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Halifax Regional Council
March 27, 2007

TO: Mayor Kelly and Members of Halifax Regional Council

SUBMITTED BY: Brad Anguish, Director, Environmental Management Services

DATE: March 12, 2007

SUBJECT: **HRM Water Quality Monitoring Program**

INFORMATION REPORT

ORIGIN

The HRM Water Resources Management Study (2003) recommended that HRM establish a water quality monitoring program for 50-70 sites (Rec. #9-2).

The HRM Regional Plan, Policy E-18, requires HRM to develop a Water Quality Monitoring Functional Plan to establish a comprehensive water quality monitoring program, including ongoing monitoring for selected lakes and rivers to determine the state of water resources and to detect changes over time. The monitoring program component was initiated in 2006.

BACKGROUND

The HRM Regional Plan as approved by Council on June 27, 2006 includes a requirement for a Water Quality Monitoring Functional Plan. One of the elements which this Functional Plan should include is: "establishing an on-going monitoring program for selected lakes and rivers to determine the state of water resources and to detect changes over time." Initial budget amounts have been allocated from Regional Planning under the capital and operating accounts to initiate this water quality monitoring program. Criteria have been established for selection of lakes or rivers to be included in the sampling program, and an initial list of sampling sites (Map 1) developed in consultation with the HRM watershed advisory boards (BWAB, HWAB, and DLAB). Initial sampling was undertaken during May 2006, using external consultants for sampling under an existing HRM Pricing Agreement for sample collection. A decision was then made to continue the program using internal HRM staff and equipment resources as a cost-saving measure. An additional set of samples was collected during October, 2006. A local commercial lab, certified by the Canadian Association of Environmental Analytical Laboratories (CAEAL), was used for sample analysis.

Capital funding from the Regional Planning budget has been used to provide for required field and office equipment, and sample analyses, and may be used to provide for additional in-house laboratory capabilities if deemed appropriate. Operating funding from the Regional Planning budget has been used to help establish the program, and will be used to fund a new position to carry out field work, data management and analysis. The province of Nova Scotia made a small contribution to the 2006 HRM Water Quality program through a financial contribution from the NS Department of Environment and Labour.

A requirement for environmental monitoring of receiving waters for wastewater effluent is currently under consideration as part of the CCME Strategy for Management of Municipal Wastewater (subject of a Report to Council, Feb. 20, 2007, Item 11.1.9). This requirement could be met through modification or extension of the present water quality monitoring program. HRM also monitors water quality in Halifax Harbour, the Northwest Arm, and Bedford Basin, as part of the Harbour Solutions Project. This monitoring completes the larger picture for the harbour watershed.

HRM has sampled bacterial levels in waters associated with sewer infrastructure for the past 5 years. The new program expands on this previous work with more complete analyses. The intention is to continue this effort as an ongoing sampling program in 2007 and subsequent years, with seasonal sampling (3-4 times per year). The assumption at this stage is that the water quality program will remain with HRM, rather than transfer to the HRWC as part of the upcoming merger, and that the program will be funded by the HRM Operating Budget. The Water Quality Monitoring Functional Plan is in development, and will include the details of the ongoing monitoring program. Approximately 50 lake/river sites were included in the 2006 program, with one sampling site per lake (deep station) or river. Samples are taken at 1 meter depth except in summer if the lake stratifies (warm water in the top layer, cold water in the deep layer), in which case several depths would be sampled. Two lakes (Russell and Morris) are currently sampled with funding from developers under their development agreements (DAs). Similar provisions are envisioned for future

DAs, and under Regional Plan Policy E-18, the Water Quality Functional Plan will specify monitoring requirements for future large-scale developments.

Results from the sampling program are used to establish the current conditions of these selected water resources in HRM. Benefits of the program are as follows:

- Assess changes over time as the program proceeds;
- Identify locations with water quality issues or problems;
- Establish relationships between water quality and associated HRM sewer or wastewater infrastructure;
- Help guide infrastructure priority assessment and infrastructure investments;
- Assess the success of mitigative measures for storm and wastewater management undertaken by HRM, or which HRM has required of developers;
- Assess the success of mitigative air quality measures (air emissions can impact water quality through local (particulate) or long-range deposition (acid rain);
- Determine the effects of land uses on water quality within the watersheds;
- Guide community stewardship measures (such as pet waste management);
- Provide a performance measure for HRM infrastructure (sewers, pumping stations, treatment plants);
- Provide a performance measure for planning and development controls intended to preserve or protect water resources.

DISCUSSION

Data for all of the program sites are provided in Appendices A (May, 2006) and B (October, 2006). Results from 2006 are discussed in Appendix C for selected lakes of particular interest, and compared with historical data (where it exists). A map of the 2006 sampling locations is provided (Map 1) as well as a map showing the trophic status of lakes in relation to adjacent HRM sewage infrastructure (Map 2). Trophic status of lakes is a reflection of the biological productivity of a lake, as determined by nutrient input to the lake measured by the Total Phosphorus (TP) concentration. Un-impacted lakes are generally in the oligotrophic category, while lakes with moderate impacts are mesotrophic, and heavily impacted lakes are eutrophic. As TP levels increase, lakes suffer reduced dissolved oxygen levels, increased growth of algae and plants, impaired aesthetic value, reductions in game fish species, and poor quality for swimming. This is also reflected in the Secchi depth, a measure of the transparency of the water (larger number = greater transparency). The process of progression to higher categories over time is termed "eutrophication". Categories as used here are those defined by the Canadian Council of Ministers of Environment (CCME) 2004 Phosphorus Guideline:

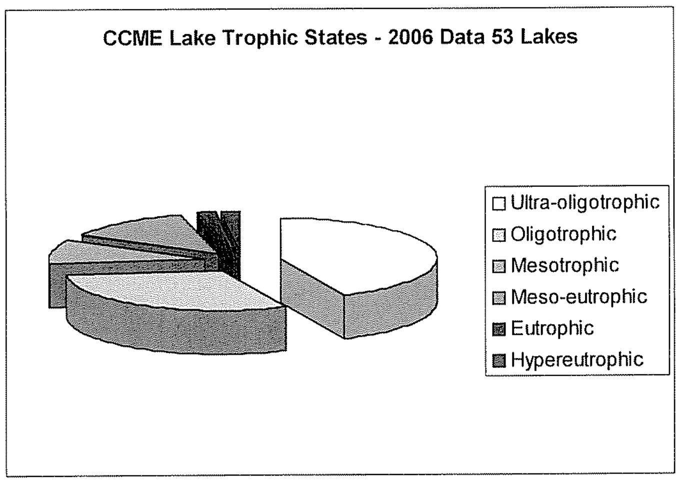
CCME Lake Trophic Categories

TP (ug/l)	Trophic state	TP (ug/l)	Trophic state
0-4	Ultra-oligotrophic	20-35	Meso-eutrophic
4-10	Oligotrophic	35-100	Eutrophic
10-20	Mesotrophic	100+	Hypereutrophic

