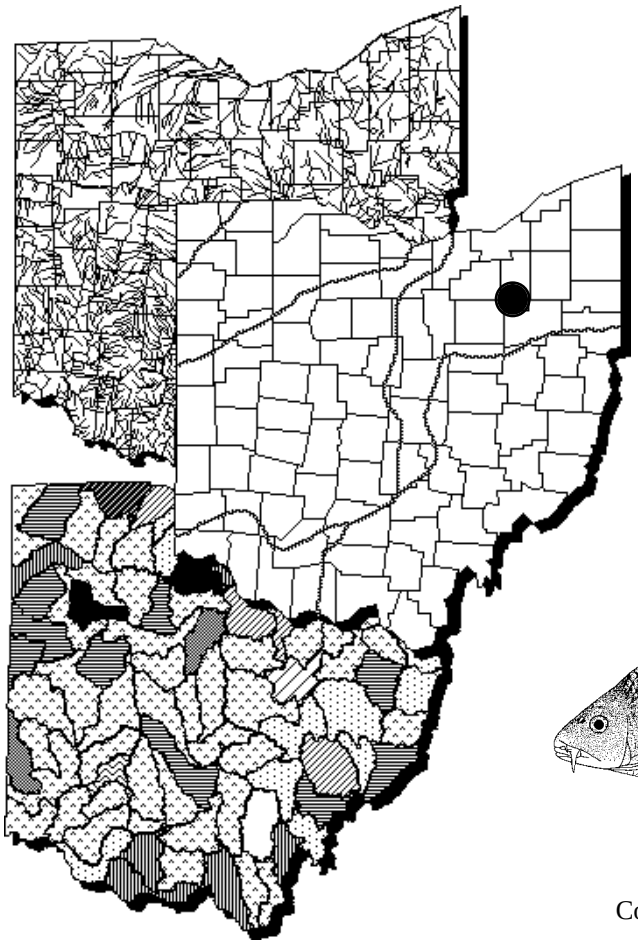
State of Ohio
Environmental Protection Agency

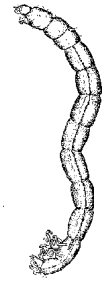
Ecological Assessment Section
Division of Surface Water

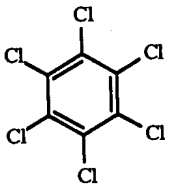
Biological, Sediment and Water Quality Study of the Tuscarawas River, Wolf Creek and Hudson Run

Summit and Stark Counties, Ohio

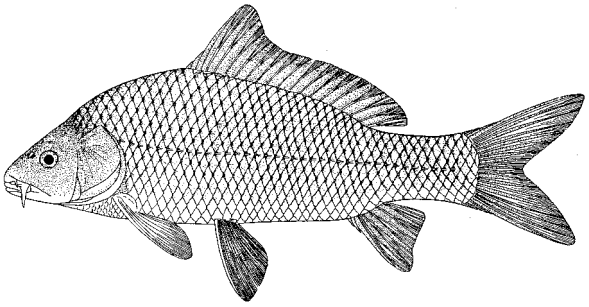


Midge (*Chironomus*)





Hexachlorobenzene



Common carp (*Cyprinus carpio*)

July 30, 1994

P.O. Box 163669, 1800 WaterMark Dr. Columbus, Ohio 43216-3669

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OEPA Technical Report EAS/1994-8-7

prepared for

State of Ohio Environmental Protection Agency
Division of Emergency and Remedial Response

prepared by

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NOTICE TO USERS

Ohio EPA adopted biological criteria into the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) regulations in February 1990 (Effective May 1990). These criteria consist of numeric values for the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), both of which are based on fish, and the Invertebrate Community Index (ICI), which is based on macroinvertebrates. Criteria for each index are specified for each of Ohio's five ecoregions, and are further organized by organism group, index, site type, and aquatic life use designation. These criteria, along with the chemical and whole effluent toxicity evaluation methods, figure prominently in the assessment of Ohio's surface water resources.

Several documents support the adoption of the biological criteria by outlining the rationale for using biological information, the specific methods by which the biocriteria were derived and calculated, the field methods by which sampling must be conducted, and the process for evaluating results. These documents are:

Ohio Environmental Protection Agency. 1987a. Biological criteria for the protection of aquatic life: Volume I. The role of biological data in water quality assessment. Division of Water Quality Monitoring & Assessment, Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1987b. Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Division of Water Quality Monitoring & Assessment, Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989a. Addendum to Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989b. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1990. The use of biological criteria in the Ohio EPA surface water monitoring and assessment program. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.

Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI): rationale,methods, and application. Division of Water Quality Planning & Assessment, Ecological Assessment Section, Columbus, Ohio.

These documents and this document can be obtained by writing to:

Ohio EPA -DSW
Ecological Assessment Section
1685 Westbelt Drive
Columbus, Ohio 43228-3809
(614) 728-3377

Acknowledgements

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Surface Water, Fish Tissue, and Sediment Data Analysis - David Altfater
Macroinvertebrate Data Analysis - Bernie Counts
Fish Data Analysis - David Altfater
Reviewer(s) - Chris Yoder, Jeff DeShon, and Marc Smith

This evaluation and report would not have been possible without the assistance of several full and part time staff in the field and the chemistry analyses provided by the Ohio EPA Division of Environmental Services, the Division of Emergency and Remedial Response contract laboratory, and the U.S. EPA CLP Laboratory. We would especially like to acknowledge Eileen Mohr, Ohio EPA, NEDO for her help during field studies and her extensive knowledge of the PPG Barberton facility.

Keith Orr of the Water Quality Modeling Section provided continuous dissolved oxygen data used in this report.

Biological, Sediment, and Water Quality Study of the Tuscarawas River, Wolf Creek, and Hudson Run, Barberton, Ohio

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INTRODUCTION

The Tuscarawas River study area included the Tuscarawas River from river mile (RM) 119.4 to RM 94.6, the lower mile of Wolf Creek, and the lower four miles of Hudson Run.

Specific objectives of this evaluation were to:

1) determine the longitudinal extent of hazardous chemical constituents in the Tuscarawas River, Wolf Creek, and Hudson Run in the vicinity of the PPG Barberton site. Media of concern included sediment, surface water, fish tissue, and biomarker response,

2) determine and measure adverse impacts on biological condition and water quality in the Tuscarawas River, Wolf Creek, and Hudson Run in the vicinity of the PPG facility,

3) identify the relative significance of PPG Barberton site contaminants, nonpermitted sewage discharges, instream habitat, and the Barberton WWTP on the impairment of the Tuscarawas River biological communities,

4) determine the accumulation of contaminants in river sediments and fish tissue, and

5) determine the attainment status of current aquatic life use designations for the Tuscarawas River, Wolf Creek, and Hudson Run.

The findings of this evaluation may factor into regulatory actions taken by Ohio EPA (e.g. NPDES permits, Director's Orders), revisions of the Ohio Water Quality Standards (OAC 3745-1), and eventually be incorporated into the State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and the biennial Water Inventory (305[b] report).

SUMMARY/CONCLUSIONS

From July to October, 1993 Ohio EPA's DSW staff, at the request of DERR, conducted biological community, fish tissue, biomarker, sediment, and surface water sampling of the Tuscarawas River, Wolf Creek, and Hudson Run in the vicinity of Barberton, Ohio. The results of these sampling events are summarized below. Biomarker results will be presented as an addendum to this report at a later date.

- NON attainment of the Modified Warmwater Habitat (MWH) and Warmwater Habitat (WWH) use designations occurred in the lower 16.2 miles of the sampled segment of the Tuscarawas River (Table 1). PARTIAL attainment was observed at the most upstream site of the Tuscarawas River. NON attainment of the MWH use designation was documented in the lower 1.1 miles of Wolf Creek and in Hudson Run downstream from Hudson Run Reservoir (RMs 0.4 -0.0). PARTIAL attainment of the WWH use designation occurred in Hudson Run at the upstream reference location. Although a substantial portion of the Tuscarawas River is not attaining its uses, results from 1993 reflect an improvement in biological performance from the results obtained by Ohio EPA in 1983 and 1989. This improvement was also observed in the lower 0.4 miles of Hudson Run, an area located downstream from the Hudson Run Reservoir and adjacent to PPG lime lakes 1 and 2.

- Area of Degradation Values (ADV) for the 1993, 1989, and 1983 sampling effort provides a relative measure of performance of the biological communities in the Tuscarawas River. The ADV/mile of the IBI, MIwb and ICI demonstrates the improvement noted between 1983, 1989 and 1993. IBI ADV/mile values improved substantially from 92.2 in 1983 to 35.8 in 1993. MIwb ADV/mile scores showed significant improvement between 1983 and 1993 (153.0 and 61.4, respectively). ICI ADV/mile values improved substantially from 114.9 in 1983, 78.9 in 1989, to 22.9 in 1993. The number of miles of FULL and PARTIAL attainment of the designated use in the Tuscarawas River within the study area during 1983, 1989 and 1993 was 2.4, 6.6 and 5.9 miles, respectively.

- Based on fish tissue results from 1989 and 1993, the Ohio Department of Health issued a fish consumption advisory for the Tuscarawas River from State Route 619 in Barberton to State Route 416 in New Philadelphia. The advisory was issued based on elevated levels of PCBs and hexachlorobenzene in fish tissue samples collected during 1989 and 1993 with the PCB levels being of particular concern. The Ohio Department of Health is recommending that largemouth bass, rock bass, smallmouth bass, channel catfish, yellow bullhead, and common carp be eaten only in limited quantities.

- Sediment data confirmed the presence of high concentrations of hexachlorobenzene (HCB) in the Tuscarawas River from Wolf Creek to the downstream end of the study area (RM 94.6), and in Hudson Run Reservoir adjacent to PPG Industries. Numerous sediment samples in the Tuscarawas River, Hudson Run, and Hudson Run Reservoir exceeded the Severe Effect Level (Persaud *et al.* 1992), a level above which sediment is considered heavily polluted and likely to affect the health of sediment-dwelling organisms. The highest HCB values within the study area were documented in Hudson Run Reservoir at RM 0.4 (438,000 ug/kg and 469,852 ug/kg). In addition to hexachlorobenzene, numerous other chlorinated benzenes were measured in sediment samples collected within the Tuscarawas River study area. The highest total chlorinated benzene concentration was recorded in Hudson Run Reservoir (126,730 ug/kg - excluding HCB).

