Appendix G.5a

Assessment of Water Quality Downstream of Tailings Management Facility, Touquoy Gold Project –November 25, 2015
Completed for the Updated 2021 Beaver Dam Mine EIS

Assessment of Water Quality Downstream of Tailings Management Facility, Touquoy Gold Project

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Sign-off Sheet

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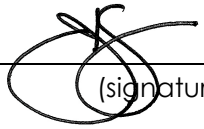
Prepared by  (signature)

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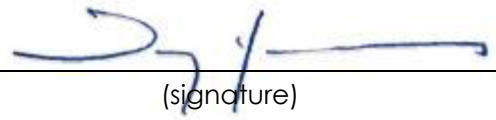
Approved by  (signature)

Troy Yeomans

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1.0 INTRODUCTION

At the request of Atlantic Mining NS Corp (AMNS), Stantec has prepared the following report to assess the mass loading and predict the water quality in the receiving waters downstream of the Tailings Management Facility (TMF) at the Touquoy mine in Moose River, Nova Scotia. This work is to support an application to amend the existing Industrial Approval (IA) No. 2012-084244 for the operation of the facility.

Predictions of water quality and mass loading submitted with the original Industrial Approval Application were prepared by Golder Associates (2007). The inputs to the water quality model were derived from bench testing which was described by CBCL (2007). Results of the water quality modelling were presented as Appendix H of the Focus Report (CRA 2007b), which formed part of the Environmental Assessment (EA). These input assumptions and resulting loading on receiving waters were carried forward to support the IA Application (CRA 2012).

This report has been prepared to assess the potential implications of the updated predictions for both quality and quantity of the controlled and uncontrolled discharge from the TMF on the mass loading and water quality in the downstream receiving environment.

The report presents the methodology used to prepare the water quality predictions, and the results. The results are compared to the original water quality predictions presented in the 2012 IA Application based on the 2007 EA documentation, and the implications of these new predictions are discussed. Updated information on the water balance for the site, and new predictions of tailings water quality are used in the assessment.

1.1.1 Scope of Work

Stantec's scope of work for this report to prepare predictions of water quality and mass loading to the receiving environment includes:

- Review inputs for water quality modelling prepared for the original Industrial Approval Application and the Environmental Assessment (EA), including the supplemental Focus Report.
- Review updated water quality inputs based on recent and ongoing field studies.
- Review results of previous water quality modelling and associated interpretations of potential impacts to the receiving environment that supported the Environmental Assessment (i.e., Appendix H of the Focus Report).
- Prepare predictions of mass loading to receiving waters and associated predictions on water quality.
- Prepare a report summarizing the methodology and results to be included with the application to amend the Industrial Approval.

2.0 METHODS

The methods used to predict the water quality downstream of the TMF are presented in this chapter. This includes a review of the previous water quality predictions, as presented by Golder (2007), and updates to the various water quality inputs, and the assumptions to make the updated predictions.

2.1 MIXING MODEL

A mixing cell model is used to predict the water quality downstream of the TMF. The mixing model used for this study assumes complete mixing of the water quality at specified flow rates from two or more sources in order to calculate the concentration of the mixture. The concentration of the mixture (representing the mixed water in a lake derived from multiple sources) can be calculated as follows:

$$C_{mixture} = \frac{(C_1 \times Q_1) + (C_2 \times Q_2) + (C_3 \times Q_3)}{Q_1 + Q_2 + Q_3}$$

where: $C_{mixture}$ = the concentration of the mixed components
C_x = concentration of component x (where x = 1 to 3)
Q_x = flow of component x (where x = 1 to 3).

The same approach to mixing was also used by Golder (2007) to prepare the water quality predictions in water bodies downstream of the TMF.

2.2 PREVIOUS WATER QUALITY PREDICTIONS

The water quality predictions prepared by Golder (2007) were presented as Appendix H of the Focus Report (CRA 2007b) prepared to support the Environmental Assessment of the Project (CRA 2007a) and the Industrial Approval Application (CRA 2012). Calculations of downstream water quality assumed that the discharges to the receiving environment from the TMF were limited to the treated effluent from the TMF. This treated effluent was discharged to the polishing pond, and ultimately to Scraggy Lake after passing through a constructed wetland. Golder assumed that improvements to the water chemistry when the effluent from the polishing pond passed through the constructed wetland.

The water quality in Scraggy Lake estimated by Golder (2007) are reproduced in Table 1 for comparison purposes. These calculations were based the water quality data from the treated effluent from the TMF to the polishing pond and the baseline water quality for Scraggy Lake, presented on Table 2, and the average monthly flow rates for normal flow conditions presented on Table 3.

Table 1 Predicted Water Quality in Scraggy Lake (Golder 2007)

Parameter	Average Monthly Concentration (mg/L)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ag	5.0E-05	5.0E-05	5.0E-05	4.9E-05	4.9E-05	4.8E-05	4.7E-05	4.7E-05	4.6E-05	4.9E-05	4.9E-05	5.0E-05
Al	1.9E-01	1.9E-01	1.9E-01	1.8E-01	1.8E-01	1.7E-01	1.6E-01	1.6E-01	1.5E-01	1.8E-01	1.8E-01	1.9E-01
As	1.0E-03	1.0E-03	1.0E-03	1.2E-03	1.3E-03	1.5E-03	1.8E-03	1.7E-03	2.0E-03	1.2E-03	1.2E-03	1.0E-03
Ca	1.0E+00	1.0E+00	1.0E+00	9.5E+00	1.3E+01	2.1E+01	3.3E+01	3.0E+01	4.4E+01	1.1E+01	1.1E+01	1.0E+00
Cd	2.0E-05	2.0E-05	2.0E-05	1.9E-05	1.9E-05	1.8E-05	1.7E-05	1.7E-05	1.6E-05	1.9E-05	1.9E-05	2.0E-05
Cl	4.0E+00	4.0E+00	4.0E+00	4.8E+00	5.2E+00	6.0E+00	7.1E+00	6.9E+00	8.2E+00	5.0E+00	5.0E+00	4.0E+00
Co	2.0E-04	2.0E-04	2.0E-04	8.6E-03	1.2E-02	2.0E-02	3.2E-02	2.9E-02	4.2E-02	1.0E-02	9.9E-03	2.0E-04
Cr	4.8E-03	4.8E-03	4.8E-03	4.6E-03	4.5E-03	4.4E-03	4.1E-03	4.1E-03	3.9E-03	4.6E-03	4.6E-03	4.8E-03
Cu	1.0E-03	1.0E-03	1.0E-03	4.7E-03	6.3E-03	9.7E-03	1.5E-02	1.4E-02	2.0E-02	5.4E-03	5.3E-03	1.0E-03
Fe	2.4E-01	2.4E-01	2.4E-01	2.3E-01	2.2E-01	2.1E-01	2.0E-01	2.0E-01	1.9E-01	2.2E-01	2.2E-01	2.4E-01
K	3.3E-01	3.3E-01	3.3E-01	3.0E+00	4.1E+00	6.5E+00	1.0E+01	9.4E+00	1.3E+01	3.4E+00	3.4E+00	3.3E-01
Mg	4.3E-01	4.3E-01	4.3E-01	7.9E-01	9.4E-01	1.3E+00	1.8E+00	1.7E+00	2.2E+00	8.5E-01	8.4E-01	4.3E-01
Mn	4.6E-02	4.6E-02	4.6E-02	4.4E-02	4.4E-02	4.2E-02	4.0E-02	4.1E-02	3.8E-02	4.4E-02	4.4E-02	4.6E-02
Na	3.0E+00	3.0E+00	3.0E+00	3.0E+01	4.1E+01	6.5E+01	1.0E+02	9.4E+01	1.4E+02	3.4E+01	3.4E+01	3.0E+00
NH4+NH3	2.5E-02	2.5E-02	2.5E-02	2.4E-02	2.4E-02	2.3E-02	2.1E-02	2.1E-02	2.0E-02	2.4E-02	2.4E-02	2.5E-02
Ni	1.0E-03	1.0E-03	1.0E-03	1.2E-03	1.3E-03	1.5E-03	1.8E-03	1.7E-03	2.0E-03	1.2E-03	1.2E-03	1.0E-03
NO3	4.8E-02	4.8E-02	4.8E-02	4.6E-02	4.5E-02	4.3E-02	4.0E-02	4.1E-02	3.8E-02	4.5E-02	4.5E-02	4.8E-02
Pb	3.1E-04	3.1E-04	3.1E-04	3.2E-04	3.2E-04	3.2E-04	3.3E-04	3.3E-04	3.3E-04	3.2E-04	3.2E-04	3.1E-04
P	1.5E-02	1.5E-02	1.5E-02	1.5E-02	1.4E-02	1.4E-02	1.3E-02	1.4E-02	1.3E-02	1.5E-02	1.5E-02	1.5E-02
Sb	1.0E-03	1.0E-03	1.0E-03	1.3E-03	1.4E-03	1.7E-03	2.1E-03	2.0E-03	2.5E-03	1.3E-03	1.3E-03	1.0E-03
Se	5.0E-04	5.0E-04	5.0E-04	5.0E-04	5.0E-04	5.0E-04	5.0E-04	5.0E-04	5.0E-04	5.0E-04	5.0E-04	5.0E-04
SO4	1.0E+00	1.0E+00	1.0E+00	6.0E+01	8.5E+01	1.4E+02	2.2E+02	2.0E+02	2.9E+02	7.0E+01	6.9E+01	1.0E+00

Table 1 Predicted Water Quality in Scraggy Lake (Golder 2007)

Parameter	Average Monthly Concentration (mg/L)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
U	5.0E-05	5.0E-05	5.0E-05	1.3E-04	1.7E-04	2.4E-04	3.6E-04	3.3E-04	4.6E-04	1.5E-04	1.4E-04	5.0E-05
Zn	1.2E-02	1.2E-02	1.2E-02	1.3E-02	1.3E-02	1.3E-02	1.3E-02	1.3E-02	1.4E-02	1.3E-02	1.3E-02	1.2E-02
CN	1.0E-03	1.0E-03	1.0E-03	1.8E-02	2.5E-02	4.0E-02	6.4E-02	5.9E-02	8.5E-02	2.1E-02	2.0E-02	1.0E-03

Table 2 Water Quality Data used by Golder (2007) to Predict Downstream Water Quality

Parameter	Baseline Concentration in Scraggy Lake (mg/L)	Treated Effluent Quality (mg/L)
Silver (Ag)	<0.0001	0.00003
Aluminum (Al)	0.19	<0.010
Arsenic (As)	<0.002	0.006
Calcium (Ca)	1.0	204
Cadmium (Cd)	0.00002	<0.000003
Chloride (Cl)	4.0	24
Cobalt (Co)	<0.0004	0.214
Chromium (Cr)	0.005	<0.0005
Copper (Cu)	<0.002	0.0883
Iron (Fe)	0.24	0.02
Potassium (K)	0.33	63.2
Magnesium (Mg)	0.43	9.25
Manganese (Mn)	0.046	0.125
Sodium (Na)	3.0	634
Total Ammonia as N (NH_4+NH_3)	0.025	17.1
Nickel (Ni)	<0.002	0.0062
Nitrate as N (NO_3)	0.05	0.12
Lead (Pb)	<0.0005	0.00037
Phosphorous (P)	0.015	<0.01
Antimony (Sb)	<0.002	0.008
Selenium (Se)	<0.001	0.001
Sulfate (SO_4)	<2	1400
Uranium (U)	<0.0001	0.0016
Zinc (Zn)	0.012	0.018
Total Cyanide (CN_{Total})	<0.002	0.44

Table 3 Discharge Rates (m^3/d) used by Golder (2007) to Predict Downstream Water Quality

Month	Discharge from Polishing Pond	Scraggy Lake Outflow
January	0	124,000
February	0	127,000
March	0	178,000
April	8,165	186,000
May	7,525	118,000
June	7,413	68,300
July	7,396	39,700
August	7,465	44,100
September	7,551	28,500
October	3,404	65,700
November	6,324	124,000
December	0	145,000

2.3 UPDATED FLOW DATA

Borehole drilling conducted by Stantec in 2016 to install a grout curtain in the bedrock beneath the TMF identified challenges that have prevented the installation of a grout curtain. Stantec modified the design of the TMF to include an upstream clay blanket to reduce the groundwater seepage from the TMF. The groundwater seepage that is generated from this updated TMF design was evaluated by Stantec (2016b), and included new permeability data for the bedrock beneath the TMF. Seepage estimates from the updated model include both seepage collected in the drainage ditches, and deeper groundwater seepage that is assumed to migrate to the receiving environment. Seepage collected in the drainage ditches are recirculated to the TMF, while deeper groundwater seepage is estimated to proceed to Scraggy Lake, and to the Unnamed Tributary (Watercourse #4), as shown on Table 4.

