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EXISTING WATER QUALITY AND CHARACTERISTICS OF SPRYFIELD AREA LAKES AND MACINTOSH RUN

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EXISTING WATER QUALITY AND CHARACTERISTICS OF SPRYFIELD AREA LAKES AND MACINTOSH RUN

-INTRODUCTION-

Annexation of county lands in the Spryfield area provided Halifax with the use of and responsibility for more than a dozen lakes within the city limits. Continuing urbanization in the Spryfield-Herring Cove area will produce changes in the hydrology and water quality of these lakes and MacIntosh Run. Evaluation of the potential impact of development in these watersheds is complicated by the impending release of the watershed lands of the Chain Lakes and Long Lake and their discharge through MacIntosh Run.

As development proceeds in the watershed of a lake, some of the inevitable consequences are increased siltation and reduced water transparency from increases in runoff. Fertilization of lawns and gardens, as well as wastes from domestic animals and overflows from septic tanks and sanitary sewer installations add nutrients and degrade the bacteriological quality of lakes and streams in developed watersheds. It should be noted that these consequences are virtually inevitable with the introduction of human activities in any watershed. The rate of change and the degree to which nuisance or aesthetic problems develop is a function of the care and protection provided to the lake watershed during the course of development and utilization. Salting of roads for ice or dust control results in increasing water salinity and may produce density stratification and oxygen depletion in deeper waters in lakes.

Under undisturbed conditions (i.e., where man has not intervened), approximatley equal amounts of nutrient material is brought into a watershed by animals as is carried away by them. This is not characteristic of human utilization of watershed areas. By and large, as people move into an area, their required materials are imported from outside the watershed area and the waste products are then usually discharged within a watershed, providing a sharp increase in the number and amount of nutrients within the watershed area. Nutrients dissolved in runoff and ground water tend to move downslope into lakes and streams, and eventually into estuaries of the sea. The ability of a lake to retain or pass on nutrients brought to it by slope wash or erosion is a function of the water supply to the lake.

As nutrients in a watershed increase, one of the consequences is an increase in biological fixation of nutrient elements. Increased growth of algae in turn supports in an increase in other organisms that require the algae as food. It is normal for the amount of nutirents in an ecosystem to increase with time as a result of the movement of water into the lake from the watershed, such that the lake becomes more productive and capable of supporting larger fish populations. One symptom of rapid nutrient addition to a lake is the development of rooted aquatic plants in shallow water. Rapid and profuse growth of water lilies, pickerel weed, and cattails is characteristic of nutrient=rich conditions. Where nutrient concentrations are sufficiently high, floating aquatic flowering plants such as duckweed may develop. Increasing nutrient stress may result in the development of large floating mats of algae, whose decay may cause unpleasant odor problems. While all of these things are characteristic of productive lakes and are essential in any lake system that is to support a large number of fish, the increase in biomass may impose severe oxygen stress on the lake system. During the day algae and other green plants manufacture Oxygen in the process of photosynthesis, thereby adding oxygen to the lake waters. Lake water, however, can only retain about 10 mg/l of oxygen at saturation. Production of oxygen in excess of this amount results in the formation of gas bubbles and not infrequently, masses of floating algae with large gas bubbles trapped in them.

Although oxygen is produced during daylight hours by photosynthesis, at night oxygen is consumed by algae, bacteria, zooplankton, and fish. In addition, as the algae mature and die, they are decomposed by bacteria which in turn impose an oxygen stress on the lake waters. In highly eutrophic lakes, oxygen stress at night may become sufficiently great as to use up most of the dissolved oxygen in the lake, causing the death of desirable species of algae and fish.

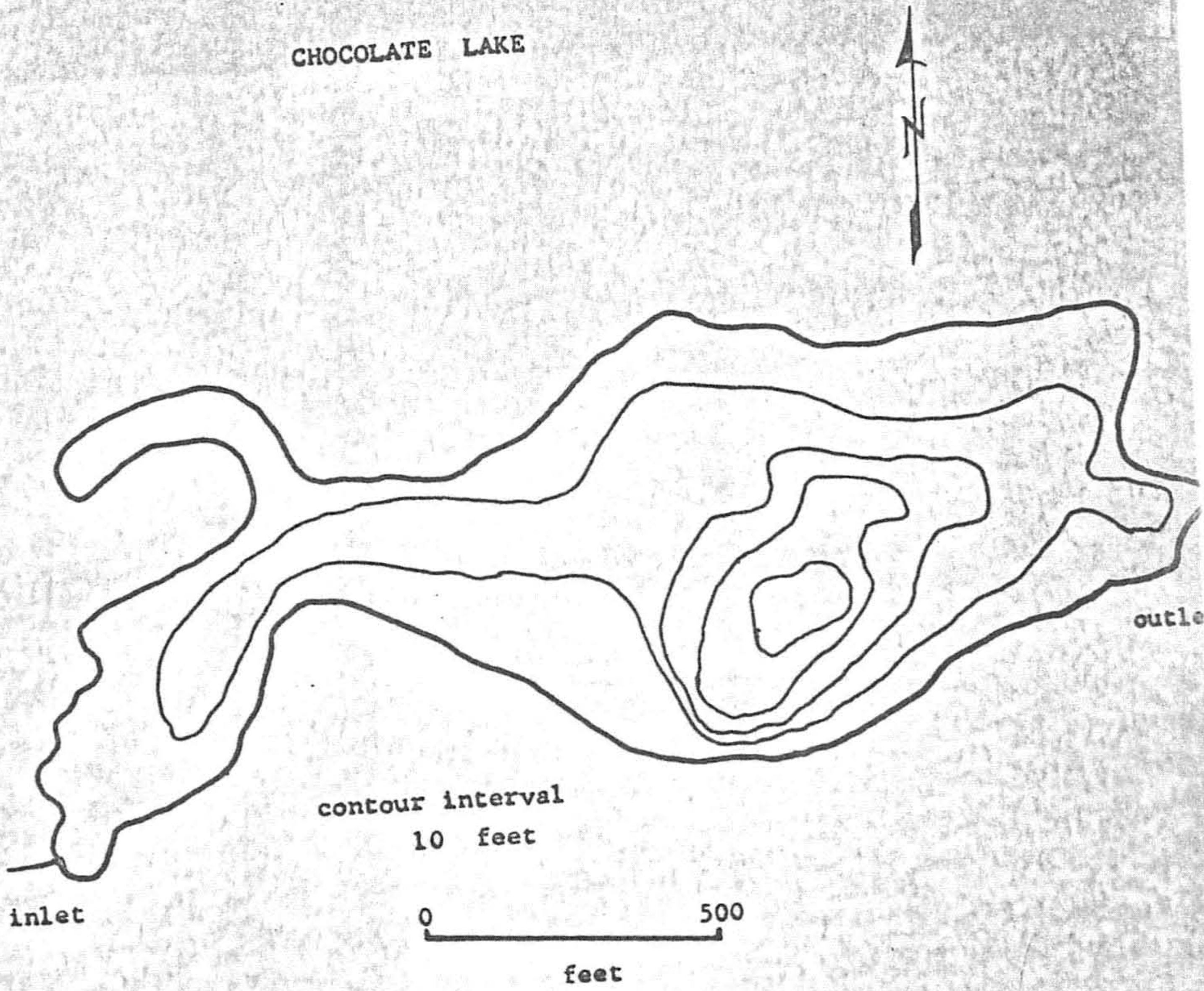
Although diversion of storm runoff from a lake may reduce the input of nutrients and silt into the system, at the same time, reduction of water supply to the lake will increase its flushing time, resulting in the longer retention of nutrients, bacteria, and solids.

WATER QUALITY OF SPRYFIELD AREA LAKES AND MACINTOSH RUN

A. CHOCOLATE LAKE. Closest to the center of Halifax, Chocolate Lake is located 75 feet above sea level near the Armdale Rotary between the St. Margaret's Bay Road and the Herring Cove Road. The surface of the lake occupies a little more than 22 acres and the watershed covers approximately 240 acres. Initially, the Chain Lakes drained through Chocolate Lake, but with the construction of the dam at the outlet of Second Chain Lake and its development as a water supply lake for the city of Halifax, this drainage has been interrupted except for occasional overflows. Virtually 100% of the Chocolate Lake watershed is developed, primarily for single and multiple family residences. A small shopping complex and motel area is located in the watershed. About .75 miles of the heavily-travelled St. Margaret's Bay Road (Rte. 3) passes through the watershed.

