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1 August 2019

Mark Cliffe-Philips
Executive Director
Mackenzie Valley Environmental Impact Review Board
200 Scotia Centre Box 938
5102-50th Ave
Yellowknife, NT
X1A 2N7

Re: Technical Report on depositing Processed Kimberlite into Pits and Underground Mine Workings, EA1819-01

Dear Mr. Cliffe-Philips,

The Tłı̨chǫ Government is writing to the Mackenzie Valley Environmental Impact Review Board (Review Board) to submit our government's Technical Report regarding Diavik Diamond Mine Inc. (Diavik) plans to put and store processed kimberlite in pits and underground mine workings.

This submission is informed by elder knowledge, including information derived from an elder focus group held on 29-30May 2019, a follow up discussion on June 28, 2019, and past research conducted by the Tłı̨chǫ on Caribou Migration and Place Names in 1999 and published in 2001 and 2014 (Tłı̨chǫ Government 2014 a and b). The Tłı̨chǫ Government has also retained technical expertise (Tony Pearse) to assist with identifying if there is sufficient certainty in key concepts relating to water quality and clay suspension.

Using these discussions, past research, and technical expertise, this summary is organized as follows:

1. The importance of Tłı̨chǫ engagement in the technical review: We encourage the Review Board to continue to ensure that Tłı̨chǫ knowledge holders are given priority in assessing impacts. The elders need to have full certainty that the predictions that are being made are correct. Our technical experts inform us of high uncertainty in predictions about how clays will settle – our elders need to follow the arguments that are made, and be assured that this certainty is attained in order to have any comfort with this proposal. Presently, there is a high degree of discomfort with the proposal.

2. Deep and continued engagement in Tłı̨chǫ elders to identify how this proposal will impact on cultural use. Tłı̨chǫ members feel that connecting Lac de Gras to the pits will alter the cultural and traditional use of, and relationship with, Lac de Gras and the surrounding area.

3. Summary of community concerns: After consulting with community members, we have found a list of key community concerns that should be considered in the hearings. These include: operational concerns - the structure and design security and the possibility of leaks, cracks or floods; cumulative effects - the cumulative impacts of the plans in the context of an already changing environment due to climate change; wildlife, habitat, and vegetation - the impacts of the project design on wildlife and vegetation; use of land - the ability for Tłı̨chǫ members to use the area; and monitoring and follow up – concerns regarding the effectiveness of monitoring of the area and the pits over the long term.

4. We also append a technical summary from Tony Pearse, with three recommendations. These are:

   A - The Board retain an independent qualified expert on clay hydrodynamics to review the available relevant information provided by DDMI on FPK and to prepare a report to the Board as to adequacy of DDMI's work to date in relation to the treatment of EFPK in its planning to date;

   B - Ideally to follow or be integrated with #1, the Board conduct or commission an independent expert review of DDMI's WQ modelling and results in order to obtain a more informed understanding of the likely outcome of the project in terms of environmental risks; and

   C - Include an assessment of cumulative impacts to Lac de Gras as a component of the environmental review conducted by the Board.

There is currently a high level of uncertainty associated with how clays will behave in the water in the pits. We therefore do not have certainty that this proposal will not adversely impact on the water in Lac de Gras at mine closure.

Our elders always listen closely to the technical experts in environmental reviews, as well as rely on their observations on the land. They have been clear – this area is of high cultural value and importance. They fully expect the Review Board to ensure that this high level of uncertainty is addressed.

Implementing these three recommendations will address the current uncertainties of the proposed project and enable reviewers and the Board to make the necessary determinations of significance.

We look forward to meeting with the Review Board and other parties in the upcoming hearings.

In Tłı̨chǫ Unity,

Violet Camsell-Blondin
Regulatory Manager
Department of Lands and Culture Protection
Tłı̨chǫ Government

Attachment

Summary of Tlicho community concerns regarding Diavik's plan to deposit processed kimberlite into Ppts and underground mine workings, EA1819-01

Introduction

This submission is informed by elder knowledge as well as technical expertise from Tony Pearse. To gather the elder expertise, the Tłı̨chǫ Government held an elder focus group on 29-30 May 2019 and a follow up discussion on June 28, 2019, and reviewed previous research done by The Tłı̨chǫ Government. The Tłı̨chǫ Government has also retained expertise from Tony Pearse to assist with identifying if there is enough certainty in key concepts relating to water quality and clay suspension.

This summary is based on this expertise and organized around four key themes: 1) the importance of relying on Tłı̨chǫ knowledge and knowledge holders; 2) Impacts from the Tłı̨chǫ Perspective; 3) key community concerns; and 4) technical expertise regarding water quality modelling (see attached report).

(1) The importance of Tłı̨chǫ knowledge

Tłı̨chǫ knowledge is based in long-term observations and the experience of living on the land. It is important to refer to this knowledge and incorporate it into monitoring and management techniques. We therefore encourage the Review Board to ensure that Tłı̨chǫ knowledge holders are given priority in assessing impacts. Rather than relying on third party and company impact assessments, impacts should be defined, identified and evaluated by the experts on the area: Tłı̨chǫ knowledge holders. To do so, the Review Board should further engage with Tłı̨chǫ knowledge and knowledge holders through community hearings and relying on past elder guidance from the previous hearing submissions and referring to past research done by the Tłı̨chǫ that highlight Tłı̨chǫ connection and knowledge of the territory (Tłı̨chǫ Government 2014a) and the importance of caribou to Tłı̨chǫ people and the depth of Tłı̨chǫ knowledge on caribou (Tłı̨chǫ Government 2014b). These reports consider the nature of Tłı̨chǫ use and knowledge of the region through the direct review of place names and caribou habitat and behaviour. The reports summarize the words of elders from that time. Many of the voices raised in these reports are from late elders whose words and knowledge must be passed on and respected in these processes. Consequently, we refer the Review Board to their guidance.

We also will be engaging the elders throughout the community and technical hearings in Yellowknife. They are the ones that will need to be convinced that the clays will settle in the manner which Golder Associates has predicted.

The Tłı̨chǫ Government is currently convinced that there is a high degree of uncertainty about this matter, and (see Tony Pearse memo) we expect that there will productive and detailed discussion of this matter. Our elders need to be a part of this dialogue, so that they can be certain of any revised approach to closure of the Diavik Diamond Mine. As there is a high level of uncertainty, we expect that the precautionary approach will be taken, and further studies will be completed, in order to shore up these predictions.

(2) Impacts from Tłı̨chǫ Perspective

Tłı̨chǫ elders and knowledge holders were clear: impacts should be approached holistically and from a perspective that evaluates impacts to traditional use. This includes impacts to surrounding ecosystems, wildlife, and use of and trust in the area.

Impacts to traditional use and culture should be given as much weight as ecological ones. The Tłı̨chǫ Government refers the Review Board to "The New Shoshoni EA decision" (MVRB 2007). In the New Shoshoni EA decision, the Review Board stated that the size of a project does not equate to the potential for cultural impact. In the words of the Review Board, "although the proposed development is physically small, the potential cultural impacts are not" (MVRB 2007, 1). The New Shoshoni EA decision identifies the significance of cultural impacts and recognizes that, even though quantifying cultural "footprint impacts" may be more difficult, it is equally important (MVRB 2004). The Report of Environmental Assessment identified impact pathways and potential ultimate outcomes of impacts on culture as:

- Reduction of the value of a place in the hearts and minds of the culture group;
- Reduced ability to know and teach about a place between generations;
- Reduced connection to the cultural landscape reducing cultural continuity overall;
- Loss of a place of refuge from the "modern" world; an area … called "quiet enjoyment of the land", is still possible;
- Disrespect of ancestors, as a valid impact pathway, and an abrogation of responsibility by the culture holders as well as the Crown; and
- Increased access to a critical cultural area contributing to culture holder alienation. (MVRB 2004, p. 40–62, cited in Gibson 2017, p. 13)[1]

In referring to this decision, the Tłı̨chǫ Government is suggesting that the knowledge and the words of the land users and culture holders should be given primary consideration.

Tłı̨chǫ members feel that connecting Lac de Gras to the pits will alter the cultural and traditional use of, and relationship with, Lac de Gras and the surrounding area. This is an important area for hunting, fishing, harvesting, trapping, medicinal plants, cultural activities and is the site of a burial ground. As an elder explained, "our forefathers have been using the lands for winter trapping, harvesting, every year they were travelling through there, getting arctic fox, fish." He went on to explain that they want to make sure they can use the area again since there is a cultural connection to the area that must be considered in project closure plans. As the Elder explained, "there's a freezer and a bank over there for us".