Compared to available historic data, the 2006 data demonstrates improvement in water quality. Spring-fall average TP showed that 43% of the sampled lakes were ultra-oligotrophic, 30% were oligotrophic, 3% were mesotrophic, 13% were meso-eutrophic, 2% were eutrophic, and 2% were hyper-eutrophic. The overall results suggest that many lakes in the urban-suburban areas of HRM are maintaining their water quality over time, or in fact improving.

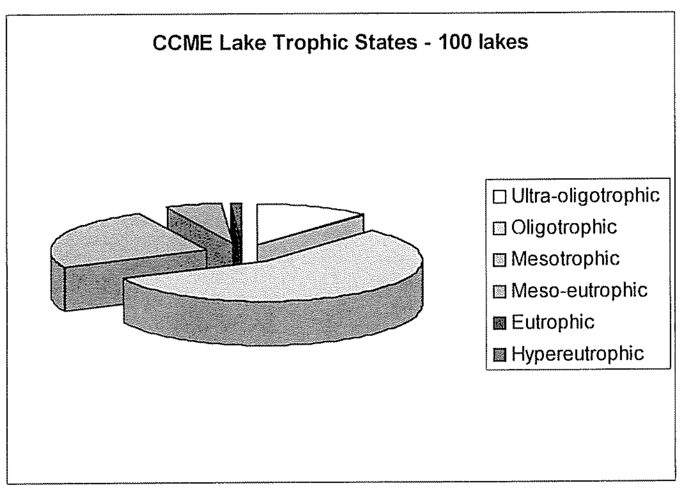
The results provided (Appendices A, B) are from two sampling dates per lake in 2006. These results should be considered preliminary, as several years' worth of seasonal data are required to establish current water quality and to begin to detect trends over time. The intention is that this will be a long-term, ongoing sampling program. Future years' data will allow more extensive analysis of results.

Lake Categories, 2006 Data



More lakes are currently in the ultra-oligotrophic category (better quality) compared with previous data: 43% as compared to 12% historically. A few more lakes are in the meso-eutrophic category (medium to poor quality): 13% as compared to 6%, indicating some deterioration in some cases. Specific selected lakes are discussed in App. C. Some lakes do show the impacts of urban development within their watersheds, while others may be at risk of such impacts in future due to impending or current development plans. An interesting example is Russell Lake, Dartmouth, which shows significant improvement compared with historical data. Russell Lake is currently undergoing additional development on the west side, and further data will indicate if this will have ongoing impacts.

Historic Lake Categories, 1983-2001 Data



For comparison with recent results, available historical TP data from between 1983 and 2001 were examined to determine the trophic categories for a sample of 100 lakes in and around the urban-suburban core of HRM. Of these 100 lakes, 12% were in the ultra-oligotrophic category, 56% were oligotrophic, 25% were mesotrophic, 6% were meso-eutrophic, 0% were eutrophic, and 1% was hyper-eutrophic. The hyper-eutrophic (most impacted) lake was Winder Lake, Preston. Of the 100 lakes, 68% were in the oligotrophic (least impacted) category.

The most impacted lake found in 2006 was Winder Lake, North Preston. This small lake is the receiving water for effluent from the North Preston sewage treatment plant (which is currently being upgraded). Other lakes which are downstream of inland sewage treatment plant discharges, such as Lake William, Fletcher Lake, and Grand Lake, do not show such evidence of impacts. Nine-Mile River, sampled at the mouth, showed elevated total phosphorus in October but not in May. This site is downstream of the Lakeside-Timberlea treatment plant, which may account for the phosphorus. Fecal coliforms were not elevated, nor was nitrogen.

As these examples and those in Appendix C show, the results of ongoing water quality monitoring provide a useful basis for evaluating the current state of lakes and rivers, and for comparison with past and future data to detect trends over time. The results can also be used to locate problem sites, and to evaluate the possible sources of pollutants or contaminants. These findings may be used to guide future infrastructure investments, or identify regulatory actions which may be needed.

Staff will continue to report water quality monitoring results to Council on an annual basis as part of HRM's State of the Environment Report which will be introduced in 2007/08.

BUDGET IMPLICATIONS

None at this time. Provision will be made in future budget submissions for ongoing operating funds for this program.

FINANCIAL MANAGEMENT POLICIES / BUSINESS PLAN

This report complies with the Municipality's Multi-Year Financial Strategy, the approved Operating, Capital and Reserve budgets, policies and procedures regarding withdrawals from the utilization of Capital and Operating reserves, as well as any relevant legislation.

ATTACHMENTS

Appendix A - Water quality data, May 2006.
Appendix B - Water quality data, October 2006.
Appendix C - Water Quality Results for Selected Lakes, 2006.
Map 1 - Sampling sites, 2006.
Map 2 - Trophic state of lakes and HRM sewage infrastructure (Parts 1 East; 2 North; 3 West).

A copy of this report can be obtained online at http://www.halifax.ca/council/agendasc/cagenda.html then choose the appropriate meeting date, or by contacting the Office of the Municipal Clerk at 490-4210, or Fax 490-4208.

