Appendix 1.0

In Response to KIA-7: Figures 2 and 3

Figure 2
Marine Wildlife Observations Recorded during the Barge Survey, September 2010

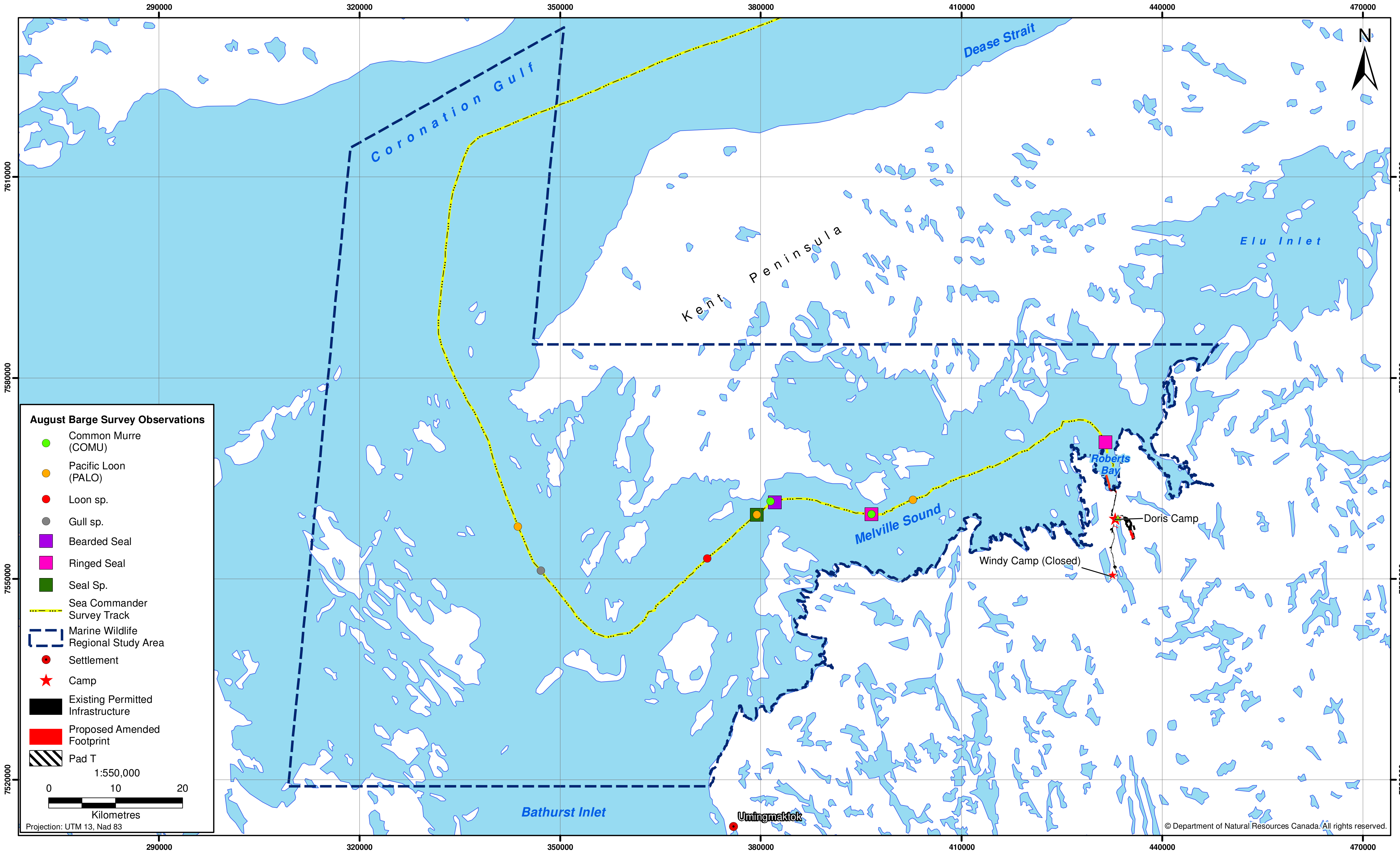
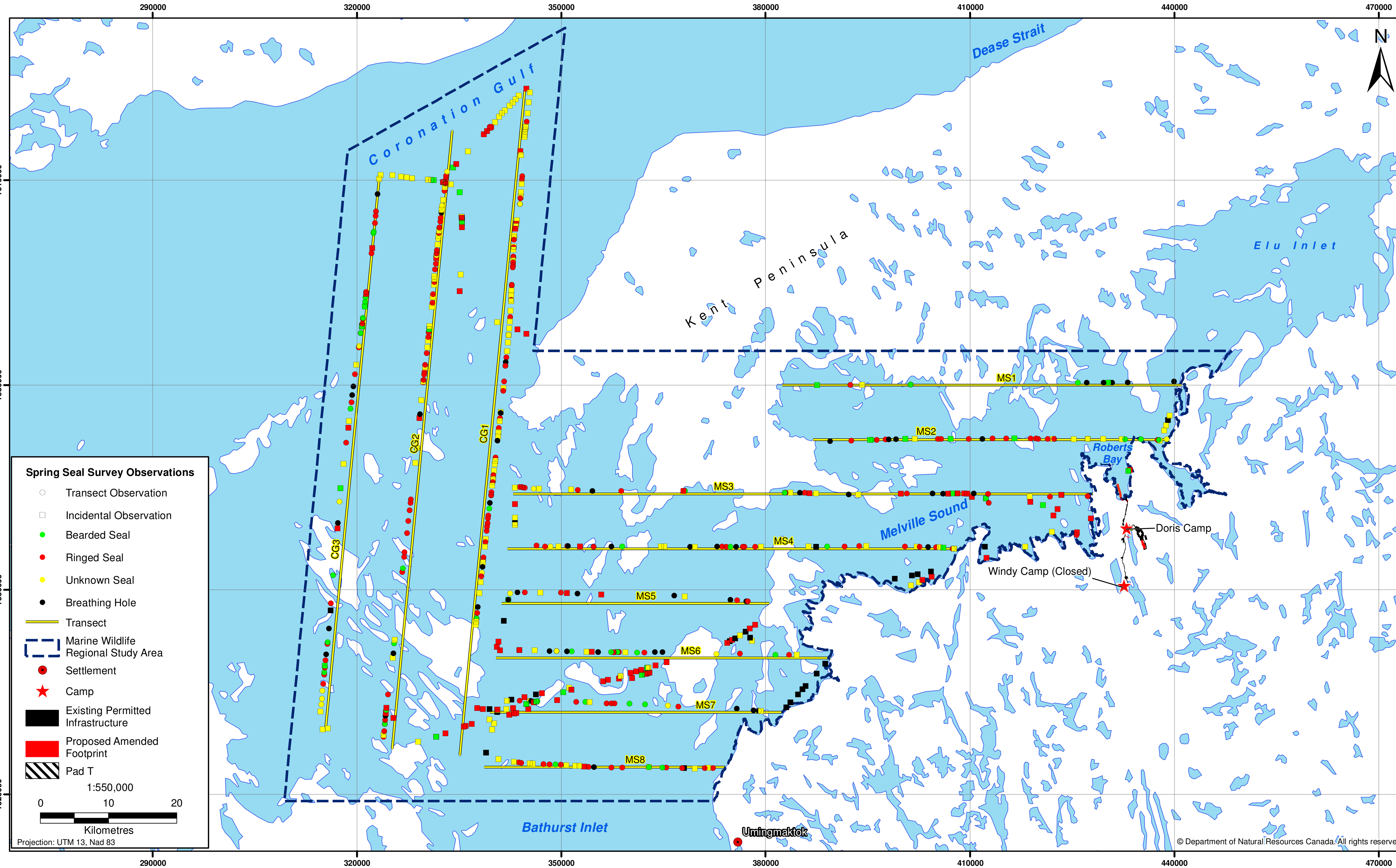


