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September 24, 2015

File: L020

Marc Casas, Regulatory Officer
Mackenzie Valley Land and Water Board
PO Box 2130
Yellowknife, Northwest Territories
X1A 2P6

Dear: Mr. Casas:

Re: MV2011L2-0004; Part D, Section 3 - Report on Correlation Between On-Site and Laboratory Measurements of Chloride and TDS

De Beers Canada Inc. (De Beers) has determined the relationship between on-site chloride measurements and laboratory calculated total dissolved solids (TDS). De Beers concludes that on-site (in-line) chloride (Cl-) measurements are unreliable, and that in-line electrical conductivity (EC) provides much more reliable operational monitoring data. In the attached technical memorandum, De Beers provides the statistical correlation between on-site (in-line and handheld) measurements and laboratory calculated Cl- and TDS.

De Beers requests that the Board approve a change to the requirements for sampling and reporting daily in-house chloride per Annex A; Part A.1; SNP 02-17b *from* "daily on-site in-house chloride", *to* "daily, on-site, in-line electrical conductivity".

Should you have any questions, please do not hesitate to contact Sean Whitaker at sean.whitaker@debeersgroup.com.

Sincerely,

DE BEERS CANADA INC.

Erica Bonhomme
Environment Manager, Snap Lake Mine

cc	M.Sanderson, J. Steele,	GNWT
	J.Potten	MVLWB
	P. di Pizzo, Z. Liu	SLEMA

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DE BEERS
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TECHNICAL MEMORANDUM

FILE: L20

FROM: DE BEERS CANADA INC.

TO: MACKENZIE VALLEY LAND AND WATER BOARD; DESIGNATED INSPECTOR

SUBJECT: IN-LINE CHLORIDE & ELECTRICAL CONDUCTIVITY METERING MV2011L2-0004 PART D; SECTION 3

DATE: SEPTEMBER 24, 2015

1.0 Background

Continuous monitoring of electrical conductivity (EC) and chloride ion (Cl^-) content is performed at the Water Treatment Plant using in-line meters, in order to maintain discharge water quality to Snap Lake within the current water license criteria at sample point 02-17b. Based upon operational data, correlations of inline conductivity and chloride against laboratory samples were conducted to establish management procedures to maintain effluent quality discharge within license parameters at SNP 02-17b. Historical instrument measurements of in-line Cl^-, compared to laboratory analyses have clearly demonstrated a poor correlation and are considered unreliable. The preferred method to manage effluent quality at Snap Lake Mine is by in-line conductivity (EC) measurement. This tool, with a strong correlation with total dissolved solids (TDS), and inherently, chloride, has been, and continues to be, the tool employed by De Beers to manage effluent quality. In-line Cl^- measurements have provided unreliable results since installation.

2.0 In-line Cl^- and Electrical Conductivity Monitoring

In-Line Chloride Analyzer

The Water Treatment Plant operates one in-line analyzer for measurements of Cl^- concentration discharged to the outflow to Snap Lake and one in-line meter for measurements of EC. The Cl^- analyzer uses a silver-silver chloride reference electrode that develops a potential proportional to the chloride concentration, whether it is sodium chloride, potassium chloride, ammonium chloride or some other chloride salt and remains constant as long as the chloride concentration remains constant. The in-line Cl^- meter is calibrated once per week as per manufacture specification; however, there is considerable variability between the in-line Cl^- analyzer and laboratory analysis samples. It is postulated that this variability is related to fluctuating chloride concentrations in effluent (between 43 to 49%) which the probe has difficulty in detecting. The cause of the analyzers variability remains unknown, although the probe itself has been replaced several times to attempt to address the issue. A separate, handheld Cl^- meter has also been found unreliable as a means to verify inline readings.

In-Line Electrical Conductivity (EC) Meter

The in-line EC meter measures the near-continuous electrical conductivity of the effluent as microSiemens/cm (µS/cm). Electrical conductivity is used to calculate the ionic content of the effluent, namely the concentration of TDS, based on a relationship with calculated TDS as determined in an accredited laboratory. The in-line EC meter is calibrated weekly. The calibration involves cleaning the probe and placing in a solution with a reference EC standard heated to 25 degrees Celsius. Daily EC measurements are also taken using a calibrated handheld EC meter.