Table 4 Updated Mine Discharge Rates (m^3/d)

Month	Discharge from Polishing Pond	Groundwater Seepage Flowing Under TMF Ditches		Total Discharge to Receiving Environment
		To Scraggy Lake	To Unnamed Tributary (Watercourse #4)	
January	485	751	118	1,354
February	5,726	751	118	6,595
March	9,939	751	118	10,808

Table 4 Updated Mine Discharge Rates (m^3/d)

Month	Discharge from Polishing Pond	Groundwater Seepage Flowing Under TMF Ditches		Total Discharge to Receiving Environment
		To Scraggy Lake	To Unnamed Tributary (Watercourse #4)	
April	10,090	751	118	10,959
May	8,696	751	118	9,565
June	7,227	751	118	8,096
July	485	751	118	1,354
August	485	751	118	1,354
September	10,002	751	118	10,871
October	7,018	751	118	7,887
November	683	751	118	1,552
December	485	751	118	1,354

The seepage estimates were also carried through the water balance modelling (Stantec 2016a) to update the discharge estimates from the polishing pond to Scraggy Lake, as are also presented on Table 4.

Baseline flow rates at the outflow of Scraggy Lake and the Unnamed Tributary (Watercourse #4) were estimated as shown on Table 5. The discharge rate at the Scraggy Lake Outflow presented on Table 5 was estimated by Golder (2007). The mean annual flow rate for Watercourse #4 was estimated using the catchment area upstream of monitoring station SW3 (1.65 km^2) and regional regression equations for the mean annual flow (Caissie and Robichaud 2009). The mean annual flow rate was estimated to be 0.067 m^3/s or 5,700 m^3/d, and was apportioned to monthly flows based on the monthly distributions observed at Scraggy Lake.

Table 5 Estimated Baseline Discharge Rates (m^3/d) in Receiving Environment

Month	Scraggy Lake Outflow	Unnamed Tributary (Watercourse #4)
January	124,000	6,880
February	127,000	7,070
March	178,000	9,910
April	186,000	10,300
May	118,000	6,590
June	68,300	3,800
July	39,700	2,210
August	44,100	2,450

Table 5 Estimated Baseline Discharge Rates (m^3/d) in Receiving Environment

Month	Scraggy Lake Outflow	Unnamed Tributary (Watercourse #4)
September	28,500	1,590
October	65,700	3,660
November	124,000	6,880
December	145,000	8,080

2.4 UPDATED WATER QUALITY DATA

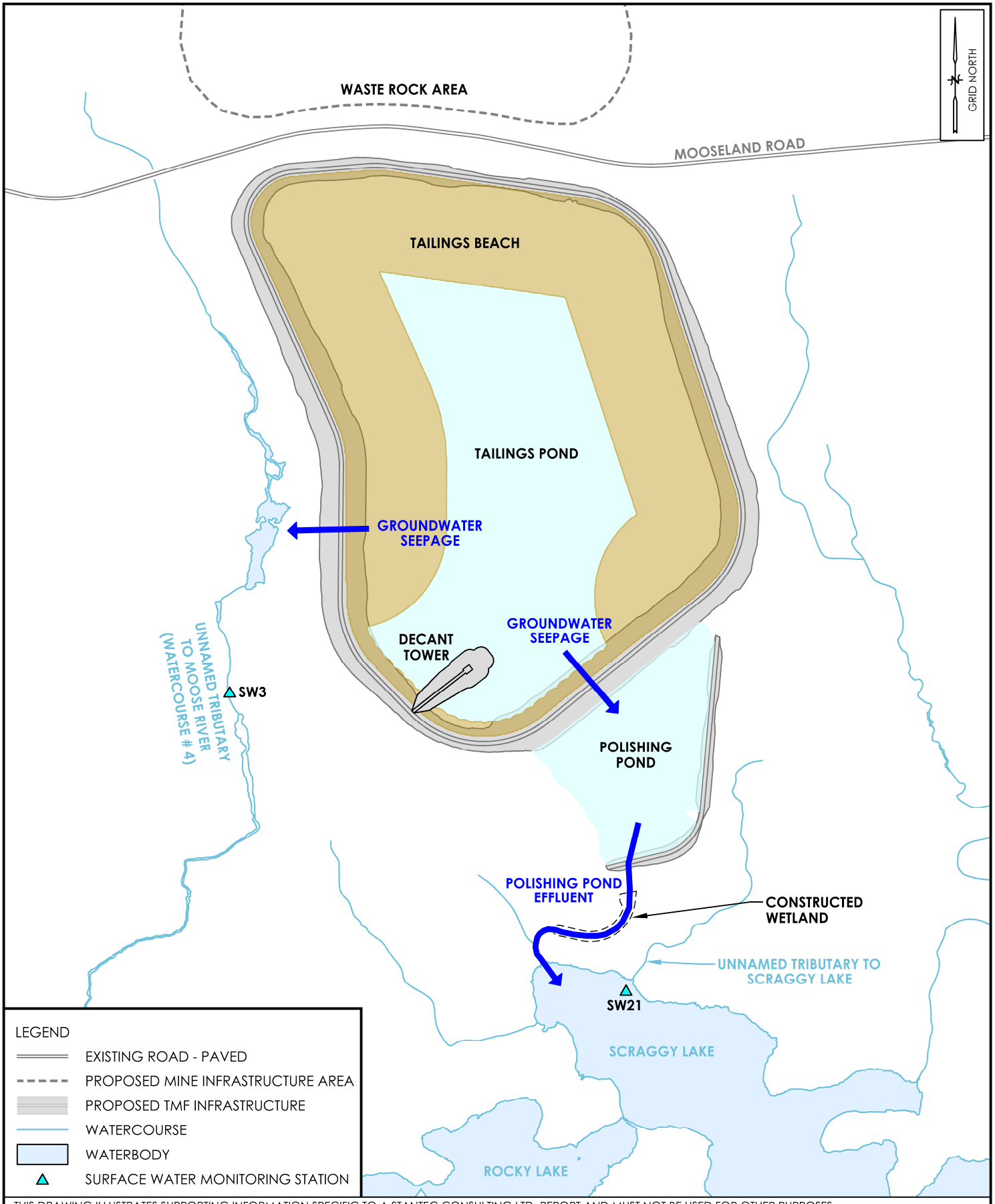
2.4.1 Baseline Water Quality

Monthly water quality sampling downstream of the TMF has been ongoing since April 2016 in Scraggy Lake (SW21) and at Watercourse #4 (SW3). The location of the monitoring stations are presented on Figure 1. The monthly water quality results are presented in Appendix A to this report, and the mean concentrations are summarized on Table 6. The baseline water quality is compared against the Guidelines for Canadian Drinking Water Quality (GCDWQ, Health Canada 2014) and the Canadian Council of Ministers of the Environment (CCME) Guidelines for the Protection of Freshwater Aquatic Life (CCME FAL, CCME 2007).

As shown on Table 6, the average baseline water quality exceeds the CCME FAL and GCDWQ in both Scraggy Lake and Watercourse #4. Exceedances include:

- Aluminum concentration above the CCME FAL guideline at both locations;
- Arsenic concentration above the CCME FAL guideline at SW3; and
- Iron and Manganese concentration above the CCME FAL and GCDWQ guidelines at both locations.

These exceedances are due to interactions of the water with the mineralogy of the local bedrock.



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GROUNDWATER SEEPAGE

TOUQUOY MINE TAILINGS MANAGEMENT FACILITY

HALIFAX COUNTY, NOVA SCOTIA

Client:	ATLANTIC MINING NS CORP.
Job No.:	121619250
Scale:	N.T.S.
Date:	2016 11 25
Dwn. By:	JL
App'd By:	JK
Fig. No.:	1

Stantec

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Table 6 Average Baseline Water Quality in Receiving Environment

Parameter	GCDWQ	CCME FAL	Mean Concentration (mg/L)	
			Scraggy Lake (SW21)	Watercourse #4 (SW3)
Silver (Ag)	-	0.00025	0.00005	0.00005
Aluminum (Al)	-	0.1	**0.223**	**0.609**
Arsenic (As)	0.01	0.005	0.000786	**0.00744**
Calcium (Ca)	-	-	1.1	2.13
Cadmium (Cd)	0.005	0.00009	0.0000229	0.0000193
Chloride (Cl)	250	120	4.31	7.66
Cobalt (Co)	-	-	0.000371	0.00163
Chromium (Cr)	-	0.0089	0.00214	0.00106
Copper (Cu)	1	0.002-0.004	0.001	0.00144
Iron (Fe)	0.3	0.3	**0.341**	**1.07**
Potassium (K)	-	-	0.37	1.13
Magnesium (Mg)	-	-	0.483	0.829
Manganese (Mn)	0.05	-	**0.055**	**0.318**
Sodium (Na)	200	-	2.91	4.81
Total Ammonia as N (NH_4+NH_3)	-		0.0382	0.0442
Nickel (Ni)	-	-	0.001	0.00137
Nitrate as N ($NO_{3)}$	10	13	0.0297	0.0553
Lead (Pb)	0.01	0.001-0.007	0.000551	0.000967
Phosphorous (P)	-	0.004-0.1	0.05	0.0571
Antimony (Sb)	0.006	-	0.0005	0.0005
Selenium (Se)	0.05	0.001	0.0005	0.0005
Sulfate (SO_4)	500	-	1.29	2.57
Uranium (U)	0.02	0.015	0.00005	0.0000657
Zinc (Zn)	5	0.03	0.00343	0.00357
Total Cyanide (CN_{Total})	-	-	0.000629	0.0009
WAD Cyanide (CN_{WAD})	0.2	0.005	0.0015	0.0015

Notes:
All statistics calculated using values half of the reported detection limit for values below detection limits
0.000 = Exceeds CCME Freshwater Aquatic Life Guidelines (CCME FAL)
<u>0.000</u> = Exceeds Guidelines for Canadian Drinking Water Quality (GCDWQ)

2.4.2 Updated Mine Effluent Water Quality

Updated metallurgical testing was conducted by Base Metallurgical Laboratories (Base Met Labs 2016) to evaluate the addition of a ferric sulphate precipitation circuit in the mill prior to releasing the tailings to the TMF. The results of this testing are included in Appendix B, and indicate that arsenic concentrations in the tailings water can be reduced compared to the previous estimates from 2007. The concentrations from this analysis were used as the basis of evaluating groundwater seepage from the foundation to the receiving environment, as shown on Table 7. However, cyanide concentrations from the Base Met Labs report was reduced based on the estimated natural degradation of cyanide concentration in the tailings pond (Phinney 2016, Phinney 2008). The total ammonia concentration was not reported in the Base Met Labs report, therefore it was assumed that the ammonia, nitrate and chloride concentrations in the groundwater seepage would be the same as the polishing pond seepage.

The polishing pond effluent concentrations were assumed to be the dissolved concentrations from the TMF, as presented by Golder (2007) and CBCL (2007). These source concentrations in the polishing pond are reproduced on Table 7.

