



APPENDIX 8H

ACUTE TOXICITY TESTING OF PREDICTED JAY PROJECT EFFLUENT COMPOSITION

DATE August 22, 2014**PROJECT No.** 1407256/4070/10**TO** Eric Denholm
Dominion Diamonds**FROM** Peter M Chapman**EMAIL** pmchapman@golder.com**ACUTE TOXICITY TESTING OF PREDICTED JAY PROJECT EFFLUENT COMPOSITION**

Please find attached to this Memorandum the following two documents, which were prepared by James Elphick (Nautilus Environmental) and reviewed by Peter Chapman (Golder Associates Ltd.):

- Rainbow Trout (*Oncorhynchus mykiss*) and *Daphnia magna* acute toxicity testing based on the ionic balance of predicted effluent composition during “End of Open Pit Mining” and “Underground Mining” scenarios (Attachment A); and,
- *Daphnia magna* toxicity testing based on the ionic balance of predicted effluent composition during “End of Open Pit Mining” under open water and under-ice scenarios (Attachment B).

These two documents provide information on acute toxicity testing conducted to determine whether effluent discharged from the proposed Jay Project would be acutely toxic. The testing considered open pit mining as well as the potential for subsequent underground mining. Although underground mining is not currently being planned for the Project, it may be considered at a future date. Effluent composition used for the toxicity testing was based on predictions from conservative modelling whose uncertainty is highest for the underground mining. Modelling predictions will be refined as mining proceeds and additional data on open pit and potentially underground water quality become available.

The 96-h Rainbow Trout and 48-h *Daphnia magna* tests conducted are those presently required for assessing acute toxicity from existing Ekati Mine effluent discharges (Environment Canada 2000a,b). The testing detailed in Attachment A indicates that there will be no acute toxicity to Rainbow Trout during open pit mining (there is no effluent discharge during the first five years of open pit mining) or during underground mining, with either under-ice or open-water discharge (effluent with the highest predicted total dissolved solids [TDS] concentration was tested for underground mining). Mixing and dilution are lower with under-ice discharge than with open-water discharge. However, the testing detailed in Attachment A also indicated that, while there will be no acute toxicity to *D. magna* during open pit mining (83% survival at the end of open pit mining represents a lethal concentration to 50% of the tested fish [LC50] of >100% effluent), effluent predicted during underground mining was acutely toxic to *D. magna* (0% survival) with under-ice discharge.

Additional testing was conducted (Attachment B) with *D. magna* to further assess acute toxicity at the end of open pit mining considering both under-ice and open-water discharges (predicted under-ice effluent TDS concentrations were higher than open water concentrations), and additional effluent dilution. Additional testing



for underground mining was not conducted as both the possibility of underground mining following open pit mining and the quality of effluent that might be produced during underground mining remain highly uncertain. The additional testing indicated that acute toxicity (i.e., LC50 <100%) was more likely for *D. magna* at end of open pit mining (highest TDS concentrations for open pit mining) with under-ice discharge than with open-water discharge, and that a relatively low rate of effluent dilution resulted in 100% survival.

Effluent toxicity to *D. magna* at the end of open pit mining varied by less than a factor of two between the initial (Attachment A) and additional testing (Attachment B): 83% survival versus $45 \pm 35\%$ survival. This difference is not unreasonably large (Cherr et al. 1994). Given the conservatism of the modelling, it is likely that effluent produced during open pit mining of the Jay Pit will not be acutely toxic even during the maximum predicted effluent TDS concentrations the last year of mining. However, monitoring including chemical analyses and toxicity testing will be conducted from initiation through closure (i.e., end of open pit mining under the current mine plan) to provide early warning whether this could occur, such that appropriate management actions can be taken, as necessary and appropriate, to prevent the release of acutely toxic effluents.

We trust that this Memorandum and attachments provide you with the information you require. However, if you have any questions or require additional information, please do not hesitate to contact the undersigned.

A handwritten signature in black ink that reads "Peter M. Chapman". The signature is fluid and cursive, with a long horizontal stroke extending from the end of the name.

Peter M. Chapman, Ph.D.
Principal, Technical Director
PMC/cd

REFERENCES CITED

- Environment Canada. 2000a. Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Rainbow Trout. Environmental Protection Series. Report EPS 1/RM/13, Second Edition, including May 2007 amendments. Method Development and Application Section, Environmental Technology Centre, Ottawa, ON, Canada, 23 pp.
- Environment Canada. 2000b. Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to *D. magna*. Environmental Protection Series. Report EPS 1/RM/14, Second Edition. Method Development and Application Section, Environmental Technology Centre, Ottawa, ON, Canada, 21 pp.
- Cherr G, Dinnel P, Caldwell R, Cardwell R, Chapman PM. 1994. West Coast Marine Species Chronic Protocol Variability Study: Criteria for Acceptable Variability of Marine Chronic Toxicity Test Methods. Washington State Biomonitoring Science Advisory Board Report No. 1. Washington Department of Ecology, Olympia, WA, USA.

Attachment A
**Rainbow Trout (*Oncorhynchus mykiss*) and *Daphnia magna* acute toxicity testing for
predicted ionic balances**



Rainbow Trout (*Oncorhynchus mykiss*) and *Daphnia magna* acute toxicity testing for predicted ionic balances

Final Report

Report date:
August 20, 2014

Submitted to:

Golder Associates Ltd.
Burnaby, BC

8664 Commerce Court
Burnaby, BC
V5A 4N7

TABLE OF CONTENTS

	Page
TABLE OF CONTENTS	I
SIGNATURE PAGE	III
1.0 INTRODUCTION.....	1
2.0 METHODS	1
3.0 RESULTS	4
4.0 QA/QC	6
5.0 REFERENCES	7

LIST OF TABLES

Table 1.	Summary of test conditions: 96-h Rainbow Trout (<i>Oncorhynchus mykiss</i>) test.	2
Table 2.	Summary of test conditions: 48-h <i>Daphnia magna</i> test.....	3
Table 3.	Results: 96-h Rainbow Trout (<i>Oncorhynchus mykiss</i>) survival.....	4
Table 4.	Results: 48-h <i>Daphnia magna</i> survival.	4
Table 5.	Ion concentrations (mg/L) for Year 6, Year 8, End of Open Pit Mining and Underground Mining samples tested in the 96-h Rainbow Trout and 48-h <i>Daphnia magna</i> survival tests. Nominal concentrations are presented in each case followed by actual (measured) concentrations for each of the fish and the daphnid.	5
Table 6.	Reference toxicant results.....	6

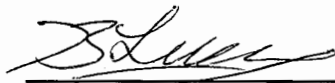
LIST OF APPENDICES

APPENDIX A - Rainbow Trout Toxicity Test Data

APPENDIX B - *Daphnia magna* Toxicity Test Data

APPENDIX C - Analytical Chemistry Data

SIGNATURE PAGE



Brett Lucas, M.Sc.
Environmental Scientist



James Elphick, R.P.Bio.
Senior Reviewer

This report has been prepared by Nautilus Environmental Company Inc. based on data and/or samples provided by our client; the results of this study are for their sole benefit. Any reliance on the data by a third party is at the sole and exclusive risk of that party. The results presented here relate only to the samples tested.

1.0 INTRODUCTION

Nautilus Environmental conducted acute toxicity tests for Golder Associates Ltd. (Golder) to characterize the toxicity of four predicted water discharges from the Dominion Diamonds Jay Pit identified as: Year 6; Year 8; End of Open Pit Mining; and, Underground Mining.

The following acute toxicity tests were conducted on the laboratory-prepared waters:

- 96-h Rainbow Trout (*Oncorhynchus mykiss*) acute single concentration screening test; and,
- 48-h *Daphnia magna* acute single concentration screening test.

This report describes the results of these toxicity tests. Copies of raw laboratory data sheets and statistical analyses are provided in Appendices A and B for Rainbow Trout and *D. magna*, respectively. Results of analytical chemistry measurements are provided in Appendix C.

2.0 METHODS

Four water samples were prepared at the Nautilus Environmental laboratory in Burnaby, BC, using deionized water mixed with analytical grade salts (NaCl, KCl, $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$, $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$, CaSO_4 , NaHCO_3 , NaF and NaNO_3). Salts were added to achieve four blends of ions associated with four water types, as specified by Golder. The salts were stirred into the waters and the samples were then stored overnight in an environmental chamber at $15 \pm 1^\circ\text{C}$ for Rainbow Trout and $20 \pm 2^\circ\text{C}$ for *D. magna*, in order equilibrate prior to testing. The Rainbow Trout and *D. magna* tests were initiated on July 17 and August 11, 2014, respectively. Subsamples of the test waters were collected and analyzed by ALS laboratories (Burnaby, BC) for the ions that were added.

Procedures used for the toxicity tests on Rainbow Trout and *D. magna* are summarized in Tables 1 and 2, respectively. Testing was conducted according to procedures described by Environment Canada (2000a,b).