Of all the lakes studied in 1971 MAPC Lakes Report (Ogden, 1971), Chocolate Lake showed the greatest evidence of effects due to human activities in the watershed. Because of heavy salting of roads in the watershed for ice control, Chocolate Lake consistently has the highest Sodium and Chloride values of any lake in the Halifax-Dartmouth metropolitan area. Continuing investigations over the past four years indicate that the lake is unable to flush or replace the annual influx of road salt completely. Figure 1 shows the surface outline and depth contours of Chocolate Lake. Density stratification of salt produces values of 400-900 parts per million of Chloride in the deep

CHOCOLATE LAKE



waters (30-40 feet) of the lake. Water Chemistry studies of the lake in 1971 showed high values of Nitrogen, indicative of sanitary waste overflows in the system. The source of these waste overflows is an overloaded force-pumping station at the foot of Crescent Avenue near the inlet to Chocolate Lake.

Winter (Feb.,1971) and summer (July, 1971) water chemistry values are shown as Tables I and II, respectively. Continuing studies on this lake have demonstrated that it is the most variable of all the lakes in the Halifax-Dartmouth area, due to road salting and the frequency of overflows from the sanitary waste pumping station. Coliform bacteria counts for several stations around the lake show uniformly high values throughout the year.

Some indication of the changes in the Chocolate Lake system can be seen in the changes that have occurred in the algal flora of Chocolate Lake in the past 50-75 years. Sediment cores from the center of the lake basin (40 feet) reveal that to a depth of 30 cm (1 foot) in the sediment algal remains characteristic of eutrophic conditions are prominent. Below this level, the characteristic algae of undisturbed oligotrophic Nova Scotian lakes are found. These data are illustrated in Figure 2.

Similarly, changes in the diatom flora of the lake show increasing effects of salt. Figure 3 shows that over the last 50-75 years (50 cm), there has been a gradual replacement of pennate (characteristic of fresh waters) diatoms by centric diatoms (characteristic of saline waters).

These data indicate that there have been very rapid and dramatic changes in the biology of Chocolate Lake within recent

Lake 7

CHOCOLATE LAKE

Watershed number : 42

Location: 44°38'20" N, 63°37'30" W

Elevation above sea level: 75 feet

Area of lake: 22.07 acres

Watershed area: 240 acres

Shoreline length: 5,800 feet

Shoreline development: 1.67

Maximum depth: 44 feet

Mean depth: 12.8 feet

Volume: 1.236 x 10^7 ft^3

Capacity: 77.05 x 10^6 Imp. gallons

Flushing time: 6 months

Date sampled: 4 July, 1971	Inlet	Surface	40 feet	Outlet
Sodium	90.5	51.4	161.0	59.2
Potassium	2.59	1.65	2.92	1.56
Calcium	1.6	1.0	2.4	1.1
Magnesium	2.6	1.51	3.15	1.39
Manganese	.63	.45	.50	.47
Iron	-	-	4.8	-
dissolved O_2	9.0	8.0	0	-
Temperature		21.5°C		
pH		7.0	6.7	6.7
Conductivity		370.0	900.0	370.0
Total alkalinity	6.0	9.0	40.0	-
Carbon dioxide	14.0	2.8	64.0	-
C.O.D.	1.7	1.4	4.0	1.9
Chloride	148.5	104.0	340.0	102.0
Sulfate	17.0	17.0	41.0	16.0
Ammonia Nitrogen	.43	.09	4.2	.09
Nitrite Nitrogen	.003	.003	.01	.002
Nitrate Nitrogen	1.009	.081	.14	.043
soluble Phosphate	$< .01$	$< .01$	.014	$< .01$

Secchi disc transparency 11.7 ft.

WATER CHEMISTRY -- CHOCOLATE LAKE, Halifax, N.S.

12 February, 1971 --- Biology 206B

Location	Inlet	Inlet	Cove	Cove	Center				Outlet	
Test	1m	3m	1m	2m	1m	3m	6m	9m	1m	3m
pH	6.7	6.3	6.5	6.3	6.7	6.5	6.5	6.6	6.7	7.3
Temperature °C.	4.5	-	4.5	-	4.5	4.5	4.5	4.5	-	-
Dissolved O_2	10	11	11	--	11	12	-	-	11	-
Conductivity µmhos	375	600	300	400	280	450	600	600	475	500
Sodium	47.	101.	40.	92.	53.	88.	120.	(155)	79.	101.
Potassium	4.	4.	3.5	4.	3.	4.	4.	4.	4.	4.
Calcium	19.6	25.9	17.9	24.2	15.4	25.0	28.0	(305)	21.3	23.3
Magnesium	2.5	3.0	2.5	3.0	2.0	3.0	3.0	2.5	2.5	2.5
Iron	0	0	0	0	0	0	0	0	0	0
Manganese	0	0	0	0	0	0	0	0	0	0
Ammonia (NH_4^+)	0.1	0.3	0.1	0.1	0.15	0.15	0.15	0.1	0.1	0.4
Nitrite (NO_2^-)	.05	-	.01	-	.008	-	-	-	.008	-
Nitrate (NO_3^-)	5.8	-	6.2	-	4.0	-	-	-	4.2	-
Phosphate (o-PO_4)										
Chloride (Cl^-)	144	247	121	196	115	236	317	305	173	247
Sulfate ($SO_4^=$)	25	35	50	30	29	35	30	40	30	30

Values in mg/liter, except for Temperature (°C.); pH; and Conductivity

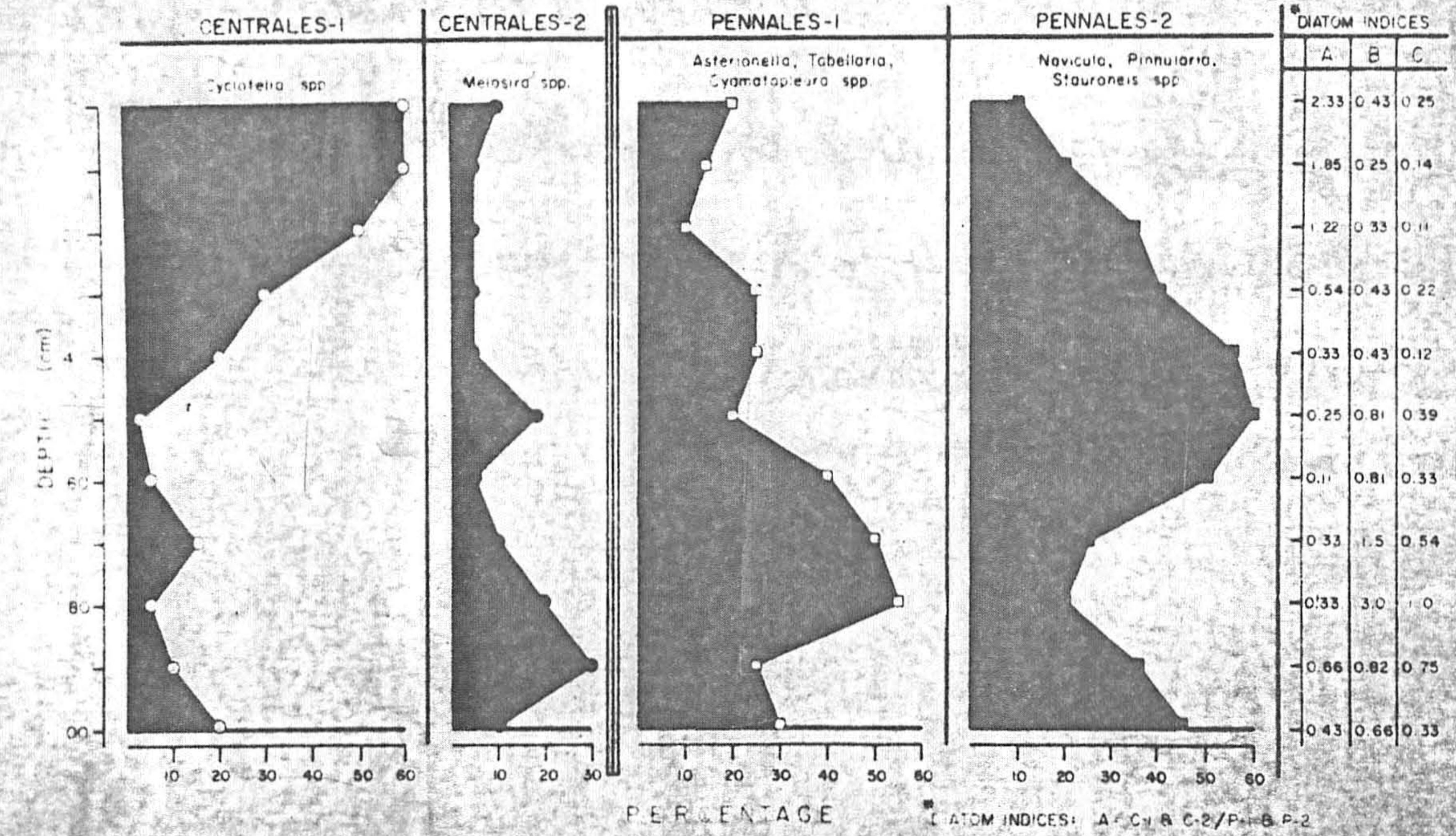
Values in brackets () doubtful

"-" means test not performed; "0" means less than detectable limit; generally .1 ppm.

