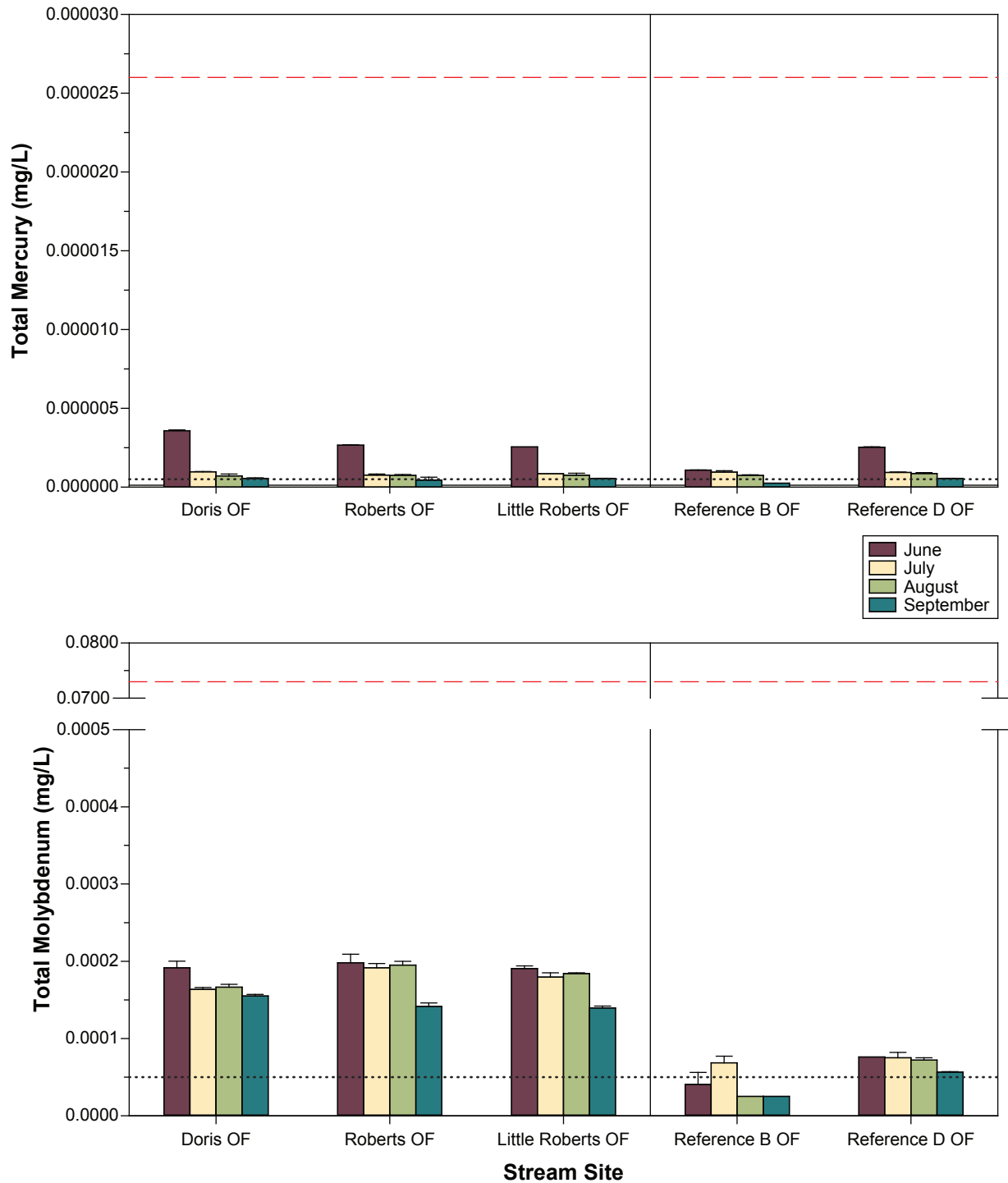


Figure A.3-8

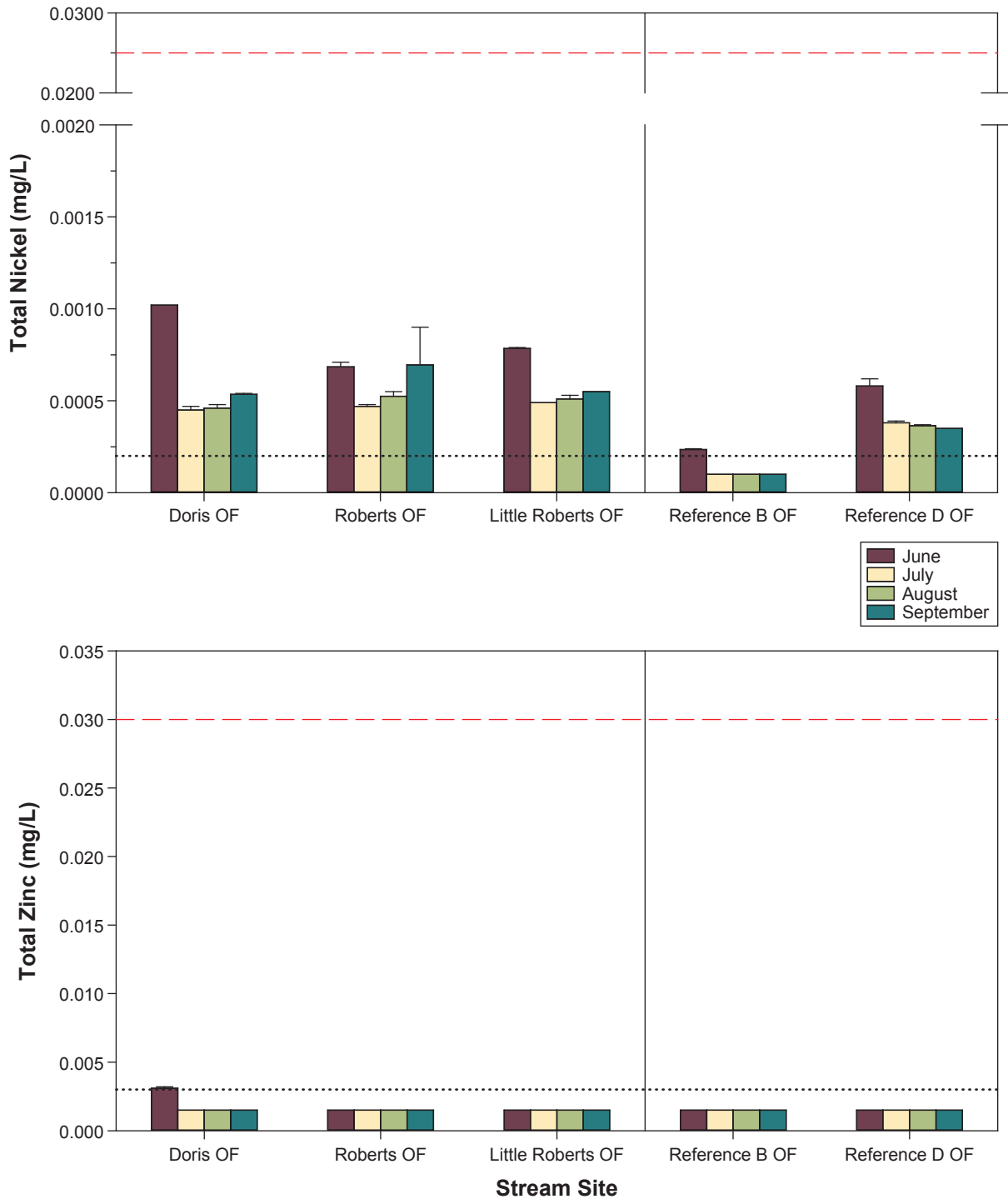
**Total Mercury and Total Molybdenum Concentrations
in Stream Sites, Doris North Project, 2014**



Notes: Error bars represent the standard error of the mean of replicates.
 Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
 Red dashed lines represent the CCME freshwater guidelines for inorganic mercury (0.000026 mg/L) and molybdenum (0.073 mg/L).
 Total mercury and total molybdenum are required parameters for effluent characterization as per Schedule 5, s. 4(1) of the MMER.

Figure A.3-9

**Total Nickel and Total Zinc Concentrations
in Stream Sites, Doris North Project, 2014**



Notes: Error bars represent the standard error of the mean of replicates.
 Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
 The CCME guideline for nickel is hardness dependent.
 Red dashed lines represent the CCME freshwater guideline for zinc (0.03 mg/L) and the site-specific CCME guideline for nickel (0.025 mg/L) based on the hardness (as CaCO₃) range in streams of 12.6 to 52.7 mg/L.
 Total nickel and total zinc are regulated as deleterious substances in effluents as per Schedule 4 of the MMER.

Annex A.3-1. Stream Water Quality Data, Doris North Project, 2014

Site ID: Replicate: Date Sampled: ALS Sample ID:				Doris OF 1 19-Jun-14 L1474754-3	Doris OF 2 19-Jun-14 L1474754-4	Roberts OF 1 18-Jun-14 L1474233-3	Roberts OF 2 18-Jun-14 L1474233-4	Little Roberts OF 1 18-Jun-14 L1474233-1
Units	CCME guideline for the Protection of Aquatic life ^a	Realized Detection Limit						
Physical Tests								
Conductivity	uS/cm	2		229	231	223	222	220.0
Hardness (as CaCO ₃)	mg/L	0.5		40.4	40.8	33.3	35.6	37.0
pH	pH	0.1	6.5–9.0	7.62	7.62	7.44	7.44	7.46
Total Suspended Solids	mg/L	1	dependent on background levels	5.6	5.6	4.8	5.6	6.2
Total Dissolved Solids	mg/L	10		143	142	144	140	138
Turbidity	NTU	0.1	dependent on background levels	6.24	7.10	6.56	5.93	7.37
Anions and Nutrients								
Alkalinity, Total (as CaCO ₃)	mg/L	1		23.0	22.7	20.6	20.3	21.7
Ammonia, Total (as N)	mg/L	0.005	pH- and temperature-dependent	<0.0050	<0.0050	0.0067	0.0057	<0.0050
Bromide (Br)	mg/L	0.05		0.181	0.184	0.175	0.183	0.177
Chloride (Cl)	mg/L	0.5	short-term: 640; long-term: 120	53.9	54.3	52.5	52.4	51.10
Fluoride (F)	mg/L	0.02	Inorganic fluorides: 0.12 ^b	0.048	0.049	0.042	0.043	0.040
Nitrate (as N)	mg/L	0.005	short-term: 124; long-term: 3.0	<0.0050	0.0052	<0.0050	<0.0050	<0.0050
Nitrite (as N)	mg/L	0.001	0.06	<0.0010	0.0013	<0.0010	<0.0010	<0.0010
Total Kjeldahl Nitrogen	mg/L	0.05 to 0.25		0.606	0.614	0.547	0.527	0.520
Orthophosphate-Dissolved (as P)	mg/L	0.001		<0.0010	<0.0010	0.0011	0.001	<0.0010
Phosphorus (P)	mg/L	0.002	Trigger ranges from guidance framework ^c	0.0316	0.0306	0.0310	0.0293	0.0290
Sulfate (SO ₄)	mg/L	0.5		2.21	2.38	3.04	3.01	2.86
Cyanides								
Cyanide, Total	mg/L	0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L	0.001	0.005	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic / Inorganic Carbon								
Dissolved Organic Carbon	mg/L	0.5		7.91	7.97	6.38	6.41	6.41
Total Organic Carbon	mg/L	0.5		8.34	8.52	6.81	6.82	6.64
Total Metals								
Aluminum (Al)	mg/L	0.003	0.005 if pH<6.5; 0.1 if pH≥6.5	0.3060	0.3110	0.186	0.192	0.2360
Antimony (Sb)	mg/L	0.00001		0.000024	0.000024	0.00002	0.000019	0.000019
Arsenic (As)	mg/L	0.00005	0.005	0.000248	0.000247	0.000337	0.000365	0.000318
Barium (Ba)	mg/L	0.0001		0.00680	0.00643	0.00464	0.00520	0.00509
Beryllium (Be)	mg/L	0.000005		0.0000134	0.0000136	0.0000081	0.0000091	0.0000111
Bismuth (Bi)	mg/L	0.00005		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)	mg/L	0.005	short-term: 29; long-term: 1.5	0.0280	0.0289	0.0297	0.0275	0.0284
Cadmium (Cd)	mg/L	0.000005	equation ^d	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)	mg/L	0.05		6.67	6.74	4.50	4.81	5.74
Cesium (Cs)	mg/L	0.000005		0.0000231	0.0000228	0.0000132	0.0000144	0.0000173
Chromium (Cr)	mg/L	0.0005	Cr(VI): 0.001; Cr(III): 0.0089 ^b	0.00078	0.00069	0.00054	0.00059	0.00075
Cobalt (Co)	mg/L	0.00005		0.000254	0.00026	0.000166	0.000178	0.000184
Copper (Cu)	mg/L	0.0005	0.002-0.004	0.00186	0.00180	0.00140	0.00150	0.00150
Gallium (Ga)	mg/L	0.00005		0.000096	0.00009	<0.000050	0.000053	0.00007
Iron (Fe)	mg/L	0.03	0.3	0.473	0.477	0.501	0.536	0.481
Lead (Pb)	mg/L	0.00005	0.001-0.007 ^f	0.000145	0.000135	0.000084	0.000088	0.000107
Lithium (Li)	mg/L	0.0002		0.00402	0.00400	0.00285	0.00308	0.00324
Magnesium (Mg)	mg/L	0.1		5.77	5.83	5.34	5.73	5.50
Manganese (Mn)	mg/L	0.0002		0.0771	0.0786	0.1070	0.1130	0.07040
Mercury (Hg)	ug/L	0.0005	Inorganic Hg: 0.026	0.00363	0.00353	0.00265	0.00268	0.00255
Molybdenum (Mo)	mg/L	0.00005	0.073 ^b	0.000200	0.000183	0.000187	0.000209	0.000187
Nickel (Ni)	mg/L	0.0002	0.025-0.150 ^g	0.00102	0.00102	0.00066	0.00071	0.00079
Phosphorus (P)	mg/L	0.3		<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)	mg/L	2		2.6	2.6	2.1	2.2	2.2
Rhenium (Re)	mg/L	0.000005		<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Rubidium (Rb)	mg/L	0.00002		0.00235	0.00230	0.00172	0.00187	0.00184
Selenium (Se)	mg/L	0.0002	0.001	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Silicon (Si)	mg/L	0.05		1.98	1.98	1.410	1.500	1.570
Silver (Ag)	mg/L	0.000005	0.0001	0.0000357	0.000031	<0.0000050	<0.0000050	<0.0000050
Sodium (Na)	mg/L	2		27.4	27.7	28.2	30.2	28.1
Strontium (Sr)	mg/L	0.00005		0.0343	0.0345	0.0302	0.0326	0.0342
Tellurium (Te)	mg/L	0.00001		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thallium (Tl)	mg/L	0.000002	0.0008	0.0000045	0.0000043	0.0000026	0.0000027	0.0000034
Thorium (Th)	mg/L	0.000005		0.0001220	0.0001280	0.0000972	0.0000979	0.0001080
Tin (Sn)	mg/L	0.0002		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)	mg/L	0.0002		0.01270	0.01240	0.00724	0.00741	0.01040
Tungsten (W)	mg/L	0.00001		<0.000010	<0.000010	<0.000010	0.000012	<0.000010
Uranium (U)	mg/L	0.000002	short-term: 0.033; long-term: 0.015	0.0000449	0.0000471	0.0000496	0.0000507	0.0000499
Vanadium (V)	mg/L	0.00005		0.000656	0.000646	0.000444	0.000462	0.000586
Yttrium (Y)	mg/L	0.000005		0.0001240	0.0001250	0.0000973	0.0001060	0.0001100
Zinc (Zn)	mg/L	0.003	0.03	0.0032	0.003	<0.0030	<0.0030	<0.0030
Zirconium (Zr)	mg/L	0.00005		0.000058	0.000059	<0.000050	<0.000050	<0.000050
Radiochemistry								
Radium-226	Bq/L	0.01		<0.010	<0.010	<0.010	<0.010	<0.010

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of freshwater aquatic life.

^a Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b Interim guideline.

^c Total phosphorus trigger ranges for lakes and rivers (mg/L): <0.004 = Ultra-oligotrophic; 0.004–0.01 = Oligotrophic; 0.01–0.02 = Mesotrophic; 0.02–0.035 = Meso-eutrophic; 0.035–0.1 = Eutrophic; >0.1 = Hyper-eutrophic.

^d Cadmium guideline is hardness dependent (hardness as CaCO₃). Short-term guideline = 10^{1.016[log(hardness)]-1.71} / 1000 mg/L. If hardness is <5.3 mg/L, the guideline is 0.00011 mg/L; if hardness is >360 mg/L, the guideline is 0.0077 mg/L. Long-term cadmium guideline = 10^{0.83[log(hardness)]-2.46} / 1000 mg/L. If hardness is <17 mg/L, the guideline is 0.00004 mg/L; if hardness is >280 mg/L, the guideline is 0.00037 mg/L.

^e Copper guideline is hardness dependent (hardness as CaCO3). Guideline = e^{0.8545[ln(hardness)]-1.465} * 0.0002 mg/L. If hardness is <82 mg/L, the guideline is 0.002 mg/L; if hardness is >180 mg/L, the guideline is 0.004 mg/L. If water hardness is not known, the guideline is 0.002 mg/L.

^f Lead guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: lead guideline (mg/L) = e^{1.273[ln(hardness)]-4.705} /1000. At hardness as CaCO₃ of ≤ 60mg/L, lead guideline is a minimum of 0.001 mg/L; at hardness as CaCO₃ of >180 mg/L, lead guideline is a maximum of 0.007 mg/L.

^g Nickel guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: nickel guideline (mg/L) = e^{0.76[ln(hardness)]+1.06} /1000. At hardness as CaCO₃ of ≤ 60mg/L, nickel guideline is a minimum of 0.025 mg/L; at hardness as CaCO₃ of >180 mg/L, nickel guideline is a maximum of 0.150 mg/L.

Annex A.3-1. Stream Water Quality Data, Doris North Project, 2014

Site ID:				Little Roberts OF	Reference B OF	Reference B OF	Reference D OF	Reference D OF
Replicate:			Realized	2	1	2	1	2
Date Sampled:	CCME guideline for the		Detection	18-Jun-14	19-Jun-14	19-Jun-14	18-Jun-14	18-Jun-14
ALS Sample ID:	Units	Protection of Aquatic life ^a	Limit	L1474233-2	L1474754-1	L1474754-2	L1474233-5	L1474233-6
Physical Tests								
Conductivity	uS/cm		2	221.0	072	072	097	109
Hardness (as CaCO ₃)	mg/L		0.5	37.5	21.1	20.7	18.5	21.2
pH	pH	6.5–9.0	0.1	7.48	7.57	7.52	7.24	7.28
Total Suspended Solids	mg/L	dependent on background levels	1	6.1	<1.0	<1.0	2.2	1.9
Total Dissolved Solids	mg/L		10	138	047	052	68	76
Turbidity	NTU	dependent on background levels	0.1	6.31	0.50	0.70	2.78	2.02
Anions and Nutrients								
Alkalinity, Total (as CaCO ₃)	mg/L		1	21.9	16.3	15.5	11.1	12.3
Ammonia, Total (as N)	mg/L	pH- and temperature-dependent	0.005	0.0062	<0.0050	<0.0050	<0.0050	<0.0050
Bromide (Br)	mg/L		0.05	0.167	<0.050	<0.050	0.065	0.091
Chloride (Cl)	mg/L	short-term: 640; long-term: 120	0.5	51.10	10.0	10.0	20.0	22.9
Fluoride (F)	mg/L	Inorganic fluorides: 0.12 ^b	0.02	0.043	0.028	0.027	0.033	0.035
Nitrate (as N)	mg/L	short-term: 124; long-term: 3.0	0.005	<0.0050	0.0065	<0.0050	<0.0050	<0.0050
Nitrite (as N)	mg/L	0.06	0.001	<0.0010	0.0017	<0.0010	<0.0010	<0.0010
Total Kjeldahl Nitrogen	mg/L		0.05 to 0.25	0.527	0.303	0.333	0.351	0.331
Orthophosphate-Dissolved (as P)	mg/L		0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)	mg/L	Trigger ranges from guidance framework ^c	0.002	0.0322	0.0072	0.0081	0.0135	0.0144
Sulfate (SO ₄)	mg/L		0.5	2.87	2.52	2.43	1.83	2.00
Cyanides								
Cyanide, Total	mg/L		0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L	0.005	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic / Inorganic Carbon								
Dissolved Organic Carbon	mg/L		0.5	6.32	3.89	3.94	5.36	5.31
Total Organic Carbon	mg/L		0.5	6.62	4.08	4.08	5.59	5.53
Total Metals								
Aluminum (Al)	mg/L	0.005 if pH<6.5; 0.1 if pH≥6.5	0.003	0.2530	0.009	0.010	0.104	0.115
Antimony (Sb)	mg/L		0.00001	0.000019	0.000021	0.000017	0.000014	0.000013
Arsenic (As)	mg/L	0.005	0.00005	0.000313	0.000109	0.000108	0.000130	0.000147
Barium (Ba)	mg/L		0.0001	0.00556	0.00318	0.00290	0.00314	0.00352
Beryllium (Be)	mg/L		0.000005	0.0000112	<0.0000050	<0.0000050	0.0000062	0.0000070
Bismuth (Bi)	mg/L		0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)	mg/L	short-term: 29; long-term: 1.5	0.005	0.0255	0.0103	0.0107	0.0170	0.0158
Cadmium (Cd)	mg/L	equation ^d	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)	mg/L		0.05	5.84	5.11	5.02	2.88	3.29
Cesium (Cs)	mg/L		0.000005	0.0000184	<0.0000050	<0.0000050	0.0000075	0.0000097
Chromium (Cr)	mg/L	Cr(VI): 0.001; Cr(III): 0.0089 ^b	0.0005	0.00069	<0.00050	<0.00050	0.00051	<0.00050
Cobalt (Co)	mg/L		0.00005	0.000178	<0.000050	<0.000050	0.000072	0.000084
Copper (Cu)	mg/L	0.002-0.004	0.0005	0.00156	0.00109	0.00112	0.00117	0.00110
Gallium (Ga)	mg/L		0.00005	0.000072	<0.000050	<0.000050	<0.000050	<0.000050
Iron (Fe)	mg/L	0.3	0.03	0.494	0.042	0.042	0.245	0.294
Lead (Pb)	mg/L	0.001-0.007 ^f	0.00005	0.000108	0.000075	<0.000050	<0.000050	0.000054
Lithium (Li)	mg/L		0.0002	0.00339	0.00080	0.00073	0.00162	0.00179
Magnesium (Mg)	mg/L		0.1	5.56	2.03	1.99	2.74	3.15
Manganese (Mn)	mg/L		0.0002	0.07230	0.0064	0.0064	0.01500	0.01920
Mercury (Hg)	ug/L	Inorganic Hg: 0.026	0.0005	0.0026	0.00108	0.00109	0.00249	0.00257
Molybdenum (Mo)	mg/L	0.073 ^b	0.00005	0.000194	0.000056	<0.000050	0.000076	0.000076
Nickel (Ni)	mg/L	0.025-0.150 ^g	0.0002	0.00078	0.00024	0.00023	0.00054	0.00062
Phosphorus (P)	mg/L		0.3	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)	mg/L		2	2.2	<2.0	<2.0	<2.0	<2.0
Rhenium (Re)	mg/L		0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Rubidium (Rb)	mg/L		0.00002	0.00197	0.00129	0.00114	0.00124	0.00141
Selenium (Se)	mg/L	0.001	0.0002	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Silicon (Si)	mg/L		0.05	1.640	0.19	0.19	0.497	0.484
Silver (Ag)	mg/L	0.0001	0.000005	<0.0000050	0.000104	0.0000324	<0.0000050	<0.0000050
Sodium (Na)	mg/L		2	28.1	05.4	05.4	11.2	13.0
Strontium (Sr)	mg/L		0.00005	0.0343	0.0252	0.0237	0.0180	0.0207
Tellurium (Te)	mg/L		0.00001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thallium (Tl)	mg/L	0.0008	0.000002	0.0000034	<0.0000020	<0.0000020	<0.0000020	<0.0000020
Thorium (Th)	mg/L		0.000005	0.0001180	0.0000079	0.0000073	0.0000670	0.0000638
Tin (Sn)	mg/L		0.0002	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)	mg/L		0.0002	0.01080	0.00020	0.00023	0.00367	0.00452
Tungsten (W)	mg/L		0.00001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Uranium (U)	mg/L	short-term: 0.033; long-term: 0.015	0.000002	0.0000501	0.0000389	0.0000368	0.0000559	0.0000552
Vanadium (V)	mg/L		0.00005	0.000594	<0.000050	<0.000050	0.000232	0.000291
Yttrium (Y)	mg/L		0.000005	0.0001190	0.0000190	0.0000173	0.0000802	0.0000821
Zinc (Zn)	mg/L	0.03	0.003	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Zirconium (Zr)	mg/L		0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Radiochemistry								
Radium-226	Bq/L		0.01	<0.010	<0.010	<0.010	<0.010	<0.010

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of freshwater aquatic life.

^a Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b Interim guideline.

^c Total phosphorus trigger ranges for lakes and rivers (mg/L): <0.004 = Ultra-oligotrophic; 0.004–0.01 = Oligotrophic; 0.01–0.02 = Mesotrophic; 0.02–0.035 = Meso-eutrophic; 0.035–0.1 = Eutrophic; >0.1 = Hyper-eutrophic.

^d Cadmium guideline is hardness dependent (hardness as CaCO₃). Short-term guideline = 10^{1.016[log(hardness)]-1.71} / 1000 mg/L. If hardness is <5.3 mg/L, the guideline is 0.00011 mg/L; if hardness is >360 mg/L, the guideline is 0.0077 mg/L. Long-term cadmium guideline = 10^{0.83[log(hardness)]-2.46} / 1000 mg/L. If hardness is <17 mg/L, the guideline is 0.00004 mg/L; if hardness is >280 mg/L, the guideline is 0.00037 mg/L.

^e Copper guideline is hardness dependent (hardness as CaCO3). Guideline = e^{0.8545[ln(hardness)]-1.465} * 0.0002 mg/L. If hardness is <82 mg/L, the guideline is 0.002 mg/L; if hardness is >180 mg/L, the guideline is 0.004 mg/L. If water hardness is not known, the guideline is 0.002 mg/L.

^f Lead guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: lead guideline (mg/L) = e^{1.273[ln(hardness)]-4.705} /1000. At hardness as CaCO₃ of ≤ 60mg/L, lead guideline is a minimum of 0.001 mg/L; at hardness as CaCO₃ of >180 mg/L, lead guideline is a maximum of 0.007 mg/L.

^g Nickel guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: nickel guideline (mg/L) = e^{0.76[ln(hardness)]+1.06} /1000. At hardness as CaCO₃ of ≤ 60mg/L, nickel guideline is a minimum of 0.025 mg/L; at hardness as CaCO₃ of >180 mg/L, nickel guideline is a maximum of 0.150 mg/L.

Annex A.3-1. Stream Water Quality Data, Doris North Project, 2014

Site ID: Replicate: Date Sampled: ALS Sample ID:				Doris OF 1 17-Jul-14 L1489340-1	Doris OF 2 17-Jul-14 L1489340-2	Roberts OF 1 17-Jul-14 L1489340-3	Roberts OF 2 17-Jul-14 L1489340-4	Little Roberts OF 1 16-Jul-14 L1489339-1
Units	CCME guideline for the Protection of Aquatic life ^a	Realized Detection Limit						
Physical Tests								
Conductivity	uS/cm	2		279	279	242	242	256.0
Hardness (as CaCO ₃)	mg/L	0.5		50.4	51.2	38.9	38.5	45.7
pH	pH	0.1	6.5–9.0	7.63	7.69	7.56	7.56	7.65
Total Suspended Solids	mg/L	1	dependent on background levels	4.1	4.2	2.1	2.1	3.2
Total Dissolved Solids	mg/L	10		170	181	144	141	154
Turbidity	NTU	0.1	dependent on background levels	3.85	3.42	1.83	2.31	3.16
Anions and Nutrients								
Alkalinity, Total (as CaCO ₃)	mg/L	1		29.2	29.5	21.5	21.1	25.0
Ammonia, Total (as N)	mg/L	0.005	pH- and temperature-dependent	0.0127	0.0099	<0.0050	<0.0050	<0.0050
Bromide (Br)	mg/L	0.05		0.213	0.209	0.197	0.193	0.2
Chloride (Cl)	mg/L	0.5	short-term: 640; long-term: 120	64.0	64.0	57.1	57.4	59.80
Fluoride (F)	mg/L	0.02	Inorganic fluorides: 0.12 ^b	0.059	0.059	0.048	0.048	0.054
Nitrate (as N)	mg/L	0.005	short-term: 124; long-term: 3.0	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite (as N)	mg/L	0.001	0.06	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Total Kjeldahl Nitrogen	mg/L	0.05 to 0.25		0.504	0.501	0.322	0.330	0.404
Orthophosphate-Dissolved (as P)	mg/L	0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)	mg/L	0.002	Trigger ranges from guidance framework ^c	0.0243	0.0256	0.0233	0.0144	0.0178
Sulfate (SO ₄)	mg/L	0.5		2.70	2.70	4.26	4.26	3.14
Cyanides								
Cyanide, Total	mg/L	0.001		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L	0.001	0.005	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic / Inorganic Carbon								
Dissolved Organic Carbon	mg/L	0.5		5.00	5.17	4.42	4.40	4.78
Total Organic Carbon	mg/L	0.5		5.40	5.64	4.60	4.78	4.98
Total Metals								
Aluminum (Al)	mg/L	0.003	0.005 if pH<6.5; 0.1 if pH≥6.5	0.0497	0.0485	0.053	0.042	0.0855
Antimony (Sb)	mg/L	0.00001		0.000021	0.000024	0.000029	0.000024	0.000023
Arsenic (As)	mg/L	0.00005	0.005	0.000277	0.000282	0.000272	0.000270	0.000267
Barium (Ba)	mg/L	0.0001		0.00348	0.00332	0.00275	0.00259	0.00330
Beryllium (Be)	mg/L	0.000005		<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)	mg/L	0.00005		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)	mg/L	0.005	short-term: 29; long-term: 1.5	0.0288	0.0294	0.0343	0.0336	0.0282
Cadmium (Cd)	mg/L	0.000005	equation ^d	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)	mg/L	0.05		9.09	9.24	5.57	5.62	7.79
Cesium (Cs)	mg/L	0.000005		0.0000061	0.0000072	0.0000079	0.0000075	0.000008
Chromium (Cr)	mg/L	0.0005	Cr(VI): 0.001; Cr(III): 0.0089 ^b	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L	0.00005		0.000061	0.000059	<0.000050	<0.000050	0.000066
Copper (Cu)	mg/L	0.0005	0.002-0.004	0.00119	0.00114	0.00137	0.00128	0.00126
Gallium (Ga)	mg/L	0.00005		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Iron (Fe)	mg/L	0.03	0.3	0.214	0.218	0.126	0.116	0.190
Lead (Pb)	mg/L	0.00005	0.001-0.007 ^f	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L	0.0002		0.00381	0.00390	0.00255	0.00249	0.00343
Magnesium (Mg)	mg/L	0.1		6.74	6.83	6.07	5.95	6.37
Manganese (Mn)	mg/L	0.0002		0.0337	0.0334	0.01400	0.01370	0.01930
Mercury (Hg)	ug/L	0.0005	Inorganic Hg: 0.026	0.00095	0.00099	0.00083	0.001	0.00085
Molybdenum (Mo)	mg/L	0.00005	0.073 ^b	0.000161	0.000166	0.000197	0.000186	0.000174
Nickel (Ni)	mg/L	0.0002	0.025-0.150 ^g	0.00047	0.00043	0.00048	0.00046	0.00049
Phosphorus (P)	mg/L	0.3		<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)	mg/L	2		2.4	2.5	2.1	2.0	2.2
Rhenium (Re)	mg/L	0.000005		<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Rubidium (Rb)	mg/L	0.00002		0.00148	0.00151	0.00136	0.00132	0.001490
Selenium (Se)	mg/L	0.0002	0.001	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Silicon (Si)	mg/L	0.05		1.40	1.41	0.349	0.309	1.100
Silver (Ag)	mg/L	0.000005	0.0001	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Sodium (Na)	mg/L	2		33.7	34.4	33.2	30.5	31.0
Strontium (Sr)	mg/L	0.00005		0.0436	0.0452	0.0335	0.0333	0.0396
Tellurium (Te)	mg/L	0.00001		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thallium (Tl)	mg/L	0.000002	0.0008	<0.0000020	<0.0000020	<0.0000020	<0.0000020	0.0000037
Thorium (Th)	mg/L	0.000005		0.0000184	0.0000182	0.0000240	0.0000218	0.0000353
Tin (Sn)	mg/L	0.0002		<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)	mg/L	0.0002		0.00188	0.00170	0.00181	0.00153	0.00292
Tungsten (W)	mg/L	0.00001		<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Uranium (U)	mg/L	0.000002	short-term: 0.033; long-term: 0.015	0.0000311	0.0000304	0.0000432	0.0000438	0.0000383
Vanadium (V)	mg/L	0.00005		0.000152	0.000164	0.000151	0.000134	0.000223
Yttrium (Y)	mg/L	0.000005		0.0000282	0.0000294	0.0000363	0.0000344	0.0000421
Zinc (Zn)	mg/L	0.003	0.03	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Zirconium (Zr)	mg/L	0.00005		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Radiochemistry								
Radium-226	Bq/L	0.01		<.01	<.01	<.01	<.01	<.01

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of freshwater aquatic life.

^a Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b Interim guideline.

^c Total phosphorus trigger ranges for lakes and rivers (mg/L): <0.004 = Ultra-oligotrophic; 0.004–0.01 = Oligotrophic; 0.01–0.02 = Mesotrophic; 0.02–0.035 = Meso-eutrophic; 0.035–0.1 = Eutrophic; >0.1 = Hyper-eutrophic.

^d Cadmium guideline is hardness dependent (hardness as CaCO₃). Short-term guideline = 10^{1.016[log(hardness)]-1.71} / 1000 mg/L. If hardness is <5.3 mg/L, the guideline is 0.00011 mg/L; if hardness is >360 mg/L, the guideline is 0.0077 mg/L. Long-term cadmium guideline = 10^{0.83[log(hardness)]-2.46} / 1000 mg/L. If hardness is <17 mg/L, the guideline is 0.00004 mg/L; if hardness is >280 mg/L, the guideline is 0.00037 mg/L.

^e Copper guideline is hardness dependent (hardness as CaCO3). Guideline = e^{0.8545[ln(hardness)]-1.465} * 0.0002 mg/L. If hardness is <82 mg/L, the guideline is 0.002 mg/L; if hardness is >180 mg/L, the guideline is 0.004 mg/L. If water hardness is not known, the guideline is 0.002 mg/L.

^f Lead guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: lead guideline (mg/L) = e^{1.273[ln(hardness)]-4.705} /1000. At hardness as CaCO₃ of ≤ 60mg/L, lead guideline is a minimum of 0.001 mg/L; at hardness as CaCO₃ of >180 mg/L, lead guideline is a maximum of 0.007 mg/L.

^g Nickel guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: nickel guideline (mg/L) = e^{0.76[ln(hardness)]+1.06} /1000. At hardness as CaCO₃ of ≤ 60mg/L, nickel guideline is a minimum of 0.025 mg/L; at hardness as CaCO₃ of >180 mg/L, nickel guideline is a maximum of 0.150 mg/L.

Annex A.3-1. Stream Water Quality Data, Doris North Project, 2014

Site ID:				Little Roberts OF	Reference B OF	Reference B OF	Reference D OF	Reference D OF
Replicate:			Realized	2	1	2	1	2
Date Sampled:		CCME guideline for the	Detection	16-Jul-14	16-Jul-14	16-Jul-14	16-Jul-14	16-Jul-14
ALS Sample ID:	Units	Protection of Aquatic life ^a	Limit	L1489339-2	L1489337-1	L1489337-2	L1489337-3	L1489337-4
Physical Tests								
Conductivity	uS/cm		2	258.0	045	044	097	097
Hardness (as CaCO ₃)	mg/L		0.5	46.00	12.6	13.0	18.2	18.4
pH	pH	6.5–9.0	0.1	7.66	7.26	7.24	7.31	7.30
Total Suspended Solids	mg/L	dependent on background levels	1	3.7	<1.0	1.3	1.8	1.7
Total Dissolved Solids	mg/L		10	154	037	030	58	58
Turbidity	NTU	dependent on background levels	0.1	4.33	0.28	0.29	1.57	1.58
Anions and Nutrients								
Alkalinity, Total (as CaCO ₃)	mg/L		1	25.5	09.4	09.3	10.8	10.9
Ammonia, Total (as N)	mg/L	pH- and temperature-dependent	0.005	0.0056	<0.0050	<0.0050	<0.0050	<0.0050
Bromide (Br)	mg/L		0.05	0.201	<0.050	<0.050	0.063	0.063
Chloride (Cl)	mg/L	short-term: 640; long-term: 120	0.5	59.90	06.0	06.0	20.4	20.4
Fluoride (F)	mg/L	Inorganic fluorides: 0.12 ^b	0.02	0.053	0.021	0.021	0.036	0.036
Nitrate (as N)	mg/L	short-term: 124; long-term: 3.0	0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite (as N)	mg/L	0.06	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Total Kjeldahl Nitrogen	mg/L		0.05 to 0.25	0.406	0.186	0.300	0.209	0.230
Orthophosphate-Dissolved (as P)	mg/L		0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)	mg/L	Trigger ranges from guidance framework ^c	0.002	0.0198	0.0032	0.0034	0.0085	0.0065
Sulfate (SO ₄)	mg/L		0.5	3.14	1.54	1.53	1.90	1.90
Cyanides								
Cyanide, Total	mg/L		0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L	0.005	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic / Inorganic Carbon								
Dissolved Organic Carbon	mg/L		0.5	4.95	2.27	2.38	3.20	3.27
Total Organic Carbon	mg/L		0.5	4.97	2.43	2.47	3.53	3.53
Total Metals								
Aluminum (Al)	mg/L	0.005 if pH<6.5; 0.1 if pH≥6.5	0.003	0.0795	0.0068	0.0072	0.0824	0.0959
Antimony (Sb)	mg/L		0.00001	0.000024	0.000012	0.000016	0.000019	0.000018
Arsenic (As)	mg/L	0.005	0.00005	0.000287	0.000063	0.000078	0.000127	0.000136
Barium (Ba)	mg/L		0.0001	0.00342	0.00146	0.00148	0.00231	0.00259
Beryllium (Be)	mg/L		0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)	mg/L		0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)	mg/L	short-term: 29; long-term: 1.5	0.005	0.0330	0.0096	0.0091	0.0145	0.0157
Cadmium (Cd)	mg/L	equation ^d	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)	mg/L		0.05	7.83	3.07	3.17	2.83	2.85
Cesium (Cs)	mg/L		0.000005	0.0000088	<0.0000050	0.0000055	0.0000095	0.0000107
Chromium (Cr)	mg/L	Cr(VI): 0.001; Cr(III): 0.0089 ^b	0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L		0.00005	0.000064	<0.000050	<0.000050	<0.000050	0.000058
Copper (Cu)	mg/L	0.002-0.004	0.0005	0.00129	0.00064	0.00064	0.00082	0.00090
Gallium (Ga)	mg/L		0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Iron (Fe)	mg/L	0.3	0.03	0.187	0.030	<0.030	0.122	0.132
Lead (Pb)	mg/L	0.001-0.007 ^f	0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L		0.0002	0.00345	0.00067	0.00046	0.00135	0.00139
Magnesium (Mg)	mg/L		0.1	6.43	1.20	1.25	2.71	2.74
Manganese (Mn)	mg/L		0.0002	0.01850	0.00156	0.00159	0.00376	0.00423
Mercury (Hg)	ug/L	Inorganic Hg: 0.026	0.0005	0.00085	0.00086	0.00104	0.00096	0.00091
Molybdenum (Mo)	mg/L	0.073 ^b	0.00005	0.000185	0.000077	0.000060	0.000068	0.000082
Nickel (Ni)	mg/L	0.025-0.150 ^g	0.0002	0.00049	<0.00020	<0.00020	0.00037	0.00039
Phosphorus (P)	mg/L		0.3	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)	mg/L		2	2.2	<2.0	<2.0	<2.0	<2.0
Rhenium (Re)	mg/L		0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Rubidium (Rb)	mg/L		0.00002	0.001530	0.00070	0.00073	0.00107	0.00111
Selenium (Se)	mg/L	0.001	0.0002	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Silicon (Si)	mg/L		0.05	1.080	0.079	0.084	0.291	0.344
Silver (Ag)	mg/L	0.0001	0.000005	<0.0000050	0.0000064	<0.0000050	<0.0000050	<0.0000050
Sodium (Na)	mg/L		2	31.3	03.4	03.6	11.9	12.0
Strontium (Sr)	mg/L		0.00005	0.04020	0.0138	0.0141	0.0165	0.0164
Tellurium (Te)	mg/L		0.00001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thallium (Tl)	mg/L	0.0008	0.000002	0.0000037	0.0000041	0.0000036	0.0000038	0.0000038
Thorium (Th)	mg/L		0.000005	0.0000324	0.0000072	0.0000078	0.0000377	0.0000439
Tin (Sn)	mg/L		0.0002	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)	mg/L		0.0002	0.00287	<0.00020	<0.00020	0.00300	0.00351
Tungsten (W)	mg/L		0.00001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Uranium (U)	mg/L	short-term: 0.033; long-term: 0.015	0.000002	0.0000358	0.0000334	0.0000358	0.0000326	0.0000340
Vanadium (V)	mg/L		0.00005	0.000225	<0.000050	<0.000050	0.000185	0.000233
Yttrium (Y)	mg/L		0.000005	0.0000424	0.0000121	0.0000126	0.0000360	0.0000388
Zinc (Zn)	mg/L	0.03	0.003	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Zirconium (Zr)	mg/L		0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Radiochemistry								
Radium-226	Bq/L		0.01	<.01	<.01	<.01	<.01	<.01

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of freshwater aquatic life.

^a Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b Interim guideline.

^c Total phosphorus trigger ranges for lakes and rivers (mg/L): <0.004 = Ultra-oligotrophic; 0.004–0.01 = Oligotrophic; 0.01–0.02 = Mesotrophic; 0.02–0.035 = Meso-eutrophic; 0.035–0.1 = Eutrophic; >0.1 = Hyper-eutrophic.

^d Cadmium guideline is hardness dependent (hardness as CaCO₃). Short-term guideline = 10^{1.016[log(hardness)]-1.71} / 1000 mg/L. If hardness is <5.3 mg/L, the guideline is 0.00011 mg/L; if hardness is >360 mg/L, the guideline is 0.0077 mg/L. Long-term cadmium guideline = 10^{0.83[log(hardness)]-2.46} / 1000 mg/L. If hardness is <17 mg/L, the guideline is 0.00004 mg/L; if hardness is >280 mg/L, the guideline is 0.00037 mg/L.

^e Copper guideline is hardness dependent (hardness as CaCO3). Guideline = e^{0.8545[ln(hardness)]-1.465} * 0.0002 mg/L. If hardness is <82 mg/L, the guideline is 0.002 mg/L; if hardness is >180 mg/L, the guideline is 0.004 mg/L. If water hardness is not known, the guideline is 0.002 mg/L.

^f Lead guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: lead guideline (mg/L) = e^{1.273[ln(hardness)]-4.705} /1000. At hardness as CaCO₃ of ≤ 60mg/L, lead guideline is a minimum of 0.001 mg/L; at hardness as CaCO₃ of >180 mg/L, lead guideline is a maximum of 0.007 mg/L.

^g Nickel guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: nickel guideline (mg/L) = e^{0.76[ln(hardness)]+1.06} /1000. At hardness as CaCO₃ of ≤ 60mg/L, nickel guideline is a minimum of 0.025 mg/L; at hardness as CaCO₃ of >180 mg/L, nickel guideline is a maximum of 0.150 mg/L.

Annex A.3-1. Stream Water Quality Data, Doris North Project, 2014

Site ID: Replicate: Date Sampled: ALS Sample ID:				Doris OF 1 16-Aug-14 L1504784-7	Doris OF 2 16-Aug-14 L1504784-8	Roberts OF 1 16-Aug-14 L1504784-5	Roberts OF 2 16-Aug-14 L1504784-6	Little Roberts OF 1 15-Aug-14 L1504784-3
	Units	CCME guideline for the Protection of Aquatic life ^a	Realized Detection Limit					
Physical Tests								
Conductivity	uS/cm		2	274	274	255	255	257.0
Hardness (as CaCO ₃)	mg/L		0.5	52.7	50.4	40.0	41.8	47.4
pH	pH	6.5–9.0	0.1	7.70	7.68	7.54	7.57	7.48
Total Suspended Solids	mg/L	dependent on background levels	1	3.9	4.0	3.2	3.4	3.5
Total Dissolved Solids	mg/L		10	171	170	144	151	162
Turbidity	NTU	dependent on background levels	0.1	5.45	5.13	3.69	4.17	4.07
Anions and Nutrients								
Alkalinity, Total (as CaCO ₃)	mg/L		1	29.1	28.8	21.7	21.7	26.3
Ammonia, Total (as N)	mg/L	pH- and temperature-dependent	0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bromide (Br)	mg/L		0.05	0.207	0.208	0.206	0.204	0.204
Chloride (Cl)	mg/L	short-term: 640; long-term: 120	0.5	62.7	62.7	60.3	60.3	61.60
Fluoride (F)	mg/L	Inorganic fluorides: 0.12 ^b	0.02	0.057	0.053	0.049	0.049	0.053
Nitrate (as N)	mg/L	short-term: 124; long-term: 3.0	0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite (as N)	mg/L	0.06	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Total Kjeldahl Nitrogen	mg/L		0.05 to 0.25	0.546	0.548	0.432	0.426	0.479
Orthophosphate-Dissolved (as P)	mg/L		0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)	mg/L	Trigger ranges from guidance framework ^c	0.002	0.0253	0.0273	0.0229	0.0221	0.0246
Sulfate (SO ₄)	mg/L		0.5	2.73	2.73	4.23	4.23	3.47
Cyanides								
Cyanide, Total	mg/L		0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L	0.005	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic / Inorganic Carbon								
Dissolved Organic Carbon	mg/L		0.5	5.44	5.53	5.42	5.44	5.22
Total Organic Carbon	mg/L		0.5	6.32	6.27	6.20	5.88	5.69
Total Metals								
Aluminum (Al)	mg/L	0.005 if pH<6.5; 0.1 if pH≥6.5	0.003	0.0401	0.0415	0.0803	0.0800	0.0615
Antimony (Sb)	mg/L		0.00001	0.000024	0.000027	0.000029	0.000026	0.000027
Arsenic (As)	mg/L	0.005	0.00005	0.000283	0.000271	0.000294	0.000280	0.000253
Barium (Ba)	mg/L		0.0001	0.00322	0.00325	0.00322	0.00317	0.00326
Beryllium (Be)	mg/L		0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)	mg/L		0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)	mg/L	short-term: 29; long-term: 1.5	0.005	0.0471	0.0430	0.0542	0.0477	0.0478
Cadmium (Cd)	mg/L	equation ^d	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)	mg/L		0.05	9.62	9.22	5.65	5.86	8.05
Cesium (Cs)	mg/L		0.000005	<0.0000050	<0.0000050	0.0000061	0.0000061	0.000006
Chromium (Cr)	mg/L	Cr(VI): 0.001; Cr(III): 0.0089 ^b	0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L		0.00005	<0.000050	<0.000050	<0.000050	<0.000050	0.000059
Copper (Cu)	mg/L	0.002-0.004	0.0005	0.00114	0.00118	0.00143	0.00148	0.00128
Gallium (Ga)	mg/L		0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Iron (Fe)	mg/L	0.3	0.03	0.127	0.123	0.156	0.161	0.194
Lead (Pb)	mg/L	0.001-0.007 ^f	0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L		0.0002	0.00446	0.00446	0.00324	0.00329	0.00398
Magnesium (Mg)	mg/L		0.1	6.96	6.66	6.29	6.60	6.63
Manganese (Mn)	mg/L		0.0002	0.0224	0.0224	0.00775	0.00804	0.01820
Mercury (Hg)	ug/L	Inorganic Hg: 0.026	0.0005	0.00083	0.00059	0.00069	0.00080	0.00062
Molybdenum (Mo)	mg/L	0.073 ^b	0.00005	0.000170	0.000163	0.000190	0.000200	0.000183
Nickel (Ni)	mg/L	0.025-0.150 ^g	0.0002	0.00048	0.00044	0.00050	0.00055	0.00049
Phosphorus (P)	mg/L		0.3	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)	mg/L		2	2.5	2.4	2.1	2.2	2.3
Rhenium (Re)	mg/L		0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Rubidium (Rb)	mg/L		0.00002	0.00153	0.00160	0.00141	0.00140	0.001470
Selenium (Se)	mg/L	0.001	0.0002	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Silicon (Si)	mg/L		0.05	1.35	1.31	0.600	0.620	1.020
Silver (Ag)	mg/L	0.0001	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Sodium (Na)	mg/L		2	33.6	31.8	33.0	34.7	33.1
Strontium (Sr)	mg/L		0.00005	0.0475	0.0482	0.0396	0.0391	0.0446
Tellurium (Te)	mg/L		0.00001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thallium (Tl)	mg/L	0.0008	0.000002	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020
Thorium (Th)	mg/L		0.000005	0.0000132	0.0000113	0.0000304	0.0000296	0.0000206
Tin (Sn)	mg/L		0.0002	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)	mg/L		0.0002	0.00100	0.00096	0.00174	0.00167	0.00163
Tungsten (W)	mg/L		0.00001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Uranium (U)	mg/L	short-term: 0.033; long-term: 0.015	0.000002	0.0000324	0.0000322	0.0000476	0.0000464	0.0000370
Vanadium (V)	mg/L		0.00005	0.000132	0.000135	0.000160	0.000163	0.000164
Yttrium (Y)	mg/L		0.000005	0.0000212	0.0000218	0.0000451	0.0000468	0.0000344
Zinc (Zn)	mg/L	0.03	0.003	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Zirconium (Zr)	mg/L		0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Radiochemistry								
Radium-226	Bq/L		0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of freshwater aquatic life.

^a Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b Interim guideline.

^c Total phosphorus trigger ranges for lakes and rivers (mg/L): <0.004 = Ultra-oligotrophic; 0.004–0.01 = Oligotrophic; 0.01–0.02 = Mesotrophic; 0.02–0.035 = Meso-eutrophic; 0.035–0.1 = Eutrophic; >0.1 = Hyper-eutrophic.

^d Cadmium guideline is hardness dependent (hardness as CaCO₃). Short-term guideline = 10^{1.016[log(hardness)]-1.71} / 1000 mg/L. If hardness is <5.3 mg/L, the guideline is 0.00011 mg/L; if hardness is >360 mg/L, the guideline is 0.0077 mg/L. Long-term cadmium guideline = 10^{0.83[log(hardness)]-2.46} / 1000 mg/L. If hardness is <17 mg/L, the guideline is 0.00004 mg/L; if hardness is >280 mg/L, the guideline is 0.00037 mg/L.

^e Copper guideline is hardness dependent (hardness as CaCO₃). Guideline = e^{0.8545[ln(hardness)]-1.465} * 0.0002 mg/L. If hardness is <82 mg/L, the guideline is 0.002 mg/L; if hardness is >180 mg/L, the guideline is 0.004 mg/L. If water hardness is not known, the guideline is 0.002 mg/L.

^f Lead guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: lead guideline (mg/L) = e^{1.273[ln(hardness)]-4.705} /1000. At hardness as CaCO₃ of ≤ 60mg/L, lead guideline is a minimum of 0.001 mg/L; at hardness as CaCO₃ of >180 mg/L, lead guideline is a maximum of 0.007 mg/L.

^g Nickel guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: nickel guideline (mg/L) = e^{0.76[ln(hardness)]+1.06} /1000. At hardness as CaCO₃ of ≤ 60mg/L, nickel guideline is a minimum of 0.025 mg/L; at hardness as CaCO₃ of >180 mg/L, nickel guideline is a maximum of 0.150 mg/L.

Annex A.3-1. Stream Water Quality Data, Doris North Project, 2014

Site ID:				Little Roberts OF	Reference B OF	Reference B OF	Reference D OF	Reference D OF
Replicate:			Realized	2	1	2	1	2
Date Sampled:		CCME guideline for the	Detection	15-Aug-14	15-Aug-14	15-Aug-14	14-Aug-14	14-Aug-14
ALS Sample ID:	Units	Protection of Aquatic life ^a	Limit	L1504784-4	L1504784-1	L1504784-2	L1503367-1	L1503367-2
Physical Tests								
Conductivity	uS/cm		2	265.0	047	047	101	100
Hardness (as CaCO ₃)	mg/L		0.5	49.1	13.6	14.3	19.4	19.0
pH	pH	6.5–9.0	0.1	7.62	7.17	7.22	7.40	7.25
Total Suspended Solids	mg/L	dependent on background levels	1	3.6	<1.0	<1.0	<1.0	1.8
Total Dissolved Solids	mg/L		10	162	032	035	73	63
Turbidity	NTU	dependent on background levels	0.1	5.10	0.40	0.42	0.99	0.94
Anions and Nutrients								
Alkalinity, Total (as CaCO ₃)	mg/L		1	26.5	09.7	09.8	12.0	10.6
Ammonia, Total (as N)	mg/L	pH- and temperature-dependent	0.005	0.0069	<0.0050	<0.0050	<0.0050	<0.0050
Bromide (Br)	mg/L		0.05	0.209	<0.050	<0.050	0.061	0.061
Chloride (Cl)	mg/L	short-term: 640; long-term: 120	0.5	61.50	06.5	06.5	20.9	20.9
Fluoride (F)	mg/L	Inorganic fluorides: 0.12 ^b	0.02	0.053	<0.020	<0.020	0.038	0.038
Nitrate (as N)	mg/L	short-term: 124; long-term: 3.0	0.005	<0.0050	0.0095	0.0075	<0.0050	<0.0050
Nitrite (as N)	mg/L	0.06	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Total Kjeldahl Nitrogen	mg/L		0.05 to 0.25	0.476	0.204	0.201	0.274	0.272
Orthophosphate-Dissolved (as P)	mg/L		0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)	mg/L	Trigger ranges from guidance framework ^c	0.002	0.0248	0.0045	0.0047	0.0051	0.0052
Sulfate (SO ₄)	mg/L		0.5	3.47	1.62	1.61	1.96	1.96
Cyanides								
Cyanide, Total	mg/L		0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L	0.005	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic / Inorganic Carbon								
Dissolved Organic Carbon	mg/L		0.5	5.22	2.89	2.85	4.40	4.24
Total Organic Carbon	mg/L		0.5	5.88	3.03	3.22	4.61	4.41
Total Metals								
Aluminum (Al)	mg/L	0.005 if pH<6.5; 0.1 if pH≥6.5	0.003	0.0599	0.006	0.006	0.0381	0.0388
Antimony (Sb)	mg/L		0.00001	0.000029	0.000020	0.000021	0.000015	0.000017
Arsenic (As)	mg/L	0.005	0.00005	0.000288	0.000076	0.000076	0.000128	0.000129
Barium (Ba)	mg/L		0.0001	0.00343	0.00151	0.00152	0.00184	0.00183
Beryllium (Be)	mg/L		0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)	mg/L		0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)	mg/L	short-term: 29; long-term: 1.5	0.005	0.0518	0.0255	0.0242	0.0201	0.0181
Cadmium (Cd)	mg/L	equation ^d	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)	mg/L		0.05	8.39	3.29	3.46	3.02	2.99
Cesium (Cs)	mg/L		0.000005	0.0000059	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Chromium (Cr)	mg/L	Cr(VI): 0.001; Cr(III): 0.0089 ^b	0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L		0.00005	0.000059	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)	mg/L	0.002-0.004	0.0005	0.00139	0.00073	0.00075	0.00098	0.00098
Gallium (Ga)	mg/L		0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Iron (Fe)	mg/L	0.3	0.03	0.195	0.036	0.038	0.091	0.086
Lead (Pb)	mg/L	0.001-0.007 ^f	0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L		0.0002	0.00407	0.00068	0.00060	0.00127	0.00130
Magnesium (Mg)	mg/L		0.1	6.84	1.30	1.37	2.87	2.81
Manganese (Mn)	mg/L		0.0002	0.01900	0.0018	0.0019	0.00377	0.00364
Mercury (Hg)	ug/L	Inorganic Hg: 0.026	0.0005	0.00088	0.00078	0.00070	0.00080	0.00092
Molybdenum (Mo)	mg/L	0.073 ^b	0.00005	0.000185	<0.000050	<0.000050	0.000075	0.000069
Nickel (Ni)	mg/L	0.025-0.150 ^g	0.0002	0.00053	<0.00020	<0.00020	0.00036	0.00037
Phosphorus (P)	mg/L		0.3	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)	mg/L		2	2.4	<2.0	<2.0	<2.0	<2.0
Rhenium (Re)	mg/L		0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Rubidium (Rb)	mg/L		0.00002	0.001520	0.00071	0.00074	0.00100	0.00097
Selenium (Se)	mg/L	0.001	0.0002	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Silicon (Si)	mg/L		0.05	1.020	0.076	0.088	0.239	0.234
Silver (Ag)	mg/L	0.0001	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Sodium (Na)	mg/L		2	33.9	03.6	03.8	12.2	11.9
Strontium (Sr)	mg/L		0.00005	0.0467	0.0152	0.0159	0.0175	0.0176
Tellurium (Te)	mg/L		0.00001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thallium (Tl)	mg/L	0.0008	0.000002	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020
Thorium (Th)	mg/L		0.000005	0.0000211	<0.0000050	0.0000057	0.0000277	0.0000286
Tin (Sn)	mg/L		0.0002	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)	mg/L		0.0002	0.00156	<0.00020	<0.00020	0.00088	0.00087
Tungsten (W)	mg/L		0.00001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Uranium (U)	mg/L	short-term: 0.033; long-term: 0.015	0.000002	0.0000367	0.0000348	0.0000364	0.0000377	0.0000386
Vanadium (V)	mg/L		0.00005	0.000166	<0.000050	<0.000050	0.000084	0.000088
Yttrium (Y)	mg/L		0.000005	0.0000337	0.0000130	0.0000145	0.0000353	0.0000333
Zinc (Zn)	mg/L	0.03	0.003	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Zirconium (Zr)	mg/L		0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Radiochemistry								
Radium-226	Bq/L		0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of freshwater aquatic life.

^a Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b Interim guideline.

^c Total phosphorus trigger ranges for lakes and rivers (mg/L): <0.004 = Ultra-oligotrophic; 0.004–0.01 = Oligotrophic; 0.01–0.02 = Mesotrophic; 0.02–0.035 = Meso-eutrophic; 0.035–0.1 = Eutrophic; >0.1 = Hyper-eutrophic.

^d Cadmium guideline is hardness dependent (hardness as CaCO₃). Short-term guideline = 10^{1.016[log(hardness)]-1.71} / 1000 mg/L. If hardness is <5.3 mg/L, the guideline is 0.00011 mg/L; if hardness is >360 mg/L, the guideline is 0.0077 mg/L. Long-term cadmium guideline = 10^{0.83[log(hardness)]-2.46} / 1000 mg/L. If hardness is <17 mg/L, the guideline is 0.00004 mg/L; if hardness is >280 mg/L, the guideline is 0.00037 mg/L.

^e Copper guideline is hardness dependent (hardness as CaCO3). Guideline = e^{0.8545[ln(hardness)]-1.465} * 0.0002 mg/L. If hardness is <82 mg/L, the guideline is 0.002 mg/L; if hardness is >180 mg/L, the guideline is 0.004 mg/L. If water hardness is not known, the guideline is 0.002 mg/L.

^f Lead guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: lead guideline (mg/L) = e^{1.273[ln(hardness)]-4.705} /1000. At hardness as CaCO₃ of ≤ 60mg/L, lead guideline is a minimum of 0.001 mg/L; at hardness as CaCO₃ of >180 mg/L, lead guideline is a maximum of 0.007 mg/L.

^g Nickel guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: nickel guideline (mg/L) = e^{0.76[ln(hardness)]+1.06} /1000. At hardness as CaCO₃ of ≤ 60mg/L, nickel guideline is a minimum of 0.025 mg/L; at hardness as CaCO₃ of >180 mg/L, nickel guideline is a maximum of 0.150 mg/L.

Annex A.3-1. Stream Water Quality Data, Doris North Project, 2014

Site ID:				Doris OF	Doris OF	Roberts OF	Roberts OF	Little Roberts OF
Replicate:			Realized	1	2	1	2	1
Date Sampled:		CCME guideline for the	Detection	17-Sep-14	17-Sep-14	18-Sep-14	18-Sep-14	17-Sep-14
ALS Sample ID:	Units	Protection of Aquatic life ^a	Limit	L1520746-1	L1520746-2	L1520746-7	L1520746-8	L1520746-5
Physical Tests								
Conductivity	uS/cm		2	272	272	256	255	273.0
Hardness (as CaCO ₃)	mg/L		0.5	52.5	52.6	41.1	40.7	47.7
pH	pH	6.5–9.0	0.1	7.38	7.45	7.46	7.29	7.23
Total Suspended Solids	mg/L	dependent on background levels	1	5.2	5.6	3.2	3.8	5.3
Total Dissolved Solids	mg/L		10	182	189	156	154	174
Turbidity	NTU	dependent on background levels	0.1	6.15	5.47	2.94	2.62	4.53
Anions and Nutrients								
Alkalinity, Total (as CaCO ₃)	mg/L		1	31.7	31.5	24.4	23.4	27.2
Ammonia, Total (as N)	mg/L	pH- and temperature-dependent	0.005	0.0066	0.0086	<0.0050	<0.0050	0.0052
Bromide (Br)	mg/L		0.05	0.213	0.216	0.212	0.210	0.218
Chloride (Cl)	mg/L	short-term: 640; long-term: 120	0.5	63.7	63.7	61.4	61.6	64.30
Fluoride (F)	mg/L	Inorganic fluorides: 0.12 ^b	0.02	0.058	0.058	0.050	0.050	0.054
Nitrate (as N)	mg/L	short-term: 124; long-term: 3.0	0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite (as N)	mg/L	0.06	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Total Kjeldahl Nitrogen	mg/L		0.05 to 0.25	0.631	0.651	0.424	0.419	0.549
Orthophosphate-Dissolved (as P)	mg/L		0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)	mg/L	Trigger ranges from guidance framework ^c	0.002	0.0203	0.0210	0.0113	0.0169	0.0173
Sulfate (SO ₄)	mg/L		0.5	2.91	2.90	4.60	4.61	3.97
Cyanides								
Cyanide, Total	mg/L		0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L	0.005	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic / Inorganic Carbon								
Dissolved Organic Carbon	mg/L		0.5	5.83	5.87	5.28	5.28	5.60
Total Organic Carbon	mg/L		0.5	6.69	6.09	5.37	5.37	5.71
Total Metals								
Aluminum (Al)	mg/L	0.005 if pH<6.5; 0.1 if pH≥6.5	0.003	0.0542	0.0516	0.107	0.1030	0.1080
Antimony (Sb)	mg/L		0.00001	0.000022	0.000020	0.000019	0.000017	0.000019
Arsenic (As)	mg/L	0.005	0.00005	0.000320	0.000321	0.000308	0.000300	0.000335
Barium (Ba)	mg/L		0.0001	0.00314	0.00316	0.00300	0.00283	0.00348
Beryllium (Be)	mg/L		0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)	mg/L		0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)	mg/L	short-term: 29; long-term: 1.5	0.005	0.0503	0.0432	0.0458	0.0450	0.0498
Cadmium (Cd)	mg/L	equation ^d	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)	mg/L		0.05	09.6	9.66	5.92	5.86	7.92
Cesium (Cs)	mg/L		0.000005	<0.0000050	<0.0000050	0.0000056	<0.0000050	0.0000062
Chromium (Cr)	mg/L	Cr(VI): 0.001; Cr(III): 0.0089 ^b	0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L		0.00005	<0.000050	<0.000050	<0.000050	<0.000050	0.000055
Copper (Cu)	mg/L	0.002-0.004	0.0005	0.00104	0.00099	0.00133	0.00114	0.00112
Gallium (Ga)	mg/L		0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Iron (Fe)	mg/L	0.3	0.03	0.104	0.101	0.138	0.137	0.191
Lead (Pb)	mg/L	0.001-0.007 ^f	0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L		0.0002	0.00451	0.00432	0.00287	0.00267	0.00371
Magnesium (Mg)	mg/L		0.1	6.90	6.92	6.38	6.34	6.79
Manganese (Mn)	mg/L		0.0002	0.0165	0.0159	0.00574	0.00553	0.01180
Mercury (Hg)	ug/L	Inorganic Hg: 0.026	0.0005	0.00052	0.00059	0.00063	<0.00050	0.00054
Molybdenum (Mo)	mg/L	0.073 ^b	0.00005	0.000157	0.000153	0.000146	0.000137	0.000142
Nickel (Ni)	mg/L	0.025-0.150 ^g	0.0002	0.00054	0.00053	0.00090	0.00049	0.00055
Phosphorus (P)	mg/L		0.3	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)	mg/L		2	2.4	2.4	2.2	2.1	2.3
Rhenium (Re)	mg/L		0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Rubidium (Rb)	mg/L		0.00002	0.00126	0.00124	0.00121	0.00114	0.001260
Selenium (Se)	mg/L	0.001	0.0002	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Silicon (Si)	mg/L		0.05	1.41	1.41	0.528	0.507	1.140
Silver (Ag)	mg/L	0.0001	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Sodium (Na)	mg/L		2	34.0	34.3	34.5	34.2	35.1
Strontium (Sr)	mg/L		0.00005	0.0423	0.0414	0.0349	0.0334	0.0380
Tellurium (Te)	mg/L		0.00001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thallium (Tl)	mg/L	0.0008	0.000002	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020
Thorium (Th)	mg/L		0.000005	0.0000130	0.0000106	0.0000277	0.0000262	0.0000258
Tin (Sn)	mg/L		0.0002	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)	mg/L		0.0002	0.00137	0.00133	0.00317	0.00301	0.00369
Tungsten (W)	mg/L		0.00001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Uranium (U)	mg/L	short-term: 0.033; long-term: 0.015	0.000002	0.0000283	0.0000303	0.0000434	0.0000422	0.0000356
Vanadium (V)	mg/L		0.00005	0.000148	0.000150	0.000183	0.000184	0.000228
Yttrium (Y)	mg/L		0.000005	0.0000146	0.0000143	0.0000333	0.0000328	0.0000313
Zinc (Zn)	mg/L	0.03	0.003	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Zirconium (Zr)	mg/L		0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Radiochemistry								
Radium-226	Bq/L		0.01	<.01	<.01	<.01	<.01	<.01

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of freshwater aquatic life.

^a Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b Interim guideline.

^c Total phosphorus trigger ranges for lakes and rivers (mg/L): <0.004 = Ultra-oligotrophic; 0.004–0.01 = Oligotrophic; 0.01–0.02 = Mesotrophic; 0.02–0.035 = Meso-eutrophic; 0.035–0.1 = Eutrophic; >0.1 = Hyper-eutrophic.

^d Cadmium guideline is hardness dependent (hardness as CaCO₃). Short-term guideline = 10^{1.016[log(hardness)]-1.71} / 1000 mg/L. If hardness is <5.3 mg/L, the guideline is 0.00011 mg/L; if hardness is >360 mg/L, the guideline is 0.0077 mg/L. Long-term cadmium guideline = 10^{0.83[log(hardness)]-2.46} / 1000 mg/L. If hardness is <17 mg/L, the guideline is 0.00004 mg/L; if hardness is >280 mg/L, the guideline is 0.00037 mg/L.

^e Copper guideline is hardness dependent (hardness as CaCO3). Guideline = e^{0.8545[ln(hardness)]-1.465} * 0.0002 mg/L. If hardness is <82 mg/L, the guideline is 0.002 mg/L; if hardness is >180 mg/L, the guideline is 0.004 mg/L. If water hardness is not known, the guideline is 0.002 mg/L.

^f Lead guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: lead guideline (mg/L) = e^{1.273[ln(hardness)]-4.705} /1000. At hardness as CaCO₃ of ≤ 60mg/L, lead guideline is a minimum of 0.001 mg/L; at hardness as CaCO₃ of >180 mg/L, lead guideline is a maximum of 0.007 mg/L.

