

Impacts of Road Dust on Small Subarctic Lake Systems

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APPENDIX 1

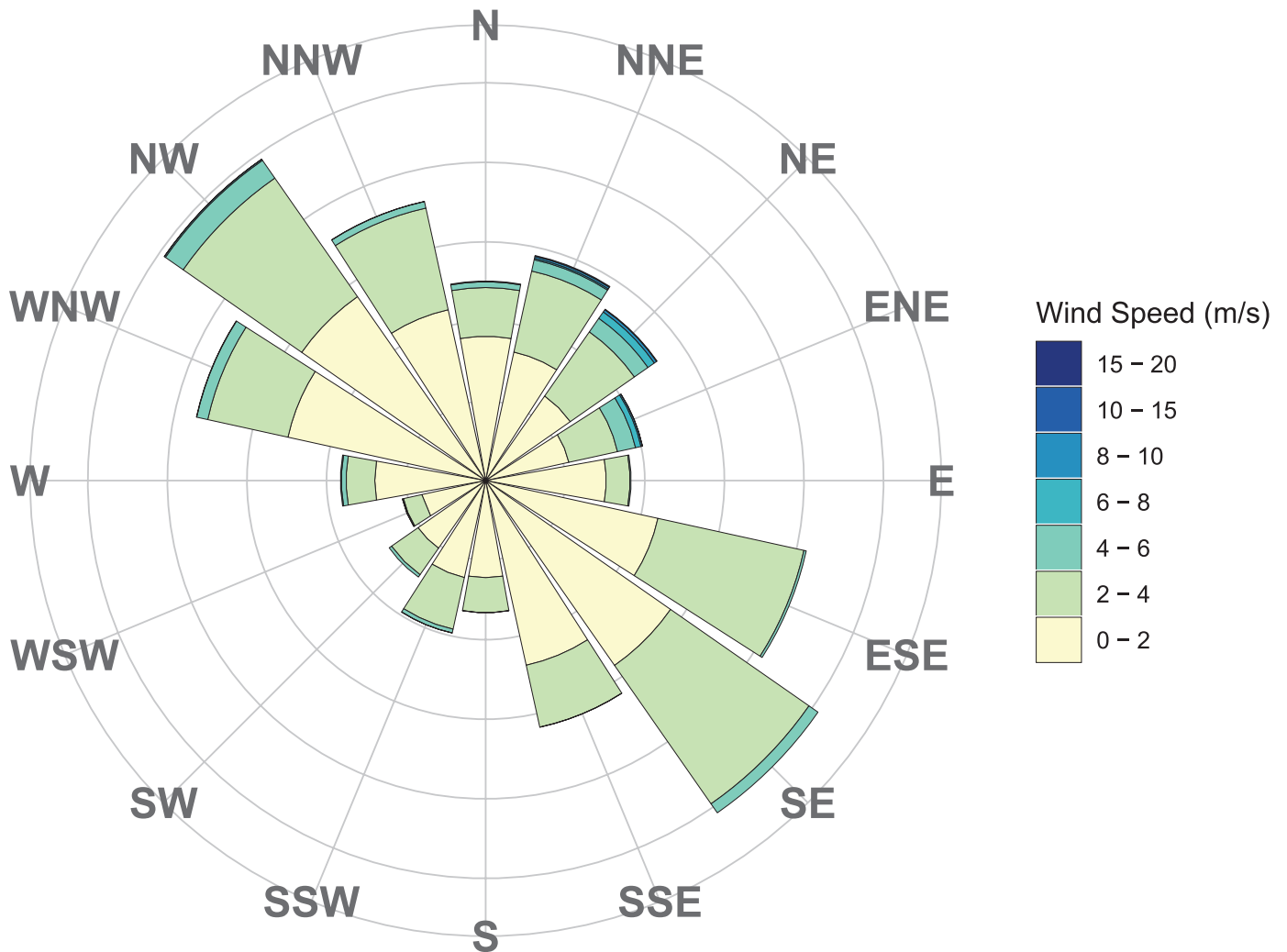


FIG. S1. Wind rose generated from a weather station situated on the Peel Plateau. Wind data was provided by the Department of Environment and Natural Resources of the Government of the Northwest Territories.

