



Korea  
National Oil Corporation

## **Appendix D**

### **Surface Water Quality**

Table D.1: Baseline Water Quality Results for Site L1

Parameter	Units	Spring 29-May-05	Summer 12-Aug-05	Fall 29-Sep-05 5-Sep-08		Fall Lab Duplicate 5-Sep-08	Winter 12-Feb-06	n	Number Below Detection	Median	min	max	Guidelines			
													Aquatic Life			Drinking Water Health Canada (2007)
													CCME (2006)	AENV (1999) Acute Chronic		
<b>Field Measured</b>																
Temperature	°C	14.7	13.7	6.9	13.1	-	0.4	5	0	13.1	0.4	14.7	-	-	-	-
pH	pH units	-	6.6	5.9	7.3	-	6.4	4	0	6.5	5.9	7.3	6.5 to 9.0	6.5 to	-	6.5 to 8.5 <sup>(d1)</sup>
Electrical Conductivity	µS/cm	70	100	93	65	-	204	5	0	93	65	204	-	-	-	-
Dissolved Oxygen (DO)	mg/L	6.2	8	13.1	7.3	-	0.8	5	0	7.3	0.8	13.1	6.5 or 9.5	5.0	6.5 <sup>c1</sup>	-
<b>Conventional Parameters and Major Ions</b>																
pH	pH Units	7.0	7.6	7.7	7.4	7.4	7.4	6	0	7.4	7.03	7.70	6.5 to 9.0	-	-	6.5 to 8.5 <sup>(d1)</sup>
Electrical Conductivity	µS/cm	81.8	84	95	88	88	276	6	0	88	82	276	-	-	-	-
Total Dissolved Solids	mg/L	45	42	49	84	88	148	6	0	67	42	148	-	-	-	≤500 <sup>(d1)</sup>
Hardness, Total	mg/L	43	46	52	51	51	140	6	0	51	43	140	-	-	-	-
Total Suspended Solids	mg/L	2	1	3	5	-	7	5	0	3	1	7	-	-	-	-
Turbidity	NTU	-	-	-	3	-	2.9	2	0	-	2.9	3	b2	b2	-	1 <sup>(d2)</sup>
Calcium	mg/L	11	11	12	12	12	37	6	0	12	11	37	-	-	-	-
Magnesium	mg/L	4	5	5	5	5	12	6	0	5	4	12	-	-	-	-
Potassium	mg/L	0.7	<0.3	0.3	<0.5	<0.5	2	6	3	0.7	0.3	<0.3	-	-	-	-
Sodium	mg/L	1.5	0.8	1.2	0.5	0.5	4	6	0	1	0.5	4	-	-	-	≤200 <sup>(d1)</sup>
Bicarbonate	mg/L	55.7	51	59	61	59	175	6	0	59	51	175	-	-	-	-
Carbonate	mg/L	<0.5	<0.5	<0.5	<1	<1	<0.5	6	6	-	<0.5	<1	-	-	-	-
Chloride	mg/L	0.5	1	1.3	0.1	0.1	2.4	6	0	0.8	0.1	2.4	-	-	-	≤250 <sup>(d1)</sup>
Sulphate	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	6	6	-	<0.5	<0.5	-	-	-	≤500 <sup>(d1)</sup>
Iron (Fe)	mg/L	0.02	0.07	0.03	<0.10	<0.10	2.47	6	2	0.1	<0.1	2.47	0.3	-	-	≤0.3 <sup>(d1)</sup>
Manganese (Mn)	mg/L	0.013	<0.004	<0.004	0.04	0.04	2.86	6	2	0.04	<0.004	2.86	-	-	-	≤0.05 <sup>(d1)</sup>
<b>Nutrients</b>																
Nitrate-Nitrogen	mg/L	<0.003	<0.003	<0.003	<0.05	<0.05	<0.003	6	6	-	<0.003	<0.05	13	-	-	45 <sup>(d3)</sup>
Nitrite-Nitrogen	mg/L	0.008	<0.003	0.009	<0.05	<0.05	<0.003	6	2	0.01	<0.003	0.01	0.06	-	-	3.2 <sup>(d3)</sup>
Ammonia-Nitrogen	mg/L	-	0.05	0.01	-	-	0.06	3	0	0.1	0.01	0.06	7.0 - 48.3	1.3 -	-	-
Total Kjeldahl Nitrogen	mg/L	0.63	0.77	1.14	-	-	2.18	4	0	1.0	0.63	2.18	-	-	1	-
Phosphorus, Total	mg/L	0.011	0.022	0.024	0.03	0.03	0.044	6	0	0.03	0.01	0.04	-	-	0.05	-
<b>Polycyclic Aromatic Hydrocarbons</b>																
Napthalene	µg/L	<0.1	<0.10	<0.10	< 0.07	-	<0.1	5	5	-	< 0.07	<0.10	1.1	-	-	-
Acenaphthene	µg/L	<0.1	<0.10	<0.10	< 0.01	-	<0.1	5	5	-	< 0.01	< 0.01	5.8	-	-	-
Acenaphthylene	µg/L	-	<0.10	-	-	-	<0.1	2	2	-	<0.1	<0.1	-	-	-	-
Acridine	µg/L	<0.2	<0.20	<0.20	< 0.07	-	<0.2	5	5	-	< 0.07	<0.2	4.4	-	-	-
Anthracene	µg/L	<0.01	<0.010	<0.010	< 0.007	-	<0.01	5	5	-	< 0.007	<0.01	0.012	-	-	-
B[a]p***	µg/L	-	<0.008	<0.0078	-	-	<0.0078	3	3	-	<0.0078	<0.008	-	-	-	-
Benzo[a]anthracene	µg/L	<0.01	<0.05	<0.010	< 0.006	-	0.02	5	4	-	< 0.006	0.02	0.018	-	-	-
Benzo[a]pyrene	µg/L	<0.01	<0.05	<0.010	< 0.005	-	0.01	5	4	-	< 0.005	0.01	0.015	-	-	-
Benzo[b]fluoranthene	µg/L	-	<0.1	<0.10	-	-	<0.1	3	3	-	<0.1	<0.1	-	-	-	-
Benzo[g,h,i]perylene	µg/L	-	<0.050	-	-	-	<0.05	2	2	-	<0.05	<0.05	-	-	-	-
Benzo[k]fluoranthene	µg/L	-	<0.05	<0.10	-	-	<0.05	3	3	-	<0.05	<0.10	-	-	-	-
Chrysene	µg/L	<0.05	<0.05	<0.050	-	-	<0.05	4	4	-	<0.05	<0.05	-	-	-	-
Dibenz[a,h]anthracene	µg/L	-	<0.05	<0.10	-	-	<0.05	3	3	-	<0.05	<0.10	-	-	-	-
Fluoranthene	µg/L	<0.04	<0.040	<0.040	< 0.04	-	<0.04	5	5	-	<0.04	<0.04	0.04	-	-	-
Fluorene	µg/L	<0.05	<0.050	<0.050	< 0.02	-	<0.05	5	5	-	< 0.02	<0.05	3	-	-	-
Indeno[1,2,3-cd]pyrene	µg/L	-	<0.1	<0.10	-	-	<0.1	3	3	-	<0.1	<0.1	-	-	-	-
Phenanthrene	µg/L	<0.05	<0.050	<0.050	< 0.01	-	<0.05	5	5	-	< 0.01	<0.05	0.04	-	-	-
Pyrene	µg/L	<0.02	<0.020	<0.020	< 0.02	-	0.02	5	4	-	0.02	0.02	0.025	-	-	-
Quinoline	µg/L	<0.2	<0.20	<0.20	< 0.06	-	<0.2	5	5	-	< 0.06	<0.2	3.4	-	-	-

Parameter	Units	Spring	Summer	Fall		Fall Lab Duplicate	Winter	n	Number Below Detection	Median	min	max	Guidelines			
													Aquatic Life		Drinking Water	
													CCME (2006)	AENV (1999)	Health Canada (2007)	
29-May-05	12-Aug-05	29-Sep-05	5-Sep-08	5-Sep-08	12-Feb-06	Acute	Chronic									
<b>Total Metals</b>																
Aluminum (Al)	µg/L	8	17	9	7	7	12	6	0	8.5	7	17	5 or 100	-	-	100 <sup>(d4)</sup>
Antimony (Sb)	µg/L	<0.2	2	<0.2	< 0.05	< 0.05	<0.2	6	5	-	< 0.05	2	-	-	-	6 <sup>(d2)</sup>
Arsenic (As)	µg/L	0.6	0.3	<0.2	0.7	0.6	0.4	6	5	0.5	<0.2	0.7	5	-	-	10 <sup>(d2)</sup>
Barium (Ba)	µg/L	2	5	6	4	4	27	6	0	4.2	2	27.3	-	-	-	1,000 <sup>(d2)</sup>
Beryllium (Be)	µg/L	<0.2	<0.2	<0.2	< 0.1	< 0.1	<0.2	6	6	-	< 0.1	<0.2	-	-	-	-
Boron (B)	µg/L	<10	<0.01	<10	4	5	<10	6	4	-	<0.01	<10	-	-	-	5,000 <sup>(d2)</sup>
Cadmium (Cd)	µg/L	<0.01	<b>0.05</b>	<0.01	< 0.02	< 0.02	<0.01	6	5	-	<0.01	<b>0.05</b>	0.02 <sup>(a4)</sup>	-	-	5 <sup>(d2)</sup>
Chromium (Cr)	µg/L	<1	<1	<1	< 0.5	< 0.5	<1	6	6	-	< 0.5	<1	1 <sup>(a5)</sup>	-	-	50 <sup>(d2)</sup>
Cobalt (Co)	µg/L	<0.3	<0.3	<0.3	< 0.05	< 0.05	<0.3	6	6	-	< 0.05	<0.3	-	-	-	-
Copper (Cu)	µg/L	<0.2	<0.2	<0.2	< 0.1	< 0.1	<0.2	6	6	-	< 0.1	<0.2	2 to 4 <sup>(a6)</sup>	8.1 to 47 <sup>b4</sup>	7 <sup>c2</sup>	≤1,000 <sup>(d1)</sup>
Lead (Pb)	µg/L	<0.3	<0.3	<0.3	< 0.05	< 0.05	<0.3	6	6	-	<0.2	< 0.05	1 to 7 <sup>(a7)</sup>	-	-	10
Lithium (Li)	µg/L	<4	<4	<4	-	-	5	4	3	-	<4	5	-	-	-	-
Mercury (Hg)	µg/L	<0.0006	0.0008	<0.0006	< 0.02	< 0.02	<0.0006	6	5	-	<0.0006	< 0.02	0.004 <sup>(a8)</sup>	0.002 <sup>b5</sup>	0.001 <sup>c3</sup>	1 <sup>(d2)</sup>
Molybdenum (Mo)	µg/L	<0.2	<0.2	<0.2	< 0.05	< 0.05	<0.2	6	6	-	< 0.05	<0.2	73	-	-	-
Nickel (Ni)	µg/L	<0.5	<0.5	<0.5	0.3	0.3	0.6	6	3	-	<0.5	0.60	25 to 150	-	-	-
Selenium (Se)	µg/L	<0.2	<0.2	<b>1.4</b>	< 0.6	< 0.6	0.5	6	4	-	<0.2	<b>1.40</b>	1	-	-	10 <sup>(d2)</sup>
Silicon (Si)	µg/L	410	1050	1550	2070	2070	4030	6	0	1810	410	4030	-	-	-	-
Silver (Ag)	µg/L	<b>0.2</b>	<b>0.9</b>	<0.1	< 0.1	< 0.1	<0.1	6	4	-	<0.1	<b>0.90</b>	0.1	-	-	-
Strontium (Sr)	µg/L	10	21	25	-	-	52	4	0	23	10	52	-	-	-	-
Thallium (Tl)	µg/L	<0.2	<0.2	<0.2	< 0.05	< 0.05	<0.2	6	6	-	< 0.05	<0.2	0.8	-	-	-
Tin (Sn)	µg/L	<1	<1	<1	-	-	<1	4	4	-	<1	<1	-	-	-	-
Titanium (Ti)	µg/L	<1	<1	<1	-	-	<1	4	4	-	<1	<1	-	-	-	-
Uranium	µg/L	<0.4	<0.4	<0.4	< 0.05	< 0.05	<0.4	6	6	-	<0.4	< 0.05	-	-	-	20
Vanadium	µg/L	<1	<1	<1	< 0.5	< 0.5	<1	6	6	-	< 0.5	<1	-	-	-	-
Zinc (Zn)	µg/L	7	19	7	1	1	9	6	0	6.8	1.00	19	30	-	-	≤5,000 <sup>(d1)</sup>
Zirconium (Zr)	µg/L	<0.2	<0.2	<0.2	-	-	<0.2	4	4	-	<0.2	<0.2	-	-	-	-
<b>Dissolved Metals</b>																
Aluminum (Al)	µg/L	-	-	-	3	3	-	2	0	3.0	3	3	-	-	-	-
Antimony (Sb)	µg/L	-	-	-	< 0.05	< 0.05	-	2	2	-	< 0.05	< 0.05	-	-	-	-
Arsenic (As)	µg/L	-	-	-	0.5	0.5	-	2	0	0.5	0.50	0.50	-	-	-	-
Barium (Ba)	µg/L	-	-	-	3	3	-	2	0	3.1	3.09	3.11	-	-	-	-
Beryllium (Be)	µg/L	-	-	-	< 0.1	< 0.1	-	2	2	-	< 0.1	< 0.1	-	-	-	-
Boron (B)	µg/L	-	-	-	2	2	-	2	0	2.0	2.00	2.00	-	-	-	-
Cadmium (Cd)	µg/L	-	-	-	< 0.02	< 0.02	-	2	2	-	< 0.02	< 0.02	-	-	-	-
Chromium (Cr)	µg/L	-	-	-	< 0.3	< 0.3	-	2	2	-	< 0.3	< 0.3	-	-	-	-
Cobalt (Co)	µg/L	-	-	-	< 0.02	< 0.02	-	2	2	-	< 0.02	< 0.02	-	-	-	-
Copper (Cu)	µg/L	-	-	-	0.5	0.1	-	2	0	0.3	0.10	0.50	-	-	-	-
Lead (Pb)	µg/L	-	-	-	< 0.050	< 0.050	-	2	2	-	< 0.050	< 0.050	-	-	-	-
Lithium (Li)	µg/L	-	-	-	-	-	-	0	0	-	-	-	-	-	-	-
Mercury (Hg)	µg/L	-	-	-	< 0.02	< 0.02	-	2	2	-	< 0.02	< 0.02	-	-	-	-
Molybdenum (Mo)	µg/L	-	-	-	< 0.05	< 0.05	-	2	2	-	< 0.05	< 0.05	-	-	-	-
Nickel (Ni)	µg/L	-	-	-	< 0.05	< 0.05	-	2	2	-	< 0.05	< 0.05	-	-	-	-
Selenium (Se)	µg/L	-	-	-	< 0.6	< 0.6	-	2	2	-	< 0.6	< 0.6	-	-	-	-
Silicon (Si)	µg/L	-	-	-	-	-	-	0	0	-	0.00	0.00	-	-	-	-
Silver (Ag)	µg/L	-	-	-	< 0.05	< 0.05	-	2	2	-	< 0.05	< 0.05	-	-	-	-
Strontium (Sr)	µg/L	-	-	-	-	-	-	0	0	-	0.00	0.00	-	-	-	-
Thallium (Tl)	µg/L	-	-	-	< 0.05	< 0.05	-	2	2	-	< 0.05	< 0.05	-	-	-	-
Tin (Sn)	µg/L	-	-	-	-	-	-	0	0	-	-	-	-	-	-	-
Titanium (Ti)	µg/L	-	-	-	-	-	-	0	0	-	-	-	-	-	-	-
Uranium	µg/L	-	-	-	< 0.05	< 0.05	-	2	2	-	< 0.05	< 0.05	-	-	-	-
Vanadium	µg/L	-	-	-	< 0.1	< 0.1	-	2	2	-	< 0.1	< 0.1	-	-	-	-
Zinc (Zn)	µg/L	-	-	-	1	1	-	2	0	1.0	1.00	1.00	-	-	-	-
Zirconium (Zr)	µg/L	-	-	-	-	-	-	0	0	-	-	-	-	-	-	-

Notes:

Shaded and **Bolded** cells indicates an aquatic life guideline exceedance.

Shaded and *Italicized* cells indicates a drinking water guideline exceedance.

\* = The method detection limit for this parameter is higher than an applicable guideline, therefore an exceedance is unknown.

NS = Not specified

## Part 1. Water Quality Guidelines for the Protection of Aquatic Life

### Canadian Environmental Quality Guidelines - CEQG (CCME 2007)

**a1** = Guideline is based on temperature preferences of biota. In this case, the cold water biota guidelines for both early life and other life stages are shown.

**a2** = Guideline is dependent on temperature and pH. The value ranges between 6.98 mg/L (pH= 7.0, temperature= 15°C) and 48.3 mg/L (pH= 6.5, temperature= 5°C).

**a3** = Guideline = 5 µg/L at pH < 6.5, [Ca<sup>2+</sup>] < 4 mg/L and DOC < 2 mg/L; Guideline = 100 µg/L at pH ≥ 6.5, [Ca<sup>2+</sup>] ≥ 4 mg/L and DOC ≥ 2 mg/L.

**a4** = Cadmium guideline =  $10^{[0.86 \log(\text{hardness})] - 3.2}$

**a5** = Guideline is for hexavalent chromium (Cr<sub>VI</sub>) because its guideline is more stringent than the trivalent chromium (Cr<sub>III</sub>) guideline of 8.9 µg/L.

**a6** = Copper guideline is dependent on [CaCO<sub>3</sub>]. Guideline shown is for when [CaCO<sub>3</sub>] is 0-120 mg/L. At 120-180 mg/L of CaCO<sub>3</sub>, guideline = 3 µg/L; and at >180 mg/L CaCO<sub>3</sub>, guideline

**a7** = Lead guideline is dependent on [CaCO<sub>3</sub>]. Guideline shown is for CaCO<sub>3</sub> at 0-60 mg/L. At 60-120 mg/L CaCO<sub>3</sub>, guideline = 2 µg/L; at 120-180 mg/L CaCO<sub>3</sub>, guideline = 4 µg/L; and at

**a8** = Guideline for methyl-mercury provided. The guideline for total inorganic mercury is 0.1 µg/L.

**a9** = Nickel guideline is dependent on [CaCO<sub>3</sub>]. Guideline shown is for CaCO<sub>3</sub> at 0-60 mg/L. At 60-120 mg/L CaCO<sub>3</sub>, guideline = 65 µg/L; at 120-180 mg/L CaCO<sub>3</sub>, guideline = 110 µg/L;

### Alberta Acute Water Quality Guidelines [AAWQG] (AENV 1999)

**b1** = The pH is to be in the range of 6.5 to 8.5 but not altered by more than 0.5 pH units

**b2** = Not to be increased by more than 10 mg/L (ppm) over background value.

**b3** = USEPA Guideline. Acute values based on one-hour average concentration of total

**b4** = Acute guideline is dependant on hardness and applies to acid-extractable copper

**b5** = Guideline for methylmercury provided. The total mercury guideline is 0.013 µg/L.

### Alberta Chronic Water Quality Guidelines [ACWQG] (AENV 1999)

**c1** = Seven day mean. The chronic guidelines should be increased to 8.3 mg/L from mid

**c2** = The evaluation of chronic copper toxicity in soft water was inconclusive; the chronic

**c3** = Guideline for methylmercury provided. The total mercury guideline is 0.005 µg/L.

### Canadian Drinking Water Quality Guideline - CDWQG (Health Canada 2008)

**d1** = Aesthetic objective.

**d2** = Maximum allowable concentration (MAC).

**d3** = Equivalent to 10 mg/L as nitrate-nitrogen. Where nitrate and nitrite are determined separately, levels of nitrite should not exceed 3.2 mg/L.

