MONITORING FOR POLYCHLORINATED BIPHENYLS IN THE AQUATIC ENVIRONMENT

PROGRAMS UNDERWAY IN MICHIGAN WATERS

Report to: Lake Michigan Toxic Substances Committee
May, 1973

MICHIGAN WATER RESOURCES COMMISSION
BUREAU OF WATER MANAGEMENT
DEPARTMENT OF NATURAL RESOURCES
ENVIRONMENTAL PROTECTION BRANCH

DSW 030434

STLCOPCB4014396

Programs Underway

1. State of Michigan

Michigan instituted a monitoring program for polychlorinated biphenyls (PCB's) early in 1971. The initial program consisted of a state-wide water sampling survey for determination of concentrations in inland waters and tributaries to the Great Lakes. Supplementary sampling has since been conducted on stream sediments, municipal raw water intakes, groundwater drinking supplies, sanitary landfill runoffs, municipal wastewater treatment plants, industrial discharges, and fish from both inland and Great Lakes waters. Sampling is being continued on a periodic basis for establishment of trends.

Quarterly water sampling in thirty Michigan tributaries showed that about 60 percent of the samples contained more than 0.01 ppb with one stream, the Saginaw River, having a high concentration of 2.9 ppb (Table 1). Fish from the Saginaw River had PCB concentrations as high as 165 ppm (Table 2). Five Michigan streams had mean concentrations in water samples over 0.10 ppb. These were all located in the populous southeastern lower peninsula which drains into lower Lake Huron, Lake St. Clair and Lake Erie. Of the Lake Michigan streams, the Grand and Kalamazoo rivers consistently showed the highest concentrations with means of 0.041 and 0.065 ppb, respectively.

A study of transport of PCB's to Lake Michigan on suspended solids was conducted during March-May, 1973, on the Grand, Kalamazoo and St. Joseph rivers. Sediment traps were suspended 1-2 meters off the bottom of the rivers and collected at varying time intervals in each river ranging from 3 times weekly to once a month. Concentrations of PCB's were notably higher in the settleable solids from the Kalamazoo River than from the Grand and St. Joseph rivers (Table 3). The over-all mean for all samples were 3.52, 0.99 and 0.97 ppm (oven-dry basis) for the Kalamzoo, Grand and St. Joseph rivers, respectively. This data substantiates earlier results indicating elevated levels of PCB's in the Kalamazoo River watershed. Extensive sampling at upstream sections of the watershed has identified past and

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present wastepaper recycling by paper industries located in the City of Kalamazoo as the major source of contamination to the river. Certain sediment deposits in impoundments on Portage Creek, a tributary to the Kalamazoo River at Kalamazoo, were found to contain PCB's at concentrations exceeding 350 ppm (dry weight basis). Leaching from these PCB enriched sediments appears to be significant. Fish collected immediately downstream from the City of Kalamazoo were found to contain residues of PCB's in their tissue as high as 110 ppm (Hesse and Willson, 1972).

PCB concentrations in drinking water supplies from 45 intakes on the Great Lakes and connecting waters and an additional 20 on inland lakes and streams have generally been less than 0.01 ppb (Tables 4 & 5). Limited sampling of groundwater drinking supplies in southern Michigan has indicated that groundwater has not been significantly contaminated with PCB's.

Analyses of surface water runoff from sanitary and industrial landfills in Michigan suggest that these are a minor source of environmental contamination. Five of the 9 samples collected had PCB concentrations ranging from 0.04 to 0.30 ppb while the others contained less than 0.01 ppb.

Sampling of municipal wastewater treatment plant (WWTP) effluents throughout Michigan in 1971 and 1972 indicated that many WWTP's represent major point sources of PCB loss to surface waters of the state (Table 6). The average PCB concentration of 60 effluents sampled was 2.55 ppb. While only seven of the WWTP effluents exceeded 1 ppb, the Bay City WWTP located on the Saginaw River had an average effluent concentration of 120 ppb (high of 340 ppb), skewing the over-all average for all plants sharply upward. The average concentration excluding the Bay City WWTP was 0.56 ppb. Those WWTP's with PCB concentrations in effluents exceeding 1 ppb were, with one exception, located on rivers already identified as having high levels of PCB contamination. Sampling of 58 WWTP effluents in 1973 continues to show high PCB levels with an average concentration of 0.52 ppb (Table 7), including the Bay City plant. The PCB discharge from the

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Bay City WWTP has been greatly reduced as a result of control measures in industries served by the WWTP.