Table 7 Estimated Mine Discharge Quality (2016)

Parameter	GCDWQ	CCME FAL	Mean Concentration (mg/L)	
			Polishing Pond Effluent	Groundwater Seepage
Silver (Ag)	-	0.00025	0.00003	0.000413
Aluminum (Al)	0.2	0.1	<0.010	0.677
Arsenic (As)	0.01	0.005	**0.006**	**0.0571**
Calcium (Ca)	-	-	204	124
Cadmium (Cd)	0.005	0.00009	<0.000003	0.0000052
Chloride (Cl)	250	120	24	24
Cobalt (Co)	-	-	0.214	0.137
Chromium (Cr)	-	0.0089	<0.0005	0.001
Copper (Cu)	1	0.002-0.004	**0.0883**	**0.0102**
Iron (Fe)	0.3	0.3	0.02	**2.11**
Potassium (K)	-	-	63.2	46.6
Magnesium (Mg)	-	-	9.25	3.48
Manganese (Mn)	0.05	-	0.125	0.0244
Sodium (Na)	200	-	634	258
Total Ammonia as N (NH_4+NH_3)	-	pH and temperature dependent	17.1	17.1

Table 7 Estimated Mine Discharge Quality (2016)

Parameter	GCDWQ	CCME FAL	Mean Concentration (mg/L)	
			Polishing Pond Effluent	Groundwater Seepage
Nickel (Ni)	-	-	0.0062	0.00059
Nitrate as N (NO_3)	10	13	0.12	0.12
Lead (Pb)	0.01	0.001-0.007	0.00037	**0.0072**
Phosphorous (P)	-	0.004-0.1	<0.01	**0.174**
Antimony (Sb)	0.006	-	0.008	0.0128
Selenium (Se)	0.05	0.001	0.001	**0.00191**
Sulfate (SO_4)	500	-	1400	533
Uranium (U)	0.02	0.015	0.0016	0.00653
Zinc (Zn)	5	0.03	0.018	**0.0471**
Total Cyanide (CN_{Total})	-	-	0.44	3.4
WAD Cyanide (CN_{WAD})	0.2	0.005 (for free CN)	<0.050	<0.050

Notes:
All statistics calculated using values half of the reported detection limit for values below detection limits
0.000 = Exceeds CCME Freshwater Aquatic Life Guidelines (CCME FAL)
0.000 = Exceeds Guidelines for Canadian Drinking Water Quality (GCDWQ)

3.0 RESULTS

The results of the updated water quality predictions in Scraggy Lake, and in the water quality in Watercourse #4 are presented for monthly calculations in Appendix C, with average annual concentrations provided in Table 8 and Table 9. The values are compared against the average baseline concentrations observed in 2016, and the GCDWQ, CCME FAL guidelines and the MMER discharge limits. The average baseline concentrations from 2016 are also provided for comparison.

The current (i.e., updated) estimate of water quality in Scraggy Lake is compared to both the baseline concentrations (observed in 2016) and the water quality guidelines in Table 8. Based on the revised design of the TMF, the water quality in Scraggy Lake is predicted to exceed the CCME FAL for aluminum, copper, and unionized ammonia. This is consistent with the previous estimate that was approved in the IA for the project. As shown on the table, the average concentration of iron and manganese are predicted to improve slightly compared to the baseline results.

Table 8 Predicted Water Quality in Scraggy Lake

Parameter	GCDWQ	CCME FAL	MMER		Scraggy Lake		
			Monthly Average	Grab Sample	Baseline	Previous Estimate	Current Estimate
Silver (Ag)	-	0.00025	-	-	0.00005	0.000049	0.0000525
Aluminum (Al)	-	0.1	-	-	**0.217**	**0.18**	**0.181**
Arsenic (As)	0.01	0.005	0.5	1	0.000786	0.0012	0.00192
Calcium (Ca)	-	-	-	-	1.04	9.6	15.7
Cadmium (Cd)	0.005	0.00009	-	-	0.0000231	0.000019	0.0000183
Chloride (Cl)	250	120	-	-	4.17	4.8	5.54
Cobalt (Co)	-	-	-	-	0.000371	0.0093	0.0158
Chromium (Cr)	-	0.0089	-	-	0.00241	0.0046	0.00446
Copper (Cu)	1	0.002-0.004	0.3	0.6	0.001	**0.0047**	**0.00689**
Iron (Fe)	0.3	0.3	-	-	**0.341**	0.23	0.241
Potassium (K)	-	-	-	-	0.37	3.0	4.97
Magnesium (Mg)	-	-	-	-	0.483	0.80	1.04
Manganese (Mn)	0.05	-	-	-	0.0553	0.049	0.0508
Sodium (Na)	200	-	-	-	2.91	30	47.5

Total Ammonia as N (NH_4+NH_3)	-	-	-	-	0.0382	0.23	1.33
Unionized Ammonia	-	0.019	-	-	0.0014	0.009	**0.051**
Nickel (Ni)	-	-	0.5	1	0.001	0.00123	0.00134
Nitrate as N (NO_3)	10	13	-	-	0.0297	0.25	0.0531
Lead (Pb)	0.01	0.001-0.007	0.2	0.4	0.000551	0.00031	0.000388
Phosphorous (P)	-	0.004-0.1	-	-	0.05	0.015	0.016
Antimony (Sb)	0.006	-	-	-	0.0005	0.0013	0.00159
Selenium (Se)	0.05	0.001	-	-	0.0005	0.0005	0.000548
Sulfate (SO_4)	500	-	-	-	1.29	60	99.2
Uranium (U)	0.02	0.015	-	-	0.00005	0.00012	0.00022
Zinc (Zn)	5	0.03	0.5	1	0.00343	0.013	0.013
Total Cyanide (CN_{Total})	-	-	1	2	0.000629	0.020	0.0655
WAD Cyanide (CN_{WAD})	0.2	0.005 (for free CN)	-	-	0.0015	-	0.00192

Notes:
All statistics calculated using values half of the reported detection limit for values below detection limits
Unionized ammonia is calculated as 0.039 * total ammonia concentration, assuming pH = 6.0 and temperature of 20°C.
0.000 = Exceeds CCME Freshwater Aquatic Life Guidelines (CCME FAL)
<u>0.000</u> = Exceeds Guidelines for Canadian Drinking Water Quality (GCDWQ)

The predicted water quality in Watercourse#4 are provided in Table 9. As shown, the water quality is predicted to exceed the CCME FAL guidelines for aluminum, arsenic, unionized ammonia, and iron. This is largely due to the baseline conditions for all of these elements exceeding these criteria. The effects of the groundwater loading to Watercourse #4 were not evaluated in the IA.

Table 9 Predicted Water Quality in Watercourse #4

Parameter	GCDWQ	CCME FAL	MMER		Watercourse #4	
			Monthly Average	Grab Sample	Baseline	Current Estimate
Silver (Ag)	-	0.00025	-	-	0.00005	0.0000614
Aluminum (Al)	-	0.1	-	-	**0.609**	**0.626**
Arsenic (As)	0.01	0.005	0.5	1	**0.00744**	**0.00903**
Calcium (Ca)	-	-	-	-	2.13	5.61
Cadmium (Cd)	0.005	0.00009	-	-	0.0000193	0.0000194
Chloride (Cl)	250	120	-	-	7.66	8.31

Table 9 Predicted Water Quality in Watercourse #4

Parameter	GCDWQ	CCME FAL	MMER		Watercourse #4	
			Monthly Average	Grab Sample	Baseline	Current Estimate
Cobalt (Co)	-	-	-	-	0.00163	0.00547
Chromium (Cr)	-	0.0089	-	-	0.00106	0.00109
Copper (Cu)	1	0.002-0.004	0.3	0.6	0.00144	0.00172
Iron (Fe)	0.3	0.3	-	-	**1.07**	**1.13**
Potassium (K)	-	-	-	-	1.13	2.44
Magnesium (Mg)	-	-	-	-	0.829	0.925
Manganese (Mn)	0.05	-	-	-	0.318	0.318
Sodium (Na)	200	-	-	-	4.81	12
Total Ammonia as N (NH_4+NH_3)	-	See unionized ammonia	-	-	0.0442	0.524
Unionized Ammonia	-	0.019	-	-	0.0017	**0.020**
Nickel (Ni)	-	-	0.5	1	0.00137	0.00138
Nitrate as N (NO_3)	10	13	-	-	0.0553	0.0586
Lead (Pb)	0.01	0.001-0.007	0.2	0.4	0.000967	0.00117
Phosphorous (P)	-	0.004-0.1	-	-	0.0571	0.0618
Antimony (Sb)	0.006	-	-	-	0.0005	0.000858
Selenium (Se)	0.05	0.001	-	-	0.0005	0.000552
Sulfate (SO_4)	500	-	-	-	2.57	17.5
Uranium (U)	0.02	0.015	-	-	0.0000657	0.000249
Zinc (Zn)	5	0.03	0.5	1	0.00357	0.00489
Total Cyanide (CN_{Total})	-	-	1	2	0.0009	0.0964
WAD Cyanide (CN_{WAD})	0.2	0.005	-	-	0.0015	0.000701

Notes:
All statistics calculated using values half of the reported detection limit for values below detection limits
Unionized ammonia is calculated as 0.039 * total ammonia concentration, assuming pH = 6.0 and temperature of 20°C.
0.000 = Exceeds CCME Freshwater Aquatic Life Guidelines (CCME FAL)
0.000 = Exceeds Guidelines for Canadian Drinking Water Quality (GCDWQ)

The water quality data predicted above are subject to uncertainty in the inputs, including the predicted flows originating from the TMF. Conservative estimates of groundwater flow rates to the receiving environment were based on seepage models. Groundwater monitoring at the base of the TMF recommended in the Groundwater Monitoring Plan included in the IA will confirm the water quality loadings to the environment. Should this monitoring produce unexpected loadings to the environment, contingency plans including the pumping of some portion of groundwater back to the TMF can be implemented to mitigate negative effects as per the original IA Application (CRA, 2012).

4.0 CONCLUSIONS AND RECOMMENDATIONS

Water quality predictions were prepared for the receiving water bodies downstream of the TMF: Scraggy Lake and Watercourse #4. These predictions were based on updated source water quality estimates from recent metallurgical testing, and revised estimates of the discharge rates to the receiving environment.

The predicted water quality downstream of the TMF is consistent with the predictions that were presented in the original IA Application. Elevated concentrations of some metals (i.e., aluminum, arsenic and iron) are predicted to exceed the CCME FAL criteria, however, these elements exceed the concentrations in the baseline conditions. Therefore, the changes to the TMF design are not anticipated to have additional adverse effects compared to those predicted in the IA.

The changes to the metallurgical testing has resulted in increased ammonia concentrations in the TMF pond water. This has resulted in predicted concentrations of unionized ammonia in the receiving environment in exceed of the CCME FAL of 0.019 mg/L. It is anticipated that the mill can be optimized for the reduction of arsenic, cyanide and ammonia, and additional evaluation is recommended.

Groundwater seepage was conservatively assumed to have the same chemistry as the tailings water. However, changes in the chemistry that reduce the concentrations of metals and cyanide can be expected as groundwater flows through the tailings. Subaqueous column testing is therefore recommended to refine the predictions of the groundwater chemistry. This refined prediction of groundwater chemistry can then be used with the groundwater monitoring program as a basis for identifying expected changes to groundwater quality from the TMF

5.0 REFERENCES

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Table A.1: Surface water chemistry data collected at SW3 in 2016

