Appendix C

AMBIENT RIVER MONITORING

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C.1 Overview of Contaminants in Lake Erie, the Niagara River, and Lake Ontario

With the aid of the background information which appears in the main text, it is now possible to follow a detailed discussion of the results from these studies. This discussion will proceed with a general evaluation of the water quality at one end of the river compared to that at the other end. The focus will then shift to the Niagara River itself, with the river being divided into segments, so that the characteristics of the different reaches can be compared.

C.1.1 Data Indicating a Contaminant Problem in the Niagara River

To deal with the mass of data available through various studies, the river was divided into its three basic environmental media: water, sediment, and biota. Contaminant levels will be discussed for each medium separately due to the disparity between the three media with respect to the numbers and types of chemicals analyzed. However, these components do not exist in isolation. The river is in reality a complex ecosystem of many interacting components-both biotic and abiotic.

The purpose of this section is to provide the reader with an overview of contaminant levels in the various ecosystem components analyzed--bottom sediments, water, suspended sediments, algae, clams, and fish--and to discern spatial trends in contaminants that are common to more than one component. It should be remembered, however, that sampling times and station locations were not always coincident between the many ambient studies and not all ecosystem components were available at an individual site. The analysis will start in the eastern end of Lake Erie and will proceed down the Niagara River to Lake Ontario. Ratios that are given for contaminants depict the concentrations found in Lake Ontario:concentrations found in Lake Erie.

Of all the contaminants discussed, the most frequently analyzed in the various ecosystem components were metals, PCBs, and pesticides. Consequently, six representative contaminants were chosen from these classes for illustrative purposes: mercury, zinc, alpha-BHC, mirex, DDT, and total PCBs (see Table C.1); however, other chemicals are also discussed where appropriate.

It should be borne in mind that the Niagara Basin of Lake Ontario, as indicated, also has other significant sources in addition to the Niagara River.

C.1.1.1 Bottom Sediments

These data are the most complete and show the changes most clearly as one moves from Lake Erie to Lake Ontario. These changes are shown in Table C.2 (corresponding Figure C.1 supplied for reference).

Mercury and zinc concentrations in Lake Ontario sediments at the mouth of the Niagara River are 2.5 and 1.7 times those in Lake Erie. For the organic contaminants, the sediment concentration ratios range from 1.7 times for total DDT to 7.1 times for PCBs and finally to $\geq$10 times for mirex (from not detected, where the detection limit=0.001 ug/g, to 0.010 ug/g). Similar increases are also evident for some other contaminants. However, for aldrin/dieldrin and p,p^{1}-DDD, the concentration is higher in the eastern basin of Lake Erie than in the Niagara basin of Lake Ontario.

C.1.1.2 Water/Suspended Sediments

The water data show a trend that is less clear than the bottom sediment data because the chemicals are much less concentrated in the water and, consequently, are much more difficult to detect. Also, chemicals in the water are "active" (ie. they can be removed from the water phase by living or inorganic particulate matter, for instance) and, therefore, changeable in terms of concentration. Once incorporated into bottom sediments, however, the chemicals being looked for are, by comparison, relatively "inactive" and,

TABLE C.1

MEAN CONCENTRATIONS OF SIX CONTAMINANTS IN DIFFERENT MEDIA AND TROPHIC LEVELS OF LAKE ERIE AND LAKE ONTARIO NEAR THE NIAGARA RIVER.

MEDIA/TROPHIC LEVEL	CONCENTRATION UNITS	EASTERN LAKE ERIE/NIAGARA RIVER INLET						WESTERN LAKE ONTARIO/NIAGARA RIVER OUTLET					
		Mercury	Zinc	α-BHC	DDT	PCBs	Mirex	Mercury	Zinc	α-BHC	DDT	PCBs	Mirex
Bottom Sediment (a)	ng/g, dry wt.	464	178000	-	30	86	ND	1162	300000	-	50	612	10
Suspended Sediment (b)	ng/g, dry wt.	83	-	9	25	ND	ND	333	-	12	34	367	2
Water (c)	ug/L	0.12	4.9	0.00289	0.000113	0.000262	0.000002	0.12	6.5	0.00553	0.000145	0.000808	Tr(0.000001)
Algae (<u>Cladophora</u>) (d)	ng/g, dry wt.	30	14300	-	-	Tr(20)	-	110	83000	-	-	58	-
Clams (<u>Elliptio</u>) (e)	ng/g, wet wt.	-	-	ND	Tr(5)	Tr(20)	ND	-	-	3	Tr(5)	74	ND
Amphipods (<u>Pontoporeia</u>) (f)	ng/g, dry wt.	-	-	-	110	560	ND	400	89750	-	440	1378	228
Young Fish (Spottail Shiners) (g)	ng/g, wet wt.	49	-	ND	19	60	ND	43	-	4	82	255	6
Rainbow Smelt (f)	ng/g, wet wt.	31	-	-	141	207	ND	58	-	-	533	858	35
Sport Fish (Smallmouth Bass) (h)	ng/g, wet wt.	440	-	-	100	850	ND	570	-	-	300	3050	80
Herring Gull Eggs (k)	ng/g, wet wt.	-	-	-	7500	60000	600	-	-	-	12000	64000	3600

NOTE: 1) All concentrations are expressed as ppb; Tr=Trace; ND=Not detected; "-" indicates no data available.
2) <u>Data Sources</u>:
- (a) Various, as indicated in Table C.2
- (b) Sub-project 23, Table C.15
- (c) Sub-projects 23 (Table C.14) and 25/26 (Table C.2), 1981 data.
- (d) Sub-project 29 (Table C.35), 1982 data.
- (e) Sub-project 28 (Table C.36), 1981 data.
- (f) Whittle & Fitzsimons (1983).
- (g) Sub-project 30 (Table C.25), 1982 data.
- (h) Sub-project 5 (Table C.3), 1981 data.
- (k) Sub-project 31 (Table C.7), 1982 data.

TABLE C.2

MEAN CONCENTRATIONS OF CONTAMINANTS IN SURFICIAL SEDIMENTS OF LAKE ERIE AND LAKE ONTARIO DEPOSITIONAL BASINS (ug/g)

	LAKE ERIE (Eastern Basin)	LAKE ONTARIO (Niagara Basin)
Inorganics		
Arsenic	0.4	5.3
Cadmium	2.3	2.9
Chromium	48.0	63.0
Copper	34.0	77.0
Lead	81.0	157.0
Manganese	1143.0	4190.0
Mercury	0.464	1.162
Nickel	45.0	67.0
Zinc	178.0	300.0
Organics		
Total PCBs	0.086[a]	0.612[d]
Aldrin/Dieldrin	0.002[a]	0.0014[b]
o,p-DDT	ND[a]	0.022[b]
p,p'-DDT	0.004[a]	
p,p'-DDD (TDE)	0.018[a]	0.011[b]
p,p'-DDE	0.009[a]	0.017[b]
Total DDT + Metabolites	0.030[a]	0.050[b]
Mirex	ND[a]	0.010[c]
Organic Carbon (%)	2.08	2.92

Notes: Concentrations on dry weight basis.

Data Sources:

a Frank *et al*. (1977), eastern basin, 1971.

b Frank *et al*. (1979), Niagara basin, 1968.

c Holdrinet *et al*. (1978), Niagara anomaly, which includes the extreme southern portions of the Niagara and Mississauga basins, as well as the inshore (non-depositional) zones.

d Fox *et al*. (1983), Niagara basin.

All others: Thomas & Mudroch (1979).

This tabulation shows increases similar to those for the six representative contaminants, for many other substances.

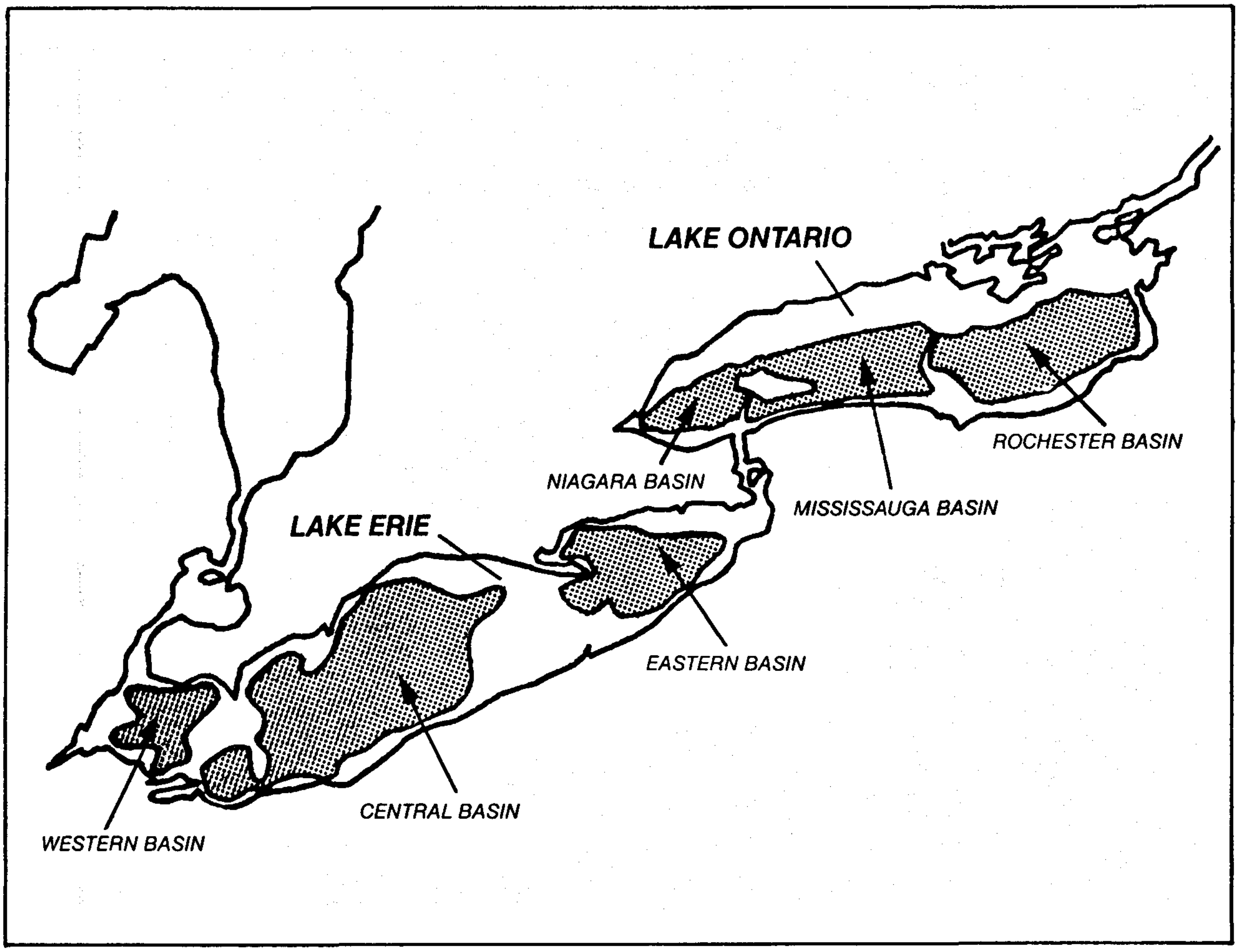

FIGURE C.1 DEPOSITIONAL BASINS IN LAKE ERIE AND LAKE ONTARIO (See Table C.2) therefore, concentrations remain more constant in the absence of inputs or resuspension. Also, bottom sediments reflect a historical discharge pattern to a greater extent than water samples. Inspite of these sources of variation, a general pattern of higher concentrations at Lake Ontario relative to Lake Erie (Table C.1) exists.

For the two metals in water, the concentration ratios are 1:1 and 1.3:1 for mercury and zinc, respectively. For the organics, the ratios are 8.8:1 for total PCBs, 1.9:1 for alpha-BHC, 1.9:1 for DDT, and 4:1 for mirex. In suspended sediments, the ratios are: 4:1 for mercury and not available for zinc, 1.3:1 for alpha-BHC, 367:1 for PCBs, 1.4:1 for DDT, and >2:1 for mirex.

C.1.1.3 Biota

Five different trophic levels of the biotic community in the Niagara River, at Lake Erie, and Lake Ontario were sampled for a wide range of substances. These included algae (Cladophora), clams, spottail shiners, small mouth bass, and herring gull eggs. Information on rainbow smelt (Osmerus mordax) and a bottom feeding amphipod (Pontoporeia affinis), was accessed from the literature. In the following discussion, six representative contaminants are presented. There were 42 possible ratios which could have been derived if a complete set of data were available for all seven trophic levels for each of the six compounds (Table C.1).

Twenty-seven of these possible ratios could be determined with the data collected. Only two of the ratios were at, or near, unity and only one was quantitatively shown to be less than unity (Table C.1). This clearly indicates that the trends which showed up in the abiotic part of the ecosystem are reflected through all the trophic levels in the biotic part of the ecosystem.

C.1.1.4 Sport Fish

Information on contaminants in sport fish in the Niagara River and adjacent Lake Erie and Lake Ontario has been collected chiefly by the New York State Department of Environmental Conservation and by the Ontario Ministry of the Environment. The New York data are part of the 1981 statewide Toxic Substances Monitoring Program while the Ontario data were generated as part of the Angler Information program which provides fish consumption advice by means of the "Guide to Eating Ontario Sport Fish" publication.

New York's 1981 program provided data for a wide variety of sport fish from Lake Erie at Dunkirk and Lackawanna and the Niagara River at Fort Niagara, below Lewiston and below Buffalo (Sloan, 1983). Contaminant levels in smallmouth bass (Table C.3) were highest at Fort Niagara (3.05 ug/g PCB, 0.30 ug/g total DDT, 0.02 ug/g dieldrin, 0.02 ug/g lindane, and 0.08 ug/g mirex) and lowest at Lackawanna (0.57 ug/g PCB, 0.08 ug/g total DDT, 0.01 ug/g dieldrin, and less than 0.01 ug/g lindane and mirex).

Ontario selected data for smallmouth bass, yellow perch, white sucker, coho salmon, and rainbow trout (steelhead) for eastern Lake Erie, upper and lower Niagara River and southwestern Lake Ontario for the contaminants, mercury, PCBs, and mirex are presented in Table C.4. Since these data were collected primarily for public health purposes, assessment of trends will emphasize qualitative rather than quantitative points.

In comparing upstream and downstream locations for the various species, it is clear that 1981-82 collections do not show a downstream elevation of mercury as has been seen in other locations where chlor-alkali cells were operated.

TABLE C.3

CONTAMINANT CONCENTRATIONS IN LAKE ERIE AND NIAGARA RIVER SMALLMOUTH BASS - 1981.
(ug/g)

PARAMETER	RIVER SEGMENT/SUB-AREA				
	Lake Erie		Bird Island-Riverside	Lower River	
	N-1	N-2	N-3	N-16	N-17
Mercury	0.44	0.52	0.40	0.48	0.57
PCBs, total	0.85	0.57	1.24	0.66	3.05
gamma-BHC (Lindane)	0.01	0.01	0.01	0.01	0.02
Σ DDT + metabolites	0.10	0.08	0.14	0.07	0.30
Dieldrin	0.01	0.01	0.01	0.01	0.02
Endrin	0.01	0.01	0.01	0.01	0.01
Hexachlorobenzene	0.01	0.01	0.01	0.01	0.01
Mirex	0.01	0.01	0.01	0.02	0.08
Chlordane	0.02	0.02	0.03	0.01	0.04
Length (mm)	406(391-433)	357(308-431)	341(308-425)	215(201-275)	319(304-344)
Weight (g)	955(813-1247)	690(435-1205)	638(391-1219)	206(173-426)	493(437-552)
No. fish/analysis	11	14	13	16	8

NOTES: Data source: Sub-project 5 (NYSDEC). Stations correspond to locations in Fig. 4.5. (Chapter IV) Concentrations of contaminants are in ppm (ug/g, wet weight), and represent averages (for each site, fish were analyzed as a single pool of the number of fish indicated).

TABLE C.4

CONTAMINANTS LEVELS IN SPORT FISH FROM EASTERN LAKE ERIE, UPPER AND LOWER NIAGARA RIVER, AND SOUTHWESTERN LAKE ONTARIO (1977-1982).

LOCATION	YEAR	#	LENGTH (cm)	WEIGHT (gm)	HG (ppb)	PCBs (ppb)	MIREX (ppb)
Yellow Perch							
Upper Niagara River-Millers Creek (M18)	80	20	22.4(18.8-26.9)	146(88-220)	140(70-270)	27(ND-106)	ND(ND-ND)
	82	8	16.4(14.5-18.6)	54(37- 69)	70(50-110)		
Lower Niagara River (M26)	80	21	22.7(17.8-28.0)	171(73-320)	160(80-370)	86(34-250)	Tr(ND- 7)
	81	20	25.6(23.5-28.2)	247		194(57-351)	5(ND-25)
	82	19	23.7 (19.7-27.5)	175		222(53-443)	8(ND-25)
Jordan Harbour - Lake Ontario	79	9	22.0(15.7-30.5)	160(45-423)	70(10-140)	98(37-230)	ND(ND-ND)
White Sucker							
Upper Niagara River (M18)	80	20	28.3(24.4-47.6)	308(157-1157)	90(30-500)	58(ND-330)	ND(ND-ND)
Lower Niagara River (M26)	80	20	37.2(26.1-48.8)	601(200-1230)	210(50-420)	505(ND-1206)	19(ND-47)
	81	19	43.6(32.8-54.4)	939		692(336-1388)	20 (ND-40)
	82	15	41.4(29.9-49.5)	829		1081(443-2038)	27(ND-58)
Coho Salmon							
Long Point Bay - Lake Erie	81	20	69.2(60.3-75.7)	3578(2452-4442)	140(90-250)	740(404-1439)	ND(ND-ND)
Jordan Harbour - Lake Ontario	82	20	46.3(35.4-58.2)	1025(419-1888)	90(30-220)	755(321-2991)	53(20-195)
Rainbow Trout							
Long Point Bay - Lake Erie	77	14	57.5(38.5-72.5)	2041(688-3444)	240(150-340)	769(340-1290)	ND(ND-ND)
Lower Niagara River (M26)	82	21	59.0(34.1-84.2)	2658(438-6396)	240(50-490)	1075(54-2439)	70(ND-150)
Jordan Harbour - Lake Ontario	82	20	51.2(40.0-69.4)	1509(615-3096)	100(40-240)	506(97-994)	50(ND-100)
Small Mouth Bass							
Long Point Bay - Lake Erie	81	37	27.9(18.6-49.0)	389(90-1505)	150(70-720)	149(33-553)	ND(ND-ND)
Upper Niagara River (M18)	80	10	31.9(24.4-42.5)	589(242-1256)	210(80-630)	141(59-299)	ND (ND-ND)
Lower Niagara River (M26)	80	3	25.2(20.0-32.0)	303(128- 570)	120(70-190)	249(191-320)	ND(ND-ND)
	81	11	28.0(20.4-43.6)	413		366(162-815)	15(7-35)
	82	4	32.1(29.9-49.5)	829		499(125-1061)	15(ND-29)

NOTES: Data Source: Sub-project 33 (MOE). Stations correspond to locations on Figure 4.5
Concentrations of contaminants are in ppb (ng/g) range (in brackets) for each collection.

Considering PCB levels, particularly in the smallmouth bass, white sucker and yellow perch, the levels in edible flesh are considerably higher in samples from the lower Niagara River than on the Canadian side of the upper River. Furthermore, 1981 and 1982 PCB data for these species in the lower Niagara River are higher than those for 1980.

Mirex is detectable in fish taken from well mixed waters of the lower Niagara River. It was not detected in samples from the Canadian side (Chippawa Channel) of the upper Niagara River.

The Ontario and New York analyses of sport fish in the Niagara River and western Lake Ontario for the chlorinated dioxin 2,3,7,8-TCDD (Tables C.5 and C.6), show that there are significant sources of 2,3,7,8-TCDD in the Niagara River. Lake Trout in Western Lake Ontario generally exceed the 20 ppt Canadian Federal and 10 ppt NYS guideline for 2,3,7,8-TCDD and are, therefore, considered to be contaminated.

In conclusion, the data base for several species of sport fish indicates that there are sources along the Niagara River of PCB, mirex, and the chlorinated dioxin 2,3,7,8-TCDD.

Chlorinated benzene concentrations have been measured in lake trout from Lakes Superior, Huron and Ontario (Oliver & Nicol, 1982). Concentrations in Lake Ontario trout were an order of magnitude greater than those from Lakes Superior and Huron. The sum of the dichloro-through hexachlorobenzenes increased from 16.8 ng/g in Lake Superior fish to 179 ng/g in Lake Ontario fish.

C.1.1.5 Contaminants in Herring Gull Eggs

The results in Table C.7 show that, spatially, the residue levels in gull eggs from the Niagara River are intermediate between those from the Pt.

TABLE C.5

2,3,7,8-TCDD (DIOXIN) LEVELS IN SPORT FISH

(ANALYSIS OF DORSAL FILLET SAMPLES FROM FISH COLLECTED IN 1980)

LOCATION (STATION)	SPECIES	# SAMPLED	# POSITIVE AT THE 10 PPT DETECTION LIMIT	2,3,7,8-TCDD*
Upper Niagara River (Miller Creek) M18	Yellow Perch	6	0	ND**
	White Sucker	1	0	ND
	Smallmouth Bass	1	0	ND
Lower Niagara River (Queenston) M26	American Eel	5	0	ND
	Walleye	1	0	ND
	Rainbow Trout	1	0	ND
	Northern Pike	1	0	ND
	Muskellunge	1	0	ND
	Yellow Perch	6	0	ND
Lake Ontario at Jordan Harbour, Ontario	Brown Trout	13	7	ND-19
	White Bass	6	2	ND-19
Lake Ontario at Credit River, Toronto, Ontario	Coho Salmon	8	0	ND
Lake Ontario at Hearn Generating Station, Toronto, Ontario	Smelt	8	1	ND-11
Lake Ontario Bluffers Park, Scarborough, Ontario	Lake Trout	5	3	ND-19
Lake Ontario Bay of Quinte, Ontario	Yellow Perch	6	0	ND
	White Perch	6	1	ND-16
Lake Erie at Port Dover, Ontario	Rainbow Trout	3	0	ND
Detroit River at Fighting Island	Yellow Perch	3	0	ND
Lake Huron Point Edward, Ontario	Lake Trout	6	0	ND
Lake Huron at Owen Sound, Ontario	Rainbow Trout	6	0	ND

TABLE C.5 (Continued)

LOCATION (STATION)	SPECIES	# SAMPLED	# POSITIVE AT THE 10 PPT DETECTION LIMIT	2,3,7.8-TCDD*
Lake Huron at St. Joseph Island	Walleye	6	0	ND
Lake Superior at Thunder Bay, Ontario	Lake Trout	6	0	ND
Grand River - (Lake Erie Watershed) Canagagigue Creek upstream of Elmira, Ontario	Rock Bass	2	0	ND
Canagagigue Creek downstream of Elmira, Ontario	White Sucker	4	0	ND
	Rock Bass	1	0	ND
	Brown Bullhead	1	0	ND

NOTES: Data Source: Sub-project 33 (MOE). Stations correspond to locations on Fig. 4.5.(Chapter IV)
*ppt = pg/g
**ND = Not detected at the 10 ppt detection limit.

TABLE C.6

2,3,7,8-TCDD (DIOXIN) LEVELS IN SPORT FISH
(ANALYSIS OF DORSAL FILLET SAMPLES FROM FISH COLLECTED IN 1981)

LOCATION (STATION)	SPECIES	LENGTH (cm)		2,3,7,8-TCDD(PPT)* IN DORSAL FILLET	
Lake Ontario at Clarkson (Port Credit)	Lake Trout (11)	60.9	(50.9-69.5)	27.4	(17.0-57.0)
Lake Ontario at Humber Bay (Toronto)	Lake Trout (6)	47.3	(43.-51.)	17.8	(6.0-28.0)
	R. Smelt (3c)	17.7	(15.-21.)	8.0	(7.0-10.0)
Lake Ontario at Ganaraska R. (Port Hope)	Rainbow Trout (7)	62.0	45.8-73.9)	8.3	(7.0-11.0)
Lower Niagara River near Queenston (M26)	S.M. Bass (6)	28.8	(18.8-43.6)	12.7	(ND*-30.0)
	Y. Perch (5)	27.3	(26.0-28.2)	6.6	(3.0-13.0)
	R. Bass (5)	19.8	(18.0-21.0)	2.4	(ND*-5.0)
Grand River at Breslau (Waterloo, Ont.)	S.M. Bass (8)	24.8	(18.0-35.0)	ND*	(ND*)
	R. Bass (5)	16.8	(14.0-19.0)	ND*	(ND*)
Lake Superior at Peninsula Harbour	Lake Trout (11)	44.9	(34.0-64.0)	0.45	(ND*-2.0)

NOTES: Data Source: Sub-project 33 (MOE). Stations correspond to locations on Fig. 4.5. (Chapter IV)
*ppt = pg/g.
**ND = Not detected at a 1.0 ppt detection limit.

TABLE C.7

CONTAMINANT CONCENTRATIONS IN HERRING GULL (*Larus argentata*) EGGS FROM THE NIAGARA RIVER AND NEARBY LAKE ERIE AND LAKE ONTARIO COLONIES (ug/g)

PARAMETER	YEAR	COLONY: LAKE ERIE (Port Colborne, Ontario)	COLONY: NIAGARA RIVER	COLONY: LAKE ONTARIO (Mugg's Island, Toronto, Ont.)
p,p'-DDE	1979	3.4 ±1.0	4.1 ±1.3	9.0±3.5
	81	4.7 ±1.7	5.7 ±2.6	10±5.2
	82	7.5	3.7	12±4.4
Mirex	1979	0.25±0.09	0.49±0.24	1.8± .87
	81	0.42±0.47	0.74±0.50	2.5±1.1
	82	0.60	0.98	3.6±1.3
PCBs	1979	38±6	50±23	76±30
	81	44±13	50±25	72±30
	82	60	46	64±20
2,3,7,8-TCDD	1980	9	--	47

NOTES: Data Source: Sub-project 31.
Concentrations are means and standard deviations in ug/g (wet weight), of 10 analyzed eggs. In 1982, the eggs from Port Colborne and the Niagara River were analyzed as two pools of 10 eggs each.

Colborne Lighthouse colony (Lake Erie) and the Mugg's Island colony (Toronto, Ontario). However, in all cases except one (PCBs-1981) residues in 1979 and 1981 in eggs from Mugg's Island were significantly greater than those from either the Pt. Colborne or Niagara River colonies ($P<0.05$). Furthermore, there were no statistical differences between the residues from the Pt. Colborne and Niagara River colonies. Hence, residues from herring gull eggs from the Niagara River more closely resemble those from eastern Lake Erie than those from western Lake Ontario (Weseloh, 1983). Although analysis of 1981 and 1982 eggs for dioxin is not yet complete, Norstrom et al. (1982) found that mean 2,3,7,8-TCDD levels were higher in eggs from Lake Ontario colonies (47 pg/g) than those from Lake Erie (9 pg/g) in 1980*.

C.1.2 Contaminants Input from Lake Erie Outside of the Project Area to the Niagara River

Results of this study have clearly demonstrated eastern Lake Erie waters outside the project area enter the Niagara River, and have an effect on water quality. The influence of this "background" concentration has been noted for conventional contaminants such as phosphorus (Kauss, 1983).

A knowledge of this input (and its magnitude) is clearly of importance when one wishes to define additional inputs to the river and the combined influence of all inputs to the Niagara River on downstream (Lake Ontario) water quality. An examination of the ambient monitoring data sets indicates that the Lake Erie outflow contains a number of metals and organics, with some contaminants present at trace (non-quantifiable) levels. (Table C.8). Statistical tests have been carried out to compare contaminant detections and concentrations in water and suspended sediments at Fort Erie and Niagara-on-the-Lake.

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* Data are uncorrected for recovery. However, percent recoveries on spiked samples were good and the accuracy of the method was shown to be equivalent to those used by other Canadian and U.S. Labs.

TABLE C.8

CONTAMINANTS DETECTED IN WATER, SUSPENDED SEDIMENTS AND BIOTA FROM THE INLET OF THE NIAGARA RIVER (LAKE ERIE) - 1981 and 1982.

Parameter	WATER	SUSPENDED SEDIMENT	BIOTA Algae	Clams	Spottails	Gull Eggs	Sport Fish
Inorganics:							
Aluminum	*		*				
Arsenic		*	*				
Cadmium	*		*				
Chromium	*		*				
Cobalt			*				
Copper	*		*				
Iron	*						
Lead	*		*				
Manganese			*				
Mercury	*	*	*		*		*
Nickel	*		*				
Selenium		*	*				
Zinc	*		*				
Organics:							
Phenol	*						
Trichlorophenols					*		
Pentachlorophenol					*		
PCBs	*		*	*	*	*	*
Dieldrin	*	*			*		*
alpha-BHC	*	*		*			
beta-BHC				*			
gamma-BHC	*			*			
alpha-Chlordane		*		*			*
gamma-Chlordane	*						
p,p'-DDT	*	*		*		*	
p,p'-DDE	*	*					*
p,p'-DDD (TDE)	*	*					
alpha-Endosulfan	*	*					
beta-Endosulfan		*					
Endrin	*				*		
Heptachlor Epoxide	*	*		*			
Methoxychlor		*					
Mirex	*					*	
1,2-Dichlorobenzene		*					
1,3-Dichlorobenzene		*					
1,2,3-Trichlorobenzene		*					
1,3,5-Trichlorobenzene		*					
Hexachlorobenzene		*		*			
Hexane	*						
Benzene	*						
m-Xylene	*						
Toluene	*						
Chlorodibromomethane	*						
Chloroform	*						
Dichlorobromethane	*						
Methylene chloride	*						
1,1,1-Trichloroethane	*						
Trichloroethylene	*						
Trichlorotrifluoroethane	*						
Tetrachloroethylene	*						
Hexanal	*						
Acetone	*						
Methyl ethyl ketone	*						
Dimethyl disulphide	*						
Methyl furan	*						
2,3,7,8-TCDD						*	

* Present in medium indicated, at trace or quantifiable level.

C.2 Water Quality Variations in the River

Data on contaminants in water and associated suspended sediments are summarized in the accompanying Tables C.10 to C.15 at the end of this section.

C.2.1 Cross-Channel Variation in Water Quality

Figures C.2-C.5 illustrate the cross-channel distribution* of some of the contaminants identified in whole water samples (sub-projects 25 and 26) for four areas of the river during 1981: between the Fort Erie-Lake Erie-Buffalo River segment, the Chippawa segment, the Wheatfield-Upper River segment, and the Lower River segment. This data base is summarized in Table C.10.

Increases in both mean concentrations and temporal variability (indicated by the large 95% confidence intervals) close to shore suggest the presence of contaminant inputs, either in the immediate vicinity of the sampling stations or further upstream. This was evident at the easterly (mainland) shore of the Tonawanda Channel at Niagara Falls, N.Y. (just downstream of the north Grand Is. bridge and the 60th Street sewer (MOE transect station M-10)) for aluminum, mercury, and zinc; at the mouth of the Buffalo River for aluminum, copper, mercury, and zinc; and at the Grand Island shore of the Chippawa Channel for zinc. However, only in the case of zinc at the mainland shore of the Tonawanda Channel was this nearshore mean concentration significantly higher. In contrast, distributions of

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* Preliminary statistical evaluation indicated that the data were not normally distributed. Consequently, all statistical calculations for sub-projects 25 and 26 (sections C.2.1 and C.2.2) were performed on the logarithmic (base 10) transforms of the data, which more adequately reflected the natural distribution of the data. For ease of interpretation, data in Figures C.2-C.8 have been transformed back to their arithmetic values, resulting in asymmetric confidence intervals.

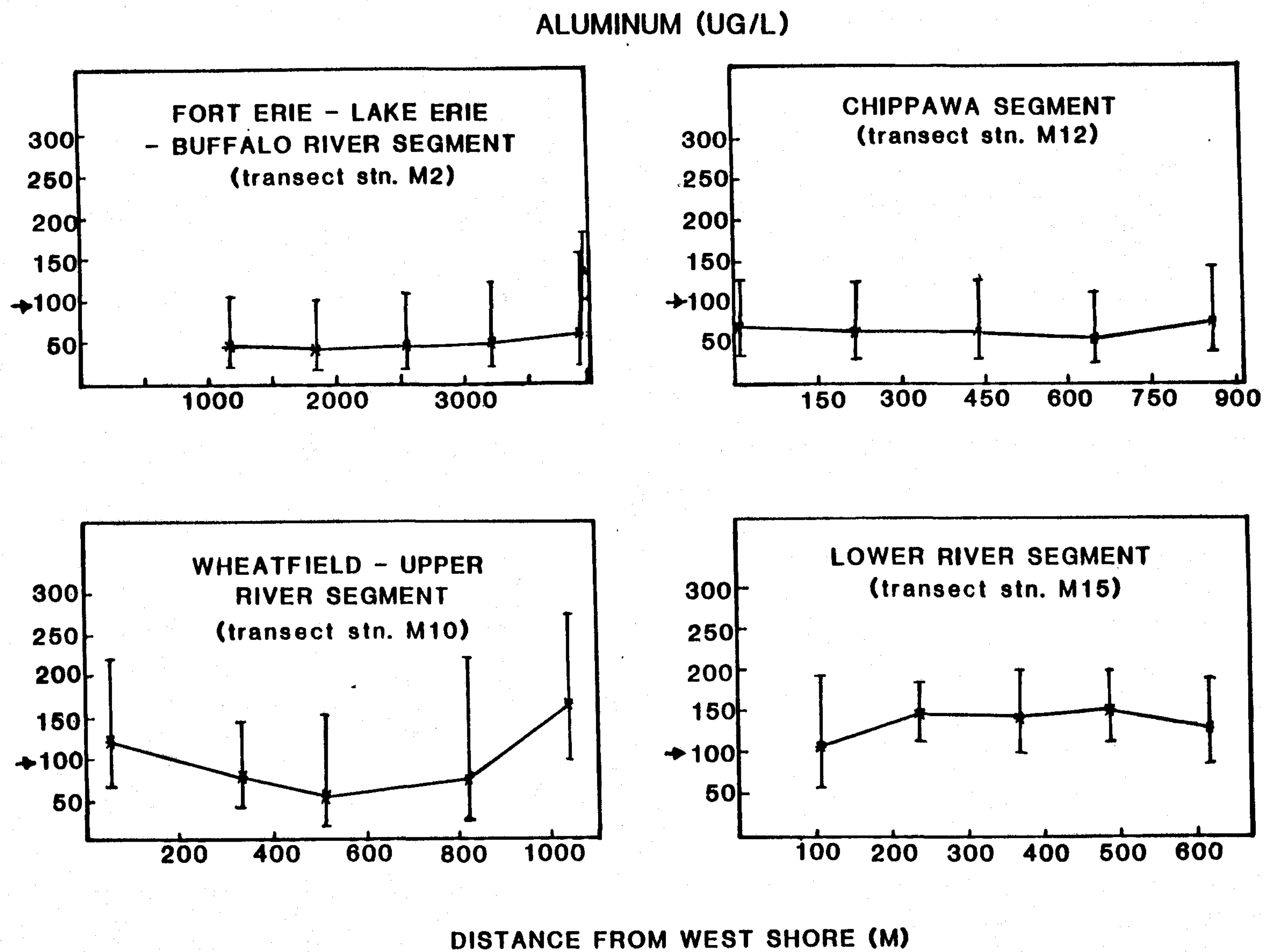

FIGURE C.2 CROSS-CHANNEL DISTRIBUTIONS OF ALUMINUM CONCENTRATIONS IN NIAGARA RIVER WATERS DURING 1981 (GEOMETRIC MEANS WITH 95% CONFIDENCE INTERVALS). DISTANCES ARE IN METRES FROM THE WEST SHORE, LOOKING DOWNRIVER (NORTH). ARROW INDICATES CRITERION FOR PROTECTION OF AQUATIC LIFE.