Sampling of sewage sludge from 57 of the 58 WWTP's tested in 1973 showed Bay City to have the highest concentration of PCB's in the sludge being removed by the treatment process. The PCB concentration in the sludge from the Bay City plant was 352 ppm (dry weight basis) compared to a state-wide average of 15.6 ppm (Table 8).

In an attempt to identify major contributors of PCB's within municipal WWTP systems, sampling at key points in the interceptor systems has been conducted within the municipalities of Bay City, Mt. Clemens, Saginaw, Adrian, Detroit and Kalamazoo. This program has been very successful. The City of Detroit has, in fact, established an on-going sampling program within their interceptor system with analytical assistance from the State. They are applying a new City of Detroit sewer ordinance which limits discharges within the wastewater system to a maximum of 0.1 ppb.

A broad scale sampling of industrial discharges throughout Michigan has shown results indicative of the widespread usage of PCB's. Nearly half of the industrial discharges sampled have contained more than 0.1 ppb with many in excess of 1 ppb. The highest concentration detected in an industrial discharge in Michigan has been 7,200 ppb. Automotive plants, chemical companies, and paper product manufacturers are among the types of industries with highest concentrations. Also industries and building complexes; including some schools and hospitals, with heat transfer systems appear to be another major source. Industries identified as sources of PCB pollution have been encouraged to changeover to replacement compounds or to clean up their operation so that discharges of PCB's do not exceed the present Michigan guideline of 0.1 parts per billion.

Michigan is currently trying to get a handle on losses from electrical transformers in leakage, servicing, and replacement within plants. It appears that many of the small transformer maintenance companies are still dumping PCB's down the drain rather than returning them for incineration.

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An example of one location in Michigan where monitoring and subsequent control measures have resulted in a marked reduction in PCB contamination is the Saginaw River basin. Even though it is not within the Lake Michigan watershed, the Saginaw River PCB situation is worthy of review. Monitoring of major Great Lakes tributaries during 1971-1972 identified the Saginaw River as having the highest concentrations of PCB's of any tributary within Michigan boundaries. Intensive sampling throughout the river basin in search of point sources successfully isolated ten major points of PCB discharge to the river system. Each of the industrial sources were asked to identify the cause of their losses and to take corrective action. Control measures, in most cases, conversion to non-PCB containing products, have proved very effective toward lowering the PCB concentrations in the Saginaw River. A sharp PCB decline at a monitoring site near the river mouth was observed (Table 9) in October, 1972, and concentrations have remained low since that date. It is hoped that a corresponding decline in PCB concentrations in fish from the river and Saginaw Bay will soon be observed.

In 1972 Michigan developed a cooperative State-Federal study of contaminant levels in Great Lakes fish species including lake trout, salmon, whitefish, chubs, menominee, yellow perch, alewife, carp, and suckers. Fish from Lakes Michigan, Huron, Erie, and Superior are systematically being sampled on an annual basis to obtain information on areas where contaminants approach or exceed FDA guidelines for consumer protection. The project, developed by the State agencies in cooperation with the U. S. Food and Drug Administration and the Bureau of Sport Fisheries and Wildlife Great Lake Laboratory, will establish patterns of residues of mercury, PCB's, DDT and dieldrin in Great Lakes fish. Table 10 shows the concentrations of PCB's detected in fish from Lake Michigan during the first year of this study. PCB's in Salmonids (lake trout, steelhead, coho salmon, and chinook salmon) and chubs were shown to exceed the FDA guideline of 5.0 ppm while concentrations in other species did not exceed this guideline.

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Table 1. Mean PCB Concentrations in Michigan Tributaries to the Great Lakes in 1971-72.