Figure 3

Marine Wildlife Observations recorded during the Spring Seal Aerial Survey, June 2010



Appendix 2.0

In Response to KIA-28: T1240 Part II: Detox Testwork Report

Gekko Global Cyanide Detox Group Testwork Report

TMAC Resources – Hope Bay – DC02

T1240 Part II: Detox Testwork Report

GEKKO

30 October 2014

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Date: 30th October 2014
Status: Final Report

For more information on procedures and test work results:

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Revision History

Version	Date	Author	Description
1.0	15/10/2014	Kur Pamarthi	Draft Report
1.1	20/10/2014	Nee San Yap	Peer Review
1.2	30/10/2014	Nick Katsikaros	Peer Review
2.0	30/10/2014	Nee San Yap	Final Report

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Executive Summary

This report presents results of cyanide destruction test work undertaken on a gravity/flotation/intensive leaching (GFIL) leach tail. The mixed gravity and flotation concentrate was produced as described in report T1240(TMAC Resources – Hope Bay Python Amenability Testwork Report). The aim of this test work was to determine if the SO_2/O_2 cyanide destruction process could achieve a primary target of less than 1.0 mg/L total cyanide (CN_{TOT}) on the products of intensive cyanide leaching of the GFIL process. The secondary aim was to determine the removal of trace elements of environmental concern.

The detox feed slurry was prepared fresh at the Gekko Global Cyanide Detox Ballarat Metallurgical Laboratory. The detox feed was prepared and suitable leach conditions were determined as reported in T1240. Bulk leaching was carried out in bottle rolls to simulate the selected InLine Leach Reactor (ILR) conditions. All detox tests were carried out in a stirred single tank reactor. The number of detox tests was constrained by the availability of sample.

The SO_2/O_2 cyanide destruction process was successful in reducing the levels of CN_{WAD} to less than 1.0 mg/L in all 6 tests. With addition of between 218 and 243 mg/L of Cu^{2+} as copper sulphate solution, 5 tests (Test 1, 2, 4, 5 and 6) were able to achieve the CN_{TOT} target of less than 1.0 mg/L. However when the Cu^{2+} addition was reduced to 105 mg/L in Test 3, the detox effluent CN_{TOT} was measured at 13.1 mg/L due to the presence of iron cyanide in solution. The results suggested that a minimum ratio of 2:1 copper to iron is required to precipitate the iron cyanide to insoluble ferrocyanide.

The best test results are summarised in Table 1. In Test 6 a detox feed slurry containing 496 mg/L CN_{WAD} was treated and resulted in a CN_{WAD} of 0.43 mg/L and a CN_{TOT} of 0.194 mg/L under conditions of 24% solids, 4.3 gSO_2 / gCN_{WAD}, 233 mg/L of Cu^{2+} addition, pH 8.6 and 127 minutes retention time.

All trace elements of concern such as arsenic, nickel, lead and zinc were below the target limits under these conditions. Copper was slightly above the target limit. The copper concentration will be reduced by the dilution with the flotation tails before discharge to the tailings impoundment area. Iron, ammonia and total cyanide levels below target limits were achieved.

Thiocyanate is another compound of possible environmental concern. It was detected at 164 mg/L in the detox effluent. It is recommended that TMAC Resources consult environmental advice in regards to thiocyanate discharge limit.

Table 1: Summary of solution analysis for Test 6 and the target limits

		Solution Analysis		
	Units	Target Limit	Detox Feed	Test 6
Arsenic	mg/L	0.5	0.061	0.028
Copper	mg/L	0.3	34.3	4.2
Nickel	mg/L	0.5	0.065	0.098
Lead	mg/L	0.2	0.002	0.033
Zinc	mg/L	0.5	8.59	0.206
Iron	mg/L	Not provided	63.3	0.59
Mercury	mg/L	Not provided	0.0002	<0.0001
Total Cyanide	mg/L	1.0	574	0.194
Thiocyanate	mg/L	Not provided	143	164
Ammonia as N	mg/L	6.0	*	1.05

Table of Contents

1. Introduction

The present test work on TMAC Resources' DCO2 samples is an optimisation program following the previous test work, T1231 carried out with the Doris North sample. Due to limited concentrate samples availability, only 2 demonstrative detox tests were conducted on the Doris North samples. The main purpose of this test work was to demonstrate the effectiveness of the SO_2/O_2 detoxification system on gravity/flotation/intensive cyanidation (GFIL) leach tails and determine suitable design conditions for the plant design. Design conditions required are retention time, reagent dosage, catalyst addition and pH for effective total cyanide (CN_{TOT}) destruction. A target of less than 1.0 mg/L CN_{TOT} in the tailings impoundment area (TIA) was requested as the target limit. TMAC Resources also requested water analysis to be conducted on the treated effluent to identify trace elements which are of environmental concern.

The test program was constrained by the small amount of concentrate available for testing. This allowed a maximum of six tests using the smallest available laboratory reactor and pumps.

The key focus of this test work was the sulphur dioxide – air (SO_2/O_2) cyanide removal process (also known as the INCO process), as it is very selective towards cyanide oxidation and is relatively unaffected by the presence of solids. The process uses a mixture of sulphur dioxide and oxygen in the presence of soluble copper (which acts as a catalyst), to oxidize cyanide (CN^-) to cyanate (OCN^-). The oxygen requirement is usually obtained from either air or pure oxygen, the copper required is often present in the feed as a copper cyanide complex, or can be added as a solution of copper sulphate.

All CN_{WAD}, which includes free cyanide, zinc cyanide, copper cyanide, and nickel cyanide, is converted to OCN^- during the destruction process. The metals, once freed of cyanide, are precipitated as metal hydroxides. The strong iron cyanide complex does not decompose in the SO_2/O_2 process but is removed as an insoluble metal ferrocyanide precipitate. In addition, a small amount of thiocyanate (SCN^-) and other-thio-species (e.g.$S_2O_3^=$) are oxidized. Under correct operating conditions, over 99.0 % of the total cyanide (CN_{TOT}) is destroyed.

1.1. Definitions and Acronyms

These are the definitions and acronyms used in this document.

