The Presence of Toxic Substances in the Ohio River

An Assessment of the Results of Stream Monitoring from 1976 to 1985 on the Ohio River and certain Major Tributaries

TOXIC SUBSTANCES CONTROL PROGRAM
Ohio River Valley Water Sanitation Commission
Cincinnati, Ohio

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*as of November 1, 1987

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September 1987

EXECUTIVE SUMMARY

Objectives and Scope

The presence of toxic substances in the Ohio River is a matter of considerable concern due to the concentration of industry along the river and its tributaries as well as the transportation of numerous materials on the river, together with the use of the Ohio as a source of public water supply. The Ohio River Valley Water Sanitation Commission operates several monitoring systems through which the presence of certain toxic substances in the water is measured. Monthly samples are collected at representative locations and analyzed for numerous parameters including ten heavy metals, total phenolics and cyanide, all of which are included in the list of "priority pollutants" utilized by the U.S. Environmental Protection Agency. The Commission's Organics Detection System involves daily sampling at 13 locations for 16 volatile organic compounds, of which 13 appear on the priority pollutants list. Four locations are equipped to detect additional compounds including three more of the priority pollutants. Periodic samples from the Organics Detection System sites were analyzed for 46 Base/Neutral compounds from the priority pollutants list for three years. Samples of fish tissue are collected biennially and analyzed for certain pesticides and PCB's.

This report is the first effort by the Commission to present results from all of its monitoring systems in order to provide an overall assessment of the presence of toxic substances in the Ohio River. The objectives of the report are to:

- summarize all Commission data on toxic substances
- identify those toxic substances which exceed established criteria
- identify portions of the river where criteria for toxics are exceeded most frequently, and
- provide the basis for needed additional analysis.

This report is the first product of the Commission's Toxics Control Program. Subsequent steps in that program include the collection of all available data on potential sources, rigorous analyses of available stream data, and collection of any additional data needed to identify specific sources of toxic substances in the river. These efforts are designed to result in a coordinated control program by the Commission and the appropriate state and federal regulatory agencies to protect the river from the adverse impact of toxic substances.

Occurrence of Toxic Substances

The various monitoring programs have different sampling frequencies and station locations which must be considered in comparing results. On the basis of percent detections, the toxic substances from the priority pollutants list which were found most frequently at Ohio River locations from 1976 through 1985 were:

Zinc	(93% of monthly samples)
Copper	(92% of monthly samples)
Chloroform	(73% of daily samples)
Lead	(65% of monthly samples)
Phenolics	(60% of monthly samples)
Nickel	(54% of monthly samples)
Chromium	(50% of monthly samples)

After chloroform, the most frequently detected organic compounds from the daily samples were tetrachloroethylene, 1,1,1-trichloroethane, and methylene chloride, all of which were found in approximately 30 percent of the samples analyzed.

Parameters included in the analysis of fish tissue have varied somewhat from year to year. Those for which the most data are available are polychlorinated biphenyls (PCB), the pesticides chlordane and dichlorodiphenyl ethylene (DDE), the base/neutral organic compound hexachlorobenzene, and the heavy metal mercury. All of these substances have been found at some level in all or most of the fish analyzed from 1979 through 1985.

Criteria Exceedance

Four types of stream criteria have been established for toxic substances:

Commission Stream Criteria - As contained in the Commission's Pollution Control Standards. These levels are essentially identical to those included in the states' water quality standards. They include maximum levels for metals, phenolics, and cyanide adopted to protect the beneficial uses of the river.

Human Health - Criteria developed by U.S. EPA to protect against long term impacts on human health through ingestion of drinking water and fish.

Cancer Risk - Criteria developed by U.S. EPA through the use of exposure models which assume a zero threshold of risk. Concentrations which may result in an incremental lifetime cancer risk over one in 100,000 (10^{-5}), one in one million (10^{-6}), and one in ten million (10^{-7}) have been established.

Aquatic Life - Criteria established by U.S. EPA to protect against acute and chronic effects on aquatic life. Many of these criteria have been established for a specific form of a substance, whereas the stream data are for the total recoverable form.

In general, the chronic aquatic life criteria are the most stringent for metals while the 10^{-7} cancer risk level criteria are the most stringent for organic chemicals. For all Ohio River samples, the most frequently exceeded criteria have been:

Chloroform	(10^{-7} Cancer Risk Level)
Lead	(Chronic Aquatic Life)
Copper	(Chronic Aquatic Life)
Mercury	(Chronic-Prevention of Bioaccumulation in Fish)
Nickel	(Human Health)
Zinc	(Chronic Aquatic Life)
Tetrachloroethylene	(10^{-7} Cancer Risk Level)
Methylene Chloride	(10^{-7} Cancer Risk Level)

Analyses of fish tissue indicate frequent exceedances of levels established by

the U.S. FDA for human consumption of fish in catfish fillets for PCB (3 percent of fillets analyzed) and chlordane (22 percent of fillets analyzed) Analyses of carp fillets, however, show considerably lower concentrations. The FDA criterion for mercury has not been exceeded in any of the fish analyzed in the Commission studies. Catfish and carp have been chosen for analyses due to characteristics which make them likely to have high concentrations of substances which bioaccumulate. Analyses of more desirable sport and commercial fish species are not available.

Stream data have also been compared to Maximum Contaminant Levels (MCL's for finished drinking water established by U.S. EPA pursuant to the Safe Drinking Water Act. This comparison is tentative at best since the fate of each substance through water treatment processes will vary. Exceedances of MCL's for arsenic, cadmium, chromium, copper, lead, mercury, selenium, silver zinc, benzene 1,2-dichloroethane, 1,1-dichloroethylene, carbon tetrachloride trichloroethylene, and 1,1,1-trichloroethane have been rare. Only the cadmium and lead MCL's have been exceeded in more than one percent of the samples from any drinking water intake, and both of those metals should be readily removed through the treatment process. An MCL of 100 ug/l has been established for total trihalomethanes. The Commission monitors the four compounds from that group which are most likely to be present in the river. The data indicate that the combined concentration of those four compounds is normally less than 10 ug/l at Ohio River intakes.

Results by River Segment

In order to facilitate determination of areas for further study, the river was divided into ten segments, based primarily on Organics Detection System sites. The data were then reviewed from four perspectives:

Criteria Exceedance - The segment or segments where a specific criterion was exceeded most frequently.

Frequent Detections - The segment or segments where a specific substance was detected most frequently.

Increase from Upstream Location - The segment where the frequency of detection of a substance showed the greatest increase from one location to the next downstream monitoring location

Increasing Trend - Segments where a substance has been detected in a significant number of samples and appears to be increasing over time.

Toxic substances identified in each of the four categories for each of the ten Ohio River segments are listed in Table S1. The substances listed will be addressed in follow-up studies of each segment.

TABLE SI: SUMMARY OF RESULTS BY RIVER SEGMENT

SEGMENT	DECRIPTION	CRITERIA EXCEEDANCE	FREQUENT DETECTIONS	INCREASE FROM UPSTREAM LOCATION	INCREA
1	Point to Beaver River (MP 0.0-25.4	Cyanide Lead Nickel PCB Benzene 1,1-Dichloroethylene Tetrachloroethylene TrichloroFluoromethane	Phenolics Chlorobenzene Trichloroethylene		Mercur
2	to New Cumberland Dam (MP 25.4-54.4)	Chromium Cyanide Lead Nickel Phenolics Zinc 1,1-Dichloroethylene PCB			Copper Mercury
3	to Wheeling (MP 54.4-86.8)	Arsenic Copper Cyanide Lead Nickel Benzene Phenolics Chloroform PCB Chlordane	Zinc Tetrachloroethylene 1,1,1-Trichloroethane Trichloroethylene	Chlorobenzene 1,2-Dichloropropane	Dibromo
4	to Belleville Dam (MP 86.8-203.9)	Cadmium Cyanide Lead Nickel Zinc Chloroform Methylene Chloride Chlordane	Mercury Hexachlorobenzene		Tetrachl
5	to Big Sandy River (MP 203.9-317.1)	Arsenic Copper Lead Bromodichloromethene Carbon Tetrachloride Chloroform Dibromochloromethane Tetrachloroethylene	Chromium Trichloroethylene		
6	to Scioto River (MP 317.1-356.5)	Arsenic Lead Bromodichloromethane Chloroform Dibromochloromethane Tetrachloroethylene	Copper		1,2 Dich 1,2 Dich
7	to Little Miami River (MP 356.5-464.1)	Arsenic Copper Lead Chloroform Methylene Chloride			Mercury
8	to McAlpine Dame (MP 464.1-605.0)	Copper Mercury Phenolics	1,1,1-Trichloroethane	Trichlorofluoromethane	Methylen
9	to Evansville (MP 605.0-791.5)	Cadmium Lead Mercury Bromodichloromethene Chloroform	PCB Chlordane	Copper Zinc	Phenolics Chlorober
10	to Mississippi River (MP 791.5-981.0)	Lead	Mercury	Zinc	Cadmium

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Fish Tissue Analysis - Ohio River Tributaries 1978-1985

BACKGROUND AND OBJECTIVES

The presence of toxic substances in the environment has been a subject of increasing public concern in the United States for the past two decades. Much of the concern has been generated by specific incidents or problems involving a single chemical and environmental medium. Examples include mercury in fish, ozone in the air, DDT in food, and chlorinated hydrocarbons in water. One of the challenges to the regulatory agencies established to protect the environment has been responding to specific public concerns while maintaining a perspective on the total spectrum of environmental problems.

While the term "toxic substances" may be relatively new in water pollution control, the concern is not. Treatment and disinfection of water supplies, and later of wastewater, was initiated for the purpose of eliminating the waterborne transmission of disease. In the first half of the twentieth century, the concern was more with the overall effects of untreated wastes than with specific chemicals. Surrogate parameters such as suspended solids, biochemical oxygen demand, and coliform bacteria were measured to express the degree of water pollution present. Concern with the effects of individual chemicals was first indicated by the establishment of drinking water standards, which set limits on concentrations of certain metals, pesticides, and radionuclides to protect human health. In the 1970's, much of the emphasis in limiting specific chemicals in water was on protection of aquatic life from lethal effects.

As the glaring problems of waterborne disease transmission and lethality to aquatic life have been solved, attention has turned to the more subtle, long term effects of certain chemicals on aquatic life and human health. The earlier problems, such as outbreaks of typhoid fever or fish kills, were much more noticeable and their causes -- untreated wastes and water supplies -- were more readily corrected. The problems being addressed today involve development

of diseases such as cancer through long-term ingestion of chemicals in drinking water and fish, or long-term adverse effects on fish growth and reproduction. Whereas the earlier problems were with substances at concentrations of milligrams per liter (parts per million), present concerns are with chemicals at concentrations in micrograms per liter (parts per billion) or less. The sources of these smaller amounts of chemicals are equally obscure.

The Ohio River Valley Water Sanitation Commission has long been active in developing water quality monitoring programs for the Ohio River in response to the needs and concerns of the member states. Early efforts included compilation and dissemination of data collected by water utilities, establishment of electronic monitoring for certain parameters, and cooperative sampling programs with federal agencies. In 1975, the Commission established a manual sampling program on the Ohio River and its major tributaries which included analyses for physical and chemical parameters such as solids, nutrients, metals, and certain organic compounds. The Commission also established a program of cooperative fish surveys involving several state and federal agencies; in 1976, analyses of fish tissue for certain pesticides and polychlorinated biphenyls (PCB's) began. In 1978, in response to growing public concern with organic chemicals in the Ohio River, the Commission established the Organics Detection System. This system involves daily analyses for certain volatile organic compounds at key utilities on the Ohio and certain tributaries. The combined results from all of these efforts have produced a substantial data base on toxic substances in the Ohio River.

The purpose of this report is to present the results of all of the Commission's monitoring programs in order to provide an overall perspective on the presence of toxic substances in the Ohio River. It is recognized that each program has inherent limitations in terms of monitoring frequency as well as geographic and parametric coverage. Because of differences in sampling frequency, comparisons of results from different programs are difficult. This report is therefore intended as a general overall assessment to

- summarize all Commission data on toxics
- identify those toxic substances which exceed established criteria
- identify portions of the river where criteria are exceeded most frequently, and
- provide the basis for additional analysis.

Stream criteria utilized in this report include values developed for the protection of human health and aquatic life. While certain aquatic life criteria are frequently exceeded in the river, no impacts on resident species are readily apparent. The Ohio supports a well balanced aquatic community, and the population of desirable fish species has generally increased over the past 20 years. (These findings are summarized in the March 1983 Commission publication Fishes of the Ohio River: A Testimony to Clean Water). The reason for the apparent lack of effect is the conservative nature of the criteria and their application in this and other assessments. In most cases, specific forms of the substances (ie, hexavalent chromium, free cyanide, methyl mercury) are the most toxic, but the available stream data, as well as most adopted stream criteria, are for the total concentration.

The human health protection criteria utilized in this assessment were designed to prevent long term impacts which would not be evident until several years after initial exposure. The criteria are based on very conservative assumptions such as the translation of effects on laboratory animals to those on humans. In most cases, data on the presence of toxic substances are only available for the past ten years or less, while the calculated effects would take place over an assumed lifetime of 70 years.

There is a widespread perception of the Ohio River as a severely polluted water body containing a "witch's brew" of toxic chemicals. This is due in large part to the concentration of industry along the river as well as the turbidity of the water caused by the sediment load it carries. Results of the Commission's monitoring programs show that the river is considerably cleaner than perceived. This is confirmed by the presence of pollution-sensitive fish and other aquatic life. Except for short segments below certain major wastewater discharges, stream criteria for contact recreation, source of public water supply (prior to reasonable treatment) and maintenance of aquatic life

are regularly met throughout the river. The concerns addressed in this report are with possible long term subtle effects on the health of the population consuming treated water and fish from the Ohio River.

PARAMETERS AND MONITORING

The Ohio River Valley Water Sanitation Commission adopted a Toxic Substances Control Strategy for the Ohio River Valley Compact District in May 1983. That strategy contains the following definition:

Toxic Substance - A substance which, when acting individually or in combination with other substances, might reasonably be expected to cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions including malfunctions in reproduction, or physical deformations in fish, other aquatic life, wildlife, or humans.

The strategy does not contain a specific list of toxic substances to be addressed; it does, however, recognize existing lists and ongoing efforts to evaluate the effects of the many chemicals in use (estimated at over 55,000).

For the purposes of this report, the list established by the U. S. Environmental Protection Agency which is commonly referred to as the "Priority Pollutants" was used as the starting point for identifying toxic substances. That list (see Table 1) includes ten of the thirteen heavy metals, as well as most of the volatile organic compounds, which are routinely measured in the Commission's monitoring programs. The Priority Pollutants include 125 chemicals which can be divided into five analytical groups. Those groups are presented below with descriptions of the Commission's monitoring programs for each.

Inorganics - A total of 15 such chemicals are included on the priority pollutants list of which 11 are measured regularly in the Commission's manual monitoring program. That program was established in 1975 and through 1985, covered 38 locations -- 24 on the Ohio River and 14 on major tributaries.

Initially, samples were collected three times per month and analyzed for physical parameters, nutrients, phenolics and cyanide. Analyses for metals were performed on one sample per month. In 1978, the sampling frequency was changed to once per month. For certain metals which were rarely detected, quarterly analyses were initiated. At the present time, analyses are performed on the following schedule:

Monthly	Quarterly
Cadmium	Arsenic
Copper	Chromium
Lead	Nickel
Mercury	Selenium
Zinc	Silver
Cyanide (Total)	
Phenolics (Total)	

All analyses for metals measure the total recoverable form.

GC/MS Fraction -- Acid Compounds - The Priority Pollutants list includes 11 chemicals under this category, all of which are phenolic compounds. The Commission does not monitor specific phenolic compounds at this time; several of these compounds are included in the total phenolics measurement, which is included in the analyses of the monthly samples.

GC/MS Fraction -- Volatile Compounds - A total of 28 volatile organic compounds are included on the Priority Pollutants list. Daily analyses for 14 of those compounds are performed at each of the 13 sites of the Commission's Organics Detection System (ODS) which was established in 1978. Eleven of the sites utilize Coulson Conductivity Detectors (CCD)'s which can detect 16 compounds at a level of 0.1 ug/l. Since 1984, two of the sites have utilized Flame Ionization Detectors (FID's) which can detect purgeable organic compounds at the 1.0 ug/l level. Earlier data from these sites, when CCD's were employed, are included in this report. Four of the sites utilize Photo Ionization Detectors (PID's) in addition to the CCD's. At these sites, daily analyses are performed

for three additional volatile organic compounds. Volatile organic compounds from Priority Pollutants which are measured at ODS sites are:

CCD's	PID's
Bromodichloromethane	Benzene
Bromoform	Ethylbenzene
Carbon Tetrachloride	Toluene
Chlorobenzene	
Chloroform	
Dibromochloromethane	
1,1-Dichloroethane	
1,2-Dichloroethane	
1,1-Dichloroethylene	
1,2-Dichloroethylene	
1,2-Dichloropropane	
Methylene Chloride	
Tetrachloroethylene	
1,1,1-Trichloroethane	
Trichloroethylene	

Bromochloromethane and Trichlorofluoromethane, which are not priority pollutants, are also measured daily at the ODS sites.

GC/MS Fraction -- Base/Neutral Compounds - The Priority Pollutants list specifies 46 Base/Neutral compounds including Nitrosamines, Phthalate esters, and Polynuclear Aromatic Hydrocarbons (PAH's). From March 1982 through June 1985, samples from each ODS site were analyzed for these compounds, initially on a monthly basis and later quarterly. Monthly analyses were performed from March 1982 through June 1983. Only one compound was detected -- Bis(2-Ethyl Benzyl)Phthalate, which was detected once at each of two locations. Quarterly analyses from September 1983 through June 1985 yielded single detections of four compounds -- 1,2-Dichlorobenzene, 1,3-Dichlorobenzene, Benzo(a)Anthracene, and Chrysene.

The three Dichlorobenzenes (1,2-, 1,3-, and 1,4-) are monitored daily at the four ODS sites equipped with PID's. One compound from this portion of the list -- Hexachlorobenzene -- is monitored in fish flesh.

GC/MS Fraction -- Pesticides and PCB's - The priority pollutant list includes 25 compounds under this category. Sampling in the late 1970's by the U.S. Geological Survey under the NASQAN program and in cooperation with the Commission yielded few measurable concentrations of these chemicals in the water column. The Commission's emphasis in monitoring pesticides and PCB has therefore been on the analysis of fish tissue. Fish are collected through lock chamber studies, which are cooperative efforts involving several state and federal agencies with coordination by the Commission. Analyses of edible fillets have been performed by the U.S. Food and Drug Administration while whole fish analyses have been performed by the U. S. Fish and Wildlife Service and U.S. EPA. Fish studies are performed every other year under the Commission auspices; additional data are usually collected by individual states in the "off" years.

Catfish and carp have been the primary species selected for tissue analyses. The former is a principal species sought after for consumption and is found throughout the Ohio River Valley. The catfish is an omnivorous feeder. The carp is also frequently taken by the angler due to its wide distribution and abundance. Carp are bottom feeders, preferring sluggish waters where contaminants often settle out of the water column.

Analyses for several chemicals have been conducted on fish tissue at times. The pesticides chlordane and dichlorodiphenyl ethylene (DDE), total PCB's, Hexachlorobenzene, and mercury have been measured most frequently; results for those substances are summarized in this report.

Sampling locations for the Commission's manual sampling, Organics Detection System, and fish collection programs are listed in Table 2.