Table 1. Summary of test conditions: 96-h Rainbow Trout (*Oncorhynchus mykiss*) test.

Test organism	<i>Oncorhynchus mykiss</i>
Test organism source	Campbell Lake Trout Farm, Little Fort, BC
Test organism age	Fry
Test type	Static
Test duration	96 hours
Test vessel	20 L glass aquarium
Test volume	10 L
Test replicates	1 test replicate per treatment
No. of organisms	10 per replicate
Control water	Dechlorinated municipal tapwater
Test solution renewal	None
Test temperature	15 ± 1°C
Feeding	None
Light intensity	100 to 500 lux
Photoperiod	16 hours light/8 hours dark
Aeration	6.5 ± 1 mL/min/L
Test protocol	Environment Canada (2000a), EPS 1/RM/13
Test endpoint	96-h survival
Test acceptability criteria for controls	Survival ≥ 90%
Reference toxicant	Sodium nitrite

Table 2. Summary of test conditions: 48-h *Daphnia magna* test.

Test organism	<i>Daphnia magna</i>
Test organism source	In-house culture
Test organism age	<24 h
Test type	Static
Test duration	48 h
Test vessel	250 mL glass beakers
Test volume	200 mL
Test replicates	3 test replicates per treatment
No. of organisms	10 per replicate
Control water	Moderately hard reconstituted water
Test solution renewal	None
Test temperature	20 ± 2°C
Feeding	None
Light intensity	400 to 800 lux
Photoperiod	16 hours light/8 hours dark
Aeration	None
Test protocol	Environment Canada (2000b), EPS 1/RM/14
Test endpoint	48-h survival
Test acceptability criteria for controls	Survival ≥ 90%
Reference toxicant	Sodium chloride

3.0 RESULTS

Results of the toxicity tests conducted using Rainbow Trout and *D. magna* are provided in Tables 3 and 4, respectively. There were no adverse effects on survival of Rainbow Trout in any of the test waters. Similarly, there were no adverse effects on survival of *D. magna* in the Year 6 and Year 8 samples; however, survival of *D. magna* was 83% and 0% in the End of Open Pit Mining and Underground Mining samples, respectively.

The targeted (nominal) and measured concentrations of ions in the Rainbow Trout and *D. magna* tests are shown in Table 5.

Table 3. Results: 96-h Rainbow Trout (*Oncorhynchus mykiss*) survival.

	Year 6	Year 8	End of Operation	Underground
Control	100	100	100	100
100% Sample	100	100	100	100

Table 4. Results: 48-h *Daphnia magna* survival.

	Year 6	Year 8	End of Operation	Underground
Control	100	100	100	100
100% Sample	100	100	83	0

Table 5. Ion concentrations (mg/L) for Year 6, Year 8, End of Open Pit Mining and Underground Mining samples tested in the 96-h Rainbow Trout and 48-h *Daphnia magna* survival tests. Nominal concentrations are presented in each case followed by actual (measured) concentrations for each of the fish and the daphnid.

		HCO ₃	Cl	F	SO ₄	NO ₃ -N	Ca	Mg	Na	K
Year 6	Nominal	5.0	140	0.06	17.0	10.0	53	8.5	37	4.7
	<i>O. mykiss</i>	6.0	134	0.08	18.0	10.4	50	9.0	43	5.5
	<i>D. magna</i>	6.3	142	0.08	17.8	10.2	56	9.0	41	5.2
Year 8	Nominal	5.0	643	0.10	14.0	13.0	228	18.0	151	5.2
	<i>O. mykiss</i>	7.4	862	<0.40	15.0	19.0	294	17.8	163	5.2
	<i>D. magna</i>	6.3	652	<0.40	13.0	13.4	230	18.3	149	5.6
End of Open Pit Mining	Nominal	5.0	1728	0.13	17.0	20.0	606	34.0	387	6.3
	<i>O. mykiss</i>	4.7	1860	<1.00	<25.0	21.6	579	31.9	368	5.8
	<i>D. magna</i>	6.8	1700	1.20	18.4	20.0	589	34.3	394	6.8
Underground Mining	Nominal	5.0	5265	0.13	17.0	23.0	1836	75.0	1147	6.3
	<i>O. mykiss</i>	<2.4	4800	<1.0	<25.0	23.0	1320	68.0	1050	6.0
	<i>D. magna</i>	3.5	5170	0.16	17.7	22.8	1790	72.3	1190	6.3

Concentrations with a "<" symbol represent measured concentrations that were below the listed detection limit of the analytical test due to matrix-related effects.

4.0 QA/QC

The health history of the test organisms used in the exposures was acceptable and met the requirements of the Environment Canada (2000a,b) protocols. The tests met all control acceptability criteria and water quality parameters remained within ranges specified in the protocols throughout the tests. There were no deviations from the test methodologies.

In general, the targeted and measured concentrations were in good agreement in the tests although, as a result of matrix related effects, some of the analytes were reported as less than detection in a subset of samples (in particular, fluoride and sulphate). The fluoride concentration in the “End of Open Pit Mining” sample tested with *D. magna* was approximately ten-times higher than targeted; however, it appears likely that this was the result of an analytical error or interference, since fluoride was introduced in the same manner volumetrically using a stock solution of NaF into the “End of Open Pit Mining” and “Underground Mining” samples, and the latter sample had measured fluoride that was in good agreement with the targeted fluoride. In addition, the concentration of fluoride that was measured was below the chronic effects benchmark of 1.94 mg/L (McPherson et al. in press).

Results of the reference toxicant tests conducted during the testing program are summarized in Table 6. Results for these tests fell within the range for acceptable organism performance of mean \pm two standard deviations, based on historical results obtained by the laboratory with these tests. Thus, the sensitivity of the organisms used in these tests was appropriate.

Table 6. Reference toxicant results.

Test Species	Endpoint	Historical Mean (2 SD Range)	CV (%)	Test Date
<i>O. mykiss</i>	LC50: 11.0 mg/L NO ₂	5.1 (2.1 - 12.6)	57	May 22, 2014
<i>D. magna</i>	LC50: 3.9 g/L NaCl	4.0 (3.7 - 4.3)	4.0	August 5, 2014

SD = Standard Deviation, CV = Coefficient of Variation, LC = Lethal Concentration.

5.0 REFERENCES

Environment Canada. 2000a. Biological test method: reference method for determining acute lethality of effluents to rainbow trout. Environmental Protection Series. Report EPS 1/RM/13, Second Edition, including May 2007 amendments. Method Development and Application Section, Environmental Technology Centre, Ottawa, ON, Canada, 23 pp.

Environment Canada. 2000b. Biological test method: reference method for determining acute lethality of effluents to *D. magna*. Environmental Protection Series. Report EPS 1/RM/14, Second Edition. Method Development and Application Section, Environmental Technology Centre, Ottawa, ON, Canada, 21 pp.

McPherson C, Lee DHY, Chapman PM. In Press. Development of a fluoride chronic effects benchmark for aquatic life in freshwater. Environ Toxicol Chem DOI: 10.1002/etc.2724.

APPENDIX A - Rainbow Trout Toxicity Test Data

Rainbow Trout Summary Sheet

Client:

Golder

Start Date/Time: July 17, 2014 @ 10:50

Work Order No.:

14447

Test Species: Oncorhynchus mykiss

Sample Information:

Sample ID:

Year 8

Sample Date:

N/A made in-house

Date Received:

N/A made in-house

Sample Volume:

15L

Other:

sample made using salts to emulate predicted site ion concentrations.

Test Validity Criteria:

≥ 90% control survival

WQ Ranges:

T (°C) = 15 ± 1; DO (mg/L) = 7.0 to 10.3; pH = 5.5 to 8.5

Dilution Water:

Type:

Dechlorinated Municipal Tap Water

Hardness (mg/L CaCO₃):

9

Alkalinity (mg/L CaCO₃):

12

Test Organism Information:

Batch No.:

061114

Source:

Campbell Lake Trout Farm

No. Fish/Volume (L):

10/10L

Loading Density (g/L):

0.38

Mean Length ± SD (mm):

35 ± 3

Mean Weight ± SD (g):

0.58 ± 0.11

Range: 30 - 41

Range: 0.23 - 0.61

NaNO₂ Reference Toxicant Results:

Reference Toxicant ID:

RTN+63

Stock Solution ID:

14N+01

Date Initiated:

June 26, 2014

96-h LC₅₀ (95% CL):

11.0 (7.7 - 18.2)

Reference Toxicant Mean and Historical Range:

5.1 (2.1 - 12.6)

Reference Toxicant CV (%):

57

Test Results:

There was 100% survival in the 100% v/v sample following a 96-h survival exposure period.