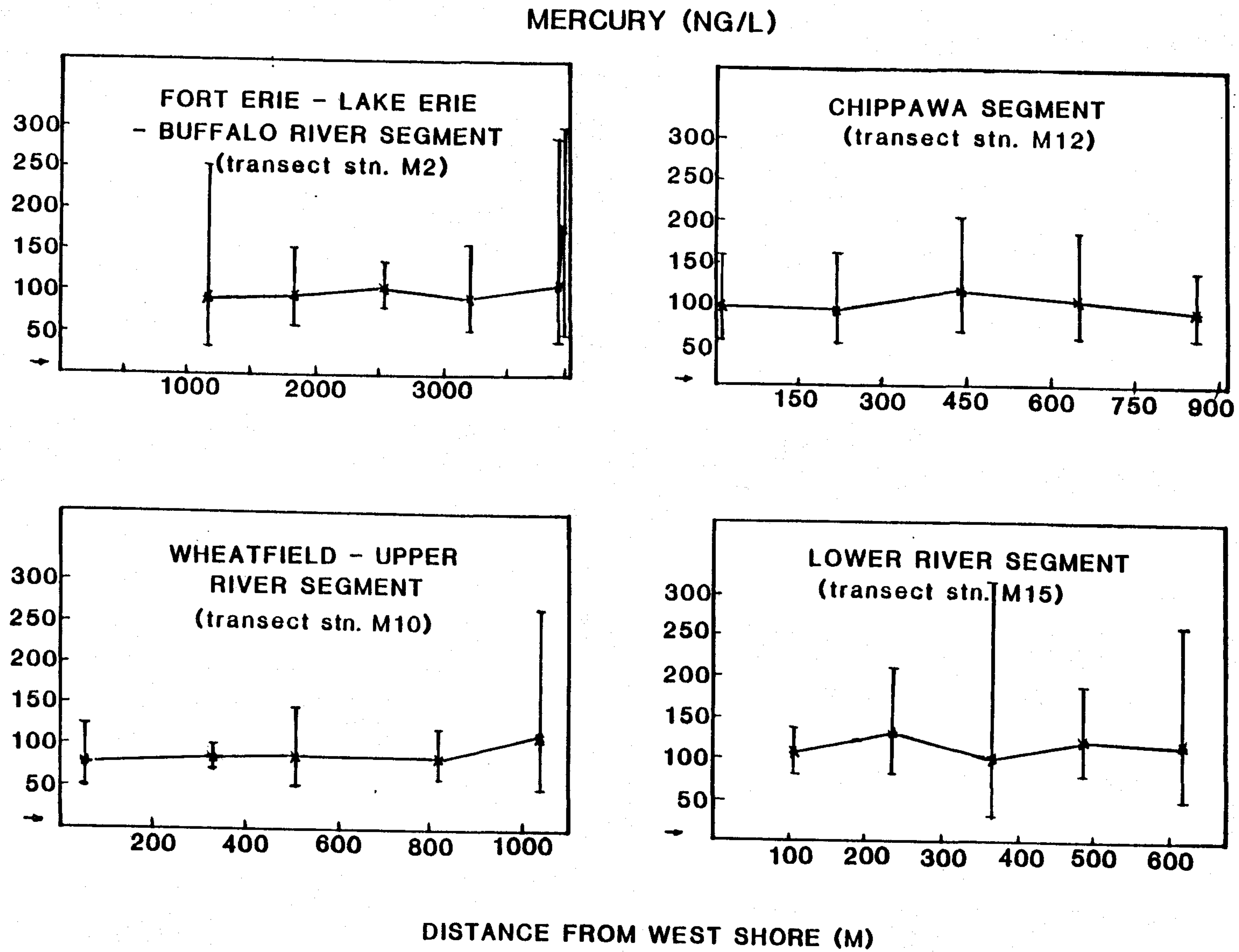

FIGURE C.3 CROSS-CHANNEL DISTRIBUTIONS OF MERCURY CONCENTRATIONS IN NIAGARA RIVER WATERS DURING 1981 (GEOMETRIC MEANS WITH 95% CONFIDENCE INTERVALS). DISTANCES ARE IN METRES FROM THE WEST SHORE, LOOKING DOWNRIVER (NORTH). ARROW INDICATES CRITERION FOR PROTECTION OF AQUATIC LIFE.

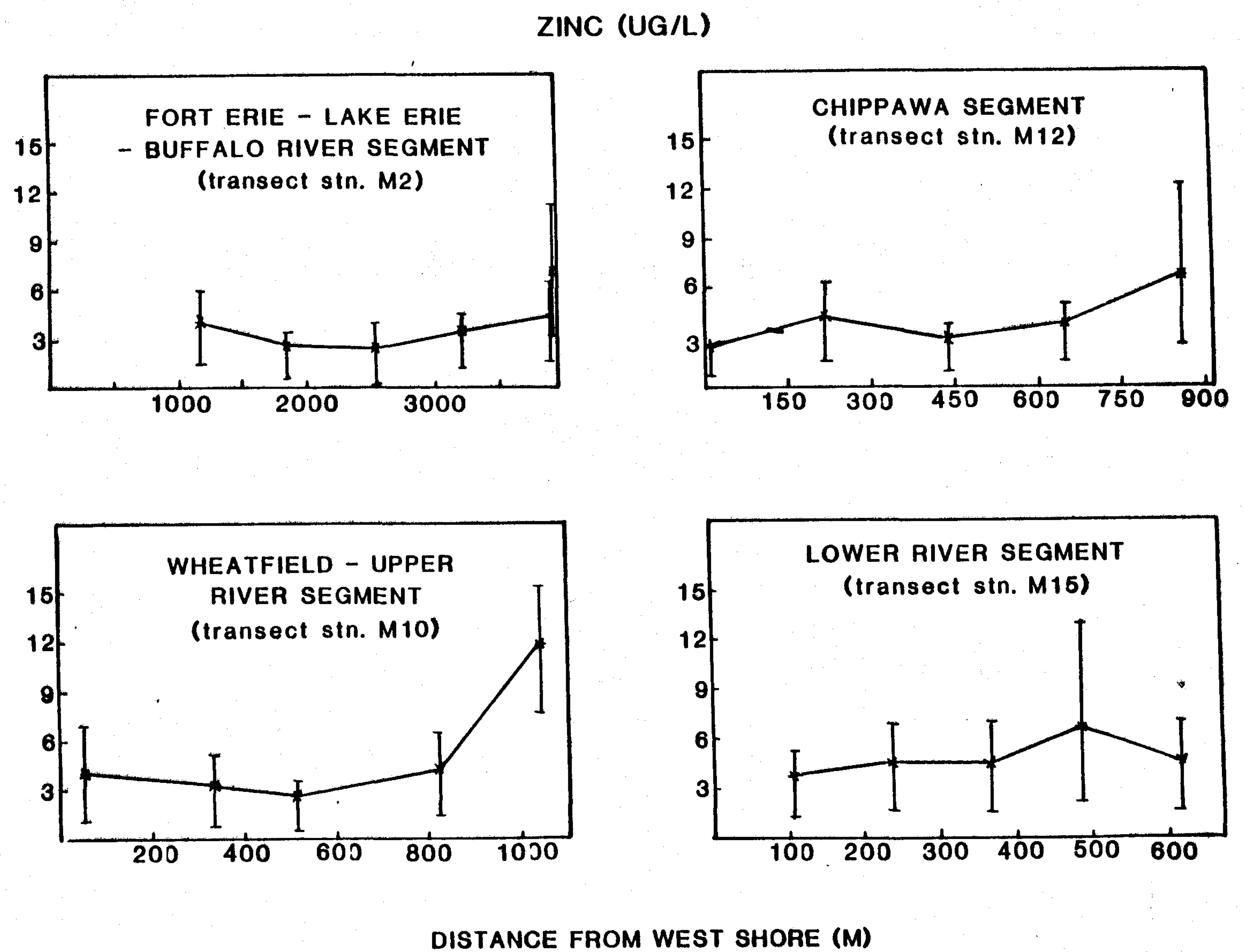

FIGURE C.4 CROSS-CHANNEL DISTRIBUTIONS OF ZINC CONCENTRATIONS IN NIAGARA RIVER WATERS DURING 1981 (GEOMETRIC MEANS WITH 95% CONFIDENCE INTERVALS). DISTANCES ARE IN METRES FROM THE WEST SHORE, LOOKING DOWNRIVER (NORTH). CRITERION FOR PROTECTION OF AQUATIC LIFE IS 30 ug/L.

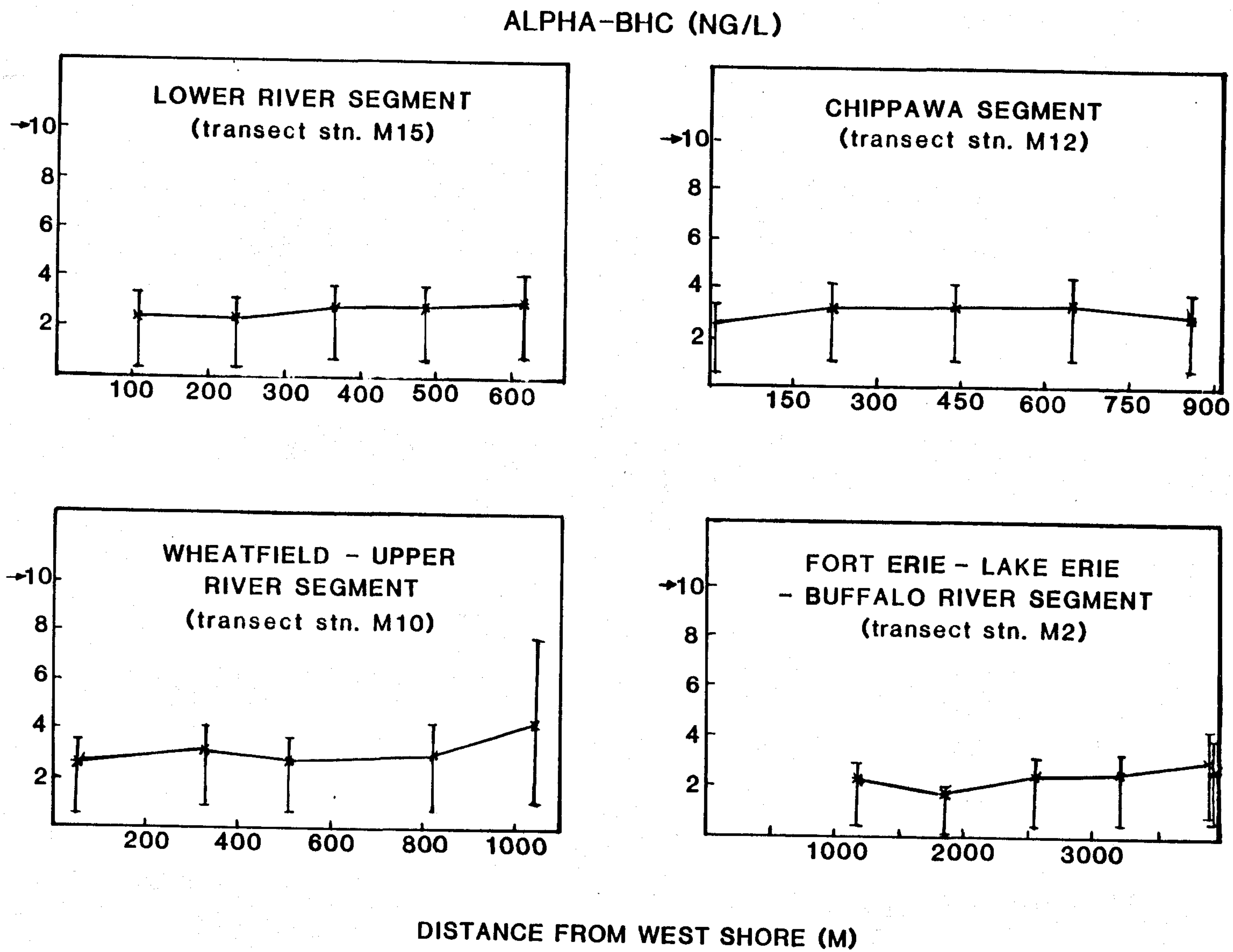

FIGURE C.5 CROSS-CHANNEL DISTRIBUTIONS OF ALPHA-BHC CONCENTRATIONS IN NIAGARA RIVER WATERS DURING 1981 (GEOMETRIC MEANS WITH 95% CONFIDENCE INTERVALS). DISTANCES ARE IN METRES FROM THE WEST SHORE, LOOKING DOWNRIVER (NORTH). ARROW INDICATES CRITERION FOR PROTECTION OF AQUATIC LIFE.

contaminants were relatively homogeneous or did not exhibit shoreward gradients in the lower river. Results of previous studies have indicated stronger cross-channel gradients in the Tonawanda Channel for aluminum, iron, mercury, and BHC isomers in 1980 (Kauss, 1983) and for iron, mercury and zinc in 1979 (Kuntz, 1983). However, this was not evident for chromium, copper, nickel, or cadmium in the present studies.

C.2.2 Longitudinal Variation in Water Quality and Organic Contaminant Distribution between Aqueous and Particulate Phases

Figures C.6-C.8 show the concentrations* of some of the contaminants identified in whole water samples obtained in 1982 (sub-projects 25 and 26) at stations close to both mainland shores usually within 20 to 50 metres (60-150 feet). Additional information on these sub-projects is available in Table C.11. Mean concentrations of these chemicals generally exhibited substantial variation along the length of the upper river, with increases in their concentrations at certain locations in the upper river segments. Relative to Fort Erie, elevated mean concentrations of certain contaminants were noted at sampling stations located at or just downstream of the following locations:

Station	Location		Contaminants
	New York		
(MOE Stn. M2)	Buffalo River mouth	-	aluminum, copper, nickel, zinc
(" M4)	Riverside, E. shore upstr. of Strawberry I.	-	chromium, copper, nickel, zinc
(" M5)	Two Mile Creek mouth	-	aluminum, lead, zinc, nickel
(" M6)	Dnstrm. of Pettit Flume	-	nickel
(" M7)	Wheatfield (NCRDD)	-	chromium, zinc
(" M8)	Griffon Park 102nd St.	-	aluminum, copper, nickel
(" M9)	Little River mouth	-	zinc, alpha-BHC
(" M10)	Niagara Falls, dnstrm. of N. Grand Is.Grand Is. bridge and 60th St. sewer	-	lead
	Ontario		
(MOE Stn. M11)	Black Creek mouth	-	aluminum, copper
(" M12)	Chippawa, upstr. of Ussher's Cr.	-	chromium, aluminum

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* Refer to footnote, page C. 31.

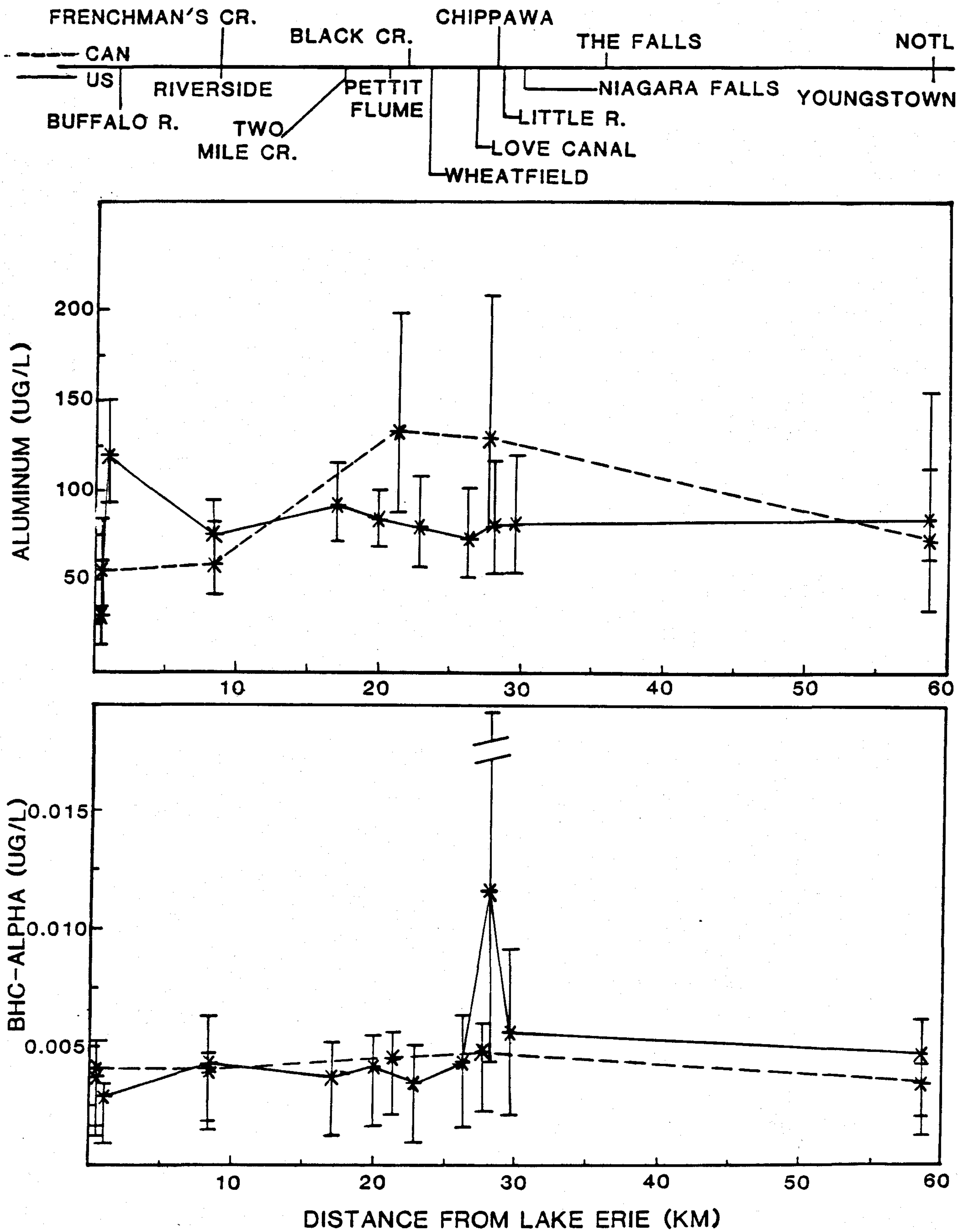

FIGURE C.6 CONCENTRATIONS OF ALUMINUM AND ALPHA-BHC IN NIAGARA RIVER NEARSHORE WATERS DURING 1982 (GEOMETRIC MEANS WITH 95% CONFIDENCE INTERVALS). CRITERIA FOR AQUATIC LIFE ARE 100 AND 0.010 ug/L, RESPECTIVELY.

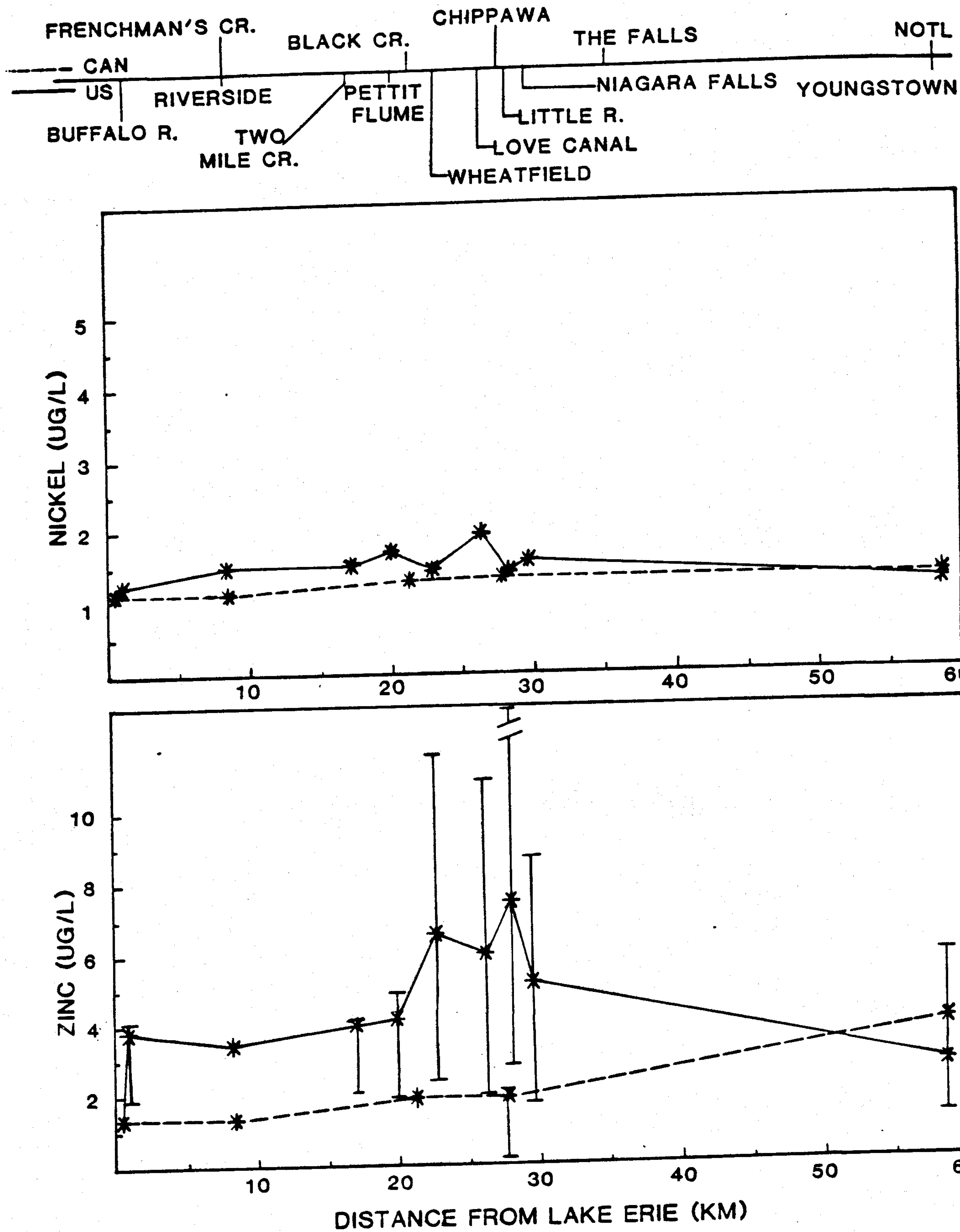

FIGURE C.7 CONCENTRATIONS OF NICKEL AND ZINC IN NIAGARA RIVER NEARSHORE WATERS DURING 1982 (GEOMETRIC MEANS WITH 95% CONFIDENCE INTERVALS). CRITERIA FOR PROTECTIO OF AQUATIC LIFE ARE 15 AND 30 ug/L, RESPECTIVELY.

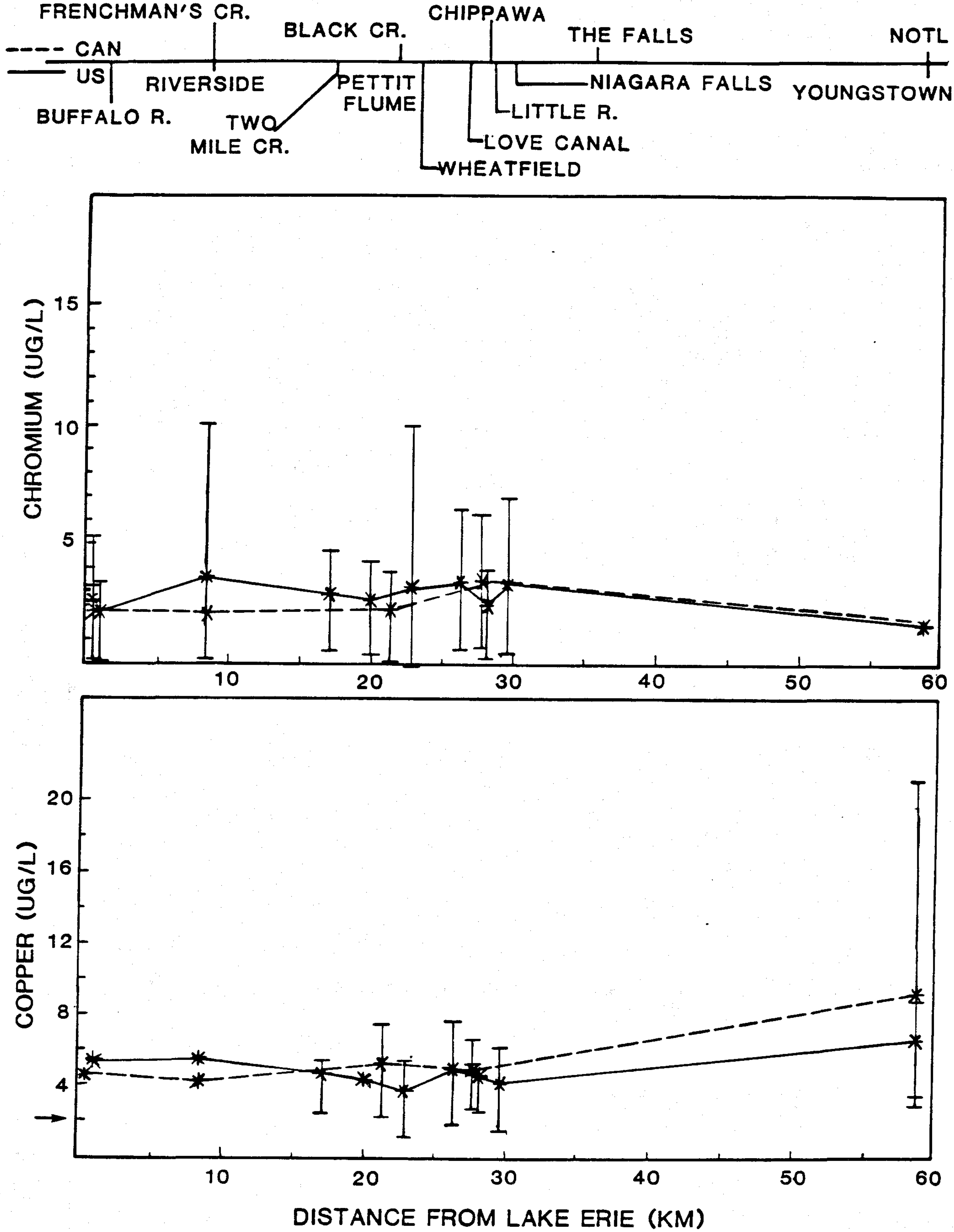

FIGURE C.8 CONCENTRATIONS OF CHROMIUM AND COPPER IN NIAGARA RIVER NEARSHORE WATERS DURING 1982 (GEOMETRIC MEANS WITH 95% CONFIDENCE INTERVALS). CRITERIA FOR PROTECTION OF AQUATIC LIFE ARE 18 AND 2 ug/L, RESPECTIVELY.

The magnitude of these increases was often quite variable during the year, as indicated by the accompanying 95% confidence interval shown in Figures C.6-C.8. In many cases, this high degree of temporal variability makes a clear differentiation difficult between the water quality on the two sides of the upper river. However, in the case of nickel and zinc, mean concentrations were consistently and significantly higher along the New York side of the upper river. Also, for alpha-BHC, the peak in both mean concentration and temporal variability was detected at the mouth of the Little River, indicating a variable input at or upstream of this sampling location. Two other BHC isomers, beta and gamma, were also detected more frequently at this station (see Table C.11).

This suggests the presence of contaminant sources at or upstream of these sampling stations. In this connection, monitoring was also carried out during 1982 at selected stations along the river and in tributaries on the New York side of the river (sub-projects 9 and 11, see Table C.13). However, the higher analytical detection limits and qualitative nature of the data preclude a direct comparison with the MOE results. Nevertheless, frequency of detection of at least 50% and two or more times that of the lowest frequency was considered indicative of a contaminant input. On this basis, the following sites were identified:

Smoke Creek (stn. N-1)	-	zinc
Two Mile Creek (stn. N-5)	-	lead, PCBs

Contaminant concentrations were essentially the same on both sides of the lower river at Niagara-on-the-Lake and Youngstown. The 1981 results (Figures C.2-C.5) and those of previous studies (Chan, 1977; Kauss, 1983) indicate that cross river concentrations in this section of the river are relatively homogeneous due to the thorough mixing of waters by Niagara Falls and the whirlpool, and the absence of significant discharges to the lower river. The 1981 mean concentrations for aluminum, and zinc were somewhat higher in this segment than at the Lake Erie inlet to the river (represented by the Lake Erie and Fort Erie segments). Both the mean concentrations as well as the temporal variation of copper were greater at NOTL-Youngstown (stn. M15) than in the upper river during 1982 (Figure C.8). However, the location or existence of additional inputs of this contaminant downstream of the falls cannot be verified by the data from the whole water samples collected during this project.

The 1981 large volume water sampling combined with centrifugation provided the lower detection levels necessary to determine trends in the distribution of organochlorine contaminants along the length of the Niagara River. In addition, it yielded information on the partitioning of these chemicals between the aqueous and particulate (suspended sediment) phases for PCBs and organochlorine pesticides.

