Technical Memorandum G

To: Nunavut Water Board
From: Shear Diamonds Ltd.
Date: August 15, 2011
Ref: Jericho Diamond Mine, 2AM-JER0410

Proposed PKCA Effluent Discharge Criteria

2AM-JER0410 Renewal Application Technical Meeting June 20-21, 2011, Jericho Diamond Mine, Nunavut

Introduction

This technical memorandum has been prepared for the proposed effluent discharge criteria at the Jericho Diamond Mine (Jericho). This is to fulfill Shear Diamonds Ltd.'s (Shear) commitment during the Technical Meeting and Pre-hearing Conference in Late June 2011. On the basis of available water quality monitoring data from 2005 to 2010, Shear also evaluated the current effluent discharge criteria (NWB 2004), and verified the Lake C3 dilution factors that were modeled in the previous water licence application document (SRK 2004a).

Review of Current Effluent Discharge Criteria

The Processed Kimberlite Containment Area (PKCA) effluent quality criteria are available in the current water licence (2AM-JER0410), Part G, Item 6a, and are present in Table 1.

Table 1: Current PKCA Effluent Quality Criteria

Parameter	Unit	Maximum Average Concentration [1]	Maximum Concentration of Any Grab Sample
pH	-	6 - 8.8	6 - 8.8
Total Suspended Solids (TSS)	mg/L	15	25
Total Dissolved Solids (TDS)	mg/L	2,000	4,000
Total Ammonia (N)	mg/L	6	12
Nitrate (N)	mg/L	28	56
Nitrite (N)	mg/L	2.5	5.0
Total Phosphorus (P)	mg/L	0.2	0.4
Chloride (Cl)	mg/L	500	1,000
Total Aluminum (Al)	mg/L	1.5	3.0
Dissolved Aluminum (Al)	mg/L	1.0	2.0
Total Arsenic (As)	mg/L	0.05	0.10
Total Cadmium (Cd)	mg/L	0.0012	0.0024
Total Chromium (Cr)	mg/L	0.087	0.170

Table 1: Current PKCA Effluent Quality Criteria

Parameter	Unit	Maximum Average Concentration [1]	Maximum Concentration of Any Grab Sample
Total Lead (Pb)	mg/L	0.01	0.02
Total Molybdenum (Mo)	mg/L	0.73	1.50
Total Nickel (Ni)	mg/L	0.05	0.10
Total Uranium (U)	mg/L	0.5	1.0
Total Zinc (Zn)	mg/L	0.25	0.50
Biological Oxygen Demand (5 days) (BOD_5) [2]	mg/L	15.0	25.0
Oil and Grease [2]	mg/L	3.0	5.0
Faecal Coliforms [2]	CFU/100	10	20

Note: 1. "Maximum Average Concentration" is referred as average concentration of any four consecutively collected samples taken from the identical sampling location and taken during any given timeframe.

2. Additional PKCA effluent quality criteria when the wastewater treatment plant (WWTP) discharges treated water into the PKCA.

As specified in the current water licence Part G, Item 6a, the PKCA effluent quality is monitored at the Station JER-WQ2 (Current station ID JER-AEM-04), at the east end of Stream C3. The statistical analysis for the water quality results from this station is summarized in Table 2. Figures 1 through 19 also show the results of each regulated parameters.

The maximum concentrations of all regulated parameters are in compliance with the water licence criteria for Maximum Average Concentrations during the period between 2005 to 2010 PKCA. The only parameters that exceed one fifth of the water licence criteria are total suspended solids (TSS), nitrate, phosphorus, total aluminum, and copper. Total dissolved solids (TDS), chloride, and nitrate showed an increasing trend during the operational period from 2005 to 2007, and a decreasing trend during the cessation of the operation after 2007. Uranium and pH showed a continuous increasing trend from 2005 to 2010.

Ammonia nitrate, a blasting reagent, was and will be used at Jericho to mine the diamond bearing kimberlite ore. The highest nitrate level in the PKCA effluent reached 17.8 mg/L in 2007, two thirds of the water licence criteria. As a result of the nature of Jericho's kimberlite, it is not expected that Shear will be able to lessen its use of ammonia nitrate. The Jericho kimberlite is very hard and requires the highest level of ammonia nitrate that is recommended in the blasting of kimberlite. With the best mining practices, Shear expects to be able to maintain the levels of ammonia, nitrite and nitrate under the current water licence criteria in the PKCA discharge.

No increasing trend for TSS, phosphorus, total aluminum, and copper are observed from 2005 to 2010, these parameters are not expected to exceed the water licence criteria when the mining operations resume.

