



Indian and Northern  
Affairs Canada

Affaires indiennes  
et du Nord Canada

# Arctic Gold & Silver Tailings Site

## Monitoring Report 2002



Prepared by:  
**Indian and Northern Affairs  
Waste Management Program  
Yukon Region**

Canada

### Location

The Arctic Gold and Silver mill and tailings impoundment is located approximately 4 km south of the Village of Carcross on the road to both the Arctic Caribou and Big Thing mines on Montana Mountain (60° 08' 00" N, 134° 43' 20" W).



Figure 1: Location of Arctic Gold and Silver Tailings

## **Background**

The Arctic Gold and Silver mill was in operation during the late 1960's. It is estimated that about 50,000 tonnes of ore were processed, using a basic flotation method (without cyanide) and leaving nearly 27,000 m<sup>3</sup> of tailings.

A phase III environmental assessment was commissioned By DIAND, Waste Management in August, 1997. It was found that the tailings were acid generating and that seepage into a small lake adjacent to the tailings impoundment contained significant concentrations of metals. Several health and safety concerns and environmental risks were identified and it was recommended to clean up the site and assess remedial measures for the tailings (Public Works and Government Services Canada, 1998).

Geotechnical and geochemical testing and delineation of the tailings were initiated in 1998 and options for remediation were presented in a report prepared by Steffen Robertson and Kirsten Inc. (1999).

Clean up of the site and preparation to secure and cap the tailings were carried out in 1999 according to specifications prepared by Public Works and Government Services Canada (1999). The contract for the The excavation of previously submerged tailings from the unnamed lake, adjacent to the tailings impoundment, took place during winter 1999/2000. The recovered tailings were expected to dry during the summer 2000 to be placed in the impoundment and covered with clay capping material. Due to a wet and cool summer, the tailings had not dried enough to the satisfaction of the Engineer. The final work, including the seeding and fertilizing of the entire capped tailings pond, had therefore be postponed to the summer of 2001. Completion of all components of the remediation effort was achieved in September, 2001 (EBA Engineering Consultants Ltd., 2001).

## **Monitoring**

Performance monitoring of the low permeability cover for the tailings and water sampling in 2001 was done by EBA Engineering Consultants Ltd. (2002). Annual site monitoring for 2002 was carried out by DIAND Waste Management according to the routine monitoring program of the division.

## **Monitoring Program**

- Visual inspection of capped tailings impoundment.
- State of vegetation and signs of erosion on all re-seeded areas.
- Inspection of tailings dam, drainage channels and diversion ditch.
- Inspection of the newly constructed spillway and dam of the unnamed lake.
- Sampling of surface water at various locations and analysis at an accredited laboratory.

## Observations

The site was visited by Waste Management personnel on August 8, 2002. The overall state of the impoundment, tailings dam, drainage channels, diversion ditch, spillway and dam of the unnamed lake were satisfactory. A few spots were found to show some erosion of minimal extent, especially where the seeding was not successful. The vegetation on the tailings cover is for the most part doing very well (Photo 1).



**Photo 1:** Vegetation on tailings cover

## Surface Water Sampling

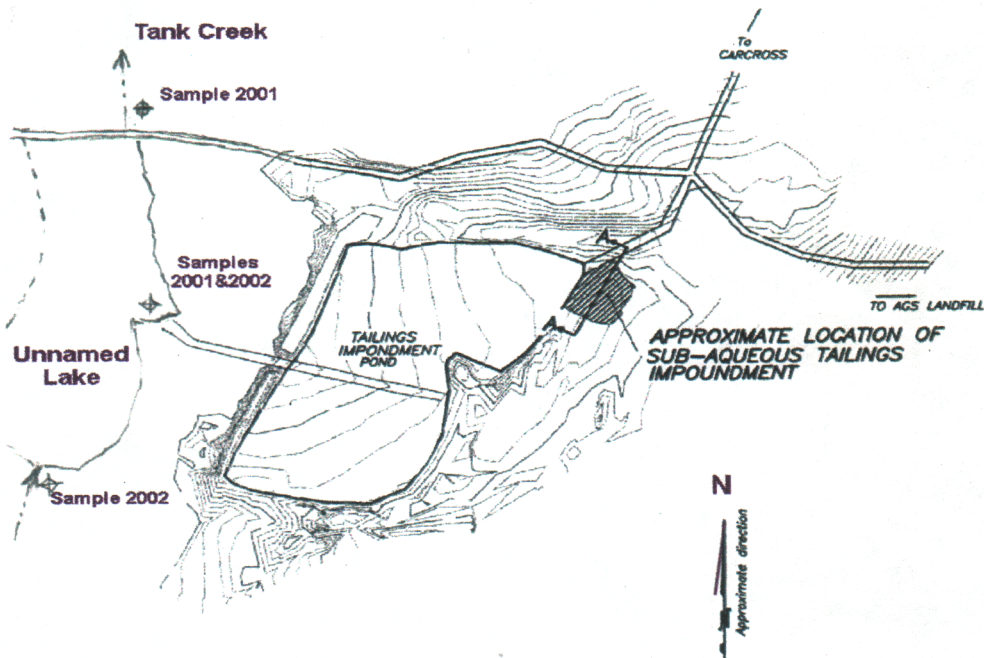
Surface water samples from the Unnamed Lake and Tank Creek at the spillway were taken by EBA Engineering in October, 2001. On August 8, 2002, DAND Waste Management collected samples from the same location at the Unnamed Lake (where drainage from the tailings impoundment flows into the lake), and background samples from Tank Creek where it enters the lake (see Figure 2 for sample locations). All critical levels of metal concentrations are well below the criteria of the water licence and very close to the Canadian Council of Ministers of the Environment (CCME, 1999) "Canadian Water Quality Guidelines for Protection of Aquatic Life".