The in-line EC meter, when compared to handheld meter readings and laboratory analysis samples, can drift over time. Drift corrections result in EC value step changes immediately after calibration. Daily measurement of EC in effluent at SNP 02-17B using the handheld meter is a reliable method for identifying in-line instrument inaccuracies. Temperatures of both the inline and handheld meters are recorded for review, should temperature be a contributing factor to measurement variation. In-line EC meter calibration is performed if the difference between instruments is greater than 50 µS/cm and there is no noticeable temperature difference between instrument readings.

Strength of In-Line Meter Relationships with Lab Results

Chloride concentrations in effluent at SNP 02-17,B as obtained through an external laboratory, are plotted against values obtained from the in-line conductivity meter and from the inline chloride meter in Figure 1. The resulting relationship is expressed as regression strength, where 1 represents a full correlation 0 no correlation and -1 a negative correlation. The following regression is shown for the two inline meters and handheld meter against the corresponding laboratory chloride result:

- R^2 = 0.14 for Inline Chloride
- R^2 = 0.43 for inline conductivity
- R^2 = 0.55 for hand held conductivity meter

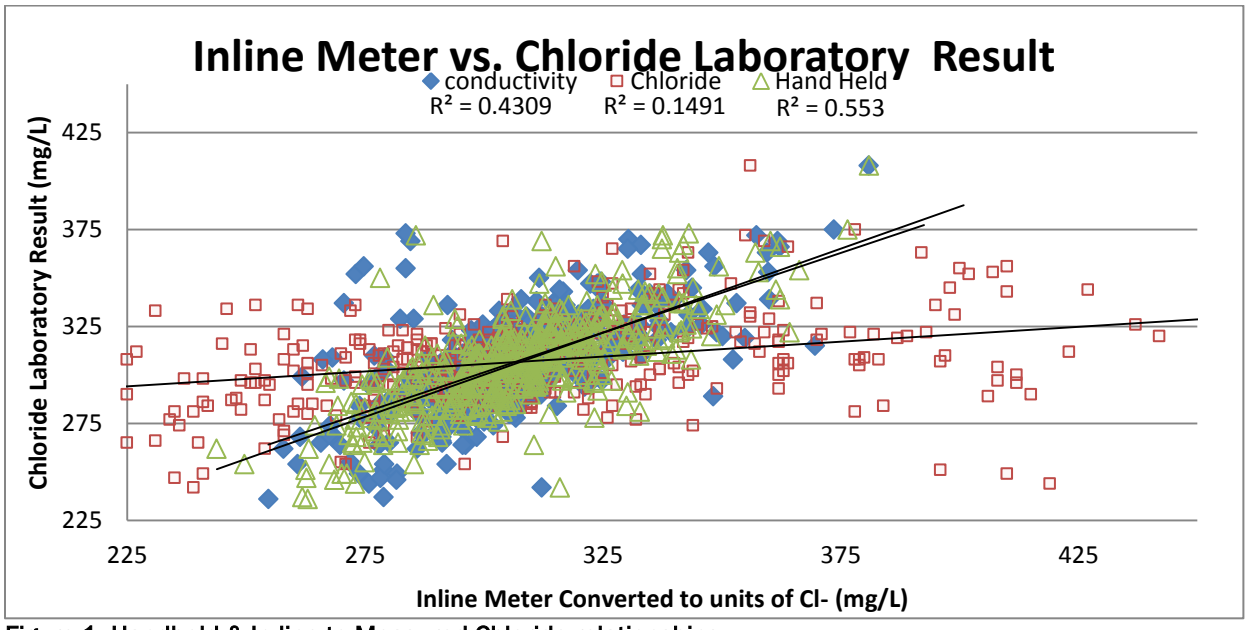

Figure 1: Handheld & In-line to Measured Chloride relationships

Table 2: Variance between in-line chloride and laboratory calculated chloride May 5-July 16

Date	In line Cl (mg/L)	Lab Cl (mg/L)	Variance
05-May-15	371	321	50
06-May-15	305	326	-21
12-May-15	378	375	3
14-May-15	407	353	54
18-May-15	362	338	24
21-May-15	284	314	-30
25-May-15	214	310	-96
01-Jun-15	335	339	-4
04-Jun-15	355	372	-17
05-Jun-15	335	352	-17
08-Jun-15	325	340	-15
11-Jun-15	379	308	71
15-Jun-15	392	363	29
17-Jun-15	387	319	68
18-Jun-15	395	336	59
22-Jun-15	442	320	122
23-Jun-15	274	316	-42
26-Jun-15	364	366	-2
29-Jun-15	356	408	-52
02-Jul-15	319	*356*	*-37*
04-Jul-15	327	365	-38
05-Jul-15	359	369	-10
07-Jul-15	343	363	-20
10-Jul-15	313	320	-7
11-Jul-15	295	321	-26
13-Jul-15	323	326	-3
16-Jul-15	291	297	-6