Lake Basin	River	PCB's (ppb as 1254)	Range (ppb as 1254)
Michigan	St. Joseph	0.013	<0.010-0.039
	Kalamazoo	0.065	0.019-0.097
	Grand	0.041	0.011-0.080
	Muskegon	0.010	<0.010-0.037
	Manistee	0.014	<0.010-0.039
	Boardman	0.017	<0.010-0.044
	Elk	0.012	<0.010-0.039
Huron	Saginaw	1.100	0.450-2.900
	Cass[1]	0.014	<0.010-0.048
	Flint[1]	0.078	0.010-0.150
	Shiawassee[1]	0.029	<0.010-0.073
	Tittabawassee[1]	0.140	<0.022-0.230
	Au Sable	<0.010	<0.010-0.010
	Thunder Bay	0.023	<0.010-0.037
	Cheboygan	0.032	<0.010-0.053
St. Clair	Clinton	0.150	<0.039-0.430
	Black	0.043	<0.010-0.110
	St. Clair	0.010	<0.010-0.029
Erie	Raisin	0.210	<0.068-0.500
	Huron	0.012	<0.010-0.039
	Rouge[2]	0.470	0.058-1.600
	Detroit	0.020	<0.010-0.053

[1] Tributary to Saginaw River
[2] Tributary to Detroit River downstream from Detroit River sampling station

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... polychlorinated biphenyls (PCB's) in fish from Saginaw River, December 7, 1971. (ppm; wet weight).

Species	Location	Length	Percent fat	PCB's based upon 1242 standard
Perch	Karn-Weadock Discharge Channel	9.0	1.3	16.3
Carp	" " " "	21.0	0.9	8.8
Catfish	" " " "	8.0	7.0	37.1
Catfish	" " " "	7.5	4.9	47.9
Carp	U.S. Coast Guard Station	23.0	---	48.0
Carp	" " " "	24.0	10.5	20.4
Carp	" " " "	20.0	6.5	15.5
Carp	" " " "	24.0	5.9	45.8
Carp	" " " "	21.0	4.6	30.2
Pike	" " " "	27.0	1.6	16.6
Pike	" " " "	23.0	1.1	6.9
Gizzard Shad	" " " "	14.0	17.5	165.3
Gizzard Shad*	" " " "	6.0	15.3	32.5
Gizzard Shad*	" " " "	4.5	15.0	161.9
Gizzard Shad*	" " " "	5.0	17.0	77.0
Gizzard Shad*	Zilwaukee Bridge	4.5	15.7	24.1
Gizzard Shad*	" "	5.0	9.6	52.0
Gizzard Shad*	" "	5.0	8.7	10.4

* Concentration based upon analysis of whole fish. All others based upon edible portion only.

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Table 3. Concentrations of PCB's (polychlorinated biphenyls) in the settleable solids collected from the mouths of the Grand, Kalamazoo, and St. Joseph Rivers; Spring 1973, for comparison of variable sampling periods. Concentrations in ppm on an oven-dry basis.

River	Sample Type [a]	Sample Dates 3/21	3/23	3/30	4/2	4/4	4/6	4/9	4/11	4/13	4/20	4/27	4/30	5/2	5/4	5/11
Grand	3X	3.24			1.6*	0.95	1.0	<0.1	0.93	1.58			0.83	3.5	0.53	
	Weekly		1.25	0.94			1.1			1.00	0.55	0.74			0.80	0.77
	Biweekly			0.85						0.73		0.50				0.60
	Monthly									1.41						0.50
															Mean	=
Kalamazoo	3X	6.7	27.5		2.08	<0.1	2.62	1.33	3.20	<0.1			3.11	3.50	3.75	
	Weekly		6.83	3.0			3.54			3.77	3.09	2.98			2.88	4.87
	Biweekly			3.77						2.54		2.64				2.50
	Monthly									2.11						3.14
															Mean	=
St. Joseph	3X								2.13	0.68		0.95	0.63	0.82		
	Weekly									0.85		0.75		0.83	1.21	
	Biweekly											0.67			0.95	
	Monthly														0.83	
															Mean	=

[a] 3X = Sample collected Mon, Wed. and Friday

* Concentration based upon a 1:1 ratio of Aroclor 1242 and 1254. All other concentrations calculated as Aroclor 1242.

