WATER QUALITY ASSESSMENT
OF
THE THAMES RIVER MOUTH,
LAKE ST. CLAIR 1975

prepared by:

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Table of Contents

List of Tables

List of Figures

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SUMMARY OF FINDINGS

The localized impact of the Thames River on the water quality of Lake St. Clair results from its nutrient and solids load and bacterial contamination from upstream sources. The Thames River is a minor contributor to the enrichment of Lake St. Clair since its nutrient load represents <1% relative to the input from the St. Clair River.

The influence of the Thames River was observed to be to the north-northeast of the mouth as a result of prevailing winds. This zone of influence was found to extend as far as 8-10 km into the lake and was characterized by nutrient levels at least twice as high as those in mid-lake. Chlorophyll a levels close to the mouth were indicative of eutrophic conditions.

Bacterial levels exceeded Ministry of the Environment (MOE) recreational use criteria (18) in a zone extending 3 km into the lake and 1 km along the shore, making the sandy beaches within this zone questionable for swimming. Observed bacterial levels however, did not appear to interfere with the water supply serving the Town of Tilbury.

Sediments in the study area were relatively uncontaminated, except for elevated levels of zinc, organic carbon and nitrogen found at the river mouth. The zinc and organic carbon levels exceeded MOE guidelines (19) for open-water disposal of dredged materials. The zoobenthic community in the area was characterized by the presence of pollution intolerant organisms suggesting that the Thames River has little deleterious effect on the benthic community (Appendix B).

A program is currently being developed by the Thames River Implementation Committee to implement the recommendations outlined in the Thames River Basin Water Management Study (1). The implementation of these recommendations will involve a long-term program that includes both direct remedial action and supportive educational efforts to achieve nutrient loading reductions and soil erosion controls throughout the basin. The expected benefits of such a program includes the protection and enhancement of water quality in Lake St. Clair in the vicinity of Thames River Mouth.

RECOMMENDATIONS

1) *The timely implementation of recommendations made in the Thames River basin report (1) should be undertaken.*
2) *An investigation should be made of the sources of bacterial contamination at the river mouth and possible remedial action.*
3) *The occurrence, source and environmental significance of dieldrin levels in water should be evaluated further.*

INTRODUCTION

The Thames River System drains 5,830 km^2 of land in Perth, Oxford, Middlesex, Elgin, and Kent counties. The river flows in a southwesterly direction from its headwaters in Logan Township, Perth County for ti 200 km to its mouth at the southeastern corner of Lake St. Clair (Figure 1). Land use in the river basin is 85% agricultural, 10% rural non-agriculture and 5% urban.

The Thames River Basin Water Management Study (1) indicated two major problems, poor water quality and flooding. Nutrient input and surface runoff from urban and rural sources, plus flooding and erosion, result in nutrients and suspended solids being discharged into the lake.

Previous studies (2) indicate that the southern section of Lake St. Clair is more enriched than the rest of the Lake's eastern section. This is due to localized nutrient inputs and current patterns found in the area.

STUDY OBJECTIVES

The primary objective of this study was to determine whether the water quality of Lake St. Clair was being adversely affected by inputs from the Thames River. The secondary objective was to establish a baseline for future comparison, prior to the implementation of nutrient loading reductions and soil erosion controls recommended in the Thames River Basin Study (1).

STUDY PLAN

A grid of stations (Figure 2) extending 4 km from the river outlet, was sampled for water, sediment and zoobenthos during the period August 29 - September 5, 1975. The shallow nature of the nearshore area (Figure 2) southwest of the river mouth prevented sampling in this area. Water samples were analysed for nutrients, chlorophyll a , chloride, conductivity, bacteria and dissolved oxygen. Field methods, analytical methods, data coding and data storage were followed according to MOE procedures (20, 21, 22 and 23).

One Shipek grab was taken at each sediment station (Figure 8) and analysed for particle size distribution, nutrients (total phosphorus, total Kjeldahl nitrogen), organic carbon (% loss on ignition), chemical oxygen demand (COD) and three heavy metals (Cu, Zn, Pb). Six stations near the mouth of the river were sampled for the evaluation of benthic invertebrates (Appendix B). These stations were sampled in triplicate, whole dredge samples, screened through a 200 µ mesh net, preserved in 10% formalin solution and subsequently identified to the level of species where possible.