TABLE 1
PRIORITY POLLUTANTS

INORGANICS

Antimony
Asbestus
Arsenic
Cadmium
Chromium
Copper
Cyanide
Lead
Mercury
Nickel
Selenium
Silver
Thallium
Zinc
Cyanide

GC/MS FRACTION - VOLATILE COMPOUNOS

Acrolein
Acrylonitrile
Benzene
Bromoform
Carbon tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane
2-Chloroethyl vinyl either
Chloroform
Dichlorobromomethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethylene
1,2-Dichloropropane
1,2/1,3-Dichloropropylene
Ethylbenzene
Methyl bromide
Methyl chloride
Methylene chloride
1,12,2-Tetrachloroethane
Tetrachloroethylene
(Perchloroethylene)
Toluene
1,2-trans-Dichloroethylene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethylene
Vinyl chloride (Chloroethene)

GS/MS FRACTION - BASE/NEUTRAL COMPOUNOS

Acenaphthene
Acenaphthylene
Anthracene
Benzidine
Benzo(a)anthracene
Benzo(a)pyrene
3,4-Benzofluoroanthene
(Benzo(b)perylene)
Benzo(ghi)perylene
Benzo(k)fluoroanthene
Bis(2-Chloroethoxy) methane
Bis(2-Chloroethyl) ether
Bis(2-Chloroisoprpyl) ether
Bis(2-Ethylehexyl) phthalate
4-Bromophenyl phenyl ether
Butylbenzyl phthalate
2-Chloronaphthalene
4-Chlorophenyl phenyl ether
Chrysene
Dibenzo)a,h)anthracene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
3,3'-Dichlorobenzidine
Diethyl phthalate
Dimethyl phthalate
Di-N-butyl phthalate
2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-N-octyl phthalate
1,2-Diphenylhydrazine
Fluoranthene
Fluorene
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Ideno(1,2,3-cd)pyrene
Isophorone
Naphthalene
Nitrobenzene
N-Nitrosodimethylamine
N-Nitrosodi-N-propylamine
N-Nitrosodiphenylamine
Phenanthrene
Pyrene
1,2,4-Trichlorobenzene

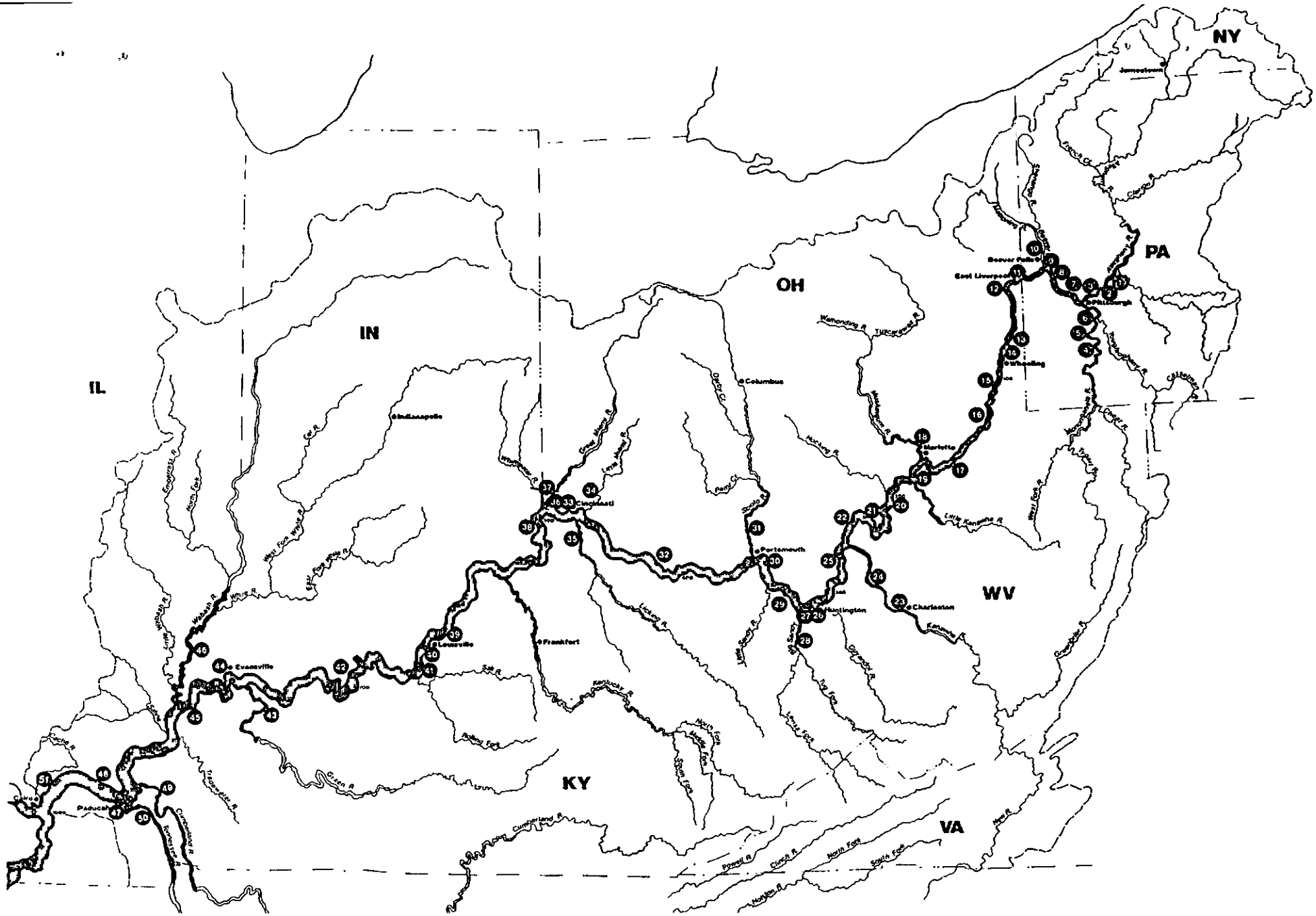
GC/MS FRACTION - PESTICIDES AND PCB'S

Aldrin
alpha-BHC
beta-BHC
gamma-BHC (Lindane)
delta-BHC
Chlordane
4,4'-DDT
4,4'DDE
4,4-DDD
Dieldrin
alpha-Endolsulfan
beta-Endosulfan
Endrin
Endrin aldehyde
Heptachlor
Heptachlor epoxide
PCB-1242
PCB-1254
PCB-1221
PCB-1232
PCB-1248
PCB-1260
PCB-1016
Toxaphene
2,3,7-TCDD (Dioxin)

GC/MS FRACTION - ACID COMPOUNDS

2-Chlorophenol
2,4-Dichlorophenol
2,4-Dimethylphenol
4,6-Dinitro-o-cresol
2,4-Dinitrophenol
2-Nitrophenol
4-Nitrophenol
Parachlorometacresol
(3-Methyl-4-chlorophenol)
Pentachlorophenol
Phenol
2,4,6-Trichlorophenol

Substances monitored in Commission programs are underlined.


NY
PA
OH
IN
IL
WV
KY
VA
Columbus
Indianapolis
Cincinnati
Louisville
Frankfort
Portsmouth
Huntington
Charleston
Evansville
Paducah
Ohio R.
Wabash R.
White R.
West Fork White R.
East Fork White R.
Kentucky R.
Licking R.
Scioto R.
Big Sandy R.
Guyandotte R.
Kanawha R.
Little Kanawha R.
Muskingum R.
Hocking R.
Monongahela R.
Youghiogheny R.
Allegheny R.
Beaver R.
Shenango R.
Mahoning R.
Tuscarawas R.
Little Miami R.
Great Miami R.
Whitewater R.
Deer Cr.
Paint Cr.
Salt R.
Green R.
Barren R.
Rough R.
Nolin R.
Tradewater R.
Cumberland R.
Tennessee R.
Clinch R.
Powell R.
Holston R.
North Fork
South Fork
Middle Fork
Little Fork
Elk R.
Gauley R.
New R.

11a

TABLE 2
COMMISSION MONITORING NETWORK[a]
STATION LOCATION AND TYPE

Station Number	Location	River	Mile-Point	Station Type
1	Lock #3	Allegheny	14.5	Fish
2	Oakmont, PA	Allegheny	13.3	Manual
3	Pittsburgh Dept. of Water	Allegheny	7.4	*ODS
4	West Penn Water, Aldrick Plt.	Monongahela	24.5	ODS
5	Lock #2	Monongahela	11.2	Fish
6	S. Pittsburgh Water Works	Monongahela	4.5	Manual
7	West View Water Authority	Ohio	4.5	ODS
8	Dashields Lock & Dam	Ohio	13.3	Fish
9	South Heights, PA	Ohio	15.2	Manual
10	Beaver Falls, PA	Beaver	5.3	Manual & Fish
11	East Liverpool, OH	Ohio	40.2	Manual
12	New Cumberland L&D	Dhio	54.4	Fish
13	Pike Island L&D	Ohio	84.2	Manual & Fish
14	Wheeling Water Dept.	Ohio	86.B	ODS
15	Shadyside, OH	Ohio	102.4	Manual
16	Hannibal L&D	Ohio	126.4	Manual & Fish
17	Willow Island L&D	Ohio	161.8	Manual & Fish
18	Lock & Dam #2	Muskingum	5.8	Manual
19	Parkersburg, WV	Ohio	190.3	ODS
20	Belleville L&D	Ohio	203.9	Manual & Fish
21	Racine L&D	Ohio	238.0	Fish
22	Addison, OH	Ohio	260.0	Manual
23	St. Albans, WV	Kanawha	38.3	ODS
24	Winfield L&D	Kanawha	31.1	Manual
25	Gallipolis L&D	Ohio	279.2	Manual & Fish
26	Huntington Water	Ohio	306.9	Manual
27	Kenova, WV	Ohio	315.8	Manual
2B	Louisa, KY	Big Sandy	20.3	Manual & Fish
29	Greenup L&D	Ohio	341.0	Manual & Fish
30	Portsmouth, OH Water Works	Ohio	350.1	ODS
31	Lucasville, OH	Scioto	15.0	Manual
32	Meldahl L&D	Ohio	436.2	Manual
33	Cincinnati Water Works	Ohio	462.8	Manual
34	Near Cincinnati, OH	Little Miami	7.5	Manual
35	Covington, KY	Licking	4.5	Manual & Fish
36	North Bend, OH	Ohio	490.0	Manual
37	Elizabethtown Bridge, OH	Great Miami	5.5	Manual
38	Markland L&D	Ohio	531.5	Manual
39	Louisville Water Co.	Ohio	600.6	Manual, ODS
40	McAlpine L&D	Ohio	606.8	Fish
41	West Point	Ohio	625.9	Manual & Fish
42	Cannelton L&D	Ohio	720.7	Manual
43	Near Sebree, KY	Green	41.3	Manual & Fish
44	Evansville Water Works	Ohio	791.5	Manual, ODS
45	Uniontown L&D	Ohio	846.0	Manual & Fish
46	New Harmony, IN	Wabash	51.5	Manual
47	Paducah Water Works	Ohio	935.5	Manual, ODS
48	Smithland L&D	Ohio	918.5	Manual
49	Near Grand Rivers, KY	Cumberland	30.6	Manual
50	At Rt. 60, KY	Tennessee	6.0	Manual & Fish
51	Joppa, IL	Ohio	952.3	Manual

a - Monitoring Network as of December, 1985
*ODS = Organics Detection System

CRITERIA

Stream criteria which specify maximum allowable concentrations to protect the beneficial uses of a waterbody have been developed for each of the toxic substances monitored by the Commission. Numerical values for stream criteria adopted by the Commission, as well as those recommended by the US Environmental Protection Agency, for each substance are shown in Table 3. Also shown for comparative purposes are Maximum Contaminant Levels for treated drinking water proposed by US EPA in November, 1986. The latter levels do not apply to river water, since the fate of the substances in drinking water treatment processes varies. The types of stream criteria are:

Commission Stream Criteria - The Commission's Pollution Control Standards for Discharges to the Ohio River, adopted in 1984, contain designated water uses, stream criteria to protect those uses, and standards of treatment necessary to attain the stream criteria. Stream criteria include those established to protect aquatic life, public water supply, and contact recreational uses. For each parameter the most stringent criterion accepted by the Commission's member states was adopted.

Aquatic Life - U.S. EPA has developed criteria to protect against acute (lethal) and chronic (long term) effects on aquatic life. The most recent aquatic life criteria have been developed for acid soluble metals, whereas previous criteria and most monitoring data are for total metals concentrations.

Human Health - Criteria have been developed by U.S. EPA for many of the priority pollutants to protect against long term impacts on human health through ingestion of drinking water and fish.

Cancer Risk - Concentrations which may result in an incremental increase of cancer risk over the lifetime of one in 100,000 (10^{-5}), one in one million (10^{-6}), and one in ten million (10^{-7}) have been developed by U.S. EPA through the use of exposure models which assume a zero threshold of risk. No

definitive guidance on the use of these criteria has been issued. Several approaches are under consideration by the states involving different risk levels. All three risk levels are therefore used in this report.

Also shown in Table 3 for comparison purposes are Maximum Contaminant Levels for finished drinking water which have been promulgated by US EPA in accordance with the Safe Drinking Water Act. Maximum Contaminant Levels (MCL's) are enforceable standards for public drinking water supplies. US EPA has also published Recommended MCL's for several substances which are goals for finished drinking water. In Table 3, MCL's are shown for 12 substances and RMCL's are shown for four. For arsenic, 1,1-dichloroethylene, and 1,1,1-Trichloroethane, the MCL's and RMCL's are identical. The MCL's for cadmium, chromium, lead, and zinc are the same as the human health criteria. For benzene 1,2-dichloroethane, carbon tetrachloride, and trichloroethylene, the RMCL's are zero. An MCL of 100 ug/l for total trihalomethanes has been adopted. Four trihalomethanes are monitored by the Commission - bromodichloromethane, bromoform, chloroform, and dibromochloromethane.

In addition to the stream criteria, the US Food and Drug Administration has established criteria for levels of certain substances in fish and shellfish to protect against long term effects from their consumption. Those criteria were developed for use in the inspection of fish intended for the market place, but are often used as guidance values in the assessment of fish populations. For substances measured in fish tissue in the Commission's studies, US FDA limits are:

PCB	-	2.0 mg/kg
Chlordane	-	0.3 mg/kg
Mercury	-	1.0 mg/kg

TABLE 3

CRITERIA FOR TOXIC SUBSTANCES

Concentrations in micrograms per liter unless otherwise specified

	Stream Criteria from Commission Standards	Aquatic Life		Human Health	Cancer Risk			Max. Contaminant Levels for Water
		Chronic	Acute		10^{-5}	10^{-6}	10^{-7}	
Manual Sampling System Parameters								
Arsenic	50	-	-	50	22 ng	2.2 ng	.22 ng	50
Cadmium	10	1.1 (h)	3.9 (h)	10	-	-	-	10
Chromium	50 (c)	11 (c)	16 (c)	50	-	-	-	50 (c)
Copper	22 (h)	12 (h)	18 (h)	-	-	-	-	1000 (s)
Cyanide	25	5.2 (f)	22 (f)	200	-	-	-	-
Lead	50 (d)	3.2 (h)	82 (h)	50	-	-	-	50
Mercury	0.2	0.12	2.4	.144	-	-	-	2
Nickel	-	96 (h)	1800 (h)	13.4	-	-	-	-
Phenolics	10	5 (t)	-	(i)	-	-	-	-
Selenium	10	35	260	10	-	-	-	10
Silver	50	-	4.1	50	-	-	-	50
Zinc	55 (h)	47	320 (h)	5000	-	-	-	5000 (s)
Organics Detection System Parameters								
Benzene	-	-	5330	-	6.6	.66	.066	5
Bromochloromethane	-	-	-	-	1.9	.19	.019	-
Bromodichloromethane	-	-	11,000	-	1.9	.19	.019	-
Bromoform	-	-	11,000	-	1.9	.19	.019	-
Carbon Tetrachloride	-	-	35,200	-	4.0	.40	.04	5
Chlorobenzene	-	-	250	488	-	-	-	-
Chloroform	-	-	-	-	1.9	.19	.019	-
Dibromochloromethane	-	-	-	-	1.9	.19	.019	-
1,2-Dichloroethane	-	20,000	118,000	-	9.4	.94	.094	5
1,1-Dichloroethylene	-	-	11,600	-	.33	.033	.003	7
1,2-Dichloropropane	-	5,700	23,000	-	-	-	-	-
Methylene Chloride	-	-	11,000	-	1.9	.19	.019	-
Tetrachloroethylene	-	840	5,280	-	8.0	.80	.08	-
1,1,1-Trichloroethane	-	-	18,000	18,400	-	-	-	200
Trichloroethylene	-	21,900	49,000	-	27.0	2.7	.27	5
Trichlorofluoromethane	-	-	-	-	1.9	.19	.019	-

(a) U.S.EPA has estimated the risk of specified concentration of certain chemicals causing one additional cancer per 100,000 (10^{-5}), 1,000,000 (10^{-6}), and 10,000,000 (10^{-7}) population.
(c) Criterion for hexavalent form.
(d) Criterion for dissolved form.
(f) Criterion for free cyanide.
(h) Criteria vary with hardness; value shown is for a hardness of 100 mg/l.
(i) U.S.EPA has recommended criteria for specific phenolic compounds rather than total phenolics.
(s) Secondary Maximum Contaminant Levels.
(t) Criterion recommended to prevent tainting of fish flesh.

OVERALL RESULTS

Incidence of Toxic Substances

Detections of individual toxic substances in Ohio River samples for the period of record are summarized in Table 4. The most frequently detected substances have been the metals copper and zinc (both detected in over 90 percent of the monthly samples analyzed), followed by the organic compound chloroform (detected in over 70 percent of the daily samples analyzed). Other substances detected in over half of the samples analyzed have been the metals lead, nickel, and chromium as well as total phenolics. Of the organic compounds measured through the Organics Detection System, the most frequently detected after chloroform have been tetrachloroethylene and 1,1,1-trichloroethane, both found in about one third of the samples analyzed.

The detection level for the Organic Detection System is 0.1 micrograms per liter (ug/l) for all compounds measured. For the manual sampling parameters, detection levels vary among the parameters. Seven different laboratories have been utilized to provide analyses of the Commission's samples. At the same time, improvements in analytical methodology have taken place which have allowed laboratories to lower their detection limits. As a result, an individual parameter measured in the manual sampling system may have had as many as five different detection levels over the ten years of record. This can have significant impacts on the results. For example, the detection level for arsenic was generally 10 ug/l until 1983, when it was lowered to 1 ug/l. The vast majority of detections of arsenic have occurred since the detection level was lowered.

Criteria Exceedance

The percentage of all Ohio River samples for the period of record which have exceeded each of the criteria presented in the previous section is shown in Table 5. The single criterion exceeded most frequently has been the one in ten million (10^{-7}) cancer risk level criterion for chloroform (over 73 percent

of Ohio River samples), followed by the chronic aquatic life criterion for lead (over 62 percent of Ohio River samples). Both of those criteria are below detection levels, so the actual rates of exceedance could be even higher. In such instances, the figure shown in Table 5 represents the percent detections of the particular substance. Observations concerning each type of criteria follow:

Commission Criteria - The figures in Table 5 indicate that criteria for zinc and copper were exceeded most frequently. Criteria for those metals vary with hardness. Since hardness measurements were not routinely conducted on samples for heavy metals in 1976 through 1978, the results shown for copper and zinc reflect the period from 1979 through 1985. The Commission criteria which were next most frequently exceeded were mercury (15 percent of Ohio River samples) and phenolics (10 percent). The Commission has not adopted specific criteria for any of the volatile organics.

Aquatic Life Criteria - Acute and chronic criteria for cadmium, copper, lead, and nickel, as well as the acute criterion for zinc, are all hardness dependent. As with the Commission criteria for copper and zinc, results shown on Table 5 reflect data from 1979 through 1985 when hardness measurements were available. For most of the parameters measured in the manual sampling system, aquatic life criteria have been developed for a specific form, i.e., hexavalent chromium, free cyanide, acid soluble metals. The available data are for total metals, cyanide, and phenolics. The figures in Table 5 probably overstate the actual problems. For the organic compounds, aquatic life criteria are all at least an order of magnitude higher than the highest levels ever found in the Ohio River.

Human Health - The most frequently exceeded of these criteria were nickel (37 percent of Ohio River samples) and mercury (25 percent). The only other human health criterion which was exceeded in more than one percent of the samples was lead (3.4 percent). Levels of the two volatile organics for which human health criteria have been established (chlorobenzene and 1,1,1-trichloroethane) did not exceed those criteria in any samples.

Cancer Risk Level Criteria - Criteria for arsenic at all three established levels of cancer risk are below laboratory detection levels. The data therefore indicate that those criteria were exceeded in at least 22 percent of the Ohio River samples, which is the percent in which arsenic was detected. For the volatile organics, cancer risk criteria at all three levels were exceeded most frequently for chloroform. The 10^{-5} risk level criterion for chloroform was exceeded in 3.3 percent of the samples; methylene chloride, at 1.5 percent, was the only other compound which exceeded the 10-5 risk level criterion in more than one percent of the Ohio River samples. The same two compounds were the only volatile organics for which the 10^{-6} risk level criteria were exceeded in more than 10 percent of the samples - 32.5 percent for chloroform and 10.5 pecent for methylene chloride. At the 10^{-7} risk level, criteria for all but one compound (trichloroethylene) are below the detection level; results shown at that risk level in Table 5 are therefore percent detections.

TABLE 4

SUMMARY OF DETECTIONS - TOXIC SUBSTANCES
ALL OHIO RIVER SAMPLES - PERIOD OF RECORD

SAMPLES	NUMBER OF SAMPLES	NUMBER OF DETECTIONS	PERCENT DETECTIONS
Manual Sampling System - 1976-1985			
Arsenic	829	185	22.3
Cadmium	2542	1211	47.6
Chromium	1368	659	50.4
Copper	2614	2402	91.9
Cyanide	4024	1189	29.5
Lead	2613	17D6	65.3
Mercury	2574	996	38.7
Nickel	1339	722	53.9
Phenolics	4025	2420	60.1
Selenium	829	61	7.4
Silver	955	66	6.9
Zinc	2616	2441	93.3
Organics Detection System - 1979-1985			
Benzene	2487	265	10.7
Bromochloromethane	14,827	143	1.0
Bromodichloromethane	14,827	1775	12.0
Bromoform	14,827	570	3.8
Carbon Tetrachloride	14,827	866	5.8
Chlorobenzene	14,827	1180	8.0
Chloroform	14,827	10,866	73.3
Dibromochloromethane	14,827	995	6.7
1,1-Dichloroethane	14,827	224	1.5
1,2-Dichloroethane	14,827	697	4.7
1,1-Dichloroethylene	14,827	545	3.7
1,2-Dichloropropane	14,827	539	3.6
Methylene Chloride	14,827	4192	28.3
Tetrachloroethylene	14,827	4839	32.6
1,1,1-Trichloroethane	14,827	4787	32.3
Trichloroethylene	14,827	3437	23.2
Trichlorofluoromethane	14,827	829	5.6

TABLE 5

PERCENT OF OHIO RIVER SAMPLES EXCEEDING SPECIFIED STREAM CRITERIA
PERIOD OF RECORD THROUGH 1985 (1)

Substances Measured in Manual Sampling System	Stream Criteria from Commission Standards	US Environmental Protection Agency Recommended Criteria					
		Aquatic Life		Human Health	Cancer Risk 10^{-5}	Cancer Risk 10^{-6}	Cancer Risk 10^{-7}
		Chronic	Acute				
Arsenic	D	-	-	0	22.3 (2)	22.3 (2)	22.3 (2)
Cadmium	0.9	17.8 (4)	D.6 (4)	0.9	-	-	-
Chromium	D.5 (3)	17.9 (3)	9.4 (3)	0.5 (3)	-	-	-
Copper	22.6	41.7 (4)	27.4 (4)	-	-	-	-
Cyanide	3.D	21.3 (5)	3.0 (5)	0	-	-	-
Lead	3.4 (6)	49.6 (4)	1.0 (4)	3.4	-	-	-
Mercury	15.2	38.7 (2)	0.5	25.3	-	-	-
Nickel	-	0.2 (4)	0 (4)	37.0	-	-	-
Phenolics	9.7	2D.4	-	-	-	-	-
Selenium	0	0	0	0	-	-	-
Silver	0	-	D.3	0	-	-	-
Zinc	18.5	29.9	0.9 (4)	0.4	-	-	-
Substances Measured by Drganics Oetection System							
Benzene	-	-	0	-	0.6	6.5	10.7 (2)
Bromochloromethane	-	-	-	-	0	0.3	1.0 (2)
Bromodichloromethane	-	-	0	-	.07	3.2	12.0 (2)
Bromoform	-	-	0	-	0.2	1.3	3.8 (2)
Carbon Tetrachloride	-	-	D	-	.05	1.2	5.8 (2)
Chlorobenzene	-	-	0	0	-	-	-
Chloroform	-	-	-	-	3.3	32.5	73.3 (2)
Dibromochloromethane	-	-	-	-	0.1	2.6	6.7 (2)
1,2-Dichloroethane	-	0	0	-	0	0.3	4.7 (2)
1,1-Oichloroethylene	-	-	D	-	0.6	3.7 (2)	3.7 (2)
1,2-Dichloropropane	-	0	D	-	-	-	-
Methylene Chloride	-	-	D	-	1.5	10.5	28.3 (2)
Tetrachloroethylene	-	0	D	-	.03	3.9	32.6 (2)
1,1,1-Trichloroethane	-	-	D	0	-	-	-
Trichloroethylene	-	D	D	-	0	.09	4.8
Trichlorofluoromethane	-	-	-	-	0.5	1.8	5.6 (2)

(1) Period of record began in 1976 for manual sampling and in 1979 for Organics Detection System. Individual stations were added to each system at later dates:
(2) Criterion is below detection level for compound; figure shown is percent detections.
(3) Criterion is for hexavalent chromium; results shown reflect comparison of total chromium data to hexavalent chromium criterion.
(4) Hardness dependent criterion; results shown are for 1979 - 1985, when hardness data were collected with metals.
(5) Criterion is for free cyanide; results shown reflect comparison of total cyanide data to free cyanide criterion.
(6) Criterion is for dissolved lead; results shown reflect comparison of total lead data to dissolved lead criterion.