^g Nickel guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: nickel guideline (mg/L) = e^{0.76[ln(hardness)]+1.06} /1000. At hardness as CaCO₃ of ≤ 60mg/L, nickel guideline is a minimum of 0.025 mg/L; at hardness as CaCO₃ of >180 mg/L, nickel guideline is a maximum of 0.150 mg/L.

Annex A.3-1. Stream Water Quality Data, Doris North Project, 2014

Site ID:				Little Roberts OF	Reference B OF	Reference B OF	Reference D OF	Reference D OF
Replicate:			Realized	2	1	2	1	2
Date Sampled:		CCME guideline for the	Detection	17-Sep-14	18-Sep-14	18-Sep-14	17-Sep-14	17-Sep-14
ALS Sample ID:	Units	Protection of Aquatic life ^a	Limit	L1520746-6	L1520746-9	L1520746-10	L1520746-3	L1520746-4
Physical Tests								
Conductivity	uS/cm		2	273.0	051	051	108	107
Hardness (as CaCO ₃)	mg/L		0.5	47.5	14.5	14.8	20.3	20.4
pH	pH	6.5–9.0	0.1	7.25	7.01	6.89	7.09	6.94
Total Suspended Solids	mg/L	dependent on background levels	1	5.1	<1.0	<1.0	<1.0	<1.0
Total Dissolved Solids	mg/L		10	173	044	045	70	72
Turbidity	NTU	dependent on background levels	0.1	4.79	0.31	0.31	0.75	0.74
Anions and Nutrients								
Alkalinity, Total (as CaCO ₃)	mg/L		1	27.3	10.6	09.9	12.8	12.2
Ammonia, Total (as N)	mg/L	pH- and temperature-dependent	0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bromide (Br)	mg/L		0.05	0.215	<0.050	<0.050	0.065	0.066
Chloride (Cl)	mg/L	short-term: 640; long-term: 120	0.5	64.30	07.1	07.1	22.3	22.3
Fluoride (F)	mg/L	Inorganic fluorides: 0.12 ^b	0.02	0.055	0.022	0.022	0.039	0.039
Nitrate (as N)	mg/L	short-term: 124; long-term: 3.0	0.005	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite (as N)	mg/L	0.06	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Total Kjeldahl Nitrogen	mg/L		0.05 to 0.25	0.541	0.250	0.243	0.279	0.280
Orthophosphate-Dissolved (as P)	mg/L		0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)	mg/L	Trigger ranges from guidance framework ^c	0.002	0.0121	0.0029	0.0035	0.0051	0.0042
Sulfate (SO ₄)	mg/L		0.5	3.97	1.80	1.80	2.16	2.16
Cyanides								
Cyanide, Total	mg/L		0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L	0.005	0.001	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic / Inorganic Carbon								
Dissolved Organic Carbon	mg/L		0.5	5.64	3.38	3.29	4.77	4.73
Total Organic Carbon	mg/L		0.5	5.90	3.50	3.47	5.13	4.88
Total Metals								
Aluminum (Al)	mg/L	0.005 if pH<6.5; 0.1 if pH≥6.5	0.003	0.1120	0.0059	0.0056	0.0456	0.0415
Antimony (Sb)	mg/L		0.00001	0.000019	0.000012	0.000011	0.000014	0.000014
Arsenic (As)	mg/L	0.005	0.00005	0.000344	0.000096	0.000090	0.000140	0.000121
Barium (Ba)	mg/L		0.0001	0.00334	0.00147	0.00158	0.00196	0.00185
Beryllium (Be)	mg/L		0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)	mg/L		0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)	mg/L	short-term: 29; long-term: 1.5	0.005	0.0432	0.0141	0.0085	0.0218	0.0194
Cadmium (Cd)	mg/L	equation ^d	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)	mg/L		0.05	7.89	3.51	3.57	3.16	3.18
Cesium (Cs)	mg/L		0.000005	0.0000055	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Chromium (Cr)	mg/L	Cr(VI): 0.001; Cr(III): 0.0089 ^b	0.0005	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L		0.00005	0.000055	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)	mg/L	0.002-0.004	0.0005	0.00115	0.00062	0.00059	0.00084	0.00086
Gallium (Ga)	mg/L		0.00005	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Iron (Fe)	mg/L	0.3	0.03	0.187	<0.030	<0.030	0.078	0.077
Lead (Pb)	mg/L	0.001-0.007 ^f	0.00005	<0.000050	<0.000050	<0.000050	0.000219	<0.000050
Lithium (Li)	mg/L		0.0002	0.00384	0.00047	0.00045	0.00144	0.00142
Magnesium (Mg)	mg/L		0.1	6.75	1.39	1.42	3.02	3.02
Manganese (Mn)	mg/L		0.0002	0.01150	0.00097	0.00093	0.00281	0.00260
Mercury (Hg)	ug/L	Inorganic Hg: 0.026	0.0005	0.00056	<0.00050	<0.00050	0.00056	0.00055
Molybdenum (Mo)	mg/L	0.073 ^b	0.00005	0.000137	<0.000050	<0.000050	0.000057	0.000056
Nickel (Ni)	mg/L	0.025-0.150 ^g	0.0002	0.00055	<0.00020	<0.00020	0.00035	0.00035
Phosphorus (P)	mg/L		0.3	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)	mg/L		2	2.4	<2.0	<2.0	<2.0	<2.0
Rhenium (Re)	mg/L		0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Rubidium (Rb)	mg/L		0.00002	0.001330	0.00062	0.00064	0.00085	0.00085
Selenium (Se)	mg/L	0.001	0.0002	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Silicon (Si)	mg/L		0.05	1.150	0.098	0.101	0.283	0.275
Silver (Ag)	mg/L	0.0001	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Sodium (Na)	mg/L		2	35.1	03.8	03.9	12.8	12.8
Strontium (Sr)	mg/L		0.00005	0.0401	0.0149	0.0151	0.0164	0.0169
Tellurium (Te)	mg/L		0.00001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thallium (Tl)	mg/L	0.0008	0.000002	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020
Thorium (Th)	mg/L		0.000005	0.0000272	0.0000076	0.0000066	0.0000222	0.0000228
Tin (Sn)	mg/L		0.0002	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)	mg/L		0.0002	0.00358	<0.00020	<0.00020	0.00102	0.00097
Tungsten (W)	mg/L		0.00001	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Uranium (U)	mg/L	short-term: 0.033; long-term: 0.015	0.000002	0.0000371	0.0000368	0.0000355	0.0000431	0.0000448
Vanadium (V)	mg/L		0.00005	0.000222	<0.000050	<0.000050	0.000083	0.000075
Yttrium (Y)	mg/L		0.000005	0.0000313	0.0000118	0.0000121	0.0000267	0.0000271
Zinc (Zn)	mg/L	0.03	0.003	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Zirconium (Zr)	mg/L		0.00005	0.000089	<0.000050	<0.000050	<0.000050	<0.000050
Radiochemistry								
Radium-226	Bq/L		0.01	<.01	<.01	<.01	0.017	<.01

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of freshwater aquatic life.

^a Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b Interim guideline.

^c Total phosphorus trigger ranges for lakes and rivers (mg/L): <0.004 = Ultra-oligotrophic; 0.004–0.01 = Oligotrophic; 0.01–0.02 = Mesotrophic; 0.02–0.035 = Meso-eutrophic; 0.035–0.1 = Eutrophic; >0.1 = Hyper-eutrophic.

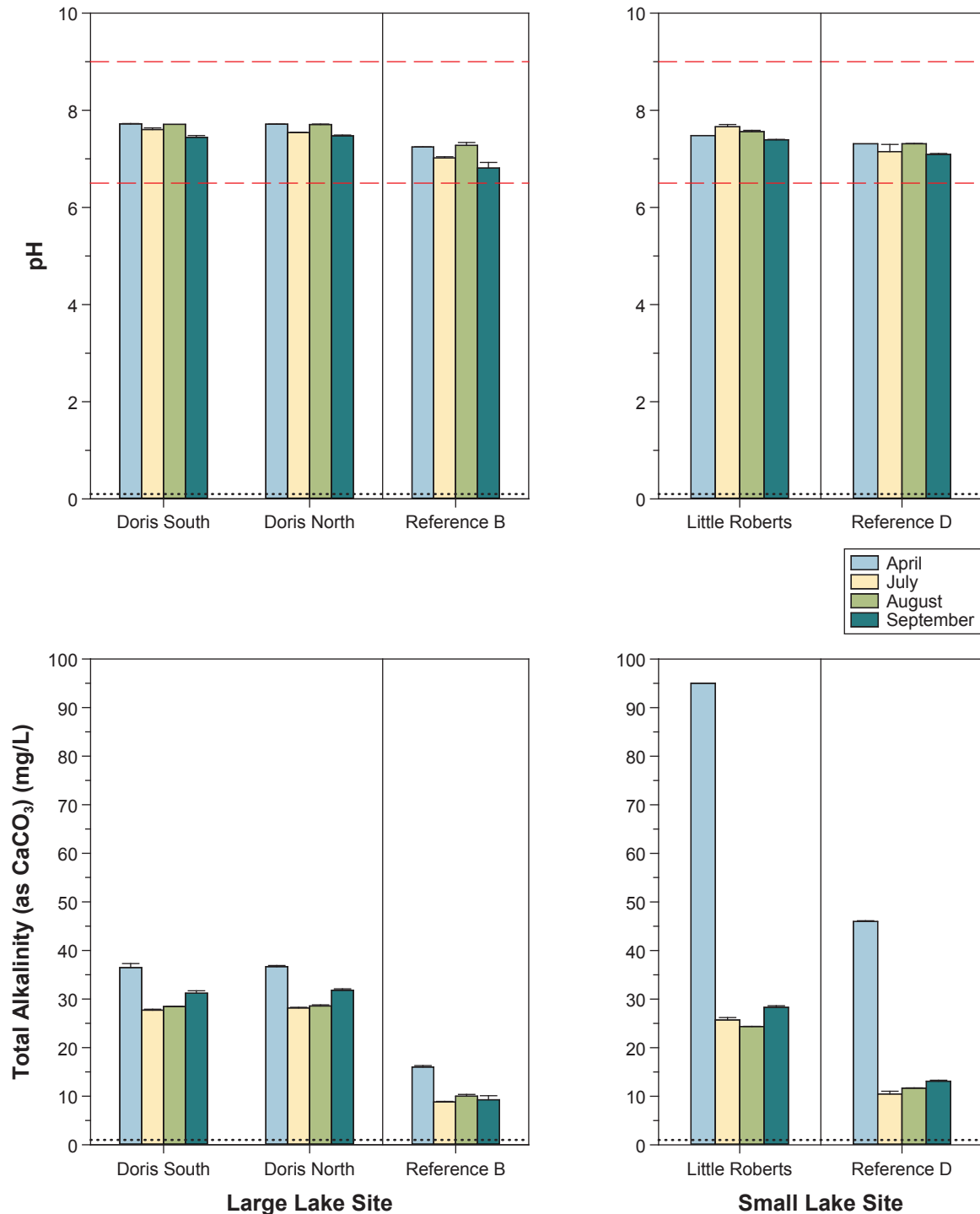
^d Cadmium guideline is hardness dependent (hardness as CaCO₃). Short-term guideline = 10^{1.016[log(hardness)]-1.71} / 1000 mg/L. If hardness is <5.3 mg/L, the guideline is 0.00011 mg/L; if hardness is >360 mg/L, the guideline is 0.0077 mg/L. Long-term cadmium guideline = 10^{0.83[log(hardness)]-2.46} / 1000 mg/L. If hardness is <17 mg/L, the guideline is 0.00004 mg/L; if hardness is >280 mg/L, the guideline is 0.00037 mg/L.

^e Copper guideline is hardness dependent (hardness as CaCO3). Guideline = e^{0.8545[ln(hardness)]-1.465} * 0.0002 mg/L. If hardness is <82 mg/L, the guideline is 0.002 mg/L; if hardness is >180 mg/L, the guideline is 0.004 mg/L. If water hardness is not known, the guideline is 0.002 mg/L.

^f Lead guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: lead guideline (mg/L) = e^{1.273[ln(hardness)]-4.705} /1000. At hardness as CaCO₃ of ≤ 60mg/L, lead guideline is a minimum of 0.001 mg/L; at hardness as CaCO₃ of >180 mg/L, lead guideline is a maximum of 0.007 mg/L.

^g Nickel guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: nickel guideline (mg/L) = e^{0.76[ln(hardness)]+1.06} /1000. At hardness as CaCO₃ of ≤ 60mg/L, nickel guideline is a minimum of 0.025 mg/L; at hardness as CaCO₃ of >180 mg/L, nickel guideline is a maximum of 0.150 mg/L.

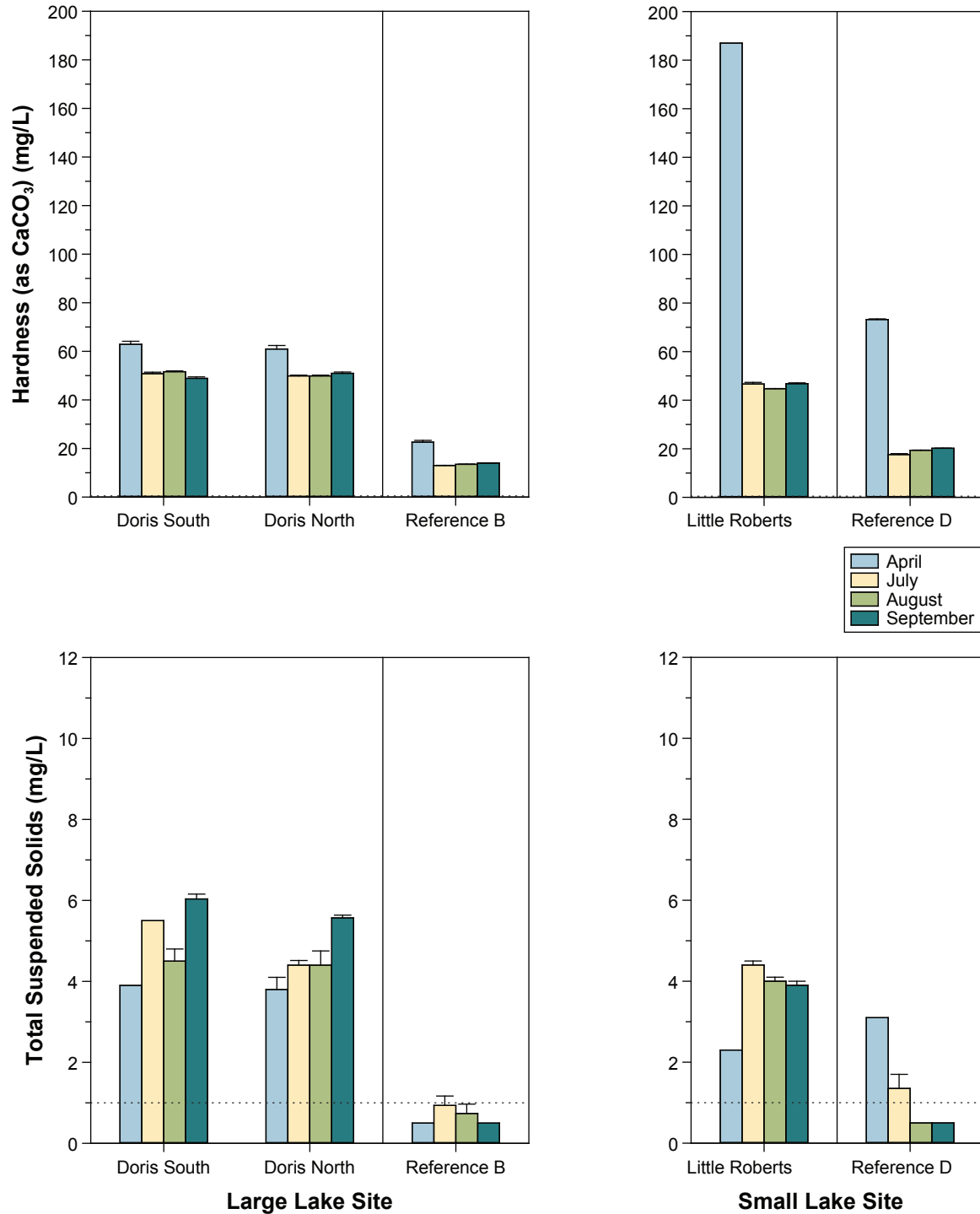
Figure A.3-10
pH and Total Alkalinity in
Lake Sites, Doris North Project, 2014



Notes: Error bars represent the standard error of the mean of replicates.
 Black dotted lines represent the analytical detection limits.
 Red dashed lines represent the CCME freshwater guideline pH range (6.5–9.0).
 pH is a required parameter for water quality monitoring as per Schedule 5, s. 7(1)(c) of the MMER.
 Total alkalinity is a required parameter for effluent characterization and water quality monitoring as per Schedule 5, s. 4(1) and s. 7(1)(c) of the MMER.

Figure A.3-11

Hardness and Total Suspended Solids in Lake Sites, Doris North Project, 2014



Notes: Error bars represent the standard error of the mean of replicates.

Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.

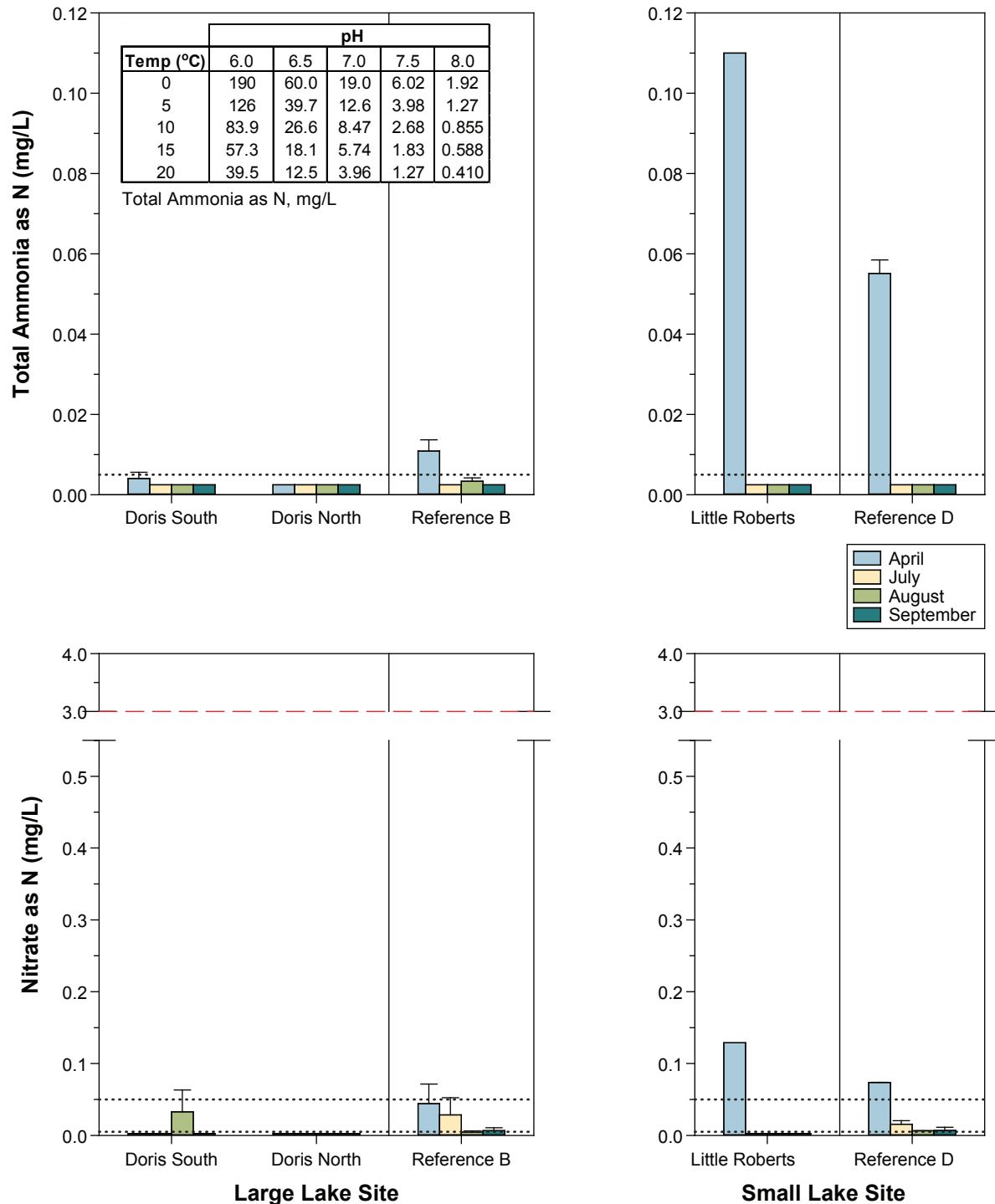
The CCME freshwater guideline for total suspended solids is dependent upon background levels.

Hardness is a required parameter for effluent characterization and water quality monitoring as per Schedule 5, s. 4(1) and s. 7(1)(c) of the MMER.

Total suspended solids are regulated as deleterious substances in effluents as per Schedule 4 of the MMER.

Figure A.3-12

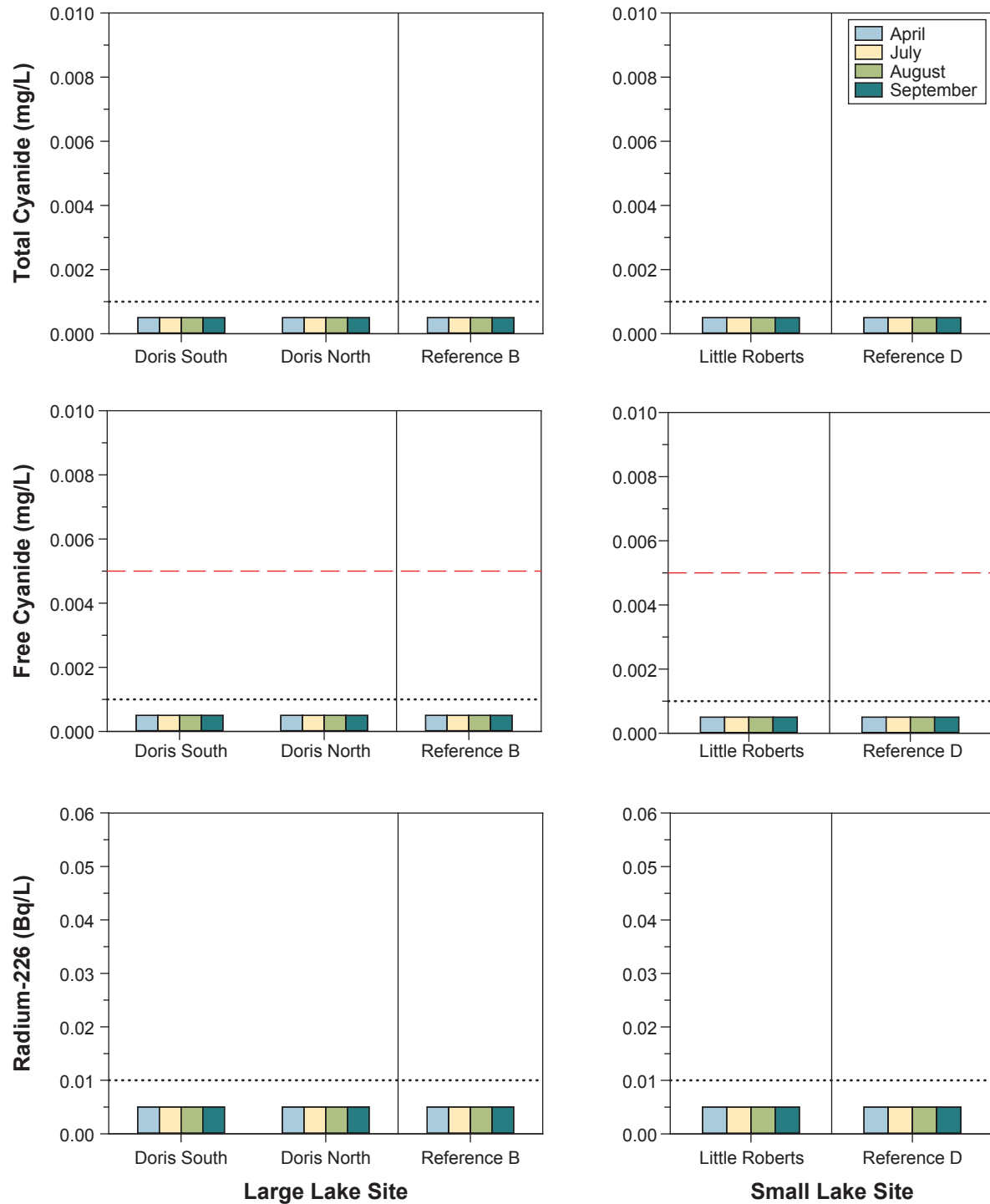
**Total Ammonia and Nitrate Concentrations
in Lake Sites, Doris North Project, 2014**



Notes: Error bars represent the standard error of the mean of replicates.
 Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
 Inset table shows the pH- and temperature-dependent CCME freshwater guideline for total ammonia.
 Red dashed line represents the CCME freshwater guideline for nitrate as N (3.0 mg/L; long-term concentration).
 Total ammonia and nitrate are required parameters for effluent characterization as per Schedule 5, s. 4(1) of the MMER.

Figure A.3-13

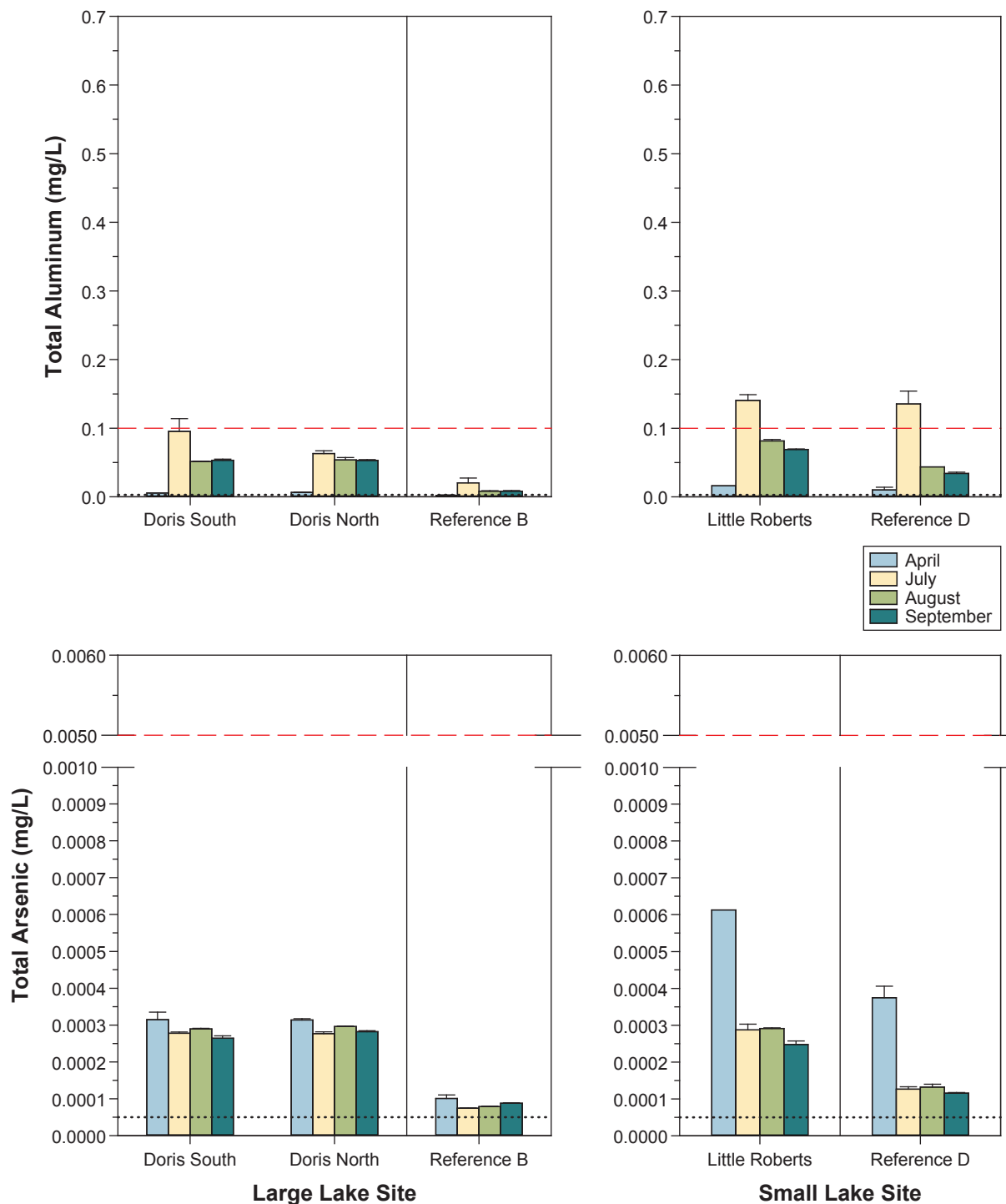
**Total Cyanide, Free Cyanide, and Radium-226
Concentrations in Lake Sites, Doris North Project, 2014**



Notes: Error bars represent the standard error of the mean of replicates.
 Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
 Red dashed line represents the CCME freshwater guideline for free cyanide (0.005 mg/L).
 Total cyanide and radium-226 are regulated as deleterious substances in effluents as per Schedule 4 of the MMER.

Figure A.3-14

Total Aluminum and Total Arsenic Concentrations in Lake Sites, Doris North Project, 2014



Notes: Error bars represent the standard error of the mean of replicates.

Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.

Red dashed lines represent the pH-dependent CCME freshwater guideline for aluminum (0.005 mg/L at pH < 6.5; 0.1 mg/L at pH ≥ 6.5)

and the CCME freshwater guideline for arsenic (0.005 mg/L).

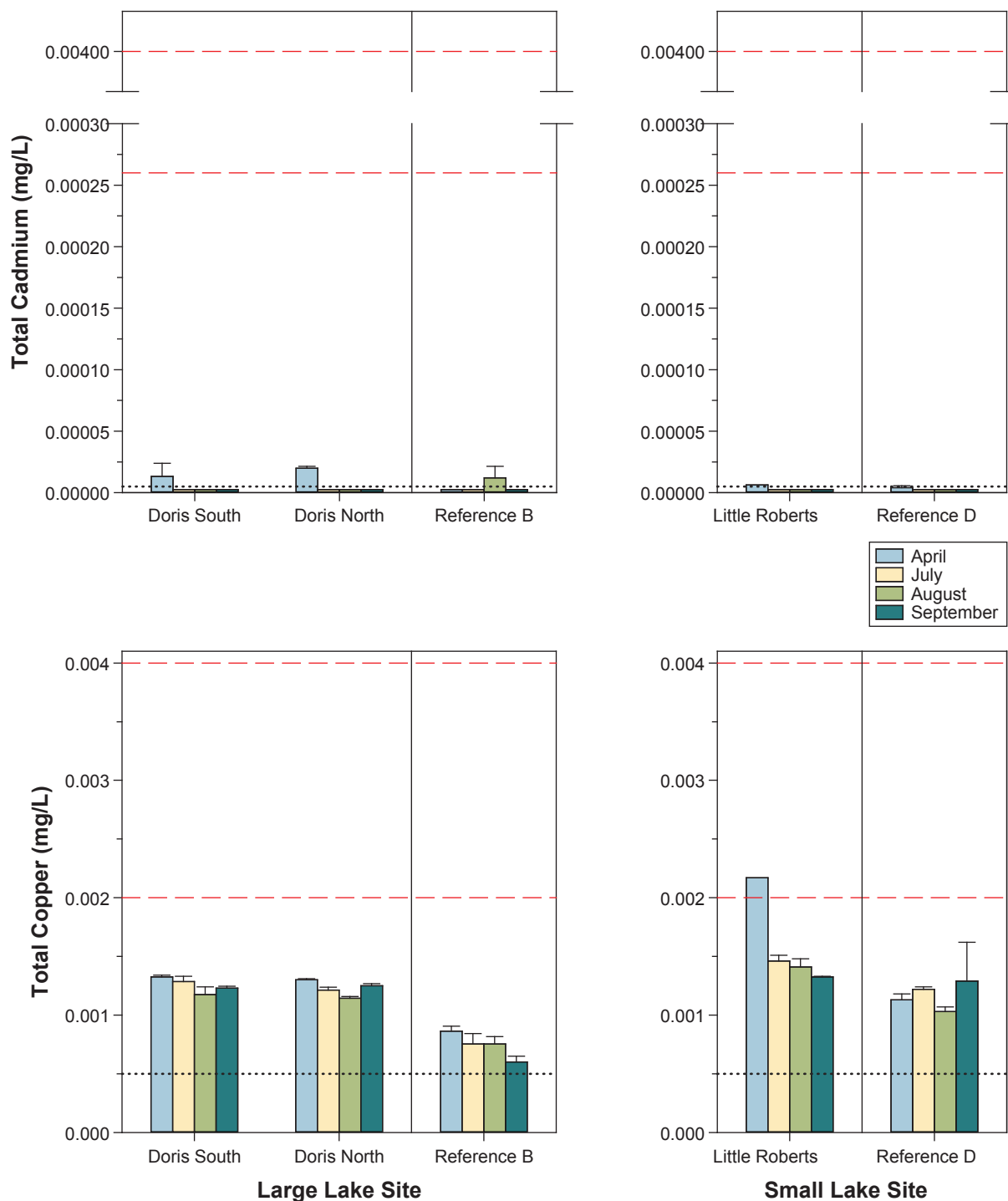
pH was greater than 6.5 in all lake samples.

Total aluminum is a required parameter for effluent characterization as per Schedule 5, s. 4(1) of the MMER.

Total arsenic is regulated as a deleterious substance in effluents as per Schedule 4 of the MMER.

Figure A.3-15

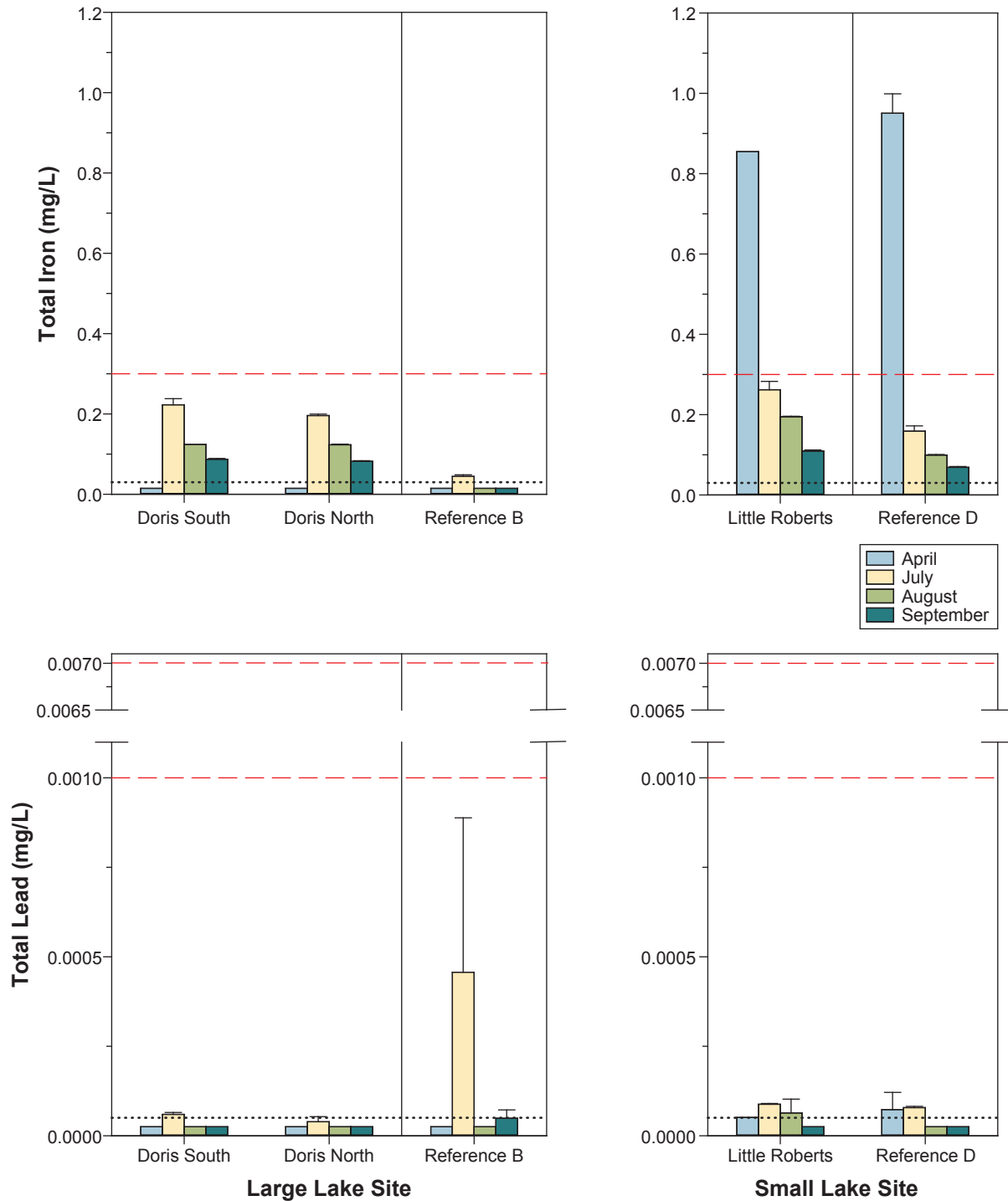
Total Cadmium and Total Copper Concentrations in Lake Sites, Doris North Project, 2014



Notes: Error bars represent the standard error of the mean of replicates.
 Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
 The CCME freshwater guidelines for cadmium and copper are hardness dependent.
 Red dashed lines represent the minimum and maximum site-specific CCME freshwater guidelines for cadmium (0.00026 and 0.004 mg/L) and for copper (0.002 mg/L) based on the hardness (as CaCO₃) range in lakes of 12.8 to 187 mg/L.
 Total cadmium is a required parameter for effluent characterization as per Schedule 5, s. 4(1) of the MMER.
 Total copper is regulated as a deleterious substance in effluents as per Schedule 4 of the MMER.

Figure A.3-16

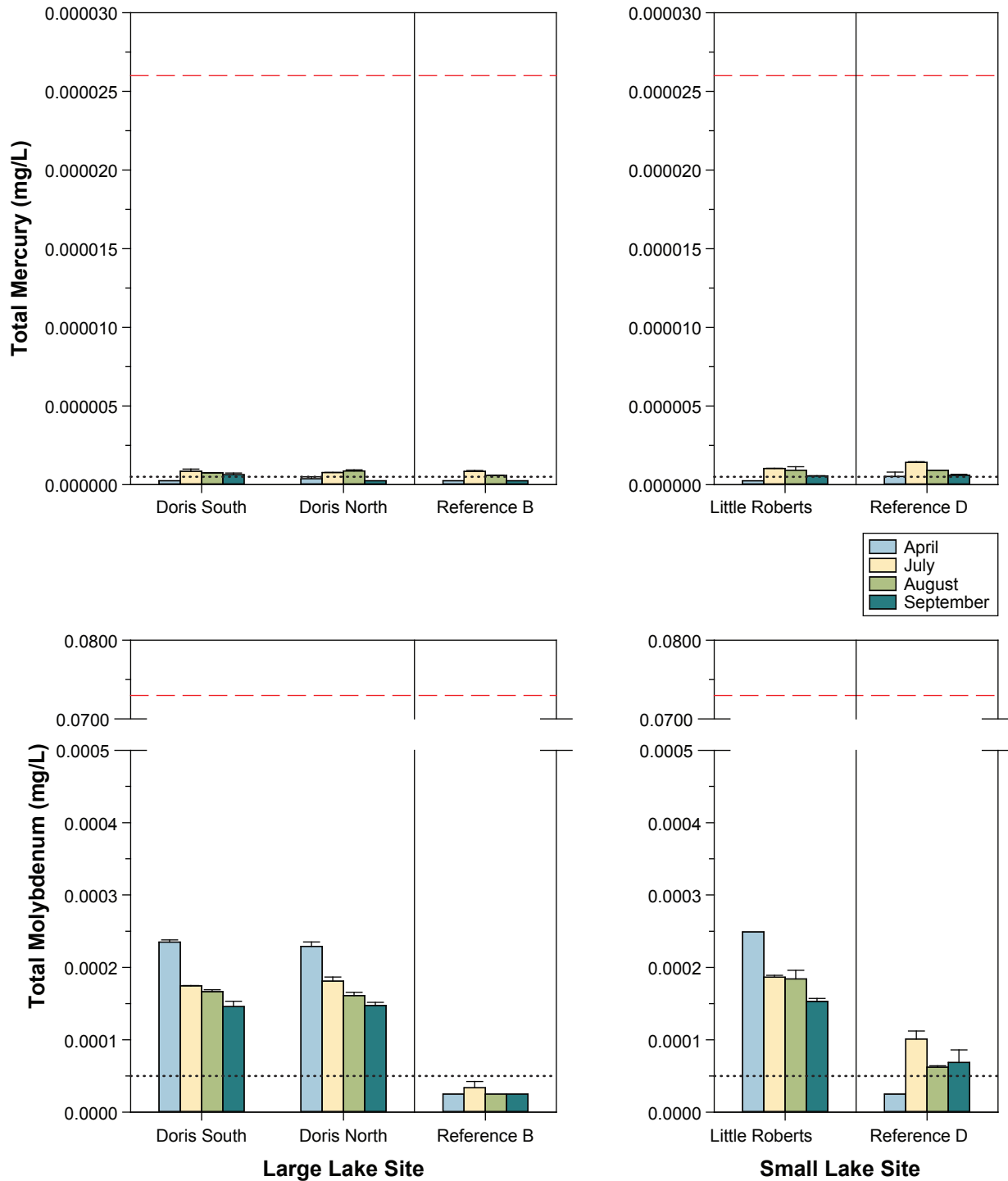
**Total Iron and Total Lead Concentrations
in Lake Sites, Doris North Project, 2014**



Notes: Error bars represent the standard error of the mean of replicates.
 Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
 The CCME freshwater guideline for lead is hardness dependent.
 Red dashed lines represent the CCME freshwater guideline for iron (0.3 mg/L) and the minimum and maximum site-specific CCME freshwater guideline for lead (0.001 and 0.007 mg/L) based on the hardness (as CaCO₃) range in lakes of 12.8 to 187 mg/L.
 Total iron is a required parameter for effluent characterization as per Schedule 5, s. 4(1) of the MMER.
 Total lead is regulated as a deleterious substance in effluents as per Schedule 4 of the MMER.

Figure A.3-17

**Total Mercury and Total Molybdenum Concentrations
in Lake Sites, Doris North Project, 2014**



Notes: Error bars represent the standard error of the mean of replicates.
 Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
 Red dashed lines represent the CCME freshwater guidelines for inorganic mercury (0.000026 mg/L) and molybdenum (0.073 mg/L).
 Total mercury and total molybdenum are required parameters for effluent characterization as per Schedule 5, s. 4(1) of the MMER.

Annex A.3-2. Lake Water Quality Data, Doris North Project, 2014

Site ID:				Doris South	Doris South	Doris North	Doris North	Reference B	Reference B
Depth Zone:				Surface	Deep	Surface	Deep	Surface	Deep
Depth Sampled (m):				2.0	9.0	3.0	12.0	3.0	9.0
Replicate:				1	1	1	1	1	1
Date Sampled:			CCME guideline for the	19-Apr-14	19-Apr-14	19-Apr-14	19-Apr-14	20-Apr-14	20-Apr-14
ALS Sample ID:	Units	Protection of Aquatic life ^a	Realized Detection Limit	L1447653-1	L1447653-2	L1447653-3	L1447653-4	L1447653-9	L1447653-10
Physical Tests									
Conductivity	uS/cm		2.0	349	347	345	345	81.7	74.3
Hardness (as CaCO ₃)	mg/L		0.50	64.2	61.6	59.5	62.4	23.1	21.2
pH	pH	6.5–9.0	0.10	7.73	7.71	7.71	7.72	7.25	7.24
Total Suspended Solids	mg/L	dependent on background levels	1.0	3.9	3.9	3.5	4.1	<1.0	<1.0
Total Dissolved Solids	mg/L		10	200	210	203	207	056	046
Turbidity	NTU	dependent on background levels	0.10	6.18	5.05	4.74	4.86	0.23	0.25
Anions and Nutrients									
Alkalinity, Total (as CaCO ₃)	mg/L		1.0	35.6	37.3	36.4	36.9	16.3	15.7
Ammonia, Total (as N)	mg/L	pH- and temperature-dependent	0.0050	0.0056	<0.0050	<0.0050	<0.0050	0.014	0.0053
Bromide (Br)	mg/L		0.05 - 0.5	0.285	0.279	0.264	0.277	<0.050	<0.050
Chloride (Cl)	mg/L	short-term: 640; long-term: 120	0.5 - 5	82.5	82.7	80.6	81.4	11.5	10.1
Fluoride (F)	mg/L	Inorganic fluorides: 0.12 ^b	0.02 - 0.2	0.065	0.065	0.063	0.066	0.034	0.023
Nitrate (as N)	mg/L	short-term: 124; long-term: 3.0	0.005 - 0.05	<0.0050	<0.0050	<0.0050	<0.0050	0.0171	0.0714
Nitrite (as N)	mg/L	0.06	0.001 - 0.01	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Total Kjeldahl Nitrogen	mg/L		0.050	0.64	0.67	0.66	0.67	0.26	0.20
Dissolved Kjeldahl Nitrogen	mg/L		0.050	-	-	-	-	-	-
Orthophosphate-Dissolved (as P)	mg/L		0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)	mg/L	Trigger ranges from guidance framework ^c	0.0020	0.0264	0.0279	0.0268	0.0271	0.0044	0.0052
Sulfate (SO ₄)	mg/L		0.5 - 5	3.54	3.56	3.45	3.49	2.92	2.65
Cyanides									
Cyanide, Total	mg/L		0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L	0.005	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic/ Inorganic Carbon									
Dissolved Organic Carbon	mg/L		0.50	6.06	6.33	5.99	6.01	3.29	2.71
Total Organic Carbon	mg/L		0.5 - 1	6.55	6.44	6.55	6.45	3.42	2.77
Total Metals									
Aluminum (Al)	mg/L	0.005 if pH<6.5; 0.1 if pH≥6.5	0.0030	0.0056	0.0058	0.0062	0.0068	<0.0030	0.0037
Antimony (Sb)	mg/L		0.000010	0.000035	0.000033	0.000028	0.000029	0.000029	0.00003
Arsenic (As)	mg/L	0.005	0.000050	0.000335	0.000294	0.00031	0.000317	0.000108	0.000082
Barium (Ba)	mg/L		0.00010	0.00354	0.00352	0.00354	0.00346	0.00294	0.00286
Beryllium (Be)	mg/L		0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)	mg/L	short-term: 29; long-term: 1.5	0.005000	0.0326	0.0336	0.0329	0.0351	0.0099	0.0148
Cadmium (Cd)	mg/L	equation ^d	0.0000050	<0.0000050	0.0000239	0.0000214	0.0000185	<0.0000050	<0.0000050
Calcium (Ca)	mg/L		0.050	11.6	11.2	10.8	11.3	05.6	05.1
Cesium (Cs)	mg/L		0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Chromium (Cr)	mg/L	Cr(VI): 0.001; Cr(III): 0.0089 ^b	0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000079
Copper (Cu)	mg/L	0.002-0.004 ^e	0.00050	0.00134	0.00131	0.00131	0.00129	0.00089	0.00078
Gallium (Ga)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Iron (Fe)	mg/L	0.3	0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Lead (Pb)	mg/L	0.001-0.007 ^f	0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L		0.00020	0.00451	0.00429	0.00426	0.00435	0.00066	0.00054
Magnesium (Mg)	mg/L		0.10	8.54	8.17	7.91	8.30	2.24	2.04
Manganese (Mn)	mg/L		0.00020	0.00840	0.00821	0.00889	0.00975	0.00112	0.02260
Mercury (Hg)	ug/L	Inorganic Hg: 0.026	0.00050	<0.00050	<0.00050	<0.00050	0.00050	<0.00050	<0.00050
Molybdenum (Mo)	mg/L	0.073 ^b	0.000050	0.000238	0.000232	0.000223	0.000235	<0.000050	<0.000050
Nickel (Ni)	mg/L	0.025-0.150 ^g	0.00020	0.00048	0.00044	0.00045	0.00045	0.00030	0.00032
Phosphorus (P)	mg/L		0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)	mg/L		2.0	3.0	2.9	2.7	2.9	<2.0	<2.0
Rhenium (Re)	mg/L		0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Rubidium (Rb)	mg/L		0.000020	0.00204	0.00199	0.00192	0.00200	0.00126	0.00105
Selenium (Se)	mg/L	0.001	0.000200	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Silicon (Si)	mg/L		0.050	1.78	1.71	1.67	1.75	0.17	0.47
Silver (Ag)	mg/L	0.0001	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Sodium (Na)	mg/L		2.0	42.4	40.7	39.2	41.3	06.3	05.6
Strontium (Sr)	mg/L		0.000050	0.0599	0.0583	0.0562	0.0571	0.0274	0.0256
Tellurium (Te)	mg/L		0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thallium (Tl)	mg/L	0.0008	0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020
Thorium (Th)	mg/L		0.0000050	<0.0000050	<0.0000050	<0.0000050	0.0000050	<0.0000050	<0.0000050
Tin (Sn)	mg/L		0.000200	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)	mg/L		0.00020	<0.00020	0.00023	<0.00020	<0.00020	<0.00020	<0.00020
Tungsten (W)	mg/L		0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Uranium (U)	mg/L	short-term: 0.033; long-term: 0.015	0.0000020	0.0000356	0.0000351	0.0000335	0.0000360	0.0000338	0.0000194
Vanadium (V)	mg/L		0.000050	0.000070	0.000072	0.000068	0.000068	<0.000050	<0.000050
Yttrium (Y)	mg/L		0.0000050	0.0000127	0.0000127	0.0000121	0.0000126	0.0000094	0.0000119
Zinc (Zn)	mg/L	0.03	0.0030	<0.0030	<0.0030	<0.0030	<0.0030	0.0038	<0.0030
Zirconium (Zr)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Radiochemistry									
Radium-226	Bq/L		0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of freshwater aquatic life.

April sampling depths are depths below the water surface and are equal to approximately 0-1 m below ice.

^a Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b Interim guideline.

^c Total phosphorus trigger ranges for lakes and rivers (mg/L): <0.004 = Ultra-oligotrophic; 0.004–0.01 = Oligotrophic; 0.01–0.02 = Mesotrophic; 0.02–0.035 = Meso-eutrophic; 0.035–0.1 = Eutrophic; >0.1 = Hyper-eutrophic.

^d Cadmium guideline is hardness dependent (hardness as CaCO₃). Short-term guideline = 10^{1.016[log(hardness)]-1.71} / 1000 mg/L. If hardness is <5.3 mg/L, the guideline is 0.00011 mg/L; if hardness is >360 mg/L, the guideline is 0.0077 mg/L. Long-term cadmium guideline = 10^{0.83[log(hardness)]-2.46} / 1000 mg/L. If hardness is <17 mg/L, the guideline is 0.00004 mg/L; if hardness is >280 mg/L, the guideline is 0.00037 mg/L.

^e Copper guideline is hardness dependent (hardness as CaCO₃). Guideline = e^{0.8545[ln(hardness)]-1.465} * 0.0002 mg/L. If hardness is <82 mg/L, the guideline is 0.002 mg/L; if hardness is >180 mg/L, the guideline is 0.004 mg/L. If water hardness is not known, the guideline is 0.002 mg/L.

^f Lead guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: lead guideline (mg/L) = e^{[1.273[ln(hardness)]-4.705]} /1000. At hardness as CaCO₃ of ≤ 60mg/L, lead guideline is a minimum of 0.001 mg/L; at hardness as CaCO₃ of >180 mg/L, lead guideline is a maximum of 0.007 mg/L.

^g Nickel guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: nickel guideline (mg/L) = e^{[0.76[ln(hardness)]+1.06]} /1000. At hardness as CaCO₃ of ≤ 60mg/L, nickel guideline is a minimum of 0.025 mg/L; at hardness as CaCO₃ of >180 mg/L, nickel guideline is a maximum of 0.150 mg/L.

Annex A.3-2. Lake Water Quality Data, Doris North Project, 2014

Site ID:				Reference B	Little Roberts	Reference D	Reference D	Doris South	Doris South	
Depth Zone:				Surface	Surface	Surface	Surface	Surface	Deep	
Depth Sampled (m):				3.0	2.0	2.5	2.5	1.0	9.0	
Replicate:				2	1	2	1	1	1	
Date Sampled:				20-Apr-14	23-Apr-14	24-Apr-14	24-Apr-14	20-Jul-14	20-Jul-14	
ALS Sample ID:			Units	Realized Detection Limit	L144765311	L1447653-27	L1447653-30	L1447653-31	L1490799-3	L1490799-4
CCME guideline for the Protection of Aquatic life ^a										
Physical Tests										
Conductivity	uS/cm		2.0	-	1030	393	394	277	278	
Hardness (as CaCO ₃)	mg/L		0.50	23.6	187.0	73.5	72.9	51.4	50.2	
pH	pH	6.5–9.0	0.10	-	7.48	7.31	7.31	7.57	7.64	
Total Suspended Solids	mg/L	dependent on background levels	1.0	-	2.3	3.1	3.1	5.5	5.5	
Total Dissolved Solids	mg/L		10	-	609	231	223	164	144	
Turbidity	NTU	dependent on background levels	0.10	-	3.93	2.18	2.21	6.04	6.05	
Anions and Nutrients										
Alkalinity, Total (as CaCO ₃)	mg/L		1.0	-	95.0	46.1	45.8	27.5	27.9	
Ammonia, Total (as N)	mg/L	pH- and temperature-dependent	0.0050	0.0134	0.11	0.0518	0.0585	<0.0050	<0.0050	
Bromide (Br)	mg/L		0.05 - 0.5	-	0.890	0.329	0.318	0.220	0.219	
Chloride (Cl)	mg/L	short-term: 640; long-term: 120	0.5 - 5	-	264.0	88.7	89.1	64.4	64.8	
Fluoride (F)	mg/L	Inorganic fluorides: 0.12 ^b	0.02 - 0.2	-	<0.20	0.080	0.080	0.062	0.059	
Nitrate (as N)	mg/L	short-term: 124; long-term: 3.0	0.005 - 0.05	-	0.129	0.0733	0.074	<0.0050	<0.0050	
Nitrite (as N)	mg/L	0.06	0.001 - 0.01	-	<0.010	0.0011	<0.0010	<0.0010	<0.0010	
Total Kjeldahl Nitrogen	mg/L		0.050	0.22	0.95	0.58	0.53	0.56	0.54	
Dissolved Kjeldahl Nitrogen	mg/L		0.050	-	-	-	-	0.29	0.38	
Orthophosphate-Dissolved (as P)	mg/L		0.0010	-	0.0018	<0.0010	<0.0010	<0.0010	0.0013	
Phosphorus (P)	mg/L	Trigger ranges from guidance framework ^c	0.0020	-	0.0336	0.0172	0.0175	0.0047	0.0047	
Sulfate (SO ₄)	mg/L		0.5 - 5	-	13.10	5.34	5.40	2.67	2.70	
Cyanides										
Cyanide, Total	mg/L		0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	
Cyanide, Free	mg/L	0.005	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	
Organic/ Inorganic Carbon										
Dissolved Organic Carbon	mg/L		0.50	3.33	14.00	8.43	8.26	5.08	4.99	
Total Organic Carbon	mg/L		0.5 - 1	3.44	15.10	8.83	8.80	5.26	5.32	
Total Metals										
Aluminum (Al)	mg/L	0.005 if pH<6.5; 0.1 if pH≥6.5	0.0030	<0.0030	0.0162	0.0142	0.0061	0.1140	0.0767	
Antimony (Sb)	mg/L		0.000010	0.000041	0.000072	0.000073	0.000044	0.000023	0.000023	
Arsenic (As)	mg/L	0.005	0.000050	0.000112	0.000613	0.000406	0.000343	0.000274	0.000281	
Barium (Ba)	mg/L		0.00010	0.00291	0.01400	0.00891	0.00881	0.00389	0.00363	
Beryllium (Be)	mg/L		0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
Bismuth (Bi)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	
Boron (B)	mg/L	short-term: 29; long-term: 1.5	0.005000	0.0164	0.0980	0.0391	0.0387	0.0312	0.0299	
Cadmium (Cd)	mg/L	equation ^d	0.0000050	<0.0000050	0.0000063	0.0000057	<0.0000050	<0.0000050	<0.0000050	
Calcium (Ca)	mg/L		0.050	05.7	30.5	11.5	11.4	09.1	09.0	
Cesium (Cs)	mg/L		0.0000050	<0.0000050	0.0000069	0.0000061	0.0000055	0.0000092	0.0000089	
Chromium (Cr)	mg/L	Cr(VI): 0.001; Cr(III): 0.0089 ^b	0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	
Cobalt (Co)	mg/L		0.000050	<0.000050	0.000156	0.000192	0.000131	0.000068	0.000061	
Copper (Cu)	mg/L	0.002-0.004 ^e	0.00050	0.00092	0.00217	0.00118	0.00108	0.00133	0.00124	
Gallium (Ga)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	
Iron (Fe)	mg/L	0.3	0.030	<0.030	0.855	0.999	0.902	0.238	0.208	
Lead (Pb)	mg/L	0.001-0.007 ^f	0.000050	<0.000050	0.000051	0.000121	<0.000050	0.000065	0.000054	
Lithium (Li)	mg/L		0.00020	0.00074	0.01060	0.00370	0.00370	0.00384	0.00371	
Magnesium (Mg)	mg/L		0.10	2.28	26.80	10.90	10.80	6.95	6.75	
Manganese (Mn)	mg/L		0.00020	0.00111	0.15600	0.18400	0.14500	0.02640	0.02690	
Mercury (Hg)	ug/L	Inorganic Hg: 0.026	0.00050	<0.00050	<0.00050	0.00080	<0.00050	0.00072	0.00099	
Molybdenum (Mo)	mg/L	0.073 ^b	0.000050	<0.000050	0.000249	<0.000050	<0.000050	0.000175	0.000174	
Nickel (Ni)	mg/L	0.025-0.150 ^g	0.00020	0.00029	0.00145	0.00105	0.00098	0.00053	0.00042	
Phosphorus (P)	mg/L		0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	
Potassium (K)	mg/L		2.0	<2.0	8.5	3.3	3.3	2.6	2.5	
Rhenium (Re)	mg/L		0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
Rubidium (Rb)	mg/L		0.000020	0.00132	0.00541	0.00318	0.00314	0.00181	0.00158	
Selenium (Se)	mg/L	0.001	0.000200	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	
Silicon (Si)	mg/L		0.050	0.18	3.88	0.97	0.95	1.67	1.54	
Silver (Ag)	mg/L	0.0001	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	
Sodium (Na)	mg/L		2.0	06.5	143.0	46.4	45.8	36.3	34.9	
Strontium (Sr)	mg/L		0.000050	0.0283	0.1810	0.0735	0.0743	0.0461	0.0445	
Tellurium (Te)	mg/L		0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	
Thallium (Tl)	mg/L	0.0008	0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	
Thorium (Th)	mg/L		0.0000050	<0.0000050	0.0000196	0.0000192	0.0000159	0.0000394	0.0000314	
Tin (Sn)	mg/L		0.000200	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	
Titanium (Ti)	mg/L		0.00020	<0.00020	0.00064	0.0005	<0.00020	0.00455	0.00293	
Tungsten (W)	mg/L		0.000010	<0.000010	<0.000010	<0.000010	<0.000010	0.000011	0.000011	
Uranium (U)	mg/L	short-term: 0.033; long-term: 0.015	0.0000020	0.0000335	0.0000758	0.0000321	0.0000303	0.0000362	0.0000328	
Vanadium (V)	mg/L		0.000050	<0.000050	0.000185	0.000115	0.000086	0.000282	0.000224	
Yttrium (Y)	mg/L		0.0000050	0.0000093	0.0000620	0.0000421	0.0000369	0.0000433	0.0000381	
Zinc (Zn)	mg/L	0.03	0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	
Zirconium (Zr)	mg/L		0.000050	<0.000050	0.000061	<0.000050	<0.000050	<0.000050	<0.000050	
Radiochemistry										
Radium-226	Bq/L		0.010	<0.010	<0.010	<0.010	<0.010	<0.01	<0.01	

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of freshwater aquatic life.

April sampling depths are depths below the water surface and are equal to approximately 0-1 m below ice.

^a Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b Interim guideline.

^c Total phosphorus trigger ranges for lakes and rivers (mg/L): <0.004 = Ultra-oligotrophic; 0.004–0.01 = Oligotrophic; 0.01–0.02 = Mesotrophic; 0.02–0.035 = Meso-eutrophic; 0.035–0.1 = Eutrophic; >0.1 = Hyper-eutrophic.

^d Cadmium guideline is hardness dependent (hardness as CaCO₃). Short-term guideline = 10^{1.016[log(hardness)]-1.71} / 1000 mg/L. If hardness is <5.3 mg/L, the guideline is 0.00011 mg/L; if hardness is >360 mg/L, the guideline is 0.0077 mg/L. Long-term cadmium guideline = 10^{0.83[log(hardness)]-2.46} / 1000 mg/L. If hardness is <17 mg/L, the guideline is 0.00004 mg/L; if hardness is >280 mg/L, the guideline is 0.00037 mg/L.

^e Copper guideline is hardness dependent (hardness as CaCO₃). Guideline = e^{0.8545[ln(hardness)]-1.465} * 0.0002 mg/L. If hardness is <82 mg/L, the guideline is 0.002 mg/L; if hardness is >180 mg/L, the guideline is 0.004 mg/L. If water hardness is not known, the guideline is 0.002 mg/L.

^f Lead guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: lead guideline (mg/L) = e^{[1.273[ln(hardness)]-4.705]} /1000. At hardness as CaCO₃ of ≤ 60mg/L, lead guideline is a minimum of 0.001 mg/L; at hardness as CaCO₃ of >180 mg/L, lead guideline is a maximum of 0.007 mg/L.

^g Nickel guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: nickel guideline (mg/L) = e^{[0.76[ln(hardness)]+1.06]} /1000. At hardness as CaCO₃ of ≤ 60mg/L, nickel guideline is a minimum of 0.025 mg/L; at hardness as CaCO₃ of >180 mg/L, nickel guideline is a maximum of 0.150 mg/L.

Annex A.3-2. Lake Water Quality Data, Doris North Project, 2014

Site ID:				Doris North	Doris North	Doris North	Reference B	Reference B	Reference B		
Depth Zone:				Deep	Surface	Surface	Surface	Deep	Deep		
Depth Sampled (m):				12.0	1.0	1.0	1.0	8.0	8.0		
Replicate:				1	1	2	1	1	2		
Date Sampled:				20-Jul-14	20-Jul-14	20-Jul-14	19-Jul-14	19-Jul-14	19-Jul-14		
ALS Sample ID:			Units	CCME guideline for the Protection of Aquatic life ^a	Realized Detection Limit	L1490835-1	L1490835-2	L1490835-3	L1490811-3	L1490811-4	L1490779-3
Physical Tests											
Conductivity	uS/cm		2.0	282	279	280	44.2	44.2	44.4		
Hardness (as CaCO ₃)	mg/L		0.50	49.3	50.6	49.7	13.0	12.8	13.2		
pH	pH	6.5–9.0	0.10	7.55	7.52	7.55	6.99	6.99	7.07		
Total Suspended Solids	mg/L	dependent on background levels	1.0	4.2	4.6	4.4	<1.0	1.3	1.0		
Total Dissolved Solids	mg/L		10	161	163	164	027	027	028		
Turbidity	NTU	dependent on background levels	0.10	5.64	5.29	4.88	1.66	1.94	0.66		
Anions and Nutrients											
Alkalinity, Total (as CaCO ₃)	mg/L		1.0	28.4	28.0	28.1	08.7	09.0	08.7		
Ammonia, Total (as N)	mg/L	pH- and temperature-dependent	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050		
Bromide (Br)	mg/L		0.05 - 0.5	0.217	0.221	0.217	<0.050	<0.050	<0.050		
Chloride (Cl)	mg/L	short-term: 640; long-term: 120	0.5 - 5	65.6	65.4	65.3	06.1	06.2	06.2		
Fluoride (F)	mg/L	Inorganic fluorides: 0.12 ^b	0.02 - 0.2	0.054	0.055	0.055	<0.020	<0.020	<0.020		
Nitrate (as N)	mg/L	short-term: 124; long-term: 3.0	0.005 - 0.05	<0.0050	<0.0050	<0.0050	0.0762	<0.0050	0.0067		
Nitrite (as N)	mg/L	0.06	0.001 - 0.01	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		
Total Kjeldahl Nitrogen	mg/L		0.050	0.61	0.60	0.59	0.20	0.19	0.20		
Dissolved Kjeldahl Nitrogen	mg/L		0.050	0.30	0.31	0.30	0.17	0.17	0.18		
Orthophosphate-Dissolved (as P)	mg/L		0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		
Phosphorus (P)	mg/L	Trigger ranges from guidance framework ^c	0.0020	0.0250	0.0218	0.0251	0.0043	0.0042	0.0031		
Sulfate (SO ₄)	mg/L		0.5 - 5	2.67	2.67	2.66	1.58	1.60	1.61		
Cyanides											
Cyanide, Total	mg/L		0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		
Cyanide, Free	mg/L	0.005	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010		
Organic/ Inorganic Carbon											
Dissolved Organic Carbon	mg/L		0.50	5.22	5.20	5.27	2.44	2.25	2.27		
Total Organic Carbon	mg/L		0.5 - 1	5.48	5.87	6.03	2.60	2.65	2.53		
Total Metals											
Aluminum (Al)	mg/L	0.005 if pH<6.5; 0.1 if pH≥6.5	0.0030	0.0589	0.0711	0.0593	0.0346	0.0124	0.0142		
Antimony (Sb)	mg/L		0.000010	0.000021	0.000026	0.000026	0.000015	0.000015	0.000012		
Arsenic (As)	mg/L	0.005	0.000050	0.000274	0.000286	0.00027	0.000073	0.000076	0.000074		
Barium (Ba)	mg/L		0.00010	0.00347	0.00438	0.00362	0.00176	0.00159	0.00178		
Beryllium (Be)	mg/L		0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050		
Bismuth (Bi)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		
Boron (B)	mg/L	short-term: 29; long-term: 1.5	0.005000	0.0304	0.0333	0.0308	0.0123	0.0107	0.0073		
Cadmium (Cd)	mg/L	equation ^d	0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050		
Calcium (Ca)	mg/L		0.050	08.8	09.0	08.8	03.2	03.1	03.2		
Cesium (Cs)	mg/L		0.0000050	0.0000061	0.0000082	0.0000076	0.0000055	<0.0000050	<0.0000050		
Chromium (Cr)	mg/L	Cr(VI): 0.001; Cr(III): 0.0089 ^b	0.00050	<0.00050	<0.00050	<0.00050	0.00166	<0.00050	<0.00050		
Cobalt (Co)	mg/L		0.000050	0.000055	0.000055	0.000054	<0.000050	<0.000050	<0.000050		
Copper (Cu)	mg/L	0.002-0.004 ^e	0.00050	0.00118	0.00126	0.00120	0.00093	0.00068	0.00065		
Gallium (Ga)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		
Iron (Fe)	mg/L	0.3	0.030	0.194	0.203	0.192	0.052	0.039	0.043		
Lead (Pb)	mg/L	0.001-0.007 ^f	0.000050	<0.000050	0.000067	<0.000050	0.001320	<0.000050	<0.000050		
Lithium (Li)	mg/L		0.00020	0.00384	0.00405	0.00394	0.00076	0.00060	0.00048		
Magnesium (Mg)	mg/L		0.10	6.64	6.81	6.70	1.25	1.24	1.30		
Manganese (Mn)	mg/L		0.00020	0.02960	0.02990	0.02890	0.00286	0.00246	0.00248		
Mercury (Hg)	ug/L	Inorganic Hg: 0.026	0.00050	0.00077	0.00080	0.00075	0.00092	0.00074	0.00088		
Molybdenum (Mo)	mg/L	0.073 ^b	0.000050	0.000173	0.000192	0.000178	0.000051	<0.000050	<0.000050		
Nickel (Ni)	mg/L	0.025-0.150 ^g	0.00020	0.00043	0.00046	0.00041	0.00044	0.00022	<0.00020		
Phosphorus (P)	mg/L		0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30		
Potassium (K)	mg/L		2.0	2.4	2.4	2.4	<2.0	<2.0	<2.0		
Rhenium (Re)	mg/L		0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050		
Rubidium (Rb)	mg/L		0.000020	0.00159	0.00176	0.00167	0.00072	0.00066	0.00070		
Selenium (Se)	mg/L	0.001	0.000200	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020		
Silicon (Si)	mg/L		0.050	1.53	1.60	1.51	0.10	0.09	0.09		
Silver (Ag)	mg/L	0.0001	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050		
Sodium (Na)	mg/L		2.0	33.4	34.1	33.4	03.5	03.5	03.7		
Strontium (Sr)	mg/L		0.000050	0.0441	0.0450	0.0443	0.0139	0.0144	0.0146		
Tellurium (Te)	mg/L		0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010		
Thallium (Tl)	mg/L	0.0008	0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020		
Thorium (Th)	mg/L		0.0000050	0.0000247	0.0000280	0.0000233	0.0000098	0.0000072	0.0000075		
Tin (Sn)	mg/L		0.000200	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020		
Titanium (Ti)	mg/L		0.00020	0.0021	0.00272	0.00208	0.00042	0.00031	0.00041		
Tungsten (W)	mg/L		0.000010	0.000013	0.000016	0.000012	<0.000010	<0.000010	<0.000010		
Uranium (U)	mg/L	short-term: 0.033; long-term: 0.015	0.0000020	0.0000326	0.0000326	0.0000327	0.0000335	0.0000335	0.0000355		
Vanadium (V)	mg/L		0.000050	0.000180	0.000210	0.000180	<0.000050	<0.000050	<0.000050		
Yttrium (Y)	mg/L		0.0000050	0.0000305	0.0000353	0.0000320	0.0000168	0.0000161	0.0000163		
Zinc (Zn)	mg/L	0.03	0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030		
Zirconium (Zr)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050		
Radiochemistry											
Radium-226	Bq/L		0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of freshwater aquatic life.