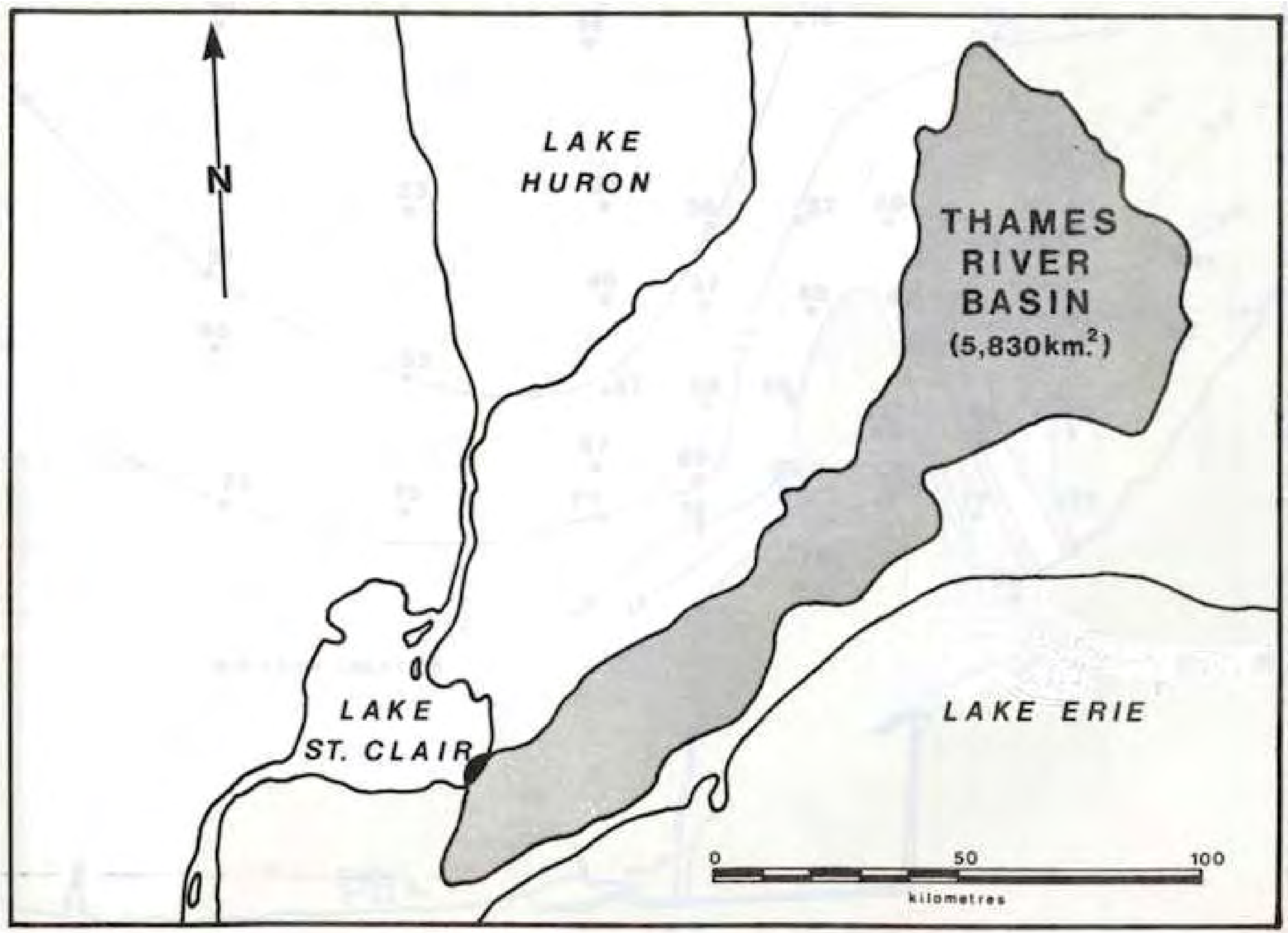

FIGURE 1. Location Of The Study Area - Thames River Mouth, Lake St. Clair

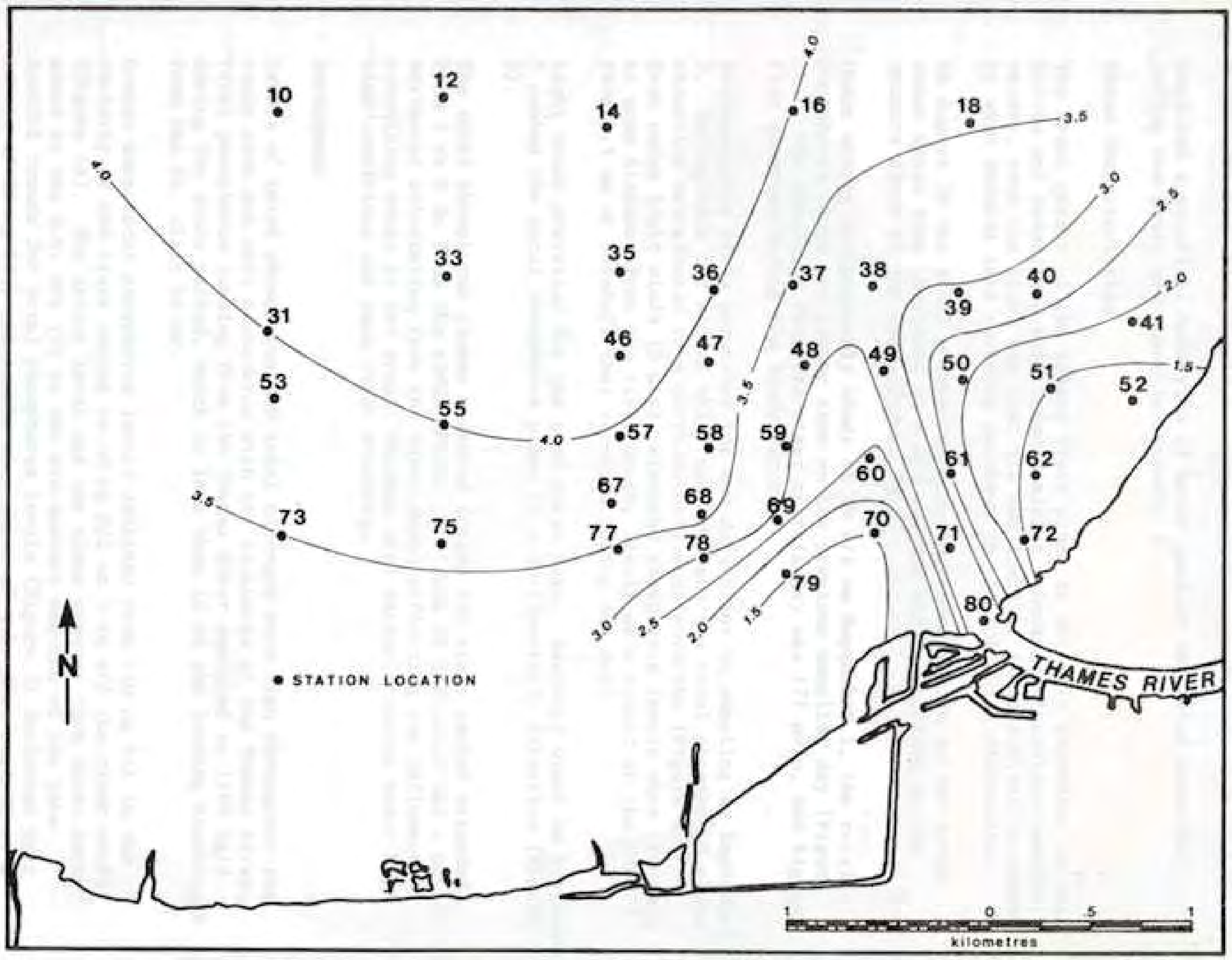

FIGURE 2. Thames River Mouth Water Quality Station Locations And Nearshore Bathymetry, (Contour Interval 0.5 Meters-depth to I.G.L.D.)

DISCUSSION

WATER QUALITY

Detailed statistical summaries of water quality variables measured during the study are shown in Appendix A.

Plume Characteristics

The areal extent of the Thames River plume is strongly dependent on wind stress and associated wind induced mixing. Because of shallow nearshore waters, once the plume has lost its own inertia, it is subject to movement by wind induced lake currents as shown in the following discussion.

On August 29 the total phosphorus plume extended 1.5 km to the north under winds from the south at 4 m/s and was mainly confined to the eastern shore of the lake (Figure 3a). Under strong northwesterly winds of 10 m/s on September 1, the total phosphorus plume was larger than on the previous sampling day (Figure 3b). The discharge from the river on this day was 171 m^3/s, the highest flow observed during the study period.

Northwesterly winds persisted for two days prior to sampling on September 3. During this day a wind shift occurred and the total phosphorus plume direction was altered to a northeasterly configuration (Figure 3c). Even under light winds (3 m/s), elevated phosphorus levels were observed at some distance from the river mouth, likely as a result of the runoff from 2.5 cm of rainfall that occurred during the day.

Light winds prevailed for the next three days. Easterly winds on September 5 pushed the total phosphorus plume in a northwesterly direction (Figure 6). The total phosphorus plumes measured during the study period extended from 1 to 4 km from the river mouth. The zone of influence had a north-northwest orientation from the river mouth reflecting the influence of prevailing winds in the area. Maximum area extent occurred under high wind conditions and peak river discharge.

Enrichment

Levels of total phosphorus and total nitrogen were high throughout the study area and were associated with the discharge of the Thames River. Total phosphorus loading from the Thames River amounted to 1100 kg/d during the study period, which is less than 1% of the loading discharged from the St. Clair River.

Cruise mean total phosphorus levels declined from 150 µg P/L in the vicinity of the river outlet to 30 µg P/L at 4 km off the river mouth (Figure 4a). The latter level was two times greater than those determined by the U.S. EPA (3) in the mid-eastern section of the lake. Spatial trends for total phosphorus levels

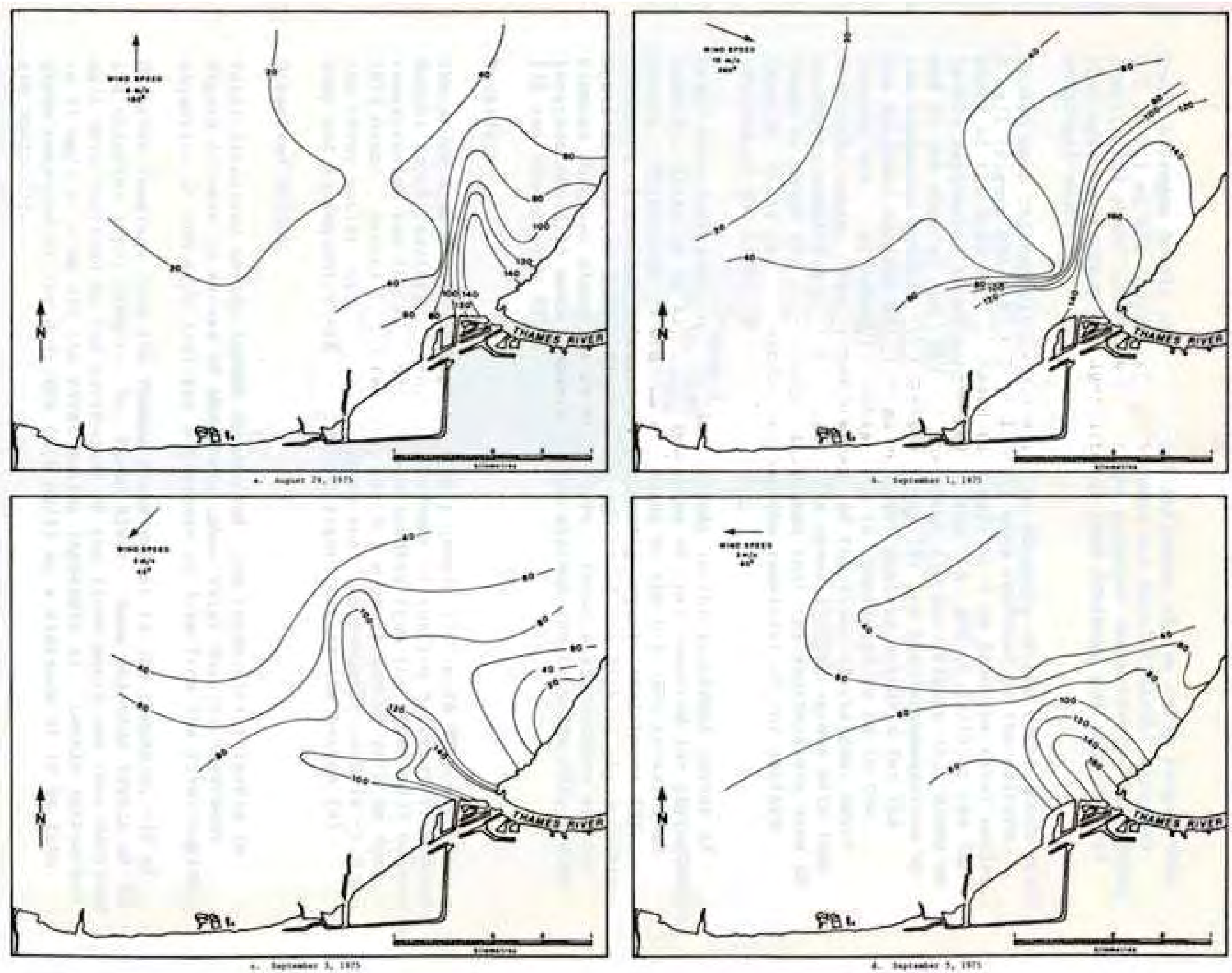

FIGURE 3. Thames River (Mouth Total Phosphorus Plumes, (contour interval 20 µg P/L)

(Figure 5) indicated that levels of 15 µg P/L, comparable with those of U.S. EPA, prevail at a distance of 8 km from the river mouth.

Total nitrogen levels in the zone of influence of the river ranged from 0.9 to 3.1 mg N/L (Appendix A). Nitrate and total Kjeldahl nitrogen constituted about 57% and 40% of total nitrogen respectively, indicating that upstream sources are agricultural land drainage and some treated municipal sources.

Cruise mean chlorophyll a levels in the vicinity of the river mouth were 8 µg/L (Figure 4b). Levels of 12 µg/L were confined to the eastern shore of the lake and decreased to 8 µg/L at 4 km from the river outlet. Levels approached those determined by the U.S. EPA (6 µg/L) at the far end of the zone of influence of the river (10 km) (Figure 5). Based on the suggested guidelines by Dobson et al (4) and the recommendation by the National Academy of Sciences on water quality criteria for the trophic status of lakes (5), this zone is considered to be in the eutrophic range. Far from the effect of the river discharges, meso-eutrophic condition would prevail. The above finding agrees with that found by Leach (2) where it was indicated that the southeastern area of Lake St. Clair is more eutrophic than the remainder of the eastern section of the lake.