Elders mentioned the likelihood that the project will add pressure to their already changing food system and will discourage wildlife from returning to the area. They highlighted the interconnectedness of the wildlife and the ecosystems. They are concerned about what will happen if one element of the ecosystem and food chains is disrupted and how this will lead

[1] See (Gibson 2017) for further discussion of importance of the "The New Shoshoni EA decision" in impact assessments.

to wider changes in the area. Elders explained that it is not just fish that will be impacted but all animals that use the area.

Therefore, when determining if the pits should be reconnected to Lac de Gras at closure, elders would like the following criteria to be considered collectively and separately:

- Impacts to ecosystems and food chains surrounding Lac de Gras;
- Impacts to fish and fish habitat as changes to water will directly impact the quality and quantity of fish in Lac de Gras;
- Impacts to use of and trust in water sources: including community drinking water, wildlife drinking source, and habitat for fish (trout and whitefish), plankton and bugs, vegetation surrounding Lac de Gras;
- Impacts to wildlife and wildlife habitat: including bears, caribou, moose, muskox, waterfowl, wolf, wolverine, arctic fox, wild rodents (muskrat, mice, chipmunks, weasels, and more), arctic hares, and insects;
- Impacts to caribou migration patterns as they travel into the area and access the lakes after closure;
- Impacts to water foul as they access the pit lakes after closure;
- Impacts to traditional plants, plant harvesting and berry harvesting: herbal and medicinal plants, medicinal tea (e.g. Labrador tea), tobacco plants, lichen, sweet grass, berries (blue berries, juniper berries plum berries, etc.). For full list of all vegetation from the area see pages 25-31 of Tłı̨chǫ Government 2014a.
- Impacts to hunting, fishing, trapping, and harvesting practices as members lose trust/security in the area and as quality and quantity of species in the area diminishes;
- Loss of use of area and impacts to culture as less members use the area for cultural purposes (including hunting and harvesting, ceremonies, visits to area, camps, etc.) due to diminished trust in area; and
- Cumulative effects of climate change as weather patterns change the environment and wildlife behaviour and may alter the project designs over time.

We anticipate continuing this engagement throughout the hearings.

In short, Tłı̨chǫ members feel that the plans may alter their use and relationship to the area. This impact to traditional use is in line with those identified in The New Shoshoni EA decision (MVRB 2007), and therefore should be considered as equally important as impacts to the environment. Tłı̨chǫ access and use must be protected for hunting and harvesting purposes as well as during rehabilitations efforts. Elders want to see plans integrating Tłı̨chǫ knowledge and knowledge holders to encourage wildlife to return to the area and to protect migration routes, which will in turn protect Tłı̨chǫ's future use of the area.

(3) Community concerns

In the June 2019 internal review, Tłı̨chǫ members raised concerns regarding the plan to place processed kimberlite into the pits and underground mine workings and connecting them to Lac de Gras. Many of the elders indicated that there was a high level of uncertainty. They have many unanswered questions and feel that the process of assessing impacts and acquiring information has been problematic so far.

In general, the Tłı̨chǫ elders were sceptical of the plan to place kimberlite into the pits and then connect the pits with Lac de Gras. The concerns raised were operational (i.e. could the placement occur without failure and impact), and related to potential impacts to wildlife, environment, and use of area:

1) Operational concerns - the structure and design security and the possibility of leaks, cracks or floods. Elders raised concerns regarding whether the PK placement in pits will behave as predicted over the long term and raised questions about how the proponent can ensure that there will be no leaks, cracks, breaches or floods overtime. There is a concern that with changes in weather due to climate change, the structure will be impacted and if the structure is impacted the kimberlite will mix in with the water and alter water quality and the surrounding ecosystems.
2) Cumulative effects - the cumulative impacts of the plans in the context of an already changing environment due to climate change. A number of elders brought up the likelihood of climate change impacting the region and the need to account for such changes in project design. Elders are concerned that climate change is already altering the environment, wildlife behaviour, and weather, and will continue to into the future. As such, project designs must be especially sensitive to these changes.
3) Wildlife, habitat, and vegetation - the impacts of the project design on wildlife and vegetation. Elders identified the following wildlife using the area: various fish species (including trout and whitefish), bears, caribou, moose, muskox, waterfowl, wolf, wolverine, arctic fox, wild rodents (muskrat, mice, chipmunks, weasels, and more), arctic hares, and various important insects. Elders were quite concerned about how the plans will impact wildlife, their habitat, and the surrounding vegetation. The elders voiced several concerns about how the project design could impact caribou in particular. Many elders are worried about how the structure design will impact the ability for caribou to migrate through the area as caribou have traditionally swam through the Lac de Gras and surrounding lakes on their migration routes (see Tłı̨chǫ Government 2014b for extensive discussion on caribou migration). As the Tłı̨chǫ Government report (2014b) presents, caribou have a very strong sense of smell, good memories, and migrate to places where the vegetation is lush. They are adaptable but they are also susceptible to pollutants and change migration routes based on where the vegetation is most accessible. Placement of PK in dikes may therefore have impacts on caribou and their willingness to return to the area. Efforts must be made to ensure Tłı̨chǫ knowledge informs all mitigation plans that relate caribou, especially caribou migration. Tłı̨chǫ Government report (2014b) lists various recommendations that should be considered in closure plans (see pgs 6-7), including, for example, protecting known ʔekwǫ̀ water crossing, documenting caribou water crossings, and fencing tailings ponds to protect caribou from using the tailings rather than ʔelà (mud) to coat themselves, and more.
4) Use of land - the ability for Tłı̨chǫ members to use the area. Several of the Elders pointed out that the plans will change the way they use and view the area. A Tłı̨chǫ member explained that if the pits are connected and the area is turned into a fish habitat, it is unlikely that they would “use the area for hunting, fishing, netting or

anything like that." Therefore, the future use of the area must be considered in remediation plans.

5) Monitoring and follow up – concerns regarding the effectiveness of monitoring of the area and the pits over the long term. Several elders raised concerns about whether and how the company will be held responsible if something happens to the structures further into the future. They questioned whether funding will be available down the road or if the community would be left to cover costs should something happen to the structure.

References

Diavik Diamond Mines (Diavik). 2019. DDMI Submission of the Summary Impact Statement for the Processed Kimberlite to Mine Workings Project (MVEIRB File No.: EA1819-01)

Gibson, G., and The Firelight Group. 2017. Culture and Rights Impact Assessment: A survey of the Field. A report prepared for the Mikisew Cree First Nation. Accessible at http://www.thefirelightgroup.com/firelightmaterials/wp-content/uploads/2016/03/MCFN-303_MAPP-Report_Final.pdf

Mackenzie Valley Environmental Impact Review Board [MVRB]. May 2007a. "Report of Environmental Assessment and Reasons for Decision On UR Energy Inc. Screech Lake Uranium Exploration Project (EA 0607-003)." Mackenzie Valley Review Board.

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Tłı̨chǫ Elder Focus Group: DCLP & Diavik Diamond Mine Project. May 29-30, 2019. DCLP Board Room

Tłı̨chǫ Government follow up discussions. June 28, 2019.

Submission to Mackenzie Valley Review Board
re
Diavik Diamond's Application for In-pit Disposal of Processed Kimberlite

by T. D. Pearse,
prepared for Tłı̨chǫ Government

1 August, 2019

Introduction & Background for the Review

This submission, made on behalf of Tłı̨chǫ Government, focuses on the credibility of DDMI's predictive work and its conclusions that depositing kimberlite tailings in one or more of open pits poses minimal adverse environmental effects for the pit lake surface water and, more generally, to Lac de Gras.

At this point in the mine-life there remain approximately 4-5 years of production before closure. DDMI faces two problems that are proving challenging for the company to resolve. These comprise:

a. an apparent shortage in the remaining years of available space in the present tailings storage facility (PKC) to deposit processed kimberlite generated by the processing plant; and,

b. uncertainties about how best to effectively reclaim the extra-fine portion of PK (EFPK) already stored in the PKC such that the facility can be effectively closed at the end of mine-life.

Twenty years ago the original proposal to build the mine was subjected to a federal environmental assessment through a process known as a 'comprehensive study'. Tłı̨chǫ Government (then the Dogrib Treaty 11 Council) did not participate in that process but, instead, struck an internal working group to conduct an independent assessment of the project. The writer was a technical advisor to that group, and a variety of other experts were contracted to assist in the Dogrib process by reviewing critical technical aspects of the proposed mine.

During the 1999 Dogrib review it became apparent through some of the submitted expert reports that the proponent, in operating and closing the mine, may be challenged in various ways with the management of smectitic clays that were showing up as a significant constituent in the kimberlite tailings slimes (i.e., EFPK). There were indications then that DDMI was aware of the potential challenges involved in managing these materials, particularly with respect to developing effective reclamation for the PKC pond at closure.