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Table 4. PCB concentrations in interstate water intake samples, Spring 1971.

Location	Collection Date	PCB's as Aroclor 1254 (ppb)
St. Clair River		
Port Huron	3-11-71	< 0.010
Marysville	3-11-71	< 0.010
St. Clair	3-11-71	< 0.010
E. China Twp.	5-17-71	< 0.010
Marine City	3-11-71	< 0.010
Algonac	4-21-71	0.028
Lake St. Clair		
Fairhaven	5-17-71	< 0.010
New Baltimore	4-21-71	< 0.010
Mt. Clemens	4-21-71	< 0.010
Grosse Pte. Farms	4-21-71	< 0.010
Detroit River		
Detroit-E. Jefferson Ave.	4-21-71	< 0.010
Wyandotte	2-9-71	< 0.010
Detroit-Allen Park	2-9-71	< 0.010
Lake Erie		
Monroe	2-9-71	< 0.010
Lake Superior		
White Pine Mine	4-28-71	< 0.010
Eagle Harbor	5-26-71	< 0.010
Copper Harbor	5-26-71	< 0.010
Gay	5-26-71	< 0.010
Baraga	4-28-71	< 0.010
L'Anse	4-28-71	< 0.010
Marquette	4-28-71	< 0.010
Munising	4-28-71	< 0.010
Sault Ste. Marie	5-27-71	< 0.010
Lake Huron		
St. Ignace	2-25-71	< 0.010
Alpena	4-8-71	< 0.010
East Tawas	3-3-71	< 0.010
Saginaw-Midland	3-3-71	0.011
Pinconning	3-3-71	< 0.010
Bay City	4-8-71	< 0.010
Lake Michigan		
South Haven	3-9-71	< 0.010
Holland	4-14-71	< 0.010
Grand Rapids	4-14-71	< 0.010
Muskegon	3-9-71	< 0.010

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Table 4. Continued.

Location	Collection Date	PCB's as Aroclor 1254 (ppb)
Ludington	3-9-71	<0.010
Traverse City	3-2-71	<0.010
Escanaba	2-25-71	0.177
Gladstone	2-25-71	<0.010
Menominee	3-23-71	<0.010
Bridgeman	4-14-71	<0.010

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Table 5. Continued.

Location	Collection Date	PCB's as Aroclor 1254 (ppb)
Saginaw-Midland	6-20-72	< 0.010
Pinconning	6-20-72	< 0.010
Bay City	6-20-72	0.046*
Port Hope	6-20-72	< 0.010
Harbor Beach	6-20-72	< 0.010
Chippewa River		
Mt. Pleasant	6-21-72	< 0.010
Pine River		
Alma	5-19-72	0.027

*PCB's as Aroclor 1242

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Table 5. PCB concentrations in Michigan water intake samples, 1972.

Location	Collection Date	PCB's as Aroclor 1254 (ppb)
St. Clair River		
Port Huron	5-16-72	<0.010
Marysville	5-16-72	<0.010
St. Clair	5-16-72	<0.010
E. China Twp.	5-22-72	0.032
Marine City	5-16-72	<0.010
Algonac	5-16-72	0.019
Lake St. Clair		
Fairhaven	5-16-72	<0.010
New Baltimore	5-16-72	<0.010
Mt. Clemens	5-16-72	<0.010
Grosse Pte Farms	5-16-72	<0.010
Detroit River		
Detroit-E. Jefferson Ave.	5-16-72	<0.010
Wyandotte	5-15-72	<0.010
Detroit-Allen Park	5-16-72	<0.010
Lake Erie		
Monroe	5-15-72	<0.010
Huron River		
Ann Arbor	5-15-72	<0.010
Flat Rock	5-15-72	<0.010
Ypsilanti	5-15-72	<0.010
River Raisin		
Adrian	5-15-72	<0.010
Blissfield	5-15-72	<0.010
Deerfield	5-15-72	<0.010
Dundee	5-15-72	0.013
Lake Michigan		
Bridgeman	5-23-72	<0.010
St. Joseph	5-18-72	<0.010
Benton Harbor	5-18-72	<0.010
South Haven	5-18-72	<0.010
Holland	5-18-72	<0.010
Grand Rapids	5-18-72	<0.010
Muskegon	5-18-72	<0.010
Ludington	5-19-72	<0.010
Northport Point	6-21-72	<0.010
Traverse City	6-21-72	<0.010
Escanaba	8-28-72	<0.010
Gladstone	8-28-72	<0.010
Menominee	8-28-72	<0.010

