TECHNICAL REVIEW

Diavik Final Closure and Reclamation Plan

Version 1

Draft Report to

Environmental Monitoring Advisory Board (EMAB)

By

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Plain Language Summary

The Diavik final closure plan is detailed and well prepared. In general, the plans as proposed are reasonable and supported by good science. The areas where there remains concern include:

1) The Dry Cover Option for the Tailings (Processed Kimberlite Containment-PKC)
2) Long Term Care and Maintenance
3) Minimal budgets for vegetation and site restoration

The dry cover option is a preferred concept as it eliminates a surface pond and has the potential require minimal maintenance in the long term. Diavik has presented a concept for the dry cover but it has not demonstrated that the option is feasible. Concerns include the robustness of the cover under some climate change scenarios and the long-term stability of the PKC and rock cover. Diavik must address these concerns before they can present this as a viable closure option for the PKC.

Long term funding remains a critical concern for the land owners. Based upon the plan as presented, Diavik proposed to abandon the facility in 2050 at which time it believes the site will be stable and require no additional monitoring and maintenance.

It is our opinion that monitoring and maintenance is required in the long term and funding should be provided by Diavik. Maintenance items include items such as the spillway at the PKC, rock covers and drainage channels. In addition, funding is required for long term monitoring. This could likely by achieved in part through remote monitoring using satellite imagery.

EMAB needs to express their concern to the Water Board about the lack funding for long-term care, maintenance and monitoring and push Diavik to provide such funds. We believe this is a moral responsibility for all mining proponents.

The allowance for revegetation and restoration of the land is minimal at less than 1 percent of the closure cost.

Overview

The Diavik closure plan is extremely detailed and for the most part supportable. Diavik has undertaken extensive consultation with the land owners and addressed many of the concerns.

There remain several issues that will need to be clarified and possibly modified. These relate to three main areas:

1) Dry rock cover closure plan for the Processed Kimberlite Containment (PKC) Facility
2) Availability of funds to finance long term maintenance
3) Allowances for vegetation/site restoration

These items are addressed in the following sections.

Areas of Concern

Dry Cover Closure Plan for the PKC

Diavik has presented a conceptual closure plan for the application of the dry cover over the PKC. The plan involves placement of cover on the competent coarse and fine PK during non frozen conditions and placement of 0.5 to 2 m of rock cover on the extra fine processed kimberlite (EFPK) once frozen to an adequate depth.

The primary concerns include:

- The plan is conceptual and **may not be feasible**. Although there is optimism that the plan can be implemented, even the designer has doubts. Golder state on page 31 of Appendix C Design Basis states "In summary, the thermal and consolidation evaluation conducted for the Rockfill Option suggests that the option **may be feasible** and warrants further evaluation."
- Thermal modelling and stability of the cover remains uncertain and does not account for several factors that could affect the results. Selected examples include:
    - excess pore-water pressure beneath the frozen zone is possible, but this aspect is not evaluated in this modelling exercise.
    - Piping of EFPK to the surface. There is no geogrid, filter fabric or engineered filters shown in the design presented in Appendix X-15 for the surface of the EFPK. The placement of 1.5 m will occur directly on the frozen EFPK. At many sites where waste rock was placed on fine tailings, elevated pore pressures has resulted in piping of tailings to surface. The rational for not including a filter zone is likely that filters would not accommodate the massive settlements of up to 7 to 10 m and as such were not proposed. This is a material concern and needs to be addressed. It is noted that the RECLAIM model does have provision for a geogrid and geotextile. It is unclear where this material is to be applied.
    - The very high in situ void ratio estimated for the upper 10 to 15 m of EFPK based on field investigation programs suggests that uncertain site conditions are delaying or limiting the consolidation process. This aspect is not captured in the models and could