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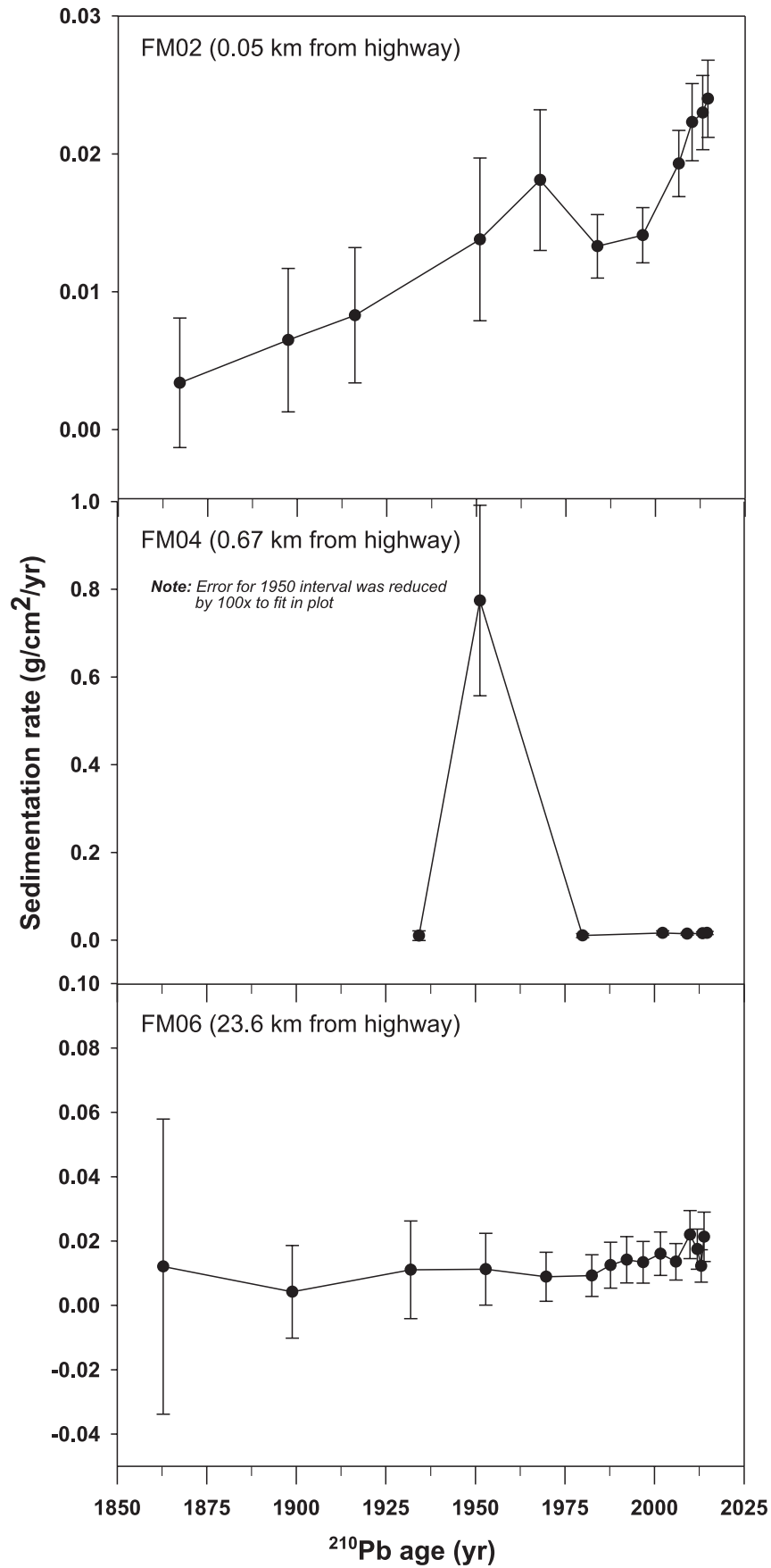


FIG. S2. Sedimentation rates and associated errors derived from the CRS model for the study lakes FM02, FM04, and FM06 plotted against the ^{210}Pb -estimated CRS dates.