Sample ID		SW3	SW3	SW3	SW3	SW3	SW3	SW3				
Sampling Date		2016-04-19	2016-05-27	2016-06-27	2016-07-27	2016-08-11	2016-09-14	2016-10-13				
Sampling Time		12:00:00 AM	12:00:00 AM	10:30:00 AM	12:25:00 PM	2:19:00 PM	12:55:00 PM	12:15:00 PM	Statistics			
Parameter Name	**Units**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Minimum**	**Mean**	**Median**	**Maximum**
Total Suspended Solids	mg/L	<1.0	<2.0	<1.0	<2.0	<2.0	<2.0	5.4	0.5	1.49	1	5.4
Anion Sum	me/L	0.18	0.2	0.2	0.38	0.39	0.41	0.44	0.18	0.314	0.38	0.44
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	<1.0	<1.0	<1.0	7.8	6.9	5.9	<1.0	0.5	3.23	0.5	7.8
Calculated TDS	mg/L	13	16	16	30	31	28	37	13	24.4	28	37
Carb. Alkalinity (calc. as CaCO3)	mg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.5	0.5	0.5	0.5
Cation Sum	me/L	0.24	0.33	0.33	0.53	0.57	0.52	0.66	0.24	0.454	0.52	0.66
Hardness (CaCO3)	mg/L	3.8	5.4	5.6	9.5	10	8.8	18	3.8	8.73	8.8	18
Ion Balance (% Difference)	%	14.3	24.5	24.5	16.5	18.8	11.8	20	11.8	18.6	18.8	24.5
Langelier Index (@ 20C)	N/A	NC	NC	NC	-3.57	-3.33	-3.61	NC	NC	NC	NC	NC
Langelier Index (@ 4C)	N/A	NC	NC	NC	-3.82	-3.58	-3.87	NC	NC	NC	NC	NC
Nitrate (N)	mg/L	<0.050	<0.050	0.053	<0.050	<0.050	0.094	0.14	0.025	0.0553	0.025	0.14
Saturation pH (@ 20C)	N/A	NC	NC	NC	10	10.1	10.2	NC	NC	NC	NC	NC
Saturation pH (@ 4C)	N/A	NC	NC	NC	10.3	10.3	10.4	NC	NC	NC	NC	NC
Total Alkalinity (Total as CaCO3)	mg/L	<5.0	<5.0	<5.0	7.8	6.9	5.9	<5.0	2.5	4.37	2.5	7.8
Dissolved Chloride (Cl)	mg/L	6.3	7.3	6.8	8	8.9	10	6.3	6.3	7.66	7.3	10
Colour	TCU	83	94	120	210	220	130	130	83	141	130	220
Dissolved Fluoride (F-)	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.05	0.05	0.05	0.05
Nitrate + Nitrite (N)	mg/L	<0.050	<0.050	0.053	<0.050	<0.050	0.094	0.14	0.025	0.0553	0.025	0.14
Nitrite (N)	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.005	0.005	0.005	0.005
Orthophosphate (P)	mg/L	<0.010	<0.010	<0.010	0.011	0.013	<0.010	<0.010	0.005	0.007	0.005	0.013
pH	pH	5.59	6.19	6.16	6.47	6.75	6.57	5.85	5.59	6.23	6.19	6.75
Reactive Silica (SiO2)	mg/L	1.5	1.2	1.9	4.7	4.5	1.7	3.8	1.2	2.76	1.9	4.7
Dissolved Sulphate (SO4)	mg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	12	1	2.57	1	12
Turbidity	NTU	1.5	8.5	1.2	6.9	2.1	1.2	37	1.2	8.34	2.1	37
Conductivity	uS/cm	28	30	31	46	47	52	61	28	42.1	46	61
Total Aluminum (Al)	ug/L	160	240	220	570	370	200	2500	160	609	240	2500
Total Antimony (Sb)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.5	0.5	0.5	0.5
Total Arsenic (As)	ug/L	<1.0	4.1	3.4	10	11	4.1	19	0.5	7.44	4.1	19
Total Barium (Ba)	ug/L	3.1	3.9	3.1	9.3	7	4.7	22	3.1	7.59	4.7	22
Total Beryllium (Be)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.5	0.5	0.5	0.5
Total Bismuth (Bi)	ug/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	1	1	1	1
Total Boron (B)	ug/L	<50	<50	<50	<50	<50	<50	<50	25	25	25	25
Total Cadmium (Cd)	ug/L	0.013	0.015	<0.010	0.022	0.018	<0.010	0.057	0.005	0.0193	0.015	0.057
Total Calcium (Ca)	ug/L	900	1400	1400	2300	2400	2200	4300	900	2130	2200	4300
Total Chromium (Cr)	ug/L	<1.0	2.5	<1.0	<1.0	<1.0	<1.0	2.4	0.5	1.06	0.5	2.5
Total Cobalt (Co)	ug/L	<0.40	1.3	<0.40	3.3	3.9	0.71	1.8	0.2	1.63	1.3	3.9
Total Copper (Cu)	ug/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	4.1	1	1.44	1	4.1
Total Iron (Fe)	ug/L	180	610	430	1600	1800	780	2100	180	1070	780	2100
Total Lead (Pb)	ug/L	<0.50	1.2	<0.50	0.86	1.1	0.51	2.6	0.25	0.967	0.86	2.6
Total Magnesium (Mg)	ug/L	380	480	530	920	970	820	1700	380	829	820	1700
Total Manganese (Mn)	ug/L	34	250	29	890	620	120	280	29	318	250	890
Total Molybdenum (Mo)	ug/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	1	1	1	1
Total Nickel (Ni)	ug/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	3.6	1	1.37	1	3.6
Total Phosphorus (P)	ug/L	<100	<100	<100	<100	<100	<100	100	50	57.1	50	100

Table A.1: Surface water chemistry data collected at SW3 in 2016

Sample ID		SW3	SW3	SW3	SW3	SW3	SW3	SW3				
Sampling Date		2016-04-19	2016-05-27	2016-06-27	2016-07-27	2016-08-11	2016-09-14	2016-10-13				
Sampling Time		12:00:00 AM	12:00:00 AM	10:30:00 AM	12:25:00 PM	2:19:00 PM	12:55:00 PM	12:15:00 PM	Statistics			
Parameter Name	**Units**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Minimum**	**Mean**	**Median**	**Maximum**
Total Potassium (K)	ug/L	170	220	230	1600	1700	2300	1700	170	1130	1600	2300
Total Selenium (Se)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.5	0.5	0.5	0.5
Total Silver (Ag)	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.05	0.05	0.05	0.05
Total Sodium (Na)	ug/L	3500	4500	4400	5300	5900	5900	4200	3500	4810	4500	5900
Total Strontium (Sr)	ug/L	4.1	6.1	6.2	11	12	9.7	20	4.1	9.87	9.7	20
Total Thallium (Tl)	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.05	0.05	0.05	0.05
Total Tin (Sn)	ug/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	1	1	1	1
Total Titanium (Ti)	ug/L	3.2	5.9	4	12	7.8	3.8	87	3.2	17.7	5.9	87
Total Uranium (U)	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.16	0.05	0.0657	0.05	0.16
Total Vanadium (V)	ug/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.7	1	1.24	1	2.7
Total Zinc (Zn)	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	10	2.5	3.57	2.5	10
Cyanate	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.025	0.025	0.025	0.025
Nitrogen (Ammonia Nitrogen)	mg/L	<0.050	<0.050	<0.050	0.14		<0.050	<0.050	0.025	0.0442	0.025	0.14
Total Organic Carbon (C)	mg/L	5.4	6.9	8.6	16	16	13	15	5.4	11.6	13	16
Total Chemical Oxygen Demand	mg/L	16	29	32	71	72	51	65	16	48	51	72
Total Mercury (Hg)	ug/L	<0.013	<0.013	<0.013	0.013	<0.013	0.013	<0.013	0.0065	0.00836	0.0065	0.013
Strong Acid Dissoc. Cyanide (CN)	mg/L	<0.0010	<0.0010	0.0013	<0.0010	0.0012	<0.0010	0.0018	0.0005	0.0009	0.0005	0.0018
Weak Acid Dissociable Cyanides	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.0015	0.0015	0.0015	0.0015
Thiocyanates	mg/L	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	0.085	0.085	0.085	0.085
>C10-C16 Hydrocarbons	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.025	0.025	0.025	0.025
>C16-C21 Hydrocarbons	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.025	0.025	0.025	0.025
>C21-<C32 Hydrocarbons	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.05	0.05	0.05	0.05
Modified TPH (Tier1)	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.05	0.05	0.05	0.05
Reached Baseline at C32	mg/L	NA	NA	NA	NA	NA	NA	NA	NC	NC	NC	NC
Hydrocarbon Resemblance	mg/L	NA	NA	NA	NA	NA	NA	NA	NC	NC	NC	NC
Benzene	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0005	0.0005	0.0005	0.0005
Toluene	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0005	0.0005	0.0005	0.0005
Ethylbenzene	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0005	0.0005	0.0005	0.0005
Total Xylenes	mg/L	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.001	0.001	0.001	0.001
C6 - C10 (less BTEX)	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.005	0.005	0.005	0.005

Table A.2: Surface water chemistry data collected at SW21 in 2016

Sample ID		SW21	SW21	SW21	SW21	SW21	SW21	SW21				
Sampling Date		2016-04-19	2016-05-27	2016-06-27	2016-07-27	2016-08-11	2016-09-14	2016-10-13				
Sampling Time		11:00:00 AM	12:00:00 AM	12:20:00 PM	11:51:00 AM	1:45:00 PM	12:32:00 PM	1:40:00 PM	Statistics			
Parameter Name	**Units**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Minimum**	**Mean**	**Median**	**Maximum**
Total Suspended Solids	mg/L	<1.0	<1.0	<1.0	1.2	1.6	17	<10	0.5	3.76	1.2	17
Anion Sum	me/L	0.11	0.12	0.12	0.11	0.11	0.12	0.22	0.11	0.13	0.12	0.22
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.5	0.5	0.5	0.5
Calculated TDS	mg/L	9	9	8	8	7	9	22	7	10.3	9	22
Carb. Alkalinity (calc. as CaCO3)	mg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.5	0.5	0.5	0.5
Cation Sum	me/L	0.17	0.18	0.19	0.18	0.17	0.21	0.56	0.17	0.237	0.18	0.56
Hardness (CaCO3)	mg/L	3	3.2	3.3	3.2	3.1	3	13	3	4.54	3.2	13
Ion Balance (% Difference)	%	21.4	20	22.6	24.1	21.4	27.3	43.6	20	25.8	22.6	43.6
Langelier Index (@ 20C)	N/A	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Langelier Index (@ 4C)	N/A	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Nitrate (N)	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.058	0.025	0.0297	0.025	0.058
Saturation pH (@ 20C)	N/A	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Saturation pH (@ 4C)	N/A	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
Total Alkalinity (Total as CaCO3)	mg/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	2.5	2.5	2.5	2.5
Dissolved Chloride (Cl)	mg/L	3.8	4.1	4.1	3.9	3.7	4.3	5.3	3.7	4.17	4.1	5.3
Colour	TCU	74	76	60	39	40	39	96	39	60.6	60	96
Dissolved Fluoride (F-)	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.05	0.05	0.05	0.05
Nitrate + Nitrite (N)	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.058	0.025	0.0297	0.025	0.058
Nitrite (N)	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.005	0.005	0.005	0.005
Orthophosphate (P)	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.005	0.005	0.005	0.005
pH	pH	5.06	5.76	6.37	5.99	6.5	6.52	4.86	4.86	5.87	5.99	6.52
Reactive Silica (SiO2)	mg/L	1.5	0.96	<0.50	0.59	<0.50	0.52	1.7	0.25	0.824	0.59	1.7
Dissolved Sulphate (SO4)	mg/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	3	1	1.29	1	3
Turbidity	NTU	0.72	1.1	1.4	1	0.83	6.3	3.1	0.72	2.06	1.1	6.3
Conductivity	uS/cm	21	18	19	19	19	23	37	18	22.3	19	37
Total Aluminum (Al)	ug/L	160	170	160	140	130	180	580	130	217	160	580
Total Antimony (Sb)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.5	0.5	0.5	0.5
Total Arsenic (As)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	1.4	1.6	0.5	0.786	0.5	1.6
Total Barium (Ba)	ug/L	3	3.2	2.8	2.5	2.4	3.9	14	2.4	4.54	3	14
Total Beryllium (Be)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.5	0.5	0.5	0.5
Total Bismuth (Bi)	ug/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	1	1	1	1
Total Boron (B)	ug/L	<50	<50	<50	<50	<50	<50	<50	25	25	25	25
Total Cadmium (Cd)	ug/L	0.013	0.037	0.016	0.015	<0.010	0.016	0.06	0.005	0.0231	0.016	0.06
Total Calcium (Ca)	ug/L	700	750	780	710	690	680	3000	680	1040	710	3000
Total Chromium (Cr)	ug/L	<1.0	<1.0	2.4	<1.0	<1.0	12	<1.0	0.5	2.41	0.5	12
Total Cobalt (Co)	ug/L	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	1.4	0.2	0.371	0.2	1.4
Total Copper (Cu)	ug/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	1	1	1	1
Total Iron (Fe)	ug/L	210	200	230	180	190	500	650	180	309	210	650
Total Lead (Pb)	ug/L	<0.50	<0.50	<0.50	<0.50	<0.50	0.92	1.3	0.25	0.496	0.25	1.3
Total Magnesium (Mg)	ug/L	300	320	340	340	330	320	1400	300	479	330	1400
Total Manganese (Mn)	ug/L	29	31	30	34	34	64	160	29	54.6	34	160
Total Molybdenum (Mo)	ug/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	1	1	1	1
Total Nickel (Ni)	ug/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	1	1	1	1
Total Phosphorus (P)	ug/L	<100	<100	<100	<100	<100	<100	<100	50	50	50	50
Total Potassium (K)	ug/L	170	190	240	130	160	240	1400	130	361	190	1400
Total Selenium (Se)	ug/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	0.5	0.5	0.5	0.5
Total Silver (Ag)	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.05	0.05	0.05	0.05
Total Sodium (Na)	ug/L	2100	2300	2400	2300	2300	2800	5100	2100	2760	2300	5100
Total Strontium (Sr)	ug/L	4.3	4.5	4.1	4.1	4.2	4.3	18	4.1	6.21	4.3	18

