



ENVIRONMENTAL DYNAMICS INC.

ATTN: Meighan Kearns

2195 - 2nd Avenue

Whitehorse YT Y1A 3T8

Date Received: 26-NOV-13

Report Date: 16-DEC-13 17:05 (MT)

Version: FINAL REV. 2

Client Phone: 867-393-4882

Certificate of Analysis

Lab Work Order #: L1396028

Project P.O. #: NOT SUBMITTED

Job Reference: 13-Y-0452

C of C Numbers: 1

Legal Site Desc:

Comments:

16-DEC-2013 Revision 2: This revision replaces and supersedes previous revision of this report. This revision includes Client Sample ID modification for the sample ALS identify as L1396028-1 as requested.

Can Dang
Senior Account Manager

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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
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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample ID Description Sampled Date Sampled Time Client ID		L1396028-1 Surface Water 25-NOV-13 09:30 NF1-E	L1396028-2 Surface Water 25-NOV-13 11:30 R10	L1396028-3 Surface Water 25-NOV-13 13:30 NF2	L1396028-4 Surface Water 25-NOV-13 12:20 X3A	L1396028-5 Surface Water 25-NOV-13 13:30 X1
Grouping	Analyte					
WATER						
Physical Tests	Conductivity (uS/cm)	215	215	236	256	251
	Hardness (as CaCO3) (mg/L)	112	110	121	129	133
	pH (pH)	7.47	7.62	7.21	7.52	7.59
	Total Suspended Solids (mg/L)	3.8	2.2	3.8	1.0	1.2
	Total Dissolved Solids (mg/L)	132	131	146	154	157
Anions and Nutrients	Alkalinity, Total (as CaCO3) (mg/L)	112	112	111	121	120
	Ammonia, Total (as N) (mg/L)	0.0147	0.0104	0.0113	0.0174	0.0172
	Chloride (Cl) (mg/L)	<0.50	<0.50	<0.50	<0.50	<0.50
	Fluoride (F) (mg/L)	0.145	0.145	0.159	0.152	0.152
	Nitrate (as N) (mg/L)	0.200	0.201	0.212	0.182	0.184
	Nitrite (as N) (mg/L)	<0.0010	<0.0010	0.0014	0.0011	0.0015
	Phosphorus (P)-Total (mg/L)	0.0064	0.0065	0.0052	0.0032	0.0035
	Sulfate (SO4) (mg/L)	18.7	18.5	28.7	27.8	30.2
	Anion Sum (meq/L)	2.64	2.65	2.85	3.02	3.05
	Cation Sum (meq/L)	2.38	2.33	2.59	2.74	2.84
	Cation - Anion Balance (%)	-5.3	-6.5	-4.6	-4.9	-3.6
Organic / Inorganic Carbon	Dissolved Organic Carbon (mg/L)	1.75	1.75	1.66	1.79	1.87
	Total Organic Carbon (mg/L)	1.89	1.63	1.70	1.70	1.66
Total Metals	Aluminum (Al)-Total (mg/L)	0.0956	0.0423	0.0870	0.0289	0.0144
	Antimony (Sb)-Total (mg/L)	0.00011	0.00013	0.00014	0.00019	0.00014
	Arsenic (As)-Total (mg/L)	0.00076	0.00067	0.00065	0.00048	0.00040
	Barium (Ba)-Total (mg/L)	0.0631	0.0647	0.0669	0.0662	0.0688
	Beryllium (Be)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Bismuth (Bi)-Total (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Boron (B)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Cadmium (Cd)-Total (mg/L)	0.000024	0.000021	0.000414	0.000152	0.000154
	Calcium (Ca)-Total (mg/L)	34.3	34.1	35.4	39.5	39.8
	Chromium (Cr)-Total (mg/L)	0.00031	0.00016	0.00026	0.00014	0.00010
	Cobalt (Co)-Total (mg/L)	0.00016	<0.00010	0.00324	0.00098	0.00107
	Copper (Cu)-Total (mg/L)	0.00067	0.00058	0.00068	0.00070	0.00054
	Iron (Fe)-Total (mg/L)	0.300	0.194	0.421	0.269	0.605
	Lead (Pb)-Total (mg/L)	0.00111	0.000162	0.00151	0.000610	0.000442
	Lithium (Li)-Total (mg/L)	0.00548	0.00508	0.00558	0.00439	0.00448
	Magnesium (Mg)-Total (mg/L)	7.72	6.88	8.62	8.56	8.74
	Manganese (Mn)-Total (mg/L)	0.0492	0.0298	0.198	0.115	0.146
	Molybdenum (Mo)-Total (mg/L)	0.000721	0.000718	0.000691	0.000588	0.000554