TABLE S1. Pearson's correlation matrix of measured environmental variables for 28 study lakes.

	DN	DOC	TOC	pH	TN	TP	Alk	Cond	Turb	Ca	K	SO ₄	Col	SiO ₂	Dist	Depth	Area	NH ₃	Mg	NO ₃	NO ₃ /NO ₂	Na	
DN	1.000																						
DOC	0.7985 ¹	1.0000																					
TOC	0.7530 ¹	0.9705 ¹	1.0000																				
pH	-0.1708	-0.3233	-0.5114	1.0000																			
TN	0.2992	0.1977	0.1808	0.1230	1.0000																		
TP	0.4968	0.3685	0.4195	-0.4333	0.4297	1.0000																	
Alk	-0.1266	-0.2394	-0.4241	0.9798 ¹	0.2115	-0.4076	1.0000																
Cond	-0.1866	-0.4550	-0.5911	0.8605 ¹	0.1472	-0.3719	0.8387 ¹	1.0000															
Turb	0.3586	0.3094	0.3516	-0.3130	0.6275	0.8695	-0.2507	-0.2319	1.0000														
Ca	-0.2091	-0.3976	-0.5493	0.9144 ¹	0.1566	-0.4377	0.9129 ¹	0.9785 ¹	-0.2723	1.0000													
K	-0.4057	-0.5957	-0.7006	0.6878	0.0599	-0.1929	0.6547	0.7869 ¹	-0.0529	0.7599 ¹	1.0000												
SO ₄	-0.2446	-0.4963	-0.6194	0.81327 ¹	0.2352	-0.2963	0.7907 ¹	0.9718 ¹	-0.1307	0.9396	0.8244 ¹	1.0000											
Col	0.6732	0.73287 ²	0.7834 ¹	-0.5250	0.5157	0.7684 ¹	-0.4288	-0.5151	0.8019 ¹	-0.5157	-0.4927	-0.4574	1.0000										
SiO ₂	0.0567	0.2014	0.2721	-0.3301	0.3608	0.2718	-0.2429	-0.2245	0.4653	-0.2166	-0.2253	-0.2081	0.4574	1.0000									
Dist	-0.2105	-0.0204	0.0254	-0.2830	-0.1567	-0.0429	-0.3144	-0.3427	-0.0504	-0.3455	-0.1035	-0.3296	-0.0101	-0.1601	1.0000								
Depth	-0.2296	-0.1532	-0.1752	0.0754	-0.0567	-0.1356	0.0328	-0.0504	-0.0448	-0.0180	0.1456	-0.1141	-0.1493	-0.0073	0.6189	1.0000							
Area	-0.2306	-0.1370	-0.1697	-0.0202	-0.0885	0.1645	-0.1067	-0.0394	0.1227	-0.0641	0.2216	0.0197	-0.0999	0.0214	0.2166	0.1940	1.0000						
NH ₃	0.0701	0.0468	0.0318	0.0760	0.3337	0.4890	0.1120	0.1277	0.5648	0.1073	0.2309	0.1671	0.3415	0.2709	-0.1887	-0.0085	0.1620	1.0000					
Mg	-0.3113	-0.4622	-0.5595	0.7338 ²	-0.0680	-0.4018	0.7417	0.8607 ¹	-0.3093	0.8612 ¹	0.8115 ¹	0.8286 ¹	-0.5585	-0.2392	-0.2988	-0.1387	-0.1416	0.0198	1.0000				
NO ₃	0.4811	0.0575	0.0716	-0.0907	-0.1213	0.1305	-0.1638	0.1033	-0.0244	-0.0282	-0.1558	0.0009	0.0323	0.0063	-0.1562	-0.0322	-0.1256	-0.0423	-0.0684	1.0000			
NO ₃ /NO ₂	0.4801	0.0558	0.0692	-0.0861	-0.1210	0.1274	-0.1592	0.1078	-0.0266	-0.0236	-0.1524	0.0049	0.0293	0.0050	-0.1569	-0.0310	-0.1273	-0.0418	-0.0645	1.0000	1.0000		
Na	-0.3911	-0.4837	-0.5368	0.3779	-0.2544	-0.2871	0.3124	0.6376	-0.3118	0.5763	0.6823	0.6324	-0.5661	-0.3149	0.0216	0.0278	0.2284	-0.0731	0.7042 ²	-0.0519	-0.0493	1.0000	

