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TECHNICAL MEMO

Date: November 28, 2009

To: Jay Cherian
Denison Environmental Services

From: Bonnie Burns
Laberge Environmental Services

Re: **Summary of Groundwater Monitoring Activities at the Faro Mine Complex for the 2009 Season**

Background

As outlined in Appendix B of the contract between the Yukon Government (YG) and Denison Environmental Services (Denison), groundwater monitoring wells are to be sampled at various frequencies during the calendar year as a component of the care and maintenance duties. In addition, there are several wells which are to be sampled as a component of closure planning. Sampling of these additional wells is not part of the contract but was covered by YG under other funding, to allow all groundwater sampling to occur concurrently.

Denison contracted Laberge Environmental Services (Laberge) to conduct the groundwater program, including the wells to support closure planning, for the 2009 season. Laberge had not performed any groundwater monitoring at the Faro site since the late 1990s. AECOM was contracted by YG to assist Laberge through technical knowledge transfer since the number of wells had increased significantly. Also, Laberge was unfamiliar with the techniques involved with the sampling of the eight multilevel wells on site; AECOM member Jennifer Funston was instrumental in the instruction of the protocols involved with these well types.

Methods

The main method of sampling the conventional groundwater wells at the FMC employed the use of dedicated 5/8" tubing equipped with foot valves. Honda centrifugal water pumps were used to aid in purging the wells. Static water level and total depth were measured at each site to calculate purge volumes. Three volumes of the standing water were removed along with the previously calculated 42 L assumed to be in the sand pack surrounding most of the wells. In-situ analysis (water temperature, pH and conductivity) was made prior to sampling.

The multi level wells were sampled using 1/4" tubing which was thoroughly rinsed with deionized water between each multi-level well in the set, and then disposed of. Where the water level was beyond 5 meters from the top of the pipe, foot valves were used. A peristaltic pump, powered by a portable generator, was used to purge and sample each well.

Sample bottles were filled and preserved following the protocols set out by the lab, Maxxam Analytics Ltd. Samples to be analyzed for dissolved metals were filtered in the field using one-time-use disposable filters and syringes. All samples were kept cool prior to shipment to the lab. As a measure of quality assurance and quality control, up to 10% of the number of wells were sampled in duplicate or as split samples. Also field and/or travel blanks were submitted.

Photographs of some of the wells are appended to this memo.

Results

The majority of the wells are sampled twice per year; spring and fall. Several wells are only sampled annually (fall) and some wells are sampled four times over the season to support several adaptive management plans (AMPs) that had been included in the past water license. The first sampling of the season was completed from May 29th to June 2nd, 2009. AECOM accompanied Laberge for this round of sampling. A total of 94 wells were measured; however a significant number of the wells were frozen or dry so only 65 wells were actually sampled (Table 1).

The summer set of samples was collected August 3rd to 6th. This round of sampling was to collect groundwater from the wells that had been identified under the various AMPs. In addition, any of the wells that were dry or frozen during the spring sampling were revisited and sampled if possible. This resulted in the measurement of a total of 39 wells, but 12 were either still frozen or dry, and samples were collected from 27 wells (Table 2).

The fall sampling took place from September 8th to 13th. AECOM accompanied Laberge for two days of this trip to familiarize the crew with the annual wells. They also performed an audit on five of the wells which Laberge had previously sampled that week. Paul Ferguson of Robertson Geoconsultants Inc, also accompanied the crews to specific wells where he collected separate samples for isotope analysis, for a YG funded project. Several of the previously frozen and dry wells remained unchanged, and 118 of 131 groundwater wells were sampled (Table 3).

The fourth round of sampling was conducted from November 2nd to 5th. SRK had installed several wells over the course of 2009 and these new wells were also sampled along with the wells to be sampled four times per season. Several of the new wells were unproductive resulting in very low volumes for samples, or no samples at all. Forty-three groundwater wells were targeted and samples were collected from 33 wells.

There were a total of 10 wells where samples could not be obtained during any of the sampling events (excluding the 2009 wells). There were as follows:

- BH12A
- BH13A
- P03-03-06
- P03-03-07
- S1B
- SRK08-P10A
- SRK08-P13A

- SRK08-P13B
- SRK08-SP8A
- SRK08-SP8B

In addition to this there were 30 unproductive wells where the wells were purged dry and the total target volume of purge water could not be removed. The first four in the list below produced so little water that the tubing had to be carefully removed and allowed to drain into the sample bottles in order to obtain some water for analysis.