DISCUSSION OF RESULTS

Discussion by Criteria Type

The percent of samples from each Ohio River monitoring location which have exceeded each of the criteria are shown in Tables 5 through 13. Discussion of those results follows.

Commission Stream Criteria (see Table 6) - Of the 11 toxic substances for which the Commission has established stream criteria, eight have been exceeded in Ohio River samples. At two locations, - South Heights (milepoint 15.2) and Pike Island (milepoint 84.2) - all eight criteria have been exceeded on occasion. Locations with the highest rates of exceedance for specific criteria have been

Cadmium - essentially the same rate at Kenova (mp 315.8), Markland (mp 531.5), Smithland (mp 918.5), and Joppa (mp 981.0).

Chromium - Pike Island (mp 84.2) - based on comparison of total chromium data to hexavalent chromium criterion.

Copper - Cincinnati (mp 462.8)

Cyanide - South Heights (mp 15.2) and Pike Island (mp 84.2)

Lead - Pike Island (mp 84.2) and Smithland (mp 918.5) - based on comparison of total lead data to dissolved lead criterion

Mercury - Markland (mp 531.5)

Phenolics - North Bend (mp 490.0)

Zinc - East Liverpool (mp 40.2)

The Commission stream criteria for arsenic, selenium, and silver have not been exceeded in any samples.

Aquatic Life Criteria (see Tables 7 and 8) - Percent of samples exceeding aquatic life criteria at Ohio River locations are shown in Tables 7 (chronic) and 8 (acute). Chronic criteria for cadmium, copper, lead, and nickel are hardness dependent, as are acute criteria for cadmium, copper, lead, and zinc. Only data from 1979 through 1985 included hardness measurements on samples analyzed for metals, so the values in the tables reflect that period. Results for total chromium and cyanide have been compared to criteria for hexavalent chromium and free cyanide; again, the actual rate of criteria exceedance for these substances was probably less than indicated. Laboratory detection levels

for cadmium and lead were lower than the chronic aquatic life criteria for many of the samples analyzed.

The chronic aquatic life criterion for lead was exceeded in over half of the samples analyzed at 12 Ohio River locations. Exceedances were most frequent at East Liverpool (mp 40.2). For the majority of the samples analyzed, the laboratory detection level for lead was higher than the chronic criterion. The acute criterion for lead was exceeded on occasion at 9 of the 23 Ohio River locations; exceedances were most frequent at East Liverpool, Smithland (mp 918.5) and Joppa (mp 952.3) with rates of approximately four percent.

Copper criteria for chronic protection of aquatic life were exceeded in over half of the samples from five locations. Exceedances were most frequent at Louisville (mp 600.6) and Cincinnati (mp 462.8). Acute aquatic life criteria for copper were also exceeded in over half of the samples from Cincinnati.

Chronic criteria for cadmium were exceeded in over 20 percent of the samples analyzed at each location from Pike Island (mp 84.2) downstream to Belleville (mp 203.9) and at Kenova (mp 315.8), West Point (mp 625.9), Cannelton (mp 720.7), and Uniontown (mp 846.0). In 1977 and 1978, samples from locations downstream of Markland were analyzed at a laboratory where the detection level for cadmium was higher than the chronic criterion. The acute criterion for cadmium was exceeded most frequently at Belleville 6.3 percent of samples) and Markland (5.1 percent).

Exceedances of both the chronic and the acute criteria for chromium were most frequent at East Liverpool. The chronic criterion for nickel was exceeded in single samples from six different locations.

The chronic criterion for zinc was exceeded in over half of the samples from East Liverpool and Shadyside (mp 102.4). The acute criterion was exceeded most frequently at Kenova (9.2 percent of the samples analyzed). The acute criterion for silver was exceeded in single samples from six different Ohio River locations.

Both the acute and chronic criteria for cyanide were exceeded most frequently at the most upstream Ohio River locations. Criteria exceedance rates declined at subsequent downstream locations.

The phenolics criterion shown with the chronic aquatic life criteria was developed to prevent tainting of fish flesh. The criterion was exceeded most frequently at North Bend (mp 490.0), followed by Pike Island and East Liverpool.

The mercury criterion shown with the chronic aquatic life criteria was developed to prevent bioaccumulation in fish to unacceptable levels. That criterion is below laboratory detection levels; rates of detection are therefore shown in Table 7. Mercury was detected in 50 percent of the samples analyzed from Markland. At other Ohio river locations, mercury was detected in percentages ranging from 33 to 47 percent of the samples analyzed. At Smithland, which has the shortest period of record, the mercury detection rate was 19 percent. Despite the frequent detections of mercury, the US FDA limit of 1.0 milligram per kilogram of mercury in edible fish tissue has not been exceeded in any catfish or carp fillets from the Ohio River. The acute criterion for mercury was exceeded in two samples from Kenova, and in single samples from eight other locations.

Human Health Criteria (see Table 9) - Criteria for cadmium, chromium, and lead are identical to the Commission Stream criteria. The human health criterion for nickel was exceeded most frequently at South Heights (mp 15.2) and East Liverpool (mp 40.2) while the criterion for mercury was exceeded most frequently at Markland (mp 531.5) and Cannelton (mp 720.7). The zinc criterion was exceeded in one sample from the Ohio River, collected at Greenup (mp 341.0).

Cancer Risk Level Criteria (see Tables 10 - 12) - The one in 100,000 (10^{-5}) Cancer Risk Level Criteria represent the greatest risk of the three criteria levels established by US EPA. Criteria for arsenic at all three risk levels are below the level of detection; the results shown for arsenic in Tables 10-12 are

therefore percent detections, and the actual criteria exceedance levels could well be greater than shown. Detections of arsenic have been highest at Pike Island (mp 84.2) and Greenup (mp 341.0). Among the organics, 10^{-5} risk level criteria for chloroform and methylene chloride have been exceeded most frequently. The most frequent exceedances have been for methylene chloride at Parkersburg (mp 190.3), followed by chloroform at Wheeling (mp 86.8) and Huntington (mp 306.9). The one in one million (10^{-6}) risk level criteria for the same compounds were exceeded in over half of the samples analyzed at those three locations. The 10^{-6} criterion for chloroform was also exceeded in over half of the samples analyzed from Parkersburg and Portsmouth (mp 350.1). Other instances of 10^{-6} CRL criteria exceedance of over 10 percent were:

Bromodichloromethane - Huntington

Chloroform - West View (mp 4.5), East Liverpool (mp 40.2), Cincinnati (mp 462.8), Louisville (mp 600.6), Evansville (mp 791.5)

1,1 Dichloroethylene - West View

Methylene Chloride - West View, Portsmouth, Cincinnati

Tetrachloroethylene - Huntington

The 10^{-6} CRL criterion for 1,1-dichloroethylene is below the laboratory detection level; figures shown in Table 11 are therefore percent detection rates and actual exceedance rates were probably higher. Detection rates for this compound at Huntington (7.1 percent) and Louisville (6.5 percent) could be of concern.

The one in ten million (10^{-7}) CRL criteria for all the compounds analyzed except trichloroethylane are below the laboratory detection limit. Figures shown in Table 9 are therefore percent detections for all other compounds listed. Instances where 10^{-7} CRL criteria were exceeded in more than 10 percent of the samples analyzed, in addition to these identified above, were:

Benzene - Wheeling

Bromodichloromethane - Portsmouth, Evansville

Carbon Tetrachloride - Huntington

Dibromochloromethane - West View, Huntington, Portsmouth

1,2-Dichloroethane - West View, Portsmouth

Methylene Chloride - East Liverpool, Wheeling, Huntington, Louisville, Evansville

Tetrachloroethylene - West View, Wheeling, Parkersburg, Cincinnati, Louisville, Evansville

Trichloroethylene - Huntington

Trichlorofluoromethane - West VIEW

TABLE 6

SUMMARY OF PERCENT EXCEEDANCE - COMMISSION STREAM CRITERIA
OHIO RIVER MAIN STEM - 1976-1985

LOCATION	MILEPOINT	CADMIUM	CHROMIUM	COPPER	CYANIDE	LEAD	MERCURY	PHENOLICS	ZINC
West View	4.5	-	-	-	-	-	-	-	-
South Heights	15.2	1.5	1.6	20.0	10.3	0.9	8.3	12.0	20.0
East Liverpool	40.2	0	1.6	25.9	8.9	1.7	9.4	12.0	48.1
Pike Island	84.2	0.9	4.8	30.9	10.4	7.4	11.8	15.3	25.0
Wheeling	86.8	-	-	-	-	-	-	-	-
Shadyside	102.4	0.9	0	22.5	7.1	1.7	7.7	8.4	27.5
Hannibal	126.4	0	0	23.2	5.6	2.1	17.5	11.0	11.0
Willow Island	161.8	0.9	0	24.7	5.0	5.9	13.6	7.3	9.9
Parkersburg	190.3	-	-	-	-	-	-	-	-
Belleville	203.9	0	1.5	25.6	4.5	5.0	15.0	3.9	9.9
Addison	260.0	0	0	40.7	3.6	1.7	13.6	10.3	21.0
Gallipolis	279.2	0.9	0	24.7	0.6	4.2	10.9	6.4	21.0
Huntington	306.9	1.7	0		0	1.7	21.6	11.8	
Kenova	315.8	2.7	0	35.5	0.6	6.2	12.5	9.4	30.3
Greenup	341.0	0.9	0	20.0	0	1.8	16.4	7.7	18.5
Portsmouth	350.1	-	-	-	-	-	-	-	-
Meldahl	436.2	0.9	0	28.4	0.6	6.1	10.5	10.4	22.0
Cincinnati	462.8	0	0	48.8	0	4.1	11.5	12.4	29.6
North Bend	490.0	0	0	11.5	0	0.8	18.1	18.2	12.8
Markland	531.5	2.8	1.8	11.1	0	5.6	36.5	14.3	12.2
Louisville	600.6	0	0	28.4	0	0.8	15.8	8.9	6.2
West Point	625.9	0	0	11.0	0	1.7	15.0	7.8	14.6
Cannelton	720.7	0.9	0	23.8	0.6	1.7	23.3	6.4	25.0
Evansville	791.5	0.9	0	14.8	0	5.1	17.1	5.9	21.0
Uniontown	846.0	0	0	8.4	0	4.0	22.6	5.8	10.8
Smithland	918.5	3.3	0	4.2	2.0	8.3	10.6	13.7	4.2
Joppa	981.0	2.5	0	7.1	0	2.5	11.1	5.6	2.4
Criterion		10	50 (a)	22 (b)	25	50 (c)	0.2	10	55 (b)

Criteria met in all samples analyzed: Arsenic (40 ug/l), Selenium (10 ug/l), Silver (50 ug/l)

(a) Criterion for hexavalent chromium; results shown for total chromium
(b) Hardness dependent criterion; criterion shown is for a hardness of 100 mg/l. Results are for 1979-1985 when hardness measurements were made on samples analyzed for metals
(c) Criterion for dissolved lead; results shown are for total lead

TABLE 7

SUMMARY OF PERCENT EXCEEDANCE - CHRONIC AQUATIC LIFE PROTECTION CRITERIA
OHIO RIVER MAIN STEM - 1976-1985

LOCATION	MILEPOINT	CADMIUM	CHROMIUM	COPPER	CYANIDE	LEAD	MERCURY	NICKEL	PHENOLICS	ZINC
South Heights	15.2	11.8	11.3	45.0	47.3	50.6	33.3	0	24.4	47.9
East Liverpool	40.2	11.7	37.1	49.4	45.8	67.5	35.0	0	27.6	62.2
Pike Island	84.2	20.5	20.6	53.1	45.9	53.1	37.0	0	28.8	43.3
Shadyside	102.4	21.1	25.8	43.8	41.1	53.1	35.0	0	24.9	56.8
Hannibal	126.4	25.6	5.0	35.4	40.1	46.3	47.4	0	24.5	29.5
Willow Island	161.8	22.8	7.9	37.0	35.8	55.6	38.1	0	20.9	33.1
Belleville	203.9	21.5	15.4	36.7	26.4	52.4	37.5	0	16.3	35.8
Addison	260.0	17.7	17.2	60.5	22.9	50.6	37.3	0	19.4	46.6
Gallipolis	279.2	19.2	15.4	37.0	17.4	47.5	35.3	0	20.9	37.8
Huntington	306.9	8.9	23.8		6.0	45.6	45.7	0	17.8	
Kenova	315.8	22.4	24.6	52.6	14.1	53.9	35.7	0	18.2	41.2
Greenup	341.0	14.1	21.4	39.0	21.3	55.0	34.5	0	23.7	30.4
Meldahl	436.2	14.8	12.1	44.4	12.2	57.3	37.7	0	15.3	36.5
Cincinnati	462.8	10.1	23.4	63.8	11.2	53.0	35.2	3.4	20.1	41.8
North Bend	490.0	13.9	25.0	33.3	14.4	41.0	37.1	0	32.7	27.1
Markland	531.5	16.7	15.8	44.0	17.5	42.7	57.7	0	23.6	18.7
Louisville	600.6	18.8	9.4	66.7	3.0	44.4	38.6	0	14.2	27.5
West Point	625.9	25.6	22.6	32.9	9.0	61.0	42.5	0	14.5	40.8
Cannelton	720.7	22.5	10.0	38.8	4.0	46.2	45.6	0	12.1	46.1
Evansville	791.5	15.9	22.6	35.8	4.0	46.9	37.6	0	11.8	44.5
Uniontown	846.0	21.7	10.6	24.1	1.7	39.8	46.0	0	13.5	22.8
Smithland	918.5	12.5	0	8.3	2.0	37.5	19.1	0	23.5	19.6
Joppa	981.0	16.5	7.9	23.5	0.6	35.0	33.3	0	19.7	15.0
Criterion		1.1 (a)	11 (b)	12 (a)	5.2 (c)	3.2 (c)	.012 (d)	96 (a)	5 (e)	47

Chronic aquatic life criteria met in all samples analyzed: Selenium (35 ug/l), 1,2-Dichloroethane (20,000 ug/l), 1,2-Dichloropropane (5,700 ug/l), Tetrachloroethylene (840 ug/l), Trichloroethylene (21,900 ug/l)

(a) Hardness dependent criterion; criteria for hardness = 100 ug/l shown
(b) Criterion is for hexavalent chromium; results shown are for total chromium
(c) Criterion is for free cyanide; results shown are for total cyanide
(d) Criterion is below laboratory detection level; results shown are for total detections
(e) Criterion to protect against tainting of fish flesh

TABLE 8

SUMMARY OF PERCENT EXCEEDANCE - ACUTE AQUATIC LIFE PROTECTION CRITERIA
OHIO RIVER MAIN STEM - 1976-1985

LOCATION	MILEPOINT	CADMIUM	CHROMIUM	COPPER	CYANIDE	LEAD	MERCURY	PHENOLICS	ZINC
West View	4.5	-	-	-	-	-	-	-	-
South Heights	15.2	2.6	6.5	25.0	10.3	I.2	0	4.0	0
East Liverpool	40.2	0	22.6	33.3	8.9	0	0	0	1.2
Pike Island	84.2	0	11.1	34.6	10.4	0	0.8	0	0
Wheeling	86.8	-	-	-	-	-	-	-	-
Shadyside	102.4	0	11.3	33.8	7.1	0	0	0	1.2
Hannibal	126.4	3.8	0	25.6	5.6	0	0	0	0
Willow Island	161.8	0	4.6	23.5	2.5	5.1	0	0	0
Parkersburg	190.3	-	-	-	-	-	-	-	-
Belleville	203.9	6.3	4.7	24.1	4.5	0	0.8	0	0
Addison	26D.0	3.8	4.7	39.5	3.6	0	0.8	0	1.2
Gallipolis	279.2	1.3	10.8	28.4	0.6	0	0.8	0	1.2
Huntington	306.9	0	17.5		0	0	0.9	0	
Kenova	315.8	3.9	11.5	42.1	0.6	D	1.8	0	9.2
Greenup	341.0	0	10.7	26.0	D	0	0	0	0
Portsmouth	350.1	-	-	-	-	-	-	-	-
Meldahl	436.2	0	8.6	30.9	0.6	0	0	0	1.2
Cincinnati	462.8	1.2	12.0	53.8	0	D	0	0	1.2
North Bend	490.0	1.2	7.4	12.8	0	0	0	0	0
Markland	531.5	5.1	5.3	13.3	0	2.7	1.0	0	0
Louisville	600.6	3.8	7.8	29.6	0	2.5	0	0	0
West Point	625.9	3.7	14.5	13.4	0	1.2	0	0	1.2
Cannelton	720.7	6.2	5.0	22.5	0.6	2.5	1.0	0	0
Evansville	791.5	3.7	17.7	I4.8	0	3.7	0	3.6	2.4
Uniontown	846.0	2.4	7.6	8.4	0	0	0.8	0	0
Smithland	918.5	2.4	0	4.2	2.D	4.2	0	0	0
Joppa	981.0	4.7	4.8	5.9	0	3.5	0	0	0
Criterion		3.9 (a)	16 (b)	18 (a)	22 (c)	82 (a)	2.4	4.1	320 (a)

Acute aquatic life criteria met in all samples analyzed: Nickel (1800 ug/l), Benzene (5300 ug/l), Bromodichloromethane (11,000 ug/l), Bromoform (11,000 ug/l), Carbon Tetrachloride (35,000 ug/l), Chlorobenzene (250 ug/l), 1,2-Dichloroethane (118,000 ug/l), 1,2-Dichloropropane (23,000 ug/l), Methylene Chloride (11,000 ug/l), Tetrachloroethylene (5280 ug/l), 1,I,1-Trichloroethane (18,000 ug/l), Trichloroethylene (45,000 ug/l).