Table A.2: Surface water chemistry data collected at SW21 in 2016

Sample ID		SW21	SW21	SW21	SW21	SW21	SW21	SW21				
Sampling Date		2016-04-19	2016-05-27	2016-06-27	2016-07-27	2016-08-11	2016-09-14	2016-10-13				
Sampling Time		11:00:00 AM	12:00:00 AM	12:20:00 PM	11:51:00 AM	1:45:00 PM	12:32:00 PM	1:40:00 PM	Statistics			
Parameter Name	**Units**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Result**	**Minimum**	**Mean**	**Median**	**Maximum**
Total Thallium (Tl)	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.05	0.05	0.05	0.05
Total Tin (Sn)	ug/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	1	1	1	1
Total Titanium (Ti)	ug/L	2.4	2.8	2.2	2.2	<2.0	4.6	13	1	4.03	2.4	13
Total Uranium (U)	ug/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.05	0.05	0.05	0.05
Total Vanadium (V)	ug/L	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	1	1	1	1
Total Zinc (Zn)	ug/L	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	9	2.5	3.43	2.5	9
Cyanate	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.025	0.025	0.025	0.025
Nitrogen (Ammonia Nitrogen)	mg/L	<0.050	0.074	<0.050	0.055		<0.050	<0.050	0.025	0.0382	0.025	0.074
Total Organic Carbon (C)	mg/L	6.2	5.9	5.7	5.4	4.9	<5.0	25	2.5	7.94	5.7	25
Total Chemical Oxygen Demand	mg/L	21	22	21	17	27	25	90	17	31.9	22	90
Total Mercury (Hg)	ug/L	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013	0.0065	0.0065	0.0065	0.0065
Strong Acid Dissoc. Cyanide (CN)	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0014	0.0005	0.000629	0.0005	0.0014
Weak Acid Dissociable Cyanides	mg/L	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	0.0015	0.0015	0.0015	0.0015
Thiocyanates	mg/L	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	<0.17	0.085	0.085	0.085	0.085
>C10-C16 Hydrocarbons	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.025	0.025	0.025	0.025
>C16-C21 Hydrocarbons	mg/L	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.025	0.025	0.025	0.025
>C21-<C32 Hydrocarbons	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.05	0.05	0.05	0.05
Modified TPH (Tier1)	mg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.05	0.05	0.05	0.05
Reached Baseline at C32	mg/L	NA	NA	NA	NA	NA	NA	NA	NC	NC	NC	NC
Hydrocarbon Resemblance	mg/L	NA	NA	NA	NA	NA	NA	NA	NC	NC	NC	NC
Benzene	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0005	0.0005	0.0005	0.0005
Toluene	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0005	0.0005	0.0005	0.0005
Ethylbenzene	mg/L	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0005	0.0005	0.0005	0.0005
Total Xylenes	mg/L	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	0.001	0.001	0.001	0.001
C6 - C10 (less BTEX)	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.005	0.005	0.005	0.005

APPENDIX B
BASE METALLURGICAL LABORATORIES REPORT (2016)

Stantec

10/11/2016

Mr. John Thomas
VP Projects
Atlantic Gold Corporation,
3083 Three Bentall Centre,
595 Burrard Street,
Vancouver BC
V7X 1L3

Dear Mr Thomas;

Re: Arsenic Precipitation Evaluation of Touquoy Gold Project – BL0097

We are pleased to report that we have completed the tests to evaluate the precipitation of arsenic from Touquoy detoxification slurry as compared to detoxification filtrate.

The sample used for this testing was the Master Composite from a previous testing program, BL71. Duplicate fire assays indicated that the sample contains about 1.2 g/tonne gold. Knelson concentration followed by panning and cyanidation leaching of the pan and Knelson tailing resulted in an overall gold extraction of 97.6 percent. The pan concentrate contained about 96 percent of the gold in the feed; the cyanidation stage only recovered about 1.6 percent of the gold. Sodium cyanide and lime consumption were low, being about 0.3 and 0.4 kg/tonne, respectively. This is in-line with previous testing for this sample.

The leached slurry was subjected to a cyanide detoxification stage utilizing conditions previously tested at an external laboratory. The Weak Acid Dissociable cyanide target of <1ppm was achieved after 195 minutes. Upon completion of the cyanide detoxification stage, the slurry was split into two equal portions. One portion was subjected to arsenic precipitation whilst in slurry form, the other portion was filtered, with the filtrate being retained and subjected to arsenic

precipitation. Similarly, to the cyanide detoxification stage, the conditions used for the arsenic precipitation were as per previously established. The feed value of arsenic in solution was about 0.22ppm. The precipitation of arsenic does not appear to be inhibited whether the stage is performed as a slurry or a filtrate. Both tests achieved residual arsenic in solution values of about 0.06ppm.

Sincerely,

Bradley Angove, P. Eng., MAusIMM(CP)
Principal Metallurgist

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
B. S. ANGOVE
40973

Helen Coombs, P. Eng., MAusIMM(CP)
Principal Metallurgist

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
H. E. COOMBS
39537

APPENDIX A – METALLURGICAL TESTING

APPENDIX A
METALLURGICAL TESTING

Test No.	Composite	Test Type	Page No.
1A	Master Composite	Gravity/Cyanide Leach	1
1B	Test 01A Cyanidation Slurry	Cyanide Leach	3
1C	Test 01B Detox Leach Slurry	Cyanide Leach	4

Test No: BL0097-01A
Date: 09-May-16
Test Type: Knelson/Panning/Leaching
Test Objective: Generate Knelson Tailings for Cyanidation
Sample: Master Composite
Primary Grind: 150µm K_{80} (Nominal)

Gravity Separation

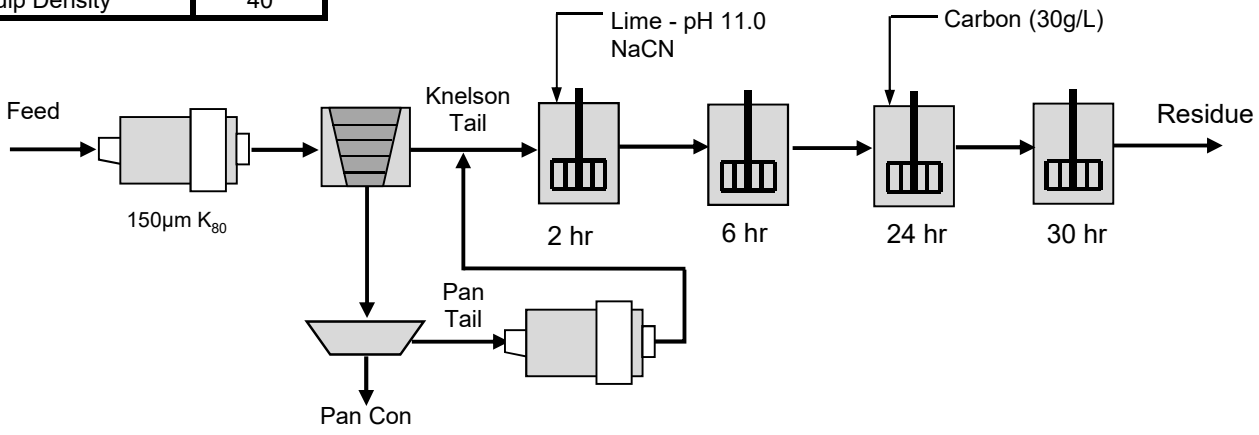
Stage	Inlet Pressure	Outlet Pressures		G-Force	Flowrate Lpm	Time Minutes
		Start	Finish			
Grind						3.25
KN Separation 1	1.0	1.1	2.1	120	4	10

Cyanidation Leaching of Knelson Tailings

Parameter	Time Cum	Added (g)		Residual (g)	Consumed (g)	pH		Dissolved O_2 (mg/L)
		NaCN	Lime	NaCN	NaCN	Measured	Adjusted	
Natural	-	-	-	-	-	7.5		<1
Leach 1	0	3.00	1.40	-	-	11.0	11.0	<1
Leach 2	2	0.00	0.00	3.00	0.00	11.1	11.1	+20
Leach 3	6	0.50	0.00	2.50	0.50	10.9	11.0	+20
Leach 4	24	0.00	0.00	2.48	0.52	11.0	11.0	+20
Leach 5	30	-	-	-	-	11.0	-	+20
Total	30	3.50	1.40	-	1.02			

Mass of Sample	4000
Volume of Water	6000
Pulp Density	40

NaCN Consumption	0.26 kg/tonne
Lime Consumption	0.35 kg/tonne



BL0097-01A

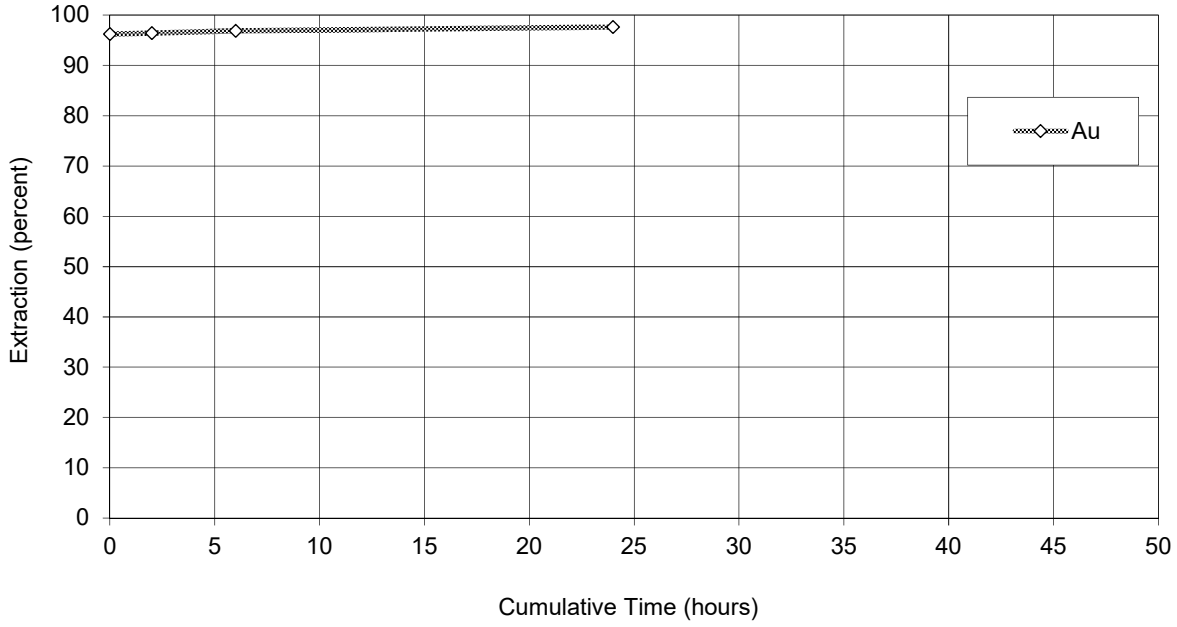
Master Composite

Cumulative Metallurgical Balance

Product	Cumulative Time - Hrs	Vol or Mass	Units	Assay - g/tonne	Distribution - percent
				Au	Au
Pan Con	0	17.2	g	226	96.2
Cyanide Liquor (2 hr)	2	6000	mL	0.001	96.4
Cyanide Liquor (6 hr)	6	6000	mL	0.004	96.8
Cyanide Liquor (24 hr)	24	6000	mL	0.010	97.6
Cyanidation Tails	-	4000	g	0.024	2.4
Calculated Feed		4000	g	1.01	100.0
Head Assay				0.86	

Duplicate CnTL Assays - g/t	
Cut	Gold
1	0.026
2	0.022

Cyanide Leach Kinetic Curves



Test No: BL0097-01B
Date: 13-May-16
Test Type: Cyanidation detoxification - SO2/Air method.
Test Objective: To achieve WADCN of <1 ppm*.
Sample: Test 1 Cyanidation Slurry

Leach Slurry

Time Cum	SMBS mLs	CuSO4 mLs	WADCN ppm
0	45	45	60
60	15	15	-
105	-	-	20
150	70	70	9
195	140	140	0.4
195	270	270	

Reagent Concentrations

SMBS	16.6g/L
$CuSO_4.5H_2O$	2.14g/L

*WADCN determined by picric acid method.