The mean concentration of suspended sediments in (whole) river water varied from station to station, ranging from 1.4 mg/L at the inlet of the river (stn. E1) to 8.4 mg/L in the middle of the Tonawanda Channel (stn. E2) (Kuntz, 1983). Since this makes the contribution of contaminants in this phase relative to that from the aqueous phase variable, the concentrations were normalized to their equivalent concentration in water as per Kuntz and Warry (1983). Figure C.9 illustrates the mean concentrations of a representative number of organochlorine contaminants in the Niagara River and compares their distribution between the aqueous and particulate phases. (Note: the data for the particulate phase in Fig. C.9 have been normalized to whole water values.) For comparison, dieldrin, which exhibited no net increase between the inlet and outlet of the river, was also included. The concentrations in the aqueous and particulate phases have been summed in Table C.9 to provide an estimate of the total levels of these contaminants in different parts of the river. However, it must be emphasized that these sums are only approximate. At each station, contaminant concentrations in the particulate phase reflect an average over a collection period of about 20

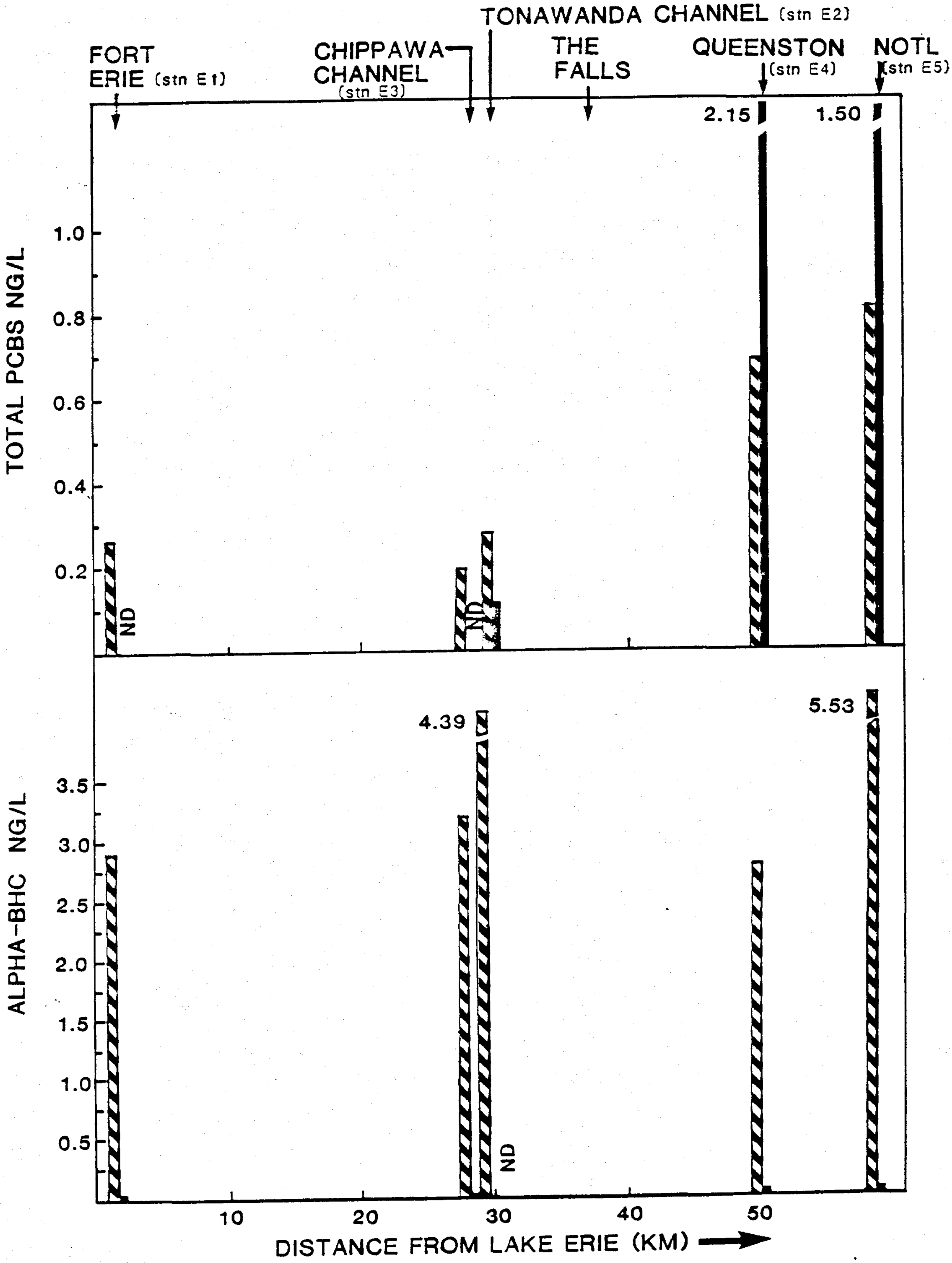

FIGURE C.9 CONCENTRATIONS OF TOTAL PCBs AND ALPHA-BHC IN THE AQUEOUS (HATCHED BAR) AND PARTICULATE PHASES (SOLID BAR) OF NIAGARA RIVER WATERS DURING 1981.
ND = NOT DETECTED

TABLE C.9

CONCENTRATIONS (ng/L) OF CHLORINATED ORGANICS IN NIAGARA RIVER WATER SAMPLES (SUM OF AQUEOUS AND PARTICULATE PHASES) - 1981

CHEMICAL CLASS/ PARAMETER	RIVER SEGMENT				
	Fort Erie	Chippawa	Wheatfield-Upper River	Lower River (Queenston)	Lower River (NOTL)
PCBs, Total	0.262	0.183	0.378	2.826	2.310
Pesticides:					
Aldrin	ND	ND	ND	ND	ND
Dieldrin	0.271	0.298	0.202	0.227	0.292
α-BHC	2.9	3.33	4.39	2.82	5.58
β-BHC	0.589	0.676	0.587	0.730	1.495
α-Chlordane	0.033	0.017	0.074	0.017	0.041
δ-Chlordane	Tr.	Tr.	Tr.	Tr.	Tr.
o,p-DDT	ND	0.005	ND	ND	ND
p,p'-DDT	0.019	0.079	0.030	0.045	0.124
p,p'-DDE	0.032	0.027	0.212	0.075	0.052
p,p'-DDD (TDE)	0.098	0.069	0.035	0.082	0.109
α-Endosulfan	0.011	0.210	0.069	0.109	0.152
β-Endosulfan	0.007	0.034	ND	ND	ND
Endrin	0.013	0.038	0.023	0.022	0.018
Heptachlor	ND	ND	ND	ND	ND
Heptachlor epoxide	0.014	0.089	0.069	0.016	0.122
Methoxychlor	0.024	ND	ND	0.046	0.103
Mirex	0.002	0.001	ND	0.011	0.008

Source: Sub-project 23 (see Appendix, Tables C.14 and C.15)
Notes: Sum of mean concentrations in aqueous and particulate phase (mean contaminant concentration multiplied by mean particulates concentration, see Kuntz (1983).
ND = Not detected in either aqueous or particulate phase samples.
Tr. = Trace (calculated mean less than detection limit).

hours, while the aqueous phase was collected over about 0.5 hours. Nevertheless, when the sum of their aqueous and suspended sediment concentrations was considered, the major increases of total PCBs, gamma-BHC, mirex, methoxychlor mercury*, tetrachlorobenzenes*, pentachlorobenzenes*, and hexachlorobenzene* occurred between the sampling locations above the falls (stns. E3 and E2) and the lower river station at Queenston/Lewiston (Table C.9 and C.15), indicating a source or sources between stn. E4 and Grand Island. In this connection, it is noteworthy that the ratio of particulate organic carbon to particulate organic nitrogen concentrations in suspended sediments was relatively constant throughout most of the river (range 6.8 to 8.4), but rose to 14 at the Queenston station, suggesting inputs of organic carbon upstream of stn. E4 and below Grand Island.

These data also indicate additional inputs of contaminants upstream of station E2 in the Tonawanda Channel (arsenic*, mercury*, selenium*, PCBs, alpha-BHC, alpha-chlordane, p,p'-DDT, p,p'-DDE, alpha-endosulfan, endrin, heptachlor epoxide, 1,4-dichlorobenzene*); station E3 in the Chippawa Channel (arsenic*, selenium*, p,p'-DDT, alpha-endosulfan, o,p-DDT, beta-endosulfan, alpha-BHC, gamma-BHC, endrin, heptachlor epoxide, dieldrin, 1,2-dichloro-benzene*, 1,3-dichlorobenzene*, 1,3,5-trichlorobenzene*, pentachlorobenzene* and hexachlorobenzene*), and in the lower river below Queenston/Lewiston (alpha- and gamma-BHC, p,p'-DDT, alpha-chlordane, p,p'-DDD, alpha-endosulfan, methoxychlor and heptachlor epoxide). It should be noted that these samples were collected in mid-channel (see Figure 4.1, Chapter IV). Consequently, concentrations for the Tonawanda Channel, where some

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* Mercury, arsenic and selenium were analyzed only in suspended sediments (see Table C.15). Chlorinated aromatics (di-, tri-, tetra-, penta- and hexachlorobenzenes) were analyzed for in both aqueous and particulate phase samples. However, subsequent evaluation of the aqueous phase data indicated that these concentrations were likely to be underestimates of the actual levels. Therefore, these values have not been included in Table C.14 or used to calculate totals for Table C.9.

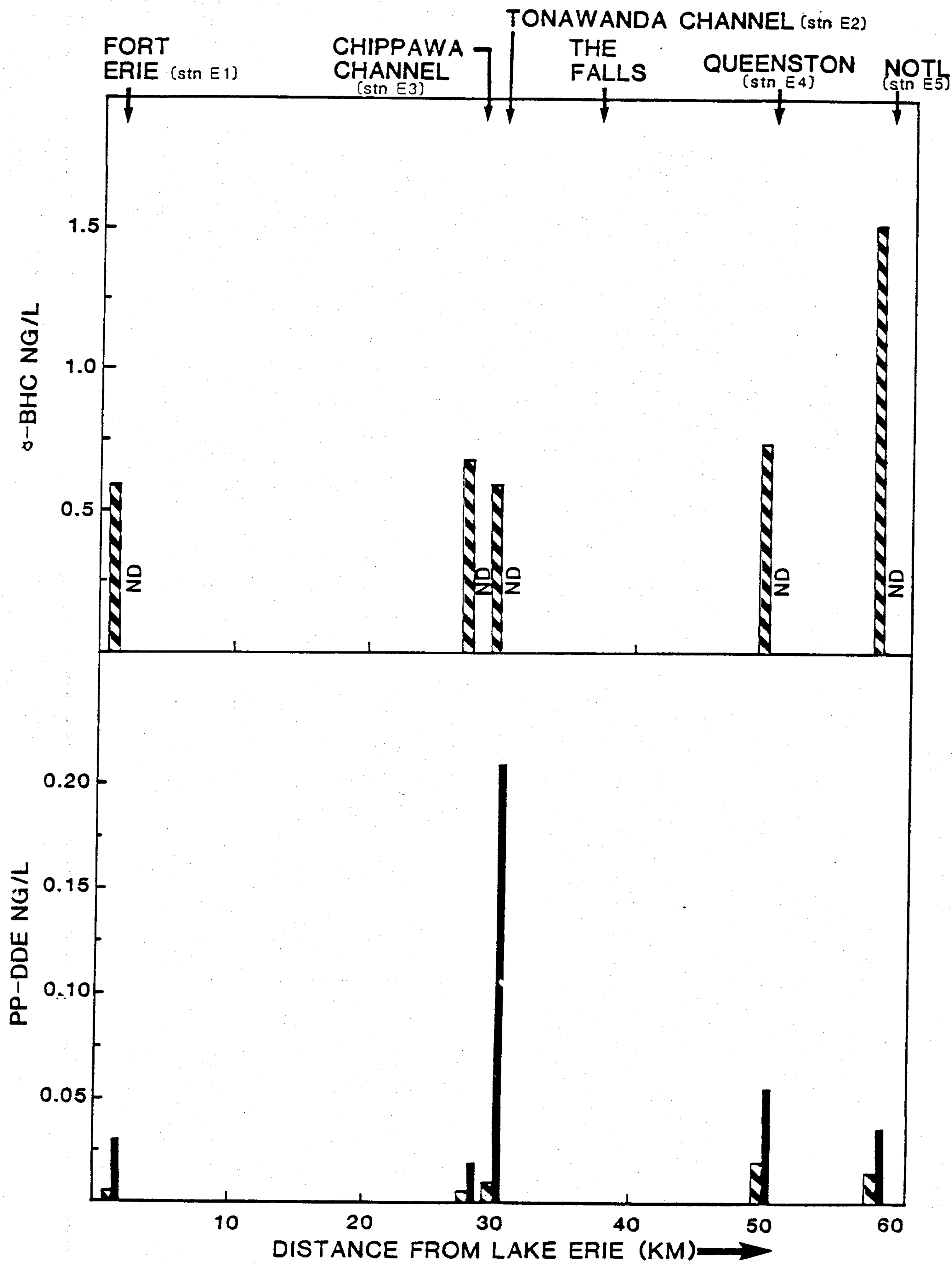

FIGURE C.10 CONCENTRATIONS OF GAMMA-BHC and p,p'-DDE IN THE AQUEOUS (HATCHED BAR) AND PARTICULATE PHASES (SOLID BAR) OF NIAGARA RIVER WATERS DURING 1981. ND = NOT DETECTED

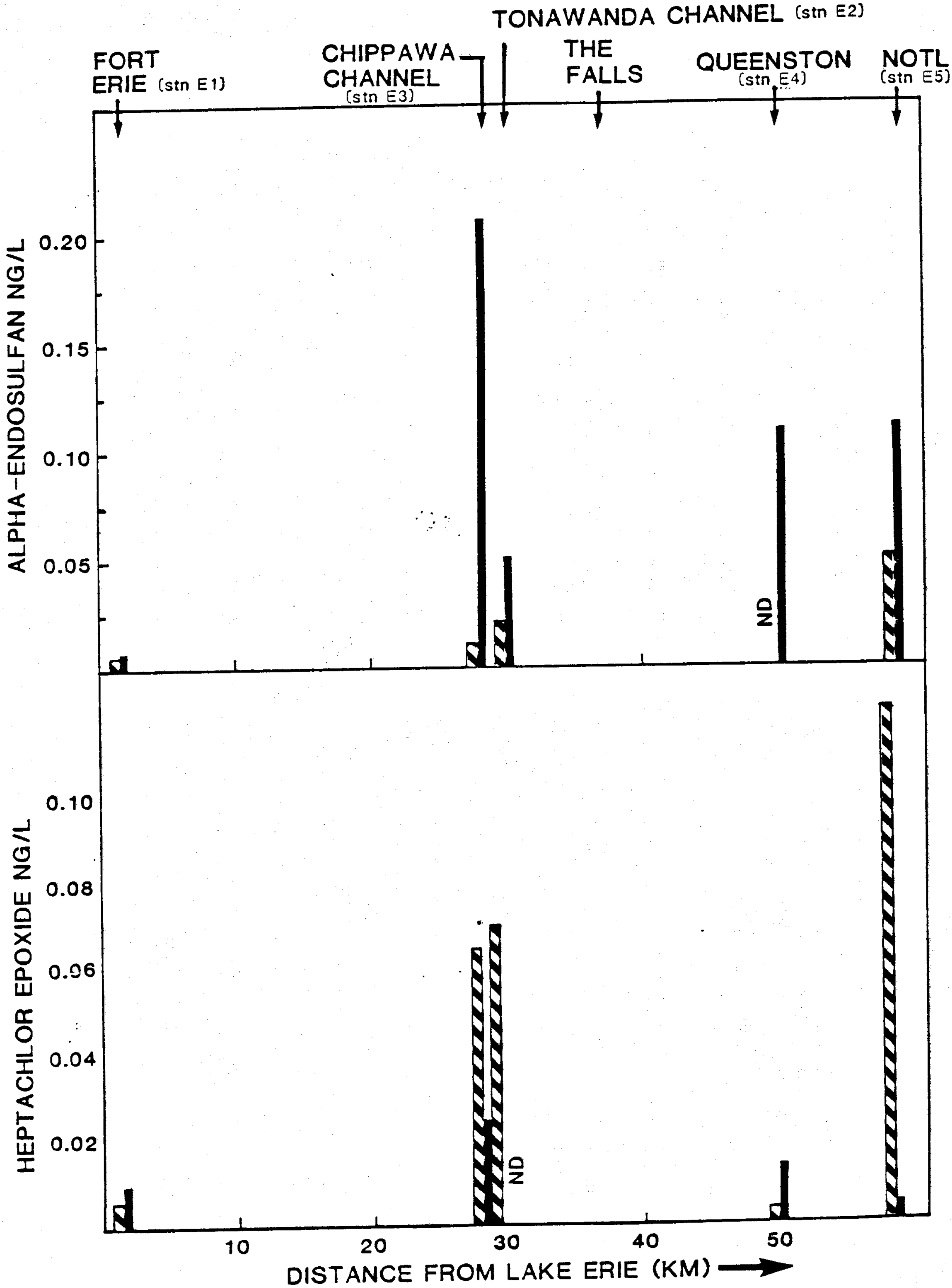

FIGURE C.11 CONCENTRATIONS OF ALPHA-ENDOSULFAN AND HEPTACHLOR EPOXIDE IN THE AQUEOUS (HATCHED BAR) AND PARTICULATE PHASES (SOLID BAR) OF NIAGARA RIVER WATERS DURING 1981. ND = NOT DETECTED

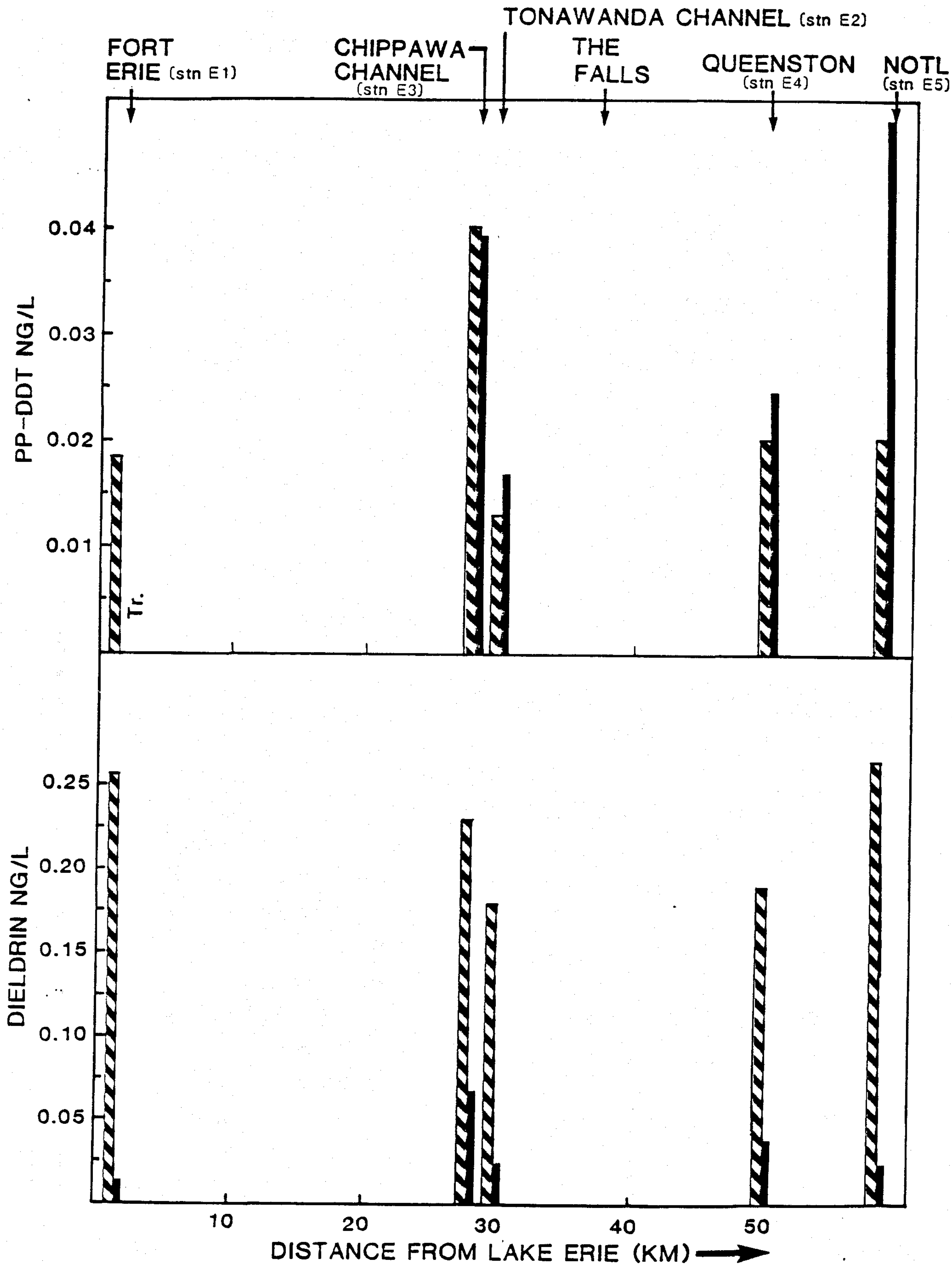

FIGURE C.12 CONCENTRATIONS OF p,p′-DDT AND DIELDRIN IN THE AQUEOUS (HATCHED BAR) AND PARTICULATE PHASES (SOLID BAR) OF NIAGARA RIVER WATERS DURING 1981. ND = NOT DETECTED; Tr. = TRACE contaminants appear to hug the U.S. mainland shore (see Figure 4.8, Chapter IV) may be underestimated, as would this channel's contribution to the lower river.

Figures C.9-C.12 and Tables C.14 to C.15 indicate that partitioning between the aqueous and particulate phases varied greatly, both with respect to the individual organic compounds as well as with sampling location. For example, p,p'-DDE and alpha-endosulfan were present mainly (more than 50%) in the suspended sediment phase. In contrast, dieldrin and alpha- and gamma-BHC were found primarily in the aqueous phase. Interestingly, PCBs and p,p'-DDT favoured the aqueous phase in Fort Erie and/or Chippawa segment samples, but in the lower river, they were present in the suspended sediment phase. Their distribution between the two phases was intermediate between these two extremes in the Tonawanda Channel.

Although mirex was detected at low levels in a few aqueous phase samples from the upper river, the highest total concentrations from the lower river were found in particulate phase samples. The exact reasons for these differences in phase distribution are presently unclear. Possible causes are the resuspension of contaminated bottom sediments or erosion of contaminated soils in the river system. The concentrations of particulate organic carbon and organic nitrogen in suspended solids at NOTL were on the average only about 40% of their Fort Erie values, suggesting dilution with inorganic material picked up along the course of the river (Kuntz, 1983). Another possible reason is that, in going over the falls, complete mixing occurs and these organics are partitioned into their preferred phase, whereas above the falls, contaminants entering the river have not had sufficient time to equilibrate with the particulate matter (the flow-through time for the whole river is only about 15 hours). Thus, the variable partitioning characteristics from station-to-station of endrin, heptachlor epoxide, and alpha-chlordane may reflect inputs along the course of the river.

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* See footnote, previous page.

The presence in the aqueous phase of many organochlorine contaminants leaving the Niagara River is of importance to studies related to the concentration and loading of organics. The majority of the load carried by the river may not be in the particulate phase, even though the opportunities for their detection and quantitation are easier in this phase. Kuntz & Warry (1983) have found that suspended sediments are responsible for only about 40% of the total loadings to Lake Ontario by the Niagara River of PCBs, p,p'-DDE and mirex, and significantly less for other organochlorine contaminants.

The relative distribution of contaminants between the aqueous and particulate phases affects their impact on aquatic biota. For example, although contaminants in the aqueous phase may be more directly available for accumulation by some organisms, chemicals associated with the particulate phase are available for uptake by organisms which feed on suspended sediments and organic particulates, either in the water column, at the sediment-water interface, or in the bottom sediments (Fox et al, 1983; Whittle & Fitzsimons, 1983).

In summary, based on higher mean concentrations and a higher frequency of detection in the aqueous phase, particulate phase, and whole water samples collected along the Niagara River versus Fort Erie, a number of trace metal and organic contaminants are being introduced to the Niagara River. The introduction of these contaminants may be occurring at point or non-point sources or tributaries along the shores, and possibly also by resuspension of contaminated sediments. The locations of these inputs (i.e., the river segment) and their associated contaminants are summarized below. It should be noted, however, that the indicated contaminant may have originated further south (i.e., in the adjacent upstream segment).

River Segment/or Sub-Area	Contaminant
Lake Erie (Smoke Creek)	- zinc.
Fort Erie	- dimethyl disulphide.
Buffalo River	- aluminum, copper, mercury, nickel

	zinc.
Black Rock Canal	- no samples.
Bird Island-Riverside	- chromium, copper, nickel, zinc.
Tonawanda-North Tonawanda	- aluminum, chromium, lead, nickel, zinc, PCBs
Wheatfield-Upper River	- aluminum, copper, lead, nickel, arsenic, selenium, zinc, alpha-, beta- and gamma-BHC, mercury, PCBs, alpha-chlordane, heptachlor epoxide, endrin, p,p'-DDE, 1,4-dichlorobenzene, p,p'-DDT, alpha-endosulfan.
Chippawa	- aluminum, copper, chromium, arsenic, selenium, endrin, zinc, p,p'-DDT, alpha- and beta-endosulfan, heptachlor epoxide, o,p-DDT, dieldrin, alpha- and gamma-BHC, 1,3,5-trichlorobenzene, 1,2- and 1,3-dichlorobenzene, HCB, pentachlorobenzene.
*Lower River	- copper, alpha- and gamma-BHC, zinc, p,p'-DDT, heptachlor epoxide; aluminum, methoxychlor, alpha-endosulfan, methoxychlor, p,p'-DDD, alpha-chlordane, dieldrin, 1,4-dichlorobenzene.

Note: * Inputs of mercury, PCBs, alpha- and gamma-BHC, alpha-endosulfan, p,p'-DDE, methoxychlor, mirex, 1,2- and 1,3-dichlorobenzene, 1,2,3- and 1,2,4-trichlorobenzene, 1,2,3,4-, 1,2,3,5- and 1,2,4,5-tetrachlorobenzene, pentachlorobenzene and hexachlorobenzene are indicated upstream of the Queenston station sampled in this segment and downstream of the Wheatfield-Upper River (Tonawanda Channel) and Chippawa (Channel) segment stations.

TABLE C.10

TRACE CONTAMINANTS DETECTIONS AND CRITERIA EXCEEDANCES IN NIAGARA RIVER WATER SAMPLES, 1981

Chemical Class & Parameter	Detection Limit	Aquatic Life Criterion	Fort Erie(M2)			Chippawa(M12)			Lake Erie(M2)			Buffalo R.(M2)			Bird Is.-Riverside			Ton.-N. Ton.			Wheatfield-Upper R.			Lower River		
			n	d	c	n	d	c	n	d	c	n	d	c	n	d	c	n	d	c	n	d	c (M10)	n	d	c (M15)
Inorganics:																										
Aluminum	1	100(O,N)	12	11	4	58	58	25	23	21	4	34	32	15	-	-	-	-	-	-	58	56	31	45	45	33
Arsenic	1	10(N)	11	0	0	53	0	0	22	0	0	33	1	0	-	-	-	-	-	-	53	0	0	55	0	0
Cadmium	0.2	0.012(U)	12	7	7	58	37	37	23	14	14	34	20	20	-	-	-	-	-	-	58	35	35	45	37	37
Chromium	2	18(U)	12	0	0	58	49	0	22	17	0	33	25	0	-	-	-	-	-	-	58	42	0	40	40	0
Copper	1	2(C)	12	11	8	58	47	39	23	17	17	34	30	27	-	-	-	-	-	-	58	52	44	45	43	36
Cyanide	10	3.5(U)	11	0	0	55	0	0	22	0	0	33	0	0	-	-	-	-	-	-	55	0	0	45	0	0
Lead	3	0.75(U)	12	4	4	56	20	20	22	8	8	33	12	12	-	-	-	-	-	-	58	20	20	45	23	23
Mercury	005-009	0.2(A,C,O,U)	14	3	0	20	16	0	7	5	0	13	11	2	-	-	-	-	-	-	24	17	1	15	15	0
Nickel	2	15(N)	12	9	0	58	43	0	23	17	0	34	26	0	-	-	-	-	-	-	58	44	1	45	45	0
Selenium	1	1(N)	3	0	0	15	0	0	6	0	0	9	0	0	-	-	-	-	-	-	14	0	0	-	-	-
Silver	0.5	0.1(N)	-	-	-	-	-	-	1	0	0	6	5	5	-	-	-	-	-	-	7	4	4	-	-	-
Zinc	1	30(O)	11	9	0	53	42	1	21	16	0	31	28	1	-	-	-	-	-	-	53	48	0	45	45	1
Phenols	1	1(O)	12	0	0	60	7	0	24	3	0	36	10	0	-	-	-	-	-	-	60	13	2	45	9	0
PCB's, total	0.020	0.001(O)	12	0	0	60	0	0	24	0	0	36	0	0	-	-	-	-	-	-	60	3	3	60	0	0
Pesticides																										
Aldrin	0.001	0.001(A,N,O)	12	0	1	60	0	0	24	0	0	36	0	0	-	-	-	-	-	-	60	0	1	60	0	0
Dieldrin	0.002		12	1		60	0		24	0		36	0		-	-	-	-	-	-	60	1		60	0	
alpha-BHC	0.001	0.010(N)	12	7	0	60	45	0	24	13	0	36	23	0	-	-	-	-	-	-	60	45	3	60	44	0
beta-BHC	0.001	0.010(N)	12	0	0	60	0	0	24	0	0	36	1	0	-	-	-	-	-	-	60	3	0	60	0	0
gamma-BHC	0.001	0.010(N)	12	1	0	60	3	0	24	2	0	36	4	0	-	-	-	-	-	-	60	9	0	60	16	0
alpha-Chlordane	0.002	0.004(N)	12	0	0	60	0	0	24	0	0	36	0	0	-	-	-	-	-	-	60	1	0	60	0	0
gamma-Chlordane	0.002		12	0		60	0		24	0		36	0		-	-	-	-	-	-	60	0		60	0	
Oxychlordane	0.002	---	12	0	-	60	0	-	24	0	-	36	0	-	-	-	-	-	-	-	60	0	-	60	0	-
o,p'-DDT	0.005	0.001(N,U)	12	0	0	60	0	0	24	0	0	36	0	0	-	-	-	-	-	-	60	0	0	60	0	0
p,p'-DDT	0.005	0.001(N,U)	12	0	0	60	0	0	24	0	0	36	0	0	-	-	-	-	-	-	60	0	0	60	0	0
p,p'-DDD(TDE)	0.005	0.001(N,U)	12	0	0	60	0	0	24	0	0	36	0	0	-	-	-	-	-	-	60	0	0	60	0	0
p,p'-DDE	0.001	0.001(N,U)	12	0	0	60	0	0	24	0	0	36	1	0	-	-	-	-	-	-	60	1	0	60	2	0
alpha-Endosulfan	0.002	0.003(N,O,U)	12	0	0	60	0	0	24	1	1	36	0	0	-	-	-	-	-	-	60	0	0	60	0	0
beta-Endosulfan	0.004		12	0		60	0		24	1		36	0		-	-	-	-	-	-	60	0		60	0	
Endosulfan Sulfate	0.004	---	12	0	-	60	0	-	24	0	-	36	0	-	-	-	-	-	-	-	60	0	-	60	0	-
Endrin	0.004	0.002(A,N,O)	12	0	0	60	0	0	24	0	0	36	0	0	-	-	-	-	-	-	60	0	0	60	0	0
HCB	0.001	0.04(N)	12	0	0	60	0	0	24	0	0	36	1	0	-	-	-	-	-	-	60	7	0	59	2	0
Heptachlor	0.001	0.001(A,N,O)	12	0	0	60	0	0	24	0	0	36	0	0	-	-	-	-	-	-	60	0	0	60	0	0
Heptachlor Epoxide	0.001		12	0		60	0		24	0		36	0		-	-	-	-	-	-	60	1		60	0	
Methoxychlor(DMDT)	0.005	0.030(N)	12	0	0	60	0	0	24	0	0	36	0	0	-	-	-	-	-	-	60	0	0	60	0	0
Mirex	0.005	0.001(N,O,U)	12	0	0	60	0	0	24	0	0	36	0	0	-	-	-	-	-	-	60	0	0	60	0	0

Notes: Source of data: Sub-projects 25 and 26 (MOE). See Figure 4.1 (Chapter IV)
Most stringent criterion was selected from the following sources:
(A)=Canada/U.S. Agreement specific objectives (1978)
(C)=Environment Canada objectives
(N)=New York State criteria
(O)= Ontario provincial objectives and guidelines (1978)
(U)=USEPA
Meaning of abbreviations used:
n = total number of samples.
d = number of samples with concentration greater or equal to detection limit.
c = number of samples with concentration greater than criterion. If criterion cited is below detection limit, "c" is preceded by "≥" (greater than or equal to).

TABLE C.11

TRACE CONTAMINANTS DETECTIONS AND CRITERIA EXCEEDANCES IN NIAGARA RIVER WATER SAMPLES, 1982

			RIVER SEGMENT/SUB-AREA																							
Chemical Class & Parameter	Detection Limit (ug/L)	Aquatic Life Criterion (ug/L)	Fort Erie(M2)			Chippawa(M11 &12)			Lake Erie(M2 &3)			Buffalo R.(M2)			Bird Is.-Riverside (M4)			Ton.-N. Ton.(M5,6 &7)			Wheatfield-Upper R. (M8,9,10)			Lower River (M15)		
			n	d	c	n	d	c	n	d	c	n	d	c	n	d	c	n	d	c	n	d	c	n	d	c
Inorganics:																										
Aluminum	1	100(O,N)	25	25	3	23	23	14	11	11	0	15	15	9	11	11	4	35	35	13	36	36	13	24	24	10
Arsenic	1	10(N)	25	0	0	23	0	0	11	0	0	15	2	0	11	0	0	35	0	0	36	0	0	24	0	0
Cadmium	0.2	0.012(U)	25	10	10	23	7	7	11	3	3	15	4	4	11	3	3	35	11	11	36	20	20	24	12	12
Chromium	2	18(U)	25	20	1	23	21	3	11	7	2	15	13	1	11	10	0	35	30	5	36	34	4	24	22	0
Copper	1	2(C)	25	25	25	23	23	23	11	11	10	15	15	15	11	11	11	35	35	32	36	36	31	24	24	24
Lead	3	0.75(U)	25	6	6	23	7	7	11	2	2	15	1	1	11	1	1	35	9	9	36	8	8	24	8	8
Mercury	0.03-0.09	0.2(A,C,O,U)	22	4	0	21	5	2	13	2	0	11	3	1	11	2	0	32	8	0	33	8	0	24	1	0
Nickel	2	15(N)	25	15	0	23	21	0	11	5	0	15	13	0	11	11	0	35	26	0	36	31	0	24	18	18
Selenium	1	1(N)	25	0	0	23	0	0	11	0	0	15	0	0	11	0	0	35	0	0	36	0	0	24	0	0
Silver	0.5	0.1(N)	25	3	3	23	3	3	11	2	2	15	1	1	11	3	3	35	2	2	36	3	3	24	4	4
Zinc	1	30(O)	25	13	0	23	19	0	11	7	0	15	14	0	11	11	0	35	35	1	36	36	3	23	23	0
Phenols	1	1(O)	47	19	12	60	30	16	25	10	5	59	30	13	36	19	4	34	21	13	96	56	28	59	28	20
PCB's,total	0.020	0.001(O)	25	0	0	23	0	0	10	0	0	15	0	0	12	0	0	33	0	0	36	1	1	24	1	1
Pesticides																										
Aldrin	0.001	0.001(A,N,O)	25	0	0	23	0	1	10	0	0	15	0	0	12	0	0	34	1	0	36	1	0	24	0	0
Dieldrin	0.002		25	0		22	1		10	0		15	0		12	0		34	0		36	0		24	0	
alpha-BHC	0.001	0.010(N)	25	21	0	23	21	1	10	8	0	15	13	0	12	11	0	34	27	2	36	33	10	24	20	1
beta-BHC	0.001	0.010(N)	25	1	0	22	0	0	10	1	0	15	1	0	12	0	0	34	2	0	36	8	0	23	1	0
gamma-BHC	0.001	0.010(N)	25	9	0	23	9	0	10	1	0	15	4	1	12	3	0	34	10	0	36	19	1	24	8	0
alpha-Chlordane	0.002	0.004(N)	25	0	0	23	0	0	10	0	0	15	0	0	12	0	0	34	1	1	36	1	0	24	0	0
gamma-Chlordane	0.002		25	0		23	0		10	0		15	0		12	0		34	0		36	0		24	0	
Oxychlordane	0.002	---	25	0	--	23	0	--	10	0	--	15	0	--	12	0	--	33	0	-	36	0	-	24	0	-
o,p'-DDT	0.005	0.001(N,U)	25	0	0	23	0	0	10	0	0	15	0	0	12	0	0	33	0	0	36	0	0	24	0	0
p,p'-DDT	0.005	0.001(N,U)	25	0	0	23	0	0	10	0	0	15	0	0	12	0	0	33	0	0	36	0	0	24	0	0
p,p'-DDD(TDE)	0.005	0.001(N,U)	25	0	0	23	0	0	10	0	0	15	0	0	12	0	0	33	0	0	36	0	0	24	0	0
p,p'-DDE	0.001	0.001(N,U)	25	1	0	23	0	0	10	0	0	15	0	0	12	0	0	33	0	0	36	0	0	24	0	0
alpha-Endosulfan	0.002	0.003(N,O,U)	25	0	0	23	0	0	10	0	0	15	0	0	12	0	0	34	0	0	36	0	0	23	0	0
beta-Endosulfan	0.004		25	0		23	0		10	0		15	0		12	0		34	0		36	0		24	0	
Endosulfan Sulfate	0.004	---	25	0	--	23	0	--	10	0	--	15	0	--	12	0	--	34	0	-	36	0	-	24	0	-
Endrin	0.004	0.002(A,N,O)	25	0	0	23	0	0	10	0	0	15	0	0	12	0	0	34	0	0	36	0	0	24	0	0
HCB	0.001	0.04(N)	25	0	0	23	0	0	10	0	0	15	1	0	12	0	0	34	2	0	36	1	0	24	0	0
Heptachlor	0.001	0.001(A,N,O)	25	0	1	23	0	0	10	0	0	15	0	0	12	0	0	33	0	0	36	0	0	24	0	0
Heptachlor Epoxide	0.001		25	2		23	1		10	0		15	0		12	0		33	1		36	1		24	1	
Methoxychlor(DMDT)	0.005	0.030(N)	25	0	0	23	0	0	10	0	0	15	0	0	12	0	0	34	0	0	36	0	0	24	0	0
Mirex	0.005	0.001(N,O,U)	25	0	0	23	0	0	10	0	0	15	0	0	12	1	1	33	0	0	36	0	0	24	0	0

Notes: Source of data: Sub-projects 25 and 26. See Figure 4.1 (Chapter IV)
Most stringent criterion was selected from the following sources:
(A)=Canada/U.S. Agreement specific objectives (1978)
(C)=Environment Canada objectives
(N)=New York State criteria
(O)= Ontario provincial objectives and guidelines (1978)
(U)=USEPA
Meaning of abbreviations used:
n = total number of samples
d = number of samples with concentration greater or equal to detection limit
c = number of samples with concentration greater than criterion. If criterion cited is below detection limit, "c" is preceded by "≥" (greater than or equal to).

