how the site will be reclaimed (areas to be vegetated and methods proposed) and; an updated Security estimate.

A key addition to Version 4 will be the addition of measurable Closure Criteria. These are the performance criteria which will confirm whether or not the Closure Objectives have been met.

This report focuses on a review of the Version 3.2 ICRP. A bibliography of documents reviewed for this review included:

- SNAP LAKE MINE INTERIM MINE CLOSURE & RECLAMATION PLAN- (Version 3.2), Arktis Solutions Inc., July 2013.
- ANNUAL CLOSURE AND RECLAMATION PLAN PROGRESS REPORT, Snap Lake Mine, by De Beers, April 2016.

- AQUATIC EFFECTS MONITORING PROGRAM, 2015 ANNUAL REPORT. Snap Lake Mine, De Beers, May 2016.
- ANNUAL GEOTECHNICAL AND GEOCHEMICAL REPORTS, Snap Lake Mine 2015, De Beers, November 2015.
- 2015 ANNUAL REPORT TYPE A WATER LICENCE, Snap Lake Mine, De Beers March 2016.
- 2013 ANNUAL REPORT TYPE A WATER LICENCE, Snap lake Mine, de Beers. March 2014.
- EXTENDED CARE AND MAINTENANCE PLAN V1.1, Snap Lake Mine, De Beers, June 2016.
- SNAP LAKE MINE 2014 NORTH PILE LIFE-OF-MINE PLAN Rev 2- De Beers, June 2014.
- STATUS UPDATE NORTH PILE DEVELOPMENT, De Beers, March 2014.

The review is based upon information presented in the above documents. There may be additional information on file that has not been reviewed and is relevant to the findings as presented below.

### KEY FINDINGS AND CONCERNS

Overall, the ICRP addresses the material issues associated with the closure of the mine. The report lacks details regarding design and specific targets and this is consistent with a mine which was to be operated until 2028. Given the mine future is uncertain, movement towards a more definitive Final Closure plan is warranted.

There are a number of areas that remain of potential concern. The following is a summary of the key findings.

#### North Pile Containment

The North pile closure was developed for a condition where about 50% of the Processed Kimberlite (PK) would be disposed in the mine as paste (paste is a dewatered slurry that does not readily drain water). To date, only small quantities of paste have been placed in the mine mainly in 2012 with minor quantities in 2013 and 2014 and nothing in 2015. Without paste placed in either the underground or North Pile, the volume requirements for storage of the PK on surface have increased dramatically. This has resulted in the redesign of the containment dams, a larger footprint for the North Pile and will require a revision to the financial security.

### Cover Concept for the North Pile

Research is proceeding on the preferred method for covering of the North Pile at closure. There is no indication to date as to the preferred method for covering of the piles. Documentation suggests that the Starter Cell cover design would be completed in 2016. Given that there is a potential for permanent closure of the mine, cover design needs to be finalized and implemented.

### Site Wide Vegetation

Vegetation research has slowly progressed and has been ongoing since about 2003. Minimal commitments for revegetation of the disturbed lands has been provided although both site objectives and criteria have provisions for vegetation. The financial assurance treats vegetation lightly allowing only 0.4% of the reclamation budget for restoration of vegetation at the site. This is likely substantially less than the costs for Reclamation Research program. Input from Elders on the vegetation programs should be encouraged.

### Progressive Reclamation North Pile

The financial security shows about \$10,000,000 would be spent by 2016 on progressive reclamation of the Starter Cell and East Cell. The cover Test Cells on the Starter Cell have been decommissioned suggesting data for the development of the cover design is available. The annual reports discuss progressive reclamation and the 2015 report indicates the cover design is not complete and suggests that no progressive reclamation of the pile has been completed.

### Paste Deposition

The North Pile was to receive Processed Kimberlite (PK) as a paste. During 2011 some surface testing on paste was completed. De Beers indicated “The failure of PK to form a paste, stack on a beach, and to achieve an early relatively high strength, has resulted in the change of design of the North Pile from upstream construction to essentially centerline and in some locations downstream construction. This has necessitated that a greater volume of rock be used to construct North Pile outer perimeter embankments than in the original design. As a result, the capacity of the facility to receive fine tailings is less than planned.” (extracted from Status Update-North Pile Development March, 2014.)

Paste has low water content and would be denser than slurry PK when placed. The higher water content of the slurry tailings will enhance the formation of ice lenses and will likely reduce storage capacity. The reduced density and ice lensing are likely to complicate final covering and closure of the North Pile.