**d4** = A health-based guideline for aluminum in drinking water has not been established. Operational guidance values of less than 100 µg/L total aluminum for conventional treatment

**Table D.2: Baseline Sediment Quality Results for the Aquatics LSA**

Parameter	Units	Method Detection Limits	L1	WC-1	WC-4	WC-8	
			Fall	Fall	Fall	Fall	
			5-Sep-08	6-Sep-08	6-Sep-08	5-Sep-08	Field Duplicate
<b>Texture and Carbon Content</b>							
Texture - Sand	%	1	88	99	48	96	97
Texture - Silt	%	1	8	< 1	26	1	1
Texture - Clay	%	1	4	1	26	3	2
Moisture	%	0.5	73.8	25.5	88.7	26	24.7
<b>Total Petroleum Hydrocarbons and BTEX</b>							
Benzene	µg/g (ppm)	0.005	* < 0.025	< 0.005	* < 0.050	< 0.005	< 0.005
Toluene	µg/g (ppm)	0.03	* < 0.15	< 0.03	* < 0.30	< 0.03	< 0.03
Ethylbenzene	µg/g (ppm)	0.01	* < 0.05	< 0.01	* < 0.10	< 0.01	< 0.01
Total Xylenes	µg/g (ppm)	0.03	* < 0.15	< 0.03	* < 0.30	< 0.03	< 0.03
F1 - VPH (C6-C10)	µg/g (ppm)	5	* < 25	< 5.0	* < 50	< 5.0	< 5.0
F1 - VPH (C6-C10) - BTEX	µg/g (ppm)	5	25	< 5.0	49	< 5.0	< 5.0
F2 - EPH (C10-C16)	µg/g (ppm)	30	* < 60	< 30	* < 180	< 30	< 30
F3 - EPH (C16-C34)	µg/g (ppm)	30	156	< 30	977	< 30	< 30
F4 - EPH (C34-C50)	µg/g (ppm)	30	* < 60	< 30	* < 180	< 30	< 30

\* MDL adjusted due to sample matrix interference.

**Table D.3: Baseline Water Quality Results for Unnamed Creek 3**

Parameter	Units	WC6			n	Number Below Detection	Median	min	max	Guidelines			
		Spring	Summer	Fall						Aquatic Life		Drinking Water	
		25-May-05	10-Aug-05	27-Sep-05						CCME (2006)	AENV (1999)		Health Canada (2007)
				Acute							Chronic		
<b>Field Measured</b>													
Temperature	°C	5.4	14.0	8.7	3	0	8.7	5.4	14.0	-	-	-	-
pH	pH units	-	7.3	7.3	2	0	-	7.3	7.3	6.5 to 9.0	6.5 to 8.5 <sup>b1</sup>	-	6.5 to 8.5 <sup>(d1)</sup>
Electrical Conductivity	µS/cm	100	230	242	3	0	230	100	242	-	-	-	-
Dissolved Oxygen (DO)	mg/L	12	9.1	15.7	3	0	12.0	9.1	15.7	6.5 or 9.5 <sup>(a1)</sup>	5.0	6.5 <sup>c1</sup>	-
Turbidity	NTU	-	-	-	0	-	-	-	-	b2	b2	-	1 <sup>(d2)</sup>
<b>Conventional Parameters and Major Ions</b>													
pH	pH Units	7.4	8.0	8.2	3	0	8.0	7.4	8.2	6.5 to 9.0	6.5 to 8.5 <sup>b1</sup>	-	6.5 to 8.5 <sup>(d1)</sup>
Electrical Conductivity	µS/cm	149	228	246	3	0	228	149	246	-	-	-	-
Total Dissolved Solids	mg/L	81	122	137	3	0	122	81	137	-	-	-	≤500 <sup>(d1)</sup>
Hardness, Total	mg/L	76	120	130	3	0	120	76	130	-	-	-	-
Total Suspended Solids	mg/L	4	4	2	3	0	4	2	4	-	-	-	-
Calcium	mg/L	19.9	31	34	3	0	31	20	34	-	-	-	-
Magnesium	mg/L	6.5	10	12	3	0	10	7	12	-	-	-	-
Potassium	mg/L	0.6	<0.3	0.4	3	1	0.4	<0.3	0.6	-	-	-	-
Sodium	mg/L	2.4	3.4	4.4	3	0	3.4	2.4	4.4	-	-	-	≤200 <sup>(d1)</sup>
Bicarbonate	mg/L	100	155	173	3	0	155	100	173	-	-	-	-
Carbonate	mg/L	<0.5	<0.5	<0.5	3	3	-	<0.5	<0.5	-	-	-	-
Chloride	mg/L	1.3	1.1	1.0	3	0	1.1	1.0	1.3	-	-	-	≤250 <sup>(d1)</sup>
Sulphate	mg/L	1.2	<0.5	<0.5	3	2	-	1.2	1.2	-	-	-	≤500 <sup>(d1)</sup>
Iron (Fe)	mg/L	0.08	0.11	0.35	3	0	0.11	0.08	0.35	0.3	-	-	≤0.3 <sup>(d1)</sup>
Manganese (Mn)	mg/L	0.018	<0.004	0.04	3	1	0.018	<0.004	0.04	-	-	-	≤0.05 <sup>(d1)</sup>
<b>Nutrients</b>													
Nitrate-Nitrogen	mg/L	<0.003	0.007	0.007	3	1	0.007	<0.003	0.007	13	-	-	45 <sup>(d3)</sup>
Nitrite-Nitrogen	mg/L	<0.003	<0.003	<0.003	3	3	-	<0.003	<0.003	0.06	-	-	3.2 <sup>(d3)</sup>
Ammonia-Nitrogen	mg/L	-	0.04	0.03	2	0	-	0.0	0.0	7.0 - 48.3 <sup>(a2)</sup>	1.3 - 32.6 <sup>b3</sup>	-	-
Total Kjeldahl Nitrogen	mg/L	0.32	0.43	0.6	3	0	0.4	0.3	0.6	-	-	1	-
Phosphorus, Total	mg/L	0.003	0.01	0.0	3	0	0.01	0.003	0.02	-	-	0.05	-
<b>Polycyclic Aromatic Hydrocarbons</b>													
Napthalene	µg/L	<0.1	<0.1	<0.1	3	3	-	<0.1	<0.1	1.1	-	-	-
Acenaphthene	µg/L	<0.1	<0.1	<0.1	3	3	-	<0.1	<0.1	5.8	-	-	-
Acenaphthylene	µg/L	-	<0.1	-	1	1	-	<0.1	<0.1	-	-	-	-
Acridine	µg/L	<0.2	<0.2	<0.2	3	3	-	<0.2	<0.2	4.4	-	-	-
Anthracene	µg/L	<0.01	<0.01	<0.01	3	3	-	<0.01	<0.01	0.012	-	-	-
B[a]p***	µg/L	-	<0.008	<0.0078	2	2	-	<0.0078	<0.008	-	-	-	-
Benz[a]anthracene	µg/L	<0.01	<0.05	<0.01	3	3	-	<0.01	<0.05	0.018	-	-	-
Benzo[a]pyrene	µg/L	<0.01	<0.05	<0.01	3	3	-	<0.01	<0.05	0.015	-	-	-
Benzo[b]flouranthene	µg/L	-	<0.1	<0.1	2	2	-	<0.1	<0.1	-	-	-	-
Benzo[g,h,i]perylene	µg/L	-	<0.05	-	1	1	-	<0.05	<0.05	-	-	-	-
Benzo[k]flouranthene	µg/L	-	<0.05	<0.1	2	2	-	<0.05	<0.1	-	-	-	-
Chrysene	µg/L	<0.05	<0.05	<0.05	3	3	-	<0.05	<0.05	-	-	-	-
Dibenzo[a,h]anthracene	µg/L	-	<0.05	<0.05	2	2	-	<0.05	<0.05	-	-	-	-
Fluoranthene	µg/L	<0.04	<0.04	<0.04	3	3	-	<0.04	<0.04	0.04	-	-	-
Fluorene	µg/L	<0.05	<0.05	<0.05	3	3	-	<0.05	<0.05	3	-	-	-
Indeno[1,2,3-cd]pyrene	µg/L	-	<0.1	<0.1	2	2	-	<0.1	<0.1	-	-	-	-
Phenanthrene	µg/L	<0.05	<0.05	<0.05	3	3	-	<0.05	0.0	0.04	-	-	-
Pyrene	µg/L	<0.02	<0.02	<0.02	3	3	-	<0.02	<0.02	0.025	-	-	-
Quinoline	µg/L	<0.2	<0.2	<0.2	3	3	-	<0.2	<0.2	3.4	-	-	-

Parameter	Units	WC6			n	Number Below Detection	Median	min	max	Guidelines				
		Spring	Summer	Fall						Aquatic Life			Drinking Water	
		25-May-05	10-Aug-05	27-Sep-05						CCME (2006)	AENV (1999)		Health Canada (2007)	
				Acute							Chronic			
<b>Total Metals</b>														
Aluminum (Al)	µg/L	23	11	11	3	0	11	11	23	5 or 100 <sup>(a3)</sup>	-	-	100 <sup>(d4)</sup>	
Antimony (Sb)	µg/L	<0.2	<0.2	<0.2	3	3	-	<0.2	<0.2	-	-	-	6 <sup>(d2)</sup>	
Arsenic (As)	µg/L	0.4	0	<0.2	3	1	0.2	<0.2	0.4	5	-	-	10 <sup>(d2)</sup>	
Barium (Ba)	µg/L	16	25	25.6	3	0	25	16	26	-	-	-	1,000 <sup>(d2)</sup>	
Beryllium (Be)	µg/L	<0.2	<0.2	<0.2	3	3	-	<0.2	<0.2	-	-	-	-	
Boron (B)	µg/L	10	10	10	3	0	10	10	10	-	-	-	5,000 <sup>(d2)</sup>	
Cadmium (Cd)	µg/L	<0.01	0.1	<0.01	3	2	-	<0.01	0.1	0.02 <sup>(a4)</sup>	-	-	5 <sup>(d2)</sup>	
Chromium (Cr)	µg/L	1	<1	<1	3	2	-	<1	1.0	1 <sup>(a5)</sup>	-	-	50 <sup>(d2)</sup>	
Cobalt (Co)	µg/L	<0.3	<0.3	<0.3	3	3	-	<0.3	<0.3	-	-	-	-	
Copper (Cu)	µg/L	0.4	2.6	<0.2	3	1	0.4	<0.2	2.6	2 to 4 <sup>(a6)</sup>	8.1 to 47 <sup>b4</sup>	7 <sup>c2</sup>	≤1,000 <sup>(d1)</sup>	
Lead (Pb)	µg/L	<0.3	<0.3	<0.3	3	3	-	<0.3	<0.3	1 to 7 <sup>(a7)</sup>	-	-	10	
Lithium (Li)	µg/L	<4	<4	<4	3	3	-	<4	<4	-	-	-	-	
Mercury (Hg)	µg/L	0.0007	<0.0006	<0.0006	3	2	-	<0.0006	0.001	0.004 <sup>(a8)</sup>	0.002 <sup>b5</sup>	0.001 <sup>c3</sup>	1 <sup>(d2)</sup>	
Molybdenum (Mo)	µg/L	0.2	0.3	0.2	3	0	0.2	0.2	0.3	73	-	-	-	
Nickel (Ni)	µg/L	<0.5	1	1.2	3	1	1.0	<0.5	1.2	25 to 150 <sup>(a9)</sup>	-	-	-	
Selenium (Se)	µg/L	<0.2	0.4	0.2	3	1	0.2	<0.2	0.4	1	-	-	10 <sup>(d2)</sup>	
Silicon (Si)	µg/L	2640	2910	2890	3	0	2890	2640	2910	-	-	-	-	
Silver (Ag)	µg/L	<b>0.3</b>	<b>1</b>	<0.1	3	1	0.3	<0.1	<b>1</b>	0.1	-	-	-	
Strontium (Sr)	µg/L	36	59	64	3	0	59	36	64	-	-	-	-	
Thallium (Tl)	µg/L	<0.2	<0.2	<0.2	3	3	-	<0.2	<0.2	0.8	-	-	-	
Tin (Sn)	µg/L	<1	<1	<1	3	3	-	<1	<1	-	-	-	-	
Titanium (Ti)	µg/L	2	<1	1	3	1	1.0	<1	2.0	-	-	-	-	
Uranium	µg/L	<0.4	<0.4	<0.4	3	3	-	<0.4	<0.4	-	-	-	20	
Vanadium	µg/L	<1	<1	<1	3	3	-	<1	<1	-	-	-	-	
Zinc (Zn)	µg/L	6	9	8	3	0	8	6	9	30	-	-	≤5,000 <sup>(d1)</sup>	
Zirconium (Zr)	µg/L	0.3	0.8	<0.2	3	1	0.3	<0.2	0.8	-	-	-	-	

Notes:

Shaded and **Bolded** cells indicates an aquatic life guideline exceedance.

Shaded and *Italicized* cells indicates a drinking water guideline exceedance.

\* = The method detection limit for this parameter is higher than or equal to an applicable guideline, therefore it is unknown if there is an exceedance.

### Part 1. Water Quality Guidelines for the Protection of Aquatic Life

#### Canadian Environmental Quality Guidelines - CEQG (CCME 2007)

**a1** = Guideline is based on temperature preferences of biota. In this case, the cold water biota guidelines for both early life and other life stages are shown.

**a2** = Guideline is dependent on temperature and pH. The value ranges between 6.98 mg/L (pH= 7.0, temperature= 15°C) and 48.3 mg/L (pH= 6.5, temperature= 5°C).

**a3** = Guideline = 5 µg/L at pH < 6.5,  $[Ca^{2+}] < 4$  mg/L and DOC < 2 mg/L; Guideline = 100 µg/L at pH ≥ 6.5,  $[Ca^{2+}] ≥ 4$  mg/L and DOC ≥ 2 mg/L.

**a4** = Cadmium guideline =  $10^{[0.86 \log(\text{hardness}) - 3.2]}$

**a5** = Guideline is for hexavalent chromium ( $Cr_{VI}$ ) because its guideline is more stringent than the trivalent chromium ( $Cr_{III}$ ) guideline of 8.9 µg/L.

**a6** = Copper guideline is dependent on  $[CaCO_3]$ . Guideline shown is for when  $[CaCO_3]$  is 0-120 mg/L. At 120-180 mg/L of  $CaCO_3$ , guideline = 3 µg/L; and at >180 mg/L  $CaCO_3$ , guideline =

**a7** = Lead guideline is dependent on  $[CaCO_3]$ . Guideline shown is for  $CaCO_3$  at 0-60 mg/L. At 60-120 mg/L  $CaCO_3$ , guideline = 2 µg/L; at 120-180 mg/L  $CaCO_3$ , guideline = 4 µg/L; and at

**a8** = Guideline for methyl-mercury provided. The guideline for total inorganic mercury is 0.1 µg/L.

**a9** = Nickel guideline is dependent on  $[CaCO_3]$ . Guideline shown is for  $CaCO_3$  at 0-60 mg/L. At 60-120 mg/L  $CaCO_3$ , guideline = 65 µg/L; at 120-180 mg/L  $CaCO_3$ , guideline = 110 µg/L; and

#### Alberta Acute Water Quality Guidelines - AAWQG (AENV 1999)

**b1** = The pH is to be in the range of 6.5 to 8.5 but not altered by more than 0.5 pH units from background values.

**b2** = Not to be increased by more than 10 mg/L (ppm) over background value.

**b3** = USEPA Guideline. Acute values based on one-hour average concentration of total ammonia-nitrogen (mg nitrogen/L). The guideline is dependant on pH and the presence of salmonids, ranging from 0.88 mg/L (ppm) (pH = 9.0; salmonids present) to 48.8 mg/L (ppm) (pH = 6.5; no salmonids present). To find the corresponding guideline value, the following equations are used:  $[Max \text{ salmonids present}] = 0.275 / (1 + 107.204 - pH) + 39.0 / (1 + 10pH - 7.204)$  &  $[Max \text{ no salmonids present}] = 0.411 / (1 + 107.204 - pH) + 58.4 / (1 + 10pH - 7.204)$ .

**b4** = Acute guideline is dependant on hardness and applies to acid-extractable copper concentrations governed by the following equation:  $[Max] = e^{[0.979123 * \ln(\text{hardness}) - 8.64497]}$ . The copper guideline ranges from 8.1 µg/L (hardness = 50 mg/L (ppm)) to 47 µg/L (hardness = 300 mg/L (ppm)).

**b5** = Guideline for methylmercury provided. The total mercury guideline is 0.013 µg/L.

#### Alberta Chronic Water Quality Guidelines - ACWQG (AENV 1999)

**c1** = Seven day mean. The chronic guidelines should be increased to 8.3 mg/L from mid May to the end of June to protect the emergence of mayfly species into

**c2** = The evaluation of chronic copper toxicity in soft water was inconclusive; the chronic guideline can therefore only be applied at water hardness equal to or greater than 50 mg/L as  $CaCO_3$ .

**c3** = Guideline for methylmercury provided. The total mercury guideline is 0.005 µg/L.

#### Canadian Drinking Water Quality Guideline - CDWQG (Health Canada 2008)

**d1** = Aesthetic objective.

**d2** = Maximum allowable concentration (MAC).

**d3** = Equivalent to 10 mg/L as nitrate-nitrogen. Where nitrate and nitrite are determined separately, levels of nitrite should not exceed 3.2 mg/L.