¹ $p \leq 0.01$ using Bonferroni-adjusted probabilities.² $p \leq 0.05$ using Bonferroni-adjusted probabilities.

TABLE S2. Summary of physical and geographical variables and general water chemistry variables¹ measured in the 28 lakes (19 August 2014 and 20 August 2015). Chemical measurements were averaged over two years for each lake unless specified. Calculations of the mean, median, minimum, and maximum chemical variables for FM-29 (thaw slump lake) were excluded.

	Alk mg/L	Area Sq km	Ca mg/L	Catch Sq km	CA:LA	CA-Road km	Col (2014) CU	Cond µS/cm	Depth m	Dist km	DN (2014) mg/L	DOC mg/L	Elev m asl	Lat Dec Deg	Long Dec Deg
Impacted lakes within 1 km from the Dempster Highway (n = 15):															
Detection limit	0.4			0.1				5	0.4			0.06	0.5		
FM03	73.6	0.017	50.0	2.55	150.0	1.32	53.0	448.5	2.00	0.04	0.40	11.2	423	67.2585	135.1134
FM02	17.7	0.020	13.4	4.54	227.0	0.40	39.0	155.5	2.15	0.05	0.30	6.7	494	67.2418	135.3263
FM10	4.5	0.045	3.3	2.55	56.7	1.32	237.0	27.3	1.50	0.05	0.46	14.4	326	67.26896	135.0645
FM50	53.3	0.002	54.5	3.21	1395.7	0.14	148.0	479.0	1.00	0.06	0.47	16.8	412	67.25221	135.1295
FM17	51.4	0.003	34.3	1.67	506.1	0.00	114.0	325.5	1.80	0.21	0.38	10.5	392	67.20852	135.6249
FM11	22.0	0.011	23.7	4.15	377.3	0.10	153.0	194.5	1.00	0.24	0.43	17.2	384	67.24415	135.188
FM05	0.5	0.017	1.1	1.64	96.5	0.82	118.0	11.3	1.50	0.43	0.30	8.9	351	67.24417	135.3398
FM12	13.9	0.020	11.1	4.5	225.0	1.66	145.0	93.3	0.80	0.43	0.48	17.5	492	67.21767	135.4559
FM14	11.9	0.068	13.2	1.7	25.0	2.50	93.0	114.0	2.00	0.57	0.37	12.4	360	67.25361	135.1934
FM32	117.0	0.026	91.2	1.7	65.4	2.50	14.0	598.0	4.00	0.64	0.25	6.8	363	67.25263	135.2014
FM04	1.5	0.015	4.6	1.38	92.0	0.00	190.0	92.9	2.95	0.67	0.64	15.5	410	67.25196	135.0993
FM15	0.8	0.006	1.8	2.52	393.8	0.04	139.0	13.7	1.00	0.73	0.37	15.5	355	67.22552	135.503
FM33	89.0	0.007	44.5	1.7	232.9	2.50	34.0	257.0	7.00	0.79	0.34	10.4	365	67.25265	135.2071
FM16	5.3	0.017	12.3	2.2	129.4	1.34	1150.0	116.0	4.00	0.93	0.49	14.8	356	67.25728	135.1544
FM18	15.4	0.059	12.1	2.27	38.5	0.76	375.0	118.5	3.50	0.95	0.40	14.2	492	67.22369	135.5827
Mean	31.8	0.022	24.7	2.6	267.4	1.0	200.1	203.0	2.41	0.45	0.41	12.8	398.3		