TABLE C.12

COMPARISON OF RANGE OF TRACE CONTAMINANTS CONCENTRATIONS (ug/l), NUMBER OF SAMPLES (N) AND NUMBER OF DETECTIONS (n) IN NIAGARA RAW INTAKE WATERS, 1981 and 1982.

PARAMETER	RIVER SEGMENT																	
	Lake Erie (Stn M-1)						Chippawa Channel (Stn M-13)						Lower River (Stn M-14)					
	1981			1982			1981			1982			1981			1982		
	Range	N	n	Range	N	n	Range	N	n	Range	N	n	Range	N	n	Range	N	n
Organics																		
Trichlorophenols (Total)	ND	8	0	ND	7	0	ND	8	0	ND	13	0	ND	8	0	ND	12	0
2,3,5-Trichlorophenol	ND	10	0	ND	12	0	ND	10	0	ND	21	0	ND-0.1	10	1	ND-0.1	21	1
2,4,6-Trichlorophenol	ND	10	0	ND	12	0	ND	10	0	ND	21	0	ND-0.2	10	1	ND-0.1	21	3
2,3,4,5-Trichlorophenol	ND	10	0	ND	12	0	ND	10	0	ND	21	0	ND	10	0	ND	21	0
2,3,6-Trichlorophenol	ND	10	0	ND	12	0	ND	10	0	ND	21	0	ND-0.1	10	1	ND	21	0
3,4,6-Trichlorophenol	ND	8	0	ND	7	0	ND	8	0	ND	13	0	ND	8	0	ND	12	0
Chlorotoluene	ND	10	0	ND	12	0	ND	10	0	ND	21	0	ND-Tr.	10	2	ND	21	0
Acetone	ND-Tr.	10	1	ND-1.5	12	7	ND	10	0	ND-7.4	21	11	ND-Tr.	10	1	ND-7.0	21	10
Dimethyldisulphide	ND-Tr.	10	3	ND-Tr.	12	3	ND-Tr.	10	1	ND	21	0	ND	10	0	ND-Tr.	21	1
Dichloroethylene	ND	10	0	ND	12	0	ND	10	0	ND	21	0	ND-Tr.	10	1	ND	21	0
Diethyl ether	ND	10	0	ND	12	0	ND-Tr.	10	1	ND-Tr.	21	2	ND-Tr.	10	2	ND-Tr.	21	1
Dichlorobenzene	ND	10	0	ND	12	0	ND	10	0	ND	21	0	ND-Tr.	10	1	ND	21	0
Butanol	ND	10	0	ND	12	0	ND	10	0	ND	21	0	ND	10	0	ND	21	0
Dichloropropylene	ND	10	0	ND	12	0	ND	10	0	ND	21	0	ND	10	0	ND	21	0
Trichlorotrifluoroethane	ND-Tr.	10	1	ND	12	0	ND	10	0	ND	21	0	ND	10	0	ND	21	0
Benzaldehyde	ND	10	0	ND	12	0	ND	10	0	ND	21	0	ND	10	0	ND	21	0
Styrene	ND	10	0	ND	12	0	ND	10	0	ND	21	0	ND	10	0	ND	21	0
Carbon Disulphide	ND	10	0	ND	12	0	ND	10	0	ND	21	0	ND	10	0	ND	21	0
Methyl Furan	ND-Tr.	10	1	ND	12	0	ND-Tr.	10	1	ND-Tr.	21	1	ND	10	0	ND	21	0
Methyl Ethyl Ketone	ND	10	0	ND-Tr.	12	2	ND	10	0	ND-Tr.	21	4	ND	10	0	ND-Tr.	21	5
Heptanone	ND	10	0	ND	12	0	ND	10	0	ND-Tr.	21	3	ND	10	0	ND-Tr.	21	3
Hydrocarbons	ND-Tr.	10	2	ND-1.2	12	3	ND-Tr.	10	1	ND-1.4	21	6	ND	10	0	ND-2.1	21	9
Volatile Organics																		
Methylene Chloride	ND-67.4	10	1	ND	12	0	ND	10	0	ND-44.0	21	5	ND	10	0	ND-50.0	21	5
1,1-Dichloroethane	ND	10	0	ND	12	0	ND	10	0	ND	21	0	ND	10	0	ND	21	0
Chloroform	ND-1.0	10	8	ND-0.8	12	11	ND-0.6	10	8	ND-1.3	21	19	Tr.-0.7	10	10	ND-2.7	21	20
1,2-Dichoroethane	ND	10	0	ND	12	0	ND	10	0	ND-0.1	21	1	ND	10	0	ND	21	0
1,1,1-Trichloroethane	ND-0.1	10	3	ND-Tr.	12	1	ND-0.2	10	2	ND-0.1	21	2	ND-0.1	10	2	ND-0.3	21	4
Carbon Tetrachloride	ND	10	0	ND	12	0	ND	10	0	ND	21	0	ND	10	0	ND-3.1	21	3
Dichlorobromomethane	ND-0.3	10	3	ND-0.2	12	1	ND-0.1	10	3	ND	21	0	ND-0.1	10	4	ND-0.3	21	3
1,2-Dichloropropane	ND	10	0	ND	12	0	ND	10	0	ND	21	0	ND	10	0	ND	21	0
Trichloroethylene	ND-Tr.	10	1	ND	12	0	ND-0.1	10	1	ND-0.2	21	2	ND-0.1	10	3	ND-0.2	21	7
Chlorodibromomethane	ND-Tr.	10	1	ND-0.1	12	1	ND	10	0	ND	21	0	ND-0.1	10	1	ND-0.1	21	5
Benzene	ND-0.6	10	5	ND-Tr.	12	2	ND-0.7	10	6	ND-0.1	21	3	ND-0.7	10	5	ND-0.1	21	5
Bromoform	ND	10	0	ND	12	0	ND	10	0	ND	21	0	ND	10	0	ND	21	0
Tetrachloroethylene	ND	10	0	ND-0.1	12	1	ND	10	0	ND-0.2	21	2	ND-0.1	10	2	ND-0.2	21	3
Toluene	ND-0.2	10	4	ND-0.2	12	9	ND-0.6	10	2	ND-0.2	21	16	ND-0.5	10	4	ND-0.2	21	14
Chlorobenzene	ND	10	0	ND	12	0	ND	10	0	ND	21	0	ND	10	0	ND	21	0
Ethyl Benzene	ND	10	0	ND	12	0	ND-Tr.	10	1	ND	21	0	ND	10	0	ND-0.1	21	1
m-Xylene	ND-0.1	10	1	ND	12	0	ND-0.1	10	1	ND-Tr.	21	1	ND	10	0	ND-0.1	21	1
o,p-Xylene	ND	10	0	ND-0.1	12	1	ND	10	0	ND-0.2	21	5	ND	10	0	ND-0.2	21	6
Hexane	ND-Tr.	10	3	ND-Tr.	12	3	ND-Tr.	10	4	ND-Tr.	21	8	ND-Tr.	10	2	ND-Tr.	21	8
Hexanal	ND-Tr.	10	3	ND-Tr.	12	1	ND-Tr.	10	1	ND-1.1	21	2	ND-Tr.	10	1	ND-Tr.	21	2
Tetrahydrofuran	ND	10	0	ND	12	0	ND	10	0	ND-Tr.	21	1	ND-Tr.	10	7	ND-Tr.	21	12
Dichloroiodomethane	ND	10	0	ND	12	0	ND	10	0	ND	21	0	ND	10	0	ND	21	0
p-Chlorotrifluorotoluene	ND	10	0	ND	12	0	ND	10	0	ND	21	0	ND-Tr.	10	3	ND-Tr.	21	2
1,1,4-Trichlorobutadiene	ND	10	0	ND	12	0	ND	10	0	ND	21	0	ND	10	0	ND	21	0

TABLE C.12 (Continued)

PARAMETER	RIVER SEGMENT																	
	Lake Erie (Stn M-1)						Chippawa Channel (Stn M-13)						Lower River (Stn M-14)					
	1981			1982			1981			1982			1981			1982		
	Range	N	n	Range	N	n	Range	N	n	Range	N	n	Range	N	n	Range	N	n
Pesticides																		
Aldrin	ND	9	0	ND	12	0	ND	10	0	ND	19	0	ND	9	0	ND	22	0
Dieldrin	ND	9	0	ND	12	0	ND	10	0	ND	19	0	ND	9	0	ND	22	0
Alpha-BHC	ND-0.005	9	6	ND-0.006	12	10	ND-0.009	10	8	ND-0.009	19	16	ND-0.01	9	6	ND-0.018	22	20
Beta-BHC	ND	9	0	ND	12	0	ND	10	0	ND	19	0	ND	9	0	ND-0.008	22	3
Gamma-BHC	ND	9	0	ND-0.002	12	2	ND	10	0	ND-0.007	19	5	ND-0.002	9	3	ND-0.003	22	7
Alpha-Chlordane	ND	9	0	ND	12	0	ND	10	0	ND	19	0	ND	9	0	ND-0.003	22	1
Gamma-Chlordane	ND	9	0	ND	12	0	ND	10	0	ND	19	0	ND	9	0	ND	22	0
DMDT-Methoxychlor	ND	8	0	ND	12	0	ND	9	0	ND	19	0	ND	9	0	ND	22	0
Endosulphan I	ND	9	0	ND	12	0	ND	10	0	ND	19	0	ND	9	0	ND	22	0
Endosulphan II	ND	9	0	ND	12	0	ND	10	0	ND	19	0	ND	9	0	ND	22	0
Endrin	ND	9	0	ND	12	0	ND	10	0	ND	19	0	ND	9	0	ND	22	0
Endosulphan Sulphate	ND	8	0	ND	12	0	ND	9	0	ND	19	0	ND	9	0	ND	22	0
Heptachlor Epoxide	ND	9	0	ND	12	0	ND	10	0	ND	19	0	ND	9	0	ND	22	0
Heptachlor	ND	9	0	ND	12	0	ND	10	0	ND	19	0	ND	9	0	ND	22	0
Mirex	ND	9	0	ND	12	0	ND	10	0	ND	19	0	ND	9	0	ND	22	0
Oxychlordane	ND	8	0	ND	12	0	ND	9	0	ND	19	0	ND	9	0	ND	22	0
o,p-DDT	ND	9	0	ND	12	0	ND	10	0	ND	19	0	ND	9	0	ND	22	0
Total PCB	ND	9	0	ND	12	0	ND	10	0	ND-0.025	19	1	ND	9	0	ND-0.030	22	1
p,p'-DDD	ND	9	0	ND	12	0	ND	10	0	ND	19	0	ND	9	0	ND	22	0
p,p'-DDE	ND	9	0	ND	12	0	ND	10	0	ND	19	0	ND	9	0	ND	22	0
p,p'-DDT	ND	9	0	ND	12	0	ND	10	0	ND	19	0	ND	9	0	ND	22	0
Hexachlorobenzene (Total)	ND	10	0	ND	12	0	ND-0.002	10	1	ND	19	0	ND	10	1	ND-0.018	22	1
Tetrachlorodioxins (Total)	ND	10	0	ND	7	0	ND	10	0	ND	7	0	ND	10	0	ND	8	0

DATA SOURCE: Sub-project 32 (MOE, West-Central Region). Stations correspond to locations in Fig. 4.1.
NOTES: ND = not detected; Tr. = trace (contaminant identified but present at level below detection limit).

TABLE C.13

CONTAMINANT CONCENTRATIONS IN NIAGARA RIVER AND TRIBUTARY WATER SAMPLES, 1982
(ug/L)

PARAMETER	Detection Limit	RIVER SEGMENT/SUB-AREA											
		Lake Erie		Buffalo River		Bird Island - Riverside				Ton-N. Ton.		Lower River	
		N-1		N-2		N-3		N-4		N-5		N-7	
		Range	%≥d	Range	%≥d	Range	%≥d	Range	%≥d	Range	%≥d	Range	%≥d
Arsenic	10	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
Beryllium	20	ND	0	ND	0	ND	0	ND	0	ND	0	ND	0
Cadmium	2	ND	0	ND-15	40	ND-2	20	ND	0	ND-3	25	ND	0
Chromium	10	ND-15	43	ND	0	ND-18	60	ND-34	60	ND-20	63	ND-18	60
Copper	50	ND	0	ND	0	ND	0	ND-505	20	ND-50	13	ND	0
Lead	10	ND-23	29	ND-260	20	ND	0	ND	0	ND-29	50	ND	0
Mercury	0.4	ND-1	14	ND	0	ND	0	ND	0	ND	0	ND	0
Nickel	50	ND-14	14	ND-90	20	ND-50	20	ND-50	20	ND	0	ND	0
Silver	20	ND	0	ND	0	ND-20	20	ND-50	20	ND-30	13	ND-20	20
Zinc	50	NND-200	71	ND	0	ND-180	20	ND	0	ND-100	38	ND	0
PCBs	0.05	ND	0	ND	0	ND	0	ND	0	ND-0.11	50	ND	0
Chloroform	1	ND-2	43	ND	0	ND	0	ND-1	20	ND-1	38	ND	0
1,2-Dichloroethene	1	ND	0	ND	0	ND	0	ND	0	ND-1	13	ND	0
1,1,1-Trichloroethane	1	ND	0	ND	0	ND	0	ND	0	ND-4	13	ND	0
Trichloroethane	1	ND	0	ND-2	20	ND-3	20	ND	0	ND	0	ND	0
Tetrachloroethane	1	ND	0	ND	0	ND	0	ND	0	ND-1	13	ND	0
Bromodichloromethane	1	ND-1	14	ND	0	ND	0	ND	0	ND	0	ND	0
Benzene	1	ND-1	14	ND-1	20	ND	0	ND	0	ND	0	ND	0
o-Xylene	1	ND	0	ND	0	ND	0	ND	0	ND-1	13	ND	0
Bis(2-ethylhexyl) phthalate	13	ND	0	ND	0	ND	0	ND	0	ND	0	ND-71	20
Number of samples	-	7		5		5		5		8		5	

NOTES: Source of data: Sub-project 9 (NYSDEC).
Concentrations are in ug/l(ppb).
≥d = number of samples with concentrations greater or equal to detection limit.
ND = Not detected at detection limit given.
Data for station N-6 not available at time of writing.

TABLE C.14

CONCENTRATIONS OF CHLORINATED ORGANICS IN THE AQUEOUS PHASE OF NIAGARA RIVER WATER SAMPLES, 1981
(ng/L)

CHEMICAL CLASS AND PARAMETER	RIVER SEGMENT/SUB-AREA				
	Fort Erie (E1)	Chippawa (E3)	Wheatfield-Upper River (E2)	Lower River (E4)	Lower River (E5)
PCBs, Total	0.262±0.228(3)	0.183±0.076(5)	0.269±0.115(5)	0.678±0.460(3)	0.808±0.524(4)
Pesticides:					
Aldrin	ND	ND	ND	ND	ND
Dieldrin	0.258±0.188(4)	0.229±0.124(5)	0.177±0.073(5)	0.188±0.157(3)	0.267±0.096(5)
α-BHC	2.89±2.55(4)	3.18±2.83(5)	4.39±2.95(5)	2.77±2.47(3)	5.53±3.76(5)
γ-BHC (Lindane)	0.589±0.470(4)	0.676±0.378(5)	0.587±0.481(5)	0.730±0.555(3)	1.50±0.815(5)
α-Chlordane	0.016±0.019(2)	0.012±0.014(2)	0.007±0.006(3)	0.003±0.004(1)	0.029±0.016(3)
γ-Chlordane	Tr.(2)	Tr.(2)	Tr.(1)	Tr.(1)	Tr.(1)
o,p-DDT	ND	ND	ND	ND	ND
p,p-DDT	0.018±0.020(2)	0.040±0.050(3)	0.013±0.018(2)	0.020±0.022(2)	0.021±0.023(1)
p,p-DDE	0.003±0.003(2)	0.007±0.007(4)	0.001±0.008(4)	0.019±0.016(3)	0.015±0.015(3)
p,p-DDD(TDE)	0.092±0.109(2)	0.069±0.096(2)	0.035±0.046(3)	0.040±0.070(1)	0.109±0.118(4)
α-Endosulfan	0.004±0.007(1)	0.005±0.007(2)	0.019±0.015(4)	ND	0.041±0.050(3)
β-Endosulfan	ND	ND	ND	ND	ND
Endrin	0.013±0.011(3)	0.019±0.005(5)	0.006±0.014(1)	0.022±0.028(3)	0.018±0.013(4)
Heptachlor	ND	ND	ND	ND	ND
Heptachlor Epoxide	0.005±0.007(3)	0.064±0.090(3)	0.069±0.154(1)	0.002±0.003(1)	0.118±0.136(3)
Methoxychlor	ND	ND	ND	ND	ND
Mirex	0.002±0.004(1)	0.001±0.002(1)	Tr.(1)	Tr.(1)	Tr.(2)

NOTES: Source: Sub-project 23 (IWD/OR/). Stations correspond to locations on Figure 4.1. (Chapter IV)
ND = Not detected at detection limit of 0.01 ng/ 200 L.
Mean and standard deviation of three samples, samples with ND values assigned concentration of zero.
Tr. = Trace (calculated mean less than detection limit).
Numbers in brackets "( )" denote number of positive detections of compound out of 3 samples.

TABLE C.15

CONCENTRATIONS OF INORGANICS AND CHLORINATED ORGANICS IN THE PARTICULATE PHASE OF THE NIAGARA RIVER WATER SAMPLES, 1981 (ng/g)

CHEMICAL CLASS AND PARAMETER	RIVER SEGMENT/SUB-AREA				
	Fort Erie (E1)	Chippawa (E3)	Wheatfield-Upper River (E2)	Lower River (E4)	Lower River (E5)
Inorganics:					
Arsenic	9870±2110	11000±2350	13030±2250	11370±640	11470±1650
Mercury	83±15	80±10	170±65	357±72	333±90
Selenium	40±69	57±98	73±127	33±50	ND
PCBs, Total	ND	ND	13±23(1)	613±271(3)	367±221(3)
Pesticides:					
Aldrin	ND	ND	ND	ND	ND
Dieldrin	9±9(2)	14±2(3)	3±3(2)	11±6(3)	6±6(2)
α-BHC	9±16(1)	3±6(1)	ND	14±13(2)	12±8(3)
γ-BHC(Lindane)	ND	ND	ND	ND	ND
α-Chlordane	12±8(3)	Tr.(1)	8±9(2)	4±4(2)	3±3(1)
γ-Chlordane	ND	ND	ND	ND	ND
o,p'-DDT	ND	1±1(1)	ND	ND	ND
p,p'-DDT	Tr.(1)	8±14(1)	3±4(1)	7±12(1)	25±23(2)
p,p'-DDE	21±7(3)	4±4(2)	25±7(3)	16±6(3)	9±6(3)
p,p'-DDD(TDE)	4±7(1)	ND	Tr.(1)	12±20(1)	ND
α-Endosulfan	5±8(1)	42±49(3)	6±1(3)	31±19(3)	27±26(2)
β-Endosulfan	5±9(1)	7±12(1)	ND	ND	ND
Endrin	ND	4±7(1)	2±4(1)	ND	ND
Heptachlor	ND	ND	ND	ND	ND
Heptachlor Epoxide	7±6(2)	5±5(1)	ND	4±3(2)	1±2(1)
Methoxychlor	17±29(1)	ND	ND	13±12(2)	25±43(1)
Mirex	ND	Tr.(1)	ND	3±1(3)	2±1(3)
Chlorinated Aromatics:					
1,2-Dichlorobenzene	24±18(3)	65±46(3)	17±4(3)	56±17(3)	75±43(3)
1,3-Dichlorobenzene	58±61(3)	89±64(3)	18±8(3)	54±19(3)	89±92(2)
1,4-Dichlorobenzene	ND	ND	4±7(1)	ND	26±46(1)
1,2,3-Trichlorobenzene	3±4(3)	2±3(1)	2±2(3)	14±8(3)	20±12(3)
1,2,4-Trichlorobenzene	ND	ND	ND	3±2(3)	4±4(2)
1,3,5-Trichlorobenzene	13±21(3)	38±34(3)	Tr.(2)	10±17(1)	29±36(2)
1,2,3,4-Tetrachlorobenzene	ND	ND	ND	59±16(3)	44±13(3)
1,2,3,5- & 1,2,4,5 Tetrachlorobenzene	ND	ND	ND	11±5(3)	16±10(3)
Pentrachlorobenzene	ND	2±2(2)	Tr.(1)	47±16(3)	37±21(3)
Hexachlorobenzene	1±2(1)	2±2(2)	Tr.(1)	75±50(3)	74±80(3)

NOTES: Source: Sub-project 23 (IWD/OR). Stations correspond to locations on Figure 4.1. (Chapter IV)
ND = Not detected at detection limit of 1 ng/g for organics.
Mean and standard deviation of three samples, samples with ND values assigned concentration of zero.
Tr. = Trace (calculated mean less than detection limit).
Numbers in brackets "( )" denote number of positive detections of compound out of 3 samples.

C.3 Areas of Contaminated Sediment Listed by Segment

With the exception of sub-project 1, bottom sediment contaminants data are summarized in the accompanying Tables C.16 to C.24. Sub-project data are available in a recent USEPA report (Rockwell et al., 1984). See page C-51 for a list of organic compounds analyzed for in bottom sediments of the Niagara River and the study area portion of Lake Erie in 1982.

C.3.1 Lake Erie Segment

Highly contaminated pockets of sediment were found at the open lake dredged material disposal site in Lake Erie. The highest levels of contamination found in this area are shown below:

Chemical	Highest Concentration (ug/g)	Sub-Project No.
Zinc	870	12
Nickel	95	12
Mercury	5.58	12
Lead	300	12
1,3-DCB	1.1	12
1,2-DCB	3.4	12
1,4-DCB	14	12
Benzo(a)pyrene	6.1	12
Fluoranthene	26	12

Sediments from the mouth of Smoke Creek had elevated levels of PAHs as follows:

Chemical	Highest Concentration (ug/g)	Sub-Project No.
Fluoranthene	4.2	12
Benzo(a)pyrene	1.2	3

Sediments from the Union Canal were found to have high concentrations of lead, zinc, and PAHs:

Chemical	Highest Concentration (ug/g)	Sub-Project No.
Zinc	737	8

LIST OF ORGANIC COMPOUNDS ANALYZED FOR IN BOTTOM SEDIMENTS OF NIAGARA RIVER AND LAKE ERIE (IN STUDY AREA), 1982

Acid Compounds

2,3,6-Trichlorophenol
p-Chloro-n-cresol
2-Chlorophenol
2,4-Dichlorophenol
2,4-Dimethylphenol
2-Nitrophenol
4-Niitrophenol
2,4-Dinitrophenol
4,6-Dinitro-o-cresol
Pentachlorophenol
Phenol

Base/Neutral Compounds

Acenaphthene
Benzidine
1,2,4-Trichlorobenzene
Hexachlorobenzene
Hexachloroethane
Bis(2-chloroethyl)ether
2-Chloronaphthalene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
3,3'-Dichlorobenzidine
2,4-Dinitrotoluene
2,6-Dinitrotoluene
1,2-Diphenylhydrazine (as azobenzene)
Fluoranthene
4-Chlorophenyl phenyl ether

Base/Neutral Compounds

4-Bromophenyl phenyl ether
Bis-(2-chloroisopropyl)ether
Bis(2-chloroethoxy)methane
Hexachlorobutadiene
Hexachlorocyclopentadiene
Isophorone
Naphthalene
Nitrobenzene
N-nitrosodiphenylamine
N-nitrosodi-n-propylamine
Bis(2-ethylhexyl)phthalate
Butyl benzyl phthalate
Di-n-butyl phthalate
Di-n-octyl phthalate
Diethyl phthalate
Dimethyl phthalate
Benzo(a)anthrocene
Benzo(a)pyrene
3,4-Benzofluoranthene
Benzo(k)fluoranthene
Chrysene
Acenaphthylene
Anthracene
Benzo(ghi)perylene
Fluorene
Phenanthrane
Dibenzo(a,h)anthracene
Indeno(1,2,3-cd)pyrene
Pyrene

Volatiles

Acrolein
Acrylonitrile
Benzene
Carbon tetrachloride
Chlorobenzene
1,2-Dichloroethane
1,1,1-Trichlorethane
1,1-Dichloroethane
1,1,2-Trichloroethane
1,1,2,2,-Tetrachloroethane
Chloroethane
2-Chloroethylvinyl ether
Chloroform
1,1-Dichloroethene
1,2-Trans-dichloroethene
1,2-Dichloropropane
1,3-Dichloroproplene
Ethylbenzene
Methylene chloride
Chloromethane
Bromoethane
Bromoform
Dichlorobromomethane
Trichlorofluoromethane
Dichlorodifluoromethane
Chlorodibromomethane
Tetrachloroethylene
Toluene
Trichloroethylene
Vinyl chloride

Pesticides

Aldrin
Dieldrin
Chlordane
4,4'-DDT
4,4'-DDE
4,4'-DDD
Endosulfan I
Endosulfan II
Endosulfan sulfate
Endrin
Endrin aldehyde
Heptachlor
Heptachlor epoxide
BHC-Alpha
BHC-Beta
BHC-Delta
BBC-Gama
PCB-1242
PCB-1254
PCB-1221
PCB-1232
PCB-1248
PCB-1260
PCB-1016
Toxaphene

Dioxins

2,3,7,8-Tetrachlorodibenzo-p-Dioxin

TABLE C.16

CONTAMINANT CONCENTRATIONS IN BOTTOM SEDIMENTS LAKE ERIE AND THE NIAGARA RIVER, 1979
(ug/g)

PARAMETER	DETECTION LIMIT	RIVER SEGMENT/SUB-AREA														
		Fort Erie		Chippawa		Buffalo River	Bird Is.-Riverside	Tonawanda North Tonawanda					Wheatfield-Upper River			
		M-1	M-2	M-14	M-15	M-3	M-4	M-5	M-6	M-7	M-8	M-9	M-10	M-11	M-12	M-13
Arsenic	0.3	2.7	4.6	3.3	3.2	8.2	2.4	2.5	14	5.4	7.6	2.4	1.9	2.4	3.4	4.0
Cadmium	0.04	<0.40	<0.40	<0.40	<0.40	0.60	<0.40	<0.40	0.50	<0.40	0.40	0.80	0.50	0.88	<0.40	<0.40
Chromium	3.0	7.8	8.0	8.0	19	34	24	7.0	79	5.8	28	19	11	24	8.2	20
Copper	1.0	5.5	3.8	7.0	15	40	14	9.5	110	10	32	12	8.5	20	7.8	18
Lead	3.0	6.0	4.5	4.0	11	56	12	7.0	200	5.0	48	13	11	31	10	20
Mercury	0.01	0.09	0.08	0.20	0.06	0.23	0.07	0.06	0.67	<0.01	0.65	0.04	0.09	0.60	0.06	0.10
Nickel	3.0	20	8.8	9.0	19	25	8.0	6.0	38	10	10	13	6.0	10	6.5	17
Zinc	1.0	32	26	36	75	170	67	42	460	50	330	120	100	200	210	76
PCBs, Total	0.010	-	0.027	0.048	ND	0.710	0.036	0.050	0.380	0.220	0.340	0.810	0.120	0.960	0.530	-
Aldrin	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	0.001	ND	ND	ND	ND	0.006	ND	ND	0.002	ND	ND	0.003	0.001	0.002	ND	ND
alpha-BHC	0.001	ND	ND	ND	ND	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-BHC (Lindane)	0.001	ND	ND	ND	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
gamma-Chlordane	0.001	ND	0.003	0.001	ND	0.002	ND	ND	0.005	ND	0.009	0.003	ND	ND	ND	ND
alpha-Chlordane	0.001	ND	0.003	ND	ND	0.003	ND	ND	0.001	ND	ND	0.001	ND	ND	ND	ND
o,p-DDT	0.005	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
p,p'-DDT	0.005	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
p,p'-DDE	0.001	0.006	0.002	0.001	0.001	0.019	0.001	0.003	0.006	0.003	0.005	0.003	0.002	0.009	0.007	0.001
p,p'-DDD (TDE)	0.005	ND	0.005	0.002	ND	0.005	ND	ND	ND	ND	0.009	0.005	ND	ND	ND	ND
Endrin	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
alpha-Endosulfan	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-Endosulfan	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Mirex	0.005	Tr	ND	ND	0.008	0.012	ND	ND	0.018	0.008	0.004	0.010	0.005	0.010	0.016	ND
Hexachloro-benzene	0.001	ND	ND	ND	ND	0.022	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

NOTES: Data Source: Sub-project 27 (MOE). Stations correspond to locations in Figure 4.2.
ND = not detected at detection limit indicated; Tr = Trace (contaminant identified but present at level below detection limit).
A dash (-) indicates no data available.
Concentrations are in ppm (ug/g, dry weight).

TABLE C.16 (Continued)

PARAMETER	DETECTION LIMIT	M-17	M-18	M-19	M-20	M-21	M-22	M-23	M-24	M-25
		RIVER SEGMENT/SUB-AREA Lower River								
Arsenic	0.3	2.8	3.7	4.2	4.0	8.2	3.5	2.0	1.5	2.5
Cadmium	0.04	0.60	0.72	0.88	0.88	0.40	0.45	0.65	0.55	0.72
Chromium	3.0	16	27	35	25	170	15	20	9.5	15
Copper	1.0	13	21	28	16	32	11	13	7.5	8.8
Lead	3.0	13	19	33	16	60	6.5	10	6.0	13
Mercury	0.01	0.26	0.96	3.2	0.34	0.86	0.03	0.22	0.51	0.19
Nickel	3.0	15	18	20	17	17	11	7.5	9.5	7.2
Zinc	1.0	79	110	140	96	170	55	150	47	63
PCBs Total		0.690	0.490	2.700	0.082	0.066	-	0.290	0.130	0.160
Aldrin	0.001	ND	ND	ND	ND	ND	-	ND	ND	ND
Dieldrin	0.001	0.010	0.006	0.026	0.005	ND	-	-	ND	0.002
alpha-BHC	0.001	ND	0.038	0.110	ND	ND	-	0.013	0.006	ND
beta-BHC	0.001	ND	ND	ND	ND	ND	-	ND	ND	ND
gamma-BHC (Lindane)	0.001	ND	0.020	ND	ND	ND	-	ND	ND	ND
gamma-Chlordane	0.001	ND	0.061	0.293	ND	-	-	0.050	0.014	0.011
alpha-Chlordane	0.001	ND	0.070	0.064	-	ND	-	0.035	0.005	0.006
o,p-DDT	0.005	ND	0.021	0.020	ND	ND	-	ND	ND	ND
p,p'-DDT	0.005	ND	0.070	0.074	ND	ND	-	ND	ND	ND
p,p'-DDE	0.001	0.005	0.036	0.020	0.004	0.005	-	0.006	0.009	0.010
p,p'-DDD (TDE)	0.005	ND	0.063	0.065	ND	ND	-	0.014	ND	ND
Endrin	0.001	0.005	0.007	0.013	ND	ND	-	-	ND	ND
alpha-Endosulfan	0.001	0.004	0.012	0.015	0.001	0.001	-	ND	0.001	0.001
beta-Endosulfan	0.001	0.006	0.045	0.015	0.001	ND	-	ND	0.001	0.001
Heptaculor	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptaculor epoxide	0.001	0.004	0.003	0.036	0.001	ND	-	0.003	0.001	0.001
Mirex	0.005	0.006	0.023	0.640	0.004	ND	-	0.011	ND	ND
Hexachloro-benzene	0.001	0.047	0.031	0.250	0.008	0.001	-	0.032	0.028	0.045

NOTES: Data Source: Sub-project 27 (MOE). Stations correspond to locations in Figure 4.2.
ND = not detected at detection limit indicated; Tr = Trace (contaminant identified but present at level below detection limit).
A dash (-) indicates no data available.
Concentrations are in ppm (ug/g, dry weight).