The data suggests that there is nearly no relationship between the inline chloride analyzer readings and laboratory chloride results, and there is only a weak correlation between laboratory chloride and inline conductivity. This poor relationship can also be shown by tabulating the variance between the in-line measurement and the laboratory result for each day.

Chloride concentration represents a portion of the total conductivity of the water ranging historically from 43% to 49% with an average of 46%. Conductivity instrumentation at Snap Lake Mine has not been statistically robust in detecting these minor shifts at an ionic level using conductivity, but when looking at TDS as a whole, as discussed below in Section 3.0, there is a strong correlation between TDS and EC. It is using this relation that Snap Lake Mine is able to make operational management decisions at the Water Treatment Plant

In summary, there isn't a statistical correlation between in-line chloride analyzer, and the laboratory reported value, and therefore it is not appropriate to base operational decisions on this analyzer, nor to monitor operational compliance on this basis.

3.0 Electrical Conductivity:Total Dissolved Solids relationship

EC is used as a surrogate measurement for Total Dissolved Solids (TDS). Snap Lake utilizes and reports calculated TDS values as stipulated in the Water Licence. EC:TDS relationships are regularly updated to track correlation (and fluctuations) between EC and TDS. Figure 2 shows linear relationships between EC and calculated TDS values for the handheld and in-line conductivity meters. The current relationships are as follows:

Handheld EC:TDS relationship (July 2015): $\boldsymbol{TDS = 0.5034\,XEC + 22.018}$

In-line EC:TDS relationship (July 2015): $\boldsymbol{TDS = 0.567XEC + 70.619}$

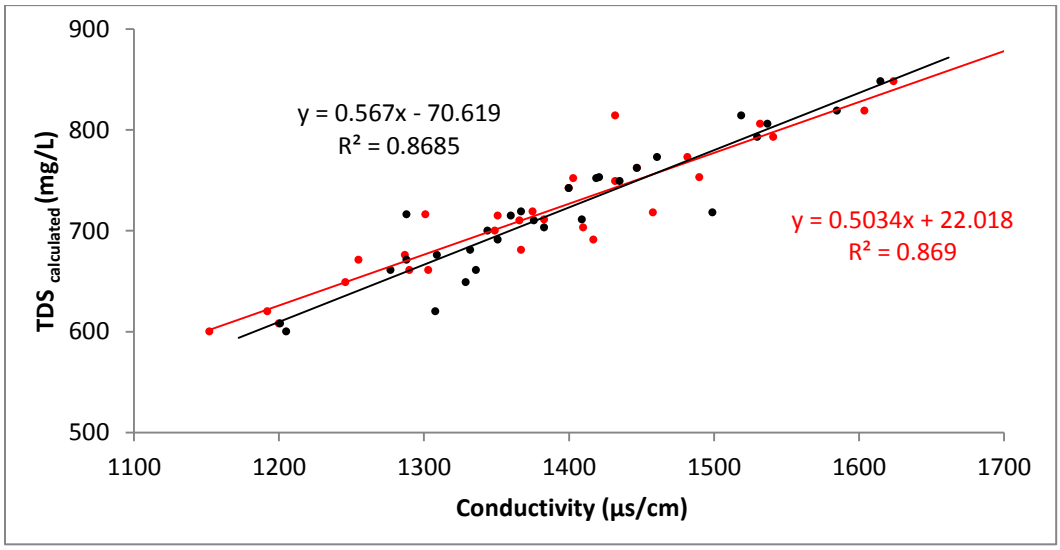

Figure 2: Handheld & In-line EC:TDS relationships

4.0 Conclusion:

As noted above, in-line conductivity provides De Beers with the best operational controls at the Water Treatment Plant. It has a strong correlation to TDS, and the constituent ions have remained stable within TDS since mining commenced.

The chloride meter has shown to have no correlation with monitoring data and is considered unreliable and not-fit for use.