BTL

Reviewed by:

Joh

Date reviewed:

July 30/14

96-Hour Rainbow Trout Toxicity Test Data Sheet

Client/Project#: Golder
 Sample I.D. Year 8
 W.O. # 14447
 RBT Batch #: 061114
 Date Collected/Time: N/A
 Date Setup/Time: July 17, 2014 @ 10:50
 Sample Setup By: RTL

 D.O. meter: 2
 pH meter: 2
 Cond. Meter: 2

Number Fish/Volume: 10/10L
 7-d % Mortality: 0.07
 Total Pre-aeration Time (mins): 30
 Aeration rate adjusted to 6.5 ± 1 mL/min/L? (Y/N): Y

Undiluted Sample WQ			
Parameters	Initial WQ	Adjustment	30 min WQ
Temp °C	15.0	/	15.0
pH	6.6		6.5
D.O. (mg/L)	8.8		7.2
Cond. (µS/cm)	1311		1885

Concentration	# Survivors							Temperature (°C)					Dissolved Oxygen (mg/L)					pH					Conductivity (µS/cm)	
(% v/v)	1	2	4	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	96
Control				10	10	10	10	14.5	14.0	14.0	14.5	14.0	9.7	9.8	10.1	10.0	10.0	7.1	7.2	7.3	7.4	7.4	32	42
100				10	10	10	10	15.0	14.0	14.0	14.5	14.0	9.2	9.9	10.0	9.9	10.0	6.5	6.6	6.8	6.9	7.0	1885	1909
Initials				JBF	JW	KW	JBF	RTL	JBF	JW	KW	JBF	RTL	JBF	JW	KW	JBF	RTL	JBF	JW	KW	JBF	RTL	JBF

WQ Ranges: T (°C) = 15 ± 1; DO (mg/L) = 7.0 to 10.3; pH = 5.5 to 8.5

Sample Description/Comments: low concentrations in 100% sample were added in the lab to match predicted field concentrations

Fish Description at 96 h All Fish OK Number of Stressed Fish at 96 h 0

Other Observations: _____

Reviewed by: JGU Date Reviewed: July 25/14

Rainbow Trout Summary Sheet

Client: Golder

Start Date/Time: July 17, 2014 @ 16:50

Work Order No.: 14447

Test Species: Oncorhynchus mykiss

Sample Information:

Sample ID: End of Operation

Sample Date: N/A made in-house

Date Received: N/A made in-house

Sample Volume: 15L

Other: Sample made using salts to emulate predicted site ion concentrations.

Test Validity Criteria:

≥ 90% control survival

WQ Ranges:

T (°C) = 15 ± 1; DO (mg/L) = 7.0 to 10.3; pH = 5.5 to 8.5

Dilution Water:

Type: Dechlorinated Municipal Tap Water

Hardness (mg/L CaCO₃): 9

Alkalinity (mg/L CaCO₃): 12

Test Organism Information:

Batch No.: 061114

Source: Campbell Lake Trout Farm

No. Fish/Volume (L): 10/10L

Loading Density (g/L): 0.354 BTL

Mean Length ± SD (mm): 34 ± 2

Range: 30-37

Mean Weight ± SD (g): 0.34 ± 0.07

Range: 0.24-0.45

NaNO₂ Reference Toxicant Results:

Reference Toxicant ID: RTN463

Stock Solution ID: 14N+01

Date Initiated: June 26, 2014

96-h LC₅₀ (95% CL): 11.0 (7.7-18.2)

Reference Toxicant Mean and Historical Range: 5.1 (2.1-12.6)

Reference Toxicant CV (%): 57

Test Results: There was 100% survival in the 100% v/v sample following a 96-h exposure period.

Reviewed by: JOU

Date reviewed: July 30/14

96-Hour Rainbow Trout Toxicity Test Data Sheet

Client/Project#: Golder
 Sample I.D. End of Operation
 W.O. # 14447
 RBT Batch #: 061114
 Date Collected/Time: N/A
 Date Setup/Time: July 17, 2014 @ 10:50
 Sample Setup By: BTL

D.O. meter: 2
 pH meter: 2
 Cond. Meter: 2

Number Fish/Volume: 10/10L
 7-d % Mortality: 0.07
 Total Pre-aeration Time (mins): 30
 Aeration rate adjusted to 6.5 ± 1 mL/min/L? (Y/N): Y

Undiluted Sample WQ			
Parameters	Initial WQ	Adjustment	30 min WQ
Temp °C	15.5	/	15.0
pH	6.5		6.5
D.O. (mg/L)	8.8		9.4
Cond. (µS/cm)	2390		4510

Concentration	# Survivors							Temperature (°C)					Dissolved Oxygen (mg/L)					pH					Conductivity (µS/cm)	
(% v/v)	1	2	4	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	96
Control				10	10	10	10	14.5	14.0	14.0	14.5	14.0	9.7	9.9	10.1	10.1	10.0	7.1	7.2	7.3	7.4	7.4	32	45
100				10	10	10	10	15.0	14.0	14.0	14.5	14.0	9.2	9.9	10.1	10.1	9.9	6.5	6.6	6.7	6.8	6.9	4510	4570
													9.4											
Initials				JBF	JW		JBF	BTL	JBF	JW		JBF	BTL	JBF	JW		JBF	BTL	JBF	JW		JBF	BTL	JBF

WQ Ranges: T (°C) = 15 ± 1; DO (mg/L) = 7.0 to 10.3; pH = 5.5 to 8.5

Sample Description/Comments: 100 concentrations in 100% sample were added in the lab to match predicted field concentrations

Fish Description at 96 h All fish ok Number of Stressed Fish at 96 h 0

Other Observations: _____

Reviewed by: Joh

Date Reviewed: July 25/14

Rainbow Trout Summary Sheet

Client: Golden

Start Date/Time: July 17, 2014 @ 10:50

Work Order No.: 14447

Test Species: Oncorhynchus mykiss

Sample Information:

Sample ID: Underground

Sample Date: N/A made in-house

Date Received: N/A made in-house

Sample Volume: 15L

Other: Sample made using salts to emulate predicted site ion concentrations.

Test Validity Criteria:

≥ 90% control survival

WQ Ranges:

T (°C) = 15 ± 1; DO (mg/L) = 7.0 to 10.3; pH = 5.5 to 8.5

Dilution Water:

Type: Dechlorinated Municipal Tap Water

Hardness (mg/L CaCO₃): 9

Alkalinity (mg/L CaCO₃): 12

Test Organism Information:

Batch No.: 061114

Source: Campbell Lake Trout Farm

No. Fish/Volume (L): 10/10L

Loading Density (g/L): 0.37

Mean Length ± SD (mm): 35 ± 4

Mean Weight ± SD (g): 0.37 ± 0.11

Range: 28-40

Range: 0.18-0.51

NaNO₂ Reference Toxicant Results:

Reference Toxicant ID: RTN463

Stock Solution ID: 14N701

Date Initiated: June 26, 2014

96-h LC₅₀ (95% CL): 11.0 (7.7-18.2)

Reference Toxicant Mean and Historical Range: 5.1 (2.1-12.6)

Reference Toxicant CV (%): 57

Test Results: There was 100% survival in the 100% v/v sample following a 96-h exposure period.

Reviewed by: JGU

Date reviewed: July 25/14

96-Hour Rainbow Trout Toxicity Test Data Sheet

Client/Project#: Goldier
 Sample I.D. Under ground
 W.O. # 14447
 RBT Batch #: 061114
 Date Collected/Time: N/A
 Date Setup/Time: July 17, 2014 @ 10:50
 Sample Setup By: BTL

D.O. meter: 2
 pH meter: 2
 Cond. Meter: 2

Number Fish/Volume: 10/10L
 7-d % Mortality: 0.07
 Total Pre-aeration Time (mins): 30
 Aeration rate adjusted to 6.5 ± 1 mL/min/L? (Y/N): Y

Undiluted Sample WQ			
Parameters	Initial WQ	Adjustment	30 min WQ
Temp °C	15.5		15.5
pH	6.4		6.4
D.O. (mg/L)	8.9		9.4
Cond. (µS/cm)	9280		9730

Concentration	# Survivors							Temperature (°C)					Dissolved Oxygen (mg/L)					pH					Conductivity (µS/cm)	
	1	2	4	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	96
Control				10	10	10	10	14.5	14.0	14.0	14.5	14.0	9.8	9.9	10.0	10.1	10.1	7.1	7.2	7.3	7.4	7.3	32	44
100				10	10	10	10	15.5	14.0	14.0	14.5	14.0	9.4	9.9	10.0	10.0	10.0	6.4	6.5	6.6	6.7	6.8	9730	9880
Initials				DBF	JW	LSL	DBF	BTL	DBF	JW	LSL	DBF	BTL	DBF	JW	LSL	DBF	BTL	DBF	JW	LSL	DBF	BTL	DBF

WQ Ranges: T (°C) = 15 ± 1; DO (mg/L) = 7.0 to 10.3; pH = 5.5 to 8.5

Sample Description/Comments: 10x concentrations in 100% sample were added in the lab to match predicted field concentrations

