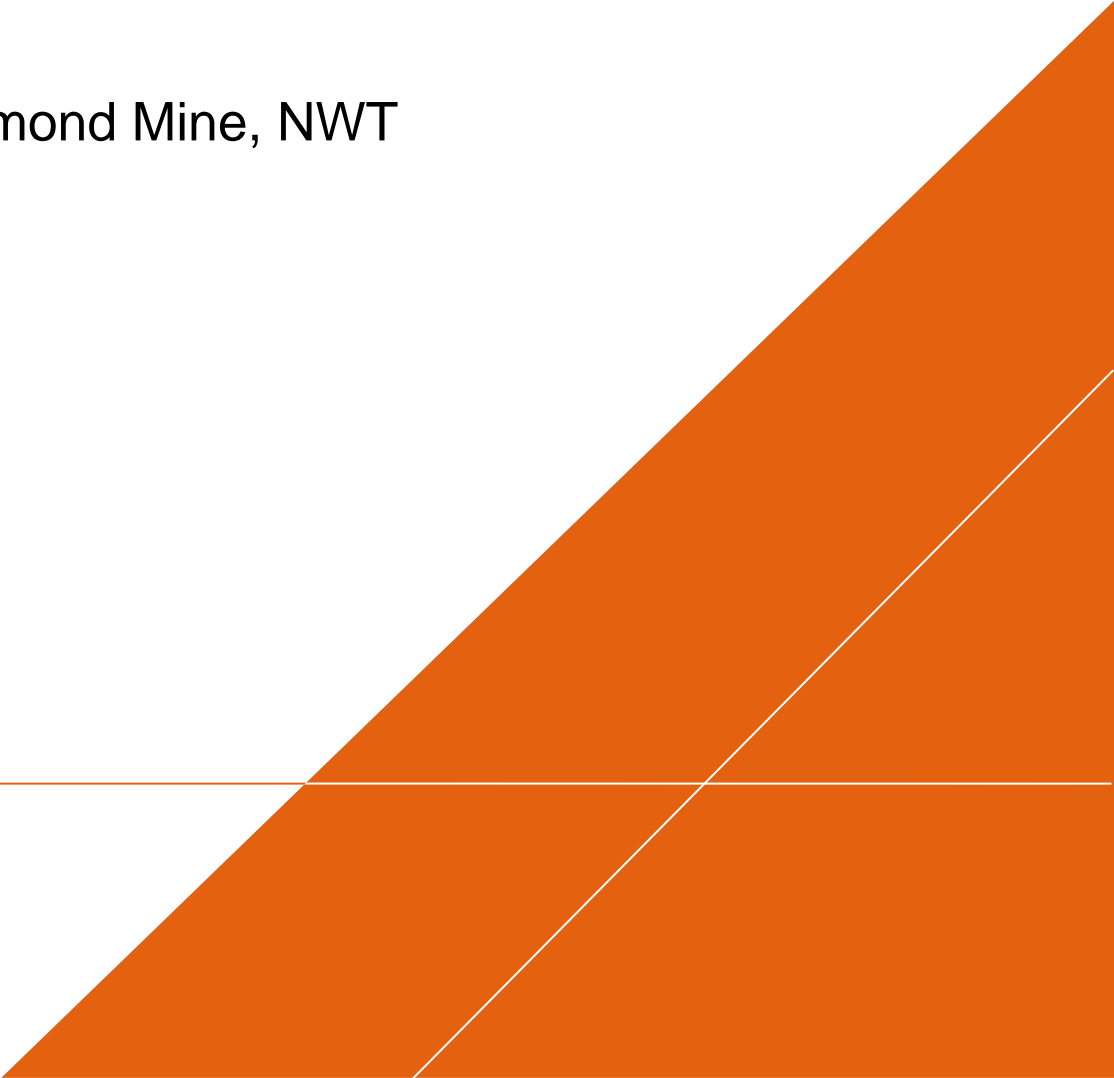


**ENVIRONMENTAL MONITORING ADVISORY BOARD (EMAB)**

**REVIEW OF DIAVIK CLOSURE CRITERIA  
FOR NORTH COUNTRY ROCK PILE –  
FINAL CLOSURE PLAN – APPENDIX IV**

Diavik Diamond Mine, NWT

July 2016



## Review of Diavik Closure Criteria for North Country Rock Pile Final Closure Plan

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## 1 INTRODUCTION

Arcadis Canada Inc. (Arcadis) was retained by the Environmental Monitoring Advisory Board (EMAB) to review the Closure Criteria associated with the Final Closure Plan North Country Rock Pile Park K Item 7 (hereafter referred to as the NCRP Closure Plan) now included in the Diavik Diamond Mines (2012) Inc. (Diavik) 2015 Closure and Reclamation Plan (CRP) Progress Report.