(a) Criterion for hexavalent chromium; results shown for total chromium
(b) Hardness dependent criterion; criterion shown is for a hardness of I00 mg/l. Results are for 1979-1985 when hardness measurements were made on samples analyzed for metals
(c) Criterion for dissolved lead; results shown are for total lead

TABLE 9

SUMMARY OF PERCENT EXCEEDANCE - HUMAN HEALTH CRITERIA
OHID RIVER MAIN STEM - 1976-1985

LOCATION	MILEPDINT	CADMIUM	CHROMIUM	LEAD	MERCURY	NICKEL	ZINC
South Heights	15.2	1.5	1.6	0.9	18.3	76.2	0
East Liverpool	40.2	0	1.6	1.7	18.8	72.6	D
Pike Island	84.2	0.9	4.8	7.4	22.7	56.5	0
Shadyside	102.4	0.9	0	1.7	17.1	59.7	0
Hannibal	126.4	D	D	2.1	29.9	31.7	0
Willow Island	161.8	D.9	0	5.9	22.0	38.1	D
Belleville	203.9	0	1.5	5.0	25.8	41.3	0
Addison	260.0	0	0	1.7	22.D	50.8	0
Gallipolis	279.2	D.9	0	4.2	22.7	41.5	0
Huntington	3D6.9	1.7	D	1.7	29.3	45.9	0
Kenova	315.8	2.7	0	6.2	25.0	31.1	0
Greenup	341.0	D.9	0	1.8	24.5	35.8	D.9
Meldahl	436.2	0.9	0	6.1	16.7	31.7	D
Cincinnati	462.8	0	D	4.1	18.9	33.3	D
North Bend	49D.0	D	0	0.8	27.6	32.2	D
Markland	531.5	7.8	1.8	5.6	38.5	30.8	D
Louisville	600.6	0	0	D.8	28.1	9.8	0
West Point	625.9	0	0	1.7	30.1	26.2	D
Cannelton	720.7	D.9	D	1.7	30.9	18.2	0
Evansville	791.5	0.9	0	5.1	31.6	18.D	D
Uniontown	846.0	D	D	4.0	30.6	19.0	D
Smithland	918.5	3.3	D	8.3	17.0	6.2	0
Joppa	981.0	2.5	0	2.5	25.6	15.D	0
Criterion, micrograms per liter		1D	50 (a)	5D	.144	13.4	5ODD

Human Health Criteria met in all samples analyzed: Arsenic (5D ug/l), Cyanide (200 ug/l), Selenium (1D ug/l), Silver (50 ug/l), Chlorobenzene (488 ug/l), 1,1,1-Trichloroethane (18,400 ug/l)

TABLE 10

SUMMARY OF PERCENT EXCEEDANCE - ONE IN 100,000 CANCER RISK LEVEL CRITERIA
OHIO RIVER MAIN STEM - 1976-1985

MILEPOINT	ARSENIC (1)	BENZENE	BROMOCHLOROMETHANE	BROMO DICHLOROMETHANE	BROMOFORM	CARBON TETRACHLORIDE	CHLOROFORM	DIBROMO CHLOROMETHANE	1,2 DICHLORO ETHYLENE	1,1 DICHLORO ETHYLENE	METHYLENE CHLORIDE	TETRA CHLOROETHYLENE	TRICHLOROETHYLENE	TRICHLORO FLUOROMETHANE
4.5	-	2.8	0	.08	0	0	0.2	0.5	0	3.2	0.8	0.2	0	1.5
15.2	27.0	-	-	-	-	-	-	-	-	-	-	-	-	-
40.2	22.9	-	0	0	1.9	0	1.2	0	0	3.1	0.6	0	0	0
84.2	35.9	-	-	-	-	-	-	-	-	-	-	-	-	-
86.8	-	0.4	0	0.1	0.1	0	11.5	.05	0	0.4	0.8	0	0	0
102.4	27.0	-	-	-	-	-	-	-	-	-	-	-	-	-
126.4	25.0	-	-	-	-	-	-	-	-	-	-	-	-	-
161.8	26.3	-	-	-	-	-	-	-	-	-	-	-	-	-
190.3	-	-	0	0	0.8	0	4.5	0	0	2.2	19.0	0	0	1.1
203.9	28.2	-	-	-	-	-	-	-	-	-	-	-	-	-
260.0	24.3	-	-	-	-	-	-	-	-	-	-	-	-	-
279.2	32.5	-	-	-	-	-	-	-	-	-	-	-	-	-
306.9	30.6	0.4	0	0.2	0.7	0.4	9.7	0.5	0	1.2	1.1	0	0	0.7
315.8	22.9	-	-	-	-	-	-	-	-	-	-	-	-	-
341.0	34.3	-	-	-	-	-	-	-	-	-	-	-	-	-
350.1	-	-	0	0.2	0.5	.06	1.5	0.2	0	0.7	1.1	0	0	0.7
436.2	31.6	-	-	-	-	-	-	-	-	-	-	-	-	-
462.8	30.8	-	0	0	0	0	0.3	0	0	0	7.7	0	0	0
490.0	10.0	-	-	-	-	-	-	-	-	-	-	-	-	-
531.5	15.8	-	-	-	-	-	-	-	-	-	-	-	-	-
600.6	10.8	0	0	.04	0	0	0.2	0	0	0.4	0.3	0	0	0
625.9	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-
720.7	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-
791.5	10.5	-	0	0	0.2	0	0.2	0	0	.04	0.2	0	0	0
846.0	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-
918.5	16.7	-	-	-	-	-	-	-	-	-	-	-	-	-
981.0	13.9	-	-	-	-	-	-	-	-	-	-	-	-	-
Criterion	.022	6.6	1.9	1.9	1.9	4.0	1.9	1.9	9.4	0.33	1.9	8.0	27.0	1.9

(1) Criterion below laboratory detection level; figure shown is percent detections

TABLE 11

SUMMARY OF PERCENT EXCEEDANCE - ONE IN ONE MILLION (
OHIO RIVER MAIN STEM - 1976-19(

MILEPOINT	ARSENIC (1)	BENZENE	BROMOCHLOROMETHANE	BROMO DICHLOROMETHANE	BROMOFORM	CARBON TETRACHLORIDE	CHLOROFORM	DIBROMO CHLOROMETHANE	1,2 DICHLORO ETHYLENE	METHYLENE CHLORIDE (1)	TETRA CHLOROETHYLENE	TRICHLORO ETHYLENE	TRICHLORO FLUOROMETHANE	
4.5	-	7.8	1.8	2.1	0.8	0.3	10.2	5.0	0.6	11.5	12.1	6.9	0.2	6.8
15.2	27.0	-	-	-	-	-	-	-	-	-	-	-	-	-
40.2	22.9	-	1.2	0	4.4	0.6	10.2	2.5	0.6	3.1	2.5	0	0	0.6
84.2	35.9	-	-	-	-	-	-	-	-	-	-	-	-	-
86.8	-	9.2	.09	1.1	2.1	0.2	56.7	3.1	.05	2.8	9.3	4.2	0.1	0.3
102.4	27.0	-	-	-	-	-	-	-	-	-	-	-	-	-
126.4	25.0	-	-	-	-	-	-	-	-	-	-	-	-	-
161.8	26.3	-	-	-	-	-	-	-	-	-	-	-	-	-
190.3	-	-	0	1.2	0.8	0.6	52.3	0.8	0.9	3.1	54.5	4.0	0	5.5
203.9	28.2	-	-	-	-	-	-	-	-	-	-	-	-	-
260.0	24.3	-	-	-	-	-	-	-	-	-	-	-	-	-
279.2	32.5	-	-	-	-	-	-	-	-	-	-	-	-	-
306.9	30.6	1.6	0.4	14.0	4.4	8.9	56.4	9.9	0.4	7.1	8.3	11.6	0.2	3.2
315.8	22.9	-	-	-	-	-	-	-	-	-	-	-	-	-
341.0	34.3	-	-	-	-	-	-	-	-	-	-	-	-	-
350.1	-	-	0.2	7.5	1.8	0.8	50.9	3.9	0.7	1.7	10.1	9.7	0.3	4.5
436.2	31.6	-	-	-	-	-	-	-	-	-	-	-	-	-
462.8	30.8	-	0	0.4	0.1	.08	14.7	0.1	.08	0.2	10.7	0	0	0
490.0	10.0	-	-	-	-	-	-	-	-	-	-	-	-	-
531.5	15.8	-	-	-	-	-	-	-	-	-	-	-	-	-
600.6	10.8	0	0.1	0.6	0.2	0	15.7	0.4	.04	6.5	7.1	0.5	0	0.6
625.9	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-
720.7	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-
791.5	10.5	-	0	1.5	0.5	.04	24.5	.04	.04	0.2	4.5	0.4	0	.03
846.0	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-
918.5	16.7	-	-	-	-	-	-	-	-	-	-	-	-	-
981.0	13.9	-	-	-	-	-	-	-	-	-	-	-	-	-
Criterion	.002	.66	.19	.19	.19	.40	.19	.19	.94	.033	.19	.80	2.7	.19

(1) Criterion below laboratory detection level; figure shown is percent detections

TABLE 12

SUMMARY OF PERCENT EXCEEDANCE - ONE IN TEN MILLION CANCER RISK LEVEL CRITERIA
OHIO RIVER MAIN STEM - 1976-1985

MILEPOINT	ARSENIC (1)	BENZENE (1)	BROMO CHLOROMETHANE (1)	BROMO DICHLOROMETHANE (1)	BROMOFORM (1)	CARBON TETRACHLORIDE (1)	CHLOROFORM (1)	DIBROMO CHLOROMETHANE (1)	1,2 DICHLORO ETHANE (1)	1,1 DICHLORO ETHYLENE (1)	METHYLENE CHLORIDE (1)	TETRA CHLOROETHYLENE (1)	TRICHLORO ETHYLENE	TRICHLORO FLUOROMETHANE (1)
4.5	-	8.3	6.3	9.2	4.1	5.4	34.9	11.1	14.0	11.5	33.1	55.5	9.7	17.5
15.2	27.0	-	-	-	-	-	-	-	-	-	-	-	-	-
40.2	22.9	-	1.2	1.9	7.5	0.6	40.0	4.4	2.5	3.1	13.8	7.5	1.9	0.5
84.2	35.9	-	-	-	-	-	-	-	-	-	-	-	-	-
86.8	-	16.0	0.7	4.7	3.5	3.3	91.7	7.4	1.6	2.8	34.2	51.0	6.2	1.2
102.4	27.0	-	-	-	-	-	-	-	-	-	-	-	-	-
126.4	25.0	-	-	-	-	-	-	-	-	-	-	-	-	-
161.8	26.3	-	-	-	-	-	-	-	-	-	-	-	-	-
190.3	-	-	0	3.1	0.8	2.0	63.6	1.2	4.3	3.1	71.2	11.3	1.5	7.0
203.9	28.2	-	-	-	-	-	-	-	-	-	-	-	-	-
260.0	24.3	-	-	-	-	-	-	-	-	-	-	-	-	-
279.2	32.5	-	-	-	-	-	-	-	-	-	-	-	-	-
306.9	30.6	2.2	1.2	24.9	9.5	31.5	76.2	19.5	9.7	7.1	21.4	44.6	19.1	8.4
315.8	22.9	-	-	-	-	-	-	-	-	-	-	-	-	-
341.0	34.3	-	-	-	-	-	-	-	-	-	-	-	-	-
350.1	-	-	0.6	28.3	5.9	4.5	83.0	15.4	10.5	1.7	24.1	56.7	4.8	9.1
436.2	31.6	-	-	-	-	-	-	-	-	-	-	-	-	-
462.8	30.8	-	.04	4.0	0.5	1.8	82.0	1.5	2.5	0.2	33.3	11.5	.04	.04
490.0	10.0	-	-	-	-	-	-	-	-	-	-	-	-	-
531.5	15.8	-	-	-	-	-	-	-	-	-	-	-	-	-
600.6	10.8	0	.04	4.0	4.5	0.3	1.6	60.2	1.0	1.5	6.5	19.2	1.0	9.2
625.9	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-
720.7	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-
791.5	10.5	-	.08	18.4	6.1	1.3	77.6	1.7	0.7	0.2	21.0	21.1	1.0	1.0
846.0	10.8	-	-	-	-	-	-	-	-	-	-	-	-	-
918.5	16.7	-	-	-	-	-	-	-	-	-	-	-	-	-
981.0	13.9	-	-	-	-	-	-	-	-	-	-	-	-	-
Criterion	.0002	.066	.019	.019	.019	.04	.019	.019	.094	.003	.019	.08	.27	.019

(1) Criterion below laboratory detection level; figure shown is percent detections

Discussion by Parameter

The following discussion of each parameter has been undertaken to identify portions of the river in which each substance has been detected most frequently and at the highest concentrations. For the manual sampling parameters in particular, tributary inputs are considered as possible contributions to main stem levels.

Trend analyses have been performed on the ambient sampling results. For the monthly data, a plotting routine available through STORET was utilized. While the plots indicated increasing or decreasing trends for each parameter at each location, the routine did not include testing for statistical significance. Values below detection levels were not considered. For the ODS data, trend analysis was performed on the annual percent detections for each compound at each site. A 95 percent significance level was used in reporting the results.

Arsenic - Detections have been most frequent at Pike Island (MP 84.2); that location also has shown the greatest increase in frequency of detections from the next upstream site, and was the site of the highest arsenic concentration on the Ohio River. The highest overall concentrations (28 ug/l) were recorded at the Scioto and Licking River monitoring locations. The Kanawha, Big Sandy, and Little Miami River locations had the most frequent detections among the tributaries. Detections were significantly less frequent at Ohio River locations below Cincinnati than above; this was due in part to differences in laboratory detection levels. For locations above Cincinnati, the detection level was lowered from 10 ug/l to 1 ug/l in 1983; the same change was made for locations below Cincinnati in 1985. Due to the significance of that change, meaningful trend analysis for arsenic could not be carried out.

Cadmium - Detections of cadmium have been most frequent at Belleville (mp 203.9), which also had one of the highest increases in detection rate from the next upstream location. The Muskingum River may have contributed to the detections at Belleville; the monitoring site on that stream had the second highest detection rate among the tributaries (the Great Miami site had the highest rate). Significant increases in detection rates were observed from

stations above Huntington, Cincinnati, Louisville, and Evansville to those below. Decreasing trends in cadmium concentrations have been observed at all Ohio River locations except Meldahl, North Bend, and Smithland.

Chromium - Chromium is the only metal which has shown increasing trends at the majority of the Ohio River monthly monitoring locations - 15 of the 23 locations, including all sites from South Heights (mp 15.2) downstream to Gallipolis (mp 279.2). The detection rate has been highest at East Liverpool (mp 84.2); that site also showed the greatest increase in detections from the next upstream location. The next downstream location, Pike Island (mp 84.2), had the most samples with chromium concentrations above 50 ug/l. Among the tributaries, detections were most frequent in the Muskingum River, followed by the Beaver and Great Miami Rivers.

Copper - Copper has been the most frequently detected of any of the metals considered here, appearing in all samples analyzed from four Ohio River locations (Addison, Huntington, Greenup, Cincinnati) and in over 90 percent of the samples analyzed at all stations upstream of Louisville. From Lousiville downstream, detection rates have ranged from 73 to 87 percent; the difference from upstream locations is primarily due to differences in laboratories. Increasing trends have been observed at six Ohio River locations - East Liverpool, Pike Island, Meldahl, Cincinnati, Markland, and Cannelton.

Cyanide - Detections of cyanide have been most frequent at the three most upstream Ohio River locations; the frequency of detection has been lower at each successive downstream location through Huntington. The next two locations - Kenova (mp 315.8) and Greenup (mp 341.0) - show the largest increases in detection frequencies over the next upstream locations. Among the tributaries, the Monongahela and Beaver Rivers have the highest detection rates and the most criteria exceedances; those two rivers are major sources of cyanide concentrations on the upper Ohio. The Great Miami River location has also had frequent detections of cyanide as well as criteria exceedances, but seems to have less impact on the Ohio River. At Ohio River locations, cyanide concentrations have shown decreasing trends at all but two sites - West Point (mp 625.9) and Smithland (mp 918.5).

Lead - Concentrations of lead show decreasing trends at all but one Ohio River location (Cannelton). This is probably due in part to the increasing use of unleaded gasoline, which has contributed to decreasing lead levels in precipitation and in urban runoff. Detections of lead have been most frequent at East Liverpool (mp 40.2) and West Point (mp 625.9); the same two locations have shown the highest increases in detections from the next upstream locations. Among the tributaries, detections have been most frequent on the Little Miami River while criteria exceedances have been most frequent on the Great Miami.

Mercury - Detections of mercury have been most frequent at Markland (mp 531.5), which is the only location at which mercury has been detected in over half of the samples analyzed. Markland has also had the highest increase in detections from the next upstream location. Increasing trends in mercury concentration have been observed at nine Ohio River locations - South Heights, East Liverpool, Hannibal, Huntington, Meldahl, Cincinnati, North Bend, Louisville, and Evansville. The Scioto River has had the most frequent detections of mercury among the tributary locations.

Nickel - Detections of nickel have been most frequent at South Heights and East Liverpool on the Ohio River and at the Beaver River location. Increasing trends have been observed at five Ohio River locations - Addison, Cincinnati, North Bend, Markland, and Joppa.

Phenolics - Detections of phenolics have been most frequent at four of the five most upstream Ohio River monitoring locations - South Heights, East Liverpool, Pike Island, and Hannibal. .All have had detection rates of over 70 percent. Three other locations - Shadyside (mp 102.4), Gallipolis (mp 279.2) and Kenova (mp 315.8) - have had detection rates of just over 68 percent. The greatest increases in detections from the next upstream location have been at Kenova and West Point. Decreasing trends have been observed at all locations upstream of Louisville, but increasing trends have occurred at Louisville, West Point, Cannelton, Evansville, and Joppa. On the tributaries, detections have been most frequent at the Beaver and Scioto River monitoring locations.

Selenium - Detections of selenium have been rare - just over seven percent of the Ohio River samples. Detections have been most frequent at Gallipolis - 8 of 40 samples, or 20 percent. The highest observed concentration has been 5 ug/l.

Silver - Detections of silver have been slightly less frequent than those of selenium for the monitoring system as a whole. Detections have been most frequent at Addison - 6 of 42 samples or 14.3 percent. On the tributaries, detections have been most frequent at the Scioto River site.

Zinc - Like copper, zinc has been detected in most samples analyzed, including all samples from Pike Island and Shadyside as well as the Beaver River site. The lowest detection rate for any Ohio River location is 78 percent at Uniontown. Increasing trends have been observed at Kenova, Cincinnati, and Cannelton.

Benzene - Daily concentrations of benzene are measured at four Organic Detection System (ODS) sites which are equipped with Photo Ionization Detectors (PID). Of the additional compounds measured at the PID sites, only benzene is presented here because it is the only one which exceeded criteria at any time, and is a compound of concern to the public because of several spills in recent years. Detections at West View (mp 4.5) can largely be attributed to discharges from a steel mill on the Monongahela River which have been well documented. Detections have been more frequent, however, at Wheeling (mp 86.8).

Bromochloromethane - Although not one of the "Priority Pollutants," this compound is a halomethane and therefore subject to cancer risk level criteria. Detections as well as criteria exceedances have been most frequent at West View. Annual numbers of detections have shown increasing trends at Wheeling, Portsmouth, and Louisville, but no significant trends at other Ohio River DDS sites.

Bromodichloromethane - Detections of bromodichloromethane were most frequent at Portsmouth (28 percent) and Huntington (25 percent), followed by Evansville (18 percent). An increasing trend was observed at Evansville; decreasing trends were observed at West View, Huntington, and Cincinnati.

Bromoform - Detections of bromoform were highest at Huntington. An increasing trend in the number of detections was observed at Louisville, while a decreasing trend took place at West View.

Carbon Tetrachloride - Detections of carbon tetrachloride have been most frequent by far among Ohio River locations at Huntington (32 percent of samples analyzed). Detections were even more frequent (83 percent of samples analyzed) at the Kanawha River site in the years (1979 - 1983) when those data were quantified. It is probable that the sources on the Kanawha River have also been responsible for the detections at Huntington. The only significant trends in annual detections have been decreases at West View, Cincinnati, and the Allegheny and Monongahela River sites.

Chlorobenzene - Detections have been most frequent at West View (27 percent), followed by Huntington (18 percent). Only three values have exceeded the 20 ug/l taste and odor criterion - two from Huntington and one from East Liverpool.

Chloroform - The most frequently detected compound among those monitored by the ODS, chloroform has been detected in 73 percent of the samples from Ohio River locations. Detections have been most frequent at Wheeling (92 percent), which also showed the highest increase in detections over the next upstream location. The only location with an increasing trend in the number of chloroform detections has been Evansville.

Dibromochloromethane - Detections of dibromochloromethane have been most frequent at Huntington (20 percent), followed by Portsmouth (15 percent) and Wheeling (11 percent). At the Kanawha River site, the detection rate was 23 percent; this probably contributed to the detections at Huntington and perhaps Portsmouth as well.

1,1-Dichloroethane - This compound has been detected least frequently of those monitored by the ODS, appearing in 1.5 percent of the samples from Ohio River sites. Detections have been most frequent (18.6 percent) at the Monongahela River site and at West View (6.5 percent). 1,1-Dichloroethane is not a priority pollutant and no criteria have been established for it.

1,2-Dichloroethane - This compound has been found in 4.7 percent of the samples analyzed from Ohio River locations, with most frequent detections at West View. It was found in 52 percent of the samples at the Kanawha River site. In less than one year's operation, the Paducah site has recorded more exceedances of the 10^{-5} CRL criterion than at all the other sites combined over the period of record. The source of the detections at Paducah has been traced to industries on the Tennessee River, and the Kentucky Division of Water is taking followup action.

1,1-Dichloroethylene - Cancer Risk level criteria at the 10^{-7} and 10^{-6} level of 1,1-Dichloroethylene are both below the detection level of the ODS while the 10^{-5} criterion is just slightly above detection. Any detection of this compound is therefore a cause for concern. The highest detection rate on the Ohio River has been at West View (11.5 percent), followed by Huntington (7.1 percent) and Louisville (6.5 percent). Decreasing trends in the number of detections have been observed at West View and Parkersburg, while an increasing trend has been observed at Portsmouth. Among the tributaries, the Kanawha River site had the highest detection rate - 43 percent of the samples analyzed.

1,2-Dichloropropane - Detections of 1,2-Dichloropropane have been most frequent at the Kanawha River location (60 percent of samples analyzed) and at Huntington (13 percent). Detections at Portsmouth show an increasing trend while West View and Parkersburg have shown decreasing trends.

Methylene Chloride - While the overall detection rate for methylene chloride has been fourth highest among the organics, it is one of just two compounds (chloroform being the other) which has been detected in over ten percent of the samples analyzed at each Ohio River ODS site, and has been second only to chloroform in terms of exceedances of cancer risk level criteria. Detections were most frequent at the Parkersburg site (71 percent), followed by West View and Cincinnati (both 33 percent). Increasing trends in the number of detections were observed at Parkersburg and Louisville, while a decrease was noted at West View, as well as the Allegheny and Monongahela sites.

Tetrachloroethylene - The second must frequently detected organic compound at Ohio River ODS sites, tetrachloroethylene has been found in over half of the

samples analyzed at Portsmouth, West View, and Wheeling. Decreasing trends in the number of detections have been observed at West View, Wheeling, Huntington, and Cincinnati. The two newest ODS sites - East Liverpool and Paducah - have had the lowest detection rates of this compound, further suggesting that its incidence is declining.

