Memorandum

To: John McCullum, Environmental Monitoring Advisory Board

From: Bill Slater

Date: April 5, 2023

Re: Diavik Water Licence Amendment
Progressive Reclamation – Re-establishing Natural Drainages

As requested, I have reviewed Diavik Diamond Mines Inc.'s (DDMI's) water licence amendment application requesting authorization for progressive reclamation by decommissioning of some collection ponds and direct discharge of runoff to Lac de Gras. As described in my estimate dated December 16, 2022, my review included the following documents:

- Water Licence Amendment Application Form and Draft Licence
- Relevant portions of Appendix E, Final Closure and Reclamation Plan (FCRP)
- Appendix VI-1, Closure and Post-Closure Monitoring
- Appendix VI-2, Closure and Post-Closure AEMP Design Plan
- Appendix X-12, Surface Water Management
- Appendix X-19, Closure Site-Wide Water Balance Model
- Appendix X-20, Sitewide Water Quality Model Update
- Appendix X-21, Hydrodynamic and Water Quality Modelling of Pit Lakes and Lac de Gras
- Appendix X-22, Rationale for Assessed Runoff Mixing Zone During Post-Closure

Following my initial review I reviewed DDMI's Responses to Comments, participated in the Wek'èezhìi Land and Water Board (WLWB) Technical Session on March 6-8, 2023 and reviewed the Responses to Information Requests arising from the Technical Session.

As part of the overall review of the FCRP, Slater Environmental engaged Core Geoscience Services (Core) to review FCRP Appendix X-10, Current and Projected Climate Parameters. Discussions at the Technical Session highlighted that the results of the Core review are also relevant to water licence amendment application. As a result, I have attached Core's review memo as Attachment 1 to this memo, and I have considered the findings in my comments and recommendations.

This memo provides the findings of my review.

1.0 Regulatory Concept for Water Quality Management

DDMI proposes that direct discharge of runoff from the mine site to Lac de Gras be authorized in the requested water licence amendment. Previous discussions envisioned that authorization to breach collection ponds could be provided on the basis of an approved Closure and Reclamation

Plan, or an approved Decommissioning Plan for specific Collection Ponds. The concept of specific Decommissioning Plans is included in the Draft Water submitted with the application Licence (Part G, Clause 33), with the intended content described in Schedule 8. In its cover letter, DDMI indicates that all of the information described in Schedule 8 has been included in the FCRP for each Collection Pond.

With respect to water quality of runoff, DDMI proposes that the water licence include limitations on pH of effluent and requirements for the effluent not to be acutely toxic to aquatic organisms (Part G, Clauses 36 and 37 of the Draft Licence). It proposes that all other parameters should be managed through the proposed Surface Water Action Level Framework (SWALF) whereby there are no specific limits on effluent concentrations, but rather progressive response actions if monitoring shows conditions that are toxic or exceed effects benchmarks (aquatic effects), or exceed criteria (wildlife and human health). This approach does not appear to fully achieve the intent of Schedule 8, Section 3:

> *"Identification, with rationale, of new or updated Closure Objectives and/or Closure Criteria being proposed, including:*
>
> 1. *SW1 and SW2 criteria for the decommissioned catchment that include a list of contaminants of potential concern with rationale;*
> 2. *Consideration of new closure criteria and/or objective(s) to assess effects in the Receiving Environment, including sediment quality, with rationale; and*
> 3. *Consideration, with rationale, of a SW2 criterion to address extent of sublethal effects*."

First, the proposed water quality limits in the licence only include pH and acute toxicity and SW2 criteria are established only of toxicity to aquatic organisms. Schedule 8 envisions SW2 criteria for all contaminants of potential concern in each catchment. In accordance with the WLWB's policy and guidance on waste management as presented at the Technical Session, closure criteria (i.e., standards that measure the success of selected activities in meeting closure objectives) could be addressed through various mechanisms including effluent quality criteria, management plans and adaptive management.

For discharge from Collection Ponds, clear licence limits should be established now for parameters that are likely to be consistently relevant for all of the runoff locations and where effects are also consistently relevant. For many dissolved contaminants (e.g., metals, major ions), the concentrations and mixing zone characteristics mean that appropriate numerical criteria will vary between catchments. In these cases, developing SW2 closure criteria on an individual basis is an acceptable site-specific approach – but it has not been done in the current version of the FCRP. Many of these contaminants would also contribute to toxicity which is included as one of the proposed licence limits. Total Suspended Solids (TSS), however, is a significant contaminant of concern for all mine site runoff, especially as reclamation activities proceed. It is often one of the first indicators of problems with reclamation measure performance. Without modifications to standard toxicity testing, TSS is not likely to have much influence on results of lab toxicity tests and therefore is not addressed by the proposed licence limits. Nonetheless, it can have adverse effects on aquatic life and aquatic habitat.