Diavik submitted the following reports for public review and discussion:

- Final Closure Plan – North Country Rock Pile – Version 1, DDMI, 2016.
- Diavik Diamond Mine Site-specific Risk-based Closure Criteria Phase I Report. January 2016, written by Environmental Resource Management Consultants Canada Ltd. (ERM); and,
- Diavik Diamond Mine Site-specific Risk-based Closure Criteria Phase II Report. March 2016, written by ERM.

The NCRP Closure Plan has been included as Appendix IV in the 2015 Annual CRP Progress Report. Within the NCRP Closure Plan, Diavik has proposed Closure Criteria for Water and for Air.

### 1.1 Scope of Work

The Scope of Work for this review includes:

- Review the Closure Criteria proposed in the NCRP Closure Plan.
- Summarize the appropriateness of the methodology used to develop the Closure Criteria in a plain language report; and
- Provide comments in the WLWB specified format for EMAB's consideration.

The purpose of this review is to comment on the:

- Process of selecting COPCs;
- Process of developing Closure Criteria; and
- Comment on any aspects not considered in the derivation of the Closure Criteria.

The review does **NOT** consider any other aspects of the NCRP Closure Plan, other than the risk-based Closure Criteria proposed.

## 2 PROJECT DESCRIPTION

A specific closure plan for the NCRP has been prepared by Diavik as requested by the Wek'èezhìi Land and Water Board (WLWB) and has reportedly been prepared as per the requirements of DDMI's Class "A" Water License WL2015L2-0001.

The final closure design for the NCRP includes:

- Re-shaping of the pile to better fit the landscape and provide a suitable surface for a cover;
- Construction of a thermal cover; and
- Caribou access ramps.

Progressive reclamation of the NCRP can begin in 2017. This Final Closure Plan – NCRP was prepared in advance of the Final Closure Plan for the site, to accommodate the progressive closure of the NCRP.

### 3 CLOSURE AND RECLAMATION PLAN GOALS – NCRP

Closure goals and objectives drive the requirements for mine closure. Closure goals are broad statements of planned outcomes. Closure criteria should be specific to an objective, measurable and are used to evaluate when an objective has been achieved.

As reported in Diavik’s NCRP Final Closure Plan, Diavik’s overall goal for the operation and closure of the mine site is:

“To operate and close the Diavik Mine responsibly, leaving behind a positive community and environmental legacy.”

The four closure principles of physical stability; chemical stability; no long-term active care and future use guided the development of the closure objectives.

The Closure Goals for the Diavik Mine Site are as follows:

1. Land and water that is physically and chemically stable and safe for people, wildlife and aquatic life.
2. Land and water that allows for traditional use.
3. Final landscape guided by traditional knowledge.
4. Final landscape guided by pre-development conditions.
5. Final landscape that is neutral to wildlife – being neither a significant attractant nor significant deterrent relative to pre-development conditions.
6. Maximize northern business opportunities during operations and closure.
7. Develop northern capacities during operations and closure for the benefit of the North, post-closure.
8. Final site conditions that do not require a continuous presence of mine staff.

The Closure Objectives are site-wide (applicable to the five closure areas) and area-specific. The site-wide closure objectives that are applicable to the NCRP were listed in the Final Closure Plan as:

- SW1. Surface runoff and seepage water quality that is safe for humans and wildlife.
- SW2. Surface runoff and seepage water quality that will not cause adverse effects on aquatic life or water uses in Lac de Gras or the Coppermine River.
- SW3. Dust levels safe for people, vegetation, aquatic life and wildlife.
- SW4. Dust levels do not affect palatability of vegetation to wildlife.

- SW6. Ground surface designed to drain naturally follow pre-development drainage patterns.
- SW7. Areas in and around the site that are undisturbed during operation of the mine should remain undisturbed during and after closure.
- SW8. No increased opportunities for predation of caribou compared to pre-development conditions.
- SW9. Landscape features (topography and vegetation) that match aesthetics and natural conditions of the surrounding natural area.
- SW10. Safe passage and use for caribou and other wildlife.