Test No: BL0097-01C
Date: 13-May-16
Test Type: Ferric Sulphate Leach
Test Objective: Precipitation of arsenic
Sample: Detox Leach Slurry (BL97-01B)

Detox Leach Slurry (~2kg solids, 3000mLs solution)

Parameter	Time Cum	Added (mLs) Ferric Sulphate (1%)	pH	Assay - ppm As
Natural	-	-	8.9	0.224
Leach 1	0	2.26	8.9	-
Leach 2	45	4.52	8.9	0.111
Leach 3	90	-	8.9	0.059
Total	90	6.78		

Detox Leach Filtrate (~3000mLs solution)

Parameter	Time Cum	Added (mLs) Ferric Sulphate (1%)	pH	Assay - ppm As
Natural	-	-	8.8	0.224
Leach 1	0	2.26	8.8	-
Leach 2*	45	4.52	8.9	0.178
Leach 3	90	-	8.9	0.057
Total	90	6.78		

*2mls of 50g/L Milk of lime added to maintain pH.

APPENDIX B – ASSAYS

APPENDIX B
ASSAYS

Table No.	Contents	Page No.
B-1	Head Assays	1

Reference
Activation Laboratories Ltd. Certificates of Analyses ALS Environmental Certificate of Analysis

TABLE B-1
HEAD ASSAYS

Composite	Au_1 ppm	Au_2 ppm
Master Composite Hd 3	1.18	1.28
Average:	**1.23**	

Quality Analysis ... *Innovative Technologies*

Date Submitted: 03-May-16
Invoice No.: A16-03863
Invoice Date: 05-May-16
Your Reference: BL97

Base Metallurgical Laboratories Ltd.
4-1425 Cariboo Place
Kamloops BC
Canada

ATTN: Bradly Angove

CERTIFICATE OF ANALYSIS

2 Pulp samples were submitted for analysis.

The following analytical package(s) were requested: Code 1A2-Kamloops Au - Fire Assay AA

REPORT **A16-03863**

Notes:

If value exceeds upper limit we recommend reassay by fire assay gravimetric-Code 1A3

CERTIFIED BY:

Emmanuel Eseme , Ph.D.
Quality Control

ACTIVATION LABORATORIES LTD.
9989 Dallas Drive, Kamloops, British Columbia, Canada, V2C 6T4
TELEPHONE +250 573-4484 or +1.888.228.5227 FAX +1.905.648.9613
E-MAIL Kamloops@actlabs.com ACTLABS GROUP WEBSITE www.actlabs.com

Analyte Symbol	Au
Unit Symbol	ppb
Lower Limit	5
Method Code	FA-AA
BL71 MC Hd3	1180
BL71 MC Hd3 Duplicate	1280

Analyte Symbol	Au
Unit Symbol	ppb
Lower Limit	5
Method Code	FA-AA
SG66 Meas	1060
SG66 Cert	1090
SG66 Meas	1080
SG66 Cert	1090
SE68 Meas	575
SE68 Cert	599
SE68 Meas	572
SE68 Cert	599
Method Blank	< 5
Method Blank	< 5

Quality Analysis ... *Innovative Technologies*

Date Submitted: 09-May-16
Invoice No.: A16-04089
Invoice Date: 12-May-16
Your Reference: BL97

Base Metallurgical Laboratories Ltd.
4-1425 Cariboo Place
Kamloops BC
Canada

ATTN: Bradly Angove

CERTIFICATE OF ANALYSIS

1 Concentrate samples were submitted for analysis.

The following analytical package(s) were requested: Code 1A3-Kamloops Au - Fire Assay Gravimetric (QOP AA-Au)

REPORT **A16-04089**

Notes:

CERTIFIED BY:

Emmanuel Eseme , Ph.D.
Quality Control

ACTIVATION LABORATORIES LTD.
9989 Dallas Drive, Kamloops, British Columbia, Canada, V2C 6T4
TELEPHONE +250 573-4484 or +1.888.228.5227 FAX +1.905.648.9613
E-MAIL Kamloops@actlabs.com ACTLABS GROUP WEBSITE www.actlabs.com

Analyte Symbol	Au
Unit Symbol	g/tonne
Lower Limit	0.03
Method Code	FA-GRA
BL97-01 Pan Con	226

Analyte Symbol	Au
Unit Symbol	g/tonne
Lower Limit	0.03
Method Code	FA-GRA
OxP 91 Meas	14.5
OxP 91 Cert	14.82
OxP 91 Meas	14.8
OxP 91 Cert	14.82
OxP 91 Meas	14.2
OxP 91 Cert	14.82
OxP 91 Meas	14.5
OxP 91 Cert	14.82
OXN117 Meas	8.06
OXN117 Cert	7.679
OXN117 Meas	7.66
OXN117 Cert	7.679
OXN117 Meas	7.53
OXN117 Cert	7.679
OXN117 Meas	7.57
OXN117 Cert	7.679

Quality Analysis ... *Innovative Technologies*

Date Submitted: 11-May-16
Invoice No.: A16-04190
Invoice Date: 16-May-16
Your Reference: BL97

Base Metallurgical Laboratories Ltd.
4-1425 Cariboo Place
Kamloops BC
Canada

ATTN: Bradly Angove

CERTIFICATE OF ANALYSIS

2 Pulp samples were submitted for analysis.

The following analytical package(s) were requested: Code 1A2-Kamloops Au - Fire Assay AA

REPORT **A16-04190**

Notes:

If value exceeds upper limit we recommend reassay by fire assay gravimetric-Code 1A3

CERTIFIED BY:

Emmanuel Eseme , Ph.D.
Quality Control

ACTIVATION LABORATORIES LTD.
9989 Dallas Drive, Kamloops, British Columbia, Canada, V2C 6T4
TELEPHONE +250 573-4484 or +1.888.228.5227 FAX +1.905.648.9613
E-MAIL Kamloops@actlabs.com ACTLABS GROUP WEBSITE www.actlabs.com

Analyte Symbol	Au
Unit Symbol	ppb
Lower Limit	5
Method Code	FA-AA
BL97-01 CnTl	26
BL97-01 CnTl Duplicate	22

Analyte Symbol	Au
Unit Symbol	ppb
Lower Limit	5
Method Code	FA-AA
SG66 Meas	1040
SG66 Cert	1090
SE68 Meas	561
SE68 Cert	599
Method Blank	< 5

Quality Analysis ... *Innovative Technologies*

Date Submitted: 17-May-16
Invoice No.: A16-04385
Invoice Date: 19-May-16
Your Reference: BL97

Base Metallurgical Laboratories Ltd.
4-1425 Cariboo Place
Kamloops BC
Canada

ATTN: Bradly Angove

CERTIFICATE OF ANALYSIS

2 Pulp samples were submitted for analysis.

The following analytical package(s) were requested: Code 1E3-Kamloops Aqua Regia ICP(AQUAGEO)

REPORT **A16-04385**

Notes:

Values which exceed the upper limit should be assayed for accurate numbers.

CERTIFIED BY:

Emmanuel Eseme , Ph.D.
Quality Control

ACTIVATION LABORATORIES LTD.
9989 Dallas Drive, Kamloops, British Columbia, Canada, V2C 6T4
TELEPHONE +250 573-4484 or +1.888.228.5227 FAX +1.905.648.9613
E-MAIL Kamloops@actlabs.com ACTLABS GROUP WEBSITE www.actlabs.com

Analyte Symbol	Ag	Cd	Cu	Mn	Mo	Ni	Pb	Zn	Al	As	B	Ba	Be	Bi	Ca	Co	Cr	Fe	Ga	Hg	K	La	Mg
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	%
Lower Limit	0.2	0.5	1	5	1	1	2	2	0.01	2	10	10	0.5	2	0.01	1	1	0.01	10	1	0.01	10	0.01
Method Code	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP
BL97-01 Detox Feed	< 0.2	< 0.5	39	649	< 1	38	17	138	2.26	352	< 10	31	< 0.5	< 2	0.77	17	26	5.05	< 10	< 1	0.05	29	1.38
BL97-01 Post Detox CnTl	< 0.2	< 0.5	85	680	< 1	37	16	131	2.40	329	< 10	38	< 0.5	< 2	0.82	15	29	5.32	< 10	< 1	0.06	31	1.46

Analyte Symbol	Na	P	S	Sb	Sc	Sr	Ti	Te	Tl	U	V	W	Y	Zr
Unit Symbol	%	%	%	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.001	0.001	0.01	2	1	1	0.01	1	2	10	1	10	1	1
Method Code	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP
BL97-01 Detox Feed	0.015	0.043	0.27	< 2	2	20	0.02	< 1	< 2	< 10	18	< 10	6	7
BL97-01 Post Detox CnTl	0.017	0.045	0.26	2	2	22	0.02	< 1	< 2	< 10	19	< 10	6	6

Analyte Symbol	Ag	Cd	Cu	Mn	Mo	Ni	Pb	Zn	Al	As	B	Ba	Be	Bi	Ca	Co	Cr	Fe	Ga	Hg	K	La	Mg
Unit Symbol	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	%	ppm	ppm	%	ppm	%
Lower Limit	0.2	0.5	1	5	1	1	2	2	0.01	2	10	10	0.5	2	0.01	1	1	0.01	10	1	0.01	10	0.01
Method Code	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP
GXR-1 Meas	30.9	2.3	1150	797	15	33	616	695	0.38	429	10	137	0.9	1490	0.80	7	7	24.0	< 10	3	0.03	< 10	0.14
GXR-1 Cert	31.0	3.30	1110	852	18.0	41.0	730	760	3.52	427	15.0	750	1.22	1380	0.960	8.20	12.0	23.6	13.8	3.90	0.050	7.50	0.217
GXR-4 Meas	3.5	< 0.5	6340	139	329	40	40	71	2.83	107	< 10	35	1.5	4	0.93	14	49	3.11	< 10	< 1	1.72	48	1.68
GXR-4 Cert	4.0	0.860	6520	155	310	42.0	52.0	73.0	7.20	98.0	4.50	1640	1.90	19.0	1.01	14.6	64.0	3.09	20.0	0.110	4.01	64.5	1.66
GXR-6 Meas	0.3	< 0.5	69	1090	2	27	94	132	7.71	241	< 10	888	1.0	< 2	0.15	14	74	5.88	20	< 1	1.19	11	0.43
GXR-6 Cert	1.30	1.00	66.0	1010	2.40	27.0	101	118	17.7	330	9.80	1300	1.40	0.290	0.180	13.8	96.0	5.58	35.0	0.0680	1.87	13.9	0.609
OREAS 922 (AQUA REGIA) Meas	0.9	< 0.5	2290	774	< 1	39	63	275	3.13	< 2		99	0.8	< 2	0.45	22	41	5.38	< 10		0.50	42	1.47
OREAS 922 (AQUA REGIA) Cert	0.851	0.28	2176	730	0.69	34.3	60	256	2.72	6.12		70	0.65	10.3	0.324	19.4	40.7	5.05	7.62		0.376	32.5	1.33
OREAS 923 (AQUA REGIA) Meas	1.8	0.7	4340	876	< 1	35	77	343	3.07	5		79	0.7	12	0.44	23	38	6.14	< 10		0.41	39	1.56
OREAS 923 (AQUA REGIA) Cert	1.62	0.40	4248	850	0.84	32.7	81	335	2.80	7.07		54	0.61	21.8	0.326	22.2	39.4	5.91	8.01		0.322	30.0	1.43
BL97-01 Post Detox CnTl Orig	< 0.2	< 0.5	88	688	< 1	36	17	135	2.39	368	< 10	38	< 0.5	< 2	0.82	15	30	5.31	< 10	< 1	0.06	31	1.46
BL97-01 Post Detox CnTl Dup	< 0.2	< 0.5	81	671	< 1	38	15	127	2.42	290	< 10	39	< 0.5	< 2	0.82	15	29	5.32	< 10	< 1	0.06	31	1.46