At any rate, the project proceeded and for the past 20 years processed kimberlite tailings have been deposited in the PKC, either as a slurry (i.e., a mix of FPK and EFPK) via pipeline or as coarse-grained 'grit' transported by truck. As the volume of PK in the facility increased over the years, a succession of raises for the containment dams around the edge of the storage area have been built, in accordance with conditions set by DDMI's water licences.

At present, DDMI has been approved for, and is now constructing, another dam raise designed for an additional 4 years of PK deposition. However, DDMI now contends that additional storage space beyond this (presumably for the final year's production) is limited on the island, such that other options are being investigated, including in-pit disposal of one or more mined-out pits.

In consequence of this, DDMI applied in 2018 for an amendment to its water licence to allow the disposal of PK slurry from the process plant into the pits, concluding in its preliminary screening work for the Wek'èezhìi Land & Water Board that all the information currently on the record demonstrates 'clear evidence that the proposed deposition of PK to mine workings is not likely to cause significant adverse environmental impacts to all aquatic life and water.'

Subsequently, in 2019, the Mackenzie Valley Review Board decided that the proposed venture, given the significant change in operations that potentially affected the Lac de Gras aquatic environment, was properly a subject for environmental assessment.

This submission, made on behalf of Tłı̨chǫ Government, questions DDMI's predictions and concludes that an environmental approval at this point is premature.

The basis for this is described in the remainder of this report. At this point there is insufficient credible evidence on the record to support a convincing conclusion that significant adverse impacts from DDMI's proposed venture, as stated by DDMI, are unlikely.

Making such an argument requires the proponent to provide thorough, believable, and accurate evidence that demonstrates the project to be environmentally viable. This was the objective that DDMI needed to achieve, and it has failed to do this. In fact, DDMI takes the unusual position that, yes, further studies and testwork are needed to better understand how to implement the proposed project, but it proposes to do this work only after it has its regulatory approvals.

As a consequence, and as supported in the text that follows, I make the following recommendations to the MVRB for the current review process:

1. the Board should retain an independent qualified expert on clay hydrodynamics to review the available relevant information provided by DDMI on FPK and to prepare a report to

the Board as to the adequacy of DDMI's work to date in relation to the treatment of EFPK;

2. ideally to follow or be integrated with #1, the Board should conduct or commission an independent expert review of DDMI's WQ modelling and results in order to obtain a more informed understanding of the likely outcome of the project in terms of environmental risks; and,
3. the Board should include potential cumulative impacts to LdG as a component of the environmental review.

These recommendations are consistent with Tłı̨chǫ Government's commitment to precautionary land use principles that afford the highest level of protection for Lac de Gras.

Many reviewers have commented on various aspects of DDMI's proposal, and much useful information has been generated to date that can benefit the Board in evaluating the project. However, it is apparent that specialized expertise, independent from the proponent, in the two areas referenced in the above recommendations has not yet been brought to bear on the very complex issues at play— and it needs to be.

The remainder of this report explains why.

The Nature of the Risk

The environmental acceptability of this project rests on the notion that at the end of mine life the open pits, flooded to the level of Lac de Gras (LdG), can be reconnected to the lake in a condition that enables the safe and productive use of the pit lakes as viable habitat for LdG aquatic life.

This is the current closure plan for the open pits, and this is the basis upon which the company was granted its water licence to operate its mine in 2000.

Diavik's new proposal to infill one or more open pits with mine tailings changes the nature of the risk. The disposal in the pits of significant quantities of fine processed kimberlite (FPK) slurry poses challenging water quality issues that are otherwise absent in the originally approved plan, as that plan relied solely on high quality LdG water for flooding of the pits.

The Board's role is to determine if DDMI has provided sufficient evidence to demonstrate that a reasonable level of certainty exists about DDMI's predictions of no significant adverse impact to LdG, or to the current closure plan.

This submission, as noted above, contends that there is significant uncertainty at this time about DDMI's predictive work and, as a result, significantly increased risk from the proposal that the ultimate pit lake water quality will not meet acceptable guidelines within a reasonable timeframe, and that reconnection with LdG will not be possible on an acceptable basis.

At that point, pools of turbid or otherwise contaminated water could be present (intermittently or permanently) within the pit lake upper areas, still hydrologically connected to LdG even if not

openly connected as part of the Closure Plan. In such an event, preventing degradation of LdG water quality in the long-term will almost certainly be unsuccessful.

Further, DDMI has presented little useful information about the contingencies for failure, such that the ultimate closure conditions are not realistically known if pit water quality does not meet criteria.

Finally, to compound the issue, the Board needs also to consider that LdG water quality is already being degraded from mining activity in its watershed, such that there is an evident cumulative effects component to the proper assessment of this project. This is further discussed below under a heading 'Cumulative Effects'.

Framing the Decision

The crux of the water quality issue at Diavik lies in the behaviour of what DDMI terms 'slimes', or the extra-fine portion of processed kimberlite tailings (EFPK) that emerge as a slurry from the process plant. As tailings (essentially, from any mining process) are deposited in water, the particles settle to the bottom leaving a clear water layer above. The settling occurs at various rates depending upon particle size, weight, shape, etc.

Once settled on the bottom, however, a secondary process occurs— consolidation— as porewater between the fine-grained particles (sand, clays, etc.) is squeezed out by the pressure of additional solid material settling out above.

The key to the present issue at Diavik is understanding the critical difference between these two properties— settling and consolidation. Most mine tailings settle and consolidate effectively enough, leaving behind a relatively clear water column that can easily be managed during operations and at closure.

At Diavik things are different. EFPK settles, but it does not effectively consolidate. It is this property— the lack of consolidation— that lies at the heart of DDMI's current problem of how to effectively manage EFPK.[1]

To support its contention that in-filling the pits with a slurry of fine processed kimberlite (FPK) and extra-fine processed kimberlite (EFPK) would likely result in no significant adverse environmental impacts, DDMI commissioned Golder to develop and run computer models to predict the resulting water quality in the pits— at different levels and under different scenarios. DDMI's position is that this computer work, with a few minor exceptions under certain conditions, has shown that adverse WQ at the resulting surface layers of the flooded pits is unlikely to occur.

Additionally, there being no significant impact to pit water quality at closure, DDMI argues, reconnection with LdG can be made in accordance with the initially approved closure plan.

[1] Note that underlining here and elsewhere throughout this document is by the writer to emphasize certain points.

The Key Question

A number of reviewers have previously commented on the deficiencies of DDMI's modelling work— both during the early water licence amendment process and as part of the MVRB's current review. The IR process set out by the Board reveals much of this 'wrangling' between the company and various reviewers over details about how the model was constructed, the assumptions made for inputs to the model, how the scenarios were established, the lack of conservatism in the modelling, and so forth.

To illustrate the nature of this discussion, some of the more salient details are presented below under the heading 'Problems with the Water Quality Modelling'.

However, the key point for the Board to consider about the modelling work is that it forms the only basis for DDMI's assertion that placement of FPK and EFPK in the pits presents no significant environmental risk to LdG in the long term.

In other words, the ultimate question to be considered in this review is— are the modelling work and its results credible?

This submission argues that the Board ought to have no confidence in DDMI's predictive work.

If DDMI gets this wrong, a significant hazard is posed for LdG aquatic ecosystem. In cases of such significance, the defence of a technically complex method for predicting impacts (i.e. a computer model to predict water quality) ought to be subjected to peer review. As previously noted, there is no apparent evidence this has been done.

In other words, DDMI's WQ modelling needs to be independently reviewed by a qualified expert such that the Board can have faith that the work is credible and justifiably useful for a decision on the project. Without this, all parties, including the Board, can have little basis for confidence in judging the proponent's ultimate predictions about environmental risk.

This point needs to be stressed, because the modelling done to date, as briefly reviewed below in the section 'Problems with the Water Quality Modelling & its Results', is fraught with seriously questionable assumptions and deficiencies, such that the results are not sufficiently credible for making an informed decision about a potentially very consequential project.

The Problem of EFPK

The key uncertainty at this point is that we have essentially insufficient evidence on the record that EFPK deposited in open pits will not pose an environmental risk. Indeed, DDMI has acknowledged that further testing of EFPK consolidation is being done (although results are scheduled to arrive after regulatory approvals are issued).

DDMI may be right that there will be no unacceptable impact in the long term to any environmental or cultural receptors from its pit infilling venture. The problem is that the company is asking the reviewing parties including, especially, the Boards, to accept at this point in the process the results of a modelling exercise that all reviewers (including the proponent's consultant) have noted to be fraught with uncertainties and non-conservative approaches.