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Appendix A - Water quality data, May 2006

HRM Lake / River Water Quality Monitoring Program

May 2006 See Notes at bottom

Lake Deep Stations

Lake	Community	Date	On-Site Data: Secchi Depth (m)	Temp (Celsius)	Dissolved Oxygen (mg/L)	pH	Specific Conductance (uS/cm)	Laboratory Data: Turbidity (NTU)	Dissolved Chloride (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	TKN (mg/L)	Total Phosphorus (mg/L)	TSS (mg/L)	Fecal Coliform (CFU/100ml)	Chlorophyll a - Acidification (ug/L)
Albro Lake	Dartmouth	18-May-06	3.0	15.17	9.15	6.55	303	0.3	76	<0.05	<0.01	0.2	<0.002	<2	3	1.70
Anderson Lake	Dartmouth	31-May-06	2.2	18.12	9.31	5.69	60	0.5	11	<0.05	<0.01	0.3	<0.002	3	1	1.35
Barrett Lake	Beaverbank	16-May-06	2.8	16.16	9.30	7.09	174	1.1	38	0.09	<0.01	0.3	0.007	4	3	7.23
Beaver Pond	Beaverbank	30-May-06	1.2	20.00	9.37	6.75	188	2.9	34	<0.05	<0.01	0.4	0.023	4	7	24.46
Bell Lake	Dartmouth	17-May-06	4.8	13.92	9.58	6.70	55	0.4	10	0.07	<0.01	0.2	0.003	<2	83	1.05
Bissett Lake	Cole Harbour	24-May-06	3.6	15.13	9.28	8.13	485	0.9	95	0.20	<0.01	0.5	0.007	<2	ND	1.69
Black Point Lake	Hubley	30-May-06	1.0	18.51	8.02	4.80	85	0.1	21	<0.05	<0.01	0.6	0.002	2	2	1.83
Chocolate Lake	Mainland South	25-May-06	9.5	14.60	9.78	5.60	373	0.4	83	0.17	<0.01	0.2	<0.002	3	ND	0.16
Cranberry Lake	Dartmouth	18-May-06	3.6	15.20	9.46	7.26	371	0.7	84	0.16	<0.01	0.3	0.003	2	9	1.80
Drain Lake	Middle Sackville	18-May-06	1.0	19.37	9.54	6.42	199	5.4	46	<0.05	<0.01	0.3	0.030	130	150	12.46
Duck Lake	Beaverbank	16-May-06	1.6	17.49	9.16	7.05	288	3.2	68	<0.05	<0.01	0.4	0.022	4	32	14.85
Fenerty Lake	Beaverbank	30-May-06	1.2	19.89	9.73	6.50	73	0.7	9	<0.05	<0.01	0.6	0.005	3	5	14.46
First Lake	Middle Sackville	16-May-06	4.8	15.16	10.72	7.74	449	0.9	110	0.14	<0.01	0.3	<0.002	2	ND	3.72
Fletchers Lake	Fall River	23-May-06	3.0	15.81	9.53	6.66	142	0.6	30	0.17	<0.01	0.2	<0.002	<2	7	2.80
Governor Lake	Timberlea	25-May-06	2.0	15.81	9.55	6.20	359	1.1	93	0.31	<0.01	0.3	0.002	3	8	1.44
Hubley Big Lake	Hubley	30-May-06	1.2	17.78	9.02	4.67	50	0.6	9	<0.05	<0.01	0.3	0.026	<2	4	7.27
Kearney Lake	Bedford	24-May-06	3.3	14.95	9.61	6.91	178	0.4	40	0.20	<0.01	0.4	0.006	<2	1	1.64
Kinsac Lake	Fall River	23-May-06	2.6	14.70	9.55	6.77	85	0.8	17	0.06	<0.01	0.4	0.003	<2	1	2.25
Lake Banook	Dartmouth	15-May-06	5.0	14.21	10.12	6.89	396	0.6	92	0.56	<0.01	0.3	0.003	3	ND	1.42
Lake Charles	Dartmouth	17-May-06	2.8	13.70	10.60	6.96	201	0.7	44	0.28	<0.01	0.2	<0.002	2	16	3.75
Lake Echo	Eastern Shore	24-May-06	1.6	15.75	9.04	5.56	51	0.9	8	<0.05	<0.01	0.4	0.014	<2	2	2.98
Lake Micmac	Dartmouth	15-May-06	3.5	14.80	10.72	6.75	372	0.5	85	0.73	<0.01	0.3	<0.002	2	ND	0.87
Lake Thomas	Waverley	23-May-06	2.8	15.20	9.83	6.98	161	0.4	33	0.13	<0.01	0.3	<0.002	<2	1	2.64
Lake William	Waverley	23-May-06	3.8	14.27	10.04	7.04	150	0.4	33	0.13	<0.01	0.3	<0.002	<2	2	2.59
Lisle Lake	Sackville	18-May-06	1.6	17.31	8.87	6.37	111	2.5	21	0.08	<0.01	0.3	0.067	<2	420	8.38
Little Albro Lake	Dartmouth	18-May-06	4.0	15.57	9.46	6.93	304	0.5	76	<0.05	<0.01	0.2	0.002	<2	20	2.43
Long Lake	Mainland South	25-May-06	2.2	14.48	9.49	5.58	197	0.6	50	0.12	<0.01	0.3	<0.002	2	8	0.50
Maynard Lake	Dartmouth	17-May-06	2.6	14.48	10.03	7.25	319	0.9	79	<0.05	<0.01	0.2	0.012	<2	51	8.18
McIntosh Run	Above outlet to Herring Co	25-May-06	1.5	15.01	10.45	5.71	134	0.9	31	0.19	<0.01	0.3	0.002	<2	24	1.58
Morris Lake	Dartmouth	17-May-06	3.3	14.10	10.29	6.98	265	1.0	64	0.10	<0.01	0.2	0.008	2	6	7.40
Nine-Mile River	Timberlea	28-Jun-06	(disk on botto	18.14	9.53	5.08	51	1.6	10	0.15	<0.01	1	0.028	4	48	2.58
Nine-Mile River	Elmsdale	23-May-06	(disk on botto	13.61	8.46	5.55	123	7.9	15	0.06	<0.01	0.6	0.010	38	46	4.19
Oathill Lake	Dartmouth	15-May-06	3.7	15.20	9.30	7.11	390	0.9	86	0.36	<0.01	0.4	0.003	2	21	3.66
Papermill Lake	Bedford	17-May-06	2.8	16.50	8.63	6.62	182	0.5	45	0.19	<0.01	0.2	0.007	<2	42	1.32
Penhorn Lake	Dartmouth	17-May-06	3.8	14.35	10.34	7.51	446	0.9	110	<0.05	<0.01	0.2	0.002	<2	72	0.63
Porters Lake	Eastern Shore	24-May-06	3.2	14.02	9.39	7.74	Ovr range	0.3	6200	<0.05	<0.01	0.5	0.008	3	ND	0.44
Powder Mill Lake	Waverley	23-May-06	2.8	15.96	9.72	7.29	196	0.4	39	0.10	<0.01	0.3	<0.002	<2	2	4.54
Rocky Lake	Bedford	23-May-06	2.2	16.38	10.44	8.35	318	0.5	61	0.39	0.01	0.5	0.003	<2	ND	11.62
Russell Lake	Dartmouth	15-May-06	5.2	16.15	9.79	7.21	492	0.6	130	<0.05	<0.01	0.2	<0.002	<2	ND	0.94
Russell Lake (Re-test)	Dartmouth	31-May-06	–	–	–	–	–	–	–	–	–	–	0.003	–	–	–
Sackville River	Below Fish Hatchery PS	25-May-06	(disk on botto	16.99	12.01	6.59	96	1.1	21	0.12	<0.01	0.8	0.004	2	18	1.63
Sandy Lake	Hammonds Plains	31-May-06	4.0	18.18	8.67	6.00	124	0.5	27	0.05	<0.01	0.3	0.002	<2	ND	0.56
Second Lake	Middle Sackville	18-May-06	2.3	15.95	10.10	7.01	132	0.9	29	<0.05	<0.01	0.2	<0.002	2	14	1.47
Settle Lake	Dartmouth	17-May-06	1.6	15.01	9.34	7.09	352	2.3	84	<0.05	<0.01	0.3	0.020	<2	180	1.92
Sheldrake Lake	Hubley	29-May-06	1.2	19.88	9.36	5.22	80	1.1	18	<0.05	<0.01	0.4	0.012	4	2	12.88
Smelt Brook	Dartmouth	17-May-06	(disk on botto	11.68	12.04	6.12	74	4.8	16	<0.05	<0.01	0.5	0.013	<2	87	2.32
Springfield Lake	Middle Sackville	16-May-06	3.8	15.08	9.68	6.92	91	0.5	17	<0.05	<0.01	0.2	0.004	<2	ND	1.95
Stillwater Lake	Hubley	29-May-06	2.0	17.21	9.31	5.16	52	0.5	10	<0.05	<0.002	0.3	0.019	<2	2	1.63
Third Lake	Windsor Junction	16-May-06	3.8	15.00	10.60	7.32	121	0.3	26	0.05	<0.01	0.4	<0.002	2	1	3.69
Tucker Lake	Beaverbank	16-May-06	3.5	16.42	9.34	6.76	180	1.3	40	0.07	<0.01	0.3	0.004	<2	5	1.63
Whimsical Lake	Mainland South	25-May-06	1.6	15.31	10.02	6.85	384	1.8	82	0.3	0.02	0.5	0.002	6	7	32.98
Williams Lake	Halifax	25-May-06	2.5	14.90	9.81	6.51	153	0.5	35	0.1	0.03	0.3	0.003	<2	ND	1.89
Winder Lake	North Preston	24-May-06	0.3	15.71	15.86	10.81	226	7.3	39	0.14	0.02	3.5	0.36	20	3	340.09
Wrights Lake	Tantallon	29-May-06	3.0	17.09	9.57	5.35	36	0.5	6	<0.05	<0.01	0.2	<0.002	<2	ND	1.39