Term or Acronym	Definition
AAS	Atomic Absorption Spectrometry
Ag	Silver
Au	Gold
CIP	Carbon in Pulp
CN_F	Free cyanide
CN_P	Cyanide measured by picric acid method
CN_T or CN_{TOT}	Total cyanide
CN_{WAD}	Weak Acid Dissociable Cyanide
Cu	Copper
$CuSO_4$	Copper Sulphate
DO	Dissolved Oxygen
Detox	Cyanide Detoxification
FA	Fire Assay
GAL	Gekko Assay Laboratory
Gekko	Gekko Systems Pty Ltd
GFIL	Gravity/Flotation/Intensive Leaching
ICP-OES	Inductively Coupled Plasma with Optical Emission Spectroscopy
ICP-MS	Inductively Coupled Plasma with Mass Spectroscopy
NaCN	Sodium Cyanide
NaOH	Sodium Hydroxide
O_2	Oxygen
SMBS or $Na_2S_2O_5$	Sodium Metabisulphite
pH	Solution Alkalinity
P_{XX}	xx% passing size of product
SO_2	Sulphur Dioxide
SG	Specific Gravity
μm	Micrometer

2. Sample Receipt and Preparation

2.1. Sample Receipt

Sample was received and blended as described in Gekko Report T1240, Part I: Python Amenability Test work. A total of 4.8 kg of combined gravity and flotation concentrates was available for detox testing.

2.2. Sample Preparation

The concentrate sample was divided into three different fractions and leached in three steps while re-using the pregnant solution produced after each step to leach the next fraction to build up impurities simulating plant recycle. Each leach step was conducted at the same leach conditions in rolling bottles for 12 hours at an initial free cyanide level of 0.5% NaCN and 30% solids. The leached slurries at each step were filtered and the filter cake washed in the filter. The washed filter cake was weighed and stored in refrigerator for detox test work. Pregnant solution from each leach step was collected, weighed and sub-sampled for assay. The remaining pregnant solution was topped up to 0.5% NaCN and was used in the subsequent leach. The bulk leaching details are shown in Appendix A.

After completing the leaching cycles, the pregnant solution was then contacted with 45 g/L of pre-conditioned activated carbon for 12 hours to remove dissolved gold and silver while leaving other metals in solution. The carbon was recovered by screening and filtering of the solution. The barren solution was sub-sampled for assay and the remaining solution was stored in the refrigerator for detox test work.

The detox feed was made-up at the start of each test. The wet filter cake was mixed with the barren leach solution and water in proportion to the proposed GFIL python plant mass balance in the ratio of 30% wet filter cake, 13% barren solution and 57% distilled water. Sub-samples of the different streams and the mixed slurry were assayed to determine critical elements and cyanide levels (Table 2). For full ICP-OES results, refer to Appendix A.

Table 2: Dissolved Metals and Cyanide Analysis Summary of Laboratory Leached Products and Feed Slurry (Critical Elements Only)

	ICP As mg/L	**ICP Cu mg/L**	**ICP Fe mg/L**	**ICP Ni mg/L**	**ICP Zn mg/L**	**AAS Ag mg/L**	**AAS Au mg/L**	**Colorimetry CN_{WAD} mg/L**
Pregnant Sol	<1.00	205.90	414.80	1.16	47.27	*	63.30	*
Barren Sol	<1.00	206.65	429.30	<1.00	36.93	0.13	0.13	*
Detox Feed T1	<1.00	60.20	102.20	<1.00	8.61	*	*	340
Detox Feed T2	<1.00	67.71	105.90	<1.00	8.26	*	*	375
Detox Feed T3	<1.00	62.10	95.80	<1.00	7.20	*	*	274
Detox Feed T4	<1.00	52.20	88.46	<1.00	7.22	*	*	291
Detox Feed T5	<1.00	52.78	94.69	<1.00	8.74	*	*	445
Detox Feed T6	<1.00	61.27	101.80	<1.00	9.99	*	*	502

* not measured

3. Experimental Procedure

3.1. Laboratory Set-up

The experimental set up for the SO_2/O_2 test (Figure 1) comprised of one reaction vessel (overflowing at 0.5 L) equipped with a Rushton turbine, baffles, a dissolved oxygen and pH probe, a cyanide sensing silver electrode (Dyna Probe) and reagent reservoirs and pumps for sodium metabisulphite ($Na_2S_2O_5$), copper sulphate ($CuSO_4$) and lime ($Ca(OH)_2$) or caustic (NaOH) addition.

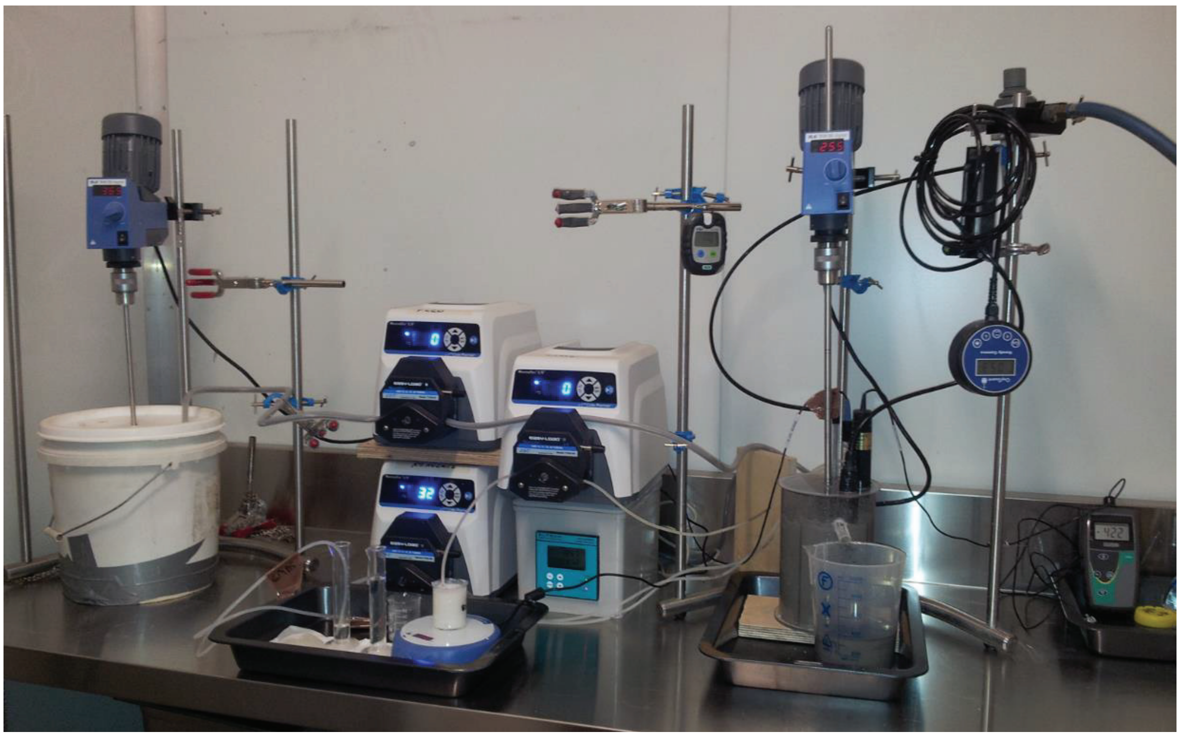

Figure 1: Laboratory Set-up – 1.5L reactor shown

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3.2. Test and Analytical Procedures

An initial batch test was performed to lower the detox feed CN_{WAD} levels to below 1.0 mg/L in the reactor, with the treated slurry obtained from this test used as starting material for continuous treatment testing. In all subsequent tests, the slurry remaining in the reactor at the conclusion of the treatment was used as the starting material for the next experiment.