Median	15.4	0.017	13.2	2.3	150.0	0.8	139.0	118.5	2.00	0.43	0.40	14.2	384.0		
Min	0.5	0.002	1.1	1.4	25.0	0.0	14.0	11.3	0.80	0.04	0.25	6.7	326.0		
Max	117.0	0.068	91.2	4.5	1395.7	2.5	1150.0	598.0	7.00	0.95	0.64	17.5	494.0		
Reference lakes greater than 1 km from the Dempster Highway (n = 13):															
FM19	5.7	0.039	4.3	2.22	56.9	0.000	313.0	29.9	3.70	4.82	0.37	16.1	346	67.17522	135.4932
FM34	2.3	0.086	2.4	2.91	33.8	0.000	193.0	16.1	2.60	5.48	0.42	16.3	345	67.28475	135.4002
FM20	3.3	0.053	4.4	9.81	185.1	0.000	388.0	45.5	1.70	5.77	0.51	15.9	268	67.19247	135.1489
FM35	7.6	0.019	5.0	3.39	178.4	0.000	347.0	32.1	4.50	5.86	0.54	19.6	322	67.29051	135.3817
FM27	2.0	0.032	2.5	12.73	397.8	0.000	261.0	22.9	3.90	7.66	0.47	18.0	238	67.30895	135.2277
FM21	5.9	0.017	3.7	3.77	221.8	0.000	194.0	22.3	2.60	8.12	0.51	20.0	310	67.16354	135.3558
FM23	7.9	0.083	4.7	1.12	13.5	0.000	102.0	40.4	7.10	15.68	0.35	14.1	327	67.09921	135.2008
FM30	8.4	0.031	6.3	3.63	117.1	0.000	106.0	50.9	1.80	16.72	0.41	14.1	363	67.38931	135.304
FM29	4.7	0.090	30.1	2.87	31.9	0.000	14.0	423.5	6.00	18.47	0.21	5.8	335	67.39811	135.4257
FM28	1.7	0.019	1.6	2.86	150.5	0.000	166.0	15.3	3.00	18.92	0.40	14.6	356	67.38644	135.5489
FM24	0.5	0.009	1.5	2.39	265.6	0.000	213.0	14.1	3.50	18.93	0.30	12.2	444	67.06777	135.3616
FM06	3.6	0.009	2.3	1.71	187.9	0.000	149.0	16.5	9.80	23.62	0.41	15.4	293	67.50562	135.3098
FM31	10.0	0.040	8.2	1.13	28.3	0.000	188.0	70.9	6.50	29.87	0.38	12.3	323	67.50111	135.3665
Mean	4.9	0.036	3.9	3.9	143.7	0.000	218.3	31.4	4.23	13.45	0.42	15.7	328.5		
Median	4.7	0.032	4.0	2.9	150.5	0.0	193.5	26.4	3.60	11.90	0.41	15.7	327.0		
Min	0.5	0.009	1.5	1.1	13.5	0.0	102.0	14.1	1.70	4.82	0.30	12.2	238.0		
Max	10.0	0.086	8.2	12.7	397.8	0.0	388.0	70.9	9.80	29.87	0.54	20.0	444.0		
Summary statistics for all lakes, excluding FM-29 (n = 27):															
Mean	19.9	0.029	15.5	3.2	209.99	0.56	208.2	126.7	3.2	6.2	0.4	14.1	365.9		
Median	7.6	0.019	5.0	2.5	150.26	0.00	153.0	50.9	2.6	0.9	0.4	14.6	356.0		
Min	0.5	0.002	1.1	1.1	13.49	0.00	14.0	11.3	0.8	0.0	0.3	6.7	238.0		
Max	117.0	0.086	91.2	12.7	1395.65	2.50	1150.0	598.0	9.8	29.9	0.6	20.0	494.0		