## Closure Criteria

Preliminary closure criteria were proposed in the Version 3.2 ICRP but these have not been approved. These criteria have been revisited and will be updated for comment in Version 4. Major comments and observations are summarized below.

- a) Objective SW4-Mine areas are physically stable and safe for use by people and wildlife. The criteria proposed is *Satisfactory final inspection by professional engineer*. This criterion will need to be expanded as wildlife safety is unlikely to be the purview of a civil/geotechnical engineer.
  
- b) Objective SW5 – Landscape features (shape and vegetation) match aesthetics of the surrounding natural area. The criterion for SW-5 is that *No visible buildings, equipment or non-local materials. Construction of physically stable drainage pathways. Revegetation activities applied to disturbed areas. Acceptable plant biodiversity at revegetation areas*. The criteria will need to include parameters for plant biodiversity. Unlike many other ICRPs, this version states **revegetation activities** will be **applied to disturbed areas** (however, SW-7 indicates only targeted areas will be revegetated and the closure activity also indicates only targeted areas. (The environmental assessment report also made no commitment to vegetate the North Pile). For all other ICRPs at diamond mines that I am aware of, there is no commitment or plan to vegetate rock covers. It should be noted that vegetation of waste piles is in accordance with draft Guidelines for the Closure and Reclamation of Advanced Mineral Exploration and Mine Sites in the Northwest Territories prepared by AANDC and the Mackenzie Valley Land and Water Boards.”. For example, the Guideline states:
  - For tailings areas (PK)- Blend with local topography and vegetation, where appropriate.
  - For waste rock piles-Blend piles with current topography and revegetate as necessary to be compatible with wildlife use, and/or meet future use targets.
  - For Buildings and equipment-Re-establish the pre-mining ground cover (as necessary), which may involve encouraging self-sustaining native vegetation growth and the establishment of supporting media (soil, rock, sediment).
  
- c) Objective SW6 – Safe passage and use for Caribou and other wildlife. The criterion is *Risk of harm to caribou and other wildlife as a direct result of passage through the project site doesn't exceed the surrounding area*. The only issue here is the gradation for the rock cover. Large angular rocks and boulders may cause harm to Caribou legs and feet. The final cover design is outstanding so it is unknown whether this is a concern and should be addressed with the Elders.
  
- d) Objective SW7 – Re-vegetation targeted to priority areas. This objective is weak as priority areas are not defined. This allows the proponent too much latitude to

implement the revegetation program as they see appropriate. The criterion for SW7 is *Revegetation activities have been completed at priority areas; acceptable vegetation biodiversity has been achieved*. The criteria is acceptable however the biodiversity target should be defined.

### Proposed Closure Works

The proposed plans for closure of the mine are reasonable and may be adjusted as additional results from the reclamation research projects becomes available. The following aspects of the plan could be addressed:

- a) Mine Flooding- Based upon the hydrogeological studies, the mine will flood to near surface but below the elevation of the portal in 1-2 years. There have been some concerns that salty water from deep in the mine could discharge through shallow groundwater to Snap Lake. Modelling suggests this is not likely however, the placement of a hydraulic plug in the ramp below the final flooded elevation would essentially isolate the underground workings. *De Beers should be asked to assess the potential for installation of a plug in the ramp to isolate the underground waters from surface discharge.*
- b) North Pile Cover- the North pile is proposed to be covered with 0.5 m of quarried granite. The cover will be placed over unconsolidated PK which will consolidate as porewater is displaced and ice melts. It is expected that much of the pile will freeze although freezing is not a requirement for closure success. The design and implementation of the closure cover is the greatest weakness in the current document. There are 4 potential concerns. 1) The potential for long term differential settlement as a result of thawing in future due to global warming. This could result in ponding and possibly increased seepage. This is not a fatal flaw and is unlikely to result in significant impact. 2) the cover depth of 0.5 m appears to be low as compared with cover designs for Gahcho Kue and Diavik. The test cover work was completed in 2015 and as such, data for the final design should be available and presented in Version 4. 3) Trafficability and access to the slime areas (where present) to allow for cover application and 4) Long term potential for piping of PK through the cover and possibly the perimeter containment dykes. Piping of tailings through shallow covers has been an issue at several sites. Given the ongoing deposition of a higher water content PK slurry which will likely be subject to separation and slimes pool formation, the potential for piping is enhanced. This is often addressed through application of deeper covers, the use of graded filters or the application of geofabrics to inhibit migration.