- The highest sediment level of 2378-tetrachlorodibenzo-*p*-dioxin (2378-TCDD) (128 pg/g) and 2378-TCDD total toxicity equivalents (TTE) (3,028 pg/g) occurred in Hudson Run Reservoir at RM 0.45. These levels were higher than surface mine reclamation sludge application criteria (100 pg/g 2378-TCDD TTEs) and the Center for Disease Control (CDC) residential action level (1000 ppt 2378-TCDD/ or 10001000 ppt 2378 ppt TTE which is commonly used by regulatory programs). In addition, Hudson Run Reservoir at RM 0.45 has the potential to be a high risk source to sensitive fish species due to the elevated 2378-TCDD concentration in the sediment (USEPA 1993a). Hudson Run Reservoir is adjacent to PPG Industries.

- Using sediment evaluation criteria developed by Kelly and Hite (1984), several metal parameters had levels considered extremely elevated above background concentrations. Generally, the highest metal concentrations in sediment of the Tuscarawas River were measured at RMs 110.90, 109.47, 107.97, and 104.30; from Snyder Ave. to Clinton. Within Wolf Creek, the highest metal levels were primarily located between RMs 0.70 and 0.40. This area has historically received industrial discharges of metal parameters. An evaluation of the Hudson Run waterway revealed that the highest metals concentrations were found within Hudson Run Reservoir between RMs 0.65 and 0.40.

- Historically, the PPG-Barberton industrial complex had been a major point source contributor to water pollution problems in the Tuscarawas River. By 1986, all process wastewaters were diverted to the Barberton WWTP or removed for off-site disposal. Currently, only non-contact cooling water and steam condensate are being directly discharged to adjacent receiving streams - three outfalls to Hudson Run/ Hudson Run Reservoir and one to Wolf Creek. Reported NPDES self-monitoring data indicates that all outfalls were within acceptable levels.

- The Barberton wastewater treatment plant (WWTP) is an advanced treatment facility which during 1993 treated an average of 4.98 MGD. The treatment plant was upgraded from a secondary treatment facility to advanced treatment during June, 1988. A substantial decrease in ammonia-N effluent loadings has occurred since 1987, with 50th percentile values declining from 60 kg/day in 1987 to 9 kg/day in 1988. Similar declines were noted in five day biochemical oxygen demand (BOD_5) and total suspended solids (TSS) loadings after completion of the major plant upgrade during 1988. One important observation on ammonia-N loadings during 1990 - 1993 was that 50th percentile loadings were less than 1.0 kg/day. Biomonitoring data from 1989, 1990 and 1991 suggest that the Barberton WWTP effluent is not acutely or chronically toxic to fathead minnows or *Ceriodaphnia dubia*.

- Spills and wild animal kills are indications of possible impacts due to pollutant discharges. Within the Tuscarawas River, Hudson Run, and Wolf Creek study area 68% of the Ohio EPA Emergency Response listed spills between 1980 and 1991 were associated with PPG. No spills have been reported between 1991 and 1993. Primary spills associated with PPG included silica solids/sodium silicate (37), wastewater (27), and hydrochloric acid (9). Pollution investigation reports for the same time period listed three incidents where a total of 3,218 fish were killed within the Hudson Run study area. Two of the three incidents were caused by chemical spills from PPG; the last incident, recorded on September 15, 1993, was caused by an undetermined source. No fish kills were reported in the Wolf Creek or Tuscarawas River study area during the 1980 through 1993 period.

- Hexachlorobenzene was detected in six surface water samples; two in Hudson Run/ Hudson Run Reservoir and four in the Tuscarawas River downstream from Wolf Creek. The highest HCB surface water concentration in the study area occurred in Hudson Run reservoir at RM 0.43, the same location were the highest sediment concentration of HCB was recorded. All six detected HCB values were below the Ohio Water Quality Standards for human health and public water supply (there are no surface water standards for aquatic life). Surface water results for total arsenic, cadmium, chromium, copper, lead, mercury, selenium, and silver were all reported as below lab detection limits. Ammonia-N concentrations were documented at or below the lab detection limit of 0.05 mg/l.

- Large increases in sodium, chloride, and total dissolved solids (TDS) were observed in surface water samples collected from the Tuscarawas River adjacent to and downstream from the Barberton WWTP and PPG lime lakes. Available data suggests that the PPG lime lakes and the Barberton WWTP are contributing to the elevated levels of sodium, chloride, and TDS in the Tuscarawas River. In the Tuscarawas River adjacent to and downstream from the PPG lime lakes, numerous exceedances of the 30-day average criterion for total dissolved solids were recorded during 1993. Of the 14 samples collected between RM 110.2 and RM 94.8, eight exceeded the TDS aquatic life water quality criterion.

- Continuous dissolved oxygen data was collected at seven locations in the Tuscarawas River from August 4 to 6, 1993 . Violations of the MWH or WWH Ohio Water Quality Standards dissolved oxygen criterion were not detected; however, a distinct decline was observed within the Barberton urban area upstream from the Barberton WWTP. Overall dissolved oxygen (D.O.) concentrations during the August sampling period were reflective of generally good water quality. Several of the stations which were channelized, shallow, and had very few trees to provide shade for the river exhibited super saturated D.O. conditions.

- The instream physical habitat of the Tuscarawas River from RM 115 to RM 103 was extensively channelized in the past. These conditions continue to prevail and result in poor to fair conditions for supporting viable warmwater biological communities. Qualitative habitat evaluation index (QHEI) scores in this segment ranged between 36.5 and 56.5, well below the scores of 74.5 and 81.0 recorded in the upstream and downstream unmodified areas. The QHEI scores in the channelized section typified conditions associated with the designated Modified Warmwater Habitat (MWH) use. In addition to channelization, soda ash waste deposition and concretion of the Tuscarawas River bottom within the PPG lime lakes area (RM 110 - 107) has markedly influenced physical habitat conditions.

- Wolf Creek was channelized in the early to mid-1970s between Barberton Reservoir (RM 5.1) and the mouth. QHEI scores were 40.5 and 51.0, indicative of poor to fair habitat conditions. The upstream site (an area outside of the PPG lime lakes influence) was characterized by a predominance of muck substrates, fairly uniform water depth, sparse instream cover and limited riffle areas. Sampling adjacent to PPG lime lake #1 revealed a bottom predominated by soda ash concretion and sand. Instream cover was sparse, and channel development was fair to poor. Several riffles of fair quality were located in this reach of the stream. Few WWH attributes were recorded in Wolf Creek.

- Natural habitat conditions occurred in Hudson Run upstream from Lake Dorothy. The QHEI score was 69.0, reflective of good stream habitat. Bottom substrates were predominated by gravel and sand, instream cover was moderate and warmwater habitat attributes predominated. Substantial modification of physical habitats has occurred in Hudson Run in the lower 0.4 miles. This modification appears to have occurred as early as the turn of the century, when PPG began to dispose of wastes in lime lakes #s 1 and 2. The stream bottom is predominated by soda ash concretion and sand, instream cover is sparse and the riparian zone was nearly devoid of woody vegetation. A high stream gradient provided for numerous pool/ riffle/ run complexes. The QHEI score was 42.0, reflective of poor to fair habitat quality.

- The fish communities in the Tuscarawas River from RM 110.9 to RM 94.6 exhibited severe biological degradation. The IBI (17 - 24) and MIwb (3.4 - 5.4) scores were reflective of poor to very poor biological conditions with the entire stream reach not fully achieving the applicable biocriteria. Fish species highly tolerant to a wide variety of environmental disturbances predominated in the Tuscarawas River within and downstream from the Barberton/ PPG area of study. The most severe degradation occurred at RM 107.8, a site located 1.3 miles downstream from the Barberton WWTP and adjacent to PPG lime lake #5. Physical habitat conditions in the Tuscarawas River between RMs 112.9 and 103.2 have been substantially altered due to past channel modifications (channel dipout, canopy removal); however, these conditions alone have not caused the severe disruption of the fish communities. The fish communities clearly were impacted by toxic stresses.

- The physical condition of fish was monitored at each sampling site by recording the incidence of gross DELT (deformities, fin erosion, lesions/ulcers and tumors) external anomalies. Biosurvey results collected by Ohio EPA from throughout the state show a high frequency of DELT anomalies is an accurate indication of pollution stress usually caused by multiple sublethal stresses as the result of degraded water quality (*i.e.*, often a combination of toxic impacts combined with marginal D.O. concentrations). Within Ohio, there also appears to be a positive relationship between sites containing chemically contaminated sediments (*e.g.*, metals, PAHs), very low biological index scores, and a high percent occurrence of DELT anomalies (Yoder 1991). At the upstream sampling site, DELT anomalies were not observed in the fish population. DELT anomalies were documented at all other Tuscarawas River sites, with the highest levels occurring between RM 107.8 and RM 94.6 (3.9% - 6.0%).

- The fish communities in Wolf Creek also exhibited severe biological degradation. The IBI (19 and 22) and MIwb (4.4 and 6.0) scores were reflective of poor to very poor biological conditions with the entire stream reach not fully achieving the applicable MWH biocriteria. The upstream Hudson Run sampling location (RM 4.1) had fish communities in the fair range (IBI = 35), with a large proportion of pollution tolerant species present. However, three darter species were well represented and one least brook lamprey was collected. Fish sampling results downstream from Hudson Run reservoir (RM 0.1) documented a decline in the number of species, number of individuals and the complete absence of darter species compared with the upstream site

at RM 4.1. This section of Hudson Run has been previously channel modified. A marginally fair biological community (IBI = 28) existed at RM 0.1, with the sampling station meeting the MWH biocriterion. A fish kill was observed by Ohio EPA biologists on September 15, 1993 at RM 0.1. The second fish sampling pass at RM 0.1 was conducted on September 30, 1993, two weeks after the observed fish kill. A substantial reduction in numbers of fish was observed in the second sampling pass results relative to the first pass results.

- Hexachlorobenzene, a compound which bioconcentrates extensively in a number of fish and invertebrates (Howard 1989), was detected in all 1993 fish tissue samples from the Tuscarawas River except at the most upstream location (RM 119.4).

- Two PCB mixtures, Aroclors-1248 and -1260, were identified and quantified in fish tissue samples. All but two of the samples had detectable levels of PCBs, with detected values for Aroclor-1248 ranging from 21 ug/kg to 2,515 ug/kg and detected values for Aroclor-1260 ranging from 31 ug/kg to 584 ug/kg. Several samples exceeded the Ohio Water Quality Standard (WQS) for total PCBs which sets a criterion of 640 ug/kg total PBCs for wholebody samples of any representative organism. The majority of Ohio WQS exceedances occurred between RMs 90 and 80.

