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To:	**Nunavut Water Board**	**Fax No.:**	**(867) 360-6369**
Attention:	**Dionne Filiatrault, P.Eng.**	**CC:**	
From:	**Holger Hartmaier (Ext. 113)**	**Date:**	**April 9, 2003**
Subject:	**Polaris Mine Reclamation and Closure Plan- Meltwater Control Procedures**		
No. of Pages (including this page): 4 Pages		**Project No:**	**0308-001-05**

I have reviewed the letter dated March 20, 2003 and attachment dated March 21, 2003 from TeckCominco regarding the handling of meltwater at the site.

The meltwater management plan consists of three major components:

1.) Removal of as much snow as possible from the areas surrounding the Accommodations barge, Concentrate storage shed and ancillary buildings to minimize the amount of meltwater that must be handled.
2.) Interception of as much meltwater as possible above the areas of contamination by existing and newly developed ditching.
3.) Disposal of the remaining meltwater which enters or originates from contaminated areas into the underground mine excavation.

TeckCominco estimates that about 8,125 m^3 of meltwater will have to be disposed underground. They propose that the meltwater will be directed into a containment sump located adjacent to the process barge, where it will undergo remediation to remove hydrocarbons and to settle particulates. The particulates will consist of materials native to the site, such as rock and ore particles. The remediated water will be piped underground via existing piping along the 1973 exploration portal to the crusher/electrical chamber. The estimated volume of the underground chambers proposed to store the meltwater is at least 9,500 m^3.

The letter from TeckCominco mentions that this proposal has also been presented to WCB-Mines Inspection Services and received endorsement, subject to provision of further details.

Comments:

The disposal of meltwater underground raises several questions and concerns:

1. From a regulatory perspective, this proposal represents a significant change in the final use of the abandoned underground workings. Previously, the closure plan was based on the philosophy that no free liquids would be disposed of underground. Would the Board be open to setting a precedent with this storage?
2. The introduction of water into the underground permafrost environment risks degradation of the thermal regime around the disposal chamber, at least temporarily.
3. Degradation of the thermal regime may result in some instability of the surrounding rock mass due to thawing propagating from the storage chamber to some distance into the rock.
4. What is the proximity of the disposal chamber to the nearest thawed zone, such as the adjacent ocean floor?
5. Are there any major geological structures (e.g. faults, shear zones, etc.), that could act as a seepage conduit if and when thawed?
6. What is the proximity of the proposed disposal chamber to the area designated for underground disposal of hydrocarbon contaminated soils?
7. What is the risk that there may be more meltwater discharge than estimated? What is the volume and retention time of the proposed settlement/remediation containment sump and is there a risk that it could be overtopped?
8. What is the chemistry of the meltwater before and after remediation?
9. The underground storage volume is about 17% greater than the expected volume of meltwater to be stored. Assuming a 10% expansion due to freezing, this leaves about 7% freeboard volume in the disposal chamber. Therefore the roof of the chamber may not have much benefit of ice-support, contrary to the idea proposed by TeckCominco. In fact the presence of water may destabilize the roof, due to thawing of the haunch area, associated with the propagation of a thawing front into the surrounding rock mass.

In addition, there may a risk of some permafrost degradation and erosion associated with the excavation of new ditching required to augment the existing network of ditches, in order to direct the flow of meltwater around the contaminated zones. This may add to the amount of suspended sediment, particulate and potential contaminant content of the meltwater. In permafrost areas, berms and dikes (potentially promoting permafrost aggradation) are normally used to direct surface water as opposed to ditching.

Discussion:

Disposal of drilling fluids into underground formations has been accepted practice for the oil and gas industry in the Arctic. Typically the host formations lie at great depth, below the base of the permafrost. The permafrost is considered to be an impervious cap to these disposal zones and is assumed to be an effective barrier against migration of fluids to the surface. Tailings are also stored in permafrost areas of the north.

Recently, the Raglan Mine, in northern Quebec has utilized a mined-out underground opening in permafrost to store mill process water for recycling (Lalonde, 2003). The underground facility includes a 20,000 m^3 underground water storage chamber in a mined out stope. An underground pumping station will return 400 m^3/h to the mill. Water temperatures range from 31° C at the mill to about 18° C as it comes out of the underground storage. The mine operators were concerned about permafrost degradation and thermistors have been installed to monitor the thaw front propagation.

At Polaris, the temperature of the meltwater will be significantly lower (say 2 to 4° C). The disposal of meltwater will be a one-time event in the summer of 2003, representing a single pulse of water rather than a continuous flux, as in the Raglan case. Nevertheless, the volume of water represents a significant thermal mass to the surrounding permafrost, which is estimated to have a temperature around –15° C; and its potential effects on the thermal regime, although short-term, need to be understood and monitored.

From a regulatory perspective, approval for disposal of liquids underground should also consider if the remediation of the meltwater prior to pumping underground is, in fact, required. If TeckCominco can confirm that the thermal integrity of the disposal chamber is maintained, then there should be no concern for disposing of meltwater, which may contain trace amounts of hydrocarbons, provided the water will freeze underground within a short period of time. There may be greater risks associated with the operation and containment of meltwater in the surface sump, if it were to become overloaded.

Recommendations

TeckCominco should provide the Nunavut Water Board with further information on the design rationale and risk assessment for the proposed meltwater control procedures, specifically:

- Details of the proposed ditching scheme and subsequent remediation to avoid degradation of the permafrost and erosion.
- Details of the volume of the containment sump, retention times and contingency plan for dealing with extreme flows.
- Chemistry of meltwater before and after remediation, including assessment of untreated water chemistry for direct underground disposal. This would include a check on the freezing point depression that may be associated with any contaminants.
- A thermal analysis should be carried out to assess the short-term effect of introducing the proposed volume of water into the underground permafrost environment, with regard to the following concerns:
    - Effects on stability of the rock mass surrounding the disposal chamber.
    - Consequences of potential rockfalls, ie waves, blockage of access, damage to pipes, etc. and need for installing supplementary rock support prior to disposal.
    - Time for freeze-back, based on meltwater chemistry, and estimated time for return to ambient conditions within the surrounding permafrost regime.
    - Confirmation that there is no risk of thaw bulb reaching adjacent talik zones, such as the ocean floor next to mine.
    - Confirmation that no geological structures may act as seepage paths, if and when thawed.
    - Confirmation that liquids will not migrate from the disposal chamber.
    - Consideration of risk to area designated for disposal of hydrocarbon contaminated soils.
    - Consideration of appropriate factors to account for long-term global warming to confirm that the disposal area will remain frozen.
    - Installation and monitoring of thermistors around the disposal chamber to monitor the effects of water disposal and subsequent freeze-back, to confirm modelled predictions and verify the assumed integrity.

BGC would be pleased to review the above information from TeckCominco, and/or undertake an independent assessment of this proposal on behalf of the Board.

References:

Lalonde A., (2003), "The Zero Process Water Discharge Project at SMRQ", Proceedings, Mining in the Arctic, 2003, J.E. Udd, G. Bekkers (Ed.), CIM Publication.

Closure

We trust that this review will satisfy you requirements at this time. If you have any questions or concerns, please do not hesitate to contact me.

Yours truly,
Per BGC Engineering Inc.

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