1,1,1-Trichloroethane - Detections of 1,1,1-trichloroethane, the third most frequently detected compound at Ohio River ODS sites, have been most frequent at Wheeling (72 percent of samples analyzed), followed by Louisville (47 percent). The Kanawha River site has been the only tributary location with a detection rate of over 10 percent (35 percent of samples analyzed). 1,1,1-trichloroethylene has replaced carbon tetrachloride in many industrial uses and is considered to be much less toxic, as evidenced by RMCL's of 200 ug/l for 1,1,1-trichloroethane and 5 ug/l for carbon tetrachloride. The number of detections of 1,1,1-trichloroethane, however, has been decreasing at West View, Parkersburg, Huntington, and Cincinnati, as well as the Allegheny River site. Increases have been observed at Evansville and the Kanawha River site. As with tetrachloroethylene, detections have been least frequent at the two newest ODS sites - East Liverpool and Paducah - further indicating decreased incidence.

Trichloroethylene - Trichloroethylene has been the fifth most frequently detected compound at Ohio River ODS sites, appearing in 23 percent of the samples analyzed. Detections have been most frequent at Wheeling (just under half of the samples), followed by Huntington (40 percent), West View (38 percent), and Portsmouth (31 percent). The only significant trends in numbers of detections have been decrases at Wheeling and Louisville.

Trichlorofluoromethane - Detections of trichlorofluoromethane have been most frequent at West View (17.5 percent) and at the Monongahela River site (17.0 percent). The number of detections at each of those sites has shown a decreasing trend. Trichlorofluoromethane has been removed from the priority pollutants list by US EPA.

Fish Tissue Analysis

Samples of fish from 17 Ohio River locations, as well as eight locations on six tributaries, have been collected and analyzed for several toxic

substances at regular intervals since 1975. Fish tissue samples are collected during lock chamber studies conducted in September and October of each year. p Beginning in 1978, analyses for polychloronated biphenls (PCB's), chlordane, dichlorodiphehyl ethylene (DDE), and hexachlorobenzene (HCB) have been performed each year on catfish and carp fillets of specified size. Analysis for mercury has also been performed on fillets in several years.

Results of fish tissue analysis can be used in two ways:

1. For certain substances, the concentrations in water are usually below laboratory detection levels. Due to bioaccumulation, the concentrations in fish tissue will be higher. Analyses of fish tissue can therefore provide a means to monitor the presence of such substances.

2. The US Food and Drug Administration has established temporary tolerance levels for certain substances in order to assess the suitability of fish for human consumption. Such levels are available for PCB's, chlordane, and mercury.

Data for DDE and HCB can be reviewed only to establish presence of those compounds, since no criteria are available for comparison. Dccurrence of DDE has been relatively consistant throughout the river as 26D of the 278 catfish fillets analyzed (94 percent) have contained detectable concentrations. Levels above the "trace" amount have been reported most frequently on the upper river, but the highest concentrations have been found in fish from the lower river. HCB has also been detected in most catfish fillets analyzed - 266 of 2B5, or 93 percent. Concentrations above the trace amount have been most frequent at Belleville and Hannibal, which have also been the locations where the highest concentrations have been found.

Analyses of fillets for mercury do not indicate any problems despite the fairly frequent exceedances of stream criteria. The FDA limit for mercury is 1.0 mg/kg while the highest level found in any fillet has been 0.4 mg/kg. This indicates that the stream criteria are adequately protective, since both the Commission and the chronic aquatic life criteria were based on prevention of bioaccumulation to unacceptable levels.

US EPA has established Cancer Risk Level criteria for chlordane and PCB. For both substances, the criteria are below current levels of detection. At the 10^{-5} risk level, the criteria are .46 ng/l (.00046 ug/l) for chlordane and .79 ng/l for PCB. While neither of the substances have been detected in water samples from the Ohio River, their levels in fish flesh have been a matter of some concern. The FOA has set limits of 0.3 mg/kg for chlordane and 2.0 mg/kg for PCB. Analyses of carp fillets indicate two of 158 exceeding the chlordane limit and one of 170 exceeding the PCB limit. Exceedances have been more frequent for catfish fillets. The chlordane limit has been exceeded in 39 of 176 catfish analyzed (22 percent) while the PCB limit has been exceeded in 71 of 230 catfish (31 percent).

Summaries of the analyses of catfish fillets are shown in Tables 13 (chlordane) and 14 (PCB). Certain tendencies from year to year can be seen in the results. For PCB, the FDA limit was exceeded in approximately 30 percent of the fish analyzed each year from 1978 to 1981. In 1983, exceedances were considerably more frequest (41 percent of the fillets analyzed), but exceedances were less frequent in 1984 (27 percent) and 1985 (10 percent). For chlordane, the FDA limit has been exceeded in 20 percent or less of the fillets analyzed in each year except 1979 (57 percent) and 1983 (33 percent).

Exceedances of the chlordane limit have been most frequent at Pike Island and Hannibal, although no exceedances occurred at Pike Island in 1984 and 1985 nor at Hannibal in 1985. Exceedances of the PCB limit have been most frequent at Dashields; again, however, no exceedances occurred in 1985. The high levels at Dashields in earlier years led to an advisory against consumption of Ohio River fish by the Pennsylvania Fish Commission. An investigation by The Pennsylvania Department of Environmental Resources led to the identification of a source of PCB and action to abate the discharge. The recent results indicates that the abatement action was successful.

TABLE 13

NUMBERS OF CATFISH FILLETS EXCEEDING U.S. FDA LIMIT FOR CHLORDANE
OHIO RIVER - 1978-1985

		1978		1979		1980		1981		1982		1983		1984		1985		Total	
		NS	N>.3	NS	N>.3	NS	N>.3	NS	N>.3	NS	N>.3	NS	N>.3	NS	N>.3	NS	N>.3	NS	N>.3
Dashields	13.3	1	0	4	4	3	0	3	0	1	0	3	0	-	-	3	0	18	4
New Cumberland	54.4	-	-	-	-	-	-	3	0	1	0	3	1	-	-	3	0	10	1
Pike Island	84.2	1	0	4	2	3	2	3	0	-	-	3	3	5	0	3	0	22	7
Hannibal	126.4	1	0	4	4	3	0	3	0	1	0	3	1	5	3	3	0	23	8
Willow Island	161.8	-	-	-	-	-	-	3	0	-	-	3	1	-	-	3	0	9	1
Belleville	203.9	1	0	4	2	3	0	3	0	1	0	3	2	5	0	3	1	23	5
Racine	237.5	-	-	-	-	-	-	-	-	1	0	3	2	-	-	3	0	7	2
Gallopolis	279.2	1	0	4	1	3	0	-	-	-	-	3	0	-	-	-	-	11	1
Greenup	341.0	-	-	-	-	-	-	3	0	-	-	-	-	-	-	-	-	3	0
Meldahl	436.2	1	0	-	-	-	-	-	-	-	-	3	1	-	-	-	-	4	1
Markland	531.5	1	0	4	2	-	-	-	-	-	-	-	-	-	-	-	-	5	2
McAlpine	605.0	1	1	-	-	-	-	3	1	-	-	3	0	-	-	3	0	10	2
West Point	628.0	-	-	-	-	-	-	-	-	-	-	3	2	-	-	-	-	3	2
Cannelton	720.7	-	-	4	1	-	-	-	-	-	-	-	-	-	-	-	-	4	1
Newburgh	726.0	1	0	-	-	-	-	-	-	-	-	-	-	-	-	3	0	4	0
Uniontown	846.0	1	1	-	-	3	1	3	0	-	-	3	0	-	-	3	0	13	2
Smithland	918.5	1	0	-	-	-	-	3	0	-	-	3	0	-	-	-	-	7	0
TOTAL		11	2	28	16	18	3	30	1	5	0	39	13	15	3	30	1	176	39

NS = Number of samples
N>.3 = Number exceeding 0.3 milligrams per kilogram

TABLE 14

NUMBERS OF CATFISH FILLETS EXCEEDING U.S. FOA LIMIT FOR PCB
OHIO RIVER - 1978-1985

		1978		1979		1980		1981		1982		1983		1984		1985		Total	
		NS	N>.2	NS	N>.2	NS	N>.2	NS	N>.2	NS	N>.2	NS	N>.2	NS	N>.2	NS	N>.2	NS	N>.2
Dashields	13.3	3	2	4	4	3	2	3	3	1	1	3	2	-	-	3	0	20	14
New Cumberland	54.4	5	1	-	-	-	-	3	3	1	0	3	0	-	-	3	1	15	5
Pike Island	84.2	6	4	4	1	3	2	3	0	-	-	3	2	5	0	3	1	27	10
Hannibal	126.4	6	5	4	1	3	1	3	0	1	0	3	1	5	3	3	0	28	11
Willow Island	161.8	5	1	-	-	-	-	3	0	-	-	3	1	-	-	3	0	14	2
Belleville	203.9	7	3	4	0	3	0	3	0	1	0	3	2	5	1	3	1	29	7
Racine	237.5	-	-	-	-	-	-	-	-	1	0	3	2	-	-	3	0	7	2
Gallopolis	279.2	6	0	4	2	3	0	-	-	-	-	3	0	-	-	-	-	16	2
Greenup	341.0	5	0	-	-	-	-	3	0	-	-	-	-	-	-	-	-	8	0
Meldahl	436.2	6	0	-	-	-	-	-	-	-	-	3	1	-	-	-	-	9	1
Markland	531.5	5	2	4	0	-	-	-	-	-	-	-	-	-	-	-	-	9	2
McAlpine	605.0	1	0	-	-	-	-	3	2	-	-	3	2	-	-	3	0	10	4
West Point	628.0	-	-	-	-	-	-	-	-	-	-	3	2	-	-	-	-	3	2
Cannelton	720.7	3	1	4	3	-	-	-	-	-	-	-	-	-	-	-	-	7	4
Newburgh	726.0	I	0	-	-	-	-	-	-	-	-	-	-	-	-	3	0	4	0
Uniontown	846.0	1	0	3	0	-	-	3	0	-	-	3	1	-	-	3	0	13	1
Smithland	918.5	5	3	-	-	-	-	3	1	-	-	3	0	-	-	-	-	11	4
TOTAL		65	22	31	11	15	5	30	9	5	1	39	16	15	4	30	3	230	71

NS = Number of samples

N>.2 = Number exceeding 2.0 milligrams per kilogram

Comparison of In Stream Concentrations to Drinking Water MCL's

Pursuant to the requirements of the Safe Drinking Water Act, US EPA has adopted Maximum Contaminant Levels (MCL's) for a number of substances. MCL's are enforceable standards for all public drinking water supplies. Should they be exceeded in the finished water produced by a utility, that utility is subject to enforcement action by US EPA or the state. US EPA has also adopted Recommended Maximum Contaminant Levels (RMCL's) for several substances. RMCL's are goals for drinking water based on health considerations, but are not enforceable standards. When both an MCL and an RMCL have been adopted for a particular substance, the RMCL will be lower and could be regarded as an "alert" level.

MCL's and/or RMCL's have been adopted for 18 substances monitored by the Commission. In addition, an MCL has been adopted for total Trihalomethanes, which includes four of the volatile organics monitored by the ODS. MCL's for arsenic, chromium, copper, selenium, and silver are identical to human health criteria for these substances which were addressed previously. MCL's for mercury, zinc, 1,1-dichloroethylene, 1,1,1-trichloroethane, and 1,2-dichloropropane are well above normal stream levels for those constituents. RMCL's and MCL's for six substances - cadmium, lead, benzene, carbon tetrachloride, 1,2-dichloroethane, and trichloroethylene - have been exceeded at times in the Ohio River and therefore are the cause of some concern. In addition, the MCL for total trihalomethanes is a matter of concern since that group of chemicals includes chloroform, the most frequently detected of the volatile organics.

Comparison of stream data to MCL's must be tenuous at best since the fate of the substances in question in water treatment processes is not consistent. It can be expected that water treatment processes will remove most of the heavy metals, especially those in the particulate form. Concentrations of certain organic compounds, however, may be increased through water treatment processes due to the use of chlorine for disinfection purposes. This has been a matter of concern to Ohio River water utilities and led to the conduct of an investigation

by the Commission and 11 utilities, with support from US EPA. That investigation was presented in the August, 1979 report Water Treatment Process Modifications for Trihalomethane Control and Organic Substances in the Ohio River. Several conclusions were reached which have enabled the participating utilities to operate their facilities in an manner which reduces the potential for production of trihalomethanes through the treatment processes.

The four trihalomethanes monitored by the ODS - chloroform, bromodichloromethane, dibromochloromethane, and bromoform - constitute the major portion of those compounds which may be expected to occur in the river. The MCL for total trihalomethanes (100 ug/l) has not been exceeded in any samples collected through the ODS in the 1979-1985 period of record. In order to obtain a "worst case" picture of the potential for trihalomethane problems in the Ohio River, three concentration levels were derived for each of the four trihalomethanes monitored at each ODS site: the maximum observed concentration, the concentration which was greater than 90 percent of those detected, and the average of all concentrations detected. The sum of those values was taken for each level at each site, with the following results:

	Maximum	90th Percentile	Average
West View	20.8	2.8	1.3
East Liverpool	12.3	8.1	2.6
Wheeling	93.4	4.8	2.1
Parkersburg	14.4	5.9	5.6
Huntington	88.6	5.5	2.7
Portsmouth	50.5	5.1	2.2
Cincinnati	9.7	1.9	1.0
Louisville	11.9	2.4	1.1
Evansville	22.2	1.9	0.9

These results indicate that, at worst, the MCL for total trihalomethanes in the finished water from those utilities might be exceeded on rare occasions.

The MCL's for cadmium and lead are identical to the human health criteria for those metals (10 ug/l cadmium, 50 ug/l lead). More stringent RMCL's have been adopted (5 ug/l cadmium, 20 ug/l lead) which could raise some concern. Similarly, MCL's for benzene, carbon tetrachloride, and 1,2-dichloroethane are

of the same order of magnitude as 10^{-5} Cancer Risk level criteria for those compounds while the MCL for trichloroethylene is of the same order of magnitude as the 10^{-6} CRL criterion for that compound. The RMCL's for those four organic compounds is zero. In Table 15, the percent of samples at selected Ohio River locations exceeding the RMCL's and MCL's for these substances is shown. The sites listed are all at or near municipal water intakes. Values shown for the RMCL's for the four organic compounds are percent detections.

Of the six MCL's, two - those for benzene and lead - have been exceeded on more than an occasional basis. The benzene MCL has been exceeded in 4.1 percent of the samples analyzed at West View, while the lead MCL has been exceeded in 5.0 percent or more of the samples from 6 of the 16 locations shown. The RMCL for lead has been exceeded in over 10 precent of the samples analyzed at all but one location. For the organics, RMCL's have been exceeded in ten percent or more of the samples analyzed at one location (out of four) for benzene, one of nine locations for carbon tetrachloride, two of nine for 1,2-dichloroethane, and five of nine for trichloroethylene.

Again it must be stressed that comparison of results from river samples to finished drinking water MCL's is tenuous at best. Based on a limited number of analyses for total and dissolved metals as well as relationships with suspended solids, it is indicated that the major portion of the metals concentrations are in the particulate form and can be readily removed in water treatment plants. The fate of the four organic compounds through water treatment processes is less certain. The potential for adverse impact on human health cannot be ignored and will remain a matter of concern to the Commission.

TABLE 15: COMPARISON OF IN STREAM CONCENTRATIONS OF CERTAIN SUBSTANCES TO MAXIMUM CONTAMINANT LEVELS FOR FINISHED ORINKING WATER
OHIO RIVER - PERIOD OF RECORD

		PERCENT OF SAMPLES EXCEEDING INDICATED LEVEL											
		CADMIUM		LEAD		BENZENE		CARBON TETRA-CHLORIDE		1,2 DICHLORO-ETHANE		TRICHLORO-ETHANE	
LOCATION	MILE POINT	RMCL	MCL	RMCL	MCL	RMCL	MCL	RMCL	MCL	RMCL	MCL	RMCL	MCL
West Point	4.5	-	-	-	-	8.3	4.1	5.4	0	14.0	0	37.6	0.2
South Heights	15.2	2.7	1.5	14.5	0.9	-	-	-	-	-	-	-	-
East Liverpool	40.2	2.6	0	28.0	1.7	-	-	0.6	0	2.5	0	3.8	0
Pike Island	84.2	2.6	0.9	28.9	7.4	-	-	-	-	-	-	-	-
Wheeling	86.8	-	-	-	-	16.0	0.8	3.3	0	1.6	0	49.6	0
Hannibal	126.4	2.2	0	8.2	2.1	-	-	-	-	-	-	-	-
Parkersburg	190.3	-	-	-	-	-	-	2.0	0	4.3	0	6.2	0
Belleville	203.9	3.4	0	17.5	5.0	-	-	-	-	-	-	-	-
Gallipolis	279.2	2.6	0.9	19.5	4.2	-	-	-	-	-	-	-	-
Huntington	306.9	1.7	1.7	25.6	1.7	2.2	0.4	31.5	0.2	9.7	0	39.7	0.1
Kenova	315.8	8.0	2.7	35.4	6.2	-	-	-	-	-	-	-	-
Greenup	341.0	3.7	0.9	28.2	1.8	-	-	-	-	-	-	-	-
Portsmouth	350.1	-	-	-	-	-	-	4.5	0.1	10.5	0	31.4	0.1
Meldahl	436.2	2.7	0.9	31.6	6.1	-	-	-	-	-	-	-	-
Cincinnati	462.8	2.5	0	21.3	4.1	-	-	1.8	0	2.5	0	9.9	0
Louisville	600.6	1.7	0	17.5	0.8	0	0	1.6	0	1.5	0	10.5	0
Evansville	791.5	3.4	0.9	22.0	5.1	-	-	1.3	0	0.7	0	6.9	0
Uniontown	846.0	1.7	0	21.6	4.0	-	-	-	-	-	-	-	-
Smithland	918.5	6.7	3.3	12.5	8.3	-	-	-	-	-	-	-	-
Joppa	952.3	3.4	2.5	15.8	2.5	-	-	-	-	-	-	-	-
Criterion ug/l		5	10	20	50	0	5	0	5	0	5	0	5

Summary by River Segment

One of the objectives of this report is to identify particular sections of the river with the most serious problems due to toxic substances. The first step in such an undertaking would be to define portions of the river, or segments, with relatively uniform characteristics in terms of water quality. The Commission normally uses a set of 19 segments for the Ohio River for reporting water quality conditions. Due to the importance of the Organics Detection System results in this analysis, and the fact that there are only nine ODS sites on the Ohio River, a different set of segments is necessary. These segments are listed in Table 16. The segment definitions were derived by taking each Ohio River ODS site and asessing available information on tributaries, waste discharges and river hydrology to determine boundaries between segments. It was still necessary to include one segment which does not contain an ODS site because the manual sampling results indicate that conditions at Evansville are not characteristic of the river below that city. The Paducah ODS site is located on the segment, but results appear to be influenced more by the Tennessee River than by the Ohio.

In Table 17, observations regarding each substance in the preceeding sections are listed by river segment. Substances are listed in four groups; criteria exceedance, freqency of detection, increase from upstream location, and increasing trend. The first group lists each substance according to the segment in which it exceeded criteria most frequently. In many cases, a particular criteria was exceeded at two or three locations at virtually the same frequency; therefore, several substances are listed in this group for more than one segment. In addition, any instance where a particular criterion was exceded in over half of the samples analyzed is listed. The second group identifies a segment where a substance was detected most frequently but did not exceed criteria as frequently as at other locations. The third group identifies the segment where a substance showed the greatest increase in frequency of detection from one monitoring location to the next downstream location. The fourth group identifies the segment where the concentration or frequency of detection of a substance appears to be increasing. Only substances not listed in the first three groups, and which were detected in over ten percent of the samples analyzed in 1985, are listed here. Some comments on the listings follow.

Segment 1 (Headwaters at the Point in Pittsburgh to confluence with the Beave River) - Water quality in this segment is effected by the Allegheny ar Monongahela Rivers, as well as direct discharges in the Pittsburgh area. A tot of 12 substances are listed for this segment, 8 for criteria exceedance, 3 f frequency of detection, and 1 for increasing trend. Eight of the substanc listed have shown decreasing trends over the period of record while three ha shown no significant trends.

Segment 2 (Beaver River to New Cumberland Dam) - Water quality in this segme is affected by the Beaver River and several small to medium size discharges. T substances are listed, eight for criteria exceedance and two for increasi trends. Five of the former exhibited decreasing trends in this segment whi one - chromium has shown an increase.

Segment 3 (New Cumberland Dam to Wheeling) - Discharges to this segment inclu several steel mills. A total of 17 substances are listed, 10 for criter exceedance, 4 for detection frequency, and 2 for increases from upstream, and for increasing trend. Seven of the substances listed have exhibited decreasi trends while two - copper and dibromochloromethane have shown increases.

Segment 4 (Wheeling to Belleville Dam) - Several chemical plants discharge this segment; in addition, the Muskingum River joins the Ohio as do t significant tributaries not monitored by the Commission, the Little Kanawha ar Hocking Rivers. Of the 11 substances listed, 8 are for criteria exceedance, are for detection frequency, and 1 is for increasing trend. Six of thes substances have shown decreasing trends at locations in this segment while two tetrachloroethylene and methylene chloride have shown increases.

Segment 5 (Belleville Dam to confluence with Big Sandy River) - Major impacts water quality in this segment can be attributed to the Kanawha Rive particularly levels of organic chemicals. The largest direct discharge is t Huntington wastewater treatment plant. Of the 10 substances listed, 8 are f criteria exceedance and 2 are for frequent detections. Five of the substanc have shown decreasing trends in this segment while one - chromium has shown increasing trend.