- SRK08-P9
- BH4
- SRK05-07
- P09-LCD4
- BH1
- BH8
- BH12B
- BH14A
- BH14B
- P03-09-08
- P2001-02A
- P2001-02B
- P96-7
- S2A
- S2B
- SRK05-05C
- SRK05-08
- SRK08-P10A
- SRK08-P9
- SRK08-P14
- V34
- V35
- V37
- X18A
- P09-LCD2
- P09-LCD3
- P09-SIS1
- P09-SIS4
- P09-SIS5
- P09-SIS6

Following each field trip, all field data was tabulated and submitted to Denison. All analytical data was sent directly to Denison from Maxxam. Therefore, none of this data is included with this memo.

Quality Assurance and Quality Control

Table 5 summarizes the QA/QC sampling that was done per trip.

TABLE 5 QA/QC SAMPLES FOR THE 2009 GROUNDWATER MONITORING PROGRAM

Sample I.D.	Sample Description	Date Sampled 2009	Care and Maintenance	Closure
BD-1	blind duplicate of P2001-02A	May 31	X	
BD-2	blind duplicate of SRK08-P15	May 31		X
BSS-1	blind split sample for BH05-9B-5	May 31	X	
BSS-2	blind split sample for P03-06-02	June 1	X	
X18-C	duplicate of X18B	June 1	X	
P01-02C	duplicate of P01-02B	June 1	X	
X21D-96	duplicate of X21B-96	June 1	X	
P03-06-02S	split sample of P03-06-02	August 5	X	
SRK05-SP-5D	duplicate of SRK05-SP5	August 4		X
P05-01-04S	split sample of P05-01-04	August 5		X
DUP1	duplicate of P05-01-05	September 9		X
DUP2	duplicate of S2B	September 10	X	
DUP3	duplicate of BH10A	September 12	X	
DUP4	duplicate of P03-05-02	September 11	X	
SS-01-09	split sample of P03-09-09	September 9	X	
SS-P5-B	split sample of SRK05-SP-1B	September 11		X
22-JSD	split sample of P03-08-02	September 12	X	
SS-G-66	split sample of P96-9A	September 13	X	
Field Blank	field blank at P03-09	September 9	X	
DI after tubing	Sample of deionized after rinsing the tubing between P03-09-08 and P03-09-09	September 9	X	
SS-05-11	split sample of P05-01-06	November 2		X
SS-06-11	split sample of P03-06-04	November 2	X	

Required Maintenance

Tubing and/or foot valves were replaced as necessary during each visit. During the spring field trip it was discovered that the tubing in several wells was too short, or the crease where they had been folded had caused cracking and hence leaking. Additional tubing was added onto existing tubing using heavy duty silicone hose as a connecting devise, during future sampling events where needed. This allowed the tubing to be folded and replaced into the well without creating creases and potential cracking. Table 6 outlines specific wells where additional investigation and maintenance is suggested.

TABLE 6 SUGGESTED MAINTENANCE TASKS FOR GW WELLS

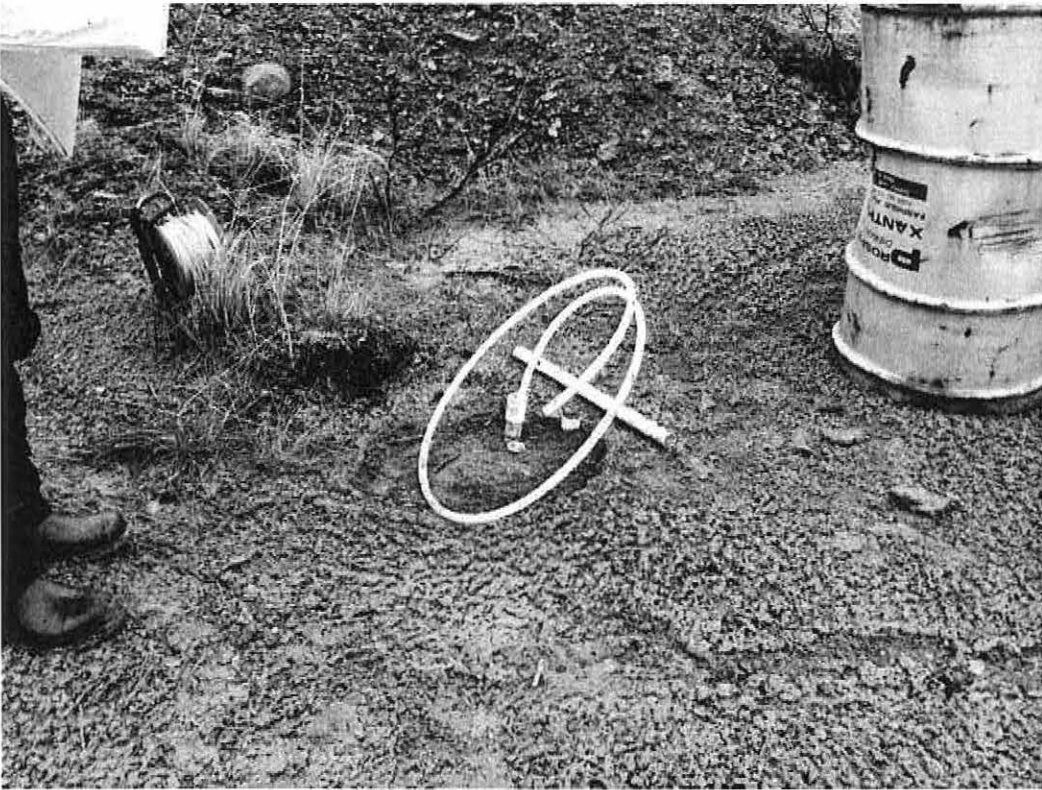
Well #	Issue and Suggested Maintenance
BH1	Broken at ground level, pipe should be extended and protective steel casing should be installed if monitoring of this well is continued.