Leach also indicated that nutrient supply in the southeast corner of Lake St. Clair is likely to be in excess of that required for phytoplankton growth. Phytoplankton studies conducted by the U.S. EPA revealed an abundance of species tolerant to increasing organic enrichment (3). Stations near the Thames River mouth exhibited the highest phytoplankton biomass observed along the eastern shore. Total phytoplankton at that location was 3365 mean number/ml, with diatoms constituting 78%, greens 17% and blue-greens 4%.

Turbidity

The study area exhibited high turbidity levels (10 to 70 FTU) and low Secchi depth readings (0.2-0.8 m), because of shallow bathymetry, sediment resuspension and the suspended solids loading from the river (335 tonnes/d; 1975 mean). Secchi depth readings of <0.5 m prevalent up to 2 km from the river outlet (Appendix A) indicate that the euphotic zone is <1.0 m deep and subsequently <1% of incident light reaches the bottom (6).

Dissolved Solids

Total dissolved solids levels (converted from conductivity levels in Figure 6) were in excess of the Great Lakes Water Quality Agreement objective of 200 mg/L (16) for a distance of 3 km from the river outlet.

Chloride loadings from the Thames River amount to 300 tonnes/d, <1% of the chloride input from the St. Clair River. Mean chloride levels of 21 mg/L were confined to the north-east of the river mouth and then declined to 11 mg/L at 4 km off the river outlet (Appendix A). Levels approached those measured by the U.S. EPA (6-8 mg/L) at a distance of 10 km from the mouth (3).

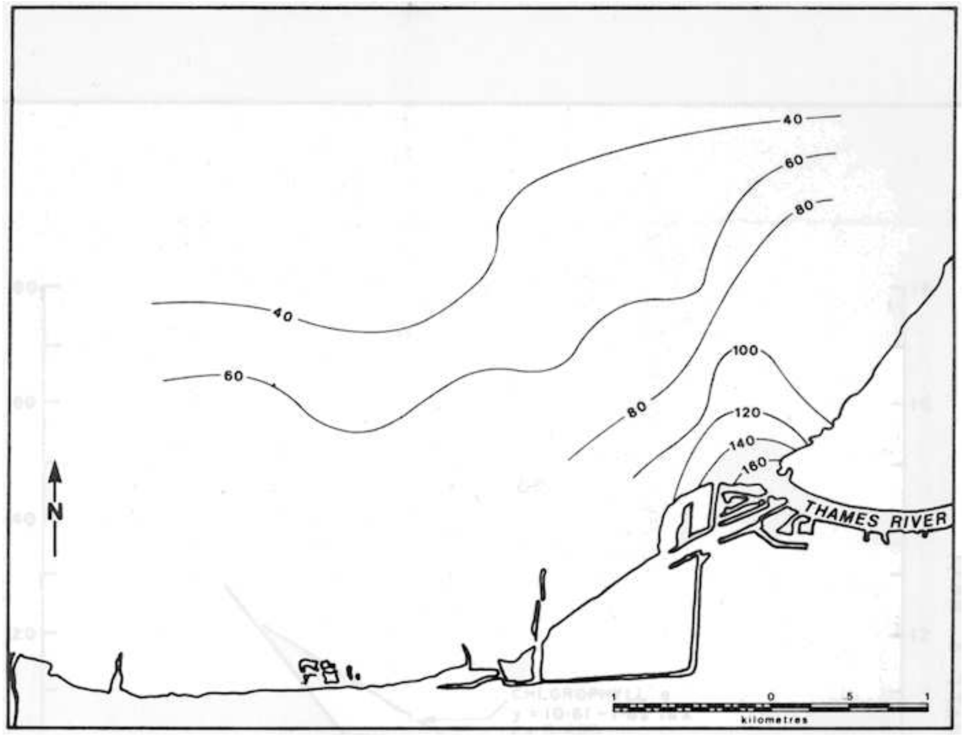

FIGURE 4A. Horizontal Distribution Of Cruise Mean Total Phosphorus, August 29 To September 15, 1975, (contour interval 20 µg P/L).

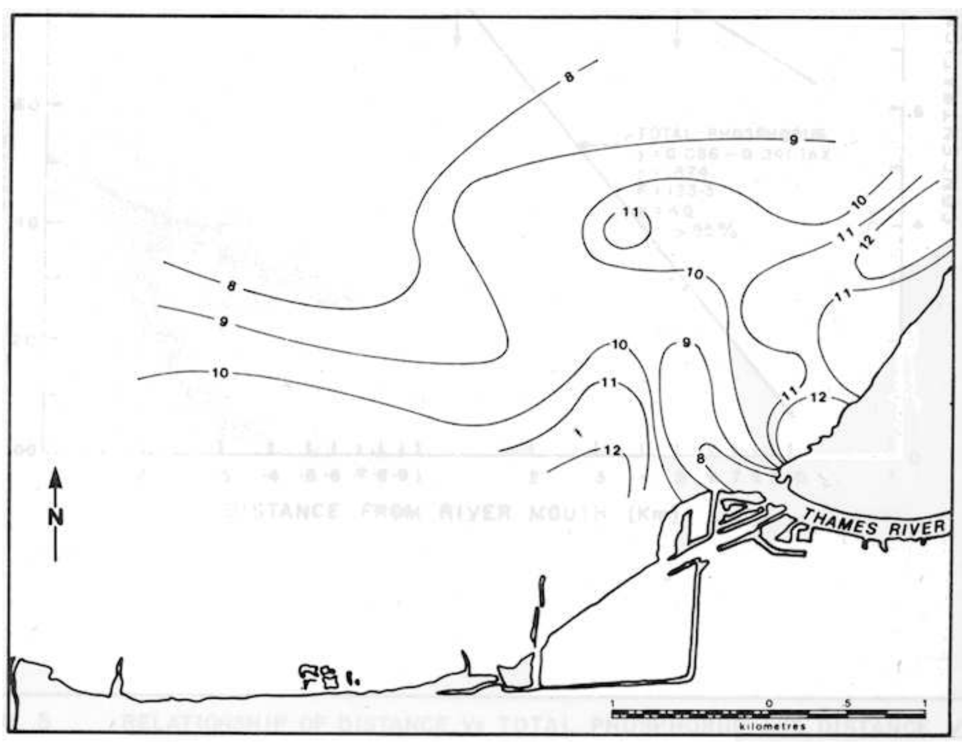

FIGURE 4B. Horizontal Distribution Of Cruise (Mean Chlorophyll a , August 29 To September 5, 1975. (contour interval 1 µg Chlorophyll a /L

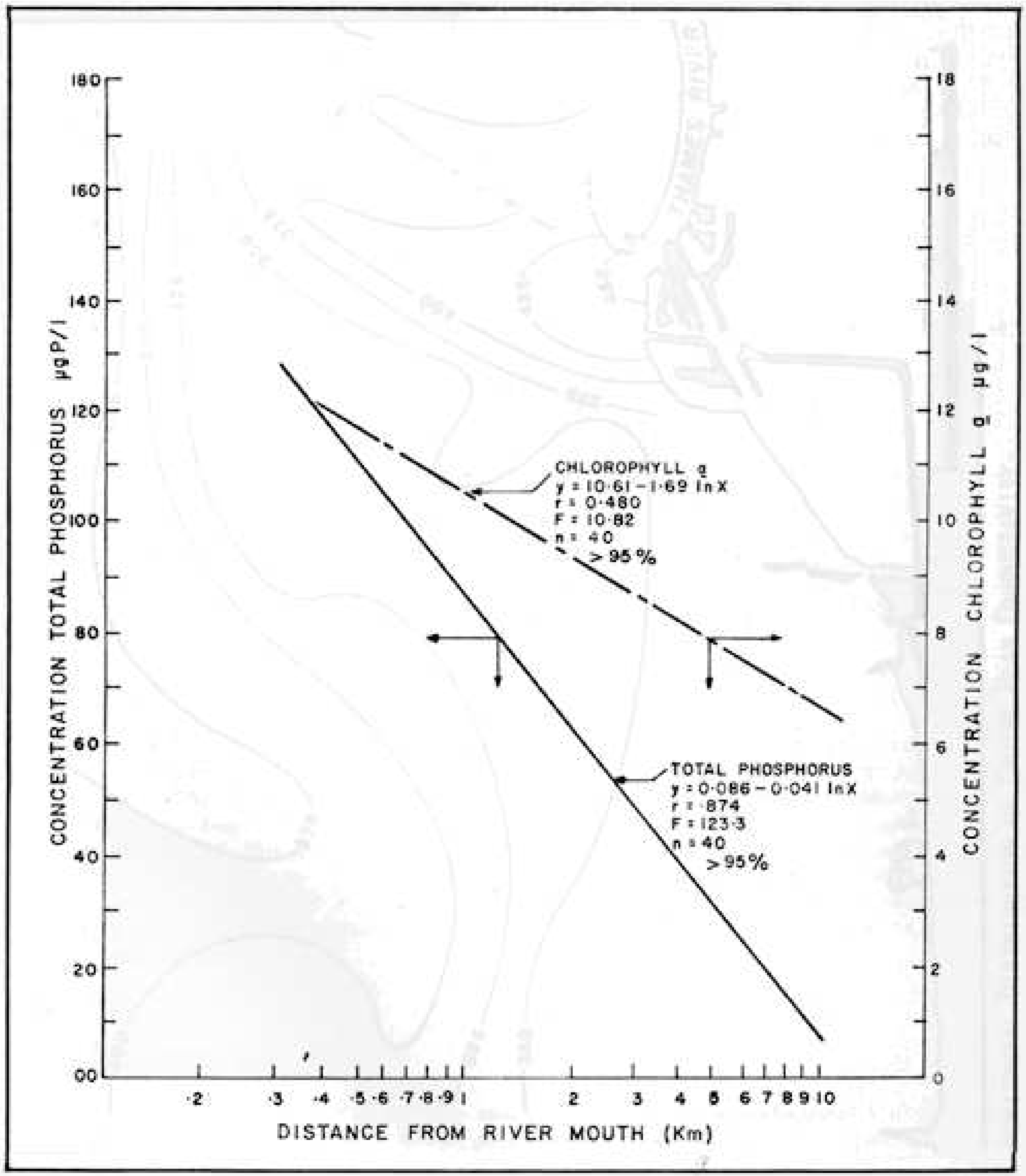

FIGURE 5: Relationship Of Distance Vs Total Phosphorus And Distance vs Chlorophyll a in the M.O.E. Study Grid Thames River Mouth, 1975.