In the Response to Comments and at the Technical Session, DDMI acknowledged an oversight with respect to TSS and acknowledge the need to address the oversight. However, the Response to Information Request appears to propose that TSS would only be addressed through the Surface Water Action Level Framework (SWALF), not by inclusion of an effluent standard as proposed for pH and acute toxicity (Part G, Clauses 36 and 37 of the Draft Water Licence). Like pH and acute toxicity, TSS should be directly regulated in the licence at least until such time as the consistent, ongoing erosion resistance of the closure landscape has been confirmed.

Recommendation 1: In addition to effluent quality limits for pH and acute toxicity, the Water Licence should include limits for TSS. These should either be consistent with the MDMER, or if/when MDMER do not apply to the runoff, then CCME Guidelines should be used.

Second, the proposed water quality management approach does not address the specific contaminants of potential concern (COPCs) that may be relevant for each Collection Pond, as envisioned for a Decommissioning Plan as per Schedule 8. The Responses to Comments and discussions at the Technical Session indicate that DDMI does not envision any further numerical criteria for specific watersheds. The analysis presented in DDMI's March 28, 2023 Response to IR#7 confirms DDMI's view that no effluent criteria are warranted for other parameters in any of the Collection Pond catchments.

There was discussion at the Technical Session about the need for specific thresholds for a broader range of parameters, and where any such thresholds should be included (e.g., in the licence or the Surface Water Action Level Framework [SWALF]).

The March 28, 2023 Response to IR#7 provides DDMI's analysis of Parameters of Interest (POIs) and subsequently Parameters of Potential Concern (POPCs), and its rationale for excluding effluent quality criteria or closure criteria for any additional parameters at any locations. Based on this, DDMI argues that no additional parameters need to be addressed either in the licence or in the SWALF.

With respect to POIs, DDMI argues that petroleum hydrocarbons are not a POI because none are anticipated in the runoff post-closure due to closure related measures. However, there is uncertainty about performance of closure measures. Because these contaminants are present in some watersheds, there is potential for contamination to occur if closure measures are ineffective. Given that sediment monitoring indicates elevated hydrocarbon concentrations in some Collection Pond sediments, there appears to be potential for contamination at locations close to runoff streams. As a result, hydrocarbons should remain as a POI. DDMI also argues that monitoring of pH and TSS indicates that these parameters will not exceed relevant limits and therefore they are not POIs. While previous monitoring provides some indication of future performance there is outstanding uncertainty, especially for TSS in watersheds where further earthworks or land disturbance activities may occur. However, it is notable that the proposed licence already provides mechanism for management of pH and TSS.

With respect to POPC, DDMI describes four steps for identification:

1. Compare maximum predicted runoff concentrations to acute benchmarks, AEMP effects benchmarks, Federal Environmental Quality Guidelines (FEQG) and drinking water guidelines.
2. Compare maximum predicted runoff concentrations to baseline median runoff concentrations from the Environmental Assessment.
3. Compare 95th percentile predicted concentrations at the mixing zone boundary (Arc 1) to baseline normal range (ice-covered conditions).
4. Compare 95th percentile predicted concentrations at the mixing zone boundary with AEMP effects benchmarks.

Each of these steps sequentially removes POIs from further consideration as POPC and seems to move towards a definitive conclusion about whether EQC are required. The results, especially of the fourth step, are not surprising because they are consistent with the modelling results presented in FCRP Appendices X-20, X-21 and X-22. The modelling to support the closure plan predicts that there will be very few instances where POI concentrations at the mixing zone boundary will exceed AEMP benchmarks.

The first three steps in DDMI's evaluation demonstrate that the predicted post-closure conditions indicate that the mine site has potential to contribute measurable loading of certain contaminants from various locations – a condition that should be sufficient to say that parameters are POPC that warrant management and monitoring in order to ensure that unexpected effects do not occur.

As noted, DDMI describes a four-step process for identifying POPC. However, the process actually includes a fifth step that introduces a subjective element to the analysis. The output from the fourth step identifies POPCs that "may require EQC." In the Response to IR#7, DDMI ultimately concludes that none of the parameters that screened through the four steps (copper silver, uranium and phosphorus) require EQC.

The analysis of POIs and POPC appears to indicate that the closed mine site will continue to contribute measurable loads of some contaminants. Management and monitoring of these substances would provide a foundation for a more proactive approach to management of any unexpected changes in water quality conditions.