Notes:
– Not Analysed
ND Not Detected

- Russell Lake re-sampled for Total Phosphorus May 31, 2006
- Nine Mile River (Timberlea) sampled June 28, 2006

Appendix B - Water quality data, October 2006

HRM Lake / River Water Quality Monitoring Program

October 2006 See Notes at bottom

Lake Deep Stations

Lake	Community	Date	On-Site Data: Secchi Depth (m)	Temp (Celsius)	Dissolved Oxygen (mg/L)	pH	Specific Conductance (uS/cm)	Laboratory Data: Turbidity (NTU)	Dissolved Chloride (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	TKN (mg/L)	Total Phosphorus (mg/L)	TSS (mg/L)	Fecal Coliform (MPN/ml)	Chlorophyll a - Acidification (ug/L)	E. coli (MPN/mL	Colour (TCU)
Albro Lake	Dartmouth	Oct 13 2006	4.0	14.70	9.98	7.49	291	0.5	72	ND	ND	0.3	ND	1	4	2.52	ND	ND
Anderson Lake	Dartmouth	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Barrett Lake	Beaverbank	Oct 17 2006	2.5	14.05	8.99	7.14	145	1.2	28	ND	ND	0.3	0.003	ND	33	2.79	19	20
Beaver Pond	Beaverbank	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Bell Lake	Dartmouth	Nov 1 2002	4.3	8.69	11.40	6.66	53	0.5	9	ND	ND	0.3	0.007	1	ND	2.12	ND	ND
Bissett Lake	Cole Harbour	Oct 13 2006	3.0	14.73	9.63	7.80	273	0.8	54	ND	ND	0.4	0.008	1	ND	2.65	ND	11
Black Point Lake	Hubley	Oct 30 2006	1.0	7.67	11.41	5.24	93	1.9	25	0.08	ND	0.7	0.018	3	ND	2.35	ND	65
Chocolate Lake	Mainland South	Oct 25 2006	5.3	12.19	10.43	6.39	317	0.5	65	0.12	ND	0.1	ND	ND	ND	0.22	ND	ND
Cranberry Lake	Dartmouth	Oct 13 2006	2.5	14.76	9.45	7.56	225	1.3	43	0.11	ND	0.4	0.008	2	6	1.53	ND	11
Drain Lake	Middle Sackville	Oct 24 2006	1.0	10.23	10.84	7.09	146	2.2	30	0.06	ND	2.5	0.033	6	ND	31.04	ND	19
Duck Lake	Beaverbank	Nov 1 2006	1.0	7.96	12.13	7.10	181	3.9	34	ND	ND	0.5	0.020	6	1	33.11	ND	15
Fenerty Lake	Beaverbank	Oct 24 2006	1.5	11.57	9.75	6.39	69	1.5	13	ND	ND	0.4	0.022	2	ND	6.19	ND	33
First Lake	Middle Sackville	Oct 17 2006	2.5	14.40	8.77	7.41	401	0.7	91	ND	ND	0.3	ND	2	170	1.67	37	ND
Fletchers Lake	Fall River	Oct 16 2006	3.2	14.41	9.58	7.19	146	0.6	31	0.10	ND	0.3	ND	ND	ND	2.17	ND	11
Governor Lake	Timberlea	Oct 25 2006	1.2	11.61	9.85	6.60	256	2.2	59	0.08	ND	0.5	0.011	2	1	2.20	ND	34
Grand Lake	Waverley	Oct 16 2006	4.5	15.07	9.83	7.09	87	0.3	17	0.10	ND	0.2	ND	ND	ND	1.66	ND	14
Hubley Big Lake	Hubley	Oct 30 2006	1.3	8.83	11.48	5.18	45	1.0	11	ND	ND	0.5	0.024	2	ND	1.66	ND	39
Kearney Lake	Bedford	Oct 25 2006	4.0	11.99	10.17	6.68	143	0.3	32	0.18	ND	0.2	ND	ND	ND	0.90	ND	14
Kinsac Lake	Fall River	Oct 16 2006	2.8	14.63	9.62	6.78	69	0.7	13	ND	ND	0.4	0.003	1	2	4.26	1	26
Lake Banook	Dartmouth	Oct 11 2006	3.0	15.18	10.02	7.81	330	1.0	65	ND	ND	0.4	0.002	1	4	2.15	ND	ND
Lake Charles	Dartmouth	Oct 16 2006	3.0	14.65	9.73	7.47	190	0.6	39	0.12	ND	0.3	0.003	1	2	5.00	ND	7
Lake Echo	Eastern Shore	Oct 31 2006	1.0	9.03	11.11	5.52	42	2.5	6	0.06	ND	0.6	0.008	3	ND	1.87	ND	46
Lake Micmac	Dartmouth	Oct 11 2006	4.5	14.69	10.17	7.81	303	0.6	59	ND	ND	0.3	0.002	ND	1	2.04	ND	5
Lake Thomas	Waverley	Oct 16 2006	4.5	14.86	9.60	7.32	155	0.5	32	0.05	ND	0.3	ND	ND	1	1.47	ND	11
Lake William	Waverley	Oct 16 2006	4.5	14.49	9.50	7.30	153	0.4	32	0.10	ND	0.3	ND	ND	ND	1.87	ND	13