If, as available data would indicate, EFPK in the pit lakes does not consolidate effectively and is not effectively immune to subsequent disturbances in the future, it is quite realistic to assume that pools of turbid water, possibly with undesirable contaminant concentrations, will remain or occur intermittently for the long-term in the surface waters within the dyke perimeter. This will pose a hazard for the LdG ecosystem.

DDMI's difficulty now is that it has not provided sufficient believable evidence to the Board that this is very unlikely to happen and/or that the consequences will be insignificant in the event that it happens.

This conclusion is strengthened by the fact that DDMI, in its predictive work to date, seems not to have used actual measured data it has on hand for EFPK behavioural characteristics.

For example, a 2010 geotechnical site investigation[2] of FPK in the PKC conducted by AMEC and others identified the characteristics of EFPK that indicate significant challenges for managing the material. In particular, AMEC noted that,

> '…fine PK slimes have clay contents (% by dry weight finer than 2 microns) in the range of 20-30%. Clay mineralogy indicates that vermiculite (a clay mineral of the montmorillonite/smectite group comprises 18-25% by mass of the fine PK slimes…' [p7]

Additionally, cone penetration tests in the centre part of the PKC produced data '..indicative of an under-consolidated condition', leading AMEC to observe that,

> '..the lack of effective stress within the upper 10 m of the PK tailings deposit will preclude many traditional tailings capping methodologies from consideration at this site unless a means of accelerating the consolidation of the material is implemented..'[p13]

X-ray diffraction studies showed also that the -3 micron size material ranged up to 22.2% by weight of the sample (clay plus sand-sized fractions) and was dominated by smectite (40% - 78%).[3]

Perhaps most importantly for the case at hand, AMEC conducted lab tests of settling and consolidation of EFPK samples extracted from borehole investigations in the PKC. The results are provided in a series of tables in AMEC's report.

A typical test of this kind for mine tailings would start with the water column being turbid once the sample was dropped in, and over the course of the 30-day test period, would show a gradually increasing clear water layer at the top as the solids settle out forming a second layer on the bottom. Typically, at the end of the test period one would see a large layer of clear water underlain by a thinner layer of solids on the bottom. Fig. 1 on the following page illustrates this.

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[2] Diavik Diamond Mine PKC Facility Geotechnical Site Investigation Factual Report. 05 Dec 2011. Attachment to DDMI's 2012 ICRP Annual Progress Report.

[3] Combined Bulk and Clay XRD Analyses of Four Mud Samples Identified as 'BH 10-05 (12m), BH 10-05 (8m), BH 10-06 (12m), and BH 10-04 (10m)'. AGAT Laboratories. April, 2011. attachment to AMEC report in footnote 1.

Fig. 1. This table shows a 30-day settling test for a sample of FPK taken at a depth of 6 m in the PKC pond area in April, 2011.[4] The sample is 600 ml placed in a 1L graduated cylinder and, as illustrated by the values in columns 3 and 4, the sample separates out over the 30 days into a final clear water layer (layer 1) of 322 ml, and a consolidated layer of 278 ml. Note that the settling rate gradually decreases, reaching its final state about two days prior to the end of the test.

Date	Time	Volume Measurement of Top of Layer (ml)					Comments
		Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	
4/19/2011	4:00 PM	600	0				
4/19/2011	5:35 PM	590	10				
4/20/2011	7:36 AM	530	70				
4/20/2011	10:20 AM	520	80				
4/20/2011	12:00 PM	515	85				
4/20/2011	1:00 PM	512	88				
4/20/2011	2:00 PM	510	90				
4/20/2011	3:00 PM	507	93				
4/20/2011	4:00 AM	504	96				
4/20/2011	5:00 AM	501	99				
4/21/2011	9:56 AM	464	136				
4/21/2011	10:56 AM	462	138				
4/21/2011	12:01 PM	460	140				
4/21/2011	2:27 PM	455	145				
4/22/2011	8:08 AM	425	175				
4/22/2011	7:46 AM	364	236				
4/25/2011	12:01 PM	362	238				
4/25/2011	4:01 PM	360	240				
4/26/2011	5:26 PM	352	248				
4/27/2011	12:30 PM	345	255				
4/30/2011	10:46 AM	340	260				
5/2/2011	11:20 AM	332	268				final weight: 1211.3 (g)
5/3/2011	4:20 PM	330	270				glass cylinder #3 weight 534.8 (g)
5/5/2011	2:30 PM	330	270				
5/7/2011	11:01 AM	328	272				
5/11/2011	3:30 AM	328	272				
5/16/2011	8:47 AM	322	278				
5/18/2011	8:42 AM	322	278				

[4] Sample BH 10-05, AMEC Report, electronic page 494 of DDMI's 2012 ICRP Annual Progress Report

Fig. 2 below is another example that illustrates dramatically the issue with EFPK. This is the same borehole as Fig.1 but the sample is taken at 12 m depth.[5] Note that approximately half-way through the test period, a new third layer of something abruptly emerges, sandwiched between the top and bottom layers. Note how layer 3 does not appreciably consolidate over the remaining 15 days of the test—the process essentially grinds to a halt at that point. In this case, layer 3, presumably EFPK, comprises approximately 3% of this sample.

Settlement Measurements							
Date	Time	Volume Measurement of Top of Layer (ml)					Comments
		Layer 1	Layer 2	Layer 3	Layer 4	Layer 5	
4/19/2011	4:34 PM	605	0				
4/19/2011	5:35 PM	592	13				
4/20/2011	7:36 AM	510	95				
4/20/2011	10:20 AM	495	110				
4/20/2011	12:00 PM	490	115				
4/20/2011	1:00 PM	485	120				
4/20/2011	2:00 PM	481	124				
4/20/2011	3:00 PM	477	128				
4/20/2011	4:00 AM	474	131				
4/20/2011	5:00 AM	470	135				
4/21/2011	9:56 AM	420	185				
4/21/2011	10:56 AM	417	188				
4/21/2011	12:01 PM	415	190				
4/21/2011	2:27 PM	410	195				
4/21/2011	4:02 PM	405	200				
4/22/2011	8:09 AM	380	225				
4/25/2011	7:47 AM	330	275				
4/25/2011	12:01 PM	326	279				
4/25/2011	4:01 PM	325	280				
4/26/2011	5:26 PM	320	285				
4/27/2011	9:31 PM	315	290				
4/30/2011	10:48 AM	310	295				
5/2/2011	11:20 AM	290	303	12			final weight: 1223.6 (g)
5/3/2011	4:20 PM	285	305	15			glass cylinder #4 weight 534.0 (g)
5/5/2011	2:31 PM	285	305	15			
5/7/2011	11:03 AM	285	305	15			
5/11/2011	3:31 AM	285	305	15			
5/16/2011	8:48 AM	280	307	18			
5/18/2011	8:42 AM	280	307	18			

[5] Sample BH 10-05, AMEC Report, electronic page 491 of DDMI's 2012 ICRP Annual Progress Report

I've picked two representative samples above to illustrate the point, but there are more examples in the AMEC report which illustrate the consolidation issues with EFPK.

The AMEC report is a substantial and valuable contribution to understanding the behaviour of FPK and EFPK. It presents a number of tests, tables and charts illustrating the various properties of the PKC materials, and at various locations and depths in the PKC. This information is completely relevant to the issues posed in managing the EFPK including, importantly, for reclamation purposes, as AMEC has noted.

This fieldwork was performed in 2010, and AMEC at that point had already highlighted the need for a reconsideration of closure strategies for the PKC based on the results of this field work.

Nine years have passed without any visible evidence that DDMI has been using this information.

At this late date the company is finally acknowledging the closure issue posed by this material. The critical thing for the Board to consider is why DDMI did not use these data in their modelling work, choosing instead to use various estimates and assumptions instead of actual measured values. Had DDMI adopted a truly precautionary approach, it would have transparently and meaningfully included the consolidation characteristics of EFPK in its modelling work.

A final note about EFPK. One apparent outcome of DDMI's proposed venture in the pits would be the presence of a porewater/EFPK layer above the consolidated portion of the FPK. There is an issue about whether the breakdown of the lower stratified layer containing unconsolidated EFPK could occur intermittently over time, possibly through occasional rock fall from the pit perimeter or through currents generated by natural forces in the water column. Unconsolidated EFPK is presumably extremely sensitive to motion and easily mobilized. Additionally, it can also attach and transport metal ions because smectitic clay particles are electrically charged.