Recommendation 2: Provide clear regulatory requirements to establish and meet numerical thresholds for relevant contaminants of concern in all of the affected watersheds.

2.0 Breaching Versus Controlled Discharge

DDMI describes the rationale for the progressive reclamation of some Collection Ponds, where water quality conditions allow, as follows: "*to enable progressive reclamation in this Application will allow us to get a head start to closure performance monitoring, support the validation of planning to date and use new results to adaptively manage the next phases of our Reclamation work.*"

Progressive reclamation at mine sites is generally beneficial because it can reduce the reclamation liability at the mine site and the time required to carry out final reclamation measures once mining is complete. Progressive reclamation typically is undertaken in areas of mine sites that are no longer active, where reclamation measures are complete and the areas will not be subject to further

disturbance. This type of progressive reclamation is often aimed at source control and stabilization of disturbed areas.

The progressive reclamation proposed by DDMI however, is focused on removal of the surface water management facilities that are present at the site, while mining and reclamation activities still remain to be completed. Typically, mining companies retain these types of facilities through closure phases to manage and provide contingencies for any sediment releases or surface water issues that may arise from the reclamation activities in upstream areas. As such, the proposed sequency of progressive reclamation is somewhat unconventional. However, DDMI has concluded that it is practical and has proposed a monitoring and response framework aimed at evaluating performance and water quality conditions after removal of the water management infrastructure.

Nonetheless, DDMI's February 24, 2023 Response to Information Request (Table 3) and responses at the Technical Session confirm that grading and re-vegetation activities will continue within most pond catchments after the proposed dates for breaching. Until grading is complete and vegetation established, there is ongoing potential for sediment release from disturbed areas.

Given that future land disturbance is possible in some of the Collection Pond catchments, water quality conditions could change quickly, leading to a need to re-establish Collection Pond functionality – an action identified in the SWALF. If the ponds are breached, reestablishment will be difficult, especially at times when water quality conditions are most likely to deteriorate, due to high flow events. Temporarily keeping pond functionality in place (i.e., not breaching) while allowing controlled discharge of water that meets licence limits for discharge from Collection Ponds should be considered further. This would provide authorization for DDMI to proceed with discharge of clean runoff, while maintaining effective and proactive contingency facilities and capacity. Discharge of water in accordance with licence requirements could be undertaken using pumps, siphons or spillways, depending on specific situations.

In Section 5.2.8.3.2 of the FCRP, DDMI argues that approaches that maintain the integrity of collection pond containment are not practical: "*DDMI has determined that it is not practical to create a controlled discharge that will accurately represent passive, diffuse and discontinuous post-closure discharge conditions*." As suggested, discharge using pumps, siphons or spillways will create discharge rates and timing that are somewhat different than discharge in a stream with no control pond. Nonetheless, discharge while retaining the pond dams in place would still entail discharge of water via stream channels, a condition that is much more similar to post-closure conditions. Discharge could be undertaken as much as possible and practical in a way that is consistent with natural hydrographs. Such an approach would provide an opportunity to reduce the costs of pumping/treatment and consider the effects of direct discharge, while maintaining the ability to rapidly respond if water quality conditions deteriorate.

Recommendation 3: Limit breaching of Surface Water Ponds until after completion of operations and closure-related earthworks and erosion control measures (e.g., re-vegetation) in the specific catchments while providing for controlled discharge of surface runoff that meets licence limits (for discharge from Collection Ponds), numerical closure criteria and thresholds in the SWALF.

3.0 Decision-making for Pond Decommissioning

The FCRP Closure and Post-Closure Monitoring Plan (Section 3.1.4.4) states that SNP monitoring will be used to make decisions about reconnecting drainages to Lac de Gras, and that "*water quality will be required to meet closure criteria during a final sampling event immediately prior to reconnecting the closure drainages to Lac de Gras*." Table 7 of Attachment 2 in the Monitoring Plan clarifies that the final sampling event will entail "*at least three stations located evenly spaced around the Collection Pond shoreline*." Because the proposed decommissioning of ponds will entail breaching the ponds leading to uncontrolled flow whenever water is present, it will be important to ensure that water quality is expected to remain suitable for discharge in a variety of flow conditions and throughout the year. As a result, the decision to decommission ponds needs to consider data collected over a range of seasons and climatic conditions.

Recommendation 4: Decommissioning should be prohibited until monitoring demonstrates that water quality has remained suitable in various flow conditions and throughout the year.