Table 2: PKCA Discharge Water Quality Summary [1]

Parameter	Unit	Detection Limits (D.L.)	Water Licence [2]		Statistical Analysis							
			Average	Max. Grab	n	Minimum	Arithmetic Mean [3]	Median [3]	Maximum	Standard Deviation	Coeff. of Variation	% <D.L. [5]
pH	-	-	6 - 8.8	6 - 8.8	44	7.1	7.7	7.7	8.1	0.2	0.03	0.0%
Total Suspended Solids (TSS)	mg/L	2	15	25	47	<2	2	2	**11** [4]	2	0.95	78.7%
Total Dissolved Solids (TDS)	mg/L	10	2,000	4,000	46	60	142	122	231	44	0.31	0.0%
Chloride (Cl)	mg/L	0.5	500	1,000	46	4.8	9.68	9.10	16.30	3.03	0.31	0.0%
Ammonia (N)	mg/L	0.005	6	12	46	0.006	0.133	0.102	0.82	0.141	1.06	0.0%
Nitrate (N)	mg/L	0.05	28	56	46	1.84	9.05	7.82	**17.80** [4]	4.57	0.50	0.0%
Nitrite (N)	mg/L	0.05	2.5	5.0	46	<0.05	0.07	0.05	0.19	0.05	0.81	30.4%
Total Phosphorus (P)	mg/L	0.002	0.2	0.4	45	<0.002	0.014	0.010	**0.106** [4]	0.019	1.37	31.1%
Total Aluminum (Al)	mg/L	0.002	1.5	3.0	48	<0.02	0.03	0.02	**0.33** [4]	0.05	1.43	6.3%
Dissolved Aluminum (Al)	mg/L	0.002	1.0	2.0	45	<0.002	0.01	0.01	0.02	0.01	0.69	17.8%
Total Arsenic (As)	mg/L	0.0004	0.05	0.10	48	<0.0004	0.0004	0.0004	0.0009	0.0002	0.45	14.6%
Total Cadmium (Cd)	mg/L	0.00005	0.0012	0.0024	48	<0.00005	0.00003	0.00003	0.00016	0.00002	0.74	85.4%
Total Chromium (Cr)	mg/L	0.0005	0.087	0.170	48	<0.0005	0.0012	0.0003	0.0102	0.00218	1.88	70.8%
Total Copper (Cu)	mg/L	0.0005	0.02	0.04	48	<0.0005	0.0021	0.0018	**0.0058** [4]	0.0012	0.59	10.4%
Total Lead (Pb)	mg/L	0.00005	0.01	0.02	48	<0.00005	0.00012	0.00005	0.0008	0.0002	1.46	41.7%
Total Molybdenum (Mo)	mg/L	0.00005	0.73	1.50	48	<0.00005	0.00373	0.00337	0.0078	0.0017	0.45	2.1%
Total Nickel (Ni)	mg/L	0.0001	0.05	0.10	48	<0.0001	0.0022	0.0022	0.0038	0.0006	0.29	2.1%
Total Uranium (U)	mg/L	0.00005	0.5	1.0	48	<0.00005	0.00179	0.00137	0.00416	0.00092	0.51	2.1%
Total Zinc (Zn)	mg/L	0.001	0.25	0.50	48	<0.001	0.004	0.001	0.029	0.007	1.68	39.6%

Note:

1. Summarized analytical results from PKCA discharge monitoring station (JER-WQ2, current station ID: JER-AEM-04) during discharge period between 2005 and 2010;
2. Taken from the Jericho Water Licence, Part G, Item 6a. (NWB 2004);
3. Analytical results below detection limits are divided by 2 for statistical purpose. If the detection limit is changed over the years, a single detection limit is chosen on a case-by-case basis;
4. Maximum monitored data (including potential outliers) that are larger than 1/5 of the water licence criteria for Maximum Average Concentrations are **Bold and Underlined.**
5. Percent of the number of samples that are below the detection limits.

Dilution in Lake C3

Previous Dilution Model in Lake C3

The Princeton Ocean Model (POM) was used to simulate the PKCA effluent dilution in Lake C3, and the finding was presented in the "Estimates of Receiving Water Quality for the Jericho Project, Nunavut" (SRK 2004a). In this report, two operational scenarios were modelled:

Scenario 1: Normal Operational Conditions: In order to simulate normal operational conditions, the model used as a basis for its assumptions, the average estimated PKCA effluent flows. The effluent is considered to be discharged into Lake C3 with average natural inflows:

Within 200 m from Stream C3 mouth, minimum dilution of approximately 20 times is predicted to occur in late June; the dilution is then predicted to increase to approximately 40 times by mid-July.

At the Lake C3 outlet, minimum dilution of approximately 30 times is predicted to occur in late June; and the dilution is then predicted to increase to a multiple factor of 40 times by mid-July.

Scenario 2: Worst Case Scenario: In order to simulate the dilution condition under which the PKCA water is stored for a year, the discharge occurs with the addition of the second year's impounded water. Higher discharge flow into Lake C3 would reduce the normal dilution rate. The model uses an average PKCA effluent flow with one year of accumulated PKCA effluent. The effluent is then discharged into Lake C3 with average natural inflows.