It is not clear that these effects have been properly examined in the work to date such that they can be either rejected as inconsequential, or incorporated into the model if they are consequential. In either case a rationale is required and none has been provided.

In the January technical sessions DDMI presented a schedule for the regulatory and planning issues related to the project. The line item 'PK laboratory consolidation testing' shows anticipated completion by the end of 2019.

As the AMEC study has indicated, FPK and EFPK consolidation data are critical for a meaningful understanding of what will happen in the pit lakes when filled with FPK slurry. Here, DDMI says the testwork is 'anticipated' to be completed by the end of 2019, but it does not say when the results will be available for review. Elsewhere, DDMI states that the results will be used in an update of pit WQ modelling that will be done later as a condition of the amended water licence.

DDMI also notes that the results from PK lab consolidation tests being done by the University of Alberta in the last part of 2019 will be used along with field results from on-going PK trials to derive the most applicable densities. These values 'will be applied in the final Processed Kimberlite Containment in Mine Working Design Report and in all associated Management Plan updates', scheduled for the last half of 2020.

Again, DDMI commits to producing critically important information but only after it obtains its approvals for the project.

The Problems with Water Quality Modelling and its Results

The inherent challenges to using models to predict outcomes arise mainly from the quality of the data and assumptions used for model design and model inputs. 'Garbage in, garbage out', as the old adage goes.

MVRB's online registry has to date accumulated substantial volumes of information on this topic — half of it raising important questions about the general integrity of the model and specific details of what was done and the assumptions made, and the other half responses by the company defending the work done. There is much to wade through, and it is not particularly instructive to go through it all in a submission such as this—indeed, the Board has staff to assist in this rather formidable task.

But, it may be helpful here to highlight some of the overriding concerns that reviewers have identified, since these are germane to the key question of acceptability that the Board needs to wrestle with.

To begin with DDMI's modeller— Golder states in its 2018 report that "many assumptions" were used in the model and that "..predictions (were) based on several inputs, all of which have inherent uncertainty."

Golder notes that a number of "simplifying assumptions were employed" [p12], including:

- water chemistry data used as inputs "are representative" and "estimated based on available measured, modelled or proxy data."
- pit lakes are assumed to be full up to LdG water elevation at start of modelling;
- no groundwater inflow; no transient period so no mixing behaviour;
- no local runoff from mine site;
- no wall rock runoff;
- a 2D model used;
- calibration of model not possible so estimated default coefficients;
- PK consolidation is conceptual and based on estimates of PK material properties.

Note this last point. It must be emphasized here that one of the stated objectives for the modelling was 'to understand the influence of PK consolidation on pit lakes water quality.' This objective was arguably the most critical piece for the modelling work to illustrate. But the objective was never achieved— while DDMI had available real measured field data about EFPK consolidation rates, it apparently never used the information in the modelling work, instead substituting assumptions or estimates for EFPK consolidation behaviour.

Golder (2018)[6] noted that;

> '…to account for the influence of PK settling and release of pore water on surface water quality, a conceptual consolidation model was developed to predict the pore water released to the pit lakes as a result of PK consolidation and associated settlement. In the consolidation model, solids component in the pits (i.e., deposited PK) was assumed to be a single layer from 20 m below the pit crest elevation for all the scenarios including PK (i.e., Development Case and Sensitivity scenarios; Section 2.3) to the bottom of the mined-out sub-level retreat.'

Again, DDMI underscores that its 2018 modelling is based on assumptions about average pore water quality from the PKC and on 'theoretical consolidation'. Moreover, DDMI 'acknowledges the uncertainty and importance around this model input.'

GNWT also questions the integrity of the WQ modelling, noting:

- all predictions regarding pit lake stability and WQ in the mixolimnion, and ultimately, statements regarding potential environmental effects for the mine rely on outputs from a single model;
- there is no rationalization or apparent validation for the particular model used;
- there is no incorporation of simultaneous events in the model and, as noted by the proponent, the one-at-time perturbations currently used have limitations in assessing the full effect of related model parameters;
- key model input data were not available for the proof-of-concept modelling conducted to date. A set of PK consolidation model parameters are currently being estimated and would be helpful in understanding potential pore water volume and composition loads to the pit lake;
- it is not clear when results from the Diavik Fine Tailings Consolidation and Release Water Characterization Study being conducted by the U of Alberta will be available. The current worst-case scenario estimates may not necessarily be "worst case" estimates;
- in short, the proposal is based on preliminary results from a single model with a very limited rationalization for selection.

DDMI's response to all this is to argue that it was not aware of the various requirements set out by GNWT and, in any event, GNWT provided no notice of these requirements, such that DDMI finds generally that GNWT's request for this information is 'unreasonable and has therefore not undertaken the requested corroborative modelling.' This position is not precautionary.

Notably, DDMI at this point states that GNWT could have commissioned an independent expert review of the pit lake modelling.

Golder's 2018 WQ modelling, as noted by EMAB's consultant[7], also highlighted the cautionary advice provided by the authors of the model user manual who wrote,

> "Results will be suspect at best and will not withstand scrutiny at worst if the model is applied with insufficient and/or inadequate calibration data."

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[6] Golder Technical Memo Diavik Mine - WQ Modelling of A418, A154, and A21 Mined Out Pits, 02 November, 2018, p.2

[7] Randy Knapp Report prepared for EMAB, 25 February, 2019.

Knapp (as well as other reviewers) noted that Golder also states that 'because the pit lake is not yet constructed, model calibration is not possible.' The result was that Golder relied on calibration data from other locations and that the most recent example the calibration used…

> '…was considered to be approximate because the true values of a large proportion of the measured data were not known. All of these inputs and assumptions carry inherent variability and uncertainty, which impose and propagate uncertainty on model predictions.'

With that observation Knapp states that 'calibration is essential for reliability of the predictions' and, given the warning by the authors of the user manual,

> '…one needs to treat the model results with a bit of skepticism and adopt a cautious approach.'

Knapp correctly notes that the use in the model of an assumed instantaneous placement and non-mixing of LdG water with the PK layer is not a rational assumption. Further, the assumption of ongoing displacement of porewater as the PK settles and consolidates, as well as the assumed rate of consolidation,

> '…has not been not measured but was estimated based upon the properties of the PK. Consolidation testing would have been useful to confirm the rate of porewater release to the stratified layer over time.'

This is a critical point, as I have previously noted. First, using estimated values instead of actual measured values is a critical deficiency of the modelling. The consolidation behaviour of EFPK is a major contributing, if not controlling, factor for the success of the pit-infilling venture.

Knapp noted that WQ of a lower stratified layer in the pit lakes 'would be a major concern if it was to mix with surface water in LdG', and 'could have a material impact on water quality and fish in the pit lake.' Breakdown of the stratified layer in the model indicated 'some elevated levels of several contaminants' and, while DDMI contends that this would a short-term issue, Knapp concludes that 'this has not been demonstrated.'

Knapp also noted that while the 2018 modelling illustrated that the greater the depth of water cover in the pits above the PK the less is the likelihood of the mixing of the two layers— in all cases, there will be some contamination from depth entering LdG over the 'very long term' (i.e., +100 years).

DDMI's May 2019 Summary Impact Statement describes a second attempt by Golder to model the effects of the proposed pit infilling. The 2019 model had different assumptions than the 2018 version and assessed three alternative scenarios with actual deposition beginning in late 2021:

1. deposit the total amount of fine PK into one or more of mine workings A21, A154, and A418, the last being preferred;
2. an additional amount of EFPK from the PKC to be optionally deposited into one or more of the mine workings; and,
3. a depth of porewater to be retained above PK in the mine workings (5 m and 15 m modelled).

However, the exercise arrived at more or less the same conclusions with respect to environmental impacts: i.e.

- no significant effects to any valued ecosystem components, including LdG water quality, fish, wildlife, birds, or cultural uses; and,
- no significant cumulative effects to LdG water quality or any other VEC.

Note that elsewhere in DDMI's documents there are stated plans to 'decant' the porewater that forms above the consolidating FPK, while here it is stated this layer will stay in place. Is this because this layer also contains unconsolidated EFPK and there is no alternative disposal site for this once removed from the pit? The inconsistency presented here is not explained.