Lisle Lake	Sackville	Oct 24 2006	2.3	9.81	9.19	6.37	120	0.7	24	0.23	ND	0.4	0.037	2	ND	3.07	ND	13
Little Albro Lake	Dartmouth	Oct 13 2006	2.5	14.57	9.40	7.29	265	0.3	62	ND	ND	0.3	ND	1	ND	0.57	ND	6
Long Lake	Mainland South	Oct 25 2006	2.0	12.00	10.11	6.06	159	0.8	39	0.09	ND	0.4	0.003	ND	ND	0.59	ND	48
Maynard Lake	Dartmouth	Oct 11 2006	6.5	15.50	9.40	7.37	306	0.4	71	ND	ND	0.3	ND	ND	1	2.47	ND	6
McIntosh Run	Above outlet to Herring Cove	Oct 27 2006	--	8.10	11.17	5.97	128	0.7	31	0.25	ND	0.4	0.010	ND	ND	0.40	ND	47
Morris Lake North	Dartmouth	Nov 8 2006	3.8	7.09	11.90	7.53	216	0.3	44	0.08	<0.01	0.3	<0.002	<2	<1	1.45	--	--
Morris Lake South	Dartmouth	Nov 8 2006	5.3	7.32	12.05	7.51	220	0.4	44	0.08	<0.01	0.6	<0.002	<2	2	0.95	--	--
Nine-Mile River	Timberlea	Oct 31 2006	--	8.69	12.25	5.70	179	1.2	48	0.24	ND	0.4	0.029	3	ND	2.87	ND	66
Oathill Lake	Dartmouth	Oct 11 2006	4.5	14.91	8.23	7.30	315	0.4	64	0.05	ND	0.3	0.003	ND	2	2.90	ND	11
Papermill Lake	Bedford	Oct 25 2006	2.5	10.93	9.90	6.75	133	0.6	30	0.21	ND	0.2	0.006	ND	1	1.17	ND	16
Penhorn Lake	Dartmouth	Oct 11 2006	2.5	15.19	8.99	7.41	385	0.9	90	ND	ND	0.3	ND	ND	2	5.92	ND	6
Powder Mill Lake	Waverley	Oct 17 2006	2.5	13.71	9.24	7.24	183	0.7	37	ND	ND	0.2	ND	2	140	2.15	26	7
Rocky Lake	Bedford	Oct 17 2006	3.0	13.77	8.90	7.56	290	0.7	53	0.06	ND	0.4	ND	2	150	4.61	26	9
Russell Lake	Dartmouth	Oct 31 2006	1.5	8.36	12.26	7.21	330	3.6	79	<0.05	<0.01	--	0.011	4	<1	6.58	--	--
Sackville River	Below Fish Hatchery PS	Oct 27 2006	--	7.30	12.20	6.69	95	1.7	20	0.13	ND	0.4	0.012	3	ND	1.66	ND	36
Sandy Lake	Bedford	Oct 24 2006	1.5	12.24	9.47	6.43	99	0.9	21	ND	ND	0.3	0.009	2	ND	8.65	ND	35
Sandy Lake	Hammonds Plains - Glen Arbour	Oct 30 2006	--	8.61	11.38	6.76	46	1.0	6	ND	ND	0.4	0.008	2	ND	4.32	ND	7
Second Lake	Middle Sackville	Oct 17 2006	3.5	14.36	9.30	7.10	120	0.4	25	ND	ND	0.4	0.002	1	32	1.49	11	12
Settle Lake	Dartmouth	Oct 31 2006	2.0	8.64	11.26	7.22	253	3.8	53	0.10	ND	0.6	0.025	2	1	12.27	1	20
Sheldrake Lake	Hubley	Oct 30 2006	1.0	8.68	10.68	5.50	76	1.5	19	0.08	ND	0.5	0.030	2	ND	1.69	ND	68
Smelt Brook	Dartmouth	Oct 11 2006	--	12.48	10.15	7.06	196	1.1	27	0.73	ND	0.4	ND	ND	ND	0.29	ND	29
Springfield Lake	Middle Sackville	Oct 24 2006	3.0	11.37	10.26	6.74	79	0.4	15	ND	ND	0.3	0.009	1	1	2.60	ND	9
Stillwater Lake	Hubley	Oct 30 2006	2.0	10.00	10.39	5.76	45	0.7	9	0.06	ND	0.3	0.010	1	ND	0.90	ND	31
Third Lake	Windsor Junction	Oct 16 2006	2.8	14.83	9.64	7.10	115	0.5	24	ND	ND	0.3	ND	1	ND	3.42	ND	9
Tucker Lake	Beaverbank	Oct 17 2006	2.0	14.39	9.77	7.33	166	0.8	34	ND	ND	0.3	ND	1	20	7.23	16	13
Upper Porters Lake	Eastern Shore	Oct 31 2006	1.5	10.37	10.84	6.13	1485	0.7	390	0.06	ND	0.5	0.003	1	ND	0.66	ND	48
Whimsical Lake	Mainland South	Oct 25 2006	2.8	11.02	9.49	7.08	236	1.1	42	0.20	ND	0.4	0.004	1	ND	2.30	ND	12
Williams Lake	Halifax	Oct 25 2006	3.6	11.55	10.13	6.66	132	0.6	26	0.10	ND	0.3	ND	1	ND	1.01	ND	14
Winder Lake	North Preston	Oct 31 2006	0.5	7.44	13.05	7.43	204	11.0	32	0.67	0.06	4.6	0.440	33	31	214.22	9	19
Wrights Lake	Tantallon	--	--	--	--	--	--	--	--	--	--	--	--	--	--		--	--