To ensure adequate mixing within the reactor tank, the agitator was operated between 750 and 800 RPM. Reagent flow rates were set according to pre-selected feed conditions and continually monitored. Sodium metabisulphite was used as the source of sulphur dioxide. Oxygen gas was injected into the reactor below the agitator to maintain the required dissolved oxygen level. Oxygen was used in all tests due to the high feed cyanide concentration in solution indicating that oxygen would be the preferred reagent in the final plant.

The cyanide destruction process was monitored on a continuous basis using a cyanide sensing silver electrode (Dyna Probe) that produces readings in mV. The dissolved oxygen levels and pH were also continuously monitored.

Representative samples of treated effluent were taken at various time intervals for analysis. A minimum of three replacements of the detox reactor tank was used to produce a representative result. The effluents were filtered using a 0.45 µm membrane filter and immediately prepared for the colorimetric determination of CN_{WAD} using the buffered picric acid method (CN_P).

The filtrates were also analysed for dissolved metal using ICP-OES and ICP-MS methods. ICP-OES was used to obtain fast turnaround for experimental control. ICP-MS was used on all final solutions to obtain the very low detection limits required for environmental samples. All filtrates were tested for copper, nickel, iron and zinc.

Upon request by TMAC Resources, the filtrates from the third replacement of the detox products were also analysed for total cyanide using segmented flow analyser, thiocyanate, mercury using FIMS and (when sufficient sample was available) ammonia as N using discrete analyser.

Note: The cyanide concentration determined by the picric acid method includes all cyanide species except cyanide complexed with iron or gold in solution. Therefore, CN_P is greater than or equal to CN_{WAD} and is reported as CN_{WAD} in this report.

4. Results

4.1. SO_2/O_2 process

From previous test work T1231, only 2 demonstrative detox tests were conducted on Doris North samples due to insufficient concentrate samples available. Both the tests were successful in destroying the CN_{WAD} to less than 0.2 mg/L, however, the total cyanide target of less than 1.0 mg/L were not achieved due to the presence of dissolved iron in the detox effluent. The SO_2/O_2 process does not destroy the iron cyanide complex but the iron cyanide can be removed by precipitation of insoluble copper-iron-cyanide complexes with addition of extra copper as copper sulphate.

In this test work, six demonstrative tests were available from DC-02 samples to optimise the SO_2/O_2 cyanide destructive process conditions. During the testing of the slurry, process conditions were adjusted in successive tests to minimise the CN_{WAD} and residual base metals in the effluent. The retention time and pH were maintained at average of 128 minutes and pH 8.6 respectively. Due to the high levels of dissolved iron relative to copper, extra copper sulphate was added as catalyst. The SO_2 dosage and copper addition were varied to investigate possible reduction in reagents consumption. Both lime and caustic were used in this test work to control the pH. A summary of the conditions tested and results obtained is provided in Table 3.

Similar to test work T1231, the detox feed CN_{WAD} level was found to decrease significantly from the start to the end of the test as seen in Test 1, 2 and 3. As a consequence, it was difficult to maintain the design detox feed CN_{WAD} at 500 mg/L. Based on Test 1, 2 and 3, the NaCN decay rate was estimated. In Test 4, 5 and 6, NaCN was added to the detox feed every 1 hour throughout the test to maintain the CN_{WAD} level and in Test 6, the target detox feed CN_{WAD} of 500 mg/L was achieved.

Table 3: Summary of SO_2/O_2 Cyanide Destruction Tests

Test	Conditions								Solution Analysis															
	pH Control	CN addition	Solids	dO	Retention Time	SO_2/CN_p	Cu^{2+} Addition	Lime/SMBS NaOH/SMBS	CN_{WAD} mg/L Start	CN_{WAD} mg/L End	CN_{WAD} mg/L	CN_{TOT} mg/L	SCN mg/L	Cu mg/L		Fe mg/L		Zn mg/L		Ni mg/L		pH
	Reagent		% w/w	ppm	min	g/g	mg/L	g/g	Feed		Product	Product	Product	Feed	Product	Feed	Product	Feed	Product	Feed	Product	
1	Lime	No	24	33.8	123	6.2	218.1	0.67	340	230	0.43	0.184	112	60.2	0.441	102.2	0.06	8.6	0.029	<1.0	0.003	8.6
2	Lime	No	24	10.5	121	7.0	229.9	0.64	375	200	<0.20	0.203	118	67.7	0.527	105.9	<0.05	8.3	0.028	<1.0	0.004	8.6
3	Lime	No	24	17.9	125	6.2	105.1	0.47	334	219	<0.20	13.1	127	62.1	0.072	95.8	3.76	7.2	0.007	<1.0	0.027	8.6
4	Caustic	Yes	24	22.7	132	7.1	242.6	0.47	373	351	<0.20	0.135	116	52.2	0.785	88.5	0.07	7.2	0.040	<1.0	0.002	8.6
5	Caustic	Yes	24	27.4	141	6.2	243.3	0.49	445	346	0.27	0.149	154	52.8	1.7	94.7	<0.50	8.7	0.052	<1.0	0.017	8.6
6	Caustic	Yes	24	29.7	127	4.3	233.3	0.47	496	480	0.43	0.194	164	61.3	4.2	101.8	0.59	10	0.206	<1.0	0.098	8.6

Highlighted test was the unsuitable conditions which led to ineffective cyanide destruction or unstable operation.

4.1.1. Effect of SO_2 Dosage

Increasing SO_2 dosing decreases the levels of CN_{WAD}, dissolved copper and iron in solution.

The sulphur dioxide dosage ratio was varied between 4.3 and 7.1 gSO_2 / gCN_{WAD}. Table 4 provides a comparison between tests, and shows that at retention time of 127 minutes and a minimum addition of 4.3 gSO_2 / gCN_{WAD}, the process was able to reduce the CN_{WAD} at 496 mg/L to 0.43 mg/L and CN_{TOT} to 0.194 mg/L. An increase in the sulphur dioxide dosage ratio to 7.1 reduced both the CN_{WAD} and CN_{TOT} to <0.2 mg/L and 0.135 mg/L respectively. In addition, both the concentration of dissolved copper and iron were also reduced at higher sulphur dioxide dosage ratio.

Table 4: Effect of SO_2 Dosage on Cyanide Destruction

Test	Conditions			Solution Analysis						
	Retention Time	SO_2/CN_p	Cu^{2+} Addition	CN_{WAD} mg/L		CN_{TOT} mg/L	Cu mg/L		Fe mg/L	
	min	g/g	mg/L	Feed	Product	Product	Feed	Product	Feed	Product
4	132	7.1	242.6	373	<0.20	0.135	52.2	0.785	88.5	0.07
5	141	6.2	243.3	445	0.27	0.149	52.8	1.7	94.7	<0.50
6	127	4.3	233.3	496	0.43	0.194	61.3	4.2	101.8	0.59

4.1.2. Effect of Cu^{2+} addition

Copper addition is required to obtain low CN_{TOT} in detox effluent.