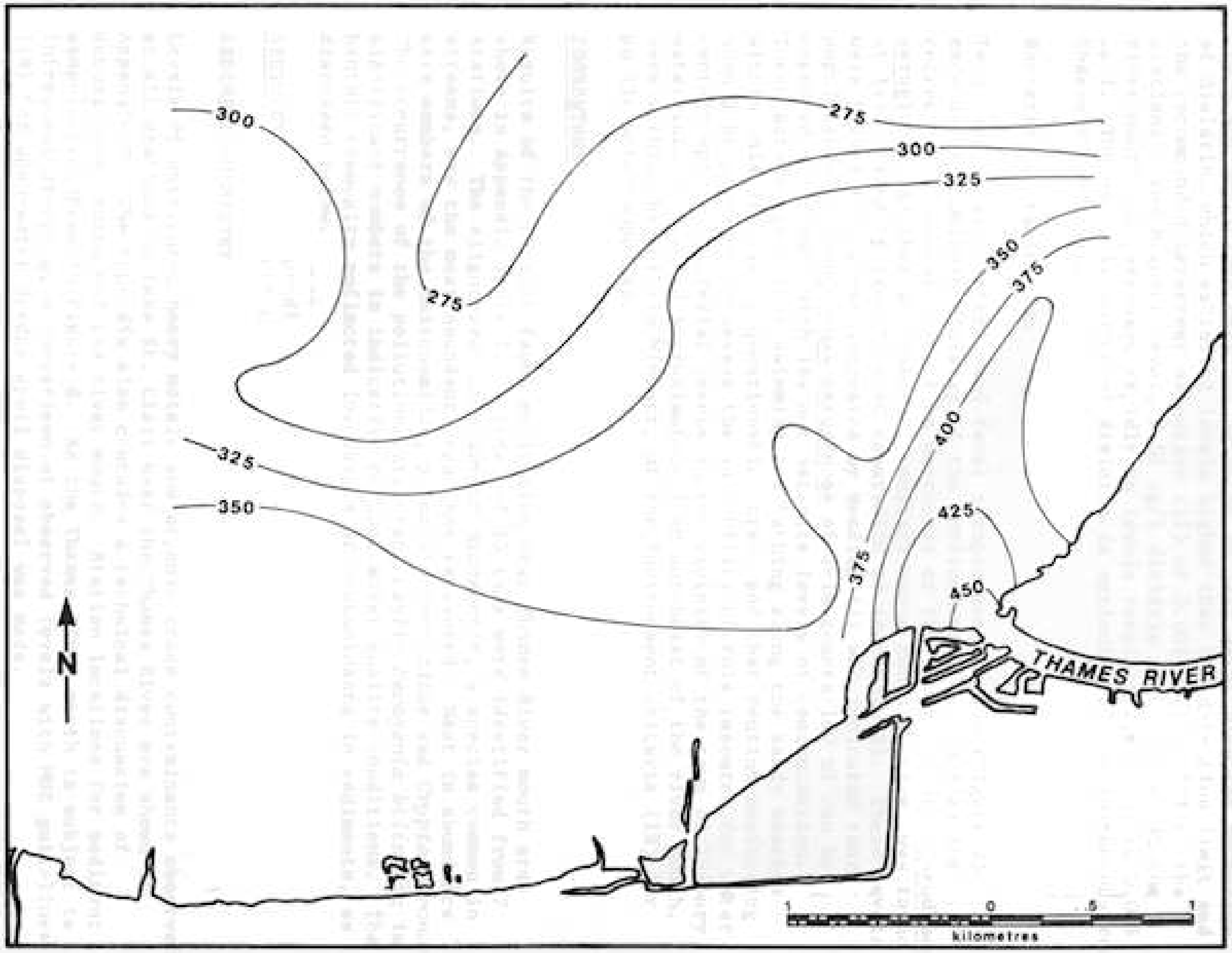

FIGURE 6. Horizontal Distribution Of Cruise Mean Conductivity, August 29 To September 5, 1975. (contour interval 25 µmhos/cm)

Organic Contaminants

PCB's and pesticides were not detected in lake water with the exception of dieldrin, which exhibited levels higher than the detection limit and the recommended Agreement objective (17) of 0.001 µg/L at 50% of the stations. The highest level, 0.01 µg/L dieldrin was observed at the river mouth and decreased rapidly to levels ranging from 0.002 to 0.005 µg/L. The probable source of dieldrin is agricultural use in the upstream Thames River basin.

Bacterial Contamination

Total and fecal coliform, and fecal streptococci levels (Figure 7) exceeded the Ontario Ministry of the Environment criteria (18) for recreational use for up to 1 km northeast of the river outlet. *Pseudomonas aeruginosa,* another indicator of sanitary waste contamination, was found at levels ranging from 1 to 40 counts/100 mL (Appendix B). These levels were higher than those suggested by Hoadley (7) who indicated that populations of *Pseudomonas aeruginosa* of 1-10 counts/100 mL can be expected in streams with low but definite levels of contamination.

These data suggest that swimming and bathing along the sandy beaches within this area is of questionable safety and that routine monitoring should be provided to assess the suitability of this resource for water contact sport. Bacterial levels in the vicinity of the town of Tilbury water intake, located approximately 1 km northeast of the river mouth, were within the Ontario Ministry of the Environment criteria (18) for public water supplies.

ZOOBENTHOS

Results of the benthic fauna evaluation near Thames River mouth are shown in Appendix Table 5. A total of 13 taxa were identified from 7 stations. The oligochaete *Limnodrilus maumeensis,* a species common in streams, was the most abundant organisms recovered. Next in abundance were members of the chironomidae, primarily *Procladius* and *Cryptochironomus.* The occurrence of the pollution intolerant mayfly *Hexagenia bilineata* in significant numbers is indicative of good water quality conditions. The benthic community reflected low levels of contaminants in sediments, as discussed below.

SEDIMENT

SEDIMENT CHEMISTRY

Levels of nutrients, heavy metals and organic trace contaminants observed at all stations in Lake St. Clair near the Thames River are shown in Appendix B. The appendix also contains a technical discussion of depositional zones off the river mouth. Station locations for sediment samples are shown in Figure 8. As the Thames River mouth is subject to infrequent dredging, a comparison of observed levels with MOE guidelines (19) for open-water dredge spoil disposal was made.

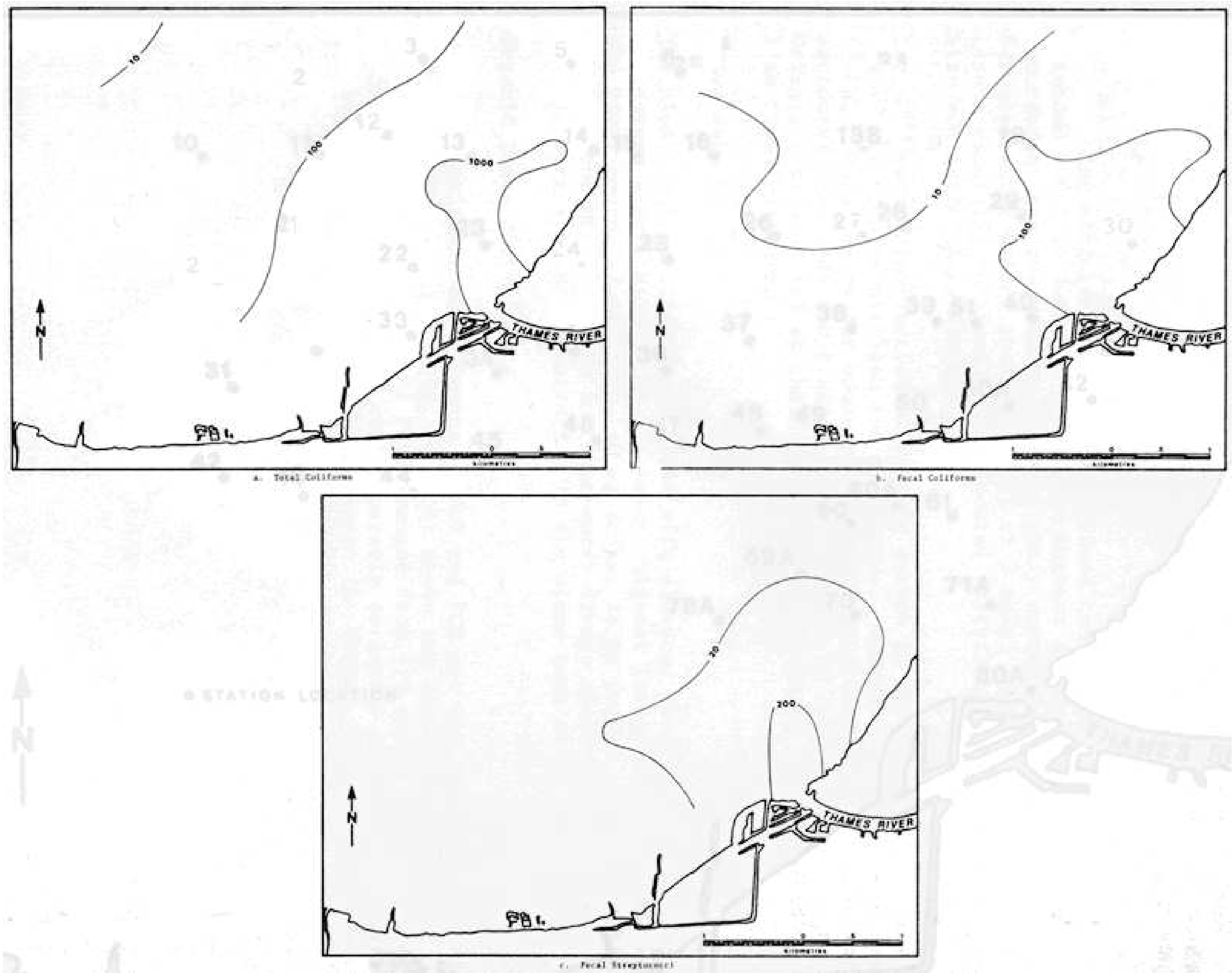

FIGURE 7. Horizontal Distribution Of Cruise Geometric Mean Bacteria August 29 To September 5, 1975. (counts/100 mL)