Segment 6 (Big Sandy River to confluence with Scioto River) - Several steel and chemical plants discharge to this segment, and to the Big Sandy River shortly above its confluence with the Ohio. Nine substances are listed, six for criteria exceedance, one for detection frequency, and two for increasing trends. Two of the listed substances - lead and copper - have exhibited decreasing trends in this segment.

Segment 7 (Scioto River to confluence with Little Miami River)- The major discharges to this segment are power plants. Major discharges to the Scioto River are located well upstream of the confluence with the Ohio. Six substances are listed, five for criteria exceedance and one for increasing trend. Lead has shown a decreasing trend while copper and mercury have increased.

Segment 8 (Little Miami River to McAlpine Dam) - Major discharges to this segment are those from the Cincinnati area; significant tributaries entering this segment are the Little Miami, Licking, Great Miami, and Kentucky Rivers (the latter is not monitored by the Commission). Six substances are listed, three for criteria exceedance, one for detection frequency, one for an increase from an upstream location and one for an increasing trend. Two substances have shown decreasing trends while copper and methylene chloride have increased.

Segment 9 (McAlpine Dame to Evansville) - Major discharges to this segment include those in the Louisville area as well as several chemical and paper plants. Significant tributaries are the Green River, which is monitored by the Commission, and the Salt River, which is not. Eleven substances are listed - five for criteria exceedance, two for detection frequency, two for increases from upstream locations, and two for increasing trends. Five have exhibited decreasing trends in this segment while four - bromodichloromethane, phenolics, chlorobenzene and chloroform - have shown increases.

Segment 10 (Evansville to confluence with Mississippi River) - Water quality in this segment is affected by three major tributaries - the Wabash, Cumberland, and Tennessee Rivers - as well as several discharges, including chemical plants. There is no ODS site in this segment of the Ohio River. One substance is listed for each group; three have shown decreasing trends.

TABLE 16

OHIO RIVER SEGMENTS FOR TOXIC SUBSTANCES STUDY

NUMBER	DEFINITION	MILEPOINTS	NUMBERS OF: WATER SUPPLY IN TAKES	MUNICPAL DISCHARGES	I D
1	Point to Beaver River	0.0-25.4	4	11	
2	Beaver to New Cumberland Dam	25.4-54.4	5	B	
3	New Cumberland to Wheeling	54.4-86.8	5	12	
4	Wheeling to Belleville Dam	86.8-203.9	2	19	
5	Belleville to Big Sandy River	203.9-317.1	2	15	
6	Big Sandy to Scioto River	317.1-356.5	4	11	
7	Scioto to Little Miami River	356.5-464.1	4	7	
8	Little Miami to McAlpine Dam	464.1-606.0	2	15	
9	McAlpine to Evansville	606.0-791.5	3	14	
10	Evansville to Mississippi River	791.5-981.0	9	12	

TABLE 17

SUMMARY OF RESULTS BY SEGMENT

EGMENT	DESCRIPTION	CRITERIA EXCEEDANCE	FREQUENT DETECTIONS	INCREASE FROM UPSTREAM LOCATION	INCREASING TREND
1	Point to Beaver River (MP 0.0-25.4)	Cyanide Lead Nickel PCB Benzene 1,2-Dichloroethylene Tetrachloroethylene Trichlorofluoromethane	Phenolics Chlorobenzene Trichloroethylene		Mercury
2	to New Cumberland Dam (MP 25.2-54.4)	Chromium Cyanide Lead Nickel Phenolics Zinc 1,1-Dichloroethylene PCB			Copper Mercury
3	to Wheeling (MP 54.4-86.8)	Arsenic Copper Cyanide Lead Nickel Benzene Phenolics Chloroform PCB Chlordane	Zinc Tetrachloroethylene 1,1,1-Trichloroethane Trichloroethylene	Chlorobenzene 1,2-Dichloropropane	Dibromochloromethane
4	to Belleville Dam (MP 86.8-203.9)	Cadmium Cyanide Lead Nickel Zinc Chloroform Methylene Chloride Chlordane	Mercury Hexachlorobenzene		Tetrachloroethylene
5	to Big Sandy River (MP 203.9-317.1)	Arsenic Copper Lead Bromodichloromethane Carbon Tetrachloride Dibromochloromethane Tetrachloroethylene	Chromium		
6	to Scioto River (MP 317.1-356.5)	Arsenic Lead Bromodichloromethane Chloroform Dibromochloromethane Tetrachloroethylene	Copper		1,2-Dichloroethane 1,2-Dichloropropane
7	to Little Miami River (MP 356.5-464.1)	Arsenic Copper Lead Chloroform Methylene Chloride			Mercury
8	to McAlpine Dam (MP 464.1-605.0)	Copper Mercury Phenolics	1,1,1-Trichloroethane	Trichlorofluoromethane	Methylene Chloride
9	to Evansville (MP 605.0-791.5)	Cadmium Lead Mercury Bromodichloromethane Chloroform	PCB Chlordane	Copper Zinc	Phenolics Chlorobenzene
0	to Missippi River (MP 791.5-981.0)	Lead	Mercury	Zinc Cadmium (MCL)	Cadmium

CONCLUSIONS

1. Toxic substances, primarily those identified by US EPA as the "priority pollutants," have been detected throughout the length of the Ohio River. Many of those substances have been detected most frequently at specific locations while a few (copper, zinc, DDE in fish tissue) have been detected frequently at all locations.

2. Comparison of Ohio River data to various adopted and proposed stream criteria indicates that the most frequently exceeded criteria levels are the cancer risk level criteria for chloroform, chronic aquatic life criteria for lead, copper, and zinc, human health criteria for mercury and nickel and cancer risk level criteria for arsenic and methylene chloride.

3. Results of ten years of monthly sampling at 36 sites on the Ohio River and its tributaries for metals, phenolics, and cyanide show that chromium, copper, lead, nickel, phenolics, and zinc have been detected in over half of the samples analyzed. Stream criteria for the protection of aquatic life have frequently been exceeded for the chemicals in this group.

4. Trend analysis for the monthly data indicates that concentrations of most of the substances monitored are decreasing at most Ohio River locations. Chromium is the only parameter from this group which has increased at more than half of the main stem monitoring locations.

5. Daily analyses for 16 volatile organic compounds are conducted at 13 sites on the Ohio River and its major tributaries through the Commission's Organics Detection System which was established in 1979. Chloroform has been the only compound found in over half of the samples analyzed. Cancer Risk Level Criteria for certain compounds in this group have frequently been exceeded.

6. Trends for the frequencies of detection were analyzed for each volatile organic compound at each ODS site. In general, the compounds detected most frequently showed significant decreasing trends at most sites.

Detections of bromochloromethane showed increasing trends at the most locations (six sites), but overall detections of that compound were quite low (0.4 percent of the samples analyzed in 1985).

7. Two groups of substances from the priority pollutants-acid compounds and base/neutral compounds - do not appear to present problems in the Ohio River.

8. Pesticides and PCB's have rarely been detected in water samples from the Ohio River and its tributaries, but are routinely found in samples of fish tissue. Levels of PCB and the pesticide chlordane have at times exceeded US FDA limits for safe consumption of fish.

9. Although the data indicate frequent exceedances of stream criteria to protect human health and aquatic life, the impact of these levels of toxic substances is not apparent. A means of quantifying extremely subtle impacts on human health and aquatic life is needed in order to fully evaluate the effects of toxic substances in the Ohio River.

10. Due to the use of the Ohio River as a source of water supply for over three million people, there is particular concern over the impacts on human health from toxic substances. Guidance on the interpretation of cancer risk level criteria is needed to address this concern.

11. No single location or portion of the Ohio River emerges from the foregoing analyses as having the "worst" toxics problem. Instead, each portion of the river has a specific combination of problems and concerns. Selection of priority segments for further study must therefore consider other factors such as population affected, availability of data, and nature of the apparent concerns.

12. In order to identify problem areas for specific toxics, the river has been divided into ten segments, based primarily on ODS sites. For each of the toxics monitored, segments have been identified where
    - criteria exceedance is greatest.
    - the frequency of detection is greatest

- the increase in detections over the next upstream location is greatest
- incidence of a substance appears to be increasing

Substances of concern for each segment are as follows:

Segment 1 (mp 0.0-25.4) - cyanide, lead, nickel, PCB, benzene, 1,1-dichloroethylene, tetrachloroethylene, trichlorofluoromethane, phenolic chlorobenzene, trichloroethylene, mercury.

Segment 2 (mp 25.4-54.4) - chromium, cyanide, lead, nickel, phenolics, zinc, 1,1-dichloroethylene, PCB, copper, mercury.

Segment 3 (mp 54.4-80.6) - arsenic, copper, cyanide, lead, nickel, benzene, phenolics, chloroform, PCB, chlordane, zinc, tetrachloroethylene, 1,1,1-trichloroethane, trichloroethylene, chlorobenzene, 1,2-dichloropropane, dibromochloromethane.

Segment 4 (mp 80.6-203.9) - cadmium, cyanide, lead, nickel, zinc, chloroform, methylene chloride, chlordane, hexachlorobenzene, mercury, tetrachloroethylene.

Segment 5 (mp 203.9-317.1) - arsenic, copper, lead, bromodichloromethane, carbon tetrachloride, chloroform, dibromochloromethane, tetrachloroethylene, chromium, trichloroethane.

Segment 6 (mp 317.1-356.5) - arsenic, lead, bromodichloromethane, chloroform, dibromochloromethane, tetrachloroethylene, copper, 1,2-dichloroethane, 1,2-dichloropropane.

Segment 7 (mp 356.5-464.1) - arsenic, copper, lead, chloroform, methylene chloride, mercury.

Segment 8 (mp 464.1-605.0) - copper, mercury, phenolics, 1,1,1-trichloroethane, trichlorofluoromethane, methylene chloride.

Segment 9 (mp 605.0-791.5) - cadmium, lead, mercury, bromodichloromethane, chloroform, PCB, chlordane, copper, zinc, phenolics, chlorobenzene.

Segment 10 (mp 791.5-981.0) - lead, mercury, zinc, cadmium.

APPENDIX

Data Summaries from

TABLE A1
OHIO RIVER ARSENIC SUMMARY - 1976-1985

	MILEPOINT	NS	ND	N>50	MAX
South Heights	15.2	37	10	0	16
East Liverpool	40.2	35	8	0	4
Pike Island	84.2	39	14	0	17
Shadyside	102.4	37	10	0	8
Hannibal	126.4	32	8	0	2
Willow Island	161.8	38	10	0	11
Belleville	203.9	39	11	0	11
Addison	260.0	37	9	0	10
Gallipolis	279.2	40	13	0	10
Huntington	306.9	36	11	0	3
Kenova	315.8	35	8	0	2
Greenup	341.0	35	12	0	7
Meldahl	436.2	38	12	0	15
Cincinnati	462.8	39	12	0	16
North Bend	490.0	40	4	0	10
Markland	531.5	38	6	0	4
Louisville	600.6	37	4	0	2
West Point	625.9	37	4	0	8
Cannelton	720.7	37	4	0	5
Evansville	791.5	38	4	0	6
Uniontown	846.0	37	4	0	5
Smithland	918.5	12	2	0	2
Joppa	952.3	36	5	0	4

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A2
OHIO RIVER CADMIUM SUMMARY - 1976-1985

	MILEPOINT	NS	ND	N>1.1	N>3.9	N>5	N>10	MAX
South Heights	15.2	112	54	30	8	3	2	29
East Liverpool	40.2	114	60	29	7	3	0	8
Pike Island	84.2	117	65	38	9	3	1	19
Shadyside	102.4	114	65	37	7	2	1	13
Hannibal	126.4	92	44	32	6	2	0	10
Willow Island	161.8	116	56	35	5	1	1	13
Belleville	203.9	118	77	37	11	4	0	10
Addison	260.0	117	59	37	10	4	0	9
Gallipolis	279.2	116	54	29	6	3	1	30
Huntington	306.9	115	49	28	5	2	2	44
Kenova	315.8	112	57	43	18	9	3	18
Greenup	341.0	109	56	34	10	4	1	29
Meldahl	436.2	113	51	39	13	3	1	13
Cincinnati	462.8	119	47	27	8	3	0	7
North Bend	490.0	118	67	34	8	1	0	6
Markland	531.5	107	61	38	13	10	3	20
Louisville	600.6	118	44	18	5	2	0	10
West Point	625.9	118	57	29	7	3	0	7
Cannelton	720.7	113	46	21	7	3	1	28
Evansville	791.5	117	39	16	5	4	1	13
Uniontown	846.0	119	53	25	5	2	0	10
Smithland	918.5	30	9	5	2	2	1	12
Joppa	952.3	118	41	16	5	4	3	13

NS = Number of samples
ND = Number of Oetections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A3
OHIO RIVER CHROMIUM SUMMARY - 1976-1985

	MILEPOINT	NS	ND	N>11	N>16	N>50	N>120	MAX	TREND
South Heights	15.2	62	34	7	4	1	1	288	+
East Liverpool	40.2	62	45	23	14	1	1	250	+
Pike Island	84.2	63	40	13	7	3	1	140	+
Shadyside	102.4	62	42	16	7	0	0	32	+
Hannibal	126.4	40	16	2	0	0	0	16	+
Willow Island	161.8	63	36	5	2	0	0	20	+
Belleville	203.9	65	35	10	3	1	1	164	+
Addison	260.0	64	38	11	3	0	0	34	+
Gallipolis	279.2	65	36	10	7	0	0	32	+
Huntington	306.9	63	39	15	11	0	0	44	-
Kenova	315.8	61	43	15	7	0	0	40	-
Greenup	341.0	56	33	12	6	0	0	28	+
Meldahl	436.2	58	32	7	5	0	0	28	+
Cincinnati	462.8	64	38	15	8	0	0	36	-
North Bend	490.0	68	40	17	5	0	0	28	+
Markland	531.5	57	28	9	3	1	0	60	+
Louisville	600.6	64	18	6	5	0	0	40	-
West Point	625.9	62	20	14	9	0	0	20	-
Cannelton	720.7	60	18	6	3	0	0	20	+
Evansville	791.5	62	22	14	13	0	0	40	-
Uniontown	846.0	66	19	7	5	0	0	40	-
Smithland	918.5	17	0	0	0	0	0	-	0
Joppa	952.3	63	17	5	3	0	0	20	+

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A4
OHIO RIVER COPPER SUMMARY - 1976-1985

	MILEPOINT	NS	ND	N>12	N>18	N>22	N>50	M>1000	MA
South Heights	15.2	119	112	53	38	22	7	0	
East Liverpool	40.2	119	113	57	38	29	6	0	9
Pike Island	84.2	121	116	60	46	30	12	0	6
Shadyside	102.4	118	115	55	33	24	37	0	3
Hannibal	126.4	97	94	40	25	45	6	0	
Willow Island	161.8	118	113	45	27	25	6	0	5
Belleville	203.9	120	115	47	35	25	12	0	2
Addison	260.0	118	118	81	38	20	26	0	7
Gallipolis	279.2	119	115	72	32	21	14	0	5
Huntington	306.9	117	117	77	71	66	49	1	24
Kenova	315.8	113	110	64	47	41	22	0	2
Greenup	341.0	110	110	52	37	23	13	0	9
Meldahl	436.2	117	114	45	35	35	16	2	16
Cincinnati	462.8	121	121	87	64	53	34	3	22
North Bend	490.0	118	113	53	25	16	6	0	1
Markland	531.5	107	100	53	30	13	6	0	2
Louisville	600.6	120	99	69	52	39	12	0	3
West Point	625.9	120	93	51	24	15	2	0	1
Cannelton	720.7	114	85	40	25	20	6	0	4
Evansville	791.5	119	103	63	48	36	18	0	2
Uniontown	846.0	121	89	30	18	11	4	0	
Smithland	918.5	48	39	12	4	1	1	0	
Joppa	952.3	120	98	45	20	12	6	0	1

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A5
OHIO RIVER CYANIDE SUMMARY - 1976-1985

	MILEPOINT	NS	ND	N>5	N>25	MAX	TREND
South Heights	15.2	224	126	106	23	70	-
East Liverpool	40.2	225	124	103	20	90	-
Pike Island	84.2	222	124	102	23	110	-
Shadyside	102.4	224	113	92	16	100	-
Hannibal	126.4	162	84	65	9	60	-
Willow Island	161.8	218	96	78	11	90	-
Belleville	203.9	178	70	47	8	60	-
Addison	260.0	166	59	38	6	60	-
Gallipolis	279.2	172	52	30	1	30	-
Huntington	306.9	167	26	10	0	20	-
Kenova	315.8	156	38	22	1	60	-
Greenup	341.0	164	56	35	0	20	-
Meldahl	436.2	164	38	20	1	30	-
Cincinnati	462.8	170	38	19	0	20	-
North Bend	490.0	167	30	24	0	20	-
Markland	531.5	166	34	29	0	20	-
Louisville	600.6	169	13	5	0	10	-
West Point	625.9	166	20	15	0	13	+
Cannelton	720.7	173	14	7	1	88	-
Evansville	791.5	173	15	7	0	20	-
Uniontown	846.0	173	7	3	0	10	-
Smithland	918.5	49	6	1	1	79	+
Joppa	952.3	176	6	1	0	10	-

NS = Number of Samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A6
OHIO RIVER LEAD SUMMARY - 1976-1985

	MILEPOINT	NS	ND	N>3.2	N>20	N>50	N>82	MAX	TRE
South Heights	15.2	117	70	69	17	1	0	60	-
East Liverpool	40.2	118	89	89	33	2	0	60	-
Pike Island	84.2	121	83	83	35	9	7	500	-
Shadyside	102.4	119	82	82	27	2	0	60	-
Hannibal	126.4	97	52	52	8	2	0	70	-
Willow Island	161.8	118	77	77	21	7	6	890	-
Belleville	203.9	120	78	78	21	6	4	410	-
Addison	260.0	118	75	75	24	2	2	180	-
Gallipolis	279.2	118	74	74	23	5	2	130	-
Huntington	306.9	117	70	70	30	2	1	150	-
Kenova	315.8	113	75	74	40	7	3	110	-
Greenup	341.0	110	74	74	31	2	1	110	-
Meldahl	436.2	114	78	78	36	7	1	180	-
Cincinnati	462.8	122	78	78	26	5	1	100	-
North Bend	490.0	118	84	72	21	1	0	59	-
Markland	531.5	107	70	57	25	6	3	300	-
Louisville	600.6	120	73	65	21	1	1	220	
West Point	625.9	120	88	80	32	2	0	70	-
Cannelton	720.7	115	74	67	26	2	1	410	-
Evansville	791.5	118	81	76	26	6	3	180	-
Uniontown	846.0	125	82	73	27	5	1	124	-
Smithland	918.5	48	30	26	6	4	3	280	-
Joppa	952.3	120	70	63	19	3	3	250	-

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A7
OHIO RIVER MERCURY SUMMARY - 1976-1985

	MILEPOINT	NS	ND	N>0.1	N>0.2	N>2.0	MAX	TREND
South Heights	15.2	120	40	22	10	0	1.1	+
East Liverpool	40.2	117	41	22	11	0	0.6	+
Pike Island	84.2	119	44	27	14	2	5.5	-
Shadyside	102.4	117	41	20	9	0	0.8	-
Hannibal	126.4	97	46	29	17	0	0.7	+
Willow Island	161.8	118	45	26	16	0	1.5	-
Belleville	203.9	120	45	31	18	1	3.0	-
Addison	260.0	118	44	26	16	2	3.2	-
Gallipolis	279.2	119	42	27	13	1	3.4	-
Huntington	306.9	116	53	34	25	2	2.5	+
Kenova	315.8	112	40	28	14	2	3.5	-
Greenup	341.0	110	38	27	18	1	2.3	-
Meldahl	436.2	114	43	19	12	0	1.3	+
Cincinnati	462.8	122	43	23	14	0	1.7	+
North Bend	490.0	116	43	32	21	0	1.6	+
Markland	531.5	104	60	40	38	1	2.7	-
Louisville	600.6	114	44	32	18	0	1.0	+
West Point	625.9	113	48	34	17	0	1.0	-
Cannelton	720.7	103	47	38	24	1	6.0	-
Evansville	791.5	117	44	37	20	0	1.2	+
Uniontown	846.0	124	57	38	28	1	8.8	-
Smithland	918.5	47	9	8	5	0	0.6	-
Joppa	952.3	117	39	30	13	0	1.0	-

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A8
OHIO RIVER NICKEL SUMMARY - 1976-1985

	MILEPOINT	NS	ND	N>13	N>96	MAX	TREND
South Heights	15.2	63	57	48	0	40	-
East Liverpool	40.2	62	50	45	0	70	-
Pike Island	84.2	62	43	35	0	40	-
Shadyside	102.4	62	42	37	0	50	-
Hannibal	126.4	41	16	13	0	24	-
Willow Island	161.8	63	34	24	1	110	-
Belleville	203.9	63	40	26	0	24	-
Addison	260.0	63	46	32	0	78	+
Gallipolis	279.2	65	38	27	0	30	-
Huntington	306.9	61	40	28	0	40	-
Kenova	315.8	61	37	19	0	76	-
Greenup	341.0	53	28	19	0	30	-
Meldahl	436.2	60	34	19	0	75	-
Cincinnati	462.8	66	40	22	1	136	+
North Bend	490.0	65	39	21	0	50	+
Markland	531.5	52	24	16	1	110	+
Louisville	600.6	61	17	6	1	100	-
West Point	625.9	61	25	16	2	100	-
Cannelton	720.7	55	14	10	1	100	-
Evansville	791.5	61	18	11	0	50	-
Uniontown	846.0	63	22	12	0	30	-
Smithland	918.5	16	2	1	0	14	-
Joppa	952.3	60	16	9	0	70	+