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

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Grouping	Analyte					
WATER						
Total Metals	Nickel (Ni)-Total (mg/L)	0.00078	0.00052	0.00517	0.00218	0.00228
	Phosphorus (P)-Total (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30
	Potassium (K)-Total (mg/L)	0.841	0.787	0.837	0.989	0.985
	Selenium (Se)-Total (mg/L)	0.00031	0.00037	0.00037	0.00035	0.00033
	Silicon (Si)-Total (mg/L)	6.13	5.77	5.97	5.66	5.61
	Silver (Ag)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Total (mg/L)	2.67	2.46	2.65	2.56	2.64
	Strontium (Sr)-Total (mg/L)	0.152	0.150	0.157	0.179	0.183
	Thallium (Tl)-Total (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Total (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Total (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Uranium (U)-Total (mg/L)	0.00194	0.00192	0.00194	0.00220	0.00223
	Vanadium (V)-Total (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Zinc (Zn)-Total (mg/L)	0.0164	0.0135	0.674	0.243	0.276
	Zirconium (Zr)-Total (mg/L)	<0.00080	<0.00080	<0.00080	<0.00080	<0.00080
Dissolved Metals	Dissolved Metals Filtration Location	FIELD	FIELD	FIELD	FIELD	FIELD
	Aluminum (Al)-Dissolved (mg/L)	0.0029	0.0030	0.0066	0.0024	0.0023
	Antimony (Sb)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Arsenic (As)-Dissolved (mg/L)	0.00047	0.00043	0.00033	0.00028	0.00023
	Barium (Ba)-Dissolved (mg/L)	0.0652	0.0613	0.0629	0.0659	0.0654
	Beryllium (Be)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Bismuth (Bi)-Dissolved (mg/L)	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
	Boron (B)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Cadmium (Cd)-Dissolved (mg/L)	0.000019	0.000018	0.000403	0.000141	0.000145
	Calcium (Ca)-Dissolved (mg/L)	33.4	32.7	34.6	37.9	39.3
	Chromium (Cr)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Cobalt (Co)-Dissolved (mg/L)	<0.00010	<0.00010	0.00305	0.00092	0.00099
	Copper (Cu)-Dissolved (mg/L)	0.00037	0.00038	0.00035	0.00037	0.00037
	Iron (Fe)-Dissolved (mg/L)	0.068	0.048	0.121	0.127	0.446
	Lead (Pb)-Dissolved (mg/L)	0.000064	<0.000050	0.000116	0.000084	0.000081
	Lithium (Li)-Dissolved (mg/L)	0.00504	0.00504	0.00542	0.00434	0.00437
	Magnesium (Mg)-Dissolved (mg/L)	6.98	6.84	8.49	8.44	8.56
	Manganese (Mn)-Dissolved (mg/L)	0.0426	0.0261	0.185	0.107	0.137
	Molybdenum (Mo)-Dissolved (mg/L)	0.000670	0.000645	0.000634	0.000524	0.000542
	Nickel (Ni)-Dissolved (mg/L)	<0.00050	<0.00050	0.00481	0.00204	0.00209
	Phosphorus (P)-Dissolved (mg/L)	<0.30	<0.30	<0.30	<0.30	<0.30
	Potassium (K)-Dissolved (mg/L)	0.774	0.760	0.806	0.949	0.950

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

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Grouping	Analyte					
WATER						
Dissolved Metals	Selenium (Se)-Dissolved (mg/L)	0.00039	0.00039	0.00040	0.00031	0.00034
	Silicon (Si)-Dissolved (mg/L)	5.75	5.73	5.67	5.32	5.43
	Silver (Ag)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Sodium (Na)-Dissolved (mg/L)	2.47	2.40	2.57	2.52	2.49
	Strontium (Sr)-Dissolved (mg/L)	0.144	0.141	0.150	0.172	0.178
	Thallium (Tl)-Dissolved (mg/L)	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
	Tin (Sn)-Dissolved (mg/L)	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
	Titanium (Ti)-Dissolved (mg/L)	<0.010	<0.010	<0.010	<0.010	<0.010
	Uranium (U)-Dissolved (mg/L)	0.00189	0.00179	0.00181	0.00205	0.00209
	Vanadium (V)-Dissolved (mg/L)	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
	Zinc (Zn)-Dissolved (mg/L)	0.0139	0.0132	0.682	0.243	0.273
	Zirconium (Zr)-Dissolved (mg/L)	<0.00080	<0.00080	<0.00080	<0.00080	<0.00080

* 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	Antimony (Sb)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Arsenic (As)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Sulfate (SO4)	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Barium (Ba)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Calcium (Ca)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Iron (Fe)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Magnesium (Mg)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Manganese (Mn)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Potassium (K)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Silicon (Si)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Sodium (Na)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5
Matrix Spike	Strontium (Sr)-Dissolved	MS-B	L1396028-1, -2, -3, -4, -5

Qualifiers for Individual Parameters Listed:

Qualifier	Description
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-COL-VA	Water	Alkalinity by Colourimetric (Automated)	EPA 310.2
This analysis is carried out using procedures adapted from EPA Method 310.2 "Alkalinity". Total Alkalinity is determined using the methyl orange colourimetric method.			
ANIONS-CL-IC-WR	Water	Chloride by Ion Chromatography	EPA 300.1
This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003.			
ANIONS-F-IC-WR	Water	Fluoride by Ion Chromatography	EPA 300.1
This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003.			
ANIONS-NO2-IC-WR	Water	Nitrite Nitrogen by Ion Chromatography	EPA 300.1
This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003. Nitrate is detected by UV absorbance.			
ANIONS-NO3-IC-WR	Water	Nitrate Nitrogen by Ion Chromatography	EPA 300.1
This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003. Nitrate is detected by UV absorbance.			
ANIONS-SO4-IC-WR	Water	Sulphate by Ion Chromatography	EPA 300.1
This analysis is carried out using procedures adapted from EPA Method 300.1, "Determination of Inorganic Anions by Ion Chromatography", Revision 1.0, April 1999 and from "Determination of Inorganic Anions in Environmental Waters Using a Hydroxide-Selective Column", Application Note 154 v.19, Dionex 2003.			
CARBONS-DOC-VA	Water	Dissolved organic carbon by combustion	APHA 5310 TOTAL ORGANIC CARBON (TOC)

Reference Information

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)". Dissolved carbon (DOC) fractions are determined by filtering the sample through a 0.45 micron membrane filter prior to analysis.

CARBONS-TOC-VA Water Total organic carbon by combustion APHA 5310 TOTAL ORGANIC CARBON (TOC)

This analysis is carried out using procedures adapted from APHA Method 5310 "Total Organic Carbon (TOC)".

EC-MAN-WR Water Conductivity by Meter APHA 2510 (B)

This analysis is carried out using procedures adapted from APHA Method 2510 "Conductivity". Conductivity is determined using an electrode.

HARDNESS-CALC-VA Water Hardness APHA 2340B

Hardness (also known as Total Hardness) is calculated from the sum of Calcium and Magnesium concentrations, expressed in CaCO₃ equivalents. Dissolved Calcium and Magnesium concentrations are preferentially used for the hardness calculation.

IONBALANCE-VA Water Ion Balance Calculation APHA 1030E

Cation Sum, Anion Sum, and Ion Balance (as % difference) are calculated based on guidance from APHA Standard Methods (1030E Checking Correctness of Analysis). Because all aqueous solutions are electrically neutral, the calculated ion balance (% difference of cations minus anions) should be near-zero.

Cation and Anion Sums are the total meq/L concentration of major cations and anions. Dissolved species are used where available. Minor ions are included where data is present. Ion Balance is calculated as:

$$\text{Ion Balance (\%)} = [\text{Cation Sum} - \text{Anion Sum}] / [\text{Cation Sum} + \text{Anion Sum}]$$

MET-D-CCMS-VA Water Dissolved Metals in Water by CRC ICPMS APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

MET-T-CCMS-VA Water Total Metals in Water by CRC ICPMS APHA 3030 B&E / EPA SW-846 6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using hotblock, or filtration (APHA 3030B&E). Instrumental analysis is by collision cell inductively coupled plasma - mass spectrometry (modified from EPA Method 6020A).

NH3-F-VA Water Ammonia in Water by Fluorescence J. ENVIRON. MONIT., 2005, 7, 37-42, RSC

This analysis is carried out, on sulfuric acid preserved samples, using procedures modified from J. Environ. Monit., 2005, 7, 37 - 42, The Royal Society of Chemistry, "Flow-injection analysis with fluorescence detection for the determination of trace levels of ammonium in seawater", Roslyn J. Weston et al.

P-T-COL-VA Water Total P in Water by Colour APHA 4500-P Phosphorous

This analysis is carried out using procedures adapted from APHA Method 4500-P "Phosphorus". Total Phosphorous is determined colourimetrically after persulphate digestion of the sample.

PH-MAN-WR Water pH by Meter APHA 4500-H (B)

"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."

TDS-CALC-VA Water TDS (Calculated) APHA 1030E (20TH EDITION)

This analysis is carried out using procedures adapted from APHA 1030E "Checking Correctness of Analyses".

TSS-LOW-WR Water Total Suspended Solids by Grav. (1 mg/L) APHA 2540 D

This analysis is carried out using procedures adapted from APHA Method 2540 "Solids". Solids are determined gravimetrically. Total Suspended Solids are determined by filtering a sample through a glass fibre filter and drying the filter at 104 degrees celsius.

ZR-D-MS-VA Water Dissolved Zr in Water by ICPMS EPA SW-846 3005A/6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

ZR-T-MS-VA Water Total Zr in Water by ICPMS EPA SW-846 3005A/6020A

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion, using either hotblock or microwave oven, or filtration (EPA Method 3005A). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

Reference Information

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
WR	ALS ENVIRONMENTAL - WHITEHORSE, YUKON, CANADA
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

1

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.



COC#

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