The area-specific Closure Objectives applicable to the NCRP were listed as:

- W1. Physically stable slopes to limit risk of failure that would impact the safety of people or wildlife.
- W2. Rock and till pile features (shape and appearance) that match aesthetics of the surrounding natural area.
- W3. Contaminated soils and waste disposal areas that cannot contaminate land and water.

For the purposes of this review, Arcadis has reviewed the criteria used to define the SW1, SW2, and SW3 objectives.

## 4 CLOSURE CRITERIA

The NCRP will have buried waste under an engineered fill cap, therefore, the primary mitigation measure of the NCRP Closure Plan with respect to chemical stability will be to minimize poor quality seepage water from entering the environment. Concern of water pooling (from precipitation and snow melt) on the NCRP has also been noted. Therefore, Diavik proposed surface water runoff and seepage criteria protective of wildlife, humans and the aquatic environment.

Wildlife and people could be exposed to contaminants in surface water from surface runoff/seepage. As a result, Diavik has proposed Closure Criteria for the SW1 Closure Objective using either site-specific risk based closure criteria (SSRBCC) developed by ERM or Health Canada's drinking water quality guidelines. Arcadis previously reviewed the derivation of the SSRBCC reported in The Phase I and Phase II reports prepared by ERM. The major review comments that apply to the NCRP Closure Plan are re-stated in the WLWB comment sheet. Other, minor comments from Arcadis' previous review also apply, but were not repeated.

The SW2 Closure Criteria proposed by Diavik define runoff/seepage water quality benchmarks that will not cause adverse effects to the aquatic environment in Lac de Gras or the use of Lac de Gras. Diavik is proposing that parameters that meet the SW2 Closure Criteria can be released to Lac de Gras without concern. If concentrations of parameters are greater than the SW2 Closure Criteria, then consideration of a continued active treatment as a contingency plan would be required.

Diavik proposed Closure Criteria to measure the SW3 objective of dust deposition that are meant to be protective of humans, wildlife, aquatic life and plants.

Arcadis has provided detailed comments regarding the Closure Criteria proposed to measure the SW1, SW2 and SW3 objectives in the WLWB Excel table and have summarized the major issues below for EMB's consideration.

#### **4.1 Comments Relevant from Review of Phase I and Phase II Reports.**

Arcadis previously reviewed the Phase I and Phase II Reports written by ERM and provided comments with respect to the approach, methodology and assumptions used in the derivation of SSRBCC. The following are major comments that apply to the NCRP Closure Plan:

- COPCs were identified using statistics and not using the maximum concentration detected. A number of COPCs that require Closure Criteria were missed in Arcadis' opinion.
- The reports did not consider ecological receptors that were representative of specific guilds and human receptors representative of workers and non-first nations in the derivation of the SSRBCC.
- The derivation of SSRBCC should have used site-specific toxicity benchmarks based on appropriate toxicological endpoints with appropriate supporting rationale or toxicity benchmarks developed by reputable agencies.

Arcadis is concerned that the appropriate COPCs were not identified in the process used in the above reports and that additional parameters should have Closure Criteria developed.

#### **4.2 Closure Criteria to Measure the SW1 Objective**

The SW1 Closure Objective is that surface runoff and seepage water quality will be protective of human health and wildlife.

Any of the comments that apply to the identification of COPC and ecological receptors and exposure pathways could influence the SW1 Closure Criteria for wildlife.

For the SW1 Closure Criteria protective of human health, an inconsistent approach was taken to select the closure screening criteria. The Phase I and Phase II Reports developed SSRBCC protective of human health from exposure to impacted water. The Phase I and Phase II Reports also developed SSRBCC protective of adults and toddlers from exposure to impacted water. In the NCRP Final Closure Plan, it seems that Diavik chose the LESS stringent (higher number) of the adult SSRBCC or the Health Canada drinking water quality guideline. If the less stringent criteria chosen was the SSRBCC, Diavik chose the adult and not the toddler criterion.

The SW1 Closure Criterion protective of human health should have been based on the most stringent criterion developed. Arcadis suggests that Diavik be requested to provide a rationale for the selection of the Closure Criteria and to use a consistent, defensible approach.

### 4.3 Closure Criteria to Measure the SW2 Objective

The SW2 Closure Objective is based on the protection of the aquatic environment and use of Lac de Gras from surface water runoff and seepage.