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Table 5, Continued

Location	Collection Date	PCB's as Aroclor 1254 (ppb)
Lake Michigan (Cont.)		
Grand Rapids	5-18-72	<0.010
Rogue River		
Rockford	5-18-72	<0.010
Muskegon River		
Big Rapids	5-19-72	<0.010
Elk Lake		
Elk Rapids	6-21-72	<0.010
Indian River		
Manistique	8-28-72	<0.010
Lake Antione		
Iron Mountain	8-29-72	<0.010
Lake Fumee		
Norway	8-29-72	<0.010
Lake Superior		
White Pine Mine	8-29-72	<0.010
Eagle Harbor	8-30-72	<0.010
Copper Harbor	8-30-72	<0.010
Gay	8-30-72	<0.010
Baraga	8-30-72	<0.010
L'Anse	8-30-72	<0.010
Marquette	11-24-72	<0.010
Munising	8-31-72	<0.010
Sault Ste. Marie	8-31-72	<0.010
Black River		
Ramsey	8-29-72	<0.010
Lake Sally		
Ishpeming	8-30-72	<0.010
Teal Lake		
Negaunee	8-30-72	<0.010
Lake Huron		
Mackinaw Island	8-31-72	<0.010
St. Ignace	9-1-72	<0.010
St. Ignace	12-14-72	<0.010
Alpena	6-21-72	<0.010
East Tawas	6-20-72	<0.010

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Table 6 Polychlorinated Biphenyls (PCB's) in Effluents of Municipal Wastewater Treatment Plants throughout Michigan 1971-1972. Unless specified, all samples are 8 hr. composites.

CITY	DATE	PCB's as Aroclor 1254 (ppb)	Mean Conc. (ppb)
Adrian	3-30-72	1.80	4.60
	6-13-72	14.00	
	6-14-72	6.90	
	9-6-72	0.41	
Albion	3-28-72	0.44	0.44
Ann Arbor	10-14-71	0.14	0.12
	3-30-72	<0.10	
Battle Creek	10-5-71	0.39	0.39
	3-28-72	0.16	
	2-21-72	0.92	
	6-6-72	0.28	
	6-7-72	0.21	
Bay City	11-4-71	340.00	120.00
	11-22-71	210.00	
	11-23-71	60.00	
	3-2-72[a]	290.00	
	4-4-72	19.00	
	6-13-72	11.00	
	6-14-72	25.00	
	9-14-72	5.70*	
Benton Harbor - St. Joseph	10-28-71	0.99	0.65
	4-4-72	0.31	
Brighton	10-5-71	0.38	0.38
Charlotte	7-20-72	0.61	0.61
Constantine	4-4-71	0.85	0.85
Detroit	10-14-71	2.20	1.95
	12-20-72[c]	3.00	
	1-20-72	0.92	
	3-9-72	2.40	
	4-17-72[b]	1.80	
	6-1-72	0.88	
	10-19-72	2.50**	
Dexter	10-14-71	<0.10	0.10