April sampling depths are depths below the water surface and are equal to approximately 0-1 m below ice.

^a Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b Interim guideline.

^c Total phosphorus trigger ranges for lakes and rivers (mg/L): <0.004 = Ultra-oligotrophic; 0.004–0.01 = Oligotrophic; 0.01–0.02 = Mesotrophic; 0.02–0.035 = Meso-eutrophic; 0.035–0.1 = Eutrophic; >0.1 = Hyper-eutrophic.

^d Cadmium guideline is hardness dependent (hardness as CaCO₃). Short-term guideline = 10^{1.016[log(hardness)]-1.71} / 1000 mg/L. If hardness is <5.3 mg/L, the guideline is 0.00011 mg/L; if hardness is >360 mg/L, the guideline is 0.0077 mg/L. Long-term cadmium guideline = 10^{0.83[log(hardness)]-2.46} / 1000 mg/L. If hardness is <17 mg/L, the guideline is 0.00004 mg/L; if hardness is >280 mg/L, the guideline is 0.00037 mg/L.

^e Copper guideline is hardness dependent (hardness as CaCO₃). Guideline = e^{0.8545[ln(hardness)]-1.465} * 0.0002 mg/L. If hardness is <82 mg/L, the guideline is 0.002 mg/L; if hardness is >180 mg/L, the guideline is 0.004 mg/L. If water hardness is not known, the guideline is 0.002 mg/L.

^f Lead guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: lead guideline (mg/L) = e^{[1.273[ln(hardness)]-4.705]} /1000. At hardness as CaCO₃ of ≤ 60mg/L, lead guideline is a minimum of 0.001 mg/L; at hardness as CaCO₃ of >180 mg/L, lead guideline is a maximum of 0.007 mg/L.

^g Nickel guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: nickel guideline (mg/L) = e^{[0.76[ln(hardness)]+1.06]} /1000. At hardness as CaCO₃ of ≤ 60mg/L, nickel guideline is a minimum of 0.025 mg/L; at hardness as CaCO₃ of >180 mg/L, nickel guideline is a maximum of 0.150 mg/L.

Annex A.3-2. Lake Water Quality Data, Doris North Project, 2014

Site ID:				Little Roberts	Little Roberts	Reference D	Reference D	Doris South	Doris South
Depth Zone:				Surface	Surface	Surface	Surface	Surface	Deep
Depth Sampled (m):				1.0	1.0	1.0	1.0	1.0	8.0
Replicate:				1	2	1	2	1	1
Date Sampled:				19-Jul-14	19-Jul-14	19-Jul-14	19-Jul-14	19-Aug-14	19-Aug-14
ALS Sample ID:				L1490850-3	L1490850-4	L1490811-1	L1490811-2	L1506834-4	L1506834-5
Units			CCME guideline for the Protection of Aquatic life ^a	Realized Detection Limit					
Physical Tests									
Conductivity	uS/cm		2.0	257	261	92.8	90.7	275	275
Hardness (as CaCO ₃)	mg/L		0.50	46.0	47.4	17.3	18.0	52.0	51.3
pH	pH	6.5–9.0	0.10	7.61	7.71	7.30	7.00	7.71	7.71
Total Suspended Solids	mg/L	dependent on background levels	1.0	4.3	4.5	1.7	1.0	4.2	4.8
Total Dissolved Solids	mg/L		10	143	147	057	055	171	170
Turbidity	NTU	dependent on background levels	0.10	6.08	6.39	5.55	3.35	5.64	6.84
Anions and Nutrients									
Alkalinity, Total (as CaCO ₃)	mg/L		1.0	25.2	26.2	11.0	09.9	28.5	28.4
Ammonia, Total (as N)	mg/L	pH- and temperature-dependent	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bromide (Br)	mg/L		0.05 - 0.5	0.199	0.199	0.051	0.059	0.220	0.236
Chloride (Cl)	mg/L	short-term: 640; long-term: 120	0.5 - 5	60.1	60.0	18.8	18.6	64.6	64.6
Fluoride (F)	mg/L	Inorganic fluorides: 0.12 ^b	0.02 - 0.2	0.054	0.054	0.035	0.035	0.063	0.057
Nitrate (as N)	mg/L	short-term: 124; long-term: 3.0	0.005 - 0.05	<0.0050	<0.0050	0.0105	0.0205	0.0631	<0.0050
Nitrite (as N)	mg/L	0.06	0.001 - 0.01	<0.0010	<0.0010	<0.0010	<0.0010	0.0077	<0.0010
Total Kjeldahl Nitrogen	mg/L		0.050	0.50	0.49	0.27	0.26	0.57	0.56
Dissolved Kjeldahl Nitrogen	mg/L		0.050	0.30	0.31	0.25	0.23	-	-
Orthophosphate-Dissolved (as P)	mg/L		0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)	mg/L	Trigger ranges from guidance framework ^c	0.0020	0.0197	0.0196	0.0078	0.0069	0.0282	0.0276
Sulfate (SO ₄)	mg/L		0.5 - 5	3.57	3.62	1.84	1.81	3.29	2.71
Cyanides									
Cyanide, Total	mg/L		0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L	0.005	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic/ Inorganic Carbon									
Dissolved Organic Carbon	mg/L		0.50	5.25	5.25	4.58	4.25	4.85	4.92
Total Organic Carbon	mg/L		0.5 - 1	5.46	5.52	4.68	4.65	5.21	5.39
Total Metals									
Aluminum (Al)	mg/L	0.005 if pH<6.5; 0.1 if pH≥6.5	0.0030	0.1320	0.1490	0.1540	0.1170	0.0508	0.0519
Antimony (Sb)	mg/L		0.000010	0.000023	0.000025	0.000014	0.000016	0.000021	0.00002
Arsenic (As)	mg/L	0.005	0.000050	0.000271	0.000303	0.00012	0.000133	0.000291	0.000288
Barium (Ba)	mg/L		0.00010	0.00379	0.00415	0.00288	0.00252	0.00350	0.00350
Beryllium (Be)	mg/L		0.0000050	<0.0000050	0.0000054	0.0000056	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)	mg/L	short-term: 29; long-term: 1.5	0.005000	0.0328	0.0305	0.0190	0.0171	0.0321	0.0329
Cadmium (Cd)	mg/L	equation ^d	0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)	mg/L		0.050	07.8	08.0	02.7	02.8	09.3	09.2
Cesium (Cs)	mg/L		0.0000050	0.0000115	0.0000134	0.0000091	0.0000082	0.0000053	0.0000054
Chromium (Cr)	mg/L	Cr(VI): 0.001; Cr(III): 0.0089 ^b	0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L		0.000050	0.000079	0.00009	0.000065	0.000053	<0.000050	<0.000050
Copper (Cu)	mg/L	0.002-0.004 ^e	0.00050	0.00141	0.00151	0.00124	0.00120	0.00111	0.00124
Gallium (Ga)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Iron (Fe)	mg/L	0.3	0.030	0.241	0.283	0.172	0.146	0.124	0.124
Lead (Pb)	mg/L	0.001-0.007 ^f	0.000050	0.000086	0.000090	0.000082	0.000075	<0.000050	<0.000050
Lithium (Li)	mg/L		0.00020	0.00336	0.00340	0.00179	0.00163	0.00368	0.00371
Magnesium (Mg)	mg/L		0.10	6.46	6.67	2.55	2.65	6.96	6.87
Manganese (Mn)	mg/L		0.00020	0.01290	0.01390	0.00368	0.00367	0.01940	0.01990
Mercury (Hg)	ug/L	Inorganic Hg: 0.026	0.00050	0.00104	0.00103	0.00146	0.00137	0.00074	0.00076
Molybdenum (Mo)	mg/L	0.073 ^b	0.000050	0.000189	0.000184	0.000112	0.000090	0.000164	0.000169
Nickel (Ni)	mg/L	0.025-0.150 ^g	0.00020	0.00061	0.00059	0.00048	0.00047	0.00045	0.00043
Phosphorus (P)	mg/L		0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)	mg/L		2.0	2.1	2.2	<2.0	<2.0	2.5	2.4
Rhenium (Re)	mg/L		0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Rubidium (Rb)	mg/L		0.000020	0.00158	0.00168	0.00110	0.00107	0.00145	0.00146
Selenium (Se)	mg/L	0.001	0.000200	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Silicon (Si)	mg/L		0.050	1.22	1.29	0.62	0.53	1.50	1.48
Silver (Ag)	mg/L	0.0001	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Sodium (Na)	mg/L		2.0	31.7	32.8	10.3	10.8	34.7	34.4
Strontium (Sr)	mg/L		0.000050	0.0386	0.0421	0.0154	0.0164	0.0466	0.0456
Tellurium (Te)	mg/L		0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thallium (Tl)	mg/L	0.0008	0.0000020	0.0000039	0.0000035	0.000004	0.0000035	<0.0000020	<0.0000020
Thorium (Th)	mg/L		0.0000050	0.0000502	0.0000616	0.0000923	0.0000739	0.0000156	0.0000152
Tin (Sn)	mg/L		0.000200	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)	mg/L		0.00020	0.00481	0.00563	0.00517	0.00395	0.0015	0.00151
Tungsten (W)	mg/L		0.000010	<0.000010	0.000013	0.000012	<0.000010	<0.000010	<0.000010
Uranium (U)	mg/L	short-term: 0.033; long-term: 0.015	0.0000020	0.0000400	0.0000443	0.0000659	0.0000606	0.0000328	0.0000333
Vanadium (V)	mg/L		0.000050	0.000316	0.000344	0.000291	0.000227	0.000155	0.000161
Yttrium (Y)	mg/L		0.0000050	0.0000624	0.0000654	0.0000850	0.0000767	0.0000239	0.0000243
Zinc (Zn)	mg/L	0.03	0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Zirconium (Zr)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Radiochemistry									
Radium-226	Bq/L		0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of freshwater aquatic life.

April sampling depths are depths below the water surface and are equal to approximately 0-1 m below ice.

^a Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b Interim guideline.

^c Total phosphorus trigger ranges for lakes and rivers (mg/L): <0.004 = Ultra-oligotrophic; 0.004–0.01 = Oligotrophic; 0.01–0.02 = Mesotrophic; 0.02–0.035 = Meso-eutrophic; 0.035–0.1 = Eutrophic; >0.1 = Hyper-eutrophic.

^d Cadmium guideline is hardness dependent (hardness as CaCO₃). Short-term guideline = 10^{1.016[log(hardness)]-1.71} / 1000 mg/L. If hardness is <5.3 mg/L, the guideline is 0.00011 mg/L; if hardness is >360 mg/L, the guideline is 0.0077 mg/L. Long-term cadmium guideline = 10^{0.83[log(hardness)]-2.46} / 1000 mg/L. If hardness is <17 mg/L, the guideline is 0.00004 mg/L; if hardness is >280 mg/L, the guideline is 0.00037 mg/L.

^e Copper guideline is hardness dependent (hardness as CaCO₃). Guideline = e^{0.8545[ln(hardness)]-1.465} * 0.0002 mg/L. If hardness is <82 mg/L, the guideline is 0.002 mg/L; if hardness is >180 mg/L, the guideline is 0.004 mg/L. If water hardness is not known, the guideline is 0.002 mg/L.

^f Lead guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: lead guideline (mg/L) = e^{[1.273[ln(hardness)]-4.705]} /1000. At hardness as CaCO₃ of ≤ 60mg/L, lead guideline is a minimum of 0.001 mg/L; at hardness as CaCO₃ of >180 mg/L, lead guideline is a maximum of 0.007 mg/L.

^g Nickel guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: nickel guideline (mg/L) = e^{[0.76[ln(hardness)]+1.06]} /1000. At hardness as CaCO₃ of ≤ 60mg/L, nickel guideline is a minimum of 0.025 mg/L; at hardness as CaCO₃ of >180 mg/L, nickel guideline is a maximum of 0.150 mg/L.

Annex A.3-2. Lake Water Quality Data, Doris North Project, 2014

Site ID:				Doris North	Doris North	Doris North	Reference B	Reference B	Reference B
Depth Zone:				Surface	Surface	Deep	Surface	Deep	Deep
Depth Sampled (m):				1.0	1.0	12.0	1.0	9.0	9.0
Replicate:				1	2	1	1	1	2
Date Sampled:	CCME guideline for the		Realized	19-Aug-14	19-Aug-14	19-Aug-14	23-Aug-14	23-Aug-14	23-Aug-14
ALS Sample ID:	Units	Protection of Aquatic life ^a	Detection Limit	L1506834-1	L1506834-2	L1506834-3	L1509274-1	L1509274-2	L1509274-3
Physical Tests									
Conductivity	uS/cm		2.0	278	275	275	49.3	47.1	47
Hardness (as CaCO ₃)	mg/L		0.50	49.2	50.1	50.4	13.8	13.4	13.3
pH	pH	6.5–9.0	0.10	7.73	7.69	7.70	7.40	7.22	7.21
Total Suspended Solids	mg/L	dependent on background levels	1.0	3.7	4.7	4.8	1.2	<1.0	<1.0
Total Dissolved Solids	mg/L		10	155	118	168	037	030	034
Turbidity	NTU	dependent on background levels	0.10	6.02	5.61	6.21	0.35	0.32	0.32
Anions and Nutrients									
Alkalinity, Total (as CaCO ₃)	mg/L		1.0	28.9	28.2	28.6	10.7	09.7	09.6
Ammonia, Total (as N)	mg/L	pH- and temperature-dependent	0.0050	<0.0050	<0.0050	<0.0050	0.0051	<0.0050	<0.0050
Bromide (Br)	mg/L		0.05 - 0.5	0.227	0.231	0.222	<0.050	<0.050	<0.050
Chloride (Cl)	mg/L	short-term: 640; long-term: 120	0.5 - 5	64.7	64.6	64.6	06.8	06.7	06.7
Fluoride (F)	mg/L	Inorganic fluorides: 0.12 ^b	0.02 - 0.2	0.057	0.057	0.057	0.022	0.022	0.022
Nitrate (as N)	mg/L	short-term: 124; long-term: 3.0	0.005 - 0.05	<0.0050	<0.0050	<0.0050	0.008	<0.0050	<0.0050
Nitrite (as N)	mg/L	0.06	0.001 - 0.01	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Total Kjeldahl Nitrogen	mg/L		0.050	0.52	0.53	0.53	0.21	0.21	0.24
Dissolved Kjeldahl Nitrogen	mg/L		0.050	-	-	-	-	-	
Orthophosphate-Dissolved (as P)	mg/L		0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)	mg/L	Trigger ranges from guidance framework ^c	0.0020	0.0287	0.0310	0.0300	0.0032	0.0029	0.0066
Sulfate (SO ₄)	mg/L		0.5 - 5	2.71	2.71	2.71	1.71	1.70	1.71
Cyanides									
Cyanide, Total	mg/L		0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L	0.005	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic/ Inorganic Carbon									
Dissolved Organic Carbon	mg/L		0.50	5.03	4.83	4.95	2.97	2.92	3.18
Total Organic Carbon	mg/L		0.5 - 1	5.23	5.34	5.22	2.98	3.04	2.86
Total Metals									
Aluminum (Al)	mg/L	0.005 if pH<6.5; 0.1 if pH≥6.5	0.0030	0.0607	0.0513	0.0495	0.0098	0.0079	0.0072
Antimony (Sb)	mg/L		0.000010	0.000022	0.000022	0.000021	0.000017	0.000016	0.000015
Arsenic (As)	mg/L	0.005	0.000050	0.000296	0.000294	0.000298	0.000081	0.000077	0.000078
Barium (Ba)	mg/L		0.00010	0.00357	0.00344	0.00347	0.00168	0.00155	0.00158
Beryllium (Be)	mg/L		0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)	mg/L	short-term: 29; long-term: 1.5	0.005000	0.0336	0.0322	0.0313	0.0130	0.0106	0.0102
Cadmium (Cd)	mg/L	equation ^d	0.0000050	<0.0000050	<0.0000050	<0.0000050	0.000031	<0.0000050	<0.0000050
Calcium (Ca)	mg/L		0.050	08.8	08.9	09.1	03.3	03.2	03.2
Cesium (Cs)	mg/L		0.0000050	<0.0000050	0.0000052	0.0000052	<0.0000050	<0.0000050	<0.0000050
Chromium (Cr)	mg/L	Cr(VI): 0.001; Cr(III): 0.0089 ^b	0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)	mg/L	0.002-0.004 ^e	0.00050	0.00117	0.00114	0.00112	0.00070	0.00068	0.00088
Gallium (Ga)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Iron (Fe)	mg/L	0.3	0.030	0.125	0.125	0.12	<0.030	<0.030	<0.030
Lead (Pb)	mg/L	0.001-0.007 ^f	0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L		0.00020	0.00375	0.00363	0.00356	0.00091	0.00104	0.00086
Magnesium (Mg)	mg/L		0.10	6.63	6.75	6.75	1.34	1.29	1.29
Manganese (Mn)	mg/L		0.00020	0.02010	0.02050	0.01950	0.00143	0.00136	0.00146
Mercury (Hg)	ug/L	Inorganic Hg: 0.026	0.00050	0.00097	0.00073	0.00091	0.00058	0.00059	0.00059
Molybdenum (Mo)	mg/L	0.073 ^b	0.000050	0.000157	0.000156	0.000170	<0.000050	<0.000050	<0.000050
Nickel (Ni)	mg/L	0.025-0.150 ^g	0.00020	0.00045	0.00043	0.00042	<0.00020	<0.00020	0.00032
Phosphorus (P)	mg/L		0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)	mg/L		2.0	2.2	2.3	2.4	<2.0	<2.0	<2.0
Rhenium (Re)	mg/L		0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Rubidium (Rb)	mg/L		0.000020	0.00144	0.00140	0.00139	0.00073	0.00072	0.00069
Selenium (Se)	mg/L	0.001	0.000200	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Silicon (Si)	mg/L		0.050	1.51	1.48	1.45	0.07	0.06	0.07
Silver (Ag)	mg/L	0.0001	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Sodium (Na)	mg/L		2.0	32.3	32.8	33.3	03.6	03.6	03.6
Strontium (Sr)	mg/L		0.000050	0.0461	0.0462	0.0459	0.0155	0.0147	0.0146
Tellurium (Te)	mg/L		0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thallium (Tl)	mg/L	0.0008	0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020
Thorium (Th)	mg/L		0.0000050	0.0000185	0.0000156	0.0000150	0.0000055	0.0000065	0.0000054
Tin (Sn)	mg/L		0.000200	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)	mg/L		0.00020	0.00162	0.00149	0.00141	<0.00020	<0.00020	<0.00020
Tungsten (W)	mg/L		0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Uranium (U)	mg/L	short-term: 0.033; long-term: 0.015	0.0000020	0.0000339	0.0000335	0.0000332	0.0000356	0.0000357	0.0000342
Vanadium (V)	mg/L		0.000050	0.000174	0.000167	0.000164	<0.000050	<0.000050	<0.000050
Yttrium (Y)	mg/L		0.0000050	0.0000233	0.0000239	0.0000231	0.0000098	0.0000102	0.0000105
Zinc (Zn)	mg/L	0.03	0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Zirconium (Zr)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Radiochemistry									
Radium-226	Bq/L		0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of freshwater aquatic life.

April sampling depths are depths below the water surface and are equal to approximately 0-1 m below ice.

^a Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b Interim guideline.

^c Total phosphorus trigger ranges for lakes and rivers (mg/L): <0.004 = Ultra-oligotrophic; 0.004–0.01 = Oligotrophic; 0.01–0.02 = Mesotrophic; 0.02–0.035 = Meso-eutrophic; 0.035–0.1 = Eutrophic; >0.1 = Hyper-eutrophic.

^d Cadmium guideline is hardness dependent (hardness as CaCO₃). Short-term guideline = 10^{1.016[log(hardness)]-1.71} / 1000 mg/L. If hardness is <5.3 mg/L, the guideline is 0.00011 mg/L; if hardness is >360 mg/L, the guideline is 0.0077 mg/L. Long-term cadmium guideline = 10^{0.83[log(hardness)]-2.46} / 1000 mg/L. If hardness is <17 mg/L, the guideline is 0.00004 mg/L; if hardness is >280 mg/L, the guideline is 0.00037 mg/L.

^e Copper guideline is hardness dependent (hardness as CaCO₃). Guideline = e^{0.8545[ln(hardness)]-1.465} * 0.0002 mg/L. If hardness is <82 mg/L, the guideline is 0.002 mg/L; if hardness is >180 mg/L, the guideline is 0.004 mg/L. If water hardness is not known, the guideline is 0.002 mg/L.

^f Lead guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: lead guideline (mg/L) = e^{[1.273[ln(hardness)]-4.705]} /1000. At hardness as CaCO₃ of ≤ 60mg/L, lead guideline is a minimum of 0.001 mg/L; at hardness as CaCO₃ of >180 mg/L, lead guideline is a maximum of 0.007 mg/L.

^g Nickel guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: nickel guideline (mg/L) = e^{[0.76[ln(hardness)]+1.06]} /1000. At hardness as CaCO₃ of ≤ 60mg/L, nickel guideline is a minimum of 0.025 mg/L; at hardness as CaCO₃ of >180 mg/L, nickel guideline is a maximum of 0.150 mg/L.

Annex A.3-2. Lake Water Quality Data, Doris North Project, 2014

Site ID:				Little Roberts	Little Roberts	Reference D	Reference D	Doris South	Doris South
Depth Zone:				Surface	Surface	Surface	Surface	Surface	Deep
Depth Sampled (m):				1.0	1.0	1.0	1.0	1.0	9.0
Replicate:				1	2	1	2	1	1
Date Sampled:			CCME guideline for the	17-Aug-14	17-Aug-14	18-Aug-14	18-Aug-14	20-Sep-14	20-Sep-14
ALS Sample ID:			Protection of Aquatic life ^a	L1504772-2	L1504772-3	L1504772-5	L1504772-6	L1523080-4	L1523080-5
Units			Realized Detection Limit						
Physical Tests									
Conductivity	uS/cm		2.0	264	261	102	102	275	276
Hardness (as CaCO ₃)	mg/L		0.50	44.8	44.7	19.4	19.5	48.2	48.4
pH	pH	6.5–9.0	0.10	7.53	7.59	7.32	7.30	7.37	7.47
Total Suspended Solids	mg/L	dependent on background levels	1.0	4.1	3.9	<1.0	<1.0	6.2	5.8
Total Dissolved Solids	mg/L		10	156	153	061	062	171	169
Turbidity	NTU	dependent on background levels	0.10	4.11	3.96	1.14	1.17	6.45	6.53
Anions and Nutrients									
Alkalinity, Total (as CaCO ₃)	mg/L		1.0	24.3	24.4	11.6	11.7	30.3	31.9
Ammonia, Total (as N)	mg/L	pH- and temperature-dependent	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bromide (Br)	mg/L		0.05 - 0.5	0.206	0.201	0.058	0.059	0.217	0.217
Chloride (Cl)	mg/L	short-term: 640; long-term: 120	0.5 - 5	61.4	61.4	21.0	21.1	65.4	65.5
Fluoride (F)	mg/L	Inorganic fluorides: 0.12 ^b	0.02 - 0.2	0.054	0.054	0.039	0.036	0.057	0.057
Nitrate (as N)	mg/L	short-term: 124; long-term: 3.0	0.005 - 0.05	<0.0050	<0.0050	0.006	0.0067	<0.0050	<0.0050
Nitrite (as N)	mg/L	0.06	0.001 - 0.01	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Total Kjeldahl Nitrogen	mg/L		0.050	0.45	0.45	0.25	0.27	0.65	0.60
Dissolved Kjeldahl Nitrogen	mg/L		0.050	-	-	-	-	-	-
Orthophosphate-Dissolved (as P)	mg/L		0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)	mg/L	Trigger ranges from guidance framework ^c	0.0020	0.0231	0.0227	0.0068	0.0072	0.0305	0.0276
Sulfate (SO ₄)	mg/L		0.5 - 5	3.81	3.86	1.96	1.96	2.79	2.78
Cyanides									
Cyanide, Total	mg/L		0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L	0.005	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic/ Inorganic Carbon									
Dissolved Organic Carbon	mg/L		0.50	5.24	5.04	4.41	4.41	5.49	5.52
Total Organic Carbon	mg/L		0.5 - 1	5.79	6.64	4.81	4.82	6.09	5.92
Total Metals									
Aluminum (Al)	mg/L	0.005 if pH<6.5; 0.1 if pH≥6.5	0.0030	0.0795	0.0837	0.0438	0.0438	0.0547	0.0551
Antimony (Sb)	mg/L		0.000010	0.000019	0.000022	0.000015	0.000016	0.000035	0.000033
Arsenic (As)	mg/L	0.005	0.000050	0.000293	0.000289	0.00014	0.000124	0.000253	0.000274
Barium (Ba)	mg/L		0.00010	0.00340	0.00347	0.00195	0.00202	0.00320	0.00325
Beryllium (Be)	mg/L		0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)	mg/L	short-term: 29; long-term: 1.5	0.005000	0.0307	0.0300	0.0128	0.0190	0.0556	0.0542
Cadmium (Cd)	mg/L	equation ^d	0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)	mg/L		0.050	07.3	07.2	03.1	03.1	08.6	08.7
Cesium (Cs)	mg/L		0.0000050	0.0000062	0.0000069	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Chromium (Cr)	mg/L	Cr(VI): 0.001; Cr(III): 0.0089 ^b	0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L		0.000050	0.000059	0.000062	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)	mg/L	0.002-0.004 ^e	0.00050	0.00134	0.00148	0.00099	0.00107	0.00124	0.00120
Gallium (Ga)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Iron (Fe)	mg/L	0.3	0.030	0.194	0.196	0.098	0.101	0.084	0.091
Lead (Pb)	mg/L	0.001-0.007 ^f	0.000050	<0.000050	0.000102	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L		0.00020	0.00284	0.00300	0.00152	0.00171	0.00393	0.00388
Magnesium (Mg)	mg/L		0.10	6.47	6.47	2.85	2.86	6.49	6.49
Manganese (Mn)	mg/L		0.00020	0.01410	0.01380	0.00407	0.00418	0.01280	0.01390
Mercury (Hg)	ug/L	Inorganic Hg: 0.026	0.00050	0.00071	0.00114	0.00092	0.00093	0.00054	0.00050
Molybdenum (Mo)	mg/L	0.073 ^b	0.000050	0.000196	0.000172	0.000060	0.000064	0.000135	0.000160
Nickel (Ni)	mg/L	0.025-0.150 ^g	0.00020	0.00050	0.00093	0.00038	0.00046	0.00045	0.00045
Phosphorus (P)	mg/L		0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)	mg/L		2.0	2.3	2.3	<2.0	<2.0	2.3	2.3
Rhenium (Re)	mg/L		0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Rubidium (Rb)	mg/L		0.000020	0.00141	0.00137	0.00099	0.00101	0.00160	0.00157
Selenium (Se)	mg/L	0.001	0.000200	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Silicon (Si)	mg/L		0.050	0.85	0.84	0.26	0.26	1.41	1.41
Silver (Ag)	mg/L	0.0001	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Sodium (Na)	mg/L		2.0	35.0	35.1	12.2	12.2	31.1	31.0
Strontium (Sr)	mg/L		0.000050	0.0411	0.0425	0.0175	0.0181	0.0401	0.0396
Tellurium (Te)	mg/L		0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thallium (Tl)	mg/L	0.0008	0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020
Thorium (Th)	mg/L		0.0000050	0.0000286	0.0000286	0.0000287	0.0000308	0.0000093	0.0000087
Tin (Sn)	mg/L		0.000200	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)	mg/L		0.00020	0.00244	0.00249	0.00128	0.00141	0.00158	0.00163
Tungsten (W)	mg/L		0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Uranium (U)	mg/L	short-term: 0.033; long-term: 0.015	0.0000020	0.0000398	0.0000387	0.0000340	0.0000336	0.0000278	0.0000282
Vanadium (V)	mg/L		0.000050	0.000192	0.000193	0.000094	0.000103	0.000153	0.000172
Yttrium (Y)	mg/L		0.0000050	0.0000388	0.0000377	0.0000362	0.0000363	0.0000151	0.0000151
Zinc (Zn)	mg/L	0.03	0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Zirconium (Zr)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Radiochemistry									
Radium-226	Bq/L		0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of freshwater aquatic life.

April sampling depths are depths below the water surface and are equal to approximately 0-1 m below ice.

^a Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b Interim guideline.

^c Total phosphorus trigger ranges for lakes and rivers (mg/L): <0.004 = Ultra-oligotrophic; 0.004–0.01 = Oligotrophic; 0.01–0.02 = Mesotrophic; 0.02–0.035 = Meso-eutrophic; 0.035–0.1 = Eutrophic; >0.1 = Hyper-eutrophic.

^d Cadmium guideline is hardness dependent (hardness as CaCO₃). Short-term guideline = 10^{1.016[log(hardness)]-1.71} / 1000 mg/L. If hardness is <5.3 mg/L, the guideline is 0.00011 mg/L; if hardness is >360 mg/L, the guideline is 0.0077 mg/L. Long-term cadmium guideline = 10^{0.83[log(hardness)]-2.46} / 1000 mg/L. If hardness is <17 mg/L, the guideline is 0.00004 mg/L; if hardness is >280 mg/L, the guideline is 0.00037 mg/L.

^e Copper guideline is hardness dependent (hardness as CaCO₃). Guideline = e^{0.8545[ln(hardness)]-1.465} * 0.0002 mg/L. If hardness is <82 mg/L, the guideline is 0.002 mg/L; if hardness is >180 mg/L, the guideline is 0.004 mg/L. If water hardness is not known, the guideline is 0.002 mg/L.

^f Lead guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: lead guideline (mg/L) = e^{[1.273[ln(hardness)]-4.705]} /1000. At hardness as CaCO₃ of ≤ 60mg/L, lead guideline is a minimum of 0.001 mg/L; at hardness as CaCO₃ of >180 mg/L, lead guideline is a maximum of 0.007 mg/L.

^g Nickel guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: nickel guideline (mg/L) = e^{[0.76[ln(hardness)]+1.06]} /1000. At hardness as CaCO₃ of ≤ 60mg/L, nickel guideline is a minimum of 0.025 mg/L; at hardness as CaCO₃ of >180 mg/L, nickel guideline is a maximum of 0.150 mg/L.

Annex A.3-2. Lake Water Quality Data, Doris North Project, 2014

Site ID:				Doris South	Doris North	Doris North	Doris North	Reference B	Reference B
Depth Zone:				Deep	Surface	Deep	Surface	Surface	Deep
Depth Sampled (m):				9.0	1.0	12.0	1.0	1.0	8.5
Replicate:				2	1	1	2	1	1
Date Sampled:	CCME guideline for the		Realized	20-Sep-14	20-Sep-14	20-Sep-14	20-Sep-14	18-Sep-14	18-Sep-14
ALS Sample ID:	Units	Protection of Aquatic life ^a	Detection Limit	L1523080-6	L1523080-1	L1523080-2	L1523080-3	L1520746-11	L1520746-12
Physical Tests									
Conductivity	uS/cm		2.0	277	280	279	276	58.6	50
Hardness (as CaCO ₃)	mg/L		0.50	50.1	51.1	50.0	51.8	14.1	14.0
pH	pH	6.5–9.0	0.10	7.49	7.48	7.50	7.44	6.69	6.93
Total Suspended Solids	mg/L	dependent on background levels	1.0	6.1	5.5	5.7	5.5	<1.0	<1.0
Total Dissolved Solids	mg/L		10	172	180	173	172	038	050
Turbidity	NTU	dependent on background levels	0.10	6.44	6.42	6.54	6.76	0.37	0.32
Anions and Nutrients									
Alkalinity, Total (as CaCO ₃)	mg/L		1.0	31.4	31.8	32.3	31.3	08.4	10.1
Ammonia, Total (as N)	mg/L	pH- and temperature-dependent	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bromide (Br)	mg/L		0.05 - 0.5	0.221	0.218	0.219	0.217	<0.050	<0.050
Chloride (Cl)	mg/L	short-term: 640; long-term: 120	0.5 - 5	65.3	65.4	65.5	65.5	06.8	06.8
Fluoride (F)	mg/L	Inorganic fluorides: 0.12 ^b	0.02 - 0.2	0.057	0.056	0.056	0.057	0.021	0.021
Nitrate (as N)	mg/L	short-term: 124; long-term: 3.0	0.005 - 0.05	<0.0050	<0.0050	<0.0050	<0.0050	0.0106	<0.0050
Nitrite (as N)	mg/L	0.06	0.001 - 0.01	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Total Kjeldahl Nitrogen	mg/L		0.050	0.61	0.62	0.65	0.65	0.27	0.23
Dissolved Kjeldahl Nitrogen	mg/L		0.050	-	-	-	-	-	-
Orthophosphate-Dissolved (as P)	mg/L		0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)	mg/L	Trigger ranges from guidance framework ^c	0.0020	0.0312	0.0281	0.0283	0.0306	0.0034	0.0038
Sulfate (SO ₄)	mg/L		0.5 - 5	2.78	2.77	2.78	2.79	1.73	1.73
Cyanides									
Cyanide, Total	mg/L		0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L	0.005	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic/ Inorganic Carbon									
Dissolved Organic Carbon	mg/L		0.50	5.58	5.54	5.43	5.70	3.06	3.14
Total Organic Carbon	mg/L		0.5 - 1	5.94	5.94	5.88	6.00	3.18	3.16
Total Metals									
Aluminum (Al)	mg/L	0.005 if pH<6.5; 0.1 if pH≥6.5	0.0030	0.0502	0.0519	0.0517	0.0556	0.0093	0.0074
Antimony (Sb)	mg/L		0.000010	0.000034	0.000034	0.000034	0.000048	0.000013	0.000011
Arsenic (As)	mg/L	0.005	0.000050	0.000266	0.000287	0.00028	0.000279	0.000089	0.000086
Barium (Ba)	mg/L		0.00010	0.00326	0.00328	0.00333	0.00345	0.00166	0.00149
Beryllium (Be)	mg/L		0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)	mg/L	short-term: 29; long-term: 1.5	0.005000	0.0506	0.0560	0.0585	0.0617	0.0131	0.0108
Cadmium (Cd)	mg/L	equation ^d	0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)	mg/L		0.050	09.0	09.2	09.0	09.3	03.4	03.4
Cesium (Cs)	mg/L		0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Chromium (Cr)	mg/L	Cr(VI): 0.001; Cr(III): 0.0089 ^b	0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)	mg/L	0.002-0.004 ^e	0.00050	0.00125	0.00122	0.00125	0.00128	0.00065	0.00055
Gallium (Ga)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Iron (Fe)	mg/L	0.3	0.030	0.087	0.082	0.08	0.085	<0.030	<0.030
Lead (Pb)	mg/L	0.001-0.007 ^f	0.000050	<0.000050	<0.000050	<0.000050	<0.000050	0.000072	<0.000050
Lithium (Li)	mg/L		0.00020	0.00416	0.00441	0.00400	0.00425	0.00044	0.00044
Magnesium (Mg)	mg/L		0.10	6.74	6.86	6.71	6.96	1.36	1.36
Manganese (Mn)	mg/L		0.00020	0.01370	0.01290	0.01240	0.01320	0.00113	0.00111
Mercury (Hg)	ug/L	Inorganic Hg: 0.026	0.00050	0.00085	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Molybdenum (Mo)	mg/L	0.073 ^b	0.000050	0.000142	0.000150	0.000139	0.000153	<0.000050	<0.000050
Nickel (Ni)	mg/L	0.025-0.150 ^g	0.00020	0.00044	0.00045	0.00047	0.00048	<0.00020	<0.00020
Phosphorus (P)	mg/L		0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)	mg/L		2.0	2.4	2.4	2.4	2.5	<2.0	<2.0
Rhenium (Re)	mg/L		0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Rubidium (Rb)	mg/L		0.000020	0.00169	0.00169	0.00166	0.00174	0.00061	0.00058
Selenium (Se)	mg/L	0.001	0.000200	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Silicon (Si)	mg/L		0.050	1.46	1.49	1.46	1.53	0.08	0.08
Silver (Ag)	mg/L	0.0001	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Sodium (Na)	mg/L		2.0	32.3	33.0	32.2	33.4	03.9	03.8
Strontium (Sr)	mg/L		0.000050	0.0417	0.0421	0.0405	0.0431	0.0140	0.0137
Tellurium (Te)	mg/L		0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thallium (Tl)	mg/L	0.0008	0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020
Thorium (Th)	mg/L		0.0000050	0.0000081	0.0000095	0.0000097	0.0000103	0.0000051	<0.0000050
Tin (Sn)	mg/L		0.000200	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)	mg/L		0.00020	0.00163	0.00157	0.00148	0.00157	0.0002	<0.00020
Tungsten (W)	mg/L		0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Uranium (U)	mg/L	short-term: 0.033; long-term: 0.015	0.0000020	0.0000291	0.0000286	0.0000281	0.0000294	0.0000347	0.0000343
Vanadium (V)	mg/L		0.000050	0.000163	0.000159	0.000157	0.000164	<0.000050	<0.000050
Yttrium (Y)	mg/L		0.0000050	0.0000156	0.0000144	0.0000145	0.0000157	0.0000091	0.0000092
Zinc (Zn)	mg/L	0.03	0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Zirconium (Zr)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Radiochemistry									
Radium-226	Bq/L		0.010	<0.01	<0.01	<0.01	<0.01	<.01	<.01

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of freshwater aquatic life.

April sampling depths are depths below the water surface and are equal to approximately 0-1 m below ice.

^a Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b Interim guideline.

^c Total phosphorus trigger ranges for lakes and rivers (mg/L): <0.004 = Ultra-oligotrophic; 0.004–0.01 = Oligotrophic; 0.01–0.02 = Mesotrophic; 0.02–0.035 = Meso-eutrophic; 0.035–0.1 = Eutrophic; >0.1 = Hyper-eutrophic.

^d Cadmium guideline is hardness dependent (hardness as CaCO₃). Short-term guideline = 10^{1.016[log(hardness)]-1.71} / 1000 mg/L. If hardness is <5.3 mg/L, the guideline is 0.00011 mg/L; if hardness is >360 mg/L, the guideline is 0.0077 mg/L. Long-term cadmium guideline = 10^{0.83[log(hardness)]-2.46} / 1000 mg/L. If hardness is <17 mg/L, the guideline is 0.00004 mg/L; if hardness is >280 mg/L, the guideline is 0.00037 mg/L.

^e Copper guideline is hardness dependent (hardness as CaCO₃). Guideline = e^{0.8545[ln(hardness)]-1.465} * 0.0002 mg/L. If hardness is <82 mg/L, the guideline is 0.002 mg/L; if hardness is >180 mg/L, the guideline is 0.004 mg/L. If water hardness is not known, the guideline is 0.002 mg/L.

^f Lead guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: lead guideline (mg/L) = e^{[1.273[ln(hardness)]-4.705]} /1000. At hardness as CaCO₃ of ≤ 60mg/L, lead guideline is a minimum of 0.001 mg/L; at hardness as CaCO₃ of >180 mg/L, lead guideline is a maximum of 0.007 mg/L.

^g Nickel guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: nickel guideline (mg/L) = e^{[0.76[ln(hardness)]+1.06]} /1000. At hardness as CaCO₃ of ≤ 60mg/L, nickel guideline is a minimum of 0.025 mg/L; at hardness as CaCO₃ of >180 mg/L, nickel guideline is a maximum of 0.150 mg/L.

Annex A.3-2. Lake Water Quality Data, Doris North Project, 2014

Site ID: Depth Zone: Depth Sampled (m): Replicate: Date Sampled: ALS Sample ID:				Little Roberts Shallow 1.0 1 19-Sep-14 L1523080-7	Little Roberts Shallow 1.0 2 19-Sep-14 L1523080-8	Reference D Shallow 1.0 1 19-Sep-14 L1523080-9	Reference D Shallow 1.0 2 19-Sep-14 L1523080-10
	Units	CCME guideline for the Protection of Aquatic life ^a	Realized Detection Limit				
Physical Tests							
Conductivity	uS/cm		2.0	265	266	103	103
Hardness (as CaCO ₃)	mg/L		0.50	47.2	46.5	20.3	20.2
pH	pH	6.5–9.0	0.10	7.39	7.40	7.07	7.11
Total Suspended Solids	mg/L	dependent on background levels	1.0	3.8	4.0	<1.0	<1.0
Total Dissolved Solids	mg/L		10	164	162	064	065
Turbidity	NTU	dependent on background levels	0.10	4.19	4.50	0.82	0.93
Anions and Nutrients							
Alkalinity, Total (as CaCO ₃)	mg/L		1.0	28.0	28.6	12.9	13.3
Ammonia, Total (as N)	mg/L	pH- and temperature-dependent	0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bromide (Br)	mg/L		0.05 - 0.5	0.207	0.211	0.061	0.060
Chloride (Cl)	mg/L	short-term: 640; long-term: 120	0.5 - 5	64.0	64.0	21.9	21.9
Fluoride (F)	mg/L	Inorganic fluorides: 0.12 ^b	0.02 - 0.2	0.052	0.052	0.037	0.038
Nitrate (as N)	mg/L	short-term: 124; long-term: 3.0	0.005 - 0.05	<0.0050	<0.0050	0.0112	<0.0050
Nitrite (as N)	mg/L	0.06	0.001 - 0.01	<0.0010	<0.0010	<0.0010	<0.0010
Total Kjeldahl Nitrogen	mg/L		0.050	0.54	0.52	0.39	0.28
Dissolved Kjeldahl Nitrogen	mg/L		0.050	-	-	-	-
Orthophosphate-Dissolved (as P)	mg/L		0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)	mg/L	Trigger ranges from guidance framework ^c	0.0020	0.0234	0.0208	0.0062	0.0070
Sulfate (SO ₄)	mg/L		0.5 - 5	4.04	4.04	2.05	2.05
Cyanides							
Cyanide, Total	mg/L		0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L	0.005	0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic/ Inorganic Carbon							
Dissolved Organic Carbon	mg/L		0.50	5.37	5.36	4.36	4.44
Total Organic Carbon	mg/L		0.5 - 1	5.83	6.12	4.60	4.44
Total Metals							
Aluminum (Al)	mg/L	0.005 if pH<6.5; 0.1 if pH≥6.5	0.0030	0.0698	0.0685	0.0361	0.0321
Antimony (Sb)	mg/L		0.000010	0.000036	0.000037	0.000033	0.000031
Arsenic (As)	mg/L	0.005	0.000050	0.000257	0.000238	0.000117	0.000114
Barium (Ba)	mg/L		0.00010	0.00325	0.00325	0.00196	0.00198
Beryllium (Be)	mg/L		0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)	mg/L	short-term: 29; long-term: 1.5	0.005000	0.0583	0.0604	0.0245	0.0249
Cadmium (Cd)	mg/L	equation ^d	0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)	mg/L		0.050	07.7	07.6	03.2	03.2
Cesium (Cs)	mg/L		0.0000050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Chromium (Cr)	mg/L	Cr(VI): 0.001; Cr(III): 0.0089 ^b	0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)	mg/L	0.002-0.004 ^e	0.00050	0.00133	0.00132	0.00162	0.00096
Gallium (Ga)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Iron (Fe)	mg/L	0.3	0.030	0.112	0.107	0.071	0.067
Lead (Pb)	mg/L	0.001-0.007 ^f	0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L		0.00020	0.00342	0.00349	0.00138	0.00143
Magnesium (Mg)	mg/L		0.10	6.79	6.70	2.99	2.99
Manganese (Mn)	mg/L		0.00020	0.00617	0.00603	0.00269	0.00265
Mercury (Hg)	ug/L	Inorganic Hg: 0.026	0.00050	0.00057	0.00056	0.00055	0.00066
Molybdenum (Mo)	mg/L	0.073 ^b	0.000050	0.000157	0.000149	0.000051	0.000086
Nickel (Ni)	mg/L	0.025-0.150 ^g	0.00020	0.00050	0.00046	0.00036	0.00033
Phosphorus (P)	mg/L		0.30	<0.30	<0.30	<0.30	<0.30
Potassium (K)	mg/L		2.0	2.3	2.2	<2.0	<2.0
Rhenium (Re)	mg/L		0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Rubidium (Rb)	mg/L		0.000020	0.00154	0.00153	0.00111	0.00113
Selenium (Se)	mg/L	0.001	0.000200	<0.00020	<0.00020	<0.00020	<0.00020
Silicon (Si)	mg/L		0.050	0.90	0.89	0.23	0.23
Silver (Ag)	mg/L	0.0001	0.000005	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Sodium (Na)	mg/L		2.0	33.2	32.7	11.7	11.7
Strontium (Sr)	mg/L		0.000050	0.0394	0.0394	0.0175	0.0177
Tellurium (Te)	mg/L		0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Thallium (Tl)	mg/L	0.0008	0.0000020	<0.0000020	<0.0000020	<0.0000020	<0.0000020
Thorium (Th)	mg/L		0.0000050	0.0000142	0.0000154	0.0000181	0.0000183
Tin (Sn)	mg/L		0.000200	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)	mg/L		0.00020	0.0017	0.00169	0.00087	0.00079
Tungsten (W)	mg/L		0.000010	<0.000010	<0.000010	<0.000010	<0.000010
Uranium (U)	mg/L	short-term: 0.033; long-term: 0.015	0.0000020	0.0000330	0.0000329	0.0000335	0.0000335
Vanadium (V)	mg/L		0.000050	0.000145	0.000126	0.000074	0.000070
Yttrium (Y)	mg/L		0.0000050	0.0000228	0.0000227	0.0000253	0.0000252
Zinc (Zn)	mg/L	0.03	0.0030	<0.0030	<0.0030	<0.0030	<0.0030
Zirconium (Zr)	mg/L		0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Radiochemistry							
Radium-226	Bq/L		0.010	<0.01	<0.01	<0.01	<0.01

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of freshwater aquatic life.

April sampling depths are depths below the water surface and are equal to approximately 0-1 m below ice.

^a Canadian water quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b Interim guideline.

^c Total phosphorus trigger ranges for lakes and rivers (mg/L): <0.004 = Ultra-oligotrophic; 0.004–0.01 = Oligotrophic; 0.01–0.02 = Mesotrophic; 0.02–0.035 = Meso-eutrophic; 0.035–0.1 = Eutrophic; >0.1 = Hyper-eutrophic.

^d Cadmium guideline is hardness dependent (hardness as CaCO₃). Short-term guideline = 10^{1.016[log(hardness)]-1.71} / 1000 mg/L. If hardness is <5.3 mg/L, the guideline is 0.00011 mg/L; if hardness is >360 mg/L, the guideline is 0.0077 mg/L. Long-term cadmium guideline = 10^{0.83[log(hardness)]-2.46} / 1000 mg/L. If hardness is <17 mg/L, the guideline is 0.00004 mg/L; if hardness is >280 mg/L, the guideline is 0.00037 mg/L.

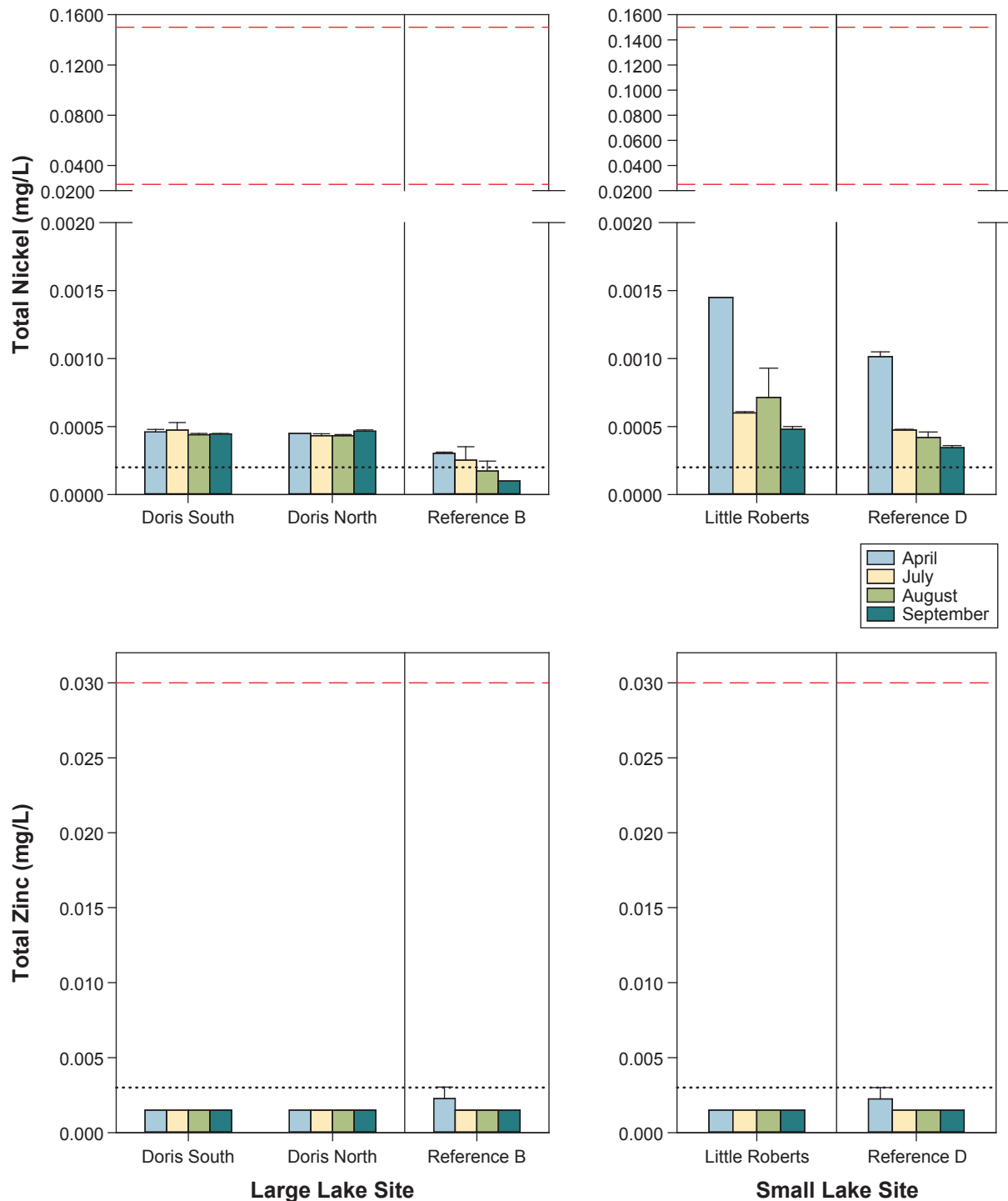
^e Copper guideline is hardness dependent (hardness as CaCO₃). Guideline = e^{0.8545[ln(hardness)]-1.465} * 0.0002 mg/L. If hardness is <82 mg/L, the guideline is 0.002 mg/L; if hardness is >180 mg/L, the guideline is 0.004 mg/L. If water hardness is not known, the guideline is 0.002 mg/L.

^f Lead guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: lead guideline (mg/L) = e^{[1.273[ln(hardness)]-4.705]} /1000. At hardness as CaCO₃ of ≤ 60mg/L, lead guideline is a minimum of 0.001 mg/L; at hardness as CaCO₃ of >180 mg/L, lead guideline is a maximum of 0.007 mg/L.

^g Nickel guideline is hardness-dependent at hardness as CaCO₃ >60 to 180 mg/L: nickel guideline (mg/L) = e^{[0.76[ln(hardness)]+1.06]} /1000. At hardness as CaCO₃ of ≤ 60mg/L, nickel guideline is a minimum of 0.025 mg/L; at hardness as CaCO₃ of >180 mg/L, nickel guideline is a maximum of 0.150 mg/L.

Figure A.3-18

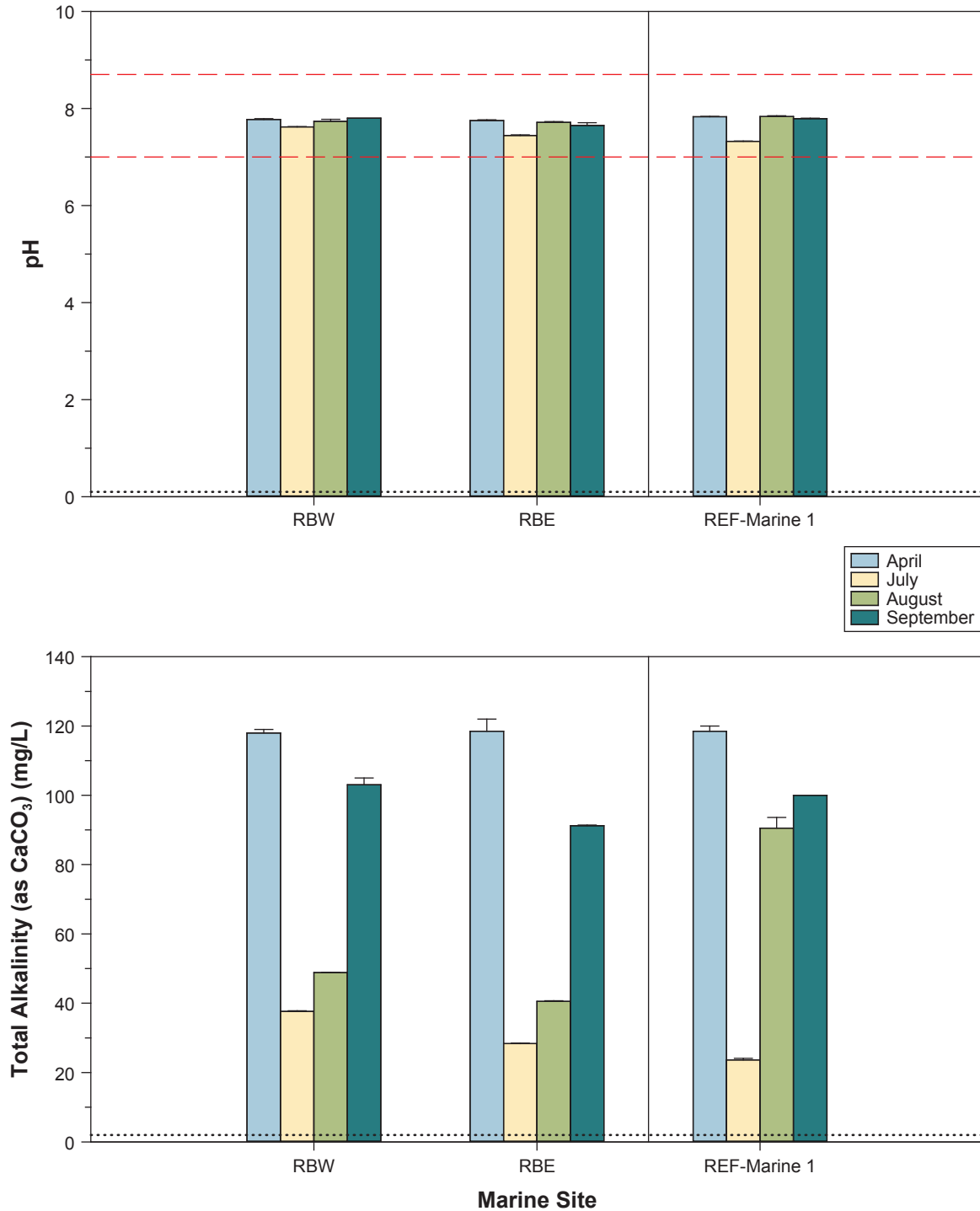
**Total Nickel and Total Zinc Concentrations
in Lake Sites, Doris North Project, 2014**



Notes: Error bars represent the standard error of the mean of replicates.
 Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
 The CCME guideline for nickel is hardness dependent.
 Red dashed lines represent the CCME freshwater guideline for zinc (0.03 mg/L) and the minimum and maximum site-specific CCME guideline for nickel (0.025 and 0.150 mg/L) based on the hardness (as CaCO₃) range in lakes of 12.8 to 187 mg/L.
 Total nickel and total zinc are regulated as deleterious substances in effluents as per Schedule 4 of the MMER.

Figure A.3-19

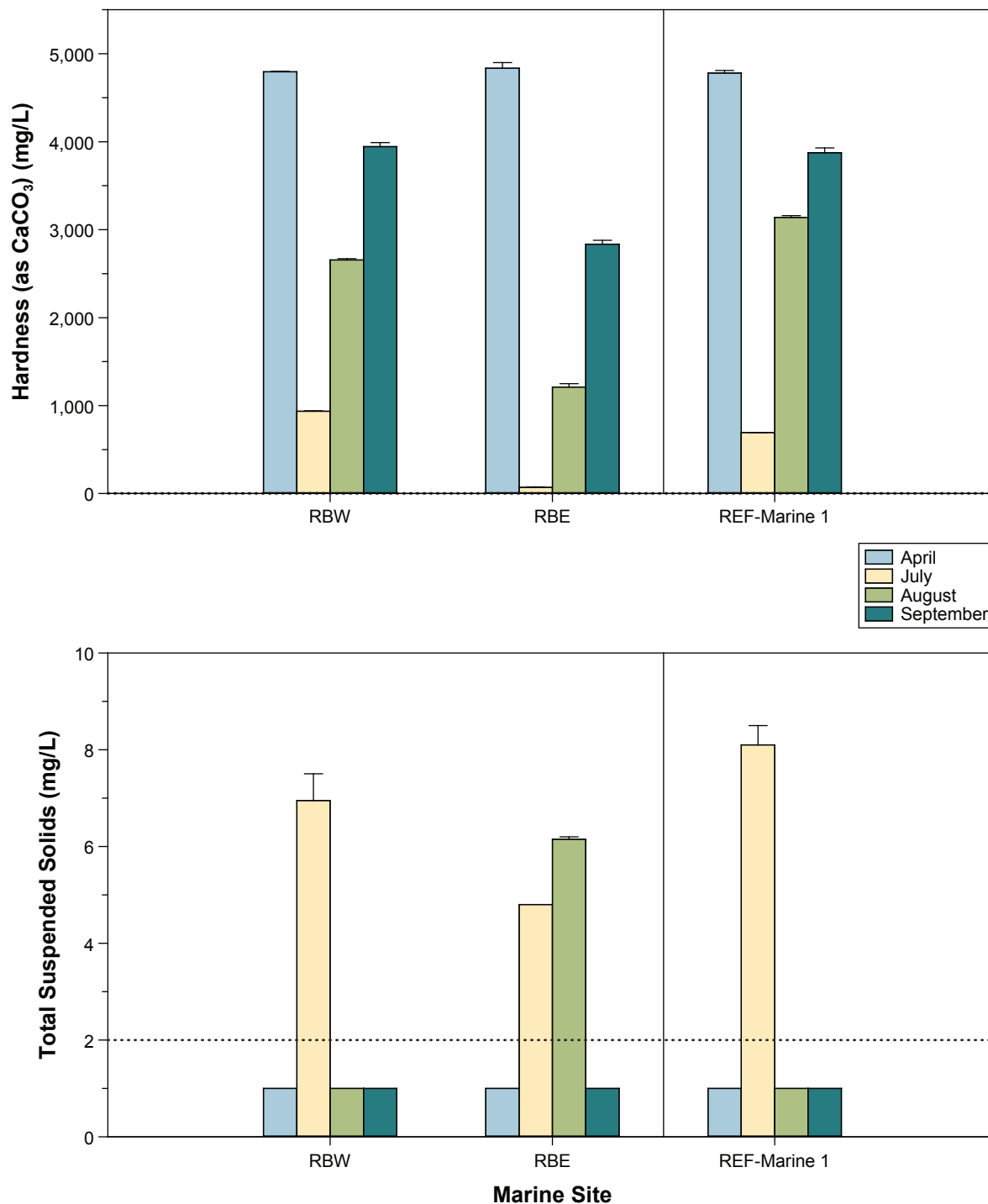
pH and Total Alkalinity in
Marine Sites, Doris North Project, 2014



Notes: Error bars represent the standard error of the mean of replicates.
Black dotted lines represent the analytical detection limits.
Red dashed lines represent the CCME marine and estuarine guideline pH range (7.0–8.7).
pH is a required parameter for water quality monitoring as per Schedule 5, s. 7(1)(c) of the MMER.
Total alkalinity is a required parameter for effluent characterization and water quality monitoring as per Schedule 5, s. 4(1) and s. 7(1)(c) of the MMER.

Figure A.3-20

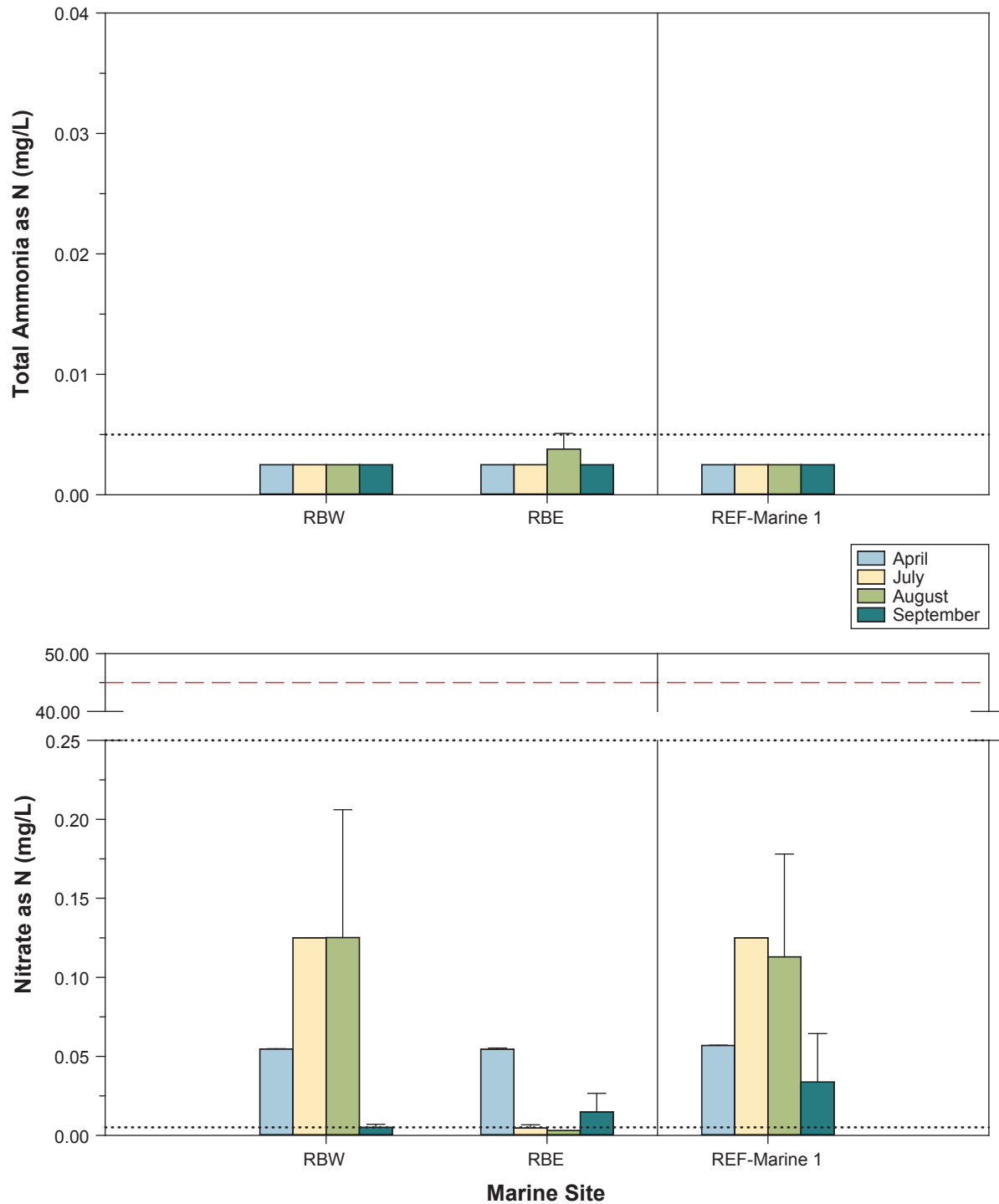
Hardness and Total Suspended Solids in Marine Sites, Doris North Project, 2014



Notes: Error bars represent the standard error of the mean of replicates.
 Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
 The CCME marine guideline for total suspended solids is dependent upon background levels.
 Hardness is a required parameter for effluent characterization and water quality monitoring as per Schedule 5, s. 4(1) and s. 7(1)(c) of the MMER.
 Total suspended solids are regulated as deleterious substances in effluents as per Schedule 4 of the MMER.

Figure A.3-21

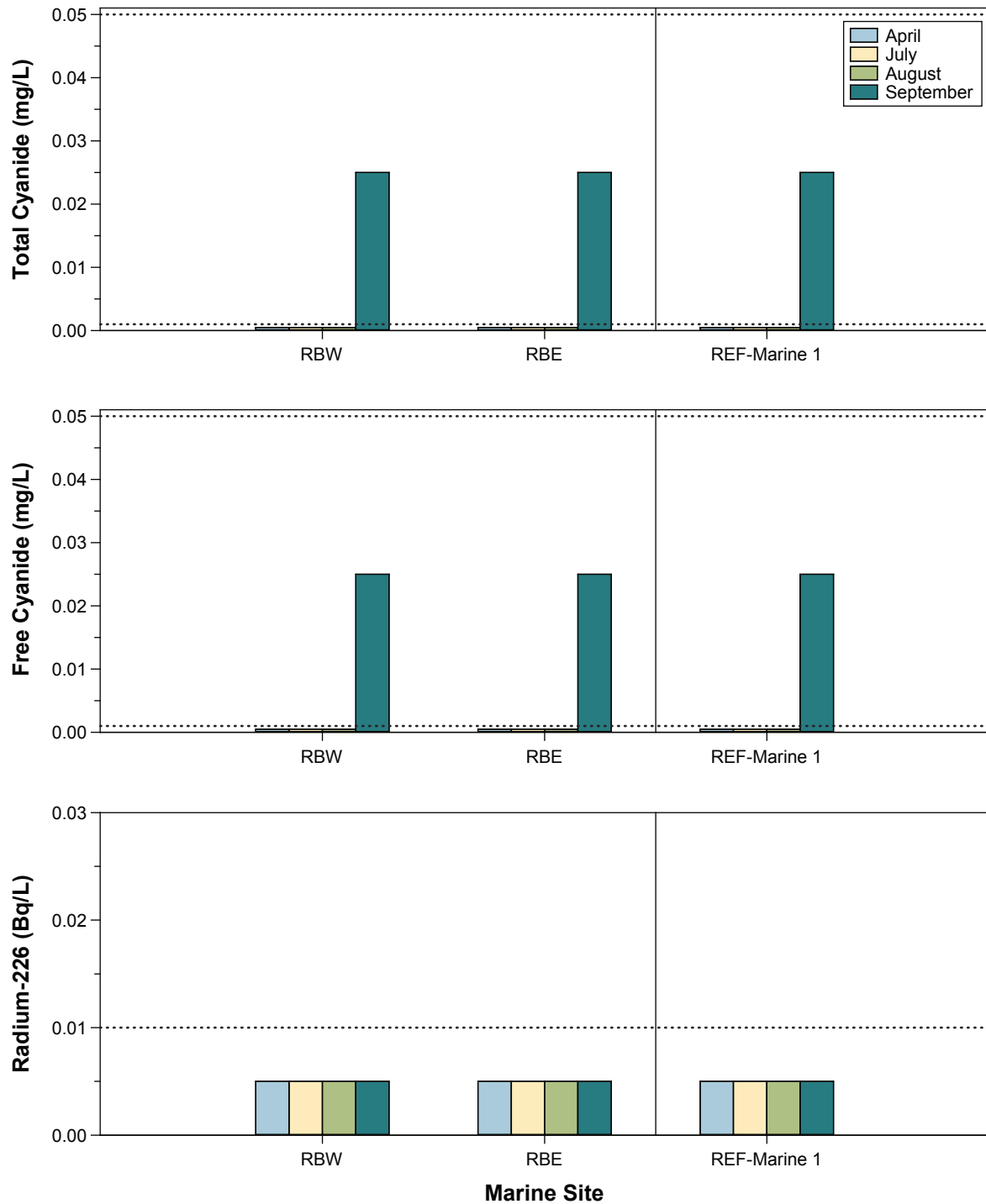
Total Ammonia and Nitrate Concentrations in Marine Sites, Doris North Project, 2014



Notes: Error bars represent the standard error of the mean of replicates.
 Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
 Red dashed line represents the CCME marine guideline for nitrate as N (45 mg/L; long-term concentration).
 Total ammonia and nitrate are required parameters for effluent characterization as per Schedule 5, s. 4(1) of the MMER.