Well #	Issue and Suggested Maintenance
BH2	The location of this well is labelled incorrectly on AECOM's map and this was the well that was sampled on May 30, however it was dry. BH2 is actually located near BH10 and YES's surveyed coordinates confirm this location. This well was sampled on September 10. Labelling and signage should be adjusted accordingly.
BH10B	Field equipment became stuck in this well and had to be rescued. The diameter is narrower than most of the other convention wells, and the deep angled structure of this well creates sampling problems.
P2001-03	There is an object at 13.5m prohibiting the use of a submersible pump. AECOM brought their down-hole camera in Sept however it was not functioning. This should be investigated prior to any other maintenance
P03-04-02	There is an obstruction at approximately 12.4 m. Samples were managed to be collected however.
SRK05-ETA-BR1	There is a potential breakage of the pipe at 9.61m. Unknown if well is compromised.
SRK05-SP5	The steel casing was broken and the well was damaged however the well was repaired by the September sampling, although a protective steel casing is still required.
X16B	AECOM was going to use their down-hole camera to check the well construction competency but due to a malfunction with the unit, photos could not be obtained.
X18B	The depth to bottom has changed significantly suggesting that the well has sloughed in at some point, DTB on Sept 6 was 10.76 m whereas it should be around 23 m. There is good yield however it is questionable whether the water being sampled is originating from the required and designed depth.

Discussion and Recommendations

A considerable number of wells within the current groundwater monitoring program are unproductive, as identified in the Results section. Consideration should be given regarding the usefulness of the data that is generated from these wells. Following that, it is expected that several of these wells would be slated for decommissioning.

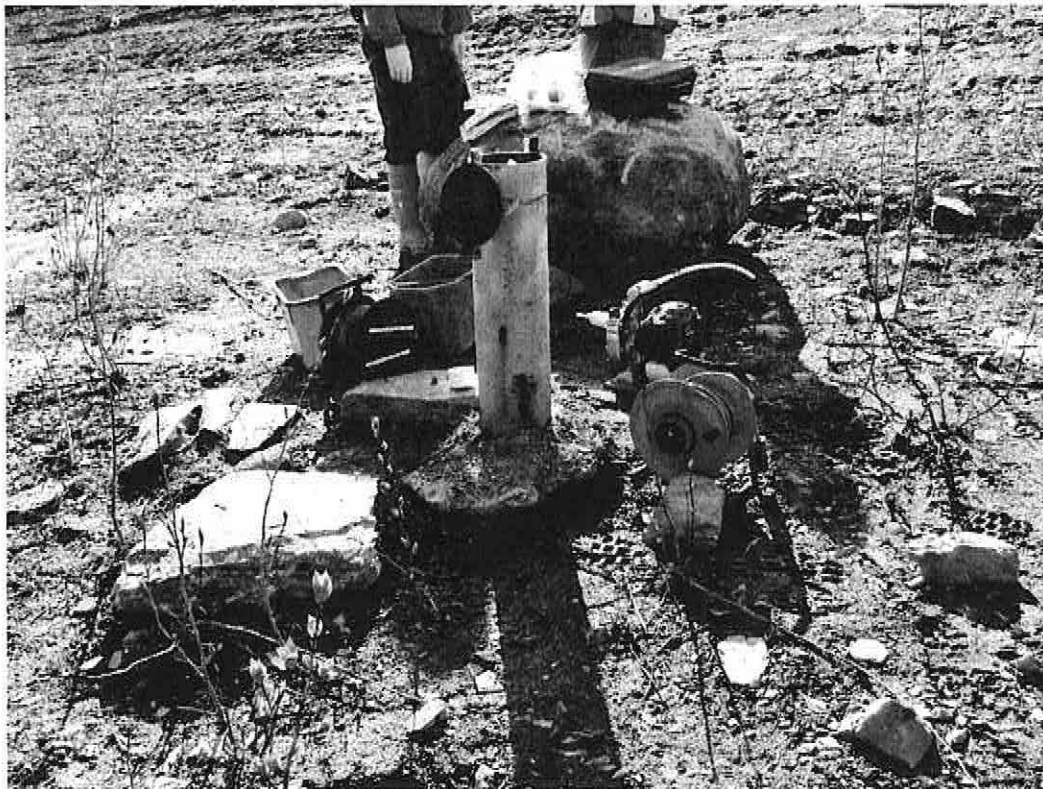
As many of the wells were frozen during the spring sampling, the timing of sampling should be reviewed. It may be more successful to conduct the first round of sampling in mid to late June. Summer sampling could be undertaken in late July/early August with the fall sampling occurring in early to mid September. If it is imperative for the wells under the AMPs to be sampled four times a season, it is recommended that this happen in October rather than November, due to climatic conditions. Alternatively, perhaps three sets of samples per year are adequate.