The presence of copper as catalyst is essential for the SO_2/O_2 cyanide destruction process. This is to improve reaction kinetics and to precipitate iron as a ferrocyanide complex. Due to the low level of dissolved copper relative to iron in the detox feed solution, Cu^{2+} was added as copper sulphate solution. Table 5 shows that with an addition of 218 mg/L of Cu^{2+}, the dissolved iron was reduced from 102.2 mg/L to 0.06 mg/L. As a result, a low CN_{tot} of 0.184 mg/L was detected in the detox effluent. When the Cu^{2+} was reduced to 105 mg/L, the SO_2/O_2 cyanide destruction process was capable to reduce the CN_{WAD} to <0.2 mg/L, but was ineffective for iron cyanide complex removal which resulted in an increase in the CN_{TOT} to 13.1 mg/L detected in the detox effluent.

Table 5: Effect of Cu^{2+} addition on Cyanide Destruction

Test	Conditions				Solution Analysis						
	Retention Time	SO_2/CN_p	Cu^{2+} Addition	Cu^{2+}: Fe	CN_{WAD} mg/L		CN_{TOT} mg/L	Cu mg/L		Fe mg/L	
	min	g/g	mg/L	Ratio	Feed	Product	Product	Feed	Product	Feed	Product
1	123	6.2	218.1	2.1	340	0.43	0.184	60.2	0.441	102.2	0.06
3	125	6.2	105.1	1.1	334	<0.20	13.1	62.1	0.072	95.8	3.76

4.1.3. Effect of Lime or Caustic for pH control

Both lime and caustic were effective pH control reagents and produced acceptable quality detox effluent

A pH between 8.0 and 9.0 is commonly used in the SO_2/O_2 process. Lime and caustic have been used as the pH control reagent in this test work as shown in Table 6. Irrespective of the sulphur dioxide dosage ratio, Test 1 and 2 used between 0.64 and 0.67 g lime / g SMBS while Test 4, 5 and 6 used between 0.47 and 0.49 g caustic / g SMBS. All the tests show successful removal of CN_{TOT} to less than the target limit of 1.0 mg/L. These results indicated that the consumption of caustic was lower compared to lime for pH control.

Table 6: Effect of lime and caustic on Cyanide Destruction

Test	Conditions				Solution Analysis							
	pH Control	SO_2/CN_p	Cu^{2+} Addition	Lime/SMBS NaOH/SMBS	CN_{WAD} mg/L		CN_{TOT} mg/L	Cu mg/L		Fe mg/L		pH
	Reagent	g/g	mg/L	g/g	Feed	Product	Product	Feed	Product	Feed	Product	
1	Lime	6.2	218.1	0.67	340	0.43	0.184	60.2	0.441	102.2	0.06	8.6
2	Lime	7.0	229.9	0.64	375	<0.20	0.203	67.7	0.527	105.9	<0.05	8.6
5	Caustic	6.2	243.3	0.49	445	0.27	0.149	52.8	1.7	94.7	<0.50	8.6
4	Caustic	7.1	242.6	0.47	373	<0.20	0.135	52.2	0.785	88.5	0.07	8.6
6	Caustic	4.3	233.3	0.47	496	0.43	0.194	61.3	4.2	101.8	0.59	8.6

4.2. Other species of concern

Water analysis was conducted to identify trace elements of environmental concern in the detox effluents. It should be noted that the target levels discussed below were set for the tailings impoundment area (TIA), where further dilution by other tailing stream and runoff is expected.

The solution analysis results show levels for arsenic, nickel, lead, zinc, ammonia and total cyanide were less than the set target limits as shown in Table 5. Copper was the only element that did not achieve the target limit due to the extra copper added to precipitate the iron. Further testing at higher and lower pH is recommended to optimise copper precipitation.

Thiocyanate is another compound of possible environmental concern, although no target was specified by the client. The solution results show that the thiocyanate levels were in the range of 112 to 165 mg/L. The SO_2/O_2 process is not suitable for thiocyanate removal. It is recommended that TMAC Resources consult environmental advice in regards to thiocyanate discharge limit to determine if further treatment is required.

Table 5: Solution Analysis of Detox Feed and Last Replacement Effluents

		Solution Analysis						
	Units	Target Limit	Detox Feed	Test 1	Test 2	Test 4	Test 5	Test 6
Arsenic	mg/L	0.5	0.061	0.005	0.005	0.01	0.027	0.028
Copper	mg/L	0.3	34.3	0.441	0.527	0.785	1.7	4.2
Nickel	mg/L	0.5	0.065	0.003	0.004	0.002	0.017	0.098
Lead	mg/L	0.2	0.002	0.001	0.004	0.002	<0.010	0.033
Zinc	mg/L	0.5	8.59	0.029	0.028	0.04	<0.052	0.206
Iron	mg/L	Not provided	63.3	0.06	<0.05	0.07	<0.50	0.59
Mercury	mg/L	Not provided	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Total Cyanide	mg/L	1.0	574	0.184	0.203	0.135	0.149	0.194
Thiocyanate	mg/L	Not provided	143	112	118	116	154	164
Ammonia as N	mg/L	6.0	*	0.75	1.32	0.74	1.61	1.05

* not measured

5. Concluding Comments

From the results of the test work the following comments can be made:

- Test work shows that under the conditions of 24% solids, 4.3 gSO_2 / g CN_{WAD}, 233 mg/L of Cu^{2+} addition, pH 8.6 and 127 minutes retention time at design detox feed CN_{WAD} of 496 mg/L, the single stage SO_2/O_2 cyanide destruction process was able to achieve the set target limits for CN_{WAD}, CN_{TOT}, arsenic, nickel, lead, zinc and ammonia except copper. However, further dilution from other streams in the tailings impoundment area will reduce the copper level to less than the target limit. Alternatively, additional test work to optimise pH is recommended to further reduce the copper level during the cyanide destruction process.

- A ratio of 2:1 copper to iron in the detox feed was effective in precipitating the iron cyanide complex in solution and subsequently reducing the CN_{TOT} level in the detox effluent.

- Test work shows both caustic and lime were effective for controlling pH. The consumptions are 0.64 g lime / g SMBS or 0.47 g caustic / g SMBS. The choice of reagent can therefore be made on a financial basis.

- Thiocyanate was detected in the detox effluents at levels ranging from 112 to 165 mg/L. The SO_2/O_2 process is not suitable for thiocyanate removal. It is recommended that TMAC Resources consult environmental advice in regards to thiocyanate discharge limit.

- Due to the difficulty in obtaining and maintaining the targeted CN_{WAD} detox feed levels, the conditions were not fully optimised, however there is enough data for confidence in engineering design.

6. Recommendations

This test work and the previous test work with Doris North have demonstrated the effectiveness of the SO_2/O_2 process. It has also shown a large variation in copper addition requirements which will translate directly to operating costs. Variability test work on the remaining major ore types is recommended to define the variations likely to be encountered.

Further optimisation of pH and Cu additions are recommended when performing ore variability tests. .