In Bill Slater's report to EMAB[8] on Golder's 2019 WQ modelling he identifies a list of deficiencies in the modelling work, all of them reflective of a lack of conservatism. The following points are made:

1. DDMI has not yet made available the most recent information (Golder's *Water Quality Modelling Results A418 (Corrected), A154 and A21 Mined Out Pits - Scenarios 2a,3a, and 4a*) and 'as a result, it is not clear what changes and corrections have been made' and, as a consequence 'it is not possible to reach any conclusions about the modelling results presented';
2. while additional inputs such as contaminant loading from the pit walls and groundwater inflow, previously omitted in the 2018 work, were examined, the scenarios treated them separately when they should have looked at conditions resulting from <u>combined</u> sources which is the 'most likely scenario';
3. the sensitivity analysis 'considered different rates of porewater release from the PK, but only considered <u>slower</u> rates of release, making the optimistic assumption that conditions would not be worse than initial conditions, but they could better;
4. no rationale was provided for the groundwater influx value of 177,647 m^3 during pit filling used in the sensitivity analysis is substantially different than the rate used in a 2010 study by Golder (*Preliminary Pit Lake Mixing Study*) of 28,300 m^3/day;
5. information provided initially in the June 2018 application to the WLWB was 'not sufficient to understand the basis for DDMI's input assumptions about porewater quality';
6. there have been no subsequent submissions of information from the company that have provided the clarity of just what assumptions have been made;
7. the company's conclusion that even with full mixing of the pit water the WQ will remain below the AEMP benchmarks 'may be an optimistic prediction given the revised input assumptions about pore water quality.'
8. while DDMI's January 2019 response document describes comparisons of laboratory and field scale predictions of PK effluent the results are described as 'preliminary' and 'no information is provided about how this information has or could inform model inputs and predictions.'

[8] Slater Environmental Consultants Report to EMAB, June 2019.

9. DDMI's consolidation and water quality models rely on assumptions of density for making predictions of effects and, further, that 'the adequacy of operational water treatment capacity also relies on an understanding of consolidation and density' and that DDMI has not yet provided details about its estimates and calculations related to slurry density and water volumes;
10. as for the 2018 modelling, the absence of model calibration for the 2019 work remains a deficiency; and,
11. the company revised its model inputs and used data from water collected from fresh PK slurry, with the consequence that contaminant concentrations used were much lower than for previous modelling and, not surprisingly, predicted lower values for WQ impacts in the pit lake and LdG. Slater concludes that 'relying on WQ data from fresh PK is likely to underestimate the pore water concentrations in deposited PK.'

DDMI acknowledged this last point in its May 10 response to the Review Board's IR#19, confirming that the model used fresh PK data and that 'this may underestimate the concentrations in PK pore water.' However, DDMI takes the position that its sensitivity analysis shows that the model is not sensitive to changes in porewater chemistry. Slater contends that DDMI's argument does not consider the potential characteristics of the water in the pit during operations and, since the 'pore water is likely the largest source of contaminant loading in the pit lakes so models should be reflective of reasonably conservative estimates of loading.'

This list of uncertainties adds substantially to the examples cited previously to paint a clear picture that overall, a precautionary approach has not been taken in DDMI's assessment of ultimate pit water quality.

In his review Slater also concludes that the transfer of EFPK from the PKC could result in elevated TSS concentrations in pit water and that EFPK,

> "...could settle very slowly, especially with water depths that may be substantially larger than those in the PK Containment Facility. Slow settling of EFPK could lead to challenges for achieving AEMP benchmarks before reconnection of pits to Lac de Gras. DDMI's modelling included predictions for a "settleable constituent" but there is no information to demonstrate that this modelling would represent behaviour of EFPK.'

It is important to note that in response to several of the IRs DDMI notes that it plans to conduct additional WQ modelling with updated information and a refined project design if the project is approved.[9]

There are two important points to be made here. First, DDMI recognizes that the modelling done to date is insufficient for planning purposes and, thus, there is an acknowledged need to update its model.

Second, more importantly, DDMI wants its approval before providing the 'updated information' that is required to explain the project. This is the wrong order. A truly precautionary approach

[9] See for example DDMI response to EMAB IR#7.

would have required updating the model with better information (among other things, real data for EFPK consolidation) before getting its approval.

The Board needs to have credible, defensible information and analysis in order to properly evaluate the potential effects of the project and make a responsible decision, not after. DDMI's position undermines the Board's ability to do its job defensibly.

EMAB also explores the issue of the effect of PK porewater on the modelling results, noting that the information provided in the June 2018 amendment application was not sufficient to understand the basis for DDMI's input assumptions about porewater quality. Again, this is an important point for the Board to understand— what exactly is the 'porewater' being described here by DDMI? No details are provided. But in several places in the MVRB registry documents DDMI talks about 'decanting' the porewater as the FPK consolidates. Since the EFPK will not consolidate effectively, this porewater layer above the FPK solids must also include EFPK. Decanting this material to another location doesn't apparently solve the EFPK storage issue— it will still present an ultimate closure risk for DDMI. The record is silent on this issue.

DDMI contends that its models [a] represent a 'worst case rather than being representative of the conditions that could be expected at Diavik' and [b] its sensitivity analyses indicate that the model results for LdG are not sensitive to changes in porewater chemistry.

EMAB argues that this does not consider the potential characteristics of the water in the pit during operations, especially since the porewater is likely the largest source of contaminant loading in the pit lakes. EMAB questions DDMI's selection of the source of porewater used in the modelling, and recommends that DDMI should:

1. revise its modelling to incorporate more realistic estimates of porewater quality that consider evolution of chemistry after placement of FPK;
2. provide a rationale for use of "fresh PK" data;
3. conduct additional sampling of the fresh PK slurry if the fresh PK slurry is confirmed to be the most appropriate and representative source for estimating effects; and,
4. then redo the modelling using updated results and the maximum concentrations from the PK slurry dataset to provide a conservative estimate of potential effects and risks to aquatic biota.

DDMI notes that the "Development Case" assumed a water chemistry based on all samples as this was expected to provide a reasonable maximum pore water concentration covering both direct deposition of PK material and re-depositing of EFPK (slimes) from the PKC.

DDMI also notes that consolidation and porewater testing underway at the U of Alberta is expected to provide more definitive estimates of pore water chemistries when they are complete later in 2019. Clearly, and as previously noted, critical variables for the pit WQ modelling are still being worked out.

EMAB IR#13 digs into the critical issue of FPK consolidation and density once placed in the pits, noting that these have implications for final depth of the water cover over the PK, capacity of the pits for PK storage, release of porewater from the PK during consolidation, and volume of excess water that may require treatment during operations.

EMAB notes that since the values for densities of FPK and EFPK have changed through the modelling and remodelling exercises, clarification from DDMI is needed for the current understanding of estimates and calculations related to slurry density and water volumes.

DDMI responds that the density estimates for FPK and EFPK are 'back-calculated' annually based on the total mass of PK deposited in the PKC and the related increase in volume taken up by PK and are considered conservative. Density estimates for FPK and EFPK are considered 'conservative' because the measurement incorporates the entrapment of ice in the PKC which will not happen in the pits. There is no mention here of the AMEC 2010 PKC study that has measured data that should have been used here.

DDMI notes also that observations to date, including *in situ* behaviour and simple jar test, indicate that the EFPK settles relatively quickly and is not particularly susceptible to resuspension. The reference to 'settling' here is misleading. The AMEC lab work, which DDMI does not cite here, indicates the problem with EFPK is with its consolidation behaviour, not its settling rate.

DDMI again notes that results from ongoing consolidation testing will be used to inform updates to PK density estimates that will be incorporated into model updates during the detailed design phase of the project— i.e. subsequent to project approval.

GNWT also sought clarification on whether the WQ modelling work described in Table 6 of DDMI's response to MVRB IR#17 is the same work DDMI has indicated it plans to submit to the WLWB board as part of the regulatory approval process, and if there will be sufficient time before the end of the regulatory process process for the report by DDMI to be completed and subsequently reviewed by parties.

DDMI responds that the current plan (as shown in Table 6) is to provide updated WQ modelling by the end of 2020, and that this would include both updated pit WQ modelling as well as v. 2 of results from hydrodynamic modelling of the pit lake interaction with LdG. The schedule in Table 6 presumes receipt of timely approvals from MVRB and WLWB.

DDMI anticipates that submission of updated modelling results may be a condition of an amended water license and that the condition could specify a requirement for Board approval of the modelling results. With the planned submission date for end of 2020, DDMI contends there will be adequate time for completion of a public review process (if required) prior to proceeding with PK deposition into mine workings.

This scheduling arrangement is worrisome, and the Board should be alert to the potential dangers here. DDMI, at this point unclear about how to effectively handle EFPK for the remaining years of mining and for reclamation at closure, wants all its approvals BEFORE producing the results of its testwork that could justify the approvals by the two boards.

This is not how environmental review or water licensing should be conducted.

GNWT also requests that DDMI describe contingency options that exist if updated modelling results in lower WQ in the open pits or LdG than has been assessed in the current review.