**d4** = A health-based guideline for aluminum in drinking water has not been established. Operational guidance values of less than 100 µg/L total aluminum for conventional treatment plants



**Table D.4: Baseline Water Quality Results for Site L2**

Parameter	Units	Summer 10-Aug-05	Fall 27-Sep-05	n	Number Below Detection	Median	Min	Max	Guidelines			
									Aquatic Life		Drinking Water	
									CCME (2006)	AENV (1999) Acute	Chronic	Health Canada (2007)
<b>Field Measured</b>												
Temperature	°C	15.4	9.5	2	0	-	9.5	15.4	-	-	-	-
pH	pH units	7	7	2	0	-	7	7	6.5 to 9.0	6.5 to 8.5 <sup>b1</sup>	-	6.5 to 8.5 <sup>(d1)</sup>
Electrical Conductivity	µS/cm	229	232	2	0	-	229	232	-	-	-	-
Dissolved Oxygen (DO)	mg/L (ppm)	6.1	11.9	2	0	-	6.1	11.9	6.5 or 9.5 <sup>(a1)</sup>	5.0	6.5 <sup>c1</sup>	-
<b>Conventional Parameters and Major Ions</b>												
pH	pH Units	8.0	8.1	2	0	-	8.0	8.1	6.5 to 9.0	-	-	6.5 to 8.5 <sup>(d1)</sup>
Electrical Conductivity	µS/cm	223	237	2	0	-	223	237	-	-	-	-
Total Dissolved Solids (TDS)	mg/L (ppm)	121	130	2	0	-	121	130	-	-	-	≤500 <sup>(d1)</sup>
Hardness, Total	mg/L (ppm)	120	130	2	0	-	120	130	-	-	-	-
Total Suspended Solids (TSS)	mg/L (ppm)	2	3	2	0	-	2	3	-	-	-	-
Turbidity	NTU	-	-	0	0	-	-	-	b2	b2	-	1 <sup>(d2)</sup>
Calcium	mg/L (ppm)	31	32	2	0	-	31	32	-	-	-	-
Magnesium	mg/L (ppm)	10	12	2	0	-	10	12	-	-	-	-
Potassium	mg/L (ppm)	<0.3	0.4	1	1	-	<0.3	0.40	-	-	-	-
Sodium	mg/L (ppm)	3.4	3.9	2	0	-	3.4	3.9	-	-	-	≤200 <sup>(d1)</sup>
Bicarbonate	mg/L (ppm)	152	164	2	0	-	152	164	-	-	-	-
Carbonate	mg/L (ppm)	<0.5	<0.5	0	2	-	<0.5	<0.5	-	-	-	-
Chloride	mg/L (ppm)	1.4	0.9	2	0	-	0.9	1.4	-	-	-	≤250 <sup>(d1)</sup>
Sulphate	mg/L (ppm)	<0.5	<0.5	0	2	-	<0.5	<0.5	-	-	-	≤500 <sup>(d1)</sup>
Iron (Fe)	mg/L (ppm)	0.07	0.12	2	0	-	0.07	0.12	0.3	-	-	≤0.3 <sup>(d1)</sup>
Manganese (Mn)	mg/L	0.004	0.027	2	0	-	0.004	0.03	-	-	-	≤0.05 <sup>(d1)</sup>
<b>Nutrients</b>												
Nitrate-Nitrogen	mg/L (ppm)	<0.003	0.003	1	1	-	<0.003	0.00	13	-	-	45 <sup>(d3)</sup>
Nitrite-Nitrogen	mg/L (ppm)	<0.003	<0.003	0	2	-	<0.003	<0.003	0.06	-	-	3.2 <sup>(d5)</sup>
Ammonia-Nitrogen	mg/L (ppm)	0.02	0.01	2	0	-	0.01	0.02	7.0 - 48.3 <sup>(a2)</sup>	1.3 - 32.6 <sup>b3</sup>	-	-
Total Kjeldahl Nitrogen	mg/L (ppm)	0.54	0.65	2	0	-	0.54	0.65	-	-	1	-
Phosphorus, Total	mg/L (ppm)	0.012	0.008	2	0	-	0.008	0.012	-	-	0.05	-
<b>Polycyclic Aromatic Hydrocarbons</b>												
Napthalene	µg/L	<0.1	<0.1	2	2	-	<0.01	<0.01	1.1	-	-	-
Acenaphthene	µg/L	<0.1	<0.1	2	2	-	<0.01	<0.01	5.8	-	-	-
Acenaphthylene	µg/L	<0.1	-	1	1	-	<0.01	<0.01	-	-	-	-
Acridine	µg/L	<0.2	<0.2	2	2	-	<0.2	<0.2	4.4	-	-	-
Anthracene	µg/L	<0.1	<0.1	2	2	-	<0.01	<0.01	0.012	-	-	-
B[a]p***	µg/L	<0.008	<0.0078	2	2	-	<0.0078	<0.008	-	-	-	-
Benz[a]anthracene	µg/L	<0.05	<0.01	2	2	-	<0.01	<0.05	0.018	-	-	-
Benzo[a]pyrene	µg/L	<0.05	<0.01	2	2	-	<0.01	<0.05	0.015	-	-	-
Benzo[b]flouranthene	µg/L	<0.05	<0.01	2	2	-	<0.01	<0.05	-	-	-	-
Benzo[g,h,i]perylene	µg/L	<0.05	-	1	1	-	<0.05	<0.05	-	-	-	-
Benzo[k]flouranthene	µg/L	<0.05	<0.01	2	2	-	<0.01	<0.05	-	-	-	-
Chrysene	µg/L	<0.05	<0.05	2	2	-	<0.05	<0.05	-	-	-	-
Dibenz[a,h]anthracene	µg/L	<0.05	<0.01	2	2	-	<0.01	<0.05	-	-	-	-
Fluoranthene	µg/L	<0.04	<0.04	2	2	-	<0.04	<0.04	0.04	-	-	-
Fluorene	µg/L	<0.05	<0.05	2	2	-	<0.05	<0.05	3	-	-	-
Indeno[1,2,3-cd]pyrene	µg/L	<0.1	<0.1	2	2	-	<0.1	<0.1	-	-	-	-
Phenanthrene	µg/L	<0.05	<0.05	2	2	-	<0.05	<0.05	0.04	-	-	-
Pyrene	µg/L	<0.02	<0.02	2	2	-	<0.02	<0.02	0.025	-	-	-
Quinoline	µg/L	<0.2	<0.2	2	2	-	<0.2	<0.2	3.4	-	-	-

Parameter	Units	Summer	Fall	n	Number Below Detection	Median	Min	Max	Guidelines			
									Aquatic Life			Drinking Water Health Canada (2007)
									CCME (2006)	AENV (1999)		
										Acute	Chronic	
		10-Aug-05	27-Sep-05									
<b>Total Metals</b>												
Aluminum (Al)	µg/L	9	4	2	0	-	4	9	5 or 100 <sup>(a3)</sup>	-	-	100 <sup>(d4)</sup>
Antimony (Sb)	µg/L	<0.2	<0.2	2	2	-	<0.2	<0.2	-	-	-	6 <sup>(d2)</sup>
Arsenic (As)	µg/L	0.2	5.8	2	0	-	0.2	5.8	5	-	-	10 <sup>(d2)</sup>
Barium (Ba)	µg/L	25	26	2	0	-	25	26	-	-	-	1,000 <sup>(d2)</sup>
Beryllium (Be)	µg/L	<0.2	<0.2	2	2	-	<0.2	<0.2	-	-	-	-
Boron (B)	µg/L	10	10	2	0	-	10	10	-	-	-	5,000 <sup>(d2)</sup>
Cadmium (Cd)	µg/L	0.06	<0.01	2	1	-	<0.01	0.06	0.02 <sup>(a4)</sup>	-	-	5 <sup>(d2)</sup>
Chromium (Cr)	µg/L	<1	<1	2	2	-	<1	<1	1 <sup>(a5)</sup>	-	-	50 <sup>(d2)</sup>
Cobalt (Co)	µg/L	<0.3	<0.3	2	2	-	<0.3	<0.3	-	-	-	-
Copper (Cu)	µg/L	2.6	<0.2	2	1	-	<0.2	2.60	2 to 4 <sup>(a6)</sup>	8.1 to 47 <sup>b4</sup>	7 <sup>c2</sup>	≤1,000 <sup>(d1)</sup>
Lead (Pb)	µg/L	<0.3	<0.3	2	2	-	<0.3	<0.3	1 to 7 <sup>(a7)</sup>	-	-	10
Lithium (Li)	µg/L	<4	<4	2	2	-	<4	<4	-	-	-	-
Mercury (Hg)	µg/L	<0.0006	<0.0006	2	2	-	<0.0006	<0.0006	0.004 <sup>(a8)</sup>	0.002 <sup>b5</sup>	0.001 <sup>c3</sup>	1 <sup>(d2)</sup>
Molybdenum (Mo)	µg/L	0.3	<0.2	2	1	-	<0.2	0.30	73	-	-	-
Nickel (Ni)	µg/L	0.9	1.3	2	0	-	0.9	1.3	25 to 150 <sup>(a9)</sup>	-	-	-
Selenium (Se)	µg/L	0.3	0.2	2	0	-	0.2	0.3	1	-	-	10 <sup>(d2)</sup>
Silicon (Si)	µg/L	2840	2620	2	0	-	2620	2840	-	-	-	-
Silver (Ag)	µg/L	1	<0.1	2	1	-	<0.1	1	0.1	-	-	-
Strontium (Sr)	µg/L	59	65	2	0	-	59	65	-	-	-	-
Thallium (Tl)	µg/L	<0.2	<0.2	2	2	-	<0.2	<0.2	0.8	-	-	-
Tin (Sn)	µg/L	<1	<1	2	2	-	<1	<1	-	-	-	-
Titanium (Ti)	µg/L	<1	<1	2	2	-	<1	<1	-	-	-	-
Uranium	µg/L	<0.4	<0.4	2	2	-	<0.4	<0.4	-	-	-	20
Vanadium	µg/L	<1	<1	2	2	-	<1	<1	-	-	-	-
Zinc (Zn)	µg/L	13	8	2	0	-	8	13	30	-	-	≤5,000 <sup>(d1)</sup>
Zirconium (Zr)	µg/L	0.3	<0.2	2	1	-	<0.2	0.3	-	-	-	-

Notes:

Shaded and Bolded cells indicates an aquatic life guideline exceedance.

Shaded and Italicized cells indicates a drinking water guideline exceedance.

\* = The method detection limit for this parameter is higher than an applicable guideline, therefore an exceedance is unknown.

NS = Not specified

#### Part 1. Water Quality Guidelines for the Protection of Aquatic Life

##### Canadian Environmental Quality Guidelines - CEQG (CCME 2007)

a1 = Guideline is based on temperature preferences of biota. In this case, the cold water biota guidelines for both early life and other life

a2 = Guideline is dependent on temperature and pH. The value ranges between 6.98 mg/L (pH= 7.0, temperature= 15oC) and 48.3 mg/L

a3 = Guideline = 5 µg/L at pH < 6.5, [Ca2+] < 4 mg/L and DOC < 2 mg/L; Guideline = 100 µg/L at pH ≥ 6.5, [Ca2+] ≥ 4 mg/L and DOC ≥ 2

a4 = Cadmium guideline =  $10[0.86 \log(\text{hardness}) - 3.2]$ .

a5 = Guideline is for hexavalent chromium (CrVI) because its guideline is more stringent than the trivalent chromium (CrIII) guideline of 8.9

a6 = Copper guideline is dependent on [CaCO3]. Guideline shown is for when [CaCO3] is 0-120 mg/L. At 120-180 mg/L of CaCO3,

a7 = Lead guideline is dependent on [CaCO3]. Guideline shown is for CaCO3 at 0-60 mg/L. At 60-120 mg/L CaCO3, guideline = 2 µg/L;at

a8 = Guideline for methyl-mercury provided. The guideline for total inorganic mercury is 0.1 µg/L.

a9 = Nickel guideline is dependent on [CaCO3]. Guideline shown is for CaCO3 at 0-60 mg/L. At 60-120 mg/L CaCO3, guideline = 65

##### Alberta Acute Water Quality Guidelines [AAWQG] (AENV 1999)

b1 = The pH is to be in the range of 6.5 to 8.5 but not altered by more than 0.5

b2 = Not to be increased by more than 10 mg/L (ppm) over background value.

b3 = USEPA Guideline. Acute values based on one-hour average

b4 = Acute guideline is dependant on hardness and applies to acid-extractable

b5 = Guideline for methylmercury provided. The total mercury guideline is

##### Alberta Chronic Water Quality Guidelines [ACWQG] (AENV 1999)

c1 = Seven day mean. The chronic guidelines should be increased to 8.3 mg/L

c2 = The evaluation of chronic copper toxicity in soft water was inconclusive;

c3 = Guideline for methylmercury provided. The total mercury guideline is

##### Canadian Drinking Water Quality Guideline - CDWQG (Health Canada 2008)

d1 = Aesthetic objective.

d2 = Maximum allowable concentration (MAC).

d3 = Equivalent to 10 mg/L as nitrate-nitrogen. Where nitrate and nitrite are determined separately, levels of nitrite should not exceed 3.2

d4 = A health-based guideline for aluminum in drinking water has not been established. Operational guidance values of less than 100 µg/L

**Table D.5: Baseline Water Quality Results for Site L3**

Parameter	Units	Spring 26-May-05	Summer 10-Aug-05	Fall 28-Sep-05	Winter 12-Feb-06	n	Number Below Detection	Median	Min	Max	Guidelines			
											Aquatic Life		Drinking Water Health Canada (2007)	
											CCME (2006)	AENV (1999) Acute		Chronic
<b>Field Measured</b>														
Temperature	°C	8.4	16.5	8.2	3.2	4	0	8.3	3.2	16.5	-	-	-	-
pH	pH units	6.7	7.1	7.2	6.8	4	0	7.0	6.7	7.2	6.5 to 9.0	6.5 to	-	6.5 to 8.5 <sup>(d1)</sup>
Electrical Conductivity	µS/cm	110	230	260	574	4	0	245	110	574	-	-	-	-
Dissolved Oxygen (DO)	mg/L	6.7	7.0	11.2	0.7	4	0	6.9	0.7	11.2	6.5 or 9.5 <sup>(a1)</sup>	5.0	6.5 <sup>(c1)</sup>	-
<b>Conventional Parameters and Major Ions</b>														
pH	pH Units	7.2	7.8	8.1	7.6	4	0	7.7	7.2	8.1	6.5 to 9.0	-	-	6.5 to 8.5 <sup>(d1)</sup>
Electrical Conductivity	µS/cm	146	226	254	526	4	0	240	146	526	-	-	-	-
Total Dissolved Solids	mg/L	79	121	142	275	4	0	132	79	275	-	-	-	≤500 <sup>(d1)</sup>
Hardness, Total	mg/L	72	110	130	250	4	0	120	72	250	-	-	-	-
Total Suspended Solids	mg/L	3	37	3	23	4	0	13	3	37	-	-	-	-
Turbidity	NTU	-	-	-	6.4	1	0	-	6.4	6.4	b2	b2	-	1 <sup>(d2)</sup>
Calcium	mg/L	19	30	35	66	4	0	33	19	66	-	-	-	-
Magnesium	mg/L	6.2	9	11	20	4	0	10	6	20	-	-	-	-
Potassium	mg/L	1.3	0.7	0.7	1.2	4	0	1.0	0.70	1.3	-	-	-	-
Sodium	mg/L	3.4	5	6.4	10	4	0	5.7	3.4	9.5	-	-	-	≤200 <sup>(d1)</sup>
Bicarbonate	mg/L	96.9	152	176	355	4	0	164	97	355	-	-	-	-
Carbonate	mg/L	<0.5	<0.5	<0.5	<0.5	4	4	-	<0.5	<0.5	-	-	-	-
Chloride	mg/L	0.6	1.4	1	1.3	4	0	1.2	0.6	1.4	-	-	-	≤250 <sup>(d1)</sup>
Sulphate	mg/L	0.9	<0.5	1.1	<0.5	4	2	1.0	<0.5	1.1	-	-	-	≤500 <sup>(d1)</sup>
Iron (Fe)	mg/L	0.08	0.12	0.05	0.07	4	0	0.1	0.05	0.1	0.3	-	-	≤0.3 <sup>(d1)</sup>
Manganese (Mn)	mg/L	<0.004	0.019	<0.004	0.46	4	2	0.2	<0.004	0.46	-	-	-	≤0.05 <sup>(d1)</sup>
<b>Nutrients</b>														
Nitrate-Nitrogen	mg/L	0.006	0.003	0.003	0.003	4	0	0.003	0.003	0.01	13	-	-	45 <sup>(d3)</sup>
Nitrite-Nitrogen	mg/L	<0.003	<0.003	<0.003	<0.003	4	4	-	<0.003	<0.003	0.06	-	-	3.2 <sup>(d3)</sup>
Ammonia-Nitrogen	mg/L	-	0.05	0.01	1.84	3	0	0.1	0.01	1.84	7.0 - 48.3 <sup>(a2)</sup>	1.3 -	-	-
Total Kjeldahl Nitrogen	mg/L	0.51	0.87	1.06	2.77	4	0	1.0	0.51	2.77	-	-	1	-
Phosphorus, Total	mg/L	0.016	0.093	0.07	1	4	0	0.1	0.02	1	-	-	0.05	-
<b>Polycyclic Aromatic Hydrocarbons</b>														
Naphthalene	µg/L	<0.1	<0.10	<0.10	<0.1	4	4	-	<0.1	<0.1	1.1	-	-	-
Acenaphthene	µg/L	<0.1	<0.10	<0.10	<0.1	4	4	-	<0.1	<0.1	5.8	-	-	-
Acenaphthylene	µg/L	-	<0.10	-	<0.1	2	2	-	<0.1	<0.1	-	-	-	-
Acridine	µg/L	<0.2	<0.20	<0.20	<0.2	4	4	-	<0.2	<0.2	4.4	-	-	-
Anthracene	µg/L	<0.01	<0.010	<0.010	<0.01	4	4	-	<0.01	<0.01	0.012	-	-	-
B[a]p***	µg/L	-	<0.008	<0.0078	<0.0078	4	4	-	<0.0078	<0.008	-	-	-	-
Benz[a]anthracene	µg/L	<0.01	<0.05	<0.010	0.02	4	3	-	<0.010	<0.05	0.018	-	-	-
Benzo[a]pyrene	µg/L	<0.01	<0.05	<0.010	0.01	4	3	-	<0.010	<0.05	0.015	-	-	-
Benzo[b]fluoranthene	µg/L	-	<0.1	<0.10	<0.1	3	3	-	<0.1	<0.1	-	-	-	-
Benzo[g,h,i]perylene	µg/L	-	<0.050	-	<0.05	2	2	-	<0.05	<0.05	-	-	-	-
Benzo[k]fluoranthene	µg/L	-	<0.05	<0.10	<0.05	3	3	-	<0.10	<0.05	-	-	-	-
Chrysene	µg/L	<0.05	<0.05	<0.050	<0.05	4	4	-	<0.05	<0.05	-	-	-	-
Dibenz[a,h]anthracene	µg/L	-	<0.05	<0.10	<0.05	3	3	-	<0.10	<0.05	-	-	-	-
Fluoranthene	µg/L	<0.04	<0.040	<0.040	<0.04	4	4	-	<0.04	<0.04	0.04	-	-	-
Fluorene	µg/L	<0.05	<0.050	<0.050	<0.05	4	4	-	<0.05	<0.05	3	-	-	-
Indeno[1,2,3,-cd]pyrene	µg/L	-	<0.1	<0.10	<0.1	3	3	-	<0.1	<0.1	-	-	-	-
Phenanthrene	µg/L	<0.05	<0.050	<0.050	<0.05	4	4	-	<0.05	<0.05	0.04	-	-	-
Pyrene	µg/L	<0.02	<0.020	<0.020	<0.02	4	4	-	<0.02	<0.02	0.025	-	-	-
Quinoline	µg/L	<0.2	<0.20	<0.20	<0.2	4	4	-	<0.02	<0.02	3.4	-	-	-

Parameter	Units	Spring	Summer	Fall	Winter	n	Number Below Detection	Median	Min	Max	Guidelines			
											Aquatic Life		Drinking Water	
											CCME (2006)	AENV (1999) Acute	AENV (1999) Chronic	Health Canada (2007)
26-May-05	10-Aug-05	28-Sep-05	12-Feb-06											
<b>Total Metals</b>														
Aluminum (Al)	µg/L	25	52	20	12	4	0	23	12	52	5 or 100 <sup>(a3)</sup>	-	-	100 <sup>(d4)</sup>
Antimony (Sb)	µg/L	<0.2	<0.2	<0.2	<0.2	4	4	-	<0.2	<0.2	-	-	-	6 <sup>(d2)</sup>
Arsenic (As)	µg/L	0.3	0.3	<0.2	<0.2	4	2	0.3	<0.2	0.30	5	-	-	10 <sup>(d2)</sup>
Barium (Ba)	µg/L	31	45	43	87	4	0	44	31	87	-	-	-	1,000 <sup>(d2)</sup>
Beryllium (Be)	µg/L	<0.2	<0.2	<0.2	<0.2	4	4	-	<0.2	<0.02	-	-	-	-
Boron (B)	µg/L	20	30	30	20	4	0	25	20	30	-	-	-	5,000 <sup>(d2)</sup>
Cadmium (Cd)	µg/L	<0.01	<b>0.06</b>	<0.01	<0.01	4	3	0.1	<0.01	<b>0.06</b>	0.02 <sup>(a4)</sup>	-	-	5 <sup>(d2)</sup>
Chromium (Cr)	µg/L	1	<1	<1	<1	4	3	-	1.00	1.00	1 <sup>(a5)</sup>	-	-	50 <sup>(d2)</sup>
Cobalt (Co)	µg/L	<0.3	<0.3	<0.3	<0.3	4	4	-	<0.3	<0.3	-	-	-	-
Copper (Cu)	µg/L	0.5	1.3	<0.2	<0.2	4	2	0.9	<0.2	1.30	2 to 4 <sup>(a6)</sup>	8.1 to 47 <sup>b4</sup>	7 <sup>c2</sup>	≤1,000 <sup>(d1)</sup>
Lead (Pb)	µg/L	<0.3	<0.3	<0.3	<0.3	4	4	-	<0.3	<0.3	1 to 7 <sup>(a7)</sup>	-	-	10
Lithium (Li)	µg/L	65	<4	<4	9	4	2	37	<4	65	-	-	-	-
Mercury (Hg)	µg/L	<b>0.0021</b>	0.0009	<0.0006	<b>0.0021</b>	4	1	0.0015	<0.0006	<b>0.0021</b>	0.004 <sup>(a8)</sup>	0.002 <sup>b5</sup>	0.001 <sup>c3</sup>	1 <sup>(d2)</sup>
Molybdenum (Mo)	µg/L	0.2	0.3	0.3	<0.2	4	1	0.3	<0.2	0.3	73	-	-	-
Nickel (Ni)	µg/L	<0.5	1	1.2	1.4	4	1	1.1	<0.5	1.4	25 to 150 <sup>(a9)</sup>	-	-	-
Selenium (Se)	µg/L	<0.2	0.5	0.7	0.5	4	1	0.5	<0.2	0.7	1	-	-	10 <sup>(d2)</sup>
Silicon (Si)	µg/L	2720	5080	6310	10900	4	0	5695	2720	10900	-	-	-	-
Silver (Ag)	µg/L	<b>0.4</b>	<b>0.9</b>	<0.1	<0.1	4	2	0.7	<0.1	<b>0.9</b>	0.1	-	-	-
Strontium (Sr)	µg/L	48	80	92	160	4	0	86	48	160	-	-	-	-
Thallium (Tl)	µg/L	<0.2	<0.2	<0.2	<0.2	4	4	-	<0.2	<0.2	0.8	-	-	-
Tin (Sn)	µg/L	<1	<1	<1	<1	4	4	-	<1	<1	-	-	-	-
Titanium (Ti)	µg/L	2	2	2	4	4	0	2	2	4	-	-	-	-
Uranium	µg/L	<0.4	<0.4	<0.4	<0.4	4	4	-	<0.4	<0.4	-	-	-	20
Vanadium	µg/L	<1	<1	<1	<1	4	4	-	<1	<1	-	-	-	-
Zinc (Zn)	µg/L	14	10	10	6	4	0	9.8	6.3	14.1	30	-	-	≤5,000 <sup>(d1)</sup>
Zirconium (Zr)	µg/L	0.2	0.3	<0.2	<0.2	4	2	0.3	0.2	0.3	-	-	-	-

Notes:

Shaded and **Bolded** cells indicates an aquatic life guideline exceedance.