Despite Diavik developing SSRBCC protective of aquatic organisms (of which there were some concerns with the choice of toxicity benchmarks, among other things), they elected to base the SW2 Closure Criteria on the Metal Mining Effluent Regulation deleterious average monthly limits (MMER). The concerns with this approach are:

- The MMER exist for a small set of deleterious substances as defined by the Fisheries Act, and not for all COPCs identified from run-off/seepage. Therefore, Closure Criteria for all COPCs are not included in the NCRP Closure Plan.
- Closure Goal 8 indicates that the final closure conditions should not require the presence of mine staff. The MMER require toxicity testing in addition to the monitoring of the runoff/seepage water on a regular basis. Frequent monitoring and testing of this Closure Criteria will be required.
- The MMER are set at a level at which adverse effects to aquatic life would be expected, thus violating the SW2 Closure Objective of no adverse effects to aquatic life.

Arcadis is of the opinion that the Closure Criteria should be set at a level protective of the aquatic environment so that they meet their closure objectives. Diavik has not seemed to consider a dilution zone within Lac de Gras or any sort of attenuation in the Closure Plan.

### 4.4 Closure Criteria to Measure the SW3 Objective

The SW3 Closure Objective states that dust levels are safe for people, wildlife, plants and the aquatic environment. The Closure Criteria selected are the total suspended particulate (TSP) fractions for annual and 24 hr exposure for the Northwest Territories and for Canada.

Defining criteria to measure this objective is not as straightforward as defining one to protect the aquatic environment or human health. There are a number of different criteria available that could be used to measure this objective. Arcadis would suggest that additional information regarding the Closure Criteria proposed be provided by Diavik. It is not clear if this objective is in place only during the NCRP closure (i.e., placement of till or Type I rock, design of the pile) or is dust anticipated to be a concern after the NCRP is closed? What is the anticipated area that could be impacted by dust from the NCRP? Has Diavik conducted chemical analysis of the dust particle fractions? Are there COPCs associated with certain fractions that would be more of a concern to receptors?

Based on the information provided in the Closure Plan, it is difficult to evaluate the appropriateness of the Closure Criteria proposed. Arcadis suggests that Diavik provide a



rationale for the Closure Criteria and describe what has been considered and how the Closure Criteria will adequately measure the Closure Objective.

#### 4.5 Additional Considerations in the Derivation of Closure Criteria

The NCRP Closure Plan considers capping Type III rock with a mixture of fill and Type I Rock, as well as having areas of Type I rock only. The Phase I and Phase II reports identified soil COPCs in the Type I rock. It is not clear if the environmental quality of the till was investigated and if COPCs exist in the till. As humans and ecological receptors could be exposed to COPCs in the Type I rock and potentially in the till, Closure Criteria considering potential exposure to soil COPCs should be part of the NCRP Closure Plan.

Appendix V1-2 indicates a number of parameters that will be included in the post-closure monitoring program including the following: total ammonia, field parameters, ICP-MS Metal Scan (total), Major Ions, pH and total petroleum hydrocarbons. These parameters should have Closure Criteria established to interpret the post-closure monitoring data.

A specific Closure Objective for the NCRP Closure Plan is stated as: W3. Contaminated soils and waste disposal areas that cannot contaminate land and water. The Closure Plan has defined the Closure Criteria for this as “the NCRP As-Built Report conforms with Golder 2016”. It is not clear if monitoring to ensure the engineering design is meeting the Closure Objective is proposed and if it is, what environmental standards the monitoring results will be compared with. Clarification of this should be sought.

## 5 CONCLUSIONS AND RECOMMENDATIONS

Arcadis has completed a review of the proposed Closure Criteria to measure the SW1, SW2 and SW3 Closure Objectives. Based on our review we offer the following conclusions:

- The approach taken to identify COPCs in the Phase I report was flawed and resulted in a number of COPCs not being identified as such. The post-closure monitoring program identified a number of COPCs, all of which should have a Closure Criteria developed.
- Relevant ecological receptors and guilds were not considered, nor were some human receptors (mine workers, people conducting future post-closure sampling). This could affect the SSRBCC developed.
- Inconsistent approaches were used by Diavik to define the Closure Criteria to measure the SW1 objective for human health. A consistent and defensible approach should be used.
- Diavik chose to ignore the SSRBCC developed for the protection of aquatic life and instead relied on the MMER values that are set at levels above those considered to be protective of the aquatic environment. The use of MMER values would require frequent monitoring and toxicity tests and violates the Closure Objective of no adverse effects.
- Additional information regarding the criterion selection to measure the SW3 Closure Objective is required. Understanding the extent and duration of impacts from dust and the

chemical composition of the dust fractions would help to develop appropriate Closure Criteria to evaluate this Closure Objective.

## 6 LIMITATIONS OF THIS REPORT

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