- The macroinvertebrate communities in the Tuscarawas River from RM 110.9 to RM 104.5 exhibited biological degradation. The ICI scores (range: 16 - 18) were reflective of fair biological conditions with the entire stream reach not achieving the applicable biocriterion. Other dipterans, non-insect taxa, and pollution tolerant taxa predominated in the Tuscarawas River within and downstream from the Barberton/ PPG study area. Physical habitat conditions in the Tuscarawas River between RM 112.9 and 103.2 have been substantially altered due to past channel modifications (channel dipout, canopy removal); however, these conditions alone could not account for the degradation of the macroinvertebrate community performance; the results also indicate the presence of toxic stresses.

- The macroinvertebrate communities in Wolf Creek (RMs 1.1 and 0.3) also reflected degraded conditions. The ICI scores (18 and 16) were reflective of marginally fair biological conditions with the entire stream reach not achieving the MWH biocriterion. The upstream Hudson Run sampling location (RM 4.1) had a macroinvertebrate community in the good range (ICI = 36), with a very small proportion of pollution tolerant species present. This site achieved the WWH biocriterion. Macroinvertebrate sampling results downstream from Hudson Run reservoir (RM 0.1) documented a decline in the number of taxa, number of individuals, relative density, and the complete absence of mayflies and caddisflies compared with the upstream site at RM 4.1. This section of Hudson Run has been previously channel modified. A poor biological community (ICI = 10) existed at RM 0.1, which was substantially below the MWH biocriterion.

RECOMMENDATIONS

Status of Aquatic Life Uses

Prior to the present study, aquatic life use designations of the Tuscarawas River upstream from RM 112.9 and between RM 103.2 and RM 47.0 were Warmwater Habitat (WWH), and Modified Warmwater Habitat (MWH) from RM 112.9 to RM 103.2 (OAC 3745-1). Wolf Creek from RM 4.6 to the mouth and Hudson Run from Hudson Run Reservoir to the mouth (RM 0.4 - 0.0) were also classified as Modified Warmwater Habitat. Hudson Run upstream from RM 0.4 was Warmwater Habitat. The following recommendations are made based on the 1993 survey results.

- All three streams and their designated aquatic life uses should remain the same as currently listed in the Ohio Water Quality Standards. Physical habitat conditions in the Tuscarawas River between RM 112.9 and 103.2, Wolf Creek from RM 4.6 to the mouth and Hudson Run from RM 0.4 to the mouth preclude the attainment of the Warmwater Habitat use. Within these three stream segments, extensive channel modifications have simplified instream habitat conditions compared to typical warmwater streams in Ohio. QHEI scores in the modified stream segments ranged between 36.5 and 56.6. On average a QHEI score of 60 is generally considered to reflect the low end score of conditions conducive to the support of WWH communities.

- Current WWH use designations for specific sections of the Tuscarawas River (upstream from RM 112.9, and RMs 103.2 - 47.0) and Hudson Run (upstream from RM 0.4) are appropriate. Two sampling stations in the Tuscarawas River and one in Hudson Run within WWH segments clearly had physical habitat conditions which could support warmwater biological communities (QHEIs 69.0 - 81.0).

Other

- Elevated levels of hexachlorobenzene in bottom sediments were observed in the Tuscarawas River downstream from Wolf Creek and in the lower 0.5 miles of Hudson Run Reservoir. Dioxins and dibenzofurans were elevated in sediments of Hudson Run Reservoir. The toxicity of these sediments and the areal extent and source of contamination needs to be explored as well as the potential of in-place bioremediation. Along with the potential removal of contaminated sediments, the feasibility of restoring the modified channel to more natural conditions should be considered as part of a total restoration project.

Table 1. Aquatic life use attainment status for the Tuscarawas River, Wolf Creek, and Hudson Run based on data collected from July to October, 1993.

RIVER MILE Fish/Invert.	IBI	Modified Iwb	ICI	QHEI	Attainment Status	Comment
Tuscarawas River						
		Erie Ontario Lake Plain- WWH Use Designation				
119.4/ 119.4	40	7.0*	48	81.0	PARTIAL	Reference / Background Conditions
		Erie Ontario Lake Plain- MWH Use Designation				
110.9/ 110.9	24	5.4*	18*	36.5	NON	Ust. Wolf Cr.
109.6/ 109.6	21*	4.9*	16*	47.5	NON	Dst. PPG lime lake 3, Ust. WWTP
107.8/ 107.8	17*	3.4*	16*	56.5	NON	Dst. Barberton WWTP Adj. PPG lime lake 6
104.3/ 104.3	19*	4.3*	18*	54.5	NON	Dst. all PPG lime lakes
		Erie Ontario Lake Plain- WWH Use Designation				
94.7/ 94.7	23*	5.3*	32^{ns}	74.5	NON	Near Massillon
Hudson Run						
		Erie Ontario Lake Plain - WWH Use Designation				
4.1/ 4.1	35*	NA	36	69.0	PARTIAL	Background Conditions
		Erie Ontario Lake Plain- MWH Use Designation				
0.1/ 0.1	28	NA	10*	42.0	NON	Fish kill, dst. Hudson Run Reservoir
Wolf Creek						
		Erie Ontario Lake Plain - MWH Use Designation				
1.1/ 1.1	19*	6.0*	18*	40.5	NON	Ust. PPG lime lakes
0.3/ 0.3	22*	4.4*	16*	51.0	NON	Adj. PPG lime lake 1

Ecoregional Biocriteria: Erie-Ontario Lake Plain (EOLP)

INDEX - Site Type	WWH	EWH	MWH[a]
IBI - Headwaters	40	50	24
IBI - Wading	38	50	24
IBI - Boat	40	48	24
Mod. Iwb - Wading	7.9	9.4	6.2
Mod. Iwb - Boat	8.7	9.6	5.8
ICI	34	46	22

* - Significant departure from applicable biological criterion; poor and very poor results are underlined.

ns - Nonsignificant departure from WWH biocriterion (≤4 IBI or ICI units or ≤0.5 MIwb units).

a - Modified Warmwater Habitat for channel modified areas.

NA - Headwater site; MIwb is not applicable.

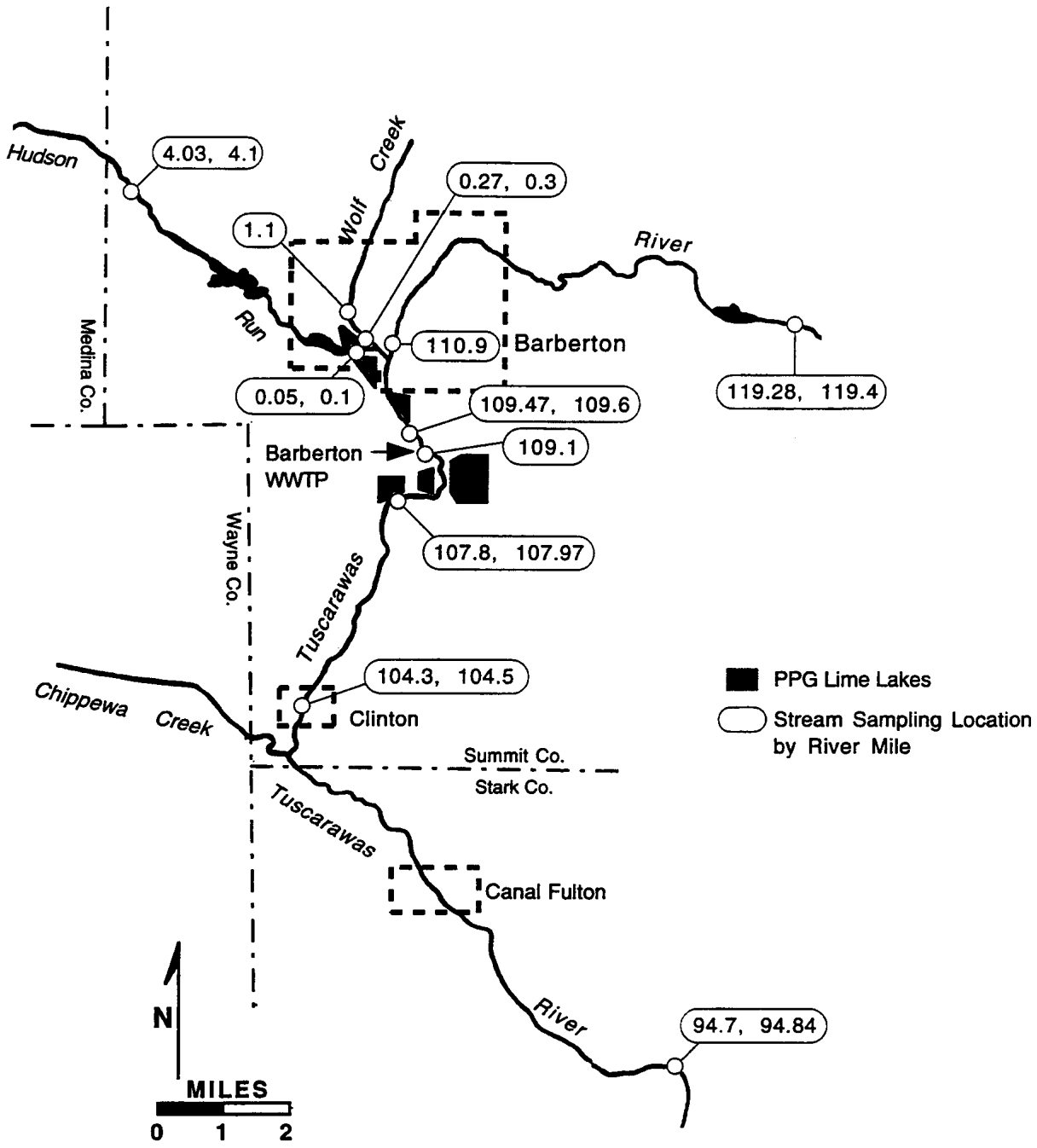

Figure 1. Map of the Tuscarawas River study area showing principal streams, landmarks, potential pollution sources, and Ohio EPA sampling locations.

METHODS

All physical and biological field, laboratory, data processing, and data analysis methods and procedures adhere to those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 1989c), Biological Criteria for the Protection of Aquatic Life, Volumes II - III (Ohio Environmental Protection Agency 1987b, 1989a, 1989b), and The Qualitative Habitat Evaluation Index (QHEI); Rationale, Methods, and Application (Rankin 1989) for habitat assessment.

Attainment/non-attainment of aquatic life uses was determined by using biological criteria codified in Ohio Administrative Code (OAC) 3745-1-07, Table 7-17. The biological communityperformance measures that were used included the Index of Biotic Integrity (IBI) and the Modified Index of Well-being (MIwb), both of which are based on fish community characteristics, and the Invertebrate Community Index (ICI) which is based on macroinvertebrate community characteristics. The IBI and ICI are multi-metric indices patterned after an original IBI described by Karr (1981) and Fausch *et al.* (1984). The MIwb is a measure of fish community abundance and diversity using numbers and weight information; it is a modification of the original Index of Well-Being applied to fish community information from the Wabash River (Gammon 1976, Gammon *et al.* 1981).