ALGAE OF CHOCOLATE LAKE

OLIGOTROPHIC:	00	10	20	30	40	50	60	70	80	90	100
BOTRYOCOCCUS SPP.	-	-	+	+	::::	+	:::	::	::	+	::
COSMARIUM SPP.	-	+	+	+	:::	::	+	::	::	+	+
STAURASTRUM SPP.	+	+	+	::	::	::	+	::	-	-	+
EUASTRUM SPP.	+	+	+	+	+	::	-	-	-	-	-
SORASTRUM SPP.	+	+	+	+	+	-	-	+	+	-	-
MICROSTRIAS SPP.	+	+	+	::	+	-	-	+	+	+	-
DESMIDIUM SPP.	+	-	+	+	+	+	+	+	-	-	+
CLOSTERIUM SPP.	+	-	+	-	+		-	-	-	-	-
SPHAEROZOSMA SPP.	+	-	-	+	:::	::	+	+	-	-	-
CHRYSOPHYCEAE CYSTS	+	+	+	::	:::	::	::	:::	+	-	+
EUTROPHIC:											
SCENEDESMUS SPP.	::::	:::	:::	::	+	+	-	+	-	+	-
ANKISTRODESMUS SPP.	:::	::	+	+	-	-	-	-	-	-	-
COELASTRUM SPP.	:::	+	-	-	-	-	-	-	-	-	-
PEDIASTRUM BORYANUM	+	+	+	::	+	+	+	+	-	+	-
P. DUPLEX	+	::	::	::	::	+	+	-	-	+	-
P. D. CLATHRUM	+	::	-	::	+	-	-	-	-	-	-
P. ARANEOSUM	::	::	::	+	+	-	-	-	-	-	-
PEDIASTRUM SPP.	::	::	::	+	-	-	-	-	-	-	-

CHOCOLATE LAKE DIATOMS



*DIATOM INDICES A	B	C
2.33	0.43	0.25
1.85	0.25	0.14
1.22	0.33	0.11
0.54	0.43	0.22
0.33	0.43	0.12
0.25	0.81	0.39
0.11	0.81	0.33
0.33	1.5	0.54
0.33	3.0	1.0
0.66	0.82	0.75
0.43	0.66	0.33

*DIATOM INDICES: A = C-1 & C-2/P-1 & P-2
B = C-2 & P-1/C-1 & P-2
C = C-2 & P-1(-T)/C-1 & P-2+T

times, and that these changes are continuing at present. In the absence of corrective measures to reduce the inputs of nutrients to this lake, it is anticipated that the very rapid eutrophication evident in the changes in algal, diatom, and planktonic flora and fauna will continue at an accelerated rate.

B. Catamaran Pond - Colpitt (Colbart) Lake - Williams Lake.

Nearly bisecting the Spryfield area is a 1420 acre watershed that includes two relatively large lakes (Colpitt and Williams) whose continuing value as recreational and aesthetic amenities are seriously threatened by rapid urbanization in the area. It should be apparent that watershed development controls must extend to the limits of the watershed (viz., Catamaran Pond) to provide effective control for inputs to the downstream lakes.

B.1 Catamaran Pond. A small pond, of approximately two acres with approximately 10 acres of watershed draining into its basin, this pond is drained primarily by ground water flow and intermittently by a surface stream to Colpitt (Colbart) Lake. The lake is quite shallow (max. depth approx. 9 feet), and is surrounded and nearly bisected by a dense stand of Cattail. Nutrient-rich surface and ground water flow into the lake have resulted in rapid eutrophication of the pond. There are few roads in the area and consequently little evidence of salting effect, although the Chloride values are approximately 10 times that for natural waters. The pond is located near the divide for the Long Lake watershed, and is separated from it by only a few hundred feet. The accompanying table shows water chemistry parameters for

CATAMARAN POND

Sampled: 26 August, 1972

	Surface	8.6 feet
Sodium	30.0	28.0
Potassium	1.12	0.98
Calcium	12.2	11.7
Magnesium	1.44	1.44
Manganese	-	-
Iron	-	-
Dissolved Oxygen	8.5	8.5
Conductivity (umhos)	270	280
Total Alkalinity	31.0	43.0
Carbon Dioxide (diss.)	26.0	24.0
C.O.D.	10.0	12.4
Chloride	67.3	70.5
Sulfate	21.0	22.0
Ammonia Nitrogen	0.29	0.29
Nitrite Nitrogen	-	-
Nitrate Nitrogen	0.34	0.34
Soluble Phosphate	0.011	0.115

Secchi Disc Transparency 6.2 feet

Catamaran Pond as determined 26 August, 1972. Relatively high values for Nitrogen and Phosphate indicate that there is an external source of nutrients for the lake, presumably as ground water leachates and domestic waste runoff. It should be noted that the extensive growth of cattail and pond weeds provide an effective nutrient trap to prevent release of nutrients into the lower lakes during the growing season.

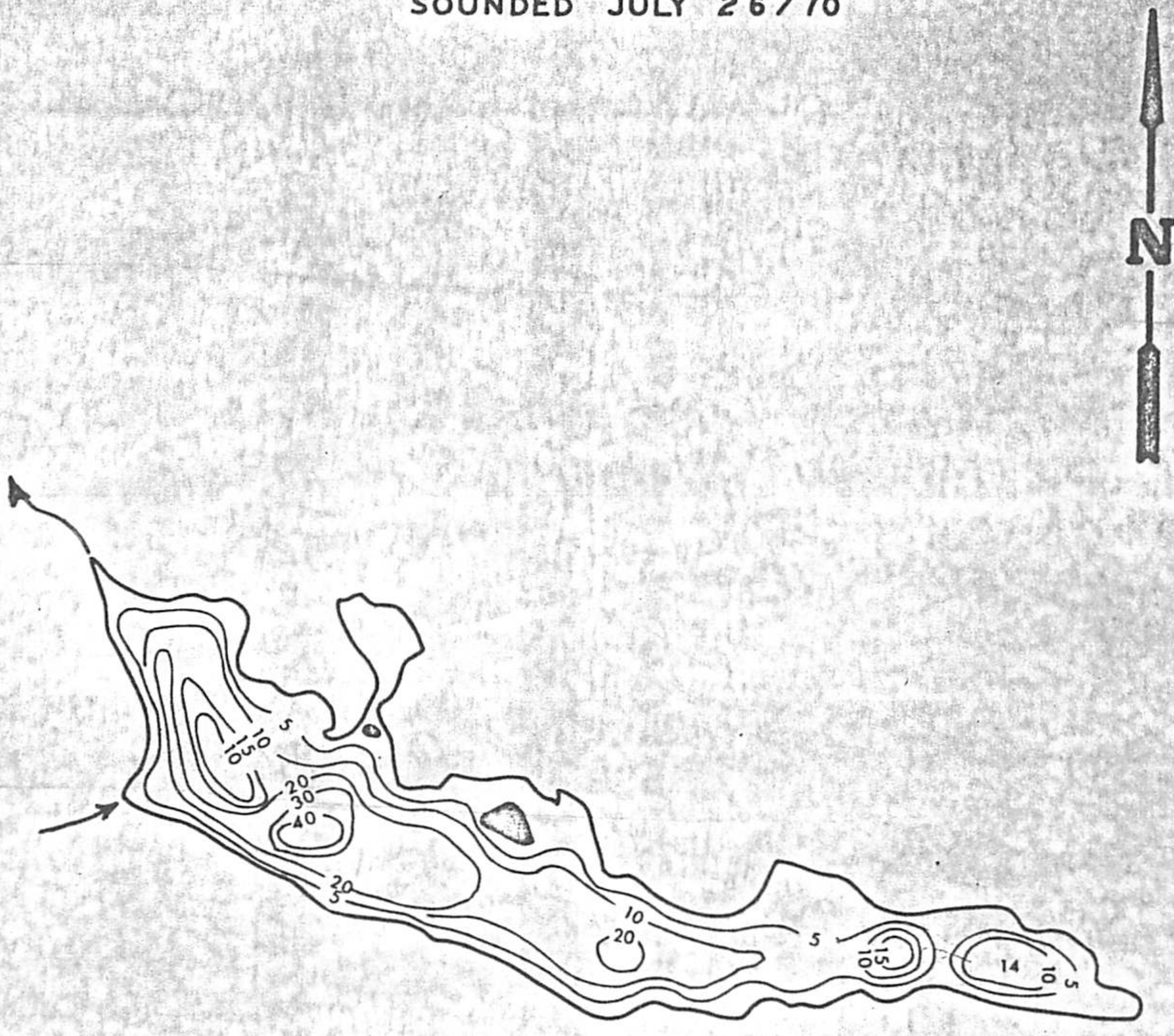
High C.O.D. (Chemical Oxygen Demand) values and Dissolved Oxygen values at less than 75% of saturation indicate that the system is highly eutrophic and under some stress at the present time. Lack of nutrient input control is likely to make this pond an aesthetic liability in the near future.