DDMI responds that it is not possible to properly describe contingency options in advance of the modelling results. In other words, we will have to wait until after the Boards approve the project before knowing what the realistic contingency measures, if any, might be.

DDMI then theorizes that there are 'likely a few key options' that would be considered, including:

- ensuring that the decant water level is a low as possible prior to filling the pit with water from LdG (again, what is 'decant water', how much EFPK is contained, and where would it go?);
- limiting the amount of EFPK deposited into the mine workings sourced from re-mining of the PKC if this is identified as contributing to different/poorer water quality ;
- excluding A21 as a potential PK deposition location if modelling results show WQ that is different/changed from what is currently expected.

GNWT #8 hones in on the issue of EFPK. Specifically, GNWT notes that DDMI has provided different estimates for the volumes of FPK and EFPK in the PKC used in the modelling, concluding that it is uncertain how much EFPK is realistically expected to be deposited.

In response DDMI estimates 'roughly' 2 Mt EFPK in the total 33.4 Mt of PK in the PKC but notes that until the EFPK removal feasibility assessment and PKC Closure Options assessment are complete in the first half of 2021, these numbers remain an estimate. The results of these studies, coming after approvals by the boards, are to inform how much EFPK could be removed from the PKC, and how much could be left behind to facilitate a dry cover option for closure of the PKC.

DDMI's modelling should have examined the contingency that a significant portion of EFPK from fresh slurry (and relocated EFPK from the PKC) will not consolidate in the pits within a reasonable timeframe. In such a case, what would be the consequences for site water management and WQ in the pits? How would the problem be addressed? This would be a proper precautionary approach, yet it remains a significant uncertainty that could substantially alter the impact predictions.

Finally, in responding to EMAB's query (IR#17) about the potential for long-term loading of porewater constituents to LdG, DDMI responds that FPK deposition in a mine area would result in some level of long-term loading of trace elements to LdG even with a stable meromixis.

There is much discussion on the record about DDMI's prediction that the pit lakes will be stratified (i.e. meromictic) with a clear water layer on the surface and contaminated water below. The boundary between these two layers varies under different assumptions, including the characteristics of the deposited materials, configuration and depth of the pits, and so forth.

Slater also notes that porewater expelled from the FPK is expected by DDMI to be an important source of contaminant loading in the pit lakes, and that the modelling indicates that this load will gradually diffuse upward and disperse into LdG over a period of many decades.

The SIS states [p11] that the total amount of FPK or EFPK to be deposited in the mine workings is unknown at this time. Nevertheless, for the modelling work it then identifies the

volumes of FPK to be deposited as 5 Mm^3 and for the EFPK as 5 Mm^3, noting that Golder's 2018 model assumed PK volumes of 'more than 30 Mm^3'. The SIS also states that one scenario (3a) involves the deposition of another 24.6 Mm^3 of EFPK slurry after mining has completed (year 2026-2028) into one of A418, A154, or A21. This volume of EFPK is presumably the transfer of the slimes from the PKC to the pits since the processing plant is not operating at this point.

Note that this schedule for EFPK deposition in pits apparently contradicts the schedule set out in Table 2-6 showing EFPK deposition from the PKC "as early as 2023 if feasible."[p25]

The SIS states that porewater will accumulate as the FPK consolidates, and will be pumped out and directed to the process plant, the WTP, or the North Inlet. As noted above, it remains unclear as to what exactly constitutes the 'porewater' that will be decanted. If it contains EFPK in suspension, then the problem is simply shifted to another location.

At the end of PK infilling "a final decanting of porewater will be conducted to remove water above PK material..." prior to adding freshwater from LdG to the pits.[p23] The SIS states [p24] that infilling from LdG will create a freshwater cap overlying the deposited PK, and that this cap will stabilize naturally creating a stratified lake that will not mix.

To sum up, DDMI regularly contends in its documents that 'a conservative (or precautionary) approach was used in the design and impact assessment of the pit infill project, and that conservative assumptions were employed— for example, conducting sensitivity analysis for scenarios ranging from plausible to improbable, and the design of mitigation measures that are more than adequate for reducing impacts to acceptable levels. It should be noted, however, that conducting sensitivity analysis for different scenarios doesn't necessarily increase our understanding of the results if the basic model is deficient.

In any event, DDMI argues that it has a high level of confidence in the conclusions of no significant environmental impacts regarding the in-pit disposal of PK.[10]

DDMI's position is difficult to support. The record is fairly clear, as most of the reviewing parties have acknowledged, that the proposal is filled with uncertainties at almost every turn. But perhaps most crucially, as described above, having available real, measured consolidation rates for EFPK in the PKC pond and not using it in the modelling work, substituting instead assumed and/or estimated values, is clearly not precautionary or conservative. Most if not all reviewers have commented to varying extents on the 'modelling problem' and, to be fair, both DDMI and Golder have also acknowledged shortcomings and the need for caution in interpreting results.

While a commitment has been made by the proponent to conduct 'more detailed' modelling in the future, post-approval, this doesn't address the inherent problems identified to date upon which DDMI's predictions of 'no impact' has been made. The Board has a decision to make in the short term, and will not benefit from post-EA submissions of new material. It will also not be useful to send DDMI away to fix the work done to date.

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[10] DDMI letter to WLWB IRs Feb 11, 2019

Cumulative Effects

The Board should be aware that Lac de Gras is already undergoing water quality changes from both the Ekati and Diavik operations. Five years ago GNWT commissioned Deton' Cho Stantec to study water quality trends in the lake and report back on two main questions:

1. Are there currently cumulative effects to LdG water quality resulting from the operation of the two mines; and,
2. Is there a potential for future cumulative effects given the current and expected levels of diamond mining.

The study[11] examined data from approximately 1994-2000 (i.e. the baseline) and from 2001-2013 (i.e., the post-baseline). Submitted in 2015, the following key points were made by the investigators:

1. Dissolved oxygen (DO) concentration, conductivity and pH in LdG did not exhibit marked depth gradients to 20 m through the period of record. The presence of near-saturation levels of DO in waters at depth will affect microbial activity within the surficial sediments and, importantly, P will remain sequestered within the lake sediments and will not readily diffuse from the deeper sediment pore spaces into the overlying water column. This means that the lake will likely remain relatively 'nutrient starved', with low primary productivity, for the foreseeable future.

2. For the post-baseline period (2001-2013) water chemistry indicates that DDMI's effluent and that Ekati/Slipper Lake effluent mixed rapidly within LdG over relatively short distances, which resulted in steep concentration gradients moving away from the discharge zone, through the mixing zone, and into the main basin of LdG.

3. Within the main basin of LdG and beyond the DDMI mixing zone there was a slight spatial gradient for hardness, sulphate, total dissolved solids, ammonia, total nitrogen, total aluminum, and arsenic.

4. The concentration of many potential contaminants has increased steadily and significantly throughout the entire LdG over the past 14 years. Those substances with consistent and persistent increasing trends through the entire lake include conductivity, hardness, chloride, sulphate, and total strontium. These significant increasing trends indicate that there has been a significant alteration in water chemistry within the entirety of LdG over the operational period of the two mines discharging into LdG.

5. There has been a significant cumulative effect of mine discharge on LdG water chemistry throughout the entirety of the lake, and clear evidence to fulfill the definition of "Temporal Cumulative Effect."

6. Significant trends over time were observed for total hardness and total strontium in three nearby 'reference' lakes (Nanuq, Vulture and Counts), while an increasing trend was also identified for sulphate in Nanuq Lake only. The results indicate that the lake-wide temporal trends observed in LdG could at least partially have been caused by alterations in water chemistry from natural causes. However, the magnitude of increase observed in the

[11] Deton' Cho Stantec, Lac de Gras Water Chemistry, Spatial Variability, and Temporal Trends - An Analysis of 'Cumulative Effects' in Lac de Gras Water Chemistry over the Period of Record. for GNWT. April, 2015.

reference lakes was considerably less than that observed in LdG, suggesting that temporal trends observed over the past 14 years in LdG were primarily the result of mine discharge.

7. The mean annual loading into LdG from DDMI effluent is greater than that from Ekati/ Slipper Lake effluent for sulphate, chloride, total nitrogen, total phosphorus, and total aluminum, arsenic, molybdenum, nickel, strontium, and uranium.

8. The mean annual loading from Ekati/Slipper Lake effluent into LdG is greater than that from DDMI effluent for total iron and total copper.

9. The relative contribution of the two identified discharge points (i.e., DDMI diffuser, Ekati/ Slipper Lake Outlet) to those potential contaminants with an observed increase in the entirety of LdG therefore appears to be largely related to loading from the DDMI effluent, with the exception of total iron.