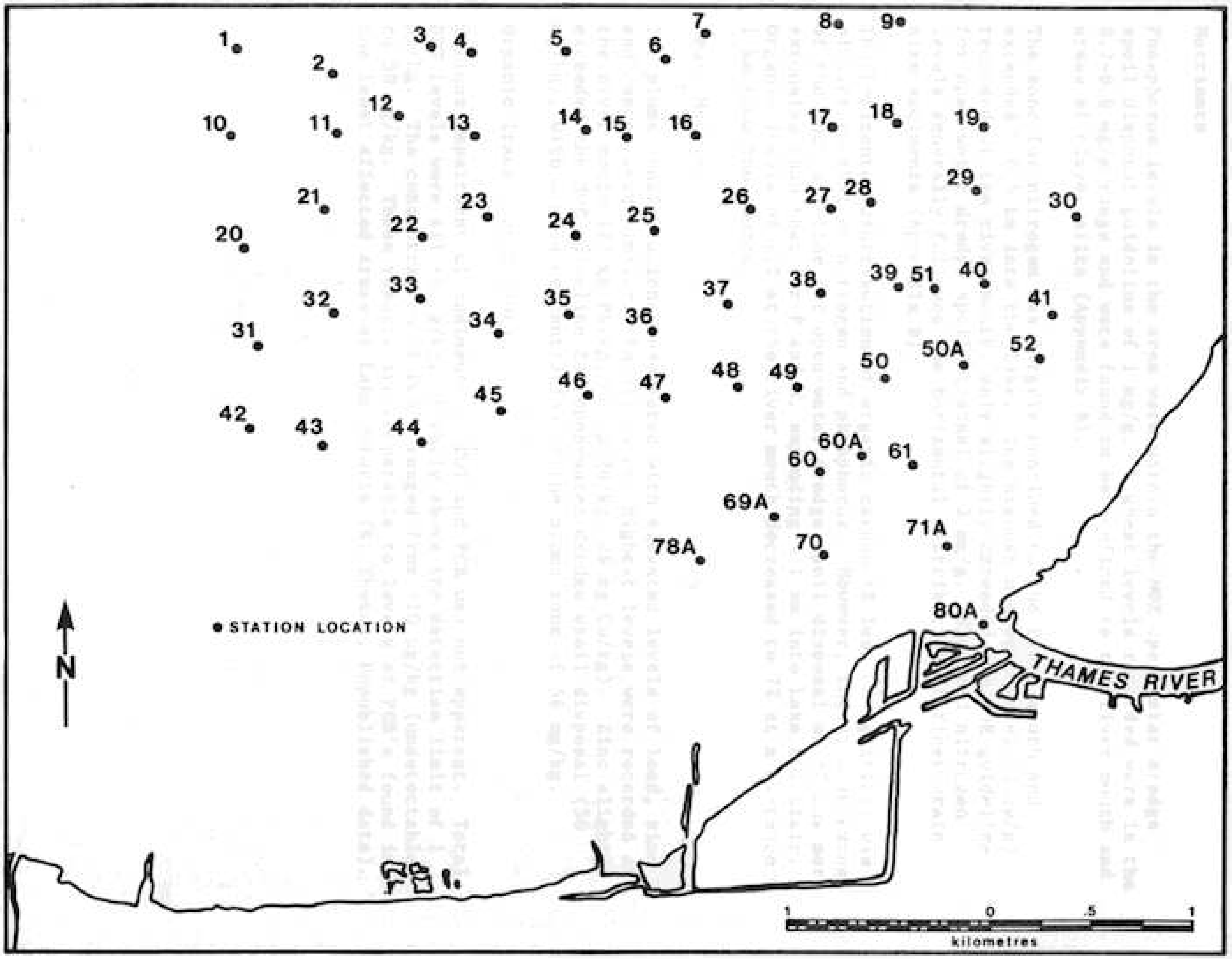

FIGURE 8. Thames River Mouth Sediment Station Locations

Nutrients

Phosphorus levels in the area were within the MOE open-water dredge spoil disposal guideline of 1 mg/g. Highest levels recorded were in the 0.7-0.8 mg/g range and were found to be confined to the river mouth and areas of clayey silts (Appendix B).

The zone for nitrogen was largely confined to the river mouth and extended ~ 0.5 km into the lake. The highest nitrogen level (3 mg/g) recorded at the river mouth, only slightly exceeded the MOE guideline for open-water dredge spoil disposal of 2 mg/g. Elevated nitrogen levels generally followed the horizontal distribution of finer grain size sediments (Appendix B).

The horizontal distribution of organic carbon (% loss on ignition) was similar to that of nitrogen and phosphorus. However, the area in excess of the MOE guideline for open-water dredge spoil disposal of 6% was more extensive than that for P and N, extending ~ 1 km into Lake St. Clair. Organic levels of 11% at the river mouth decreased to 7% at a distance ~ 1 km from the source.

Heavy Metals

The plume configurations associated with elevated levels of lead, zinc and copper were similar. In all cases, highest levels were recorded at the river mouth (27 mg Pb/kg, 90 mg Zn/kg, 26 mg Cu/kg). Zinc slightly exceeded the MOE guideline for open-water dredge spoil disposal (50 mg/kg), with a mean concentration in the plume zone of 56 mg/kg.

Organic Trace Contaminants

Serious impairment of sediments by DDT and PCB was not apparent. Total DDT levels were all <5 µg/kg, slightly above the detection limit of 1 µg/kg. The concentration of PCB's ranged from <10 µg/kg (undetectable) to 50 µg/kg. These results are comparable to levels of PCB's found in the least affected areas of Lake Ontario (R. Thomas, Unpublished data).

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APPENDIX A. Statistical Water Quality Data Summaries - Table 1

WATER QUALITY DATA - THAMES RIVER MOUTH - AUGUST 29 SEPTEMBER 5, 1975

Stn. No.	Chloro a µg/L	Total N mg/L	NO_2 mg/L	NO_3 mg/L	Ammonia mg/L	Secchi Disk m	Tot P mg/L	Turb. FTU	Conduct. µmhos/cm^2	Chloride mg/L	Kjeld. mg/L	Diss. P. mg/L	Diss. O_2 mg/L
80	8.0*	3.09	0.071	2.04	0.095	0.1	.169	60.5	468	21.3	0.978	0.061	5.9
	±3.14	±.69	±.037	±.65	±.038	0	±.025	±12.2	±37	±1.6	±.129	±.020	± 1.7
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
79	11.9	1.59	0.036	0.87	0.031	0.6	0.087	70.1	334	15.9	0.681	.021	8.8
	±6.04	±.63	±.022	±.45	±.037	±.41	±.039	±11.7	±52	±3.6	±.269	±.009	±1.2
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
78	11.2	1.46	0.036	0.81	0.026	0.6	0.069	19.8	337	16	0.604	.018	8.3
	±5.18	±.60	±.015	±.39	±.021	±.44	±.129	±15.8	±65	±4.1	±.197	±.007	±.5
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
77	10.1	1.38	0.034	0.76	0.028	0.6	0.069	20.6	347	16.8	.594	0.021	8.5
	±4.56	±.82	±.024	±.58	±.015	±.47	±.040	±17.9	±90	±6.2	±.217	±.013	1.6
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
75	10.6	1.24	0.031	0.69	0.026	0.7	0.059	18.2	332	15.5	0.518	0.018	8.6
	±5.24	±.72	±.019	±.53	±.017	±.47	±.035	±16.7	±87	±5.9	±.184	±.010	±.9
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
73	10.9	1.43	0.038	0.8	0.026	0.6	0.069	22.2	358	17.5	0.519	.022	8.5
	±5.02	±.81	±.026	±.57	±.019	±.44	±.040	±16.7	±101	±6.9	±.217	±.017	±.9
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
72	12.8	2.43	0.063	1.55	0.051	0.2	0.121	49.8	408	21.3	0.82	0.033	6.9
	±1.89	±.82	±.056	±.70	±.043	±.10	±.046	±22.0	±57	±5.7	±.076	±.008	±1.2
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
71	9.9	2.84	0.058	1.83	0.093	0.1	0.136	56.5	431	21.8	0.949	0.054	6.3
	±1.92	±.93	±.030	±.73	±.078	±.05	±.050	±21.0	±69	±5.6	±.174	±.031	±1.3
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
70	8.2	1.81	0.042	1.1	0.041	0.4	0.089	39.8	376	17.9	0.655	0.034	7.6
	±1.99	±1.09	±.015	±.81	±.003	±.33	±.062	±35.6	±73	±2.8	±.276	±.029	±1.3
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)