Fish Description at 96 h All Fish OK Number of Stressed Fish at 96 h 0

Other Observations: _____

Reviewed by: JGh Date Reviewed: July 25/14

Rainbow Trout Summary Sheet

Client:

Golder

Start Date/Time: July 17, 2014 @ 10:50

Work Order No.:

14447

Test Species: Oncorhynchus mykiss

Sample Information:

Sample ID:

Year 6

Sample Date:

N/A made in-house

Date Received:

N/A made in-house

Sample Volume:

15 L

Other:

Sample made using salts to emulate predicted site ion concentrations

Test Validity Criteria:

≥ 90% control survival

WQ Ranges:

T (°C) = 15 ± 1; DO (mg/L) = 7.0 to 10.3; pH = 5.5 to 8.5

Dilution Water:

Type:

Dechlorinated Municipal Tap Water

Hardness (mg/L CaCO₃):

9

Alkalinity (mg/L CaCO₃):

12

Test Organism Information:

Batch No.:

061114

Source:

Campbell Lake Trout Farm

No. Fish/Volume (L):

10/10 L

Loading Density (g/L):

0.36

Mean Length ± SD (mm):

35 ± 2

Range: 31-37

Mean Weight ± SD (g):

0.36 ± 0.07

Range: 0.22-0.43

NaNO₂ Reference Toxicant Results:

Reference Toxicant ID:

RTN+63

Stock Solution ID:

14N+01

Date Initiated:

June 26, 2014

96-h LC50 (95% CL):

11.0 (7.7-18.2)

Reference Toxicant Mean and Historical Range:

5.1 (2.1-12.6)

Reference Toxicant CV (%):

57

Test Results:

There was 100% survival in the 100% v/v sample following a 96-h exposure period.

Reviewed by:

Joh

Date reviewed:

July 25/14

96-Hour Rainbow Trout Toxicity Test Data Sheet

Client/Project#: Golder
 Sample I.D. Year 6
 W.O. # 14447
 RBT Batch #: 061114
 Date Collected/Time: N/A
 Date Setup/Time: July 17, 2014 @ 10:50
 Sample Setup By: BTL

D.O. meter: 2
 pH meter: 2
 Cond. Meter: 2

Number Fish/Volume: 10/10L
 7-d % Mortality: 0.07
 Total Pre-aeration Time (mins): 30
 Aeration rate adjusted to 6.5 ± 1 mL/min/L? (Y/N): Y

Undiluted Sample WQ			
Parameters	Initial WQ	Adjustment	30 min WQ
Temp °C	15.0	/	15.0
pH	6.7		6.7
D.O. (mg/L)	8.8		9.4
Cond. (µS/cm)	550		579

Concentration (% v/v)	# Survivors							Temperature (°C)					Dissolved Oxygen (mg/L)					pH					Conductivity (µS/cm)	
	1	2	4	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	24	48	72	96	0	96
Control				10	10	10	10	14.5	14.0	14.0	14.5	14.5	9.7	9.6	10.1	10.0	9.9	7.0	7.2	7.3	7.4	7.4	32	42
100				10	10	10	10	15.0	14.0	14.0	14.5	14.5	9.4	9.8	10.1	10.0	10.0	6.7	6.9	7.1	7.1	7.2	579	592
Initials				DBF	JW	KJL	DBF	BTL	DBF	JW	KJL	BTL	DBF	DBF	JW	KJL	BTL	DBF	DBF	JW	KJL	DBF	BTL	DBF

WQ Ranges: T (°C) = 15 ± 1; DO (mg/L) = 7.0 to 10.3; pH = 5.5 to 8.5

Sample Description/Comments: 100 concentrations in 100% sample were added in the lab to match predicted field concentrations

Fish Description at 96 h All fish OK Number of Stressed Fish at 96 h 0

Other Observations: _____

Reviewed by: JGh

Date Reviewed: July 25/14

APPENDIX B - *Daphnia magna* Toxicity Test Data

Daphnia magna Summary Sheet

Client:

Golder Associates

Work Order No.:

14505

Start Date/Time:

Aug 11/14 @ 16:35

Test Species:

Daphnia magna

Set up by:

BLC

Sample Information:

Sample ID:

Year 6

Sample Date:

N/A made in-house

Date Received:

N/A

Sample Volume:

2L

Test Validity Criteria:

≥ 90% mean control survival (no more than 2 mortalities in any control replicate)

WQ Ranges:

T (°C) = 20 ± 2; DO (mg/L) = 3.6 to 9.4; pH = 6 to 8.5

Test Organism Information:

Broodstock No.:

072214A + B

Age of young (Day 0):

<24 h

Avg No. young per brood in previous 7 d:

15 / 18

Mortality (%) in previous 7 d:

10 / 0

Days to first brood:

9 / 10

NaCl Reference Toxicant Results:

Reference Toxicant ID:

Dm 124

Stock Solution ID:

14 NaCl

Date Initiated:

Aug 05/14

48-h LC50 (95% CL):

3.9 (2.8-5.5) g/L NaCl

Reference Toxicant Mean and Historical Range: 4.0 (3.7-4.3) g/L NaCl

Reference Toxicant CV (%):

4.0

Test Results:

There was 100% survival in the 100% undiluted sample after a 48-h exposure.

Reviewed by:

JOH

Date reviewed:

Aug. 18/14

Freshwater Acute 48 Hour Toxicity Test Data Sheet

Client: Golder Associates
 Sample ID: Year 6
 Work Order No.: 14505

Start Date/Time: Aug 11/14 @ 16:35
 No. Organisms/volume: 10/200mL
 Test Organism: D.magna
 Set up by: BTL

DO meter: 3 pH meter: 3 Conductivity meter: 3

Concentration	Number of Live Organisms Rep	No. Immobilized		Temperature (°C)			Dissolved oxygen (mg/L)			pH			Conductivity (µS/cm)		
		24	48	48	0	24	48	0	24	48	0	24	48	0	48
Control	A	10	10	0	21.0	19.5	20.0	8.4	7.7	8.4	8.0	8.1	8.0	361	385
	B	10	10	0											
	C	10	10	0											
	D														
100	A	10	10	0	20.0	19.0	19.5	8.8	7.7	8.6	6.7	7.3	7.1	612	644
	B	10	10	0											
	C	10	10	0											
	D														
	A														
	B														
	C														
	D														
	A														
	B														
	C														
	D														
	A														
	B														
	C														
	D														
Technician Initials		BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL

WQ Ranges: T (°C) = 20 ± 2; DO (mg/L) = 3.6 to 9.4; pH = 6 to 8.5

	Hardness*	Alkalinity*
Conc.	*(mg/L as CaCO ₃)	
Control (MHW)	<u>100</u>	<u>70</u>
Highest conc.	<u>158</u>	<u>2</u>

	Initial WQ	Adjustment	Adjusted WQ
Temp (°C)	<u>20.0</u>		
DO (mg/L)	<u>8.8</u>		
pH	<u>6.7</u>		
Cond (µS/cm)	<u>612</u>		

Sample Description: Sample prepared to emulate predicted water quality, specified by Golder.

Comments: Batch# 072244-7-d previous # young/brood: 15/18 Day of 1st Brood: 9/10 Previous 7-d % Mortality: 10/0

Reviewed by: JGL Date reviewed: Aug 18/14

Daphnia magna Summary Sheet

Client: Golder Associates
Work Order No.: 14505

Start Date/Time: Aug 11/14 @ 16:35
Test Species: Daphnia magna
Set up by: BTL

Sample Information:

Sample ID: Year 8
Sample Date: N/A make in-house
Date Received: N/A
Sample Volume: 2-L

Test Validity Criteria:

≥ 90% mean control survival (no more than 2 mortalities in any control replicate)

WQ Ranges:

T (°C) = 20 ± 2; DO (mg/L) = 3.6 to 9.4; pH = 6 to 8.5

Test Organism Information:

Broodstock No.: 072214A + B
Age of young (Day 0): <24 h
Avg No. young per brood in previous 7 d: 15/18
Mortality (%) in previous 7 d: 10/0
Days to first brood: 9/10

NaCl Reference Toxicant Results:

Reference Toxicant ID: Dm124
Stock Solution ID: 14Na01
Date Initiated: Aug 05/14
48-h LC50 (95% CL): 3.9 (2.8-5.5) g/L NaCl

Reference Toxicant Mean and Historical Range: 4.0 (3.7-4.3) g/L NaCl
Reference Toxicant CV (%): 4.6

Test Results:

There was 100% survival in the 100% undiluted sample following a 48-h exposure.