result in a much longer term for settlement to occur and thus future ponding beyond 2050 could occur. This could result in thawing of the EFPK and failure of the concept.
    - The mode for the dissipation of excess pore pressures is unknown. Where does this water go, how is the heat in this drainage water handled in the thermal balance and how does it affect future freezing? The modeler indicated that it is uncertain where this water will flow or even if it will be trapped by frozen PK.
    - The stability of sloped rock cover over a deep zone of potentially liquifiable EFPK has not been addressed. Stability analysis has shown the dams will be stable however, the effect of an earthquake on the closed PKC was not discussed. Can it be demonstrated that the EFPK will not liquefy? If not, what happens when the EFPK liquifies? Can the surface flatten and result in EFPF discharge? These aspects need to be addressed.
    - Golder has stated "Given the uncertainties associated with the EFPK characteristics into closure, there is potential for the EFPK to consolidate more than the predicted 4 m. If this occurs, the closure inlet channel gradient may reverse such that water cannot drain and a pond may form." There is no allowance to address this potential issue if it occurs beyond 2050.
- Preliminary modelling suggests it may not be possible to maintain the EFPK frozen. For example:
    - If settlement in future allows a pond to form, the EFPK will thaw.
    - If the climate change exceeds 5.6^{o} C, the EFPK will thaw. Given that the Arctic is undergoing more substantive changes than are occurring elsewhere, a greater than 5.6^{o} C change may need to be considered.
    - The rock depth on surface will vary from .5 to 2 m. Modelling has shown that reducing the rock depth from 1.5 to 1 m increases thawing and increase surface temperatures by about 0.7^{o} C. Less cover would have would result in much higher surface temperature increases. Why is 0.5 m an appropriate depth of cover? This need to be confirmed.
- The stability of sloped rock cover over a deep zone of potentially liquifiable EFPK has not been adequately addressed. Stability analysis has shown the dams will be stable however, the effect of an earthquake on the closed PKC was not discussed. Can it be demonstrated that: 1) the EFPK will not liquefy? If not, what happens when the EFPK liquifies? Can the surface flatten and result in EFPK discharge? These aspects need to be addressed. Furthermore, the Zone 1 cover over the shoreline is shown at 20:1 slope (~3^{o}) and is founded over a layer of EFPK. It is understood that the stability analysis suggests that the undrained strength of 0.15 is required to assure the beach is stable while EFPK undrained strength range from 0.05 to 0.15. It is unclear why the assessment was completed with the maximum shear strength for EFPK.
- The Reclaim model indicates 171,000 m^3 of tailings are to be hydraulicly mined yet the design is to rip and excavate in frozen conditions. This needs to clarified.

In summary, the dry cover option has potential but many issues remain to be resolved.

Financial Assurance and Financing for Long-Term Care

The post closure monitoring plan is provided in Appendix VI. The plan is detailed, has been reviewed by the Water Board and Territorial Government and appears to be reasonable complete. There are two

primary issues that appear to be lacking. 1) assumption that long term monitoring beyond 2050 is not required and not funded 2) assumption that future maintenance beyond 2050 will not be required and minimal funding for future maintenance appears to have been included and 3) The allowance for revegetation and restoration of the land is minimal at less than 1% of the total closure cost.

It is Diavik's position that once the Closure plan meets closure criteria, that much of the holdback funding should be returned. Certainly, there is potential for closure works to meet criteria for several years but climate change may cause future conditions that are not acceptable. If any maintenance/monitoring is required, does this becomes the responsibility of the land owner? Certainly, Diavik or it successors may not exist and if most funds are returned, then the land owner is left holding the bag.

For both the North Country Rock Pile and PKC facility, there is a reliance on freezing. If climate change is more than 5.6^{o} C, the frozen Type III rock may thaw and the EFPK is expected to thaw. The consequences are not assessed and may be material both environmentally and economically. The LWB/GNWT/CIRNAC Guidelines for Closure and Reclamation state "Where climate change beyond 2100 could reasonably mean that closure criteria may not be met (for example, if PAG rock might thaw after the year 2100), a performance holdback may be appropriate." In the current plan, Diavik has suggested that the holdback for vegetation, North Waste Rock Pile and PKC should be about $4 million. Given a total closure plan cost of about $200 million, this seems to be very low (2%) and likely should be materially higher. Possible costs could include:

- Rebuilding the PKC spillway as a result of damage or need to lower the invert because of settlement in the PKC.
- Additional rock to either the NCRP or PKC to assure long-term freezing or to address greater than expected settlement.
- Monitoring costs beyond 2050.
- Cleanup of spilled PKC in the event of catastrophic failure.

It is our understanding that Diavik expects that the holdbacks will be released in future leaving no funding for long term care and maintenance. It is our opinion that monitoring and maintenance is required in the long term and funding should be provided by Diavik. Maintenance items include items such as the spillway at the PKC, rock covers and drainage channels. In addition, funding is required for long term monitoring. This could likely by achieved through remote monitoring using tools such as INSAR.

EMAB needs to push the Water Board to retain a portion of the holdback funds for a minimum of 50 years. Thet should only be returned when updated climate forecast have been verified, updated and future predictions confirm that the design are robust to climate change for the next 100 years.

Vegetation/Site Restoration

Diavik has now provided a plan for vegetation of the disturbed areas of the site. The plan provides for scarifying and seeding of 324 ha of land. The areas are based upon those suggested by the TK Panel and are reasonable. The only measure of success for vegetation is that dust levels are controlled and 10 germinated seeds/m^2 was achieved. This is only to be monitored in selected areas at specified monitoring pads. The total estimated cost is $628,000 with an allowance of $101,000 for reseeding. This

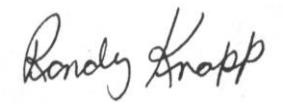
modest allowance for vegetation and restoration of the site represents substantially less than 1% of the reclamation cost. This is not a material effort to return the land to a condition similar to that occurred which to prior to mining.

Closure

We do caution the reader that the document covers more than 6000 pages with extensive technical content. With the limited time available to review the detailed information, the author may have missed key information or misinterpreted information presented.

We trust this report meets your expectations. If you would like additional details or clarification, please contact the writer at your convenience.

Yours truly



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