B.2 <u>Colbart Lake</u>. Surface area of this lake is approximately 37 acres and the surrounding watershed (including Catamaran Pond) is about 544 acres. A Bathymetric map of the lake shows that the average depth of the lake is about 15-20 feet, with a small area greater than 40 feet. Proximity of the inlet (from Catamaran Pond) to the outlet (to Williams Lake) indicates that there may be poor mixing from the upstream end throughout the lake. Although the eastern end of the lake is quite boggy, extensive shallow areas and sluggish circulation indicate that water temperatures in excess of 70° F. may be expected during the summer season, offering possible summer recreational swimming. Because of weak flushing characteristics in the eastern end, bacteriological quality of this portion of the lake is particularly susceptible to surface runoff pollution. There is very little development in the watershed at the present time, with only the inlet

COLBART LAKE

DEPTH CONTOURS

SOUNDED JULY 26/70



CONDUCTIVITY PPM. JULY 26/70.
TEMP. SURFACE 78° F. "

stream from Catamaran Pond passing through a residential area and crossed by the Williams Lake Road from Spryfield to Jollimore.

Water chemistry data from the MAPC Lakes Survey (Ogden, 1971) are included for comparison with samples collected one year later. Although season totals for snowfall for the two years are nearly the same (1971 = 119.4 in; 1972 = 113.7 in), residual Chloride values in Colbart L. were nearly twice the 1971 values. The difference is apparently attributable to the use of Calcium Chloride ($CaCl_2$) for dust control on roads in the watershed during the summer. This interpretation is supported by the increase from 1.60 mg/liter (ppm) in 1971 to 9.10 mg/l in 1972.

High values of C.O.D. (Chemical Oxygen Demand) at the inlet to Colbart Lake indicate substantial organic loadings from the stream. Qualitative coliform tests indicate that the water is probably unsuitable for recreational purposes at the present time in the vicinity of the inlet stream. Since only 20% of the Colbart Lake watershed is under development at the present time, and the Halifax City Master Plan indicates approximately 75% development in the watershed area, it is apparent that this lake is in a critical position with respect to maintaining water quality for recreational use and aesthetic enjoyment.

COLPITT (COLBART) LAKE

Date Sampled: 26 August, 1972

	Inlet	36 feet
Sodium	27.0	24.0
Potassium	1.93	0.98
Calcium	9.10	4.17
Magnesium	1.33	0.62
Manganese	-	-
Iron	-	-
Dissolved Oxygen	8.0	3.5
Temperature	60° F.	
Conductivity	178	142
Total Alkalinity	23.0	14.0
Carbon dioxide (diss.)	12.0	20.0
C.O.D.	14.8	4.5
Chloride	65.2	50.6
Sulfate	10.0	17.5
Ammonia Nitrogen	0.61	0.60
Nitrite Nitrogen	-	-
Nitrate Nitrogen	0.33	0.27
Soluble Phosphate	0.10	0.07

Secchi disc transparency 12.0 ft.

B.3. <u>Williams Lake</u>. Largest (115 acres), and most visible and accessible of the newly acquired Halifax Metropolitan lakes, Williams Lake drains approximately 1420 acres from Catamaran Pond and Colbart Lakes. In addition to being the largest of the lakes in the annexed area, it is also the deepest (max. depth 66 feet). The West end of the lake is uniformly shallow, rarely exceeding five feet of water depth. This end of the lake not only includes the inlet from Colbart Lake and Catamaran Pond, but also (A. on the accompanying Figure) a shallow embayment receiving nutrient input from overflows from a sanitary sewer force main pumping station on the Williams Lake Road. The shallow bay is nearly overgrown at present with Water lilies and Pontederia as a result of nutrient input from this station. At present, this area is being developed and includes a number of expensive dwellings whose location capitalizes on proximity to the pond and Williams Lake. Measurements from aerial photographs in 1971 and 1972 indicate that the macrophyte flora (water lilies and pond weeds) have more than doubled in areal extent in one year. In view of the extensive shallow (less than 5 feet) area extending from this embayment and the Colbart Lake inlet (where a less extensive, but prominent area of emergent aquatic plants is found), it may be anticipated that this whole area will become covered with such growths within a few years in the absence of development controls on nutrient inputs. It should be noted that these consequences are independent of any further development in this watershed area. At the present rate of growth, the West end of Williams Lake will become unsuitable for even recreational canoeing with 10-20 years. Development of these plant communities provides an effective nutrient trapping mechanism which assists in maintaining the clarity of waters in the central and eastern parts of the lake.

The ability of emergent plant communities and their associated microflora and fauna to control and reduce coliform bacterial populations is not well understood. The eastern end of Williams Lake is at present a recreational swimming area. Sequential sampling by public health authorities indicate that the swimming area has threateningly high coliform bacterial counts at least 30% of the time during the summer season. Independently of development plans, this situation may be expected to continue to degrade in future with remedial action to reduce nutrient and waste inputs to Williams Lake.

For comparative purposes, 1971 lake water chemistry data is presented (MAPC Lake Report, 1971) as well as data from the same period (August) in 1972. It can be seen that there are no dramatic changes at any of the stations sampled. Although superficially reassuring, it should be remembered that a substantial part of the chemical stability of the system is due to the fact that the aquatic macrophyte community is absorbing a substantial part of the loading imposed by increasing waste loadings imposed on the system. It is anticipated that a continuing degradation of water quality will take place in the absence of effective development controls and remedial action for inputs presently entering the system.

Lake 40 WILLIAMS LAKE

Watershed number: 43

Location: 44°37'20" N, 63°31'25" W

Elevation above sea level: 62 feet

Lake area: 115 acres	Watershed area: 1420 acres (including Colbart Lake)
Shoreline length: 14,560 feet	Shoreline development: 1.73
Maximum depth: 66 feet	Mean depth: 8.1 feet
Volume: 71.4 x 10^6 ft^3	Capacity: 445.1 x 10^6 Imp. gallons

Flushing time: 8 months

Date sampled: 17 August, 1971	Inlet (ex Colbart)	Surface	65 feet	Outlet
Sodium	9.7	35.7	146	37.9
Potassium	.70	.98	1.70	.98
Calcium	3.11	5.40	.76	5.11
Magnesium	.73	1.13	2.06	1.13
Manganese	-	-	.19	-
Iron	-	-	-	-
dissolved O_2	7.8	7.8	2.75	7.25
Temperature		19.3°C.	4.5°C.	
pH				
Conductivity	83	260	600	278
Total alkalinity	8	18	18	11
Carbon dioxide	10	4.8	25	4.8
C.O.D.	9.4	3.1	2.7	3.1
Chloride	17.5	77.0	229.5	77.0
Sulfate	14	11	18	12
Ammonia Nitrogen	.47	.76	.67	.05
Nitrite Nitrogen	.004	.007	.003	.004
Nitrate Nitrogen	.72	.108	.255	.085
soluble Phosphate	.029	.017	.039	.016

Secchi disc transparency 33 feet

WILLIAMS LAKE

8/27/72

	0M	19.5M	Wms.Lake Inlet	Wms. Lake Outlet
Sodium	61.0	146	12.0	61.0
Potassium	1.12	1.51	0.70	1.12
Calcium	6.52	11.30	2.34	6.1
Magnesium	8.21	1.23	0.71	0.82
Manganese				
Iron				
Dissolved O_2	8.7	4.1	7.8	
Temperature			64°	70°
pH				
Conductivity	370		77	360
Total Alkalinity	10	10	10	11
Carbon Dioxide	4	16	12	4
C.O.D.	2.1	2.6	6.1	3.1
Chloride	109.6	289.1	31.5	116.2
Sulfate	13.5	25	12	12
Ammonia NITROGEN	.19	.34	.27	.13
Nitrite Nitrogen	.001	0	0	.002
Nitrate Nitrogen	.15	.33	.32	.152
Soluble Phosphate	.157	.013	.035	.08
Secchi Disc.	~~8.0M~~ 27.4 feet			

C, SEWAGE AND STORM DRAINAGE FACILITIES IN THE WHIMSICAL LAKE- FROG POND JOLLIMORE-WILLIAMS LAKE AREA

1 - ~~Introduction~~ - The watershed area described ~~in this report~~ includes approximately 335 acres to the Frog Pond outlet. Of this total approximately 195 acres lie behind the outlet of Whimsical Lake. A total of approximately 600 dwelling units are at present serviced by sanitary sewer throughout this region. As many as 150 additional units may be added, including the proposed developments under consideration at this meeting, representing an increase in system loading of approximately 25%.