Analyte Symbol	Na	P	S	Sb	Sc	Sr	Ti	Te	Tl	U	V	W	Y	Zr
Unit Symbol	%	%	%	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
Lower Limit	0.001	0.001	0.01	2	1	1	0.01	1	2	10	1	10	1	1
Method Code	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP	AR-ICP
GXR-1 Meas	0.053	0.044	0.19	86	1	189	< 0.01	12	3	31	83	140	25	21
GXR-1 Cert	0.0520	0.0650	0.257	122	1.58	275	0.036	13.0	0.390	34.9	80.0	164	32.0	38.0
GXR-4 Meas	0.131	0.124	1.59	4	7	73	0.18	2	< 2	< 10	83	11	12	15
GXR-4 Cert	0.564	0.120	1.77	4.80	7.70	221	0.29	0.970	3.20	6.20	87.0	30.8	14.0	186
GXR-6 Meas	0.082	0.035	0.01	6	23	34		< 1	< 2	< 10	182	< 10	6	15
GXR-6 Cert	0.104	0.0350	0.0160	3.60	27.6	35.0		0.0180	2.20	1.54	186	1.90	14.0	110
OREAS 922 (AQUA REGIA) Meas	0.032	0.063	0.35	< 2	4	18			< 2	< 10	39	< 10	22	27
OREAS 922 (AQUA REGIA) Cert	0.021	0.063	0.386	0.57	3.15	15.0			0.14	1.98	29.4	1.12	16.0	22.3
OREAS 923 (AQUA REGIA) Meas		0.060	0.62	4	4	16			< 2	< 10	37	< 10	20	53
OREAS 923 (AQUA REGIA) Cert		0.061	0.684	0.58	3.09	13.6			0.12	1.80	30.6	1.96	14.3	22.5
BL97-01 Post Detox CnTl Orig	0.016	0.046	0.27	2	2	21	0.02	3	< 2	< 10	19	< 10	6	6
BL97-01 Post Detox CnTl Dup	0.017	0.045	0.26	2	2	22	0.02	< 1	< 2	< 10	19	< 10	6	6

BASE METALLURGICAL LABORATORIES LTD.
ATTN: Bradley Angove
4-1425 Cariboo Place
Kamloops BC V2C 5Z3

Date Received: 13-MAY-16
Report Date: 27-JUN-16 17:48 (MT)
Version: FINAL

Client Phone: 250-314-4046

Certificate of Analysis

Lab Work Order #: L1768623

Project P.O. #: NOT SUBMITTED
Job Reference: BL97
C of C Numbers:
Legal Site Desc:

Ariel Tang, B.Sc.
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Grouping	Analyte	L1768623-1 Liquor 11-MAY-16 12:00 BL97-01 24HR LIQUOR	L1768623-2 Liquor 12-MAY-16 12:00 BL97-01 DETOX FEED	L1768623-3 Liquor 13-MAY-16 12:00 BL97-01 POST DETOX LIQUOR	L1768623-4 Liquor 13-MAY-16 12:00 BL97-01 DETOX SLURRY FINAL LIQUOR	L1768623-5 Liquor 13-MAY-16 12:00 BL97-01 DETOX SOLUTION FINAL LIQUOR
WATER						
Anions and Nutrients	Sulfate (SO4) (mg/L)	46.1	44.9		525	533
Cyanides	Cyanide, Weak Acid Diss (mg/L)	121	68.0		0.067	<0.050 DLHC
	Cyanide, Total (mg/L)	144	88.7		6.84	6.12
	Thiocyanate (SCN) (mg/L)	9.98 SP	7.15 SP		24.9 SP	24.4 SP
	Cyanide, Free (mg/L)	110	62.9		0.055	<0.050 DLHC
Dissolved Metals	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	2.88	2.55	0.682	0.570	0.677
	Antimony (Sb)-Dissolved (mg/L)	0.0102	0.0222	0.0115	0.00861	0.0128
	Arsenic (As)-Dissolved (mg/L)	1.15	2.43	0.289	0.0944	0.0571
	Barium (Ba)-Dissolved (mg/L)	0.0408	0.0245	0.0492	0.0442	0.0437
	Beryllium (Be)-Dissolved (mg/L)	<0.00050 DLM	<0.00050 DLM	<0.00010	<0.00010	<0.00010
	Bismuth (Bi)-Dissolved (mg/L)	<0.00025 DLM	<0.00025 DLM	<0.000050	<0.000050	<0.000050
	Boron (B)-Dissolved (mg/L)	<0.050 DLM	<0.050 DLM	0.026	0.026	0.026
	Cadmium (Cd)-Dissolved (mg/L)	0.00158	0.00242	0.0000071	0.0000132	0.0000052
	Calcium (Ca)-Dissolved (mg/L)	14.3	13.8	84.0	102	124
	Cesium (Cs)-Dissolved (mg/L)	0.000120	0.000455	0.000021	0.000020	<0.000010
	Chromium (Cr)-Dissolved (mg/L)	0.00227	0.00212	0.00092	0.00096	0.00100
	Cobalt (Co)-Dissolved (mg/L)	0.175	0.193	0.155	0.122	0.137
	Copper (Cu)-Dissolved (mg/L)	1.71	1.40	0.0530	0.0510	0.0102
	Gold (Au)-Dissolved (mg/L)	0.242	<0.0050 DLM	0.0082	0.0066	0.0076
	Iron (Fe)-Dissolved (mg/L)	11.9	10.7	2.57	2.63	2.11
	Lead (Pb)-Dissolved (mg/L)	0.00775	0.00560	0.00631	0.00537	0.00720
	Lithium (Li)-Dissolved (mg/L)	<0.0050 DLM	<0.0050 DLM	0.0030	0.0021	0.0026
	Magnesium (Mg)-Dissolved (mg/L)	1.15	1.64	4.62	3.35	3.48
	Manganese (Mn)-Dissolved (mg/L)	0.0212	0.0207	0.0346	0.0204	0.0244
	Molybdenum (Mo)-Dissolved (mg/L)	0.0701	0.0754	0.0652	0.0649	0.0584
	Nickel (Ni)-Dissolved (mg/L)	0.915	0.148	0.00300	0.00125	0.00059
	Phosphorus (P)-Dissolved (mg/L)	<0.25 DLM	<0.25 DLM	0.127	0.109	0.174
	Potassium (K)-Dissolved (mg/L)	8.82	41.4	47.8	45.5	46.6
	Rubidium (Rb)-Dissolved (mg/L)	0.0065	0.0982	0.0178	0.0107	0.0134
	Selenium (Se)-Dissolved (mg/L)	0.00398	0.00320	0.00215	0.00160	0.00191
	Silicon (Si)-Dissolved (mg/L)	5.64	4.98	2.77	2.23	2.39
	Silver (Ag)-Dissolved (mg/L)	0.0297	0.0245	0.00139	0.000438	0.000413
	Sodium (Na)-Dissolved (mg/L)	231	171	271	259	258
	Strontium (Sr)-Dissolved (mg/L)	0.0661	0.0526	0.233	0.248	0.261
	Sulfur (S)-Dissolved (mg/L)	49.3	41.4	260	233	237
	Tellurium (Te)-Dissolved (mg/L)	<0.0010 DLM	<0.0010 DLM	<0.00020	<0.00020	<0.00020

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID	L1768623-1	L1768623-2	L1768623-3	L1768623-4	L1768623-5
Description	Liquor	Liquor	Liquor	Liquor	Liquor
Sampled Date	11-MAY-16	12-MAY-16	13-MAY-16	13-MAY-16	13-MAY-16
Sampled Time	12:00	12:00	12:00	12:00	12:00
Client ID	BL97-01 24HR LIQUOR	BL97-01 DETOX FEED	BL97-01 POST DETOX LIQUOR	BL97-01 DETOX SLURRY FINAL LIQUOR	BL97-01 DETOX SOLUTION FINAL LIQUOR
Grouping **Analyte**					
WATER					
Dissolved Metals Thallium (Tl)-Dissolved (mg/L)	<0.000050 DLM	0.000056	0.000032	0.000031	0.000022
Thorium (Th)-Dissolved (mg/L)	0.00110	0.00110	0.00013	<0.00010	<0.00010
Tin (Sn)-Dissolved (mg/L)	0.00099	<0.00050 DLM	0.00509	0.00556	0.0213
Titanium (Ti)-Dissolved (mg/L)	0.0227	0.0213	0.0185	0.0174	0.0171
Tungsten (W)-Dissolved (mg/L)	0.00239	0.00236	0.00251	0.00188	0.00187
Uranium (U)-Dissolved (mg/L)	0.000365	0.00128	0.00767	0.00648	0.00653
Vanadium (V)-Dissolved (mg/L)	0.0089	0.0096	<0.00050	<0.00050	<0.00050
Zinc (Zn)-Dissolved (mg/L)	0.877	0.874	0.0348	0.0419	0.0471
Zirconium (Zr)-Dissolved (mg/L)	<0.0015 DLM	0.0038	0.00372	0.00364	0.00286

* Please refer to the Reference Information section for an explanation of any qualifiers detected.

Reference Information

Qualifiers for Individual Samples Listed:

Sample Number	Client Sample ID	Qualifier	Description
L1768623-3	BL97-01 POST DETOX LIQU	ISCR:ST	Improper Sample Container Received: Subsamples Taken
L1768623-4	BL97-01 DETOX SLURRY FI	ISCR:ST	Improper Sample Container Received: Subsamples Taken
L1768623-5	BL97-01 DETOX SOLUTION	ISCR:ST	Improper Sample Container Received: Subsamples Taken

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Sulfate (SO4)	MS-B	L1768623-1, -2, -4, -5
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1768623-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1768623-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1768623-1, -2, -3, -4, -5
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1768623-1, -2, -3, -4, -5
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1768623-1, -2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1768623-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1768623-1, -2, -3, -4, -5
Matrix Spike	Iron (Fe)-Dissolved	MS-B	L1768623-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1768623-1, -2, -3, -4, -5
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1768623-1, -2, -3, -4, -5
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1768623-1, -2, -3, -4, -5
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1768623-1, -2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1768623-1, -2, -3, -4, -5

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.
SP	Sample was Preserved at the laboratory

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
AU-DIS-MS-VA	Water	Dissolved Au in Water by ICPMS	EPA SW-846 3005A/6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedure involves filtration (EPA Method 3005A) and analysis by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

CN-FREE-CFA-VA	Water	Free Cyanide in water by CFA	ASTM 7237

This analysis is carried out using procedures adapted from ASTM Method 7237 "Free Cyanide with Flow Injection Analysis (FIA) Utilizing Gas Diffusion Separation and Amperometric Detection". Free cyanide is determined by in-line gas diffusion at pH 6 with final determination by colourimetric analysis.

CN-SCN-VA	Water	Thiocyanate by Colour	APHA 4500-CN CYANIDE

This analysis is carried out using procedures adapted from APHA Method 4500-CN- M "Thiocyanate" Thiocyanate is determined by the ferric nitrate colourimetric method.

CN-T-CFA-VA	Water	Total Cyanide in water by CFA	ISO 14403:2002

This analysis is carried out using procedures adapted from ISO Method 14403:2002 "Determination of Total Cyanide using Flow Analysis (FIA and CFA)". Total or strong acid dissociable (SAD) cyanide is determined by in-line UV digestion along with sample distillation and final determination by colourimetric analysis. Method Limitation: This method is susceptible to interference from thiocyanate (SCN). If SCN is present in the sample, there could be a positive interference with this method, but it would be less than 1% and could be as low as zero.

CN-WAD-CFA-VA	Water	Weak Acid Diss. Cyanide in water by CFA	APHA 4500-CN CYANIDE

This analysis is carried out using procedures adapted from APHA Method 4500-CN I. "Weak Acid Dissociable Cyanide". Weak Acid Dissociable (WAD) cyanide is determined by in-line sample distillation with final determination by colourimetric analysis.