Appendix A – Bulk Concentrate Leaching Results

GEKKO

LABORATORY TEST WORK RESULTS

Intensive Cyanidation Test

Project: TMAC DC-02 Gravity/Float Composite
Stream:
Test: TMAC DC-02 (03A) Bulk Leach for Detox
Date: 15/09/2014

Grind p80 = 38µm

Conditions:

Wt % Solids		**30.0%**	**NaCN** consumed	**-3.91 g**	**-2.1 kg/t**
H_2O_2 addition		0.00 **g** / 0.00 **kg/t**	Net NaCN added	10.65 g	5.7 kg/t
$Pb(NO_3)_2$ addition		0.00 **g** / 0.00 **kg/t**	NaCN residual	0.34%	14.57 g
pH	natural	8.08			
	initial	10.95	**NaOH**	0.28 **g**	
	final	10.98	addition	0.15 **kg/t**	

SAMPLE NAME		Wt. OR VOLUME	SOLUTION SUB/ADD		ASSAYS Au	**Recovery Au**	**dO_2**	**pH**	**Sodium Cyanide level**	**added**	**removed**	Au Removed in Sample	Total Au Leached	NaCN Consumed	
		g	g	g	ppm	**%**	**ppm**		**%w/v**	**g**	**g**	µg	µg	g	kg/t
Sampled Head		1858.40			25.1										
Solutions	hours						initial	8.08							
	0	4336.27				**0.0%**		10.95	0.25%	10.82				0	0
	12	4336.27	50.00	0.00	22.05	**94.2%**	20.90	10.98	0.34%		0.17	1103	95615	-3.746594	-2.016032
									Total	10.82	0.17				
Leach Residue		2200.00			2.69								5918		
Calculated Head 1		1858.40			**54.63**								101533		

Preg. Leach Sol'n	3900.00		22.05			
Rinse Solution	6040.00		1.56		Metal in Solution (PLS + rinse + sample)	96519.9
Calculated Head 2	1858.40		**55.1215562**	**94.22%**	Total Metal	102438

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LABORATORY TEST WORK RESULTS

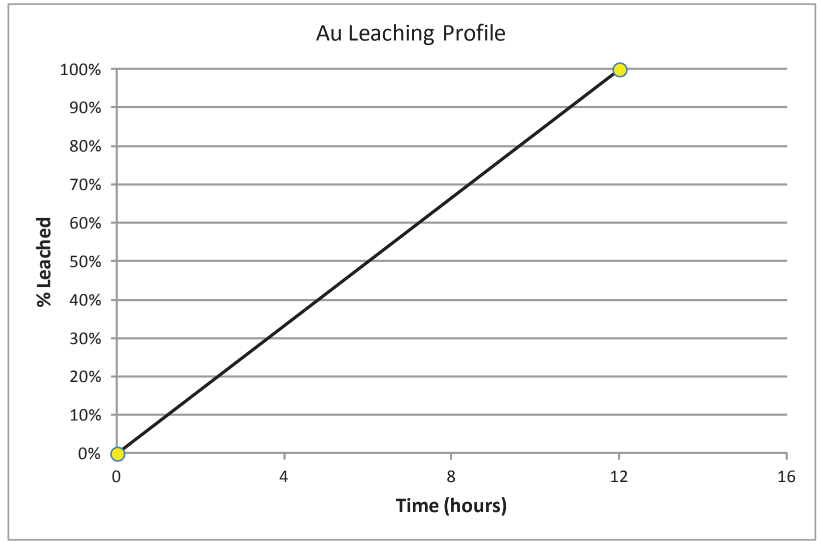
Intensive Cyanidation Test

Project: TMAC DC-02 Gravity/Float Composite
Stream:
Test: TMAC DC-02 (03B) Bulk Leach for Detox
Date: 15/09/2014

Grind p80 = 38 µm

Conditions:

Wt % Solids	**30.0%**		**NaCN**	**10.86 g**
			consumed	**11.7 kg/t**
H_2O_2	0.00 **g**			
addition	0.00 **kg/t**		Net NaCN	10.86 g
			added	11.7 kg/t
$Pb(NO_3)_2$	0.00 **g**			
addition	0.00 **kg/t**		NaCN	0.00%
			residual	0.00 g
pH	natural	8.29		
	initial	10.88	**NaOH**	0.20 **g**
	final	10.88	addition	0.22 **kg/t**



SAMPLE NAME	Wt. OR VOLUME	SOLUTION SUB/ADD		ASSAYS Au	**Recovery Au**	**dO_2**	**pH**	**Sodium Cyanide** **level**	**added**	**removed**	Au Removed in Sample	Total Au Leached	NaCN Consumed	
	g	g	g	ppm	**%**	**ppm**		**%w/v**	**g**	**g**	µg	µg	g	kg/t
Sampled Head	930.90			25.1										
Solutions hours						initial	8.29							
0	2172.10				**0.0%**		10.88	0.50%	10.86				0	0
12	2172.10	3269.77	0.00	22.05	**100.0%**	32.90	10.88	0.00%		0.00	72098	47895	10.8605	11.666667
								Total	10.86	0.00				
Leach Residue	0.00			2.69								0		
Calculated Head 1	930.90			**51.45**								47895		

Preg. Leach Sol'n	0.00		22.05			
Rinse Solution	0.00		1.56		Metal in Solution (PLS + rinse + sample)	72098.4285
Calculated Head 2	930.90		**77.4502401**	**100.00%**	Total Metal	72098

GEKKO

LABORATORY TEST WORK RESULTS

Intensive Cyanidation Test

Project: TMAC DC-02 Gravity/Float Composite
Stream:
Test: TMAC DC-02 (04A) Bulk Leach for Detox
Date: 15/09/2014

Grind p80 = 38 µm

Conditions:

Wt % Solids	**30.0%**		**NaCN**	**-5.92 g**
			consumed	**-3.7 kg/t**
H_2O_2	0.00 **g**			
addition	0.00 **kg/t**		Net NaCN	9.14 g
			added	5.7 kg/t
$Pb(NO_3)_2$	0.00 **g**			
addition	0.00 **kg/t**		NaCN	0.40%
			residual	15.06 g
pH	natural	10.60		
	initial	0.00	**NaOH**	0.00 **g**
	final	10.77	addition	0.00 **kg/t**

SAMPLE NAME	Wt. OR VOLUME	SOLUTION SUB/ADD		ASSAYS Au	**Recovery Au**	**dO_2**	**pH**	**Sodium Cyanide level**	**added**	**removed**	Au Removed in Sample	Total Au Leached	NaCN Consumed	
	g	g	g	ppm	**%**	**ppm**		**%w/v**	**g**	**g**	µg	µg	g	kg/t
Sampled Head	1601.70			25.1										
Solutions hours						initial	10.60							
0	3737.30				**0.0%**		0.00	0.25%	9.34				0	0
12	3737.30	50.00	0.00	41.00	**75.0%**	13.10	10.77	0.40%		0.20	2050	153229	-5.720089	-3.571261
								Total	9.34	0.20				
Leach Residue	1910.50			26.80								51201		
Calculated Head 1	1601.70			**127.63**								204431		