Figure A.3-22

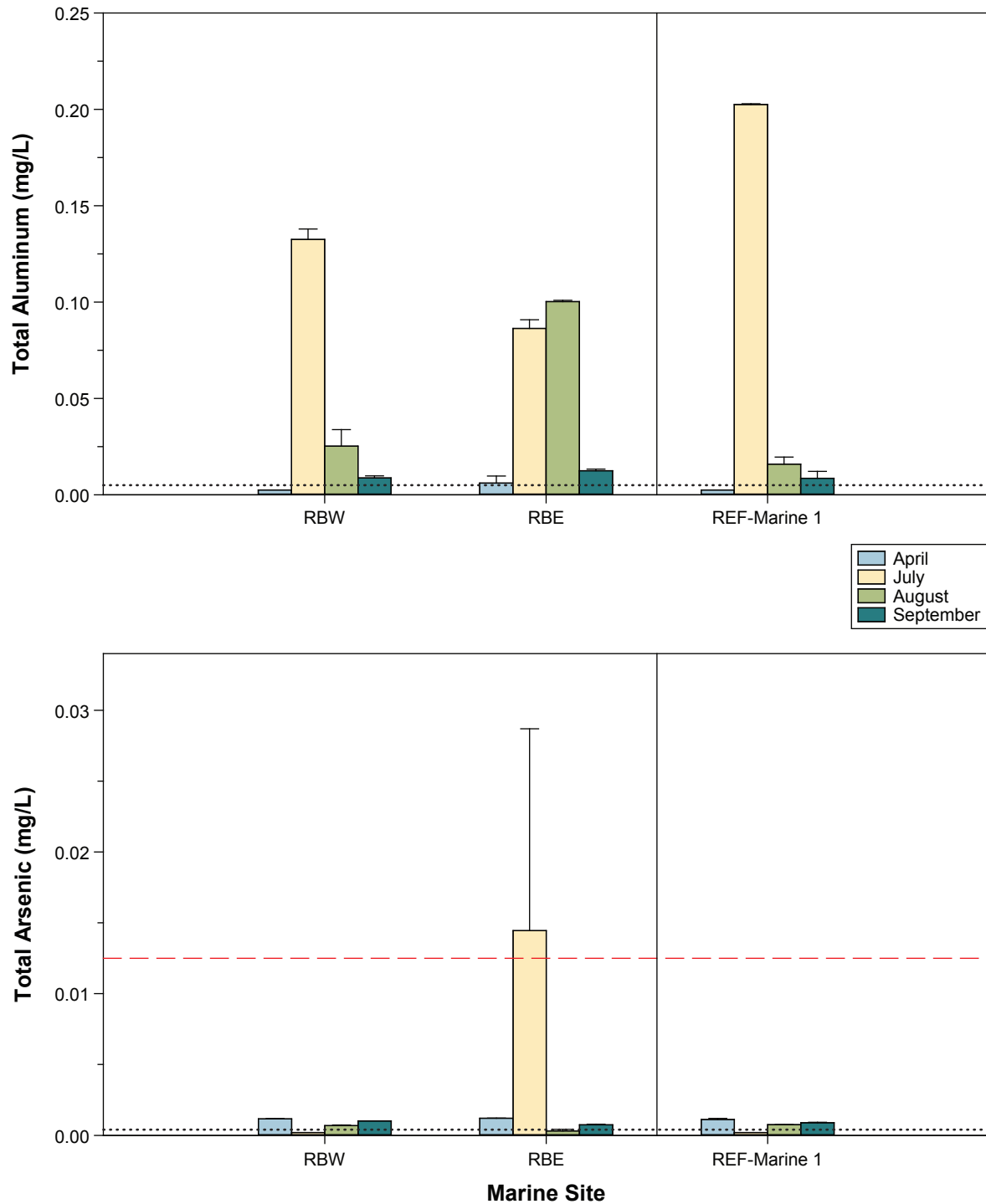
Total Cyanide, Free Cyanide, and Radium-226
Concentrations in Marine Sites, Doris North Project, 2014



Notes: Error bars represent the standard error of the mean of replicates.
Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
Total cyanide and radium-226 are regulated as deleterious substances in effluents as per Schedule 4 of the MMER.

Figure A.3-23

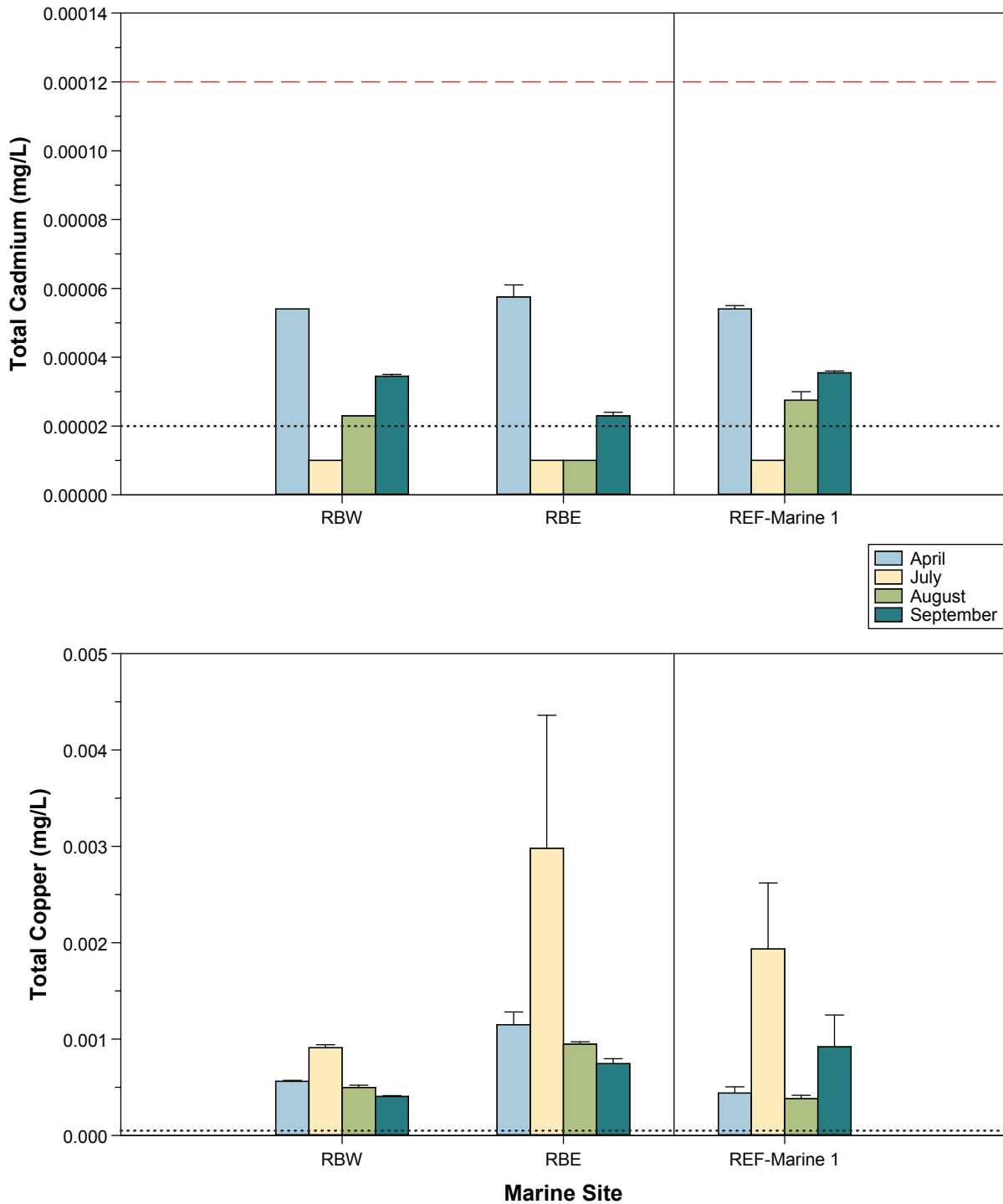
**Total Aluminum and Total Arsenic Concentrations
in Marine Sites, Doris North Project, 2014**



Notes: Error bars represent the standard error of the mean of replicates.
 Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
 Red dashed line represents the interim CCME marine guideline for arsenic (0.0125 mg/L).
 Total aluminum is a required parameter for effluent characterization as per Schedule 5, s. 4(1) of the MMER.
 Total arsenic is regulated as a deleterious substance in effluents as per Schedule 4 of the MMER.

Figure A.3-24

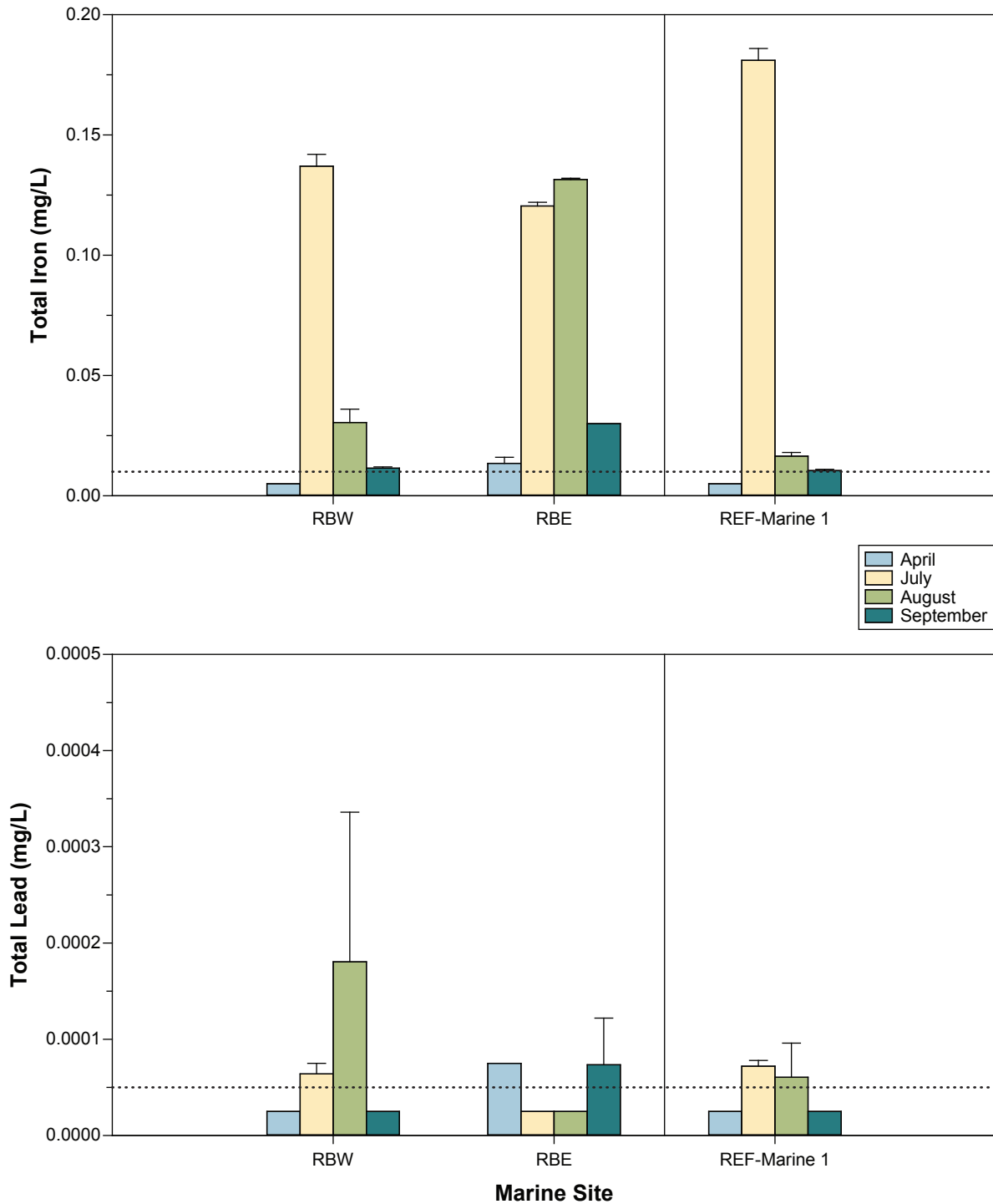
**Total Cadmium and Total Copper Concentrations
in Marine Sites, Doris North Project, 2014**



Notes: Error bars represent the standard error of the mean of replicates.
 Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
 Red dashed line represents the CCME marine guideline for cadmium (0.00012 mg/L).
 Total cadmium is a required parameter for effluent characterization as per Schedule 5, s. 4(1) of the MMER.
 Total copper is regulated as a deleterious substance in effluents as per Schedule 4 of the MMER.

Figure A.3-25

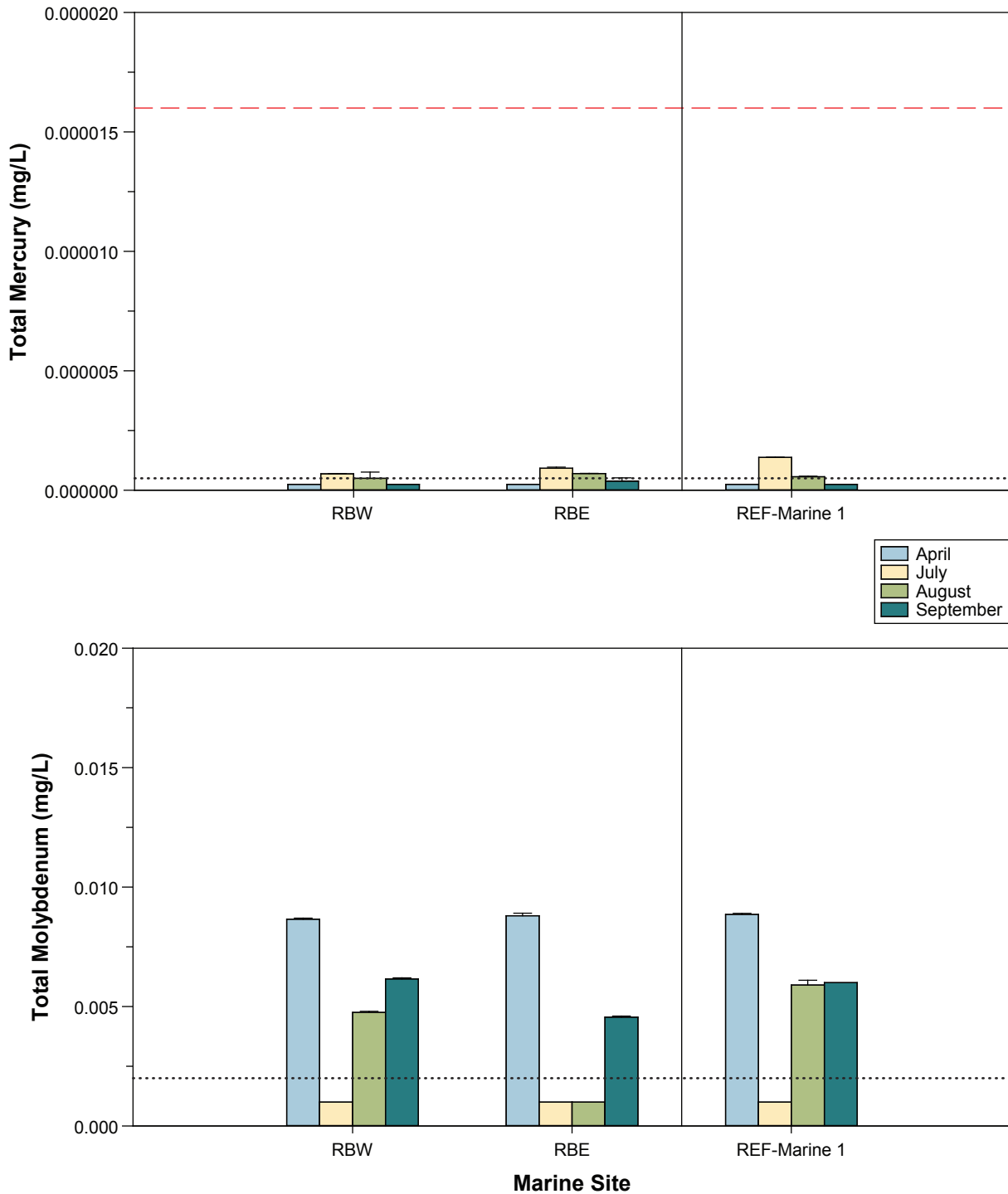
**Total Iron and Total Lead Concentrations
in Marine Sites, Doris North Project, 2014**



Notes: Error bars represent the standard error of the mean of replicates.
 Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
 Total iron is a required parameter for effluent characterization as per Schedule 5, s. 4(1) of the MMER.
 Total lead is regulated as a deleterious substance in effluents as per Schedule 4 of the MMER.

Figure A.3-26

**Total Mercury and Total Molybdenum Concentrations
in Marine Sites, Doris North Project, 2014**



Notes: Error bars represent the standard error of the mean.

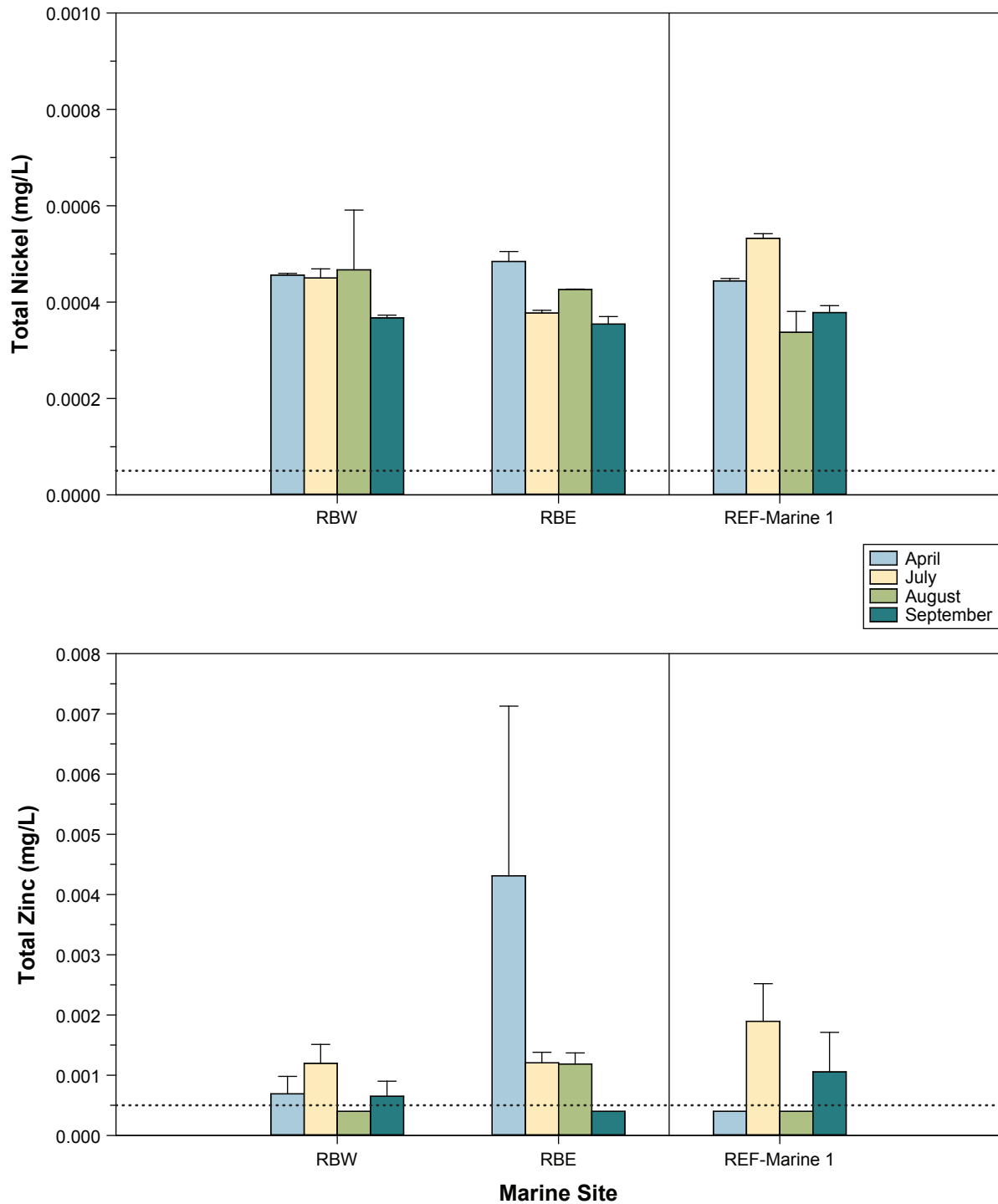
Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.

Red dashed line represents the interim CCME marine guideline for inorganic mercury (0.000016 mg/L).

Total mercury and total molybdenum are required parameters for effluent characterization as per Schedule 5, s. 4(1) of the MMER.

Figure A.3-27

**Total Nickel and Total Zinc Concentrations
in Marine Sites, Doris North Project, 2014**



Notes: Error bars represent the standard error of the mean of replicates.
 Black dotted lines represent the analytical detection limits; values below the detection limit are plotted at half the applicable detection limit.
 Total nickel and total zinc are regulated as deleterious substances in effluents as per Schedule 4 of the MMER.

Annex A.3-3. Marine Water Quality Data, Doris North Project, 2014

Site ID: Depth Zone: Depth Sampled (m): Replicate: Date Sampled: ALS Sample ID:					RBW Surface 2.0 1 20-Apr-14 L1447653-5	RBW Surface 2.0 2 20-Apr-14 L1447653-6	RBE Surface 2.0 1 23-Apr-14 L1447653-25	RBE Surface 2.0 2 23-Apr-14 L1447653-26	REF-Marine 1 Surface 3.0 1 24-Apr-14 L1447653-28	REF-Marine 1 Surface 3.0 2 24-Apr-14 L1447653-29
CCME guideline for the Protection of Aquatic life ^a			Units	Realized Detection Limit						
Physical Tests										
Hardness (as CaCO ₃)	mg/L			0.5 to 4.3	4790	4800	4900	4770	4810	4750
pH	pH	7.0-8.7		0.10	7.76	7.79	7.73	7.77	7.82	7.84
Salinity	psu	<10% fluctuation ^b		1.0	27.4	27.6	27.8	27.5	27.6	27.6
Total Suspended Solids	mg/L	dependent on background levels		2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Total Dissolved Solids	mg/L			10 to 80	28600	29400	29700	29000	30000	28900
Turbidity	NTU	dependent on background levels		0.10	0.18	0.15	0.26	0.27	0.16	0.17
Anions and Nutrients										
Alkalinity, Total (as CaCO ₃)	mg/L			2.0	117	119	115	122	120	117
Ammonia, Total (as N)	mg/L			0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bromide (Br)	mg/L			0.05 to 5	58.4	56.2	55.7	55.1	51.4	55.8
Chloride (Cl)	mg/L			0.5 to 50	16400	15900	16000	15700	15500	16000
Fluoride (F)	mg/L			0.02 to 1	1.21	1.13	1.05	1.05	1.03	1.03
Nitrate and Nitrite (as N)	mg/L			0.0060	-	-	-	-	-	-
Nitrate (as N)	mg/L	short-term: 339; long-term: 45		0.005 to 0.25	0.0548	0.0544	0.0537	0.0552	0.0566	0.0571
Nitrite (as N)	mg/L			0.001 to 0.05	<0.0020	<0.0020	<0.0020	<0.0020	0.0022	0.0021
Total Kjeldahl Nitrogen	mg/L			0.050	0.110	0.102	0.120	0.103	0.102	0.168
Dissolved Kjeldahl Nitrogen	mg/L			0.0500	-	-	-	-	-	-
Orthophosphate-Dissolved (as P)	mg/L			0.0010	0.0386	0.0356	0.0366	0.0378	0.0380	0.0374
Phosphorus (P)	mg/L			0.0020	0.0409	0.0390	0.0391	0.0398	0.0405	0.0414
Sulfate (SO ₄)	mg/L			0.5 to 50	2310	2240	2250	2180	2160	2260
Cyanides										
Cyanide, Total	mg/L			0.001 to 0.05	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L			0.001 to 0.05	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic / Inorganic Carbon										
Dissolved Organic Carbon	mg/L			0.50	1.08	0.99	0.90	0.89	0.86	0.86
Total Organic Carbon	mg/L			0.50	1.09	0.96	0.98	0.94	0.98	1.03
Total Metals										
Aluminum (Al)	mg/L			0.0050	<0.0050	<0.0050	<0.0050	0.0098	<0.0050	<0.0050
Antimony (Sb)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Arsenic (As)	mg/L	0.0125 ^b		0.00040	0.00115	0.00118	0.00122	0.00120	0.00104	0.00120
Barium (Ba)	mg/L			0.0010	0.0117	0.0117	0.0122	0.0119	0.0119	0.0118
Beryllium (Be)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Bismuth (Bi)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Boron (B)	mg/L			0.10	3.71	3.75	3.82	3.63	3.94	3.91
Cadmium (Cd)	mg/L	0.00012		0.000020	0.000054	0.000054	0.000061	0.000054	0.000053	0.000055
Calcium (Ca)	mg/L			0.50	320	322	326	314	317	313
Cesium (Cs)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Chromium (Cr)	mg/L	Cr(VI): 0.0015; Cr(III): 0.056 ^b		0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L			0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)	mg/L			0.000050	0.000571	0.000552	0.001280	0.001020	0.000504	0.000375
Gallium (Ga)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Iron (Fe)	mg/L			0.010	<0.010	<0.010	0.011	0.016	<0.010	<0.010
Lead (Pb)	mg/L			0.000050	<0.000050	<0.000050	0.000075	0.000075	<0.000050	<0.000050
Lithium (Li)	mg/L			0.020	0.154	0.152	0.154	0.148	0.155	0.153
Magnesium (Mg)	mg/L			1.0	970	970	993	969	975	964
Manganese (Mn)	mg/L			0.000050	0.001570	0.001610	0.001890	0.001820	0.001930	0.001950
Mercury (Hg)	ug/L	Inorganic Hg: 0.016 ^b		0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Molybdenum (Mo)	mg/L			0.0020	0.0086	0.0087	0.0089	0.0087	0.0088	0.0089
Nickel (Ni)	mg/L			0.000050	0.000460	0.000452	0.000505	0.000464	0.000439	0.000449
Phosphorus (P)	mg/L			1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Potassium (K)	mg/L			20	289	291	299	284	293	288
Rhenium (Re)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Rubidium (Rb)	mg/L			0.0050	0.0930	0.092	0.094	0.092	0.093	0.094
Selenium (Se)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Silicon (Si)	mg/L			0.50	0.67	0.63	0.63	0.57	0.63	0.59
Silver (Ag)	mg/L			0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Sodium (Na)	mg/L			20	8470	8620	8750	8250	8390	8320
Strontium (Sr)	mg/L			0.050	5.65	5.70	5.80	5.41	5.51	5.46
Tellurium (Te)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Thallium (Tl)	mg/L			0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Thorium (Th)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Tin (Sn)	mg/L			0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Titanium (Ti)	mg/L			0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Tungsten (W)	mg/L			0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Uranium (U)	mg/L			0.000050	0.00250	0.00251	0.00253	0.00250	0.00249	0.00250
Vanadium (V)	mg/L			0.00050	0.00079	0.00071	0.00070	0.00073	0.00069	0.00069
Yttrium (Y)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Zinc (Zn)	mg/L			0.00080	0.00098	<0.00080	0.00713	0.00149	<0.00080	<0.00080
Zirconium (Zr)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Speciated Metals										
Methyl Mercury	ug/L			0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Radiochemistry										
Radium-226	Bq/L			0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010

Notes:
Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of marine aquatic life.
April sampling depths are depths below the water surface and are equal to approximately 0-1 m below ice.

^a Canadian water quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b Interim guideline.

Annex A.3-3. Marine Water Quality Data, Doris North Project, 2014

Site ID: Depth Zone: Depth Sampled (m): Replicate: Date Sampled: ALS Sample ID:					RBW Surface 1.0 1 21-Jul-14 L1490818-3	RBW Surface 1.0 2 21-Jul-14 L1490818-4	RBE Surface 0.1 1 21-Jul-14 L1490779-1	RBE Surface 0.1 2 21-Jul-14 L1490779-2	REF-Marine 1 Surface 1.0 1 20-Jul-14 L1490818-1	REF-Marine 1 Surface 1.0 2 20-Jul-14 L1490818-2
CCME guideline for the Protection of Aquatic life ^a			Units	Realized Detection Limit						
Physical Tests										
Hardness (as CaCO ₃)	mg/L			0.5 to 4.3	0929	0941	0075	0066	0693	0694
pH	pH	7.0-8.7		0.10	7.63	7.61	7.43	7.46	7.33	7.32
Salinity	psu	<10% fluctuation ^b		1.0	05.7	06.2	<1.0	<1.0	04.3	03.9
Total Suspended Solids	mg/L	dependent on background levels		2.0	6.4	7.5	4.8	4.8	8.5	7.7
Total Dissolved Solids	mg/L			10 to 80	06110	06400	00374	00297	04500	04230
Turbidity	NTU	dependent on background levels		0.10	0.78	0.58	5.35	4.98	7.17	7.84
Anions and Nutrients										
Alkalinity, Total (as CaCO ₃)	mg/L			2.0	038	038	029	028	024	023
Ammonia, Total (as N)	mg/L			0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bromide (Br)	mg/L			0.05 to 5	09.0	12.1	00.6	00.5	08.4	07.9
Chloride (Cl)	mg/L			0.5 to 50	02630	03510	00181	00130	02430	02290
Fluoride (F)	mg/L			0.02 to 1	1.20	1.30	0.06	0.06	1.20	1.40
Nitrate and Nitrite (as N)	mg/L			0.0060	-	-	-	-	-	-
Nitrate (as N)	mg/L	short-term: 339; long-term: 45		0.005 to 0.25	<0.25	<0.25	0.0067	<0.0050	<0.25	<0.25
Nitrite (as N)	mg/L			0.001 to 0.05	<0.050	<0.050	<0.0010	<0.0010	<0.050	<0.050
Total Kjeldahl Nitrogen	mg/L			0.050	0.283	0.274	0.464	0.445	0.249	0.273
Dissolved Kjeldahl Nitrogen	mg/L			0.0500	0.2210	0.2210	0.3000	0.3000	0.2160	0.2120
Orthophosphate-Dissolved (as P)	mg/L			0.0010	<0.0010	<0.0010	<0.0010	<0.0010	0.0028	0.0026
Phosphorus (P)	mg/L			0.0020	0.0156	0.0160	0.0227	0.0215	0.0158	0.0160
Sulfate (SO ₄)	mg/L			0.5 to 50	0357	0481	0020	0013	0335	0316
Cyanides										
Cyanide, Total	mg/L			0.001 to 0.05	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L			0.001 to 0.05	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic / Inorganic Carbon										
Dissolved Organic Carbon	mg/L			0.50	3.37	3.62	5.02	5.17	3.40	3.60
Total Organic Carbon	mg/L			0.50	3.45	3.60	5.57	5.26	3.95	3.68
Total Metals										
Aluminum (Al)	mg/L			0.0050	0.127	0.138	0.0909	0.0818	0.203	0.202
Antimony (Sb)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Arsenic (As)	mg/L	0.0125 ^b		0.00040	<0.00040	<0.00040	<0.00040	0.02870	<0.00040	<0.00040
Barium (Ba)	mg/L			0.0010	0.0047	0.0048	0.0033	0.0032	0.0045	0.0047
Beryllium (Be)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Bismuth (Bi)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Boron (B)	mg/L			0.10	0.65	0.69	<0.10	<0.10	0.50	0.52
Cadmium (Cd)	mg/L	0.00012		0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020	<0.000020
Calcium (Ca)	mg/L			0.50	063	064	010	009	046	046
Cesium (Cs)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Chromium (Cr)	mg/L	Cr(VI): 0.0015; Cr(III): 0.056 ^b		0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00072
Cobalt (Co)	mg/L			0.000050	0.000091	0.000084	<0.000050	<0.000050	0.000109	0.000107
Copper (Cu)	mg/L			0.000050	0.000941	0.000877	0.004360	0.001600	0.001250	0.002620
Gallium (Ga)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Iron (Fe)	mg/L			0.010	0.142	0.132	0.122	0.119	0.186	0.176
Lead (Pb)	mg/L			0.000050	0.000053	0.000075	<0.000050	<0.000050	0.000066	0.000078
Lithium (Li)	mg/L			0.020	0.025	0.026	<0.020	<0.020	<0.020	<0.020
Magnesium (Mg)	mg/L			1.0	187	190	012	010	140	141
Manganese (Mn)	mg/L			0.000050	0.007310	0.006810	0.011500	0.011400	0.004500	0.004270
Mercury (Hg)	ug/L	Inorganic Hg: 0.016 ^b		0.00050	0.0007	0.00068	0.00097	0.00087	0.00136	0.00139
Molybdenum (Mo)	mg/L			0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Nickel (Ni)	mg/L			0.000050	0.000469	0.000431	0.000383	0.000372	0.000523	0.000542
Phosphorus (P)	mg/L			1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Potassium (K)	mg/L			20	058	059	004	003	043	043
Rhenium (Re)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Rubidium (Rb)	mg/L			0.0050	0.016	0.017	<0.0050	<0.0050	0.013	0.013
Selenium (Se)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Silicon (Si)	mg/L			0.50	0.89	0.86	1.12	1.13	0.82	0.84
Silver (Ag)	mg/L			0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Sodium (Na)	mg/L			20	1620	1630	0083	0064	1210	1210
Strontium (Sr)	mg/L			0.050	1.12	1.14	0.08	0.06	0.86	0.87
Tellurium (Te)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Thallium (Tl)	mg/L			0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Thorium (Th)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Tin (Sn)	mg/L			0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Titanium (Ti)	mg/L			0.0050	0.0087	0.0079	0.0055	0.0052	0.0133	0.0134
Tungsten (W)	mg/L			0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Uranium (U)	mg/L			0.000050	0.00050	0.00051	0.00006	0.00005	0.00040	0.00039
Vanadium (V)	mg/L			0.00050	0.00060	0.00061	<0.00050	<0.00050	0.00081	0.00074
Yttrium (Y)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Zinc (Zn)	mg/L			0.00080	0.00088	0.00151	0.00138	0.00103	0.00127	0.00252
Zirconium (Zr)	mg/L			0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Speciated Metals										
Methyl Mercury	ug/L			0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Radiochemistry										
Radium-226	Bq/L			0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of marine aquatic life.

April sampling depths are depths below the water surface and are equal to approximately 0-1 m below ice.

^a Canadian water quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b Interim guideline.

Annex A.3-3. Marine Water Quality Data, Doris North Project, 2014

Site ID: Depth Zone: Depth Sampled (m): Replicate: Date Sampled: ALS Sample ID:					RBW Surface 1.0 1 13-Aug-14 L1503356-2	RBW Surface 1.0 2 13-Aug-14 L1503356-3	RBE Surface 0.2 1 14-Aug-14 L1503356-5	RBE Surface 0.2 2 14-Aug-14 L1503356-6	REF-Marine 1 Surface 1.0 1 21-Aug-14 L1506830-1	REF-Marine 1 Surface 1.0 2 21-Aug-14 L1506830-2
CCME guideline for the Protection of Aquatic life ^a			Realized Detection Limit							
Physical Tests										
Hardness (as CaCO ₃)	mg/L		0.5 to 4.3		2640	2670	1170	1250	3160	3120
pH	pH	7.0-8.7	0.10		7.69	7.78	7.73	7.70	7.82	7.85
Salinity	psu	<10% fluctuation ^b	1.0		15.7	15.7	06.9	07.6	18.2	18.0
Total Suspended Solids	mg/L	dependent on background levels	2.0		<2.0	<2.0	6.2	6.1	<2.0	<2.0
Total Dissolved Solids	mg/L		10 to 80		16500	16600	07440	07940	18600	19500
Turbidity	NTU	dependent on background levels	0.10		0.74	0.56	4.29	4.84	0.43	0.60
Anions and Nutrients										
Alkalinity, Total (as CaCO ₃)	mg/L		2.0		049	049	040	041	087	094
Ammonia, Total (as N)	mg/L		0.0050		<0.0050	<0.0050	0.0051	<0.0050	<0.0050	<0.0050
Bromide (Br)	mg/L		0.05 to 5		31.2	30.8	13.8	14.9	34.4	35.0
Chloride (Cl)	mg/L		0.5 to 50		09060	08950	03850	04240	09940	10100
Fluoride (F)	mg/L		0.02 to 1		<0.75	<0.75	1.20	<1.0	0.82	0.80
Nitrate and Nitrite (as N)	mg/L		0.0060		0.2060	0.0444	<0.0060	<0.0060	0.1780	0.0479
Nitrate (as N)	mg/L	short-term: 339; long-term: 45	0.005 to 0.25		0.2060	0.0444	<0.0060	<0.0060	0.1780	0.0479
Nitrite (as N)	mg/L		0.001 to 0.05		<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Total Kjeldahl Nitrogen	mg/L		0.050		0.148	0.153	0.338	0.317	0.143	0.132
Dissolved Kjeldahl Nitrogen	mg/L		0.0500		-	-	-	-	-	-
Orthophosphate-Dissolved (as P)	mg/L		0.0010		0.0086	0.0105	<0.0010	<0.0010	0.0159	0.0161
Phosphorus (P)	mg/L		0.0020		0.0147	0.0152	0.0157	0.0167	0.0219	0.0215
Sulfate (SO ₄)	mg/L		0.5 to 50		1260	1250	0532	0587	1400	1410
Cyanides										
Cyanide, Total	mg/L		0.001 to 0.05		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L		0.001 to 0.05		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic / Inorganic Carbon										
Dissolved Organic Carbon	mg/L		0.50		1.35	1.36	3.50	3.50	1.55	1.39
Total Organic Carbon	mg/L		0.50		1.57	1.55	3.85	3.80	1.63	1.41
Total Metals										
Aluminum (Al)	mg/L		0.0050		0.0339	0.0167	0.0995	0.101	0.0196	0.0123
Antimony (Sb)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Arsenic (As)	mg/L	0.0125 ^b	0.00040		0.00073	0.00064	0.00043	<0.00040	0.00076	0.00074
Barium (Ba)	mg/L		0.0010		0.0077	0.0074	0.0054	0.0055	0.0082	0.0082
Beryllium (Be)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Bismuth (Bi)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Boron (B)	mg/L		0.10		2.17	2.24	1.09	1.10	2.52	2.49
Cadmium (Cd)	mg/L	0.00012	0.000020		0.000023	0.000023	<0.000020	<0.000020	0.000030	0.000025
Calcium (Ca)	mg/L		0.50		175	176	077	082	202	200
Cesium (Cs)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Chromium (Cr)	mg/L	Cr(VI): 0.0015; Cr(III): 0.056 ^b	0.00050		0.00605	0.00053	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L		0.000050		<0.000050	<0.000050	0.000079	0.000083	<0.000050	<0.000050
Copper (Cu)	mg/L		0.000050		0.000521	0.000473	0.000971	0.000923	0.000416	0.000347
Gallium (Ga)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Iron (Fe)	mg/L		0.010		0.036	0.025	0.131	0.132	0.018	0.015
Lead (Pb)	mg/L		0.000050		0.000336	<0.000050	<0.000050	<0.000050	0.000096	<0.000050
Lithium (Li)	mg/L		0.020		0.093	0.092	0.040	0.042	0.104	0.098
Magnesium (Mg)	mg/L		1.0		536	541	237	254	645	637
Manganese (Mn)	mg/L		0.000050		0.002180	0.002200	0.011500	0.011100	0.001740	0.001500
Mercury (Hg)	ug/L	Inorganic Hg: 0.016 ^b	0.00050		0.00076	<0.00050	0.00069	0.00071	0.00055	0.00059
Molybdenum (Mo)	mg/L		0.0020		0.0048	0.0047	<0.0020	<0.0020	0.0061	0.0057
Nickel (Ni)	mg/L		0.000050		0.000591	0.000343	0.000427	0.000425	0.000381	0.000294
Phosphorus (P)	mg/L		1.0		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Potassium (K)	mg/L		20		159	164	068	073	197	198
Rhenium (Re)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Rubidium (Rb)	mg/L		0.0050		0.052	0.052	0.021	0.023	0.061	0.059
Selenium (Se)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Silicon (Si)	mg/L		0.50		<0.50	<0.50	0.70	0.74	<0.50	<0.50
Silver (Ag)	mg/L		0.00010		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Sodium (Na)	mg/L		20		4560	4670	1930	2090	5200	5200
Strontium (Sr)	mg/L		0.050		3.26	3.36	1.39	1.50	3.69	3.70
Tellurium (Te)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Thallium (Tl)	mg/L		0.000050		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Thorium (Th)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Tin (Sn)	mg/L		0.0010		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Titanium (Ti)	mg/L		0.0050		<0.0050	<0.0050	0.0072	0.0064	<0.0050	<0.0050
Tungsten (W)	mg/L		0.0010		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Uranium (U)	mg/L		0.000050		0.00136	0.00137	0.00058	0.00061	0.00159	0.00153
Vanadium (V)	mg/L		0.00050		0.00057	0.00052	0.00056	0.00051	<0.00050	0.00050
Yttrium (Y)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Zinc (Zn)	mg/L		0.00080		<0.00080	<0.00080	0.00137	0.00100	<0.00080	<0.00080
Zirconium (Zr)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Speciated Metals										
Methyl Mercury	ug/L		0.000050		-	-	-	-	-	-
Radiochemistry										
Radium-226	Bq/L		0.010		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of marine aquatic life.

April sampling depths are depths below the water surface and are equal to approximately 0-1 m below ice.

^a Canadian water quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b Interim guideline.

Annex A.3-3. Marine Water Quality Data, Doris North Project, 2014

Site ID: Depth Zone: Depth Sampled (m): Replicate: Date Sampled: ALS Sample ID:					RBW Surface 1.0 1 21-Sep-14 L1523080-15	RBW Surface 1.0 2 21-Sep-14 L1523080-16	RBE Surface 0.2 1 21-Sep-14 L1523080-13	RBE Surface 0.2 2 21-Sep-14 L1523080-14	REF-Marine 1 Surface 1.0 1 21-Sep-14 L1523080-17	REF-Marine 1 Surface 1.0 2 21-Sep-14 L1523080-18
CCME guideline for the Protection of Aquatic life ^a			Realized Detection Limit							
Physical Tests										
Hardness (as CaCO ₃)	mg/L		0.5 to 4.3		3900	3990	2880	2790	3820	3930
pH	pH	7.0-8.7	0.10		7.80	7.80	7.59	7.71	7.80	7.78
Salinity	psu	<10% fluctuation ^b	1.0		22.1	22.2	16.8	16.8	21.1	21.0
Total Suspended Solids	mg/L	dependent on background levels	2.0		<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Total Dissolved Solids	mg/L		10 to 80		22800	22800	17300	17300	21500	21900
Turbidity	NTU	dependent on background levels	0.10		0.49	0.36	1.23	1.31	0.39	0.44
Anions and Nutrients										
Alkalinity, Total (as CaCO ₃)	mg/L		2.0		105	101	091	091	100	100
Ammonia, Total (as N)	mg/L		0.0050		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Bromide (Br)	mg/L		0.05 to 5		45.1	42.8	33.0	33.8	40.8	40.4
Chloride (Cl)	mg/L		0.5 to 50		13200	12600	09710	09990	12000	11900
Fluoride (F)	mg/L		0.02 to 1		0.78	0.78	<0.75	<0.75	<0.75	<0.75
Nitrate and Nitrite (as N)	mg/L		0.0060		0.0070	<0.0060	0.0266	<0.0060	0.0644	<0.0060
Nitrate (as N)	mg/L	short-term: 339; long-term: 45	0.005 to 0.25		0.0070	<0.0060	0.0266	<0.0060	0.0644	<0.0060
Nitrite (as N)	mg/L		0.001 to 0.05		<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Total Kjeldahl Nitrogen	mg/L		0.050		0.135	0.142	0.232	0.248	0.152	0.145
Dissolved Kjeldahl Nitrogen	mg/L		0.0500		-	-	-	-	-	-
Orthophosphate-Dissolved (as P)	mg/L		0.0010		0.0190	0.0195	0.0053	0.0054	0.0188	0.0209
Phosphorus (P)	mg/L		0.0020		0.0160	0.0235	0.0114	0.0130	0.0227	0.0236
Sulfate (SO ₄)	mg/L		0.5 to 50		1850	1760	1360	1410	1680	1670
Cyanides										
Cyanide, Total	mg/L		0.001 to 0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cyanide, Free	mg/L		0.001 to 0.05		<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Organic / Inorganic Carbon										
Dissolved Organic Carbon	mg/L		0.50		1.59	1.52	2.89	3.31	1.59	1.69
Total Organic Carbon	mg/L		0.50		1.59	1.36	3.13	3.47	1.73	1.55
Total Metals										
Aluminum (Al)	mg/L		0.0050		0.0077	0.0099	0.0134	0.0116	0.0122	0.005
Antimony (Sb)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Arsenic (As)	mg/L	0.0125 ^b	0.00040		0.00102	0.00102	0.00070	0.00079	0.00087	0.00092
Barium (Ba)	mg/L		0.0010		0.0090	0.0090	0.0073	0.0073	0.0088	0.0088
Beryllium (Be)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Bismuth (Bi)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Boron (B)	mg/L		0.10		3.28	3.33	2.22	2.25	3.15	3.11
Cadmium (Cd)	mg/L	0.00012	0.000020		0.000034	0.000035	0.000022	0.000024	0.000035	0.000036
Calcium (Ca)	mg/L		0.50		245	254	186	175	242	249
Cesium (Cs)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Chromium (Cr)	mg/L	Cr(VI): 0.0015; Cr(III): 0.056 ^b	0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L		0.000050		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)	mg/L		0.000050		0.000397	0.000412	0.000796	0.000691	0.001250	0.000589
Gallium (Ga)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Iron (Fe)	mg/L		0.010		0.011	0.012	0.03	0.03	0.011	0.01
Lead (Pb)	mg/L		0.000050		<0.000050	<0.000050	0.000122	<0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L		0.020		0.139	0.138	0.091	0.092	0.130	0.131
Magnesium (Mg)	mg/L		1.0		798	816	587	572	782	804
Manganese (Mn)	mg/L		0.000050		0.001460	0.001490	0.002770	0.002940	0.001590	0.001520
Mercury (Hg)	ug/L	Inorganic Hg: 0.016 ^b	0.00050		<0.00050	<0.00050	0.00052	<0.00050	<0.00050	<0.00050
Molybdenum (Mo)	mg/L		0.0020		0.0062	0.0061	0.0046	0.0045	0.0060	0.0060
Nickel (Ni)	mg/L		0.000050		0.000362	0.000373	0.000339	0.000370	0.000393	0.000364
Phosphorus (P)	mg/L		1.0		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Potassium (K)	mg/L		20		235	244	174	164	231	238
Rhenium (Re)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Rubidium (Rb)	mg/L		0.0050		0.102	0.099	0.065	0.064	0.095	0.095
Selenium (Se)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Silicon (Si)	mg/L		0.50		<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Silver (Ag)	mg/L		0.00010		<0.00010	<0.00010	<0.00010	<0.00010	<0.00010	<0.00010
Sodium (Na)	mg/L		20		6480	6850	4840	4540	6410	6690
Strontium (Sr)	mg/L		0.050		4.47	4.67	3.36	3.14	4.45	4.58
Tellurium (Te)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Thallium (Tl)	mg/L		0.000050		<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Thorium (Th)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Tin (Sn)	mg/L		0.0010		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Titanium (Ti)	mg/L		0.0050		<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Tungsten (W)	mg/L		0.0010		<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Uranium (U)	mg/L		0.000050		0.00175	0.00176	0.00129	0.00126	0.00167	0.00168
Vanadium (V)	mg/L		0.00050		0.00063	0.00063	<0.00050	<0.00050	0.00055	0.00062
Yttrium (Y)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Zinc (Zn)	mg/L		0.00080		0.00090	<0.00080	<0.00080	<0.00080	0.00171	<0.00080
Zirconium (Zr)	mg/L		0.00050		<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Speciated Metals										
Methyl Mercury	ug/L		0.000050		-	-	-	-	-	-
Radiochemistry										
Radium-226	Bq/L		0.010		<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Notes:

Shaded cells indicate values that are both above analytical detection limits and exceed CCME guidelines for the protection of marine aquatic life.

April sampling depths are depths below the water surface and are equal to approximately 0-1 m below ice.

^a Canadian water quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b Interim guideline.

Annex A.3-4. QA/QC Blank Data for Water Quality Sampling, Doris North Project, 2014

Blank Type			Equipment Blank (Freshwater)	Equipment Blank (Marine)	Field Blank (Freshwater)	Field Blank (Marine)	Travel Blank (Freshwater)	Travel Blank (Marine)	Field Blank (Freshwater)	Travel Blank (Freshwater)
Date Sampled:			19-Apr-14	20-Apr-14	23-Apr-14	24-Apr-14	1-Apr-14	1-Apr-14	19-Jun-14	19-Jun-14
ALS Sample ID:	Units	Realized Detection Limit	L1447653-7	L1447653-8	L1447653-12	L1447653-32	L1447653-45	L1447653-46	L1474754-6	L1474754-5
Physical Tests										
Conductivity	µS/cm	2.0	<2.0	-	<2.0	-	<2.0	-	<2.0	<2.0
Hardness (as CaCO ₃)	mg/L	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
pH	pH	0.10	5.60	5.79	5.47	5.61	5.69	5.86	5.36	5.41
Salinity	PSU	1	-	<1.0	-	<1.0	-	<1.0	-	-
Total Suspended Solids	mg/L	1 to 2	<1.0	<2.0	<1.0	<2.0	<1.0	<2.0	<1.0	<1.0
Total Dissolved Solids	mg/L	10	<10	<10	<10	<10	<10	<10	<10	<10
Turbidity	NTU	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Anions and Nutrients										
Alkalinity, Total (as CaCO ₃)	mg/L	1 to 2	<1.0	<2.0	<1.0	<2.0	<1.0	<2.0	<1.0	<1.0
Ammonia, Total (as N)	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0073	<0.0050	0.0189
Bromide (Br)	mg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Chloride (Cl)	mg/L	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Fluoride (F)	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Nitrate and Nitrite (as N)	mg/L	0.006	-	-	-	-	-	-	-	-
Nitrate (as N)	mg/L	0.005 to 0.006	<0.0050	<0.0060	<0.0050	<0.0060	<0.0050	<0.0050	<0.0050	<0.0050
Nitrite (as N)	mg/L	0.001 to 0.002	<0.0010	<0.0020	<0.0010	<0.0020	<0.0010	<0.0010	<0.0010	<0.0010
Total Kjeldahl Nitrogen	mg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Dissolved Kjeldahl Nitrogen	mg/L	0.050	-	-	-	-	-	-	-	-
Orthophosphate-Dissolved (as P)	mg/L	0.0010	0.0016	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)	mg/L	0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Sulfate (SO ₄)	mg/L	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Cyanides										
Cyanide, Total	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic / Inorganic Carbon										
Dissolved Organic Carbon	mg/L	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Total Organic Carbon	mg/L	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Total Metals										
Aluminum (Al)	mg/L	0.003 to 0.005	<0.0030	<0.0050	<0.0030	<0.0050	<0.0030	<0.0050	<0.0030	<0.0030
Antimony (Sb)	mg/L	0.00001 to 0.0005	<0.000010	<0.00050	<0.000010	<0.00050	<0.000010	<0.00050	<0.000010	<0.000010
Arsenic (As)	mg/L	0.00005 to 0.0004	<0.000050	<0.00040	<0.000050	<0.00040	<0.000050	<0.00040	<0.000050	<0.000050
Barium (Ba)	mg/L	0.0001 to 0.001	0.00035	<0.0010	<0.00010	<0.0010	<0.00010	<0.0010	<0.00010	<0.00010
Beryllium (Be)	mg/L	0.000005 to 0.0005	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.0000050
Bismuth (Bi)	mg/L	0.00005 to 0.0005	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.000050
Boron (B)	mg/L	0.005 to 0.1	<0.0050	<0.10	<0.0050	<0.10	<0.0050	<0.10	<0.0050	<0.0050
Cadmium (Cd)	mg/L	0.000005 to 0.00002	<0.0000050	<0.000020	<0.0000050	<0.000020	<0.0000050	<0.000020	<0.0000050	<0.0000050
Calcium (Ca)	mg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cesium (Cs)	mg/L	0.000005 to 0.0005	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.0000050
Chromium (Cr)	mg/L	0.000500	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L	0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)	mg/L	0.00005 to 0.0005	<0.00050	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.00050	<0.00050
Gallium (Ga)	mg/L	0.00005 to 0.0005	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.000050
Iron (Fe)	mg/L	0.01 to 0.03	<0.030	<0.010	<0.030	<0.010	<0.030	<0.010	<0.030	<0.030
Lead (Pb)	mg/L	0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L	0.0002 to 0.02	<0.00020	<0.020	<0.00020	<0.020	<0.00020	<0.020	<0.00020	<0.00020
Magnesium (Mg)	mg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Manganese (Mn)	mg/L	0.00005 to 0.0002	<0.00020	<0.000050	<0.00020	<0.000050	<0.00020	<0.000050	<0.00020	<0.00020
Mercury (Hg)	ug/L	0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Molybdenum (Mo)	mg/L	0.00005 to 0.002	<0.000050	<0.0020	<0.000050	<0.0020	<0.000050	<0.0020	<0.000050	<0.000050
Nickel (Ni)	mg/L	0.00005 to 0.0002	<0.00020	<0.000050	<0.00020	<0.000050	<0.00020	<0.000050	<0.00020	<0.00020
Phosphorus (P)	mg/L	0.3 to 1	<0.30	<1.0	<0.30	<1.0	<0.30	<1.0	<0.30	<0.30
Potassium (K)	mg/L	2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Rhenium (Re)	mg/L	0.000005 to 0.0005	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.0000050
Rubidium (Rb)	mg/L	0.00002 to 0.005	<0.000020	<0.0050	<0.000020	<0.0050	<0.000020	<0.0050	<0.000020	<0.000020
Selenium (Se)	mg/L	0.0002 to 0.0005	<0.00020	<0.00050	<0.00020	<0.00050	<0.00020	<0.00050	<0.00020	<0.00020
Silicon (Si)	mg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Silver (Ag)	mg/L	0.000005 to 0.0001	<0.0000050	<0.00010	<0.0000050	<0.00010	<0.0000050	<0.00010	<0.0000050	<0.0000050
Sodium (Na)	mg/L	2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Strontium (Sr)	mg/L	0.00005 to 0.005	<0.000050	<0.0050	<0.000050	<0.0050	<0.000050	<0.0050	<0.000050	<0.000050
Tellurium (Te)	mg/L	0.00001 to 0.0005	<0.000010	<0.00050	<0.000010	<0.00050	<0.000010	<0.00050	<0.000010	<0.000010
Thallium (Tl)	mg/L	0.000002 to 0.00005	<0.0000020	<0.000050	<0.0000020	<0.000050	<0.0000020	<0.000050	<0.0000020	<0.0000020
Thorium (Th)	mg/L	0.000005 to 0.0005	<0.0000050	<0.000050	<0.0000050	<0.000050	<0.0000050	<0.000050	<0.0000050	<0.0000050
Tin (Sn)	mg/L	0.0002 to 0.001	<0.00020	<0.0010	<0.00020	<0.0010	<0.00020	<0.0010	<0.00020	<0.00020
Titanium (Ti)	mg/L	0.0002 to 0.005	<0.00020	<0.0050	<0.00020	<0.0050	<0.00020	<0.0050	<0.00020	<0.00020
Tungsten (W)	mg/L	0.00001 to 0.001	<0.000010	<0.0010	<0.000010	<0.0010	<0.000010	<0.0010	<0.000010	<0.000010
Uranium (U)	mg/L	0.000002 to 0.00005	<0.0000020	<0.000050	<0.0000020	<0.000050	<0.0000020	<0.000050	<0.0000020	<0.0000020
Vanadium (V)	mg/L	0.00005 to 0.0005	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.000050
Yttrium (Y)	mg/L	0.000005 to 0.0005	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.0000050
Zinc (Zn)	mg/L	0.0008 to 0.003	0.0482	0.0020	<0.0030	<0.00080	<0.0030	<0.00080	<0.0030	<0.0030
Zirconium (Zr)	mg/L	0.00005 to 0.0005	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.000050
Speciated Metals										
Methyl Mercury	ug/L	0.00005	-	<0.000050	-	<0.000050	<0.000050	<0.000050	-	-
Radiochemistry										
Radium-226	Bq/L	0.010	<0.010	<0.010	-	-	-	-	-	-

Note:
Bold values represent concentrations that are higher than analytical detection limits.

Annex A.3-4. QA/QC Blank Data for Water Quality Sampling, Doris North Project, 2014

Blank Type			Equipment Blank (Freshwater)	Equipment Blank (Marine)	Field Blank (Freshwater)	Field Blank (Marine)	Travel Blank (Freshwater)	Travel Blank (Marine)	Equipment Blank (Freshwater)	Equipment Blank (Marine)
Date Sampled:			15-Jul-14	15-Jul-14	20-Jul-14	20-Jul-14	19-Jul-14	20-Jul-14	17-Aug-14	13-Aug-14
ALS Sample ID:	Units	Realized Detection Limit	L1489339-3	L1489339-4	L1490799-1	L1490799-2	L1490850-1	L1490850-2	L1504772-1	L1503356-1
Physical Tests										
Conductivity	µS/cm	2.0	<2.0	-	<2.0	-	<2.0	-	<2.0	-
Hardness (as CaCO ₃)	mg/L	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
pH	pH	0.10	5.48	5.43	5.57	5.60	5.42	5.44	5.56	5.46
Salinity	PSU	1	-	<1.0	-	<1.0	-	<1.0	-	<1.0
Total Suspended Solids	mg/L	1 to 2	<1.0	<2.0	<1.0	<2.0	<1.0	<2.0	<1.0	<2.0
Total Dissolved Solids	mg/L	10	<10	<10	<10	<10	<10	<10	<10	<10
Turbidity	NTU	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Anions and Nutrients										
Alkalinity, Total (as CaCO ₃)	mg/L	1 to 2	<1.0	<2.0	<1.0	<2.0	<1.0	<2.0	<1.0	<2.0
Ammonia, Total (as N)	mg/L	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0163	<0.0050	0.0074
Bromide (Br)	mg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Chloride (Cl)	mg/L	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Fluoride (F)	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Nitrate and Nitrite (as N)	mg/L	0.006	-	-	-	<0.0060	-	<0.0060	-	0.0205
Nitrate (as N)	mg/L	0.005 to 0.006	0.0444	0.0161	<0.0050	<0.0060	<0.0050	<0.0060	0.014	0.0205
Nitrite (as N)	mg/L	0.001 to 0.002	<0.0010	<0.0010	<0.0010	<0.0020	<0.0010	<0.0020	<0.0010	<0.0020
Total Kjeldahl Nitrogen	mg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Dissolved Kjeldahl Nitrogen	mg/L	0.050	-	-	<0.050	<0.050	<0.050	<0.050		
Orthophosphate-Dissolved (as P)	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)	mg/L	0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Sulfate (SO ₄)	mg/L	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Cyanides										
Cyanide, Total	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic / Inorganic Carbon										
Dissolved Organic Carbon	mg/L	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Total Organic Carbon	mg/L	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Total Metals										
Aluminum (Al)	mg/L	0.003 to 0.005	0.0204	<0.0050	<0.0030	<0.0050	<0.0030	<0.0050	0.0063	0.0168
Antimony (Sb)	mg/L	0.00001 to 0.0005	<0.000010	<0.00050	<0.000010	<0.00050	<0.000010	<0.00050	<0.000010	<0.00050
Arsenic (As)	mg/L	0.00005 to 0.0004	<0.000050	<0.00040	<0.000050	<0.00040	<0.000050	<0.00040	<0.000050	<0.00040
Barium (Ba)	mg/L	0.0001 to 0.001	<0.00010	<0.0010	<0.00010	<0.0010	<0.00010	<0.0010	0.00034	<0.0010
Beryllium (Be)	mg/L	0.000005 to 0.0005	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.00050
Bismuth (Bi)	mg/L	0.00005 to 0.0005	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.00050
Boron (B)	mg/L	0.005 to 0.1	<0.0050	<0.10	<0.0050	<0.10	<0.0050	<0.10	<0.0050	<0.10
Cadmium (Cd)	mg/L	0.000005 to 0.00002	<0.0000050	<0.000020	<0.0000050	<0.000020	<0.0000050	<0.000020	<0.0000050	<0.000020
Calcium (Ca)	mg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cesium (Cs)	mg/L	0.000005 to 0.0005	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.00050
Chromium (Cr)	mg/L	0.000500	0.00063	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L	0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)	mg/L	0.00005 to 0.0005	<0.00050	0.000173	<0.00050	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050
Gallium (Ga)	mg/L	0.00005 to 0.0005	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.00050
Iron (Fe)	mg/L	0.01 to 0.03	<0.030	<0.010	<0.030	<0.010	<0.030	<0.010	<0.030	<0.010
Lead (Pb)	mg/L	0.000050	0.00649	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L	0.0002 to 0.02	<0.00020	<0.020	<0.00020	<0.020	<0.00020	<0.020	<0.00020	<0.020
Magnesium (Mg)	mg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Manganese (Mn)	mg/L	0.00005 to 0.0002	<0.00020	<0.000050	<0.00020	<0.000050	<0.00020	<0.000050	<0.00020	0.000097
Mercury (Hg)	ug/L	0.00050	<0.00050	<0.00050	<0.00050	<0.00050	0.00055	<0.00050	<0.00050	<0.00050
Molybdenum (Mo)	mg/L	0.00005 to 0.002	<0.000050	<0.0020	<0.000050	<0.0020	<0.000050	<0.0020	<0.000050	<0.0020
Nickel (Ni)	mg/L	0.00005 to 0.0002	<0.00020	<0.000050	<0.00020	<0.000050	<0.00020	<0.000050	<0.00020	<0.000050
Phosphorus (P)	mg/L	0.3 to 1	<0.30	<1.0	<0.30	<1.0	<0.30	<1.0	<0.30	<1.0
Potassium (K)	mg/L	2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Rhenium (Re)	mg/L	0.000005 to 0.0005	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.00050
Rubidium (Rb)	mg/L	0.00002 to 0.005	<0.000020	<0.0050	<0.000020	<0.0050	<0.000020	<0.0050	<0.000020	<0.0050
Selenium (Se)	mg/L	0.0002 to 0.0005	<0.00020	<0.00050	<0.00020	<0.00050	<0.00020	<0.00050	<0.00020	<0.00050
Silicon (Si)	mg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Silver (Ag)	mg/L	0.000005 to 0.0001	<0.0000050	<0.00010	<0.0000050	<0.00010	<0.0000050	<0.00010	<0.0000050	<0.00010
Sodium (Na)	mg/L	2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Strontium (Sr)	mg/L	0.00005 to 0.005	<0.000050	<0.0050	<0.000050	<0.0050	<0.000050	<0.0050	0.000197	<0.0050
Tellurium (Te)	mg/L	0.00001 to 0.0005	<0.000010	<0.00050	<0.000010	<0.00050	<0.000010	<0.00050	<0.000010	<0.00050
Thallium (Tl)	mg/L	0.000002 to 0.00005	<0.0000020	<0.000050	<0.0000020	<0.000050	<0.0000020	<0.000050	<0.0000020	<0.000050
Thorium (Th)	mg/L	0.000005 to 0.0005	<0.0000050	<0.000050	<0.0000050	<0.000050	<0.0000050	<0.000050	<0.0000050	<0.000050
Tin (Sn)	mg/L	0.0002 to 0.001	<0.00020	<0.0010	<0.00020	<0.0010	<0.00020	<0.0010	<0.00020	<0.0010
Titanium (Ti)	mg/L	0.0002 to 0.005	<0.00020	<0.0050	<0.00020	<0.0050	<0.00020	<0.0050	<0.00020	<0.0050
Tungsten (W)	mg/L	0.00001 to 0.001	<0.000010	<0.0010	<0.000010	<0.0010	<0.000010	<0.0010	<0.000010	<0.0010
Uranium (U)	mg/L	0.000002 to 0.00005	<0.0000020	<0.000050	<0.0000020	<0.000050	<0.0000020	<0.000050	<0.0000020	<0.000050
Vanadium (V)	mg/L	0.00005 to 0.0005	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.00050
Yttrium (Y)	mg/L	0.000005 to 0.0005	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.00050
Zinc (Zn)	mg/L	0.0008 to 0.003	<0.0030	0.0024	<0.0030	<0.00080	<0.0030	<0.00080	<0.0030	<0.00080
Zirconium (Zr)	mg/L	0.00005 to 0.0005	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.00050
Speciated Metals										
Methyl Mercury	ug/L	0.00005	-	<0.000050	-	<0.000050	-	<0.000050	-	-
Radiochemistry										
Radium-226	Bq/L	0.010	<.01	<.01	-	-	-	-	<0.01	<0.01

Note:
Bold values represent concentrations that are higher than analytical detection limits.