Reviewed by: JGU

Date reviewed: Aug. 18/14

Freshwater Acute 48 Hour Toxicity Test Data Sheet

Client: Goldier Associates
 Sample ID: Yew 8
 Work Order No.: 14505

Start Date/Time: Aug 11/14 @ 16:35
 No. Organisms/volume: 10/200mL
 Test Organism: D. magna
 Set up by: BTC

DO meter: 3 pH meter: 3 Conductivity meter: 3

Concentration	Number of Live Organisms Rep	No. Immobilized		Temperature (°C)			Dissolved oxygen (mg/L)			pH			Conductivity (µS/cm)		
		24	48	48	0	24	48	0	24	48	0	24	48	0	48
Control	A	10	10	0	21.0	19.5	20.0	8.4	7.7	8.4	8.0	8.1	8.0	357	375
	B	10	10	0											
	C	10	10	0											
	D														
100	A	10	10	0	20.0	18.5	19.5	8.9	7.8	8.6	6.7	7.0	7.0	2170	2230
	B	10	10	0											
	C	10	10	0											
	D														
	A														
	B														
	C														
	D														
	A														
	B														
	C														
	D														
	A														
	B														
	C														
	D														
Technician Initials		BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL

WQ Ranges: T (°C) = 20 ± 2; DO (mg/L) = 3.6 to 9.4; pH = 6 to 8.5

Hardness*	Alkalinity*
Conc. (mg/L as CaCO ₃)	
Control (MHW)	100
Highest conc.	570

	Initial WQ	Adjustment	Adjusted WQ
Temp (°C)	20.0		
DO (mg/L)	8.9		
pH	6.7		
Cond (µS/cm)	2170		

Sample Description: Sample prepared to emulate predicted ion concentrations, specified by Goldier Associates

Comments: Batch #: 072244-18-d previous # young/brood: 15/18 Day of 1st Brood: 9/10 Previous 7-d % Mortality: 10/10

Reviewed by: JBL Date reviewed: Aug 18/14

Daphnia magna Summary Sheet

Client: Folder Associates
Work Order No.: 14505

Start Date/Time: Aug 11/14 @ 16:35
Test Species: Daphnia magna
Set up by: BTC

Sample Information:

Sample ID: End of open pit mining
Sample Date: N/A sample made in-house
Date Received: N/A
Sample Volume: 2-L

Test Validity Criteria:

≥ 90% mean control survival (no more than 2 mortalities in any control replicate)

WQ Ranges:

T (°C) = 20 ± 2; DO (mg/L) = 3.6 to 9.4; pH = 6 to 8.5

Test Organism Information:

Broodstock No.: 072214 A+B
Age of young (Day 0): <24 h
Avg No. young per brood in previous 7 d: 15/18
Mortality (%) in previous 7 d: 10/10
Days to first brood: 9/10

NaCl Reference Toxicant Results:

Reference Toxicant ID: Dm124
Stock Solution ID: 14Na01
Date Initiated: Aug 05/14
48-h LC50 (95% CL): 3.9 (2.8-5.5) g/L NaCl

Reference Toxicant Mean and Historical Range: 4.0 (3.7-4.3) g/L NaCl
Reference Toxicant CV (%): 4.0

Test Results:

BTC

There was 83.3% survival in the 100% undiluted sample following a 48-h exposure.

Reviewed by:

JOH

Date reviewed:

Aug. 18/14

Freshwater Acute 48 Hour Toxicity Test Data Sheet

Client: Golder Associates
 Sample ID: End of open pit mining
 Work Order No.: 14505

Start Date/Time: Aug 11/14 @ 16:35
 No. Organisms/volume: 10/200mL
 Test Organism: D. magna
 Set up by: BTC

DO meter: 3 pH meter: 3 Conductivity meter: 3

Concentration	Number of Live Organisms Rep	No. Immobilized		Temperature (°C)			Dissolved oxygen (mg/L)			pH			Conductivity (µS/cm)		
		24	48	48	0	24	48	0	24	48	0	24	48	0	48
control	A	10	10	0	21.0	19.0	20.0	8.4	7.7	8.4	8.1	8.1	8.1	557	372
	B	10	10	0											
	C	10	10	0											
	D														
100	A	10 ⁰	7	0	20.0	18.5	19.5	9.2	7.8	8.6	6.7	6.9	6.8	5450	5600
	B	10 ⁰	10	0											
	C	9 ⁰	8	0											
	D														
	A														
	B														
	C														
	D														
	A														
	B														
	C														
	D														
	A														
	B														
	C														
	D														
Technician Initials		BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL

WQ Ranges: T (°C) = 20 ± 2; DO (mg/L) = 3.6 to 9.4; pH = 6 to 8.5
 ① 3 floating Daphnids ② 2 Daphnids floating

Hardness*	Alkalinity*
Conc. (mg/L as CaCO ₃)	
Control (MHW)	100 70
Highest conc.	1540 2

	Initial WQ	Adjustment	Adjusted WQ
Temp (°C)	20.0		
DO (mg/L)	9.2		
pH	6.7		
Cond (µS/cm)	5450		

Sample Description: Sample prepared to emulate predicted ion concentrations, specified by Golder.

Comments: Batch#: 072214-17 7-d previous # young/brood: 15/18 Day of 1st Brood: 9/10 Previous 7-d % Mortality: 10/10

Reviewed by: JGh Date reviewed: Aug. 18/14

Daphnia magna Summary Sheet

Client: Goldner Associates
Work Order No.: 14505

Start Date/Time: Aug 11/14 @ 16:35
Test Species: Daphnia magna
Set up by: BTL

Sample Information:

Sample ID: Underground
Sample Date: N/A sample made in-house
Date Received: N/A
Sample Volume: 2-L

Test Validity Criteria:

≥ 90% mean control survival (no more than 2 mortalities in any control replicate)

WQ Ranges:

T (°C) = 20 ± 2; DO (mg/L) = 3.6 to 9.4; pH = 6 to 8.5

Test Organism Information:

Broodstock No.: 072214A+B
Age of young (Day 0): <24 h
Avg No. young per brood in previous 7 d: 15/18
Mortality (%) in previous 7 d: 10/0
Days to first brood: 9/10

NaCl Reference Toxicant Results:

Reference Toxicant ID: Dm124
Stock Solution ID: 14 NaCl
Date Initiated: Aug 05/14
48-h LC50 (95% CL): 3.9 (2.8-5.5) g/L NaCl

Reference Toxicant Mean and Historical Range: 4.0 (3.7-4.3) g/L NaCl
Reference Toxicant CV (%): 4.0

Test Results: There was 0% survival in the 100% undiluted sample following a 48-h exposure.

Reviewed by: Jon

Date reviewed: Aug. 18/14

**Freshwater Acute
48 Hour Toxicity Test Data Sheet**

Client: Golder Associates
 Sample ID: Underground
 Work Order No.: 14505

Start Date/Time: Aug 11/14 @ 16:35
 No. Organisms/volume: 10/200mL
 Test Organism: D. magna
 Set up by: BTL

DO meter: 3 pH meter: 3 Conductivity meter: 3

Concentration	Rep	Number of Live Organisms		No. Immobilized	Temperature (°C)			Dissolved oxygen (mg/L)			pH			Conductivity (µS/cm)	
		24	48		48	0	24	48	0	24	48	0	24	48	0
control	A	10	10	0	20.0	19.0	20.0	8.4	7.7	8.4	8.1	8.1	8.1	357	375
	B	10	10	0											
	C	10	10	0											
	D														
100	A	40	—	—	20.0	18.5	—	9.2	7.7	—	6.6	6.8	—	14880	15510
	B	40	—	—											
	C	40	—	—											
	D			BTL											
	A														
	B														
	C														
	D														
	A														
	B														
	C														
	D														
	A														
	B														
	C														
	D														
Technician Initials		BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL

WQ Ranges: T (°C) = 20 ± 2; DO (mg/L) = 3.6 to 9.4; pH = 6 to 8.5

	Hardness*	Alkalinity*
Conc.	*(mg/L as CaCO ₃)	
Control (MHW)	100	70
Highest conc.	5400	4

	Initial WQ	Adjustment	Adjusted WQ
Temp (°C)	20.0		
DO (mg/L)	6.9.2		
pH	6.6		
Cond (µS/cm)	14880		

Sample Description: Sample prepared to emulate predicted ion concentrations, specified by Golder

Comments: Batch #: 0722447-d previous # young/brood: 15/18 Day of 1st Brood: 9/10 Previous 7-d % Mortality: 10/0

Reviewed by: Jon Date reviewed: Aug. 18/14

APPENDIX C – Analytical Chemistry Data



Analytical chemistry for Rainbow Trout tests

NAUTILUS ENVIRONMENTAL


ATTN: Brett Lucas
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 21-JUL-14
Report Date: 29-JUL-14 16:07 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1490080
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:



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ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700
ALS CANADA LTD Part of the ALS Group A Campbell Brothers Limited Company