*Mean ± 1 Standard Deviation (No. of samples)

Table 1 (cont'd) WATER QUALITY DATA - THAMES RIVER MOUTH - AUGUST 29 TO SEPTEMBER 5, 1975

Stn. No.	Chloro a µg/L	Total N mg/L	NO_2 mg/L	NO_3 mg/L	Ammonia mg/L	Secchi Disk m	Tot P mg/L	Turb. FTU	Conduct. µmhos/cm^2	Chloride mg/L	Kjeld. mg/L	Diss. P. mg/L	Diss. O_2 mg/L
69	12.0*	1.34	.030	0.74	0.023	0.5	0.058	22.2	346	16.5	0.569	.018	8.2
	±6.17	±.71	±.016	±.48	±.013	±.38	±.033	±15.6	±55	±3.3	±.221	±.009	±.4
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
68	10	1.41	0.028	0.78	0.021	0.5	0.063	23	339	15.9	0.605	.018	8.2
	±4.16	±.77	±.016	±.57	±.013	±.43	±.035	±19.7	±60	±3.1	±.192	±.010	±.5
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
67	10.2	1.37	0.034	0.74	0.028	0.5	0.062	21.2	352	17.1	0.599	.019	8.0
	±4.11	±.92	±.026	±.66	±.016	±.39	±.032	±16.4	±91.0	±6.2	±.239	±.014	±.40
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
62	11.1	2.07	0.051	1.28	0.066	0.3	0.096	39.3	395	20.6	0.741	0.033	7.7
	±1.47	±.98	±.044	±.79	±.079	±.17	±.051	±20.9	±68	±5.3	±.157	±.023	±.6
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(+.6	(4)
61	10.2	2.29	0.048	1.48	0.061	0.1	0.126	51.5	421	20.5	0.773	0.039	6.6
	±.99	±.64	±.021	±.55	±.041	±.24	±.043	±16.7	±86.0	±5.8	±.093	±.011	±1.3
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
60	8.8	1.47	0.031	0.82	0.034	0.4	0.076	27.3	342	15.8	0.623	.025	7.9
	±1.14	±.77	±.012	±.58	±.017	±.24	±.037	±20.4	±41	±1.7	±.191	±.018	±.8
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
59	10.5	1.47	0.032	0.81	0.024	0.5	0.07	26.4	360	17.3	0.63	.023	8.3
	±4.36	±.74	±.014	±.53	±.015	±.30	±.043	±20.9	±54.0	±2.8	±.218	±.014	±.9
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
58	9.4	1.34	0.028	0.72	0.024	0.5	0.056	22.9	342	16.6	0.593	.018	8.5
	±2.29	±.69	±.010	±.49	±.015	±.33	±.031	±13.8	±38.0	±2.1	±.203	±.009	±.6
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	0.6	(4)
57	8.9	1.27	0.028	0.66	0.024	0.6	0.054	18.9	336	16	0.575	.017	8.5
	±2.66	±7.5	±.021	±.540	±.011	±.41	±.027	±11.7	±59.0	±4.0	±.201	±.011	±.5
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)

* Mean ± 1 Standard Deviation (Number of Samples)

WATER QUALITY DATA - THAMES RIVER MOUTH - AUGUST 29 TO SEPTEMBER 5, 1975

Stn. No.	Chloro a µg/L	Total N mg/L	NO_2 mg/L	NO_3 mg/L	Ammonia mg/L	Secchi Disk m	Tot P mg/L	Turb. FTU	Conduct. µmhos/cm^2	Chloride mg/L	Kjeld. mg/L	Diss. P. mg/L	Diss. O_2 mg/L
55	8.2	0.956	0.018	0.43	0.011	0.9	0.039	13.7	295	21.9	0.435	0.011	8.8
	±4.04	±.720	±.017	±.560	±.008	±.49	±.024	±12.8	±72.0	±5.2	±.209	±.006	±0.7
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
53	9	.909	0.019	0.43	0.013	0.7	0.039	13.6	291	12.5	0.458	0.013	8.6
	±4.25	±.631	±.016	±.44	±.009	±.49	±.025	±10.7	±59.0	±4.4	±.199	±.008	0.2
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
52	10.9	1.74	0.043	1.08	0.05	0.4	0.082	34.1	383	21.3	0.673	0.025	8
	±3.10	±.97	±.036	±.76	±.052	±.	±.056	±22.8	±11.0	±5.5	±.179	±.017	±1.2
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
51	11.0	1.88	0.049	1.18	0.058	0.2	0.088	37.8	396	19	0.676	0.028	7.3
	±2.11	±.72	±.029	±.61	±.054	±.10	±.044	±17.3	±99.0	±7.8	±.151	±.012	±1.3
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
50	11.5	1.77	0.046	1.03	0.06	0.2	0.094	34.5	372	17.9	0.693	0.029	7.8
	±1.29	±.57	±.024	±.38	±.061	±.10	±.037	±14.6	±60.0	±5.4	±.174	±.015	±0.8
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
49	9.7	1.15	0.027	0.6	0.024	0.3	0.057	19.5	322	14.9	0.518	0.017	8.3
	±1.16	±.11	±.008	±.09	±.019	±.05	±.008	±3.7	±23.0	±2.3	±.049	±.003	±0.1
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
48	9.8	1.19	0.029	0.63	0.024	0.4	0.054	18.2	333	15.6	0.539	0.016	8.6
	±.92	±.38	±.012	±.23	±.017	±.17	±.021	±9.6	±39.0	±3.1	±.152	±.006	±0.6
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
47	9.8	1.19	0.026	0.65	0.026	0.5	0.051	16.2	335	16	0.524	0.02	8.8
	±2.42	±.65	±.027	±.390	±.017	±.36	±.040	±12.9	±68.0	±5.0	±.254	±.013	±0.9
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
46	9	0.937	0.022	0.46	0.023	0.8	0.039	12.5	306	14.3	0.454	0.013	8.5
	±4.02	±.411	±.016	±.31	±.012	±.46	±.021	±8.8	±49.0	±3.9	±.096	±.006	±.5
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)

* Mean ± 1 Standard Deviation (Number of samples)

WATER QUALITY DATA - THAMES RIVER MOUTH - AUGUST 29 TO. SEPTEMBER 5, 1975

Stn. No.	Chloro <u>a</u> µg/L	Total N mg/L	NO_2 mg/L	NO_3 mg/L	Ammonia mg/L	Secchi Disk m	Tot P mg/L	Turb. FTU	Conduct. µmhos/cm^2	Chloride mg/L	Kjeld. mg/L	Diss. P. mg/L	Diss. O_2 mg/L
41	13	1.81	0.048	1.08	0.043	0.2	0.084	27.3	395	19.9	0.649	0.027	7.1
	±3.6	±.65	±.029	±.52	±.043	±.08	±.043	±12.6	±83.0	±6.1	±.129	±.011	±.8
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
40	10	1.74	0.047	1.04	0.053	0.4	0.089	28.3	399	19.9	0.644	0.025	7.6
	±3.53	±.82	±.034	±.62	±.046	±.36	±0.047	±20.1	±113.0	±7.8	±.205	±.012	±1.2
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
39	10.6	1.42	0.042	0.8	0.048	0.41	0.07	19.8	349	17.9	0.545	0.023	8.2
	±2.96	±.54	±.023	±.34	±.035	±.29	±.026	±10.1	±72.0	±6.1	±.159	±.009	±.4
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
38	10.7	1.36	0.038	0.75	0.038	0.5	0.057	20.0	345	17.0	0.556	.020	8.07
	±2.79	±.54	±.023	±.36	±.029	±.31	±.024	±8.6	±66.0	±5.5	±.192	±.008	±.8
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
37	11	1.3	0.037	0.71	0.035	0.5	0.054	20.0	343	17	0.563	0.019	8.9
	±3.50	±.61	±.022	±.39	±.024	±.22	±.023	±7.4	±65.0	±5.0	±.207	±.009	±.7
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
36	9.8	1.27	0.034	0.69	0.031	0.7	0.052	14.1	340	16.8	0.538	0.02	8.6
	±2.95	±.83	±.026	±.59	±.019	±.31	±.037	±9.2	±76.0	±5.5	±.229	±.020	±.6
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
35	9	0.92	0.021	0.47	0.021	0.7	0.038	11.4	298	13.4	0.432	0.013	8.9
	±2.65	±.56	±.015	±.41	±.011	±.26	±.020	±4.1	±48.0	±4.2	±.142	±.006	±.5
	(4)	(4)	(4)	(4)	(±4.l	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
33	7	0.698	0.015	0.32	0.01	0.9	0.027	9.2	265	10.8	0.368	0.008	9
	±2.03	±.372	±.007	±.26	±.006	±.37	±.O11	±6.2	±32.0	±2.7	±.115	±.002	±.7
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
31	7	0.987	0.021	0.51	0.031	0.8	0.038	12.3	318	13	0.456	0.012	8.9
	±3.61	±.668	±.017	±.49	±.037	±.39	±.030	±12.1	±63.0	±4.3	±.167	±.007	±.7
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)

* Mean ± 1 Standard Deviation (Number of samples)