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Table 6
Page Two

CITY	DATE	PCB's Aroclor 1254 (ppb)	Mean Conc. (ppb)
E. Lansing	11-15-71	0.69	0.51
	4-3-71	0.35	
Escanaba	12-16-71	0.29	0.29
Essexville	11-4-71	0.21	0.24
	3-31-72	0.28	
Flint	10-5-71	1.30	0.68
	3-31-72	0.92	
	6-7-72	0.47	
	6-8-72	0.30	
	10-5-72	< 0.10	
Flushing	10-5-72	0.52	0.52
Gladstone	7-21-72	0.19	0.19
Grand Haven	4-4-72	< 0.50	<0.50
Grand Rapids	11-15-71	0.37	0.52
	3-30-72	0.68	
Holland	10-20-71	0.79	0.60
	3-29-72	0.42	
Houghton-Hancock	3-21-72	< 0.10	0.10
Iron Mountain-Kingsford	3-21-72	0.55	0.87
	4-4-72	1.20	
Ironwood	3-20-72	0.16	0.16
Jackson	11-16-71	<0.10	<0.10
	2-21-72	<0.10	
	3-28-72	<0.10	
Kalamazoo	10-5-71	1.30	0.66
	3-28-72	0.83	
	6-6-72	0.48	
	6-7-72	0.53	
	12-6-72	0.19[e]	
L'Anse	4-21-72	<0.10	<0.10
Lansing	10-7-71	0.23	0.18
	4-4-72	0.13	

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CITY	DATE	PCB/s Aroclor 1254 (ppb)	Mean Conc. (ppb)
Manistique	12-15-72	<0.20	<0.20
Marquette	12-14-71	0.35	0.35
Marshall	3-28-72	<0.10	<0.10
Menominee	12-15-71	0.35	0.35
Midland	2-2-72	0.29	0.23
	3-31-72	0.40	
	4-14-72	0.13	
	[d]10-2-72	0.13	
Milford	10-14-71	<0.10	<0.10
Monroe	11-15-71	0.60	0.46
	3-30-72	0.33	
Mt. Clemens	11-15-71	1.40	5.21
	3-30-72	2.90	
	6-7-72[c]	4.50	
	6-8-72[c]	3.10	
	7-26-72	9.40	
	8-2-72	10.00	
t. Pleasant	3-31-72	<0.10	<0.10
Muskegon	11-15-71[c]	0.28	0.28
Muskegon Heights	11-15-71[c]	0.37	0.37
Niles	4-4-72	0.68	0.68
Norway	4-5-72	0.40	0.40
Ontonagon	4-21-72	<0.10	<0.10
Owosso	9-14-72	<0.10	<0.10
Parchment	4-20-72	<0.10	<0.10
Pontiac (Auburn Rd.)	11-17-71	<0.10	0.35
	3-30-72	0.61	
Pontiac (E. Blvd.)	11-17-71	0.20	0.45
	3-30-72	1.30	
	6-6-72	0.15	
	6-7-72	0.16	
Portage	11-15-71[d]	1.90	1.90

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CITY	DATE	PCB's as Aroclor 1254 (ppb)	Mean Conc. (ppb)
Port Huron	11-15-71	0.28	0.40
	3-30-72	0.52	
Saginaw	10-6-71	1.10	1.80
	3-31-72	3.80	
	6-7-72	2.00	
	6-8-72	1.50	
	10-4-72[d]	0.74	
St. Ignace	12-15-72	<0.20	<0.20
South Haven	4-4-72	<0.10	<0.10
Swartz Creek	10-5-72	<0.10	<0.10
Three Rivers	4-4-72	<0.30	<0.30
Trenton	11-16-71	0.14	0.53
	3-30-72	1.10	
	6-6-72	0.47	
	6-7-72	0.91[e]	
Warren	11-15-71	0.16	0.13
	3-30-72	0.10	
Wayne County (Wyandotte)	11-16-71	0.64	0.40
	3-30-72	0.17	
White Pine	4-21-72	0.2	0.20
Wyoming	11-30-72[c]	0.44	0.49
	3-30-72	0.55	
Ypsilanti	11-16-71	0.22	0.21
	4-2-72	0.21	
Ypsilanti Twp #1	11-16-71	0.12	0.11
	4-2-72	<0.10	
Ypsilanti Twp #2	11-16-71	0.19	0.17
	4-2-72	0.16	

*Aroclor 1242 Standard
**Aroclor 1242 and 1254 in 1:1 ratio

[a]6 hr [b]10 hr [c]24 hr [d]Grab [e]hexane lost GRAND MEAN 2.55

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Table 7. Concentrations of PCB's in the Final Effluent from Wastewater Treatment Plants throughout Michigan, Spring, 1973. Concentrations in parts per billion dry weight.