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID		L1490080-1 water 21-JUL-14 10:00 YEAR 6-RAINBOW TROUT	L1490080-2 water 21-JUL-14 10:00 YEAR 8-RAINBOW TROUT	L1490080-3 water 21-JUL-14 10:00 END OF OPERATION- RAINBOW TROUT	L1490080-4 water 21-JUL-14 10:00 UNDERGROUND- RAINBOW TROUT	L1490080-5 water 21-JUL-14 10:00 YEAR 6-D.MAGNA
Grouping	Analyte					Not used
WATER						
Physical Tests	pH (pH)	6.91	6.93	6.79	6.65	7.01
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	4.9	6.1	3.8	<2.0	5.9
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Alkalinity, Total (as CaCO3) (mg/L)	4.9	6.1	3.8	<2.0	5.9
	Chloride (Cl) (mg/L)	134	862	1860	4800	134
	Fluoride (F) (mg/L)	0.077	<0.40 ^{DLM}	<1.0 ^{DLM}	<1.0 ^{DLM}	0.078
	Nitrate (as N) (mg/L)	10.4	19.0	21.6	23.0	10.3
	Sulfate (SO4) (mg/L)	18.0	15	<25 ^{DLM}	<25 ^{DLM}	17.8
Total Metals	Calcium (Ca)-Total (mg/L)	50.4	294	579	1320	49.7
	Magnesium (Mg)-Total (mg/L)	9.00	17.8	31.9	68.0	8.71
	Potassium (K)-Total (mg/L)	5.5	5.2	5.8	6.0	5.2
	Sodium (Na)-Total (mg/L)	42.7	163	368	1050	40.5

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

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Matrix Spike	Sulfate (SO4)	MS-B	L1490080-1, -2, -3, -4, -5, -6, -7, -8

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLA	Detection Limit adjusted for required dilution
DLM	Detection Limit Adjusted due to sample matrix effects.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-SCR-VA	Water	Alkalinity by colour or titration	EPA 310.2 OR APHA 2320
This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method. OR This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
ANIONS-F-IC-VA	Water	Fluoride by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
ANIONS-NO3-IC-VA	Water	Nitrate in Water by Ion Chromatography	EPA 300.0
This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.			
ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
F-SIE-VA	Water	Fluoride by SIE	APHA 4500-F "Fluoride"
This analysis is carried out using procedures adapted from APHA Method 4500-F "Fluoride". Fluoride is determined using a selective ion electrode. This method has a significant negative interference (i.e. results could be biased low) when Al ³⁺ is present in the sample at a concentration greater than 2.5 mg/L.			
F-SIE-VA	Water	Fluoride by SIE	APHA 4500-F Fluoride
This analysis is carried out using procedures adapted from APHA Method 4500-F "Fluoride". Fluoride is determined using a selective ion electrode. This method has a significant negative interference (i.e. results could be biased low) when Al ³⁺ is present in the sample at a concentration greater than 2.5 mg/L.			
MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B
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 procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).			
PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"
This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode It is recommended that this analysis be conducted in the field.			
PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value
This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode It is recommended that this analysis be conducted in the field.			

** 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

Reference Information

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 ww - milligrams per kilogram based on wet weight of sample.

mg/kg lw - 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.



Analytical chemistry for Daphnia magna tests

NAUTILUS ENVIRONMENTAL

ATTN: Brett Lucas
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7


Date Received: 11-AUG-14
Report Date: 19-AUG-14 09:55 (MT)
Version: FINAL REV. 2

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: **L1500270**
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

Comments: 19-AUG-2014 This report replaces and supersedes previously sent report. This report includes modified sulfate results for ALS identified samples L1500270-3 and L1500270-4.



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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID		L1500270-1 WATER 11-AUG-14 16:35 YEAR 6	L1500270-2 WATER 11-AUG-14 16:35 YEAR 8	L1500270-3 WATER 11-AUG-14 16:35 END OF OPEN PIT MINING	L1500270-4 WATER 11-AUG-14 16:35 UNDERGROUND	
Grouping	Analyte					
WATER						
Physical Tests	pH (pH)	6.46	7.24	7.28	7.19	
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	5.2	5.2	5.6	2.9	
	Alkalinity, Total (as CaCO3) (mg/L)	5.2	5.2	5.6	2.9	
	Chloride (Cl) (mg/L)	142	652	1700	5170	
	Fluoride (F) (mg/L)	0.081	<0.40 ^{DLM}	1.2	0.164	
	Nitrate (as N) (mg/L)	10.2	13.4	20.0	22.8	
	Sulfate (SO4) (mg/L)	17.8	13	18.4	17.7	
Total Metals	Calcium (Ca)-Total (mg/L)	56.2	230	589	1790	
	Magnesium (Mg)-Total (mg/L)	8.96	18.3	34.3	72.3	
	Potassium (K)-Total (mg/L)	5.2	5.6	6.8	6.3	
	Sodium (Na)-Total (mg/L)	41.4	149	394	1190	

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

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Chloride (Cl)	DLM	L1500270-1, -2, -3, -4

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-SCR-VA	Water	Alkalinity by colour or titration	EPA 310.2 OR APHA 2320
This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.			
OR			
This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
ANIONS-F-IC-VA	Water	Fluoride by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
ANIONS-NO3-IC-VA	Water	Nitrate in Water by Ion Chromatography	EPA 300.0
This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.			
ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
F-SIE-VA	Water	Fluoride by SIE	APHA 4500-F "Fluoride"
This analysis is carried out using procedures adapted from APHA Method 4500-F "Fluoride". Fluoride is determined using a selective ion electrode.			
This method has a significant negative interference (i.e. results could be biased low) when Al ³⁺ is present in the sample at a concentration greater than 2.5 mg/L.			
F-SIE-VA	Water	Fluoride by SIE	APHA 4500-F Fluoride
This analysis is carried out using procedures adapted from APHA Method 4500-F "Fluoride". Fluoride is determined using a selective ion electrode.			
This method has a significant negative interference (i.e. results could be biased low) when Al ³⁺ is present in the sample at a concentration greater than 2.5 mg/L.			
MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B
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 procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).			
PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"
This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode			
It is recommended that this analysis be conducted in the field.			
PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value
This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode			
It is recommended that this analysis be conducted in the field.			
SO4-TUR-VA	Water	Sulfate(SO ₄) by Turbidity	APHA 4500-SO ₄ E. SULFATE
This analysis is carried out using procedures adapted from APHA Method 4500-SO ₄ "Sulfate". Sulfate is determined using the turbidimetric method.			

** 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
	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Reference Information

VA

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 ww - 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.

Attachment B
***Daphnia magna* toxicity testing of “End of Open Pit Mining” predicted ion balance**



***Daphnia magna* toxicity testing of "End of Open Pit Mining" predicted ion balance**

Final Report

Report date:
August 20, 2014

Submitted to:

Golder Associates Ltd.
Burnaby, BC

8664 Commerce Court
Burnaby, BC
V5A 4N7

TABLE OF CONTENTS

	Page
TABLE OF CONTENTS	i
SIGNATURE PAGE	ii
1.0 INTRODUCTION.....	1
2.0 METHODS	1
3.0 RESULTS	3
4.0 QA/QC	4
5.0 REFERENCES	6

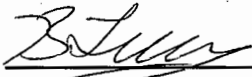
LIST OF TABLES

Table 1.	Summary of test conditions: 48-h <i>Daphnia magna</i> LC50 test.	2
Table 2.	Results: 48-h <i>Daphnia magna</i> LC50 test.	3
Table 3.	Targeted and measured ion concentrations (mg/L) in the test concentrations.	4
Table 4.	Reference toxicant results for <i>Daphnia magna</i> testing.	5

LIST OF APPENDICES

APPENDIX A - <i>Daphnia magna</i> toxicity test data
APPENDIX B - Analytical chemistry data

SIGNATURE PAGE



Brett Lucas, M.Sc.

Environmental Scientist



James Elphick, R.P.Bio.

Senior Reviewer

This report has been prepared by Nautilus Environmental Company Inc. based on data and/or samples provided by our client; the results of this study are for their sole benefit. Any reliance on the data by a third party is at the sole and exclusive risk of that party. The results presented here relate only to the samples tested.

1.0 INTRODUCTION

Nautilus Environmental conducted an acute LC50 test using *Daphnia magna* for Golder Associates Ltd. (Golder) to characterize the toxicity of a predicted water ion balance identified as “End of Open Pit Mining, Under Ice” for the Dominion Diamonds Jay Pit. This water ion balance was diluted such that toxicity testing included “End of Open Pit Mining, Open Water”.

This report describes the results of the 48-h toxicity test. Copies of raw laboratory data sheets and statistical analyses are provided in Appendix A. Results of analytical chemistry are provided in Appendix B.

2.0 METHODS

One water sample was prepared at the Nautilus Environmental Laboratory in Burnaby, BC using deionized water mixed with analytical grade salts (NaCl, KCl, $\text{MgCl}_2 \cdot 6\text{H}_2\text{O}$, $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$, CaSO_4 , NaHCO_3 , NaF and NaNO_3). Salts were measured and added to the deionized water in order to achieve the desired ratio of ions to match predicted ion concentrations associated with the “End of Open Pit Mining, Under Ice” water type, as specified by Golder Associates. The water was thoroughly mixed and then stored at $4 \pm 1^\circ\text{C}$ prior to testing.