Within 200 m from Stream C3 mouth, minimum dilution rates of approximately 10 times are predicted in late June; dilution is then predicted to increase to a multiple factor of 20 times by the beginning of July.

At the Lake C3 outlet, minimum dilution of approximately 20 times is predicted to occur in late June; dilution is then predicted to increase to a multiple factor of approximately 27times by mid-July.

In the "Proposed Discharge Limits for the Jericho Project" (SRK 2004b), a dilution multiple factor of 10 times in Lake C3 at 200 m from the Stream C3 mouth was proposed as the basis for developing the PKCA discharge limit.

Dilution Model Verification

The process of verifying the dilution model results includes comparing the recorded volumes of PKCA discharge, and comparing the actual dilution at the monitoring station placed at 200 m from the Stream C3 Mouth and the Lake C3 Outlet with the modelled values.

The monthly distribution of the modelled and recorded PKCA discharge flows are summarized in Table 3. As described in Section 3.1, the modelled Lake C3 dilution ratios are based on the two operational scenarios: Scenario 1: the average PKCA discharge of 510,130 m3 per year under normal operational conditions, and Scenario 2: This scenario forecasts storing an entire year's worth of operational water discharged into the PKCA as well as discharge from the current year's operations. Thus the model uses as an assumption of a total accumulated effluent flow of 959,487 m3. The modelled monthly discharges are based on the monthly proportions of the natural inflows to Lake C3, in which the majority of the discharging occurs in June.

In comparison, the actual PKCA discharge during operation in 2006 and 2007 are based on the quantity of inflow into PKCA and the desired water level in the PKCA. Therefore, in 2006 the majority

of the discharging occurred in August and October; and in 2007 the majority of the discharging occurred in July.

As the monthly discharge in August, October and November 2006 exceeded the second scenario in the POM model (Scenario 2), the actual dilution in Lake C3 may be lower than the minimum modelled dilution at the time. The monthly discharge in July and August 2007 exceeded the first scenario but is less the second scenario; therefore, the actual dilution in Lake C3 would be between the dilution ratios for the two scenarios.

Table 3: Monthly Distributions of Inflows into Lake C3

Month	Average Natural Inflows into Lake C3 (m^3) (1)	Monthly Distribution	PKCA Discharge into Lake C3			
			Volume in POM Model for Average Discharge (m^3) (1)	Volume in POM Model for 1 year Accumulation (m^3) (1)	Recorded Discharge Volume in Year 2006 (m^3) (2)	Recorded Discharge Volume in Year 2007 (m^3) (2)
May	607,611	2.6%	13,330	25,071	0	0
June	13,367,450	57.5%	293,252	551,570	0	47,975 (3)
July	3,711,356	16.0%	81,419	153,138	54,403	134,158
August	2,118,429	9.1%	46,474	87,411	110,450	77,175
September	2,939,525	12.6%	64,487	121,291	45,381	42,972
October	509,080	2.2%	11,168	21,006	183,460	0
November	0	0.0%	0	0	19,214	0
Total	**23,253,451**	**100.0%**	**510,130**	**959,487**	**412,908**	**302,280**

Note:

1. Values taken from *Estimates of Receiving Water Quality for the Jericho Project, Nunavut* (SRK 2004a);
2. Values summarized from *Monthly Operation Monitoring Reports* for 2006 and 2007 (Tahera, 2006 and 2007);
3. PKCA discharge records on June 20 and 23, 2007 are 175,089 m^3 and 318,659 m^3, and are deemed to be errors. These two records are adjusted to 1,751 m^3 and 3,187 m^3.

The chemical constituents that are used as the tracers for estimating the actual lake dilution should have high solubility in the aqueous environment, should not be likely to be consumed by aquatic microorganisms or react with other substances, and should have relatively high initial concentrations in the discharge effluent and low concentrations in the receiving environment. Chloride and sodium satisfy the aforementioned selection criteria. The Dilution Factors are then calculated based on the method presented in the "Proposed Discharge Limits for the Jericho Project" (SRK 2004b) as follows:

In the previous Aquatic Effects Monitoring Plan (Mainstream 2005), monitoring stations JER-WQ20 (currently JER-AEM-06) and JER-WQ5 (currently JER-AEM-08) are located in Lake C3 near the Stream C3 mouth and the Lake C3 outlet, respectively. The monitoring records from these two stations can be used to verify the modelled monitoring location at 200 m from the Stream C3 mouth and at the Lake C3 outlet. The monitoring data for station JER-WQ20 is only available for year 2005 and 2006; and the chloride and sodium concentrations at station JER-WQ20 and JER-WQ5 are too close to the detection limits and cannot be used to make proper data analysis. Only the monitoring data at Station JER-WQ5 (Lake C3 outlet) for 2007 can be used for calculating the dilution factor. Table 4 summarizes the calculated dilution factors at Lake C3 outlet for 2007.