BH1 on May 30th, 2009.



The conventional wells SRK08-13A and 13B were frozen on every sampling event. This photo was taken on May 30, 2009.



Frost jacking at P2001A and B on May 31, 2009.



Inside P2001A and B – silica sand and bentonite inside the annular space has been pushed up to above the top of pipe, May 31, 2009.



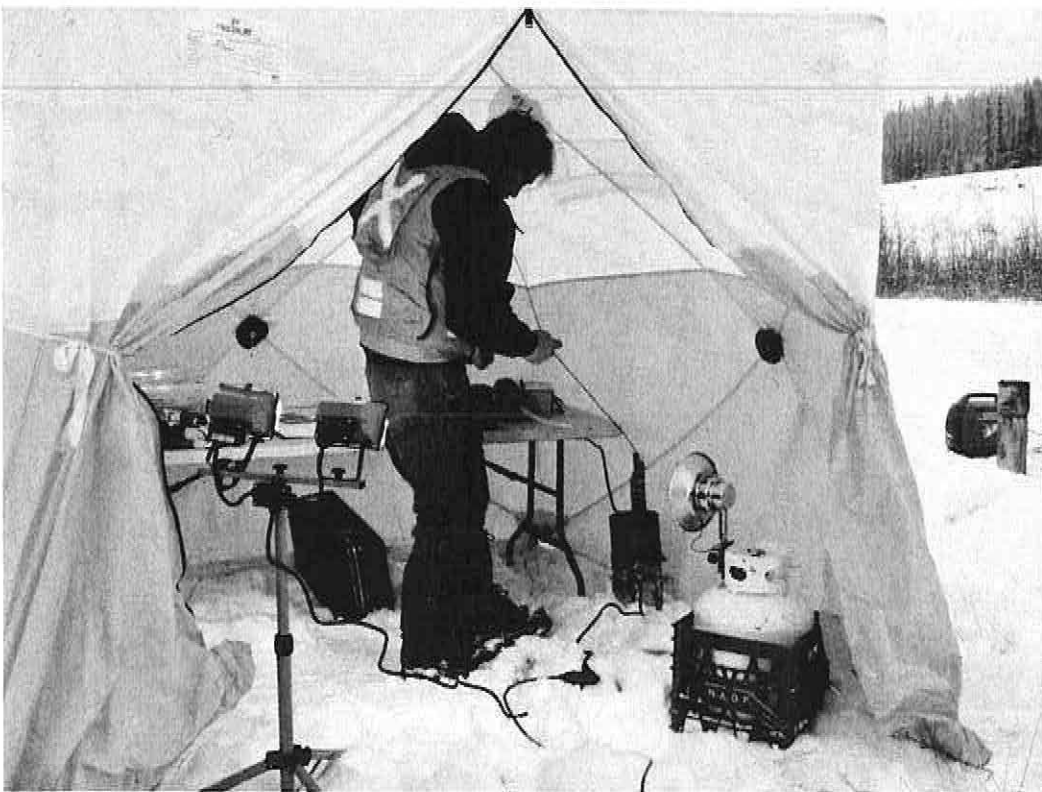
The casing and well of SRK05-SP5 had been damaged prior to May 30th, 2009.



Carefully sampling SRK05-SP5 on August 4th, 2009 prior to the repair of this well.



The repaired monitoring well, SRK09-SP5, Sept 11, 2009.



Sampling multi-level well P05-01, November 2nd, 2009.