II - Sanitary Sewer - The sanitary sewer system includes approximately 40,000 lineal feet (7.5 miles) of 8,10, and 12 inch collector pipes all delivering to a 15 inch main at the Williams Lake Pumping Station. From this point sewage is conducted by two 10" force mains up into the Spryfield MacIntosh Run system. Within the Jollimore and North Spryfield system, two force main pumping stations, one at Whimsical Lake and one at the Dingle Tower, contribute to the Williams Lake pumping station. Evidence has been presented at this hearing that all of these systems exhibit operating stress during periods of heavy runoff. Fig. I and table 1 shows coliform bacterial counts at Whimsical Lake in relation to rainfall in the preceeding 24 hours. It is extremely unlikely that coliform loadings of ths magnitude can be expected from the few houses presently ajacent to the lake shoreline. These data are consistent with sewage backup and overflow from the Whimsical Lake pumping station.

Similar evidence in the vicinity of the Williams Lake pumping station confirms continuing problems with overload at the present time. The extremely rapid development of water lilies in the arm of Williams Lake ajacent to the sewage pumping station is evidence of extremely rapid eutrophication of this water body by overflow from the pumping station. At present, the water quality of Williams Lake is protected by the nutrients removed during the growth of the water lilies and associated vegetation, Nutrients trapped by the plants during the growing season will be released during winter, threatening continuing water quality of William's Lake. The addition of 25% more load than presently carried by the sewer system can only exacerbate an already degraded system. The problem of determining existing system load is further complicated by the fact that there is extensive infiltration into the nearly 40,000 feet of sewer line in many parts of the system. This has been demonstrated in a recent surve of waterflow in various parts of the system conducted by the City Engineering crew last year.

III - Storm Runoff - A hydrologic study relating to surface drainage in the Albion Road-Parkhill-McManus Road section of Jollimore is appended to this report.

On sloping terrain and frozen ground (maximum runoff potential the rate of runoff can approach the rate of rainfall. On several occasions in the past few months we have had rainfall rates in excess of .25 inches per hr. and accumulations ranging up to nearly 3 inches in 24 hrs. On the Whimsical Lake watershed, consisting of approximately 195 acres, 1 inch of rain may present 0.7x10^6 cubi feet of water at the outlet of the pond. This water is conducted by an intermittent stream bed to Frog Pond. There are approximatel 355 acres of land in the Frog Pond watershed to the outlet of the pond. Including the Whimsical Lake drainage, 1 inch of rain on this watershed may produce 1.3x10^6 cubic feet of water. At present the rate of runoff is diminished by the presence of swampy land at the head of Whimsical Lake. The rocky bed of the stream channel from Whimsical Lake to Frog Pond further delays the rate of appearance of runoff peaks at Frog Pond.

Construction of storm drains and ditches will only serve to bring water more rapidly to drainage points in the system. Continue development in the upper part of the Whimsical Lake watershed must inevitably result in flooding in the lower regions of the watershed unless runoff water is conducted completely out of the system.

The practice of conducting water away from watersheds is undesirable in general, as it increases the natural flushing time of the lakes formerly served by runoff and ground water developed within the watersheds. In the case of Whimsical Lake and Frog Pond, such practice is guaranteed to further degrade the water quality of these two bodies of water.

CONCLUSIONS:

As all parts of the system demonstrate stress at the present time, it is imperative that a moratorium on development be declare until such time as the problems outlined in this and other reports presented to this hearing can be resolved.