DIAND Waste Management and Northern Contaminants Programs  
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Parameter	Max. Levels Water Licence mg/L	Unnamed Lake 2001 mg/L	Unnamed Lake 2002 mg/L	Spillway Tank Creek 2001 mg/L	Inflow Tank Creek 2002 mg/L	CCME <sup>1</sup> Guidelines mg/L
Arsenic	0.5	0.005	0.0033	0.002	0.0009	0.005
Copper	0.3	0.003	0.005	0.002	<0.001	0.002 - 0.004
Lead	0.2	<0.001	<0.0001	<0.001	<0.0001	0.001 - 0.007
Nickel	0.5	<0.05	0.0010	<0.05	<0.0005	0.025 - 0.150
Zinc	0.5	<0.05	0.034	<0.05	<0.001	0.030

**Table 1: Laboratory Results**

- 1 CCME: Canadian Council of Ministers of the Environment 1999 - "Canadian Water Quality Guidelines for Protection of Aquatic Life"



**Figure 2: Sampling Locations modified from PWGS base drawing (EBA, 2001)**

## References

- EBA Engineering Consultants Ltd. 2001. *Arctic Gold & Silver Tailings Site Remediation Near Carcross, Yukon*. Prepared for Public Works and Government Services Canada, Environmental Services, Western & Northern Region and DIAND Waste Management, Yukon Region. EBA Whitehorse, Yukon.
- EBA Engineering Consultants Ltd. 2001. *Monitoring of Low Permeability Cover Performance: Arctic Gold and Silver Mine Site, Carcross Yukon*. Prepared for the Mining Environment Research Group (MERG). EBA Whitehorse, Yukon
- Public Works and Government Services Canada. 1998. *Phase III Environmental Assessment of the Arctic Gold and Silver Mill and Tailings Impoundment*. Environmental Services, Western & Northern Region, Edmonton, Alberta.
- Public Works and Government Services Canada. 1999. *Specifications: Arctic Gold and Silver, Environmental Clean Up of Mine Tailings Site*. Environmental Services, Western & Northern Region, Edmonton, Alberta.
- Steffen Robertson & Kirsten. 1999. *Final Report: Assessment of Remedial Measures for Arctic Gold & Silver Tailings Site*. SRK Consulting, Vancouver, B.C.

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Arctic Gold and Silver Tailings Site - Monitoring Report, 2002

## **Appendix**

### **Analytical Reports (2001 / 2002)**



# CHEMICAL ANALYSIS REPORT

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**Date:** October 17, 2001

**ALS File No.** N6497

**Report On:** 99-14535.002 Water Analysis

**Report To:** **EBA Engineering Consultants Ltd.**  
Calcite Business Centre  
Unit 6 - 151 Industrial Road  
Whitehorse, YT  
Y1A 2V3


**Attention:** Mr. Ryan Martin

**Received:** October 5, 2001

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ALS ENVIRONMENTAL

per:



Amber Springer, B.Sc. - Project Chemist  
Brent C. Mack, B.Sc. - Project Chemist



File No. N6497

**REMARKS**



The detection limits for some dissolved metals were increased for the samples reported due to interferences encountered during analysis.

**RESULTS OF ANALYSIS - Water**



Sample ID		MW-1	MW-2	MW-3	MW-4	LAKE
Sample Date						Unnamed Lake
ALS ID		1	2	3	4	2001 5
<b>Physical Tests</b>						
Hardness	CaCO3	149	1270	100	1650	36.6
<b>Total Metals</b>						
Aluminum	T-Al	-	-	-	-	0.11
Antimony	T-Sb	-	-	-	-	<0.01
Arsenic	T-As	-	-	-	-	0.005
Barium	T-Ba	-	-	-	-	<0.02
Beryllium	T-Be	-	-	-	-	<0.005
Boron	T-B	-	-	-	-	<0.1
Cadmium	T-Cd	-	-	-	-	0.0004
Calcium	T-Ca	-	-	-	-	10.6
Chromium	T-Cr	-	-	-	-	<0.01
Cobalt	T-Co	-	-	-	-	<0.01
Copper	T-Cu	-	-	-	-	0.003
Iron	T-Fe	-	-	-	-	0.36
Lead	T-Pb	-	-	-	-	<0.001
Lithium	T-Li	-	-	-	-	<0.05
Magnesium	T-Mg	-	-	-	-	2.5
Manganese	T-Mn	-	-	-	-	0.04
Mercury	T-Hg	-	-	-	-	<0.0002
Molybdenum	T-Mo	-	-	-	-	<0.001
Nickel	T-Ni	-	-	-	-	<0.05
Selenium	T-Se	-	-	-	-	<0.001
Silver	T-Ag	-	-	-	-	<0.0001
Sodium	T-Na	-	-	-	-	<2
Thallium	T-Tl	-	-	-	-	<0.0002
Uranium	T-U	-	-	-	-	<0.0002
Vanadium	T-V	-	-	-	-	<0.03
Zinc	T-Zn	-	-	-	-	<0.05

Remarks regarding the analyses appear at the beginning of this report.  
 Results are expressed as milligrams per litre except where noted.  
 < = Less than the detection limit indicated.