10. Molybdenum, strontium and uranium from DDMI are observed moving downstream over relatively long distances. These gradients indicated that the DDMI effluent in LdG was not completely mixed throughout the entire main basin, but rather that concentrations decreased slightly moving further downstream from the DDMI mixing zone.

11. Because of the rapid mixing of both the DDMI effluent and the Slipper Lake discharge, and the assumed rapid mixing of the LDS discharge, there was no observable evidence of a persistent spatial overlap in effluent plumes within the designated zones of potential overlap. These results indicate that there was no evidence at this time to fulfill the definition of "Spatial Cumulative Effect".

These results raise an important issue for the Board to consider in evaluating the potential effects of DDMI's pit infilling proposal on long term water chemistry in LdG. DDMI and others have recognized the potential for WQ changes as a result of flooded pit water interacting over time with LdG water. The enduring quality of LdG water for the Aboriginal peoples relying on this lake for cultural and economic purposes is an important issue. The DDMI project presents an unanticipated hazard that now needs to be understood and considered for its regional, cumulative implications.

Uncertainties About Closure

Twenty years ago the Dogrib Treaty 11 Council's environmental assessment raised the possibility that DDMI may have underestimated the size of the PK containment facility.[12] First, tailings deposition may be characterized by massive ice buildup on the beaches. Second, Diavik may have over-estimated the amount by which the tailings will consolidate and reach an acceptable density, so that planned storage volume may not be available. Third, miscalculations in the water balance, particularly with respect to the efficiency of water reclaim for the process plant, may under-estimate storage.

DDMI's position then was that the impoundment was initially designed for a 15% contingency above what was required for their early estimates of 32 Mt of kimberlite tailings. The company

[12] Dogrib Treaty 11 Council Environmental Assessment of the Proposed Diavik Diamond Mine, June 1999. p.45

had since decreased its projected tailings disposal to 26 Mt, but would be maintaining the original size of the containment. This, it then argued, should be ample contingency to handle unpredicted increases in storage capacity.

Twenty years on the 'room' problem has indeed emerged, with DDMI now exploring the use of the open pits for FPK storage while also planning to conduct a 'closure options assessment' for the PKC (dry vs wet cover) to be completed in 2020, along with a feasibility study of relocating slimes (EFPK) from the pits. If a dry final landscape for the PKC is to be considered rather than the currently approved surface pond, the concept is to be submitted as part of a revised CRP in 2022.

DDMI's Summary Impact Statement identifies 4 options for storing PK for the remainder of mine life:

1. increase PKC dam height;
2. place all FPK to mine workings;
3. fill PKC to approved capacity (Phase 7a raise) and construct new onsite PK facility; or,
4. fill PKC to approved capacity (Phase 7a raise) and divert remainder to mine workings.

DDMI already has approval for Phase 7a dam raise of 4 m. This is apparently 1 m short of the stated 5 m required for remaining FPK. The SIS states that 'completing a traditional downstream rockfill dam is constrained by a lack of footprint on the east and west dam portions of the PKC facility.'[p26]

MVRB IR#6 focuses in on alternatives to the in-pit disposal project, noting that Diavik has identified that two of the key disadvantages of its Option 1 (a traditional dam raise) are footprint restrictions and limited closure options, and that DDMI's preferred option includes <u>both</u> a dam raise and depositing FPK into mine workings.

DDMI responds that an inability to expand the PKC footprint outwards results in a design focused on traditional dam raises. While this type of expansion is permitted and technically feasible, the result is a taller land-based PKC, which will need to be managed into closure.

It is accepted that the PKC, however high the containment structures are, will always require some level of long-term oversight and maintenance. This requirement is unlikely to change significantly whether or not the additional 1 m height is constructed.

In its May 10 response to MVRB IR#7 DDMI states that it has received approval for dam raises to enable storage of all PK on-land in the PKC. These designs can be constructed, operated and closed safely or they would not have been proposed or approved. Having said that, storage of PK on-land is not the preferred storage option from a technical perspective. DDMI considers the option of permanent subaqueous disposal of PK into mine workings to be beneficial when compared to any land-based storage option. This technical judgement, DDMI contends, exists regardless of the option between dam expansions which focus on unconstrained outward or constrained upward expansion.

This may be the case, but the position should be supported by a proper risk assessment.

DDMI, referencing the 1999 federal Comprehensive Study Report (Section 4.3.1 Alternative #3) states that from a geochemical and closure perspective the better option would be to store PK below LdG. This statement is not correct— the wording in the CSR is this alternative is "possibly advantageous from a geochemical and closure perspective."[p56]

DDMI also notes in this response that it has identified technical closure challenges that have resulted from the decision to store PK on-land. In addition to general geochemical (WQ) concerns, DDMI has identified a closure challenge with EFPK located in the center of the PKC. EFPK, it states, has 'the consistency of toothpaste that would likely not be safe for people or wildlife if it was accessible post-closure.'

DDMI's preferred closure option, and the one that is approved by the WLWB, is to maintain a pond over the EFPK post-closure ("wet-cover option") such that people and wildlife would not come into direct contact with the EFPK. The identified uncertainty with this closure option is the ability to maintain a pond given current seepage rates from the facility. An alternative to the wet-cover option is to remove some or all of the EFPK from the PKC and instead of a closure pond leave the facility in a dry but stable surface ("dry-cover" option). If PK deposition into pits is permitted, it would enable consideration of a dry- cover option because the EFPK could be disposed of in the pits. Without this option there is no other practical location to store EFPK that has been removed from the PKC.

As for placement in mine workings, DDMI believes A418, the preferred pit option, will not be mined out in time for PK placement required in 2021. As for alternate onsite options, DDMI states that there is "not enough cumulative storage capacity" to accommodate the predicted PK volumes. Therefore, DDMI's preferred option is a combination of the already-approved and under construction Phase 7a dam raise, with in-pit deposition in A418 once it becomes available.

This is an important point for the Board to consider— the in-pit disposal option for FPK slurry from the processing plant, with the concomitant potential risk posed to LdG, is being proposed essentially to avoid only an additional 1 m raise of the PKC dams.

In responding to MVRB IR#5 which asked about the results of DDMI's review of pit lake experience in other parts of the world, DDMI provided the following:

1. early planning is key – few closure management options exist at completion of a mine void, particularly so in the context of a largely completed overall mine site;
2. development of successful pit lakes typically entailed strategically identifying factors critical their success, then incorporating those factors into adaptive closure planning. well in advance of 'Rubicon' moments of mine development;
3. problematic geochemistry must be understood and managed;
4. holistic planning views the pit lake as one part of a larger closure landscape– successful pit lake closures were typically well-planned in advance;
5. holistic planning may improve overall mine closure outcomes (reduced risk and liability) at the expense of reduced pit lake success.

In view of these lessons, DDMI notes that it:

- considers the present state of planning and management of the pit lakes appropriate for the stage of the mining (i.e., pre-closure);
- has a good working knowledge of the materials to be placed in the pit, and is working with the University of Alberta, in-house experts and consultants to close remaining knowledge gaps; and,
- the timelines to address the remaining knowledge gaps are shorter than the timelines to place materials in the pits, so there is adequate time to adapt plans if detailed information indicates a need to do so.

Given the array of deficiencies and problematic issues well documented on the MVRB registry by reviewers, as well as the obvious lateness in DDMI's attempting now to wrestle with vexing operational and closure challenges that have been looming for some years, it is difficult to reconcile the lessons learned with the current state of affairs. If the timelines are adequate, as alleged, then why not develop the critical information needed to both demonstrate the environmental viability of the project and to update the plans before seeking approvals?

To be still in flux at this point about what closure measures are most feasible, and to not have effectively investigated an issue known for a significant number of years now, can scarcely be called 'precautionary'. DDMI, having had 20 years to collect and utilize real data about EFPK behaviour in the pond, has done apparently little serious planning to date to design an effective closure plan for the PKC.

Conclusions and Recommendations

To be helpful to the Board at this point, and to all those parties concerned about DDMI's latest proposal, the following steps are recommended for the Board's consideration:

1. the Board should retain an independent qualified expert on clay hydrodynamics to review the available relevant information provided by DDMI on FPK and to prepare a report to the Board as to the adequacy of DDMI's work to date in relation to the treatment of EFPK in its planning to date;
2. ideally to follow or be integrated with #1, the Board should conduct or commission an independent expert review of DDMI's WQ modelling and results in order to obtain a more informed understanding of the likely outcome of the project in terms of environmental risks; and,
3. the Board should include potential cumulative impacts to LdG as a component of the environmental review.

Respectfully Submitted,