TABLE C.17

CONTAMINANT CONCENTRATIONS IN BOTTOM SEDIMENTS OF THE NIAGARA RIVER - 1981
(ug/g)

PARAMETER	DETECTION LIMIT	RIVER SEGMENT/SUB-AREA								
		Fort Erie	Chippawa		Buffalo River	Black Rock Canal	Bird Is.-Riverside	Tonawanda-North Tonawanda		
		E-4	E-11	E-12	E-1	E-2	E-3	E-5	E-6	E-7
Arsenic		4	3	8	16	16	12	20	7	5
Cadmium (extr.)	0.10	0.44	0.39	< 0.10	2.0	19.0	2.4	1.1	3.2	0.79
Chromium (extr.)		5	2	3	18	119	44	34	49	14
Cobalt (extr.)		3	2	4	5	4	3	4	2	2
Copper (extr.)		4	5	19	49	169	116	88	58	25
Lead (extr.)		13	11	9	109	767	145	88	105	72
Mercury		0.10	0.06	0.02	0.52	2.45	0.89	1.44	0.29	0.16
Nickel (extr.)		11	13	7	10	32	16	20	11	9
Selenium	0.10	0.25	0.20	0.17	< 0.10	0.19	0.22	0.22	0.27	0.20
Zinc (extr.)		11	33	7	179	1055	16	299	239	197
<u>PCBs</u>, Total	0.010	ND	0.020	ND	0.480	10.280	2.820	0.230	0.530	17.900
Aldrin	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	0.001	ND	ND	ND	ND	ND	ND	ND	ND	0.010
alpha-BHC	0.001	ND	ND	ND	0.016	0.032	0.002	ND	0.002	0.015
gamma-BHC (Lindane)	0.001	ND	0.002	ND	ND	ND	0.004	ND	ND	ND
alpha-Chlordane	0.001	ND	ND	ND	ND	0.049	ND	ND	ND	ND
gamma-Chlordane	0.001	ND	ND	ND	ND	0.094	ND	ND	ND	0.020
o,p-DDT	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND
p,p'-DDT	0.001	0.024	0.009	ND	0.005	ND	0.073	ND	ND	ND
p,p'-DDE	0.001	0.005	ND	ND	0.008	0.100	0.024	ND	0.011	0.280
p,p'-DDD (TDE)	0.001	ND	ND	ND	0.005	0.007	0.005	0.007	0.054	0.007
Endrin	0.001	ND	ND	ND	0.010	0.181	0.008	ND	0.050	0.015
alpha-Endosulfan	0.001	ND	ND	ND	0.012	0.078	0.016	0.003	ND	0.008
beta-Endosulfan	0.001	ND	ND	ND	ND	ND	ND	0.007	ND	ND
Heptachlor	0.001	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	0.001	ND	ND	ND	0.008	ND	ND	ND	0.019	ND
Methoxychlor	0.001	ND	0.018	ND	0.001	ND	0.059	0.014	0.103	0.008
Mirex	0.001	ND	0.003	ND	ND	ND	ND	ND	ND	ND
Σ -Dichlorobenzenes	0.001	0.019	ND	0.043	0.050	0.112	0.119	0.068	0.060	0.027
Σ -Trichlorobenzenes	0.001	ND	ND	ND	0.068	0.081	0.023	0.008	0.002	ND
Σ -Tetrachlorobenzenes	0.001	ND	ND	ND	0.001	ND	0.002	ND	ND	ND
Pentachlorobenzene	0.001	ND	ND	ND	0.004	0.003	0.002	0.013	0.002	ND
Hexachlorobenzene	0.001	ND	ND	ND	0.002	0.002	0.002	0.012	0.003	0.088

NOTES: Data source: sub-project 23 (IWD-OR). Stations correspond to locations in Figure 4.2.
Concentrations are in ppm, (ug/g dry weight). All inorganics values are <u>total</u> except those designated "(extr.)" for extractable.
ND = Not detected at detection limit indicated.

TABLE C.17 (Continued)

PARAMETER	DETECTION LIMIT	RIVER SEGMENT/SUB-AREA: Wheatfield-Upper River E-8	E-9	E-10	Lower River E-13	E-14	E-15	E-16
Arsenic		5	3	7	4	6	4	5
Cadmium (extr.)	0.10	0.20	0.38	2.0	0.19	0.76	0.19	2.0
Chromium (extr.)		4	4	28	5	10	4	18
Cobalt (extr.)		3	1	4	1	2	2	5
Copper (extr.)		9	6	43	6	10	4	46
Lead (extr.)		10	12	80	17	18	9	98
Mercury		0.03	0.42	2.29	0.18	0.41	0.18	0.27
Nickel (extr.)		6	4	13	5	7	4	11
Selenium	0.10	< 0.10	0.10	0.52	0.14	0.14	0.43	0.26
Zinc (extr.)		6	4	357	41	71	33	595
PCBs, Total	0.010	0.050	0.120	0.630	0.310	0.140	0.100	0.190
Aldrin	0.001	ND	ND	ND	ND	ND	ND	ND
Dieldrin	0.001	ND	ND	0.008	ND	ND	ND	ND
alpha-BHC	0.001	ND	ND	2.26	0.004	0.002	0.004	0.151
gamma-BHC (Lindane)	0.001	ND	ND	0.021	ND	ND	ND	0.087
alpha-Chlordane	0.001	ND	ND	0.007	0.007	0.002	ND	ND
gamma-Chlordane	0.001	ND	ND	ND	ND	ND	ND	ND
o,p-DDT	0.001	ND	ND	ND	ND	ND	ND	ND
p,p'-DDT	0.001	ND	ND	ND	ND	ND	ND	ND
p,p'-DDE	0.001	0.001	ND	0.005	0.001	ND	ND	ND
p,p'-DDD(TDE)	0.001	ND	ND	ND	0.003	0.002	0.002	0.001
Endrin	0.001	ND	ND	ND	ND	0.004	ND	ND
alpha-Endosulfan	0.001	ND	ND	ND	ND	ND	ND	ND
beta-Endosulfan	0.001	ND	ND	ND	ND	ND	0.005	0.004
Heptachlor	0.001	ND	ND	0.028	0.003	ND	ND	ND
Heptachlor expoxide	0.001	ND	ND	ND	ND	ND	ND	ND
Methoxychlor	0.001	ND	ND	0.010	0.001	ND	ND	ND
Mirex	0.001	ND	ND	ND	ND	0.024	ND	0.004
				0.890	0.004	0.002	ND	0.002
Σ-Dichlorobenzenes	0.001	0.045	0.052	0.153	ND	0.044	0.050	0.064
Σ-Trichlorobenzenes	0.001	ND	0.003	0.068	ND	0.002	ND	0.010
Σ-Tetrachlorobenzenes	0.001	ND	0.002	0.211	ND	0.006	ND	0.014
Pentachlorobenzene	0.001	ND	0.001	0.489	ND	0.001	0.001	0.006
Hexachlorobenzene	0.001	ND	0.001	0.086	ND	0.004	0.003	0.110

NOTES: Data source: sub-project 23 (IWD-OR). Stations correspond to locations in Figure 4.2.
Concentrations are in ppm, (ug/g dry weight). All inorganics values are total except those designated "(extr.)" for extractable.
ND = Not detected at detection limit indicated.

TABLE C.18

CONTAMINANT CONCENTRATIONS IN BOTTOM SEDIMENTS OF THE LOWER NIAGARA RIVER, 1981

PARAMETER	DETECTION LIMIT	RIVER SEGMENT Lower River						
		M-16	M-17	M-18	M-19	M-20	M-24	M-25
Arsenic		4.1	4.4	5.0	2.9	3.3	2.4	2.3
Cadmium		0.32	0.45	0.38	0.41	0.45	0.48	0.30
Chromium		23	28	26	18	20	28	14
Copper		13	16	15	13	18	19	7.8
Lead		17	14	13	11	16	25	4.7
Mercury		0.16	0.15	0.15	0.14	0.18	0.50	0.10
Nickel		17	19	18	10	15	12	5.0
Zinc		93	92	94	69	92	92	43
PCBs, Total	0.020	0.070	0.106	0.126	0.131	0.024	0.126	0.057
Aldrin	ND	ND	ND	ND	ND	ND	ND	ND
Dieldrin	ND	ND	ND	-	ND	ND	ND	ND
alpha-BHC	0.001	Tr	0.002	0.002	-	Tr	0.007	ND
beta-BHC	0.001	ND	ND	0.002	-	0.002	ND	ND
gamma-BHC (Lindane)	0.001	TR	ND	0.001	-	ND	ND	ND
alpha-Chlordane		0.002	0.001	0.002	-	ND	0.003	ND
gamma-Chlordane		0.001	ND	ND	-	ND	ND	ND
Oxychlordane	ND	ND	ND	ND	-	ND	ND	ND
o,p-DDT	0.005	ND	ND	ND	-	ND	ND	ND
p,p'-DDT	0.005	ND	ND	ND	-	ND	ND	ND
p,p'-DDE	0.001	ND	ND	ND	ND	ND	0.001	Tr
p,p'-DDD(TDE)	0.005	ND	ND	0.002	-	ND	ND	ND
Endrin		ND	ND	ND	-	ND	ND	ND
alpha-Endosulphan		ND	ND	ND	-	ND	Tr	Tr
beta-Endosulphan		ND	ND	ND	-	ND	ND	ND
Endosulphan sulphate		0.003	ND	ND	-	ND	0.001	ND
Heptachlor	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	0.001	Tr	0.001	ND	-	Tr	ND	ND
Methoxychlor		ND	ND	0.007	-	ND	0.007	ND
Mirex	0.005	0.006	ND	ND	Tr	ND	Tr	ND
Hexachlorobenzene	0.001	0.011	0.006	0.014	0.005	0.028	0.014	0.004

NOTES: Data Source: sub-project 27 (MOE). Stations correspond to locations in Figure 4.2.
ND = Not detected at detection limit indicated; Tr = Trace (contaminant identified but present at level below detection limit).
A dash (-) indicates no data available.
Concentrations are average, in ppm (ug/g, dry weight) of 2 or 3 analysis for each station (embayment).

TABLE C.19

HEAVY METAL CONCENTRATIONS IN BOTTOM SEDIMENTS OF BUFFALO HARBOR, OCTOBER 1981
(ug/g)

PARAMETER	RIVER SEGMENT/SUB-AREA												
	Lake Erie						Buffalo River				Black Rock Canal		
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13
Aluminum	7920	10280	7480	8855±35	4320	7820	10270±170	8520	8930	9050	8890	6780	11030
	8865±474	9920	7760	7820	4300	8270	10040	8680	9980±438	8830	8380	7360	10860±410
	8200	9440	9560	9075±686	3900	7910±156	10400	8380	9190	8850	7960±71	7353±172	11230
Arsenic	8.7	0.9	11.5	12.2±0.5	5.2	13.9	7.9±0.1	13.3	9.9	27.4	7.6	6.7	7.2
	9.5±0.4	7.9	13.1	11.5	6.1	9.8	10.0	15.0	12.3±0.8	11.5	7.9	5.0	5.7±0.8
	10.5	7.6	12.5	12.1±0.2	7.6	11.6±0.8	9.3	11.9	10.3	10.1	8.5±0.8	6.0±1.6	9.8
Cadmium	0.7	11.5	0.2	0.5±0.1	0.2	0.7	0.3±0.0	1.2	1.1	3.3	1.9	0.8	12.2
	0.6±0.0	11.6	0.5	0.5	0.2	0.5	0.7	1.6	1.4±0.1	1.9	1.1	0.9	16.1±0.2
	0.3	11.5	0.8	0.4±0.2	0.2	0.7±0.2	1.1	1.4	1.0	1.0	1.6±0.1	0.7±0.5	16.1
Chromium	48.3	89.3	41.6	44.3±0.0	19.7	43.4	24.7±0.5	29.6	27.5	85.8	30.6	35.0	111.2
	49.4±0.4	91.2	46.1	42.4	19.5	41.9	25.0	34.2	31.1±0.5	41.9	29.8	41.4	125.9±4.1
	49.7	92.5	49.0	44.7±1.7	17.9	43.6±0.2	23.5	38.2	31.3	28.0	29.8±1.1	41.0±1.0	124.8
Copper	50.3	139.3	42.4	42.4±2.2	16.9	42.6	56.3±0.7	65.5	57.1	123.4	49.9	43.9	199.9
	51.2±0.8	142.8	44.8	41.5	18.7	42.3	57.7	78.7	66.7±1.5	73.9	51.4	49.3	206.9±2.1
	50.9	139.0	43.1	44.1±2.4	18.6	45.0±0.3	53.6	83.4	62.2	56.1	49.4±0.1	48.2±0.6	197.5
Iron	25800	25800	31500	35250±212	25700	31300	26150±212	27700	23700	35700	25400	32000	25500
	44000±566	23000	35700	32900	25900	31900	26400	28700	28700±141	28300	25700	33900	27250±778
	43700	23200	36600	35950±778	25700	32800±424	25500	28400	26800	26800	24800±0	34433±115	26500
Lead	117.9	328.5	52.6	75.8±0.9	38.2	86.9	225.5±145.7	164.6	79.7	112.6	94.1	100.3	426.1
	123.7±7.1	343.5	68.9	81.7	21.9	70.6	123.1	204.4	96.7±1.8	223.1	99.3	105.5	465.3±5.1
	114.0	327.9	84.9	77.9±0.7	18.3	67.0	118.9	160.7	92.1	81.7	82.8±0.7	106.7±1.3	464.7
Manganese	394.9	409.1	989.3	944.9±3.7	685.8	884.1	519.1±0.6	479.2	451.6	529.9	48.74	42.3	416.6
	1045.6±43.8	418.8	1038.5	940.0	651.5	859.5	532.9	487.8	438.2±11.6	474.7	491.9	804.3	448.6±6.4
	1083.2	405.4	1065.3	856.5±129.7	635.8	872.6±2.6	501.6	495.6	439.7	468.0	492.7±1.1	800.8±10.8	452.3
Mercury	0.46	1.03	0.25	0.27	0.11	0.54±0.0	0.24	0.52	0.47	66.57	0.42	0.51	0.84
	0.48	1.03	0.31	0.41	0.13	0.48	0.22	0.71	0.56	0.95	0.41	0.45	0.94
	0.43±0.02	1.03	0.31	0.38	0.10	0.50	0.26	0.81	0.57	0.52	12.38	0.51	0.89
Nickel	37.3	51.3	37.3	39.9±0.5	18.7	37.1	36.7±1.6	36.6	33.9	43.4	36.1	32.5	50.1
	40.8±0.8	56.1	38.3	41.4	19.0	40.5	39.5	35.4	40.0±0.4	37.8	35.6	35.2	54.1±1.6
	41.7	53.5	41.7	42.3±1.9	17.1	40.1±0.8	38.0	34.2	36.8	36.1	34.4±0.7	35.3±1.1	53.7
Zinc	776.4	696.0	496.5	598.8±4.9	267.1	590.1	380.2±4.7	463.3	375.3	71.99	423.1	678.5	757.8
	737.2±0.8	702.6	567.2	592.5	286.7	713.4	401.2	489.9	417.5±7.4	529.1	413.4	773.1	779.3±6.2
	725.6	147.9	658.1	601.4±10.5	240.3	565.5±1.9	363.8	496.0	364.8	360.8	433.5±11.8	782.0±2.1	768.7

NOTES: Data Source: Sub-project 8 (USACOE). Stations correspond to locations in Figure 4.2.
Concentrations are in ppm (ug/g, dry weight).

TABLE C.20

ORGANIC CONTAMINANTS IN BOTTOM SEDIMENTS OF LAKE ERIE (IN STUDY AREA), 1982
(ng/g)

PARAMETER	RIVER SEGMENT/SUB-AREA Lake Erie															
	U-17	U-18	U-19	U-20	U-13	U-14	U-15	U-16	U-10	U-11	U-12	U-8	U-9	U-4	U-5	U-7
Volatile																
Chlorobenzene					62	12	630		1800	9.5	4.8					
Benzene							13		55							
Ethylbenzene							43		96							
Toluene					11		7.8		22					300		
Non-Volatile																
Acenaphthene	340				J	240	6700	80	2700	1200	160					J
1,2,4-trichloro-benzene	430				260	350	1100		20000	87						
1,2-dichloro-benzene	260				J	220	330		3400							
1,3-dichloro-benzene	J						1100		610							
1,4-dichloro-benzene	1100		J		540	370	14000	140	7200	430	110					
fluoranthene	5100	730	890	770	2300	2300	26000	1300	10000	3600	1700	2000	480	500	360	4200
napthalene	2500	270	390	310	1400	1600	13000	1100	9300	3200	1900					2300
n-nitrosodipheny-lamine	870			J	310	350	17000	80	11000	550						

NOTE: Data Source: Sub-project 12 (USEPA II). Stations correspond to locations in Fig. 4.3

* indicates isomeric pair.
J indicates present but not quantitated.
Concentrations are in ppb (ng/g dry weight)
Space indicates contaminant not detected.

TABLE C.20 (Continued)

ORGANIC CONTAMINANTS IN BOTTOM SEDIMENTS OF LAKE ERIE (IN STUDY AREA), 1982
(ng/g)

PARAMETER	RIVER SEGMENT/SUB-AREA Lake Erie															
	U-17	U-18	U-19	U-20	U-13	U-14	U-15	U-16	U-10	U-11	U-12	U-8	U-9	U-4	U-5	U-7
bis(2-ethylhexyl)-phthalate	200			470	410	470	4800			180	60					
Benzo(a)-anthracene	3100	510	550	570	1700	1400	13000	930	4400	1300	1100	1100	150	J	190	1600
Benzo(a)-pyrene	2300	550	490	710	1600	1300	6100	610	2600	920	990	1200		J	160	
Benzo(b)-fluoranthene*	4100	910	870	1200	2600	2200	5400	520	4300	1600	1700	1100		J	170	
Benzo(k) fluoranthene*																
Chrysene	2800	550	510	560	110	990	10000	670	3300	1100	970	1100	140	J	220	1600
Acenaphthylene	770	110	J	J	210	J	770	87		340	150	70				250
Anthracene	1600	150	200	J	520	450	1600	280	6400	1100	340	250	120			1000
Benzo(gni)-perylene	1100	350	240	500	1300	780	2200	290	980	460	660	640		J		
Fluorene	530	J	J	J	310	380		120	4100	1600	310	83				470
Phenanthrene	3000	400	530	490	1900	2000	22000	830	19000	5600	1500	1100	260	J	190	3100
Indeno(k,2,3,-cd)-pyrene	790	230	200	560	1200	830	1900	230	1100	510	640	670		J	J	
Pyrene	4200	650	770	720	2000	1900	22000	1200	8900	2700	1400	1600	430	450	330	3200
Butyl benzyl phthalate		130	180	J											330	
Di-n-butyl phthalate				230	2300		5300		11000	2100	1100					
Dibenzo(a,n)-anthracene				J							200					
Di-n-octyl phthalate						1000				170						J

TABLE C.21

METAL CONTAMINANTS IN BOTTOM SEDIMENTS OF LAKE ERIE (IN STUDY AREA), 1982
(ug/g)

PARAMETER	RIVER SEGMENT/SUB-AREA													
	Lake Erie													
	U-17	U-18	U-19	U-20	U-13	U-14	U-15	U-16	U-10	U-11	U-12	U-4	U-5	U-7
Silver	J	ND	ND	ND	ND	ND	J	ND	J	ND	ND	ND	4.9	1.4
Arsenic	25	12	12	20	24	13	76	8.0	30	22	9.0	12	4.0	7.0
Beryllium	1.1	0.8	0.8	1.0	1.0	1.0	0.9	1.1	0.2	1.3	1.2	1.0	2.0	J
Cadmium	J	J	J	J	J	J	2.5	ND	J	J	ND	J	J	J
Chromium	77	35	31	33	39	34	260	30	230	83	33	31	1100	270
Copper	45	26	26	28	33	33	200	26	130	77	28	28	31	30
Mercury	0.33	ND	ND	ND	0.30	ND	5.58	ND	2.21	1.83	ND	ND	ND	ND
Nickel	33	34	23	29	28	29	39	28	95	65	30	33	16	24
Lead	75	36	44	50	54	43	240	28	300	85	32	31	45	50
Antimony	ND	ND	ND	ND	ND	ND	J	ND	J	ND	ND	ND	23	J
Selenium	J	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Thallium	0.12	J	0.09	0.10	0.12	0.11	0.41	0.10	0.15	0.25	0.13	0.12	ND	ND
Zinc	390	150	150	170	270	200	550	870	670	240	99	100	74	210

NOTES: Data Source: Sub-project 12 (USEPA II). Stations correspond to locations in Fig. 4.3.
J indicates present but not quantitated.
ND indicates analyzed for, but not detected.
Concentrations are in ppm (ug/g, dry weight)

TABLE C.22

ORGANIC COMPOUND CONCENTRATIONS IN BOTTOM SEDIMENTS OF NIAGARA RIVER AND LAKE ERIE (IN STUDY AREA), 1982
(ug/kg)

PARAMETER	RIVER SEGMENT/SUB-AREA														
	Fort Erie	Lake Erie										Tonawanda-N. Tonawanda			
	U-1	U-2	U-3	U-6	U-21	U-22	U-23	U-24	U-25	U-26	U-27	U-28	U-29	U-30	U-31
Fluorotrichloro-methane		a	3.3	2.9	a	2.6	a	a	a			3.4	a	a	a
Toluene			a												
Fluoranthene					460	440	b		c				650	550	
Bis(2-ethylhexyl)-phthalate					b										b
Benzo (a)-anthracene					b	b	b						b	b	
Chrysene					b	b	b						650	b	
Phenanthrene					b	b	b						450	600	
Pyrene					b	b	b		c				700	420	
Di-n-butyl-phthalate									c			b			
Chlorobenzene															
Bromoform															
PCB-1248													16.9	88.8	29.6
PCB-1260															
Benzo(a)pyrene													e		
Benzo(b)-fluoranthene													e		
Styrene															
O-xylene															
N-nitrosodi-phenylamine															
Naphthalene													1500	b	
Benzo(k)-fluoranthene													e		
Dibenzo(a,h)-anthracene													e		

NOTES: Data Source: Sub-project 12 (USEPA II). Stations correspond to locations in Fig. 4.3.

This table summarizes detectable concentrations in ppb (mg/g, dry weight) only. See accompanying list of organic compounds for which analysis was conducted.

a = present at a concentration between 1.25 - 2.5 ug/kg
b = present at a concentration between 200 - 400 ug/kg
c = present at a concentration between 800 - 1600 ug/kg
d = present at a concentration between 2.5 - 5.0 ug/kg
e = present at a concentration between 400 - 800 ug/kg

f = present at a concentration between 5.0 - 10 ug/kg
g = present at a concentration between 10 - 20 ug/kg
- = no sample
Blank = Not detected (ND).

TABLE C.22 (Continued)

RIVER SEGMENT/SUB-AREA

PARAMETER	Wheatfield-Upper River							Lower River			
	U-32	U-33	U-34	U-35	U-36	U-37	U-38	U-39	U-40	U-41	U-42
Fluorotrichloro-methane			a		3.1			4.6			
Toluene						a					
Fluoranthene	f									460	
Bis(2-ethylhexyl)-phthalate		b		4400							
Benzo(a)-anthracene				b						b	
Chrysene				b						b	
Phenanthrene				b						b	
Pyrene	f			4400						480	
Di-n-butyl phthalate						b		b	640	b	
Chlorobenzene						b					
Bromoform						d					
PCB-1248			87.5	58	1050						
PCB-1260										55.4	
Benzo(a)pyrene	g									e	
Benzo(b)fluoranthene										e	
Styrene										d	
O-xylene										d	
N-nitrosodiphenylamine											
Naphthalene				b							
Benzo(k)fluoranthene											
Dibenzo(a,h)anthracene											

TABLE C.23

METALS CONCENTRATIONS BOTTOM SEDIMENTS OF THE NIAGARA RIVER AND LAKE ERIE (in Study Area), SEPTEMBER 29-30, 1982
(ug/g)

METALS	DETECTION LIMIT	RIVER SEGMENT/SUB-AREA													
		FT. ERIE	LAKE ERIE									TON.-N. TON.			
		U-1	U-2	U-3	U-6	U-26	U-27	U-21	U-23	U-25	U-24	U-28	U-29	U-30	U-31
Silver	1.0														
Aluminum	20	800	840	450	3100	1200	1000	680	590	600	640	220	530	280	1400
Boron	10														
Barium	10	31	22		41	31	30	33	24	25	28				24
Beryllium	0.5														
Chromium	1.0	3.2	3.3		43	13	10	7.0	5.3	4.4	4.1		16	1.6	6.0
Cobalt	5.0														
Copper	5.0	8.1			12	11	10	7.7	7.2	8.0	8.2		6.1	7.2	16
Iron	5.0	2100	4200	1400	11000	6500	5200	3700	3300	3000	3200	940	2400	1400	7200
Manganese	1.0	210	110	130	2700	710	410	330	220	180	220	30	56	120	430
Nickel	4.0	6.6	6.2		13	8.9	7.5	6.3	6.0		5.8			7.1	6.9
Vanadium	20				32										
Zinc	1.0	50	37	21	85	110	130	56	37	38	41		47	40	160
Arsenic	1.0	3.2	3.6	2.0	4.8	4.9	5.4	3.3	4.5	3.6	3.6	1.5	2.2		
Cadmium	0.1	1.5	0.8	0.4	0.9	0.9	1.2	0.5	0.5	0.6	0.5	0.6	1.0	0.5	1.1
Mercury	0.02					0.044			0.40	0.036	0.045				
Lead	0.5	21	19	11	24	32	33	15	24	16	16	6.3	16	15	30
Antimony	2.0														
Selenium	0.2														
Tin	2.0				2.1										
Thallium	1.0														

NOTE: Date Source: Sub-project 12 (USEPA II). Stations correspond to locations in Fig. 4.3.
Blank spaces indicate that the metal was analyzed for but not detected.
Concentrations are in ppm (ug/g, dry weight)

TABLE C.23 (Continued)

METALS	DETECTION LIMIT	RIVER SEGMENT/SUB-AREA: WHEATFIELD - UPPER RIVER						LOWER RIVER			
		U-32	U-35	U-33	U-37	U-38	U-35	U-36	U-42	U-39	U-40
Silver	1.0										
Aluminum	20	680	720	310	210	260	570	740	210	260	420
Boron	10										
Barium	10	19	28				22	24		28	24
Beryllium	0.5										
Chromium	1.0	5.6	14	1.6				5.8	3.6	2.7	2.3
Cobalt	5.0										
Copper	5.0	10	21				8.3	6.8			
Iron	5.0	3100	3900	1500	1100	1600	2600	3100	1100	1500	1100
Manganese	1.0	85	160	31	58	240	77	130	74	110	290
Nickel	4.0	6.0	10					8.2			6.1
Vanadium	20										
Zinc	1.0	170	180	75	13	11	150	49	19	26	9.3
Arsenic	1.0		2.3		1.4	3.0	1.8	4.2	1.4	1.7	4.1
Cadmium	0.1	1.9	2.8	0.6	0.5	0.9	1.1	1.0	0.5	0.5	0.8
Mercury	0.02						0.078	0.023			
Lead	0.5	60	61	12	6.8	14	33	24	14	23	17
Antimony	2.0										
Selenium	0.2										
Tin	2.0										
Thallium	1.0										

TABLE C.24

PAH CONCENTRATIONS IN BOTTOM SEDIMENTS IN NIAGARA RIVER AND LAKE ERIE (in Study Area), 1983
(ng/g)

	RIVER SEGMENT/SUB-AREA													
	Fort Erie	Lake Erie												
PARAMETER	N-29	N-1	N-2	N-3	N-4	N-5	N-6	N-7	N-8	N-9	N-10	N-12	N-13	N-14
Fluorene	13.3	46.0	39.0	21.0	104.0	319.0	112.0	197.0	171.0	5611.0	2710.0	395.0	573.0	267.0
Phenanthrene	146.5	344.0	310.0	162.0	851.0	2379.0	921.0	1317.0	1268.0	23370.0	13081.0	2947.0	3858.0	2307.0
Anthracene	10.8	77.0	55.0	20.0	140.0	529.0	140.0	415.0	314.0	8551.0	5466.0	936.0	1120.0	614.0
Fluoranthene	433.9	369.0	640.0	349.0	1409.0	2224.0	1594.0	1358.0	2079.0	35719.0	23497.0	5565.0	7240.0	4497.0
MePhenanthrene	46.8	55.0	92.0	55.0	185.0	617.0	237.0	291.0	298.0	3978.0	2549.0	531.0	1143.0	448.0
Pyrene	253.3	229.0	392.0	166.0	712.0	2326.0	967.0	1169.0	1178.0	21142.0	12550.0	3536.0	4404.0	2550.0
MeAnthracene	15.7	30.0	19.0	17.0	53.0	320.0	112.0	243.0	161.0	2876.0	1775.0	294.0	483.0	263.0
Benzofluorene	90.5	151.0	128.0	102.0	292.0	1849.0	306.0	1461.0	1159.0	15363.0	9383.0	1621.0	3032.0	1772.0
Benzathracene	50.3	107.0	134.0	51.0	292.0	1060.0	463.0	376.0	783.0	7662.0	5351.0	1584.0	1974.0	1301.0
Chrysene	0.0	87.0	55.0	17.0	0.0	1011.0	1356.0	271.0	629.0	4611.0	4304.0	1072.0	1534.0	985.0
Benzo(e)Pyrene	0.0	33.0	64.0	33.0	248.0	662.0	68.0	586.0	667.0	4960.0	5196.0	1241.0	316.0	1094.0
Perylene	60.0	159.0	281.0	121.0	459.0	2637.0	563.0	558.0	1620.0	14901.0	14589.0	2371.0	3593.0	2130.0
Benzo(b)Fluoranthene	180.0	81.0	107.0	50.0	335.0	969.0	597.0	309.0	700.0	4575.0	3519.0	1211.0	1465.0	1058.0
BENZO(k)FLURANTHENE	35.7	52.0	69.0	29.0	163.0	605.0	268.0	176.0	456.0	3142.0	2449.0	821.0	1049.0	698.0
Benzo(a)Pyrene	63.1	91.0	109.0	42.0	204.0	1169.0	506.0	299.0	865.0	6244.0	4327.0	1415.0	1804.0	1204.0
Dibenz(a,h)Anthracene	11.1	17.0	21.0	9.0	51.0	249.0	62.0	53.0	138.0	1403.0	987.0	285.0	351.0	246.0
Benzo(g,h,i)Perylene	43.6	60.0	79.0	38.0	181.0	901.0	212.0	196.0	362.0	3474.0	2544.0	979.0	1070.0	943.0
Indeno(1,2,3-c,d)-Pyrene	59.1	62.0	98.0	42.0	218.0	979.0	280.0	238.0	586.0	5089.0	3054.0	1276.0	1571.0	1097.0
TOTAL:	1513.7	2052.0	2558.0	1324.0	5897.0	20825.0	8764.0	9513.0	13434.0	162671.0	117325.0	28080.0	36581.0	23474.0

NOTES: Data Source: Sub-project 3 (NYSDEC). Stations correspond to locations in Fig. 4.4. (Chapter IV)
Concentrations are in ppb (ng/g, dry weight).