The sample was tested using a 48-h *D. magna* test to determine the LC50. The dilution series included the 100% undiluted sample, a 70.4% sample that was prepared to approximate ion concentrations of a sample “End of Open Pit Mining, Open Water” (as specified by Golder), and a 50%, 25%, and a 10% sample, with dilution being prepared using deionized water. The test was performed using two replicates for each concentration in order to increase the precision of the test. At the initiation of the test, a sub-sample from each dilution was collected and analyzed by ALS laboratories (Burnaby, BC) for the ions that were added.

The procedure used for the 48-h *D. magna* toxicity test is summarized in Table 1. Testing was conducted according to procedures described by Environment Canada protocols (2000). Statistical analysis for this test was performed using CETIS (Tidepool Scientific Software 2013).

Table 1. Summary of test conditions: 48-h *Daphnia magna* LC50 test.

Test organism	<i>D. magna</i>
Test organism source	In-house culture
Test organism age	<24 h
Test type	Static
Test duration	48 h
Test vessel	250 mL glass beakers
Test volume	200 mL
Test replicates	2 test replicate per treatment
No. of organisms	10 per replicate
Control water	Moderately hard reconstituted water
Test solution renewal	None
Dilution water	Deionized water
Test temperature	20 ± 2°C
Feeding	None
Light intensity	400 to 800 lux
Photoperiod	16 hours light/8 hours dark
Aeration	None
Test protocol	Environment Canada (2000), EPS 1/RM/14
Statistical software	Tidepool Scientific Software (2013)
Test endpoint	48-h LC50
Test acceptability criteria for controls	Survival ≥ 90%
Reference toxicant	Sodium chloride

3.0 RESULTS

Results of the 48-h *D. magna* test are summarized in Table 2. The 48-h LC50 was calculated to be 89.0%.

The targeted (nominal) and measured concentrations of ions for the test are presented in Table 3; the TDS concentration in the full strength sample (i.e., End of Open Pit Mining, Under Ice) based on the measured values was 2740 mg/L, and in the 70.4% sample (i.e., End of Open Pit Mining, Open Water) was 1902 mg/L.

Table 2. Results: 48-h *Daphnia magna* LC50 test.

Concentration (% v/v)	Survival (%)
Control	100 ± 0
10	100 ± 0
25	100 ± 0
50	75 ± 7
70.4	60 ± 14
100	45 ± 35
Test endpoint	
LC50 (95% C.L.)	89.0 (60.4 - >100.00)

LC = Lethal Concentration, C.L. = Confidence Limits, * = statistically significant difference from the control (p < 0.05).

Table 3. Targeted (nominal) and measured ion concentrations (mg/L) in the test concentrations.

Ion	HCO ₃	Cl	F	SO ₄	NO ₃ -N	Ca	Mg	Na	K
Targeted 100.0%	5.0	1728	0.13	17.0	20.0	606	34.0	387	6.3
Measured									
100.0%	5.2	1740	<0.40	16.0	20.6	548	31.8	375	6.1
70.4%	5.2	1230	<0.40	10.0	14.7	371	20.8	249	4.1
50.0%	4.4	867	<0.40	<10.0	10.3	278	15.5	186	3.1
25.0%	3.4	432	<0.20	<5.0	5.2	141	7.9	94	<2.0
10.0%	2.4	172	<0.02	1.8	2.1	58	3.2	38	<2.0

Concentrations with a "<" symbol represent measured concentrations that were below the listed detection limit of the analytical test due to matrix-related effects.

4.0 QA/QC

The health history of the test organisms used in the exposures was acceptable and met the requirements of the test protocol. The test control acceptability criteria and water quality parameters remained within ranges specified in the protocol (Environment Canada 2000) throughout the test. There were no deviations from the test methodology. Uncertainty associated with this test is best described by the confidence intervals around the LC50 estimate.

The measured concentrations were in good agreement with the targeted values for the full strength sample, although fluoride could not be measured as a result of matrix interference.

Results of the reference toxicant test conducted during the testing program are summarized in Table 4. Results for this test fell within the range for acceptable organism performance of mean \pm two standard deviations, based on historical results obtained by the laboratory with these tests. Thus, the sensitivity of the organisms used in this test was appropriate.

Table 4. Reference toxicant results for *Daphnia magna* testing.

Test Species	Endpoint	Historical Mean (2 SD Range)	CV (%)	Test Date
<i>D. magna</i>	Survival (LC50): 3.9 g/L NaCl	4.0 (3.7-4.3)	4.0	August 5, 2014

SD = Standard Deviation, CV = Coefficient of Variation, LC = Lethal Concentration.

5.0 REFERENCES

- Environment Canada. 2000. Biological test method: reference method for determining acute lethality of effluents to *D. magna*. Environmental Protection Series. Report EPS 1/RM/14, Second Edition. Method Development and Application Section, Environmental Technology Centre, Ottawa, ON, Canada, 21 pp.
- Tidepool Scientific Software. 2013. CETIS comprehensive environmental toxicity information system, version 1.8.7.16 McKinleyville, CA, USA, 222 pp.

APPENDIX A - *Daphnia magna* toxicity test data

Daphnia magna Summary Sheet

Client: Golder
Work Order No.: 14481

Start Date/Time: July 28/14 @14:20
Test Species: Daphnia magna
Set up by: BTL

Sample Information:

Sample ID: End of Operation
Sample Date: Prepared on July 25th in lab
Date Received: N/A Prepared in-house
Sample Volume: 5-L

Test Validity Criteria:

≥ 90% mean control survival (no more than 2 mortalities in any control replicate)

WQ Ranges:

T (°C) = 20 ± 2; DO (mg/L) = 3.6 to 9.4; pH = 6 to 8.5

Test Organism Information:

Broodstock No.: 070914A
Age of young (Day 0): <24 h
Avg No. young per brood in previous 7 d: 19
Mortality (%) in previous 7 d: 0
Days to first brood: 9

NaCl Reference Toxicant Results:

Reference Toxicant ID: Dm124
Stock Solution ID: 14Na01
Date Initiated: Aug 05/14
48-h LC50 (95% CL): 3.9 (2.8-5.5) g/L NaCl

Reference Toxicant Mean and Historical Range: 4.0 (3.7-4.3) g/L NaCl

Reference Toxicant CV (%): 4.0

Test Results:

Following a 48-h exposure the LC50 was calculated to be 88.96% of the full strength undiluted End of Operation sample, with 95% confidence limits between 60.42% and 100%.

Reviewed by: Joh

Date reviewed: Aug 8/14

Freshwater Acute 48 Hour Toxicity Test Data Sheet

Client: Golder
 Sample ID: End of Operation
 Work Order No.: 14481

Start Date/Time: July 28/14 @ 14:20
 No. Organisms/volume: 10/200mL
 Test Organism: D. magna
 Set up by: BTL

DO meter: 3 pH meter: 3/4 Conductivity meter: 3

Concentration (%)	Number of Live Organisms Rep	24		No. Immobilized 48	Temperature (°C)			Dissolved oxygen (mg/L)			pH			Conductivity (µS/cm)	
		48	48		0	24	48	0	24	48	0	24	48	0	48
Control	A	10	10	0	19.5	19.5	19.0	8.6	8.7	8.5	7.9	8.0	8.1	355	368
	B	10	10	0											
	C														
	D														
10	A	10	10	0	20.5	19.0	19.0	8.2	8.8	8.7	6.4	6.7	6.8	614	631
	B	10	10	0											
	C														
	D														
25	A	10	10	0	21.0	19.0	19.0	8.3	8.9	8.9	6.3	6.7	6.6	1458	1490
	B	10	10	0											
	C														
	D														
50	A	10	8	0	20.5	19.0	19.0	8.5	9.0	8.9	6.5	6.8	6.6	2820	2870
	B	10	7	0											
	C														
	D														
70.4	A	10	7	0	20.0	19.5	19.0	8.6	9.0	8.9	6.5	7.0	6.7	3900	4010
	B	10	5	0											
	C														
	D														
100	A	10	2	0	19.0	19.5	19.0	9.1	9.0	8.9	6.6	7.0	6.7	5400	5580
	B	9	7	0											
	C														
	D														
Technician Initials		BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL	BTL

WQ Ranges: T (°C) = 20 ± 2; DO (mg/L) = 3.6 to 9.4; pH = 6 to 8.5

Hardness*		Alkalinity*	
Conc.	(mg/L as CaCO ₃)		
Control (MHW)	98	70	
Highest conc.	1310	4	

	Initial WQ	Adjustment	Adjusted WQ
Temp (°C)	19.0		
DO (mg/L)	9.0		
pH	6.7		
Cond (µS/cm)	5,450		