**RESULTS OF ANALYSIS - Water**

Sample ID	MW-1	MW-2	MW-3	MW-4
Sample Date ALS ID	1	2	3	4

**Dissolved Metals**

Aluminum	D-Al	0.73	8.2	0.35	33.2
Antimony	D-Sb	<0.01	<0.5	<0.01	<0.5
Arsenic	D-As	0.060	1.92	0.013	80.5
Barium	D-Ba	0.05	0.05	0.04	<0.1
Beryllium	D-Be	<0.005	<0.01	<0.005	<0.03
Boron	D-B	<0.1	<0.2	<0.1	<0.5
Cadmium	D-Cd	0.0004	0.01	0.0011	<0.01
Calcium	D-Ca	44.7	340	29.5	421
Chromium	D-Cr	<0.01	<0.02	<0.01	<0.05
Cobalt	D-Co	<0.01	1.65	<0.01	1.88
Copper	D-Cu	0.005	0.41	0.005	<0.05
Iron	D-Fe	1.20	2000	0.76	3520
Lead	D-Pb	0.001	<0.05	<0.001	<0.05
Lithium	D-Li	<0.05	<0.1	<0.05	<0.3
Magnesium	D-Mg	9.0	102	6.5	146
Manganese	D-Mn	0.55	55.9	0.09	116
Mercury	D-Hg	<0.0002	<0.0002	<0.0002	<0.0002
Molybdenum	D-Mo	0.002	<0.05	<0.001	<0.05
Nickel	D-Ni	<0.05	0.5	<0.05	1.0
Selenium	D-Se	<0.001	<0.05	<0.001	<0.05
Silver	D-Ag	<0.0001	<0.005	<0.0001	<0.005
Sodium	D-Na	4	19	4	15
Thallium	D-Tl	<0.0002	<0.01	<0.0002	<0.01
Uranium	D-U	0.0016	<0.01	0.0010	<0.01
Vanadium	D-V	<0.03	<0.06	<0.03	<0.2
Zinc	D-Zn	<0.05	55.8	<0.05	60.1

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**RESULTS OF ANALYSIS - Water**



Sample ID	CREEK-1	
Sample Date	Spillway	
ALS ID	Tank Creek	
	6 2001	
<b>Physical Tests</b>		
Hardness	CaCO3	33.3
<b>Total Metals</b>		
Aluminum	T-Al	0.07
Antimony	T-Sb	<0.01
Arsenic	T-As	0.002
Barium	T-Ba	<0.02
Beryllium	T-Be	<0.005
Boron	T-B	<0.1
Cadmium	T-Cd	<0.0002
Calcium	T-Ca	9.7
Chromium	T-Cr	<0.01
Cobalt	T-Co	<0.01
Copper	T-Cu	0.002
Iron	T-Fe	0.36
Lead	T-Pb	<0.001
Lithium	T-Li	<0.05
Magnesium	T-Mg	2.2
Manganese	T-Mn	0.02
Mercury	T-Hg	<0.0002
Molybdenum	T-Mo	<0.001
Nickel	T-Ni	<0.05
Selenium	T-Se	<0.001
Silver	T-Ag	<0.0001
Sodium	T-Na	<2
Thallium	T-Tl	<0.0002
Uranium	T-U	<0.0002
Vanadium	T-V	<0.03
Zinc	T-Zn	<0.05

Remarks regarding the analyses appear at the beginning of this report.  
 Results are expressed as milligrams per litre except where noted.  
 < = Less than the detection limit indicated.

## Appendix 1 - QUALITY CONTROL - Replicates



Water	MW-1	MW-1
		QC # 260321

**Physical Tests**

Hardness	CaCO3	149	149
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**Dissolved Metals**

Aluminum	D-Al	0.73	0.74
Antimony	D-Sb	<0.01	<0.01
Arsenic	D-As	0.060	0.060
Barium	D-Ba	0.05	0.05
Beryllium	D-Be	<0.005	<0.005
Boron	D-B	<0.1	<0.1
Cadmium	D-Cd	0.0004	0.0005
Calcium	D-Ca	44.7	44.8
Chromium	D-Cr	<0.01	<0.01
Cobalt	D-Co	<0.01	<0.01
Copper	D-Cu	0.005	0.005
Iron	D-Fe	1.20	1.22
Lead	D-Pb	0.001	0.001
Lithium	D-Li	<0.05	<0.05
Magnesium	D-Mg	9.0	9.1
Manganese	D-Mn	0.55	0.56
Mercury	D-Hg	<0.0002	<0.0002
Molybdenum	D-Mo	0.002	0.002
Nickel	D-Ni	<0.05	<0.05
Selenium	D-Se	<0.001	<0.001
Silver	D-Ag	<0.0001	<0.0001
Sodium	D-Na	4	4
Thallium	D-Tl	<0.0002	<0.0002
Uranium	D-U	0.0016	0.0016
Vanadium	D-V	<0.03	<0.03
Zinc	D-Zn	<0.05	<0.05

Remarks regarding the analyses appear at the beginning of this report.  
Results are expressed as milligrams per litre except where noted.  
< = Less than the detection limit indicated.