FCRP Section 5.2.18 proposes that "*Sediment remaining in the ponds will be tested for contamination and covered, if required*." Section 5.2.8.3.2 makes a similar statement. The FCRP Monitoring Plan does not include any information about monitoring of sediment in Collection Ponds.

In the Response to Comments, DDMI noted that sediment sample results were included in Appendix X-27 (1273 pp). However, neither the FCRP nor the water licence application provide any analysis or interpretation of these data, or any details of how they are used. At the Technical Session, DDMI confirmed that it would make decisions about management of these materials as if they were sediments in a waterbody, similar to the North Inlet, where the threshold for remediation (i.e., placement of a rock cover) proposed is 1,500 mg/kg of F3 hydrocarbons. However, once the ponds are drained the sediments will be primarily in a terrestrial environment. In this case, they are more similar to contaminated soils. The thresholds proposed for remediation of contaminated soils at Diavik are described in FCRP Appendix V Table 3. These include standards for F1, F2, F3 and F4 hydrocarbons (respectively 210, 150, 300 and 2,800 mg/kg), based on CCME standards. The threshold for soil remediation for F3 hydrocarbons is five times lower than that for North Inlet sediments.

Recommendation 5: DDMI should revise the thresholds and remediation plans for sediment in control pond areas to consider the material as contaminated soil rather than sediment that will remain submerged.

There was discussion at the Technical Session about the need for additional criteria to address other contaminants of concern for sediments in control ponds. DDMI argued that work done for the North Inlet confirmed that hydrocarbons were the only relevant contaminant of concern. However, the mechanism for sediment contamination and the source of contamination in the North Inlet (i.e., pumping of water from active mining areas) are likely not the same as those for contamination in the control pond sediments. As a result, the evaluation of the need for sediment remediation may need to consider a broader range of contaminants. For example, if there are sources of metal contamination in pond catchments, sediment should be evaluated for relevant metal contaminants.

Recommendation 6: DDMI should conduct an analysis of contaminants of concern for Collection Pond sediments to consider a range of contaminants consistent with the potential sources and mechanisms of contamination for these materials.

4.0 Surface Water Action Level Framework

DDMI proposes that management of surface runoff from the site will rely on the proposed SWALF. The Technical Session included substantial discussion about the SWALF and IR#4 required DDMI to provide a revised SWALF or options that DDMI is prepared to consider. DDMI's Response to IR#4 provided options for further consideration.

With respect to both Wildlife and Human Health, the revised SWALF proposes that the response to Action Level 1 triggers (exceeding 80% of a criterion) would entail a "detailed risk assessment to confirm or adjust" the criterion/criteria. Investigation of cause and implementation of control mitigation are identified as responses to Level 2 triggers – i.e., when water quality exceeds any adjusted/confirmed criteria.

At a fundamental level, the proposed framework begins with the assumption that it is the criteria that are the problem, not the measured conditions. In the context of a mine closure project an adaptive response plan should initially be focused on whether the closure plan is performing as expected, not on whether the measurement criteria need to be relaxed. To achieve this, the response to Action Level 1 triggers should include investigation of cause. This would form the basis for subsequent decisions about responses. For example, if the cause is not mine-related and is expected to continue, then reconsideration of criteria may be warranted – but that may or may not be to rely on a risk assessment methodology depending on conditions. On the other hand, if the cause is mine-related appropriate, practical mitigation (e.g., runoff management, source control) should be developed and implemented. Only after such measures have been implemented, with continued exceedance of criteria, should there be consideration of risk assessment to adjust criteria. This outcome could be addressed as a response to a revised Action Level 2 trigger.

Recommendation 7: Revise the SWALF to provide for investigation of causes of SW1-1 or SW1-2 exceedance, and consideration of maintenance/mitigation before revising closure criteria, potentially as a response to a revised Action Level 2.

None of the Action Levels in the SWALF consider a comparison of water quality to the predicted conditions, in either Lac de Gras or individual catchments. Instead, all Action Levels rely on comparison with benchmarks, criteria or toxicity. Variance of water quality from that predicted during planning is an important early indicator that conditions are different than what was expected, conditions which may eventually lead to failure of closure criteria. Such comparison could be carried out in Lac de Gras but also in individual catchments. Comparison to predicted conditions is not specific to wildlife, human health or aquatic conditions, but rather provides a general, early indicator of unexpected water quality conditions before they would be considered problematic. The expected responses to variance from predicted conditions could likely be much less onerous than for exceedances of benchmarks, criteria or toxicity, but would at least provide an opportunity for early consideration of causes – whether mine-related or not.

Recommendation 8: Revise the SWALF to include an Action Level trigger that is based on comparisons between actual and predicted conditions potentially considering predictions in both individual catchments (i.e., close to sources) and Lac de Gras.