Performance expectations for the basic aquatic life uses (Warmwater Habitat [WWH], Exceptional Warmwater Habitat [EWH], and Modified Warmwater Habitat [MWH]) were developed using the regional reference site approach (Hughes *et al.* 1986; Omernik 1988). This fits the practical definition of biological integrity as the biological performance of the natural habitats within a region (Karr and Dudley 1981). Attainment of an aquatic life use was FULL if all three indices (or those available) meet the applicable criteria, PARTIAL if at least one of the indexes did not attain and performance did not fall below the fair category, and **NON** if all indices either failed to attain or any index indicated poor or very poor performance.

Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989). Various attributes of the available habitat were scored based on their overall importance to the establishment of viable, diverse aquatic faunas. Evaluations of type and quality of substrate, amount of instream cover, channel morphology, extent of riparian canopy, pool and riffle development and quality, and stream gradient are among the metrics used to evaluate the characteristics of a stream segment, not just the characteristics of a single sampling site. As such, individual sites may have much poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have indicated that values higher than 60 were generally conducive to the establishment of warmwater faunas while those which scored in excess of 75-80 often typify habitat conditions which have the ability to support exceptional faunas.

During this survey, macroinvertebrates were sampled using modified Hester/Dendy multiple-plate artificial substrate samplers supplemented with a qualitative assessment of the available natural substrates. Qualitative macroinvertebrate sampling consists of an inventory of species with no attempt to quantify the populations and a measure of EPT (Ephemeroptera -mayfly, Plecoptera - stonefly, and Trichoptera - caddisfly) taxa richness - an indication of the prevalence of pollution sensitive organisms.

Fish were sampled 2-3 times using pulsed DC electrofishing gear using either the wading or boat methods. Fillet and whole body fish were collected in October, 1992 for tissue analysis. Fish tissue sampling procedures are detailed in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 1989c). Fine grained sediment samples were collected in the upper 6 inches of bottom material at select locations using decontaminated stainless steel scoops (decontamination followed the procedures outlined in FSOP 10.01, DERR Sampling Guidance, Vol III, 1992). Collected sediment was placed into glass jars with teflon lined lids, placed on ice (to maintain 4^{o}C) and shipped to a US EPA contract lab. Surface water samples were collected directly into appropriate containers, preserved and delivered to either a USEPA contract lab or Ohio EPA lab. Dissolved oxygen was monitored continuously over a three-day period in the Tuscarawas River using Datasonde™ monitors. PPG sediment and surface water data collected during 1993 as part of the RFI study was incorporated into this report. All data reported by PPG to Ohio EPA which was used in this report was stamped 'Preliminary'.

All surface water, sediment, fish tissue, biomarker, and biological sampling locations are listed in Table 2.

White sucker and common carp were collected for biomarker processing during October, 1993 . Fish were kept in a floating livewell until biomarker tissue samples could be taken. Fish were anesthetized with MS222 and length and weight was measured. Fish health/condition was assessed using procedures in Goede (1988). Blood was drawn from the caudal vein through a 21 gauge needle into heparin treated 3 ml blood drawing tubes. Whole blood was centrifuged on-site and the plasma removed (flash frozen at -100°C in a liquid nitrogen dry shipper). The liver was excised, wrapped in aluminum foil and frozen in a liquid nitrogen dry shipper. Bile was removed, placed in amber microcentrifuge tubes and placed in a liquid nitrogen dry shipper. Sections of liver and spleen were excised from each fish and placed in buffered formalin for histological evaluation. Tissue samples were transported to the U.S. EPA in Cincinnati for laboratory analysis. Specific biomarker analyses included ethoxyresorufin-O-deethylase (EROD), total hepatic glutathione, blood urea nitrogen, plasma levels of pseudocholinesterase and bile metabolites. Each bile sample was diluted with distilled/deionized water and measured by fixed fluorescence at four excitation/emission wavelength pairs according to Lin et al. (in preparation).

Although more than one compound is known to fluoresce under these conditions, some compounds give a greater response. The metabolites are referred to by one of their most sensitive respondents: pyrenol-type at 340/380 nm, benzo(a)pyrenol-type at 380/430 nm, phenanthrol-type at 256/380 nm and naphthol-type at 290/335 nm. Microsomes for measuring EROD and cytosol for glutathione were prepared from liver tissue. Microsomes were prepared according to Lin *et al.*(1989) and the cytosolic supernatant resulting from the high speed centrifugation was reserved for glutathione measurement. EROD activity was measured fluorometrically according to Pohl and Fouts (1980) and modified Lin *et al.* (1989). Glutathione was measured according to Akerboum and Sies (1981) and adapted for use with an automated chemistry analyzer.

An Area of Degradation Value (ADV; Rankin and Yoder 1991) was calculated for the study area based on the longitudinal performance of the biological communities. The ADV portrays the length or "extent" of degradation to aquatic communities and is simply the distance that the biological index (IBI, MIwb, and ICI) departs from the stream criterion or the upstream level of performance (Figure 2). The magnitude of impact refers to the vertical departure of each index below the criterion. The total ADV is the area beneath the ecoregional criterion when the results for each index are plotted against river mile. This is also expressed as ADV/mile to normalize comparisons between segments and other areas.

Table 2. Ohio EPA sampling locations (sediment - S, fish community - F, macroinvertebrates - M, surface water - W, fish tissue - T, biomarker - B, and dissolved oxygen - D) in the Tuscarawas River study area, 1993.

Stream/ River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 min. Quad. Map
Tuscarawas River				
119.4	F,M,B,T	41 00 45 / 81 29 25	Arlington Rd.	Akron East
119.28	S,W,D	41 00 25 / 81 29 33	Dst. Arlington Rd.	Akron East
110.9	F,M,B,T,D	41 00 15 / 81 36 16	Snyder Ave.	Akron West
109.6	F,M,B,T,D	40 59 10 / 81 36 04	PPG Lime Lake 3/ Van Buren Rd. (North)	Canal Fulton
109.47	S,W	40 59 06 / 81 36 00	Dst. Van Buren Rd. (North)	Canal Fulton
109.1	D	40 58 52 / 81 35 45	Barberton WWTP	Canal Fulton
107.97	S,W	40 58 21 / 81 36 06	PPG Lime Lake 5/ Van Buren Rd. (South)	Canal Fulton
107.8	F,M,B,T,D	40 58 13 / 81 36 10	Adj. PPG Lime Lake 5	Canal Fulton
104.5	F,M,B,T	40 55 50 / 81 37 44	Clinton	Doylestown
104.30	S,W,D	40 55 43 / 81 37 57	Clinton	Doylestown
94.84	S,W,D	40 50 42 / 81 31 55	High Mill Rd.	Massillon
94.7	F,M,B,T	40 50 43 / 81 31 47	Dst. High Mill Rd.	Massillon
Hudson Run				
4.1	F,M	41 01 43 / 81 40 06	Hametown Rd.	Wadsworth
4.03	S,W	41 01 43 / 81 40 05	Hametown Rd.	Wadsworth
0.43	S	41 00 11 / 81 37 06	Hudson Run Reservoir	Akron West
0.1	F,M	41 00 12 / 81 36 40	PPG Lime Lake 1/ near mouth	Akron West
0.05	S,W	41 00 12 / 81 36 38	PPG Lime Lake 1/ near mouth	Akron West
Wolf Creek				
1.1	F,M,B,T	41 00 41 / 81 37 06	Wooster Rd.	Akron West
0.3/0.27	F,M,S,W	41 00 13 / 81 36 35	Snyder Ave./ PPG Lime Lake 1	Akron West

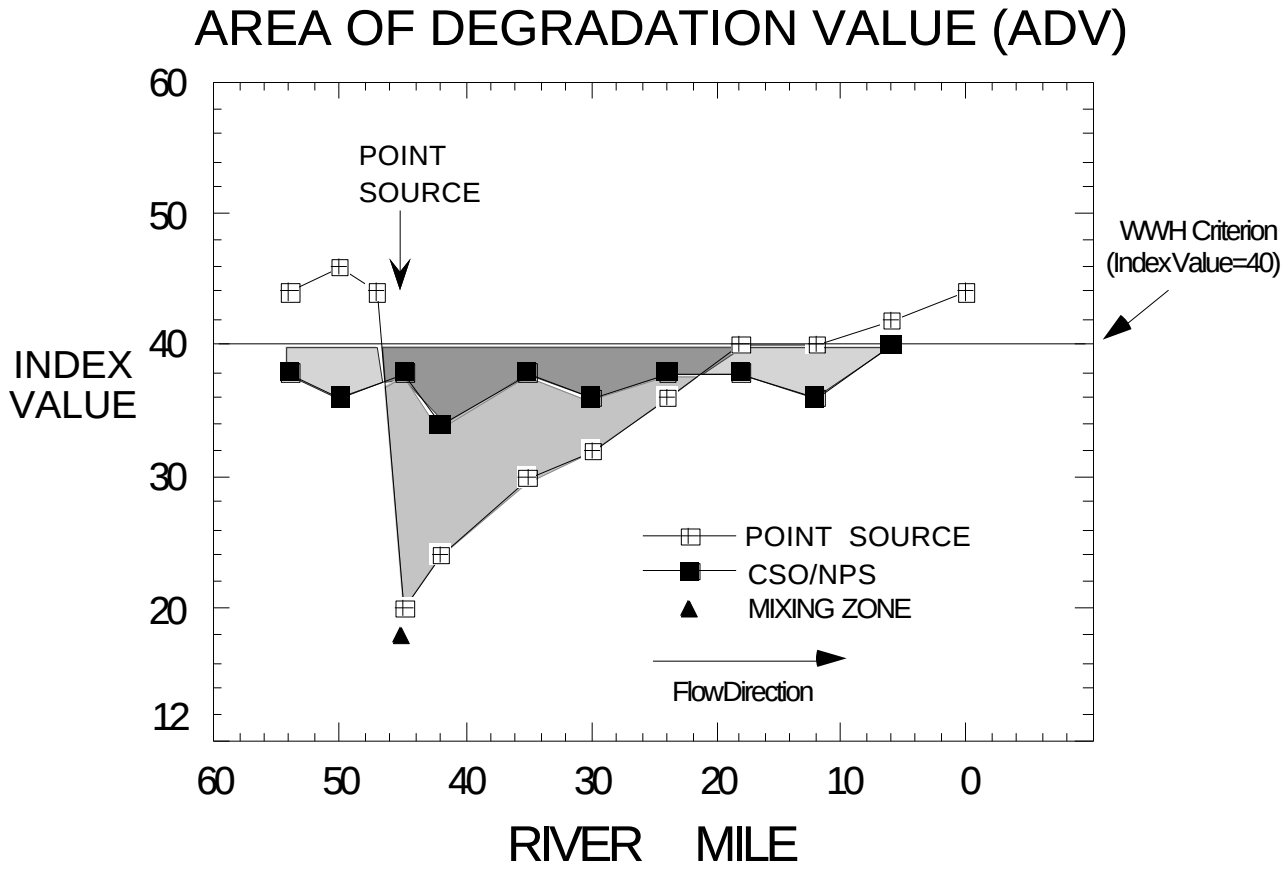

Figure 2. Graphic illustration of the Area of Degradation Values (ADV) based on the ecoregion biocriterion (WWH in this example). The index value trend line indicated by the unfilled boxes and solid shading (area of departure) represents a typical response to a point source impact (mixing zone appears as a solid triangle); the filled boxes and dashed shading (area of departure) represents a typical response to a nonpoint source impact or combined sewer overflow impact. The blended shading represents the overlapping impact of the point and nonpoint sources.