Notes:

-- Not Analysed

ND Not Detected

Wrights Lake - no access

Anderson Lake - no access

Russell Lake - sampled by JWL for Clayton Developments

Morris Lake - sampled by JWL for HRM

Appendix C: Water Quality Results for Selected Lakes, 2006

Results for total phosphorus from spring 2006 are mapped by region (Map 2, Parts 1-3) to illustrate the relationships between lake trophic status as determined by TP, and proximity to HRM sewer and sewage treatment infrastructure. Other sources of TP also exist, for example private treatment plants and septic systems, stormwater and fertiliser runoff.

Results are discussed below for key water quality parameters in selected lakes of interest. These lakes were selected for discussion due to some unusual results, or on the basis of changes as compared with historic data. Refer to Appendices A and B for the full 2006 data set.
Notes: N/A - Not analysed; ND - Not detected.

Lake MicMac (Dartmouth)

Date	Turbidity (NTU)	Colour (TCU)	TSS (mg/L)	TP (ug/L)	O2 (mg/L)	pH	Secchi (meters)	FC (#/100ml)
May 06	0.5	N/A	2	<2	10.72	6.75	3.5	ND
Oct 06	0.6	5	ND	2	10.17	7.81	4.5	100

Lake MicMac is of interest due to concerns that runoff from a grubbings pile in Burnside may have impacted the lake through Grassy Brook in 2006. The water was a bit less clear (reduced Secchi depth) and more alkaline (higher pH) comparing spring to fall, but nothing that would indicate any significant impacts. Historical data for TP has ranged between 6 and 12 from 1990-2000, so the lake is still at the low end of that range. Secchi depths historically have been around 4.5, so the lake is still in that range of water clarity. pH has historically been just above 7, turbidity 0.6-0.8, suspended solids 0.4 - 8.0. Nothing indicates any deterioration in water quality comparing back to at least 1990.

Hubley Big Lake (Hubley)

Date	Turbidity (NTU)	Colour (TCU)	TSS (mg/L)	TP (ug/L)	O2 (mg/L)	pH	Secchi (meters)	FC (#/100ml)
May 06	0.6	N/A	<2	26	9.02	4.7	1.2	4
Oct 06	1.0	39	2	24	11.5	5.2	1.3	ND

Hubley Big Lake is not downstream of any HRM sewer infrastructure, and does not have an urbanised basin. However, total phosphorus levels are in the meso-eutrophic range. Historical data from 1990-2001 showed lower values ranging from 6-13, with one date in 2001 showing values in the 20's range. This is a coloured lake, indicating high organic input, and limited light penetration, so the chlorophyll levels (reflecting algal growth) are low in spite of the high TP.

Drain Lake (Middle Sackville)

Date	Turbidity (NTU)	Colour (TCU)	TSS (mg/L)	TP (ug/L)	O2 (mg/L)	pH	Secchi (meters)	FC (#/100ml)
May 06	5.4	N/A	130	30	9.5	6.4	1.0	150
Oct 06	2.2	19	6	33	10.8	7.1	1.0	ND

Drain Lake is not downstream of any HRM sewage infrastructure, but it is adjacent to Hwy. 101. The high TP values indicate that the lake is meso-eutrophic. Historical data from the 1980s and 90s showed similar levels. High suspended solids were found in May, but not in October. Springfield Estates trailer park operates a private sewage treatment system which discharges to Drain Lake.

Duck Lake (Beaverbank)

Date	Turbidity (NTU)	Colour (TCU)	TSS (mg/L)	TP (ug/L)	O2 (mg/L)	pH	Secchi (meters)	FC (#/100ml)
May 06	3.2	N/A	4	22	9.2	7.1	1.6	32
Oct 06	3.9	15	6	20	12.1	7.1	1.0	100

Duck Lake also receives effluent from the Woodbine Trailer Park private sewage treatment facility, resulting in TP in the meso-eutrophic range. One historical data point from 1984 indicated oligotrophic status, so this lake may have deteriorated since that time.

Kinsac Lake (Fall River)

Date	Turbidity (NTU)	Colour (TCU)	TSS (mg/L)	TP (ug/L)	O2 (mg/L)	pH	Secchi (meters)	FC (#/100ml)
May 06	0.8	N/A	<2	0.003	9.6	6.8	2.6	1
Oct 06	0.7	26	1	0.003	9.6	6.8	2.8	200

Kinsac Lake is downstream of Duck Lake. Flow from meso-eutrophic Duck Lake passes through Beaver Pond, which is also meso-eutrophic. However, Kinsac Lake remains ultra-oligotrophic. This is notable, since Kinsac Lake was mesotrophic in historical data from the 1970s to the 1990s. This indicates a possible improvement in lake quality.