Annex A.3-4. QA/QC Blank Data for Water Quality Sampling, Doris North Project, 2014

Blank Type			Field Blank (Freshwater)	Field Blank (Marine)	Travel Blank (Freshwater)	Travel Blank (Marine)	Equipment Blank (Freshwater)	Equipment Blank (Marine)	Field Blank (Freshwater)	Field Blank (Marine)
Date Sampled:		Realized Detection	17-Aug-14	13-Aug-14	14-Aug-14	21-Aug-14	18-Sep-14	20-Sep-14	19-Sep-14	21-Sep-14
ALS Sample ID:	Units	Limit	L1504772-4	L1503356-4	L1503367-3	L1506830-3	L1520746-13	L1523080-21	L1523080-12	L1523080-20
Physical Tests										
Conductivity	µS/cm	2.0	<2.0	-	<2.0	-	<2.0	<2.0	<2.0	<2.0
Hardness (as CaCO ₃)	mg/L	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
pH	pH	0.10	5.58	5.45	5.74	5.43	5.47	5.14	5.58	5.30
Salinity	PSU	1	-	<1.0	-	<1.0	-	-	-	-
Total Suspended Solids	mg/L	1 to 2	<1.0	<2.0	<1.0	<2.0	<1.0	<1.0	<1.0	<1.0
Total Dissolved Solids	mg/L	10	<10	<10	<10	<10	<10	<10	<10	<10
Turbidity	NTU	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Anions and Nutrients										
Alkalinity, Total (as CaCO ₃)	mg/L	1 to 2	<1.0	<2.0	<1.0	<2.0	<1.0	<1.0	<1.0	<1.0
Ammonia, Total (as N)	mg/L	0.0050	<0.0050	0.0282	<0.0050	0.0177	<0.0050	0.0068	<0.0050	<0.0050
Bromide (Br)	mg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Chloride (Cl)	mg/L	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Fluoride (F)	mg/L	0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Nitrate and Nitrite (as N)	mg/L	0.006	-	<0.0060	-	<0.0060	-	-	-	-
Nitrate (as N)	mg/L	0.005 to 0.006	<0.0050	<0.0060	<0.0050	<0.0060	0.021	0.073	<0.0050	<0.0050
Nitrite (as N)	mg/L	0.001 to 0.002	<0.0010	<0.0020	<0.0010	<0.0020	<0.0010	<0.0010	<0.0010	<0.0010
Total Kjeldahl Nitrogen	mg/L	0.050	<0.050	0.085	<0.050	0.064	<0.050	<0.050	<0.050	<0.050
Dissolved Kjeldahl Nitrogen	mg/L	0.050			-	-	-	-	-	-
Orthophosphate-Dissolved (as P)	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Phosphorus (P)	mg/L	0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020	<0.0020
Sulfate (SO ₄)	mg/L	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Cyanides										
Cyanide, Total	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L	0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Organic / Inorganic Carbon										
Dissolved Organic Carbon	mg/L	0.50	<0.50	<0.50	-	<0.50	<0.50	<0.50	<0.50	<0.50
Total Organic Carbon	mg/L	0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Total Metals										
Aluminum (Al)	mg/L	0.003 to 0.005	<0.0030	<0.0050	<0.0030	<0.0050	<0.0030	0.029	<0.0030	<0.0030
Antimony (Sb)	mg/L	0.00001 to 0.0005	<0.000010	<0.00050	<0.000010	<0.00050	<0.000010	<0.000010	<0.000010	<0.000010
Arsenic (As)	mg/L	0.00005 to 0.0004	<0.000050	<0.00040	<0.000050	<0.00040	<0.000050	<0.000050	<0.000050	<0.000050
Barium (Ba)	mg/L	0.0001 to 0.001	<0.00010	<0.0010	<0.00010	<0.0010	<0.00010	0.00011	<0.00010	<0.00010
Beryllium (Be)	mg/L	0.000005 to 0.0005	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Bismuth (Bi)	mg/L	0.00005 to 0.0005	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.000050	<0.000050	<0.000050
Boron (B)	mg/L	0.005 to 0.1	0.0052	<0.10	<0.0050	<0.10	0.0052	<0.0050	<0.0050	<0.0050
Cadmium (Cd)	mg/L	0.000005 to 0.00002	<0.0000050	<0.000020	<0.0000050	<0.000020	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Calcium (Ca)	mg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Cesium (Cs)	mg/L	0.000005 to 0.0005	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Chromium (Cr)	mg/L	0.000500	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Cobalt (Co)	mg/L	0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Copper (Cu)	mg/L	0.00005 to 0.0005	<0.00050	<0.000050	<0.00050	<0.000050	<0.00050	<0.00050	<0.00050	<0.00050
Gallium (Ga)	mg/L	0.00005 to 0.0005	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.000050	<0.000050	<0.000050
Iron (Fe)	mg/L	0.01 to 0.03	<0.030	<0.010	<0.030	<0.010	<0.030	<0.030	<0.030	<0.030
Lead (Pb)	mg/L	0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L	0.0002 to 0.02	<0.00020	<0.020	<0.00020	<0.020	<0.00020	<0.00020	<0.00020	<0.00020
Magnesium (Mg)	mg/L	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Manganese (Mn)	mg/L	0.00005 to 0.0002	<0.00020	<0.000050	<0.00020	<0.000050	<0.00020	<0.00020	<0.00020	<0.00020
Mercury (Hg)	ug/L	0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050	<0.00050
Molybdenum (Mo)	mg/L	0.00005 to 0.002	<0.000050	<0.0020	<0.000050	<0.0020	<0.000050	<0.000050	<0.000050	<0.000050
Nickel (Ni)	mg/L	0.00005 to 0.0002	<0.00020	<0.000050	<0.00020	<0.000050	<0.00020	<0.00020	<0.00020	<0.00020
Phosphorus (P)	mg/L	0.3 to 1	<0.30	<1.0	<0.30	<1.0	<0.30	<0.30	<0.30	<0.30
Potassium (K)	mg/L	2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Rhenium (Re)	mg/L	0.000005 to 0.0005	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Rubidium (Rb)	mg/L	0.00002 to 0.005	<0.000020	<0.0050	<0.000020	<0.0050	<0.000020	<0.000020	<0.000020	<0.000020
Selenium (Se)	mg/L	0.0002 to 0.0005	<0.00020	<0.00050	<0.00020	<0.00050	<0.00020	<0.00020	<0.00020	<0.00020
Silicon (Si)	mg/L	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Silver (Ag)	mg/L	0.000005 to 0.0001	<0.0000050	<0.00010	<0.0000050	<0.00010	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Sodium (Na)	mg/L	2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Strontium (Sr)	mg/L	0.00005 to 0.005	<0.000050	<0.0050	<0.000050	<0.0050	<0.000050	<0.000050	<0.000050	<0.000050
Tellurium (Te)	mg/L	0.00001 to 0.0005	<0.000010	<0.00050	<0.000010	<0.00050	<0.000010	<0.000010	<0.000010	<0.000010
Thallium (Tl)	mg/L	0.000002 to 0.00005	<0.0000020	<0.000050	<0.0000020	<0.000050	<0.0000020	<0.0000020	<0.0000020	<0.0000020
Thorium (Th)	mg/L	0.000005 to 0.0005	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Tin (Sn)	mg/L	0.0002 to 0.001	<0.00020	<0.0010	<0.00020	<0.0010	<0.00020	<0.00020	<0.00020	<0.00020
Titanium (Ti)	mg/L	0.0002 to 0.005	<0.00020	<0.0050	<0.00020	<0.0050	<0.00020	<0.00020	<0.00020	<0.00020
Tungsten (W)	mg/L	0.00001 to 0.001	<0.000010	<0.0010	<0.000010	<0.0010	<0.000010	<0.000010	<0.000010	<0.000010
Uranium (U)	mg/L	0.000002 to 0.00005	<0.0000020	<0.000050	<0.0000020	<0.000050	<0.0000020	<0.0000020	<0.0000020	<0.0000020
Vanadium (V)	mg/L	0.00005 to 0.0005	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.000050	<0.000050	<0.000050
Yttrium (Y)	mg/L	0.000005 to 0.0005	<0.0000050	<0.00050	<0.0000050	<0.00050	<0.0000050	<0.0000050	<0.0000050	<0.0000050
Zinc (Zn)	mg/L	0.0008 to 0.003	<0.0030	<0.00080	<0.0030	<0.00080	<0.0030	<0.0030	<0.0030	<0.0030
Zirconium (Zr)	mg/L	0.00005 to 0.0005	<0.000050	<0.00050	<0.000050	<0.00050	<0.000050	<0.000050	<0.000050	<0.000050
Speciated Metals										
Methyl Mercury	ug/L	0.00005	-	-	-	-	-	-	-	-
Radiochemistry										
Radium-226	Bq/L	0.010	-	-	-	-	<.01	<0.01	-	-

Note:
Bold values represent concentrations that are higher than analytical detection limits.

Annex A.3-4. QA/QC Blank Data for Water Quality Sampling, Doris North Project, 2014

Blank Type			Travel Blank (Freshwater)	Travel Blank (Marine)
Date Sampled:		Realized Detection	20-Sep-14	21-Sep-14
ALS Sample ID:	Units	Limit	L1523080-11	L1523080-19
Physical Tests				
Conductivity	µS/cm	2.0	<2.0	<2.0
Hardness (as CaCO ₃)	mg/L	0.50	<0.50	<0.50
pH	pH	0.10	5.58	5.38
Salinity	PSU	1	-	-
Total Suspended Solids	mg/L	1 to 2	<1.0	<1.0
Total Dissolved Solids	mg/L	10	<10	<10
Turbidity	NTU	0.10	<0.10	<0.10
Anions and Nutrients				
Alkalinity, Total (as CaCO ₃)	mg/L	1 to 2	<1.0	<1.0
Ammonia, Total (as N)	mg/L	0.0050	<0.0050	<0.0050
Bromide (Br)	mg/L	0.050	<0.050	<0.050
Chloride (Cl)	mg/L	0.50	<0.50	<0.50
Fluoride (F)	mg/L	0.020	<0.020	<0.020
Nitrate and Nitrite (as N)	mg/L	0.006	-	-
Nitrate (as N)	mg/L	0.005 to 0.006	<0.0050	<0.0050
Nitrite (as N)	mg/L	0.001 to 0.002	<0.0010	<0.0010
Total Kjeldahl Nitrogen	mg/L	0.050	<0.050	<0.050
Dissolved Kjeldahl Nitrogen	mg/L	0.050	-	-
Orthophosphate-Dissolved (as P)	mg/L	0.0010	<0.0010	<0.0010
Phosphorus (P)	mg/L	0.0020	<0.0020	<0.0020
Sulfate (SO ₄)	mg/L	0.50	<0.50	<0.50
Cyanides				
Cyanide, Total	mg/L	0.0010	<0.0010	<0.0010
Cyanide, Free	mg/L	0.0010	<0.0010	<0.0010
Organic / Inorganic Carbon				
Dissolved Organic Carbon	mg/L	0.50	<0.50	<0.50
Total Organic Carbon	mg/L	0.50	<0.50	<0.50
Total Metals				
Aluminum (Al)	mg/L	0.003 to 0.005	<0.0030	<0.0030
Antimony (Sb)	mg/L	0.00001 to 0.0005	<0.000010	<0.000010
Arsenic (As)	mg/L	0.00005 to 0.0004	<0.000050	<0.000050
Barium (Ba)	mg/L	0.0001 to 0.001	<0.00010	<0.00010
Beryllium (Be)	mg/L	0.000005 to 0.0005	<0.0000050	<0.0000050
Bismuth (Bi)	mg/L	0.00005 to 0.0005	<0.000050	<0.000050
Boron (B)	mg/L	0.005 to 0.1	0.0056	<0.0050
Cadmium (Cd)	mg/L	0.000005 to 0.00002	<0.0000050	<0.0000050
Calcium (Ca)	mg/L	0.050	<0.050	<0.050
Cesium (Cs)	mg/L	0.000005 to 0.0005	<0.0000050	<0.0000050
Chromium (Cr)	mg/L	0.000500	<0.00050	<0.00050
Cobalt (Co)	mg/L	0.000050	<0.000050	<0.000050
Copper (Cu)	mg/L	0.00005 to 0.0005	<0.00050	<0.00050
Gallium (Ga)	mg/L	0.00005 to 0.0005	<0.000050	<0.000050
Iron (Fe)	mg/L	0.01 to 0.03	<0.030	<0.030
Lead (Pb)	mg/L	0.000050	<0.000050	<0.000050
Lithium (Li)	mg/L	0.0002 to 0.02	<0.00020	<0.00020
Magnesium (Mg)	mg/L	0.10	<0.10	<0.10
Manganese (Mn)	mg/L	0.00005 to 0.0002	<0.00020	<0.00020
Mercury (Hg)	ug/L	0.00050	<0.00050	<0.00050
Molybdenum (Mo)	mg/L	0.00005 to 0.002	<0.000050	<0.000050
Nickel (Ni)	mg/L	0.00005 to 0.0002	<0.00020	<0.00020
Phosphorus (P)	mg/L	0.3 to 1	<0.30	<0.30
Potassium (K)	mg/L	2.0	<2.0	<2.0
Rhenium (Re)	mg/L	0.000005 to 0.0005	<0.0000050	<0.0000050
Rubidium (Rb)	mg/L	0.00002 to 0.005	<0.000020	<0.000020
Selenium (Se)	mg/L	0.0002 to 0.0005	<0.00020	<0.00020
Silicon (Si)	mg/L	0.050	<0.050	<0.050
Silver (Ag)	mg/L	0.000005 to 0.0001	<0.0000050	<0.0000050
Sodium (Na)	mg/L	2.0	<2.0	<2.0
Strontium (Sr)	mg/L	0.00005 to 0.005	<0.000050	<0.000050
Tellurium (Te)	mg/L	0.00001 to 0.0005	<0.000010	<0.000010
Thallium (Tl)	mg/L	0.000002 to 0.00005	<0.0000020	<0.0000020
Thorium (Th)	mg/L	0.000005 to 0.0005	<0.0000050	<0.0000050
Tin (Sn)	mg/L	0.0002 to 0.001	<0.00020	<0.00020
Titanium (Ti)	mg/L	0.0002 to 0.005	<0.00020	<0.00020
Tungsten (W)	mg/L	0.00001 to 0.001	<0.000010	<0.000010
Uranium (U)	mg/L	0.000002 to 0.00005	<0.0000020	<0.0000020
Vanadium (V)	mg/L	0.00005 to 0.0005	<0.000050	<0.000050
Yttrium (Y)	mg/L	0.000005 to 0.0005	<0.0000050	<0.0000050
Zinc (Zn)	mg/L	0.0008 to 0.003	<0.0030	<0.0030
Zirconium (Zr)	mg/L	0.00005 to 0.0005	<0.000050	<0.000050
Speciated Metals				
Methyl Mercury	ug/L	0.00005	-	-
Radiochemistry				
Radium-226	Bq/L	0.010	-	-

Note:
Bold values represent concentrations that are higher than analytical detection limits.

A.4 2014 SEDIMENT QUALITY

The following sections present the sediment quality data collected in August 2014 from stream, lake, and marine sites. Only the variables that were subjected to an evaluation of effects (see main body of report) are shown graphically. All sediment quality variables were screened against CCME sediment quality guidelines for the protection of aquatic life (CCME 2014b). CCME guidelines for sediments include interim sediment quality guidelines (ISQGs) and probable effects levels (PELs). The more conservative ISQGs are levels below which adverse biological effects are rarely observed. The higher PELs correspond to concentrations above which negative effects would be expected (CCME 2014b). CCME guidelines are included in all graphs and annexes.

A.4.1 Stream Data

Figures A.4-1 to A.4-5 show select sediment quality variable concentrations in the AEMP streams. Annex A.4-1 presents the full stream sediment quality dataset.

A.4.2 Lake Data

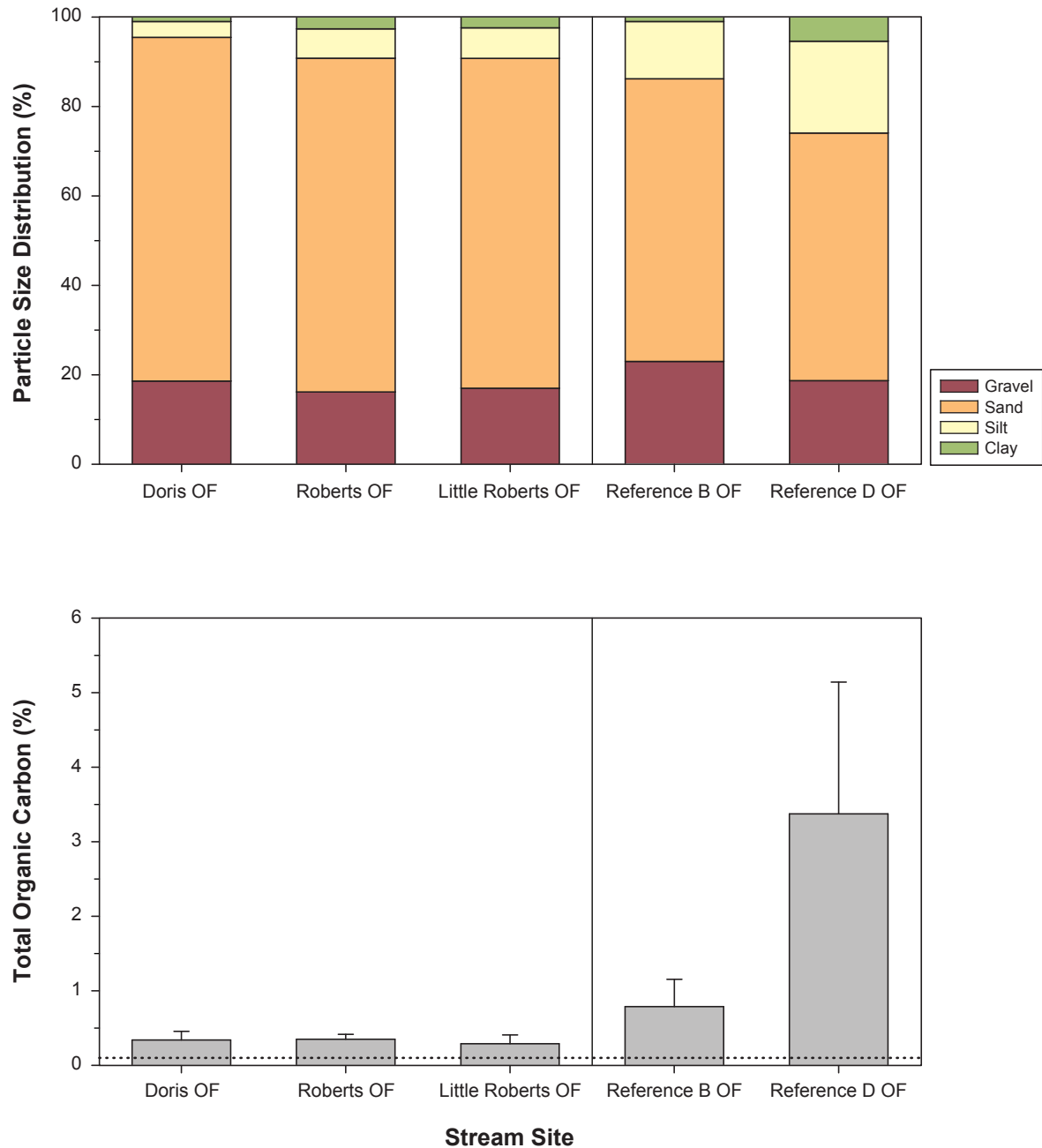
Figures A.4-6 to A.4-10 show select sediment quality variable concentrations in the AEMP lakes. Annex A.4-2 presents the full lake sediment quality dataset.

A.4.3 Marine Data

Figures A.4-11 to A.4-15 show select sediment quality variable concentrations at the AEMP marine sites. Annex A.4-3 presents the full marine sediment quality dataset.

Figure A.4-1

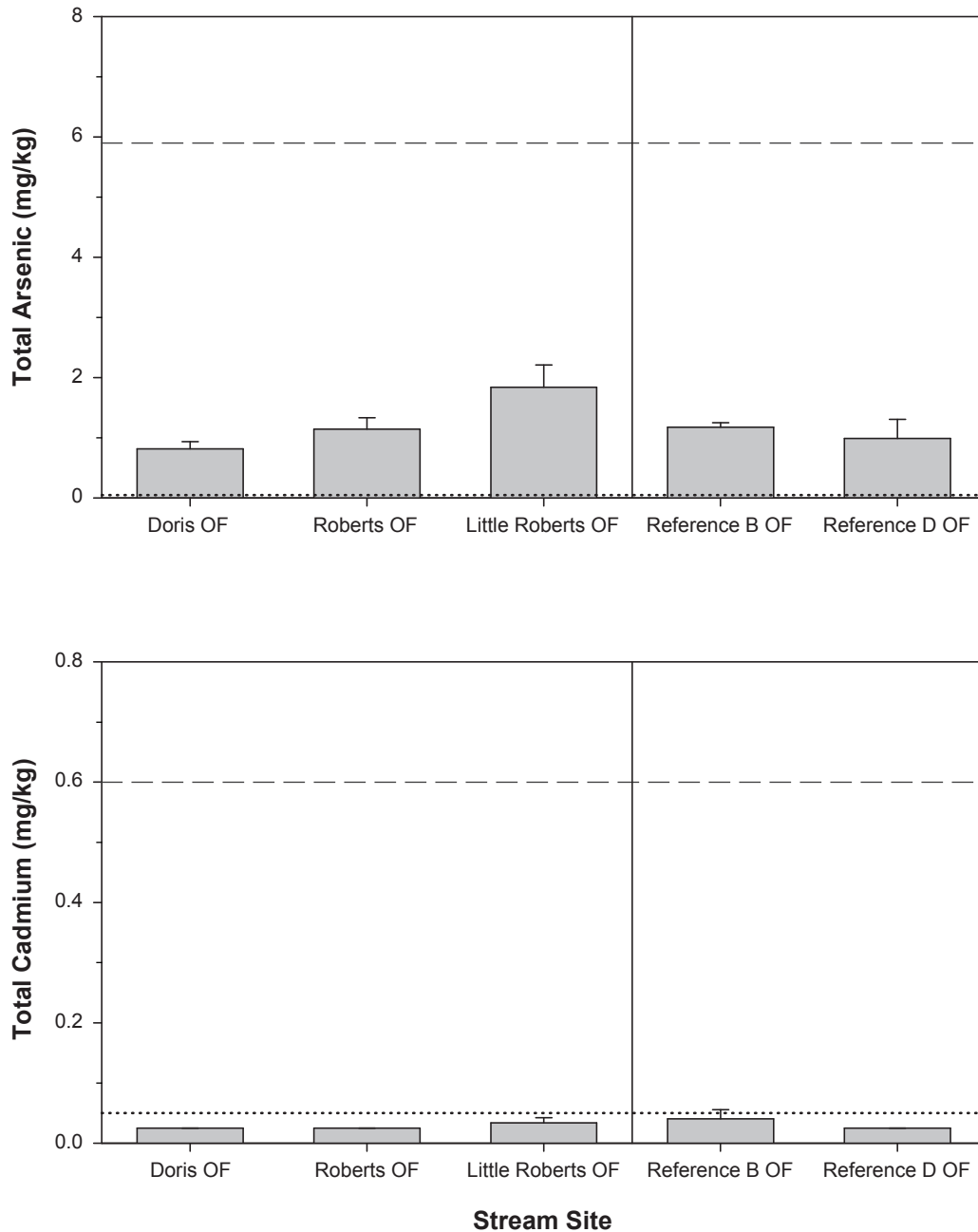
Particle Size Distribution and Total Organic Carbon
in Stream Sediments, Doris North Project, August 2014



Notes: Error bars represent the standard error of the mean of replicates.
Stacked bars represent the mean of replicate samples.
Dotted line represents the analytical detection limit; values below the detection limit are plotted at half the detection limit.
Particle size distribution and total organic carbon content of sediments are required parameters as part of benthic invertebrate surveys as per Schedule 5, s.16a (iii) of the MMER.

Figure A.4-2

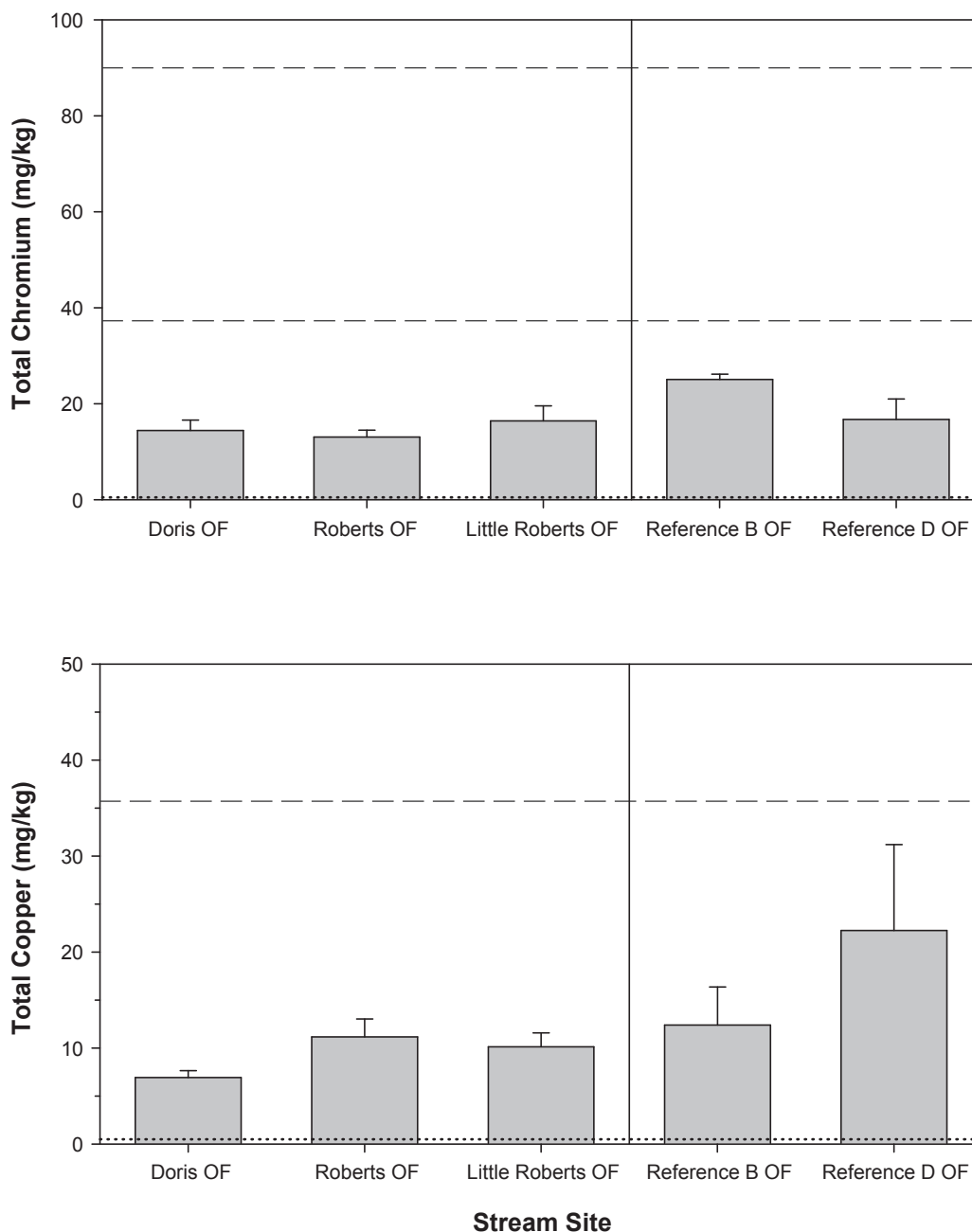
**Total Arsenic and Total Cadmium Concentrations
in Stream Sediments, Doris North Project, August 2014**



Notes: Error bars represent the standard error of the mean of replicates.
Dotted line represents the analytical detection limit; values below the detection limit are plotted at half the detection limit.
Dashed lines represent the CCME freshwater interim sediment quality guidelines (ISQGs) for arsenic (5.9 mg/kg) and cadmium (0.6 mg/kg); probable effects levels (PELs) for arsenic (17 mg/kg) and cadmium (3.5 mg/kg) are not shown.

Figure A.4-3

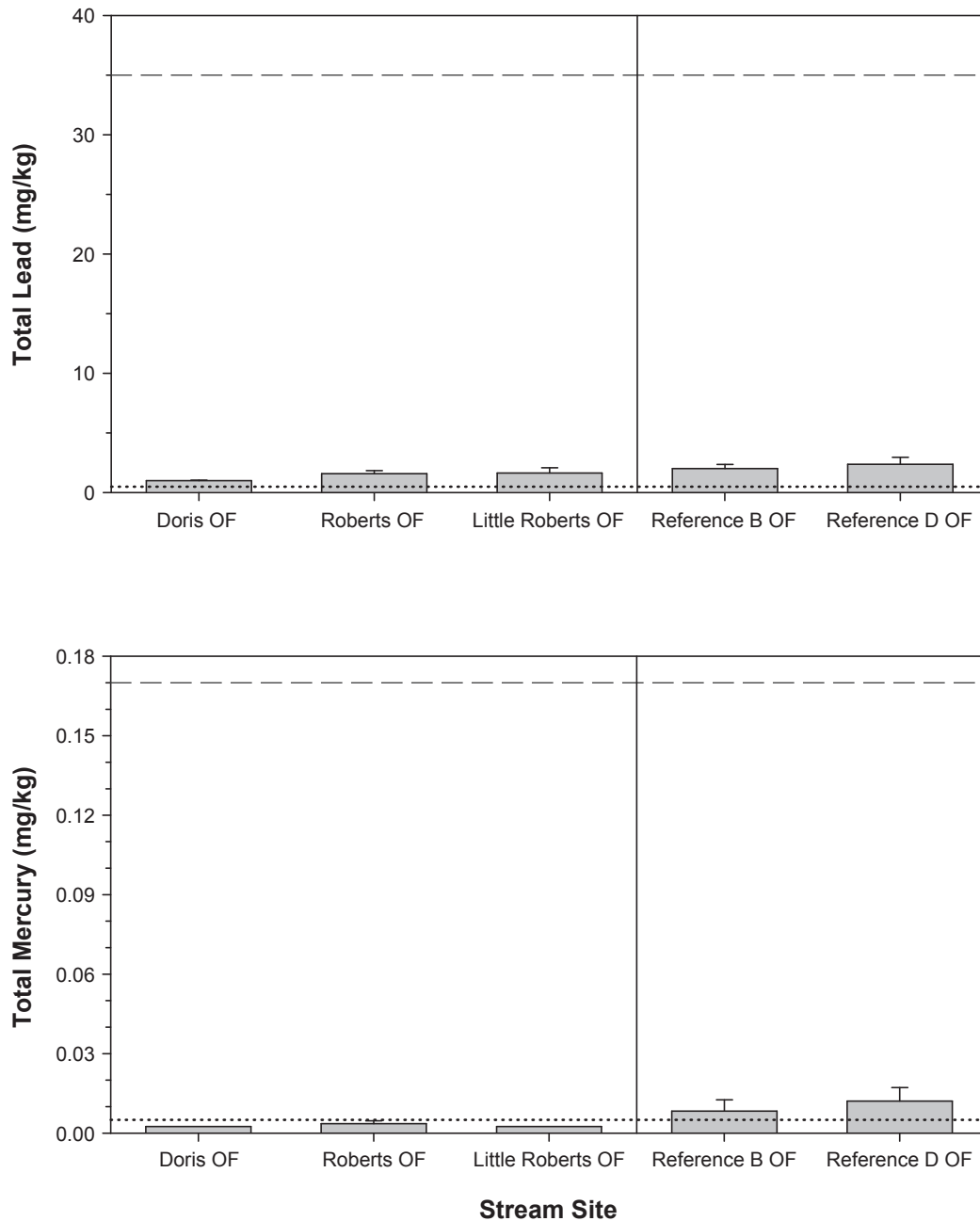
**Total Chromium and Total Copper Concentrations
in Stream Sediments, Doris North Project, August 2014**



Notes: Error bars represent the standard error of the mean of replicates.
Dotted line represents the analytical detection limit; values below the detection limit are plotted at half the detection limit.
Dashed lines represent the CCME freshwater interim sediment quality guideline (ISQG) for chromium (37.3 mg/kg) and copper (35.7 mg/kg).
The probable effects levels (PELs) for chromium (90 mg/kg) and copper (197 mg/kg) are not shown.

Figure A.4-4

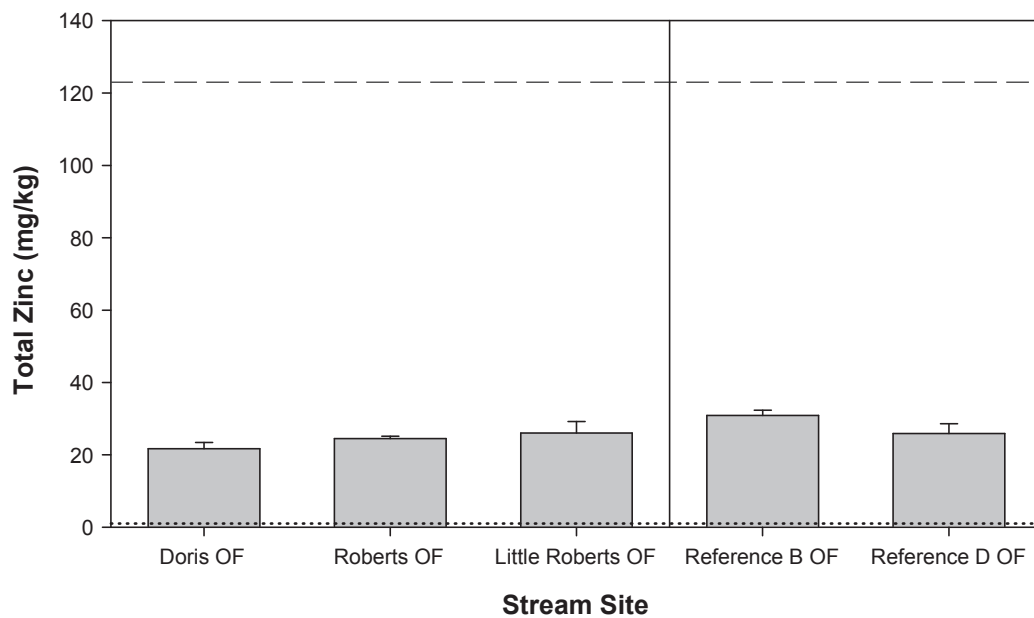
Total Lead and Total Mercury Concentrations
in Stream Sediments, Doris North Project, August 2014



Notes: Error bars represent the standard error of the mean of replicates.
Dotted line represents the analytical detection limit; values below the detection limit are plotted at half the detection limit.
Dashed lines represent the CCME freshwater interim sediment quality guidelines (ISQGs) for lead (35 mg/kg) and mercury (0.17 mg/kg); probable effects levels (PELs) for lead (91.3 mg/kg) and mercury (0.486 mg/kg) are not shown.

Figure A.4-5

**Total Zinc Concentrations
in Stream Sediments, Doris North Project, August 2014**



Notes: Error bars represent the standard error of the mean of replicates.

Dotted line represents the analytical detection limit; values below the detection limit are plotted at half the detection limit.

Dashed lines represent the CCME freshwater interim sediment quality guidelines (ISQGs) for zinc (123 mg/kg); the probable effects level (PEL) for zinc (315 mg/kg) is not shown.

Annex A.4-1. Stream Sediment Quality Data, Doris North Project, 2014

Site ID: Replicate: Date Sampled:		Guidelines for the Protection of Aquatic Life ^a		Realized Detection Limit	Doris OF 1 16-Aug-14	Doris OF 2 16-Aug-14	Doris OF 3 16-Aug-14	Roberts OF 1 16-Aug-14	Roberts OF 2 16-Aug-14	Roberts OF 3 16-Aug-14	OF 1 15-Aug-14	OF 2 15-Aug-14	OF 3 15-Aug-14	OF 1 15-Aug-14	OF 2 15-Aug-14	OF 3 15-Aug-14	OF 1 14-Aug-14	OF 2 14-Aug-14	OF 3 14-Aug-14	
ALS Sample ID:	Unit	ISQG ^b	PEL ^c		L1504838-10	L1504838-11	L1504838-12	L1504838-7	L1504838-8	L1504838-9	L1504838-4	L1504838-5	L1504838-6	L1504838-1	L1504838-2	L1504838-3	L1503369-1	L1503369-2	L1503369-3	
Physical Tests																				
Moisture	%			0.25	31.7	19.3	26.2	17.5	26.9	43.3	23.6	23.8	18.6	31.1	18.2	73.1	23.0	61.7	63.4	
pH	pH			0.10	6.70	7.03	7.01	7.40	7.15	6.57	7.00	7.52	8.44	6.15	6.61	5.72	6.76	5.60	6.00	
Particle Size																				
% Gravel (>2 mm)	%			0.10	10.5	23.1	22.2	25.0	21.8	01.8	10.9	22.2	17.9	20.6	30.6	17.9	28.3	<0.10	27.8	
% Sand (2.0 mm - 0.063 mm)	%			0.10	83.8	74.4	72.4	70.3	66.8	86.8	76.1	74.1	71.1	63.8	63.7	62.1	68.0	65.4	32.7	
% Silt (0.063 mm - 4 µm)	%			0.10	4.28	2.14	4.27	3.17	8.45	8.08	10.60	2.92	7.07	14.30	5.16	18.90	2.32	27.50	31.80	
% Clay (<4 µm)	%			0.10	1.39	0.37	1.22	1.46	2.98	3.30	2.49	0.72	3.94	1.26	0.55	1.06	1.31	7.16	7.69	
Texture	-			-	Sand	Sand	Sand	Sand	Loamy sand	Sand	Sand / Loamy sand	Sand	Sand / Loamy sand	Loamy sand	Sand	Loamy sand	Sand	Sandy loam	Loam / Sandy loam	
Anions & Nutrients																				
Total Nitrogen	%			0.020	0.032	<0.020	0.037	<0.020	0.022	0.042	0.037	<0.020	0.022	0.054	<0.020	0.096	0.025	0.275	0.383	
Organic / Inorganic Carbon																				
Total Organic Carbon	%			0.10	0.43	0.11	0.48	0.28	0.29	0.48	0.51	0.11	0.25	0.81	0.14	1.41	0.20	3.60	6.32	
Plant Available Nutrients																				
Available Ammonium-N	mg/kg			1 to 4	1.8	<1.6	5.2	<1.0	2.1	5.6	3.8	<1.0	<1.0	2.0	<1.6	7.8	<1.0	20.3	7.6	
Nitrate+Nitrite-N	mg/kg			2 to 6	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<4.0	<6.0	
Available Nitrate-N	mg/kg			2 to 6	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<4.0	<6.0	
Available Nitrite-N	mg/kg			0.4 to 1.2	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.80	<1.2	
Available Phosphate-P	mg/kg			2.0	3.7	2.2	5.7	3.5	5.4	6.8	3.3	4.5	<2.0	2.2	2.5	4.6	3.0	2.2	5.5	
Metals																				
Aluminum (Al)	mg/kg	5.9	17	50	5070	6250	6270	5820	6060	6040	5810	5490	8220	8670	8540	8230	5580	9100	9670	
Antimony (Sb)	mg/kg			0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Arsenic (As)	mg/kg			0.050	0.582	0.889	0.979	0.807	1.460	1.170	1.400	1.540	2.580	1.220	1.030	1.280	0.486	1.580	0.906	
Barium (Ba)	mg/kg			0.50	11.7	12.9	18.1	17.7	26.8	25.0	19.5	17.1	33.2	22.6	14.3	28.7	15.8	42.2	40.9	
Beryllium (Be)	mg/kg			0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.2	<0.20	<0.20	<0.20	<0.20	0.24	0.26	
Bismuth (Bi)	mg/kg			0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	
Cadmium (Cd)	mg/kg	0.6	3.5	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.051	<0.050	<0.050	0.071	<0.050	<0.050	<0.050	
Calcium (Ca)	mg/kg			50	1340	1770	1670	2060	2100	1850	2100	2400	7120	2570	2250	2840	2140	2800	3050	
Chromium (Cr)	mg/kg	37.3	90	0.50	10.3	15.2	17.8	10.7	15.7	12.8	13.5	13.1	22.7	23.8	27.3	24.1	08.3	20.5	21.5	
Cobalt (Co)	mg/kg			0.10	3.80	5.34	4.90	4.80	4.54	4.29	4.61	5.39	6.21	6.05	6.76	6.24	3.75	6.37	4.69	
Copper (Cu)	mg/kg	35.7	197	0.50	7.15	8.04	5.57	7.56	12.00	13.90	7.82	12.80	9.76	10.10	6.99	20.10	9.24	18.10	39.40	
Iron (Fe)	mg/kg			50	10100	13700	12900	11400	11800	10900	11000	12800	15900	15700	16300	15200	10200	17000	11000	
Lead (Pb)	mg/kg	35	91.3	0.50	0.92	1.06	1.04	1.15	2.00	1.64	1.22	1.20	2.52	2.09	1.37	2.59	1.24	2.81	3.10	
Lithium (Li)	mg/kg			5.0	10.3	11.9	10.9	13.1	11.8	12.9	11.3	11.3	15.9	14.7	12.8	12.6	13.4	17.7	17.2	
Magnesium (Mg)	mg/kg			20	3740	5260	4670	4790	4490	4540	4300	4760	5790	6030	6330	5150	4320	5750	5570	
Manganese (Mn)	mg/kg			1.0	121	193	158	157	164	161	195	187	293	194	217	198	161	268	191	
Mercury (Hg)	mg/kg	0.17	0.486	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0057	<0.0050	<0.0050	<0.0050	0.0058	<0.0050	0.0166	<0.0050	0.0199	0.0138	
Molybdenum (Mo)	mg/kg			0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.88	<0.50	<0.50	<0.50	<0.50	
Nickel (Ni)	mg/kg			0.50	7.85	10.80	10.00	8.47	9.60	9.05	9.22	10.00	12.70	14.60	15.50	15.80	7.24	13.60	14.60	
Phosphorus (P)	mg/kg			50	242	463	351	256	301	347	254	294	339	414	350	419	394	421	470	
Potassium (K)	mg/kg			100	560	780	670	860	1110	1030	860	730	1620	980	640	910	720	1540	1260	
Selenium (Se)	mg/kg			0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.22	<0.20	<0.20	<0.20	
Silver (Ag)	mg/kg			0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	
Sodium (Na)	mg/kg			100	100	<100	110	150	250	200	170	120	330	130	120	150	160	430	390	
Strontium (Sr)	mg/kg			0.50	6.26	5.74	7.54	10.30	11.70	9.82	11.40	10.70	44.50	13.80	9.03	13.00	11.70	17.00	18.50	
Sulphur (S)	mg/kg			500	<500	<500	<500	1000	<500	<500	<500	<500	500	700	<500	600	<500	700	1100	
Thallium (Tl)	mg/kg			0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.08	0.057	<0.050	0.068	<0.050	0.074	0.08	
Tin (Sn)	mg/kg			2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	
Titanium (Ti)	mg/kg			1.0	276	348	284	395	478	376	409	436	698	587	571	562	346	551	583	
Uranium (U)	mg/kg			0.050	0.241	0.327	0.414	0.306	0.487	0.469	0.410	0.351	0.689	0.770	0.360	1.790	0.552	2.140	1.730	
Vanadium (V)	mg/kg			0.20	18.7	25.0	21.0	18.8	25.0	19.3	22.1	35.7	47.0	27.8	28.6	29.0	19.2	30.3	27.7	
Zinc (Zn)	mg/kg	123	315	1.0	18.2	23.7	23.1	24.2	23.6	25.7	21.9	23.8	32.3	30.8	28.4	33.4	21.2	30.6	25.8	

Notes:

Shaded cells indicate values that exceed CCME guidelines (light grey ISQG, dark grey PEL).

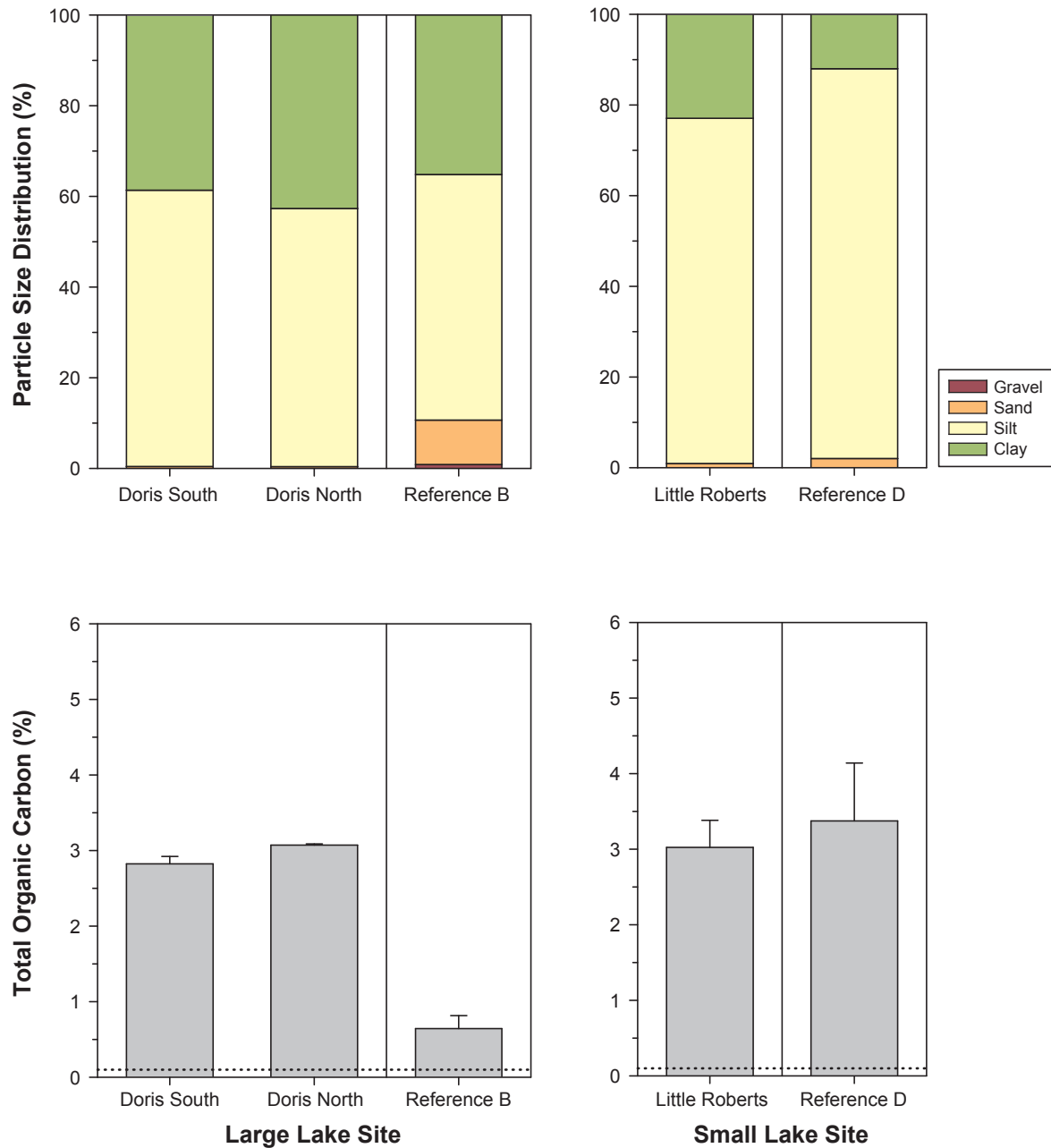
^a Canadian sediment quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b ISQG = Interim Sediment Quality Guideline

^c PEL = Probable Effects Level

Figure A.4-6

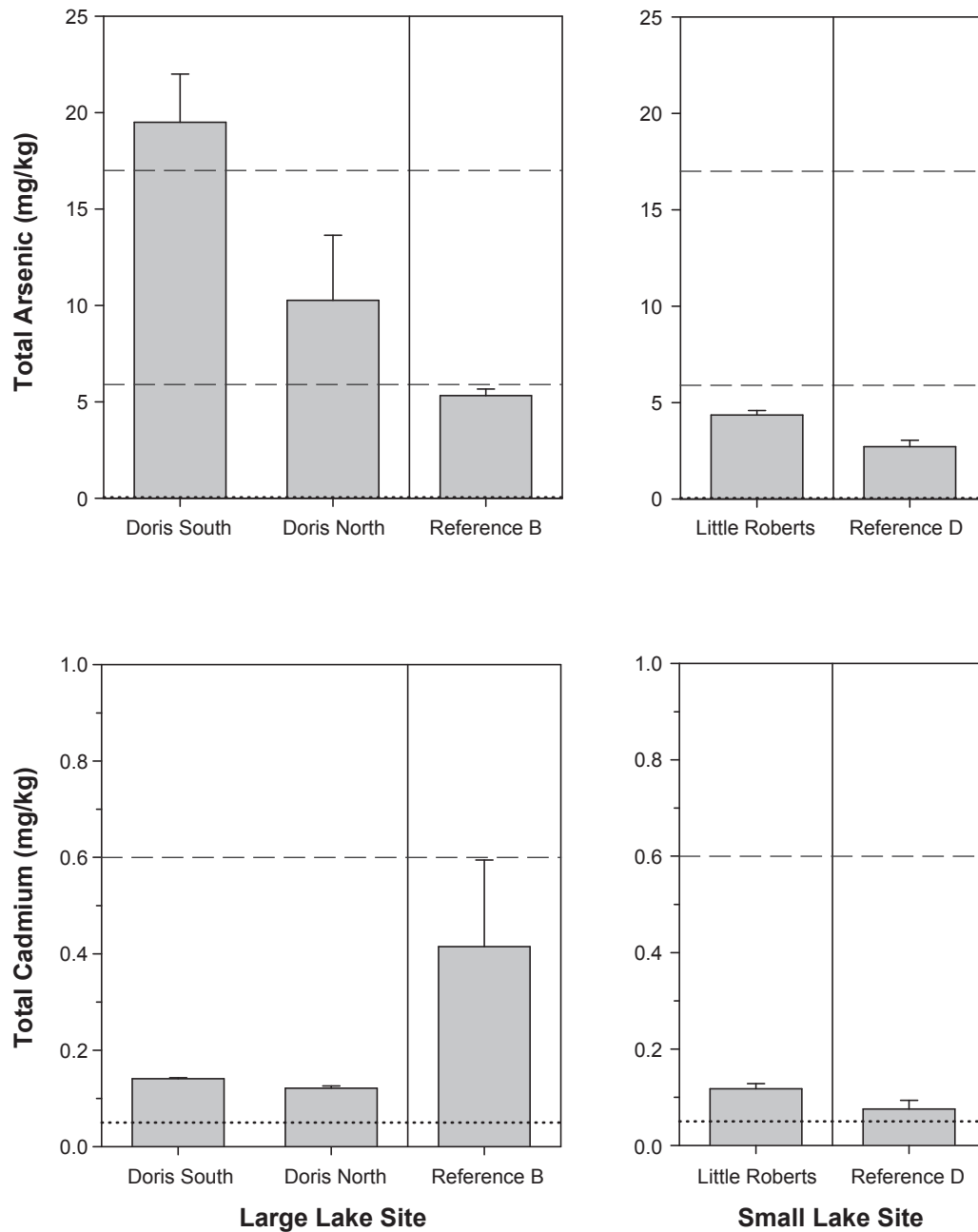
Particle Size Distribution and Total Organic Carbon
in Lake Sediments, Doris North Project, August 2014



Notes: Error bars represent the standard error of the mean of replicates.
Stacked bars represent the mean of replicate samples.
Black dotted line represents the analytical detection limit; values below the detection limit are plotted at half the detection limit.
Particle size distribution and total organic carbon content of sediments are required parameters as part of benthic invertebrate surveys as per Schedule 5, s.16a (iii) of the MMER.

Figure A.4-7

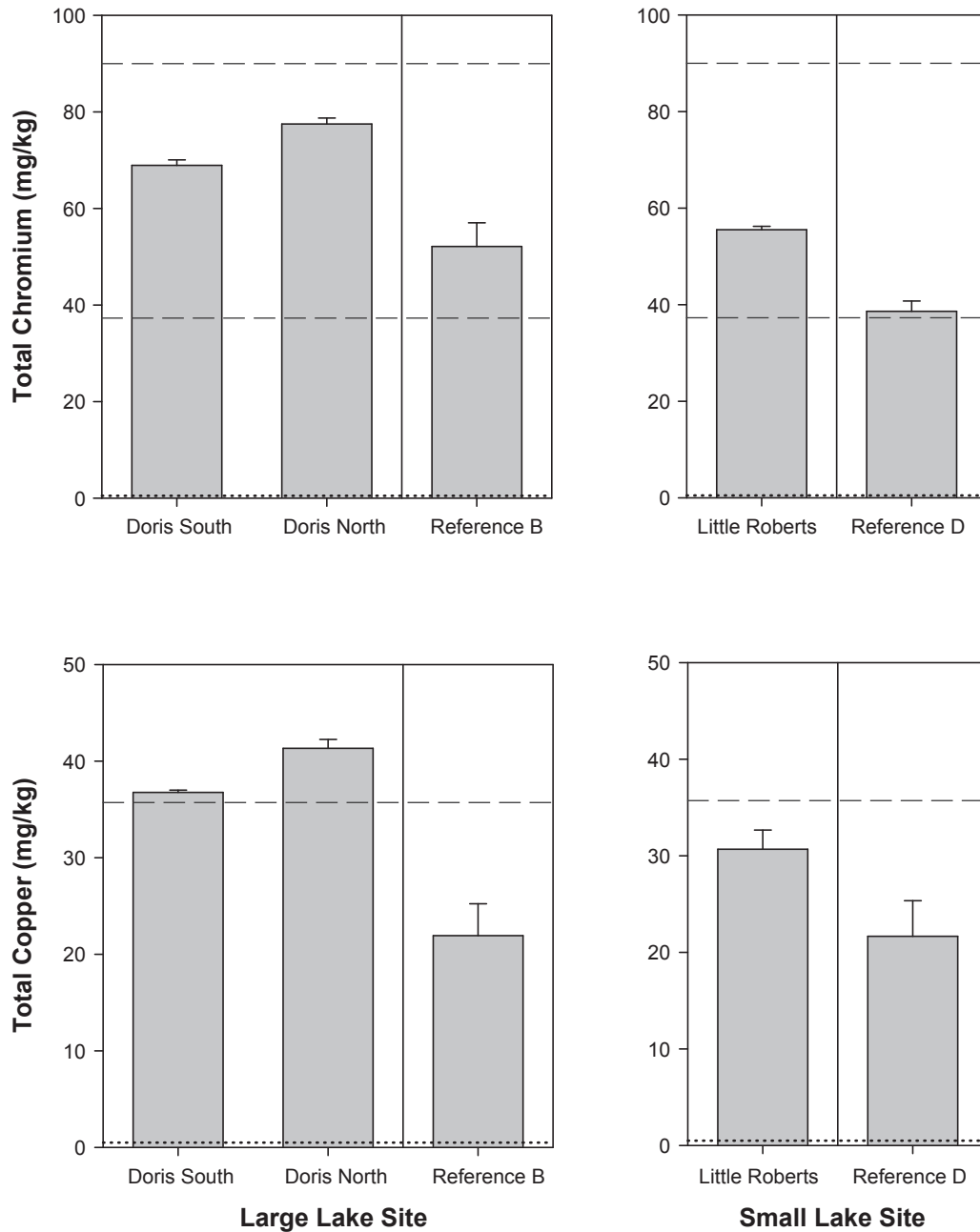
**Total Arsenic and Total Cadmium Concentrations
in Lake Sediments, Doris North Project, August 2014**



Notes: Error bars represent the standard error of the mean of replicates.
Dotted lines represent the analytical detection limit; values below the detection limit are plotted at half the detection limit.
Dashed lines represent the CCME freshwater interim sediment quality guidelines (ISQGs) for arsenic (5.9 mg/kg) and cadmium (0.6 mg/kg) and the probable effects level (PEL) for arsenic (17 mg/kg); the PEL for cadmium (3.5 mg/kg) is not shown.

Figure A.4-8

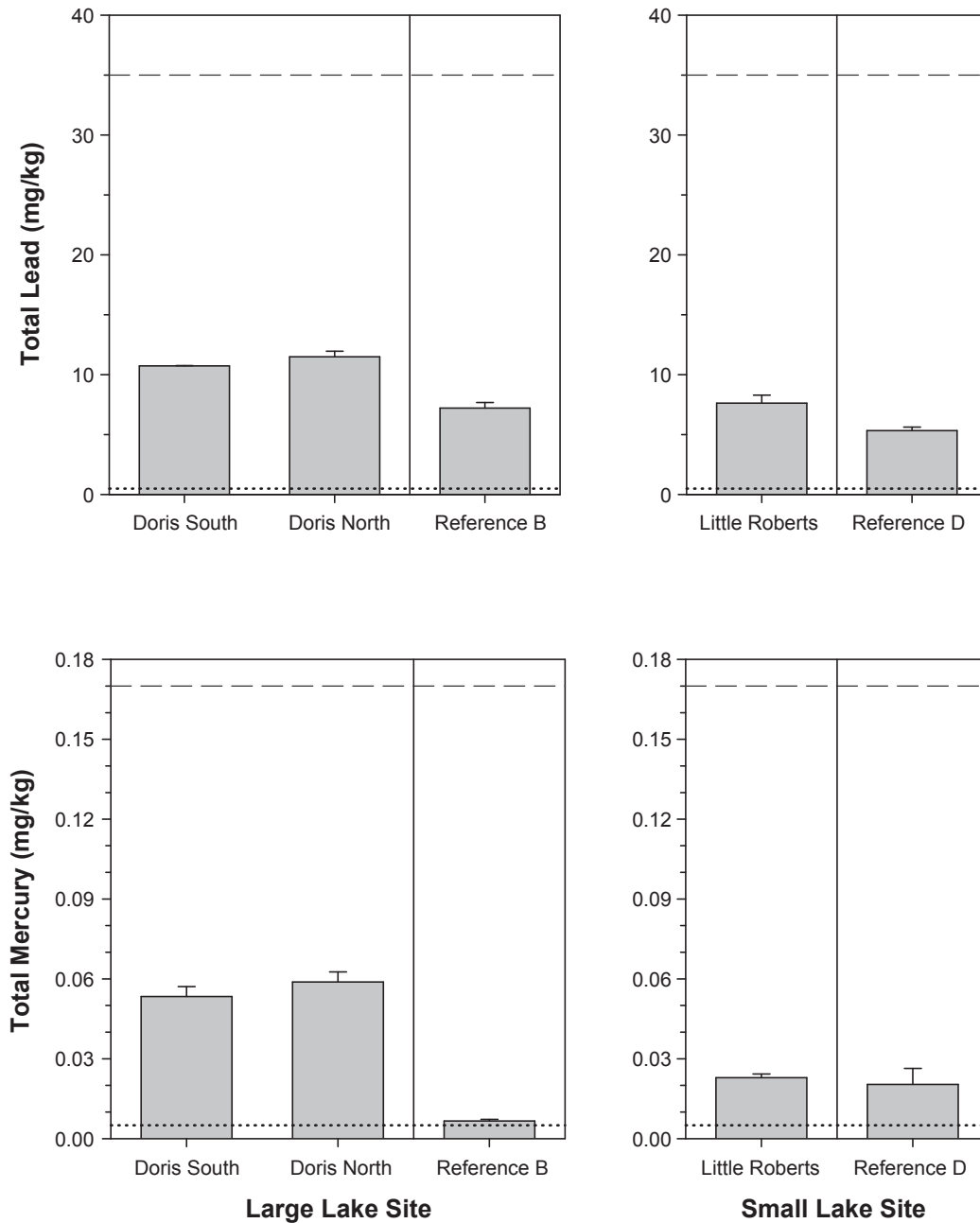
**Total Chromium and Total Copper Concentrations
in Lake Sediments, Doris North Project, August 2014**



Notes: Error bars represent the standard error of the mean of replicates.
Dotted lines represent the analytical detection limit; values below the detection limit are plotted at half the detection limit.
Dashed lines represent the CCME freshwater interim sediment quality guidelines (ISQGs) for chromium (37.3 mg/kg) and copper (35.7 mg/kg) and the probable effects level (PEL) for chromium (90 mg/kg); the PEL for copper (197 mg/kg) is not shown.

Figure A.4-9

**Total Lead and Total Mercury Concentrations
in Lake Sediments, Doris North Project, August 2014**



Notes: Error bars represent the standard error of the mean of replicates.
Dotted lines represent the analytical detection limit; values below the detection limit are plotted at half the detection limit.
Dashed lines represent the CCME freshwater interim sediment quality guidelines (ISQGs) for lead (35 mg/kg) and mercury (0.17 mg/kg); probable effects levels (PELs) for lead (91.3 mg/kg) and mercury (0.486 mg/kg) are not shown.

Annex A.4-2. Lake Sediment Quality Data, Doris North Project, 2014

Site ID: Date Sampled: Replicate: Depth Sampled:		CCME Guidelines for the Protection of Aquatic Life ^a		Realized Detection Limit	Doris South 19-Aug-14	Doris South 19-Aug-14	Doris South 19-Aug-14	Doris North 20-Aug-14	Doris North 20-Aug-14	Doris North 20-Aug-14	Reference B 23-Aug-14	Reference B 23-Aug-14	Reference B 23-Aug-14	Little Roberts 17-Aug-14	Little Roberts 17-Aug-14	Little Roberts 17-Aug-14	Reference D 18-Aug-14	Reference D 18-Aug-14	Reference D 18-Aug-14
ALS Sample ID:	Unit	ISQG ^b	PEL ^c		1 10.0	2 10.0	3 10.0	1 14.0	2 14.0	3 14.0	1 11.0	2 11.0	3 11.0	1 3.0	2 3.0	3 3.0	1 2.0	2 2.0	3 2.0
L1506833-1	L1506833-2	L1506833-3	L1506833-4	L1506833-5	L1506833-6	L1509279-1	L1509279-2	L1509279-3	L1504799-1	L1504799-2	L1504799-3	L1504799-4	L1504799-5	L1504799-6					
Physical Tests																			
Moisture	%			0.25	74.4	78.4	77.6	72.8	78.1	75.3	43.4	45.0	57.4	68.8	70.8	72.9	75.5	63.8	59.3
pH	pH			0.10	5.95	6.09	6.04	5.63	5.81	5.70	5.76	5.61	5.50	6.04	6.35	5.87	5.55	5.55	5.55
Particle Size																			
% Gravel (>2 mm)	%			0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	1.85	0.76	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
% Sand (2.0 mm - 0.063 mm)	%			0.10	0.47	0.40	0.37	0.30	0.26	0.54	9.41	9.89	10.10	0.82	1.41	0.51	0.23	5.01	0.71
% Silt (0.063 mm - 4 µm)	%			0.10	63.0	59.2	60.6	55.1	53.7	62.0	58.4	57.1	47.0	74.1	77.7	76.6	84.8	84.8	88.3
% Clay (<4 µm)	%			0.10	36.6	40.4	39.0	44.6	46.0	37.4	32.2	31.2	42.1	25.0	20.9	22.9	15.0	10.2	11.0
Texture	-			-	Silty clay loam	Silty clay loam	Silty clay loam	Silty clay loam	Silty clay	Silty clay loam	Silty clay loam	Silt loam / Silty clay loam	Silty clay loam	Silt loam	Silt loam	Silt loam	Silt	Silt	Silt
Anions and Nutrients																			
Total Nitrogen	%			0.020	0.313	0.342	0.345	0.363	0.381	0.365	0.046	0.068	0.105	0.290	0.277	0.377	0.379	0.232	0.195
Organic / Inorganic Carbon																			
Total Organic Carbon	%			0.10	2.63	2.89	2.95	3.04	3.10	3.07	0.37	0.60	0.96	2.89	2.48	3.70	4.90	2.70	2.52
Plant Available Nutrients																			
Available Ammonium-N	mg/kg			2.4 to 6.4	27.5	29.4	34.4	37.7	32.3	27.7	3.1	2.8	<3.2	12.5	22.3	20.8	36.3	25.7	31.3
Nitrate+Nitrite-N	mg/kg			2 to 6	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<6.0	<6.0	<6.0	<6.0	<6.0	<6.0
Available Nitrate-N	mg/kg			2 to 6	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<6.0	<6.0	<6.0	<6.0	<6.0	<6.0
Available Nitrite-N	mg/kg			0.4 to 1.2	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<0.40	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2
Available Phosphate-P	mg/kg			2 to 4	2.0	<2.0	2.9	4.0	2.4	3.2	3.1	3.0	19.4	5.9	5.5	3.4	6.0	4.5	3.8
Metals																			
Aluminum (Al)	mg/kg	5.9	17	50	23300	25100	24800	27400	27800	26700	17500	17200	23900	19900	19200	19800	15100	13000	12700
Antimony (Sb)	mg/kg			0.10	<0.10	0.11	0.11	0.11	0.1	0.11	0.21	0.16	0.23	0.24	0.12	0.11	<0.10	<0.10	<0.10
Arsenic (As)	mg/kg			0.050	14.9	23.5	20.1	5.48	8.52	16.8	5.02	4.94	6.02	4.74	3.93	4.41	3.36	2.22	2.58
Barium (Ba)	mg/kg			0.50	174	189	183	152	160	166	099	096	145	113	108	116	090	070	068
Beryllium (Be)	mg/kg	0.6	3.5	0.20	0.87	0.86	0.90	0.92	0.94	0.97	0.60	0.55	0.70	0.56	0.53	0.57	0.48	0.38	0.38
Bismuth (Bi)	mg/kg			0.20	0.25	0.26	0.24	0.24	0.26	0.27	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd)	mg/kg			0.050	0.137	0.143	0.143	0.119	0.115	0.130	0.223	0.248	0.774	0.130	0.097	0.126	0.110	0.066	0.051
Calcium (Ca)	mg/kg			50	5600	5940	5920	6230	6560	6160	4310	3920	4690	5950	5730	5960	4790	4460	4440
Chromium (Cr)	mg/kg	37.3	90	0.50	66.8	70.8	69.2	78.6	78.9	75.0	48.2	46.3	61.9	56.6	54.2	55.8	42.9	36.5	36.5
Cobalt (Co)	mg/kg	35.7	197	0.10	14.7	15.9	15.4	15.0	15.3	15.4	15.4	15.3	19.4	12.2	11.6	12.3	08.8	07.6	07.4
Copper (Cu)	mg/kg			0.50	36.3	37.0	37.0	43.2	40.4	40.4	19.1	18.2	28.5	34.2	27.3	30.5	29.0	17.8	18.2
Iron (Fe)	mg/kg			50	53500	65000	59200	43300	49700	59900	27900	27300	34200	31700	29000	32900	28900	21500	20400
Lead (Pb)	mg/kg	35	91.3	0.50	10.7	10.8	10.7	10.7	11.5	12.3	06.9	06.6	08.2	08.9	06.8	07.2	05.9	05.1	05.0
Lithium (Li)	mg/kg	0.17	0.486	5.0	41.3	41.1	42.5	49.4	48.0	45.2	28.2	27.4	37.9	30.7	30.4	32.1	24.7	22.4	22.3
Magnesium (Mg)	mg/kg			20	13500	14100	14000	16100	15800	14700	09140	08900	11700	12600	12200	12700	08920	07500	07500
Manganese (Mn)	mg/kg			1.0	1870	3100	2620	0491	0729	0887	0251	0238	0326	0375	0491	0429	0251	0212	0210
Mercury (Hg)	mg/kg			0.0050	0.0470	0.0598	0.0534	0.0516	0.0645	0.0604	0.0055	0.0070	0.0074	0.0239	0.0201	0.0246	0.0320	0.0170	0.0122
Molybdenum (Mo)	mg/kg	0.17	0.486	0.50	1.94	2.55	2.78	1.45	1.27	1.34	2.05	1.73	8.05	1.61	1.24	1.39	0.81	0.80	0.76
Nickel (Ni)	mg/kg			0.50	44.0	45.9	44.9	48.6	47.2	47.2	26.6	26.6	38.5	30.9	29.5	32.0	25.2	19.4	19.0
Phosphorus (P)	mg/kg			50	1320	1590	1430	1130	1170	1610	0546	0617	0816	0806	0776	0843	0968	0710	0779
Potassium (K)	mg/kg			100	5770	6070	5950	6580	6590	6350	4190	4020	5150	5200	5070	5440	3580	3040	3080
Selenium (Se)	mg/kg	123	315	0.20	0.42	0.49	0.44	0.39	0.40	0.45	0.38	0.36	0.78	0.28	0.27	0.34	0.37	<0.20	0.20
Silver (Ag)	mg/kg			0.10	0.11	0.12	0.12	0.24	0.27	0.31	<0.10	<0.10	0.13	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	mg/kg			100	1470	1640	1540	1680	1660	1650	0650	0510	0550	1090	1020	1150	0840	0580	0560
Strontium (Sr)	mg/kg			0.50	39.4	42.0	41.4	40.2	44.3	43.0	32.6	29.9	35.4	35.9	33.4	36.1	29.2	24.8	23.7
Sulphur (S)	mg/kg	0.050		500	1800	1500	1800	1700	1400	1400	1000	1200	2200	2800	1700	2200	1900	1000	1400
Thallium (Tl)	mg/kg			0.050	0.288	0.291	0.292	0.311	0.308	0.304	0.278	0.254	0.565	0.243	0.219	0.240	0.159	0.146	0.134
Tin (Sn)	mg/kg			2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	mg/kg			1.0	1260	1390	1370	1530	1530	1470	1190	1120	1380	1410	1370	1350	1030	1040	1040
Uranium (U)	mg/kg	0.050		0.050	2.53	2.53	2.55	2.30	2.42	2.64	1.86	1.64	3.37	1.70	1.58	1.83	2.84	1.79	1.75
Vanadium (V)	mg/kg			0.20	78.7	81.8	79.6	80.1	83.8	86.9	52.4	51.1	69.1	65.9	61.8	65.9	51.7	44.2	45.0
Zinc (Zn)	mg/kg			1.0	92.6	98.7	96.5	106.0	107.0	105.0	61.1	63.9	129.0	88.0	74.8	81.6	60.5	47.6	46.0

Notes:

Shaded cells indicate values that exceed CCME guidelines (light grey ISQG, dark grey PEL).