TABLE C.24 (Continued)

PARAMETER	RIVER SEGMENT/SUB-AREA														
	Chippawa	Buffalo River											Ton.-N. Ton.		
	N-30	N-15	N-16	N-17	N-18	N-19	N-20	N-21	N-22	N-23	N-24	N-25	N-26	N-27	N-28
Fluorene	21.0	0.0	171.0	129.0	0.0	645.0	631.0	235.0	131.0	261.0	167.0	2161.0	355.0	0.0	141.0
Phenanthrene	60.1	764.0	841.0	669.0	2255.0	9603.0	3577.0	2484.0	1413.0	1665.0	1707.0	10707.0	2436.0	539.0	3433.0
Anthracene	29.5	197.0	172.0	210.0	564.0	3401.0	1351.0	799.0	702.0	560.0	595.0	2768.0	632.0	0.0	635.0
Fluoranthene	175.0	3369.0	3329.0	2454.0	4009.0	10070.0	3228.0	6388.0	4059.0	4418.0	5285.0	43485.0	6934.0	6510.0	10988.0
MePhenanthrene	29.4	297.0	352.0	347.0	517.0	1432.0	898.0	1013.0	990.0	555.0	611.0	5651.0	6934.0	166.0	695.0
Pyrene	10.7	1999.0	1744.0	1395.0	5480.0	21946.0	7121.0	5327.0	3649.0	2746.0	3405.0	126783.0	0.0	1082.0	6716.0
MeAnthracene	9.1	0.0	236.0	235.0	402.0	1013.0	543.0	671.0	762.0	398.0	219.0	7426.0	1094.0	168.0	357.0
Benzofluorene	59.7	797.0	1222.0	1267.0	3502.0	9227.0	5886.0	6562.0	6445.0	4103.0	3973.0	33409.0	1098.0	3052.0	2534.0
Benzathracene	16.4	600.0	637.0	456.0	789.0	2073.0	2595.0	2308.0	1627.0	1030.0	1248.0	3544.0	695.0	4861.0	2254.0
Chrysene	0.0	504.0	359.0	242.0	344.0	385.0	1759.0	1772.0	1276.0	653.0	702.0	88.0	1323.0	5086.0	2400.0
Benzo(e)Pyrene	0.0	1870.0	847.0	2783.0	4451.0	0.0	4177.0	3914.0	4509.0	3538.0	3962.0	7583.0	910.0	5096.0	1756.0
Perylene	17.3	2510.0	2097.0	5090.0	4787.0	13727.0	7909.0	5641.0	6359.0	4513.0	4898.0	0.0	1869.0	12201.0	6263.0
Benzo(b)Fluoranthene	10.9	942.0	862.0	662.0	5503.0	0.0	1992.0	2514.0	1599.0	1383.0	1632.0	1103.0	593.0	6012.0	3740.0
Benzo(k)Fluoranthene	4.6	396.0	403.0	322.0	656.0	896.0	1150.0	1111.0	638.0	536.0	727.0	436.0	298.0	2995.0	1660.0
Benzo(a)Pyrene	16.6	629.0	674.0	468.0	215.0	1917.0	2539.0	2228.0	1296.0	1031.0	1296.0	583.0	585.0	6012.0	2526.0
Dibenz(a,h)Anthracene	6.0	167.0	147.0	121.0	140.0	6313.0	453.0	506.0	274.0	292.0	282.0	202.0	153.0	2995.0	385.0
Benzo(g,h,i)Perylene	16.7	747.0	636.0	717.0	212.0	2138.0	2353.0	2615.0	1339.0	1439.0	1352.0	847.0	793.0	5168.0	2060.0
Indeno(1,2,3-c,d)-Pyrene	0.0	806.0	619.0	891.0	2023.0	795.0	1658.0	1655.0	2801.0	2049.0	2093.0	714.0	429.0	5556.0	2176.0
TOTAL:	483.0	16594.0	15349.0	18488.0	35850.0	85581.0	49821.0	4774.0	39869.0	31170.0	34153.0	247480.0	27131.0	67497.0	50719.0

TABLE C.24A

CONTAMINANT CONCENTRATIONS IN BOTTOM SEDIMENTS OF SCAJAQUADA AND TWO-MILE CREEKS

(μg/g dry weight)

Substance	N-31	N-32	N-33	N-34	N-35	N-36	N-37	N-38	N-39	N-40	N-41	N-42	N-43
acenaphthene	≤20	ND	≤2	≤2	≤2	≤4	ND	ND	ND	ND	ND	≤20	≤20
anthracene	ND	ND	≤2	ND	≤2	≤4	ND	ND	≤2	ND	≤5	ND	≤20
benz(a)anthracene	ND	ND	≤2	≤2	2.6	≤4	≤30	≤2	≤2	≤2	≤5	≤20	≤20
benzo(a)pyrene	≤20	ND	ND	≤2	2.2	≤4	≤30	≤2	≤2	ND	ND	≤20	ND
benzo(b)fluoranthene	≤20	ND	ND	≤2	6.5	≤4	≤30	≤2	≤2	ND	≤5	≤20	≤20
benzo(g,h,i)perylene	ND	ND	ND	ND	ND	ND	≤40	ND	ND	ND	ND	ND	≤50
benzo(k)fluoranthene	NA	ND	ND	NA	NA	NA	NA	NA	NA	ND	NA	NA	NA
chrysene	ND	ND	≤2	≤2	3.2	≤4	≤30	≤2	≤2	≤2	≤5	≤20	≤20
fluoranthene	≤20	ND	≤2	≤2	3.9	ND	≤30	ND	≤2	≤2	≤5	≤20	ND
fluorene	ND	ND	≤2	ND	≤2	5	ND	≤2	≤2	≤2	≤5	ND	≤20
naphthalene	ND	ND	ND	≤2	ND	≤4	ND	ND	ND	ND	ND	ND	≤20
phenanthrene	≤20	ND	≤2	≤2	≤2	≤4	≤30	ND	≤2	ND	≤5	ND	21
pyrene	≤20	ND	≤2	≤2	5.7	≤4	≤30	≤2	≤2	≤2	≤5	≤20	30
Aldrin	ND	ND	0.45	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
alpha-BHC	0.19	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
beta-BHC	0.13	ND	0.08	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
delta-BHC	0.04	0.03	ND	0.07	0.05	0.15	ND	ND	ND	ND	ND	ND	ND
gamma-BHC	0.05	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PCB-1248	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.5	ND	ND
PCB-1254	ND	1.0	45	1.3	ND	ND	ND	ND	1.8	0.20	ND	ND	ND
PCB-1260	0.20	ND	ND	ND	1.4	1.3	ND	ND	ND	ND	ND	2.0	5.3
Total Recoverable Phenolics	2.2	ND	0.90	0.62	0.73	0.31	0.77	0.12	1.3	5.9	3.2	13	2.5
Total Cyanide	4.1	ND	1.6	1.4	1.9	1.5	ND	0.56	1.4	1.7	2.1	ND	2.3
Arsenic	0.88	1.5	0.54	0.32	0.28	ND	ND	ND	ND	ND	ND	ND	ND
Selenium	1.4	1.1	0.10	0.32	0.49	ND	ND	ND	ND	ND	1.2	ND	ND
Mercury	0.03	0.14	0.89	0.07	0.37	0.13	0.11	ND	0.24	0.23	ND	0.16	0.44
Antimony	ND	ND	ND	ND	ND	ND	28	89	21	5.4	6.2	21	44
Thallium	ND	ND	0.17	ND	ND	ND	ND	ND	0.19	ND	ND	ND	ND
Beryllium	ND	0.48	0.95	1.1	0.54	0.66	2.4	2.0	0.19	3.3	3.4	2.4	3.8
Silver	0.87	0.36	4.8	1.7	1.2	0.95	22	78	19	47	17	22	53
Cadmium	0.12	2.9	41	4.2	9.0	0.43	17	71	19	44	15	19	52
Copper	27	32	140	24	40	40	260	51	12	26	71	660	2,900
Chromium	19	23	430	26	160	46	470	53	160	130	120	290	510
Lead	68	230	360	160	34	97	18	6.9	13	18	14	15	30
Zinc	220	390	1,100	500	680	220	ND	0.51	ND	1.1	ND	ND	ND
Nickel	10	14	79	28	29	28	ND	0.55	0.45	ND	ND	0.26	ND

NOTES: Data Source: Sub-Projects 13, 14 (NYSDEC). Stations correspond to locations in Figure 4.4.
All EPA priority pollutants expect asbestos were analyzed except where noted. Chemicals not reported were below the detection level in all samples.
ND - not detected; NA - not analyzed.

Lead	124	8
Benzo(a)pyrene	106.5	1
Fluoranthene	63.9	1

Sediments in the Lackawanna Canal were found to have high levels of metals and PAHs:

Chemical	Highest Concentration (ug/g)	Sub-Project No.
Zinc	3300	1
Lead	1200	1
Cadmium	4.2	1
Benzo(a)pyrene	14	1
Fluoranthene	17.6	1

From the foregoing, there are apparently sources for these chemicals on Smoke Creek, the Union Canal, and the Lackawanna Canal. The source of the contaminants at the open lake disposal site could either be past deposition of material dredged from the Buffalo River and Harbor or deposition of contaminated sediments from Smoke Creek which is in close proximity. Under certain wind conditions these contaminated sediments could be transported into the Niagara River, thereby acting as a contaminant source to the river.

C.3.2 Fort Erie Segment

Elevated levels of p,p'-DDT were found in bottom sediments from the area around Frenchman's Creek.

Chemical	Highest Concentration (ug/g)	Sub-Project No.
p,p'-DDT	0.024	23

C.3.3 Buffalo River Segment

The Buffalo River segment has some of the highest sediment contaminant levels and greatest variety of chemicals of concern in the

Niagara system. Many of the highest levels occurred near Buffalo Color on the Buffalo River. The chemicals and their highest bottom sediment concentrations were:

Chemical	Highest Concentration (ug/g)	Sub-Project No.
Lead	3300	1
Zinc	600	1
Mercury	66.6	8
Cadmium	4.5	1
p,p'-DDT	1.84	1
p,p'-DDE	0.125	1
Benzo(a)pyrene	72.5	1
Fluoranthene	35.6	1
Heptachlor epoxide	0.300	1
alpha-Endosulfan	0.015	1
alpha-BHC	0.016	23
gamma-BHC	0.298	1
Endrin	0.267	1
1,2-DCB	247.8	1
1,3-DCB	10	1
1,4-DCB	3	1
HCB	58.7	1

One would expect very high contaminant levels in the sediments of the Buffalo River due to the heavy concentration of industrial facilities and hazardous landfill sites along the river and because its slow current makes it an area of high sediment deposition.

C.3.4 Black Rock Canal Segment

Like the Buffalo River, the Black Rock Canal is an area of high sediment deposition. This factor, coupled with the input from the Buffalo River and direct discharges to the Canal, results in high levels of bottom sediment contamination. The chemicals found, along with their highest levels are:

Chemical	Highest Concentration (ug/g)	Sub-Project No.
Zinc	1400	1
Lead	950	1
Mercury	4.2	1
p,p'-DDT	0.024	1
p,p'-DDE	0.028	1

Bottom sediments at the mouth of Scajaquada Creek are highly contaminated with a variety of organic and inorganic chemicals as follows:

Chemical	Highest Concentration (ug/g)	Sub-Project No.
Zinc	1300	1
Nickel	68	1
Cadmium	25	1
Lead	950	1
Mercury	3	1
alpha-BHC	0.032	23
gamma-BHC	0.734	1
Total PCBs	16.25	1
p,p'-DDE	0.218	1
HCB	0.010	1
1,2-Dichlorobenzene	1.7	1
1,3-Dichlorobenzene	1.2	1
1,4-Dichlorobenzene	1.7	1

These levels of contamination most likely reflect both the Black Rock Canal contamination as well as additional sources along Scajaquada Creek.

C.3.5 Bird Island-Riverside Segment

The only area of elevated sediment contamination in the Bird Island-Riverside segment is along the east shore of the Niagara River at the border between the Bird Island-Riverside segment and the Tonawanda-North Tonawanda segment in the vicinity of Strawberry Island. High levels of zinc, lead, PCBs, and some pesticides were found in sediments from this area as shown below:

Chemical	Highest Concentration (ug/g)	Sub-Project No.
Zinc	1100	1
Lead	560	1
Total PCBs	20.5	1
alpha-BHC	0.002	23
gamma-BHC	3.25	1
p,p'-DDE	0.18	1
p,p'-DDT	0.073	23
HCB	0.48	1

C.3.6 Chippawa Segment

Mirex was found in bottom sediments at a level of 0.003 ug/g at the mouth of Miller Creek (sub-project 23) and by MOE at a level of 0.008 ug/g at the downstream end of Navy Island (sub-project 27). These concentration levels were within the range of concentrations of mirex found in the lower river sediments. However, due to the distance between the two sets of observations and the paucity of additional sampling sites in this segment, an area of elevated sediment contamination could not be delineated.

1,4-Dichlorobenzene was found in the bottom sediments at the mouth of Black Creek at a level of 0.043 ug/g (sub-project 23). This concentration is comparable to the levels of this compound found in lower river sediments (sub-project 23). This finding could not be confirmed because of the sparseness of sampling in the Chippawa Channel.

C.3.7 Tonawanda-North Tonawanda Segment

Bottom sediments at the mouth of Two Mile Creek contained elevated levels of zinc and PAHs:

Chemical	Highest Concentration (ug/g)	Sub-Project No.
Zinc	460	27a
Benzo(a)pyrene	6.0	3
Fluoranthene	43.5	3

Sediments from the vicinity of the mouth of Tonawanda Creek and along the east side of Tonawanda Island were contaminated with zinc, PCBs, PAHs and BHCs as follows:

Chemical	Highest Concentration (ug/g)	Sub-Project No.
Zinc	630	1
Benzo(a)pyrene	2.5	3
Fluoranthene	11.0	3
alpha-BHC	0.015	23
gamma-BHC	0.048	1
Total PCBs	17.9	23

Elevated levels of mercury and zinc were found in bottom sediments in an area just south of the border between the Tonawanda-North Tonawanda and Wheatfield-Upper River segments. The highest levels found were:

Chemical	Highest Concentration (ug/g)	Sub-Project No.
Mercury	1.2	1
Zinc	780	1

C.3.8 Wheatfield-Upper River Segment

Bottom sediments at the west end of Little River behind Cayuga Island were contaminated with mercury, zinc, and a wide variety of organic chemicals. The highest levels found in the area were as follows:

Chemical	Highest Concentration (ug/g)	Sub-Project No.
Zinc	480	1
Mercury	2.29	23
pp'-DDE	0.031	1
Mirex	1.89	1
alpha-BHC	2.26	23
gamma-BHC	0.21	23
HCB	0.111	1
7,2-DCB	5.2	1
1,3-DCB	17.5	1
1,4-DCB	21.4	1

C.3.9 Lower River Segment

Elevated levels of a wide variety of chemicals were found in the bottom sediments of the Lower River. The chemicals found, and their highest concentrations were as follows:

Chemical	Highest Concentration (ug/g)	Sub-Project No.
Zinc	595	23
Mercury	3.2	27a
p,p'-DDT	0.074	27a
alpha-Endosulfan	0.015	27a

Table (continued)

Chemical	Highest Concentration (ug/g)	Sub-Project No.
alpha-BHC	0.151	23
gamma-BHC	0.087	23
Mirex	0.640	27a
1,4-Dichlorobenzene	0.05	23
Heptachlor epoxide	0.036	27a
Total PCBs	2.7	27a
HCB	0.250	27a

These highest concentrations were found on the Ontario side of the river, between Queenston and NOTL. Sources are contaminated sediments from the upper Niagara River segments as well as municipal and industrial point and non-point sources downstream of Grand Island, where the proximity to the Falls precludes sampling from a vessel.

While the observed locations of bottom sediment contamination suggest that sources exist at or upstream of these areas, the observed levels of contamination may not be due solely to inputs. Other factors which affect the contaminant content of the sediments include the organic content and particle size of the sediments and whether the area is a depositional or non-depositional area. (Pollutant levels would generally be higher in more organic, finer sediments than in coarse sediments, and higher in depositional areas than in nondepositional areas.) Therefore, site-specific trackdown efforts employing information about the locations of point and non-point sources and the type of chemicals they are likely to release, but also including discharge and groundwater monitoring data are needed to verify specific sources.

A number of chlorinated organic chemicals were identified in samples from the Fort Erie and Chippawa segments. However, the sparseness of sample sites in these segments hampered efforts to identify areas of elevated sediment contamination. More intensive bottom sediment sampling is needed to clarify the present findings.

C.4 Significant Areas of Contaminated Sediments and Effects of Resuspension

C.4.1 Lake Erie Dredged Material Disposal Site

A study of the old Lake Erie open water dredged material disposal site off Bethlehem Steel showed the presence of localized shallow pockets of fine-grained, highly contaminated sediments in areas of the site (sub-project 12). The study could not determine whether the source of the contaminated sediments was the dredged materials deposited in the past, more recent sediments coming from Smoke Creek, the Bethlehem Steel fill area, or all three. Regardless of the source of the pollutants, it appears that during storm events, the contaminated sediments from this nearshore area are resuspended and subsequently transported to the Niagara River.

Elevated concentrations in the Niagara River of iron and aluminum, as well as other conventional parameters, have been attributed to high westerly winds in Lake Erie (Kauss, 1983; Kuntz, 1983). This results in elevated suspended sediment loadings of iron and aluminum to the river due to increased shore erosion and sediment resuspension in the eastern basin of Lake Erie. No such correlation has been found for organic contaminants during storm events (Kuntz and Warry, 1983).

C.4.2 Depositional Areas in the Niagara River

Very little is known about depositional areas in the river where fine-grained sediments could accumulate and later be resuspended by currents. Scientists have been unable to obtain sediment samples from many portions of the Niagara River, especially the center of the river and its channels (for example, see Figure C.13 from a study by Kuntz (1983)). Fine-grained, highly contaminated sediments have been found in the river at some locations, primarily near shore, and behind islands, for example, indicating that some depositional areas do exist. However, nothing is known about the extent of these deposits (thickness or areal extent). In order to

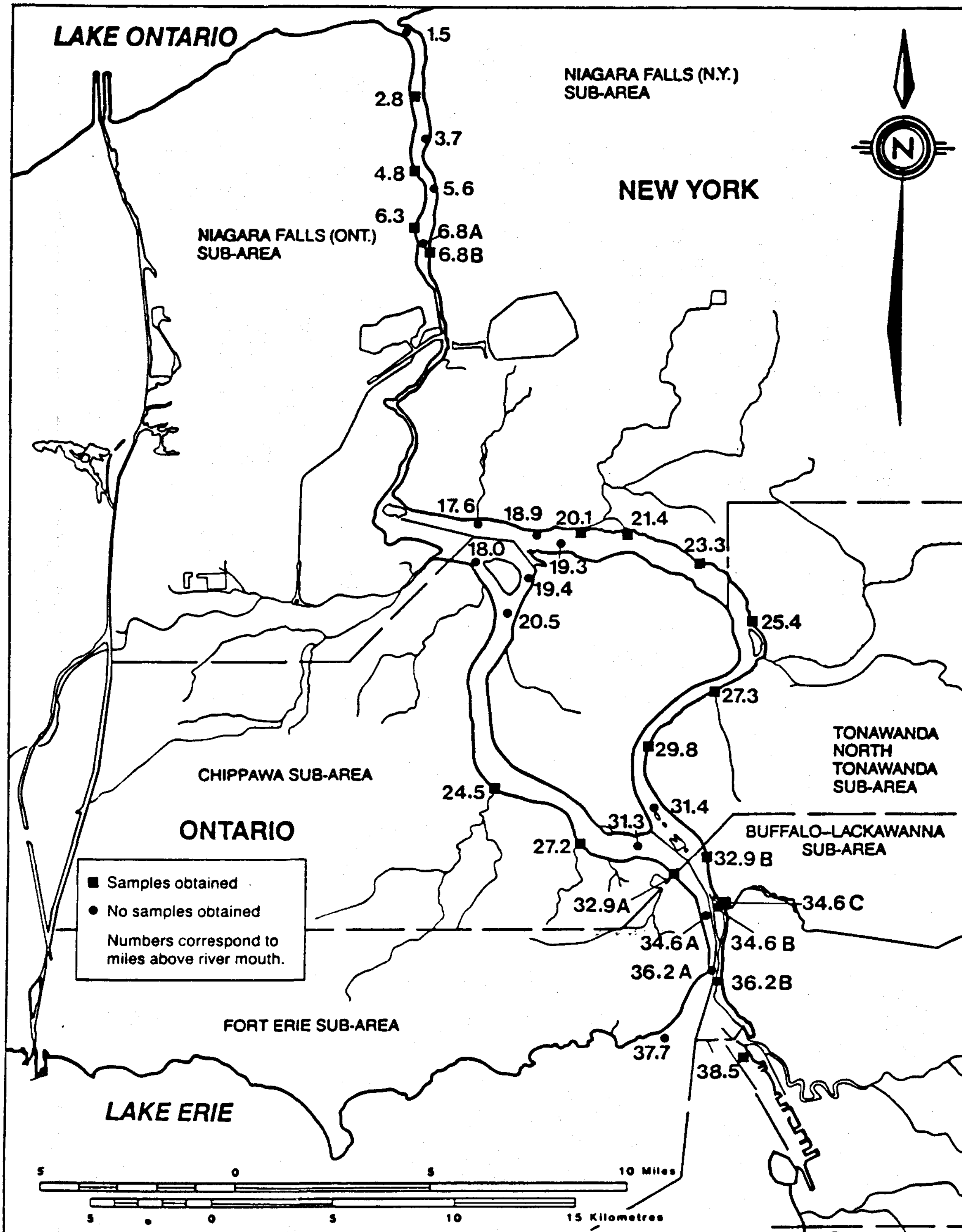

FIGURE C.13 PRESENCE/ABSENCE OF BOTTOM SEDIMENTS IN THE NIAGARA RIVER SYSTEM BASED ON SEDIMENT SAMPLING ATTEMPTED FROM A RESEARCH VESSEL (from Kuntz, 1983) address these issues, a preliminary side-scan sonar study was conducted by IWD-OR in the upper Tonawanda Channel in 1982. Results indicated that the bottom was mainly glaciolacustrine clay with bedrock outcroppings and very little deposition of unconsolidated material. In addition, a more extensive side scan and sub-bottom profiling study of the river is planned by USEPA V and IWD-OR to identify and map depositional areas and their extent. During 1983, a benthic and sediment study was conducted throughout the river by MOE. Samples were collected by a diver, and data on surface and bottom current velocities as well as visual observations will serve as a useful additions to the above study.

C.5 Description of Contaminant Levels Found in Individual Species

C.5.1 Young-of-the-Year Spottail Shiners

Spottail shiners have been collected for contaminant monitoring in the Great Lakes by the Ontario MOE since 1975. Collections have been made in the Niagara River, therefore, the data generated can be used to compare spatial and temporal contaminant concentrations in fish from within the Niagara river and with other Great Lakes locations. Data for the NOTL collection are summarized for 1975 to 1982 in Table C.25, while Table C.26 lists data for the 1981 MOE collection. In 1982, an MOE-DEC cooperative sampling and analytical project was conducted to increase the number of sites at which fish were collected in the Niagara River and Lake Erie to better understand the spatial distribution of contaminants in fish from these waters. These data are summarized in Table C.27.

A discussion of distribution of fish contaminants by specific chemical or chemical group follows.

Generally fish collected in Lake Erie outside the project area were less heavily contaminated both with regard to concentration and numbers of contaminants than those fish collected in the Niagara River (Table C.27). Fish from Strawberry Island (station N7) which is isolated from either shore of the Niagara River exhibited contaminant burdens that were most similar to

TABLE C.25
CONTAMINANT CONCENTRATIONS (ng/g) IN LAKE ERIE AND NIAGARA-ON-THE-LAKE YOUNG-OF-THE-YEAR SPOTTAIL SHINERS, 1975 TO 1982.
(ng/g)

PARAMETER	YEAR	RIVER SEGMENT/SUB-AREA			
		Fort Erie M-1		Lower River M-36	
Mercury	1977	--	--	77+6	7
	78	40+4	8	50+6	8
	79	30+10	5	50+9	8
	80	--	--	23+4	7
	81	--	--	--	--
	82	49+6	7	43+13	5
BHC (α, β, γ)	1975	--	--	ND	5
	77	--	--	50+15	9
	78	5+1	8	7+1	8
	79	ND	5	ND	8
	80	3+1	7	26+6	7
	81	--	--	ND	7
	82	ND	7	4+1	5
Chlordane (α, γ)	1975	--	--	ND	5
	77	--	--	61+15	9
	78	7+2	8	6+6	8
	79	9+2	5	21+13	8
	80	20+7	7	24+5	7
	81	--	--	11+3	7
	82	ND	7	17+7	5
Total DDT & Metabolites	1975	--	--	244+51	5
	77	--	--	157+30	9
	78	38+9	8	99+36	8
	79	14+4	5	26+7	8
	80	--	--	41+7	7
	81	--	--	73+8	7
	82	19+6	7	82+14	5
Mirex	1975	--	--	--	--
	77	--	--	13+3	9
	78	ND	8	29+6	8
	79	ND	5	Tr.	8
	80	ND	7	11+2	7
	81	--	--	10+2	7
	82	ND	7	6+2	5
PCBs, total	1975	--	--	690+191	5
	77	--	--	654+136	9
	78	157+21	8	320+36	8
	79	31+12	5	153+17	8
	80	95+13	7	266+41	7
	81	--	--	327+50	7
	82	60+14	7	255+24	5
Chlorinated Benzenes, total	1980	5+5	3	11+6	3
	81	--	3	5+5	3
	82	Tr.	3	3+2	3
Chlorinated Phenols, total	1980	ND	3	ND	3
	81	--	--	--	--
	82	33+15	3	20+15	3
Octachlorostyrene	1980	ND	3	9+1	3
	81	--	3	3+3	3
	82	ND	3	4+1	3

NOTES: Data Source: Sub-project 30. (MOE) Stations correspond to locations in Fig. 4.5. (Chapter IV).
Concentrations are means with 95% confidence intervals, in ppb, (ng/g wet weight), of number of replicates indicated in brackets (each replicate is a composite of 10 fish).
ND = Not detected (assigned a value of zero for calculation of mean).
Tr.= Trace (calculated mean concentration below detection limit).
4) A dash (-) indicates no data available.

TABLE C.26

CONTAMINANT CONCENTRATIONS IN 1981 YOUNG-OF-THE-YEAR SPOTTAIL SHINERS (*Notropis hudsonius*) FROM LAKE ERIE AND THE NIAGARA RIVER (ng/g)

PARAMETER	Detection Limit	RIVER SEGMENT/SUB-AREA							
		Fort Erie	Chippawa	Wheatfield - Upper River		Lower River			
		M-6	M-21	M-11	M-12	M-28	M-29	M-32	M-36
		(5)	(7)	(7)	(4)	(5)	(6)	(7)	(7)
PCBs, Total	20	164 ± 56	124 ± 14	327 ± 53	573 ± 84	405 ± 87	329 ± 120	309 ± 90	327 ± 62
BHC (α, β, γ)	1	1 ± 1		31 ± 11	34 ± 9	9 ± 3	4 ± 3	Tr	
Chlordane (α, γ)	2	Tr		11 ± 3	18 ± 4	ND	47 ± 20	10 ± 14	11 ± 4
Total DDT & Metabolites	5	37 ± 19	30 ± 5	9 ± 4	23 ± 4	74 ± 17	107 ± 57	189 ± 62	73 ± 15
Dieldrin	2	ND		ND	ND	ND	Tr	ND	Tr
Endrin	1	Tr		ND	ND	6 ± 4	7 ± 3	Tr	6 ± 11
Heptachlor	1	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	1	Tr		ND	ND	ND	Tr	Tr	Tr
Mirex	5	ND	ND	17 ± 6	18 ± 4	12 ± 3	15 ± 8	6 ± 3	10 ± 2
						(3)		(3)	(3)
Trichlorobenzenes	1	-	-	-	-	3 ± 6	-	3 ± 6	ND
Tetrachlorobenzenes	1	-	-	-	-	11 ± 1	-	5 ± 1	4 ± 1
Pentachlorobenzene	1	-	-	-	-	7 ± 0	-	5 ± 1	7 ± 7
Hexachlorobenzene	1	-	-	-	-	7 ± 2	-	6 ± 1	5 ± 2
Hexachloroethane	1	-	-	-	-	ND	-	ND	ND
Octachlorostyrene	1	-	-	-	-	3 ± 1	-	3 ± 1	3 ± 0
2,4,6-Trichlorophenol		-	-	-	-	-	-	-	-
2,3,5-Trichlorophenol		-	-	-	-	-	-	-	-
2,3,4,6-Tetrachlorophenol		-	-	-	-	-	-	-	-
Pentachlorophenol	5	-	-	-	-	-	-	-	-
		(1)		(2)	(2)			(2)	(2)
2,3,7,8-TCDD	0.001	0.015	-	0.008	0.059	-	-	0.007	0.014

NOTES: Data source: Sub-project 30 (MOE) and Suns *et al*. (1983). Stations correspond to locations in Fig. 4.5 (Chapter IV)
Concentrations are mean and standard deviation in ppb (ng/g, wet weight) of number of composite samples indicated at tops of columns in brackets. Each composite sample was composed of 10 fish (PCBs and pesticides), 15 fish (chlorinated aromatics) or 20 fish (2,3,7,8-TCDD).
A dash (-) indicates no data available.
ND = Not detected at detection limit indicated; Tr = Trace (mean below detection limit).

TABLE C.27

CONTAMINANT CONCENTRATIONS IN 1982 YOUNG-OF-THE-YEAR SPOTTAIL SHINERS (*Notropis hudsonius*) FROM LAKE ERIE AND THE NIAGARA RIVER (ng/g)

PARAMETER	DETECTION LIMIT MOE	DETECTION LIMIT NYSDEC	RIVER SEGMENT: FORT ERIE M-1	FORT ERIE M-5	FORT ERIE M-6	CHIPPAWA M-21	LAKE ERIE N-1	LAKE ERIE N-2	BLACK ROCK CANAL N-4	BLACK ROCK CANAL N-5	BIRD ISLAND - RIVERSIDE N-6	BIRD ISLAND - RIVERSIDE N-7
			(7)	(6)	(7)	(7)	(5)	(5)	(5)	(5)	(5)	(4)
PCBs, Total	20		60±17	181±69	216±34	124±14	83±19	40±6	673±	1683±477	646±173	93±14
BHC (α, β, γ)	1	2-8	ND	4±1	6±1	ND	ND	ND	ND	ND	ND	ND
Chlordane (α, γ)	2	1-8	ND	6±4	8±6	10±2	ND	ND	ND	17±4	Tr	ND
Total DDT & Metabolites	5		19±8	31±12	57±10	30±5	13±4	13±4	30±8	112±28	40±7	12±
Dieldrin	1		Tr	2±1	4±3	5±2	Tr	Tr	4±1	9±	3±2	3±0.4
Endrin	1	1-2	-	-	-	-	Tr	ND	ND	ND	ND	ND
Heptachlor	1	1-2	ND	ND	ND	ND	ND	ND	ND	Tr	ND	ND
Heptachlor expoxide	1	1-2	ND	ND	1±0	ND	ND	ND	ND	2±0.4	ND	ND
Mirex	5	1-5	ND	ND	ND	ND	ND	ND	ND	ND	Tr	ND
							(5)	(5)	(5)	(5)	(5)	(4)
ΣTrichlorobenzenes	1	3-6	ND	ND	-	25±6	Tr	ND	ND	ND	13±	ND
ΣTetrachlorobenzenes		-	ND	Tr	-	ND	-	-	-	-	-	-
Pentachlorobenzene		-	ND	ND	-	ND	-	-	-	-	-	-
Hexachlorobenzene	1	2-8	Tr	Tr	-	1±0	ND	ND	Tr	2±0.6	2±	ND
Hexachloroethane		-	ND	ND	-	ND	-	-	-	-	-	-
Hexachlorobutadiene	1	1-2	ND	ND	-	ND	ND	ND	ND	ND	ND	ND
Octachlorostyrene	1	1-2	ND	ND	ND	ND	ND	ND	ND	10±	8±	ND
							(2)	(2)	(2)	(2)	(2)	(2)
2,4,6-Trichlorophenol			ND	ND	-	ND	3	2	5	7	2	11
2,3,5-Trichlorophenol		1	ND	ND	-	ND	ND	ND	ND	ND	ND	ND
2,3,4,6-Tetrachlorophenol		1	-	-	-	-	ND	ND	ND	ND	4	ND
Pentachlorophenol	5		33±11	ND	-	17±20	8	9	4	5	18	5
				(1)	(1)	(1)				(1)	(1)	(1)
2,3,7,8-TCDD	0.001		-	ND	ND	ND	-	-	-	ND	0.001	ND

NOTES: Data Sources: Sub-projects 30 (MOE) and 4 (NYSDEC). MOE stations prefixed by "M"; NYSDEC stations prefixed by "N" (see Fig. 4.5 for locations). (Chapter IV)
Concentrations are mean and standard deviation in ppb (ng/g, wet weight) of number of composite samples indicated at tops of columns in brackets.
A dash (-) indicates no data available.
ND = Not detected at applicable detection limit (MOE or NYSDEC); Tr = Trace (calculated mean below detection limit).
Rock bass substituted for spottail shiners at station N-15 in lower river.

TABLE C.27 (Continued)

PARAMETER	RIVER SEGMENT/SUB-AREA																
	TONAWANDA-NORTH TONAWANDA							WHEATFIELD-UPPER RIVER			LOWER RIVER						
	N-8	N-9	N-10	N-11	N-12	N-13	N-14	M-11	M-12	M-16	M-22	M-23	N-15	M-28	M-29	M-32	M-36
	(5)	(5)	(5)	(5)	(3)	(5)	(5)	(6)	(6)	(5)	(5)	(5)	(1)	(5)	(5)	(6)	(5)
PCBs, Total	331±89	457±345	560±170	918±101	458±	426±	394±64	512±143	880±136	1091±351	96±5	187±45	500±	180±45	245±21	260±56	255±24
BHCs (α,β,γ)	ND	ND	ND	ND	ND	ND	ND	28±11	29±10	7±3	Tr	Tr	ND	ND	3±1	3±1	4±1
Chlordane (α, γ)	ND	ND	ND	17±5	ND	ND	ND	15±6	19±7	13±6	7±3	10±5	48±	8±2	8±2	7±3	17±7
DDT & Metabolities	Tr	Tr	Tr	84±7	34±	65±	23±4	18±6	50±4	14±7	36±12	19±15	91±	26±10	61±19	47±22	82±14
Dieldrin	8±10	Tr	3±1	8±1	4±	3±	2±1	ND	4±2	2±2	4±2	ND	5±	4±3	Tr	2±1	-
Endrin	ND	ND	ND	ND	ND	ND	ND	-	-	-	-	-	ND	-	-	-	-
Heptachlor	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor epoxide	ND	ND	ND	2±0.2	ND	ND	ND	ND	ND	ND	2±3	ND	ND	3±2	ND	ND	-
Mirex	ND	ND	ND	ND	ND	3±	ND	ND	6±2	5±3	ND	ND	7±	6±4	7±6	6±2	6±2
	(5)	(5)	(5)	(5)	(3)	(5)	(5)	( )	( )	( )	( )	( )	(1)	( )		( )	( )
Trichlorobenzenes	ND	ND	ND	ND	Tr	428±	ND	9±1	-	ND	-	50±1	86±	ND	-	ND	2±1
Tetrachlorobenzenes	-	-	-	-	-	-	-	4±3	-	Tr	-	ND	-	3±3	-	3±4	ND
Pentachlorobenzene	-	-	-	-	-	-	-	ND	-	ND	-	ND	-	ND	-	ND	ND
Hexachlorobenzene	2±0.4	Tr	2±	8±5	3±	261±	4±1	8±3	-	8±4	-	1±0	31±	3±1	-	3±1	4±1
Hexachloroethane	-	-	-	-	-	-	-	ND	-	ND	-	ND	-	ND	-	4±4	ND
Hexachlorobutadiene	ND	ND	ND	ND	ND	14±	ND	Tr	-	7±3	-	Tr	29±	2±2	-	ND	2±2
Octachlorostyrene	18±17	ND	ND	8±	Tr	94±	6±3	ND	-	6±3	-	Tr	536±	1+1	-	2±1	4±1
	(2)	(2)	(2)	(2)	(2)	(2)	(2)						(2)				
2,4,6-Trichlorophenol	11	2	4	2	14	52	9	ND	ND	ND	-	ND	20	ND	ND	ND	ND
2,3,5-Trichlorophenol	ND	ND	ND	ND	ND	5	ND	ND	ND	ND	-	ND	5	ND	ND	ND	ND
2,3,4,6-Tetra-chlorophenol	ND	1	2	2	ND	ND	ND	-	-	-	-	-	7	-	-	-	-
Pentachlorophenol	6	8	10	14	7	12	7	70±35	23±15	43±8	-	42±29	4	45±23	25±23	Tr	20±11
	(1)	(1)		(1)	(1)	(1)	(1)			(1)							
2,3,7,8-TCDD	ND	ND	-	ND	ND	0.120	ND	-	-	ND	-	-	-	-	-	-	-

Lake Erie fish. The higher degree of contamination of Niagara River Basin fish suggests an association with sources of contaminants and fish in this area.