Sample Description: Deionized water mixed with different salts to achieve predicted end of operation ion concentration

Comments: Batch#: 070914A 7-d previous # young/brood: 19 Day of 1st Brood: 9 Previous 7-d % Mortality: 0

Reviewed by: JGU Date reviewed: Aug. 8/14

CETIS Analytical Report

 Report Date: 30 Jul-14 14:09 (p 1 of 2)
 Test Code: 14481 | 18-7570-9587

Daphnia magna 48-h Acute Survival Test

Nautilus Environmental

Analysis ID: 04-0637-5136	Endpoint: Survival Rate	CETIS Version: CETISv1.8.7
Analyzed: 30 Jul-14 14:06	Analysis: Trimmed Spearman-Kärber	Official Results: Yes
Batch ID: 14-8024-5815	Test Type: Survival	Analyst:
Start Date: 28 Jul-14	Protocol: EC/EPS 1/RM/14	Diluent:
Ending Date: 30 Jul-14	Species: Daphnia magna	Brine:
Duration: 48h	Source: In-House Culture	Age:
Sample ID: 02-1953-1107	Code: D15C763	Client:
Sample Date: 25 Jul-14	Material: Sodium chloride	Project:
Receive Date: 25 Jul-14	Source: Golder	
Sample Age: 72h	Station: End of Operation LC-50 BTL	

Trimmed Spearman-Kärber Estimates

Threshold Option	Threshold	Trim	Mu	Sigma	EC50	95% LCL	95% UCL
Control Threshold	0	45.00%	1.949	0.084	88.96	60.42	131

Survival Rate Summary

Calculated Variate(A/B)

C-gm/L	Control Type	Count	Mean	Min	Max	Std Err	Std Dev	CV%	%Effect	A	B
0	Lab Water	2	1	1	1	0	0	0.0%	0.0%	20	20
10		2	1	1	1	0	0	0.0%	0.0%	20	20
25		2	1	1	1	0	0	0.0%	0.0%	20	20
50		2	0.75	0.7	0.8	0.05	0.07071	9.43%	25.0%	15	20
70.4		2	0.6	0.5	0.7	0.1	0.1414	23.57%	40.0%	12	20
100		2	0.45	0.2	0.7	0.25	0.3536	78.57%	55.0%	9	20

Survival Rate Detail

C-gm/L	Control Type	Rep 1	Rep 2
0	Lab Water	1	1
10		1	1
25		1	1
50		0.8	0.7
70.4		0.7	0.5
100		0.2	0.7

Survival Rate Binomials

C-gm/L	Control Type	Rep 1	Rep 2
0	Lab Water	10/10	10/10
10		10/10	10/10
25		10/10	10/10
50		8/10	7/10
70.4		7/10	5/10
100		2/10	7/10

CETIS Analytical Report

Report Date: 30 Jul-14 14:09 (p 2 of 2)
Test Code: 14481 | 18-7570-9587

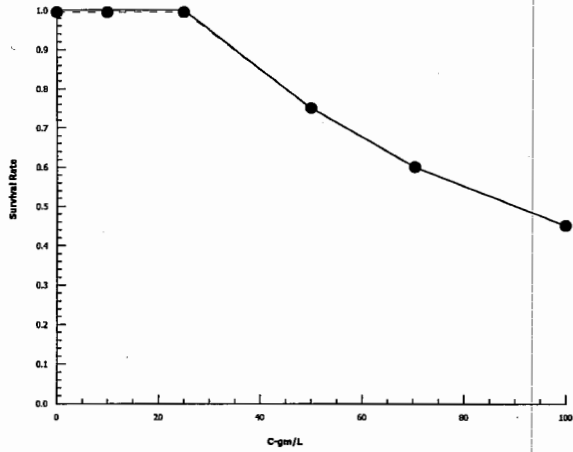
Daphnia magna 48-h Acute Survival Test

Nautilus Environmental

Analysis ID: 04-0637-5136 Endpoint: Survival Rate
Analyzed: 30 Jul-14 14:06 Analysis: Trimmed Spearman-Kärber

CETIS Version: CETISv1.8.7
Official Results: Yes

Graphics



APPENDIX B - Analytical chemistry data




NAUTILUS ENVIRONMENTAL
ATTN: Brett Lucas
8664 Commerce Court
Imperial Square Lake City
Burnaby BC V5A 4N7

Date Received: 28-JUL-14
Report Date: 01-AUG-14 16:53 (MT)
Version: FINAL

Client Phone: 604-420-8773

Certificate of Analysis

Lab Work Order #: L1493671
Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:



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ADDRESS: 8081 Lougheed Hwy, Suite 100, Burnaby, BC V5A 1W9 Canada | Phone: +1 604 253 4188 | Fax: +1 604 253 6700
ALS CANADA LTD Part of the ALS Group A Campbell Brothers Limited Company

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID		L1493671-1 Water 28-JUL-14 14:00 END OF OPERATION(100%)	L1493671-2 water 28-JUL-14 14:00 END OF OPERATION (70.4%)	L1493671-3 Water 28-JUL-14 14:00 END OF OPERATION (50%)	L1493671-4 Water 28-JUL-14 14:00 END OF OPERATION (25%)	L1493671-5 Water 28-JUL-14 14:00 END OF OPERATION (10%)
Grouping	Analyte					
WATER						
Physical Tests	pH (pH)	6.69	6.70	6.59	6.41	6.20
Anions and Nutrients	Alkalinity, Bicarbonate (as CaCO3) (mg/L)	4.3	4.3	3.6	2.8	2.0
	Alkalinity, Carbonate (as CaCO3) (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Alkalinity, Hydroxide (as CaCO3) (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0
	Alkalinity, Total (as CaCO3) (mg/L)	4.3	4.3	3.6	2.8	2.0
	Chloride (Cl) (mg/L)	1740	1230	867	432	172
	Fluoride (F) (mg/L)	<0.40 ^{DLM}	<0.40 ^{DLM}	<0.40 ^{DLM}	<0.20 ^{DLM}	<0.020
	Nitrate (as N) (mg/L)	20.6	14.7	10.3	5.15	2.07
	Sulfate (SO4) (mg/L)	16	10	<10 ^{DLM}	<5.0 ^{DLM}	1.75
Total Metals	Calcium (Ca)-Total (mg/L)	548	371	278	141	58.5
	Magnesium (Mg)-Total (mg/L)	31.8	20.8	15.5	7.87	3.19
	Potassium (K)-Total (mg/L)	6.1	4.1	3.1	<2.0	<2.0
	Sodium (Na)-Total (mg/L)	375	249	186	94.5	38.0

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

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Fluoride (F)	DLM	L1493671-1, -2, -3, -4, -5
Duplicate	Nitrate (as N)	DLM	L1493671-1, -2, -3, -4, -5
Matrix Spike	Chloride (Cl)	MS-B	L1493671-1, -2, -3, -4, -5
Matrix Spike	Fluoride (F)	MS-B	L1493671-1, -2, -3, -4, -5
Matrix Spike	Nitrate (as N)	MS-B	L1493671-1, -2, -3, -4, -5

Qualifiers for Individual Parameters Listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects.
MS-B	Matrix Spike recovery could not be accurately calculated due to high analyte background in sample.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
ALK-SCR-VA	Water	Alkalinity by colour or titration	EPA 310.2 OR APHA 2320
This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method. OR This analysis is carried out using procedures adapted from APHA Method 2320 "Alkalinity". Total alkalinity is determined by potentiometric titration to a pH 4.5 endpoint. Bicarbonate, carbonate and hydroxide alkalinity are calculated from phenolphthalein alkalinity and total alkalinity values.			
ANIONS-CL-IC-VA	Water	Chloride by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
ANIONS-F-IC-VA	Water	Fluoride by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
ANIONS-NO3-IC-VA	Water	Nitrate in Water by Ion Chromatography	EPA 300.0
This analysis is carried out using procedures adapted from EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography". Nitrate is detected by UV absorbance.			
ANIONS-SO4-IC-VA	Water	Sulfate by Ion Chromatography	APHA 4110 B.
This analysis is carried out using procedures adapted from APHA Method 4110 B. "Ion Chromatography with Chemical Suppression of Eluent Conductivity" and EPA Method 300.0 "Determination of Inorganic Anions by Ion Chromatography".			
MET-TOT-ICP-VA	Water	Total Metals in Water by ICPOES	EPA SW-846 3005A/6010B
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 procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010B).			
PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H "pH Value"
This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode			
It is recommended that this analysis be conducted in the field.			
PH-PCT-VA	Water	pH by Meter (Automated)	APHA 4500-H pH Value
This analysis is carried out using procedures adapted from APHA Method 4500-H "pH Value". The pH is determined in the laboratory using a pH electrode			
It is recommended that this analysis be conducted in the field.			

** 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:

Reference Information

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 ww - 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.