MET-D-CCMS-VA	Water	Dissolved Metals in Water by CRC ICPMS	APHA 3030B/6020A (mod)

Water samples are filtered (0.45 um), preserved with nitric acid, and analyzed by CRC ICPMS.

Method Limitation (re: Sulfur): Sulfide and volatile sulfur species may not be recovered by this method.

SO4-IC-N-VA	Water	Sulfate in Water by IC	EPA 300.1 (mod)

Reference Information

Inorganic anions are analyzed by Ion Chromatography with conductivity and/or UV detection.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogate - A compound that is similar in behaviour to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.
mg/kg - milligrams per kilogram based on dry weight of sample.
mg/kg wwt - milligrams per kilogram based on wet weight of sample.
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight of sample.
mg/L - milligrams per litre.
< - Less than.
D.L. - The reported Detection Limit, also known as the Limit of Reporting (LOR).
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental

www.alsglobal.com

Canada Toll Free: 1 800 668 9878

Affix ALS barcode label here (lab use only)

COC Number: 15 -

Page of

Report To	Contact and company name below will appear on the final report
Company:	Base Met Labs
Contact:	Brad Angove
Phone:	250 314 4046
	Company address below will appear on the final report
Street:	#4 1425 caribou place
City/Province:	Kamloops
Postal Code:	V1S 1H9
Invoice To	Same as Report To ☑ YES ☐ NO
	Copy of Invoice with Report ☑ YES ☐ NO
Company:	Base Met Labs
Contact:	Brad Angove

Report Format / Distribution

Select Report Format: ☐ PDF ☐ EXCEL ☑ EDD (DIGITAL)

Quality Control (QC) Report with Report ☐ YES ☐ NO

☐ Compare Results to Criteria on Report - provide details below if box checked

Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: brad@basemetlabs.com

Email 2: darren@basemetlabs.com

Email 3:

Invoice Distribution

Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX

Email 1 or Fax: michelle@basemetlabs.com

Email 2: brad@basemetlabs.com

Project Information

ALS Account # / Quote #:

Job #: BL97

PO / AFE:

LSD:

Oil and Gas Required Fields (client use)

AFE/Cost Center: PO#

Major/Minor Code: Routing Code:

Requisitioner:

Location:

ALS Lab Work Order # (lab use only): L1768623

ALS Contact: Sampler:

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☒ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ | 3 day [P3] ☐ | 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ | Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs:

For tests that can not be performed according to the service level selected, you will be contacted.

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	TCN	Free CN	WCN	CNO	SCN	Au by ICPMS	SO4	ICP-Scan (including Cu Fe)	Met-D-CCMS-VA	Number of Containers
	BL97-01 24hr liquor	11-May-16	12 PM	liquor										5
	BL97-01 Detox Feed	12-May-16		liquor										
	BL97-01 Post detox liquor	13 May 16		liquor										
	BL97-01 Detox slurry final liquor	↓	↓	liquor										
	BL97-01 Detox solution final liquor			liquor										

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ YES ☒ NO

Are samples for human drinking water use? ☐ YES ☑ NO

Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
15	15	16			

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
				13 May 2016				

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

APPENDIX C
MIXING CALCULATION TABLES FOR TMF DOWNSTREAM WATER QUALITY

Stantec

Table C1: Predicted Water Quality in Scraggy Lake

Parameter	GCDWQ	CCME	Average Monthly Concentration (mg/L)											
			January	February	March	April	May	June	July	August	September	October	November	December
Subwatershed Net Flow Rate (m^3/s)			1.47	1.49	2.08	2.18	1.39	0.81	0.48	0.62	0.46	0.90	1.57	1.82
Ag		0.00025	0.000052	0.0000523	0.0000516	0.0000517	0.0000525	0.0000543	0.0000573	0.0000528	0.0000525	0.0000513	0.0000507	0.0000506
Al	0.2	0.1	**0.187**	**0.189**	**0.189**	**0.188**	**0.19**	**0.192**	**0.195**	**0.167**	**0.149**	**0.167**	**0.176**	**0.178**
As	0.01	0.005	0.0015	0.00141	0.0013	0.0013	0.00145	0.00175	0.00226	0.0027	0.00356	0.00233	0.00177	0.00166
Ca			6.5	2.97	2.82	3.35	3.53	4.57	6.9	35	58.2	30.9	18.4	15.7
Cd	0.005	0.00009	0.0000191	0.0000195	0.0000194	0.0000194	0.0000194	0.0000193	0.000019	0.0000165	0.0000145	0.0000169	0.0000181	0.0000183
Cl	250	120	4.6	4.25	4.22	4.27	4.31	4.45	4.75	7.48	9.81	7.04	5.76	5.49
Co			0.00604	0.00232	0.00215	0.00271	0.00292	0.00405	0.00657	0.0361	0.0606	0.0318	0.0185	0.0157
Cr		0.0089	0.00467	0.00474	0.00475	0.00473	0.00473	0.0047	0.00465	0.00402	0.00349	0.00412	0.0044	0.00446
Cu	1	0.002-0.004	0.00307	0.00155	0.00157	0.00181	0.00177	0.00199	0.00262	0.0149	0.0247	0.0134	0.00819	0.00707
Fe	0.3	0.3	0.243	0.247	0.243	0.242	0.247	0.257	0.271	0.232	0.218	0.226	0.229	0.231
K			2.08	0.99	0.929	1.09	1.17	1.53	2.33	11	18.2	9.69	5.76	4.92
Mg			0.648	0.495	0.493	0.517	0.518	0.552	0.634	1.87	2.86	1.7	1.17	1.05
Mn	0.05		0.0475	0.0461	0.0462	0.0464	0.0463	0.0463	0.0467	0.058	0.0666	0.0567	0.0521	0.0512
Na	200		19.2	8.23	8.02	9.69	9.93	12.5	18.6	107	178	94.6	56.2	47.9
NH4+NH3			0.533	0.236	0.211	0.254	0.287	0.409	0.663	2.99	4.98	2.62	1.53	1.3
Ni			0.00112	0.00103	0.00103	0.00104	0.00104	0.00105	0.00108	0.00181	0.00239	0.00173	0.00142	0.00136
NO3	10	13	0.0496	0.0484	0.0483	0.0484	0.0486	0.0491	0.0503	0.0601	0.0686	0.0585	0.0539	0.0529
Pb	0.01	0.001-0.007	0.000361	0.000359	0.000346	0.000345	0.000363	0.000399	0.000459	0.000433	0.000477	0.000397	0.000361	0.000355
P		0.004-0.1	0.0158	0.0161	0.0157	0.0157	0.0161	0.0168	0.0182	0.016	0.0158	0.0154	0.0152	0.0152
Sb	0.006		0.00124	0.00112	0.0011	0.00112	0.00114	0.00122	0.00136	0.0023	0.00314	0.00212	0.00165	0.00155
Se	0.05	0.001	0.000521	0.000512	0.00051	0.000513	0.000514	0.000523	0.000538	0.000602	0.000665	0.000586	0.00055	0.000542
SO4	500		36.7	12.4	12	15.7	16.2	21.6	35	230	388	204	119	100
U	0.02	0.015	0.00013	0.000102	0.0000907	0.0000937	0.000109	0.000146	0.000212	0.0004	0.000607	0.000341	0.000218	0.000193
Zn	5	0.03	0.0127	0.0126	0.0125	0.0125	0.0126	0.0128	0.0131	0.0137	0.0146	0.0135	0.013	0.0129
CN			0.0343	0.0264	0.0201	0.0205	0.0291	0.0477	0.0797	0.126	0.192	0.101	0.0587	0.0501
CN WAD	0.2	0.005	0.000744	0.000309	0.000272	0.000335	0.000383	0.000562	0.000934	0.00435	**0.00726**	0.0038	0.0022	0.00186

Table C2: Predicted Unnamed Tributary WQ at SW3

Parameter	GCDWQ	CCME	Average Monthly Concentration (mg/L)											
			January	February	March	April	May	June	July	August	September	October	November	December
Subwatershed Net Flow Rate (m^3/s)			0.08	0.08	0.11	0.12	0.08	0.04	0.03	0.03	0.02	0.04	0.08	0.09
Ag		0.00025	0.0000576	0.0000758	0.0000565	0.0000362	0.0000357	0.0000408	0.0000738	0.0000501	0.000136	0.000104	0.0000648	0.00000603
Al	0.2	0.1	**0.627**	**0.85**	**0.636**	**0.392**	**0.357**	**0.365**	**0.674**	**0.406**	**1.35**	**1.13**	**0.715**	0.00989
As	0.01	0.005	**0.0085**	**0.0112**	**0.00835**	**0.00534**	**0.00523**	**0.00595**	**0.0108**	**0.00726**	**0.0199**	**0.0154**	**0.00957**	0.000834
Ca			4.28	5	3.68	2.76	3.42	4.99	8.61	7.09	13.3	7.81	4.58	1.81
Cd	0.005	0.00009	0.0000196	0.0000267	0.00002	0.0000122	0.000011	0.0000111	0.0000206	0.0000121	0.0000417	0.0000352	0.0000224	7.59E-08
Cl	250	120	8.16	10.9	8.18	5.1	4.77	5.05	9.28	5.86	18.1	14.7	9.26	0.351
Co			0.00399	0.00453	0.00332	0.00259	0.00337	0.00511	0.00875	0.00738	0.0131	0.00732	0.00422	0.002
Cr		0.0089	0.00109	0.00148	0.00111	0.000679	0.000618	0.000628	0.00117	0.000701	0.00234	0.00196	0.00124	0.0000146
Cu	1	0.002-0.004	0.00163	0.00216	0.00161	0.00102	0.000998	0.00112	0.00204	0.00136	0.0038	0.00295	0.00184	0.000149
Fe	0.3	0.3	**1.12**	**1.51**	**1.13**	**0.698**	**0.644**	**0.669**	**1.23**	**0.759**	**2.44**	**2.02**	**1.27**	0.0308
K			1.94	2.34	1.72	1.25	1.47	2.06	3.58	2.87	5.69	3.54	2.1	0.681
Mg			0.897	1.2	0.897	0.562	0.531	0.574	1.05	0.673	2.02	1.62	1.02	0.0508
Mn	0.05		0.321	0.438	0.328	0.201	0.181	0.18	0.336	0.197	0.685	0.579	0.368	0.000356
Na	200		9.28	10.9	8.04	5.98	7.32	10.6	18.3	15	28.4	16.9	9.97	3.77
NH4+NH3			0.337	0.346	0.25	0.224	0.33	0.548	0.925	0.823	1.29	0.623	0.344	0.25
Ni			0.00139	0.0019	0.00142	0.00087	0.000787	0.000792	0.00147	0.000873	0.00297	0.0025	0.00159	0.00000862
NO3	10	13	0.0579	0.0782	0.0585	0.0362	0.0335	0.035	0.0644	0.0397	0.127	0.105	0.066	0.00175
Pb	0.01	0.001-0.007	0.0011	0.00145	0.00108	0.000692	0.000676	0.000766	0.00138	0.000932	0.00258	0.00199	0.00124	0.000105
P		0.004-0.1	0.0606	0.0816	0.0609	0.038	0.0354	0.0375	0.0691	0.0432	0.134	0.11	0.0689	0.00254
Sb	0.006		0.000724	0.000902	0.000669	0.000462	0.000512	0.000673	0.00118	0.000904	0.00197	0.00132	0.000797	0.000187
Se	0.05	0.001	0.000538	0.000721	0.000539	0.000337	0.000318	0.00034	0.000624	0.000397	**0.0012**	0.000971	0.00061	0.0000279
SO4	500		11.7	12.4	9.02	7.72	11	17.7	30.1	26.4	42.9	21.6	12.1	7.78
U	0.02	0.015	0.000178	0.000199	0.000146	0.000116	0.000154	0.000237	0.000405	0.000345	0.000599	0.000327	0.000188	0.0000954
Zn	5	0.03	0.00442	0.0057	0.00424	0.00279	0.00287	0.00346	0.00617	0.00439	0.011	0.008	0.00493	0.000688
CN			0.0591	0.0579	0.0415	0.0395	0.0612	0.104	0.176	0.159	0.24	0.11	0.0592	0.0497
CN WAD	0.2	0.005	0.000428	0.000416	0.000299	0.000286	0.000446	0.000764	0.00128	0.00116	0.00175	0.000793	0.000428	0.000365