## Appendix 2 - METHODOLOGY



Outlines of the methodologies utilized for the analysis of the samples submitted are as follows

### Conventional Parameters in Water

These analyses are carried out in accordance with procedures described in "Methods for Chemical Analysis of Water and Wastes" (USEPA), "Manual for the Chemical Analysis of Water, Wastewaters, Sediments and Biological Tissues" (BCMOE), and/or "Standard Methods for the Examination of Water and Wastewater" (APHA). Further details are available on request.

### Metals in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 20th Edition 1998 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 procedures may involve preliminary sample treatment by acid digestion, using either hotplate or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by atomic absorption/emission spectrophotometry (EPA Method 7000 series), inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B), and/or inductively coupled plasma - mass spectrometry (EPA Method 6020).

Recommended Holding Time:

Sample:	6 months
Reference:	EPA
For more detail see:	ALS "Collection & Sampling Guide"

### Mercury in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 20th Edition 1998 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 a cold-oxidation of the acidified sample using bromine monochloride prior to reduction of the sample with stannous chloride. Instrumental analysis is by cold vapour atomic absorption and/or fluorescence spectrophotometry (EPA Method 7470A/7471A/245.7).

Recommended Holding Time:

Sample:	28 days
Reference:	EPA
For more detail see	ALS Environmental "Collection & Sampling Guide"

**End Of Report**



## Analytical Report

Norwest Labs  
 #104, 19575-55 A Ave.  
 Surrey, BC. V3S 8P8  
 Phone: (804) 514-3322  
 Fax: (804) 514-3323

Agri-Food & Environmental Group  
 Calgary Edmonton Winnipeg Lethbridge Surrey

Bill to: Northern Affairs Program  
 Report to: Northern Affairs Program

345-300 Main Street  
 Whitehorse, YT, Canada  
 Y1A 2B5

Attn: Pat Roach

Sampled By:  
 Company:

Project  
 ID:  
 Name: Standard  
 Location:  
 LSD:  
 P.O.:  
 Acct. Code:

NWL Lot ID: 186686  
 Control Number:  
 Date Received: Aug 13, 2002  
 Date Reported: Sep 04, 2002  
 Report Number: 296251

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Analyte	Units	Results	NWL Number	186686-2	186686-3	Detection Limit
			Sample Date	AGP-2 Aug 08/02	AGC-2 Aug 08/02	
			VSA-2 Aug 08/02			
<b>Metals Dissolved</b>						
Silicon	Dissolved	mg/L	4.30	4.79	4.73	0.05
Sulphur	Dissolved	mg/L	29.2	5.76	0.86	0.05
Aluminum	Dissolved	mg/L	<0.005	0.030	0.008	0.005
Antimony	Dissolved	mg/L	0.0014	<0.0002	<0.0002	0.0002
Arsenic	Dissolved	mg/L	0.299	0.0027	0.0007	0.0002
Barium	Dissolved	mg/L	0.028	0.008	0.007	0.001
Beryllium	Dissolved	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Bismuth	Dissolved	mg/L	<0.0005	<0.0005	<0.0005	0.0005
Boron	Dissolved	mg/L	0.003	<0.002	<0.002	0.002
Cadmium	Dissolved	mg/L	0.00167	0.00102	<0.00001	0.00001
Chromium	Dissolved	mg/L	0.0011	0.0005	<0.0005	0.0005
Cobalt	Dissolved	mg/L	<0.0001	0.0010	<0.0001	0.0001
Copper	Dissolved	mg/L	<0.001	0.004	<0.001	0.001
Lead	Dissolved	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Lithium	Dissolved	mg/L	0.010	<0.001	<0.001	0.001
Molybdenum	Dissolved	mg/L	0.008	<0.001	<0.001	0.001
Nickel	Dissolved	mg/L	<0.0005	0.0008	<0.0005	0.0005
Selenium	Dissolved	mg/L	0.0009	<0.0002	<0.0002	0.0002
Silver	Dissolved	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Strontium	Dissolved	mg/L	1.20	0.057	0.038	0.002
Thallium	Dissolved	mg/L	<0.00005	<0.00005	<0.00005	0.00005
Tin	Dissolved	mg/L	<0.001	<0.001	<0.001	0.001
Titanium	Dissolved	mg/L	0.0012	<0.0005	<0.0005	0.0005
Vanadium	Dissolved	mg/L	<0.0001	0.0001	0.0001	0.0001
Zinc	Dissolved	mg/L	0.060	0.040	<0.001	0.001
<b>Routine Water</b>						
Calcium	Dissolved	mg/L	53.7	14.1	8.9	0.2
Magnesium	Dissolved	mg/L	27.7	3.3	2.2	0.2
Sodium	Dissolved	mg/L	5.5	2.1	1.7	0.4
Potassium	Dissolved	mg/L	0.5	0.4	0.4	0.4
Iron	Dissolved	mg/L	<0.01	0.11	0.03	0.01
Manganese	Dissolved	mg/L	<0.005	0.139	<0.005	0.005



Accredited by the Standards Council of Canada (SCC) and by the Canadian Association for Environmental Analytical Laboratories (CAEAL) for specific tests registered with the Council and the Association



## Analytical Report

Norwest Labs  
 #104, 19575-55 A Ave.  
 Surrey, BC. V3S 8P8  
 Phone: (604) 514-3322  
 Fax: (604) 514-3323