WATER QUALITY DATA - THAMES RIVER MOUTH - AUGUST 29-TO SEPTEMBER 5, 1975

Stn. No.	Chloro a µg/L	Total N mg/L	NO_2 mg/L	NO_3 mg/L	Ammonia mg/L	Secchi Disk m	Tot P mg/L	Turb. FTU	Conduct. µmhos/cm^2	Chloride mg/L	Kjeld. mg/L	Diss. P. mg/L	Diss. O_2 mg/L
18	8.8 *	0.826	0.021	0.43	0.019	0.8	0.037	11.3	270	14.8	0.38	0.012	7.9
	±4.25	±.219	±.011	±.180	±.013	±.19	±.010	±5.1	±29.0	±5.0	±.058	±.004	±1.3
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
16	8.4	0.874	0.02	0.45	0.018	.7	0.034	11.3	276	13.8	0.408	0.01	8.5
	±3.29	±.116	±.003	±.080	±.012	±.17	±.004	±2.5	±9.0	±2.90	±.060	±.003	±.4
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(3)	(3)	(4)	(4)	(4)	(4)
14	7.1	0.794	0.017	0.38	0.013	0.8	0.033	9.1	275	11.6	0.381	0.009	8.8
	±2.18	±.255	±.005	±.220	±.009	±.32	±.014	±5.9	±25.0	±.3	±.056	±.002	±.2
	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(3)	(4)	(4)	(4)	(4)
12	6.7	0.795	0.016	0.39	0.016	0.8	0.031	9.2	286	11.1	0.385	0.009	8.6
	±3.17	±.473	±.010	±.340	±.009	±.42	±.025	±9.2	±32.0	±2.3	±.124	±.005	±.2
	(4)	(4)	(4)	(4)	(4)	(3)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
10	8.0	0.963	0.019	0.5	0.025	0.1	0.037	11.2	294	12.3	0.442	0.01	8.9
	±3.46	±.680	±.018	±.550	±.030	±.46	±.027	±11.1	±69.0	±5.0	±.117	±.006	±1.0
	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)

* Mean ± 1 Standard Deviation (Number of Samples)

Bacteriological Water Quality Data - August 29 to September 5, 1975

Station Number	Total Coliform /100 mL	Fecal Coliform/100 mL	Fecal Streptococci /100 mL	*P.* aeruginosa
80	2500	800	270	12
	(720- 4600)	(288-2100)	(52-1500)	(8-16)
	(4)	(4)	(4)	(4)
79	2700	44	17	2
	(48-2400)	(8-236)	(1-336)	(1-8)
	(5)	(5)	(5)	(5)
78	220	63	19	2.5
	(48-1400)	(32-208)	(1-192)	(1-8)
	(4)	(4)	(4)	(4)
77	250	37	8	2
	(32-2000)	(8-260)	(1-188)	(1-10)
	(4)	(4)	(4)	(4)
75	86	13	8	2
	(1-2400)	(1-172)	(1-60)	(1-4)
	(4)	(4)	(4)	(4)
73	120	40	9	2
	(1-3200)	(1-2100)	(1-384)	(1-14)
	(4)	(4)	(4)	(4)
72	1400	510	198	5
	(62-2700)	(168-2100)	(84-560)	(1-12)
	(4)	(4)	(4)	(4)
71	3400	1800	230	5
	(1380-9100)	(560-6700)	(140-440)	(4-6)
	(4)	(4)	(4)	(4)
70	820	200	82	2.5
	200- 4900	56-3000	12-760	1-18
	(4)	(4)	(4)	(4)
69	650	110	57	4
	(40-3800)	(8-1700)	(1-10000)	(1-18)
	(4)	(4)	(4)	(4)
68	270	55	32	2
	(24-2900)	(1-1700)	(1-520)	(1-8)
	(4)	(4)	(4)	(4)
67	200	34	25	2.5
	(8-2200)	(1-1300)	(1-100)	(1-4)
	(4)	(4)	(4)	(4)

* Geometric Mean ** Standard Deviation (-1σ - =1σ) *** (number of samples)

Bacteriological Water Quality Data - August 29 to September 5, 1975

Station Number	Total Coliform /100 mL	Fecal Coliform /100 mL	Fecal Streptococci /100 m	*P. aeruginosa*
62	510*	100	87	2.5
	(8-2200)**	(1-1300)	(1-100)	(1-4)
	(4)***	(4)	(4)	(4)
61	3200	400	314	6
	1300-7600	136-1100	92-2700	1-24
	(4)	(5)	(4)	(4)
60	640	110	38	3.5
	(170-2800)	(12-2300)	(8-284)	(2-6)
	(4)	(4)	(4)	(3)
59	380	65	40	4
	90-3600	8-1900	8-384	1-24
	(4)	(4)	(4)	(3)
58-	310	40	27	2
	(20-2100)	(1-1300)	(1-324)	(1-4)
	(4)	(4)	(4)	(3)
57	240	40	14	2
	(57-1100)	(4-124)	(1-48)	(1-6)
	(4)	(4)	(4)	(4)
55	51	8	5	1
	1-900	1-64	1-20	1-1
	(4)	(4)	(4)	(4)
53	27	8	5	1
	(1-1500)	(1-72)	(1-20)	(1-1)
	(4)	(4)	(4)	(4)
52	460	82	15	4
	1-9400	1-2100	1-64	1-40
	(4)	(4)	(4)	(4)
51	750	156	74	4.5
	(172-7600)	(40-1100)	(4-1200)	(1-26)
	(4)	(4)	(4)	(4)
50	2000	224	82	5.5
	(480-6400)	(44-3000)	(36-364)	1-22
	(4)	(4)	(4)	(4)
49	1000	114	44	4
	(410-2200)	(20-1000)	(16-164)	(1-8)
	(4)	(4)	(4)	(4)

** Geometric Mean ** Standard Deviation (-1σ - =1σ) *** (number of samples)

Bacteriological Water Quality Data - August 29 to September 5, 1975

Station Number	Total Coliform /100 mL	Fecal Coliform /100 mL	Fecal Streptococci /100 mL	*P.* aeruginosa
48	560*	92	21	2
	(72-2000)**	(12-2000)	(1-92)	(1-6)
	(4)***	(4)	(4)	(4)
47	200	58	15	2
	(12-2200)	(4-2200)	(1-104)	(1-16)
	(4)	(4)	(4)	(4)
46	120	7.2	11	2
	(12-1100)	(1-112)	(1-40)	(1-6)
	(4)	(4)	(4)	(4)
41	1000	198	66	5
	(160-9200)	(28-1900)	(8-1500)	(1-30)
	(4)	(4)	(4)	(4)
40	840	118	41	4
	(128-7500)	(8-1100)	(4-1100)	(1-14)
	(4)	(4)	(4)	(4)
39	740	91	40	3.5
	(120-2600)	(1-1300)	(8-272)	(2-8)
	(4)	(4)	(4)	(4)
38	240	40	24	2.5
	(92-1700)	(1-208)	(4-208)	(1-6)
	(4)	(4)	(4)	(4)
37	810	112	14	2.5
	(120-2100)	(24-1700)	(1-136)	(1-6)
	(4)	(4)	(4)	(4)
36	270	28	6	2.5
	(80-1000)	(1-1000)	(1-52)	(1-8)
	(4)	(4)	(4)	(4)
35	65	8	6	2
	(1-344)	(1-28)	(1-24)	(1-4)
	(4)	(4)	(4)	(4)
33	66	10	1.5	2
	(1-1200)	(1-32)	(1-4)	(1-4)
	(4)	(4)	(4)	(4)

** Geometric Mean   ** Standard Deviation (-1σ - =1σ)   *** (number of samples)

Bacteriological Water Quality Data - August 29 to September 5, 1975

Station Number	Total Coliform /100 ml	Fecal Coliform/100 ml	Fecal Streptococci /100 ml	*P. aeruginosa*
31	120*	71	3.5	1
	(20-2400)**	(4-1900)	(1-28)	(1-4)
	(4)***	(4)	(4)	(4)
18	150	25	6	1.5
	(60-1000)	(8-68)	(1-40)	(1-2)
	-3	-3	(4)	-3
16	81	11	45	1.5
	(12-276)	(1-40)	(1-12)	(1-2)
	(4)	(4)	(4)	(4)
14	79	10	6	1.1
	(20-324)	(4-32)	(1-16)	(1-2)
	(4)	(4)	(4)	(4)
12	82	10	3	1.5
	(24-304)	(4-52)	(1-44)	(1-6)
	(4)	(4)	(4)	(4)
10	12	4	3	2
	(1-144)	(1-72)	(1-24)	(1-8)
	(3)	(3)	(4)	(3)

** Geometric Mean
** Standard Deviation (-1σ - =1σ)
*** (number of samples)

APPENDIX B

DEPOSITIONAL CHARACTERISTICS OF SEDIMENT

The mean particle size of sediment samples was calculated in phi ø) units, where $ø = -\log_2$ particle diameter in mm. The percentage composition of sediments in terms of gravel, sand, silt and clay was calculated using a modified Wentworth (8) classification to conform with the sieve size used in the Ministry's particle size analysis. A comparison of the true Wentworth classification with that used in this report is presented in Table 3. The overall sediment texture of each sample was based on the Shepard (9) classification and derived from a ternary diagram comprising sand plus gravel, silt and clay as end members.

The influence of the Thames River on Lake St. Clair is marked by a zone of finer sediments extending from the river's mouth towards the northwest. This zone is characterized by a band of finer material composed of sandy silt, clayey sand and clayey silt in its northern end (Figure 9a). The differential sorting of sediments suggests that a northward current prevails in the area. This is supported by water quality observations discussed earlier.

The mean grain size of sediments found in the southern portion of the zone of influence lies between 4ø - 5ø (coarse silt) as compared with >5ø (finer silt) in the northern portion and <4 ø (fine sand) in the area outside this zone (Figure 9b) and apparently characteristic of deeper portions of Lake St. Clair.