Table 4: Dilution Factor Calculation at Lake C3 Outlet for 2007

Location	PKCA Discharge	Control Lake	Lake C3 Outlet	Dilution Factor
Previous Station ID	**JER-WQ2**	**JER-WQ4**	**JER-WQ5**	
Current Station ID	**JER-AEM-04**	**JER-AEM-03**	**JER-AEM-08**	
Sampling Period	Jun 25 – Sep 4, 2007	Jul 16 – Sep 23, 2007	Jul 16 – Sep 23, 2007	
# of samples	13	3	3	
Chloride (Cl) (mg/L)	10.6 [(1)]	0.25 [(2,3)]	0.5 [(2,3)]	42
Sodium (Na) (mg/L)	11.7 [(1)]	0.25 [(2,3)]	0.7 [(2)]	26

Note:

1. Values are calculated using the weekly water quality and daily pumping records;
2. Arithmetic mean of the monthly water quality records;
3. Analytical results below detection limits are assumed to be a half of the detection limits.

The dilution factors for chloride and sodium at Lake C3 outlet for 2007 are calculated to be 26 and 42. The reason for having different calculated dilutions factors may be due to assumed values, when concentrations are below detection limits. As described in Section 3.1, the modelled dilution factors for average discharge and for accumulated effluent discharge are 40 and 27, which are close to the calculated dilution factor from the measured data. This provides confidence that the modelled dilution factors are appropriate. Shear will monitor the water quality at 200 m from Stream C3 during PKCA discharge to verify the modelled dilution factor at this location.

Conclusion

Based on the review of the previous water quality records, Shear is confident the current PKCA effluent discharge limits are achievable when mining operations resume, and are adequate in regulating the PKCA effluent to meet the aquatic thresholds in Lake C3. Shear requests the effluent quality criteria listed in Part G, Item 6a (Table 1) remain unchanged in the renewed water licence. In addition, Shear requests the TSS limits in the surface runoff during construction and road maintenance (Water licence Part G, Item 6b) remain unchanged (50.0 mg/L for Maximum Average Concentration and 100.0 mg/L for Maximum Grab Sample Concentration).

References

Mainstream Aquatics Ltd. (Mainstream), 2005. Aquatic Effects Monitoring Plan, Jericho Diamond Project. In association with AMEC Earth and Environmental. Prepared for Tahera Diamond Corporation. March 2005

Nunavut Water Board (NWB), 2004. Licence NWB1JER0410, Jericho Diamond Mine, Nunavut. December 22, 2004

SRK Consulting (SRK), 2004a. Technical Memorandum N: Estimates of Receiving Water Quality for the Jericho Project, Nunavut. Prepared for Tahera Diamond Corporation, August 2004.

SRK Consulting (SRK), 2004b. Technical Memorandum O: Proposed Discharge Limits for the Jericho Project. Prepared for Tahera Diamond Corporation, August 2004.

Tahera Diamond Corporation (TDC), 2006 and 2007. Monthly Operation Monitoring Reports. Submitted to Nunavut Water Board, January to December 2006 and 2007.

FIGURES

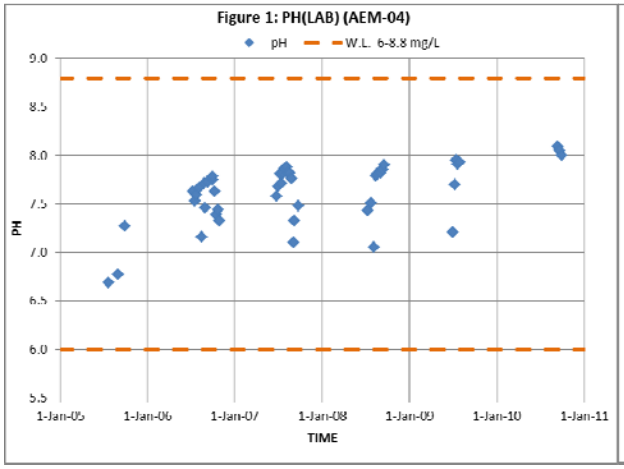
Figure 1: PH(LAB) (AEM-04)
pH
W.L. 6-8.8 mg/L
PH
TIME


Figure 2: Total Suspended Solids (AEM-04)
TSS
W.L. 15 mg/l
D.L.
Concentration (mg/L)
TIME

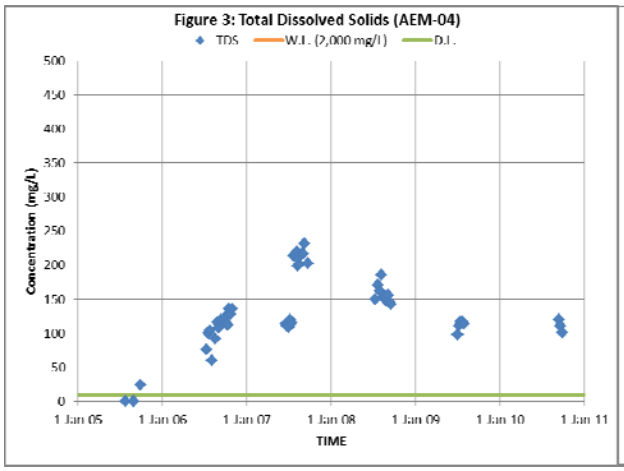
Figure 3: Total Dissolved Solids (AEM-04)
TDS
W.L. (2,000 mg/l)
D.L.
Concentration (mg/L)
TIME