Agri-Food & Environmental Group  
 Calgary Edmonton Winnipeg Lethbridge Surrey

Bill to: Northern Affairs Program  
 Report to: Northern Affairs Program

345-300 Main Street  
 Whitehorse, YT, Canada  
 Y1A 2B5

Attn: Pat Roach

Sampled By:  
 Company:

Project  
 ID:  
 Name: Standard  
 Location:  
 LSD:  
 P.O.:  
 Acct. Code:

NWL Lot ID: 186686  
 Control Number:  
 Date Received: Aug 13, 2002  
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Page: 2 of 8

Analyte	Units	Results	NWL Number	186686-5	186686-6	Detection Limit
			Sample Date	Sample Description	Results	
			186686-4	186686-5 <i>Unnamed Lake 2002</i> AGP-1 Aug 08/02	186686-6 <i>Inflow Tank Creek</i> AGC-1 Aug 08/02	
			VSA-1 Aug 08/02			
<b>Metals Dissolved</b>						
Silicon	Dissolved	mg/L 4.22		4.92	4.69	0.05
Sulphur	Dissolved	mg/L 29.4		4.87	0.94	0.05
Aluminum	Dissolved	mg/L <0.005		0.066	0.007	0.005
Antimony	Dissolved	mg/L 0.0016		<0.0002	<0.0002	0.0002
Arsenic	Dissolved	mg/L 0.307		0.0029	0.0007	0.0002
Barium	Dissolved	mg/L 0.027		0.007	0.006	0.001
Beryllium	Dissolved	mg/L <0.0001		<0.0001	<0.0001	0.0001
Bismuth	Dissolved	mg/L <0.0005		<0.0005	<0.0005	0.0005
Boron	Dissolved	mg/L 0.003		0.007	0.005	0.002
Cadmium	Dissolved	mg/L 0.00163		0.00083	0.00002	0.00001
Chromium	Dissolved	mg/L 0.0008		<0.0005	<0.0005	0.0005
Cobalt	Dissolved	mg/L <0.0001		0.0003	<0.0001	0.0001
Copper	Dissolved	mg/L <0.001		0.003	<0.001	0.001
Lead	Dissolved	mg/L 0.0003		<0.0001	<0.0001	0.0001
Lithium	Dissolved	mg/L 0.011		<0.001	<0.001	0.001
Molybdenum	Dissolved	mg/L 0.008		<0.001	<0.001	0.001
Nickel	Dissolved	mg/L <0.0005		0.0009	<0.0005	0.0005
Selenium	Dissolved	mg/L 0.0009		<0.0002	<0.0002	0.0002
Silver	Dissolved	mg/L <0.0001		<0.0001	<0.0001	0.0001
Strontium	Dissolved	mg/L 1.11		0.036	0.037	0.001
Thallium	Dissolved	mg/L 0.00007		<0.00005	<0.00005	0.00005
Tin	Dissolved	mg/L <0.001		<0.001	<0.001	0.001
Titanium	Dissolved	mg/L 0.0014		<0.0005	<0.0005	0.0005
Vanadium	Dissolved	mg/L <0.0001		<0.0001	<0.0001	0.0001
Zinc	Dissolved	mg/L 0.057		0.030	0.001	0.001
<b>Metals Total</b>						
Calcium	Total	mg/L 47.8		12.9	8.0	0.2
Iron	Total	mg/L <0.1		0.2	<0.1	0.1
Magnesium	Total	mg/L 26.4		3.0	2.0	0.2
Manganese	Total	mg/L <0.005		0.137	0.006	0.005
Potassium	Total	mg/L 0.5		0.4	<0.4	0.4
Silicon	Total	mg/L 3.99		4.35	4.29	0.05
Sodium	Total	mg/L 5.2		2.1	2.0	0.4
Sulphur	Total	mg/L 26.9		4.14	0.83	0.05
Aluminum	Total	mg/L 0.010		0.114	0.042	0.005
Antimony	Total	mg/L 0.0011		<0.0002	<0.0002	0.0002



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Analytical Report

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Analyte	Units	Results	186686-5	186686-6	Detection Limit
			AGP-1 Aug 08/02	AGC-1 Aug 08/02	
		NWL Number 186686-4	186686-5 <i>Unnamed Lake</i>	186686-6 <i>Inflow Tank Creek</i>	
		Sample Date	AGP-1 Aug 08/02	AGC-1 Aug 08/02	
		Sample Description VSA-1 Aug 08/02			
<b>Metals Total - Continued</b>					
Arsenic	Total mg/L	0.242	0.0033	0.0009	0.0002
Barium	Total mg/L	0.028	0.007	0.007	0.001
Beryllium	Total mg/L	<0.0001	<0.0001	<0.0001	0.0001
Bismuth	Total mg/L	<0.0005	<0.0005	<0.0005	0.0005
Boron	Total mg/L	0.004	<0.002	<0.002	0.002
Cadmium	Total mg/L	0.00160	0.00084	<0.00001	0.00001
Chromium	Total mg/L	<0.0005	<0.0005	<0.0005	0.0005
Cobalt	Total mg/L	<0.0001	0.0010	<0.0001	0.0001
Copper	Total mg/L	<0.001	0.005	<0.001	0.001
Lead	Total mg/L	0.0021	<0.0001	<0.0001	0.0001
Lithium	Total mg/L	0.012	<0.001	<0.001	0.001
Molybdenum	Total mg/L	0.008	<0.001	<0.001	0.001
Nickel	Total mg/L	<0.0005	0.0010	<0.0005	0.0005
Selenium	Total mg/L	0.0006	<0.0002	<0.0002	0.0002
Silver	Total mg/L	<0.0001	<0.0001	<0.0001	0.0001
Strontium	Total mg/L	1.29	0.059	0.039	0.001
Thallium	Total mg/L	<0.00005	<0.00005	<0.00005	0.00005
Titanium	Total mg/L	0.0018	0.0006	0.0017	0.0005
Uranium	Total mg/L	0.0052	<0.0005	<0.0005	0.0005
Vanadium	Total mg/L	<0.0001	<0.0001	0.0001	0.0001
Zinc	Total mg/L	0.064	0.034	<0.001	0.001
Zirconium	Total mg/L	<0.001	<0.001	<0.001	0.001
<b>Routine Water</b>					
Calcium	Dissolved mg/L	50.0	13.5	8.2	0.2
Magnesium	Dissolved mg/L	27.9	3.1	2.0	0.2
Sodium	Dissolved mg/L	5.5	2.1	2.1	0.4
Potassium	Dissolved mg/L	<0.4	<0.4	<0.4	0.4
Iron	Dissolved mg/L	0.02	0.13	0.02	0.01
Manganese	Dissolved mg/L	<0.005	0.083	0.005	0.005