The spatial distribution of contaminants from the 1982 spottail shiner sampling clearly indicates sources of contamination in the Niagara River Basin for chlorinated benzenes, hexachlorobutadiene, chlordane, heptachlor/heptachlor-epoxide, hexachlorocyclohexanes, mirex, octachlorostyrene, 2,3,7,8-TCDD and, DDT. Dieldrin and chlorinated phenols appear to have a generalized distribution in fish from the study area. The presence of some of these compounds in Lake Erie fish suggests that Lake Erie sources may provide an input of these compounds to the Niagara River, with additional localized inputs occurring within the river itself.

Trichlorobenzenes occurred in fish collected from six locations in the Niagara River Basin. These sites were Cornelius Creek (N6), the Pettit Flume (N13), 102nd Street (M11), Welland River West (M21) and below Niagara Falls (N15) and Niagara-on-the-Lake (M36) (Table C.27). The presence of trichlorobenzenes in fish at six locations suggest specific sources at or upstream of these sites.

Heptachlor occurred in a single composite of four fish samples taken from Scajaquada Creek (N5). Heptachlor epoxide occurred in fish from two locations in the Niagara River Basin. These were Scajaquada Creek (N5), and Two-Mile Creek (N11). Such localized contamination of fish suggests a source of these compound in these areas.

Hexachlorobenzene was found in fish from twenty-one locations in the Niagara River Basin (Table C.27). Relatively low concentrations of hexachlorobenzene were found in most sites where it was detected. However, high concentrations of this compound were found in fish from the Pettit Flume (N13), the Search and Rescue base (M16) and below Niagara Falls (N15) suggesting sources of this contaminant in the vicinity of these sites.

Hexachlorocyclohexanes (BHCs) were found in all fish collected by MOE in the Niagara River Basin downstream of site M50 (Table C.27). These compounds were not detected at any NYSDEC sites, which may reflect the higher detection limit employed (see Table C.27). These compounds were detected in fish from all ten MOE locations which included Fort Erie (M5), Frenchman's Creek (M6), 102nd Street (M11), Cayuga Creek (M12), the Search and Rescue base (M16), Welland River West (M23), Welland River East (M22), Queenston (M29), Peggy's Eddy (M32) and Niagara-on-the-Lake (M37) (Table C.27). The highest concentrations occurred at two adjoining sites, 102nd Street and Cayuga Creek, suggesting a source of these contaminants in the vicinity of these sites.

Hexachlorobutadiene occurred in fish from 7 locations. These sites were the Pettit Flume (N13), Search and Rescue Base (M16), Welland River West (M23), below Niagara Falls (N15), Lewiston (M28), 102nd Street (M11) and Niagara-on-the-Lake (M36) (Table C.27). The presence of hexachlorobutadiene in fish at these locations may suggest sources at these sites.

Chlordane occurred in fish from 16 locations in the Niagara River basin. These were Fort Erie (M5), Frenchman's Creek (M6), Scajaquada Creek (N5), Cornelius Creek (N6), Two-Mile Creek (N11), Usher's Creek (M21), 102nd Street (M11), Cayuga Creek (M12), the Search Rescue base (M16), Welland River West (M23), Welland River East (M22), below Niagara Falls (N15), Queenston (M29), Lewiston (M28), Peggy's Eddy (M32), and Niagara-on-the-Lake (M36). Sources of this contaminant occur at or upstream of these locations.

DDT compounds occurred in fish from all sampling locations reflecting the generalized presence of this contaminant throughout the environment. However, fish from eight locations were noticeably higher in total DDT contaminants than at other sites. These locations were Frenchman's Creek (M6), Scajaquada Creek (N5), Two-Mile Creek (N11), Pettit Flume (N13), below Niagara Falls (N15), Queenston (M29), Peggy's Eddy (M32) and Niagara-on-the-Lake (M36) (Table C.27). These higher concentrations suggest a greater localized contamination at or upstream of these sites.

Polychlorinated biphenyls (PCBs) occurred in fish collected at all sites reflecting the generalized environmental contamination by these compounds. However, fish from most Niagara River basin stations were higher in PCB burden than fish collected from Lake Erie. Highest values of PCB occurred in fish collected from Scajaquada Creek (N5), Two-Mile Creek (N11), the confluence of Cayuga Creek with Little River, and the Search and Rescue base (M16). Sources of PCB may occur at or upstream of these locations.

Mirex occurred in fish collected from nine locations in the Niagara River Basin. These locations were Cornelius Creek (N6), the Pettit Flume (N13), Cayuga Creek (M12), the Search and Rescue base (M16), below Niagara Falls (N15), Queenston (M29), Lewiston (M28), Peggy's Eddy (M32) and Niagara-on-the-Lake (M36). All fish from stations in the Niagara River from Cayuga Creek downstream were contaminated with mirex at similar concentrations. Consequently no suggestions can be made about relative contributions of mirex contamination to the river among these sites. However, the Pettit Flume and Cornelius Creek are some distance upstream from the other sites where mirex occurred in fish. This suggests an input of mirex to the river in the vicinity of these locations.

Octachlorostyrene occurred in fish collected at twelve locations in the Niagara River basin. These sites were Scajaquada Creek (N5), Cornelius Creek (N6), eastern shore opposite Strawberry Island (N8), Two-Mile Creek (N11), Tonawanda Creek (N12), Pettit Flume (N13), Gratwick-Riverside Park (N14), Search and Rescue base (M16), Welland River East (M22), below Niagara Falls (N15), Lewiston (M28) and Peggy's Eddy (M32). This compound was at relatively low concentration in fish except at the Pettit Flume and below Niagara Falls where the concentrations of this compound in fish suggested a substantial source of octachlorostyrene in the vicinity of these sites (Table C.27).

Dieldrin occurred in fish collected in both Lake Erie outside the project area and in the Niagara River Basin at similar concentrations.

Endrin occurred in only one of five composites of fish collected from Lake Erie at Dunkirk outside the project area. Endrin was not quantitated in 1982 MOE fish; however, 1981 sampling by MOE did identify endrin in Spottail Shiners from the lower river.

Trichlorophenols were found in fish in both Lake Erie outside the project area and the Niagara River Basin. However, the highest concentrations of these compounds occurred in fish collected at the Pettit Flume (N13), and below Niagara Falls (N15), suggesting relatively high inputs of trichlorophenols at these locations. Tetrachlorophenols occurred in fish collected from Cornelius Creek (N6), Tonawanda boat launch (N9), S. Grand Island Bridge (N10) and Two-Mile Creek (N11) (Table C.27). Pentachlorophenol was found in fish from twenty-four sites in Lake Erie and the Niagara River. Chlorinated phenol contamination was generally widespread.

All 2,3,7,8-TCDD (Dioxin) analyses for 1982 are not yet completed. Both 1981 and available 1982 data are presented here. Determination of the 2,3,7,8-TCDD levels in whole young-of-the-year Spottail Shiners collected in 1981 by the MOE indicated that the highest levels (58 and 60 ppt) were found in the samples from the mouth of Cayuga Creek (M12) which receives storm water drainage from the Love Canal via Black and Bergholtz Creeks. Spottail Shiners collected in 1982 by DEC at this site and analyzed by NYSDOH had a lower 2,3,7,8-TCDD concentration of 7.8 ppt. MOE 1982 data identified 2,3,7,8-TCDD in Cornelius Creek and Pettit Flume spottail shiners at concentrations at 1 ppt and 120 ppt, respectively (Tables C.26 and C.27).

C.5.2 Cladophora

While Cladophora was collected from the Niagara River and Lake Erie in 1980, 1981 and 1982, the following discussion deals only with the 1982 data set (Table C.28). However, the previous years' data are included in Tables C.29 to C.32, and Table C.33 compares contaminant levels in algae from the inlet and the outlet of the river for 1980 to 1982. The highest mean PCB levels in Cladophora collected in 1982 were found at the

TABLE C.28

CONTAMINANT CONCENTRATIONS IN LAKE ERIE AND NIAGARA RIVER FILAMENTOUS ALGAE (*Cladophora glomerata*), 1982

PARAMETER	RIVER SEGMENT/SUB-AREA													
	Fort Erie		Chippawa			Buffalo R.		Bird Is. Riverside	Ton.-N. Ton	Wheatfield-Upper River				
	M-2	M-6	M-20	M-21	M-19	M-3	M-4	M-7	M-9	M-11	M-16	M-14	M-15	M-13
Inorganics (ug/g)														
Aluminum	420±20	3317±1990	-	2467±58	2466±51	3000±0	-	5933±153	5933±115	3667±115	793±30	-	2967±153	-
Arsenic	11.8±0.6	10.2±2.2	-	7.0±0.3	7.4±0.3	11.4±0.6	-	14.8±0.1	11.4±0.2	7.0±4.0	11.9±0.5	-	11.0±0.2	-
Cadmium	1.2±0.1	1.4±0.4	-	0.7±0.1	0.4±0.01	0.7±0.04	-	2.8±0.1	2.3±0.06	1.0±0.06	1.7±0.0	-	1.0±0.1	-
Chromium	3.8±0.0	35.0±19.7	-	6.9±0.2	6.6±0.0	15.7±0.6	-	55.7±1.5	46.3±1.2	30.0±1.0	5.0±0.4	-	14.0±0.0	-
Cobalt	1.2±0.0	3.4±1.4	-	3.2±0.1	3.0±0.0	7.2±0.2	-	6.9±0.2	6.9±0.06	5.1±0.15	1.3±0.1	-	3.9±0.1	-
Copper	6.8±6.2	11.1±5.3	-	5.4±0.4	6.7±0.3	18.7±0.6	-	36.7±0.6	30.3±0.6	13.0±1.0	5.0±0.9	-	20.0±1.0	-
Lead	4.3±0.2	12.6±3.0	-	8.0±0.8	7.0±0.1	56.7±1.5	-	44.0±1.0	45.0±1.0	35.3±2.5	12.2±2.7	-	32.7±2.5	-
Manganese	75±1	462±210	-	307±12	456±13	2400±0	-	647±6	547±6	373±6	94±2	-	637±6	-
Mercury	0.03±0.01	0.04±0.01	-	0.03±0.01	0.03±0.01	0.12±0.01	-	0.21±0.02	0.21±0.02	0.9±0.02	0.06±0.01	-	0.8±0.03	-
Nickel	3.9±0.3	10.1±4.3	-	10.3±0.6	9.2±0.0	11.0±0.0	-	26.0±0.0	20.7±0.6	15.7±0.6	5.9±0.2	-	14.0±0.0	-
Selenium	0.2±0.03	0.7±0.4	-	0.7±0.02	0.7±0.03	1.17±0.01	-	1.7±0.03	0.9±0.05	0.9±0.5	0.4±0.02	-	1.5±0.06	-
Zinc	14.3±0.6	47.8±15.3	-	35.7±0.6	25.0±0.0	88.0±1.7	-	177±6	307±6	170±0	71±4	-	96±20	-
Organics (ng/g)														
PCBs	Tr(20)	42±8	-	53±42	67±12	90±5	-	82±3	85±10	375±23	578±88	-	16333±1845	-

SOURCE: Sub-project 29 (MOE). Stations correspond to locations in Fig. 4.5.(Chapter IV)
NOTE: Concentrations are means and standard deviations in ppm (ug/g) or ppb (ng/g) (dry weight) of 3 replicates.
Tr = Trace (calculated mean concentration below detection limit).
Dash (-) indicates no data available.

TABLE C.28 (Continued)

CONTAMINANT CONCENTRATIONS IN LAKE ERIE AND NIAGARA RIVER FILAMENTOUS ALGAE *(Cladophora glomerata)*, 1982

PARAMETER	RIVER SEGMENT/SUB-AREA									
	Lower River									
	M-39	M-36	M-31	M-35	M-26	M-27	M-32	M-34	M-38	M-24
Inorganics (ug/g)										
Aluminum	1667±115	3500±100	3167±115	4367±58	2600±0	3462±58	4617±104	5900±200	5267±2196	1300±0
Arsenic	10.4±0.2	12.1±1.5	10.3±0.06	11.8±0.5	15.2±0.6	15.1±0.8	13.6±0.5	12.6±0.3	13.1±0.4	6.6±0.2
Cadmium	0.6±0.02	1.6±0.0	1.3±0.15	1.9±0.1	1.7±0.06	1.7±0.06	1.6±0.06	1.8±0.1	1.8±0.7	1.4±0.06
Chromium	9.0±0.3	18.3±0.6	15.0±1.0	22.0±0.0	11.7±0.6	17.0±0	23.3±0.6	29.0±1.0	27.0±11.3	7.0±0.17
Cobalt	1.8±0.15	4.2±0.0	4.0±0.1	5.2±0.0	3.3±0.1	4.3±0.1	5.6±0.1	7.1±0.2	6.8±2.8	2.0±0.2
Copper	8.9±0.5	15.0±0.0	14.7±0.6	18.7±0.6	8.5±0.3	15.7±0.6	18.0±0.0	25.0±1.0	27.3±11.8	8.6±0.1
Lead	4.3±0.2	22.3±1.2	15.7±1.2	21.0±0.0	15.0±1.0	26.7±2.1	24.7±2.1	28.0±1.0	51.7±20.2	25.0±1.0
Manganese	210±10	317±6	467±15	400±20	233±6	307±6	440±26	467±15	820±329	207±6
Mercury	0.1±0.01	0.11±0.01	0.08±0.01	0.11±0.01	0.07±0.02	0.09±0.01	0.12±0.01	0.13±0.0	0.14±0.01	0.08±0.0
Nickel	6.5±0.31	12.0±0.0	11.0±0.0	14.7±0.6	8.9±0.4	12.0±0.0	15.7±0.6	21.0±1.0	18.3±7.5	8.9±0.15
Selenium	1.07±0.06	0.74±0.04	0.63±0.05	0.86±0.03	0.29±0.05	0.49±0.14	0.5±0.07	0.92±0.15	0.66±0.04	0.84±0.02
Zinc	32±0.6	83±4	77±2.0	97±1	61±1	86±3	99±1.0	125±5	147±64	78±3.5
Organics (ng/g)										
PCBs	63±28	58±15	42±16	58±8	40±13	50±0	50±5	52±6	77±10	1810±634

TABLE C.29

CONTAMINANT CONCENTRATIONS IN LAKE ERIE AND NIAGARA RIVER FILAMENTOUS ALGAE (*Cladophora glomerata*), 1980

PARAMETER	RIVER SEGMENT/SUB-AREA													
	Fort Erie		Chippawa			Buffalo R.		Bird Is. Riverside	Ton.-N. Ton	Wheatfield-Upper River				
	M-2	M-3	M-20	M-21	M-19	M-3	M-4	M-7	M-9	M-11	M-16	M-14	M-15	M-13
Inorganics (ug/g)														
Aluminum	1300	-	7800	-	-	7300	1900	-	-	-	-	-	-	2400
Arsenic	10.0	-	11.0	-	-	35.0	15.0	-	-	-	-	-	-	10.0
Cadmium	0.4	-	1.3	-	-	0.98	0.53	-	-	-	-	-	-	1.5
Chromium	6.5	-	14.0	-	-	15.5	7.0	-	-	-	-	-	-	15.8
Cobalt	0.7	-	3.2	-	-	4.0	0.8	-	-	-	-	-	-	1.2
Copper	6.5	-	14.8	-	-	20.2	8.0	-	-	-	-	-	-	12.2
Lead	2.0	-	5.8	-	-	41.0	9.3	-	-	-	-	-	-	8.3
Manganese	265	-	433	-	-	274	358	-	-	-	-	-	-	480
Mercury	0.01	-	ND	-	-	0.04	ND	-	-	-	-	-	-	0.03
Nickel	7.8	-	22.0	-	-	14.2	6.0	-	-	-	-	-	-	11.2
Selenium	1.5	-	1.25	-	-	1.8	1.0	-	-	-	-	-	-	1.0
Zinc	32	-	46	-	-	110	65	-	-	-	-	-	-	130
Organics (ng/g)														
PCBs	-	-	-	-	-	-	-	-	-	-	-	-	-	-

NOTES: Data Source: Sub-project 29 (MOE). Stations correspond to locations in Fig. 4.5. (Chapter IV)
Concentrations are averages of duplicate analyses of a composite sample in ppm (ug/g) or ppb (ug/g), dry weight basis.
Tr = Trace (calculated average concentration below detection limit).
Dash (-) indicates no data available.
ND = Not detected.

TABLE C.29 (Continued)

CONTAMINANT CONCENTRATIONS IN LAKE ERIE AND NIAGARA RIVER FILAMENTOUS ALGEA *(Cladophora glomerata)*, 1980

PARAMETER	RIVER SEGMENT/SUB-AREA									
	LOWER RIVER									
	M-39	M-36	M-31	M-35	M-26	M-27	M-32	M-34	M-38	M-24
Inorganics (ug/g)										
Aluminum	650	1400	5200	-	-	-	3400	-	-	-
Arsenic	9±1	11.0	9.2	-	-	-	12.0	-	-	-
Cadmium	0.6	1.1	0.9	-	-	-	0.7	-	-	-
Chromium	7.8	6.5	11.0	-	-	-	13.0	-	-	-
Cobalt	0.9	2.2	2.6	-	-	-	1.8	-	-	-
Copper	4.1	12.5	13.8	-	-	-	12.0	-	-	-
Lead	0.2	4.0	4.8	-	-	-	7.0	-	-	-
Manganese	118	312	432	-	-	-	1122	-	-	-
Mercury	0.02	ND	ND	-	-	-	ND	-	-	-
Nickel	8	17.8	12.8	-	-	-	10.5	-	-	-
Selenium	0.5±0.1	0.8	1.1	-	-	-	1.0	-	-	-
Zinc	25±3	49	49	-	-	-	52	-	-	-
Organics (ng/g)										
PCBs	-	-	-	-	-	-	-	-	-	-

TABLE C.30

CONTAMINANT CONCENTRATIONS IN LAKE ERIE AND NIAGARA RIVER FILAMENTOUS ALGAE (*Cladophora glomerata*), JUNE 1981

CHEMICAL CLASS/ PARAMETER	RIVER SEGMENT/SUB-AREA: Fort Erie			Chippawa		Buffalo		Bird Is. Riverside	Tonawanda N. Tonawanda	Wheatfield-Upper River				
	M-2	M-6	M-20	M-21	M-19	M-3	M-4	M-7	M-9	M-11	M-16	M-14	M-15	M-13
Inorganics (ug/g)														
Aluminum	846±20	1823±21	2473±55	-	-	1740±71	-	4190±71	4063±47	4640±47	1305±35	-	-	-
Arsenic	3.1±0.8	8.3±0.6	5.0±0.7	-	-	9.2±0.3	-	11.3±0.6	10.6±0.7	6.2±0.4	6.5±0.4	-	-	-
Cadmium	1.1±0.1	1.1±0.1	1.1±0.1	-	-	0.6±0.2	-	1.8±0.1	1.6±0.1	1.1±0.1	1.4±0.1	-	-	-
Chromium	6.3±0.2	16±0	8.8±0.2	-	-	7.4±0.4	-	44.0±1.0	38.0±0	43.0±0	6.6±0.2	-	-	-
Cobalt	1.0±0.1	2.3±0.17	2.8±0	-	-	2.5±0	-	5.0±0	4.6±0.2	7.8±0	1.5±0	-	-	-
Copper	6.4±0	10.7±0.6	4.4±0.1	-	-	11.0±0	-	24±-	24.0±0	28.0±1.4	3.7±0.7	-	-	-
Lead	5.6±-	7.9±0.7	7.2±-	-	-	24.0±0	-	35.0±1.0	32.3±1.1	39.0±1.4	7.2±-	-	-	-
Manganese	116±5	403±21	227±6	-	-	510±14	-	470±36	493±6	560±28	160±0	-	-	-
Mercury	0.02±0.01	0.03±0.01	0.03±0	-	-	0.06±0.01	-	0.12±0.01	0.12±0.01	1.8±0.4	0.09±0.01	-	-	-
Nickel	5.9±0.2	10.7±0.6	9.2±0.1	-	-	6.4±0.2	-	16.0±0	15.0±0	20.0±0	6.3±0.3	-	-	-
Selenium	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	43±3	95±27	55±2	-	-	83±3	-	193±6	207±6	230±0	67±3	-	-	-
Organics (ng/g)														
PCBs	53±10	62±8	27±8	-	-	93±19	-	168±21	160±0	58±19	463±152	-	-	-

NOTES: Data Source: Sub-project 29 (MOE). Station correspond to locations in Fig. 4.5.(Chapter IV)
Concentrations are means and standard deviations in ppm (ug/g) or ppb (ng/g) (dry weight) of 3 replicates.
Some replicates were below the detection limit; values are means of the detection limit and values above the detection limit, preceeded by (less than).
A dash (-) indicates no data available.

TABLE C.30 (Continued)

CHEMICAL CLASS/ PARAMETER	RIVER SEGMENT/SUB-AREA Lower River									
	M-39	M-36	M-31	M-35	M-26	M-27	M-32	M-34	M-38	M-24
Inorganics (ug/g)										
Aluminum	1243±280	1947±58	2790±87	3760±36	1533±21	3383±150	2453±49	2620±85	3237±110	-
Arsenic	11.3±06	7.4±0.8	8.8±0.8	11.3±0.6	11.0±2.0	6.7±0.5	5.2±0.5	6.7±0.1	6.8±0.2	-
Cadmium	0.4±0.1	1.2±0.2	1.5±0.1	1.5±0.1	1.4±0.1	1.5±0.2	1.0±0.2	1.5±0.2	1.3±0.1	-
Chromium	8.1±0.4	11.7±0.6	15.7±0.6	21.7±0.6	8.3±0.2	16.7±0.6	12.3±0.6	14.7±0.6	18.3±0.6	-
Cobalt	-	2.1±0.1	3.4±0.2	4.4±0.4	1.6±0.2	4.0±0	3.1±0.1	3.2±0	4.2±0	-
Copper	5.4±0.8	4.6±0.3	6.3±0.3	15.7±0.6	-	13.7±0.6	10.1±0.8	11.7±0.6	14.7±1.2	-
Lead	-	11.3±0.6	11.3±1.2	17.3±1.5	9.2±1.1	15.3±1.5	12.0±2.0	13.0±2.6	28.0±1.7	-
Manganese	177±12	220±0	343±6	457±6	153±6	370±0	340±10	353±12	473±15	-
Mercury	0.03±0	0.05±0	0.08±0.01	0.09±0	0.06±0.01	0.06±0	0.09±0	0.07±0.01	0.07±0.02	-
Nickel	4.9±0.5	7.9±0.2	12.0±0	14.0±0	5.9±0	15.3±0.6	12.0±1	11.3±0.6	17.3±0.6	-
Selenium	-	-	-	-	-	-	-	-	-	-
Zinc	72±3	210±0	273±6	137±6	147±6	100±0.6	70±2	81±2	93±3	-
Organics (ng/g)										
PCBs	60±9	52±22	53±8	37±18	32±10	68±3	68±8	145±93	133±50	-

TABLE C.31

CONTAMINANT CONCENTRATIONS IN LAKE ERIE AND NIAGARA RIVER FILAMENTOUS ALGAE (*Cladophora glomerata*), JULY 1981

PARAMETER	RIVER SEGMENT/SUB-AREA													
	Fort Erie		Chippawa			Buffalo		Bird Is. Riverside	Tonawanda N.Tonawanda	Wheatfield-Upper River				
	M-2	M-6	M-20	M-21	M-19	M-3	M-4	M-7	M-9	M-11	M-16	M-14	M-15	M-13
Inorganics (ug/g)														
Aluminum	1973±147	1527±42	2227±31	-	-	2973±100	-	1643±50	1546±60	1657±15	-	-	1697±139	-
Arsenic	2.8±0	3.1±0.1	3.2±0.4	-	-	11.3±0.6	-	3.3±0.3	5.3±0.4	2±0	-	-	4.1±0	-
Cadmium	0.4± -	0.5±0.1	0.5±0.1	-	-	0.5±0.1	-	1.3±0.1	1.3±0.1	0.53±0.06	-	-	1.2±0.1	-
Chromium	7.1±0.2	21.0±0	6.8±0.1	-	-	13.7±0.6	-	21.7±0.6	16.3±0.5	23.6±1.5	-	-	12.3±0.6	-
Cobalt	2.0±0	2.0±0.2	3.0±0.2	-	-	5.6±0.2	-	2.0±0.1	3.0±0.1	4.3±0.1	-	-	2.7±0.2	-
Copper	10.7±0.6	8.0±0.3	9.7±0.3	-	-	21.7±3.5	-	18.0±1.7	8.0±2.9	10.3±3.2	-	-	30.7±3.5	-
Lead	6.4±0	6.1±0.7	6.4±1.4	-	-	60.0±1.0	-	21.7±0.6	21.3±0.5	25.3±1.1	-	-	20.0± -	-
Manganese	270±10	583±6	407±12	-	-	1620±44	-	470±17	400±17	1243±211	-	-	523±21	-
Mercury	0.02±0.01	0.02±0.01	0.04±0.01	-	-	0.13±0.01	-	0.06±0	0.06±0.01	0.70±0.10	-	-	0.62±0.02	-
Nickel	7.9±0.2	6.2±0.2	12.0±0	-	-	12.7±0.6	-	9.6±0.1	8.6±0.4	1016±0.5	-	-	16.3±0.6	-
Selenium	0.9±0.06	0.5±0.1	0.7±0.2	-	-	0.9±0.8	-	0.6±0	0.4±0	0.4± -	-	-	2.8±0.2	-
Zinc	25±2	34±1	38±5	-	-	99±1.2	-	97±3	127±6	102±8	-	-	95±4	-
Organics (ng/g)														
PCBs	35±18	28±8	25±5	-	-	220±110	-	70±56	105±22	157±15	-	-	-	-

NOTES: Data Source: Sub-project 29 (MOE). Stations correspond to locations in Fig. 4.5.(Chapter IV)
Concentrations are means and standard deviations in ppm (ug/g) or ppb (ng/g) (dry weight) of 3 replicates.
Some replicates were below the detection limit; values are means of the detection limit and values above the detection limit, preceeded by (less than).
A dash (-) indicates no data available.

TABLE C.31 (Continued)

PARAMETER	RIVER SEGMENT/SUB-AREA Lower River M-39	M-36	M-31	M-35	M-26	M-27	M-32	M-34	M-38	M-24
Inorganics: (ug/g)										
Aluminum	860±17	560±17	2077±253	1080±137	2357±93	1247±15	1140±36	890±67	760±35	-
Arsenic	3±0	3.9±0	2.3±0.1	2.4±02	5.0±0	4.6±2.0	3.2±0.1	3.4±0.5	3.3±0	-
Cadmium	0.3± -	0.9±0.03	0.3± -	0.5±0.1	1.4±0	1.5±0.1	0.5±0.1	0.8±0.3	0.7±0	-
Chromium	7.1±0.2	6.7±0	10.3±0.6	9.1±0.1	14.0±0	8.7±0.1	7.1±0.1	6.9±0.3	6.1±0.2	
Cobalt	1.3±0.2	1.0± -	2.07±0.1	1.6±0.2	3.6±0.4	1.6±0.1	1.7±0.1	1.5±0.3	1.2±0	-
Copper	11.0±1.0	6.9±0.2	19.3±1.1	15.0±2.0	16.3±0.6	9.1±0.3	8.1±0.6	7.4±0.3	6.1±0.6	-
Lead	5.3± -	6.3±1.2	6.3±0.4	7.2±0.5	14.0±1.7	10.5±1.2	7.9±1.3	8.4±1.2	11.7±0.6	-
Manganese	307±6	176±5	327±6	307±12	273±12	18-±10	413±6	367±23	313±6	-
Mercury	0.05±0.01	0.03±0.01	0.04±0.01	0.03±0.01	0.06±0.01	0.04±0.01	0.06±0.01	0.06±0	0.08±0.01	-
Nickel	6.0±0.2	5.2±0.1	8.2±0.2	7.3±0.2	12.0±0	5.9±0.1	6.8±0.1	7.3±0.7	5.6±0.2	-
Selenium	0.4±0.1	-	0.5±0	0.7±0.1	0.3±0	05.±0.1	0.7±0	0.7±0.1	0.6±0.1	-
Zinc	38±2	39±0	35±1	35±1	64±3	41±1	37±1	35±2	29±1	-
Organics: (ng/g)										
PCBs (ng/g)	28±14	20±0	25±9	47±19	37±6	42±25	47±29	50±31	52±19	-

TABLE C.32

CONTAMINANT CONCENTRATIONS IN LAKE ERIE AND NIAGARA RIVER FILAMENTOUS ALGAE (*Cladophora glomerata*), 1981

CHEMICAL CLASS/ PARAMETER	RIVER SEGMENT/SUB-AREA													
	Fort Erie		Chippawa			Buffalo		Bird Is. Riverside	Tonawanda N.Tonawanda	Wheatfield-Upper River				
	M-2	M-6	M-20	M-21	M-19	M-3	M-4	M-7	M-9	M-11	M-16	M-14	M-15	M-13
Inorganics (ug/g)														
Aluminum	767±12	1070±288	3133±153	-	-	-	-	1597±68	2367±126	3980±117	-	3107±117	5107±398	-
Arsenic	2.6±0.5	1.8±0.7	2.8±0.3	-	-	-	-	3.6±0.3	4.9±0.2	3.3±0.5	-	3.1±0.2	5.3±0.2	-
Cadmium	0.3± -	0.9± -	0.6±0.2	-	-	-	-	0.9±0.3	1.3±0.2	1.1±0.3	-	0.7±0.3	1.2±0.3	-
Chromium	6.1±1.3	8.4±1.5	9.0±1.8	-	-	-	-	18.0±1.7	42.3±2.3	47.7±2.1	-	14.0±1.0	21.0±1.0	-
Cobalt	1.0± -	1.0± 0	4.0±0.8	-	-	-	-	1.8±0.1	3.0±0.2	5.1±0.4	-	2.7±0.2	5.4±0.5	-
Copper	9.4±0.6	3.6±0.4	13.0±1.0	-	-	-	-	20.0±1.0	24.7±2.5	31.0±1.0	-	17.6±0.5	48.7±1.2	-
Lead	5.0± -	6.2± -	8.1± -	-	-	-	-	18.6±2.0	28.3±0.6	40.7±2.1	-	14.3±2.3	35.3±4.2	-
Manganese	127±6	270±35	370±10	-	-	-	-	370±17	403±21	530±17	-	313±6	620±135	-
Mercury	0.01± -	0.02± -	0.02±0.01	-	-	-	-	0.04±0.01	0.07±0.03	4.37±1.27	-	0.08±0.01	1.57±0.12	-
Nickel	6.1±0.4	4.8±0.4	12.3±0.5	-	-	-	-	10.6±0.5	13.0±1.0	15.7±1.2	-	12.0±0	36.0±1.7	-
Selenium	0.7±0.1	0.4± -	0.8±0.2	-	-	-	-	1.2±0.2	1.2±0.2	0.8±0.2	-	0.9±0.2	6.6±0.6	-
Zinc	20±2	24±2	40±3	-	-	-	-	83±4	170±10	197±6	-	65±5	243±15	-
Organics (ng/g)														
PCBs	45±25	27±11	66±29	-	-	-	-	52±19	-	604±185	-	32±12	-	-

NOTE: Data Source; Sub-Project 29 (MOE). Stations correspond to locations in Fig. 4.5.(Chapter IV)
Concentrations are means and standard deviations in ppm (ug/g) or ppb (ug/g) (any weight) of 3 replicates.
Some replicates were below the detection limit; values are means of the detection limit and values above the detection link preceeded by (less than).
A dash (-) indicates no data available.