### Reclamation Research Programs

There is a good Reclamation Research program in place. The primary concern with the program relates to the schedule for completion of the research given that the mine may

remain closed. These programs need to be advanced to conclusion such that a final defensible closure plan can be developed.

### Financial Security

Version 3.2 includes a cost estimate for closure. The cost estimate will be updated in Version 4. The financial security held at the end of 2015, with deposition of PK having occurred in the Starter Cell, East Cell and West Cell, was \$80,401,918 and includes:

- Class A Land Use Permit- \$21,335,671 (MVLWB, 2011);
- Type A Water Licence- \$39,066,247 (MVLWB, 2015); and,
- Environmental Agreement – Additional Security Deposit, \$20,000,000

Some general comments on the estimate include:

a) The cost estimate provides minimal details on the basis for the quantity estimates. For example the estimate for the North Pile does not include the basis for:

- the depth or area of waste rock to be applied for the cover
- the grain size of the rock. Cover test plots used crushed material and no mention of crushing is included in the description which says screening only.
- the excavation required for ditching
- the geotextile requirements

This complicates the interpretation and the adequacy of the estimate. However, given De Beers has estimated a maximum liability of about \$50,000,000 it is likely more than adequate financial security is available.

b) The allowance for vegetation at \$150,000 is inadequate.

c) No justification or description of the long term monitoring, care and maintenance requirements and allowances. They do not however appear to be unreasonable.

### Miscellaneous Items

- a) Visual Appearance of the reclaimed site. It would be most helpful to show pictures (photos, artist impressions, 3d models etc.) of how the site looked before mining, during mining before reclamation, immediately post reclamation and 20 years post reclamation. It is difficult from engineered drawings to gain an appreciation of how the site will appear at closure. This type of pictorial description of the site is an extremely useful communication and education tool. Some preliminary sketches shown from a distance have been prepared and are a good first step.



## SUMMARY AND CONCLUSIONS

The Version 3.2 ICRP is a credible document and meets the basic requirements for an interim closure and reclamation plan. The major concern is that the plan was predicated on mine operations to 2028. The research deficiencies are well defined, however, if the mine is permanently closed, key results from the research programs may not be available for use in the design if the closure works. It is therefore paramount that Reclamation Research programs be expedited such that the final closure design can be completed.

It is expected that Version 4 of the plan will update closure designs and security estimates based upon the Reclamation Research findings to date. For example, the cover research from the Starter Cell has been completed and the selection and implementation of the final cover for the Starter Cell should now be underway. Preliminary data are also available from the initial vegetation trials and as such a conceptual revegetation plan could be prepared.

Based upon the detailed hydrogeologic, geochemical and water quality modelling studies and the extensive monitoring data presented in the annual reports, the reclaimed site is unlikely to have a material long term effect on Snap Lake and the surrounding watershed. The primary impact is likely to be loss of ecological habitat and aesthetic appearance of the large unvegetated rock mounds and rock covers which will occupy more than 50% of the disturbed area of the site.

The greatest weakness with the current draft is the closure concept for the North Pile. The concept was originally developed assuming paste deposition in the impoundment and the concept has not changed. In contrast, only lower density slurries have been placed in the containment. Paste is dense, does not segregate, has low water content and can be readily covered. In contrast, slurries tend to segregate into coarse and fine fraction when discharged. The fine slurry called slimes typically has low strength, is difficult to dewater and represents a challenge for covering. Covering of the slime pools (if present at the lower ends of the beaches) will be challenging and may not be practicable given the high water contents, potential ice lensing and lack of bearing strength. Cover application was the original concept at Diavik for closure of the PK containment, however this was later changed as it was considered to be technically impractical to cover the slime tailings. This led to a revised concept having a residual slimes pool at the lower parts of the beach with water cover and overflow spillway for runoff.

The long term maintenance and care requirements for this site are expected to be minimal. There are no spillways or dams remaining and as such the need for long term maintenance beyond the 20 years proposed is likely minimal. The site does however still need to function to store the PK and acid rock to assure long term containment and to

protect water quality. Annual visual inspection of the site would likely be suitable. This could be accomplished through remote inspection (satellite) with occasional closer ground inspection by aircraft or snow mobile. Some funding for long term surveillance, care and maintenance of the site should be included in the security.