Preg. Leach Sol'n	3360.00		41.00			
Rinse Solution	7000.00		2.37		Metal in Solution (PLS + rinse + sample)	156365
Calculated Head 2	1601.70		**129.591309**	**75.33%**	Total Metal	207566

GEKKO

LABORATORY TEST WORK RESULTS

Intensive Cyanidation Test

Project: TMAC DC-02 Gravity/Float Composite
Stream:
Test: TMAC DC-02 (04B) Bulk Leach for Detox
Date: 15/09/2014

Grind p80 = 38 µm

Conditions:

Wt % Solids	**30.0%**		**NaCN**	**9.35**	**g**
			consumed	**11.7**	**kg/t**
H_2O_2	0.00	**g**			
addition	0.00	**kg/t**	Net NaCN	9.35	g
			added	11.7	kg/t
$Pb(NO_3)_2$	0.00	**g**			
addition	0.00	**kg/t**	NaCN	0.00%	
			residual	0.00	g
pH natural	10.66				
initial	0.00		**NaOH**	0.00	**g**
final	10.72		addition	0.00	**kg/t**

SAMPLE NAME	Wt. OR VOLUME	SOLUTION SUB/ADD		ASSAYS Au	**Recovery Au**	**dO_2**	**pH**	**Sodium Cyanide level**	**added**	**removed**	Au Removed in Sample	Total Au Leached	NaCN Consumed	
	g	g	g	ppm	**%**	**ppm**		**%w/v**	**g**	**g**	µg	µg	g	kg/t
Sampled Head	801.10			25.1										
Solutions hours						initial	10.66							
0	1869.23				**0.0%**		0.00	0.50%	9.35				0	0
12	1869.23	2838.87	0.00	41.00	**100.0%**	12.90	10.72	0.00%		0.00	116394	76639	9.3461667	11.666667
								Total	9.35	0.00				
Leach Residue	0.00			26.80								0		
Calculated Head 1	801.10			**95.67**								76639		

Preg. Leach Sol'n	0.00		41.00			
Rinse Solution	0.00		2.37		Metal in Solution (PLS + rinse + sample)	116393.67
Calculated Head 2	801.10		**145.292311**	**100.00%**	Total Metal	116394

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LABORATORY TEST WORK RESULTS

Intensive Cyanidation Test

Project: TMAC DC-02 Gravity/Float Composite
Stream:
Test: TMAC DC-02 (05A) Bulk Leach for Detox
Date: 16/09/2014

Grind p80 = 38 µm

Conditions:

Wt % Solids		**30.0%**	**NaCN**	**1.54 g**
			consumed	**2.2 kg/t**
H_2O_2		0.00 **g**		
addition		0.00 **kg/t**	Net NaCN	7.98 g
			added	11.4 kg/t
$Pb(NO_3)_2$		0.00 **g**		
addition		0.00 **kg/t**	NaCN	0.39%
			residual	6.44 g
pH	natural	10.66		
	initial	0.00	**NaOH**	0.00 **g**
	final	10.57	addition	0.00 **kg/t**

SAMPLE NAME	Wt. OR VOLUME	SOLUTION SUB/ADD		ASSAYS Au	**Recovery Au**	**dO_2**	**pH**	**Sodium Cyanide** level	**added**	**removed**	Au Removed in Sample	Total Au Leached	NaCN Consumed	
	g	g	g	ppm	**%**	**ppm**		**%w/v**	**g**	**g**	µg	µg	g	kg/t
Sampled Head	700.90			25.1										
Solutions hours						initial	10.66							
0	1635.43				**0.0%**		0.00	0.50%	8.18				0	0
12	1635.43	50.00	0.00	63.30	**97.8%**	14.10	10.57	0.39%		0.20	3165	103523	1.7342135	2.4742667
								Total	8.18	0.20				
Leach Residue	1650.00			1.41								2327		
Calculated Head 1	700.90			**151.02**								105849		

Preg. Leach Sol'n	2960.00		63.30			
Rinse Solution	8620.00		0.55		Metal in Solution (PLS + rinse + sample)	195274
Calculated Head 2	700.90		**281.923955**	**98.82%**	Total Metal	197601

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LABORATORY TEST WORK RESULTS

Intensive Cyanidation Test

Project: TMAC DC-02 Gravity/Float Composite
Stream:
Test: TMAC DC-02 (05B) Bulk Leach for Detox
Date: 16/09/2014

Grind p80 = 38 µm

Conditions:

Wt % Solids	**30.0%**		**NaCN**	**8.18 g**	
			consumed	**11.7 kg/t**	
H_2O_2	0.00 **g**				
addition	0.00 **kg/t**		Net NaCN	8.18 g	
			added	11.7 kg/t	
$Pb(NO_3)_2$	0.00 **g**				
addition	0.00 **kg/t**		NaCN	0.00%	
			residual	0.00 g	
pH	natural	10.72			
	initial	0.00	**NaOH**	0.00 **g**	
	final	10.60	addition	0.00 **kg/t**	

SAMPLE NAME	Wt. OR VOLUME	SOLUTION SUB/ADD		ASSAYS Au	**Recovery Au**	**dO_2**	**pH**	**Sodium Cyanide** level	added	removed	Au Removed in Sample	Total Au Leached	NaCN Consumed	
	g	g	g	ppm	**%**	**ppm**		**%w/v**	**g**	**g**	µg	µg	g	kg/t
Sampled Head	700.90			25.1										
Solutions hours						initial	10.72							
0	1635.43				**0.0%**		0.00	0.50%	8.18				0	0
12	1635.43	2502.78	0.00	63.30	**100.0%**	14.20	10.60	0.00%		0.00	158426	103523	8.1771667	11.666667
								Total	8.18	0.00				
Leach Residue	0.00			1.41								0		
Calculated Head 1	700.90			**147.70**								103523		

Preg. Leach Sol'n	0.00		63.30			
Rinse Solution	0.00		0.55		Metal in Solution (PLS + rinse + sample)	158425.974
Calculated Head 2	700.90		**226.032207**	**100.00%**	Total Metal	158426

Table A1: Dissolved Metals of Laboratory Leached Product and Feed Slurries – ICP OES

	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	ICP	AAS	AAS	AAS	AAS
	As	Ba	Be	Ca	Cd	Co	Cr	Cu	Fe	K	Mg	Mn	Mo	Ni	Sb	Sn	Zn	Ag	Ag	Au	Au
	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Pregnant Solution	<1.00	<1.00	<1.00	25.1	<1.00	<1.00	<1.00	205.9	414.8	59.1	3.51	11.71	<1.00	1.16	<1.00	<1.00	47.27	*	*	63.3	*
Barren Solution	<1.00	<1.00	<1.00	2.48	<1.00	<1.00	<1.00	206.65	429.3	309	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	36.93	0.14	0.13	0.13	0.13
Detox Feed T1	<1.00	<1.00	<1.00	7.79	<1.00	<1.00	<1.00	60.22	102.25	26.4	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	8.61	*	*	*	*
Detox Feed T2	<1.00	<1.00	<1.00	4.37	<1.00	<1.00	<1.00	67.7	105.9	37.61	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	8.3	*	*	*	*
Detox Feed T3	<1.00	<1.00	<1.00	7.6	<1.00	<1.00	<1.00	62.1	95.8	37.37	2.9	<1.00	<1.00	<1.00	<1.00	<1.00	7.2	*	*	*	*
Detox Feed T4	<1.00	<1.00	<1.00	8.08	<1.00	<1.00	<1.00	52.2	88.46	44.74	2.72	<1.00	<1.00	<1.00	<1.00	<1.00	7.22	*	*	*	*
Detox Feed T5	<1.00	<1.00	<1.00	10.57	<1.00	<1.00	<1.00	52.78	94.69	43	2.99	<1.00	<1.00	<1.00	<1.00	<1.00	8.74	*	*	*	*
Detox Feed T6	<1.00	<1.00	<1.00	8.35	<1.00	<1.00	<1.00	61.27	101.8	39.81	1.85	<1.00	<1.00	<1.00	<1.00	<1.00	9.99	*	*	*	*