Shaded and *Italicized* cells indicates a drinking water guideline exceedance.

\* = The method detection limit for this parameter is higher than an applicable guideline, therefore an exceedance is unknown.

NS = Not specified

### Part 1. Water Quality Guidelines for the Protection of Aquatic Life

#### Canadian Environmental Quality Guidelines - CEQG (CCME 2007)

**a1** = Guideline is based on temperature preferences of biota. In this case, the cold water biota guidelines for both early life and other life stages are shown.

**a2** = Guideline is dependent on temperature and pH. The value ranges between 6.98 mg/L (pH= 7.0, temperature= 15°C) and 48.3 mg/L (pH= 6.5, temperature=

**a3** = Guideline = 5 µg/L at pH < 6.5,  $[Ca^{2+}] < 4$  mg/L and DOC < 2 mg/L; Guideline = 100 µg/L at pH ≥ 6.5,  $[Ca^{2+}] ≥ 4$  mg/L and DOC ≥ 2 mg/L.

**a4** = Cadmium guideline =  $10^{[0.86 \log(\text{hardness}) - 3.2]}$

**a5** = Guideline is for hexavalent chromium ( $Cr_{VI}$ ) because its guideline is more stringent than the trivalent chromium ( $Cr_{III}$ ) guideline of 8.9 µg/L.

**a6** = Copper guideline is dependent on  $[CaCO_3]$ . Guideline shown is for when  $[CaCO_3]$  is 0-120 mg/L. At 120-180 mg/L of  $CaCO_3$ , guideline = 3 µg/L; and at >180

**a7** = Lead guideline is dependent on  $[CaCO_3]$ . Guideline shown is for  $CaCO_3$  at 0-60 mg/L. At 60-120 mg/L  $CaCO_3$ , guideline = 2 µg/L; at 120-180 mg/L  $CaCO_3$ ,

**a8** = Guideline for methyl-mercury provided. The guideline for total inorganic mercury is 0.1 µg/L.

**a9** = Nickel guideline is dependent on  $[CaCO_3]$ . Guideline shown is for  $CaCO_3$  at 0-60 mg/L. At 60-120 mg/L  $CaCO_3$ , guideline = 65 µg/L; at 120-180 mg/L  $CaCO_3$ ,

#### Alberta Acute Water Quality Guidelines [AAWQG] (AENV 1999)

**b1** = The pH is to be in the range of 6.5 to 8.5 but not altered by more than 0.5 pH units

**b2** = Not to be increased by more than 10 mg/L (ppm) over background value.

**b3** = USEPA Guideline. Acute values based on one-hour average concentration of total

**b4** = Acute guideline is dependant on hardness and applies to acid-extractable copper

**b5** = Guideline for methylmercury provided. The total mercury guideline is 0.013 µg/L.

#### Alberta Chronic Water Quality Guidelines [ACWQG] (AENV 1999)

**c1** = Seven day mean. The chronic guidelines should be increased to 8.3 mg/L from mid

**c2** = The evaluation of chronic copper toxicity in soft water was inconclusive; the chronic

**c3** = Guideline for methylmercury provided. The total mercury guideline is 0.005 µg/L.

#### Canadian Drinking Water Quality Guideline - CDWQG (Health Canada 2008)

**d1** = Aesthetic objective.

**d2** = Maximum allowable concentration (MAC).

**d3** = Equivalent to 10 mg/L as nitrate-nitrogen. Where nitrate and nitrite are determined separately, levels of nitrite should not exceed 3.2 mg/L.

**d4** = A health-based guideline for aluminum in drinking water has not been established. Operational guidance values of less than 100 µg/L total aluminum for

**Table D.6: Baseline Water Quality Results for Sunday Creek**

Parameter	Units	WC7				WC8						n	Number Below Detection	Median	min	max	Guidelines			
		Spring	Summer	Fall	Winter	Spring	Summer	Fall		Fall Field Duplicate	Winter						Aquatic Life		Drinking Water	
		25-May-05	10-Aug-05	27-Sep-05	11-Feb-06	28-May-05	12-Aug-05	29-Sep-05	5-Sep-08	5-Sep-08	12-Feb-06						CCME (2006)	AENV (1999)		Health Canada (2007)
		Acute	Chronic																	
<b>Field Measured</b>																				
Temperature	°C	7.87	13.1	6.79	0.02	7.3	12.2	6.4	11.3	-	0.07	9	0	7.3	0.02	13.1	-	-	-	-
pH	pH units	-	7.5	7.4	7.1	-	7.1	7.6	7.9	-	5.3	7	0	7.4	5.3	7.9	6.5 to 9.0	6.5 to 8.5 <sup>b1</sup>	-	6.5 to 8.5 <sup>(d1)</sup>
Electrical Conductivity	µS/cm	100	230	238	257	100	250	263	166	-	371	9	0	238	100	371	-	-	-	-
Dissolved Oxygen (DO)	mg/L	9.5	10.6	15.1	10.5	9.5	7.3	12.4	10.8	-	10.5	9	0	10.5	7.3	15.1	6.5 or 9.5	5.0	6.5 <sup>c1</sup>	-
<b>Conventional Parameters and Major Ions</b>																				
pH	pH Units	7.24	8.02	8.18	7.9	7.4	8.1	8.2	8.0	8.0	7.8	10	0	8.0	7.2	8.2	6.5 to 9.0	-	-	6.5 to 8.5 <sup>(d1)</sup>
Electrical Conductivity	µS/cm	135	226	243	337	139	229	252	237	235	389	10	0	236.0	135.0	389.0	-	-	-	-
Total Dissolved Solids	mg/L	75	122	135	179	77	125	142	176	176	206	10	0	138.5	75.0	206.0	-	-	-	≤500 <sup>(d1)</sup>
Hardness, Total	mg/L	69	110	130	170	69	120	130	132	131	180	10	0	130.0	69.0	180.0	-	-	-	-
Total Suspended Solids	mg/L	12	3	6	9	9	2	5	<2	<2	2	10	2	4.0	<2	12.0	-	-	-	-
Calcium	mg/L	18.1	30.9	33.3	45.3	18	31	34	35	35	50	10	0	33.7	17.9	50.2	-	-	-	-
Magnesium	mg/L	5.7	9.1	10.7	13.2	6	9	11	11	11	14	10	0	10.7	5.7	14.4	-	-	-	-
Potassium	mg/L	1	0.7	0.9	1.2	0.8	0.6	0.8	0.7	0.7	1.4	10	0	0.8	0.6	1.4	-	-	-	-
Sodium	mg/L	2.4	4.3	5.1	7.9	3	5	6	4	4	11	10	0	4.6	2.4	10.5	-	-	-	≤200 <sup>(d1)</sup>
Bicarbonate	mg/L	90.8	153	169	219	97	157	178	163	163	258	10	0	163	91	258	-	-	-	-
Carbonate	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<1	<1	<0.5	10	10	-	<0.5	<1	-	-	-	-
Chloride	mg/L	1.3	1.6	0.9	1.2	0.9	1.1	1.3	0.5	0.3	1	10	0	1.1	0.3	1.6	-	-	-	≤250 <sup>(d1)</sup>
Sulphate	mg/L	1.6	<0.5	0.9	0.5	0.9	<0.5	0.9	<0.5	<0.5	0.5	10	4	0.9	<0.5	1.6	-	-	-	≤500 <sup>(d1)</sup>
Iron (Fe)	mg/L	0.08	0.44	0.44	0.25	0.1	0.4	0.5	0.6	0.6	0.2	10	0	0.4	0.1	0.6	0.3	-	-	≤0.3 <sup>(d1)</sup>
Manganese (Mn)	mg/L	<0.004	0.023	0.016	0.082	0.009	0.008	0.009	0.03	0.03	0.2	10	1	0.0	<0.004	0.2	-	-	-	≤0.05 <sup>(d1)</sup>
<b>Nutrients</b>																				
Nitrate-Nitrogen	mg/L	0.006	0.018	<0.003	0.184	<0.003	<0.003	<0.003	<0.05	<0.05	<0.003	10	7	-	<0.003	0.2	13	-	-	45 <sup>(d3)</sup>
Nitrite-Nitrogen	mg/L	<0.003	<0.003	<0.003	<0.003	0.019	<0.003	0.008	<0.05	<0.05	0.18	10	7	-	<0.003	0.18	0.06	-	-	3.2 <sup>(d3)</sup>
Ammonia-Nitrogen	mg/L	-	0.04	0.01	0.11	-	0.02	<0.01	-	-	0.26	6	1	0.03	<0.01	0.3	7.0 - 48.3	1.3 - 32.6 <sup>b3</sup>	-	-
Total Kjeldahl Nitrogen	mg/L	0.42	0.33	0.51	0.55	0.3	0.32	0.51	-	-	0.73	8	0	0.5	0.3	0.7	-	-	-	1
Phosphorus, Total	mg/L	0.008	0.038	0.031	0.043	0.008	0.036	0.045	0.04	0.04	0.11	10	0	0.04	0.01	0.1	-	-	-	0.05
<b>Polycyclic Aromatic Hydrocarbons</b>																				
Napthalene	µg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	-	< 0.07	< 0.07	<0.1	9	9	-	<0.07	<0.01	1.1	-	-	-
Acenaphthene	µg/L	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	-	< 0.01	< 0.01	<0.1	9	9	-	<0.01	<0.1	5.8	-	-	-
Acenaphthylene	µg/L	<0.10	-	<0.10	-	<0.10	-	-	-	-	<0.1	4	4	-	<0.1	<0.2	-	-	-	-
Acridine	µg/L	<0.2	<0.2	<0.2	<0.2	<0.20	<0.20	-	< 0.07	< 0.07	<0.2	9	9	-	<0.07	<0.2	4.4	-	-	-
Anthracene	µg/L	<0.10	<0.10	<0.10	<0.10	<0.010	<0.010	-	< 0.007	< 0.007	<0.01	9	9	-	<0.007	<0.01	0.012	-	-	-
B[a]p***	µg/L	-	<0.008	<0.0078	<0.0078	<0.008	<0.0078	-	-	-	<0.0078	6	6	-	<0.0078	<0.008	-	-	-	-
Benzo[a]anthracene	µg/L	<0.10	<0.05	<0.10	<0.10	<0.05	<0.10	-	< 0.006	< 0.006	<0.01	9	9	-	<0.006	<0.01	0.018	-	-	-
Benzo[a]pyrene	µg/L	<0.10	<0.05	<0.10	<0.10	<0.05	<0.10	-	< 0.005	< 0.005	<0.01	9	9	-	<0.005	<0.01	0.015	-	-	-
Benzo[b]fluoranthene	µg/L	-	<0.10	<0.10	<0.10	<0.10	<0.10	-	-	-	<0.1	6	6	-	<0.1	<0.1	-	-	-	-
Benzo[g,h,i]perylene	µg/L	-	<0.05	-	<0.05	<0.050	-	-	-	-	<0.05	4	4	-	<0.05	<0.05	-	-	-	-
Benzo[k]fluoranthene	µg/L	-	<0.05	<0.10	<0.05	<0.05	<0.10	-	-	-	<0.05	6	6	-	<0.05	<0.1	-	-	-	-
Chrysene	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.050	-	-	-	<0.05	7	7	-	<0.05	<0.05	-	-	-	-
Dibenz[a,h]anthracene	µg/L	-	<0.05	<0.10	<0.05	<0.05	<0.10	-	-	-	<0.05	6	6	-	<0.05	<0.1	-	-	-	-
Fluoranthene	µg/L	<0.04	<0.04	<0.04	<0.04	<0.040	<0.040	-	< 0.04	< 0.04	<0.04	9	9	-	<0.04	<0.04	0.04	-	-	-
Fluorene	µg/L	<0.05	<0.05	<0.05	<0.05	<0.050	<0.050	-	< 0.02	< 0.02	<0.05	9	9	-	<0.02	<0.05	3	-	-	-
Indeno[1,2,3-cd]pyrene	µg/L	-	<0.10	<0.10	<0.10	<0.1	<0.10	-	-	-	<0.1	6	6	-	<0.1	<0.1	-	-	-	-
Phenanthrene	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	-	< 0.01	< 0.01	<0.05	9	9	-	<0.01	<0.05	0.04	-	-	-
Pyrene	µg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-	< 0.02	< 0.02	<0.02	9	9	-	<0.02	<0.02	0.025	-	-	-
Quinoline	µg/L	<0.2	<0.2	<0.2	<0.2	<0.20	<0.20	-	< 0.06	< 0.06	<0.2	9	9	-	<0.06	<0.2	3.4	-	-	-





Notes:

Shaded and **Bolded** cells indicates an aquatic life guideline exceedance.

Shaded and *Italicized* cells indicates a drinking water guideline exceedance.

\* = The method detection limit for this parameter is higher than an applicable guideline, therefore an exceedance is unknown.

#### Part 1. Water Quality Guidelines for the Protection of Aquatic Life

##### Canadian Environmental Quality Guidelines - CEQG (CCME 2007)

**a1** = Guideline is based on temperature preferences of biota. In this case, the cold water biota guidelines for both early life and other life stages are shown.

**a2** = Guideline is dependent on temperature and pH. The value ranges between 6.98 mg/L (pH= 7.0, temperature= 15 °C) and 48.3 mg/L (pH= 6.5, temperature= 5°C).

**a3** = Guideline = 5 µg/L at pH < 6.5, [Ca<sup>2+</sup>] < 4 mg/L and DOC < 2 mg/L; Guideline = 100 µg/L at pH ≥ 6.5, [Ca<sup>2+</sup>] ≥ 4 mg/L and DOC ≥ 2 mg/L.

**a4** = Cadmium guideline =  $10^{[0.86 \log(\text{hardness}) - 3.2]}$

**a5** = Guideline is for hexavalent chromium (Cr<sub>VI</sub>) because its guideline is more stringent than the trivalent chromium (Cr<sub>III</sub>) guideline of 8.9 µg/L.

**a6** = Copper guideline is dependent on [CaCO<sub>3</sub>]. Guideline shown is for when [CaCO<sub>3</sub>] is 0-120 mg/L. At 120-180 mg/L of CaCO<sub>3</sub>, guideline = 3 µg/L; and at >180 mg/L CaCO<sub>3</sub>, guideline = 4 µg/L.

**a7** = Lead guideline is dependent on [CaCO<sub>3</sub>]. Guideline shown is for CaCO<sub>3</sub> at 0-60 mg/L. At 60-120 mg/L CaCO<sub>3</sub>, guideline = 2 µg/L; at 120-180 mg/L CaCO<sub>3</sub>, guideline = 4 µg/L; and at >180 mg/L CaCO<sub>3</sub>, guideline = 7 µg/L.

**a8** = Guideline for methyl-mercury provided. The guideline for total inorganic mercury is 0.1 µg/L.

**a9** = Nickel guideline is dependent on [CaCO<sub>3</sub>]. Guideline shown is for CaCO<sub>3</sub> at 0-60 mg/L. At 60-120 mg/L CaCO<sub>3</sub>, guideline = 65 µg/L; at 120-180 mg/L CaCO<sub>3</sub>, guideline = 110 µg/L; and at >180 mg/L CaCO<sub>3</sub>, guideline = 150 µg/L.

##### Alberta Acute Water Quality Guidelines [AAWQG] (AENV 1999)

**b1** = The pH is to be in the range of 6.5 to 8.5 but not altered by more than 0.5 pH units from background values.

**b2** = Not to be increased by more than 10 mg/L (ppm) over background value.

**b3** = USEPA Guideline. Acute values based on one-hour average concentration of total ammonia-nitrogen (mg nitrogen/L). The guideline is dependant on pH and the presence of salmonids, ranging from 0.88 mg/L (ppm) (pH = 9.0; salmonids present)

**b4** = Acute guideline is dependant on hardness and applies to acid-extractable copper concentrations governed by the following equation: [Max] =  $e^{[0.979123 * \ln(\text{hardness}) - 8.64497]}$ . The copper guideline ranges from 8.1 µg/L (hardness = 50 mg/L)

**b5** = Guideline for methylmercury provided. The total mercury guideline is 0.013 µg/L.

##### Alberta Chronic Water Quality Guidelines [ACWQG] (AENV 1999)

**c1** = Seven day mean. The chronic guidelines should be increased to 8.3 mg/L from mid May to the end of June to protect the emergence of mayfly species into adults; it should be increased to 9.5 mg/L for those areas and times where embryonic and

**c2** = The evaluation of chronic copper toxicity in soft water was inconclusive; the chronic guideline can therefore only be applied at water hardness equal to or greater than 50 mg/L as CaCO<sub>3</sub>.

**c3** = Guideline for methylmercury provided. The total mercury guideline is 0.005 µg/L.

##### Canadian Drinking Water Quality Guideline - CDWQG (Health Canada 2008)

**d1** = Aesthetic objective.

**d2** = Maximum allowable concentration (MAC).

**d3** = Equivalent to 10 mg/L as nitrate-nitrogen. Where nitrate and nitrite are determined separately, levels of nitrite should not exceed 3.2 mg/L.