RESULTS AND DISCUSSION

Sediment Chemistry

Sediment samples were collected at five locations in the Tuscarawas River, three locations in Hudson Run/ Reservoir and one location in Wolf Creek by Ohio EPA during 1993. All sampling locations are indicated by river mile (RM) in Figure 1. In addition, sediment sampling results collected in 1989 (6 locations) and 1985 (8 locations) by Ohio EPA, and data collected by PPG during 1993 (34 locations) were used in the evaluation of sediment conditions is the study area. Ohio EPA samples were collected at the 0-6" depth; samples collected by PPG varied between 0-6" and 12-48". Samples were analyzed for volatile organic compounds, semivolatile organic compounds, pesticides and PCBs (organochlorine compounds), metals, herbicides (PPG only), and organophosphates (PPG only). Specific chemical parameters tested are listed in Appendix Table A-1 and organic and metal parameters detected in sediment are listed in Appendix Tables A-2 through A-6.

- Both Ohio EPA and PPG sediment data confirms the presence of high concentrations of hexachlorobenzene (HCB) in the Tuscarawas River from Wolf Creek to the downstream end of the study area (RM 94.6), and in Hudson Run Reservoir (Figure 3). Of the 24 samples tested for HCB in the Tuscarawas River between Wolf Creek and the lower end of the study area (RM 110.2 - 94.6), 16 exceeded the Severe Effect Level (Persaud *et al*. 1992). In the 'Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario' (Persaud *et al.* 1992), Severe Effect Level is defined as sediment which is considered heavily polluted and likely to affect the health of sediment-dwelling organisms. Within Hudson Run Reservoir and Hudson Run downstream from the reservoir, 13 of 16 samples exceeded Severe Effect Level guidelines. The highest HCB values within the study area were documented in Hudson Run Reservoir at RM 0.4 (438,000 ug/kg and 469,852 ug/kg). A summary of hexachlorobenzene concentrations by river segment is listed in Table 3.

- Aside from hexachlorobenzene, numerous other chlorinated benzenes were measured in sediment samples collected within the Tuscarawas River study area. Chlorinated benzene parameters detected included chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 1,2,4-trichlorobenzene, 1,2,4,5-tetrachlorobenzene, and pentachlorobenzene. Elevated total chlorinated benzene concentrations (excluding hexachlorobenzene) were documented in the Tuscarawas River between RMs 110.2 and 107.4 and in Hudson Run Reservoir and Hudson Run between RM 0.4 and the mouth (Table 3). The highest total chlorinated benzene value (excluding HCB) was recorded in Hudson Run Reservoir (126,730 ug/kg).

- 2378-Tetrachlorodibenzo-*p*-dioxin (2378-TCDD), 2378-tetrachlorodibenzofuran (2378-TCDF) and other dioxin and furan congeners were measured in the sediment of the Tuscarawas River, Hudson Run, and Wolf Creek within the study area. The highest level of 2378-TCDD (128 pg/g) and 2378-TCDD total toxicity equivalents

(TTE) (3,028 pg/g) occurred in Hudson Run Reservoir at RM 0.45. These levels were higher than surface mine reclamation sludge application criteria (100 pg/g 2378-TCDD TTEs) and the CDC residential action level (1000 ppt 2378-TCDD/ or 1000 ppt TTE as is commonly used by regulatory programs). In addition, Hudson Run Reservoir at RM 0.45 has the potential to be a high risk source to sensitive fish species due to the elevated 2378-TCDD concentration in the sediment (USEPA 1993a). Other locations within the study area with elevated 2378-TCDD TTEs (greater than 100 pg/g) included the Tuscarawas River at RMs 112.1, 109.47, 107.97, and 107.4; Hudson Run Reservoir at RM 0.40; and Wolf Creek at RM 0.7.

- Using sediment evaluation criteria developed by Kelly and Hite (1984), several metal parameters had levels considered extremely elevated above background concentrations. The following is a list of metal parameters with the number of samples exceeding the extremely elevated level, the percent of the total samples analyzed, along with the highest concentration reported in the study area:

  Mercury - 22 (27%) extremely elevated - 7.3 mg/kg
  Lead - 20 (21%) extremely elevated - 3470 mg/kg
  Chromium - 15 (16%) extremely elevated - 822 mg/kg
  Arsenic - 11 (12%) extremely elevated - 269 mg/kg
  Zinc - 11 (11%) extremely elevated - 946 mg/kg
  Iron - 4 (4%) extremely elevated - 98,100 mg/kg
  Copper - 1 (1%) extremely elevated - 207 mg/kg

- Generally, the highest metal concentrations in sediment of the Tuscarawas River were measured at RMs 110.9, 109.47, 107.97 and 104.3 (Table 4). River mile 110.9 is located upstream from Wolf Creek, and downstream from past industrial effluent discharges. Within Wolf Creek, the highest metal levels were primarily located between RMs 0.7 and 0.4. The highest mercury level within the entire study area was located at RM 0.4 (7.3 mg/kg). Significant concentrations of lead were observed in Wolf Creek between RMs 2.1 and 1.6 (203 - 589 mg/kg). An evaluation of the Hudson Run waterway revealed that the highest metals concentrations were found within Hudson Run Reservoir between RMs 0.65 and 0.40. The highest lead level in the study area was reported in Hudson Run Reservoir at RM 0.5.

- Chlorinated herbicide and organophosphate compounds analyzed were less than lab detection limits, excluding one sample collected in Wolf Creek at RM 0.7 (2,4-D = 427 ug/kg).

- Two locations within the study area had detectable levels of PCBs reported. Lake Dorothy at RM 3.0 and RM 0.4 reported Aroclor-1242 at 285 ug/kg. Wolf Creek at RM 2.0 had Aroclor-1248 reported at 508 ug/kg and 2,690 ug/kg and Aroclor-1254 at 639 ug/kg. All four of the results are considered highly elevated and the 2,690 ug/kg value extremely elevated above background conditions (Kelly and Hite 1984).

Table 3. Range of concentrations of selected organic chemicals collected in sediment from the Tuscarawas River, Hudson Run (and reservoirs), and Wolf Creek by Ohio EPA, U.S. EPA, and PPG during 1993. nd = not detected. **Boldface** numbers indicate values exceeding the Severe Effect Level (Persaud *et al.* 1992) and a potential source of high risk to aquatic life level (USEPA 1993a), respectively.

	SEDIMENT (dry weight basis)			
Stream River Mile Segment (Location)	**Hexa chloro benzene** (ug/kg)	**Total Chlorobenzenes (excluding HCB)** (ug/kg)	**Dioxin-2378 TCDD** (pg/g)	**2378 TCDD Total Toxicity Equivalents** (pg/g)
Tuscarawas River				
119.4 - 110.9 (Upstream Wolf Creek)	nd - 120	nd	nd - 8.0	0.95 - 181.58
110.2 - 107.4 (Downstream Wolf Creek, adjacent Lime Lakes 3,4,5,6)	nd - **190,000**	nd - 5,990	0.67 - 20.0	6.46 - 142.40
106.0 - 94.8 (Downstream Lime lakes, upstream Massillon)	150 - **38,000**	nd - 1,098.8	0.96 - 6.14	20.56 - 79.84
Wolf Creek				
2.0 - 1.2 (Upstream PPG)	nd	nd	nd[1]	2.58[1]
0.7 - 0.1 (Adjacent Lime Lake 1)	nd - **2,160**	nd - 112	nd - 64.8	3.81 - 290.03
Hudson Run/ Lake Dorothy				
4.0 - 1.4 (Upper Hudson Run to Hudson Run Reservoir, Lake Dorothy)	nd - 160	nd	nd - 3.5	0.66 - 6.73
Hudson Run Reservoir				
1.05 - 0.40 (Reservoir)	nd - **473,000**	nd - 126,730	nd - **128**	nd - 3,028.04
Hudson Run				
0.35 - 0.05 (Adjacent Lime Lakes 1, 2)	nd -**20,700**	nd - 3,729	nd - 0.23	4.52 - 19.62

[1] - one sample.

Table 4. Range of concentrations of selected total metals collected in sediment from the Tuscarawas River, Hudson Run (and reservoirs), and Wolf Creek by PPG during 1993, U.S. EPA during 1993, and Ohio EPA during 1993, 1989, and 1985. nd = not detected. **Boldface** values indicate levels extremely elevated above background conditions (Kelly and Hite 1984).

	SEDIMENT (dry weight basis)			
Stream River Mile Segment (Location)	**Arsenic** (mg/kg)	**Cadmium** (mg/kg)	**Chromium** (mgkg)	**Copper** (mg/kg)
Tuscarawas River **119.4 - 115.3** (Upstream Barberton)	6.00 - 18.2	nd - 0.074	<7.56 - 13.3	8.11 - 18.7
112.5 - 110.7 (Barberton to upstream from Wolf Creek)	4.09 - **55.7**	0.0828 - 2.1	4.75 - **822**	10.2 - 89.7
110.2 - 107.4 (Downstream Wolf Creek, adjacent Lime Lakes 3,4,5,6)	3.4 - **269**	nd - 2.9	2.96 - **137**	5.6 - 125
106.0 - 90.4 (Downstream Lime lakes to Massillon)	5.7 - **39.2**	nd - 0.83	7.72 - 59.0	9.2 - 63.1
Wolf Creek **2.0 - 1.2** (Upstream PPG)	5.3 - 14.9	nd - 1.5	9.4 - **76.4**	11.6 - 38.1
0.7 - 0.1 (Adjacent Lime Lake 1)	5.72 - 24.6	nd - 3.00	11.0 - **234**	11.7 - 115
Hudson Run/ Lake Dorothy **4.0 - 1.4** (Upper Hudson Run to Hudson Run Reservoir, Lake Dorothy)	2.6 - 15.3	nd - 1.6	4.2 - 17.3	nd - 27.4
Hudson Run Reservoir **1.05 - 0.40** (Reservoir)	6.5 - **69.1**	nd - 0.651	11.0 - **244**	12.2 - **207**
Hudson Run **0.3 - 0.05** (Adjacent Lime Lakes 1, 2)	1.20 - **146**	nd - 1.5	7.68 - 14.2	8.7 - 22.5

Table 4. Continued.