5.0 Closure Objective SW1

Table 5 in Appendix V specifies the numerical water quality criteria for Closure Criteria SW1-1 (Human Health) and SW1-2 (Wildlife). For human health, the criteria are aimed at protecting recreational use of water and are based on human health drinking water guidelines "*multiplied by a factor of twenty to account for the potential for incidental consumption during recreation.*" This approach assumes that the runoff water will not be used as a source for drinking water but only ingested incidentally for example while swimming.

DDMI's modelling predicts that concentrations at the mixing zone boundaries will meets the consumption criteria for both wildlife and humans, indicating that use of water for drinking at these locations is not expected to be adversely affected by mine discharges. The modelling also predicts that runoff water in the streams on East Island will have concentrations that meet the criteria for consumption by wildlife, indicating that all of the water should be safe for consumption by wildlife. However, that water may not meet consumption criteria for people. DDMI confirmed this in its Response to Comments and at the Technical Session, noting that it does not expect runoff streams to be used as a source for drinking water (and that signs will be in place). This is a reasonable assumption.

However, the modelling also predicts that water quality within the mixing zones in Lac de Gras may exceed drinking water standards. DDMI acknowledged in FCRP documents and at the Technical Session that people will likely drink water from Lac de Gras. Also, the SWALF Action Level 3 trigger is reached only when water quality at the mixing zone boundary exceeds drinking water criteria – providing that water quality within the mixing zone would exceed drinking water guidelines before corrective action is taken. The implications of consumption of water in these mixing zone areas should be considered.

Recommendation 9: DDMI should provide information about how it has addressed potential use of water in mixing zones for human consumption, and whether there may be long-term constraints on consumption in these areas.

6.0 Closure Objective SW2

Closure Objective SW2 requires that water quality from the mine site will not cause adverse effects on aquatic life or water uses in Lac de Gras or the Coppermine River. The proposed Closure Criteria address sublethal toxicity (SW2-1) and acute toxicity (SW2-2). As discussed in Section 1.0 of this memo, Schedule 8 of the Draft Water Licence envisioned Closure Criteria for a broader range of relevant contaminants of potential concerns.

Sublethal toxicity is to be evaluated using a single species of invertebrate (*Ceriodaphnia dubia)* using 12.5% strength of effluent – i.e., 8:1 dilution. DDMI's rationale for selecting 8:1 dilution is that it provides an indication of potential toxicity before reaching 10:1 dilution that DDMI expects to have at the mixing zone boundary. The selection of this dilution ratio for evaluation of achievement

of the Closure Objective means that sublethal toxicity may occur in effluent streams and large parts of mixing zones, while still meeting the Closure Criterion and therefore achieving the Closure Objective. Also, the decision to rely on a single species to evaluate sublethal toxicity means that potential sublethal effects on other species are not considered in the evaluating performance.

Recommendation 10: Closure Criterion SW2-1 should be revised to address toxicity to a broader range of species. Typically testing would be completed on relevant sensitive fish, invertebrate and algae/aquatic plant species.

At the Technical Session DDMI explained that for some parameters, the predicted background (i.e., non-mine related) water quality loading can lead to concentrations that are very close to the AEMP benchmarks in post-closure conditions. In the Response to Information Request #1 following the technical session, DDMI states that this arises from an "artifact of conservative modelling assumptions." This may be a reasonable conclusion given the approach for modelling and the assumptions about background water quality.

However, the issue does raise some questions about the methods for evaluating achievement of the proposed closure criteria, specifically toxicity testing methods. The proposed testing may not provide an accurate characterization of the actual conditions, depending on the source of dilution water used for toxicity testing. Lab toxicity testing typically relies on dilution water that is low in contaminant concentrations. In this case, the lab dilution water may not be representative of the actual dilution water that will be present in Lac de Gras. Therefore, the toxicity testing at 8:1 dilution using lab water may have contaminant concentrations lower than what will be present at the actual mixing zone boundaries and therefor underpredict the toxicity conditions that are present in Lac de Gras.

Recommendation 11: DDMI should consider whether xoxicity testing protocols for evaluating achievement of closure criterion SW2-1 should be revised to require use of Lac de Gras water as dilution water for lab testing.

7.0 Closure Objective SW6

Closure Objective SW6 is stated as "*ground surface designed to drain naturally following pre-development drainage patterns*." The associated Closure Criteria address satisfactory completion of the design (SW6-1) and satisfactory performance of drainage networks (SW6-2). DDMI proposes annual monitoring at freshet for a period of five years to evaluate the performance and condition of the drainage network, and identify any need for maintenance or repair. This is a reasonable approach to evaluate initial performance and confirm initial achievement of the Closure Objective. However, the stability and performance of drainage networks is related to the size of hydrologic events that occur more than to the passage of time.