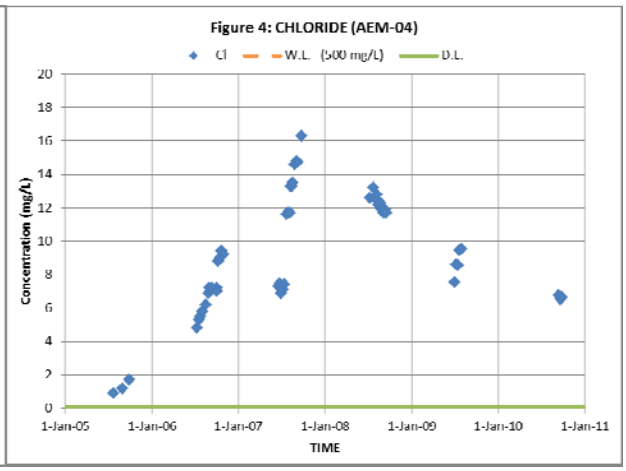
Figure 4: CHLORIDE (AEM-04)
Cl
W.L. (500 mg/L)
D.L.
Concentration (mg/L)
TIME

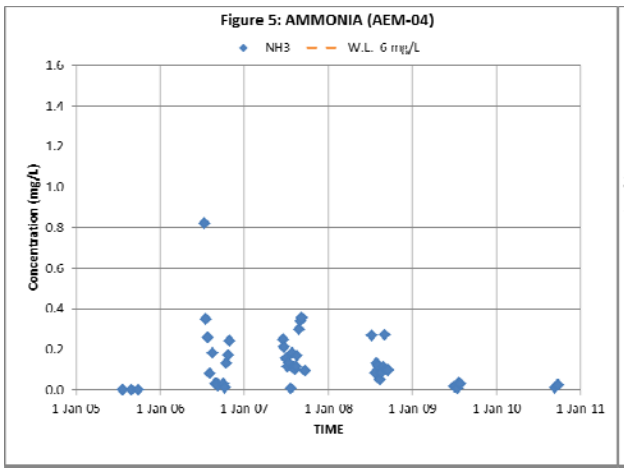
Figure 5: AMMONIA (AEM-04)
NH3
W.L. 6 mg/L
Concentration (mg/L)
TIME

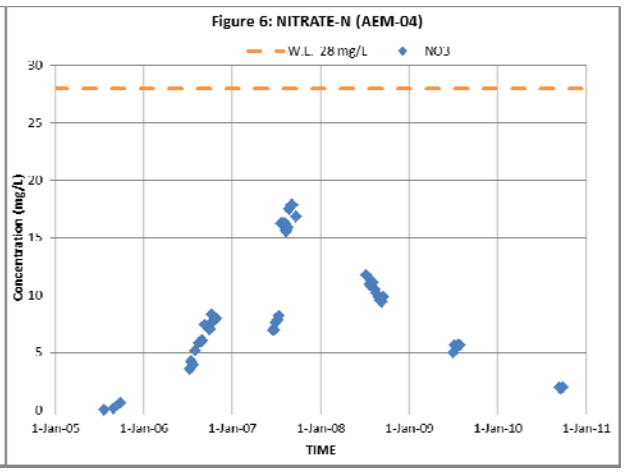
Figure 6: NITRATE-N (AEM-04)
W.L. 28 mg/L
NO3
Concentration (mg/L)
TIME

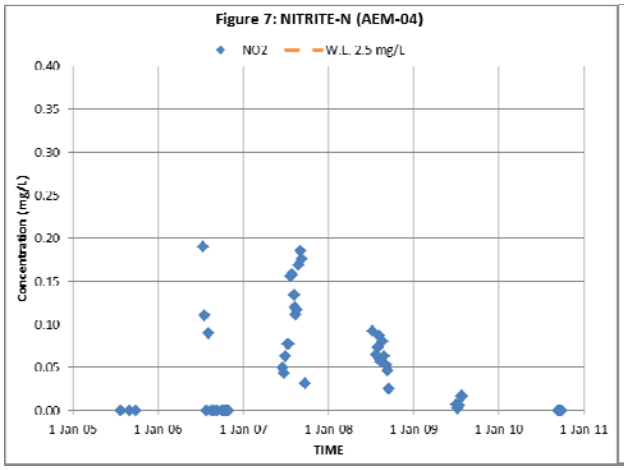
Figure 7: NITRITE-N (AEM-04)
NO2
W.L. 2.5 mg/L
Concentration (mg/L)
TIME
1 Jan 05
1 Jan 06
1 Jan 07
1 Jan 08
1 Jan 09
1 Jan 10
1 Jan 11