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A9
OHIO RIVER PHENOLICS SUMMARY - 1976-1985

	MILEPOINT	NS	ND	N>2	N>10	MAX	TREND
South Heights	15.2	225	163	55	27	100	-
East Liverpool	40.2	225	175	62	27	87	-
Pike Island	84.2	222	164	64	34	75	-
Shadyside	102.4	225	154	56	19	182	-
Hannibal	126.4	163	124	40	18	295	-
Willow Island	161.8	206	135	43	15	133	-
Belleville	203.9	178	113	29	7	46	-
Addison	260.0	175	110	34	18	80	-
Gallipolis	279.2	172	118	36	11	44	-
Huntington	306.9	169	93	30	20	50	-
Kenova	315.8	159	109	29	15	45	-
Greenup	341.0	169	113	40	13	51	-
Meldahl	436.2	163	107	25	17	54	-
Cincinnati	462.8	169	105	34	21	68	-
North Bend	490.0	165	99	54	30	58	-
Markland	531.5	161	95	38	23	75	-
Louisville	600.6	169	60	24	15	133	+
West Point	625.9	166	78	24	13	76	+
Cannelton	720.7	173	67	21	11	38	+
Evansville	791.5	170	67	20	10	35	+
Uniontown	846.0	171	75	23	10	54	-
Smithland	918.5	51	23	12	7	49	
Joppa	952.3	178	73	28	10	40	+

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentrations, micrograms per liter

TABLE A10
OHIO RIVER SELENIUM SUMMARY - 1976-1985

	MILEPOINT	NS	ND	N>10	MA
South Heights	15.2	38	2	0	1
East Liverpool	40.2	36	2	0	2
Pike Island	84.2	38	3	0	1
Shadyside	102.4	37	2	0	1
Hannibal	126.4	32	2	0	2
Willow Island	161.6	37	4	0	3
Belleville	203.9	38	4	0	3
Addison	260.0	37	5	0	3
Gallipolis	279.2	40	8	0	5
Huntington	306.9	35	5	0	3
Kenova	315.8	35	4	0	2
Greenup	341.0	35	6	0	2
Meldahl	436.2	37	3	0	2
Cincinnati	462.8	40	4	0	2
North Bend	490.0	39	1	0	1
Markland	531.5	37	1	0	2
Louisville	600.6	37	1	0	1
West Point	625.9	37	1	0	2
Cannelton	720.7	36	1	0	1
Evansville	791.5	37	0	0	-
Uniontown	846.0	37	1	0	2
Smithland	918.5	17	0	0	-
Joppa	952.3	37	1	0	1

NS = Number of Samples
ND = Number of Detections
N> = Number of Samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A11
OHIO RIVER SILVER SUMMARY - 1976-1985

	MILEPOINT	NS	ND	N>4	N>50	MAX
South Heights	15.2	43	3	1	0	7
East Liverpool	40.2	40	3	0	0	2
Pike Island	84.2	44	5	1	0	6
Shadyside	102.4	42	3	1	0	5
Hannibal	126.4	32	1	0	0	2
Willow Island	161.6	42	5	1	0	5
Belleville	203.9	43	3	0	0	3
Addison	260.0	42	6	0	0	3
Gallipolis	279.2	45	5	0	0	2
Huntington	306.9	41	3	0	0	3
Kenova	315.8	41	4	0	0	2
Greenup	341.0	37	5	0	0	3
Meldahl	436.2	43	5	0	0	4
Cincinnati	462.8	47	5	0	0	2
North Bend	490.0	47	4	0	0	1
Markland	531.5	39	1	0	0	3
Louisville	600.6	46	1	0	0	1
West Point	625.9	46	3	1	0	26
Cannelton	720.7	39	0	0	0	-
Evansville	791.5	48	1	1	0	20
Uniontown	846.0	47	0	0	0	-
Smithland	918.5	17	0	0	0	-
Joppa	952.3	44	0	0	0	-

NS = Number of samples
ND = Number of detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration micrograms per liter

TABLE A12
OHIO RIVER ZINC SUMMARY - 1976-1985

	MILEPOINT	NS	ND	N>47	N>55	N>100	N>320	MA
South Heights	15.2	119	117	57	39	12	0	26
East Liverpool	40.2	119	118	74	65	24	2	56
Pike Island	84.2	120	120	52	38	15	1	53
Shadyside	102.4	118	118	67	52	20	1	58
Hannibal	126.4	98	96	29	17	5	0	23
Willow Island	161.8	118	114	39	27	5	0	32
Belleville	203.9	120	117	43	25	10	1	19
Addison	260.0	118	116	55	41	14	1	33
Gallipolis	279.2	119	115	45	35	12	2	120
Kenova	315.8	114	110	47	39	18	10	64
Greenup	341.0	112	106	34	30	11	1	14,00
Meldahl	436.2	115	113	42	35	13	1	60
Cincinnati	462.8	122	115	51	40	15	1	60
North Bend	490.0	118	112	32	20	6	0	16
Markland	531.5	107	92	20	17	4	1	35
Louisville	600.6	120	98	33	21	3	0	23
West Point	625.9	120	110	49	43	12	2	154
Cannelton	720.7	115	104	53	33	10	0	26
Evansville	791.5	119	111	53	43	20	2	42
Uniontown	846.0	127	99	29	22	5	0	15
Smithland	918.5	51	45	10	5	2	0	12
Joppa	952.3	120	96	18	10	1	1	85

NS = Number of samples
ND = Number of detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration micrograms per liter

TABLE A13
ARSENIC SUMMARY - OHIO RIVER TRIBUTARIES
1976 - 1985

	NS	ND	N>50	MAX
Allegheny	40	9	0	9
Monongahela	39	10	0	10
Beaver	38	9	0	11
Muskingum	37	10	0	10
Kanawha	40	13	0	15
Big Sandy	37	13	0	9
Scioto	36	12	0	28
Little Miami	37	13	0	18
Licking	39	9	0	28
Great Miami	40	7	0	4
Green	37	3	0	2
Wabash	36	8	0	9
Cumberland	37	4	0	2
Tennessee	35	3	0	2

NS = Number of Samples
ND = Number of Detections
N> = Number of Samples exceeding indicated concentrations
MAX= Maximum concentration, micrograms per liter

TABLE A14
CADMIUM SUMMARY - OHIO RIVER TRIBUTARIES
1976 - 1985

	NS	ND	N>5	N>10	MAX
Allegheny	114	57	0	0	5
Monongahela	112	56	3	0	9
Beaver	115	52	3	0	7
Muskingum	116	71	8	1	13
Kanawha	105	47	4	1	16
Big Sandy	109	45	5	0	9
Scioto	113	64	7	0	8
Little Miami	116	56	5	1	17
Licking	119	45	1	0	7
Great Miami	115	77	9	2	20
Green	115	63	5	2	11
Wabash	111	39	6	4	34
Cumberland	111	42	7	5	19
Tennessee	110	51	3	1	14

NS = Number of Samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A15

CHROMIUM SUMMARY - OHIO RIVER TRIBUTARIES
1976 - 1985

	NS	ND	N>11	N>16	N>50	N>120	MAX
Allegheny	62	34	7	3	0	0	38
Monongahela	57	31	7	2	0	0	22
Beaver	63	44	10	6	2	1	266
Muskingum	63	44	17	5	0	0	44
Kanawha	55	26	7	2	0	0	18
Big Sandy	57	36	12	6	0	0	27
Scioto	62	41	12	4	1	0	60
Little Miami	61	26	6	2	0	0	20
Licking	64	30	9	3	0	0	20
Great Miami	65	44	25	11	0	0	40
Green	59	12	4	3	0	0	30
Wabash	56	15	7	3	0	0	24
Cumberland	57	6	2	2	0	0	24
Tennessee	55	11	5	5	0	0	50

TABLE A16

COPPER SUMMARY - OHIO RIVER TRIBUTARIES
1976 - 1985

	NS	ND	N>12	N>18	N>22	N>50	N>1000	M
Allegheny	117	109	42	25	17	5	0	1
Monongahela	116	106	47	33	21	3	0	5
Beaver	119	111	56	37	23	4	0	6
Muskingum	117	115	58	39	24	5	0	2
Kanawha	106	104	40	31	22	5	0	2
Big Sandy	109	107	54	35	27	11	0	9
Scioto	115	112	50	30	28	7	1	15
Little Miami	117	112	33	22	18	5	0	44
Licking	120	114	32	20	13	5	2	13
Great Miami	114	108	44	21	14	4	1	47
Green	117	84	19	8	5	2	0	11
Wabash	112	79	35	23	15	3	0	1
Cumberland	113	83	41	25	17	5	0	9
Tennessee	112	67	4	1	1	0	0	4

TABLE A17
CYANIDE SUMMARY - OHIO RIVER TRIBUTARIES
1976 - 1985

	NS	ND	N>5	N>10	MAX
Allegheny	194	42	30	0	20
Monongahela	196	139	127	52	230
Beaver	188	132	120	34	90
Muskingum	172	24	4	1	30
Kanawha	165	19	1	0	6
Big Sandy	167	17	2	0	10
Scioto	161	27	3	1	40
Little Miami	164	21	2	0	10
Licking	169	24	2	0	10
Great Miami	166	76	70	20	200
Green	165	4	1	0	6
Wabash	170	3	0	0	2
Cumberland	169	5	0	0	1
Tennessee	171	5	1	1	62

NS = Number of Samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A18
LEAD SUMMARY - OHIO RIVER TRIBUTARIES
1976 - 1985

	NS	ND	N>20	N>50	MAX
Allegheny	116	65	11	1	60
Monongahela	115	69	17	1	70
Beaver	117	83	32	5	130
Muskingum	116	86	44	13	600
Kanawha	107	55	21	5	150
Big Sandy	110	63	25	5	190
Scioto	115	88	46	7	100
Little Miami	118	90	39	8	200
Licking	120	65	18	1	80
Great Miami	113	77	45	12	336
Green	123	82	30	10	205
Wabash	113	72	25	5	520
Cumberland	114	52	14	5	120
Tennessee	111	64	28	7	185

NS = Number of Samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A19
MERCURY SUMMARY - OHIO RIVER TRIBUTARIES
1976 - 1985

	NS	ND	N>0.1	N>0.2	N>2.0	MAX
Allegheny	118	40	20	11	0	1.1
Monongahela	124	46	23	12	1	8.0
Beaver	119	35	18	8	0	0.5
Muskingum	117	46	32	21	0	1.3
Kanawha	106	32	18	9	1	3.4
Big Sandy	109	40	20	12	0	1.4
Scioto	116	50	35	20	2	2.7
Little Miami	117	45	22	12	2	9.6
Licking	120	38	18	14	0	08
Great Miami	114	40	28	11	0	1.5
Green	117	45	38	24	1	22.5
Wabash	107	41	31	18	1	9.2
Cumberland	106	32	23	12	0	0.7
Tennessee	105	40	26	21	0	1.1

NS = Number of Samples
ND = Number of Detections
N> = Number of Samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A20
NICKEL SUMMARY - OHIO RIVER TRIBUTARIES
1976 - 1985

	NS	ND	N>13	N>96	MAX
Allegheny	61	44	39	0	40
Monongahela	57	38	29	0	36
Beaver	63	46	33	0	40
Muskingum	62	44	37	0	40
Kanawha	63	26	12	0	30
Big Sandy	54	26	17	0	50
Scioto	62	40	26	0	70
Little Miami	61	32	17	0	30
Licking	64	30	13	0	60
Great Miami	62	40	33	0	40
Green	57	19	9	0	40
Wabash	53	16	7	0	50
Cumberland	53	3	1	0	12
Tennessee	52	3	0	0	10

NS = Number of Samples
ND = Number of Detections
N> = Number of Samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A21
PHENOLICS SUMMARY - OHIO RIVER TRIBUTARIES
1976 - 1985

	NS	ND	N>5	N>10	MAX
Allegheny	193	122	36	14	57
Monongahela	195	151	49	26	73
Beaver	200	166	78	36	100
Muskingum	189	131	44	20	124
Kanawha	166	111	34	13	96
Big Sandy	168	86	24	15	61
Scioto	163	132	57	22	110
Little Miami	161	120	54	27	49
Licking	169	113	44	29	81
Great Miami	165	117	64	38	98
Green	165	61	20	11	31
Wabash	180	82	31	16	35
Cumberland	169	51	12	7	156
Tennessee	166	58	15	6	76

NS = Number of Samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A22
SELENIUM SUMMARY - OHIO RIVER TRIBUTARIES
1976 - 1985

	NS	ND	N>96	MAX
Allegheny	40	2	0	1
Monongahela	39	3	0	1
Beaver	38	3	0	5
Muskingum	36	3	0	2
Kanawha	35	3	0	2
Big Sandy	36	7	0	4
Scioto	37	5	0	3
Little Miami	37	2	0	2
Licking	39	3	0	2
Great Miami	40	1	0	1
Green	37	0	0	-
Wabash	36	0	0	-
Cumberland	35	1	0	5
Tennessee	34	0	0	-

NS = Number of Samples
ND = Number of Detections
N> = Number of Samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A23
SILVER SUMMARY - OHIO RIVER TRIBUTARIES
1976 - 1985

	NS	ND	N>96	MAX
Allegheny	40	1	0	1
Monongahela	39	3	0	4
Beaver	43	4	0	2
Muskingum	41	7	0	2
Kanawha	36	0	0	-
Big Sandy	37	2	0	2
Scioto	42	B	0	4
Little Miami	44	5	0	2
Licking	45	5	0	2
Great Miami	46	3	1	6
Green	45	0	0	-
Wabash	38	0	0	-
Cumberland	3B	0	0	-
Tennessee	37	0	0	-

NS = Number of Samples
ND = Number of Detections
N> = Number of Samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A24
ZINC SUMMARY - OHIO RIVER TRIBUTARIES
1976 - 1985

	NS	ND	N>47	N>100	N>320	M
Allegheny	117	115	46	2	0	
Monongahela	116	115	62	14	1	
Beaver	119	119	89	23	1	
Muskingum	117	113	24	1	0	
Kanawha	107	97	22	3	0	
Big Sandy	109	97	21	8	0	
Scioto	116	110	37	5	2	
Little Miami	117	103	23	4	2	
Licking	120	99	11	1	1	1
Great Miami	113	111	49	12	1	
Green	120	94	14	3	0	
Wabash	113	95	24	4	0	
Cumberland	112	68	5	0	0	
Tennessee	111	59	1	0	0	

NS = Number of Samples
ND = Number of Detections
N> = Number of Samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A25

BENZENE SUMMARY
OHIO RIVER
1981 - 1985

	MP	NS	ND	N>.66	N>5.0	N>6.6
West View	4.5	218	18	17	9	6
Wheeling	86.8	1448	232	133	12	6
Huntington	306.9	684	15	11	3	3
Louisville	600.6	137	0	0	0	0

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A26
BROMOCHLOROMETHANE SUMMARY
OHIO RIVER AND TRIBUTARIES - 1979-85

	MP	NS	ND	N>.2	N>1.9	MAX
West View	4.5	1310	83	24	0	1.7
East Liverpool	40.2	160	2	2	0	1.2
Wheeling	86.8	2157	16	2	0	1.8
Parkersburg	190.3	646	0	-	-	-
Huntington	306.9	1666	20	6	0	1.5
Portsmouth	350.1	1616	9	3	0	0.6
Cincinnati	462.8	2477	1	0	0	0.1
Louisville	600.6	2338	10	3	0	0.5
Evansville	791.5	2457	2	0	0	0.1
TOTAL		14,827	143	40	0	-
Allegheny		2143	1	1	0	1.0
Monongahela		1003	8	8	2	6.2
Kanawha		692	17	8	1	6.3
Paducah		125	0	0	0	-

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A27
BROMODICHLOROMETHANE SUMMARY
OHIO RIVER AND TRIBUTARIES - 1979-1985

	MP	NS	ND	N>.2	N>1.9	MAX	TREND
West View	4.5	1310	121	27	1	7.9	-
East Liverpool	40.2	160	3	0	0	0.1	
Wheeling	86.8	2157	101	24	3	2.6	0
Parkersburg	190.3	646	20	B	0	0.9	0
Huntington	306.9	1666	415	233	3	7.9	-
Portsmouth	350.1	1616	458	122	3	7.9	0
Cincinnati	462.8	2477	99	10	0	1.3	-
Louisville	600.6	233B	106	14	1	2.6	0
Evansville	791.5	2457	452	36	0	1.2	+
TOTAL		14,827	1775	474	11		
Allegheny		2143	167	107	12	7.8	-
Monongahela		1003	130	42	4	4.5	-
Kanawha		692	301	162	4	4.6	0
Paducah		125	0	-	-	-	

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A28
BROMOFORM SUMMARY
OHIO RIVER AND TRIBUTARIES - 1979-19B5

	MP	NS	ND	N>.2	N>1.9	MAX
West View	4.5	1310	54	11	0	1.7
East Liverpool	40.2	160	12	7	3	7.5
Wheeling	86.8	2157	75	45	3	5.3
Parkersburg	190.3	646	5	5	5	5.7
Huntington	306.9	1666	158	73	12	11.5
Portsmouth	350.1	1616	95	29	8	17.4
Cincinnati	462.8	2477	13	3	0	1.1
Louisville	600.6	2338	8	4	0	1.0
Evansville	791.5	2457	150	12	4	6.0
TOTAL		14,827	570	189	35	
Allegheny		2143	18	13	5	6.0
Monongahela		1003	3	3	0	1.9
Kanawha		692	60	37	2	2.7
Paducah		125	2	2	1	10.5

NS = Number of samples
NO = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A29
CARBON TETRACHLORIDE SUMMARY
OHIO RIVER AND TRIBUTARIES - 1979-1985

	MP	NS	ND	N>.4	N>4.0	N>5.0	MAX	TREND
West View	4.5	1310	71	4	0	0	0.9	-
East Liverpool	40.2	160	1	1	0	0	0.5	
Wheeling	86.8	2157	71	4	0	0	1.8	0
Parkersburg	190.3	646	13	4	0	0	3.6	0
Huntington	306.9	1666	524	148	7	3	9.1	0
Portsmouth	350.1	1616	73	13	1	1	9.1	0
Cincinnati	462.8	2477	45	2	0	0	0.7	-
Louisville	600.6	2338	37	0	0	0	0.4	0
Evansville	791.5	2457	31	1	0	0	0.5	0
TOTAL		14,827	866	177	8	4		
Allegheny		2143	44	10	0	0	2.4	-
Monongahela		1003	15	3	0	0	1.3	-
Kanawha		692	572	374	23	16	14.7	0
Paducah		125	0	-	-		0.1	

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A30
CHLOROBENZENE SUMMARY
OHIO RIVER AND TRIBUTARIES - 1979-1985

	MP	NS	ND	N>20	MAX	TRE
West View	4.5	1310	355	0	9.9	-
East Liverpool	40.2	160	6	1	32.1	
Wheeling	86.8	2157	96	0	2.3	0
Parkersburg	190.3	646	16	0	5.9	+
Huntington	306.9	1666	294	2	53.6	-
Portsmouth	350.1	1616	150	0	8.7	0
Cincinnati	462.8	2477	132	0	1.1	0
Louisville	600.6	2338	7	0	1.9	+
Evansville	791.5	2457	124	0	2.9	+
TOTAL		14,827	1180	3		
Allegheny		2143	28	0	3.9	0
Monongahela		1003	8	0	0.9	0
Kanawha		692	98	0	5.8	+
Paducah		125	4	0	3.0	

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A31
CHLOROFORM SUMMARY
OHIO RIVER AND TRIBUTARIES - 1979-1985

	MP	NS	ND	N>.2	N>1.9	MAX	TREND
West View	4.5	1310	457	133	2	7.3	-
East Liverpool	40.2	160	64	26	2	3.5	
Wheeling	86.8	2157	1978	1227	248	79.9	0
Parkersburg	190.3	646	411	338	29	6.5	0
Huntington	306.9	1666	1270	939	162	59.8	-
Portsmouth	350.1	1616	1342	822	25	12.5	0
Cincinnati	462.8	2477	2031	365	8	6.8	0
Louisville	600.6	2338	1407	366	5	7.5	0
Evansville	791.5	2457	1906	603	5	13.4	+
TOTAL		14,827	10,866	4819	486		
Allegheny		2143	484	300	56	16.0	-
Monongahela		1003	795	567	53	10.2	-
Kanawha		692	637	142	142	28.8	0
Paducah		125	68	11	0	1.1	

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A32
DIBROMDCHLDROMETHANE SUMMARY
OHIO RIVER AND TRIBUTARIES - 1979-1985

	MP	NS	ND	N>.2	N>1.9	MAX
West View	4.5	1310	145	65	7	3.9
East Liverpool	40.2	160	7	4	0	1.2
Wheeling	86.8	2157	159	67	1	5.6
Parkersburg	19D.3	646	8	5	0	1.3
Huntington	306.9	1666	325	165	8	9.4
Portsmouth	350.1	1616	249	63	4	12.7
Cincinnati	462.8	2477	37	3	0	0.5
Louisville	600.6	2338	23	9	0	0.8
Evansville	791.5	2457	42	1	0	0.6
TOTAL		14,827	995	382	20	
Allegheny		2143	57	28	1	2.9
Monongahela		1003	12	6	0	1.4
Kanawha		692	160	54	0	1.4
Paducah		125	33	32	2	4.3

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A33
1,1-DICHLOROETHANE SUMMARY
OHIO RIVER AND TRIBUTARIES - 1979-1985