Lisle Lake (Sackville)

Date	Turbidity (NTU)	Colour (TCU)	TSS (mg/L)	TP (ug/L)	O2 (mg/L)	pH	Secchi (meters)	FC (#/100ml)
May 06	2.5	N/A	<2	67	8.9	6.4	1.6	420
Oct 06	0.7	13	2	37	9.2	6.4	2.3	ND

Lisle Lake is downstream from HRM's Springfield Lake sewage treatment plant. Springfield Lake, upstream of the treatment plant, is oligotrophic, while Lisle Lake is eutrophic, indicating an impact from the plant. Fecal coliforms were above the swimming guideline level of 200/100ml in May, but were not detected in October. Fenerty Lake, which is downstream of Lisle, does not show the same degree of impact, and is mesotrophic (2006 average TP 14).

Morris Lake (Dartmouth)

Date	Turbidity (NTU)	Colour (TCU)	TSS (mg/L)	TP (ug/L)	O2 (mg/L)	pH	Secchi (meters)	FC (#/100ml)
May 06	1.0	N/A	2	8	10.3	7	3.3	6
Oct 06	0.3	N/A	<2	<2	12.1	7.5	3.8	100

Morris Lake is downstream of HRM pumping stations, and receives stormwater runoff via Ellenvale Run. Data collected by Clayton Developments under the development agreement for Portland Estates Phase 4 from August and November showed TPs of 26 and 15, so the overall annual average TP was 12.5. Morris Lake is one of two HRM lakes which have had TP thresholds set. The threshold level is 15 ug/L, so on the basis of 2006 data Morris Lake remains below the threshold which would trigger further action. Fecal coliform levels remain within the CCME swimming guideline limit.

Russell Lake (Dartmouth)

Date	Turbidity (NTU)	Colour (TCU)	TSS (mg/L)	TP (ug/L)	O2 (mg/L)	pH	Secchi (meters)	FC (#/100ml)
May 06	0.6	N/A	<2	<2	9.8	7.2	5.2	ND
Oct 06	3.6	N/A	4	11	12.3	7.2	1.5	<100

Russell Lake has also had a TP threshold limit set of 15 ug/L. Sampling done for Clayton Developments under their development agreement for Russel Lake West showed TP values ranging from 8 (June) to 20 (August). Overall annual mean of the Clayton and HRM data for TP was 11, below the threshold value of 15. Historical data from the 1970s show Russell Lake well into the eutrophic or hyper-eutrophic category, likely due to livestock and agricultural activity within the watershed at that time. From 1980 to 1992, Russel Lake improved into the meso-eutrophic or mesotrophic category, as the farming operations had ceased. Currently Russell Lake is at the very low end of the mesotrophic range. A transitory elevation of fecal coliform bacteria was noted by Clayton's consultants at Russell Lake during fall of 2006, possibly from stormwater runoff. No other specific source for this FC peak was identified during investigations conducted at the time.

Sandy Lake (Glen Arbour)

Date	Turbidity (NTU)	Colour (TCU)	TSS (mg/L)	TP (ug/L)	O2 (mg/L)	pH	Secchi (meters)	FC (#/100ml)
May 06	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oct 06	1.0	7	2	8	11.4	6.8	N/A	ND

Sandy Lake (Hammonds Plains - Glen Arbour) is of interest since it was subjected to development adjacent to the lake in the 1990s in the form of the Glen Arbour housing development and golf course. Concern has been expressed regarding the apparent deterioration of Sandy Lake following the development. Data from 1996 showed TP values in the oligotrophic range. By 1998-99 the lake had become mesotrophic to meso-eutrophic, indicating a decline in quality apparently as a result of the development. The 2006 data (although only a single point) indicates that the lake may be recovering to oligotrophic status, although this requires further data to confirm.

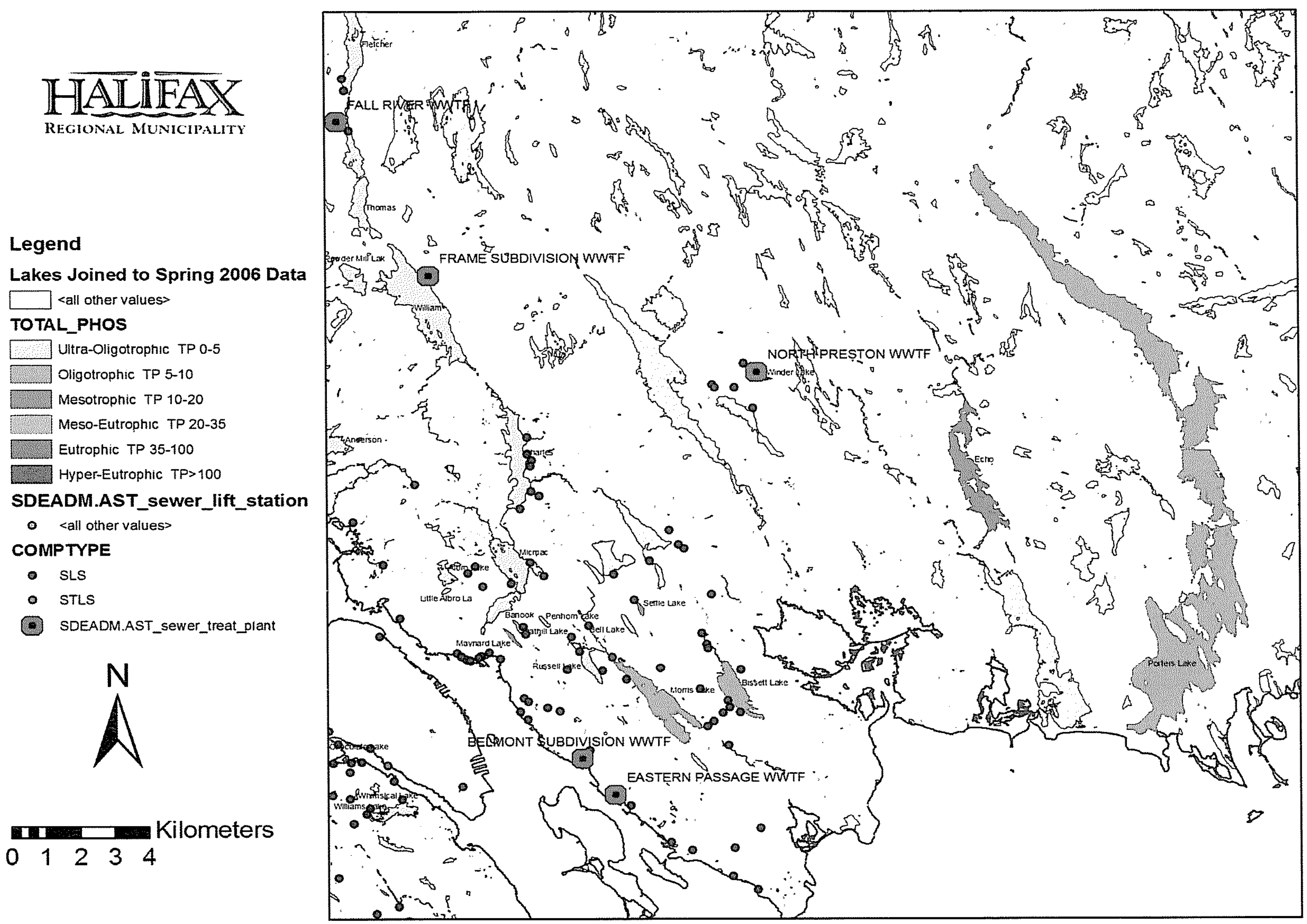
Winder Lake (North Preston)