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**NORWEST  
LABS**

## Analytical Report

Norwest Labs  
#104, 19575-55 A Ave.  
Surrey, BC. V3S 8P8  
Phone: (604) 514-3322  
Fax: (604) 514-3323

Agri-Food & Environmental Group  
Calgary Edmonton Winnipeg Lehighbridge Surrey

Bill to: Northern Affairs Program  
Report to: Northern Affairs Program

345-300 Main Street  
Whitehorse, YT, Canada  
Y1A 2B5

Attn: Pat Roach

Sampled By:  
Company:

Project  
ID:  
Name: Standard  
Location:  
LSD:  
P.O.:  
Acct. Code:

NWL Lot ID: 186686  
Control Number:  
Date Received: Aug 13, 2002  
Date Reported: Sep 04, 2002  
Report Number: 296251

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Analyte	Units	NWL Number	186686-7	186686-8	186686-9	Detection Limit
		Sample Date	VSI-2 Aug 11/02	VSD-2 Aug 11/02	VSO-2 Aug 11/02	
		Sample Description	Results	Results	Results	
<b>Metals Dissolved</b>						
Silicon	Dissolved	mg/L	3.52	3.92	4.11	0.05
Sulphur	Dissolved	mg/L	53.0	57.6	59.0	0.05
Aluminum	Dissolved	mg/L	<0.005	<0.005	<0.005	0.005
Antimony	Dissolved	mg/L	0.0002	0.0010	0.0012	0.0002
Arsenic	Dissolved	mg/L	0.0012	0.509	0.645	0.0002
Barium	Dissolved	mg/L	0.002	0.015	0.015	0.001
Beryllium	Dissolved	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Bismuth	Dissolved	mg/L	<0.0005	<0.0005	<0.0005	0.0005
Boron	Dissolved	mg/L	0.012	0.012	0.011	0.002
Cadmium	Dissolved	mg/L	<0.00001	0.00037	0.00045	0.00001
Chromium	Dissolved	mg/L	0.0016	0.0013	0.0013	0.0005
Cobalt	Dissolved	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Copper	Dissolved	mg/L	<0.001	<0.001	<0.001	0.001
Lead	Dissolved	mg/L	<0.0001	<0.0001	<0.0002	0.0001
Lithium	Dissolved	mg/L	0.001	0.001	0.001	0.001
Molybdenum	Dissolved	mg/L	<0.001	0.002	0.002	0.001
Nickel	Dissolved	mg/L	<0.0005	<0.0005	<0.0005	0.0005
Selenium	Dissolved	mg/L	0.0016	0.0014	0.0011	0.0002
Silver	Dissolved	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Strontium	Dissolved	mg/L	0.261	0.289	0.292	0.001
Thallium	Dissolved	mg/L	<0.00005	<0.00005	<0.00005	0.00005
Tin	Dissolved	mg/L	<0.001	<0.001	<0.001	0.001
Titanium	Dissolved	mg/L	0.0023	0.0025	0.0026	0.0005
Vanadium	Dissolved	mg/L	0.0003	0.0003	0.0003	0.0001
Zinc	Dissolved	mg/L	0.011	0.104	0.119	0.001
<b>Routine Water</b>						
Calcium	Dissolved	mg/L	52.0	63.1	65.4	0.2
Magnesium	Dissolved	mg/L	39.6	40.2	40.1	0.2
Sodium	Dissolved	mg/L	3.3	3.6	3.7	0.4
Potassium	Dissolved	mg/L	<0.4	<0.4	<0.4	0.4
Iron	Dissolved	mg/L	<0.01	<0.01	<0.01	0.01
Manganese	Dissolved	mg/L	<0.005	<0.005	<0.005	0.005

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## Analytical Report

Norwest Labs  
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Agri-Food & Environmental Group  
 Calgary Edmonton Winnipeg Lethbridge Surrey

Bill to: Northern Affairs Program  
 Report to: Northern Affairs Program

345-300 Main Street  
 Whitehorse, YT, Canada  
 Y1A 2B5

Attn: Pat Roach

Sampled By:  
 Company:

Project  
 ID:  
 Name: Standard  
 Location:  
 LSD:  
 P.O.:  
 Acct. Code:

NWL Lot ID: 186686  
 Control Number:  
 Date Received: Aug 13, 2002  
 Date Reported: Sep 04, 2002  
 Report Number: 296251

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Analyte	Units	NWL Number	186686-8	186686-10	186686-11	Detection Limit
		Sample Date	VSD-2 Aug 11/02	VSI-1 Aug 11/02	VSD-1 Aug 11/02	
<b>Metals Total</b>						
Calcium	Total	mg/L	54.8	46.1	56.0	0.2
Iron	Total	mg/L	<0.1	<0.1	0.2	0.1
Magnesium	Total	mg/L	39.9	38.5	38.9	0.2
Manganese	Total	mg/L	<0.005	<0.005	0.015	0.005
Potassium	Total	mg/L	<0.4	<0.4	0.5	0.4
Silicon	Total	mg/L	2.85	3.19	3.53	0.05
Sodium	Total	mg/L	2.9	3.4	3.5	0.4
Sulphur	Total	mg/L	54.3	49.1	53.9	0.05
Aluminum	Total	mg/L	0.012	0.009	0.017	0.005
Antimony	Total	mg/L	0.0008	<0.0002	0.0008	0.0002
Arsenic	Total	mg/L	0.432	0.0010	0.466	0.0002
Barium	Total	mg/L	0.013	0.002	0.015	0.001
Beryllium	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Bismuth	Total	mg/L	<0.0005	<0.0005	<0.0005	0.0005
Boron	Total	mg/L	0.016	0.013	0.012	0.002
Cadmium	Total	mg/L	0.00036	<0.00001	0.00033	0.00001
Chromium	Total	mg/L	<0.0005	0.0008	0.0005	0.0005
Cobalt	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Copper	Total	mg/L	<0.001	<0.001	<0.001	0.001
Lead	Total	mg/L	<0.0001	<0.0001	0.0004	0.0001
Lithium	Total	mg/L	0.002	0.001	0.001	0.001
Molybdenum	Total	mg/L	0.002	<0.001	0.002	0.001
Nickel	Total	mg/L	<0.0005	<0.0005	<0.0005	0.0005
Selenium	Total	mg/L	0.0008	0.0014	0.0009	0.0002
Silver	Total	mg/L	<0.0001	<0.0001	<0.0001	0.0001
Strontium	Total	mg/L	0.269	0.274	0.299	0.001
Thallium	Total	mg/L	<0.00005	<0.00005	<0.00005	0.00005
Titanium	Total	mg/L	0.0020	0.0021	0.0027	0.0005
Uranium	Total	mg/L	0.0009	0.0006	0.0008	0.0005
Vanadium	Total	mg/L	0.0003	0.0004	0.0005	0.0001
Zinc	Total	mg/L	0.091	0.014	0.105	0.001
Zirconium	Total	mg/L	<0.001	<0.001	<0.001	0.001



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## Analytical Report

Norwest Labs  
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Agri-Food & Environmental Group  
 Calgary Edmonton Winnipeg Lethbridge Surrey

Bill to: Northern Affairs Program  
 Report to: Northern Affairs Program

345-300 Main Street  
 Whitehorse, YT, Canada  
 Y1A 2B5

Attn: Pat Roach

Sampled By:  
 Company:

Project  
 ID:  
 Name: Standard  
 Location:  
 LSD:  
 P.O.:  
 Acct. Code:

NWL Lot ID: 186686  
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 Date Received: Aug 13, 2002  
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Analyte		Units	NWL Number		Results	Detection Limit
			186686-10	186686-12		
			Sample Date	Sample Date		
Sample Description		VSI-1 Aug 11/02	VSO-1 Aug 11/02			
<b>Metals Dissolved</b>						
Silicon	Dissolved	mg/L	3.44	3.90	0.05	
Sulphur	Dissolved	mg/L	55.3	57.9	0.05	
Aluminum	Dissolved	mg/L	<0.005	<0.005	0.005	
Antimony	Dissolved	mg/L	<0.0002	0.0010	0.0002	
Arsenic	Dissolved	mg/L	0.0012	0.493	0.0002	
Barium	Dissolved	mg/L	0.002	0.015	0.001	
Beryllium	Dissolved	mg/L	<0.0001	<0.0001	0.0001	
Bismuth	Dissolved	mg/L	<0.0005	<0.0005	0.0005	
Boron	Dissolved	mg/L	0.015	0.016	0.002	
Cadmium	Dissolved	mg/L	0.00001	0.00031	0.00001	
Chromium	Dissolved	mg/L	0.0014	0.0012	0.0005	
Cobalt	Dissolved	mg/L	<0.0001	<0.0001	0.0001	
Copper	Dissolved	mg/L	<0.001	<0.001	0.001	
Lead	Dissolved	mg/L	<0.0001	<0.0001	0.0001	
Lithium	Dissolved	mg/L	0.001	0.001	0.001	
Molybdenum	Dissolved	mg/L	<0.001	0.002	0.001	
Nickel	Dissolved	mg/L	<0.0005	<0.0005	0.0005	
Selenium	Dissolved	mg/L	0.0016	0.0013	0.0002	
Silver	Dissolved	mg/L	<0.0001	<0.0001	0.0001	
Strontium	Dissolved	mg/L	0.242	0.266	0.001	
Thallium	Dissolved	mg/L	<0.00005	<0.00005	0.00005	
Tin	Dissolved	mg/L	<0.001	<0.001	0.001	
Titanium	Dissolved	mg/L	0.0027	0.0028	0.0005	
Vanadium	Dissolved	mg/L	0.0003	0.0004	0.0001	
Zinc	Dissolved	mg/L	0.013	0.096	0.001	
<b>Routine Water</b>						
Calcium	Dissolved	mg/L	48.1	56.6	0.2	
Magnesium	Dissolved	mg/L	40.5	41.1	0.2	
Sodium	Dissolved	mg/L	3.6	3.8	0.4	
Potassium	Dissolved	mg/L	<0.4	<0.4	0.4	
Iron	Dissolved	mg/L	<0.01	<0.01	0.01	
Manganese	Dissolved	mg/L	<0.005	<0.005	0.005	