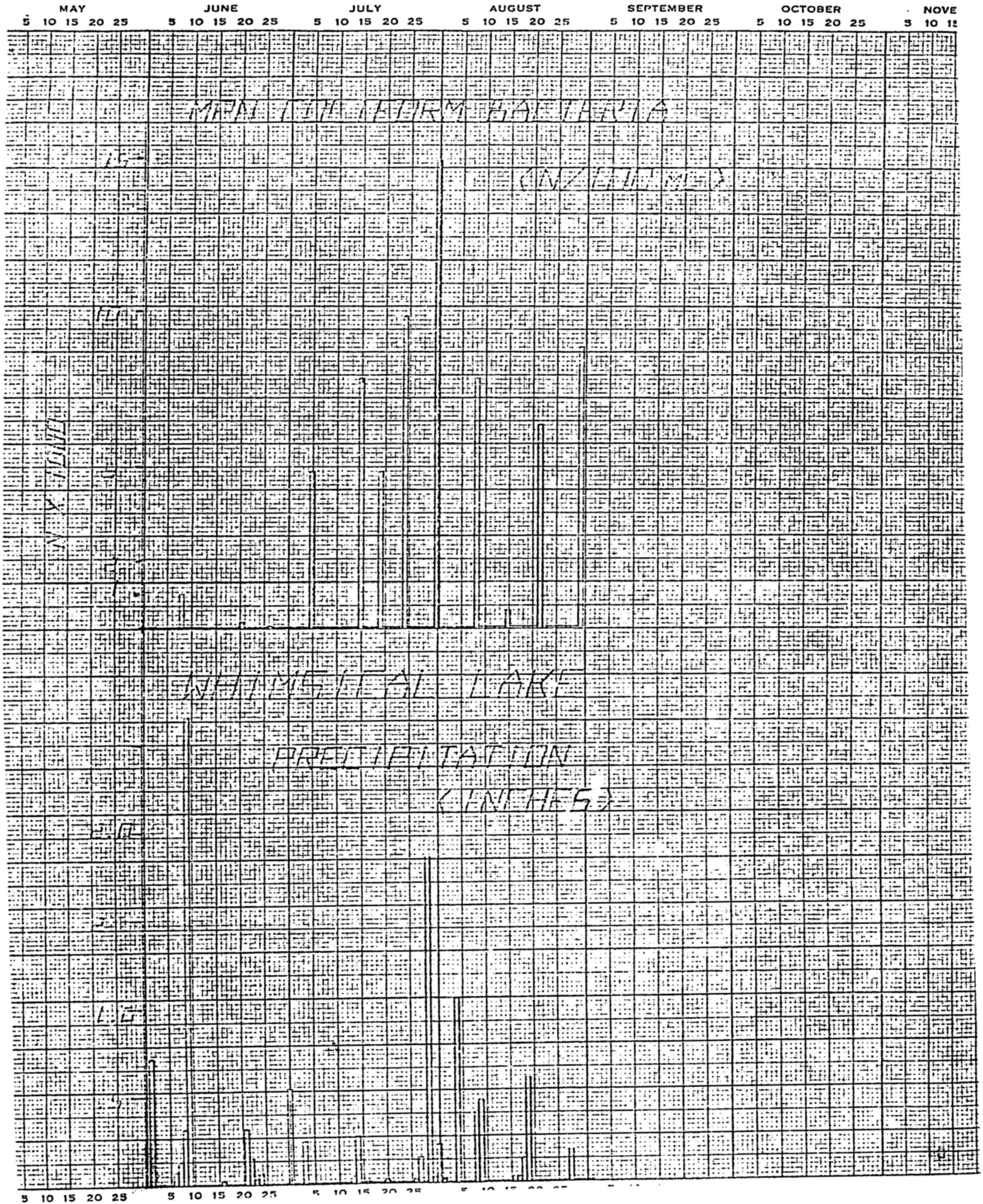
TABLE I

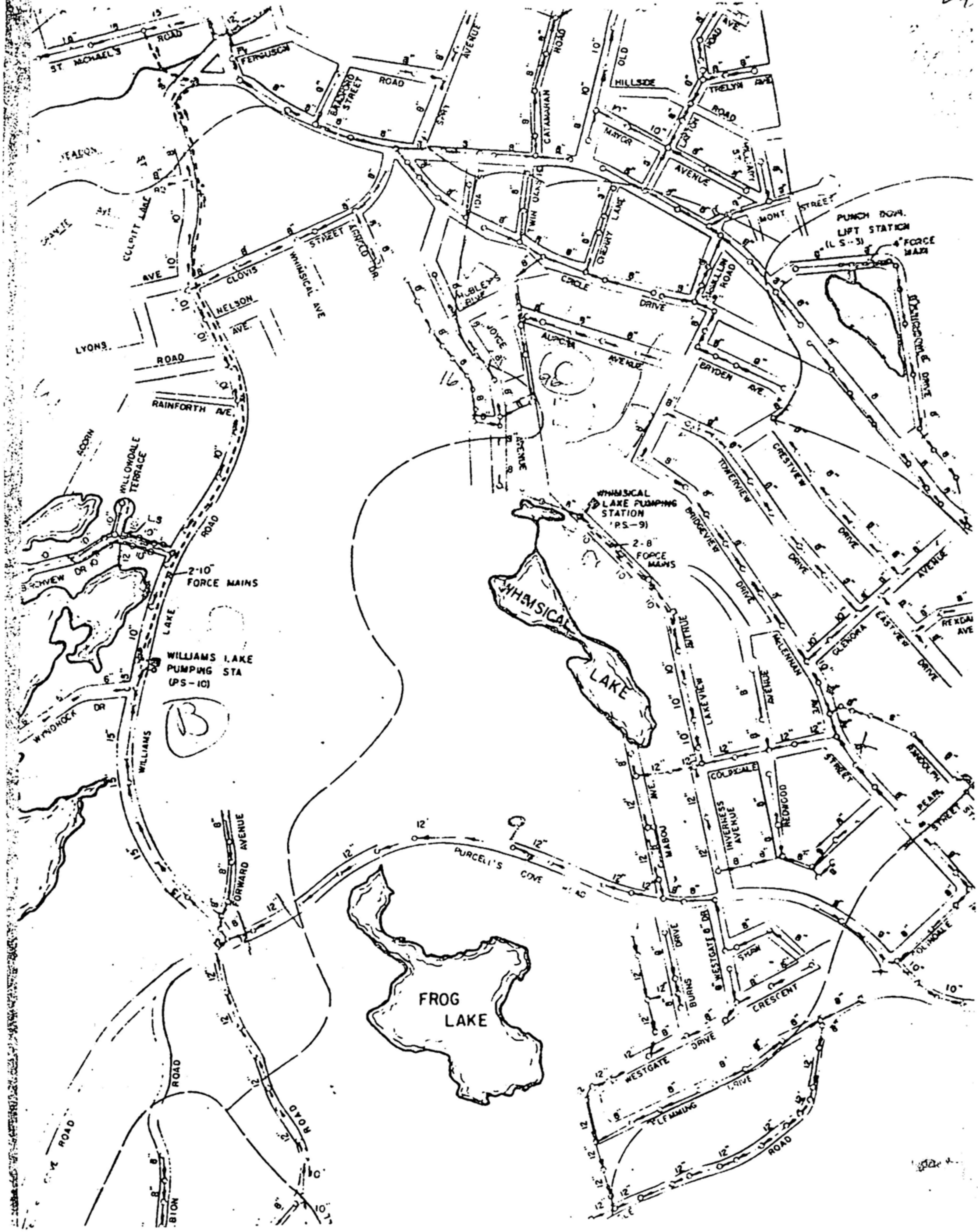
COLIFORM BACTERIAL COUNTS

WHIMSICAL (TIGER) LAKE
SUMMER, 1972

DATE	MPN No./100 ml	RAINFALL (24 Hr. previous)
June 8	1100	.19
14	0	0
21	200	TR*
27	60	.03
July 6	5000	.23
15	8000	.26
19	5000	.02
25	10000	.02
Aug.1	15000	.02
8	8060	.84
16	550	.03
22	6500	0
30	9550	0

Tr=Trace


MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVE
5 10 15 20 25
MPN COLIFORM BACTERIA
(N/100 ML)
WHIMSICAL LAKE
PRECIPITATION
(INCHES)
2.0
1.0

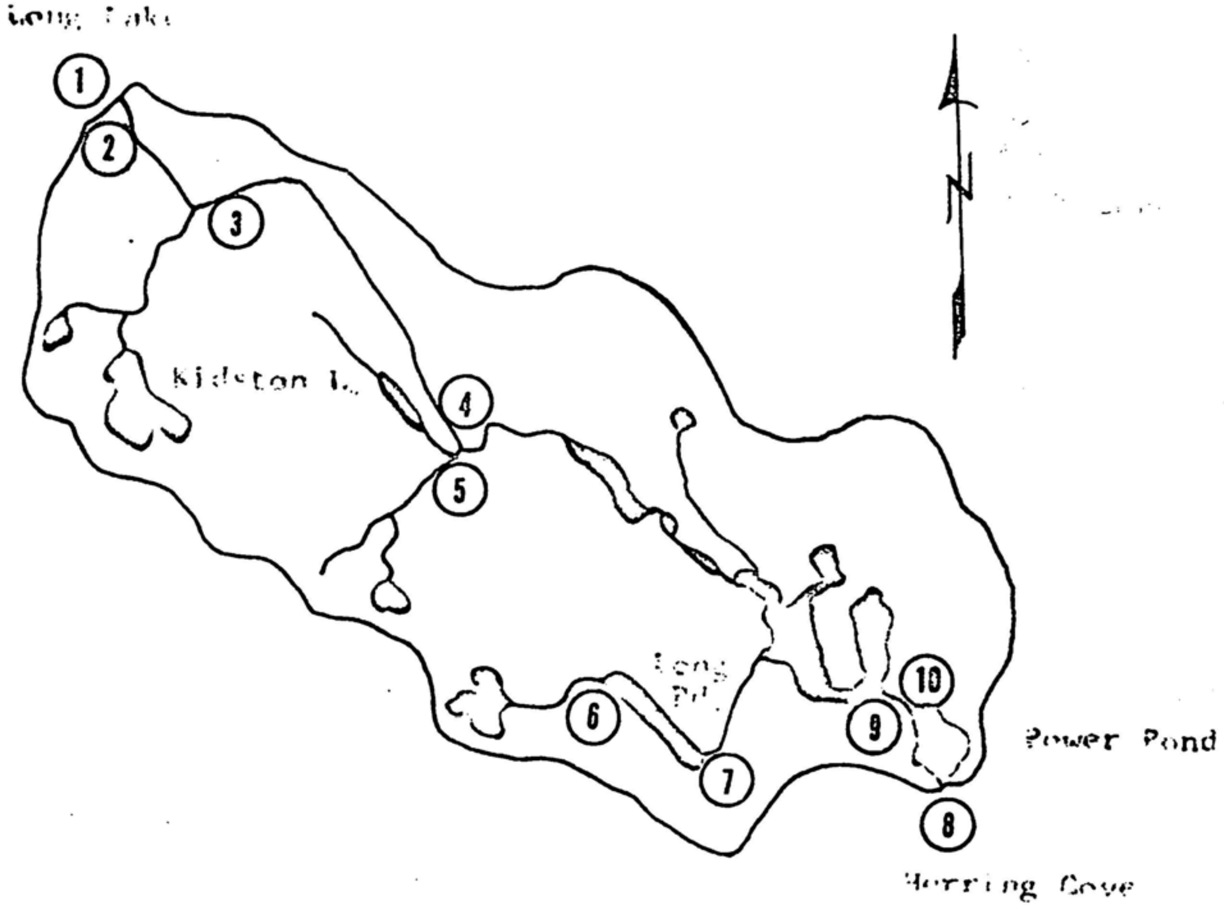

ST. MICHAEL'S ROAD
FERGUSON
BAKER STREET
ROAD
ST. AVENUE
CATAMARAN ROAD
OLD
HILLSIDE
TRELYN AVE
ROAD
MAYOR AVENUE
LAYTON
ST.
MONT STREET
PUNCH BOWL LIFT STATION (L.S.-3)
4" FORCE MAIN
CULPIT LAKE
AVE
CLOVIS STREET
WHIMSICAL AVE
ACADIA DR.
IDA ST.
TWIN OAKS
CHERRY LANE
CIRCLE DRIVE
McMILLAN ROAD
NELSON AVE.
LYONS ROAD
RAINFORTH AVE.
JOYCE
AURORA AVENUE
BRYDEN AVE.
AVENUE
ACORN
WILLOWDALE TERRACE
L.S.
BIRCHVIEW DR
2-10" FORCE MAINS
WILLIAMS LAKE PUMPING STA (P.S.-10)
WINDROCK DR
WILLIAMS LAKE ROAD
WHIMSICAL LAKE PUMPING STATION (P.S.-9)
2-8" FORCE MAINS
WHIMSICAL LAKE
BRIDGEVIEW DRIVE
TOWERVIEW
CRESTVIEW DRIVE
DRIVE
AVENUE
GLENORA AVE
EASTVIEW DRIVE
REXDALE AVE
McLENNAN AVENUE
LAKEVIEW
AVENUE
STREET
RANDOLPH
PEARL STREET
COLPDALE
INVERNESS AVENUE
REDWOOD
MABOU AVE.
PURCELL'S COVE ROAD
FORWARD AVENUE
FROG LAKE
DRIVE
BURNS
WESTGATE DR
SHAW
CRESCENT
WESTGATE DRIVE
FLEMMING DRIVE
ROAD
ROAD
ROAD
BION
OLDHOLME
8"
10"
12"
15"
16
C
13

D. <u>MacIntosh Run</u>. In the MacLaren Report (1970), it is proposed that MacIntosh Run be used for storm water drainage for the Spryfield area. The problem is complicated by the fact that the present drainage characteristics will be altered by the addition of approximately 440 cfs to the system with the release of the Chain Lake-Long Lake reservoirs of the Public Service Commission water-supply system.