CITY	DATE	PCB's		
		1242	1254	1242:1254
Adrian	3/7			0.26
Albion	2/22		0.34	
Ann Arbor	3/1		0.25	
Bay City	3/1	3.20		
Battle Creek	2/28		<0.10	
Benton Harbor-St. Joseph	2/28		0.20	
Brighton	3/1			0.33
Cadillac	3/28		0.53	
Charlotte	5/1		0.34	
Constantine	2/28		0.46	
Detroit	2/28	2.15		
Dexter	3/1		0.23	
East Lansing	5/2		0.18	
Escanaba	3/28			0.28
Essexville	3/1		0.10	
Flint	2/22		<0.10	
Gladstone	3/28		0.44	
Grand Haven	2/21		<0.10	
Grand Rapids	2/21		1.05	
Holland	2/21		<0.10	
Houghton-Hancock	3/27		0.18	
Iron Mountain-Kingsford	3/28		0.69	
Ironwood	3/27			0.29
Jackson	2/22		<0.1	
Kalamazoo	2/29			1.12
L'Anse	3/27			0.31
Lansing	4/18		0.22	
Manistique	3/28		0.63	
Marquette	3/27		0.29	
Marshall	2/22		0.15	
Menominee	2/28		0.57	
Midland	3/1		<0.10	
Milford	3/8			2.20
Monroe	5/4		<0.10	
Mt. Clemens	3/8			2.90
Mt. Pleasant	3/28		0.29	
Muskegon	2/28		0.88	
Muskegon Heights	2/28		0.18	
Niles	2/20		0.48	
Norway	3/28		<0.10	
Owosso	2/21		0.12	
Pontiac (Auburn)	3/12			0.60
Pontiac (E. Blvd.)	3/12			0.54
Port Huron	3/8			1.80
Saginaw	3/1			0.77
Sault Ste. Marie	3/28		0.73	

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Table
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CITY	DATE	PCB's 1242	1254	1242:1254
St. Ignace	3/28		0.31	
Three Rivers	2/21		<0.10	
Traverse City	3/7		<0.10	
Trenton	2/28		<0.10	
Warren	2/27		<0.10	
Wayne County	2/28		0.40	
Wyoming	2/21		0.22	
Ypsilanti	2/28			0.31
Ypsilanti Twp #1	3/1		<0.10	
Ypsilanti Twp #2	3/1		<0.10	

*Concentrations based on best fit of 3 standards: Aroclor 1242, Aroclor 1254, or a mixture of Aroclor 1242 and 1254 in a 1:1 ratio.

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Table 8. Concentrations of PCB's in the sludge from fifty-seven municipal wastewater treatment plants in Michigan, Spring 1973. Concentrations in parts per million, dry weight.

City	Date	PCB's* 1242	1254	1242:1254
Adrian	3/ 7			24.0
Albion	2/22		1.5	
Ann Arbor	3/1		1.1	
Bay City	3/1	352.0		
Battle Creek	2/28		2.8	
Benton Harbor-St. Joseph	2/28		13.8	
Brighton	3/1		<0.1	
Cadillac	3/28		<0.1	
Charlotte	5/1		6.8	
Constantine	2/28		2.1	
Detroit	2/28	32.1		
Dexter	3/1		3.2	
E. Lansing	5/2		4.6	
Escanaba	3/28		5.9	
Essexville	3/1		3.9	
Flint	2/22		6.3	
Gladstone	3/28		4.1	
Grand Haven	2/21		4.1	
Grand Rapids	2/21		11.8	
Holland	2/21		0.8	
Howell	4/26		15.0	
Houghton-Hancock	3/27		5.5	

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Table 8. Continued.