**d4** = A health-based guideline for aluminum in drinking water has not been established. Operational guidance values of less than 100 µg/L total aluminum for conventional treatment plants and less than 200 µg/L total aluminum for other types of treatment systems are

**Table D.7: Baseline Water Quality Results for Unnamed Creek 1**

Parameter	Units	WC1						WC2	n	Number Below Detection	Median	min	max	Guidelines				
		Spring	Summer	Fall	Fall	Winter	Fall	CCME (2006)						Aquatic Life		Drinking Water		
		28-May-05	11-Aug-05	1-Oct-05	5-Sep-08	11-Feb-06	30-Sep-05							AENV (1999)	Health Canada (2007)			
		Acute	Chronic															
<b>Field Measured</b>																		
Temperature	°C	8.1	12.7	12.7	7.6	-	6.12	5	0	8.1	6.1	12.7	-	-	-	-		
pH	pH units	-	6.9	6.9	7.7	-	7.4	4	0	7.2	6.9	7.7	6.5 to 9.0	6.5 to	-	6.5 to 8.5 <sup>(d1)</sup>		
Electrical Conductivity	µS/cm	40.0	85	85	66	-	104	5	0	85	40	104	-	-	-	-		
Dissolved Oxygen (DO)	mg/L	10.5	10.4	10.4	11.9	-	12.8	5	0	10.5	10.4	12.8	6.5 or 9.5	5.0	6.5 <sup>(c1)</sup>	-		
<b>Conventional Parameters and Major Ions</b>																		
pH	pH Units	6.9	7.7	7.8	7.6	7.9	7.9	6	0	7.8	6.9	7.9	6.5 to 9.0	-	-	6.5 to 8.5 <sup>(d1)</sup>		
Electrical Conductivity	µS/cm	52	87.9	97	105	476	104	6	0	101	52	476	-	-	-	-		
Total Dissolved Solids (TDS)	mg/L	29	47	49	92	251	55	6	0	52	29	251	-	-	-	≤500 <sup>(d1)</sup>		
Hardness, Total	mg/L	29	46	51	61	230	57	6	0	54	29	230	-	-	-	-		
Total Suspended Solids	mg/L	7	6	21	6	1	2	6	0	6	1	21	-	-	-	-		
Turbidity	NTU	-	-	-	3	-	-	1	0	-	3	3	b2	b2	-	1 <sup>(d2)</sup>		
Calcium	mg/L	7	12	13	15	60	14	6	0	13.1	6.9	60.0	-	-	-	-		
Magnesium	mg/L	2.8	4	5	6	21	5	6	0	5.1	2.8	20.6	-	-	-	-		
Potassium	mg/L	<0.3	<0.3	<0.3	<0.5	1	<0.3	6	5	-	<0.3	1.0	-	-	-	-		
Sodium	mg/L	1.4	1.7	1.4	1	6.4	1.5	6	0	1.5	1.0	6.4	-	-	-	≤200 <sup>(d1)</sup>		
Bicarbonate	mg/L	35.7	56.5	58.6	74	314	66.8	6	0	62.7	35.7	314.0	-	-	-	-		
Carbonate	mg/L	<0.5	<0.5	<0.5	<1	<0.5	<0.5	6	6	-	<0.5	<1	-	-	-	-		
Chloride	mg/L	<0.5	1.8	0.8	<0.1	1.2	1.2	6	2	1.2	<0.1	1.8	-	-	-	≤250 <sup>(d1)</sup>		
Sulphate	mg/L	<0.5	<0.5	<0.5	<0.5	3.7	<0.5	6	5	-	<0.5	3.7	-	-	-	≤500 <sup>(d1)</sup>		
Iron (Fe)	mg/L	0.07	0.21	0.37	<0.10	0.09	0.28	6	1	0.2	<0.1	0.37	0.3	-	-	≤0.3 <sup>(d1)</sup>		
Manganese (Mn)	mg/L	0.005	0.04	0.13	0.09	3.4	0.028	6	0	0.1	0.01	3.4	-	-	-	≤0.05 <sup>(d1)</sup>		
<b>Nutrients</b>																		
Nitrate-Nitrogen	mg/L	<0.003	0.005	0.012	<0.05	0.006	0.004	6	2	0.006	<0.003	<0.05	13	-	-	45 <sup>(d3)</sup>		
Nitrite-Nitrogen	mg/L	<0.003	<0.003	<0.003	<0.05	<0.003	<0.003	6	6	-	<0.003	<0.05	0.06	-	-	3.2 <sup>(d3)</sup>		
Ammonia-Nitrogen	mg/L	-	0.03	0.02	-	0.024	<0.01	4	1	0.02	<0.01	0.03	7.0 - 48.3	1.3 -	-	-		
Total Kjeldahl Nitrogen	mg/L	0.31	0.35	0.62	-	0.62	0.56	5	0	0.6	0.3	0.6	-	-	1	-		
Phosphorus, Total	mg/L	0.004	0.024	0.028	<0.02	0.024	0.021	6	1	0.02	<0.02	0.028	-	-	0.05	-		
<b>Polycyclic Aromatic Hydrocarbons</b>																		
Naphthalene	µg/L	<0.1	<0.1	<0.1	<0.07	<0.1	<0.07	6	6	-	<0.07	<0.1	1.1	-	-	-		
Acenaphthene	µg/L	<0.1	<0.1	<0.1	<0.01	<0.1	<0.01	6	6	-	<0.01	<0.1	5.8	-	-	-		
Acenaphthylene	µg/L	<0.1	-	<0.1	-	-	-	2	2	-	<0.1	<0.1	-	-	-	-		
Acridine	µg/L	<0.2	<0.2	<0.2	<0.07	<0.2	<0.07	6	6	-	<0.07	<0.2	4.4	-	-	-		
Anthracene	µg/L	<0.01	<0.01	<0.01	<0.007	<0.01	<0.007	6	6	-	<0.007	<0.01	0.012	-	-	-		
B[a]p***	µg/L	-	<0.008	<0.0078	-	<0.0078	-	3	3	-	<0.0078	<0.008	-	-	-	-		
Benz[a]anthracene	µg/L	<0.01	<0.05	<0.01	<0.006	<0.01	<0.006	6	6	-	<0.006	<0.05	0.018	-	-	-		
Benzo[a]pyrene	µg/L	<0.01	<0.05	<0.01	<0.005	<0.01	<0.005	6	6	-	<0.005	<0.05	0.015	-	-	-		
Benzo[b]fluoranthene	µg/L	-	<0.05	<0.01	-	<0.05	<0.05	0	0	-	<0.01	<0.05	-	-	-	-		
Benzo[g,h,i]perylene	µg/L	-	<0.05	-	-	<0.05	-	0	0	-	<0.05	<0.05	-	-	-	-		
Benzo[k]fluoranthene	µg/L	-	<0.05	<0.01	-	<0.05	<0.05	4	4	-	<0.01	<0.05	-	-	-	-		
Chrysene	µg/L	<0.05	<0.05	<0.05	-	<0.05	<0.05	6	6	-	<0.05	<0.05	-	-	-	-		
Dibenz[a,h]anthracene	µg/L	-	<0.05	<0.01	-	<0.05	<0.05	0	0	-	<0.01	<0.05	-	-	-	-		
Fluoranthene	µg/L	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	6	6	-	<0.04	<0.04	0.04	-	-	-		
Fluorene	µg/L	<0.05	<0.05	<0.05	<0.02	<0.05	<0.02	6	6	-	<0.02	<0.05	3	-	-	-		
Indeno[1,2,3-cd]pyrene	µg/L	<0.1	<0.1	<0.1	-	<0.1	-	4	4	-	<0.1	<0.1	-	-	-	-		
Phenanthrene	µg/L	0.05	0.05	0.05	<0.01	0.05	<0.01	6	2	0.05	<0.01	0.05	0.04	-	-	-		
Pyrene	µg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	6	6	-	<0.02	<0.02	0.025	-	-	-		
Quinoline	µg/L	<0.2	<0.2	<0.2	<0.06	<0.2	<0.06	6	6	-	<0.06	<0.2	3.4	-	-	-		

Parameter	Units	WC1					WC2	n	Number Below Detection	Median	min	max	Guidelines				
		Spring	Summer	Fall	Fall	Winter	Fall						Aquatic Life		Drinking Water		
		28-May-05	11-Aug-05	1-Oct-05	5-Sep-08	11-Feb-06	30-Sep-05						CCME (2006)	AENV (1999)		Health Canada (2007)	
		Acute		Chronic													
<b>Total Metals</b>																	
Aluminum (Al)	µg/L	96	67	70	63	7	27	6	0	65	7	96	5 or 100	-	-	100 <sup>(d4)</sup>	
Antimony (Sb)	µg/L	<0.2	<0.2	<0.2	< 0.05	<0.2	<0.2	6	6	-	<0.05	<0.2	-	-	-	6 <sup>(d2)</sup>	
Arsenic (As)	µg/L	0.5	0.8	0.5	0.7	0.7	0.3	6	0	0.6	0.3	0.8	5	-	-	10 <sup>(d2)</sup>	
Barium (Ba)	µg/L	8.4	12	12	9	56	11	6	0	12	8	56	-	-	-	1,000 <sup>(d2)</sup>	
Beryllium (Be)	µg/L	<0.2	<0.2	<0.2	< 0.1	<0.2	<0.2	6	6	-	<0.1	<0.2	-	-	-	-	
Boron (B)	µg/L	<10	<10	<10	2	20	<10	6	4	-	<10	20	-	-	-	5,000 <sup>(d2)</sup>	
Cadmium (Cd)	µg/L	<0.01	<b>0.05</b>	<0.01	< 0.02	<0.01	<0.01	6	5	-	<0.01	<b>0.05</b>	0.02 <sup>(a4)</sup>	-	-	5 <sup>(d2)</sup>	
Chromium (Cr)	µg/L	<1	<1	<1	< 0.5	<1	<1	6	6	-	<0.5	<1	1 <sup>(a5)</sup>	-	-	50 <sup>(d2)</sup>	
Cobalt (Co)	µg/L	<0.3	<0.3	<0.3	0.1	0.4	<0.3	6	4	-	<0.3	0.4	-	-	-	-	
Copper (Cu)	µg/L	0.3	0.4	<0.2	< 0.1	<0.2	<0.2	6	4	-	<0.1	0.4	2 to 4 <sup>(a6)</sup>	8.1 to 47 <sup>(a4)</sup>	7 <sup>(c2)</sup>	≤1,000 <sup>(d1)</sup>	
Lead (Pb)	µg/L	<0.3	<0.3	<0.3	0.06	<0.3	<0.3	6	5	-	<0.3	<0.3	1 to 7 <sup>(a7)</sup>	-	-	10	
Lithium (Li)	µg/L	<4	<4	<4	-	11	<4	5	4	-	<4	11.0	-	-	-	-	
Mercury (Hg)	µg/L	<0.0006	<0.0006	<0.0006	< 0.02	<0.0006	<0.0006	6	6	-	<0.0006	<0.02	0.004 <sup>(a8)</sup>	0.002 <sup>(b5)</sup>	0.001 <sup>(c3)</sup>	1 <sup>(d2)</sup>	
Molybdenum (Mo)	µg/L	0.3	<0.2	<0.2	< 0.05	<0.2	<0.2	6	5	-	<0.05	0.3	73	-	-	-	
Nickel (Ni)	µg/L	<0.5	0.6	0.6	0.2	2.1	0.6	6	1	0.6	<0.5	2.1	25 to 150	-	-	-	
Selenium (Se)	µg/L	<0.2	0.6	0.3	< 0.6	0.5	0.2	6	2	0.4	0.2	0.6	1	-	-	10 <sup>(d2)</sup>	
Silicon (Si)	µg/L	2200	3160	3410	4510	4780	349	6	0	3285	349	4780	-	-	-	-	
Silver (Ag)	µg/L	<b>0.2</b>	<b>0.9</b>	<0.1	< 0.1	<0.1	<0.1	6	4	-	<0.1	<b>0.9</b>	0.1	-	-	-	
Strontium (Sr)	µg/L	12	23	23	-	141	26	5	0	23	12	141	-	-	-	-	
Thallium (Tl)	µg/L	<0.2	<0.2	<0.2	< 0.05	<0.2	<0.2	6	6	-	<0.05	<0.2	0.8	-	-	-	
Tin (Sn)	µg/L	<1	<1	<1	-	<1	<1	5	5	-	<1	<1	-	-	-	-	
Titanium (Ti)	µg/L	3	2	2	-	<1	1	5	1	2.0	<1	3.0	-	-	-	-	
Uranium	µg/L	<0.4	<0.4	<0.4	< 0.05	<0.4	<0.4	6	6	-	<0.05	<0.4	-	-	-	20	
Vanadium	µg/L	<1	<1	<1	< 0.5	<1	<1	6	6	-	<0.5	<1	-	-	-	-	
Zinc (Zn)	µg/L	6	12	11	<1	<b>750</b>	5.9	6	1	8.5	<1	<b>750</b>	30	-	-	≤5,000 <sup>(d1)</sup>	
Zirconium (Zr)	µg/L	0.4	0.2	<0.2	-	<0.2	<0.2	5	3	-	<0.2	0.4	-	-	-	-	
<b>Dissolved Metals</b>																	
Aluminum (Al)	µg/L	-	-	-	6	-	-	1	0	-	6.0	6.0	-	-	-	-	
Antimony (Sb)	µg/L	-	-	-	< 0.05	-	-	1	1	-	0.0	0.0	-	-	-	-	
Arsenic (As)	µg/L	-	-	-	0.5	-	-	1	0	-	0.5	0.5	-	-	-	-	
Barium (Ba)	µg/L	-	-	-	8	-	-	1	0	-	7.8	7.8	-	-	-	-	
Beryllium (Be)	µg/L	-	-	-	< 0.1	-	-	1	1	-	< 0.1	< 0.1	-	-	-	-	
Boron (B)	µg/L	-	-	-	< 1	-	-	1	1	-	< 1	< 1	-	-	-	-	
Cadmium (Cd)	µg/L	-	-	-	< 0.02	-	-	1	1	-	< 0.02	< 0.02	-	-	-	-	
Chromium (Cr)	µg/L	-	-	-	< 0.3	-	-	1	1	-	< 0.3	< 0.3	-	-	-	-	
Cobalt (Co)	µg/L	-	-	-	0.04	-	-	1	0	-	0.04	0.04	-	-	-	-	
Copper (Cu)	µg/L	-	-	-	< 0.1	-	-	1	1	-	< 0.1	< 0.1	-	-	-	-	
Lead (Pb)	µg/L	-	-	-	< 0.050	-	-	1	1	-	< 0.050	< 0.050	-	-	-	-	
Lithium (Li)	µg/L	-	-	-	-	-	-	0	0	-	-	-	-	-	-	-	
Mercury (Hg)	µg/L	-	-	-	< 0.02	-	-	1	1	-	< 0.02	< 0.02	-	-	-	-	
Molybdenum (Mo)	µg/L	-	-	-	< 0.05	-	-	1	1	-	< 0.05	< 0.05	-	-	-	-	
Nickel (Ni)	µg/L	-	-	-	0.06	-	-	1	0	-	0.06	0.06	-	-	-	-	
Selenium (Se)	µg/L	-	-	-	< 0.6	-	-	1	1	-	< 0.6	< 0.6	-	-	-	-	
Silicon (Si)	µg/L	-	-	-	-	-	-	0	0	-	-	-	-	-	-	-	
Silver (Ag)	µg/L	-	-	-	< 0.05	-	-	1	1	-	< 0.05	< 0.05	-	-	-	-	
Strontium (Sr)	µg/L	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	
Thallium (Tl)	µg/L	-	-	-	< 0.05	-	-	1	1	-	< 0.05	< 0.05	-	-	-	-	
Tin (Sn)	µg/L	-	-	-	-	-	-	0	0	-	-	-	-	-	-	-	
Titanium (Ti)	µg/L	-	-	-	-	-	-	0	0	-	-	-	-	-	-	-	
Uranium	µg/L	-	-	-	< 0.05	-	-	1	1	-	< 0.05	< 0.05	-	-	-	-	
Vanadium	µg/L	-	-	-	< 0.1	-	-	1	1	-	< 0.1	< 0.1	-	-	-	-	
Zinc (Zn)	µg/L	-	-	-	1	-	-	1	0	-	1	1	-	-	-	-	
Zirconium (Zr)	µg/L	-	-	-	-	-	-	0	0	-	-	-	-	-	-	-	

Notes:

Shaded and **Bolded** cells indicates an aquatic life guideline exceedance.

Shaded and *italicized* cells indicates a drinking water guideline exceedance.

#### Part 1. Water Quality Guidelines for the Protection of Aquatic Life

##### Canadian Environmental Quality Guidelines - CEQG (CCME 2007)

**a1** = Guideline is based on temperature preferences of biota. In this case, the cold water biota guidelines for both early life and other life stages are shown.

**a2** = Guideline is dependent on temperature and pH. The value ranges between 6.98 mg/L (pH= 7.0, temperature= 15°C) and 48.3 mg/L (pH= 6.5, temperature= 5°C).

**a3** = Guideline = 5 µg/L at pH < 6.5, [Ca<sup>2+</sup>] < 4 mg/L and DOC < 2 mg/L; Guideline = 100 µg/L at pH ≥ 6.5, [Ca<sup>2+</sup>] ≥ 4 mg/L and DOC ≥ 2 mg/L.

**a4** = Cadmium guideline =  $10^{0.86(\log(\text{hardness})) - 3.2}$ .

**a5** = Guideline is for hexavalent chromium (Cr<sub>VI</sub>) because its guideline is more stringent than the trivalent chromium (Cr<sub>III</sub>) guideline of 8.9 µg/L.

**a6** = Copper guideline is dependent on [CaCO<sub>3</sub>]. Guideline shown is for when [CaCO<sub>3</sub>] is 0-120 mg/L. At 120-180 mg/L of CaCO<sub>3</sub>, guideline = 3 µg/L; and at >180 mg/L CaCO<sub>3</sub>, guideline = 4

**a7** = Lead guideline is dependent on [CaCO<sub>3</sub>]. Guideline shown is for CaCO<sub>3</sub> at 0-60 mg/L. At 60-120 mg/L CaCO<sub>3</sub>, guideline = 2 µg/L; at 120-180 mg/L CaCO<sub>3</sub>, guideline = 4 µg/L; and at

**a8** = Guideline for methyl-mercury provided. The guideline for total inorganic mercury is 0.1 µg/L.

**a9** = Nickel guideline is dependent on [CaCO<sub>3</sub>]. Guideline shown is for CaCO<sub>3</sub> at 0-60 mg/L. At 60-120 mg/L CaCO<sub>3</sub>, guideline = 65 µg/L; at 120-180 mg/L CaCO<sub>3</sub>, guideline = 110 µg/L; and

##### Alberta Acute Water Quality Guidelines [AAWQG] (AENV 1999)

**b1** = The pH is to be in the range of 6.5 to 8.5 but not altered by more than 0.5 pH units from background values.

**b2** = Not to be increased by more than 10 mg/L (ppm) over background value.

**b3** = USEPA Guideline. Acute values based on one-hour average concentration of total ammonia-nitrogen (mg nitrogen/L). The guideline is dependant on pH and the presence of salmonids, ranging from 0.88 mg/L (ppm) (pH = 9.0; salmonids

**b4** = Acute guideline is dependant on hardness and applies to acid-extractable copper concentrations governed by the following equation: [Max] = e[0.979123 \* ln(hardness) - 8.64497]. The copper guideline ranges from 8.1 µg/L (hardness = 50

**b5** = Guideline for methylmercury provided. The total mercury guideline is 0.013 µg/L.

##### Alberta Chronic Water Quality

**c1** = Seven day mean. The chronic guidelines should be increased to 8.3 mg/L from mid May to the end of June to protect the emergence of mayfly species into adults; it should be increased to 9.5 mg/L for those areas and times where embryonic

**c2** = The evaluation of chronic copper toxicity in soft water was inconclusive; the chronic guideline can therefore only be applied at water hardness equal to or greater than 50 mg/L as CaCO<sub>3</sub>.