The delineation of energy zones, which are related to hydraulic energy controlling the sediment sorting processes, was determined from the relationship of skewness to kurtosis, after Folk and Ward (10), Thomas *et al* (11), and Damiani and Thomas (12). The progression in energy levels represents changes occurring in sediment characteristics from predominantly sand in Zone A (low energy) (Figure 9c).

The energy levels within the channel is found to be lower than elsewhere in the study area. This observation indicates that this zone serves as a depositional environment for sediments supplied by the Thames River. The lowest energy level (Zone D) found within the zone, coincides with the deposition zone of the finest grain size sediments (clayey silts).

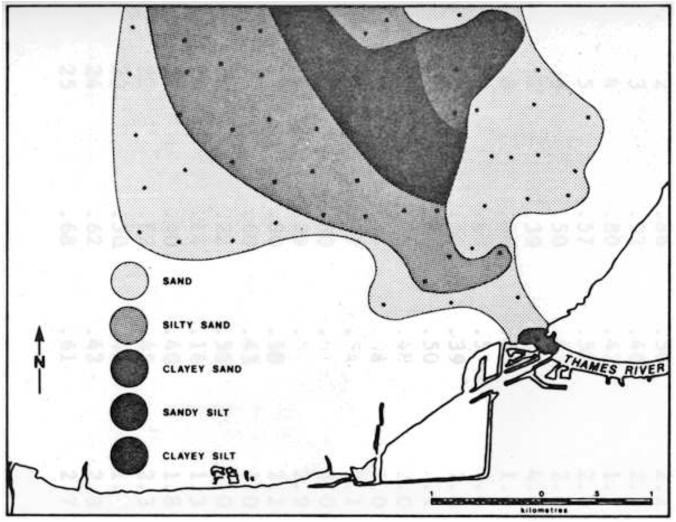

FIGURE 9A. Horizontal Distribution Of Surficial Sediment Texture, 1975
-texture classification after Shepard (9).
(sample depth 0-5 cm)

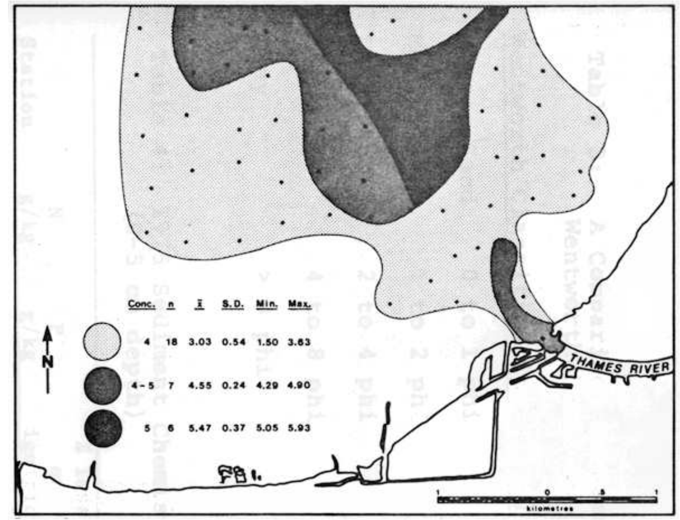

FIGURE 9B. Horizontal Distribution Of Surficial Sediment Mean Particle Size, 1975 (sample depth 0-5 cm)
-units - phi ø (- log, particle size diameter mm)

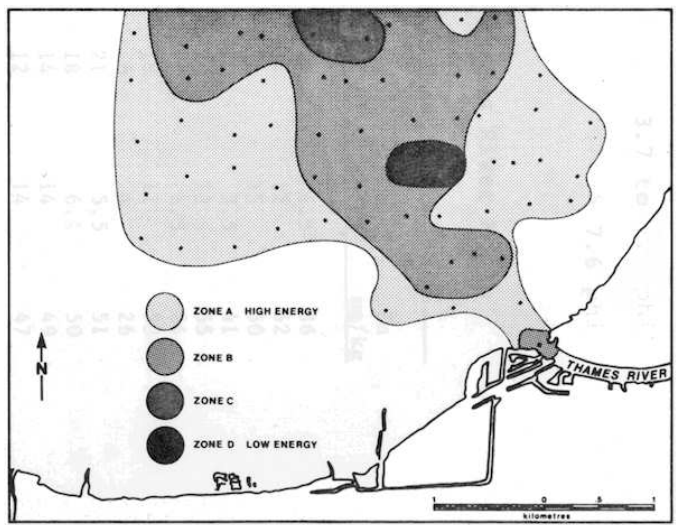

FIGURE 9C. Surficial Sediment Energy Distribution Depositional Zones, 1975
- after Folk and Ward (10), Thomas *et al* (11) and Damiani and Thomas (12).

Table 3: A Comparison Between Wentworth (8) and Modified Wentworth Particle Size Classification

Wentworth Classification (1922)		Modified Wentworth
Coarse Sand	0 to 1 phi	-2.3 to 0 phi
Medium Sand	1 to 2 phi	0 to 1.3 phi
Fine Sand	2 to 4 phi	1.3 to 3.7 phi
Silt	4 to 8 phi	3.7 to 7.6 phi
Clay	> 8 phi	> 7.6 phi

Table 4: 1975 Sediment Chemistry Thames River Mouth (0-5 cm depth)

Station	N g/kg	P µg/kg	loss on ignition	Cu mg/kg	Pb mg/kg	Zn mg/kg
1	0.61	0.28	1.6	9.2	4.5	36
2	0.86	0.50	2.2	14	12	52
3	0.92	0.46	2.3	14	15	50
4	0.80	0.42	1.7	10	7.5	41
5	0.57	0.58	2.6	15	13	55
6	0.50	0.43	2.0	5.5	6.5	24
7	1.39	0.62	4.0	18	11	53
8	0.36	0.43	1.0	6	4	26
9	0.63	0.59	2.4	21	5.5	51
10	0.66	0.39	1.8	18	6.8	50
11	0.81	0.50	2.1	14	14	49
12	0.76	0.48	2.0	12	14	47
13	0.44	0.38	1.0	6.8	7.5	33
14	0.97	0.54	2.1	15	15	52
15	0.80	0.61	3.0	15	17	59
16	0.99	0.57	2.9	17	8	54
17	0.80	0.58	2.2	13	8.8	41
18	0.60	0.43	1.0	9	7	34
19	0.22	0.53	1.0	9	7	37
20	0.14	0.16	1.3	6.8	5	29
21	0.40	0.40	1.8	11	13	48
22	0.62	0.45	2.3	15	14	57
23	0.30	0.42	1.5	9.2	9.2	39
24	0.62	0.42	2.3	13	8.8	50
25	0.68	0.61	2.7	15	14	57

Table 4: (continued) 1975 Sediment Chemistry

Station	N g/kg	P µg/kg	loss on ignition	Cu mg/kg	Pb mg/kg	Zn mg/kg
26	0.64	0.61	4.7	16	13	52
27	0.56	0.52	2.3	13	7.5	46
28	0.52	0.36	1.9	8.5	3.5	29
29	0.10	0.27	2.6	4	<3	18
30	0.20	0.52	1.3	9	12	34
31	0.20	0.28	1.9	10	7.5	34
32	0.20	0.34	1.5	9.5	12	40
33	0.22	0.41	3.1	9.8	12	43
34	0.59	0.44	1.8	12	10	53
35	0.69	0.51	2.1	13	11	51
36	0.47	0.52	2.5	15	9.8	54
37	1.10	0.73	3.3	17	11	58
38	0.87	0.72	3.5	15	7.5	51
39	0.27	0.37	1.2	2.5	2.5	20
40	0.50	0.56	1.1	5.5	7.0	26
41	0.51	0.63	1.0	4	3.8	22
42	0.49	0.29	1.2	4.2	3.8	26
43	0.85	0.42	N/A	9.5	7.5	40
44	1.10	0.32	N/A	7.5	5.2	32
45	0.95	0.46	N/A	7.8	7.2	35
46	0.85	0.52	N/A	9.5	7.0	40
47	0.71	0.62	2.5	14	11	50
48	1.20	0.77	N/A	15	11	63
49	<.5	0.43	2.0	7.5	5.5	35

Station	N g/kg	µg/kg	loss on ignition	Cu mg/kg	Pb mg/kg	Zn mg/kg	pp-DDD µg/kg	PCB µg/kg
50	<.5	0.63	1.2	3.3	<3.5	21		
51	0.39	0.45	N/A	3.5	<2	18		
52	0.23	0.38	N/A	2.8	<2	14		
61	1.2	0.63	6.7	16	13	56		
70	<.5	0.4	1.2	<3	<3.5	13		
78A	0.45	0.51	2.1	6.5	5	32	5	30
71A	1.9	0.67	6.5	19	16	70	-	20
50A	0.14	0.27	4.5	5.5	1.5	14	1	-
60A	0.29	0.41	<1	2.5	1.5	18	2	50
69A	0.33	0.64	1.3	3.5	4.5	20	2	20
80A	3.00	0.89	11	26	27	90	5	25

Table 5: 1975 Benthic Fauna-Thames River Mouth

identification after (13, 14)

Station	number of individuals/m^2						
Taxa	80A	71A	78A	69A	60A	50A	10
Limnodrilus maumeensis	448	1193	1068	387	168	44	275
L. undekemianus		52					
Gammarus fasciatus	11	5					
Chironomus sp.		5					
Procladius sp.	36	16	16				35
Cryptochironomus sp.	11	30	5	43	21		
Tanytarsus sp.				8			
Tribelos sp.							8
Tanypus sp.		16					
Chaobrus sp.	5			8			
Hexagenia bilineata		25	38	11			
Pisidium compressum				8	8	5	
Lampsilis radiata			5				