	MP	NS	ND	MAX	TREND
West View	4.5	1310	85	2.3	0
East Liverpool	40.2	160	2	2.3	
Wheeling	86.8	2157	17	1.4	0
Parkersburg	190.3	646	16	4.5	-
Huntington	306.9	1666	42	10.6	-
Portsmouth	350.1	1616	34	5.5	0
Cincinnati	462.8	2477	3	2.5	-
Louisville	600.6	2338	23	1.8	0
Evansville	791.5	2457	2	0.3	0
TOTAL		14,827	224		
Allegheny		2143	11	1.0	0
Monongahela		1003	86	19.2	0
Kanawha		692	35	2.9	0
Paducah		125	0	-	

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A34
1,2-DICHLOROETHANE SUMMARY
OHIO RIVER AND TRIBUTARIES - 1979-1985

	MP	NS	ND	N>.9	N>5.0	N>9.4	MAX	TRE
West View	4.5	1310	184	8	0	0	4.7	-
East Liverpool	40.2	160	4	1	0	0	1.6	
Wheeling	86.8	2157	35	1	0	0	2.1	(
Parkersburg	190.3	646	28	6	0	0	2.7	-
Huntington	306.9	1666	161	7	0	0	3.9	(
Portsmouth	350.1	1616	170	12	0	0	2.8	+
Cincinnati	462.8	2477	62	2	0	0	2.0	(
Louisville	600.6	2338	35	1	0	0	4.0	(
Evansville	791.5	2457	18	1	0	0	1.0	(
TOTAL		14,827	697	39	0	0		
Allegheny		2143	70	5	1	0	2.6	
Monongahela		1003	25	5	0	0	4.6	
Kanawha		692	357	52	2	0	8.5	
Paducah		125	105	96	60	43	43.8	

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A35
1,1-DICHLOROETHYLENE SUMMARY
OHIO RIVER AND TRIBUTARIES - 1979-1985

	MP	NS	ND	N>.3	N>7.0	MAX	TREND
West View	4.5	1310	151	42	0	2.9	-
East Liverpool	40.2	160	5	1	0	1.2	
Wheeling	86.8	2157	61	8	0	1.0	0
Parkersburg	190.3	646	20	14	0	5.4	-
Huntington	306.9	1666	118	20	0	6.7	0
Portsmouth	350.1	1616	28	12	0	2.6	+
Cincinnati	462.8	2477	4	0	0	0.2	0
Louisville	600.6	2338	152	1	0	1.3	0
Evansville	791.5	2457	6	1	1	17.0	0
TOTAL		14,827	545	99	1		
Allegheny		2143	13	4	0	0.8	0
Monongahela		1003	2	1	0	1.0	0
Kanawha		692	295	122	4	23.2	+
Paducah		125	1	1	0	3.1	

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A36
1,2-DICHLOROPROPANE SUMMARY
OHIO RIVER AND TRIBUTARIES - 1979-1985

	MP	NS	ND	N>6	MAX	TREND
West View	4.5	131D	104	0	5.3	-
East Liverpool	40.2	160	4	D	0.8	
Wheeling	86.8	2157	28	0	0.9	0
Parkersburg	190.3	646	13	0	1.D	-
Huntington	306.9	1666	218	1	11.0	0
Portsmouth	350.1	1616	126	2	17.3	+
Cincinnati	462.8	2477	D	-	-	0
Louisville	600.6	2338	31	0	0.4	0
Evansville	791.5	2457	15	0	D.4	0
TOTAL		14,827	539	3		
Allegheny		2143	8	0	2.9	0
Monongahela		1003	5	0	0.5	0
Kanawha		692	418	0	5.4	0
Paducah		125	0	0	-	

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A37
METHYLENE CHLORIDE SUMMARY
OHIO RIVER AND TRIBUTARIES - 1979-1985

	MP	NS	ND	N>.2	N>1.9	MAX	TREND
West View	4.5	1310	433	159	10	26.3	-
East Liverpool	40.2	160	22	4	1	3.8	
Wheeling	86.8	2157	738	200	17	11.3	0
Parkersburg	190.3	646	460	352	123	80.2	+
Huntington	306.9	1666	356	139	19	27.8	0
Portsmouth	350.1	1616	391	164	17	17.0	0
Cincinnati	462.8	2477	825	264	19	9.7	0
Louisville	600.6	2338	450	166	8	10.3	+
Evansville	791.5	2457	517	111	6	3.8	0
TOTAL		14,827	4192	1559	220		
Allegheny		2143	261	160	33	13.8	-
Monongahela		1003	103	87	23	13.0	-
Kanawha		692	268	126	23	73.5	0
Paducah		125	12	12	0	8.8	

NS = Number of samples
ND = Number of Oetections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A38
TETRACHLOROETHYLENE SUMMARY
OHIO RIVER AND TRIBUTARIES - 1979-1985

	MP	NS	ND	N>.8	N>8.0	MAX
West View	4.5	1310	727	91	2	18.7
East Liverpool	40.2	160	12	0	0	0.7
Wheeling	86.8	2157	1100	90	0	6.4
Parkersburg	190.3	646	73	26	0	4.7
Huntington	306.9	1666	743	194	0	7.9
Portsmouth	350.1	1616	917	156	2	12.8
Cincinnati	462.8	2477	286	0	0	0.5
Louisville	600.6	2338	462	11	0	2.9
Evansville	791.5	2457	519	10	0	2.6
TOTAL		14,827	4839	578	4	
Allegheny		2143	373	33	5	20.1
Monongahela		1003	221	113	7	25.3
Kanawha		692	334	29	0	6.5
Paducah		125	1	0	0	1.0

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A39
1,1,1-TRICHLOROETHANE SUMMARY
OHIO RIVER AND TRIBUTARIES - 1979-1985

	MP	NS	ND	N>200	MAX	TREND
West View	4.5	1310	391	0	3.3	-
East Liverpool	40.2	160	8	0	38.1	
Wheeling	86.8	2157	1562	0	8.9	0
Parkersburg	190.3	646	27	0	4.7	-
Huntington	306.9	1666	329	0	19.2	-
Portsmouth	350.1	1616	468	0	43.2	0
Cincinnati	462.8	2477	265	0	4.5	-
Louisville	600.6	2338	1093	0	79.6	0
Evansville	791.5	2457	644	0	1.8	+
TOTAL		14,827	4787	0		
Allegheny		2143	187	0	4.6	-
Monongahela		1003	3B	0	2.5	0
Kanawha		692	240	0	20.8	+
Paducah		125	4	0	14.9	

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A40
TRICHLOROETHYLENE SUMMARY
OHIO RIVER AND TRIBUTARIES - 1979-1985

	MP	NS	ND	N>.3	N>2.7	N>5.0	N>27.0	MAX
West View	4.5	1310	492	127	2	2	0	18
East Liverpool	40.2	160	6	3	0	0	0	1
Wheeling	86.8	2157	1070	134	3	0	0	4
Parkersburg	190.3	646	40	10	0	0	0	2
Huntington	306.9	1666	661	318	3	1	0	9
Portsmouth	350.1	1616	507	77	5	2	0	19
Cincinnati	462.8	2477	246	1	0	0	0	0
Louisville	600.6	2338	245	24	0	0	0	1
Evansville	791.5	2457	170	24	0	0	0	2
TOTAL		14,827	3437	718	13	5	0	
Allegheny		2143	114	24	0	0	0	1
Monongahela		1003	94	32	4	0	0	3
Kanawha		692	338	68	9	1	0	5
Paducah		125	0	-	-	-	-	

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

TABLE A41
TRICHLOROFLUOROMETHANE SUMMARY
OHIO RIVER AND TRIBUTARIES - 1979-1985

	MP	NS	ND	N>.2	N>1.9	MAX	TREND
West View	4.5	1310	229	89	20	21.7	-
East Liverpool	40.2	160	1	1	0	0.7	
Wheeling	86.8	2157	26	6	0	1.0	0
Parkersburg	190.3	646	45	36	7	11.4	+
Huntington	306.9	1666	140	53	11	30.7	0
Portsmouth	350.1	1616	147	73	37	10.5	+
Cincinnati	462.8	2477	1	0	0	0.1	0
Louisville	600.6	2338	215	14	0	0.9	0
Evansville	791.5	2457	25	2	0	0.9	0
TOTAL		14,827	829	274	75		
Allegheny		2143	70	49	4	6.5	0
Monongahela		1003	171	82	34	9.8	-
Kanawha		692	37	23	3	5.8	+
Paducah		125	1	0	0	14.9	

NS = Number of samples
ND = Number of Detections
N> = Number of samples exceeding indicated concentration
MAX = Maximum concentration, micrograms per liter

POLYCHLORINATED BIPHENYL (PCB) - 1978-1985

	FILLETS								WHOLE FISH			
	CATFISH				CARP				COMBINED SPECIES			
	NS	N>2	N>5	MAX	NS	N>2	N>5	MAX	NS	N>2	N>5	MAX
Dashields (13.3)	20	14	3	9.1	18	0	0	2.0	9	9	9	12.0
New Cumberland (54.4)	15	4	0	3.9	10	0	0	1.5	4	3	1	5.8
Pike Island (184.2)	27	10	0	4.0	22	0	0	0.8	6	3	0	3.6
Hannibal (I26.4)	28	11	1	5.4	23	0	0	1.0	8	3	0	4.0
Willow Island (161.8)	14	2	0	3.6	9	0	0	1.1	4	1	0	2.1
Belleville (203.9)	31	6	1	7.5	23	1	0	2.2	8	0	0	1.6
Racine (237.5)	7	2	0	3.8	7	1	0	2.5	0	-	-	-
Gallipolis (279.2)	16	2	0	3.8	10	0	0	1.8	8	3	0	3.6
Greenup (341.0)	8	0	0	1.8	3	0	0	0.5	6	1	0	2.5
Meldahl (436.2)	9	1	0	3.0	4	0	0	0.3	2	0	0	1.3
Markland (531.5)	9	2	1	6.3	5	0	0	0.4	3	2	0	4.2
McAlpine (606.0)	10	4	0	3.6	10	0	0	0.7	6	3	1	5.8
West Point (628.0)	3	2	0	2.5	0	-	-	-	4	4	0	4.2
Cannelton (720.7)	7	4	0	3.6	4	0	0	0.3	2	0	0	1.4
Newburgh (776.0)	4	0	0	1.1	4	0	0	0.4	2	1	0	2.2
Uniontown (846.0)	13	1	0	3.7	13	0	0	0.5	6	0	0	1.2
Smithland (918.5)	11	3	1	7.1	5	0	0	0.8	3	1	0	3.7
TOTAL	232	68	7	9.1	170	2	0	2.5	81	34	10	12.0

TABLE A43
FISH TISSUE ANALYSIS - OHIO RIVER
CHLORDANE - 1978-1985

	FILLETS								WHOLE FISH			
	CATFISH				CARP				COMBINED SPECIES			
	NS	ND	N>.3	MAX	NS	ND	N>.3	MAX	NS	ND	N>.3	MAX
Dashields (13.3)	18	18	4	.67	18	18	0	.10	9	9	9	1.66
New Cumberland (54.4)	10	10	1	.37	10	10	0	.20	4	4	3	.36
Pike Island (184.2)	22	22	7	.59	17	17	0	.18	8	8	4	.69
Hannibal (126.4)	23	23	8	.61	18	18	0	.15	10	10	7	.71
Willow Island (161.8)	9	9	1	.42	9	8	0	.20	4	4	0	.28
Belleville (203.9)	23	23	5	.60	18	18	0	.25	10	10	1	.50
Racine (237.5)	7	7	2	.35	7	7	0	.25	0	-	-	-
Gallipolis (279.2)	11	11	1	.41	10	10	1	.39	10	9	4	.76
Greenup (341.0)	3	3	0	.26	3	3	0	.02	7	7	3	.70
Meldahl (436.2)	4	4	1	.37	4	3	0	.02	2	2	0	.28
Markland (531.5)	5	5	2	1.16	5	5	0	.11	3	3	2	.87
McAlpine (606.0)	10	10	2	.51	10	10	0	.08	6	6	4	.73
West Point (628.0)	3	3	2	.43	3	3	0	.17	4	4	3	.50
Cannelton (720.7)	4	4	1	.62	4	4	0	.04	4	4	1	.41
Newburgh (776.0)	4	4	0	.18	4	4	1	.35	2	2	1	.35
Uniontown (846.0)	13	13	2	.49	13	13	0	.13	13	6.	2	.34
Smithland (918.5)	7	7	0	.22	5	5	0	.29	5	5	2	2.09
TOTAL	176	176	39	1.16	158	156	2	.39	94	93	46	2.09

TABLE A44
FISH TISSUE ANALYSIS - OHIO RIVER
MERCURY - 1978-1985

FILLETS

	CATFISH				CARP			
	NS	N>.5	N>1.0	MAX	NS	N>.5	N>1.0	
Dashields (13.3)	12	0	0	.27	12	0	0	
New Cumberland (54.4)	4	0	0	.38	4	0	0	
Pike Island (184.2)	12	0	0	.22	12	0	0	
Hannibal (126.4)	13	0	0	.21	12	0	0	
Willow Island (161.8)	4	0	0	.18	4	0	0	
Belleville (203.9)	12	0	0	.23	12	0	0	
Racine (237.5)	1	0	0	.06	1	0	0	
Gallipolis (279.2)	9	0	0	.21	9	0	0	
Greenup (341.0)	3	0	0	.39	3	0	0	
Meldahl (436.2)	2	0	0	.27	5	0	0	
Markland (531.5)	5	0	0	.20	5	0	0	
McAlpine (606.0)	5	0	0	.16	5	0	0	
West Point (628.0)	1	0	0	.10	1	0	0	
Cannelton (720.7)	4	0	0	.27	4	0	0	
Newburgh (776.0)	1	0	0	.12	1	0	0	
Uniontown (846.0)	8	0	0	.13	8	0	0	
Smithland (918.5)	5	0	0	.15	3	0	0	
TOTAL	101	0	0	.39	101	0	0	

TABLE A45

FISH TISSUE ANALYSIS - OHIO RIVER
HEXACHLOROBENZENE (HCB) - 1978-1985

	FILLETS				WHOLE FISH			
	CATFISH				COMBINED SPECIES			
	NS	ND	N>T	MAX	NS	ND	N>T	MAX
Dashields (13.3)	33	25	2	.02	8	2	2	.01
New Cumberland (54.4)	17	15	1	.02	4	4	2	.03
Pike Island (184.2)	41	39	4	.01	8	2	0	T
Hannibal (126.4)	43	39	24	.14	10	8	8	.06
Willow Island (161.8)	15	15	13	.08	4	4	4	.04
Belleville (203.9)	43	43	35	.12	10	9	9	.09
Racine (237.5)	11	11	10	.06	0	-	-	-
Gallipolis (279.2)	21	21	17	.07	10	5	5	.07
Greenup (341.0)	6	6	2	.04	7	4	4	.15
Meldahl (436.2)	8	7	3	.04	2	2	2	.02
Markland (531.5)	10	9	6	.03	2	2	2	.02
McAlpine (606.0)	17	17	6	.04	6	5	5	.05
West Point (628.0)	6	6	6	.05	4	4	4	.05
Cannelton (720.7)	8	8	4	.08	5	0	-	-
Newburgh (776.0)	5	3	3	.01	2	2	2	.03
Uniontown (846.0)	23	22	1	.03	6	4	4	.02
Smithland (918.5)	8	7	3	.02	5	2	2	.02
TOTAL	315	291	149	.14	93	59	55	.15

T = Trace Concentration

TABLE A46

FISH TISSUE ANALYSIS - OHIO RIVER
DICHLORODIPHENYL ETHYLENE (DDE) - 1978-1985

	FILLETS				WHOLE FISH			
	CATFISH				COMBINED SPECIES			
	NS	ND	N>T	MAX	NS	ND	N>T	MA
Dashields (13.3)	33	26	11	.09	9	9	8	.
New Cumberland (54.4)	17	15	10	.11	4	4	4	.
Pike Island (184.2)	37	35	18	.09	8	7	5	
Hannibal (126.4)	40	32	21	.09	10	10	8	.
Willow Island (161.8)	15	15	8	.08	4	4	3	
Belleville (203.9)	43	43	21	.08	10	10	10	.
Racine (237.5)	11	11	6	.12	0	-	-	-
Gallipolis (279.2)	21	21	6	.06	10	9	9	.
Greenup (341.0)	6	6	3	.03	8	6	4	.
Meldahl (436.2)	8	7	5	.10	2	2	2	.
Markland (531.5)	10	10	8	.14	3	3	3	.
McAlpine (606.0)	17	17	11	.14	6	6	6	.
West Point (628.0)	6	6	4	.12	4	4	4	.
Cannelton (720.7)	8	8	5	.25	4	2	2	.
Newburgh (776.0)	5	5	5	.03	2	2	2	.
Uniontown (846.0)	23	22	10	.41	6	6	6	.
Smithland (918.5)	8	7	5	.19	5	5	5	.
TOTAL	308	286	157	.41	95	89	81	.

TABLE A47
FISH TISSUE ANALYSIS - OHIO RIVER TRIBUTARIES
POLYCHLORINATED BIPHENYL (PCB) - 1978-1985

	FILLETS								WHOLE FISH			
	CATFISH				CARP				COMBINED SPECIES			
	NS	N>2	N>5	MAX	NS	N>2	N>5	MAX	NS	N>2	N>5	MAX
Allegheny River at L&D #8 (MP 52.6)	8	0	0	1.8	6	0	0	1.4	0			
Allegheny River at L&D #3 (MP 14.5)	13	4	0	4.8	13	1	1	5.3	6	4	1	8.71
Monongahela River at Maxwell L&D (MP 61.2)	4	0	0	.5	4	0	0	1.1	0			
Monongahela River at L&D #2 (MP 11.2)	10	2	0	4.5	10	1	0	2.2	6	5	0	4.56
Big Sandy River	3	0	0	2.0	3	0	0	.6	4	0	0	1.61
Licking River	2	1	0	3.4	3	0	0	.6	5	0	0	1.83
Green River	1	0	0	.4	3	0	0	1.4	4	0	0	.69
Tennessee River				3	0	0	.3	4	1	0	2.32	

TABLE A48
FISH TISSUE ANALYSIS - OHIO RIVER TRIBUTARIES
CHLORDANE - 1978-1985

	FILLETS								WHOLE FISH			
	CATFISH				CARP				COMBINED SPECIES			
	NS	ND	N>.3	MAX	NS	ND	N>.3	MAX	NS	ND	N>.3	MAX
Allegheny River at L&D #8 (MP 52.6)	7	7	0	.12	6	6	0	.02	0			
Allegheny River at L&D #3 (MP 14.5)	13	13	0	.22	8	8	0	.18	6	6	4	.78
Monongahela River at Maxwell L&D (MP 61.2)	4	4	1	.36	4	4	1	.51	0			
Monongahela River at L&D #2 (MP 11.2)	10	10	2	.66	10	10	0	.26	6	6	6	1.81
Big Sandy River	3	3	1	.57	3	3	0	.16	4	4	0	.26
Licking River	2	2	0	.14	3	3	0	.01	5	5	2	.40
Green River	1	1	0	.02	3	3	0	.06	4	4	1	.33
Tennessee River	0				3	3	0	.03	4	4	0	.28

TABLE A49
FISH TISSUE ANALYSIS - OHIO RIVER TRIBUTARIES
MERCURY - 1978-1985

FILLETS

	CATFISH				CARP			
	NS	N>.5	N>1.0	MAX	NS	N>.5	N>1.0	MAX
Allegheny River at L&D #8 (MP 52.6)	4	1	0	.59	3	0	0	.17
Allegheny River at L&D #3 (MP 14.5)	8	0	0	.32	4	0	0	.12
Monongahela River at Maxwell L&D (MP 61.2)	1	0	0	.09	1	0	0	.08
Monongahela River at L&D #2 (MP 11.2)	5	0	0	.17	5	0	0	.13
Big Sandy River	1	0	0	.07	1	0	0	.14
Licking River	1	0	0	.30	1	0	0	.31
Green River	1	0	0	.31	1	0	0	.21
Tennessee River	0				1	0	0	.15

TABLE A50
FISH TISSUE ANALYSIS - OHIO RIVER TRIBUTARIES
HEXACHLOROBENZENE - 1978-1985

	FILLETS				WHOLE FISH			
	CATFISH				COMBINED SPECIES			
	NS	ND	N>T	MAX	NS	ND	N>T	M
Allegheny River at L&D #8 (MP 52.6)	10	4	0	T	0			
Allegheny River at L&D #3 (MP 14.5)	18	18	0	T	6	2	2	.
Monongahela River at Maxwell L&D (MP 61.2)	5	3	1	.01	0			
Monongahela River at L&D #2 (MP 11.2)	17	15	1	.01	6	2	0	T
Big Sandy River	6	6	1	.05	4	3	2	.(
Licking River	6	6	D	T	5	3	0	T
Green River	4	4	0	T	5	2	0	T
Tennessee River	3	3	0	T	2	1	1	.'

T = Trace Concentration

TABLE A51
FISH TISSUE ANALYSIS - OHIO RIVER TRIBUTARIES
DICHLORDDIPHENYL ETHYLENE (DDE) - 1978-1985

	FILLETS				WHOLE FISH			
	CATFISH				COMBINED SPECIES			
	NS	ND	N>T	MAX	NS	ND	N>T	MAX
Allegheny River at L&D #8 (MP 52.6)	10	10	3	.03	0			
Allegheny River at L&D #3 (MP 14.5)	18	18	15	.14	6	6	6	.16
Monongahela River at Maxwell L&D (MP 61.2)	5	5	3	.04	0			
Monongahela River at L&D #2 (MP 11.2)	17	17	12	.19	6	5	3	.25
Sandy River	6	6	4	.09	4	4	4	.04
Licking River	6	6	5	.22	5	5	4	.09
Green River	4	4	4	.15	5	5	4	.09
Tennessee River	3	3	3	.11	4	4	4	.24

T = Trace Concentration

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