**c3** = Guideline for methylmercury provided. The total mercury guideline is 0.005 µg/L.

##### Canadian Drinking Water Quality Guidelines - CDWQG (Health Canada 2008)

**d1** = Aesthetic objective.

**d2** = Maximum allowable concentration (MAC).

**d3** = Equivalent to 10 mg/L as nitrate-nitrogen. Where nitrate and nitrite are determined separately, levels of nitrite should not exceed 3.2 mg/L.

**d4** = A health-based guideline for aluminum in drinking water has not been established. Operational guidance values of less than 100 µg/L total aluminum for conventional treatment plants

**Table D.8: Baseline Water Quality Results for Unnamed Creek 2**

Parameter	Units	WC4					n	Number Below Detection	Median	min	max	Guidelines				
		Spring	Summer	Fall	Fall	Winter						Aquatic Life		Drinking Water		
		28-May-05	11-Aug-05	1-Oct-05	6-Sep-08	12-Feb-06						CCME (2006)	AENV (1999)		Health Canada (2007)	
													Acute	Chronic		
<b>Field Measured</b>																
Temperature	°C	5.7	13.8	6.7	7.2	2.0	5	0	6.7	2.0	13.8	-	-	-	-	
pH	pH units	-	6.7	<b>6.3</b>	7.2	6.5	4	0	6.6	6.3	7.2	6.5 to 9.0	6.5 to 8.5 <sup>b1</sup>	-	6.5 to 8.5 <sup>(d1)</sup>	
Electrical Conductivity	µS/cm	50	130	130	80	495	5	0	130	50	495	-	-	-	-	
Dissolved Oxygen (DO)	mg/L	7.4	<b>3.1</b>	<b>5.7</b>	7.9	<b>0.3</b>	5	0	5.7	<b>0.3</b>	7.9	6.5 or 9.5 <sup>(a1)</sup>	5.0	6.5 <sup>c1</sup>	-	
Turbidity	NTU	-	-	-	-	<b>11.25</b>	1	0	-	11.3	11.3	b2	b2	-	1 <sup>(d2)</sup>	
<b>Conventional Parameters and Major Ions</b>																
pH	pH Units	6.8	7.4	7.8	7.6	7.4	5	0	7.4	6.8	7.8	6.5 to 9.0	6.5 to 8.5 <sup>b1</sup>	-	6.5 to 8.5 <sup>(d1)</sup>	
Electrical Conductivity	µS/cm	69	126	132	125	406	5	0	126.0	68.9	406.0	-	-	-	-	
Total Dissolved Solids	mg/L	39	67	69	104	221	5	0	69.0	39.0	221.0	-	-	-	≤500 <sup>(d1)</sup>	
Hardness, Total	mg/L	38	68	71	74	200	5	0	71.0	38.0	200.0	-	-	-	-	
Total Suspended Solids	mg/L	1	1	-	<2	20	4	1	1.0	0.5	20.0	-	-	-	-	
Calcium	mg/L	9.5	18	18	19	53	5	0	17.9	9.5	52.5	-	-	-	-	
Magnesium	mg/L	3.5	6	6	7	16	5	0	6.3	3.5	16.1	-	-	-	-	
Potassium	mg/L	0.6	<0.3	0.4	<0.5	1.4	5	2	0.6	0.4	1.4	-	-	-	-	
Sodium	mg/L	1.1	1.3	1.4	1.0	3	5	0	1.3	1.0	2.7	-	-	-	≤200 <sup>(d1)</sup>	
Bicarbonate	mg/L	46.3	82	83.4	87	276	5	0	83.4	46.3	276.0	-	-	-	-	
Carbonate	mg/L	<0.5	<0.5	<0.5	<1	<0.5	5	5	-	<0.5	<1	-	-	-	-	
Chloride	mg/L	0.9	1.4	1.0	0.3	1.7	5	0	1.0	0.3	1.7	-	-	-	≤250 <sup>(d1)</sup>	
Sulphate	mg/L	0.5	<0.5	<0.5	<0.5	<0.5	5	4	-	<0.5	0.5	-	-	-	≤500 <sup>(d1)</sup>	
Iron (Fe)	mg/L	0.17	<b>0.74</b>	<b>0.35</b>	<b>0.38</b>	<b>0.59</b>	5	0	<b>0.4</b>	<b>0.17</b>	<b>0.7</b>	0.3	-	-	≤0.3 <sup>(d1)</sup>	
Manganese (Mn)	mg/L	<b>0.06</b>	<b>0.272</b>	<b>0.102</b>	<b>0.12</b>	<b>8.91</b>	5	0	<b>0.1</b>	<b>0.06</b>	<b>8.9</b>	-	-	-	≤0.05 <sup>(d1)</sup>	
<b>Nutrients</b>																
Nitrate-Nitrogen	mg/L	<0.003	<0.003	<0.003	<0.05	<0.003	5	5	-	<0.003	<0.05	13	-	-	45 <sup>(d3)</sup>	
Nitrite-Nitrogen	mg/L	<0.003	<0.003	0.02	<0.05	0.01	5	3	0.02	<0.003	<0.05	0.06	-	-	3.2 <sup>(d3)</sup>	
Ammonia-Nitrogen	mg/L	-	0.04	-	-	1.43	2	0	-	0.04	1.4	7.0 - 48.3 <sup>(a2)</sup>	1.3 - 32.6 <sup>(b3)</sup>	-	-	
Total Kjeldahl Nitrogen	mg/L	0.43	0.62	0.8	-	<b>3.0</b>	4	0	0.7	0.4	<b>3.0</b>	-	-	1	-	
Phosphorus, Total	mg/L	0.007	0.1	-	<0.02	<b>1.2</b>	4	1	0.04	0.01	<b>1.2</b>	-	-	0.05	-	
<b>Polycyclic Aromatic Hydrocarbons</b>																
Napthalene	µg/L	<0.1	<0.10	-	< 0.07	<0.1	4	4	-	<0.07	<0.1	1.1	-	-	-	
Acenaphthene	µg/L	<0.1	<0.10	-	< 0.01	<0.1	4	4	-	<0.01	<0.1	5.8	-	-	-	
Acenaphthylene	µg/L	-	<0.10	-	-	<0.1	2	2	-	<0.1	<0.1	-	-	-	-	
Acridine	µg/L	<0.2	<0.20	-	< 0.07	<0.2	4	4	-	<0.07	<0.2	4.4	-	-	-	
Anthracene	µg/L	<0.01	<0.010	-	< 0.007	<0.01	4	4	-	<0.007	<0.01	0.012	-	-	-	
B[a]p***	µg/L	-	<0.008	-	-	<0.0078	2	2	-	<0.0078	<0.008	-	-	-	-	
Benz[a]anthracene	µg/L	<0.01	<0.05	-	< 0.006	<0.01	4	4	-	<0.006	<0.05	0.018	-	-	-	
Benzo[a]pyrene	µg/L	<0.01	<0.05	-	< 0.005	<0.01	4	4	-	<0.005	<0.05	0.015	-	-	-	
Benzo[b]flouranthene	µg/L	-	<0.1	-	-	<0.1	2	2	-	<0.1	<0.1	-	-	-	-	
Benzo[g,h,i]perylene	µg/L	-	<0.050	-	-	<0.05	2	2	-	<0.05	<0.05	-	-	-	-	
Benzo[k]flouranthene	µg/L	-	<0.05	-	-	<0.05	2	2	-	<0.05	<0.05	-	-	-	-	
Chrysene	µg/L	<0.05	<0.05	-	-	<0.05	3	3	-	<0.05	<0.05	-	-	-	-	
Dibenz[a,h]anthracene	µg/L	-	<0.05	-	-	<0.05	2	2	-	<0.05	<0.05	-	-	-	-	
Flouranthene	µg/L	<0.04	<0.040	-	< 0.04	<0.04	4	4	-	<0.04	<0.04	0.04	-	-	-	
Fluorene	µg/L	<0.05	<0.050	-	< 0.02	<0.05	4	4	-	<0.02	<0.05	3	-	-	-	
Indeno[1,2,3,-cd]pyrene	µg/L	-	<0.1	-	-	<0.1	2	2	-	<0.1	<0.1	-	-	-	-	
Phenanthrene	µg/L	<0.05	<0.050	-	< 0.01	<0.05	4	4	-	<0.01	<0.05	0.04	-	-	-	
Pyrene	µg/L	<0.02	<0.020	-	< 0.02	<0.02	4	4	-	<0.02	<0.02	0.025	-	-	-	
Quinoline	µg/L	<0.2	<0.20	-	< 0.06	<0.2	4	4	-	<0.06	<0.2	3.4	-	-	-	



Notes:

Shaded and **Bolded** cells indicates an aquatic life guideline exceedance.

Shaded and *Italicized* cells indicates a drinking water guideline exceedance.

\* = The method detection limit for this parameter is higher than or equal to an applicable guideline, therefore it is unknown if there is an exceedance.

#### Part 1. Water Quality Guidelines for the Protection of Aquatic Life

##### Canadian Environmental Quality Guidelines - CEQG (CCME 2007)

**a1** = Guideline is based on temperature preferences of biota. In this case, the cold water biota guidelines for both early life and other life stages are shown.

**a2** = Guideline is dependent on temperature and pH. The value ranges between 6.98 mg/L (pH= 7.0, temperature= 15 °C) and 48.3 mg/L (pH= 6.5, temperature= 5°C).

**a3** = Guideline = 5 µg/L at pH < 6.5, [Ca<sup>2+</sup>] < 4 mg/L and DOC < 2 mg/L; Guideline = 100 µg/L at pH ≥ 6.5, [Ca<sup>2+</sup>] ≥ 4 mg/L and DOC ≥ 2 mg/L.

**a4** = Cadmium guideline =  $10^{[0.66 \log(\text{hardness})] - 3.2}$ .

**a5** = Guideline is for hexavalent chromium (Cr<sub>VI</sub>) because its guideline is more stringent than the trivalent chromium (Cr<sub>III</sub>) guideline of 8.9 µg/L.

**a6** = Copper guideline is dependent on [CaCO<sub>3</sub>]. Guideline shown is for when [CaCO<sub>3</sub>] is 0-120 mg/L. At 120-180 mg/L of CaCO<sub>3</sub>, guideline = 3 µg/L; and at >180 mg/L CaCO<sub>3</sub>, guideline = 4 µg/L.

**a7** = Lead guideline is dependent on [CaCO<sub>3</sub>]. Guideline shown is for CaCO<sub>3</sub> at 0-60 mg/L. At 60-120 mg/L CaCO<sub>3</sub>, guideline = 2 µg/L; at 120-180 mg/L CaCO<sub>3</sub>, guideline = 4 µg/L; and at >180 mg/L CaCO<sub>3</sub>, guideline = 7 µg/L.

**a8** = Guideline for methyl-mercury provided. The guideline for total inorganic mercury is 0.1 µg/L.

**a9** = Nickel guideline is dependent on [CaCO<sub>3</sub>]. Guideline shown is for CaCO<sub>3</sub> at 0-60 mg/L. At 60-120 mg/L CaCO<sub>3</sub>, guideline = 65 µg/L; at 120-180 mg/L CaCO<sub>3</sub>, guideline = 110 µg/L; and at >180 mg/L CaCO<sub>3</sub>, guideline = 150 µg/L.

##### Alberta Acute Water Quality Guidelines - AAWQG (AENV 1999)

**b1** = The pH is to be in the range of 6.5 to 8.5 but not altered by more than 0.5 pH units from background values.

**b2** = Not to be increased by more than 10 mg/L (ppm) over background value.

**b3** = USEPA Guideline. Acute values based on one-hour average concentration of total ammonia-nitrogen (mg nitrogen/L). The guideline is dependant on pH and the presence of salmonids.

**b4** = Acute guideline is dependant on hardness and applies to acid-extractable copper concentrations governed by the following equation: [Max] = e[0.979123 \* ln(hardness) - 8.64497]. The

**b5** = Guideline for methylmercury provided. The total mercury guideline is 0.013 µg/L.

##### Alberta Chronic Water Quality Guidelines - ACWQG (AENV 1999)

**c1** = Seven day mean. The chronic guidelines should be increased to 8.3 mg/L from mid May to the end of June to protect the emergence of mayfly species into adults; it should be increased to 9.5 mg/L from the end of June to the end of August.

**c2** = The evaluation of chronic copper toxicity in soft water was inconclusive; the chronic guideline can therefore only be applied at water hardness equal to or greater than 50 mg/L as CaCO<sub>3</sub>.

**c3** = Guideline for methylmercury provided. The total mercury guideline is 0.005 µg/L.

##### Guideline for Canadian Drinking Water Quality - GCDWQ (Health Canada 2008)

**d1** = Aesthetic objective.

**d2** = Maximum allowable concentration (MAC).

**d3** = Equivalent to 10 mg/L as nitrate-nitrogen. Where nitrate and nitrite are determined separately, levels of nitrite should not exceed 3.2 mg/L.

**d4** = A health-based guideline for aluminum in drinking water has not been established. Operational guidance values of less than 100 µg/L total aluminum for conventional treatment plants and less than 200 µg/L total aluminum for advanced treatment plants.

**Table D.9: Baseline Water Quality Results for Site L4 (Christina Lake)**

Parameter	Units	Winter 19-Mar-86	Winter 14-Mar-88	Spring 28-May-05	Summer 2004 13-Aug-05		Fall 30-Sep-05 2007		n	Number Below Detection	median	min	max	Guidelines				
														Aquatic Life			Drinking Water	
														CCME (2006)	AENV (1999)		Health Canada (2007)	
															Acute	Chronic		
<b>Field Measured</b>																		
Temperature	°C	2.1	-	10.1	15.3	16.0	11.4	11.9	6	0	11.7	2.1	16.0	-	-	-	-	
pH	pH units	6.7	-	6.7	8.0	8.0	7.8	7.9	6	0	7.9	6.70	8.0	6.5 to 9.0	6.5 to	-	6.5 to 8.5 <sup>(d1)</sup>	
Electrical Conductivity	µS/cm	192	-	140	137	206	180	162	6	0	171	137	206	-	-	-	-	
Dissolved Oxygen (DO)	mg/L	9.3	-	9.9	9.6	9.3	10.7	11.9	6	0	9.8	9.3	11.9	6.5 or 9.5	5.0	6.5 <sup>c1</sup>	-	
<b>Conventional Parameters and Major Ions</b>																		
pH	pH Units	8	8.0	7.7	8.1	8.1	8.1	8.1	6	0	8.1	7.7	8.1	6.5 to 9.0	-	-	6.5 to 8.5 <sup>(d1)</sup>	
Electrical Conductivity	µS/cm	225	230	188	182	173	176	187	6	0	187	173	230	-	-	-	-	
Total Dissolved Solids	mg/L	124	165	104	130	93	96	124	6	0	124	93	165	-	-	-	≤500 <sup>(d1)</sup>	
Hardness, Total	mg/L	114	114	93	86	82	88	90	6	0	90	82	114	-	-	-	-	
Total Suspended Solids	mg/L	124	-	3	3	3	1	3	5	0	3	1	124	-	-	-	-	
Turbidity	NTU	-	-	-	-	-	-	-	-	-	-	-	-	b2	b2	-	1 <sup>(d2)</sup>	
Calcium	mg/L	31	31	25	23	22	23	24	7	0	24	22	31	-	-	-	-	
Magnesium	mg/L	9	9	7.4	7	7	7	7	7	0	7	7	9	-	-	-	-	
Potassium	mg/L	1	1	1.1	1	0.8	0.8	2	7	0	1	0.8	2	-	-	-	-	
Sodium	mg/L	7	7	6.3	6	5.3	5.2	6	7	0	6	5	7	-	-	-	≤200 <sup>(d1)</sup>	
Bicarbonate	mg/L	142	152.37	125	113	114	116	121	7	0	121	113	152	-	-	-	-	
Carbonate	mg/L	-	-	<0.5	<5	<0.5	<0.5	<5	5	5	-	<0.5	<5	-	-	-	-	
Chloride	mg/L	<1	<1	1.3	2	1.3	1.4	1	7	2	1.3	<1	2	-	-	-	≤250 <sup>(d1)</sup>	
Sulphate	mg/L	<5	<5	1.6	3	0.6	1.1	2	7	2	1.6	<5	3	-	-	-	≤500 <sup>(d1)</sup>	
Iron (Fe)	mg/L	0.02	<0.02	0.02	0.04	0.01	0.02	0.09	7	1	0.02	0.01	0.09	0.3	-	-	≤0.3 <sup>(d1)</sup>	
Manganese (Mn)	mg/L	-	-	<0.0004	0.01	<0.0004	<0.0004	0.02	5	3	0.02	<0.0004	0.02	-	-	-	≤0.05 <sup>(d1)</sup>	
<b>Nutrients</b>																		
Nitrate-Nitrogen	mg/L	0.084	-	0.007	-	<0.003	0.012	-	4	2	0.01	<0.003	0.01	13	-	-	45 <sup>(d3)</sup>	
Nitrite-Nitrogen	mg/L	0.002	<0.005	<0.003	-	<0.003	<0.003	-	5	4	-	<0.003	<0.005	0.06	-	-	3.2 <sup>(d3)</sup>	
Ammonia-Nitrogen	mg/L	-	0.016	-	<0.05	<0.01	<0.01	<0.05	5	4	0.02	<0.01	0.02	7.0 - 48.3	1.3 -	-	-	
Total Kjeldahl Nitrogen	mg/L	0.48	0.49	0.4	0.5	0.52	0.6	0.6	7	0	0.5	0.4	0.6	-	-	1	-	
Phosphorus, Total	mg/L	0.016	0.022	0.003	0.014	0.013	0.011	0.021	7	0	0.01	0.003	0.02	-	-	0.05	-	
<b>Polycyclic Aromatic Hydrocarbons</b>																		
Naphthalene	µg/L	-	-	-	-	<0.1	<0.1	-	2	2	-	<0.1	<0.1	1.1	-	-	-	
Acenaphthene	µg/L	-	-	-	-	<0.1	<0.1	-	2	2	-	<0.1	<0.1	5.8	-	-	-	
Acenaphthylene	µg/L	-	-	-	-	<0.1	<0.1	-	2	2	-	<0.1	<0.1	-	-	-	-	
Acridine	µg/L	-	-	-	-	<0.2	<0.2	-	2	2	-	<0.2	<0.2	4.4	-	-	-	
Anthracene	µg/L	-	-	-	-	<0.1	<0.1	-	2	2	-	<0.1	<0.1	0.012	-	-	-	
B[a]p***	µg/L	-	-	-	-	<0.008	<0.0078	-	2	2	-	<0.0078	<0.008	-	-	-	-	
Benz[a]anthracene	µg/L	-	-	-	-	<0.05	<0.01	-	2	2	-	<0.01	<0.05	0.018	-	-	-	
Benzo[a]pyrene	µg/L	-	-	-	-	<0.05	<0.01	-	2	2	-	<0.01	<0.05	0.015	-	-	-	
Benzo[b]fluoranthene	µg/L	-	-	-	-	<0.1	<0.1	-	2	2	-	<0.1	<0.1	-	-	-	-	
Benzo[g,h,i]perylene	µg/L	-	-	-	-	<0.05	-	-	1	1	-	<0.05	<0.05	-	-	-	-	
Benzo[k]fluoranthene	µg/L	-	-	-	-	<0.05	<0.1	-	2	2	-	<0.05	<0.1	-	-	-	-	
Chrysene	µg/L	-	-	-	-	<0.05	<0.05	-	2	2	-	<0.05	<0.05	-	-	-	-	
Dibenz[a,h]anthracene	µg/L	-	-	-	-	<0.05	<0.1	-	2	2	-	<0.05	<0.1	-	-	-	-	
Fluoranthene	µg/L	-	-	-	-	<0.04	<0.04	-	2	2	-	<0.04	<0.04	0.04	-	-	-	
Fluorene	µg/L	-	-	-	-	<0.05	<0.05	-	2	2	-	<0.05	<0.05	3	-	-	-	
Indeno[1,2,3-cd]pyrene	µg/L	-	-	-	-	<0.1	<0.1	-	2	2	-	<0.1	<0.1	-	-	-	-	
Phenanthrene	µg/L	-	-	-	-	<0.05	<0.05	-	2	2	-	<0.05	<0.05	0.04	-	-	-	
Pyrene	µg/L	-	-	-	-	<0.02	<0.02	-	2	2	-	<0.02	<0.02	0.025	-	-	-	
Quinoline	µg/L	-	-	-	-	<0.2	<0.2	-	2	2	-	<0.2	<0.2	3.4	-	-	-	





Notes:

Shaded and **Bolded** cells indicates an aquatic life guideline exceedance.