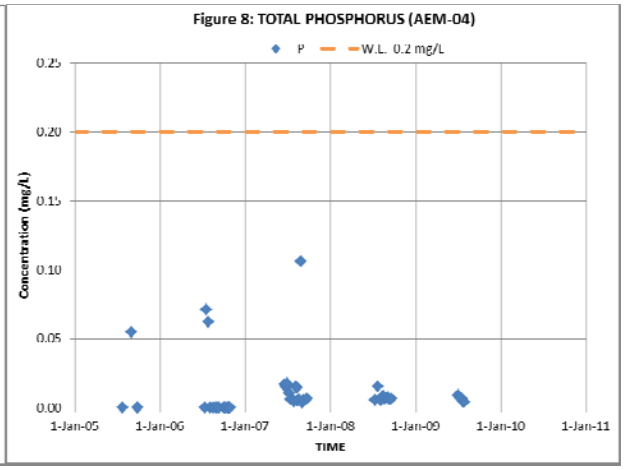
Figure 8: TOTAL PHOSPHORUS (AEM-04)
P
W.L. 0.2 mg/L
Concentration (mg/L)
TIME
1-Jan-05
1-Jan-06
1-Jan-07
1-Jan-08
1-Jan-09
1-Jan-10
1-Jan-11

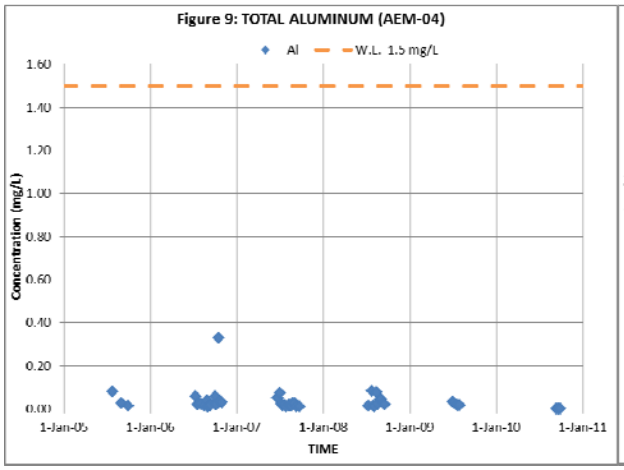
Figure 9: TOTAL ALUMINUM (AEM-04)
Al
W.L. 1.5 mg/L
Concentration (mg/L)
TIME
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1-Jan-06
1-Jan-07
1-Jan-08
1-Jan-09
1-Jan-10
1-Jan-11

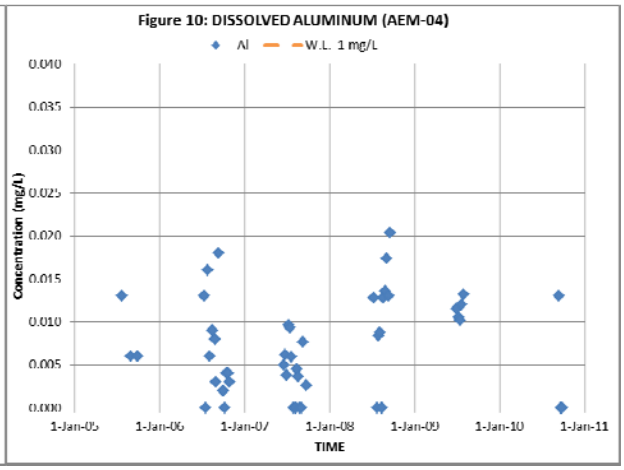
Figure 10: DISSOLVED ALUMINUM (AEM-04)
Al
W.L. 1 mg/L
Concentration (mg/L)
TIME
1-Jan-05
1-Jan-06
1-Jan-07
1-Jan-08
1-Jan-09
1-Jan-10
1-Jan-11

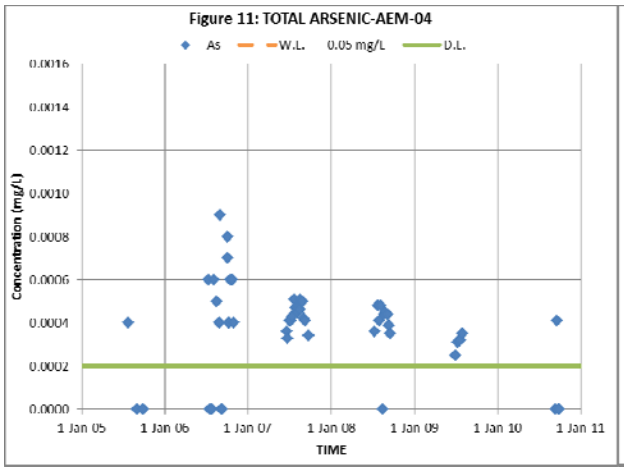
Figure 11: TOTAL ARSENIC-AEM-04
As
W.L.
0.05 mg/L
D.L.
Concentration (mg/L)
TIME
1 Jan 05
1 Jan 06
1 Jan 07
1 Jan 08
1 Jan 09
1 Jan 10
1 Jan 11