The proposed initial monitoring program makes sense because it includes monitoring at freshet when major flows are likely to occur. But, additional monitoring is needed to confirm performance after the initial period, and after any high flow events whether in the initial five years or in the long-term.

Recommendation 12: The monitoring program should include inspections during the initial five-year period after any major storm events that may cause erosion or damage to conveyance channels or pond breaches. Once the initial five-year period has passed, periodic monitoring should likely continue at lower frequency, and event specific monitoring should be conducted after large events.

8.0 Design Criteria

Appendix X-12, a Golder report on Surface Water Management, provides designs for the breaches of most Collection Ponds – all except Pond 3 which is to be addressed through design for the PKC Facility. The design basis assumes a design life of 100 years from the start of closure. The design criterion for floods is conveyance of peak flows from a 1:200-year 24-hour storm event.

The closure landscape at Diavik must perform adequately in perpetuity, not just for 100 years. As a result, facilities designed to convey 1:200-year events will, over the life of the project, certainly sustain some damage from events larger than the design events. In some cases, this may be tolerable, provided that the damage expected: (1) is consistent with the level of channel evolution that may happen in natural channels during similar return-period events, and (2) does not create risks for mine waste storage facilities. If failure of any breach could lead to progressive erosion that may affect a mine waste storage facility, then more robust designs should be required.

In its Response to Comments, DDMI states that "upslope progression of erosion to mine waste facilities is unlikely given the distance between collection pond breaches and these facilities" referring to FCRP Appendix X-12 Sub-Appendix A, Table 1, Item 4. The referenced item addresses incremental consequences of failure and provides a design basis relating to erosion. However, it does not confirm that upslope progression of erosion near other structures was considered. Sub-Appendix D of Appendix X-12 provides a geomorphological assessment for the pond breaches and Task 2 characterizes terrain downstream of the breaches, but does not consider potential upstream progression. Figures in the Sub-Appendix confirm that some breaches are located within close proximity to the toes of other mine structures (e.g., Pond 4). DDMI has not provided evidence that upstream progression of erosion from pond breaches has been specifically addressed at relevant breach locations.

Recommendation 13: DDMI should provide evidence for each proposed breach about the potential erosion that may result from failure during events larger than the design event. As part of this, it should consider whether that erosion is consistent with erosion rates in similar natural channels during similar events and whether progressive erosion at any of these locations could adversely affect mine waste storage facilities. Where erosion could affect mine waste storage facilities, more robust closure designs would be required. Where erosion greater than that expected in natural channels may occur, post-closure maintenance should be expected and required.

9.0 Water Quality Model – Source Term for PKC

The water quality model, described in Appendix X-20 assumes that, in the long-term, there is no seepage from processed kimberlite (PK) stored in the Processed Kimberlite Containment (PKC) Facility and that loading only occurs from water contacting PK that is in the active layer. The total

active layer is estimated to be 2.2 m, of which 0.7 m will be unfrozen PK (the remainder is in the cover), meaning that modelling assumes that there is no long-term loading from most of the PK stored in the PKC Facility. This is likely a substantial uncertainty in the model and if more PK contributes load, then the modelling could underpredict the long-term contaminant loading to the relevant Collection Pond catchments. The modelling does not consider any potential increase in active layer thickness as a result of climate change. The 2.2 m estimated active layer thickness compares with 3.9 m predicted for the North Country Rock Pile (NCRP) by the year 2110. The potential contributions from PK could be quite important because, as noted in Section 6.1 of Appendix X-20, loading rates for many contaminants are at least an order of magnitude higher in PK than in Type I rock material.

The thickness of the predicted active layer for the PKC Facility was discussed at the Technical Session. DDMI confirmed at the Technical Session and in response to IR#6 that the estimate of 2.2 m active layer thickness was provided in a thermal analysis that is in ICRP v4.1, Appendix X-5, Sub-Appendix B. The Sub-Appendix is a 2013 memo from Golder Associated titled "Diavik PKC Facility Thermal and Seepage Analyses to Support the Revised Closure Concept." The closure concept at the time entailed a cover similar to that now proposed for the PKC Facility, so the analyses represent an appropriate physical configuration.