Stream River Mile Segment (Location)	**SEDIMENT** (dry weight basis) **Lead** (mg/kg)	**Mercury** (mg/kg)	**Zinc** (mgkg)
Tuscarawas River			
119.4 - 115.3 (Upstream Barberton)	20.2 - 27.4	nd	41.9 - 114
112.5 - 110.7 (Barberton to upstream from Wolf Creek)	27.2 - **496**	nd - **0.53**	65.2 - **525**
110.2 - 107.4 (Downstream Wolf Creek, adjacent Lime Lakes 3,4,5,6)	6.8 - **287**	nd - **0.80**	31.8 - **463**
106.0 - 90.4 (Downstream Lime lakes to Massillon)	7.7 - **573**	nd - **0.36**	53.0 - **484**
Wolf Creek			
2.0 - 1.2 (Upstream PPG)	10.3 - 76.6	nd	50.5 - **589**
0.7 - 0.1 (Adjacent Lime Lake 1)	10.1 - **127**	nd - **7.3**	64 - **946**
Hudson Run/ Lake Dorothy			
4.0 - 1.4 (Upper Hudson Run to Hudson Run Reservoir, Lake Dorothy)	6.3 - 39.3	nd	26.8 - **338**
Hudson Run Reservoir			
1.05 - 0.40 (Reservoir)	22.1 - **3470**	nd - **1.1**	65.7 - **483**
Hudson Run	19.3 - **164**	nd - 0.22	32.0 - 95.6
0.3 - 0.05 (Adjacent Lime Lakes 1, 2)			

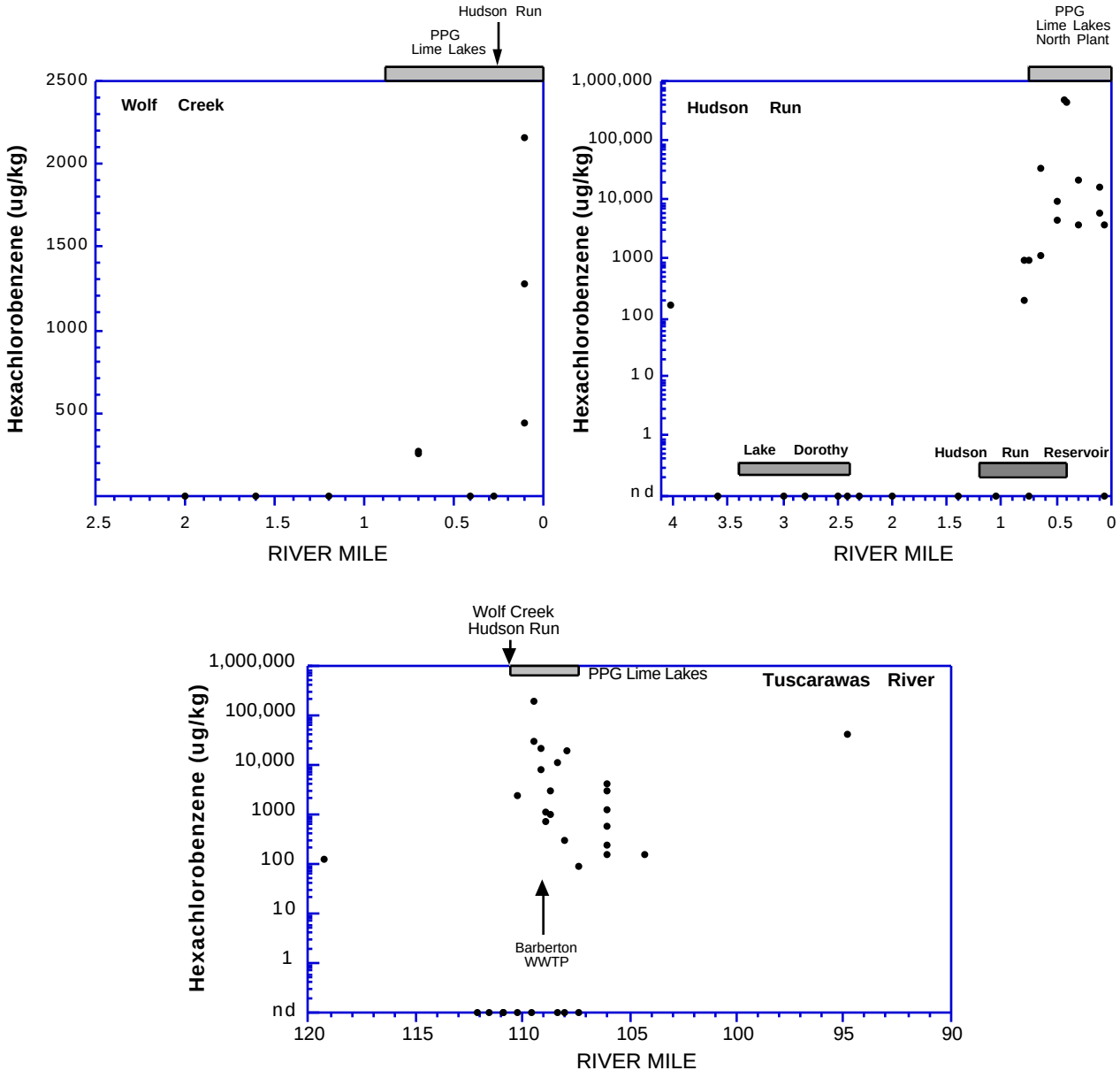

Figure 3. Longitudinal trend of hexachlorobenzene concentrations in the sediment of the Tuscarawas River, Wolf Creek, and Hudson Run from data collected in 1993 (Ohio EPA and PPG) and 1989 (Ohio EPA).

Pollutant Loadings: 1977 - 1993

- Historically, the PPG-Barberton industrial complex on Wolf Creek, Hudson Run, and the Tuscarawas River had been a major point source contributor to pollution problems in the Tuscarawas River. The major source of wastes at PPG came from the manufacturing of soda ash (calcium carbonate) which began in 1899 and continued until 1973. During that period, an estimated 744,655 metric tons/year of waste were produced, much of which was deposited in a series of six settling lagoons (lime lakes) which border the lower mile of Wolf Creek, 0.4 miles of Hudson Run, and the Tuscarawas River from the confluence with Wolf Creek at RM 110.7 to RM 107.5. Effluents discharged from the lagoons were characteristically high in chlorides, solids, conductivity, and sodium and impacted the river far downstream. Sampling in 1953 revealed elevated chloride levels associated with PPG throughout the 220 mile length of the Tuscarawas and Muskingum Rivers. Since that time, levels of chloride and associated chemicals have been substantially reduced by the reduction or elimination of production, changes in plant processes, the diversion of discharges to the Barberton WWTP (pretreated), and environmental controls. By 1986, all process wastewaters were discharged to the Barberton WWTP or removed for off-site disposal. Currently, only non-contact cooling water and steam condensate are permitted to be discharged to adjacent receiving streams(e.g. outfalls 3IE00010 - 011, 012, 013, and 014). Outfall 011 contains non-contact cooling water from the Silica Plant and discharges to Hudson Run at RM 0.35; outfall 012 discharges non-contact cooling water to Hudson Run Reservoir at RM 0.50; outfall 013 consists of blowdown from the Fine Chemicals Plant non-contact cooling water tower and discharges to Hudson Run Reservoir at RM 0.55; and outfall 014 discharges non-contact steam condensate from the Teslin Plant to Wolf Creek at RM 0.90. Outfall 011 reports pH, temperature and flow via internal stations 601 and 602. Data from 1992 and 1993 indicated acceptable levels of these parameters in outfall 011. Outfalls 012, 013 and 014 report flow, pH, and water temperature as a permit requirement. Only outfall 013 reported data from 1992 and 1993. Reported values for permitted parameters from outfall 013 were within acceptable levels.

- The Barberton wastewater treatment plant (WWTP) (OEPA permit number 3PD00004) is an advanced treatment facility with an average design flow of 6.0 million gallons per day (MGD) and a peak hydraulic capacity of 12 MGD. During 1993, the Barberton WWTP treated an average of 4.98 MGD. The treatment plant was upgraded from a secondary treatment facility to advanced treatment during June, 1988. Final effluent from the plant enters the Tuscarawas River at RM 109.14. The city implements an approved industrial pretreatment program, with approximately 15% of the influent flow to the plant comprised of industrial users. Three significant industrial users and approximately 70 other noncategorical industrial users discharge to the treatment plant. The sewage collection system is serviced by separate sanitary and storm sewers, with no CSOs or bypasses existing. Current summer 30-day average permit limits for ammonia-N and $CBOD_5$ are 2.0 mg/l (45.4 kg/day) and 10 mg/l (227 kg/day), respectively.

- Loading trends of three pollutants discharged to the Tuscarawas River from the Barberton WWTP 001 effluent from 1977 through 1993 are shown in Figure 4. The ammonia-N annual loadings graph shows a substantial decrease in loadings from 1988 onward, with 50th percentile values declining from 60 kg/day in 1987 to 9 kg/day in 1988. Similar declines were noted in BOD_5 and TSS results upon completion of the major plant upgrade during 1988. One important observation on ammonia-N loadings during 1990 - 1993 was that 50th percentile loadings were less than 1.0 kg/day. Biomonitoring data from 1989, 1990, and 1991 suggest that the Barberton WWTP effluent is not acutely or chronically toxic to fathead minnows or *Ceriodaphnia dubia*.

- The Canal Fulton WWTP (OEPA permit number 3PB00008) is a secondary extended aeration treatment plant which during 1993 treated an average of 0.6 MGD. The plant was designed to treat an average of 1.5 MGD. The final effluent from the plant enters the Tuscarawas River at RM 97.70. The collection system is serviced by separate sewers, with no CSOs or bypasses existing. There are no industrial users which discharge into the sewer system. Current summer 30-day average permit limits for ammonia-N and $CBOD_5$ are monitoring and 25 mg/l, respectively.