At present, MacIntosh Run serves as a drainage system for approximately 8500 acres, of which about 487 acres are developed for residential or light commercial purposes (1971). Development is occurring rapidly in this watershed area, with an additional 250 acres cleared and under construction in 1972.

For comparative purposes, water chemistry data from sampling stations established in 1971 were revisited twice in 1972 to obtain some idea of the variability and possible changes in loading associated with changing land use in the watershed area. Sampling stations are located as shown on the accompanying outline map, and sampling procedures are similar to those used for the earlier survey. Stations 1 and 2 are located immediately above the town of Spryfield near the head of MacIntosh Run at Long Lake. Very little overflow occurs from Long Lake at the present time, and none took place during the period of the surveys shown in the accompanying tables. Station number 3 is located just below the town of Spryfield and includes inputs from the Kidston Lake area (cf. MAPC Lakes report, 1971). The sharp increase in values for conductivity, sodium, chloride, chemical Oxygen demand, total nitrogen and phosphate clearly indicate the

SAMPLING STATIONS -- McINTOSH RUN
SPRYFIELD -- HERRING COVE



Scale 1:50,000

Although less than 20% of the total watershed area of MacIntosh Run is developed at present (1972), almost all of the existing industries and housing are located in close proximity to MacIntosh Run or on streams draining into MacIntosh Run.

Data in the water chemistry tables are arranged in sequence beginning with the head of the watershed and ending at the outlet of Power Pond where it enters tidal waters at Herring Cove. The effects of dilution by undeveloped watersheds can be clearly traced from station number 3 to Herring Cove by comparing values of selected nutrients downstream from major sources contributed at and above station #3. Changes at station #6 indicate the effects of overflow of a pumping station near Roadh Pond.

Incomplete information from older residents in the Herring Cove area indicate that MacIntosh Run has improved substantially in recent years as a result of collection of domestic waste in the trunk sewer running adjacent to Herring Cove Road. Present studies indicate that continuing improvement in the Run is threatened by uncontrolled discharges and overflows. Increased attention to effluent control to MacIntosh Run is necessary if the potential of this natural area is to be realized for recreational and passive land use development.

MAC INTOSH RUN

Date sampled: 8 July,1971.

Station #	1	2	3	4	5	6	7	9	10	8
Sodium	4.94	4.94	23.9	15.7	14.7	7.68	6.51	6.70	7.09	7.29
Potassium	.29	.62	.87	1.24	.83	.46	.54	.42	.50	.50
Calcium	lost	2.20	1.0	5.03	4.75	1.56	1.92	1.65	1.37	1.92
Magnesium	.55	.80	1.51	1.04	1.04	.65	.60	.63	.62	.63
Manganese	-	.20	.31	-	-	-	-	-	-	-
Iron	-	-	1.6	1.2	1.3	.90	.30	-	-	-
dissolved O_2	3.5	9.5	8.0	9.0	9.5	4.5	8.5	7.0	8.0	9.0
Temperature										
pH	5.3	5.9	6.5	6.3	6.4	4.7	5.4	5.1	5.4	5.4
Conductivity	50.0	42.0	153.0	100.0	100.0	54.0	44.0	50.0	47.0	47.0
Total alkalinity	4.0	11.0	20.0	10.0	10.0	3.0	6.0	6.0	9.0	7.0
Carbon dioxide	8.0	12.0	16.0	6.0	8.0	26.0	9.0	10.0	7.0	6.0
C.O.D.	6.0	2.1	7.5	12.1	12.3	22.8	12.4	8.0	8.0	7.1
Chloride	12.5	12.5	45.0	33.0	30.0	19.5	15.5	15.5	15.5	15.0
Sulfate	5.5	3.5	9.5	11.0	11.0	14.5	12.0	7.0	9.0	7.0
Ammonia Nitrogen	.26	.14	.25	.94	.34	.81	.40	.32	.30	.23
Nitrite Nitrogen	.003	.003	.006	0	0	0	0	0	.001	0
Nitrate Nitrogen	.41	.21	.74	.98	1.03	1.8	1.02	.57	.53	.55
soluble Phosphate	.01	.01	.07	.20	.225	.103	.035	.078	.018	.14

MCINTOSH RUN - SERIES
3rd August, 1972

	1	2	3	4	5	6	7	8
Sodium	6.31	7.01	7.95	10.95	10.53	7.81	8.65	8.72
Potassium	.49	0.48	0.73	1.01	0.84	0.58	0.59	0.73
	010	0.30						
Magnesium	0.60	0.95	0.98		1.32	0.76	0.88	0.84
Manganese			0.11	0.12	0.10		0.11	0.09
Calcium	1.05	1.95	3.98	4.21	4.12	1.44	2.18	1.99
O_2 Diss,	8,1	8.6	8.25	5.5	7.0	8.5	8	8.5
Carbon Dioxide	4	10	9	14	16	9	8	7
Total Alkalinity	11	11	18	15	18	12.5	12	13
COD	7.9	4.7	14.1	24.2	22.6	21.2	22	14.7
Chloride	15.2	17.5	19	22.9	23.3	19.4	19.1	22.1
Sulfate	5	3.5	13	18	18	12	13	12
Ammonia Nitrogen	15	.1	.57	.53	62	.42	.17	.32
Nitrite Nitrogen	.002	.006	.007	.009	.009	.014	.012	.005
Nitrate Nitrogen	.23	.194	.345	.32	.325	.285	.32	. 3
Soluble Phosphate	6.01	.019	.052	.10	.092	.03	.065	.091
PH	4.62	5.5	5.6	5.6	5.6	4.5	4.9	4.9
TEMP	71°	59.5°	68°	67°	69°	72°	72°	73°

MCINTOSH RUN SERIES

29th AUGUST, 1972

	1	2	3	4	5	6	7	8
Sodium	5,5	6,9	3,0	16.0	12.8	13.7	13.9	8.4
Potassium	0.47	0.51	0.32	0.98	0.95	0.56	0.77	0.52
Magnesium	0.57	0.90	0.49	0.16	0.70	0.82	0.82	0.85
Maganese		0.33		1.03				
Calcium	0.96	1.96	0.83	7.0	3.96	4.09	4.04	1.48
0^2 Diss	8.9	7	7.5	6.7	4.5	7.5	8	7.5
Carbon Dioxide	5.2	14	12	14	19	8	6	7.2
Total Alkalinity	11	14	15	22	16	17	15	12
COD	4.4	2.7	9.5	7.5	11.9	11.9	10.5	12.1
Chloride	18.9	24.8	12.2	44.1	33.3	39.2	38.6	24.6
Sulfate	6	5	11	8	7.5	18.5	7.5	6
Ammonia Nitrogen	.04	.04	.23	.53	.27	.11	.31	.33
Nitrite Nitrogen	0	0	0	.004	0	0	0	0
Nitrate Nitrogen	.24	.225	.33	.34	.32	.34	.342	.30
Soluable Phosphate	2.01	.023	.09	.078	.112	.458	2.5	.038
PH								
Temp.	69.2°	59.5°	69°	67.7	66°	74	75	76.5

ZOOPLANKTON REPORT

J.N. COOLEY

In early August of 1972 a total of 10 lakes and ponds were visited to obtain samples of their free swimming zooplankton communities. The purpose of this investigation was to obtain base line information on the relative abundance and distribution of the local zooplankton communities in a hydrographic area referred to as the McIntosh Run (7 of 10 samples) in the Spryfield-Herring Cove area. In addition samples were also taken from three bodies of water in another watershed adjacent to the McIntosh Run (Williams L., Colbart L., Catamaran Pond).

Table 1 contains a brief list of the common zooplankters collected in tow-net samples at the 10 sites visited. Table 2 is a summary of the information obtained from analysis of the samples.