In the Response to IR#6 DDMI provided estimates of water quality in runoff from the PKC Facility after consideration of a 4 m active layer. It asserts, based on the 2013 analysis, that the PK would otherwise remain frozen and therefore no further modelling or consideration of water quality conditions is warranted, even though this modest increase in the amount of PK contributing to loading results in predicted concentrations up to 3.5 times greater.

There are remaining concerns about whether the analyses provide a conservative, up-to-date estimate of post-closure conditions, especially when considering the implications of climate change. The more recent thermal modelling for the NCRP also provides an example for comparison including consideration of material properties used in the analyses.

Attachment 1, a memo from Core, provides comments and recommendations related to the climate change projections updated to support the FCRP. As noted in the memo, the FCRP analysis relied on the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report (AR5, 2013) because climate projections for the more recent 6th Assessment Report (AR6, 2021) have not been downscaled. Core identifies that "there is potential for predicted climate parameters to be different (potentially hotter temperatures) than under AR5." The thermal analysis for the PKC Facility was conducted before IPCC AR5 was available, and therefore relies on even older climate projections.

Recommendation 14: The thermal analysis and related seepage and water quality predictions should be updated based on conservative, current projections of climate change.

The thermal analyses rely on estimates of material properties in order to predict temperature profiles over time – for example the thermal conductivity of materials, and their capacity to hold heat both influence the temperature profiles over time. Table 3 in the 2013 Golder memo lists properties of materials, including Type I rock fill that will be part of the cover. The source of these properties is referenced to earlier work completed by Golder in 2007 – design reports for the PKC

Facility. Appendix XI for the NCRP Final Closure and Reclamation Plan v1.1 (2017) is a thermal analysis conducted by TetraTech to support the cover design for the NCRP. Table 7 of that report provides thermal properties for Type I rock fill that is part of the cover. The properties were "determined indirectly from well-established correlations with soil index properties" and were verified by comparison to measurements made in test piles at Diavik and other locations reported in literature. Table 1 below provides comparisons of material thermal properties for Type I rock fill used in the two analyses.

Table 1: Comparison of Thermal Properties for Type 1 Rock Fill

	Moisture Content (%)	Bulk Density (Mg/m^3)	Thermal Conductivity (W/m-ºC)		Specific Heat (kJ/kgºC)	
			Frozen	Unfrozen	Frozen	Unfrozen
Golder 2013	5	1.9	1.9	1.6	0.89	1.05
TetraTech 2017	3	2.06	1.32	1.57	0.77	0.83

There are some substantial differences between the thermal properties used for Type I rock fill in the two analyses. It is not clear whether the differences reflect a better understanding of the properties for the later study, or if there is significant uncertainty about the actual properties. Nonetheless, the difference in material properties could have a significant influence on the predictions of temperature profiles and freeze/thaw characteristics. Therefore, it would be useful to understand whether the 2013 thermal model accurately portrays the conditions that have developed in the facility.

Recommendation 15: Use existing conditions to validate whether the PKC Facility thermal model provides an accurate prediction of current thermal conditions in the Facility, and consider whether the model and its assumptions and inputs (e.g., material properties) should be refined.

10.0 Misclassified Waste Rock

Section 4.4.3.3 of the FCRP discusses misclassified waste rock from the A-Portal. This Type III rock has potential for acid-generation and metal leaching, but was used for construction activities in some areas of the site. Based on subsequent investigations and sampling, DDMI concluded that "*the bulk geochemical characteristics of the areas that incorporated A-Portal waste rock into construction (and specifically the worst-case surface construction scenarios) are still constructed with Type I or non-PAG rock"* and that *"acid rock drainage and metal leaching is expected to remain within the normal range for Type I Rock."*

As shown on FCRP Figure 4.4, the misclassified rock is concentrated in a few drainages. Even though the bulk characteristics of the material used for construction may be non-acid generating/non metal leaching, the Type III materials could cause increased concentrations of contaminants at a local scale and could affect runoff quality. For example, materials are not necessarily well mixed with other neutralizing materials, and flow paths of runoff/seepage may not

contact neutralizing materials. Elevated contaminant concentrations caused by oxidation of reactive materials may not be apparent in current sampling and may take many years to develop because the effects will not be apparent until reactions consume all of the effective neutralization potential in the materials. For catchments that contain misclassified rock, it will be important to continue monitoring for at least as long as it would take for the reactive materials to produce ARD and metal leaching, and for any contamination to be measurable in the drainage path if it were to occur.

In the Response to Comments and at the Technical Session, DDMI asserted that any effects of the misclassified rock would already be measurable in downstream locations. However, it did not provide or refer to test work and/or analyses to confirm that the rock would have currently released sufficient acidity to consume its inherent neutralizing potential and that contaminants would have travelled to monitoring locations. In the absence of this type of information, there is remaining uncertainty about performance.