- Loading trends of three pollutants discharged to the Tuscarawas River from the Canal Fulton WWTP 001 effluent from 1982 through 1993 are shown in Figure 5. No clear trends are evident in the loadings of ammonia-N, BOD5 or total nonfilterable residue from the Canal Fulton WWTP. Ammonia-N values were generally low, with 50th percentile loadings values less than 4 kg/day (7 of 11 years had values less than 1.0 kg/day). However, the differences between the 50th percentile and 95th percentile ammonia-N values were large during most years, suggesting high variability in effluent quality. Average 1993 loadings of ammonia-N were comparable between Canal Fulton and the Barberton WWTP.

- The Summit County (#36) Upper Tuscarawas WWTP (OEPA permit number 3PK00013) is an advanced treatment facility with an average design flow of 4.0 million gallons per day (MGD) and a peak hydraulic capacity of 10 MGD. During 1993, the Summit Co. Upper Tuscarawas WWTP treated an average of 0.794 MGD. This facility has both effluent chlorination and dechlorination prior to discharging to the Tuscarawas River at RM 120.0. The collection system is serviced by separate sewers, with no CSOs or bypasses existing. There are no industrial users which discharge into the sewer system. Current summer 30-day average permit limits for ammonia-N and $CBOD_5$ are 1.5 mg/l and 10 mg/l, respectively.

- Loading trends of pollutants discharged to the Tuscarawas River from the Summit Co. Upper Tuscarawas WWTP 001 effluent during 1992 and 1993 are shown in Table 5. All parameters listed were quite low, especially values reported for 1993. Monitoring of the Tuscarawas River both upstream and downstream from the WWTP by the facility revealed no significant difference between stations. All metal parameters reported in the effluent discharge were near or below lab detection limits and ammonia-N 50th and 95th percentile concentrations for 1993 were 0.1 mg/l and 0.5 mg/l, respectively.

- Babcock and Wilcox is a company which produces nuclear reactor components and power generating equipment. This facility currently has five permitted effluent points (OEPA permit number 3ID00012) which discharge to the following locations: 001 - Wolf Creek RM 0.95, 003 - Wolf Creek RM 0.55, 004 - Wolf Creek RM 0.74, 005 - Wolf Creek RM 0.86, and 006 - Tuscarawas River RM 111.15. Sanitary wastes are discharged to the Barberton sewer system. Outfall 001 discharges treated process wastewater, non-contact cooling water, and stormwater runoff. The 001 has a batch treatment system, consisting of oil/water separation, activated carbon, cationic polymer addition for coagulation, and sedimentation/clarification. Outfall 001 parameters with permit limits include oil & grease, copper, lead, zinc, and phenol. Outfalls 003, 004, 005, and 006 discharge untreated non-contact cooling water and/or stormwater runoff. Outfall 003 is regulated for oil & grease, silver, and zinc; outfall 005 is regulated for ammonia-N and silver; and outfall 006 is regulated for oil & grease. Outfall 004 has monitoring requirements only.

- Limited testing of the Babcock and Wilcox 001 effluent discharge during 1993 indicated general compliance with permit conditions. One violation of the daily oil & grease limit was observed during 1993. Monitoring data from outfall 005 documented highly elevated concentrations of total silver (1993 data: 31 of 41 samples reported as not detected, detected values ranged between 140 ug/l and 260 ug/l), with several in violation of the daily permit limit. Zinc was elevated in a number of 1993 samples from outfall 003 (50th percentile = 120 ug/l, maximum = 430 ug/l), outfall 005 (50th percentile = 120 ug/l, maximum = 440 ug/l), and outfall 006 (50th percentile = 320 ug/l, maximum = 830 u/gl). Copper was generally documented at low levels; however, outfall 004 had a reported maximum copper value of 220 ug/l during 1993.

- Preferred Rubber Compounding Corp.(OEPA permit number 3IR00023) (previously called Polysar Rubber) discharges non-contact cooling water and boiler blowdown. In addition, contact cooling water is discharged through outfall 001; contact cooling water will be September, 1994. Two outfalls discharge untreated effluent to Mud Run at RM 0.10, which flows into the Tuscarawas River at RM 113.23.

- Wright Tool and Forge (OEPA permit number 3IC00060) discharges non-contact cooling water to the Tuscarawas River at RM 112.78. Prior to 1991, Wright Tool and Forge discharged effluent containing elevated levels of hexavalent chromium (maximum = 200 ug/l), total chromium (maximum = 900 ug/l) and nickel (maximum = 2,500 u/gl).

- Lists of spills and wild animal kills are also indications of possible impacts due to pollutant loadings. Reviews were conducted for discharges and kills to the Tuscarawas River, Hudson Run, and Wolf Creek within the study area as reported by Ohio EPA's Division of Emergency and Remedial Response and Ohio DNR's Division of Wildlife Pollution Investigation Reports. Spill results are listed in Appendix Table A-7. Results from 1980 through 1993 show:

  1) 68% of the listed spills were associated with PPG, although no spills have been reported since 1991. Primary spills associated with PPG included silica solids/sodium silicate (37), wastewater (27), and hydrochloric acid (9). Other reported PPG spills included diethyl chloroformate, calcium hypochorite, dipropylcarbamothioic acid S-ethyl ester, caustic wastewater, styrene butadiene, and mercaptan.

  2) Pollution investigation reports for the same time period listed three incidents where a total of 3,218 fish were killed within the Hudson Run study area. Two of the three incidents were caused by chemical spills from PPG; the last incident, recorded on September 15, 1993, was caused by an undetermined source. No fish kills were reported in the Wolf Creek or Tuscarawas River during the 1980 through 1993 period.

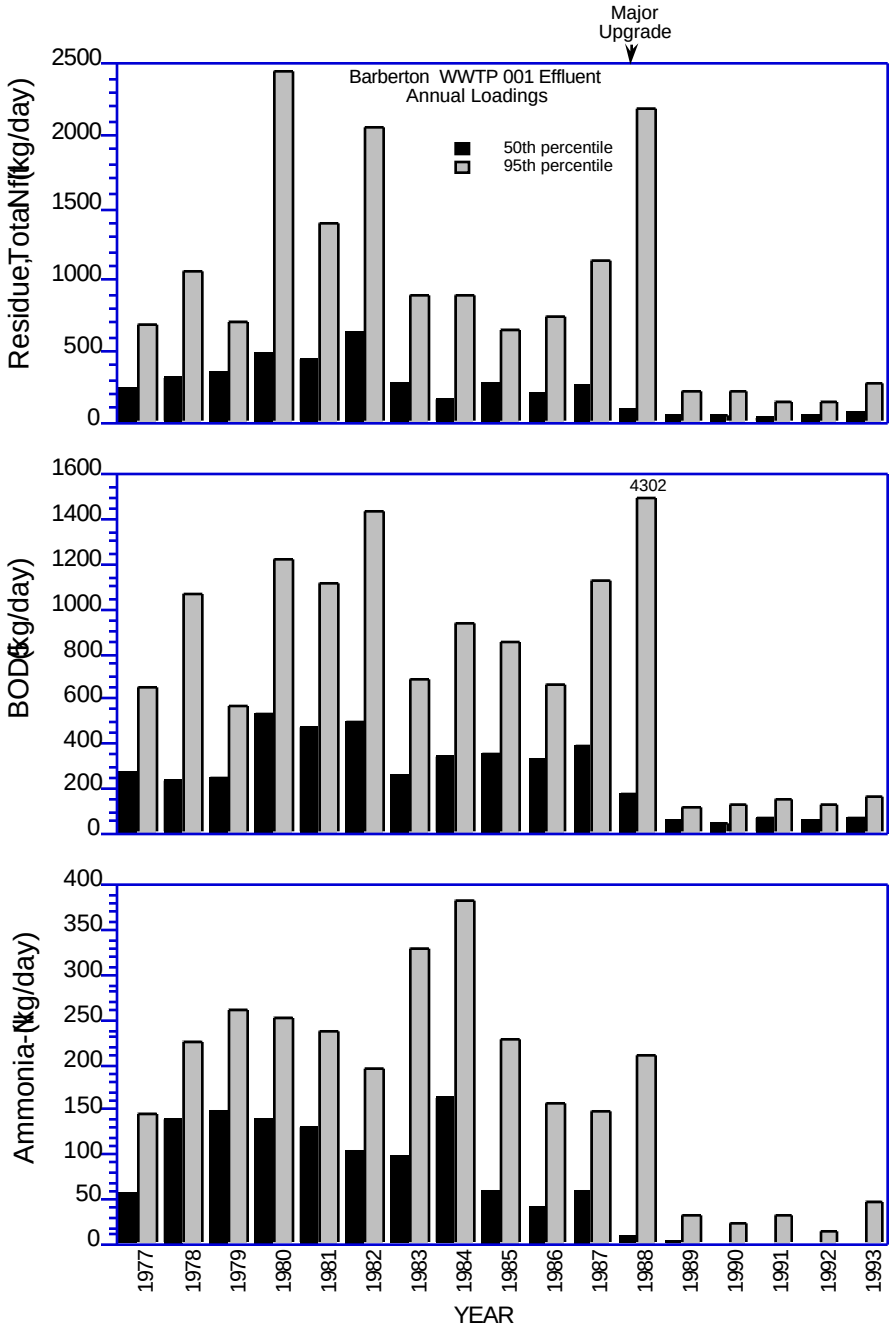

Figure 4. Loadings (kg/day) of total nonfilterable residue (TSS), biochemical oxygen demand (BOD_5), and ammonia-nitrogen from the Barberton WWTP 001 effluent to the Tuscarawas River from 1977 - 1993.

