Memo

To	**Robin Johnstone**	File No.	**U638B**
From	**Tom Higgs**	cc	**Colleen English**
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Date	**April 16, 2003**		

Subject **Outstanding Environment Canada Issues – March 13, 2003**

This memo has been prepared to address outstanding water treatment related issues outlined in the Environment Canada e-mail of March 13 from Mark Dahl.

Issues raised in the e-mail can be summarized as follows

1. Has De Beers committed to provide treatment for dissolved metals?
2. Pilot plant studies indicated that the use of coagulants (i.e. ferric sulfate and lime) plus flocculants did not demonstrate a clear benefit over just flocculants since metal concentrations were variable and near detection. Were the results with dissolved metals during the pilot plant studies variable as well?
3. It was understood during the technical sessions that lime and ferric sulfate would effectively deal with most of the dissolved metals. Will the system be able to deal with dissolved metals that exceed guidelines (specifically Cr and Cu) in the minewater?
4. The information provided in the Technical Sessions suggested that the addition of lime and ferric sulfate "might be retained as a contingency". When would this additional treatment be considered "required"?

Background Discussion

Based on the data collected on minewater during the AEP, the concentrations of dissolved metals in the minewater were very low - near detection or solubility limits in most cases. This factor forms the basis for the treatment process. Since the particulate matter from the mine contains metals, the removal of this material to low levels is essential and will ensure that the final discharge targets for metals are met.

Its important to recognize that the term "dissolved" from a chemical perspective refers to a material that is present in solution in the free ionic form, while the actual concentration of a "dissolved" species must be defined by an analytical method involving membrane filtration at 0.45 micron. The reality is that in some cases metals can be present as colloidal material finer than 0.45 micron. This colloidal metal can report analytically as if it is dissolved, but in fact chemically it is present as very fine particulate. A key point to recognize is that this colloidal material can be removed during water treatment via physical methods using coagulants and flocculants plus settling and filtration (which are the processes being used for the Snap Lake WTP). However true dissolved species are not as easily removed since the concentrations of these dissolved species are controlled by empirical solubility limits. These published limits have been established by experimental procedures. Minewater characterization work as well as the bench and pilot testing to date has indicated that the presence of colloidal material in the minewater is not expected to be

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an issue during operation. At minewater pH conditions the dissolved metal concentrations are at minimum concentrations, which are not related to the concentration of that metal in the particulate form.

Some further information may be valuable for interveners regarding the use of flocculants, their performance and fate. The term "flocculant" refers to a group of high molecular weight long chain organic compounds, that are used in water treatment to remove fine colloidal suspended solids. Flocculants are also often referred to as "polymers" or "polyelectrolytes". Fine colloidal solids in water carry electrical charges, which prevent them from joining together to form larger particles. Colloidal particles are so fine that they do not settle out or are removed by convention filtration. The addition of flocculants to water provides sites for charge neutralization and attachment of colloidal particles to form a larger particles. Once flocculation occurs, these particles become large enough that they can be removed by physical means such as settling or filtration. The flocculated particle containing metals such as chromium would then be retained in the filter media. This particle would eventually report with the filter backwash water when the filter is cleaned. The backwash water is sent to the thickener where these solids settle out and are incorporated with the thickener sludge which is sent to the backfill plant. Once colloidal metals, such as chromium are removed from the water they do not some back into solution or fine suspended since they are retained in the solid phase.

Summary

Therefore based on the above discussion the response of the issues presented by EC above can be summarized as follows,

1. In the event that the Snap Lake WTP feed concentrations for particular dissolved metals are elevated above the current predicted concentrations, the treatment system, supplemented with coagulants, will reduce them to the same predicted discharge target concentration since these dissolved species will in fact be "colloidal".
2. The dissolved metal concentrations for elements such as Cu and Cr during the pilot plant studies were also variable since they were typically assayed at concentration near their detection limits where the assay error can be higher.
3. As per Item 1 above, the WTP will be effective in reducing elevated dissolved Cu and Cr levels in the feed, since at the current minewater pH range, these metals will be present as colloidal material and not in true solution. The WTP will still be effective in reducing concentrations to particulate matter to low levels.
4. All reagent storage and metering equipment will be installed in the WTP at the outset and therefore be available to assist with the removal of particulate and colloidal material. Continuous monitoring plus routine sampling and assays will provide input as to when the use of ferric sulfate and lime are required to meet discharge targets. Flocculant addition to both the thickener and the filter feed will however be part of the normal treatment process.