* not measured

Appendix B – Water Analysis

Table B1: Full Analysis of Detox Feed and Final Replacement of Tests – ICP MS

	Units	Solution Analysis						
		Detox Feed	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6
EG020F: Dissolved Metals by ICP-MS								
Aluminium	mg/L	0.41	0.06	0.04	0.09	0.04	0.2	0.23
Dysprosium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Silver	mg/L	0.027	<0.001	<0.001	<0.010	<0.010	<0.010	<0.010
Arsenic	mg/L	0.061	0.005	0.005	0.007	0.01	0.027	0.028
Bismuth	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Erbium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Boron	mg/L	0.24	0.2	0.21	0.17	0.13	<0.50	<0.50
Europium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Strontium	mg/L	0.06	0.849	0.758	0.658	0.417	0.413	0.605
Barium	mg/L	0.006	0.081	0.074	0.059	0.065	0.069	0.107
Gadolinium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Titanium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.10	<0.10
Beryllium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Gallium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Cadmium	mg/L	0.003	<0.0001	0.0001	<0.0001	<0.0001	<0.0010	<0.0010
Hafnium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.10	<0.10
Tellurium	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.052	<0.052
Cobalt	mg/L	0.012	0.054	0.048	0.116	0.057	0.082	0.097
Holmium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Uranium	mg/L	<0.001	<0.001	<0.001	0.001	<0.001	<0.010	<0.010
Caesium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Chromium	mg/L	0.009	0.008	0.007	0.006	0.004	<0.010	<0.010
Indium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Copper	mg/L	34.3	0.441	0.527	0.072	0.785	1.7	4.2
Lanthanum	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Rubidium	mg/L	0.029	0.003	0.003	0.002	0.003	<0.010	<0.010
Lithium	mg/L	0.001	0.016	0.015	0.008	0.014	0.022	0.018
Lutetium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Thorium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Cerium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Manganese	mg/L	0.023	0.08	0.081	0.032	0.06	0.119	0.174
Neodymium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Molybdenum	mg/L	0.1	0.066	0.07	0.076	0.072	0.084	0.089
Praseodymium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Nickel	mg/L	0.065	0.003	0.004	0.027	0.002	0.017	0.098
Samarium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Lead	mg/L	0.002	0.001	0.004	0.001	0.002	<0.010	0.033
Terbium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Antimony	mg/L	0.056	0.03	0.03	0.04	0.037	0.061	0.056
Thulium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Selenium	mg/L	<0.01	<0.01	<0.01	0.01	0.01	<0.10	<0.10
Ytterbium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Tin	mg/L	<0.001	<0.001	<0.001	0.002	0.001	<0.010	0.029
Yttrium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Thallium	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.010	<0.010
Zirconium	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.052	<0.052
Vanadium	mg/L	0.01	<0.01	<0.01	<0.01	<0.01	<0.10	<0.10
Zinc	mg/L	8.59	0.029	0.028	0.007	0.04	<0.052	0.206
Iron	mg/L	63.3	0.06	<0.05	3.76	0.07	<0.50	0.59

	Units	Solution Analysis						
		Detox Feed	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6
EG035F: Dissolved Mercury by FIMS								
Mercury	mg/L	0.0002	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK026SF: Total CN by Segmented Flow Analyser								
Total Cyanide	mg/L	574	0.184	0.203	13.1	0.135	0.149	0.194
EK027: Thiocyanate								
Thiocyanate	mg/L	143	112	118	127	116	154	164
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	mg/L	*	0.75	1.32	0.82	0.74	1.61	1.05

* not measured

Appendix C – Disclaimer

Gekko has undertaken test work to characterize the response of your ore to certain separation techniques and/or to help your own experts make a decision as to whether you wish to purchase our product and, if so, the number and type.

It is important that you understand that:

- *You must have your own experts examine the detailed analysis in our report to decide its applicability to your project.*
- *We analyse only the sample you provide. Any one of a number of factors may cause that sample inaccurately to reflect the ore body. You must determine the extent to which the sample represents the ore body. That includes the detection limits and confidence intervals relevant to our results.*

At all times we endeavour to provide accurate test work outcomes but you should not use our results as a basis for your broader business decisions about your project.

If we have not exercised due care with our tests, the limit of our liability, both at common law and under any statute, will be to provide a further set of test results to you free of charge. You indemnify us with respect to all other loss and damage of every kind, including, without limitation:

- *damage to or loss of property;*
- *injury to or death of any person; and*
- *economic and consequential loss arising from the negligent act or omission of us or anyone else in connection with our test*

Appendix 3.0

In Response to EC IR#14: Hope Bay Oil Pollution Prevention Plan/Oil Pollution Emergency Plan

TMAC
RESOURCES

OIL POLLUTION PREVENTION PLAN (OPPP) /
OIL POLLUTION EMERGENCY PLAN (OPEP)

Hope Bay Doris North Project
TMAC Resources Inc.
Roberts Bay, NU

2015

Document Revision 1.4

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Appendix 4.0

In Response to AANDC-NIRB #19 – Table 1. Volume of Estimated Non-Hazardous Solid Waste

Appendix 4.0. In Response to AANDC-NIRB IR#19 - Table 1. Volume of Estimated Non-Hazardous Solid Waste

Phase:		Development/Construction			C & M		Construction		Operations						Closure	
Year:	**Unit**	**2010***	**2011***	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023+**	**TOTALS**
Doris North Estimated Annual Volumes of Non-Haz Solid Waste generated during 1 final construction year and 6 year operating mine life averaged over period 2016 - 2022	m^3	1100	2400	1500	-	-	-	1500	1500	1500	1500	1500	1500	1500	-	12000
Doris North Closure Estimated Volumes - App. F, Reclamation and Security w/ 13% contingency	m^3														30000	30000
Windy Camp Closure Estimated Volumes - *Table B.15* with 3% contingency	m^3														2400	2400
Madrid Closure Estimated Volumes (North, South and AWR) with avg 6% contingency	m^3														1550	1550
															Landfill Design Capacity:	**45950**

** pre-2012 figures for Doris North included for estimation purposes only - this waste has been backhauled*

Note: Q3 Landfill capacity designed to accommodate non-hazardous solid waste from 2BE-HOP1222 (Old Windy Camp) Closure and proposed Madrid 2BB-MAE--- infrastructure disposal