Date	Turbidity (NTU)	Colour (TCU)	TSS (mg/L)	TP (ug/L)	O2 (mg/L)	pH	Secchi (meters)	FC (#/100ml)
May 06	7.3	N/A	20	360	15.9	10.8	0.3	3
Oct 06	11.0	19	33	440	13.1	7.4	0.5	3100

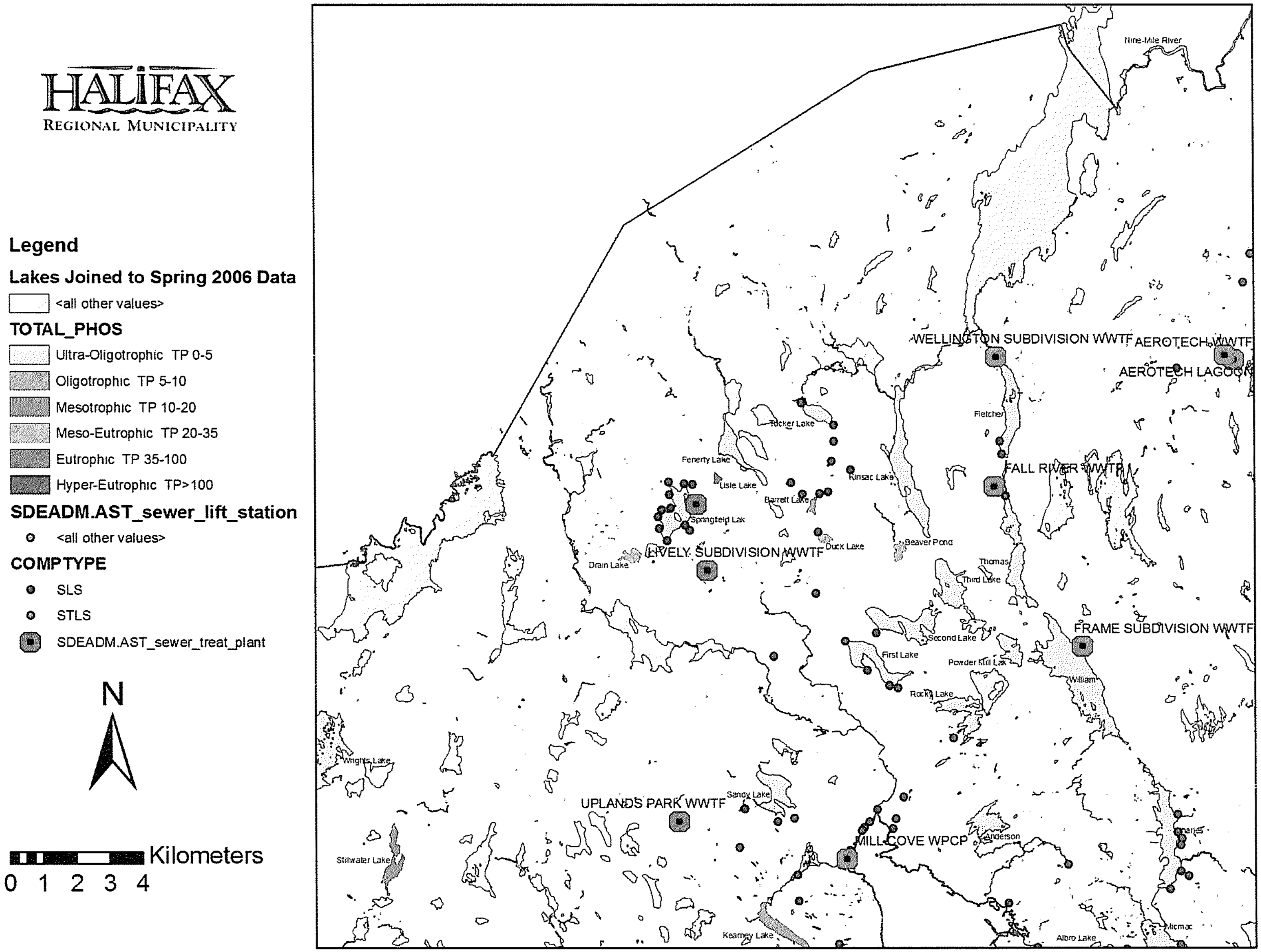
Winder Lake is the receiving water for effluent from the North Preston sewage treatment plant. Winder Lake shows significant impacts as a result of the treated effluent. TP indicates the lake is hyper-eutrophic, with high turbidity and suspended solids. Chlorophyll values are extremely high in this lake, indicating dense algal growth. The fall fecal coliform level was well above the safe contact guideline. The North Preston sewage treatment plant is currently completing an expansion and upgrade from secondary to tertiary level. Follow-up data in future years will assess the expected improvements as a result of this upgrade.

Map 1 - Sampling sites, 2006

Map 2 - Trophic state of lakes and HRM sewage infrastructure - Part 1 East



Map 2 - Trophic state of lakes and HRM sewage infrastructure - Part 2 North



Map 2 - Trophic state of lakes and HRM sewage infrastructure - Part 3 West