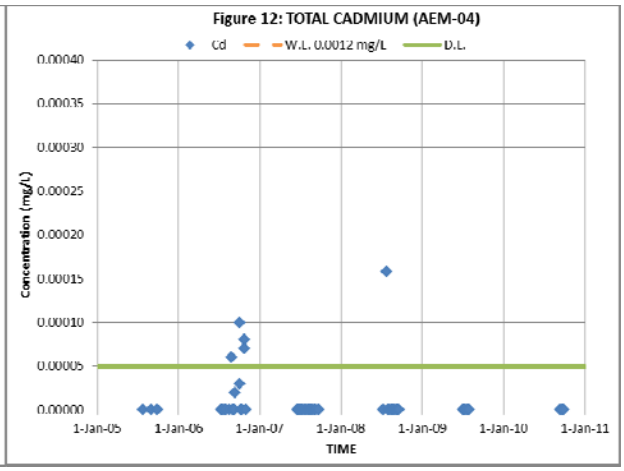
Figure 12: TOTAL CADMIUM (AEM-04)
Cd
W.L. 0.0012 mg/L
D.L.
Concentration (mg/L)
TIME
1-Jan-05
1-Jan-06
1-Jan-07
1-Jan-08
1-Jan-09
1-Jan-10
1-Jan-11

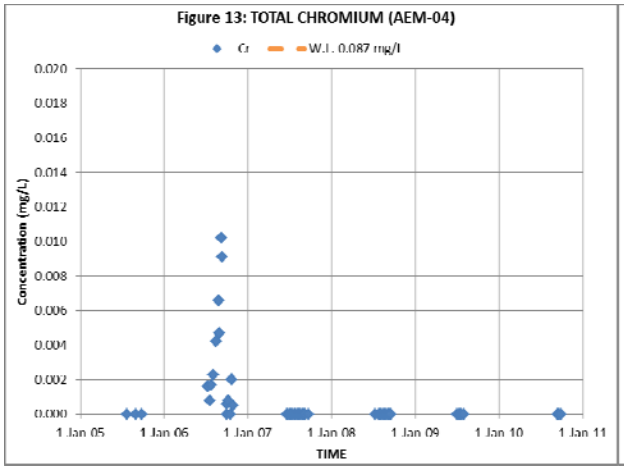
Figure 13: TOTAL CHROMIUM (AEM-04)
Cr
W.L. 0.087 mg/l
Concentration (mg/L)
TIME

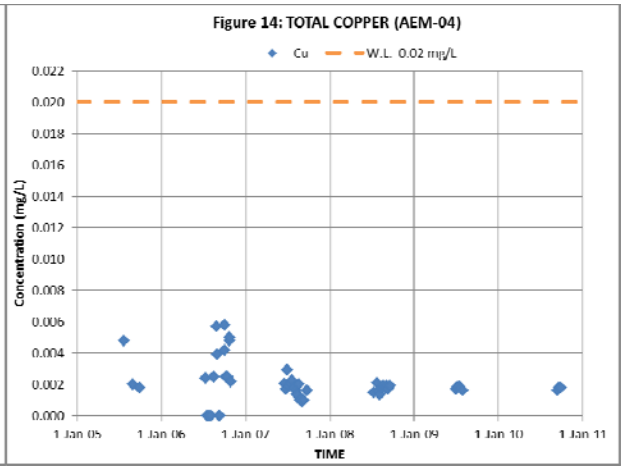
Figure 14: TOTAL COPPER (AEM-04)
Cu
W.L. 0.02 mg/L
Concentration (mg/L)
TIME

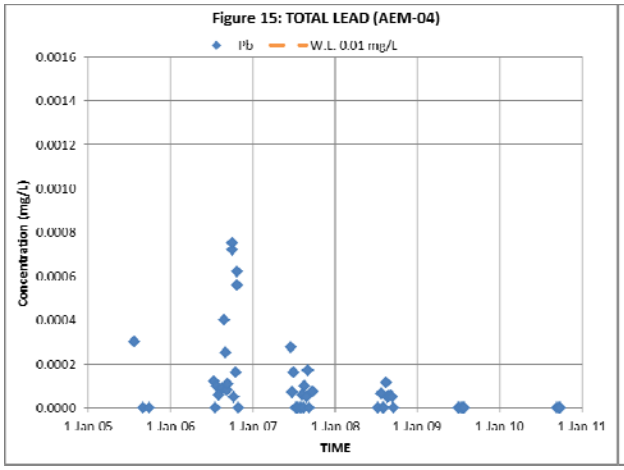
Figure 15: TOTAL LEAD (AEM-04)
Pb
W.L. 0.01 mg/L
Concentration (mg/L)
TIME