¹ Alk = total alkalinity as CaCO₃, Area = lake surface area, Ca = calcium, Catch = catchment area, CA:LA = catchment area: lake area, %CA-Road = the percentage of the catchment area occupied by the road ((road area/catchment area) × 100), Col = apparent colour, Cond = specific conductivity at 25°C, Depth = coring depth, Dist - distance to Dempster Highway, DN - dissolved nitrogen, DOC = dissolved organic carbon, Elev = elevation, Hard = hardness, Lat = Latitude, Long = Longitude, Mg = magnesium, NH₃ = ammonia as nitrogen, NO₃ = nitrate as nitrogen, NO₃/NO₂ = nitrate/nitrite, K = potassium, Si = reactive silica, TDS = total dissolved solids, TN = total nitrogen, TOC = total organic carbon, TP = total phosphorus, Turb = turbidity, SO₄ = sulphate, TN:TP mass ratios: < 9 - N-limitation (Guildford and Hecky, 2000).

TABLE S2. Summary of physical and geographical variables and general water chemistry variables¹ measured in the 28 lakes (19 August 2014 and 20 August 2015). Chemical measurements were averaged over two years for each lake unless specified. Calculations of the mean, median, minimum, and maximum chemical variables for FM-29 (thaw slump lake) were excluded – *continued*:

	Mg mg/L	Na mg/L	NH ₃ mg/L	NO ₃ mg/L	NO ₃ /NO ₂ mg/L	pH pH units	K mg/L	Si (2015) mg/L	TOC mg/L	Turb NTU	SO ₄ mg/L	TN µg/L	TP µg/L	TN:TP
Impacted lakes within 1 km from the Dempster Highway (n = 15):														
Detection limit	0.1	0.1	0.005	0.01	0.01		0.1	0.025	0.5	0.05	1	60	2	
FM03	20.8	13.1	0.013	0.10	0.11	7.96	1.3	0.185	11.5	1.25	160	435	14	31.1
FM02	7.7	4.3	0.007	0.06	0.07	7.34	0.5	0.565	7.4	2.73	53	405	23	17.6
FM10	1.0	0.7	0.013	0.04	0.04	6.43	0.3	1.710	15.8	6.37	5	650	113	5.8
FM50	21.8	13.7	0.011	0.08	0.09	7.67	0.9	1.200	17.9	1.60	193	490	16	30.6
FM17	17.0	6.3	0.024	0.10	0.10	7.50	1.1	3.860	11.3	4.15	114	380	22	17.3
FM11	8.0	3.4	0.007	0.06	0.07	7.26	0.3	1.560	18.0	3.11	71	500	17	29.4
FM05	0.6	0.4	0.005	0.03	0.03	5.50	0.3	0.740	11.7	2.28	2	415	27	15.4
FM12	4.0	1.5	0.007	0.05	0.06	6.93	0.3	0.647	19.0	0.89	27	470	10	47.0
FM14	4.0	2.4	0.006	0.05	0.05	7.16	0.6	2.030	13.7	2.78	37	395	10	39.5
FM32	22.2	6.4	0.005	0.13	0.14	8.15	2.0	0.715	6.8	0.65	212	255	5	51.0
FM04	1.3	0.6	0.007	2.54	2.54	6.14	0.2	1.520	17.8	2.83	8	565	47	12.0
FM15	0.8	0.3	0.008	0.03	0.03	5.31	0.1	4.990	18.5	0.98	1	380	9	42.2
FM33	5.4	0.5	0.005	0.09	0.10	8.05	0.3	1.370	10.7	0.37	42	335	4	83.8
FM16	4.3	2.3	0.061	0.06	0.06	6.30	0.5	3.200	16.8	52.37	44	660	103	6.4
FM18	5.5	0.9	0.210	0.08	0.08	7.05	0.8	2.600	15.5	33.70	37	995	127	7.8
Mean	8.3	3.8	0.026	0.23	0.24	6.98	0.6	1.793	14.1	7.74	67	489	36	13.4
Median	5.4	2.3	0.007	0.06	0.07	7.16	0.5	1.520	15.5	2.73	42	435	17	25.6
Min	0.6	0.3	0.005	0.03	0.03	5.31	0.1	0.185	6.8	0.37	1	255	4	63.8
Max	22.2	13.7	0.210	2.54	2.54	8.15	2.0	4.990	19.0	52.37	212	995	127	7.8
Reference lakes greater than 1 km from the Dempster Highway (n = 13):														
FM19	1.2	0.4	0.007	0.03	0.03	6.53	0.2	2.670	17.8	10.58	5	505	32	15.8
FM34	.8	0.3	0.005	0.03	0.03	6.00	0.2	1.970	18.4	2.47	1	475	38	12.5
FM20	1.7	1.5	0.019	0.04	0.04	6.33	0.4	1.030	18.2	15.88	13	790	97	8.1
FM35	1.4	0.3	0.012	0.03	0.04	6.68	0.2	1.930	21.6	7.75	3	630	56	11.3
FM27	1.1	0.3	0.008	0.03	0.03	5.84	0.3	1.400	20.9	4.93	4	515	30	17.2
FM21	0.9	0.4	0.009	0.04	0.04	6.50	0.1	0.346	22.0	1.45	1	575	19	30.3
FM23	1.9	0.7	0.007	0.04	0.04	6.98	0.4	2.700	15.0	2.33	7	395	19	20.8
FM30	2.1	0.8	0.006	0.04	0.04	6.95	0.2	0.279	15.2	0.86	12	455	19	23.9
FM29	14.2	30.3	0.005	0.08	0.09	6.84	1.9	0.549	6.1	0.74	195	220	11	20.0
FM28	0.8	0.4	0.009	0.03	0.04	5.88	0.3	1.330	16.8	3.99	2	515	31	16.6
FM24	0.6	0.4	0.006	0.03	0.03	5.15	0.1	2.780	17.6	4.33	2	415	30	13.8
FM06	0.8	0.3	0.005	0.03	0.04	6.40	0.4	0.855	17.1	2.21	1	495	22	22.5
FM31	2.9	0.6	0.006	0.05	0.05	6.79	0.5	1.110	13.2	4.37	19	380	16	23.8
Mean	1.3	0.5	0.008	0.03	0.04	6.33	0.3	1.533	17.8	5.09	6	512	34	15.0
Median	1.1	0.4	0.007	0.03	0.04	6.45	0.2	1.365	17.7	4.16	3	500	30	16.7
Min	0.6	0.3	0.005	0.03	0.03	5.15	0.1	0.279	13.2	0.86	1	380	16	23.8
Max	2.9	1.5	0.019	0.05	0.05	6.98	0.5	2.780	22.0	15.88	19	790	97	8.1
Summary statistics for all lakes, excluding FM-29 (n = 27):														
Mean	5.2	2.3	0.018	0.14	0.15	6.69	0.5	1.677	15.8	6.56	40	499	35	24.2
Median	1.9	0.7	0.007	0.04	0.04	6.68	0.3	1.400	16.8	2.78	12	475	22	17.6
Min	0.6	0.3	0.005	0.03	0.03	5.15	0.1	0.185	6.8	0.37	1	255	4	5.8
Max	22.2	13.7	0.210	2.54	2.54	8.15	2.0	4.990	22.0	52.37	212	995	127	83.8

¹ Alk = total alkalinity as CaCO₃, Area = lake surface area, Ca = calcium, Catch = catchment area, CA:LA = catchment area: lake area, %CA-Road = the percentage of the catchment area occupied by the road ((road area/catchment area) × 100), Col = apparent colour, Cond = specific conductivity at 25°C, Depth = coring depth, Dist - distance to Dempster Highway, DN - dissolved nitrogen, DOC = dissolved organic carbon, Elev = elevation, Hard = hardness, Lat = Latitude, Long = Longitude, Mg = magnesium, NH₃ = ammonia as nitrogen, NO₃ = nitrate as nitrogen, NO₃/NO₂ = nitrate/nitrite, K = potassium, Si = reactive silica, TDS = total dissolved solids, TN = total nitrogen, TOC = total organic carbon, TP = total phosphorus, Turb = turbidity, SO₄ = sulphate, TN:TP mass ratios: < 9 - N-limitation (Guildford and Hecky, 2000).