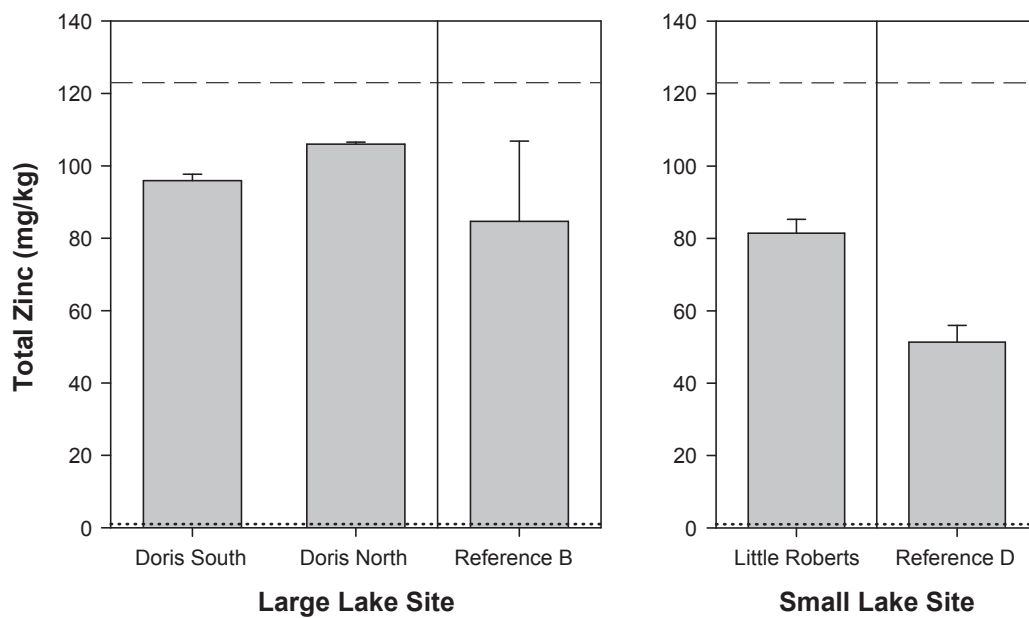
^a Canadian sediment quality guidelines for the protection of freshwater aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b ISQG = Interim Sediment Quality Guideline

^c PEL = Probable Effects Level

Figure A.4-10

**Total Zinc Concentrations
in Lake Sediments, Doris North Project, August 2014**



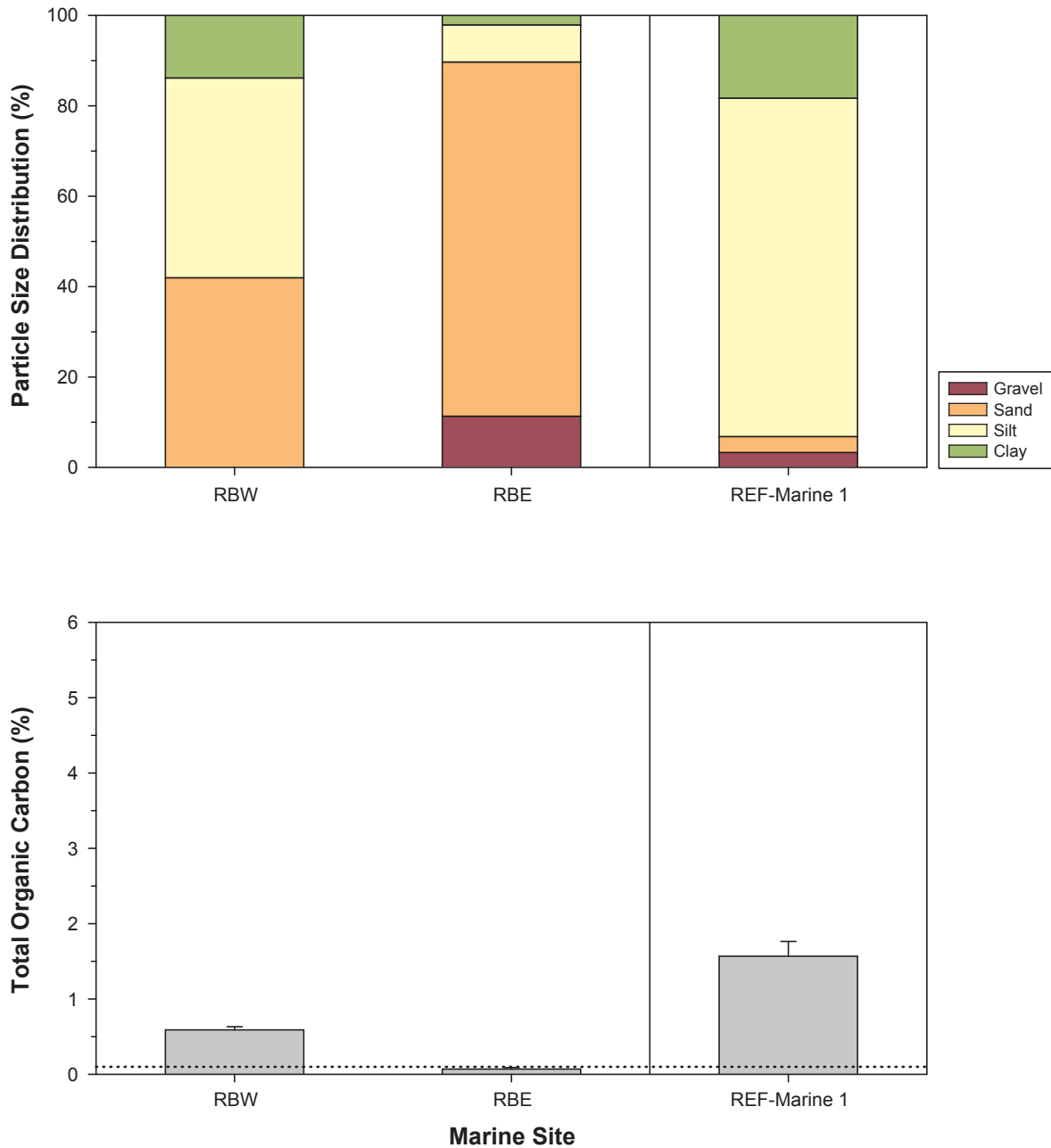
Notes: Error bars represent the standard error of the mean of replicates.

Dotted line represents the analytical detection limit; values below the detection limit are plotted at half the detection limit.

Dashed lines represent the CCME freshwater interim sediment quality guideline (ISQG) for zinc (123 mg/kg); the probable effects level (PEL) for zinc (315 mg/kg) is not shown.

Figure A.4-11

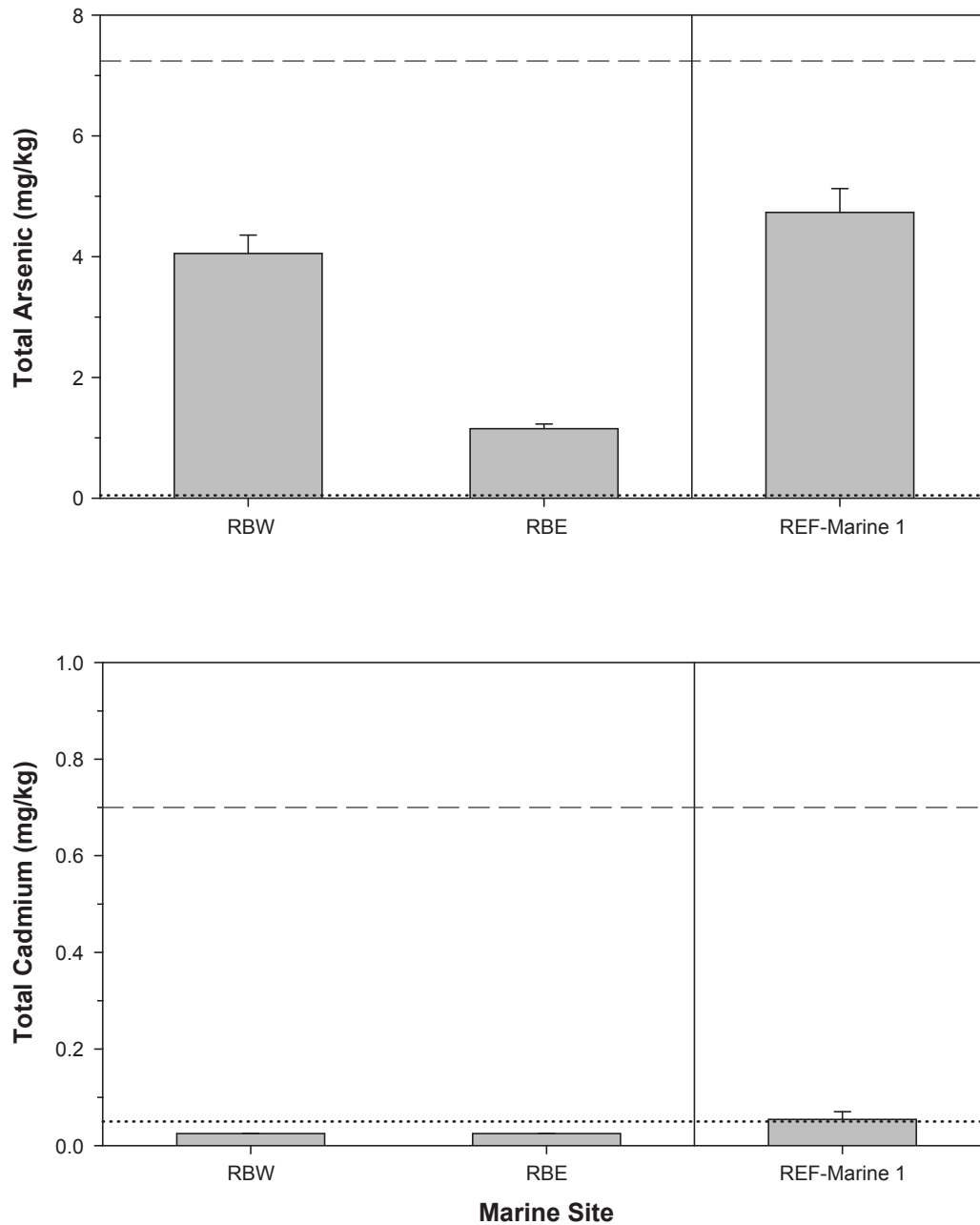
Particle Size Distribution and Total Organic Carbon
in Marine Sediments, Doris North Project, August 2014



Notes: Error bars represent the standard error of the mean of replicates.
Stacked bars represent the mean of replicate samples.
Dotted line represents the analytical detection limit; values below the detection limit are plotted at half the detection limit.
Particle size distribution and total organic carbon content of sediments are required parameters as part of benthic invertebrate surveys as per Schedule 5, s.16a (iii) of the MMER.

Figure A.4-12

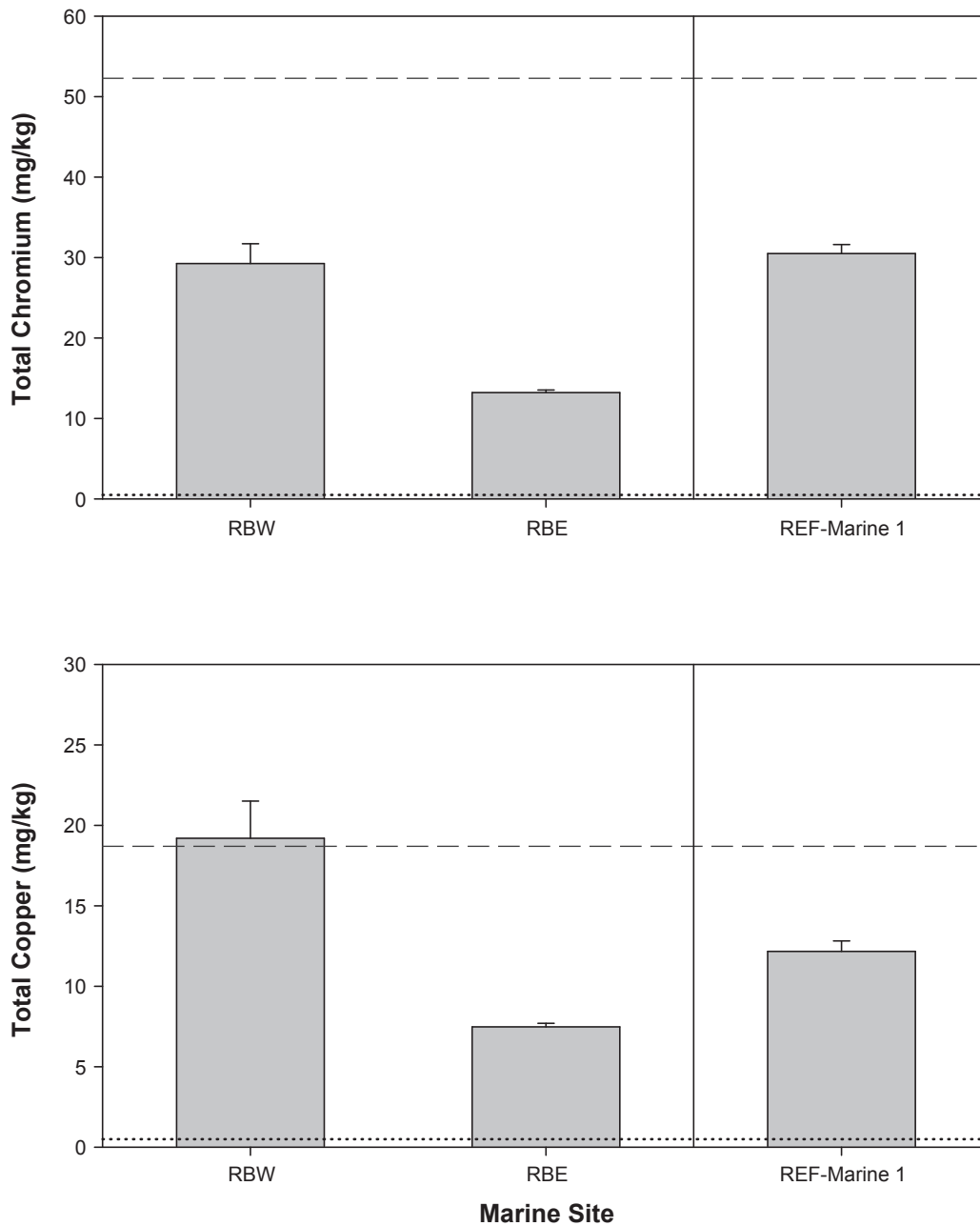
**Total Arsenic and Total Cadmium Concentrations
in Marine Sediments, Doris North Project, August 2014**



Notes: Error bars represent the standard error of the mean of replicates.
Dotted line represents the analytical detection limit; values below the detection limit are plotted at half the detection limit.
Dashed lines represent the CCME marine and estuarine interim sediment quality guidelines (ISQGs) for arsenic (7.24 mg/kg) and cadmium (0.7 mg/kg); probable effects levels (PELs) for arsenic (41.6 mg/kg) and cadmium (4.2 mg/kg) are not shown.

Figure A.4-13

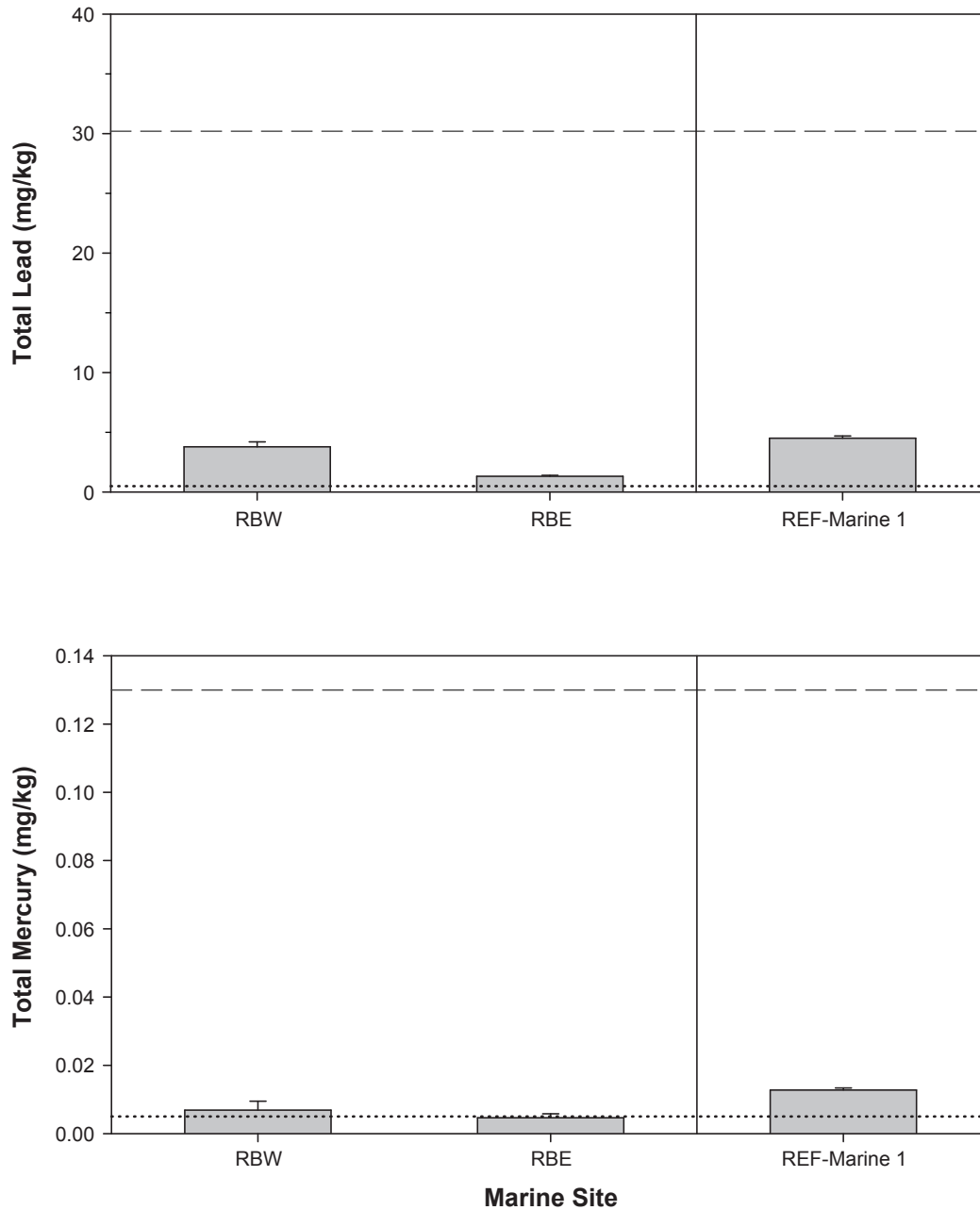
**Total Chromium and Total Copper Concentrations
in Marine Sediments, Doris North Project, August 2014**



Notes: Error bars represent the standard error of the mean of replicates.
Dotted line represents the analytical detection limit; values below the detection limit are plotted at half the detection limit.
Dashed lines represent the CCME marine and estuarine interim sediment quality guidelines (ISQGs) for chromium (52.3 mg/kg) and copper (18.7 mg/kg); probable effects levels (PELs) for chromium (160 mg/kg) and copper (108 mg/kg) are not shown.

Figure A.4-14

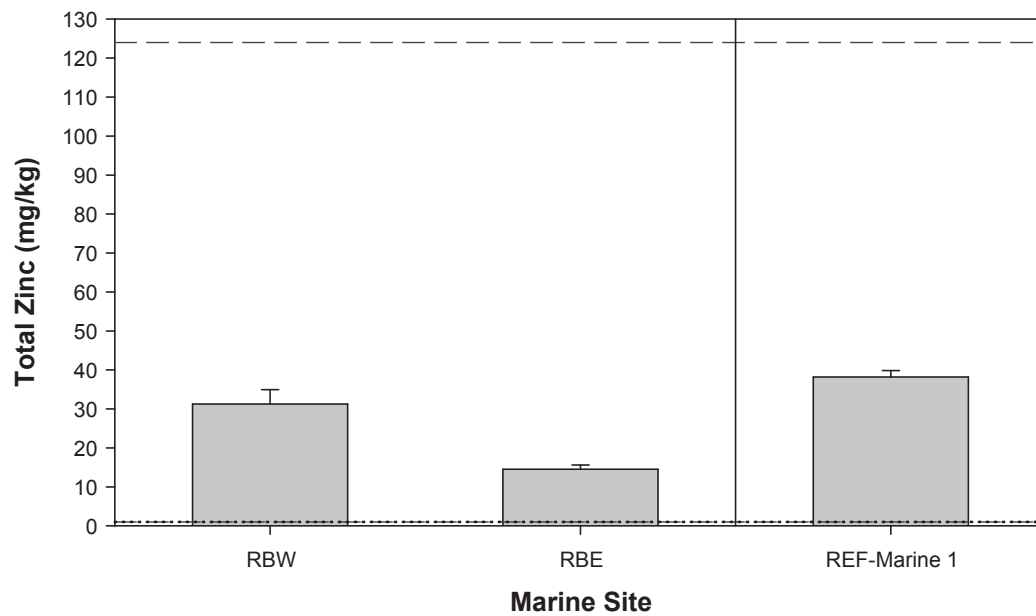
**Total Lead and Total Mercury Concentrations
in Marine Sediments, Doris North Project, August 2014**



Notes: Error bars represent the standard error of the mean of replicates.
Dotted line represents the analytical detection limit; values below the detection limit are plotted at half the detection limit.
Dashed lines represent the CCME marine and estuarine interim sediment quality guidelines (ISQGs) for lead (30.2 mg/kg) and total mercury (0.13 mg/kg); probable effects levels (PELs) for lead (112 mg/kg) and mercury 0.7 mg/kg are not shown.

Figure A.4-15

**Total Zinc Concentrations
in Marine Sediments, Doris North Project, August 2014**



Notes: Error bars represent the standard error of the mean of replicates.

Dotted line represents the analytical detection limit; values below the detection limit are plotted at half the detection limit.

Dashed line represents the CCME marine and estuarine interim sediment quality guideline (ISQG) for zinc (124 mg/kg); probable effects level (PEL) for zinc (271 mg/kg) is not shown.

Annex A.4-3. Marine Sediment Quality Data, Doris North Project, 2014

Site ID: Date Sampled: Replicate: Depth Sampled:		CCME Guidelines for the Protection of Aquatic Life ^a			RBW 13-Aug-14 1 5 L1503361-1	RBW 13-Aug-14 2 4 L1503361-2	RBW 13-Aug-14 3 3.5 L1503361-3	RBE 20-Aug-14 1 0.4 L1506829-1	RBE 20-Aug-14 2 0.4 L1506829-2	RBE 20-Aug-14 3 0.8 L1506829-3	REF- Marine 1 21-Aug-14 1 4.7 L1506829-4	REF- Marine 1 21-Aug-14 2 6 L1506829-5	REF- Marine 1 21-Aug-14 3 8.5 L1506829-6
ALS Sample ID:	Unit	ISQG ^b	PEL ^c	Realized Detection Limit									
Physical Tests													
Moisture	%			0.25	53.60	46.30	33.50	24.90	17.60	17.60	48.70	58.20	53.40
pH	pH			0.10	7.15	7.05	7.46	7.04	6.82	7.21	7.28	7.05	7.08
Particle Size													
% Gravel (>2 mm)	%			0.10	<0.10	<0.10	<0.10	1.22	28.70	4.15	0.25	7.64	2.10
% Sand (2.0 mm - 0.063 mm)	%			0.10	38.20	37.00	50.60	86.30	65.40	83.40	5.47	3.44	1.67
% Silt (0.063 mm - 4 µm)	%			0.10	45.50	48.00	39.10	10.10	4.53	9.95	79.00	67.30	78.30
% Clay (<4 µm)	%			0.10	16.30	15.00	10.30	2.41	1.38	2.51	15.30	21.70	18.00
Texture	-			0	Loam	Loam	Sandy loam	Sand	Sand	Sand	Silt	Silt loam	Silt loam
Anions and Nutrients													
Total Nitrogen	%			0.020	0.069	0.076	0.050	<0.020	<0.020	<0.020	0.130	0.213	0.182
Organic / Inorganic Carbon													
Total Organic Carbon	%			0.10	0.64	0.62	0.51	<0.10	<0.10	0.11	1.23	1.91	1.56
Plant Available Nutrients													
Available Ammonium-N	mg/kg			1 to 2.4	8.1	6.8	9.9	<1.0	<1.0	<1.0	22.6	19.6	13.5
Nitrate+Nitrite-N	mg/kg			2 to 4	<4.0	<4.0	<4.0	<2.0	<2.0	<2.0	<2.0	<4.0	3.5
Available Nitrate-N	mg/kg			2 to 4	<4.0	<4.0	<4.0	<2.0	<2.0	<2.0	<2.0	<4.0	3.5
Available Nitrite-N	mg/kg			0.4 to 0.8	<0.80	<0.80	<0.80	<0.40	<0.40	<0.40	<0.40	<0.80	<0.40
Available Phosphate-P	mg/kg			2.0	18.3	19.3	17.9	11.0	3.3	10.6	30.9	52.3	52.6
Metals													
Aluminum (Al)	mg/kg			50	10300	9400	7350	4890	4140	3940	10700	12000	11300
Antimony (Sb)	mg/kg			0.10	0.11	<0.10	<0.10	<0.10	<0.10	<0.10	0.11	0.14	0.17
Arsenic (As)	mg/kg	7.24	41.6	0.050	4.470	4.230	3.460	1.200	0.999	1.260	4.590	5.480	4.130
Barium (Ba)	mg/kg			0.50	46.70	41.60	31.30	14.40	11.70	13.00	49.60	58.30	54.60
Beryllium (Be)	mg/kg			0.20	0.29	0.23	<0.20	<0.20	<0.20	<0.20	0.33	0.35	0.33
Bismuth (Bi)	mg/kg			0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Cadmium (Cd)	mg/kg	0.7	4.2	0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.059	0.079
Calcium (Ca)	mg/kg			50	4990	4270	3470	1960	1880	2110	5380	9620	5350
Chromium (Cr)	mg/kg	52.3	160	0.50	32.70	30.60	24.50	12.70	13.80	13.20	28.30	32.10	31.10
Cobalt (Co)	mg/kg			0.10	7.49	6.68	5.53	3.97	4.17	3.69	5.47	6.43	6.12
Copper (Cu)	mg/kg	18.7	108	0.50	22.80	19.90	14.90	7.25	7.91	7.28	10.90	12.60	13.00
Iron (Fe)	mg/kg			50	19000	17400	13900	9310	10600	9410	15600	18100	16500
Lead (Pb)	mg/kg	30.2	112	0.50	4.37	4.02	2.99	1.22	1.29	1.48	4.18	4.81	4.56
Lithium (Li)	mg/kg			5.0	18.1	16.6	12.5	8.4	7.2	6.7	19.5	22.7	20.9
Magnesium (Mg)	mg/kg			20	8640	7780	5850	4000	3240	2940	8010	9780	9270
Manganese (Mn)	mg/kg			1.0	204.0	180.0	140.0	99.1	86.2	77.0	171.0	213.0	182.0
Mercury (Hg)	mg/kg	0.13	0.7	0.0050	0.0115	0.0067	<0.0050	0.0052	<0.0050	0.0063	0.0120	0.0140	0.0123
Molybdenum (Mo)	mg/kg			0.50	0.60	0.51	<0.50	<0.50	<0.50	<0.50	0.78	0.98	1.01
Nickel (Ni)	mg/kg			0.50	17.40	15.60	12.80	7.93	7.55	6.69	13.90	16.30	15.70
Phosphorus (P)	mg/kg			50	668	584	581	278	280	327	797	1100	913
Potassium (K)	mg/kg			100	3080	2610	1980	870	690	700	3410	4590	4100
Selenium (Se)	mg/kg			0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	0.24	0.37	0.38
Silver (Ag)	mg/kg			0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Sodium (Na)	mg/kg			100	6740	5710	3080	2710	2200	1320	9350	14300	13500
Strontium (Sr)	mg/kg			0.50	29.50	25.70	20.00	10.10	9.79	11.00	38.10	68.40	48.40
Sulphur (S)	mg/kg			500	1300	1100	1200	800	900	1000	2000	3000	2900
Thallium (Tl)	mg/kg			0.050	0.109	0.096	0.078	0.051	<0.050	<0.050	0.125	0.138	0.137
Tin (Sn)	mg/kg			2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Titanium (Ti)	mg/kg			1.0	743.0	691.0	556.0	352.0	392.0	403.0	858.0	873.0	846.0
Uranium (U)	mg/kg			0.050	0.698	0.642	0.550	0.317	0.395	0.539	1.160	1.290	1.350
Vanadium (V)	mg/kg			0.20	41.00	38.10	30.90	18.70	27.10	23.70	37.60	42.40	41.60
Zinc (Zn)	mg/kg	124	271	1.0	37.2	32.1	24.5	16.6	14.2	12.8	35.2	40.8	38.6

Notes:
Shaded cells indicate values that exceed CCME guidelines (light grey ISQG, dark grey PEL).

^a Canadian sediment quality guidelines for the protection of marine aquatic life, Canadian Council of Ministers of the Environment, 2014.

^b ISQG = Interim Sediment Quality Guideline

^c PEL = Probable Effects Level

A.5 2014 PRIMARY PRODUCERS

The following sections present the periphyton and phytoplankton biomass (as chlorophyll *a*) data collected from April to September 2014 at stream, lake, and marine sites.

A.5.1 Stream Data

Stream periphyton sampling plates were installed three times in AEMP streams in 2014 (in June, July, and August), and were retrieved after approximately one month (in July, August, and September, respectively). Figure A.5-1 shows the average periphyton biomass concentrations measured in streams. Annex A.5-1 presents the full periphyton biomass dataset.

A.5.2 Lake Data

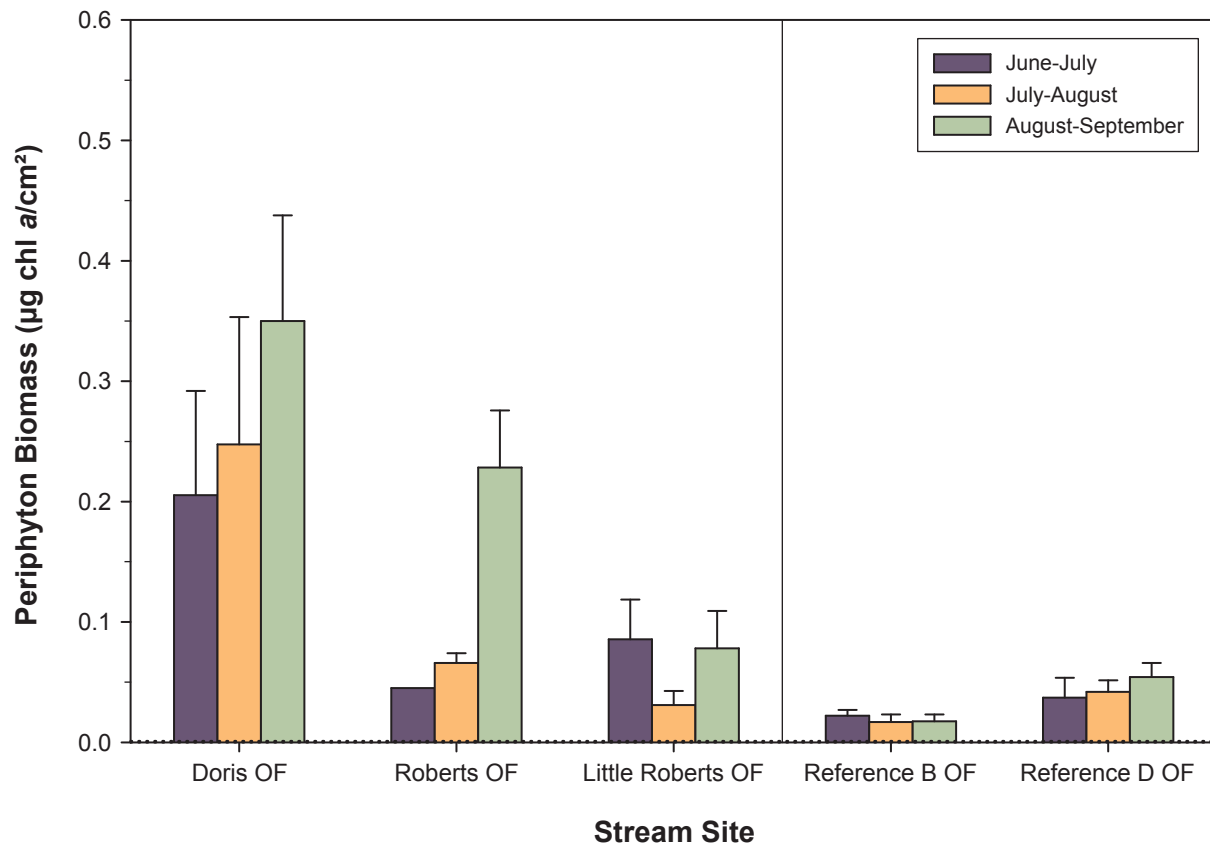
Lake phytoplankton samples were collected in April (under-ice sampling) and monthly from July to September 2014. Figure A.5-2 shows the average phytoplankton biomass concentrations measured in lakes. Annex A.5-2 presents the full phytoplankton biomass dataset.

A.5.3 Marine Data

Marine phytoplankton samples were collected in April (under-ice sampling) and monthly from July to September 2014. Figure A.5-3 shows the average phytoplankton biomass concentrations measured at marine sites. Annex A.5-3 presents the full phytoplankton biomass dataset.

Figure A5-1

Periphyton Biomass (as Chlorophyll *a*)
in Stream Sites, Doris North Project, 2014



Notes: Error bars represent the standard error of the mean.
Black dotted line represents analytical detection limit.

Annex A.5-1. Stream Periphyton Biomass Data, Doris North Project, 2014

Stream Site	Date Sampler Installed	Date Sampler Retrieved	Number of Days Immersed	Area sampled (cm ²)	ALS Sample ID	Replicate #	Periphyton Biomass (µg chl <i>a</i> /cm ²)	Mean	SE
Doris OF	19-Jun-14	17-Jul-14	28	100	L1491820-1	1	0.12	0.21	0.09
Doris OF	19-Jun-14	17-Jul-14	28	100	L1491820-2	2	0.29		
Doris OF	19-Jun-14	17-Jul-14	28	100	L1491820-3	3*	-		
Doris OF	17-Jul-14	16-Aug-14	30	100	L1512032-13	1	0.10	0.25	0.11
Doris OF	17-Jul-14	16-Aug-14	30	100	L1512032-14	2	0.19		
Doris OF	17-Jul-14	16-Aug-14	30	100	L1512032-15	3	0.45		
Doris OF	16-Aug-14	17-Sep-14	32	100	L1526667-1	1	0.42	0.35	0.09
Doris OF	16-Aug-14	17-Sep-14	32	100	L1526667-2	2	0.46		
Doris OF	16-Aug-14	17-Sep-14	32	100	L1526667-3	3	0.18		
Roberts OF [†]	18-Jun-14	17-Jul-14	29	100	L1491820-4	1	0.05	0.05	0.00
Roberts OF	17-Jul-14	16-Aug-14	30	100	L1512032-10	1	0.05	0.07	0.01
Roberts OF	17-Jul-14	16-Aug-14	30	100	L1512032-11	2	0.08		
Roberts OF	17-Jul-14	16-Aug-14	30	100	L1512032-12	3	0.07		
Roberts OF	16-Aug-14	18-Sep-14	33	100	L1526667-16	1	0.30	0.23	0.05
Roberts OF	16-Aug-14	18-Sep-14	33	100	L1526667-17	2	0.14		
Roberts OF	16-Aug-14	18-Sep-14	33	100	L1526667-18	3	0.24		
Little Roberts OF	18-Jun-14	17-Jul-14	29	100	L1491820-5	1	0.15	0.09	0.03
Little Roberts OF	18-Jun-14	17-Jul-14	29	100	L1491820-6	2	0.06		
Little Roberts OF	18-Jun-14	17-Jul-14	29	100	L1491820-7	3	0.05		
Little Roberts OF	17-Jul-14	15-Aug-14	29	100	L1512032-7	1	0.03	0.03	0.01
Little Roberts OF	17-Jul-14	15-Aug-14	29	100	L1512032-8	2	0.05		
Little Roberts OF	17-Jul-14	15-Aug-14	29	100	L1512032-9	3	0.01		
Little Roberts OF	15-Aug-14	17-Sep-14	33	100	L1526667-13	1	0.05	0.08	0.03
Little Roberts OF	15-Aug-14	17-Sep-14	33	100	L1526667-14	2	0.14		
Little Roberts OF	15-Aug-14	17-Sep-14	33	100	L1526667-15	3	0.05		
Reference B OF	19-Jun-14	16-Jul-14	27	100	L1491820-8	1	0.01	0.02	0.00
Reference B OF	19-Jun-14	16-Jul-14	27	100	L1491820-9	2	0.02		
Reference B OF	19-Jun-14	16-Jul-14	27	100	L1491820-10	3	0.03		
Reference B OF	16-Jul-14	15-Aug-14	30	100	L1512032-4	1	0.01	0.02	0.01
Reference B OF	16-Jul-14	15-Aug-14	30	100	L1512032-5	2	0.03		
Reference B OF	16-Jul-14	15-Aug-14	30	100	L1512032-6	3	0.01		
Reference B OF	15-Aug-14	18-Sep-14	34	100	L1526667-7	1	0.01	0.02	0.01
Reference B OF	15-Aug-14	18-Sep-14	34	100	L1526667-8	2	0.02		
Reference B OF	15-Aug-14	18-Sep-14	34	100	L1526667-9	3	0.02		
Reference D OF	18-Jun-14	16-Jul-14	28	100	L1491820-11	1	0.07	0.04	0.02
Reference D OF	18-Jun-14	16-Jul-14	28	100	L1491820-12	2	0.03		
Reference D OF	18-Jun-14	16-Jul-14	28	100	L1491820-25	3	0.02		
Reference D OF	16-Jul-14	14-Aug-14	29	100	L1512032-1	1	0.03	0.04	0.01
Reference D OF	16-Jul-14	14-Aug-14	29	100	L1512032-2	2	0.06		
Reference D OF	16-Jul-14	14-Aug-14	29	100	L1512032-3	3	0.03		
Reference D OF	14-Aug-14	17-Sep-14	34	100	L1526667-4	1	0.06	0.05	0.01
Reference D OF	14-Aug-14	17-Sep-14	34	100	L1526667-5	2	0.07		
Reference D OF	14-Aug-14	17-Sep-14	34	100	L1526667-6	3	0.03		

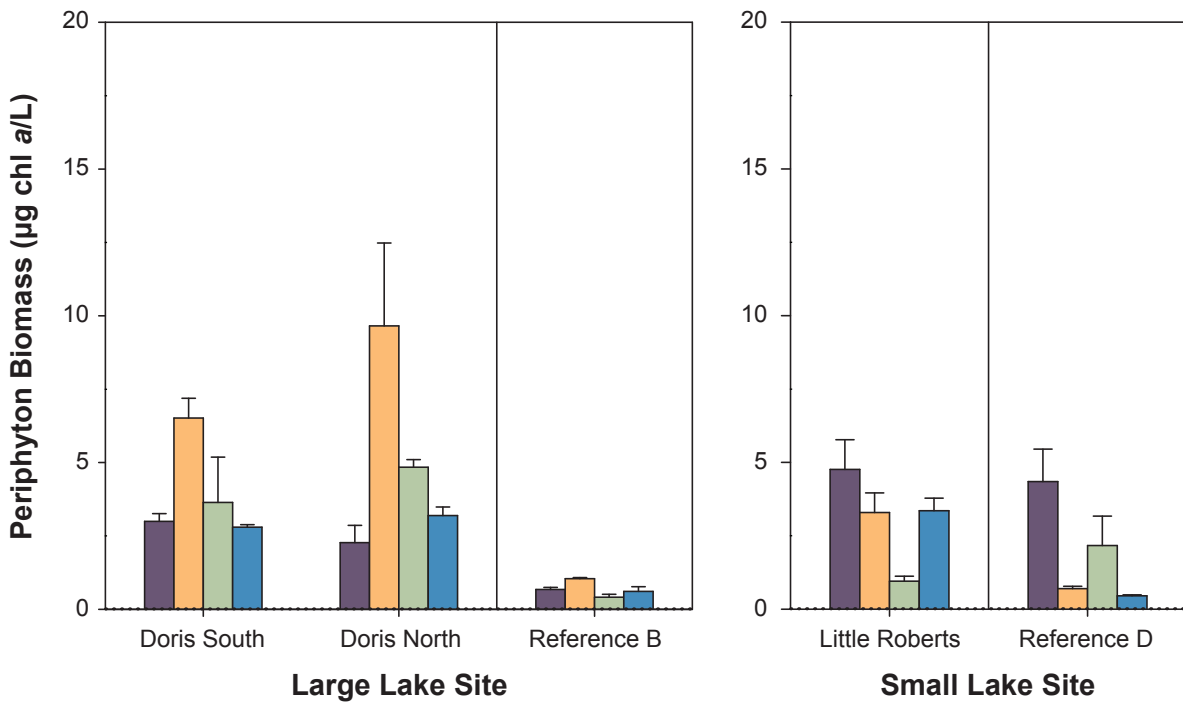
SE = standard error of the mean

*Raw data (µg) could not be converted to µg/cm² because the volume of sample filtered was not recorded

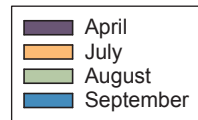
[†] only one replicate was retrieved, the remainder of plates placed in June at Roberts OF were found exposed above the water surface in July

Figure A.5-2

Phytoplankton Biomass (as Chlorophyll *a*) in
Lake Sites, Doris North Project, 2014



Notes: Error bars represent the standard error of the mean of the mean.
Dotted lines represent the analytical detection limit of 0.01 µg.



Annex A.5-2. Lake Phytoplankton Biomass Data, Doris North Project, 2014

Lake Site	Date Sampled	Depth Sampled	ALS Sample ID	Replicate #	Phytoplankton Biomass (µg chl <i>a</i> /L)	Mean	SE
Doris Lake South	19-APR-14	2 m	L1447653-13	1	3.20	2.99	0.26
Doris Lake South	19-APR-14	2 m	L1447653-14	2	3.31		
Doris Lake South	19-APR-14	2 m	L1447653-15	3	2.47		
Doris Lake South	20-JUL-14	1 m	L1491820-14	1	6.80	6.52	0.67
Doris Lake South	20-JUL-14	1 m	L1491820-15	2	5.24		
Doris Lake South	20-JUL-14	1 m	L1491820-16	3	7.52		
Doris Lake South	19-AUG-14	1 m	L1511953-10	1	6.70	3.64	1.54
Doris Lake South	19-AUG-14	1 m	L1511953-11	2	1.76		
Doris Lake South	19-AUG-14	1 m	L1511953-12	3	2.46		
Doris Lake South	20-SEP-14	1 m	L1526667-28	1	0.01	1.87	0.93
Doris Lake South	20-SEP-14	1 m	L1526667-29	2	2.88		
Doris Lake South	20-SEP-14	1 m	L1526667-30	3	2.72		
Doris Lake North	19-APR-14	3 m	L1447653-16	1	3.31	2.27	0.59
Doris Lake North	19-APR-14	3 m	L1447653-17	2	1.28		
Doris Lake North	19-APR-14	3 m	L1447653-18	3	2.22		
Doris Lake North	20-JUL-14	1 m	L1491820-35	1	0.02	6.45	3.60
Doris Lake North	20-JUL-14	1 m	L1491820-36	2	12.48		
Doris Lake North	20-JUL-14	1 m	L1491820-13	3	6.84		
Doris Lake North	19-AUG-14	1 m	L1511953-7	1	4.58	4.84	0.26
Doris Lake North	19-AUG-14	1 m	L1511953-8	2	5.36		
Doris Lake North	19-AUG-14	1 m	L1511953-9	3	4.58		
Doris Lake North	20-SEP-14	1 m	L1526667-25	1	2.74	3.19	0.29
Doris Lake North	20-SEP-14	1 m	L1526667-26	2	3.10		
Doris Lake North	20-SEP-14	1 m	L1526667-27	3	3.74		
Reference Lake B	20-APR-14	3 m	L1447653-22	1	0.77	0.68	0.07
Reference Lake B	20-APR-14	3 m	L1447653-23	2	0.72		
Reference Lake B	20-APR-14	3 m	L1447653-24	3	0.54		
Reference Lake B	19-JUL-14	1 m	L1491820-26	1	1.06	1.04	0.04
Reference Lake B	19-JUL-14	1 m	L1491820-27	2	0.97		
Reference Lake B	19-JUL-14	1 m	L1491820-28	3	1.10		
Reference Lake B	23-AUG-14	1 m	L1511953-13	1	0.23	0.41	0.10
Reference Lake B	23-AUG-14	1 m	L1511953-14	2	0.54		
Reference Lake B	23-AUG-14	1 m	L1511953-15	3	0.47		
Reference Lake B	18-SEP-14	1 m	L1526667-10	1	0.93	0.61	0.16
Reference Lake B	18-SEP-14	1 m	L1526667-11	2	0.47		
Reference Lake B	18-SEP-14	1 m	L1526667-12	3	0.42		
Little Roberts Lake	23-APR-14	2 m	L1447653-42	1	6.29	4.76	1.01
Little Roberts Lake	23-APR-14	2 m	L1447653-43	2	5.15		
Little Roberts Lake	23-APR-14	2 m	L1447653-44	3	2.84		
Little Roberts Lake	19-JUL-14	1 m	L1491820-29	1	4.40	3.29	0.67
Little Roberts Lake	19-JUL-14	1 m	L1491820-30	2	2.10		
Little Roberts Lake	19-JUL-14	1 m	L1491820-31	3	3.38		
Little Roberts Lake	17-AUG-14	1 m	L1511953-1	1	1.15	0.95	0.17
Little Roberts Lake	17-AUG-14	1 m	L1511953-2	2	1.09		
Little Roberts Lake	17-AUG-14	1 m	L1511953-3	3	0.61		
Little Roberts Lake	19-SEP-14	0 m	L1526667-22	1	3.30	3.35	0.43
Little Roberts Lake	19-SEP-14	0 m	L1526667-23	2	2.64		
Little Roberts Lake	19-SEP-14	0 m	L1526667-24	3	4.12		
Reference Lake D	24-APR-14	2.5 m	L1447653-39	1	2.15	4.35	1.10
Reference Lake D	24-APR-14	2.5 m	L1447653-40	2	5.24		
Reference Lake D	24-APR-14	2.5 m	L1447653-41	3	5.65		
Reference Lake D	19-JUL-14	1 m	L1491820-32	1	0.85	0.70	0.08
Reference Lake D	19-JUL-14	1 m	L1491820-33	2	0.57		
Reference Lake D	19-JUL-14	1 m	L1491820-34	3	0.67		
Reference Lake D	18-AUG-14	1 m	L1511953-4	1	0.52	2.17	1.00
Reference Lake D	18-AUG-14	1 m	L1511953-5	2	2.00		
Reference Lake D	18-AUG-14	1 m	L1511953-6	3	3.98		
Reference Lake D	19-SEP-14	1 m	L1526667-19	1	0.42	0.45	0.03
Reference Lake D	19-SEP-14	1 m	L1526667-20	2	0.49		
Reference Lake D	19-SEP-14	1 m	L1526667-21	3*	-		

SE = standard error of the mean

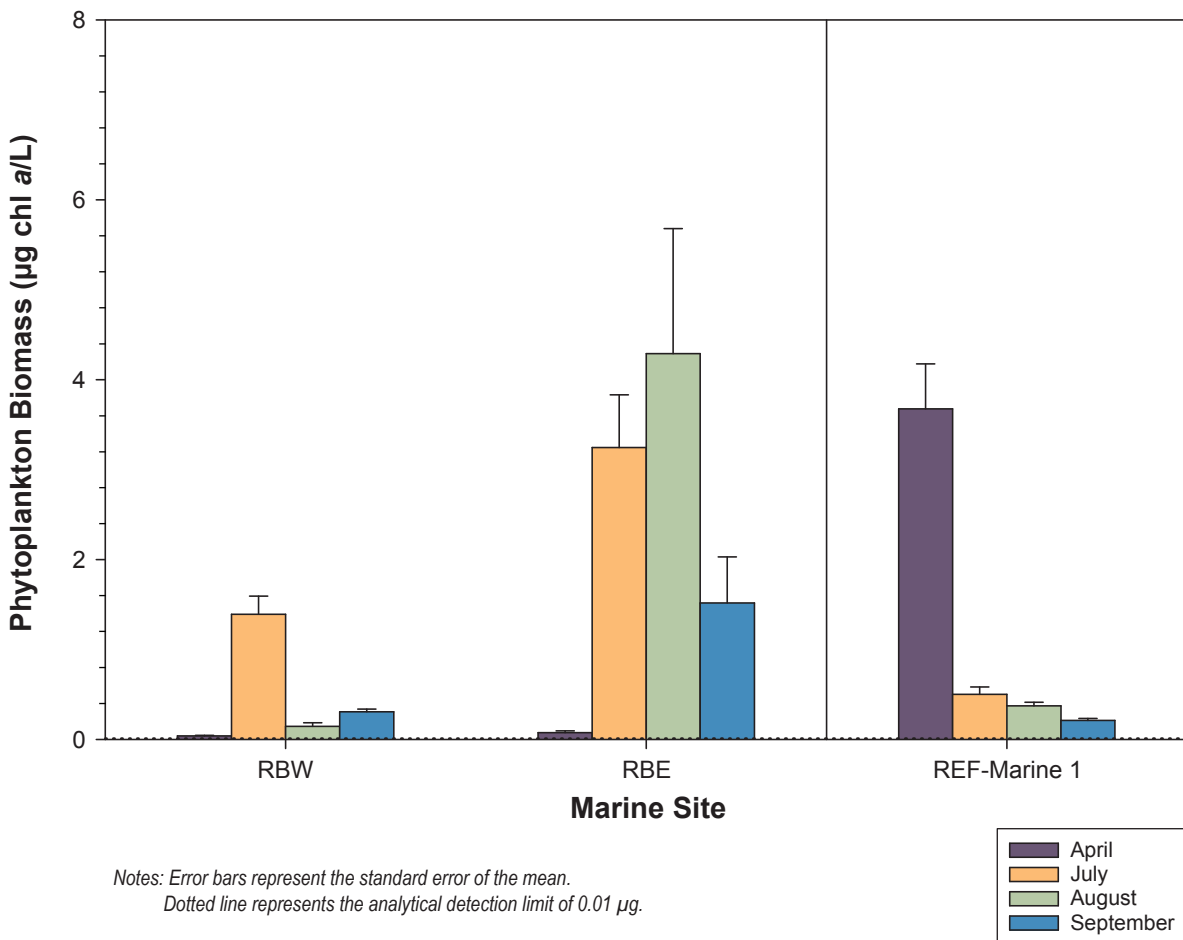
Little Roberts Lake site was too shallow for sampling at 1 m depth in September

April depths are recorded as depth from water surface and equal approximately 0 to 1 m below ice

*Raw data (µg) could not be converted to µg/L because the volume of sample filtered was not recorded.

Figure A.5-3

Phytoplankton Biomass (as Chlorophyll *a*) in
Marine Sites, Doris North Project, 2014



Annex A.5-3. Marine Phytoplankton Biomass Data, Doris North Project, 2014

Marine Site	Date Sampled	Depth Sampled	ALS Sample ID	Replicate #	Phytoplankton Biomass ($\mu\text{g chl } a/\text{L}$)	Mean	SE
RBW	20-APR-14	2 m	L1447653-19	1	0.05	0.04	0.01
RBW	20-APR-14	2 m	L1447653-20	2	0.04		
RBW	20-APR-14	2 m	L1447653-21	3	0.03		
RBW	21-JUL-14	1 m	L1491820-23	1	1.68	1.39	0.20
RBW	21-JUL-14	1 m	L1491820-24	2	1.49		
RBW	21-JUL-14	1 m	L1491820-37	3	1.00		
RBW	13-AUG-14	1 m	L1512016-1	1	0.22	0.14	0.04
RBW	13-AUG-14	1 m	L1512016-2	2	0.09		
RBW	13-AUG-14	1 m	L1512016-3	3	0.12		
RBW	21-SEP-14	1 m	L1526667-34	1	0.36	0.31	0.03
RBW	21-SEP-14	1 m	L1526667-35	2	0.30		
RBW	21-SEP-14	1 m	L1526667-36	3	0.26		
RBE	23-APR-14	2 m	L1447653-33	1	0.05	0.08	0.02
RBE	23-APR-14	2 m	L1447653-34	2	0.11		
RBE	23-APR-14	2 m	L1447653-35	3	0.06		
RBE	21-JUL-14	0 m	L1491820-20	1	2.10	3.25	0.59
RBE	21-JUL-14	0 m	L1491820-21	2	3.60		
RBE	21-JUL-14	0 m	L1491820-22	3	4.04		
RBE	14-AUG-14	0.2 m	L1512016-4	1	2.90	2.86	1.64
RBE	14-AUG-14	0.2 m	L1512016-5	2	0.01		
RBE	14-AUG-14	0.2 m	L1512016-6	3	5.68		
RBE	21-SEP-14	0.2 m	L1526667-31	1	1.21	1.52	0.51
RBE	21-SEP-14	0.2 m	L1526667-32	2	2.52		
RBE	21-SEP-14	0.2 m	L1526667-33	3	0.82		
REF-Marine 1	24-APR-14	3 m	L1447653-36	1	3.28	3.68	0.50
REF-Marine 1	24-APR-14	3 m	L1447653-37	2	4.67		
REF-Marine 1	24-APR-14	3 m	L1447653-38	3	3.08		
REF-Marine 1	20-JUL-14	1 m	L1491820-17	1	0.63	0.50	0.08
REF-Marine 1	20-JUL-14	1 m	L1491820-18	2	0.35		
REF-Marine 1	20-JUL-14	1 m	L1491820-19	3	0.53		
REF-Marine 1	21-AUG-14	1 m	L1512016-7	1	0.33	0.37	0.04
REF-Marine 1	21-AUG-14	1 m	L1512016-8	2	0.34		
REF-Marine 1	21-AUG-14	1 m	L1512016-9	3	0.45		
REF-Marine 1	21-SEP-14	1 m	L1526667-37	1	0.19	0.21	0.02
REF-Marine 1	21-SEP-14	1 m	L1526667-38	2	0.19		
REF-Marine 1	21-SEP-14	1 m	L1526667-39	3	0.26		

SE = standard error of the mean

RBE site was too shallow for sampling at 1 m depth

April depths are recorded as depth from water surface and equal approximately 0 to 1 m below ice

A.6 2014 BENTHIC INVERTEBRATES

The following sections present the benthic invertebrate taxonomy data collected in August 2014 from stream, lake, and marine sites. Benthos data were used to calculate several community descriptors including: total density, taxa richness, evenness, diversity, and the Bray-Curtis Index. Details of these calculations are provided in the main body of the report.

A.6.1 Stream Data

Figure A.6-1 presents the average density and taxonomic composition of benthos community at stream sites. Figure A.6-2 presents the average family richness, Simpson's Evenness Index, and Simpson's Diversity Index. Figure A.6-3 presents the average Bray-Curtis Index. Annex A.6-1 provides the full stream benthos taxonomy dataset, and Annex A.6-2 presents the summary statistics calculated for the community descriptors.

A.6.2 Lake Data

Figure A.6-4 presents the average density and taxonomic composition of the lake benthos community at lake sites. Figure A.6-5 presents the average family richness, Simpson's Evenness Index, and Simpson's Diversity Index. Figure A.6-6 presents the average Bray-Curtis Index. Annex A.6-3 provides the full lake benthos taxonomy dataset, and Annex A.6-4 presents the summary statistics calculated for the community descriptors.

A.6.3 Marine Data

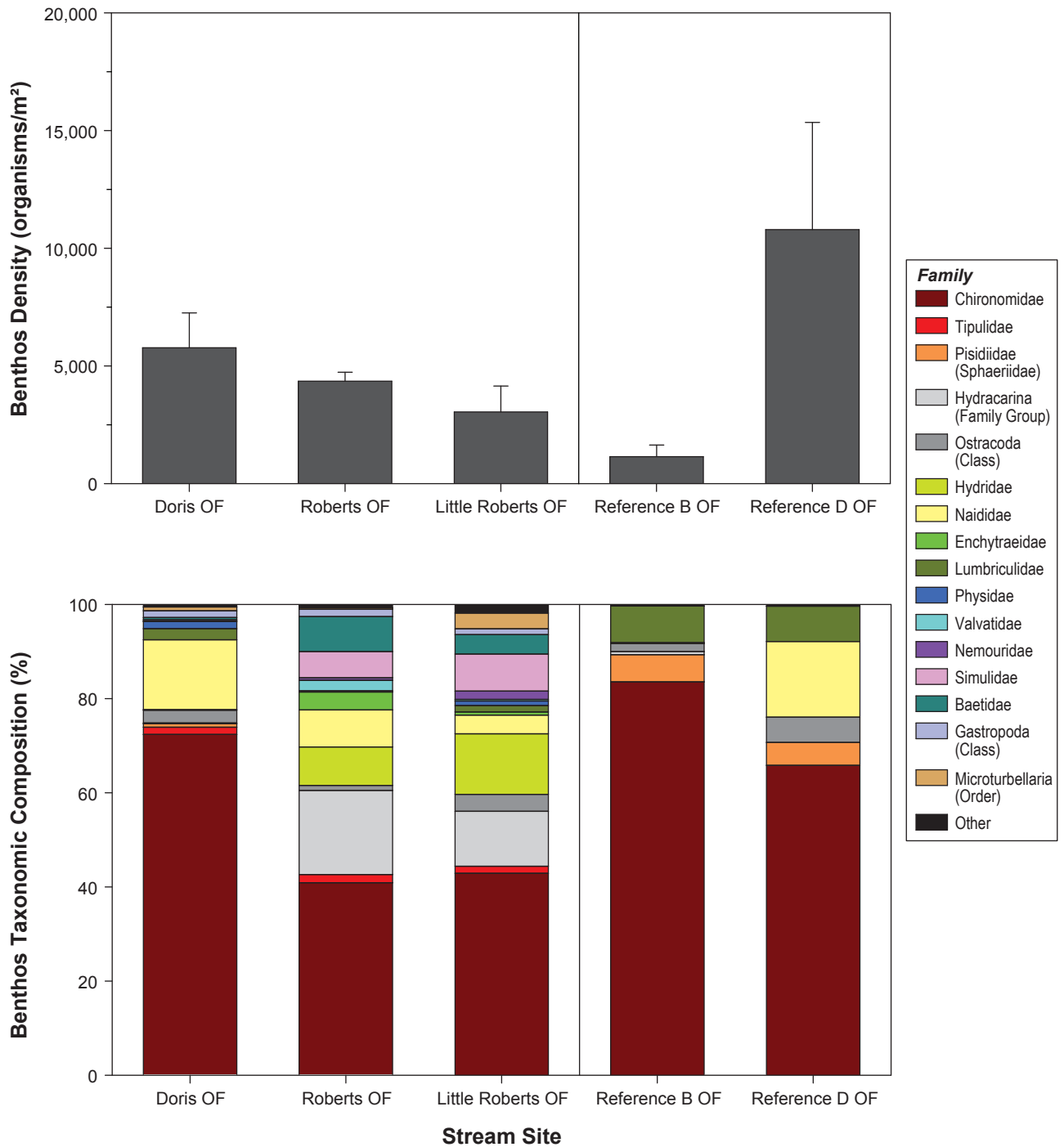
Figure A.6-7 presents the average density and taxonomic composition of the benthos community at marine sites. Figure A.6-8 presents the average family richness, Simpson's Evenness Index, and Simpson's Diversity Index. Figure A.6-9 presents the average Bray-Curtis Index. Annex A.6-5 provides the full marine benthos taxonomy dataset, and Annex A.6-6 presents the summary statistics calculated for the community descriptors.

A.6.4 Quality Assurance/Quality Control (QA/QC) Data

A re-sorting of randomly selected sample residues was conducted by taxonomists on a minimum of 10% of the benthos samples to determine the level of sorting efficiency. Results of this QA/QC procedure are provided in Annex A.6-7.

Figure A.6-1

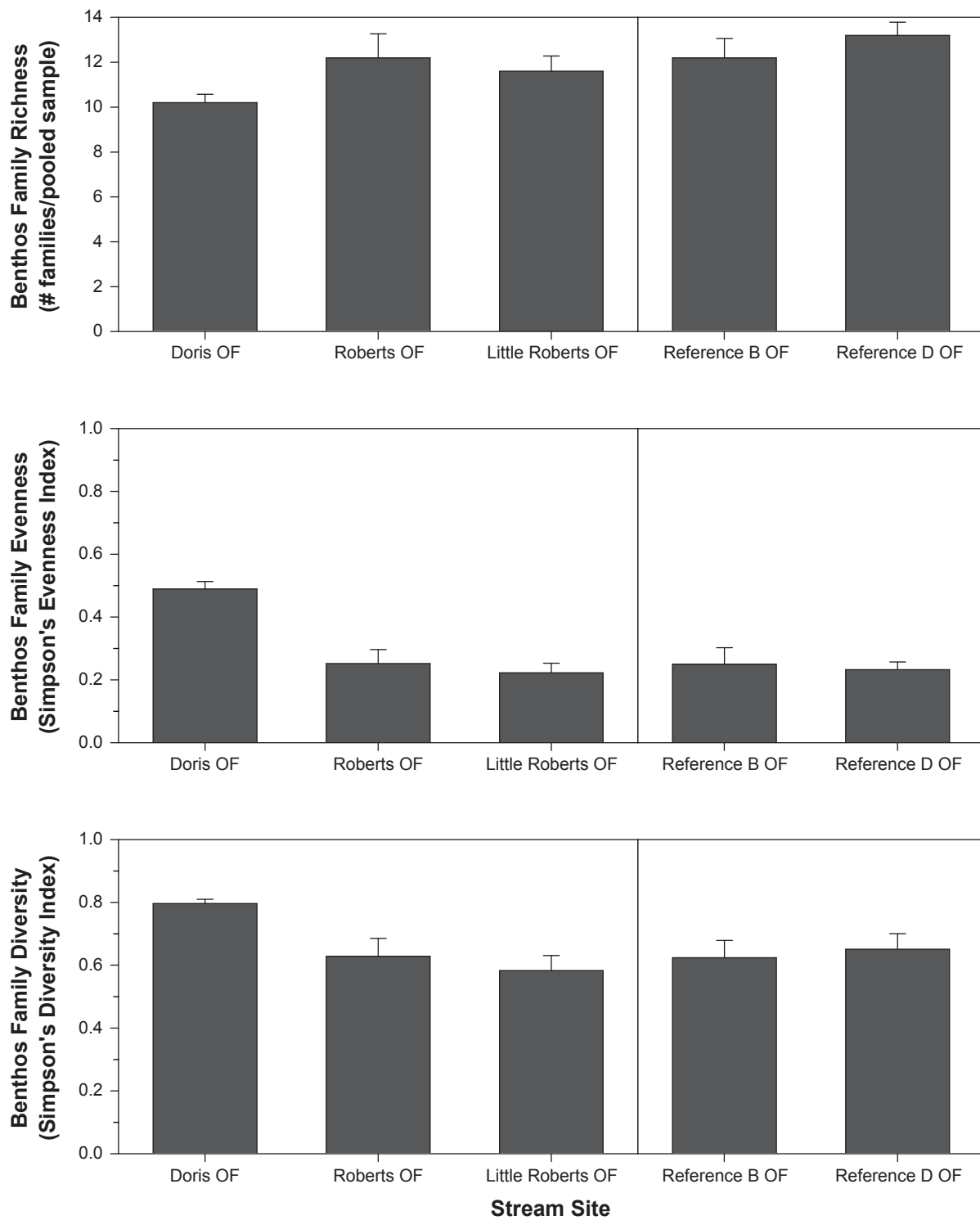
Benthos Density and Taxonomic Composition
in Stream Sites, Doris North Project, August 2014



Notes: Error bars represent the standard error of the mean of replicates.
Stacked bars represent the mean of replicate samples.

Figure A.6-2

Benthos Richness, Evenness, and Diversity in
Stream Sites, Doris North Project, August 2014



Note: Error bars represent the standard error of the mean of replicates.

Annex A.6-1. Stream Benthos Taxonomy Data, Doris North Project, 2014

					Roberts OF 16-Aug-14					Little Roberts OF 15-Aug-14					Doris OF 16-Aug-14																			
Major Group	Family	Subfamily	Tribe	Genus	Rep-1	Rep-2	Rep-3	Rep-4	Rep-5	Rep-1	Rep-2	Rep-3	Rep-4	Rep-5	Rep-1	Rep-2	Rep-3	Rep-4	Rep-5															
Coelenterata	Hydridae	-	-	<i>Hydra</i>	25	104	24	8	80	1	15	30	104	64	48	72	96	176	208															
Microturbellaria	-	-	-	-	8					32					9					8					24									
Nematoda*	-	-	-	-	64	228	201	42	86	17	46	19	264	196	46	133	328	47	27															
Oligochaeta	Enchytraeidae	-	-	-	32					16					110					178														
	Lumbriculidae	-	-	-	26	6	5	13		3	4	13	8	10	76	376	832	160	120															
	Naididae	Naidinae	-	-											10					20					24					2				
	Naididae	Naidinae	-	<i>Nais</i>											3					1										16				
	Naididae	Tubificinae	-	-	8	19	73	39	103	8	37	1	36	24	57	9	333	176	72															
Gastropoda	-	-	-	(i/d)																120														
	Physidae	-	-	<i>Physa</i>						1																								
	Valvatidae	-	-	<i>Valvata sincera</i>																														
Pelecypoda	Pisidiidae	-	-	(i/d)																														
		-	-	<i>Pisidium</i>											1																			
Hydracarina	-	-	-	(i/d)											1					5					32									
	Hygrobatidae	-	-	<i>Atractides</i>						2					7																			
		-	-	<i>Hygrobates</i>											2																			
	Lebertiidae	-	-	<i>Lebertia</i>	2	2	3	15		3	11	4						16	8															
	Sperchontidae	-	-	<i>Sperchon</i>	52	78	71	89	53	5	39	114	156	106	68	96	632	96	128															
Copepoda - Calanoida*	-	-	-	-	16					4	10	20	16	64	416	32	256	112	64															
Copepoda - Cyclopoida*	-	-	-	-						1	1																							
Ostracoda	-	-	-	-	88	24	48	216		27	24	32							80															
Cladocera*	Chydoridae	-	-	<i>Eurycercus</i>																8					16									
	Daphnidae	-	-	<i>Daphnia</i>						2					1																			
Isopoda	Chaetiliidae	-	-	<i>Saduria entomon</i>	1																													
Ephemeroptera	Baetidae	-	-	<i>Acentrella</i>	6	5	7	7	1	10					1					160	184	160	208	48										
	Baetidae	-	-	<i>Baetis</i>	4	5	10	3	12	2	14	87	172	66	20	32	96	56																
	Baetidae	-	-	<i>Baetis bicaudatus</i>						1					13																			
	Baetidae	-	-	<i>Baetis tricaudatus</i> group	2	1	2	5	2	3					70	196	93	4	16	24	16	40												
	Ephemerellidae	-	-	<i>Ephemerella</i>																														
	Heptageniidae	-	-	<i>Maccaffertium</i>																														
Plecoptera	Nemouridae	-	-	<i>Nemoura</i>	6	5	5	1			5	15	24	9	4	8																		
Trichoptera	Brachycentridae	-	-	<i>Brachycentrus</i>																														
		-	-	<i>Micrasema</i>																														
	Hydroptilidae	-	-	<i>Agraylea</i>																														
	Limnephilidae	-	-	(i/d)	1																													
		-	-	<i>Philarctus bergrothi</i>											4																			
Coleoptera	Dytiscidae	-	-	(i/d)																														
	Dytiscidae	-	-	<i>Oreodytes</i>																														
	Haliplidae	-	-	<i>Haliplus</i>																														

Notes:

* Taxa marked with an asterisk were excluded from total counts and from all benthos analyses.

i/d = immature or damaged

Cladocerans and cyclopoid copepods were excluded because they are generally planktonic.

Nematodes and harpacticoid copepods were excluded because they are meiofauna and are not adequately sampled using a 500 um sieve bucket.

Immature/damaged organisms that were not identifiable to the family level were excluded from the community analysis.

Terrestrial organisms were excluded because they are not aquatic invertebrates.