TABLE C.32 (Continued)

CHEMICAL CLASS/ PARAMETER	RIVER SEGMENT/SUB-AREA Lower River									
	M-39	M-36	M-31	M-35	M-26	M-27	M-32	M-34	M-38	M-24
Inorganics (ug/g)										
Aluminum	1247±57	1177±21	-	-	2990±10	2383+108	1340±79	1117±23	827±30	-
Arsenic	2.4±0.1	3.0±0.6	-	-	3.8±0.3	3.5+0.1	2.7±0.2	2.6±0.2	2.5±0.5	-
Cadmium	0.9±0.2	1.2±0.4	-	-	1.5±0.1	1.9±0.2	0.7±0.3	0.8±0.2	0.9±0.1	-
Chromium	8.5±2.2	8.7±1.0	-	-	14.0±2.0	13.6±1.1	8.2±1.4	8.4±1.4	7.4±0.9	-
Cobalt	1.7±0.6	1.2±0.4	-	-	3.6±0.7	2.7±0.2	1.8±0.2	1.5±0.1	1.1± -	-
Copper	15.7±1.5	12.6±2.0	-	-	14.6±1.1	14.3±0.5	8.4±2.4	10.5±0.8	9.3±1.6	-
Lead	7.2± -	10.5±2.5	-	-	13.6±2.5	17.3±2.0	16.7±1.2	7.8±1.8	10.4±2.3	-
Manganese	223±15	243±6	-	-	296±55	330±17	383±29	310±10	223±15	-
Mercury	0.04±0	0.03±0.01	-	-	0.05±0.01	0.07±0.01	0.07±0.01	0.05±0.01	0.04±0.01	-
Nickel	8.6±0.5	7.5±0.6	-	-	12.3±0.5	11.6±0.5	8.2±0.2	7.7±0.4	6.2±0.4	-
Selenium	1.0±0.1	0.6±0.1	-	-	0.7±0.1	1.0±0.1	0.8±0.1	0.9±0.1	0.8±0.2	-
Zinc	51±2	56±3	-	-	73±	57±4	34±4	32±2	31±4	-
Organics (ng/g)										
PCBs	43±21	43±25	-	-	47±30	38±12	72±76	40±22	34±12	-

TABLE C.33
CONTAMINANT CONCENTRATIONS IN LAKE ERIE AND LOWER NIAGARA RIVER
FILAMENTOUS ALGAE (*Cladophora glomerata*), 1980 TO 1982.

PARAMETER	YEAR	RIVER SEGMENT Fort Erie M2	RIVER SEGMENT Lower Niagara River M36
Inorganics (ug/g)			
Aluminum	1980	1300	
	81	1973±147	560±17
	82	767±12	3500±100
Arsenic	1980	10	12
	81	2.8±0.0	3.9±0.0
	82	2.6±0.5	12.1±1.8
Cadmium	1980	0.4	1.1
	81	0.25	0.88±0.03
	82	0.25	1.60±0.00
Chromium	1980	6.5	6.0
	81	7.1±0.2	6.8±0.1
	82	6.1±1.3	18.3±0.6
Cobalt	1980	0.7	2.2
	81	2.0±0.0	1.0
	82	1.0	4.2±0.0
Copper	1980	6.5	12
	81	10.7±0.6	6.9±0.3
	82	9.4±0.6	15.0±0.0
Lead	1980	2.0	7.0
	81	5.0	6.3±1.2
	82	4.3±0.2	22.3±1.2
Manganese	1980	265	
	81	270±10	177±6
	82	127±6	317±6
Mercury	1980	0.01	0.01
	81	0.02±0.01	0.03±0.01
	82	0.01±0.01	0.11±0.01
Nickel	1980	7.8	
	81	7.9±0.2	5.27±0.15
	82	6.1±0.4	12.0±0.0
Selenium	1980	1.5	
	81	0.93±0.06	0.30
	82	0.17±0.03	0.74±0.04
Zinc	1980	32	49
	81	25±2	40±1
	82	14±1	83±4
Organics (ng/g)			
PCBs, total	1980	-	-
	81	28±28	20
	82	Tr.	58

NOTES: Data Source; Sub-project 29. (MOE) Stations correspond to locations
Concentrations are means and standard deviations in ppm (ug/g) or ppb (ng/g) (dry weight, with the
exception of wet weight for PCBs) of 3 replicates (1981 and 1982). In 1980, results are average of duplicate analyses of a composite sample.
Tr. = Trace (calculated mean concentration below detection limit).
A dash (-) indicates no data available.

mouth of Gill Creek (M15) and downstream of Bloody Run Creek (M24), suggesting sources in these areas. Levels at the 102nd Street (M11) and Search and Rescue (M16)sites were intermediate between these and the generally lower concentrations found in this alga from the other river sites (Table C.28).

The highest mean concentrations of mercury in Cladophora were found near the 102nd Street (M.11), and Gill Creek sites (M15). These high concentrations suggest sources at these two sites. Additional sources of mercury are suggested by the elevated levels in Cladophora collected in the Buffalo River (M3), at the east shore opposite Strawberry Island (M7) and downstream of the Pettit Flume (M9), (Table C.28).

Zinc concentrations in Cladophora were highest downstream of the Pettit Flume input to the Tonawanda Channel in the Tonawanda-North Tonawanda segment (M9). Additional inputs of zinc are also indicated by levels in Cladaphora collected in the Buffalo River (M3), at the east shore opposite Strawberry Island (M7) and at the 102nd Street Sites (M11).

Lead concentrations in Cladophora were highest at the mouth of the Buffalo River (M3). Elevated concentrations were also found in Cladophora from the east shore opposite Strawberry Island (M7), downstream of Pettit Flume (M9), the 102nd Street (M11) and the Gill Creek sites (M15), indicating inputs of lead at or just upstream of these locations (Table C.28).

Concentrations of a number of other inorganic contaminants (aluminum, cadmium, chromium, cobalt, copper, manganese, nickel, and selenium were higher in Cladophora from various locations in the river as shown in Tables C.28 and C.29.

Also the fact that concentrations of metals and PCBs in Cladophora are consistently higher on the American side of the lower river and increasing concentrations toward the river mouth are apparent on both sides of the river are suggestive of "local" smaller sources.

C.5.3 Clams

While biomonitoring with clams (*Elliptio complanatus*) was also conducted in 1980, the present discussion will be based on the more recent 1981 study results (Table C.34). However, the 1980 data summary is included (Table C.35), as is a comparison of contaminants levels in clams from the inlet and outlet of the river (Table C.36). In 1981, highest mean PCB levels in clams were found in the Buffalo River (M3), with elevated levels in the Wheatfield-Upper River segment at the Niagara County Refuse Disposal Site drain/Gratwick-Riverside (M10), 102nd Street (M11), Niagara Falls upstream of the "S" Area (M13), and Gill Creek (M15). Trace or non-detectable levels were found in the Fort Erie and Chippawa segments. Levels found in the Lower Niagara River segment were between 44 ng/g and 74 ng/g which are much below the elevated levels found in the upper Niagara River (Table C.34).

The highest mean levels of alpha-BHC occurred at the mouth of Gill Creek (M15) and in the Buffalo River (M3). Levels in the lower Niagara River and remaining upper river sites ranged from non-detected to 3 ng/g (Table C.34).

The highest mean concentrations of alpha-chlordane occurred at the Buffalo River site (M15), Niagara County Refuse Disposal Site Drain/Gratwick-Riverside (M10), 102nd Street site (M11) and the Pettit Flume site (M8). Concentrations at sites in the lower river (trace to 5 ng/g) were intermediate between these high levels and those in Lake Erie and the Chippawa Channel (Table C.34).

The highest levels of DDT and metabolites were found at the Sir Adam Beck Reservoir (M25). This was composed mainly of p,p'-DDD (33 ng/g), with lesser amounts of p,p'-DDE (14 ng/g) and p,p'-DDT (5 ng/g). The second highest level occurred at the Buffalo River mouth site (M3). The high level found in clams in the Sir Adam Beck Reservoir warrants investigation for an active source of the pesticide in the Welland River drainage basin. Concentrations in clams from the remaining sites ranged from not detected to 7 ng/g (Table C.34).

TABLE C.34

ORGANOCHLORINE CONTAMINANTS ACCUMULATED BY CLAMS (*Elliptio complanatus*) EXPOSED TO LAKE ERIE AND NIAGARA RIVER WATERS IN 1981.

(ng/g)

PARAMETER	DETECTION LIMIT	Fort Erie (M1)	Buffalo (M3)	Chippawa (M20)	Tonawanda-N.Tonawanda (M8)	Wheatfield Upper-River (M10)	Wheatfield Upper-River (M11)	Wheatfield Upper-River (M13)	Wheatfield Upper-River (M15)	Lower River (M25)	Lower River (M30)	Lower River (M28)	Lower River (M31)	Lower River (M33)	Lower River (M36)	Lower River (M37)
PCBs, Total	20	Tr.	1284±277	ND	58±21	481±175	212±49	161±37	722±164	ND	63±18	52±11	48±5	44±7	74±28	57±15
alpha-BHC	1	Tr.	5±4	3±3	2±1	Tr.	1±0	3±1	9±1	Tr.	ND	ND	2±1	2±1	Tr.+	Tr.
beta-BHC	1	Tr.	3±5	5±3	4±1	ND	ND	3±1	3±4	ND	ND	1±2	ND	ND	ND	ND
gamma-BHC	1	Tr.	ND	3±1	5±2	Tr.	Tr.	1±2	ND	ND	ND	ND	Tr.	Tr.	3±2	Tr.
alpha-Chlordane	2	Tr.	13±4	ND	9±1	11±7	10±7	2±2	Tr.	ND	4±4	5±2	4±1	3±1	Tr.	2±1
gamma-Chlordane	2	ND	13±7	Tr.	6±3	6±5	9±3	Tr.	Tr.	Tr.	3±3	4±2	Tr.	Tr.	Tr.	Tr.
Dieldrin	2	ND	ND	ND	--	ND	ND	--	ND	ND	2±1	2±2	Tr.	Tr.	ND	Tr.
p,p'-DDD	5	ND	7±7	Tr.	Tr.	7±9	Tr.	ND	ND	33±5	ND	ND	ND	ND	ND	ND
p,p' DDE	1	ND	ND	4±3	3±2	ND	ND	2±1	ND	14±7	2±3	1±3	5±4	3±1	Tr.	4±1
o,p-DDT	5	ND	5±10	ND	Tr.	ND	ND	ND	ND	Tr.	ND	ND	ND	ND	ND	ND
p,p'-DDT	5	Tr.	Tr.	ND	Tr.	ND	5±3	ND	ND	5±5	ND	ND	ND	ND	ND	ND
Endosulphan Sulphate	4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Heptachlor Epoxide	1	2±2	3±3	--	--	5±2	4±0.5	--	3±2	4±0.5	3±3	3±2	3±1	3±2	ND	2±2
Hexachloro-Benzene	1	Tr.	2±1	2±3	14±5	5±1	3±2	3±1	10±8	ND	1±0	2±0.5	2±1	1±0.4	2±2	1±1
Mirex	5	ND	ND	ND	ND	ND	ND	ND	Tr.	ND	Tr.	ND	ND	ND	ND	ND
Octachloro-styrene	1	ND	ND	ND	ND	ND	ND	ND	3±1	ND	Tr.	Tr.	1±0.4	1±0	Tr.	1±0
% Fat	--	0.9±0.2	1.0±0.3	--	--	0.9±0.2	1.0±0.3	--	0.9±0.2	1.3±0.4	1.8±0.6	1.3±0.2	1.3±0.3	1.4±0.1	--	1.1±0.3
Number of Replicates	--	5	4	5	5	5	5	5	5	5	5	5	5	5	5	5

NOTES: Data Source: Sub-project 28 (MOE). Stations correspond to locations in Fig. 4.5.(Chapter IV)
ND = Not detected at detection limit indicated (ND taken as zero for calculations of mean and standard deviation). Concentrations are in ppb (ng/g, wet weight).
Tr. - Trace (Mean is less than detection limit).
Aldrin, Heptachlor, alpha-Endosulphan, beta-Endosulphan, Methoxychlor and Oxychlordane were not detected at detection limits of 1,1,2,4,4 and 2 ng/g, respectively. Endrin values were not quantitative.
Exposure time was 21 days (Aug. 15 - Sept. 8). Clams were kept on bottom.
"--" indicates no data available.

TABLE C.35

ORGANOCHLORINE CONTAMINANTS ACCUMULATED BY CLAMS (*Elliptio complanatus*) EXPOSED TO LAKE ERIE AND NIAGARA RIVER WATERS IN 1980.

(ng/g)

PARAMETER	DETECTION LIMIT	RIVER SEGMENT/SUB-AREA						
		Fort Erie	Buffalo River	Chippawa	Wheatfield-Upper River	Lower River		
		(M1)	(M4)	(M20)	(M13)	(M22)	(M31)	(M36)
PCBs, Total	20	ND	Tr.	23±4	78±8	ND	ND	81±31
alpha-BHC	1	5±1	3±1	5±1	11±3	4±1	Tr.	2±3
beta-BHC	1	ND	ND	ND	ND	ND	ND	ND
gamma-BHC	1	2±0	3±1	2±0	3±2	ND	ND	ND
alpha-Chlordane	1	Tr.	2±3	ND	4±1	ND	ND	ND
gamma-Chlordane	1	ND	2±2	Tr.	3±1	ND	Tr.	2±3
Dieldrin	1	ND	ND	ND	5±8	Tr.	ND	ND
p,p'-DDD	5	ND	ND	Tr.	ND	ND	ND	ND
p,p'-DDE	1	1±0	2±1	5±4	1±0	1±0	3±3	4±5
o,p-DDT	5	ND	ND	ND	ND	ND	ND	6±8
p,p'-DDT	5	ND	ND	ND	ND	ND	ND	ND
Endrin	1	ND	ND	ND	16±14	ND	ND	ND
Heptachlor Epoxide	1	ND	ND	ND	8±7	Tr.	1±2	1±1
Hexachlorobenzene	1	Tr.	ND	ND	4±1	ND	Tr.	Tr.
Mirex	5	ND	ND	ND	ND	ND	ND	ND
%Fat	--	1.3±0.2	1.0±0.3	1.3±0.4	1.5±0.3	0.4±0.1	0.2±0.1	0.4±0.08
Number of Replicates	--	3	3		3	3	3	5

NOTES: Data Source: Sub-project 28 (MOE). Stations correspond to locations in Fig. 4.5.(Chapter IV)

ND = Not detected at detection limit indicated (ND taken as zero for calculations of mean and standard deviation). Concentrations are in ppb (ng/g, wet weight)

TR. = Trace (Mean is less than detection limit).

Aldrin, Dieldrin, Heptachlor, α-Endosulphan, and β-Endosulphan, not detected in clams at detection limits of 1,2,1,2 and 4 ng/g, respectively.

Clams were kept on bottom (approx. 2 m depth).

A dash (--) indicates no data available.

TABLE C.36

CONTAMINANTS CONCENTRATIONS IN CLAMS (*Elliptio complanatus*) EXPOSED TO LAKE ERIE AND LOWER NIAGARA RIVER WATERS IN 1980 and 1981. (ng/g)

PARAMETER	YEAR	RIVER SEGMENT/SUB-AREA: Fort Erie M1		Lower Niagara River M36	
BHC (α, β, γ)	1980	7±	(3)	2±	(5)
	81	Tr.	(5)	3±	(5)
Chlordane (α, γ)	1980	Tr.	(3)	2±3	(5)
	81	Tr.	(5)	Tr.	(5)
Dieldrin	1980	ND	(3)	ND	(5)
	81	ND	(5)	ND	(5)
Total DDT & Metabolites	1980	1±0	(3)	10±	(5)
	81	Tr.	(5)	Tr.	(5)
Endrin	1980	ND	(3)	ND	(5)
	81	-		-	
Heptachlor Epoxide	1980	ND	(3)	1±1	(5)
	81	2±2	(5)	ND	(5)
Hexachlorobenzene	1980	Tr.	(3)	Tr.	(5)
	81	Tr.	(5)	2±2	(5)
Octachlorostyrene	1980	-		-	
	81	ND	(5)	Tr.	(5)
Mirex	1980	ND	(3)	ND	(5)
	81	ND	(5)	ND	(5)
PCBs, total	1980	ND	(3)	81±31	(5)
	81	Tr.	(5)	74±28	(5)

NOTES: Data Source: Sub-project 28. (MOE) Stations correspond to locations in Fig. 4.5.(Chapter IV)
Concentrations are means and standard deviations, ng/g (wet weight), of number of replicates indicated in brackets.
ND = Not detected (assigned a value of zero for calculation of mean).
Tr. = Trace (calculated mean concentration below detection limit).
A dash (-) indicates no data available.

The highest levels of hexachlorobenzene occurred at the Pettit Flume (M8) and Gill Creek (M15). Low levels (1 to 2 ng/g) predominate in the Lower Niagara River sites. The high and elevated levels found along the Tonawanda Channel in the Wheatfield Upper River segment suggest local sources of this contaminant (Table C.34).

Octachlorostyrene was only detected in clams from the mouth of Gill Creek (M15) and sites in the lower river (Table C.34).

Heptachlor epoxide was detected in clams from most locations in the river. However, the highest concentrations were found at the Niagara County Refuse Disposal Site (M10), 102nd Street (M11) and Sir Adam Beck Reservoir (M25) sites.

Concentrations of a number of other organic contaminants are shown in Tables C.34 and C.35 for 1980 and 1981.

C.6 Summary

Data from the ambient sub-projects discussed in Chapter IV and Appendix C are summarized in Table C.37. This Table provides an overview of locations in the Niagara River with numerically higher mean concentrations in the various media than in Lake Erie.

TABLE C.37

SUMMARY OF LOCATIONS IN THE NIAGARA RIVER WHERE MEAN CONTAMINANTS CONCENTRATIONS ARE NUMERICALLY HIGHER THAN IN LAKE ERIE.

SEGMENT/SUB-AREA & MEDIUM	CONTAMINANT	LOCATION	REFERENCE
FORT ERIE SUB-AREA			
Water	-dimethyl disulphide	Bertie Bay WTP (raw water)	Section 4.3.1.3, Table 4.6
Suspended Sediment	-Reference collection site	--	--
Bottom Sediment	-p,p'-DDT	At mouth of Frenchman's Creek	Section C.3.2
Biota			
Alga (*Cladophora*)	-Al,Cr,Co,Cu,Mn,Ni,Pb,Se,Zn,PCBs	At mouth of Frenchman's Creek	Section C.4.2, Table C.28
Clam (*Elliptio*)	-No collection sites in Fort Erie portion of Upper River	--	--
Young Fish (*Notropis*)	-BHCs, Chlordane, ΣDDT, Dieldrin, PCBs	Downstream of Peace Bridge	Section C.4.1, Table C.26, C.27
	-BHCs, Chlordane, ΣDDT, Dieldrin, Heptachlor epoxide, PCBs, 2,3,7,8-TCDD	At mouth of Frenchman's Creek	Section C.4.1, Table C.26, C.27
	-PCP	Higher at Thunder Bay, Ont. site than other L. Erie sites	Section C.4.1, Table C.26, C.27
CHIPPAWA SUB-AREA			
Water	-Al,Cu	Mouth of Black Creek	Section C.2.2
	-Al,Cr	Upstream of Usher's Cr. & Navy Is.	Section C.2.2
	-Zn	Grand Is. shore of Channel	Section C.2.1
	- α-BHC, γ-BHC, α, β-Endosulfan, o,p-DDT, p,p-DDT, Dieldrin, Endrin, Heptachlor epoxide	Middle of Channel, upstream of Navy Is.	Section C.2.2
Suspended Sediment	-As,Se,o,p-DDT,p,p-DDt, Dieldrin, 1,3-DCB, 1,2-DCB 1,3,5-TCB, Endrin, α-Endosulfan, HCB, PeCB	Middle of Channel, upstream of Navy Is.	Section C.2.2
Bottom Sediment	-1,4-DCB	At mouth of Black Creek	Section C.3.6
Biota			
Alga (*Cladophora*)	-Al,Cr,Mn,Ni,Pb,Se,Zn,PCBs	At mouth of Black Creek & opposite Navy Is. downstream of Ussher's Creek	Section C.4.2, Table C.28
Clam (*Elliptio*)	- α, β, γ-BHC, p,p-DDE, HCB	At mainland shore, upstream of Ussher's Cr. and Navy Is.	Section C.4.3, Table C.34
Young Fish (*Notropis*)	-Chlordane, ΣDDT, Dieldrin, HCB, PCBs, PCP, ΣTCB	At mainland shore, upstream of Ussher's Cr.	Section C.4.1, Table C.26, C.27
LAKE ERIE SEGMENT			
Water	-Zn	Mouth of Smoke Creek	Section C.2.2
Suspended Sediment	No collection site	--	--
Bottom Sediment	-Hg,Pb,Ni,Zn,1,2-DCB,1,3-DCB,1,4-DCB, Benzo(a)pyrene, Fluoranthene	at open lake dredged material disposal site	Section C.3.1
	-Benzo(a)pyrene, Fluoranthene	At mouth of Smoke Creek	Section C.3.1
	-Pb,Zn,Benzo(a)pyrene, Fluoranthene	In Union Ship Canal	Section C.3.1
	-Cd,Pb,Zn,Benzo(a)pyrene, Fluoranthene	In Lackawanna Canal	Section C.3.1
Biota			
Alga (*Cladophora*)	No collection sites	--	--
Clam (*Elliptio*)	No collection sites	--	--
Young Fish (*Notropis*)	Collection sites are controls since they are upstream of Smoke Creek	--	--

TABLE C.37 (Continued)

SEGMENT/SUB-AREA & MEDIUM	CONTAMINANT	LOCATION	REFERENCE
BUFFALO RIVER SEGMENT			
Water	-Al, Cu, Hg, Ni, Zn	Downstream of mouth of Buffalo River	Sections C.2.1, C.2.2
Suspended Sediments	-No collection sites	--	--
Bottom Sediment	-Cd, Hg, Pb, Zn, α-BHC, γ-BHC, p,p'-DDT, p,p'-DDE, 1,2-DCB, 1,3-DCB, 1,4-DCB, HCB, α-Endosulfan, Endrin, Benzo(a)pyrene, Fluoranthene	Many of the highest levels occurred near Buffalo Color on the Buffalo River	Section C.3.3
Biota			
Alga (Cladophora)	-Al, Cr, Co, Cu, Hg, Mn, Ni, Pb, Se, Zn, PCBs	in Buffalo River downstream of confluence with Buffalo Ship Canal	Section C.4.2, Table C.28
Clam (Elliptio)	- α, β-BHC. α, γ-Chlordane, p,p-DDD, o,p-DDT, HCB, PCBs	in Buffalo River downstream of confluence with Buffalo Ship Canal	Section C.4.3, Table C.34
Young Fish (Notropis)	-No collection sites	--	--
BLACK ROCK CANAL SEGMENT			
Water	-No collection sites	--	--
Suspended Sediment	-No collection sites	--	--
Bottom Sediment	-Hg, Pb, Zn, p,p'-DDT, p,p'-DDE	In Black Rock Canal	Section C.3.4
	-Cd, Hg, Pb, Ni, Zn, α-BHC, γ-BHC, p,p'-DDE 1,2-DCB, 1,3-DCB, 1,4-DCB, HCB, PCBs	At mouth of Scajaquada Creek	Section C.3.4
Biota			
Alga (Cladophora)	-No collection sites	--	--
Clam (Elliptio)	-No collection sites	--	--
Young Fish (Notropis)	- ΣDDT, Dieldrin, PCBs, 2,4,6-TCP	In Black Rock Canal	Section C.4.1, Table C.26, C.27
	- ΣDDT, Chlordane, Dieldrin, Heptachlor epoxide, HCB OCS, 2,4,6-TCP, PCBs	At Mouth of Scajaquada Creek	Section C.4.1, Table C.26, C.27
BIRD ISLAND - RIVERSIDE SEGMENT			
Water	-Cr, Cu, Ni, Zn	East shore upstream of Strawberry Island, downstream of combined sewer 054	Section C.2.2
Suspended Sediment	-No collection sites	--	--
Bottom Sediment	-Pb, Zn, α-BHC, γ-BHC, p,p'-DDT, p,p'-DDE, PCBs, HCB	At juncture of this segment with Tonawanda - North Tonawanda along east shore opposite Strawberry Island	Section C.3.5
Biota			
Alga (Cladophora)-	-Al, As, Cr, Co, Cu, Cd, Mn, Ni, Pb, Hg, Se, Zn, PCBs	Eastern shore, upstream of Strawberry Island, downstream of combined sewer 054	Section C.4.2, Table C.28
Clam (Elliptio)	No collection sites	--	--
Young Fish (Notropis)	- ΣDDT, Dieldrin, HCB, OCS, PCBs, 2,3,4,6-T CP, ΣTCB, 2,3,7,8-TCDD, PCP	At Cornelius Creek	Section C.4.1, Table C.26, C.27
	-Dieldrin, PCBs, 2,4,6-TCP	Upstream shore of Strawberry Island	Section C.4.1, Table C.26, C.27

TABLE C.37 (Continued)

SEGMENT/SUB-AREA & MEDIUM	CONTAMINANT	LOCATION	REFERENCE
BIRD ISLAND - RIVERSIDE SEGMENT (Cont'd)			
TONAWANDA - NORTH TONAWANDA SEGMENT			
Water	-Al, Pb, Ni, Zn, PCBs	Mouth of Two Mile Creek	Section C.2.2
	-Ni	Downstream of Pettit Flume	Section C.2.2
	-Cr, Zn	Mainland shore, downstream of NCRDD	Section C.2.2
Suspended Sediment	No collection sites	--	--
Bottom Sediment	-Zn, Benzo(a)pyrene, Fluoranthene	At mouth of Two Mile Creek	Section C.3.7
	α -BHC, γ -BHC, Zn, PCBs, Benzo(a)pyrene, Fluoranthene	Vicinity of mouth of Tonawanda Creek and along east side of Tonawanda Island	Section C.3.7
	-Hg, Zn	Just south of border with Wheatfield-Upper River	Section C.3.7
Biota			
Alga (Cladophora)	-Pb, Hg, Zn, Al, Cd, Cr, Co, Cu, Mn, Ni, Se, PCBs	east shore, downstream of North Tonawanda WWTP 001 and Pettit Flume	Section C.4.2, Table C.28
Clam (Elliptio)	-α , β , γ -BHC, α , γ -Chlordane, p,p-DDE, HCB, PCBs	East shore, just downstream of Pettit Flume	Section C.4.3, Table C.34
	-α , γ -Chlordane, p,p'-DDD, HCB, Heptachlor epoxide, PCBs	Mainland shore, downstream of drainage from NCRDD	Section C.4.3, Table C.34
Young Fish (Notropis)	Dieldrin, HCB, PCBs, OCS, 2,4,6-TCP	East shore, opposite Strawberry Island	Section C.4.1, Table C.26, C.27
	-PCBs, 2,3,4,6-TeCP	East shore, at Tonawanda boat launch	Section C.4.1, Table C.26, C.27
	-Dieldrin, HCB, PCBs, 2,4,6-TCP, 2,3,4,6-TeCP	East Shore at South Grand Island Bridge	Section C.4.1, Table C.26, C.27
	2,3,4,6-TeCP, PCP, PCBs, OCs, ΣDDT, Chlordane, -Dieldrin, HCB, Heptachlor epoxide	Mouth of Two Mile Creek	Section C.4.1, Table C.26, C.27
	- ΣDDT, Dieldrin, HCB, PCBs, 2,4,6-TCP	East shore, downstream of Tonawanda Creek	Section C.4.1, Table C.26, C.27
	- ΣDDT, Dieldrin, HCB, HCBD, Mirex, PCBs, PCP, OCS 2,3,5-TCP, 2,4,6-TCP, ΣTCB, 2,3,7,8-TCDD	Pettit Flume	Section C.4.1, Table C.26, C.27
	- ΣDDT, Dieldrin, HCB, OCS, PCBs, 2,4,6-TCP	Gratwick-Riverside Park	Section C.4.1, Table C.26, C.27
WHEATFIELD - UPPER RIVER SEGMENT			
Water	-Al, Cu, Ni	At Griffon Park, downstream of 102nd St. Sites	Section C.2.2
	-Zn, α -BHC, β -BHC, γ -BHC	Mouth of Little River	Section C.2.2
	-Al, Pb, Hg, Zn	Mainland shore downstream of 60th St. sewer	Section C.2.1, C.2.2
	α -BHC, α -Chlordane, p,p'-DDE, p,p'-DDT, - α -Endosulfan, Endrin, Heptachlor epoxide, PCBs	Middle of Tonawanda Channel	Section C.2.2
Suspended Sediment	-As, Hg, Se, p,p'-DDE, p,p'-DDT, 1,4-DCB, α -Endosulfan, Endrin, PCBs	Middle of Tonawanda Channel, at North Grand Island Bridge	Section C.2.2
Bottom Sediment	-Hg, Zn, α -BHC, γ -BHc, p,p'-DDE, 1,2-DCB, 1,3-DCB 1,4-DCB, HCB, Mirex	At west end of Little River behind Cayuga Island	Section C.3.8
Biota			
Alga (Cladophora)	-Pb, Hg, Zn, PCBs, Al, Cr. Co, Mn, Ni, Se, Cu	At Griffon Park, downstream of 102nd St. sites	Section C.4.2, Table C.28
	-Pb, Hg, Zn, PCBs, Al, Cr, Co, Mn, Ni, Se, Cu	At mouth of Gill Creek	Section C.4.2, Table C.28
	-Pb, Hg, Zn, PCBs, Al, Cd, Cr, Mn, Ni, Se	At Search & Rescue Station, just above falls	Section C.4.2, Table C.28

TABLE C.37 (Continued)

SEGMENT/SUB-AREA & MEDIUM	CONTAMINANT	LOCATION	REFERENCE
WHEATFIELD - UPPER RIVER SEGMENT (Cont'd)			
Clam (Elliptio)	- α-BHC, α, γ-Chlordane, p,p'-DDT, HCB, Heptachlor epoxide, PCBs	At Griffon Park, downstream of 102nd St sites	Section C.4.3, Table C.34
	- α, β, γ-BHC, α-Chlordane, p,p-DDE, HCB, PCBs	Mainland shore, downstream of 60th St. sewer	Section C.4.3, Table C.34
	- α, β-BHC, HCB, Heptachlor epoxide, OCS, PCBs	At mouth of Gill Creek	Section C.4.3, Table C.34
Young Fish (Notropis)	- ΣChlordane, PCBs, HCB, ΣTCB, PCP, BHC ΣTeCB, Mirex, 2,3,7,8-TCDD	At Griffon Park, downstream of 102nd St sites	Section C.4.1, Table C.26, C.27
	-BHC, ΣDDT, Dieldrin, Chlordane, Mirex, PCBs, PCP, 2,3,7,8-TCDD	At Little River, downstream of Cayuga Creek	Section C.4.1, Table C.26, C.27
	-BHC, ΣChlordane, Dieldrin, Mirex, PCBs, HCB, HCBD OCS, PCP	At Search & Rescue Station	Section C.4.1, Table C.26, C.27
LOWER RIVER SEGMENT			
Water	- α-BHC, p,p-DDE, p,p-DDT, DMDT, Endrin, α-Endosulfan, Heptachlor epoxide, Mirex, PCBs	In mid-river, at Queenston In mid-river, at NOTL	Section C.2.2 Section C.2.2
	-Al, Cu, Zn, α-BHC, γ-BHC, α-Chlordane, p,p-DDD, p,p-DDT, p,p-DDE, Dieldrin, DMDT, α-Endosulfan, Endrin, Heptachlor epoxide, Mirex, PCBs	In mid-river, at Queenston	Section C.2.2
Suspended Sediment	-As, α-BHC, p,p-DDD, p,p-DDT, Hg, Dieldrin, 1,2-DCB, α-Endosulfan, Mirex, PeCB', HCB, 1,2,3-TCB, 1,2,4-TCB, TeCBs, PCBs	In mid-river, at NOTL	Section C.2.2
	-As, Hg, α-BHC, p,p'-DDT, DMDT, 1,2-DCB, 1,3-DCB, 1,4-DCB α-Endosulfan, HCB, Mirex, PeCB, PCBs, TeCBs, 1,2,3-TCB, 1,2,4-TCB, 1,3,5-TCB		
Bottom Sediment	-Hg, Zn, α-BHC, γ-BHC, p,p-DDT, 1,4-DCB, α-Endosulfan, Heptachlor epoxide, HCB, Mirex, PCBs	Highest concentrations on Ontario side between Queenston and NOTL (in 1979, but not in later surveys)	Section C.3.9
Biota			
Alga (Cladophora)	Pb, Hg, Zn, Al, As, Cd, Cr, Co, Cu, Mn, Ni, Se, PCBs	PCBs much higher at drainage from Bloody Run Creek	Section C.4.2, Table C.28
Clam (Elliptio)	- α, β, γ-BHC, α, γ-Chlordane, p,p'-DDE, Dieldrin, Heptachlor epoxide, HCB, OCS, PCBs, p,p-DDD, p,p-DDT	DDT highest in the Sir Adam Beck Hydro Reservoir	Section C.4.3, Table C.28
Young Fish (Notropis)	-Chlordane, PCBs, TCB, PCP, HCB	Welland River, west side of power canal	Section C.4.3, Table C.34
	-Chlordane, ΣDDT, Heptachlor epoxide, PCBs, Dieldrin	Welland River, east side of power canal	Section C.4.1, Table C.26, C.27
	BHCs, ΣDDT, Dieldrin, Chlordane, Endrin, HCB, HCBD Heptachlor epoxide, HCE, Mirex, PCBs, OCS, PCP, PeCB TCBs, TeCBs, 2,3,7,8-TCDD	Lower River	Section C.4.1, Table C.26, C.27

Explanation of Abbreviations:

Al = Aluminum
Cd = Cadmium
Cr = Chromium
Co = Cobalt
Cu = Copper
As = Arsenic
Pb = Lead
Hg = Mercury
Mn = Manganese
Ni = Nickel
Se = Selenium
Zn = Zinc
DMDT = Methoxychlor
DCB = Dichlorobenzene
TeCB = Tetrachlorobenzene
PeCB = Pentachlorobenzene
HCB - Hexachlorobenzene
BHC = Hexachlorocyclohexane
HCE = Hexachloroethane
HCBD = Hexachlorobutadiene
OCS = Octachlorostyrene
PCP = Pentachlorophenol
TCP = Trichlorophenol
TeCP = Tetrachlorophenol
PCBs = Polychlorinated biphenyls
TCDD = Tetrachlorodibenzo-p-dioxin