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MINUTES OF MEETING

Date/Time:	April 10, 2003; 1:00pm	**File No:**	
Location:	Various - telecon	**Written By:**	G. Oryall
Subject:	Water Treatment Plant	**Project No.:**	U638A
Project Title:	Snap Lake Diamond Project	**Date Issued:**	April 10, 2003

Present: Environment Canada: Anne Wilson; Mark Dahl
DFO: Dave Balint
INAC: Don MacDonald; Sevn Bohnet(part time)
De Beers: Robin Johnstone; Colleen English
AMEC: Tom Higgs; Greg Oryall

Other Distribution: MVEIRB Public Registry

Purpose: Discuss EC's unresolved issue that "it remains unclear if the treatment plant will be equipped to remove dissolved metals."

ITEM NO	ITEM	ACTION BY	DUE DATE	REVISED DUE DATE
1.	AMEC clarified the following points: (a) The benchscale pilot testwork conducted to evaluate water treatment processes found that treatment for removal of suspended solids was sufficient to meet water quality objectives. The level of actual dissolved metals in the feed and discharge water was very low, controlled by their very low solubility limits under the pH and temperatures of the minewater. (b) Removal of actual dissolved metals below the levels observed in the pilot testwork program is not practical. (c) Although it was not experienced in bench-scale pilot testwork, it is possible that during mine operations very fine colloidal (clay) material could be present in the feed, and could assay as apparent dissolved metals. This is because standard assay practice reports any suspended particles smaller than a 0.45 micron sieve size as "dissolved".			

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	(d) In the event colloidal particles are present, the addition of a coagulant in the treatment process would be an effective means of removal. (The reason coagulation did not yield improved results in the bench-scale testwork was because only very low levels of colloidal particles were present in the feed samples collected and tested.) (e) As a conservative precaution, equipment for coagulant addition (ferric sulphate and lime for pH balance) will be installed at the outset in the WTP, with a supply of the chemicals on hand. In this way, if colloidal particles become an issue, they can be removed.			
2.	The question was asked whether a multi-stage treatment process would be required in the event that elevated levels of dissolved metals were experienced. AMEC responded that, based on the measured pH of the feed, elevated levels of dissolved metals could not occur because of their low solubility limits under these conditions. If the pH were to shift outside the acceptable range, it could be readjusted to the desired set point using either ferric sulphate or lime addition, both of which will be on hand. Environment Canada stated that they were not looking for a parameter by parameter approach to the treatment process, but rather assurance that treatment possibilities have been considered.			
3.	Specific hypothetical questions were raised about potentially elevated levels of dissolved chromium and aluminum. AMEC responded that in such cases, it is highly probable that these would be present in colloidal form, and therefore removeable by coagulation. If due to pH shift, then it would be corrected as in 2, above.			
4.	A question was asked about plant control systems and the establishment of a database which would correlate turbidity to metal levels. AMEC responded that continuous automated monitoring of pH and turbidity would be included. Chemical addition for pH adjustment would be automatic. Turbidity would be calibrated to assayed TSS and metals values, to establish			

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	the on-stream control criteria for compliance with permit limits.			
5.	A question was raised by DFO regarding reasons for the difference between the "EA Assessed" and "Expected" chromium concentrations (0.0020 ppb and 0.0046 ppb respectively) presented in Table 12c of Golder's February 28, 2003 Technical Memorandum entitled "Snap Lake Diamond Project Mine Water Assessment and Variability". A more thorough explanation of DFO's concerns is also highlighted on page 7 of their Technical Report Addendum submitted 14 March 2003. This issue was recommended for discussion with De Beers and Golder, and could not be resolved during this telecon.	De Beers/ Golder	16 April 2003	
6.	Conclusion: At the conclusion of the telecon, all parties stated the issue of dissolved metals treatment has been resolved to their satisfaction. Environment Canada requested a written response to their March 12th e-mail from Mark Dahl as further clarification of today's discussion.	De Beers/ AMEC	16 April 2003	