Of the 10 sites visited in the summer of 1972, six had also been visited and sampled in a similar manner the previous summer (see Ogden MAPC report 1971-72). These paired samples thus provided comparative information over 2 years. The four new sampling sites being smaller in area and quite shallow were all ponds (see Table 2).

Of the 6 lakes visited again in 1972 only one, Power Pond,[1] showed a distinct change in its zooplankton associations. The dominant species in 1972 was overwhelmingly a bosminid as opposed to a small cyclopoid, Tropocyclops prasinus, in 1971. The significance (if any) of this finding cannot be determined unless more and regular studies on its zooplankters are continued in future years. It is interesting to note however that the two dominant species at [illegible] time of sampling in two successive years was not Diaptomus minutus, the most frequent dominant zooplankter in this area. This may or may not indicate a certain instability in Power Pond, possibly due to changes affected in the watershed. As the terminal link in the McIntosh Run and because of the changes listed above it is recommended that subsequent studies on McIntosh Run water quality should include examinations of its zooplankton populations.

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[1] while characterized on local maps as a pond, it is in the parlance of a limnologist better described as a lake because of its depth and size characteristics

TABLE 1

A list of the common zooplankters found in the sites visited in 1972.

Diaptomus minutus
Diaptomus spatulocrenatus
Epischura nordenskiöldi
Mesocyclops ~~dax~~ edax
Tropocyclops prasinus
Diaphanasoma brachyurmm
Bosmina sp.
Daphnia pulex
Leptodora kindtii

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	NAME	Diaptomus minutus	Diaptomus spatulocrenatus	Epischura nordenskiöldi	Mesocyclops edax	Tropocyclops prasinus	Diaphanasoma brachyurum	Bosmina sp.	Daphnia pulex	Leptodora kindtii
	* Williams L.	D	+	C	+		C	+	C	
	* Colbart L.	D		+	+		+	+	C	
	Catamaran P.				D	+		+		
McIntosh Run	* Long L.	D		C	+	+	+	+	+	+
	* Kidston L.	D	+	+			C	C	+	
	* Long P.	D	+	+					C	
	* Power P.	+			+			D		
	Reach P.		C		C				D	
	East Pine Island P.	C	+	+			+	D		
	West Pine Island P.	+			+			+		

* Also visited in summer of 1971

D = numerically dominant form in sample
C = common in sample
+ = present in small numbers

TABLE 2
A summary of the relative abundance of common zooplankters in 7 bodies of water located in the "McIntosh Run", plus 3 other areas close to the major area of study.

The lack of any previous information on the four new sampling sites (Catamaran P., Roach P., East and West Pine Island Ponds) precludes any conclusive assessment of the state of their zooplankton communities with respect to changes occurring in their drainage basins. The fact that the common area dominant Diaptomus minutus was either absent or present in small numbers is most likely a function of the pond like nature (ie shallow) of theses bodies of water rather than any cultural influences in the watershed. Again future studies may prove more enlightening.

The very obvious differences in the plankton associations of East and West Pine Island Ponds (see Table 2) in spite of their very close proximity to one another are also more probably explained on the basis of their different morphology than on cultural influences. The very much deeper East Pine Island Pond contains as expected the common zooplankters exhibited by most Halifax-Dartmouth area lakes (see Ogden MAPC report 1971-72) while the very shallow and weedy West Pine Island Pond had on the day visited, a very scarce and limited plankton community. Again future studies may prove helpful in assessing changes occurring in the drainage basin.

It should be noted that today there is a limited amount of information existing on the relationships between plankton associations and cultural changes of lakes and ponds. However with present emphasis of limnological investigations clearly directed toward pollution studies it is not unreasonable to expect that information and samples of the type collected in this study will be very useful in future years as this area of limnology becomes more predictive. In the interim one can theorize with a certain amount of confidence that cultural changes of lakes caused either by increased organic loading (ie sewage, industrial pollution) and/or increased siltation (caused by removal of vegetation cover in the drainage basin) will alter the kinds and abundance of phytoplankton (microscopic floating plants) of lakes and ponds. Since phytoplankton is the major source of food for most of the zooplankton present in this area, they also will be affected. The resultant changes in the zooplankton caused by cultural manipulations in the watershed could conceivably accelerate or conceivable even retard changes in the state of eutrophication (pollution) of these bodies of water. Therefore it is concluded that the zooplankton should be sampled routinely in any future studies concerned with the McIntosh Run. Also it is already possible that the last body of standing water in the McIntosh Run , Power Pond, is beginning to show effects of cultural changes in the watershed.

SUMMARY AND CONCLUSIONS

At the present time, only Chocolate, Whimsical, and Williams Lake have extensive housing developments in their watersheds. The town of Spryfield is situated near the head of MacIntosh Run, whose flow will soon be increased with the abandonment of the Chain Lakes and Long Lake as part of the Halifax City Water Supply system. Recreational swimming and some boating are carried on at present in the three lakes first mentioned, and Whimsical (Tiger) Lake has a recreational playground and supervised swimming program during the summer months.

Frequent overflows from sanitary sewer pumping facilities result in contamination of these lakes by untreated domestic waste. During the period 8 June to 30 July, 1972, 9 of 13 bacteriological samples showed unacceptable levels of coliform bacteria for recreational swimming at Whimsical (Tiger) Lake. It should be noted that in all of these lakes, the existing problems of inadequate sanitary sewer service will only be exacerbated by additional development, since each of the systems demonstrates failure by ground water seepage into the sewers during periods of rainfall. Continued degradation of the quality of these waters is to be expected independently of further building development and storm water drainage. Deterioration of Williams Lake is evident in increasingly high bacterial counts in the swimming area near the outlet of the lake. Rapid proliferation of aquatic plants such as water lilies and pond weeds in the arm of Williams Lake adjacent to Cunard Junior High School and the new housing development reflect rapid eutrophication caused by overflows from the Williams Lake pumping station, which serves some 40,000 lineal feet of sanitary sewer in the Jollimore-Flemming Heights area. Although only about 7% of the Williams Lake area watershed is developed at present, anticipated development of more than 50% of the watershed land around the lake constitutes a definite threat to the maintenance of water quality in the lake.

<u>Recommendation</u>: That prior to any further development in the Williams Lake-Colpitt (Colbart)Lake-Catamaran Pond and Whimsical (Tiger) Lake-Frog Pond watersheds, existing problems in these watersheds be solved. No amount of storm water diversion or treatment, or land use development controls can halt or reverse the deteriorating water quality in these lakes presently occurring.

The Chain Lakes, Long Lake, and Flat Lake have no development in their watersheds at present. Protection of these lakes involves not only control of storm water runoff, but also accidental introduction of domestic waste as a result of improperly designed or installed sanitary sewer systems.

<u>Recommendation</u>: Prior to development in these watersheds, attention be given to control of sanitary waste overflows in the vicinity of the lakes. Development controls should include a buffer zone of at least 100 feet adjacent to the lakes where the slope of the land is 15% or less, of 300 feet where the slope is between 15% and 25%, and no development on slopes in excess of 25%.

MacIntosh Run at present carries overflow water from Long Lake, pursues an irregular course through the town of

Spryfield, and discharges through Power Pond to Herring Cove. The addition of 500-600 cfm of water to the Run with the abandonment of the Chain Lake-Long Lake Water Supply system will drastically alter the flow characteristics of the system. Because of diversions created by the Public Service Commission, MacIntosh Run did not carry this amount of water prior to the development of the Water Supply system. In any event, reduction of the former water discharge through the Run has permitted the encroachment of trees on the flood plain of the Run , narrowing and constricting the course of the Run. It is quite doubtful that the present stream configuration is competent to handle the added water flow in the absence of some stream widening activities. Canalization of the stream will result in the rapid appearance of storm peaks downstream with the possibility of flooding at Power Pond and the Herring Cove outlet.

Recommendation: That careful hydrologic studies of the impact of storm waters on the flow characteristics of MacIntosh Run be carried out in advance of planned stream widening or course changing activities. It is further recommedded that development in the flood plain of MacInsosh Run be restricted and that no development be permitted to an elevation not less than 10 feet above the projected stream level during normal flow.

-- CONCLUSION --

Impending development of a substantial number of lakes and watersheds in lands recently annexed by the City of Halifax has placed a burden of responsibility upon the municipal government to insure continuing high quality of recreational and aesthetic properties of the lakes. Abandonment of the lakes to conventional development practices insures that they will become liabilities to the City.

Although the principal concern of this report has been the existing water quality of the lakes and watersheds in the annexed area, review of existing developed areas indicate that present practices and installations for control of storm water runoff and domestic waste are grossly inadequate and promise continuing deterioration in the absence of remedial action.