City	Date	PCB's 1242	PCB's 1254	1242:1254
Iron Mountain - Kingsford	3/28		9.5	
Ironwood	3/27		5.2	
Jackson	2/22		3.0	
Kalamazoo	2/29	23.3		
L'Anse	3/27		4.4	
Lansing	4/18		5.3	
Manistique	3/28		1.5	
Marquette	3/27		2.8	
Marshall	2/22		3.9	
Menominee	2/28		4.2	
Midland	3/1		2.9	
Milford	3/8			50.5
Monroe	5/4		3.3	
Mt. Clemens	3/8	175.0		
Mt. Pleasant	3/28		6.5	
Muskegon	2/28		12.7	
Muskegon Heights	2/28		11.0	
Niles	2/20		7.8	
Norway	3/28		<0.1	
Owosso	2/21		2.0	
Pontiac (Auburn)	3/12			12.1
Pontiac (E. Blvd.)	3/12			9.2
Port Huron	3/8			9.2

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Table 8. Continued.

City	Date	PCB's 1242	1254	1242:1254
Saginaw	3/1		5.0	
Sault Ste. Marie	3/28		2.4	
St. Ignace	3/28		1.5	
Three Rivers	2/21		4.1	
Traverse City	3/7		1.8	
Trenton	3/28		<0.1	
Warren	2/27		<0.1	
Wayne County	2/28	2.0		
Wyoming	2/21		0.58	
Ypsilanti	2/28		2.0	
Ypsilanti Twp. #1	3/1		<0.1	
Ypsilanti Twp #2	3/1		<0.1	

* Concentration based on best fit of 3 standards: Aroclor 1242, Aroclor 1254, or a mixture of Aroclor 1242 and 1254 in a 1:1 ratio.

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Table 9. Polychlorinated biphenyls (PCB's) in composite water samples from the Saginaw River at Bay Harbor Marina, March 1971 - May 1973.

Collection Date	Concentration in parts per billion
3-9-71	0.450
6-10-71	0.560
8-27-71	2.900
10-26-71	1.100
6-8-72	0.640
10-13-72	0.360
10-29-72	<0.020
10-30-72	<0.020
11-1-72	0.091
11-2-72	0.031
11-4-72	<0.020
11-6-72	0.022
1-26-73	<0.100
5-24-73	0.210

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Table 10. Concentrations of polychlorinated biphenyls (PCB's) found in fish species taken from Michigan waters of Lake Michigan during 1972*.

Species	PCB's by District**in ppm (sample size in parenthesis) MM3	MM4	MM5	MM6	MM7	MM8	Total # Fish Sampled	Mean Concentration
Alewife	1.7 (3)			2.3 (1)	2.7 (6)	2.7 (6)	16	2.4 ± 0.6
Carp					3.9 (6)		6	3.9 ± 2.0
Chub				3.2 (2)	8.5 (8)	6.5 (9)	19	7.0 ± 4.2
Chinominee				0.8 (1)	1.2 (2)		3	1.1
Perch				0.5 (1)	0.4 (5)	0.5 (11)	17	0.4 ± 0.4
Coho Salmon			11.2 (3)				3	11.2
Chinook Salmon				12.4 (10)			10	12.4 ± 5.0
Suckers	0.8 (6)			0.7 (2)	1.5 (3)	1.1 (6)	17	1.0 ± 0.7
Steelhead			6.0 (2)				2	6.0
Lake Trout	11.1 (3)	6.4 (3)		3.2 (2)	5.7 (6)	9.2 (6)	20	7.4 ± 4.0
Whitefish		0.6 (3)		0.8 (2)	1.1 (1)		6	0.7 ± 0.3

* Data from Michigan's Great Lakes Environmental Contaminant Survey, 1972.
Zones of Lake Michigan within Michigan Boundaries
MM3 - Northern Basin
MM4 - Grand Traverse Bay
MM5 & MM6 - Central Basin
MM7 & MM8 - Southern Basin

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References Cited

Hesse, J. L and Ronald Willson, 1972. Evaluation of the Aquatic Environment of the Kalamazoo River Watershed, Part A: Biological Survey, June-August, 1971. Michigan Water Resources Commission Report.

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