Annex A.6-1. Stream Benthos Taxonomy Data, Doris North Project, 2014

					Reference D OF 14-Aug-14					Reference B OF 15-Aug-14				
Major Group	Family	Subfamily	Tribe	Genus	Rep-1	Rep-2	Rep-3	Rep-4	Rep-5	Rep-1	Rep-2	Rep-3	Rep-4	Rep-5
Coelenterata	Hydridae	-	-	<i>Hydra</i>	136	105		3640	602					4
Microturbellaria	-	-	-	-						3	6	3	12	14
Nematoda*	-	-	-	-	36	8	37	139	7	4	1	1	53	20
Oligochaeta	Enchytraeidae	-	-	-			8					4		
	Lumbriculidae	-	-	-		1	9	17	12	3		5	44	36
	Naididae	Naidinae	-	-			8							
	Naididae	Naidinae	-	<i>Nais</i>	33	192		260	200	2	2	3	16	16
	Naididae	Tubificinae	-	-			8					3	9	9
Gastropoda	-	-	-	(i/d)				20		1	1	4	2	46
	Physidae	-	-	<i>Physa</i>						2		4		49
	Valvatidae	-	-	<i>Valvata sincera</i>	23	9	86		29	1				
Pelecypoda	Pisidiidae	-	-	(i/d)									12	
		-	-	<i>Pisidium</i>	1								4	3
Hydracarina	-	-	-	(i/d)	40	17	8	40	40					
	Hygrobatidae	-	-	Atractides			1							1
		-	-	<i>Hygrobates</i>	1		25							
	Lebertiidae	-	-	<i>Lebertia</i>	1	2	14	8	6		2			
	Sperchontidae	-	-	<i>Sperchon</i>	386	186	266	716	616	24	3			5
Copepoda - Calanoida*	-	-	-	-										
Copepoda – Cyclopoida*	-	-	-	-							1	8	12	
Ostracoda	-	-	-	-				60		2	5	7	72	20
Cladocera*	Chydoridae	-	-	<i>Eurycerus</i>								19	55	5
	Daphnidae	-	-	<i>Daphnia</i>										
Isopoda	Chaetiliidae	-	-	<i>Saduria entomon</i>										
Ephemeroptera	Baetidae	-	-	<i>Acentrella</i>										
	Baetidae	-	-	<i>Baetis</i>	59	14	41	104	67	7	1	1		9
	Baetidae	-	-	<i>Baetis bicaudatus</i>										
	Baetidae	-	-	<i>Baetis tricaudatus</i> group	30	27	9	24	82	4		4		6
	Ephemerellidae	-	-	<i>Ephemerella</i>	1					1			4	
	Heptageniidae	-	-	<i>Maccaffertium</i>		1								
Plecoptera	Nemouridae	-	-	<i>Nemoura</i>	26	7	8	68	79	2	2		4	
Trichoptera	Brachycentridae	-	-	<i>Brachycentrus</i>	4		5		4	4	1			
		-	-	<i>Micrasema</i>		8	9		73					
	Hydroptilidae	-	-	<i>Agraylea</i>					1					
	Limnephilidae	-	-	(i/d)										1
		-	-	<i>Philarctus bergrothi</i>										
Coleoptera	Dytiscidae	-	-	(i/d)									7	2
	Dytiscidae	-	-	<i>Oreodytes</i>			7							3
	Haliplidae	-	-	<i>Haliplus</i>					1					

Notes:

* Taxa marked with an asterisk were excluded from total counts and from all benthos analyses.

i/d = immature or damaged

Cladocerans and cyclopoid copepods were excluded because they are generally planktonic.

Nematodes and harpacticoid copepods were excluded because they are meiofauna and are not adequately sampled using a 500 um sieve bucket.

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Annex A.6-1. Stream Benthos Taxonomy Data, Doris North Project, 2014

					Roberts OF 16-Aug-14					Little Roberts OF 15-Aug-14					Doris OF 16-Aug-14				
Major Group	Family	Subfamily	Tribe	Genus	Rep-1	Rep-2	Rep-3	Rep-4	Rep-5	Rep-1	Rep-2	Rep-3	Rep-4	Rep-5	Rep-1	Rep-2	Rep-3	Rep-4	Rep-5
Diptera	Chironomidae	-	-	(pupa)	74	90	53	41	110	10	4	16	12	43	4	16	8	16	48
		Tanypodinae	Pentaneurini	(i/d)						1									
				<i>Thienemannimyia</i> group	227	276	174	36	114	30	63	124	168	86		72	96	8	32
		Diamesinae	Procladiini	<i>Procladius</i>															
			Diamesini	<i>Potthastia longimana</i> group					1										
				<i>Pseudokiefferiella parva</i>	10	11	12	27	10		1	8	468	212	1		24		32
		Orthoclaadiinae	-	(i/d)															
			Orthoclaadiini	<i>Cricotopus</i> / <i>Orthocladius</i>	153	114	182	33	202	9	9			8	25			16	16
		Chironominae	Chironomini	<i>Corynoneura</i>															16
				<i>Eukiefferiella</i>											48	8	168	56	248
				<i>Euryhopsis</i>	1					1		1	48	30	8	8	8		8
				<i>Heterotanytarsus</i>															
				<i>Nanocladius</i>		8													
				<i>Parakiefferiella</i>	32	16	32	1		11	1	5	48	8	32	32	176	16	32
				<i>Psectrocladius</i>						13			8						
				<i>Synorthocladius semivirens</i>		8	8	1											
				<i>Tvetenia</i>	27	20	42	93	32	2	11	17	108	47	31	64	168	176	96
				<i>Zalutschia</i>						1									
				(i/d)						5									
				<i>Cryptochironomus</i>	1					1			4						
				<i>Demicryptochironomus</i>															
				<i>Dicrotendipes</i>						1	7	1							
				<i>Glyptotendipes</i>														8	
				<i>Parachironomus</i>															
				<i>Polypedilum</i>	8								8						
				<i>Sergenta</i>						17									
				<i>Stictochironomus</i>	135	171	79	1	51	8	25	6	20	10		8	16	8	
			Pseudochironomini	<i>Pseudochironomus</i>							1					8			
			Tanytarsini	<i>Cladotanytarsus</i>		8	8			1	2	5	8		8	8			
				<i>Constempellina</i>	40	40	80		16		1		8			16	32		16
				<i>Paratanytarsus</i>	8					59	75			8					16
				<i>Rheotanytarsus</i>		1					1	5	88	43					
				<i>Tanytarsus</i>	48	112	64		8	5	1	10	144	128	24	16		16	16
				<i>Clinocera</i>		1			1										
	Empididae	-	-																
	Muscidae	-	-	<i>Limnophora</i>															
	Simulidae	-	-	adult	1			2	1	1				1		8			24
	Simulidae	-	-	pupa	54	59	127	69	142	1	3	13	44	46	52	64	88	8	128
		-	-	<i>Metacnephia</i>		6	22	16	43			1	8	12	32		8	16	8
		-	-	<i>Prosimulium</i>											4		24	8	8
		-	-	<i>Simulium</i>	40	41	97	358	112		1	2	40	83	16	32	136	24	64
	Tipulidae	-	-	<i>Tipula</i>	28	39	34	27	65	7	36	16	20	7	19	48	93	59	52
Terrestrial*	-	-	-	-		18	1	2					8		4	8			
Total number of individuals					1170	1557	1480	1027	1701	272	477	632	2276	1406	1217	1402	3850	1692	1655

Notes:

* Taxa marked with an asterisk were excluded from total counts and from all benthos analyses.

i/d = immature or damaged

Cladocerans and cyclopoid copepods were excluded because they are generally planktonic.

Nematodes and harpacticoid copepods were excluded because they are meiofauna and are not adequately sampled using a 500 um sieve bucket.

Immature/damaged organisms that were not identifiable to the family level were excluded from the community analysis.

Terrestrial organisms were excluded because they are not aquatic invertebrates.

Annex A.6-1. Stream Benthos Taxonomy Data, Doris North Project, 2014

					Reference D OF 14-Aug-14					Reference B OF 15-Aug-14				
Major Group	Family	Subfamily	Tribe	Genus	Rep-1	Rep-2	Rep-3	Rep-4	Rep-5	Rep-1	Rep-2	Rep-3	Rep-4	Rep-5
Diptera	Chironomidae	-	-	(pupa)	29	1	8	88			4			8
		Tanypodinae	Pentaneurini	(i/d)										
				<i>Thienemannimyia</i> group	86	17	1	48	83	4	2	2	6	36
		Diamesinae	Procladiini	<i>Procladius</i>									24	5
			Diamesini	<i>Potthastia longimana</i> group	1	1								
				<i>Pseudokiefferiella parva</i>	389	107	180	1435	381	6	1			1
		Orthoclaadiinae	-	(i/d)						1				
				<i>Cricotopus</i> / <i>Orthocladius</i>	136	74	16	160	162	4	1	1		4
				<i>Corynoneura</i>							1	1		
				<i>Eukiefferiella</i>	88	34	33		123	7	3	2		
				<i>Euryhapsis</i>	159	16	45	36	85	3				6
				<i>Heterotanytarsus</i>					40					20
				<i>Nanocladius</i>										
				<i>Parakiefferiella</i>										
				<i>Psectrocladius</i>								20	175	20
				<i>Synorthocladius semivirens</i>										
				<i>Tvetenia</i>	152	32	50	197	133	8	1			4
				<i>Zalutschia</i>										
		Chironominae	Chironomini	(i/d)										
				<i>Cryptochironomus</i>		1						1	1	3
				<i>Demicryptochironomus</i>										6
				<i>Dicrotendipes</i>		26	2		1	1	5	2	11	59
				<i>Glyptotendipes</i>										
				<i>Parachironomus</i>						1				
				<i>Polypedilum</i>	24									1
				<i>Sergenta</i>									16	
				<i>Stictochironomus</i>								3	74	56
			Pseudochironomini	<i>Pseudochironomus</i>										
			Tanytarsini	<i>Cladotanytarsus</i>	8									
				<i>Constempellina</i>										
				<i>Paratanytarsus</i>	8	8		48	1		1	23	150	67
				<i>Rheotanytarsus</i>	449	86	8	1032	215	6				
				<i>Tanytarsus</i>	80	24		40	40	8	1	18	20	104
				<i>Clinocera</i>								1		
				<i>Limnophora</i>									1	
	Empididae	-	-	adult			2		1	9	3	2	1	9
		-	-	pupa	35		10	24	15	11	2			
		-	-	<i>Metacnephia</i>	1	8	13			5	1			
		-	-	<i>Prosimulium</i>					1					
		-	-	<i>Simulium</i>	17		34	8	41	4	1			
		-	-											
		-	-											
		-	-											
	Tipulidae	-	-	<i>Tipula</i>	5	8	4	4	2			9	23	29
Terrestrial*	-	-	-	-						2	2			9
Total number of individuals					2444	1020	955	8216	3143	140	54	151	808	696

Notes:

* Taxa marked with an asterisk were excluded from total counts and from all benthos analyses.

i/d = immature or damaged

Cladocerans and cyclopoid copepods were excluded because they are generally planktonic.

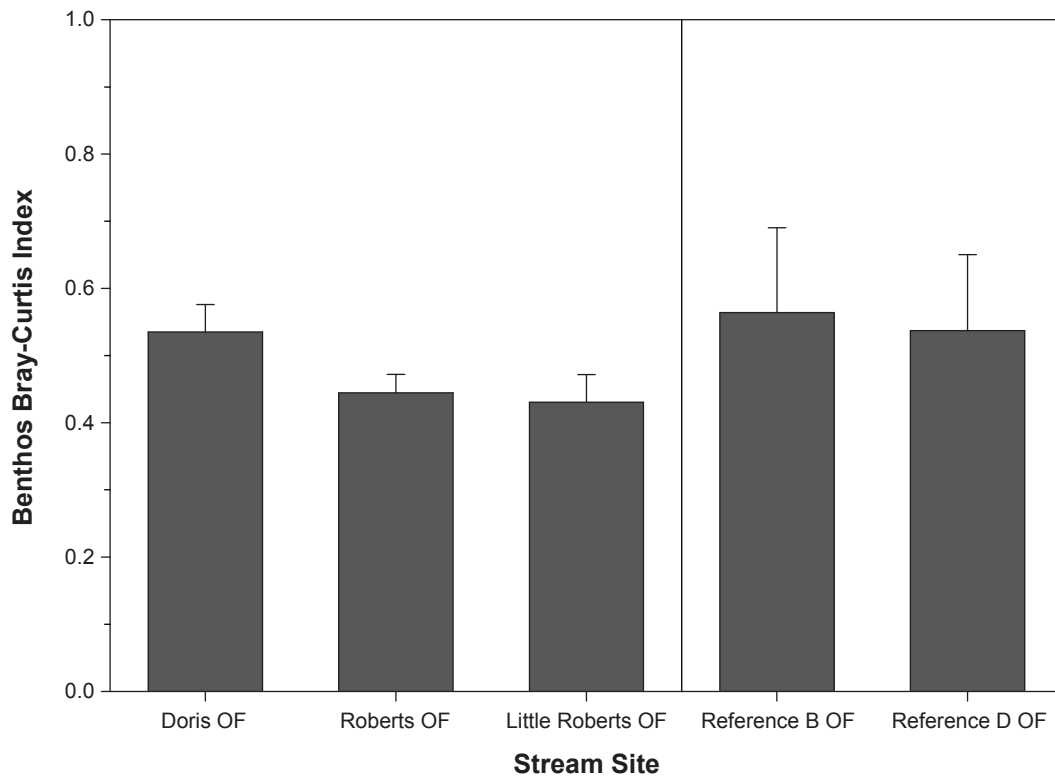
Nematodes and harpacticoid copepods were excluded because they are meiofauna and are not adequately sampled using a 500 um sieve bucket.

Immature/damaged organisms that were not identifiable to the family level were excluded from the community analysis.

Terrestrial organisms were excluded because they are not aquatic invertebrates.

Figure A.6-3

Benthos Bray-Curtis Index for Stream Sites,
Doris North Project, August 2014



Note: Error bars represent the standard error of the mean of replicates.

Annex A.6-2. Stream Benthos Summary Statistics, Doris North Project, 2014

	Doris OF					
	Min	Max	Median	Mean	SD	SE
Density (#/m ²)	2,608	11,340	5,323	5,777	3,306	1,479
Family Richness	9.0	11.0	10.0	10.2	0.8	0.4
Simpson's Diversity Index	0.76	0.83	0.80	0.80	0.03	0.01
Simpson's Evenness Index	0.42	0.55	0.48	0.49	0.05	0.02
Bray-Curtis Index	0.44	0.69	0.51	0.54	0.09	0.04

	Little Roberts OF					
	Min	Max	Median	Mean	SD	SE
Density (#/m ²)	861	6,903	2,059	3,051	2,451	1,096
Family Richness	10.0	13.0	12.0	11.6	1.5	0.7
Simpson's Diversity Index	0.48	0.71	0.56	0.58	0.11	0.05
Simpson's Evenness Index	0.15	0.31	0.23	0.22	0.07	0.03
Bray-Curtis Index	0.31	0.53	0.41	0.43	0.09	0.04

	Roberts OF					
	Min	Max	Median	Mean	SD	SE
Density (#/m ²)	3,358	5,608	4,438	4,359	848	379
Family Richness	9.0	15.0	12.0	12.2	2.4	1.1
Simpson's Diversity Index	0.49	0.81	0.61	0.63	0.13	0.06
Simpson's Evenness Index	0.15	0.37	0.22	0.25	0.10	0.04
Bray-Curtis Index	0.39	0.51	0.41	0.44	0.06	0.03

	Reference B OF					
	Min	Max	Median	Mean	SD	SE
Density (#/m ²)	174	2,389	465	1,151	1,095	490
Family Richness	10.0	15.0	12.0	12.2	1.9	0.9
Simpson's Diversity Index	0.50	0.77	0.57	0.62	0.12	0.05
Simpson's Evenness Index	0.15	0.43	0.21	0.25	0.12	0.05
Bray-Curtis Index	0.24	0.87	0.69	0.56	0.28	0.13

	Reference D OF					
	Min	Max	Median	Mean	SD	SE
Density (#/m ²)	3,188	28,045	8,361	10,799	10,178	4,552
Family Richness	11.0	14.0	14.0	13.2	1.3	0.6
Simpson's Diversity Index	0.47	0.73	0.71	0.65	0.11	0.05
Simpson's Evenness Index	0.13	0.26	0.26	0.23	0.06	0.02
Bray-Curtis Index	0.26	0.86	0.59	0.54	0.25	0.11

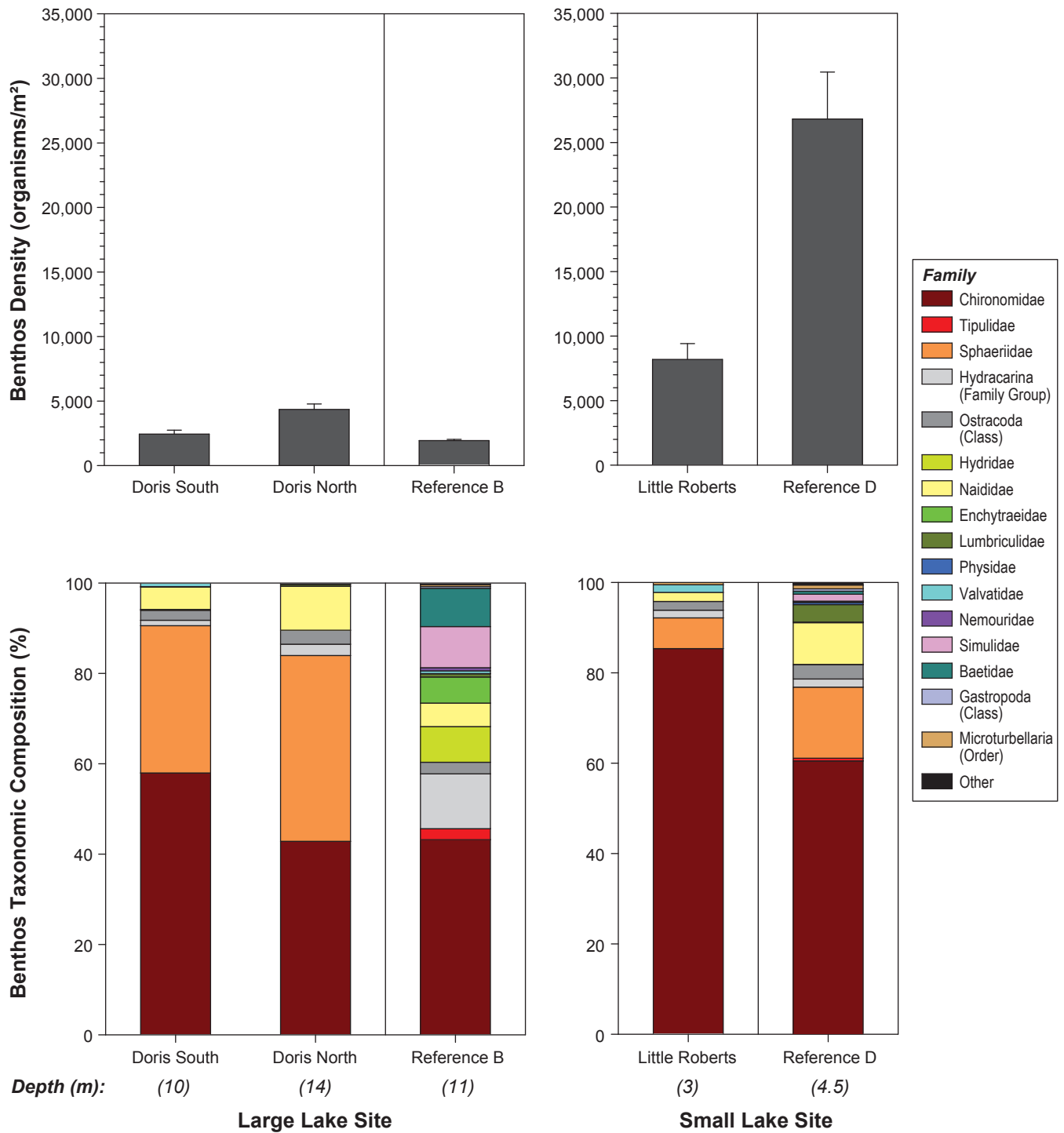
Notes:

SD - Standard deviation of the mean

SE - Standard error of the mean

Figure A.6-4

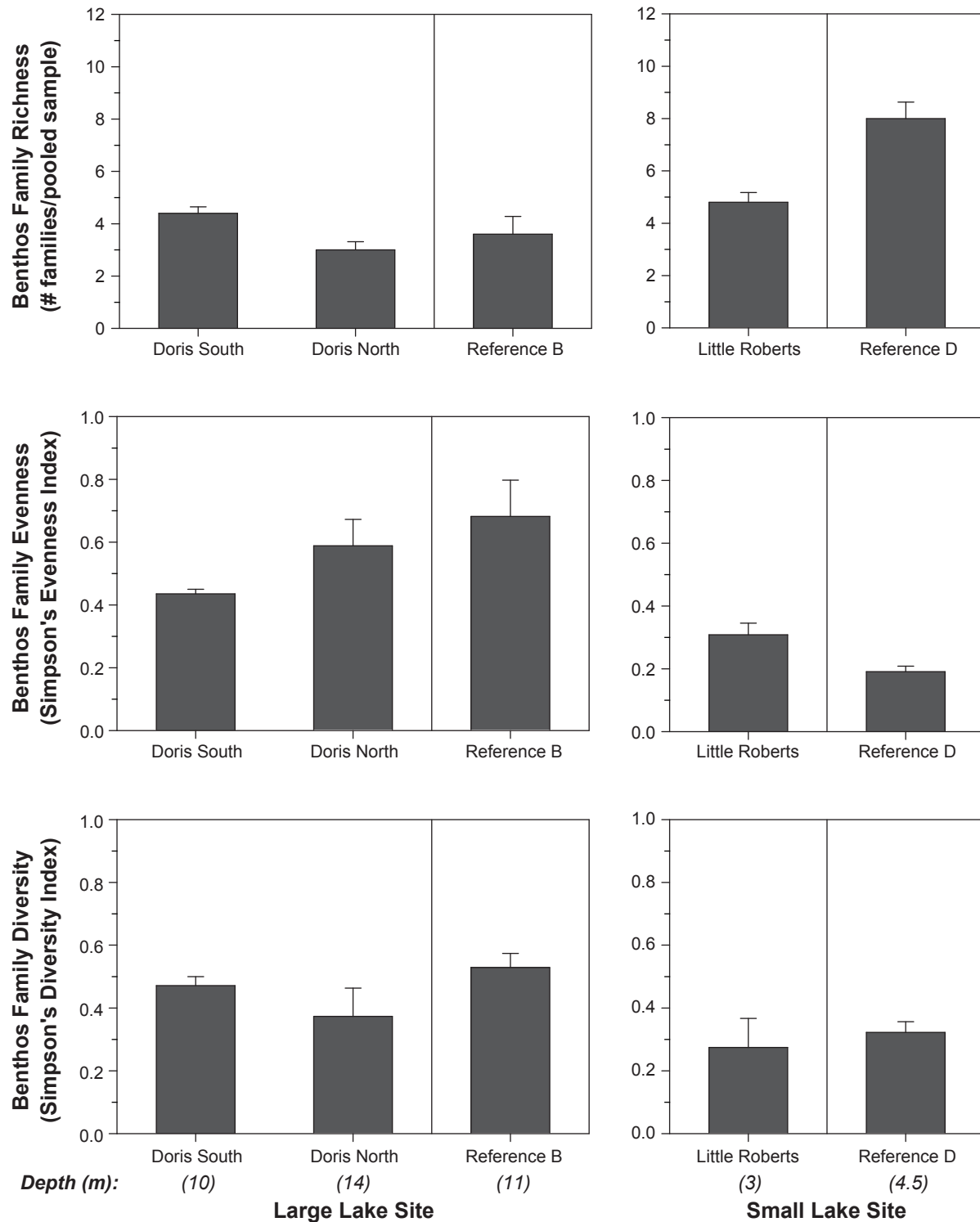
**Benthos Density and Taxonomic Composition
in Lake Sites, Doris North Project, August 2014**



Notes: Error bars represent the standard error of the mean of replicates.
Stacked bars represent the mean of replicate samples.

Figure A.6-5

Benthos Richness, Evenness, and Diversity in Lake Sites, Doris North Project, August 2014



Note: Error bars represent the standard error of the mean of replicates.

Annex A.6-3. Lake Benthos Taxonomy Data, Doris North Project, 2014

Major GroupFamilySubfamilyTribeGenus					Doris Lake North					Doris Lake South					Little Roberts Lake					Reference B Lake					Reference D Lake							
					20-Aug-14					19-Aug-14					17-Aug-14					23-Aug-14					18-Aug-14							
Rep-1	Rep-2	Rep-3	Rep-4	Rep-5	Rep-1	Rep-2	Rep-3	Rep-4	Rep-5	Rep-1	Rep-2	Rep-3	Rep-4	Rep-5	Rep-1	Rep-2	Rep-3	Rep-4	Rep-5	Rep-1	Rep-2	Rep-3	Rep-4	Rep-5	Rep-1	Rep-2	Rep-3	Rep-4	Rep-5			
Coelenterata	Hydridae	-	-	Hydra																												
Microturbellaria	-	-	-	-																												
Nematoda*	-	-	-	-						2		1			8	26	2	1	4	13	22	8	24	37	136	65	264	96	48			
Oligochaeta	Lumbriculidae	-	-	-						16	21	24	34	22											6							
	Naididae	Tubificinae	-	-	1	92	87	131	148								8			24	32	7	22		4	58	80	68	12			
Gastropoda	Valvatidae	-	-	Valvata sincera																					32	4	28	44	20			
Pelecypoda	Pisidiidae	-	-	(i/ d)	1			1		1		1			24		8	74	6	22	42	63	30	20	84	69	208	104				
		-	-	Sphaerium											1					1		1	2	4	8	4		4				
		-	-	Pisidium			1			12	23	6	10	10	12	20	14	82	42	51	10	42	61	50	44	72	84	44	100			
Hydracarina	-	-	-	(i/ d)																						4						
	Lebertiidae	-	-	Lebertia												3	8	1	1						8		16		16			
	Oxidae	-	-	Oxus											8			8	35							4			16			
	Sperchontidae	-	-	Sperchon																					16							
	Unionicolidae	-	-	Neumania														1							20	8	32	20	8			
Copepoda - Calanoida*	-	-	-	-						1	4	2	1	6		8																
Copepoda - Cyclopoida*	-	-	-	-																1					16	8	16	32	8			
Ostracoda	-	-	-	-						27	20	5	7	3	8			24	37	1					80	56	32	80				
Cladocera*	Chydoridae	-	-	Eurycercus																			1						64			
	Daphnidae	-	-	Daphnia																							16		8			
Malacostraca	Mysidae	-	-	Mysis relicta					1						1					1												
Notostraca	Triopsidae	-	-	Lepidurus												1				1												
Isopoda	Chaetiliidae	-	-	Saduria entomon					1		2		2																			
Diptera	Chironomidae	-	-	(pupa)	2		1		1	5	2	2	6	8	8		8		16		1	1						4				
		Tanypodinae	Pentaneurini	Ablabesmyia													8		8	3		1					12	12		8		
				Thienemannimyia group															76													
			Procladiini	Procladius				1	2	2	3	3		3	54	67		166	74	2	1	9	2	3	81	43	30	17	24			
		Diamesinae	Protanypini	Protanypus																2			4	1	2							
		Prodiamesinae		Monodiamesa						22	14	14	18	10					1	4			6	3		4						
		Orthocladiinae	Orthocladiini	Abyskomyia																							4					
				Heterotrissocladius																												
				Psectrocladius						1															1				1	8		
				Zalutschia																						32	25	7	14	28		
			Chironominae	Chironomini	Chironomus	217	223	144	240	174			1		1	81	218	340	26	6								40	41	44	52	4
		Cladopelma																										4				
		Cryptochironomus																										6	2		2	
		Parachironomus																													4	
		Sergenta																	2	155	14										220	
		Stictochironomus										22	6	3	8	19	3	2		4	10										8	
					Tanytarsini	(i/ d)																8										
		Cladotanytarsus																													16	
		Constempellina													1																	
		Corynocera																										1				
		Paratanytarsus									1						8	17	25	3					1	1	12	56	80	4	12	
		Rheotanytarsus																	2													
		Stempellinella																														
		Tanytarsus									128	82	69	81	44	265	172	291	123	73							2	1	1	4	3	
				Chelifera/Metachela																									4			
Terrestrial	-	-	-	-																1		1	1									
Total number of individuals					221	315	233	373	327	240	178	131	167	126	472	533	774	709	328	158	141	150	161	153	1872	1155	2837	2223	1739			

Notes:

* Taxa marked with an asterisk were excluded from total counts and from all benthos analyses.

i/d = immature or damaged

Cladocerans and cyclopoid copepods were excluded because they are generally planktonic.

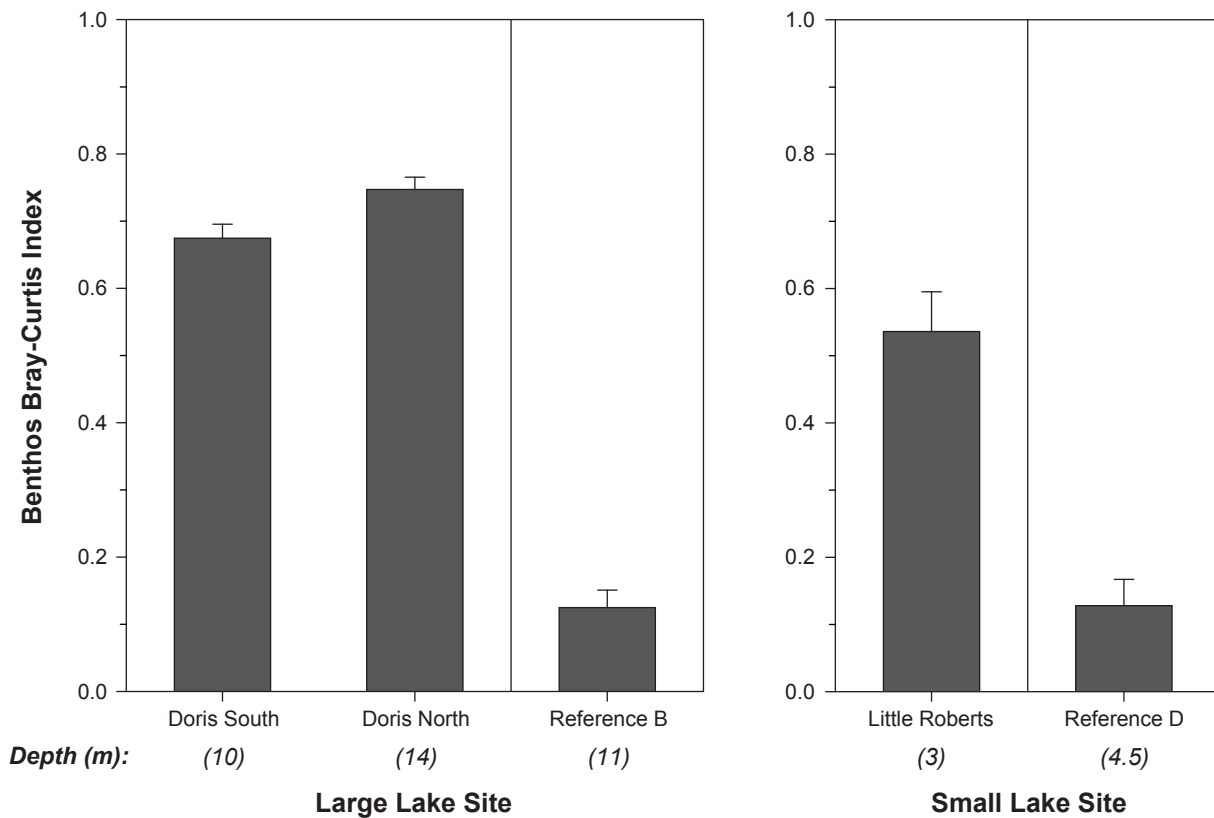
Nematodes and harpacticoid copepods were excluded because they are meiofauna and are not adequately sampled using a 500 um sieve bucket.

Immature/damaged organisms that were not identifiable to the family level were excluded from the community analysis.

Terrestrial organisms were excluded because they are not aquatic invertebrates.

Figure A.6-6

Benthos Bray-Curtis Index for Lake Sites,
Doris North Project, August 2014



Note: Error bars represent the standard error of the mean of replicates.

Annex A.6-4. Lake Benthos Summary Statistics, Doris North Project, 2014

	Doris Lake South					
	Min	Max	Median	Mean	SD	SE
Density (#/m ²)	1,778	3,511	2,459	2,444	689	308
Family Richness	4.0	5.0	4.0	4.4	0.5	0.2
Simpson's Diversity Index	0.40	0.57	0.46	0.47	0.06	0.03
Simpson's Evenness Index	0.39	0.46	0.45	0.44	0.03	0.01
Bray-Curtis Index	0.62	0.74	0.68	0.67	0.05	0.02

	Doris Lake North					
	Min	Max	Median	Mean	SD	SE
Density (#/m ²)	3,274	5,526	4,667	4,353	961	430
Family Richness	2.0	4.0	3.0	3.0	0.7	0.3
Simpson's Diversity Index	0.02	0.50	0.46	0.37	0.20	0.09
Simpson's Evenness Index	0.34	0.85	0.62	0.59	0.19	0.08
Bray-Curtis Index	0.68	0.79	0.75	0.75	0.04	0.02

	Little Roberts Lake					
	Min	Max	Median	Mean	SD	SE
Density (#/m ²)	4,800	11,437	7,393	8,199	2,724	1,218
Family Richness	4.0	6.0	5.0	4.8	0.8	0.4
Simpson's Diversity Index	0.09	0.56	0.21	0.27	0.21	0.09
Simpson's Evenness Index	0.25	0.46	0.28	0.31	0.08	0.04
Bray-Curtis Index	0.39	0.72	0.56	0.54	0.13	0.06

	Reference Lake B					
	Min	Max	Median	Mean	SD	SE
Density (#/m ²)	1,704	2,133	2,015	1,947	201	90
Family Richness	2.0	6.0	3.0	3.6	1.5	0.7
Simpson's Diversity Index	0.42	0.65	0.49	0.53	0.10	0.04
Simpson's Evenness Index	0.43	0.95	0.65	0.68	0.26	0.12
Bray-Curtis Index	0.044	0.21	0.13	0.13	0.06	0.03

	Reference Lake D					
	Min	Max	Median	Mean	SD	SE
Density (#/m ²)	16,030	37,881	25,481	26,812	8,142	3,641
Family Richness	6.0	10.0	8.0	8.0	1.4	0.6
Simpson's Diversity Index	0.22	0.43	0.32	0.32	0.08	0.03
Simpson's Evenness Index	0.15	0.24	0.19	0.19	0.04	0.02
Bray-Curtis Index	0.04	0.24	0.09	0.13	0.09	0.04

Notes:

SD - Standard deviation of the mean

SE - Standard error of the mean

Figure A.6-7

Benthos Density and Taxonomic Composition in Marine Sites, Doris North Project, August 2014

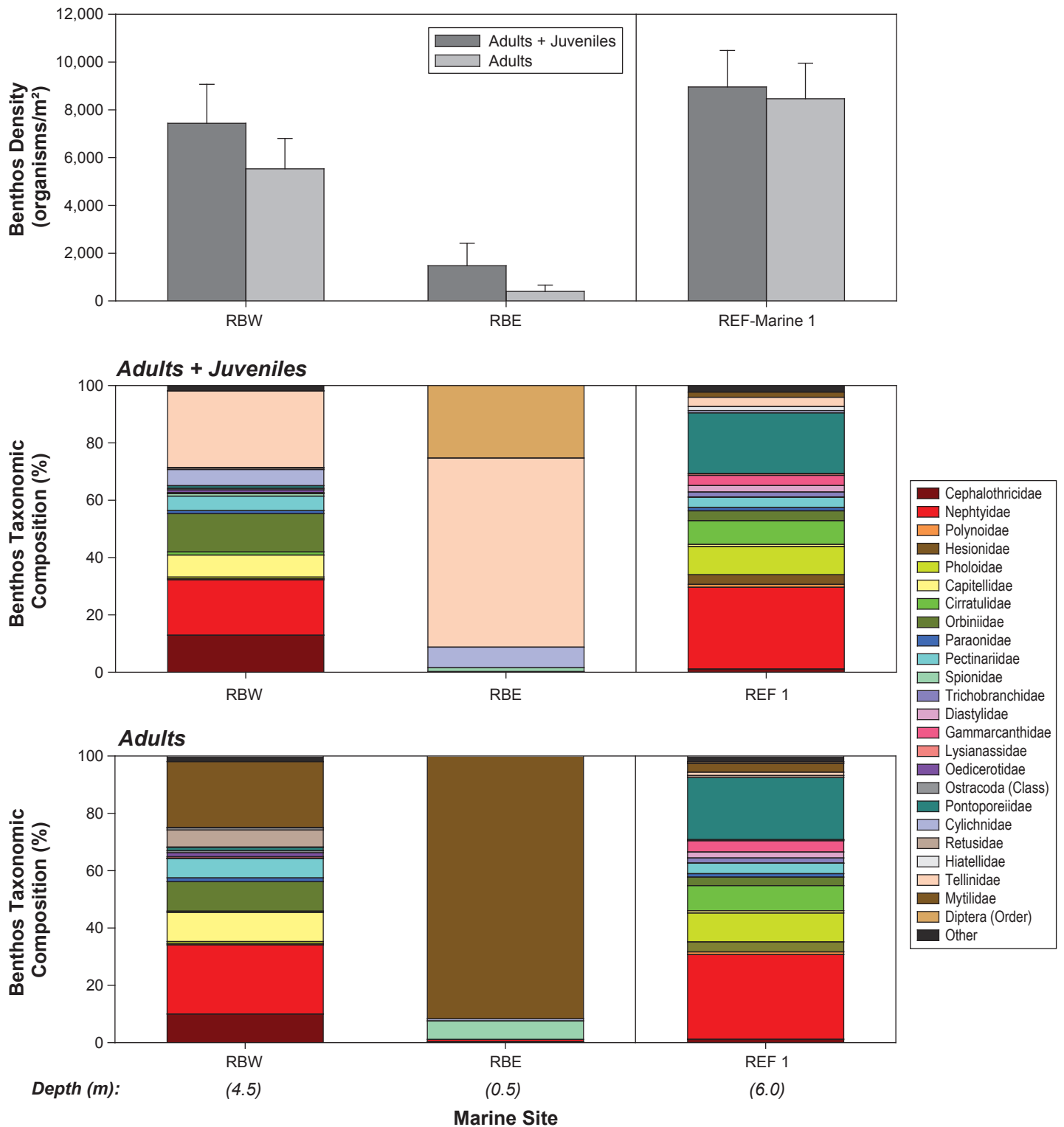
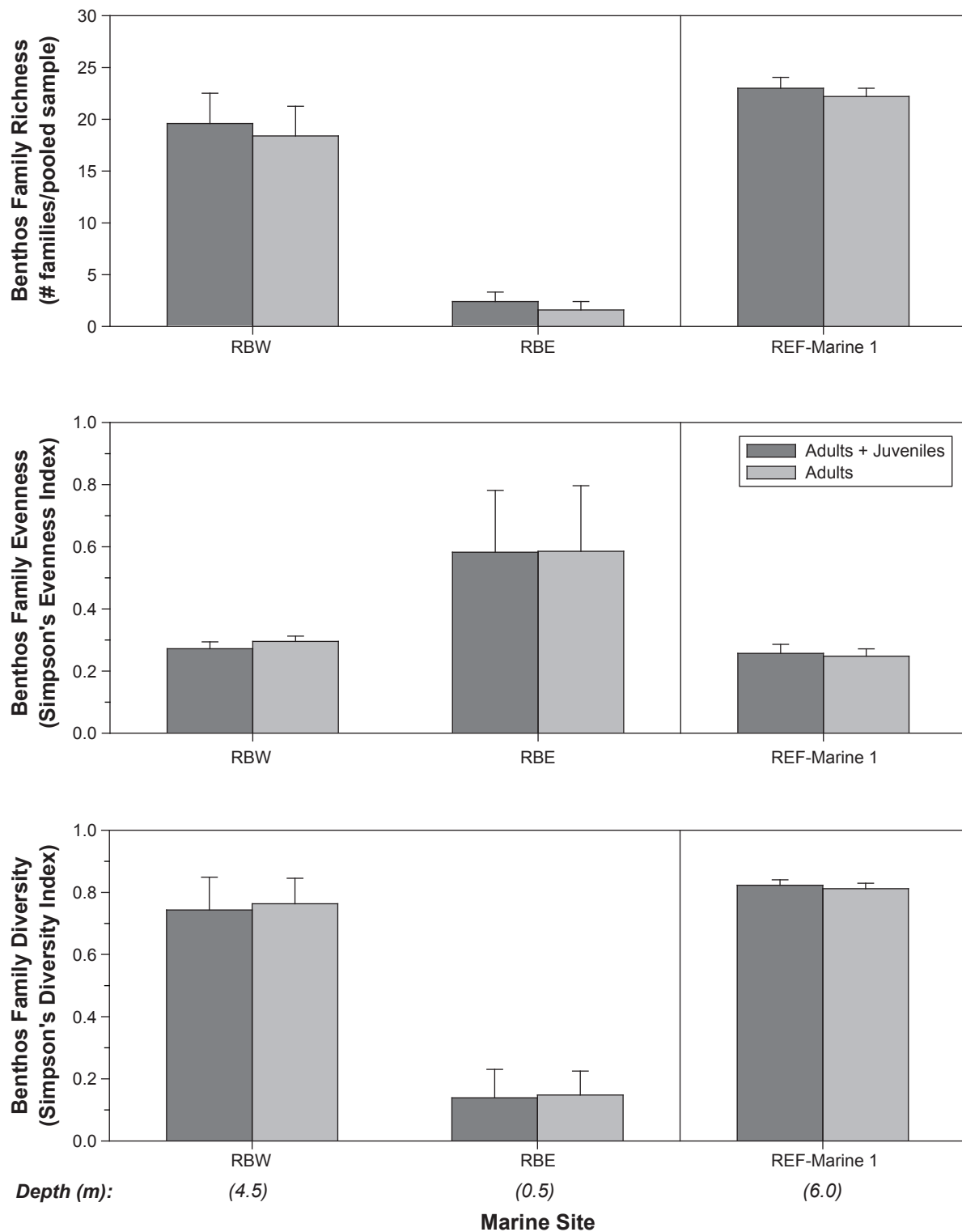


Figure A.6-8

Benthos Richness, Evenness, and Diversity in Marine Sites, Doris North Project, August 2014



Note: Error bars represent the standard error of the mean of replicates.

Annex A.6-5. Marine Benthos Taxonomy Data, Doris North Project, 2014

Taxonomic Identification		REF-Marine 1 21-Aug-2014					RBE 20-Aug-2014					RBW 13-Aug-2014														
		Rep-1		Rep-2		Rep-3	Rep-4		Rep-5		Rep-1	Rep-2		Rep-3	Rep-4		Rep-5									
		A	J	A	J	A	J	A	J	A	J	A	J	A	J	A	J	A	J							
TAXA	Family																									
FORAMINIFERA																										
Cornuspira sp.	Cornuspiridae			3		1		1		1					1		2			1						
CNIDARIA																										
Actiniaria indet	Anthozoa (Class)																		1							
NEMERTEA																										
Cephalothrix nr linearis	Cephalothricidae			5		16		1		2				1			100	41	10	13	82	43			49	74
Cerebratulus sp.	Lineidae			1		2		1						1			3		2		1				1	
Nemertea sp. Indet	Nemertea (Phylum)					1											1		1							
ANNELIDA																										
Polychaeta Errantia																										
Bipalponephtys neotena	Nephtyidae	163	8	148	5	83		211	25	232	14			2			123	2	136	25	104	14	5		132	15
Eteone sp.	Phyllodocidae																				1				1	
Harmothoe imbricata Cmplx	Polynoidae	5		5	1	1		3		2																
Hesionidae indet	Hesionidae																4									
Lumbrineris sp.	Lumbrineridae			1																						
Nephtys ciliata	Nephtyidae																1									
Nereimyia sp.	Hesionidae	5		22		29	1	4		34	2						6				1					
Pholoe inornata	Pholoidae	30		63				46	2	189	10						3		2						1	
Pholoe nr longa	Pholoidae	5		13		4				12									3	2	5				3	
Polynoidae sp indet	Polynoidae		2			6																				
Scoletoma fragilis	Lumbrineridae					2																				
Polychaeta Sedentaria																										
Aphelochaeta nr marioni	Cirratulidae	16		50		69		1		105							9	12							2	10
Aricidea catherinae	Paraonidae	19	2	3		4				2							5		9		7				9	3
Capitella capitata Cmplx	Capitellidae					1		1									2	1	1		2				2	
Cautleriella sp.	Cirratulidae							2		6																
Cistenides granulata	Pectinariidae	25		28		4	3	22		25	2						17		32		46				18	
Cistenides hyperborea	Pectinariidae	2		1													4		8		29				6	
Clymenura polaris	Maldanidae	4		3				2		2									1							
Leitoscoloplos nr pugettensis	Orbiniidae	31	12	22	1	6	2	8	1	10	1						50	21	29	38	78	71	1		69	58
Levinsenia gracilis	Orbiniidae					2													1							
Mediomastus ambiseta	Capitellidae																32		2		2				3	
Mediomastus sp.	Capitellidae	1		2		5		4		6							47		51		22		1		58	1
Myriochele sp.	Oweniidae																		1							
Pygospio elegans	Spionidae							1																		
Scolelepis sp.	Spionidae																									
Terebellides sp.	Trichobranchidae	11	2	20				3		29														3		
ARTHROPODA																										
Amphipoda																										
Apherusa glacialis	Calliopiidae	1				6		2		1									1							
Atylus sp.	Atylidae																		1							
Gammaracanthus loricatus	Gammaracanthidae	83		1				10											1							
Metopa sp.	Stenothoidae					1																				
Monoculodes sp.	Oedicerotidae																			1					1	
Monoculopsis longirostris	Oedicerotidae							2		3													1		1	
Onisimus affinis	Lysianassidae			4	2	2	4	1																		
Orchomenella minuta	Lysianassidae																						1			
Orchomenella sp.	Lysianassidae																									
Paroedicros lynceus	Oedicerotidae																6		10		1					
Pontoporeia femorata	Pontoporeiidae	34	3	211	4	65	2	128	5	230	3						14	1			1		1		2	2

Annex A.6-5. Marine Benthos Taxonomy Data, Doris North Project, 2014

Taxonomic Identification		REF-Marine 1 21-Aug-2014					RBE 20-Aug-2014					RBW 13-Aug-2014																			
		Rep-1		Rep-2		Rep-3		Rep-4		Rep-5		Rep-1		Rep-2		Rep-3		Rep-4		Rep-5											
		A	J	A	J	A	J	A	J	A	J	A	J	A	J	A	J	A	J	A	J										
TAXA	Family																														
Copepoda*																															
Harpacticoida indet	Harpacticoida (Order)									1		1				3															
Ostracoda														3		8		3													
Ostracoda sp indet	Ostracoda (Class)																			2											
Cumacea																															
Brachydiastylis resima	Diastylidae	2		6		4																									
Diastylis rathkei	Diastylidae	5	1	19	2	4		3	2	18	6										1										
Diastylis sp.	Diastylidae			2																											
Isopoda																															
Saduria entomon	Idoteidae			6				1										2													
MOLLUSCA																															
Gastropoda																															
Admete sp.	Cancellariidae													1		1		2													
Buccinidae indet	Buccinidae																	1													
Cylichna occulta	Cylichnidae	6		5	1	1		6	2	3		1		2		18	12	55	6	44	6	21	11								
Haminoea solitaria	Haminoeidae															2		3		3											
Retusa obtusa	Retusidae															1		7		5	1	2									
Bivalvia																															
Astarte borealis	Astartidae					6										4						2									
Astarte montagui	Astartidae															4															
Hiatella arctica	Hiatellidae	8	2	15	2	2	3	1		10								3		2											
Macoma balthica	Tellinidae	18	2	10		9	1	33	2	9	1					40	134	81	229	2	3	50	5	58	20	47	62	28	31	28	38
Macoma calcarea	Tellinidae																	4													
Macoma sp.	Tellinidae					2												2													
Mendicula ferruginosa	Thyasiridae															2				4											
Musculus discors	Mytilidae	5		3																											
Musculus niger	Mytilidae									2																					
Mya pseudoarenaria	Myidae			3		5		1		2																		2		2	
Mytilus trossulus	Mytilidae	2	14		6		3	10	3	1	1																	1		1	
Serripes groenlandicus	Cardiidae																														
Yoldiella sp.	Yoldiidae																														
CHORDATA																															
Rhizomolgula globularis	Molgulidae															3															
MISCELLANEOUS																															
Diptera larva	Insecta (Class)									1																					
Nematoda*										2		11		2						1		1									
Unid invertebrate eggs*						11		3												3		51		6				62			
Total number of individuals		476	53	666	38	337	21	506	54	937	43	0	1	2	0	59	135	90	230	5	5	520	103	444	161	495	204	38	34	419	277

Notes:

* Taxa marked with an asterisk were excluded from total counts and from all benthos analyses.

Nematodes and harpacticoid copepods were excluded because they are meiofauna and are not adequately sampled using a 500 um sieve bucket.

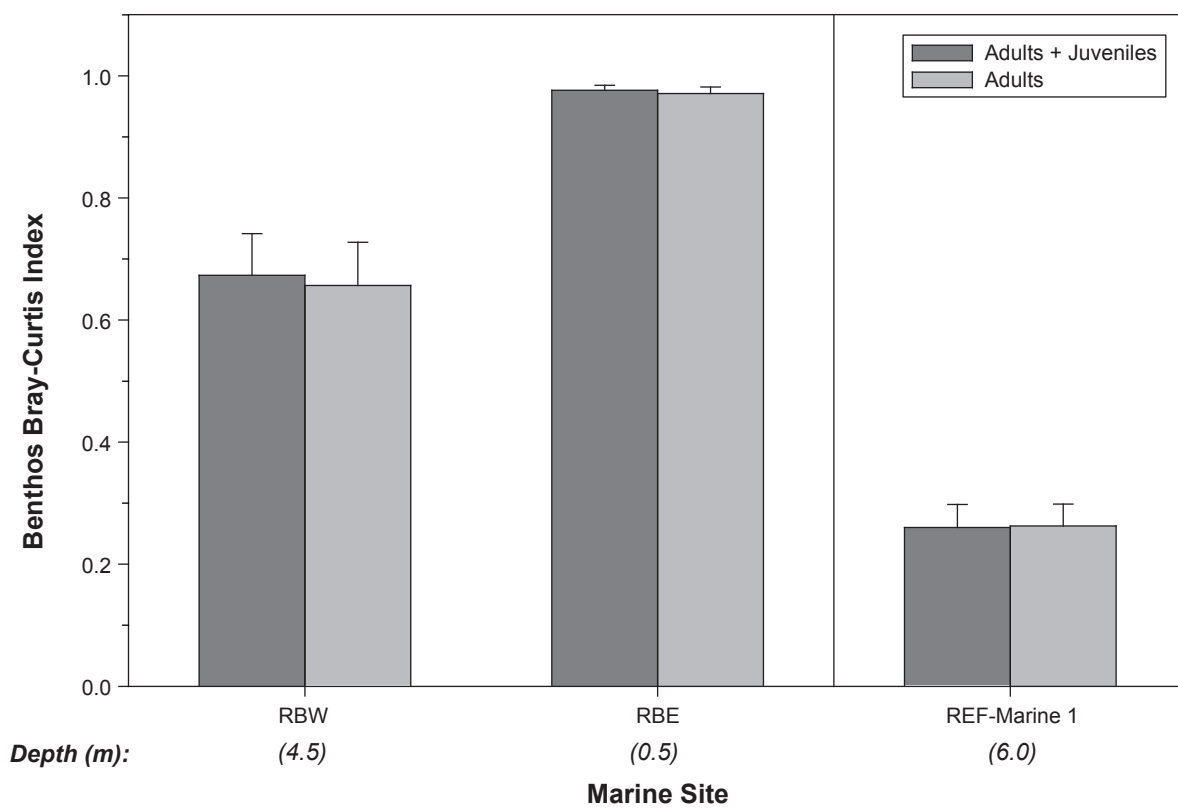
Nemertea identified only to the Phylum level and other Immature or damaged organisms that were not identifiable to the family level were excluded from the community analysis.

A = adult

J = juvenile

Figure A.6-9

Benthos Bray-Curtis Index for Marine Sites,
Doris North Project, August 2014



Note: Error bars represent the standard error of the mean of replicates.

Annex A.6-6. Marine Benthos Summary Statistics, Doris North Project, 2014

	Roberts Bay West (RBW) - Adults and Juveniles					
	Min	Max	Median	Mean	SD	SE
Density (#/m ²)	1,043	10,043	8,971	7,443	3,653	1,634
Family Richness	8.0	24.0	22.0	19.6	6.54	2.93
Simpson's Diversity Index	0.32	0.86	0.84	0.74	0.24	0.11
Simpson's Evenness Index	0.18	0.30	0.29	0.27	0.05	0.02
Bray-Curtis Index	0.56	0.93	0.60	0.67	0.15	0.07

	Roberts Bay West (RBW) - Adults					
	Min	Max	Median	Mean	SD	SE
Density (#/m ²)	551	7,522	6,377	5,539	2,849	1,274
Family Richness	7.0	22.0	21.0	18.4	6.39	2.86
Simpson's Diversity Index	0.44	0.86	0.84	0.76	0.18	0.08
Simpson's Evenness Index	0.25	0.34	0.30	0.30	0.04	0.02
Bray-Curtis Index	0.56	0.93	0.58	0.66	0.16	0.07

	Roberts Bay East (RBE) - Adults and Juveniles					
	Min	Max	Median	Mean	SD	SE
Density (#/m ²)	0	4,638	101	1,478	2,095	937
Family Richness	0.0	5.0	2.0	2.4	2.07	0.93
Simpson's Diversity Index	0.00	0.41	0.07	0.14	0.18	0.09
Simpson's Evenness Index	0.21	1.00	0.56	0.58	0.40	0.20
Bray-Curtis Index	0.96	1.00	0.98	0.98	0.02	0.01

	Roberts Bay East (RBE) - Adults					
	Min	Max	Median	Mean	SD	SE
Density (#/m ²)	0	1,304	29	403	582	260
Family Richness	0.0	4.0	1.0	1.6	1.82	0.81
Simpson's Diversity Index	0.00	0.26	0.18	0.15	0.13	0.08
Simpson's Evenness Index	0.31	1.00	0.45	0.59	0.37	0.21
Bray-Curtis Index	0.96	1.00	0.99	0.98	0.02	0.01

	Ida Bay (REF-Marine 1) - Adults and Juveniles					
	Min	Max	Median	Mean	SD	SE
Density (#/m ²)	5,188	14,159	7,667	8,962	3,403	1,522
Family Richness	19.0	25.0	24.0	23.0	2.35	1.05
Simpson's Diversity Index	0.76	0.86	0.84	0.82	0.04	0.02
Simpson's Evenness Index	0.17	0.34	0.24	0.26	0.06	0.03
Bray-Curtis Index	0.17	0.35	0.30	0.26	0.08	0.04

	Ida Bay (REF-Marine 1) - Adults					
	Min	Max	Median	Mean	SD	SE
Density (#/m ²)	4,884	13,580	7,333	8,470	3,321	1,485
Family Richness	19.0	23.0	23.0	22.2	1.79	0.80
Simpson's Diversity Index	0.75	0.85	0.82	0.81	0.04	0.02
Simpson's Evenness Index	0.17	0.31	0.25	0.25	0.05	0.02
Bray-Curtis Index	0.17	0.35	0.30	0.26	0.08	0.04

Notes:

SD - Standard deviation of the mean

SE - Standard error of the mean

Annex A.6-7. Results of Benthos QA/QC Sorting Efficiencies, Doris North Project, 2014

Sample ID	# from First Sort	1st QA/QC Re-sort # Found	Initial Sort Efficiency (%)	Re-sort Required?	2nd QA/QC Re-sort # Found	Final Efficiency (%)
<i>Freshwater</i>						
Roberts Outflow, rep 1	911	11	98.8	N	-	98.8
Little Roberts Outflow, rep 3	605	9	98.5	N	-	98.5
Reference D Outflow, rep 1	2444	22	99.1	N	-	99.1
Doris Lake North, rep 4	373	3	99.2	N	-	99.2
Reference B Outflow, rep 1	158	2	98.8	N	-	98.8
<i>Marine</i>						
REF-Marine 1, rep 1	529	0	100%	N		100%
REF-Marine 1, rep 2	704	0	100%	N		100%
REF-Marine 1, rep 3	358	0	100%	N		100%
REF-Marine 1, rep 4	549	0	100%	N		100%
REF-Marine 1, rep 5	977	0	100%	N		100%
RBE, rep 1	1	0	100%	N		100%
RBE, rep 2	0	0	100%	N		100%
RBE, rep 3	183	0	100%	N		100%
RBE, rep 4	320	0	100%	N		100%
RBE, rep 5	8	0	100%	N		100%
RBW, rep 1	619	0	100%	N		100%
RBW, rep 2	553	0	100%	N		100%
RBW, rep 3	693	0	100%	N		100%
RBW, rep 4	72	0	100%	N		100%
RBW, rep 5	634	0	100%	N		100%

Notes:

If the efficiency is 90% or better nothing further is done and the QA/QC invertebrates are not added to the data.

If the efficiency is less than 90%, the QA/QC invertebrates are added to the sample, it is re-sorted,

and a second 20% QA/QC is performed.

Freshwater data: % Sorting Efficiency = $[1 - \{\# \text{ in QA/QC re-sort} / (\# \text{ sorted originally} + \# \text{ in QA/QC re-sort})\}] * 100$

Marine data (20% of sample is re-sorted): % Sorting Efficiency = $[1 - \{(5 \times \# \text{ in QA/QC re-sort}) / (\# \text{ sorted originally} + (5 \times \# \text{ in QA/QC re-sort}))\}] * 100$

Appendix B

2014 Evaluation of Effects Supporting Information

DORIS NORTH PROJECT

2014 Aquatic Effects Monitoring Program

Appendix B.1

Baseline Data Selection Rationale for Evaluation of Effects

DORIS NORTH PROJECT

2014 Aquatic Effects Monitoring Program

APPENDIX B. 2014 EVALUATION OF EFFECTS SUPPORTING INFORMATION

B.1 BASELINE DATA SELECTION RATIONALE FOR EVALUATION OF EFFECTS

The tables presented in this section present a summary of the baseline water quality, sediment quality, and primary producer biomass data collected at the AEMP sites, as well as the rationale for the inclusion or exclusion of certain baseline data from the 2014 evaluation of effects.

B.1.1 Water Quality Data

Table B.1-1 presents a summary of the baseline water quality data collected at AEMP stream, lake, and marine sites, and the rationale for the inclusion or exclusion of certain baseline data from the 2014 evaluation of effects. The selection of historical data to include in the water quality evaluation of effects was mainly based on similarity of baseline sampling locations to 2014 sampling locations, methodology, and sampling depth.

B.1.2 Sediment Quality Data

Table B.1-2 presents a summary of the baseline sediment quality data collected at AEMP stream, lake, and marine sites, and the rationale for the inclusion or exclusion of certain baseline data from the 2014 evaluation of effects. The selection of historical data to include in the sediment quality evaluation of effects was mainly based on the comparability of the depth strata sampled between baseline and 2014 samples, the proximity of baseline sampling sites to the 2014 sites, and the similarity of sampling techniques.

B.1.3 Phytoplankton and Periphyton Biomass Data

Table B.1-3 presents a summary of the baseline phytoplankton and periphyton biomass data collected at AEMP stream, lake, and marine sites, and the rationale for the inclusion or exclusion of certain baseline data from the 2014 evaluation of effects. The main criteria for the selection of historical phytoplankton and periphyton biomass data for inclusion in the evaluation of effect were the proximity of baseline sampling sites to 2014 AEMP sampling sites, and the comparability of sampling methodologies.

Table B.1-1. Baseline Data Selection Rationale for Water Quality, Doris North Project, 2014

Sampling Sites	Years Sampled	Months Sampled	Data Included in Historical Graphs and Statistical Analyses	Data Excluded from Historical Graphs and Statistical Analyses	Rationale for Exclusion
Streams					
Doris OF	1996	June, August	All	None	
	1997	June July, August	All	None	
	2000	June, September	All	None	
	2003	July, August, September	All	None	
	2004	June, July, August, September	All	None	
	2005	June, July, August, September	All	None	
	2006	June, July, August, September	All	None	
	2007	June, July, August, September	All	None	
	2008	June, July, August, September	All	None	
	2009	June, August, September	All	None	
Roberts OF	2004	June, July, August, September	All	None	
	2005	June, July, August, September	All	None	
	2006	June, July, August, September	All	None	
	2007	June, July, August, September	All	None	
	2008	June, July, August, September	All	None	
Little Roberts OF	1996	June, August	None	All	1996-1997 sampling site was further downstream than the 2003-2014 sampling site.
	1997	June, July, August	None	All	1996-1997 sampling site was further downstream than the 2003-2014 sampling site.
	2003	July, August, September	All	None	
	2004	June, July, August, September	All	None	
	2005	June, July, August, September	All	None	
	2006	June, July, August, September	All	None	
	2007	June, July, August, September	All	None	
	2008	June, July, August, September	All	None	
	2009	June, August, September	All	None	
Reference B OF	2009	June, August, September	All	None	
Reference D OF	no pre-2010 baseline data available				

(continued)

Table B.1-1. Baseline Data Selection Rationale for Water Quality, Doris North Project, 2014 (continued)

Sampling Sites	Years Sampled	Months Sampled	Data Included in Historical Graphs and Statistical Analyses	Data Excluded from Historical Graphs and Statistical Analyses	Rationale for Exclusion
Lakes					
Doris South	1995	May, June, July, August	Included May and June under-ice samples and August samples collected from boat at site SW4	Excluded shoreline grabs from July and August	Shoreline grabs from July and August were from a near-shore site that is not comparable to the 2014 Doris South site.
	1996	April, August	All	None	
	1997	April, July, August	All	None	
	1998	April	All	None	
	2000	July, August	All	None	
	2009	April, August	All	None	
Doris North	1995	May, June, July, August	Included May and June under-ice samples and August samples collected	Excluded shoreline grabs from July and August	Shoreline grabs from July and August are from a shallow, near-shore site that is not comparable to the 2014 Doris North site.
	2003	July, August, September	All	None	
	2004	June, July, August, September	All	None	
	2005	July, August, September	All	None	
	2006	May, July, August, September	All	None	
	2007	May, July, August, September	All	None	
	2008	May, July, August, September	All	None	
	2009	April, August	All	None	
Little Roberts	1995	May, June, July, August	Included May and June under-ice samples	Excluded shoreline grabs from July and August	Shoreline grabs from July and August are from a near-shore site that is not comparable to the 2014 Little Roberts Lake site.
	1996	August	All	None	
	1997	July	All	None	
	2003	July, August, September	All	None	
	2004	July, August, September	All	None	
	2005	July, August, September	All	None	
	2006	May, July, August, September	All	None	
	2007	May, July, August, September	All	None	
	2008	May, July, August, September	All	None	
	2009	April, August	All	None	
Reference B	2009	April, August	All	None	
Reference D	no pre-2010 baseline data available				

(continued)

Table B.1-1. Baseline Data Selection Rationale for Water Quality, Doris North Project, 2014 (completed)

Sampling Sites	Years Sampled	Months Sampled	Data Included in Historical Graphs and Statistical Analyses	Data Excluded from Historical Graphs and Statistical Analyses	Rationale for Exclusion
Marine Sites					
RBW	1996	August	None	All	1996-1998 sampling sites were >1 km away from 2014 RBW site.
	1997	August	None	All	1996-1998 sampling sites were >1 km away from 2014 RBW site.
	1998	July	None	All	1996-1998 sampling sites were >1 km away from 2014 RBW site.
	2009	April, August	Included surface samples from sites WT1 and ST2	Excluded samples from sites: WT2, WT4, WT6, ST1, ST3, ST4, ST5, ST6, and deep sample from site ST2	Excluded sites that were >1 km away from 2014 RBW site, and excluded deep samples because only surface samples were collected in 2014.
RBE	1996	August	Included single site that was in the eastern basin	None	
	1997	August	None	All	1997-1998 sampling site in eastern basin was closer to the mouth of Little Roberts Outflow than the 2014 RBE site (greater freshwater influence).
	1998	July	None	All	1997-1998 sampling site in eastern basin was closer to the mouth of Little Roberts Outflow than the 2014 RBE site (greater freshwater influence).
	2004	July, August, September	All	None	
	2005	July, August, September	All	None	
	2006	May, July, August, September	All	None	
	2007	May, July, August, September	All	None	
	2008	July, August, September	All	None	
	2009	April, August	All	None	
REF-Marine 1	2009	April, August	Included surface samples from site RP3	Excluded samples from sites: REF-W and REF-4, and deep samples from site RP3	Excluded sites that were >1 km away from 2014 REF-Marine 1 site, and excluded deep samples because only surface samples were collected in 2014.

Table B.1-2. Baseline Data Selection Rationale for Sediment Quality, Doris North Project, 2014

Sampling sites	Years Sampled	Month Sampled	Data Included in Historical Graphs and Statistical Analyses	Data Excluded from Historical Graphs and Statistical Analyses	Rationale for Exclusion
Streams					
Doris OF	2009	August	All	None	
Roberts OF	no pre-2010 baseline data available				
Little Roberts OF	2009	August	All	None	
Reference B OF	2009	August	All	None	
Reference D OF	no pre-2010 baseline data available				
Lakes					
Doris South (deep)	1996	August	None	All	Sediment sample was separated into layers (0-1 cm and 1-3 cm).
	1997	July	All	None	
	2009	August	Included deep site	Excluded shallow site	
Doris North (deep)	2009	August	Included deep site	Excluded shallow site	Shallow site was sampled.
Little Roberts (shallow)	1996	August	None	All	Sediment sample was separated into layers (0-1 cm and 1-3 cm).
	1997	July	All	None	
	2009	August	All	None	
Reference B (deep)	2009	August	None	All	Shallow/mid depth sites and located at opposite end of lake relative to 2014 site.
Reference D (shallow)	no pre-2010 baseline data available				
Marine Sites					
RBW (shallow)	1997	August	None	All	Mid-depth/deep sites and located >1 km from 2014 RBW site.
	2002	August	Included shallow site RB4	Excluded sites RB1, RB2, RB3	RB1 and RB2 were >1 km from 2014 RBW site; RB3 was a mid-depth site.
	2009	August	None	All	Sites were all ~0.4 km or more away from 2014 RBW site.
RBE (shallow)	1997	August	None	All	Sampling site in eastern basin was closer to the mouth of Little Roberts Outflow than the 2014 RBE site (greater freshwater influence, and depositional zone).
REF-Marine 1	2009	August	Included shallow site RP1	Excluded sites RP2, RP3	RP2 was a mid-depth site and RP3 was a deep site.

Table B.1-3. Baseline Data Selection Rationale for Primary Producer Biomass (as Chlorophyll *a*), Doris North Project, 2014

Sampling Sites	Years Sampled	Months Sampled	Data Included in Historical Graphs and Statistical Analyses	Data Excluded from Historical Graphs and Statistical Analyses	Rationale for Exclusion
Streams (Periphyton)					
Doris OF	1996	August	None	All	An instantaneous sample was collected, and chlorophyll <i>a</i> concentrations were not measured (only abundance and taxonomy data).
	1997	June-July, July-August	All	None	
	2000	July-August	All	None	
	2009	July-August	All	None	
Roberts OF	no pre-2010 baseline data available				
Little Roberts OF	1996	August	None	All	1996 sampling site was further downstream than 2009-2014 sampling site, an instantaneous sample was collected, and chlorophyll <i>a</i> concentrations were not measured (only abundance and taxonomy data).
	1997	June-July, July-August	None	All	1997 sampling site was further downstream than 2009-2014 sampling site.
	2009	July-August	All	None	
Reference B OF	2009	July-August	All	None	
Reference D OF	no pre-2010 baseline data available				
Lakes (Phytoplankton)					
Doris South	1996	August	None	All	Chlorophyll <i>a</i> concentrations were not measured (only abundance and taxonomy data).
	1997	July	All	None	
	2000	July	All	None	
	2009	April, August	All	None	
Doris North	2003	July, August, September	None	All	Each sample consisted of a composite of 5 subsamples collected throughout the euphotic zone (not comparable to discrete surface samples collected in 2014).
	2006	September	None	All	Phytoplankton biomass sampling method not described in report.
	2007	July, August, September	None	All	Phytoplankton biomass samples were collected using an integrated tube sampler deployed throughout the euphotic zone (not comparable to discrete surface samples collected in 2014).
	2008	July, August, September	None	All	Phytoplankton biomass samples were collected using an integrated tube sampler deployed throughout the euphotic zone (not comparable to discrete surface samples collected in 2014).
	2009	April, August	All	None	

(continued)

Table B.1-3. Baseline Data Selection Rationale for Primary Producer Biomass (as Chlorophyll *a*), Doris North Project, 2014 (completed)

Sampling Sites	Years Sampled	Months Sampled	Data Included in Historical Graphs and Statistical Analyses	Data Excluded from Historical Graphs and Statistical Analyses	Rationale for Exclusion
Lakes (Phytoplankton; <i>cont'd</i>)					
Little Roberts	1996	August	None	All	Chlorophyll <i>a</i> concentrations were not measured (only abundance and taxonomy data).
	1997	July	All	None	
	2003	July, August, September	None	All	Each sample consisted of a composite of 5 subsamples collected throughout the euphotic zone (not comparable to discrete surface samples collected in 2014).
	2006	September	None	All	Phytoplankton biomass sampling method not described in report.
	2007	July, August, September	None	All	Phytoplankton biomass samples were collected using an integrated tube sampler deployed throughout the euphotic zone (not comparable to discrete surface samples collected in 2014).
	2008	July, August, September	None	All	Phytoplankton biomass samples were collected using an integrated tube sampler deployed throughout the euphotic zone (not comparable to discrete surface samples collected in 2014).
	2009	April, August	All	None	
Reference B	2009	August	All	None	
Reference D	no pre-2010 baseline data available				
Marine Sites (Phytoplankton)					
RBW	2009	August	Included surface samples from site ST2	Excluded samples from sites: ST1, ST3, ST4, ST5, ST6, and deep samples from site ST2	Excluded sites that were >1 km away from 2014 RBW site, and excluded deep samples because only surface samples were collected in 2014.
RBE	2006	September	None	All	Phytoplankton biomass sampling method not described in report.
	2007	July, August, September	None	All	Phytoplankton biomass samples were collected using an integrated tube sampler deployed throughout the euphotic zone (not comparable to discrete surface samples collected in 2014).
	2008	July, August, September	None	All	Phytoplankton biomass samples were collected using an integrated tube sampler deployed throughout the euphotic zone (not comparable to discrete surface samples collected in 2014).
	2009	August	All	None	
REF-Marine 1	2009	August	Included surface samples from site RP3	Excluded samples from site REF-4, and deep samples from site RP3	Excluded sites that were >1 km away from 2014 REF-Marine 1 site, and excluded deep samples because only surface samples were collected in 2014.