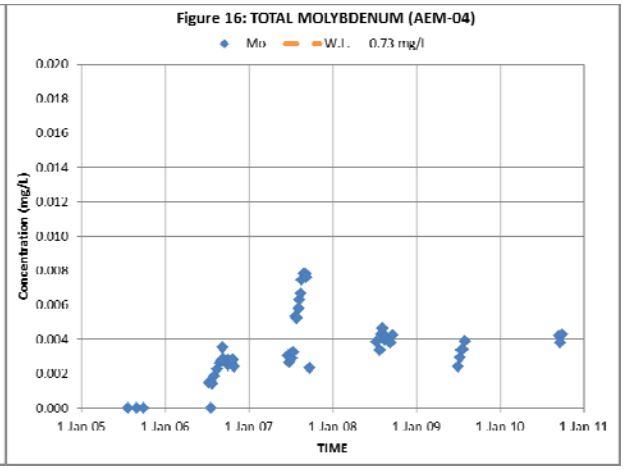
Figure 16: TOTAL MOLYBDENUM (AEM-04)
Mo
W.L. 0.73 mg/l
Concentration (mg/L)
TIME

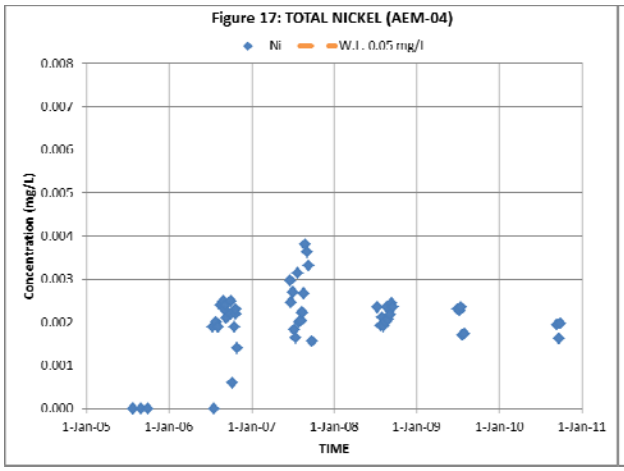
Figure 17: TOTAL NICKEL (AEM-04)
Ni
W.L. 0.05 mg/l
Concentration (mg/L)
TIME

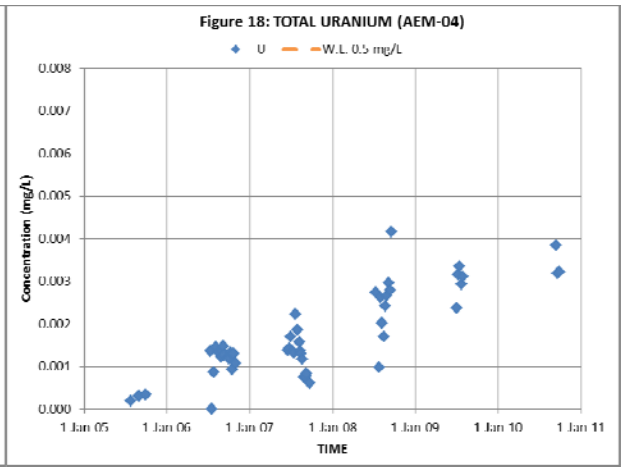
Figure 18: TOTAL URANIUM (AEM-04)
U
W.L. 0.5 mg/L
Concentration (mg/L)
TIME

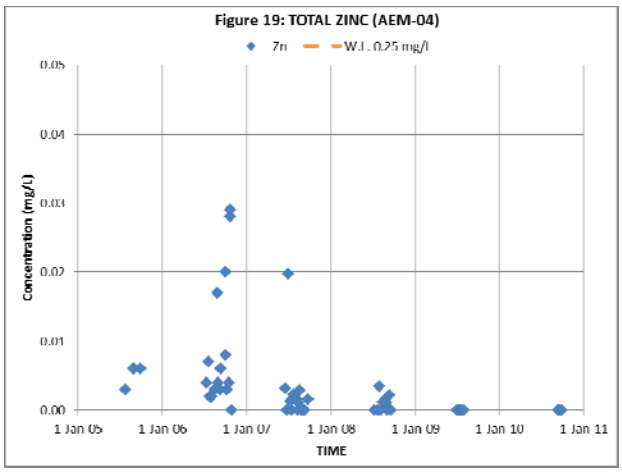
Figure 19: TOTAL ZINC (AEM-04)
Zn
W.L. 0.25 mg/l
0.05
0.04
0.03
0.02
0.01
0.00
Concentration (mg/L)
1 Jan 05
1 Jan 06
1 Jan 07
1 Jan 08
1 Jan 09
1 Jan 10
1 Jan 11
TIME