Shaded and *Italicized* cells indicates a drinking water guideline exceedance.

\* = The method detection limit for this parameter is higher than an applicable guideline, therefore an exceedance is unknown.

NS = Not specified

### Part 1. Water Quality Guidelines for the Protection of Aquatic Life

#### Canadian Environmental Quality Guidelines - CEQG (CCME 2007)

**a1** = Guideline is based on temperature preferences of biota. In this case, the cold water biota guidelines for both early life and other life stages are shown.

**a2** = Guideline is dependent on temperature and pH. The value ranges between 6.98 mg/L (pH= 7.0, temperature= 15°C) and 48.3 mg/L (pH= 6.5, temperature=

**a3** = Guideline = 5 µg/L at pH < 6.5,  $[Ca^{2+}] < 4$  mg/L and DOC < 2 mg/L; Guideline = 100 µg/L at pH ≥ 6.5,  $[Ca^{2+}] ≥ 4$  mg/L and DOC ≥ 2 mg/L.

**a4** = Cadmium guideline =  $10^{(0.86 \log(\text{hardness}) - 3.2)}$

**a5** = Guideline is for hexavalent chromium ( $Cr_{VI}$ ) because its guideline is more stringent than the trivalent chromium ( $Cr_{III}$ ) guideline of 8.9 µg/L.

**a6** = Copper guideline is dependent on  $[CaCO_3]$ . Guideline shown is for when  $[CaCO_3]$  is 0-120 mg/L. At 120-180 mg/L of  $CaCO_3$ , guideline = 3 µg/L; and at >180

**a7** = Lead guideline is dependent on  $[CaCO_3]$ . Guideline shown is for  $CaCO_3$  at 0-60 mg/L. At 60-120 mg/L  $CaCO_3$ , guideline = 2 µg/L; at 120-180 mg/L  $CaCO_3$ ,

**a8** = Guideline for methyl-mercury provided. The guideline for total inorganic mercury is 0.1 µg/L.

**a9** = Nickel guideline is dependent on  $[CaCO_3]$ . Guideline shown is for  $CaCO_3$  at 0-60 mg/L. At 60-120 mg/L  $CaCO_3$ , guideline = 65 µg/L; at 120-180 mg/L

#### Alberta Acute Water Quality Guidelines [AAWQG] (AENV 1999)

**b1** = The pH is to be in the range of 6.5 to 8.5 but not altered by more than 0.5 pH units from background values.

**b2** = Not to be increased by more than 10 mg/L (ppm) over background value.

**b3** = USEPA Guideline. Acute values based on one-hour average concentration of total ammonia-nitrogen (mg

**b4** = Acute guideline is dependant on hardness and applies to acid-extractable copper concentrations governed by the

**b5** = Guideline for methylmercury provided. The total mercury guideline is 0.013 µg/L.

#### Alberta Chronic Water Quality Guidelines [ACWQG] (AENV 1999)

**c1** = Seven day mean. The chronic guidelines should be increased to 8.3 mg/L from mid May to the end of June to

**c2** = The evaluation of chronic copper toxicity in soft water was inconclusive; the chronic guideline can therefore only be

**c3** = Guideline for methylmercury provided. The total mercury guideline is 0.005 µg/L.

#### Canadian Drinking Water Quality Guidelines - CDWQG (Health Canada 2008)

**d1** = Aesthetic objective.

**d2** = Maximum allowable concentration (MAC).

**d3** = Equivalent to 10 mg/L as nitrate-nitrogen. Where nitrate and nitrite are determined separately, levels of nitrite should not exceed 3.2 mg/L.

**d4** = A health-based guideline for aluminum in drinking water has not been established. Operational guidance values of less than 100 µg/L total aluminum for

**Table D.10: Baseline Sediment Quality Results for the Regional Study Area**

Parameter	Units	Christina Lake	WC3-07	WC4-07	WC1-04	WC6-04	WC10-04	Interim Sediment Quality Guidelines
		Fall 2007	Fall 2007	Fall 2007	Fall 2007	Fall 2007	Fall 2007	
<b>Texture and Carbon Content</b>								
Texture - Sand	%	84	56	49	78	73	45	-
Texture - Silt	%	9	31	36	12	18	42	-
Texture - Clay	%	8	12	15	9	9	13	-
Total Inorganic carbon	% by wt	0.1	<0.1	<0.1	<0.1	<0.1	0.2	-
Total Organic Carbon	% by wt	0.5	49	29.3	4.1	4.6	43	-
Total Carbon	% by wt	0.6	49	29.3	4.1	4.6	43.2	-
<b>Organics</b>								
Total Recoverable Hydrocarbons	µg/g (ppm)	<100	1400	3500	600	100	1800	-
<b>1710</b>								
Aluminum (Al)	µg/g (ppm)	490	1520	3340	2880	3090	1710	-
Arsenic (As)	µg/g (ppm)	0.3	3.6	2.8	0.9	1.1	2.4	5.9
Barium (Ba)	µg/g (ppm)	7.7	85.2	120	48.5	52.8	57.4	-
Beryllium (Be)	µg/g (ppm)	<0.2	<0.2	<0.2	<0.2	0.2	<0.2	-
Boron (B)	µg/g (ppm)	<2	20	13	5	7	10	-
Cadmium (Cd)	µg/g (ppm)	<0.1	0.3	0.3	<0.1	<0.1	0.4	0.6
Calcium (Ca)	µg/g (ppm)	400	15600	21200	3200	3300	17300	-
Chromium (Cr)	µg/g (ppm)	0.7	2.5	6.2	5.1	5.8	2.9	37.3
Cobalt (Co)	µg/g (ppm)	0.4	1.7	2.7	2.1	1.8	1.6	-
Copper (Cu)	µg/g (ppm)	<0.5	4	7	3	3	5	35.7
Iron (Fe)	µg/g (ppm)	800	6900	9200	5300	6800	5000	-
Lead (Pb)	µg/g (ppm)	0.6	1.7	2.7	2.1	2.3	1.6	35
Magnesium (Mg)	µg/g (ppm)	180	1900	2950	1040	1030	1950	-
Manganese (Mn)	µg/g (ppm)	33	390	140	174	115	235	-
Mercury (Hg)	µg/g (ppm)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.17
Molybdenum (Mo)	µg/g (ppm)	<0.1	0.8	0.6	0.2	0.1	0.7	-
Nickel (Ni)	µg/g (ppm)	0.7	3.5	5.8	4	4.1	5.1	-
Potassium (K)	µg/g (ppm)	<100	100	400	300	400	200	-
Selenium (Se)	µg/g (ppm)	<0.2	0.8	0.8	0.2	0.2	0.9	-
Silver (Ag)	µg/g (ppm)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	-
Sodium (Na)	µg/g (ppm)	<100	200	200	100	100	200	-
Strontium (Sr)	µg/g (ppm)	5	68	59	15	15	44	-
Thallium (Tl)	µg/g (ppm)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Titanium (Ti)	µg/g (ppm)	18	29	35	35	55	29	-
Uranium	µg/g (ppm)	0.1	0.4	0.8	0.4	0.4	0.5	-
Vanadium	µg/g (ppm)	1.2	3.1	7.4	6.9	7.6	3.6	-
Zinc (Zn)	µg/g (ppm)	5	80	51	15	20	56	123

Note: Data is from MEG (2008).



Notes:

Shaded and **Bolded** cells indicates an aquatic life guideline exceedance.

Shaded and *Italicized* cells indicates a drinking water guideline exceedance.

\* = The method detection limit for this parameter is higher than an applicable guideline, therefore an exceedance is unknown.

#### Part 1. Water Quality Guidelines for the Protection of Aquatic Life

##### Canadian Environmental Quality Guidelines - CEQG (CCME 2007)

**a1** = Guideline is based on temperature preferences of biota. In this case, the cold water biota guidelines for both early life and other life stages are shown.

**a2** = Guideline is dependent on temperature and pH. The value ranges between 6.98 mg/L (pH= 7.0, temperature= 15 °C) and 48.3 mg/L (pH= 6.5, temperature= 5 °C).

**a3** = Guideline = 5 µg/L at pH < 6.5, [Ca<sup>2+</sup>] < 4 mg/L and DOC < 2 mg/L; Guideline = 100 µg/L at pH ≥ 6.5, [Ca<sup>2+</sup>] ≥ 4 mg/L and DOC ≥ 2 mg/L.

**a4** = Cadmium guideline =  $10^{[0.046(\text{pH}-6.5) - 1.2]}$

**a5** = Guideline is for hexavalent chromium (Cr<sup>VI</sup>) because its guideline is more stringent than the trivalent chromium (Cr<sup>III</sup>) guideline of 8.9 µg/L.

**a6** = Copper guideline is dependent on [CaCO<sub>3</sub>]. Guideline shown is for when [CaCO<sub>3</sub>] is 0-120 mg/L. At 120-180 mg/L of CaCO<sub>3</sub>, guideline = 3 µg/L; and at >180 mg/L CaCO<sub>3</sub>, guideline = 4 µg/L.

**a7** = Lead guideline is dependent on [CaCO<sub>3</sub>]. Guideline shown is for CaCO<sub>3</sub> at 0-60 mg/L. At 60-120 mg/L CaCO<sub>3</sub>, guideline = 2 µg/L; at 120-180 mg/L CaCO<sub>3</sub>, guideline = 4 µg/L; and at >180 mg/L CaCO<sub>3</sub>, guideline = 7 µg/L.

**a8** = Guideline for methyl-mercury provided. The guideline for total inorganic mercury is 0.1 µg/L.

**a9** = Nickel guideline is dependent on [CaCO<sub>3</sub>]. Guideline shown is for CaCO<sub>3</sub> at 0-60 mg/L. At 60-120 mg/L CaCO<sub>3</sub>, guideline = 65 µg/L; at 120-180 mg/L CaCO<sub>3</sub>, guideline = 110 µg/L; and at >180 mg/L CaCO<sub>3</sub>, guideline = 150 µg/L.

##### Alberta Acute Water Quality Guidelines [AAWQG] (AENV 1999)

**b1** = The pH is to be in the range of 6.5 to 8.5 but not altered by more than 0.5 pH units from background values.

**b2** = Not to be increased by more than 10 mg/L (ppm) over background value.

**b3** = USEPA Guideline. Acute values based on one-hour average concentration of total ammonia-nitrogen (mg nitrogen/L). The guideline is dependent on pH and the presence of salmonids, ranging from 0.88 mg/L

**b4** = Acute guideline is dependant on hardness and applies to acid-extractable copper concentrations governed by the following equation: [Max] =  $e^{[0.979123 * \ln(\text{hardness}) - 8.64497]}$ . The copper guideline ranges

**b5** = Guideline for methylmercury provided. The total mercury guideline is 0.013 µg/L.

##### Alberta Chronic Water Quality Guidelines [ACWQG] (AENV 1999)

**c1** = Seven day mean. The chronic guidelines should be increased to 8.3 mg/L from mid May to the end of June to protect the emergence of mayfly species into adults; it should be increased to 9.5 mg/L for those

**c2** = The evaluation of chronic copper toxicity in soft water was inconclusive; the chronic guideline can therefore only be applied at water hardness equal to or greater than 50 mg/L as CaCO<sub>3</sub>.

**c3** = Guideline for methylmercury provided. The total mercury guideline is 0.005 µg/L.

##### Canadian Drinking Water Quality Guidelines - CDWQG (Health Canada 2008)

**d1** = Aesthetic objective.

**d2** = Maximum allowable concentration (MAC).

**d3** = Equivalent to 10 mg/L as nitrate-nitrogen. Where nitrate and nitrite are determined separately, levels of nitrite should not exceed 3.2 mg/L.

**d4** = A health-based guideline for aluminum in drinking water has not been established. Operational guidance values of less than 100 µg/L total aluminum for conventional treatment plants and less than 200 µg/L total aluminum for other types of treatment systems are recommended.

Table D.12: Summary data for lakes including in the acid sensitivity analysis

Lake Identifier	Easting	Northing	Conductivity ( $\mu\text{S}/\text{cm}$ )	TDS (mg/L)	Alkalinity	pH	Calcium	Sulphate	Magnesium	Sodium	Potassium
1	504672	6250565	138	118	96	7.7	14	15.3	10.5	7.8	2.4
2	510499	6163433	197	125	104	7.9	25	0.8	7.5	6.3	1
3	489729	6258036	127	77	55	7.4	17	8.5	4.6	3	0.9
25	498871	6257215	90	100	40	7.1	10	2.2	3.2	4.3	0.9
26	502017	6251357	80	100	34	7.2	9	4.5	2.6	3.6	1.1
27	503226	6248721	84	79	39	7.8	10	1.1	2.4	1.9	2.4
28	508895	6252653	223	164	112	7.8	26	4.4	7.8	10.4	1.6
29	504488	6254133	184	158	91	7.7	24	3.2	7.1	8.6	1.1
30	505212	6252653	180	141	91	7.8	23	2.2	6.2	8.1	1.2
31	507487	6251545	207	141	104	7.8	26	4.5	7.8	6.9	1.3
32	501467	6264562	183	139	87	7.7	23	6.7	7.6	5.6	0.8
33	499571	6266398	191	143	97	7.8	24	3.1	7.4	6.6	0.8
34	502641	6249587	29	65	9	6.1	3	2.1	0.8	0.1	1.3
35	500505	6255692	37	74	10	6.2	9	3.2	<0.1	2.1	1
36	509942	6244399	207	172	104	7.8	25	4.7	6.8	11	2.3
37	489222	6240033	66	73	30	7	10	2.7	2.5	0.3	0.6
38	490427	6237963	64	103	28	6.8	10	2.3	2.5	<0.1	0.6
39	480727	6243329	41	83	8	5.8	2	5.8	0.7	<0.1	0.3
40	481229	6244129	26	73	8	6	3	2	1	<0.1	0.3
41	482249	6246921	59	72	27	6.9	8	1.8	2.3	0.2	0.5
42	479375	6142060	164	106	88	8.2	23	1.2	7.4	2.8	0.7
43	496692	6127900	136	67	67	7.5	17	1.5	5.4	1.5	0.4
44	491437	6137987	142	82	70	8	18	2.1	6.4	2.3	0.6
45	497711	6132160	80	55	38	7.3	10	0.9	3.7	1	0.4
46	498367	6133579	178	121	89	7.9	22	1.3	8.5	2	0.5
47	493933	6132222	106	80	52	7.7	13	0.8	4.9	1	0.6
48	491151	6134421	94	55	43	7.4	11	1.3	4.4	1.3	0.6
49	493107	6134651	96	45	46	7.4	11	1	4.3	0.5	0.4
50	489844	6137549	35	17	13	6.5	4	2.1	1.5	<0.1	0.4
68	541457	6082627	96	125	49	7.8	13	0.9	4.9	1.5	0.4
109	530780	6261842	257	-	141	8.4	24	2.2	10	21.1	1.8
110	536018	6249984	271	130	143	8.8	17	2.1	11.3	25.5	1.8
115	483819	6235130	15	54	2	5	2	3.4	0.4	0.8	0.4
116	484387	6230872	34	44	1	4.7	1	1	0.3	0.7	0.4
117	489502	6230877	14	49	3	5.6	2	1.4	0.5	0.6	0.5
122	448014	6170896	25	43	7	6.6	2	1.5	0.9	0.8	1.6
130	493516	6226026	110	46	55	7.7	15	1.4	3.4	1.6	0.5
131	446510	6167454	129	69	62	7.6	17	2.2	4.9	1.9	0.8
132	533788	6137575	222	119	117	8.5	30	3.3	8.5	4	0.9
136	474056	6213581	101	76	51	7.5	14	1.4	3.6	2.1	0.6
138	457796	6141365	100	52	50	7.7	12	1.4	4.3	0.8	0.9
139	538503	6201610	154	87	79	9.2	18	1.6	5.9	7	0.9
142	549064	6277789	140	111	70	9	17	0.3	5.7	5.8	0.9
143	487594	6229281	13	54	2	5.2	1	1.6	0.3	0.6	0.4
144	477248	6225400	16	32	5	6.5	2	0.8	0.6	0.6	0.4
146	448271	6183205	32	107	11	6.8	3	0.6	1.4	1.5	1.1
147	515689	6179208	48	75	19	7.3	6	0.7	1.7	1.3	1.1
167	463161	6151511	185	-	100	9.1	28	0.2	7.4	3.5	1.2
167A	466149	6224878	13	36	3	5.8	1.4	0.8	0.5	0.9	0.3
168	559470	6264932	236	-	123	8.9	19	0.1	17.5	5.5	1.6
169	548241	6260147	251	-	133	7.9	33	0.4	9.9	7.7	1.8
171	546271	6252711	271	-	145	8.5	27	0.4	13.3	11.9	3.1
172	554471	6254656	253	-	133	8.7	30	0.2	13.4	6.2	2.5
175	513419	6236708	316	-	155	8.4	42	6.8	11.5	9.6	1.6
176	525809	6235841	204	-	96	7.9	22	0.8	6.4	14.7	0.5
178	487070	6226500	11	-	2	5.2	1	0.6	0.3	0.3	0.3
198	432715	6224227	64	-	23	7.1	6	1.1	1.4	8	0.3
199	420621	6214236	54	-	17	7	7	3.5	1.4	3.9	0.2
201	413544	6197673	78	-	34	7.5	12	1.4	2.7	3.7	1.1
202	435473	6200997	150	-	19	7.2	9	3.2	2.6	15.4	1.2
203	432308	6198262	73	-	14	6.9	7	2.1	2.1	4.7	0.6
204	437499	6197260	70	-	29	7.5	10	0.4	2.3	2	0.5
205	426862	6184436	201	-	98	8.8	30	3.2	7.1	3.7	1
206	425742	6179813	213	-	97	8.5	30	3.3	7.1	5.1	1
207	429371	6177905	172	-	85	8.1	28	1.3	5.6	1.1	0.9
208	414088	6172614	73	-	29	7.3	11	3.6	2.7	1.4	0.7
218	452595	6196133	68	-	31	7.1	11	0.5	2.7	1.6	0.5
219	444220	6193451	86	-	41	7.3	13	0.6	2.7	1.1	0.3
220	448879	6190611	68	-	32	7.5	10	0.4	2.4	1.7	0.6
221	458295	6193292	47	-	50	7.3	6	0.2	2.1	1.2	0.6
223	438372	6185182	95	-	46	7.9	16	0.5	2.5	0.8	0.7
224	443436	6173058	33	-	13	7.1	4	0.6	1.3	0.8	0.9
225A	443913	6295483	79	92	34	7.4	11		4	0.9	0.9
225	446589	6173942	32	-	14	7.2	4	0.5	1.3	0.7	1.2
226	455811	6296483	44	86	15	6.8	6		2	1.2	0.8
230	533411	6186731	112	-	58	7.9	15	0.2	5.9	2.1	0.5
231	516751	6175506	59	67	28	7.6	8	0.8	2.5	1.8	0.7
232	528841	6167222	85	65	43	7.8	12	0.5	3.9	1.4	0.4