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## Analytical Report

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 Report to: Northern Affairs Program

345-300 Main Street  
 Whitehorse, YT, Canada  
 Y1A 2B5

Attn: Pat Roach

Sampled By:  
 Company:

Project  
 ID:  
 Name: Standard  
 Location:  
 LSD:  
 P.O.:  
 Acct. Code:

NWL Lot ID: 186686  
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 Date Received: Aug 13, 2002  
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NWL Number 186686-12  
 Sample Date  
 Sample Description VSO-1 Aug 11/02

Analyte	Units	Results	Results	Results	Detection Limit
<b>Metals Total</b>					
Calcium	Total	mg/L	55.2		0.2
Iron	Total	mg/L	<0.1		0.1
Magnesium	Total	mg/L	38.3		0.2
Manganese	Total	mg/L	<0.005		0.005
Potassium	Total	mg/L	<0.4		0.4
Silicon	Total	mg/L	3.50		0.05
Sodium	Total	mg/L	3.5		0.4
Sulphur	Total	mg/L	53.3		0.05
Aluminum	Total	mg/L	0.032		0.005
Antimony	Total	mg/L	0.0008		0.0002
Arsenic	Total	mg/L	0.464		0.0002
Barium	Total	mg/L	0.016		0.001
Beryllium	Total	mg/L	<0.0001		0.0001
Bismuth	Total	mg/L	<0.0005		0.0005
Boron	Total	mg/L	0.013		0.002
Cadmium	Total	mg/L	0.00033		0.00001
Chromium	Total	mg/L	0.0005		0.0005
Cobalt	Total	mg/L	<0.0001		0.0001
Copper	Total	mg/L	0.002		0.001
Lead	Total	mg/L	0.0007		0.0001
Lithium	Total	mg/L	0.001		0.001
Molybdenum	Total	mg/L	0.002		0.001
Nickel	Total	mg/L	<0.0005		0.0005
Selenium	Total	mg/L	0.0009		0.0002
Silver	Total	mg/L	<0.0001		0.0001
Strontium	Total	mg/L	0.306		0.001
Thallium	Total	mg/L	<0.00005		0.00005
Titanium	Total	mg/L	0.0033		0.0005
Uranium	Total	mg/L	0.0008		0.0005
Vanadium	Total	mg/L	0.0006		0.0001
Zinc	Total	mg/L	0.113		0.001
Zirconium	Total	mg/L	<0.001		0.001

Approved by: Bill Warning  
 Lab Operations Manager



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Fax: (504) 514-3323

Agri-Food & Environmental Group  
Calgary Edmonton Winnipeg Lethbridge Surrey

Bill to: Northern Affairs Program  
Report to: Northern Affairs Program  
345-300 Main Street  
Whitehorse, YT, Canada  
Y1A 2B5  
Attn: Pat Roach  
Sampled By:  
Company:

Project  
ID:  
Name: Standard  
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LSD:  
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NWL Lot ID: 186686  
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Date Received: Aug 13, 2002  
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**Method of Analysis:**

Test	Reference	Method	Date of Analysis	Location	Analyst
Metals ICP-MS (Dissolved) in water	US EPA	* Determination of Trace Elements in Waters and Wastes by ICP-MS, 200.8	Aug 16, 2002	Norwest Labs Edmonton	Darren Crichton
		*	Aug 17, 2002	Norwest Labs Edmonton	Darren Crichton
		*	Aug 30, 2002	Norwest Labs Edmonton	Darren Crichton
		*	Sep 03, 2002	Norwest Labs Edmonton	To Thong
Metals ICP-MS (Total) in water	US EPA	* Determination of Trace Elements in Waters and Wastes by ICP-MS, 200.8	Aug 17, 2002	Norwest Labs Edmonton	Darren Crichton
		*	Aug 31, 2002	Norwest Labs Edmonton	To Thong
Metals Trace (Dissolved) in water	APHA	* Inductively Coupled Plasma (ICP) Method, 3120 B	Aug 16, 2002	Norwest Labs Edmonton	Jesse Dang
		*	Aug 30, 2002	Norwest Labs Edmonton	Darren Crichton
Metals Trace (Total) in water	APHA	* Inductively Coupled Plasma (ICP) Method, 3120 B	Aug 19, 2002	Norwest Labs Edmonton	Jesse Dang
		*	Sep 03, 2002	Norwest Labs Edmonton	Jesse Dang

\* Norwest method(s) is based on reference method

**References:**

APHA  
US EPA

Standard Methods for the Examination of Water and Wastewater  
US Environmental Protection Agency Test Methods

**Comments:**

Norwest Labs strongly recommends that this report is not reproduced except in full.

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