Recommendation 16: DDMI should revise monitoring durations for catchments in which misclassified Type III rock was used for construction. Monitoring durations should be sufficient to detect any contamination that arises from potential ARD and metal leaching, based on predictions of the time for the specific materials to react and consume neutralizing materials.

11.0 Monitoring

DDMI proposes that frequency of monitoring of site runoff will be reduced to twice annually after completion of closure activities on the site. The desire to reduce monitoring frequency once all closure activities are complete is understandable. Nonetheless, monitoring of site runoff is an important mechanism for understanding performance of the closure landscape. At the very least, the post-closure monitoring program should be designed to understand the water quality conditions including seasonal variability, and conditions in various flow conditions. Twice annual monitoring is likely not sufficient to achieve this purpose. Understanding the variability will require monitoring at least during freshet (when flows and TSS are both likely to be high) after freshet (when modelling indicates that maximum effects are likely to occur – FCRP Closure and Post-Closure Monitoring Plan Section 3.1.4.3) during summer, and during fall (once open water flows have declined). For intermittent discharges, monitoring will need to focus on times when flows are likely to be present (e.g, storm events). This frequency of monitoring should be continued until results demonstrate that lower frequency can provide statistically representative understanding of variability.

Recommendation 17: Increase post-closure monitoring frequency for surface runoff, with sampling of sufficient frequency to capture major hydrological periods and water quality variability. For intermittent flows, monitoring should focus on time periods when flow is likely to be present.

DDMI proposes once annual monitoring of water quality at the mixing zone boundary for a period of two years following completion of decommissioning of each Collection Pond. It proposes that sampling would continue if source water samples do not meet closure criteria, or if concentrations at the edge of the mixing zone exceed AEMP effects benchmarks. The modelling predicts that concentrations at mixing zone boundaries for many parameters and locations will be well below

AEMP benchmarks. As a result, exceedance of AEMP benchmarks at the mixing zone boundary would, in most cases, be unlikely, and therefore the AEMP benchmarks at this location are not an effective threshold for making decisions about future monitoring. Instead, it makes sense to rely on comparison with predicted conditions and evaluation of trends to assess the need for continued monitoring.

Recommendation 18: Sampling conducted in the first two years at mixing zone boundaries should be compared with predicted concentrations from modelling and evaluation of trends, to assess whether the runoff and mixing conditions are consistent with expectations. If concentrations of any parameters are higher than predictions or trending upward, monitoring should continue.

Appendix VI-2, the FCRP Closure and Post-Closure Aquatic Effects Monitoring Program Design Plan describes proposed AEMP monitoring for the closure and post-closure period. It "*incorporates updates that account for changes to site drainage conditions on the East Island that will occur during closure and post-closure*" (AEMP Design Plan, Section 4.4.1). Until then, DDMI proposes to continue with the operational AEMP Program. The operational AEMP Program is premised on a single discharge of water from the site, the North Inlet Water Treatment Plan (NIWTP) discharge. The Closure and Post-Closure Plan on the other hand, is premised on discharges from various catchments around East Island. DDMI plans to decommission some of the Collection Ponds as early as 2023, before the mine enters the closure and post-closure stage. FCRP Section 6.3.1.4 indicates that breaching of Collection Ponds 1,2,4,7,10,11,12, and 13 and Sump 21 may potentially occur as progressive reclamation. The AEMP for the operational period is not designed to monitor potential effects of the additional discharge locations.

Recommendation 19: DDMI should be required to implement relevant parts of the Closure and Post-Closure AEMP Design Plan, including monitoring potential effects of the additional discharge locations, in association with any Collection Ponds that are decommissioned during the operational period.

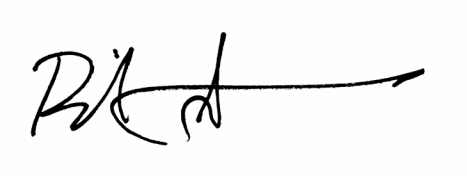
12.0 Specific Comment on Draft Licence

1. Part G, Clause 33 should be revised to clarify that authorization to discharge from components of the Collection Pond System is subject to other conditions of the licence, e.g., Part G, Clauses 36 and 37.
2. Part J, Clause 10 should be revised to clarify that authorization to discharge from components of the Collection Pond System is subject to other conditions of the licence.

13.0 Closing

Thank you for the opportunity to support EMAB in its review of the water licence amendment application. Please contact me if you have any questions about the comments provided or further questions about the application.

Sincerely,



Bill Slater.