Table D.12: Summary data for lakes including in the acid sensitivity analysis

Lake Identifier	Easting	Northing	Conductivity (µS/cm)	TDS (mg/L)	Alkalinity	pH	Calcium	Sulphate	Magnesium	Sodium	Potassium
233	502625	6165269	105	-	50	7.8	14	0.5	4.5	3.5	0.8
234	547077	6178511	152	-	82	8.1	22	0.3	7.3	5	0.7
235	548176	6173881	142	-	73	8.3	20	1.8	7.5	1.4	0.4
236	558657	6173086	97	-	49	7.9	13	0.5	4.4	1.3	0.3
237	531585	6150547	190	125	104	8.4	27	-	7	3.5	0.9
238	544256	6146950	144	-	77	9	21	1.6	6.4	2.8	1.1
239	525364	6133813	208	-	108	8.3	30	0.2	8.8	2	1.8
240	514750	6146752	228	-	123	8.6	32	1.4	10.1	3.6	1.1
241	510533	6149522	198	-	101	8.2	28	0.2	8.5	3.3	0.7
242	464179	6147797	87	-	43	8.3	11	0.3	4	1.3	0.7
243	475751	6144012	68	-	52	7.7	14	0.4	2.7	2.4	0.4
244	492606	6137452	128	-	64	8	17	0.2	6.4	1.6	0.5
245	468315	6136636	66	-	30	7.6	8	0.2	3.7	1.6	0.7
246	452463	6135855	70	-	32	7.7	8	1.1	3.5	0.9	1.5
247	467222	6132003	120	-	57	7.8	13	0.5	7.4	1.9	1.3
248	470369	6128275	159	-	79	8.1	22	0.3	6.8	2.5	1
249	465073	6127390	118	-	58	8.2	15	0.2	5.8	1.9	1.1
250	475613	6118973	135	-	66	8.7	17	0.2	6.8	2.1	0.5
251	458671	6121881	114	-	54	7.9	15	0.9	4.8	1.7	2.4
252	458438	6096843	101	-	47	7.9	12	0.8	4.2	1.4	3.1
253	444801	6114608	285	-	148	8.7	30	1.8	15.2	7.7	4.8
254	446862	6106018	200	-	106	9.5	26	0.5	8	7.9	2.1
255	443614	6104417	289	-	143	8.5	35	3	11.3	13.3	3
256	461651	6098662	316	-	160	8.7	36	3.6	14.7	16.5	2.7
257	468042	6098611	304	-	157	8.9	32	3.4	13.9	16.9	2.4
258	470756	6106015	315	-	162	8.5	39	3	17	5.9	2.8
259	476591	6104122	267	-	147	9.2	33	4.7	12	14.1	1.7
267	442016	6292310	93	77	44	7.8	13		4	1.8	0.9
268	506038	6305518	60	145	23	7.2	8		1.8	4	0.5
270	505535	6291503	157	138	80	8.3	23		8	2	0.3
271	549089	6277344	155	111	77	8.7	19		6	6	1.4
452	493296	6259805	65	-	22	6.9	9	5.6	2.6	<0.1	1.3
453	495869	6259633	43	-	10	6.1	5	2.5	2	<0.1	0.7
455	498560	6265951	200	-	99	7.7	25	3.9	8.1	5	0.4
461	479616	6256890	190	-	83	7.5	21	9.4	9.5	8	0.5
462	471630	6268385	197	-	67	7.4	14	19.1	5.2	20	3
463	488075	6256727	99	-	32	7.1	12	12.3	4.3	3	0.5
530	592417	6259032	229	190	119	8.1	26	-	9.3	7.8	1
609	520557	6172578	152	137	75	8.1	18	1.1	6.7	3.7	1.7
610	509795	6169983	69	78	33	7.8	9	1.4	2.7	2	0.8
611	527280	6170976	81	93	40	7.8	11	1	3.3	1.4	0.6
612	508500	6170350	84	61	43	7.8	11	1.1	3.7	2.3	0.8
613	509779	6174077	68	111	31	7.5	11	0.8	3	0.8	0.6
614	513212	6167678	148	143	76	8	20	1	7	2.5	0.2
615	513525	6175472	53	71	25	7.6	8	0.7	2.3	0.8	0.5
616	514431	6168793	134	124	68	8	18	1.1	6.3	3	0.4
617	515450	6170023	69	90	32	7.6	8	1.3	4.3	1.7	0.5
618	515711	6168936	123	143	61	7.9	17	1.5	6	2.7	0.5
620	522016	6168496	102	92	51	8	14	2.1	5	1.2	0.5
621	523415	6162401	180	149	98	8.8	25	5.4	8.3	3.3	0.8
A10	506092	6305331	-	-	22	7.4	7		1.6	5	0.2
A101	559459	6228753	-	-	134.1	8.5	-		-	-	-
A105	466180	6224950	-	29	2	5.4	1.2		0.5	0.7	0.4
A12	554892	6301050	-	-	90	9.6	22		7	8	0.5
A13	506113	6291417	-	-	70	7.7	19		7	2	0.7
A14	549064	6277785	-	-	60	9.4	14		5	5	0.4
A15	538195	6200993	-	87	84	8.9	17		6	7	0.9
A164	448002	6287963	-	62	61	7.5	16		5	<1	1.1
A166	416003	6353212	-	51	37	7.9	10		4	5	1.1
A167	418303	6353462	-	104	65	7.6	22		7	9	0.8
A17	559468	6264932	236	-	123	8.9	19	0.1	18	5	1.6
A178	483501	6360762	-	179	173	7.7	50		11	6	1
A19	526688	6259959	157	-	79	9.1	17	0.2	9	3	1.1
A215	443552	6301613	-	92	79	7.3	22		7	10	0.5
A216	444002	6295513	-	36	31	7.7	9		3	<1	0.8
A217	456002	6296463	-	19	15	7.6	5		1.9	<1	0.5
A218	451762	6293513	-	40	35	7.5	11		4	<1	0.5
A225	448416	6280450	-	137	136	7.5	43		6	2	0.3
A226	442406	6276535	-	133	130	7.6	42		6	2	0.6
A228	451429	6268553	-	112	111	7.7	34		7	1	0.8
A229	450033	6268135	-	91	89	7.8	29		5	<1	0.4
A237	429874	6398738	-	55	50	8.2	14		5	<1	<0.1
A24	561829	6243629	191	-	87	8.1	23	0.7	7	8	0.9
A247	492308	6313536	-	72	68	7.7	18		7	3	<0.1
A248	491531	6306260	-	71	67	7.8	20		6	2	0.1
A25	487105	6238562	61	-	28	7.3	9	1.3	2	1.3	0.5
A27	525807	6235838	-	-	96	7.9	22		6	15	0.5

**Table D.12: Summary data for lakes including in the acid sensitivity analysis**

Lake Identifier	Easting	Northing	Conductivity (µS/cm)	TDS (mg/L)	Alkalinity	pH	Calcium	Sulphate	Magnesium	Sodium	Potassium
A28	489154	6232991	26	-	11	6.9	3	1.3	1	0.4	0.4
A29	487594	6229285	-	-	2	5.2	1.1		0.3	0.5	0.4
A30	477250	6228400	-	-	6	6.6	2		0.6	0.5	0.4
A31	487066	6225576	18	56	4	6.1	1.9	0.7	0.8	0.4	0.3
A32	487068	6226504	-	-	2	5.2	1		0.3	0.3	0.3
A33	480352	6228385	15	-	3	5.6	1.4	1.4	0.3	0.3	0.3
A34	493791	6225561	-	-	68	8.0	21		5	1.1	0.7
A35	491198	6222320	24	-	7	6.6	3	0.6	1.3	0.9	0.3
A37	540312	6230385	213	-	102	7.9	29	0.7	7	9	1.3
A38	559898	6234325	-	-	97	8.1	27		7	8	0.7
A39	554289	6228684	254	-	134	8.5	31	0.6	11	10	3
A40	543469	6224850	184	-	90	8.6	25	0.9	7	7	1.1
A41	554877	6223126	139	-	69	7.9	17	0.6	6	6	0.5
A42	521815	6208917	226	-	104	8.1	24	3.3	8	16	1.5
A52	437499	6197257	-	-	29	7.5	10		2	2	0.5
A55	444222	6193454	-	-	41	7.3	13		3	1.1	0.3
A57	458297	6193296	-	-	20	7.3	6		2	1.2	0.6
A58	471892	6199679	-	-	31	7.6	10	0.2	3	1.5	0.6
A59	438646	6204661	-	-	50	7.9	16	0.5	5	4	0.7
A60	520834	6196855	193	-	101	8.7	26	0.9	8	8	1.4
A61	530203	6197838	157	-	81	8.0	21	0.2	6	10	1.6
A62	538501	6201614	-	-	75	9.5	18		6	7	0.9
A63	534391	6195087	143	-	74	9.1	19	2	6	6	0.9
A9	441917	6290888	-	-	32	7.4	9		3	1	0.8
L1	500749	6158135	86	47	-	7.5	11	0.3	5	1	0.5
L2	501284	6156320	230	126	-	8.0	32	0.3	11	4	0.4
L3	502111	6156385	240	132	-	7.7	33	0.6	10	6	1.0

Note: Legend for Acid Sensitivity Ratings (Saffran and Trew, 1996)

Parameter	High	Moderate	Low	Least
Alkalinity	0 - 10	11 - 20	21 - 40	> 40
pH	0 - 6.5	6.6 - 7.0	7.1 - 7.5	> 7.5
Calcium	0 - 4	5 - 8	9 - 25	> 25

Saffran, K., and D. Trew. 1996. Sensitivity of Alberta Lakes to Acidifying Deposition: An Update on Sensitivity Maps with Emphasis on 109 Northern Lakes. Special report prepared by Water Sciences Branch, Water Management Division, Alberta Environment Protection.



Table D.13: Calculated Depositions for SOx and NOx Emmissions

ID	Easting (NAD 83, Zone 12)	Northing (NAD 83, Zone 12)	Baseline					Project				
			PA (keq/ha/yr)	SO4 Deposition (keq/ha/yr)	Nitrogen N DEP (keq/ha/yr)	Nleach over threshold (keq/ha/yr)	Total Deposition (keq/ha/yr)	PAI (keq/ha/yr)	SO4 Deposition (keq/ha/yr)	Nitrogen N DEP (keq/ha/yr)	Nleach over threshold (keq/ha/yr)	Total Deposition (keq/ha/yr)
<b>ALSA</b>												
L1	500749	6158136	0.178	0.022	0.323	-	0.113	0.214	0.026	0.398	-	0.136
L2	501284	6156321	0.185	0.023	0.332	-	0.118	0.205	0.026	0.372	-	0.130
L3	502111	6156385	0.192	0.025	0.339	-	0.122	0.207	0.027	0.370	-	0.132
<b>ARSA</b>												
147	515689	6179208	0.217	0.024	0.427	-	0.136	0.222	0.025	0.437	-	0.140
231	516751	6175506	0.216	0.025	0.413	-	0.136	0.220	0.026	0.421	-	0.139
232	528841	6167222	0.196	0.022	0.381	-	0.123	0.199	0.022	0.387	-	0.125
233	502625	6165269	0.160	0.020	0.294	-	0.102	0.166	0.021	0.301	-	0.106
610	509795	6169983	0.187	0.022	0.347	-	0.118	0.194	0.023	0.360	-	0.123
611	527280	6170976	0.202	0.022	0.400	-	0.127	0.205	0.022	0.407	-	0.129
612	508500	6170350	0.189	0.022	0.358	-	0.119	0.196	0.023	0.372	-	0.124
613	509779	6174077	0.196	0.021	0.394	-	0.123	0.201	0.021	0.404	-	0.126
614	513212	6167678	0.218	0.028	0.393	-	0.139	0.225	0.029	0.406	-	0.144
615	513525	6175472	0.196	0.021	0.384	-	0.123	0.200	0.022	0.393	-	0.126
616	514431	6168793	0.213	0.026	0.395	-	0.135	0.219	0.027	0.406	-	0.139
617	515450	6170023	0.241	0.029	0.456	-	0.153	0.246	0.030	0.466	-	0.156
618	515711	6168936	0.249	0.030	0.485	-	0.158	0.254	0.030	0.494	-	0.161
620	522016	6168496	0.292	0.035	0.569	-	0.185	0.296	0.036	0.577	-	0.188
<b>AqRSA</b>												
34	502641	6249587	0.417	0.061	0.710	-	0.268	0.417	0.061	0.711	-	0.269
39	480727	6243329	0.279	0.027	0.599	-	0.174	0.280	0.027	0.600	-	0.174
40	481229	6244129	0.275	0.027	0.582	-	0.172	0.276	0.027	0.583	-	0.172
45	497711	6132160	0.182	0.020	0.352	-	0.115	0.184	0.020	0.357	-	0.116
50	489844	6137549	0.100	0.010	0.195	-	0.062	0.102	0.010	0.198	-	0.064
115	483819	6235130	0.230	0.022	0.484	-	0.143	0.230	0.022	0.485	-	0.144
116	484387	6230872	0.197	0.019	0.408	-	0.123	0.197	0.019	0.409	-	0.123
117	489502	6230877	0.214	0.022	0.441	-	0.134	0.215	0.022	0.442	-	0.135
122	448014	6170896	0.077	0.007	0.150	-	0.048	0.078	0.007	0.152	-	0.048
143	487594	6229281	0.196	0.020	0.400	-	0.123	0.197	0.020	0.402	-	0.123
144	477248	6225400	0.155	0.015	0.317	-	0.096	0.155	0.015	0.318	-	0.097
167A	466149	6224878	0.153	0.013	0.329	-	0.095	0.154	0.013	0.330	-	0.095
178	487070	6226500	0.177	0.018	0.361	-	0.111	0.178	0.018	0.362	-	0.111
226	455811	6296483	0.703	0.060	1.618	-	0.435	0.703	0.060	1.619	-	0.435
A105	466180	6224950	0.154	0.013	0.330	-	0.095	0.154	0.014	0.331	-	0.096
A217	456002	6296463	0.708	0.061	1.628	-	0.439	0.708	0.061	1.629	-	0.439
A28	489154	6232991	0.230	0.023	0.480	-	0.144	0.231	0.023	0.481	-	0.144
A29	487594	6229285	0.196	0.020	0.400	-	0.123	0.197	0.020	0.402	-	0.123
A30	477250	6228400	0.176	0.016	0.369	-	0.109	0.176	0.016	0.370	-	0.110
A31	487066	6225576	0.174	0.017	0.354	-	0.108	0.174	0.017	0.356	-	0.109
A32	487068	6226504	0.177	0.018	0.361	-	0.111	0.178	0.018	0.362	-	0.111
A33	480352	6228385	0.177	0.017	0.368	-	0.110	0.178	0.017	0.369	-	0.111
A35	491198	6222320	0.188	0.018	0.390	-	0.118	0.189	0.018	0.392	-	0.118

Table D.14: Cumulative Effects Calculated Depositions for SOx and NOx Emmisions

ID	Easting (NAD 83, Zone 12)	Northing (NAD 83, Zone 12)	Baseline					CEA				
			PAI (keq/ha/yr)	SO4 Deposition (keq/ha/yr)	Nitrogen N DEP (keq/ha/yr)	Nleach over threshold (keq/ha/yr)	Total Deposition (keq/ha/yr)	PAI (keq/ha/yr)	SO4 Deposition (keq/ha/yr)	Nitrogen N DEP (keq/ha/yr)	Nleach over threshold (keq/ha/yr)	Total Deposition (keq/ha/yr)
<b>ALSA</b>												
L1	500749	6158136	0.178	0.022	0.323	-	0.113	0.253	0.028	0.506	-	0.113
L2	501284	6156321	0.185	0.023	0.332	-	0.118	0.242	0.027	0.473	-	0.118
L3	502111	6156385	0.192	0.025	0.339	-	0.122	0.245	0.028	0.471	-	0.122
<b>ARSA</b>												
147	515689	6179208	0.217	0.024	0.427	-	0.136	0.306	0.028	0.666	-	0.136
231	516751	6175506	0.216	0.025	0.413	-	0.136	0.298	0.030	0.628	-	0.136
232	528841	6167222	0.196	0.022	0.381	-	0.123	0.273	0.026	0.590	-	0.123
233	502625	6165269	0.160	0.020	0.294	-	0.102	0.210	0.023	0.423	-	0.102
610	509795	6169983	0.187	0.022	0.347	-	0.118	0.259	0.026	0.542	-	0.118
611	527280	6170976	0.202	0.022	0.400	-	0.127	0.272	0.026	0.582	-	0.127
612	508500	6170350	0.189	0.022	0.358	-	0.119	0.265	0.025	0.565	-	0.119
613	509779	6174077	0.196	0.021	0.394	-	0.123	0.321	0.025	0.748	-	0.123
614	513212	6167678	0.218	0.028	0.393	-	0.139	0.283	0.032	0.561	-	0.139
615	513525	6175472	0.196	0.021	0.384	-	0.123	0.283	0.025	0.622	-	0.123
616	514431	6168793	0.213	0.026	0.395	-	0.135	0.281	0.030	0.571	-	0.135
617	515450	6170023	0.241	0.029	0.456	-	0.153	0.316	0.035	0.638	-	0.153
618	515711	6168936	0.249	0.030	0.485	-	0.158	0.322	0.035	0.654	-	0.158
620	522016	6168496	0.292	0.035	0.569	-	0.185	0.371	0.044	0.747	-	0.185
<b>AQRSA</b>												
34	502641	6249587	0.417	0.061	0.710	-	0.268	0.479	0.066	0.889	-	0.268
39	480727	6243329	0.279	0.027	0.599	-	0.174	0.383	0.035	0.850	-	0.174
40	481229	6244129	0.275	0.027	0.582	-	0.172	0.375	0.035	0.821	-	0.172
45	497711	6132160	0.182	0.020	0.352	-	0.115	0.205	0.021	0.414	-	0.115
50	489844	6137549	0.100	0.010	0.195	-	0.062	0.124	0.011	0.254	-	0.062
115	483819	6235130	0.230	0.022	0.484	-	0.143	0.313	0.028	0.691	-	0.143
116	484387	6230872	0.197	0.019	0.408	-	0.123	0.264	0.024	0.579	-	0.123
117	489502	6230877	0.214	0.022	0.441	-	0.134	0.297	0.027	0.650	-	0.134
122	448014	6170896	0.077	0.007	0.150	-	0.048	0.100	0.008	0.209	-	0.048
143	487594	6229281	0.196	0.020	0.400	-	0.123	0.265	0.024	0.577	-	0.123
144	477248	6225400	0.155	0.015	0.317	-	0.096	0.202	0.018	0.441	-	0.096
167A	466149	6224878	0.153	0.013	0.329	-	0.095	0.213	0.017	0.486	-	0.095
178	487070	6226500	0.177	0.018	0.361	-	0.111	0.233	0.021	0.505	-	0.111
226	455811	6296483	0.703	0.060	1.618	-	0.435	0.807	0.072	1.835	-	0.435
A105	466180	6224950	0.154	0.013	0.330	-	0.095	0.213	0.017	0.488	-	0.095
A217	456002	6296463	0.708	0.061	1.628	-	0.439	0.812	0.073	1.844	-	0.439
A28	489154	6232991	0.230	0.023	0.480	-	0.144	0.317	0.029	0.699	-	0.144
A29	487594	6229285	0.196	0.020	0.400	-	0.123	0.266	0.024	0.577	-	0.123
A30	477250	6228400	0.176	0.016	0.369	-	0.109	0.235	0.020	0.521	-	0.109
A31	487066	6225576	0.174	0.017	0.354	-	0.108	0.229	0.021	0.497	-	0.108
A32	487068	6226504	0.177	0.018	0.361	-	0.111	0.233	0.021	0.505	-	0.111
A33	480352	6228385	0.177	0.017	0.368	-	0.110	0.236	0.020	0.520	-	0.110
A35	491198	6222320	0.188	0.018	0.390	-	0.118	0.252	0.022	0.553	-	0.118