Appendix B.2
Statistical Methodology and Results for Evaluation of Effects

APPENDIX B. 2014 EVALUATION OF EFFECTS SUPPORTING INFORMATION

B.2 STATISTICAL METHODOLOGY AND RESULTS FOR EVALUATION OF EFFECTS

The following reports present the statistical methodology and results, including lists of outliers and statistical outputs, for the evaluation of effects on Secchi depth, water quality, sediment quality, phytoplankton and periphyton biomass, and benthic invertebrates:

- Appendix B.2.1. Statistical Methodology and Results for Secchi Depth Evaluation of Effects, Doris North Project, 2014
- Appendix B.2.2. Statistical Methodology and Results for Water Quality Evaluation of Effects, Doris North Project, 2014
- Appendix B.2.3. Statistical Methodology and Results for Sediment Quality Evaluation of Effects, Doris North Project, 2014
- Appendix B.2.4. Statistical Methodology and Results for Phytoplankton and Periphyton Evaluation of Effects, Doris North Project, 2014
- Appendix B.2.5. Statistical Methodology and Results for Benthos Evaluation of Effects, Doris North Project, 2014

APPENDIX B.2.1. STATISTICAL METHODOLOGY AND RESULTS FOR SECCHI DEPTH EVALUATION OF EFFECTS, DORIS NORTH PROJECT, 2014

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1. ANALYSIS METHODS

1.1 ASSUMPTIONS

The key assumption was that the Secchi depth measurements included in this analysis were representative of each lake site's Secchi depth for that monitoring period.

1.2 TRANSFORMATIONS

No transformation was needed.

1.3 OUTLINE OF ANALYSIS PLAN

There are several classes of statistical tests that can be done to assess evidence of change in the Secchi depth over time and to assess if changes may reflect an impact of the Project.

1.3.1 Before vs. After Analysis

The first analysis compared the mean Secchi depth for all years prior to 2010 (before initiation of construction) to the mean for 2014. Each lake site was treated independently.

The final statistical model (in standard shorthand notation) was:

$$Y = \text{Period Season Period*Season Year(period)}-R$$

where Y is the mean Secchi depth for a year; *Period* is the effect of before vs. after Project initiation (which is the effect of interest); *Season* is the effect of season (three seasons in the sampling year: 1) July, 2) August, and 3) September); *Period*Season* is an interaction effect between period and season; and *Year(Period)* is a random year effect (applicable if more than one year was sampled during each period). If the data were too sparse (e.g., not all seasons measured in all periods), then the *Period*Season* interaction effect could not be estimated and was dropped.

This model is preferable to simply treating all measurement within a period (e.g., over two years pre-construction) as having the same mean and assuming that they are completely independent of each other. This model also "averages" the Secchi depth data in way that weights each baseline year equally rather than weighting by the sample size. For example, suppose that the Secchi depth measured in 2008 was 22 m, while the two Secchi depths measured in 2009 were 25 m and 27 m. The simple mean $(22+25+27)/3=24.7$ m would be more heavily weighted toward the mean in the second year. In order to give each year's data equal weight, the reading over both years should be computed as an average of averages:

$$\frac{\frac{22}{1} + \frac{25 + 27}{2}}{2} = 24.0$$

This could be extended to multiple years in a similar fashion.

This model was fit using R version 2.15.2. In order to reduce the number of “false positives” associated with performing a large number of statistical tests, a reduced significance level (e.g., 0.01) was primarily used when reviewing the results. Significance levels of 0.01 to 0.05 for exposure sites were considered marginally non-significant and were also discussed in the evaluation of effects.

The key disadvantage of this model was that changes in Secchi depth over time may be unrelated to the effects of the Project, e.g., the average Secchi depth in 2014 could be shallower than expected because of long term climate change that is unrelated to the Project. Consequently, if a statistically significant effect was detected, it would require further investigation.

1.3.2 BACI Analysis

Before-After-Control-Impact (BACI) analysis is the standard method used to assess a potential environmental impact (Smith 2002). BACI designs evaluate potential non-parallelism in response over time between exposure and reference waterbodies.

A BACI analysis was performed for each large Project lake (Doris Lake North and Doris Lake South) versus the corresponding reference lake (Reference Lake B). A BACI analysis was not performed for Little Roberts Lake (small lake) because there is no pre-construction data for Reference Lake D.

The formal statistical model (in standard shorthand notation) was:

$$Y = \text{Period Class Period*Class Season Period*Season Year(Period)-R}$$

where Y is the variable of interest; *Period* is the effect of period (before or after construction); *Class* is the effect of the site classification (Project or reference); *Period*Class* is the BACI effect of interest (i.e., is the effect of *Period* the same (parallel) for both classes of sites); *Season* is the seasonal (sampling month) effect; *Period*Season* is an interaction effect between period and season; and *Year(Period)* is the random year effect within each period (applicable if more than one year was sampled during each period). If the data were too sparse (e.g., not all seasons measured in all periods), then the *Period*Season* interaction effect could not be estimated and was dropped. Sites that were measured only in one period (i.e., pre- or post-construction) contribute some information on the year-effect which improves precision of the BACI estimate and were, therefore, included.

The key variable of interest was the *Period*Class* effect as this measures the amount of non-parallelism between the changes in the mean (Before-After) over the two classes of sites (exposure or reference). The BACI estimate was computed as the “difference in the differences”:

$$BACI = (\mu_{PA} - \mu_{PB}) - (\mu_{RA} - \mu_{RB})$$

where μ_{PA} is the mean variable reading in the *Project* class of sites *after* Project initiation, μ_{PB} is the mean variable reading in the *Project* class of sites *before* Project initiation, μ_{RA} is the mean variable reading in the *reference* class of sites *after* Project initiation, and μ_{RB} is the mean variable reading in the *reference* class of sites *before* Project initiation. The BACI contrast was estimated by replacing the

population means above by the model-based estimates. Estimated differences close to 0 would indicate no evidence of non-parallelism.

Note that the hypothesis that the BACI contrast has the value of zero is identical to the hypothesis that the *Period*Class* interaction is zero with identical p-values. Consequently, only the results for the BACI contrast were reported here.

The BACI model was fit using R version 2.15.2. A reduced significance level (e.g., 0.01) was primarily used when reviewing the results. Significance levels of 0.01 to 0.05 were considered marginally non-significant. If the results of the before-after analysis indicated that a 2014 variable mean was not significantly different (i.e., and was not marginally non-significant) from the baseline mean, it was concluded that there was no effect of 2014 Project activities on this variable, and BACI analyses were not discussed.

2. RESULTS

There was no censoring of the Secchi depth data, and preliminary plots of the data showed no obvious outliers.

The lakes were divided into small lakes (Little Roberts Lake and Reference Lake D) and large lakes (Doris Lake North, Doris Lake South, and Reference Lake B) and separate results are presented for each size class of lake. The results from the analysis that compared the mean prior to 2010 (before initiation of construction) to the mean for 2014 are presented in Tables Large Lake-1 and Small Lake-1. There was no evidence of a significant or marginally non-significant change in the mean Secchi depth for any exposure lake between the before and after periods. Thus, no BACI results are discussed (Table Large Lake-2).

REFERENCES

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Smith, E. P. 2002. BACI Design. *Encyclopedia of Environmetrics*. Wiley: New York.

TABLES

Table Large Lake-1. Summary of Test for No Difference in Mean between Before and After Periods for Large Lake Secchi Depth

Variable	Large Lake Site		
	Doris North p-value	Doris South p-value	Reference B p-value
Secchi Depth	0.2960	0.5723	-

Notes:

To reduce the number of false positives, a smaller alpha level (0.01) was used to screen for effects and p-values less than 0.01 are bolded. P-values of 0.01 to 0.05 were considered marginally non-significant.

A before-after analysis was not possible for Reference Lake B.

Table Small Lake-1. Summary of Test for No Difference in Mean between Before and After Periods for Small Lake Secchi Depth

Variable	Small Lake Site	
	Little Roberts p-value	Reference D p-value
Secchi Depth	0.5656	-

Notes:

To reduce the number of false positives, a smaller alpha level (0.01) was used to screen for effects and p-values less than 0.01 are bolded. P-values of 0.01 to 0.05 were considered marginally non-significant.

No pre-construction Secchi depth readings were collected at Reference Lake D, so no before-after comparison was possible.

Table Large Lake-2. Summary of BACI Comparison of Large Lake Secchi Depth for Individual Project Sites

Variable	Large Lake Site	
	Doris North p-value	Doris South p-value
Secchi Depth	0.0424	0.4715

Note:

To reduce the number of false positives, a smaller alpha level (0.01) was used to screen for effects and p-values less than 0.01 are bolded. P-values of 0.01 to 0.05 were considered marginally non-significant.

APPENDIX B.2.2. STATISTICAL METHODOLOGY AND RESULTS FOR WATER QUALITY EVALUATION OF EFFECTS, DORIS NORTH PROJECT, 2014

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1. ANALYSIS METHODS

1.1 ASSUMPTIONS

There were several assumptions made for the analyses of water quality. The key assumption was that the samples taken were a random sample of the site's water for that monitoring period (e.g., for that month in that year when measured).

Another assumption was that missing data (e.g., a stream was not measured in a month in a particular year) is missing completely at random (MCAR), so that there is no information about water quality associated with "missingness". This assumption could be violated if, for example, samples were not taken because it was known that water quality was compromised on the selected sampling date. There was no way to assess this assumption except by carefully considering why data were not collected on a particular date. If, for example, data were not collected because the sampling vial broke in transit, this was likely a case of MCAR.

It is further assumed that the water columns of all sampled waterbodies were completely mixed so that depth effects can be ignored. This assumption was verified by examining the raw sample means at various depths and fitting statistical models to examine the effects of depth, and few depth effects were seen.

1.2 REPLICATE SAMPLES

Replicate samples collected within the same day and at the same depth were treated as pseudo-replicates (Hurlbert 1984) and values were averaged before further analyses. This represents an approximate analysis (compared to actually modelling replicated values as nested within a particular day), but given the high variability observed for most of the readings, the reported results should be insensitive to this averaging.

1.3 DEALING WITH CENSORING (VALUES BELOW DETECTION LIMITS)

The proportion of data with readings below the detection limit varied by waterbody and by water quality variable. The analyses below follow the advice of McBride (2005; Section 11.4.3).

- When the dataset included a small number of below detection values, values were replaced by values equal to $\frac{1}{2}$ of the detection limit for the analysis.
- When the majority of the dataset consisted of values below the detection limit (e.g., more than about 70% below detection limit), there was very little that could be done as there is essentially no information (other than the values are below the detection limit). The analyses were performed as outlined below, but results were interpreted with caution. Helsel (2005) has other suggestions for analysis (e.g., comparing the proportions below the detection limits) but these tests require much larger sample sizes than available here.

- When there was an intermediate amount of censoring, a more complex analysis could be conducted that fully integrates the information from the censored values with the known values. This is most easily done using Bayesian methods using Markov chain Monte Carlo (MCMC) methods as likelihood methods would require integration of the likelihood for each censored value over and above dealing with the other random effects in the model.

Most water quality variables fell into one of the first two categories and only those methods were employed in the 2014 Program.

It should be noted that for data collected in the late 1990's, the detection limits were often considerably higher than the detection limits available for more recent sampling (often 5× or 6× higher). Consequently, there was little to be gained from using this very early data and it was often removed prior to analysis and treated as outliers as noted in the appropriate sections below.

1.4 TRANSFORMATIONS

For all water quality variables, the values were fairly homogeneous and no obvious transformation was suggested, i.e., metals analyzed on the parts per million (ppm) scale and pH measured on the log-scale.

1.5 DEALING WITH SPARSE DATA IN SOME CLASSIFICATIONS SUCH AS SEASON

In models with season effects, samples were not always collected during all seasons of all years or periods. In these cases, interaction effects involving season could not be fit. Additive models were fit (i.e., models without the interaction effect).

1.6 OUTLINE OF ANALYSIS PLAN

There are several classes of statistical tests that can be done to assess evidence of change in the mean of the water quality variable over time and to assess if changes in the means may reflect an impact of the Project.

1.6.1 Before vs. After Analysis

The first analysis compared the mean readings for all years prior to 2010 (before initiation of construction) to the mean for 2014. Each waterbody was treated independently, and each water quality variable was treated separately.

The final statistical model (in standard shorthand notation) was:

$$Y = \text{Period Season Period*Season Year(Period)} - R$$

where Y is the (mean) variable reading for a date within a year; *Period* is the effect of before vs. after Project initiation (which is the effect of interest); *Season* is the effect of early or late in the year; *Period*Season* represent the interaction between Project and season effects (i.e., is the effect of the period consistent in both seasons); and *Year(Period)* is a random year effect (applicable if more than one year was sampled during each period). This separates the variation in water quality into

components representing variation within a season in a year and year-to-year variation. If the data were too sparse (e.g., not all seasons measured in all periods), then the *Period*Season* interaction effect could not be estimated and was dropped.

This model is preferable to simply treating all measurement within a period (e.g., over several years pre-construction) as having the same mean and assuming that they are completely independent of each other. This model also “averages” the water quality values collected over the baseline years in way that weights each year equally rather than weighting by the sample size. For example, suppose that the water quality variable measured in 2008 was 22 ppm, while the two readings measured in 2009 were 25 and 27 µg/L. The simple mean $(22+25+27)/3=24.7$ µg/L would be more heavily weighted toward the mean in 2009. In order to give each year’s data equal weight, the reading over both years was computed as an average of averages:

$$\frac{\frac{22}{1} + \frac{25 + 27}{2}}{2} = 24.0 \text{ µg/L}$$

This could be extended to multiple years in a similar fashion.

This model was fit using a mixed-model ANOVA using R version 2.15.2. In order to reduce the number of “false positives” associated with performing a large number of statistical tests, a reduced significance level (e.g., 0.01) was primarily used when reviewing the results. Significance levels of 0.01 to 0.05 for exposure sites were considered marginally non-significant and were also discussed in the evaluation of effects.

The key disadvantage of this model was that changes over time may be unrelated to the effects of the Project, e.g., the mean water quality readings in 2014 could be higher than expected because of long term climate change that is unrelated to the Project. Consequently, if a statistically significant effect was detected, it required further investigation.

1.6.2 BACI Analysis

Before-After-Control-Impact (BACI) analysis is the standard method used to assess a potential environmental impact (Smith 2002). BACI designs evaluate potential non-parallelism in response over time between the exposure and reference waterbodies. A BACI analysis was performed for each exposure waterbody versus the corresponding reference waterbody.

The formal statistical model (in standard shorthand notation) was:

$$Y = \text{Period Season Period*Season Class Period*Class Year(Period)-R}$$

where Y is the variable of interest; *Period* is the effect of period (before or after construction); *Season* is the effect of season (early (June or earlier) or late (July or later)); *Period*Season* represents the interaction between Project and season effects (i.e., is the effect of the period consistent in both seasons); *Class* is the effect of the site classification (Project or reference); *Period*Class* is the BACI effect of interest (i.e., is the effect of Period the same (parallel) for both classes of sites); and *Year(Period)* is the random year effect within each period (applicable if more than one year was

sampled during each period). If the data were too sparse (e.g., not all seasons measured in all periods), then the *Period*Season* interaction effect could not be estimated and was dropped. If there were multiple reference waterbodies (as was the case for streams), a term *Body(Class)-R* (the random site effect within each class) would also be added to the model so that the change in the mean for the Project site was compared to the average change in the mean for the reference bodies. Sites that were measured only in one period (e.g., Reference D OF was measured only post-construction) contribute some information on the year-effect which improves precision of the BACI estimate and were, therefore, included.

The key variable of interest was the *Period*Class* effect as this measures the amount of non-parallelism between the changes in the mean (Before-After) over the two classes of sites (exposure or reference). The BACI estimate was computed as the “difference in the differences”:

$$BACI = (\mu_{PA} - \mu_{PB}) - (\mu_{RA} - \mu_{RB})$$

where μ_{PA} is the mean variable reading in the *Project* class of sites *after* Project initiation, μ_{PB} is the mean variable reading in the *Project* class of sites *before* Project initiation, μ_{RA} is the mean variable reading in the *reference* class of sites *after* Project initiation, and μ_{RB} is the mean variable reading in the *reference* class of sites *before* Project initiation. The BACI contrast was estimated by replacing the population means above by the model-based estimates. Estimated differences close to 0 would indicate no evidence of non-parallelism.

Note that the hypothesis that the BACI contrast has the value of zero is identical to the hypothesis that the *Period*Class* interaction is zero with identical p-values. Consequently, only the results for the BACI contrast were reported.

The model was fit using R version 2.15.2. A reduced significance level (e.g., 0.01) was primarily used when reviewing the results. Significance levels of 0.01 to 0.05 were considered marginally non-significant. If the results of the before-after analysis indicated that a 2014 variable mean was not significantly different (i.e., and was not marginally non-significant) from the baseline mean, it was concluded that there was no effect of 2014 Project activities on this variable, and BACI analyses were not discussed.

1.6.3 Multivariate Approaches

All of the approaches above analyze each water quality variable independently of any other. However, the chemical constituents do not occur independently of each other, and presumably higher power would result if a multivariate approach were used. However, because of the censoring and missing data, no simple multivariate approach was possible and such an analysis would likely require the use of a full Bayesian MCMC approach. Thus, multivariate analyses were not attempted in this report.

2. RESULTS

2.1 STREAM DATA

A summary of the amount of censoring (i.e., the fraction of values below the detection limit) for the stream data is presented in Table Stream-1. High levels of censoring in all streams were found for cyanide and radium-226. The results of the analyses for these variables would be non-informative and were discarded. The same applied to ammonia and zinc in the two reference streams; TSS and molybdenum in Reference B Outflow; cadmium for all sites except Little Roberts Outflow; nitrate for all sites except Reference B Outflow, and mercury for Doris Outflow.

Preliminary plots of the data showed some outliers, primarily from readings in the late 1990's where the detection limit was much higher than in recent times (Table Stream-2). These values were discarded as such a large detection limit compared to more recent data provides little information on the actual value. Some other outliers that were not related to high detection limits were also discarded (Table Stream-2).

The results from the analysis that compared the means before and after Project construction are presented in Table Stream-3. There was evidence of a significant change in the mean between the before and after periods for mercury and lead in Reference B Outflow. Before-after comparisons of arsenic and mercury concentrations in Roberts Outflow; molybdenum concentrations in Doris Outflow; and alkalinity, hardness, and aluminum concentrations in Reference B Outflow were marginally non-significant. The results of the BACI comparison of each Project stream against the reference streams (Table Stream-4) found evidence of a significant differential response in the mean of mercury at Roberts Outflow compared to reference streams over the before and after periods.

2.2 MARINE DATA

A summary of the amount of censoring (i.e., the fraction of values below the detection limit) for the site data is presented in Table Marine-1. High levels of censoring in all marine exposure sites were found for radium-226 and cyanide. The results of the analyses for these variables would be non-informative and were discarded. The same applied to ammonia at RBW and REF-Marine-1, mercury at RBW, and nitrate at RBE.

Preliminary plots of the data showed some outliers which were removed prior to analysis (Table Marine-2). Of particular concern were the arsenic readings at the RBE site, which were substantially elevated between 2004 and 2006, but then fell to near or below detection limits from 2007 to 2014 for most samples. The elevated readings prior to 2007 were treated as outliers and removed from the analysis to ensure that these observations did not artificially inflate the variance estimates, leading to a reduced power to detect effects.

Results from the analysis that compared the means before and after Project construction are presented in Table Marine-3. There was no evidence of a significant change in the mean between the

before and after periods for either marine exposure site. The before-after comparison of mercury at REF-Marine-1 was marginally non-significant.

No BACI analyses are discussed because no significant or marginally non-significant before-after effects for exposure sites were detected.

2.3 SMALL LAKE DATA

A summary of the amount of censoring (i.e., the fraction of values below the detection limit) for the small lake data is presented in Table Small Lake-1. High levels of censoring in all lakes were found for cadmium, cyanide, and radium-226. The results of the analyses for these variables would not be informative and were discarded. High levels of censoring were also found for ammonia and zinc in Reference Lake D.

Preliminary plots of the data showed some outliers that were primarily censored data from the early 1990s. The observations listed in Table Small Lake-2 were discarded prior to analysis to ensure that these observations did not artificially inflate the variance estimates leading to a reduced power to detect effects.

Results from the analysis that compared the means before and after Project construction are presented in Table Small Lake-3. There was no evidence of a significant change in the mean between the before and after periods, except for hardness at Little Roberts Lake. There was no evidence of marginally non-significant changes between the before and after periods. Because water quality samples were not collected at Reference Lake D before construction started, no BACI analysis was possible.

2.4 LARGE LAKE DATA

A summary of the amount of censoring (i.e., the fraction of values below the detection limit) for the large lake data is presented in Table Large Lake-1. High levels of censoring in all lakes were found for cadmium, cyanide, and radium-226, and for mercury at Doris South. The results of the analyses for these variables would be non-informative and no further analysis was performed. High levels of censoring were also found for the reference lake for TSS, molybdenum, and zinc. This will make the BACI comparison difficult to interpret for these variables.

Preliminary plots of the data showed some potential outliers that were excluded from the analysis (Table Large Lake-2).

There was evidence of a significant difference in the means between the before and after periods for hardness in Doris Lake South; arsenic and molybdenum in Doris Lake North; and mercury in Reference Lake B (Table Large Lake-3). The before-after comparisons of hardness at Doris Lake South, and hardness and arsenic at Reference Lake B were marginally non-significant.

The BACI comparison for hardness at Doris Lake South compared to the reference lake over the before-after period did not indicate a significant effect (Table Large Lake-4). No other BACI analyses are discussed because no other significant (or marginally non-significant) before-after effects for exposure sites were detected.

REFERENCES

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- Hurlbert, S.H. 1984. Pseudoreplication and the Design of Ecological Field Experiments. *Ecological Monographs*, 54: 187-211.
- McBride, G.B. 2005. *Using Statistical Methods for Water Quality Management*. Wiley: New York.
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TABLES

Table Stream-1. Summary of the Proportion of Measurements that were Below Detection Limit (Before Outliers were Removed) for Stream Sampling

Variable	Stream Site				
	Doris OF	Roberts OF	Little Roberts OF	Ref. B OF	Ref. D OF
	Proportion Censored	Proportion Censored	Proportion Censored	Proportion Censored	Proportion Censored
Aluminum (Al)	0.00	0.00	0.00	0.00	0.00
Alkalinity	0.00	0.00	0.00	0.00	0.00
Ammonia	0.32	0.32	0.31	0.86	1.00
Arsenic (As)	0.06	0.00	0.03	0.00	0.00
Cyanide (CN)	0.88	0.81	0.77	1.00	1.00
Cadmium (Cd)	0.78	0.71	0.69	1.00	1.00
Copper (Cu)	0.00	0.00	0.00	0.07	0.00
Iron (Fe)	0.00	0.00	0.00	0.21	0.00
Hardness	0.00	0.00	0.00	0.00	0.00
Mercury (Hg)	0.75	0.55	0.68	0.57	0.00
Molybdenum(Mo)	0.05	0.00	0.00	0.79	0.00
Nickel (Ni)	0.05	0.00	0.00	0.43	0.00
Nitrate	0.85	0.84	0.95	0.50	1.00
Lead (Pb)	0.22	0.19	0.26	0.93	0.75
Radium-226 (Ra)	0.91	1.00	0.94	1.00	0.88
Total Suspended Solids (TSS)	0.14	0.03	0.05	0.93	0.38
Zinc (Zn)	0.26	0.29	0.33	1.00	1.00
pH	0.00	0.00	0.00	0.00	0.00

Notes:

Dataset includes all baseline years up to and including 2009, and 2014.

Proportions ≥ 0.70 are bolded.

Table Stream-2. Summary of Potential Outliers from the Stream Data

Stream	Variable	Year	Date	Rep	Value	Censored (1 = yes; 0 = no)
Doris OF	Ammonia	1997	19JUL97	1	1.359800	0
Doris OF	Ammonia	1997	19JUL97	2	1.402400	0
Doris OF	Ammonia	1997	20AUG97	1	1.353300	0
Doris OF	As	1996	23JUN96	1	0.002000	1
Doris OF	As	1996	22AUG96	1	0.003000	0
Doris OF	Cd	1996	23JUN96	1	0.000190	0
Doris OF	Cd	1996	22AUG96	1	0.000025	1
Doris OF	Cd	1997	19JUN97	1	0.000100	1
Doris OF	Cd	1997	19JUL97	1	0.000100	1
Doris OF	Cd	1997	19JUL97	2	0.000100	1
Doris OF	Cd	1997	20AUG97	1	0.000100	1
Doris OF	Cd	2000	20JUN00	1	0.000025	1
Doris OF	Cd	2000	20JUN00	2	0.000025	1
Doris OF	Cd	2000	14SEP00	1	0.000025	1
Doris OF	Cd	2000	14SEP00	2	0.000025	1
Doris OF	Cd	2004	24JUN04	1	0.000025	1
Doris OF	Pb	1997	19JUN97	1	0.000500	1
Doris OF	Pb	1997	19JUL97	1	0.000500	1
Doris OF	Pb	1997	19JUL97	2	0.000500	1
Doris OF	Pb	1997	20AUG97	1	0.000500	1
Doris OF	Hg	1997	20AUG97	1	0.000025	1
Doris OF	Hg	2000	20JUN00	1	0.000025	1
Doris OF	Hg	2000	20JUN00	2	0.000025	1
Doris OF	Hg	2000	14SEP00	1	0.000025	1
Doris OF	Hg	2000	14SEP00	2	0.000025	1
Doris OF	Hg	2003	28JUL03	1	0.000025	1
Little Roberts OF	Hg	2003	28JUL03	1	0.000025	1
Doris OF	Mo	1997	19JUN97	1	0.000500	1
Doris OF	Mo	1997	19JUL97	1	0.000500	1
Doris OF	Mo	1997	19JUL97	2	0.000500	1
Doris OF	Mo	1997	20AUG97	1	0.000500	1

Note:

Censored values were replaced with values equal to ½ of the detection limit.

Table Stream-3. Summary of Test for No Difference in Mean between Before and After Periods for Stream Water Quality Variables

Variable	Stream Site				
	Doris OF p-value	Roberts OF p-value	Little Roberts OF p-value	Ref. B OF p-value	Ref. D OF p-value
Aluminum (Al)	0.2038	0.0582	0.0916	0.0474	-
Alkalinity	0.6656	0.1899	0.6522	0.0323	-
Ammonia	0.5288	0.3716	0.4580*	<0.0001*	-
Arsenic (As)	0.4283	0.0436	0.3602	0.0864	-
Cyanide (CN)	0.6344*	0.3110*	0.3238*	-	-
Cadmium (Cd)	0.6952*	0.7195*	0.7289	<0.0001*	-
Copper (Cu)	0.7488	0.3436	0.1810	0.7221	-
Iron (Fe)	0.0963	0.3995	0.5016	0.1020	-
Hardness	0.2764	0.0919	0.3092	0.0327	-
Mercury (Hg)	0.6288*	0.0135	0.8500	0.0005	-
Molybdenum (Mo)	0.0415	0.4709	0.8423	0.4487*	-
Nickel (Ni)	0.2352	0.3487	0.6435	0.3285	-
Nitrate	0.6684*	0.2316*	0.5926*	0.2045	-
Lead (Pb)	0.9402	0.1220	0.2512	<0.0001	-
Radium-226 (Ra)	0.1871*	-	0.0030*	-	-
Total Suspended Solids (TSS)	0.6061	0.7366	0.9670	0.0098*	-
Zinc (Zn)	0.9514	0.2991	0.3005	<0.0001*	-
pH	0.3442	0.4022	0.3571	0.3046	-

Notes:

To reduce the number of false positives, an alpha level of 0.01 was used to screen for effects and p-values less than 0.01 are bolded. P-values of 0.01 to 0.05 were considered marginally non-significant.

- denotes that no analysis could be performed because of the lack of variation in a variable over time, or because data were only available from one period (i.e., no "before" data were available).

** denotes that ≥70% of the data were below the analytical detection limit, therefore, a robust analysis could not be performed and results were considered unreliable.*

Table Stream-4. Summary of BACI Comparison of Water Quality Variables for Individual Project Stream Sites

Variable	Stream Site		
	Doris OF p-value	Roberts OF p-value	Little Robert OF p-value
Aluminum (Al)	0.7393	0.3628	0.4111
Alkalinity	0.6923	0.7228	0.8741
Ammonia	0.5941	0.5984	0.8682*
Arsenic (As)	0.8247	0.0948	0.7003
Cyanide (CN)	-	-	-
Cadmium (Cd)	0.4546*	0.8801*	0.9240
Copper (Cu)	0.5747	0.6646	0.3458
Iron (Fe)	0.4075	0.7862	0.9028
Hardness	0.3905	0.4913	0.4594
Mercury (Hg)	0.1035*	0.0004	0.4341
Molybdenum (Mo)	0.7262	0.4062	0.4704
Nickel (Ni)	0.5605	0.9556	0.4172
Nitrate	0.2365*	0.8524*	0.0274*
Lead (Pb)	0.8953	0.2754	0.3061
Radium-226 (Ra)	-	-	-
Total Suspended Solids (TSS)	0.6177	0.5556	0.6061
Zinc (Zn)	0.6904	0.3031	0.4690
pH	0.7196	0.7429	0.8762

Notes:

To reduce the number of false positives, a smaller alpha level (0.01) was used to screen for effects and p-values less than 0.01 are bolded. P-values of 0.01 to 0.05 were considered marginally non-significant.

- denotes that no analysis could be performed because of the lack of variation in a variable over time, or because data were only available from one period (i.e., no “before” data were available).

** denotes that ≥70% of the data were below the analytical detection limit, therefore, a robust analysis could not be performed and results were considered unreliable.*

Table Marine-1. Summary of the Proportion of Measurements that were Below Detection Limit (Before Outliers Removed) for Marine Sampling

Variable	Site		
	RBE Proportion Censored	RBW Proportion Censored	REF-Marine 1 Proportion Censored
Aluminum (Al)	0.07	0.36	0.22
Alkalinity	0.00	0.00	0.00
Ammonia	0.48	1.00	0.89
Arsenic (As)	0.10	0.18	0.22
Cyanide (CN)	0.82	1.00	1.00
Cadmium (Cd)	0.37	0.18	0.22
Copper (Cu)	0.00	0.00	0.00
Iron (Fe)	0.03	0.27	0.22
Hardness	0.00	0.00	0.00
Mercury (Hg)	0.59	0.73	0.56
Molybdenum (Mo)	0.17	0.27	0.22
Nickel (Ni)	0.10	0.00	0.00
Nitrate	0.75	0.36	0.44
Lead (Pb)	0.40	0.55	0.67
Radium-226 (Ra)	0.93	1.00	1.00
Total Suspended Solids (TSS)	0.17	0.55	0.67
Zinc (Zn)	0.13	0.55	0.56
pH	0.00	0.00	0.00

Notes:

Dataset includes all baseline years up to and including 2009, and 2014.

Proportions ≥ 0.70 are bolded.

Table Marine-2. Summary of Potential Outliers from the Marine Data

Site	Variable	Year	Date	Rep	Value	Censored (1 = yes; 0 = no)
RBE	Ammonia	1996	28AUG96	1	2.500000	1
RBE	Ammonia	2007	23JUL07	1	0.214000	0
RBE	As	1996	28AUG96	1	0.002500	1
RBE	As	2004	19JUL04	1	0.008020	0
RBE	As	2004	14AUG04	1	0.015200	0
RBE	As	2004	16AUG04	1	0.013100	0
RBE	As	2004	09SEP04	1	0.022300	0
RBE	As	2005	21JUL05	1	0.004730	0
RBE	As	2005	18AUG05	1	0.022100	0
RBE	As	2005	14SEP05	1	0.021200	0
RBE	As	2006	31MAY06	1	0.015200	0
RBE	As	2006	20JUL06	1	0.013300	0
RBE	As	2006	12AUG06	1	0.025600	0
RBE	As	2006	11SEP06	1	0.023680	0
RBE	As	2014	21JUL14	1	0.028700	0
RBE	Cyanide	2007	27MAY07	1	0.250000	1
RBE	Cyanide	2007	23JUL07	1	2.500000	1
RBE	Cd	1996	28AUG96	1	0.003480	0
RBE	Ni	1996	28AUG96	1	0.021500	0
RBE	Nitrate	1996	28AUG96	1	2.500000	1

Notes: Censored values were replaced by values equal to ½ of the detection limit.

Table Marine-3. Summary of Test for No Difference in Mean between Before and After Periods for Marine Water Quality Variables

Variable	Marine Site		
	RBE p-value	RBW p-value	REF-Marine 1 p-value
Aluminum (Al)	0.6729	0.7243	0.6403
Alkalinity	0.4194	-	-
Ammonia	0.2610	-	<0.0001*
Arsenic (As)	0.9315	0.7329	0.6903
Cyanide (CN)	0.8731*	-	-
Cadmium (Cd)	0.8151	0.9842	0.8006
Copper (Cu)	0.6839	0.6889	0.5962
Iron (Fe)	0.6488	0.7270	0.6721
Hardness	0.2798	0.9044	-
Mercury (Hg)	0.3216	0.0019*	0.0237
Molybdenum (Mo)	0.8780	0.8444	0.7317
Nickel (Ni)	0.7599	0.9226	0.5691
Nitrate	0.9099*	0.5621	0.2660
Lead (Pb)	0.6932	0.8968	0.4336
Radium-226 (Ra)	0.9343*	-	-
Total Suspended Solids (TSS)	0.2763	0.1202	0.9354
Zinc (Zn)	0.8334	0.4379	0.5618
pH	0.9260	0.4418	0.7880

Notes:

To reduce the number of false positives, a smaller alpha level (0.01) was used to screen for effects and p-values less than 0.01 are bolded. P-values of 0.01 to 0.05 were considered marginally non-significant.

- denotes that no analysis could be performed because of the lack of variation in a variable over time, or because data were only available from one period (i.e., no “before” data were available).

** denotes that ≥70% of the data were below the analytical detection limit, therefore, a robust analysis could not be performed and results were considered unreliable.*

Table Marine-4. Summary of BACI Comparison of Water Quality Variables for Individual Project Marine Sites

Variable	Marine Project Site	
	RBE p-value	RBW p-value
Aluminum (Al)	0.6573	0.9154
Alkalinity	-	-
Ammonia	0.5248	<0.0001
Arsenic (As)	0.1929	0.8448
Cyanide (CN)	-	-
Cadmium (Cd)	0.3483	0.8168
Copper (Cu)	0.9965	0.7778
Iron (Fe)	0.6583	0.9778
Hardness	-	-
Mercury (Hg)	0.5608	0.7779*
Molybdenum (Mo)	0.7779	0.5056
Nickel (Ni)	0.6584	0.8439
Nitrate	0.1922*	0.9584
Lead (Pb)	0.7248	0.7581
Radium-226 (Ra)	-	-
Total Suspended Solids (TSS)	0.4336	0.7786
Zinc (Zn)	0.9344	0.9441
pH	0.9116	0.9685

Notes:

To reduce the number of false positives, a smaller alpha level (0.01) was used to screen for effects and p-values less than 0.01 are bolded. P-values of 0.01 to 0.05 were considered marginally non-significant.

- denotes that no analysis could be performed because of the lack of variation in a variable over time, or because data were only available from one period (i.e., no “before” data were available).

** denotes that ≥70% of the data were below the analytical detection limit, therefore, a robust analysis could not be performed and results were considered unreliable.*

Table Small Lake-1. Summary of the Proportion of Measurements that were Below Detection Limit (Before Outliers Removed) for Small Lake Sampling

Variable	Small Lake Site	
	Little Roberts Proportion Censored	Reference D Proportion Censored
Aluminum (Al)	0.00	0.00
Alkalinity	0.03	0.00
Ammonia	0.33	0.75
Arsenic (As)	0.09	0.00
Cyanide (CN)	0.84	1.00
Cadmium (Cd)	0.78	0.88
Copper (Cu)	0.00	0.00
Iron (Fe)	0.00	0.00
Hardness	0.00	0.00
Mercury (Hg)	0.52	0.12
Molybdenum (Mo)	0.06	0.25
Nickel (Ni)	0.03	0.00
Nitrate	0.67	0.12
Lead (Pb)	0.14	0.62
Radium-226 (Ra)	0.92	1.00
Total Suspended Solids (TSS)	0.11	0.50
Zinc (Zn)	0.28	0.88
pH	0.00	0.00

*Notes:**Dataset includes all baseline years up to and including 2009, and 2014.**Proportions ≥ 0.70 are bolded.*

Table Small Lake-2. Summary of Potential Outliers from the Small Lake Data

Lake	Variable	Year	Date	Rep	Reading	Censored (1 = yes; 0 = no)
Little Roberts	Ammonia	2007	24MAY07	1	0.240000	0
Little Roberts	Cd	1995	07MAY95	1	0.000100	1
Little Roberts	Cd	1995	07JUN95	1	0.000100	1
Little Roberts	Cd	1996	27AUG96	1	0.000025	1
Little Roberts	Cd	1996	27AUG96	2	0.000025	1
Little Roberts	Cd	1997	15JUL97	1	0.000100	1
Little Roberts	Cd	1997	15JUL97	2	0.000100	1
Little Roberts	Hg	2003	27JUL03	1	0.000230	0
Little Roberts	Mo	1997	15JUL97	1	0.000500	1
Little Roberts	Mo	1997	15JUL97	2	0.000500	1
Little Roberts	Nitrate	2004	13SEP04	1	5.300000	0
Little Roberts	Zn	1995	07MAY95	1	0.327000	0

Note:

Censored values were replaced with values equal to ½ of the detection limit.

Table Small Lake-3. Summary of Test for No Difference in Mean between Before and After Periods for Small Lake Water Quality Variables

Variable	Small Lake Site	
	Little Roberts p-value	Reference D p-value
Aluminum (Al)	0.4787	-
Alkalinity	0.0505	-
Ammonia	0.4798	-
Arsenic (As)	0.5086	-
Cyanide (CN)	0.2282*	-
Cadmium (Cd)	0.6353*	-
Copper (Cu)	0.4574	-
Iron (Fe)	0.6100	-
Hardness	0.0053	-
Mercury (Hg)	0.7566	-
Molybdenum (Mo)	0.7607	-
Nickel (Ni)	0.8897	-
Nitrate	0.8849	-
Lead (Pb)	0.5075	-
Radium-226 (Ra)	0.5573*	-
Total Suspended Solids (TSS)	0.2695	-
Zinc (Zn)	0.4249	-
pH	0.0504	-

Notes:

To reduce the number of false positives, a smaller alpha level (0.01) was used to screen for effects and p-values less than 0.01 are bolded. P-values of 0.01 to 0.05 were considered marginally non-significant.

- denotes that no analysis could be performed because of the lack of variation in a variable over time, or because data were only available from one period (i.e., no “before” data were available).

** denotes that ≥70% of the data were below the analytical detection limit, therefore, a robust analysis could not be performed and results were considered unreliable.*

Table Large Lake-1. Summary of the Proportion of Measurements that were Below Detection Limit (Before Outliers Removed) for Large Lake Sampling

Variable	Large Lake Site		
	Doris North	Doris South	Reference B
	Proportion Censored	Proportion Censored	Proportion Censored
Aluminum (Al)	0.00	0.05	0.12
Alkalinity	0.00	0.00	0.00
Ammonia	0.33	0.64	0.50
Arsenic (As)	0.08	0.23	0.12
Cyanide (CN)	0.83	1.00	1.00
Cadmium (Cd)	0.72	0.96	0.81
Copper (Cu)	0.01	0.00	0.06
Iron (Fe)	0.05	0.14	0.56
Hardness	0.00	0.00	0.00
Mercury (Hg)	0.49	0.77	0.56
Molybdenum (Mo)	0.07	0.32	0.94
Nickel (Ni)	0.00	0.23	0.44
Nitrate	0.69	0.57	0.47
Lead (Pb)	0.24	0.43	0.62
Radium-226 (Ra)	0.93	1.00	1.00
Total Suspended Solids (TSS)	0.08	0.18	0.80
Zinc (Zn)	0.22	0.54	0.81
pH	0.00	0.00	0.00

Notes:

Dataset includes all baseline years up to and including 2009, and 2014.

Proportions ≥ 0.70 are bolded.

Table Large Lake-2. Summary of Potential Outliers from the Large Lake Data

Lake	Variable	Year	Date	Rep	Reading	Censored (1 = yes; 0 = no)
Doris North	As	1995	20AUG95	1	0.003000	0
Doris South	As	1996	28AUG96	1	0.005000	0
Doris South	As	1996	28AUG96	1	0.004000	0
Doris South	As	1996	28AUG96	1	0.007000	0
Doris South	As	1996	28AUG96	1	0.015000	0
Doris North	Cd	1995	04MAY95	1	0.000100	1
Doris North	Cd	1995	07JUN95	1	0.000100	1
Doris North	Cd	1995	20AUG95	1	0.000050	1
Doris North	Cd	1995	20AUG95	1	0.000050	1
Doris North	Cd	1995	20AUG95	1	0.000050	1
Doris North	Cd	1995	20AUG95	1	0.000050	1
Doris North	Cd	1995	20AUG95	1	0.000050	1
Doris North	Cd	1995	20AUG95	1	0.000050	1
Doris South	Cd	1995	04MAY95	1	0.000100	1
Doris South	Cd	1995	07JUN95	1	0.000100	1
Doris South	Cd	1995	20AUG95	1	0.000050	1
Doris South	Cd	1995	20AUG95	1	0.000050	1
Doris South	Cd	1995	20AUG95	1	0.000050	1
Doris South	Cd	1995	20AUG95	2	0.000050	1
Doris South	Cd	1997	18APR97	1	0.000100	1
Doris South	Cd	1997	18JUL97	1	0.000100	1
Doris South	Cd	1997	18JUL97	1	0.000100	1
Doris South	Cd	1997	18JUL97	2	0.000100	1
Doris South	Cd	1997	18JUL97	2	0.000100	1
Doris South	Cd	1997	22AUG97	1	0.000100	1
Doris South	Cd	1997	22AUG97	1	0.000100	1
Doris South	Cd	1998	25APR98	1	0.000100	1
Doris South	Cd	1998	25APR98	2	0.000100	1
Doris South	Cd	1998	25APR98	3	0.000100	1
Doris South	Hg	1997	22AUG97	1	0.000025	1
Doris South	Hg	1997	22AUG97	1	0.000025	1
Doris South	Hg	1998	25APR98	1	0.000025	1
Doris South	Hg	1998	25APR98	2	0.000025	1
Doris South	Hg	1998	25APR98	3	0.000025	1
Doris South	Hg	2000	24JUL00	1	0.000025	1
Doris South	Hg	2000	24JUL00	2	0.000025	1

Table Large Lake-2. Summary of Potential Outliers from the Large Lake Data

Lake	Variable	Year	Date	Rep	Reading	Censored (1 = yes; 0 = no)
Doris South	Hg	2000	24JUL00	1	0.000025	1
Doris South	Hg	2000	24JUL00	2	0.000025	1
Doris South	Hg	2000	22AUG00	1	0.000025	1
Doris South	Hg	2000	22AUG00	2	0.000025	1
Doris South	Mo	1997	18APR97	1	0.000500	1
Doris South	Mo	1997	18JUL97	1	0.000500	1
Doris South	Mo	1997	18JUL97	1	0.000500	1
Doris South	Mo	1997	18JUL97	2	0.000500	1
Doris South	Mo	1997	18JUL97	2	0.000500	1
Doris South	Mo	1997	22AUG97	1	0.000500	1
Doris South	Mo	1997	22AUG97	1	0.000500	1
Doris South	Mo	1998	25APR98	1	0.000500	1
Doris South	Mo	1998	25APR98	2	0.000500	1
Doris South	Mo	1998	25APR98	3	0.000500	1
Doris North	Ni	2005	19JUL05	1	0.028300	0
Doris North	Pb	2004	05JUN04	1	0.006690	0
Doris South	Nitrate	1996	28AUG96	1	4.510000	0

Note:

Censored values were replaced with values equal to $\frac{1}{2}$ of the detection limit.

Table Large Lake-3. Summary of Test for No Difference in Mean between Before and After Periods for Large Lake Water Quality Variables

Variable	Large Lake Site		
	Doris North p-value	Doris South p-value	Reference B p-value
Aluminum (Al)	0.5828	0.6772	0.9124
Alkalinity	0.1820	0.1672	0.0879
Ammonia	0.0671	0.1313	0.4842
Arsenic (As)	0.0010	0.4375	0.0395
Cyanide (CN)	0.3736*	<0.0001*	-
Cadmium (Cd)	0.9218*	0.4713*	0.2169*
Copper (Cu)	0.1611	0.1371	0.7243
Iron (Fe)	0.9729	0.6866	0.7994
Hardness	0.0388	0.0054	0.0367
Mercury (Hg)	0.2898	<0.0001*	0.0005
Molybdenum (Mo)	0.0033	0.9039	0.7818*
Nickel (Ni)	0.7027	0.4221	0.3702
Nitrate	0.1335	0.4890	0.3449
Lead (Pb)	0.3032	0.3136	0.9683
Radium-226 (Ra)	0.7398*	-	-
Total Suspended Solids (TSS)	0.7301	0.7548	0.0462*
Zinc (Zn)	0.5227	0.4308	<0.0001*
pH	0.2843	0.2638	0.7673

Notes:

To reduce the number of false positives, a smaller alpha level (0.01) was used to screen for effects and p-values less than 0.01 are bolded. P-values of 0.01 to 0.05 were considered marginally non-significant.

- denotes that no analysis could be performed because of the lack of variation in a variable over time, or because data were only available from one period (i.e., no "before" data were available).

** denotes that $\geq 70\%$ of the data were below the analytical detection limit, therefore, a robust analysis could not be performed and results were considered unreliable.*

Table Large Lake-4. Summary of BACI Comparison of Water Quality Variables for Individual Project Large Lake Sites

Variable	Large Lake Site	
	Doris North p-value	Doris South p-value
Aluminum (Al)	0.8938	0.8957
Alkalinity	0.6305	0.4410
Ammonia	0.3558	0.3150
Arsenic (As)	0.5112	0.0180
Cyanide (CN)	-	-
Cadmium (Cd)	0.6899*	0.8317*
Copper (Cu)	0.2712	0.2593
Iron (Fe)	0.9125	0.7089
Hardness	0.1005	0.2871
Mercury (Hg)	0.0425†	0.0403*
Molybdenum (Mo)	0.8840	0.2999
Nickel (Ni)	0.2656	0.0508
Nitrate	0.1707	0.0815
Lead (Pb)	0.0222†	0.1227
Radium-226 (Ra)	-	-
Total Suspended Solids (TSS)	0.1625	0.4330
Zinc (Zn)	0.5888	0.8076
pH	0.7834	0.5666

Notes:

To reduce the number of false positives, a smaller alpha level (0.01) was used to screen for effects and p-values less than 0.01 are bolded. P-values of 0.01 to 0.05 were considered marginally non-significant.

- denotes that no analysis could be performed because of the lack of variation in a variable over time, or because data were only available from one period (i.e., no “before” data were available).

* denotes that $\geq 70\%$ of the data were below the analytical detection limit, therefore, a robust analysis could not be performed and results were considered unreliable.

† indicates that the result of lower order model (i.e., before-after comparison) was not significant.

APPENDIX B.2.3. STATISTICAL METHODOLOGY AND RESULTS FOR SEDIMENT QUALITY EVALUATION OF EFFECTS, DORIS NORTH PROJECT, 2014

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1. ANALYSIS METHODS

1.1 ASSUMPTIONS

There were several assumptions made for the analyses in this section. The key assumption was that the samples taken were a random sample of the site's sediment for that monitoring period.

Samples were typically collected only once per year (usually August). Consequently no information was available on month-to-month variation in sediment variables, and inference was limited to the sampled months.

For the marine environment, the sampling years before construction were quite different (2002 and 2009) for the two sites for which historical data were available (RBW and REF-Marine 1). Consequently, care must be taken in the interpretation of any comparisons between sites as the results may be artifacts of the specific years chosen.

1.2 DEALING WITH CENSORING (VALUES BELOW DETECTION LIMITS)

The proportion of data with readings below the detection limit varied by waterbody and by chemical variable. The analyses below follow the advice of McBride (2005; Section 11.4.3).

- When the dataset included a small number of below detection values, values were replaced by values equal to $\frac{1}{2}$ of the detection limit for the analysis.
- When the majority of the dataset consisted of values below the detection limit (e.g., more than about 70% below detection limit), there was very little that could be done as there is essentially no information (other than the values are below the detection limit). The analyses were performed as outlined below, but the results were interpreted with caution. Helsel (2005) has other suggestions for analysis (e.g., comparing the proportions below the detection limits) but these tests require much larger sample sizes than available here.
- When there was an intermediate amount of censoring, a more complex analysis can be conducted that fully integrates the information from the censored values with the known values. This is most easily done using Bayesian methods using Markov chain Monte Carlo (MCMC) methods as likelihood methods would require integration of the likelihood for each censored value over and above dealing with the other random effects in the model.

Most water quality variables fell into one of the first two categories and only those methods were employed in the 2014 Program.

1.3 TRANSFORMATIONS

For most variables, the values were fairly homogeneous and no obvious transformation was suggested, i.e., metals analyzed on the ppm scale (mg/kg).

1.4 COMPOSITIONAL DATA

The measurements of sediment particle size composition (e.g., sand, gravel, etc.) are compositional with the values necessarily adding to 100%. Each component was analyzed separately, but it is impossible to have changes in the percent composition of one component without changes in other components. Alternative methods dealing with compositional data are available (Aitchison 1986), but have not been used in this report because they cannot easily handle censoring and because the number of samples was limited.

1.5 OUTLINE OF ANALYSIS PLAN

There are several classes of statistical tests that can be done to assess evidence of change in the mean of the sediment quality variable over time and to assess if changes in the means may reflect an impact of the Project.

1.5.1 Before vs. After Analysis

The first analysis compared the mean readings for all years prior to 2010 (before initiation of construction) to the mean for 2014. Each waterbody was treated independently, and each sediment quality variable was treated separately.

The final statistical model (in standard shorthand notation) was:

$$Y = \text{Period Year}(\text{period}) - R$$

where Y is the (mean) variable reading in a year; *Period* is the effect of before vs. after Project initiation (which is the effect of interest), and *Year(Period)* is a random year effect (applicable if more than one year was sampled during each period).

This model is preferable to simply treating all measurement within a period (e.g., over all baseline years) as having the same mean and assuming that they are completely independent of each other. This model also “averages” the sediment quality values collected over the baseline years in a way that weights each year equally rather than weighting by the sample size. For example, suppose that the sediment quality variable measured in 2008 was 22 mg/kg, while the two readings measured in 2009 were 25 and 27 mg/kg. The simple mean $(22+25+27)/3=24.7$ mg/kg would be more heavily weighted toward the mean in the second year. In order to give each year’s data equal weight, the reading over both years should be computed as an average of averages:

$$\frac{\frac{22}{1} + \frac{25 + 27}{2}}{2} = 24.0 \text{ mg/kg}$$

This could be extended to multiple years in a similar fashion. Note that in the case of balanced data (i.e., an equal number of replicates in all years), the average-of-the-averages and simple-average would be identical. The model with a random year effect is still preferred in the case of balanced data because the readings within a year may be correlated due to year-specific random factors that cause all the readings within a year to increase or decrease in step.

This model was fit using R version 2.15.2. In order to reduce the number of “false positives” associated with performing a large number of statistical tests, a reduced significance level (e.g., 0.01) was primarily used when reviewing the results. Significance levels of 0.01 to 0.05 for exposure sites were considered marginally non-significant and were also discussed in the evaluation of effects.

The key disadvantage of this model is that changes over time may be unrelated to the effects of the Project, e.g., the mean sediment quality readings in 2014 could be greater than expected because of long term climate change that is unrelated to the Project. Consequently, if a statistically significant effect was detected, it would require further investigation.

1.5.2 BACI Analysis

Before-After-Control-Impact (BACI) analysis is the standard method used to assess a potential environmental impact (Smith 2002). BACI designs evaluate potential non-parallelism in response over time between the exposure and reference waterbodies.

No “before” sediment quality data was available for the reference lakes. Consequently, no BACI analysis could be performed for lake sediments.

For marine and stream environments, the formal statistical model (in standard shorthand notation) was:

$$Y = \text{Period} + \text{Class} + \text{Period} * \text{Class}$$

where Y is the sediment quality variable reading; *Period* is the effect of period (before or after construction); *Class* is the effect of water body classification (Project or reference); and *Period*Class* is the BACI effect of interest, i.e., is the effect of *Period* the same (parallel) for both classes of waterbody. For the stream environments, a term *Body(Class)-R* (the random site effect within each class) would also be added to the model so that the change in the mean for each exposure stream is compared to the average change in the mean for the reference bodies. Sites that were measured only in one period (e.g., Reference D OF was measured only post-construction) contribute some information on the year-effect which improves precision of the BACI estimate and were, therefore, included. Only one year of baseline data was available for stream and marine sites; therefore, the model did not include a random year effect.

The key variable of interest was the *Period*Class* effect as this measures the amount of non-parallelism between the changes in the mean (Before-After) over the two classes of waterbodies (exposure or reference).

The BACI estimate was computed as the “difference in the differences”:

$$BACI = (\mu_{PA} - \mu_{PB}) - (\mu_{RA} - \mu_{RB})$$

where μ_{PA} is the mean variable reading in the *Project* class of sites *after* Project initiation, μ_{PB} is the mean variable reading in the *Project* class of sites *before* Project initiation, μ_{RA} is the mean variable reading in the *reference* class of sites *after* Project initiation, and μ_{RB} is the mean variable reading in the *reference* class of sites *before* Project initiation. The BACI contrast was estimated by replacing the

population means above by the model-based estimates. Estimated differences close to 0 would indicate no evidence of non-parallelism.

Note that the hypothesis that the BACI contrast has the value of zero is identical to the hypothesis that the Period*Class interaction is zero with identical p-values. Consequently, only the results for the BACI contrast were reported here.

This model was fit using R version 2.15.2. A reduced significance level (e.g., 0.01) was primarily used when reviewing the results. Significance levels of 0.01 to 0.05 were considered marginally non-significant. If the results of the before-after analysis indicated that a 2014 variable mean was not significantly different (i.e., and was not marginally non-significant) from the baseline mean, it was concluded that there was no effect of 2014 Project activities on this variable, and BACI analyses were not discussed.

1.5.3 Multivariate Approaches

All of the approaches above analyze each sediment quality variable independently of any other. However, the chemical constituents do not occur independently of each other, and presumably higher power would result if a multivariate approach were used. However, because of the censoring and missing data, no simple multivariate approach was possible and such an analysis would likely require the use of a full Bayesian MCMC approach. Thus, multivariate analyses were not attempted in this report.

2. RESULTS

2.1 STREAM DATA

A summary of the amount of censoring (i.e., the number of values below the detection limit) for the stream data is presented in Table Stream-1. High levels of censoring were found for cadmium (at all sites) and mercury (at Doris Outflow). As a consequence, the results of the analyses for these variables would be non-informative and were discarded. Preliminary plots of the data failed to show any outliers.

The results from the analysis that compared the means before and after Project construction are presented in Table Stream-2. Significant differences between before and after means were detected for % gravel and % sand in Doris Outflow; % gravel, % sand, % silt, % clay, % TOC, lead, and mercury in Little Roberts Outflow; and zinc in Reference B Outflow. There was also evidence of marginally non-significant non-parallelisms for chromium, copper and zinc at Little Roberts OF and chromium at Reference B OF.

The results of the BACI comparison (Table Stream-3) found evidence of significant differential changes in % sand in Doris Outflow; and % clay, % TOC, lead and mercury between Little Roberts Outflow and reference streams over the before and after periods. There was also a marginally non-significant BACI result for % silt at Little Roberts OF.

2.2 MARINE DATA

A summary of the amount of censoring (i.e., the number of values below the detection limit) for the marine data is presented in Table Marine-1. High levels of censoring were found for % gravel (at RBW) and cadmium (at RBE and RBW), and the results of the analyses for these variables would be non-informative and were discarded. Preliminary plots of the data showed no outliers.

The results from the analysis that compared the means before and after Project construction are presented in Table Marine-2. At RBW, there was evidence of a significant difference in means across the periods for % silt, % clay, % TOC, arsenic, chromium, and copper; and % sand, % silt, % clay, % TOC, arsenic, chromium, copper, lead, mercury, and zinc at REF-Marine 1. Evidence of marginally non-significant differences in before and after means for % sand, lead, and zinc was also present for RBW.

A BACI analysis could not be performed for RBW because of a lack of degrees of freedom in the before periods. Additionally, BACI and before-after comparisons could not be performed for RBE because sediment quality data was not collected pre-construction.

2.3 LAKE DATA

A summary of the amount of censoring (i.e., the number of values below the detection limit) for the lake data is presented in Table Lake-1. High levels of censoring were found for the % gravel variable

(at all sites except Reference Lake B); the results of analyses for this variable would be non-informative and were discarded. Preliminary plots of the data showed no evidence of outliers.

Before-after comparisons indicated that there was a significant change between the before and after periods in mean % TOC and copper in Doris Lake North; % silt, % clay, and copper in Doris Lake South; and % sand, % silt, arsenic and zinc in Little Roberts Lake (Table Lake-2). There was also evidence of marginally non-significant changes in before and after means for cadmium and lead at Doris Lake North; lead at Doris Lake South; and % clay at Little Roberts Lake. Because no reference lakes were measured in the before period, no BACI comparisons were possible.

REFERENCES

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TABLES

Table Stream-1. Summary of the Proportion of Measurements that were Below Detection Limit

Variable	Stream Site				
	Doris OF	Roberts OF	Little Roberts OF	Reference B OF	Reference D OF
	Proportion Censored	Proportion Censored	Proportion Censored	Proportion Censored	Proportion Censored
% Gravel (>2mm)	0.00	0.00	0.33	0.00	0.33
% Sand (2.0mm - 0.063mm)	0.00	0.00	0.00	0.00	0.00
% Silt (0.063mm – 4µm)	0.17	0.00	0.00	0.00	0.00
% Clay (<4 µm)	0.33	0.00	0.00	0.17	0.00
Arsenic (As)	0.00	0.00	0.00	0.00	0.00
Cadmium (Cd)	1.00	1.00	0.83	0.83	1.00
Chromium (Cr)	0.00	0.00	0.00	0.00	0.00
Copper (Cu)	0.00	0.00	0.00	0.00	0.00
Lead (Pb)	0.33	0.00	0.00	0.33	0.00
Mercury (Hg)	0.83	0.67	0.50	0.67	0.33
Total Organic Carbon	0.17	0.00	0.00	0.00	0.00
Zinc (Zn)	0.00	0.00	0.00	0.00	0.00

Notes:

Dataset includes all baseline years up to and including 2009, and 2014.

Proportions ≥ 0.70 are bolded.

Table Stream-2. Summary of Test for No Difference in Mean between Before and After Periods for Stream Sediment Quality Variables

Variable	Stream Site				
	Doris OF	Roberts OF	Little Roberts OF	Reference B OF	Reference D OF
	p-value	p-value	p-value	p-value	p-value
% Gravel (>2mm)	0.0018	-	0.0077	0.4533	-
% Sand (2.0mm - 0.063mm)	0.0002	-	0.0014	0.1395	-
% Silt (0.063mm - 4µm)	0.8520	-	0.0007	0.9831	-
% Clay (<4µm)	0.4579	-	0.0004	0.4321	-
Arsenic (As)	0.4711	-	0.5521	0.0605	-
Cadmium (Cd)	<0.0001*	-	0.1326*	0.5626*	-
Chromium (Cr)	0.1555	-	0.0192	0.0491	-
Copper (Cu)	0.3412	-	0.0162	0.7888	-
Lead (Pb)	0.3757	-	0.0065	0.5376	-
Mercury (Hg)	0.3739*	-	0.0039	0.2448	-
Total Organic Carbon	0.9087	-	0.0009	0.3564	-
Zinc (Zn)	0.2612	-	0.0178	0.0064	-

Notes:

To reduce the number of false positives, a smaller alpha level (0.01) was used to screen for effects and p-values less than 0.01 are bolded. P-values of 0.01 to 0.05 were considered marginally non-significant.

- denotes that no analysis could be performed because of the lack of variation in a variable over time, or because data were only available from one period (i.e., no “before” data were available).

** denotes that ≥70% of the data were below the analytical detection limit, therefore, a robust analysis could not be performed and results were considered unreliable.*

Table Stream-3. Summary of BACI Comparison of Sediment Quality Variables for Individual Project Stream Sites

Variable	Stream Site	
	Doris OF p-value	Little Roberts OF p-value
% Gravel (>2mm)	0.0479	0.0961
% Sand (2.0mm - 0.063mm)	0.0018	0.2572
% Silt (0.063mm - 4µm)	0.9696	0.0204
% Clay (<4µm)	0.8183	0.0013
Arsenic (As)	0.1813	0.1745
Cadmium (Cd)	0.3466*	0.7149*
Chromium (Cr)	0.0545	0.0020†
Copper (Cu)	0.3362	0.1435
Lead (Pb)	0.2751	0.0056
Mercury (Hg)	0.1469*	0.0069
Total Organic Carbon	0.4262	0.0013
Zinc (Zn)	0.0615	0.0008†

Notes: To reduce the number of false positives, a smaller alpha level (0.01) was used to screen for effects and p-values less than 0.01 are bolded. P-values of 0.01 to 0.05 were considered marginally non-significant.

A BACI analysis could not be performed for Roberts OF as no "before" data was available for this site.

* denotes that ≥70% of the data were below the analytical detection limit, therefore, a robust analysis could not be performed and results were considered unreliable.

† indicates that the result of lower order model (i.e., before-after comparison) was not significant.

Table Marine-1. Summary of the Proportion of Measurements that were Below Detection Limit

Variable	Marine Site		
	RBE Proportion Censored	RBW Proportion Censored	REF-Marine 1 Proportion Censored
% Gravel (>2mm)	0.00	0.88	0.17
% Sand (2.0mm - 0.063mm)	0.00	0.00	0.00
% Silt (0.063mm - 4µm)	0.00	0.00	0.00
% Clay (<4 µm)	0.00	0.00	0.00
Arsenic (As)	0.00	0.00	0.00
Cadmium (Cd)	1.00	1.00	0.67
Chromium (Cr)	0.00	0.00	0.00
Copper (Cu)	0.00	0.00	0.00
Lead (Pb)	0.00	0.00	0.50
Mercury (Hg)	0.33	0.62	0.50
Total Organic Carbon	0.67	0.62	0.00
Zinc (Zn)	0.00	0.00	0.00

Notes:

Dataset includes all baseline years up to and including 2009, and 2014.

Proportions ≥ 0.70 are bolded.

Table Marine-2. Summary of Test for No Difference in Mean between Before and After Periods for Marine Sediment Quality Variables

Variable	Marine Site		
	RBE p-value	RBW p-value	REF-Marine 1 p-value
% Gravel (>2mm)	-	0.4816*	0.3933
% Sand (2.0mm - 0.063mm)	-	0.0226	<0.0001
% Silt (0.063mm - 4µm)	-	0.0002	0.0001
% Clay (<4µm)	-	0.0098	0.0014
Arsenic (As)	-	0.0001	0.0005
Cadmium (Cd)	-	<0.0001*	0.7970
Chromium (Cr)	-	0.0013	0.0001
Copper (Cu)	-	0.0008	0.0004
Lead (Pb)	-	0.0365	<0.0001
Mercury (Hg)	-	0.7115	0.0001
Total Organic Carbon	-	<0.0001	0.0023
Zinc (Zn)	-	0.0104	0.0002

Notes:

To reduce the number of false positives, a smaller alpha level (0.01) was used to screen for effects and p-values less than 0.01 are bolded. P-values of 0.01 to 0.05 were considered marginally non-significant.

- denotes that no analysis could be performed because of the lack of variation in a variable over time, or because data were only available from one period (i.e., no "before" data were available).

* denotes that ≥70% of the data were below the analytical detection limit, therefore, a robust analysis could not be performed and results were considered unreliable.

Table Lake-1. Summary of the Proportion of Measurements that were Below Detection Limit

Variable	Lake Site				
	Doris North	Doris South	Little Roberts	Reference B	Reference D
	Proportion censored	Proportion censored	Proportion censored	Proportion censored	Proportion censored
% Gravel (>2mm)	0.83	1.00	1.00	0.33	1.00
% Sand (2.0mm - 0.063mm)	0.17	0.17	0.00	0.00	0.00
% Silt (0.063mm - 4µm)	0.00	0.00	0.00	0.00	0.00
% Clay (<4 µm)	0.00	0.00	0.00	0.00	0.00
Arsenic (As)	0.00	0.00	0.00	0.00	0.00
Cadmium (Cd)	0.00	0.14	0.14	0.00	0.00
Chromium (Cr)	0.00	0.00	0.00	0.00	0.00
Copper (Cu)	0.00	0.00	0.00	0.00	0.00
Lead (Pb)	0.00	0.00	0.00	0.00	0.00
Mercury (Hg)	0.00	0.00	0.00	0.00	0.00
Total Organic Carbon	0.00	0.00	0.00	0.00	0.00
Zinc (Zn)	0.00	0.00	0.00	0.00	0.00

Notes:

Dataset includes all baseline years up to and including 2009, and 2014.

Proportions ≥ 0.70 are bolded.

Table Lake-2. Summary of Test for No Difference in Mean between Before and After Periods for Lake Sediment Quality Variables

Variable	Lake Site				
	Doris North	Doris South	Little Roberts	Reference B	Reference D
	p-value	p-value	p-value	p-value	p-value
% Gravel (>2mm)	0.2381*	<0.0001*	<0.0001*	-	-
% Sand (2.0mm - 0.063mm)	0.0682	0.0681	0.0002	-	-
% Silt (0.063mm - 4µm)	0.1042	0.0049	0.0004	-	-
% Clay (<4 µm)	0.2285	0.0078	0.0329	-	-
Arsenic (As)	0.4232	0.1350	0.0019	-	-
Cadmium (Cd)	0.0307	0.8012	0.7262	-	-
Chromium (Cr)	0.3008	0.5638	0.8347	-	-
Copper (Cu)	0.0034	<0.0001	0.7934	-	-
Lead (Pb)	0.0138	0.0460	0.7950	-	-
Mercury (Hg)	0.1216	0.7639	0.7682	-	-
Total Organic Carbon	0.0065	0.7414	0.8219	-	-
Zinc (Zn)	0.2746	0.5597	0.0013	-	-

Notes:

To reduce the number of false positives, a smaller alpha level (0.01) was used to screen for effects and p-values less than 0.01 are bolded. P-values of 0.01 to 0.05 were considered marginally non-significant.

- denotes that no analysis could be performed because of the lack of variation in a variable over time, or because data were only available from one period (i.e., no "before" data were available).

* denotes that ≥70% of the data were below the analytical detection limit, therefore, a robust analysis could not be performed and results were considered unreliable.