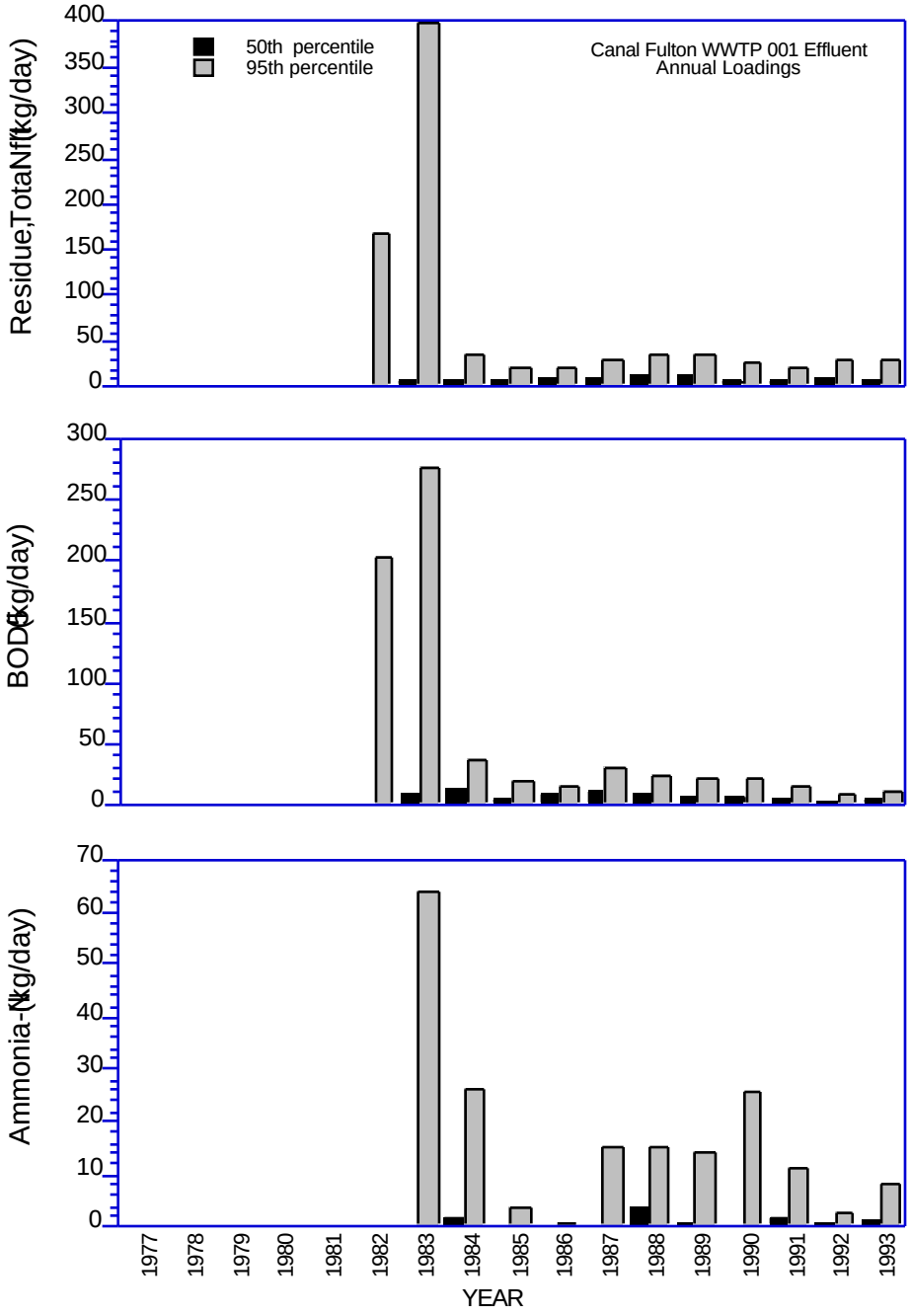

Figure 5. Loadings (kg/day) of total nonfilterable residue (TSS), biochemical oxygen demand (BOD_5), and ammonia-nitrogen from the Canal Fulton WWTP 001 effluent to the Tuscarawas River from 1977 - 1993.

Table 5. Comparison of loadings of selected pollutants from Babcock and Wilcox Co., Canal Fulton WWTP, Summit Co. Upper Tuscarawas WWTP, and Barberton WWTP to the Tuscarawas River, Wolf Creek, and Hudson Run during January to December, 1992 and January to October, 1993. Results are reported in median kg/day. Asterisks indicate values reported as below lab detection limits.

Facility	Flow (MGD)	O & G (kg/day)	TSS (kg/day)	Copper (kg/day)	Zinc (kg/day)	NH3N (kg/day)
1992						
Barberton WWTP	4.7	*	47.69	0.244	1.032	0.23
Babcock & Wilcox	0.875	6.0	10.9	0.006	0.221	*
Canal Fulton	0.59	2.09	10.05	*	0.039	0.76
Summit Co. Up. Tusc WWTP	0.835	*	3.86	*	0.019	*
1993						
Barberton WWTP	4.6	*	66.92	0.212	1.070	0.50
Babcock & Wilcox	0.875	*	*	0.008	0.173	*
Canal Fulton	0.596	2.10	8.25	*	0.034	1.09
Summit Co. Up. Tusc WWTP	0.794	*	*	*	*	*

Surface Water Chemical Quality

Surface water samples were collected in the Tuscarawas River, Wolf Creek, and Hudson Run by Ohio EPA during the 1993 study on August 16, September 14, and October 28. In addition, samples collected by PPG during 1993 were included in the surface water evaluation. Results are presented in Appendix Tables A-8 and A-9.

- The daily flows as reported by the United States Geological Survey for May through September 1993 in the Tuscarawas River at RM 89.0 are shown in Figure 6. The mean monthly discharge during these months was greatest during May (497 cfs) and lowest during September (215 cfs). The minimum daily flows during the end of August approached $Q_{7,10}$ (seven-day ten year low flows measured in cubic feet per second) conditions (71cfs) and a majority of the daily flows during August and September were at or below the 80% duration value (110 cfs).

- Four volatile organic compounds (chloroform, tetrachloroethene, trichloroethene, and carbon tetrachloride) were consistently detected in surface waters from Hudson Run Reservoir and Hudson Run between RM 0.7 and 0.05. Detected values ranged from 2.3 - 7.0 ug/l for chloroform, 2.3 - 36 ug/l for tetrachloroethene, 2.2 - 15 ug/l for trichloroethene, and 2 - 6.5 ug/l for carbon tetrachloride. All detected values were below applicable Ohio water quality standards criteria. All sampling stations in the Tuscarawas River upstream from Wolf Creek, in Hudson Run upstream from Hudson Run Reservoir, and in Wolf Creek upstream from PPG reported these four parameters as not detected.

- Hexachlorobenzene (HCB) was detected in six surface water samples; two in Hudson Run/ Hudson Run Reservoir and four in the Tuscarawas River downstream from Wolf Creek. The highest HCB surface water concentration in the study area occurred in Hudson Run reservoir at RM 0.43, the same location where the highest sediment concentration of HCB was recorded. All six detected HCB values were below the Ohio water quality standards for human health and public water supply (there are no surface water standards for aquatic life). Detection limits varied greatly between samples analyzed for Ohio EPA and samples analyzed for PPG.

- Results for total arsenic, cadmium, chromium, copper, lead, mercury, selenium, and silver were all reported as below lab detection limits.

- Ammonia-N concentrations were documented at or below the lab detection limit of 0.05 mg/l.

- All PCB compounds were reported as not detected.

- Large increases in sodium, chloride, and total dissolved solids (TDS) were observed in surface water samples collected from the Tuscarawas River adjacent to and downstream from the Barberton WWTP and PPG lime lakes (Figure 7). Monthly operating report data from the Barberton WWTP during 1993 indicated that a portion of the increase was attributable to the WWTP effluent discharge. Fiftieth percentile effluent data for total dissolved solids and chloride (sodium is not monitored in the effluent) was 1,220 mg/l and 485 mg/l, respectively. Elevated concentrations of these three parameters in the Tuscarawas River upstream from the Barberton WWTP suggests that PPG lime lakes 1, 2 and/ or 3 are a contributing source of sodium, chloride, and total dissolved solids. A waste disposal sites assessment of PPG Industries (O'Brien and Gere 1987) identified the Tuscarawas River Valley South as an area south and hydraulically down gradient of the lime lakes. The valley is filled with glacial material and has a high capacity to transmit ground water. It has been identified as a major transport pathway and receptor for soluble contaminants originating in the lime lakes region. Field studies indicated that a plume of ground water containing chlorides has moved southward from the area of the lime lakes along the Tuscarawas River valley and have been found to discharge into the Tuscarawas River due to a upward hydraulic gradient. In the Tuscarawas River adjacent to and downstream from the PPG lime lakes, numerous exceedances of the 30-day average water quality standard for total dissolved solids were recorded during 1993. Of the 14 samples collected between RM 110.2 and RM 94.8, eight exceeded the TDS aquatic life water quality criteria.

- Continuous dissolved oxygen data was collected at seven locations in the Tuscarawas River from August 4 to 6, 1993 (Figure 8). Violations of the MWH or WWH Ohio Water Quality Standards were not detected; however, a distinct decline was observed within the Barberton urban area upstream from the Barberton WWTP. Overall, dissolved oxygen (D.O.) concentrations during the August sampling period were reflective of generally good water quality. Several of the stations which were channelized, shallow, and had very few trees to provide shade for the river exhibited highly saturated D.O. conditions.

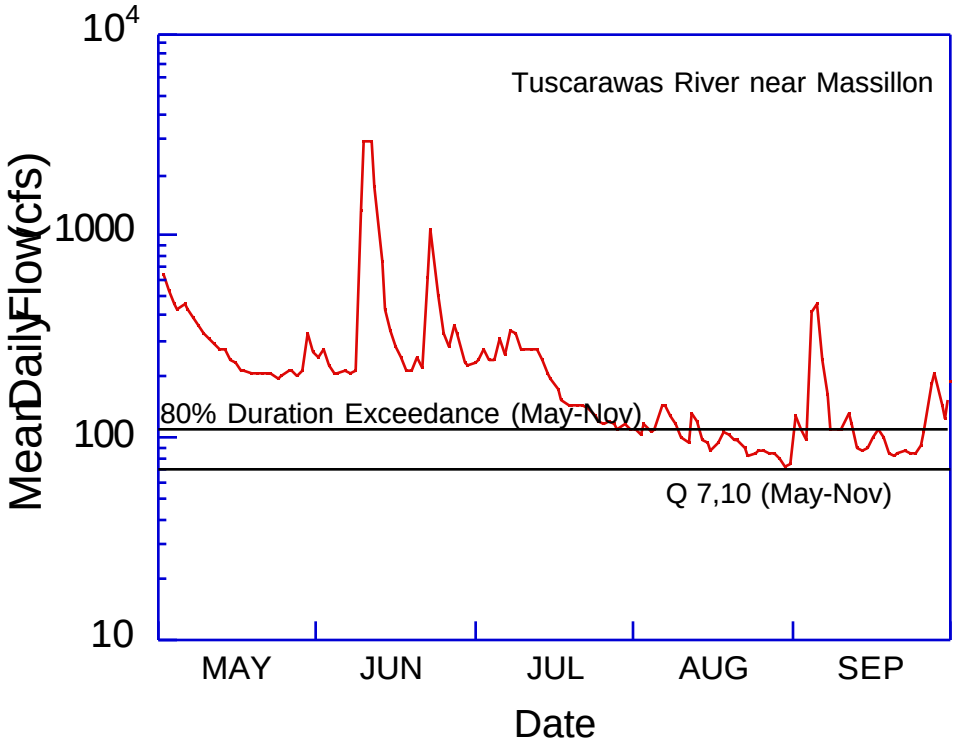

Figure 6. Flow hydrograph for the Tuscarawas River near Massillon, Ohio (RM 89.0), May through September, 1993.

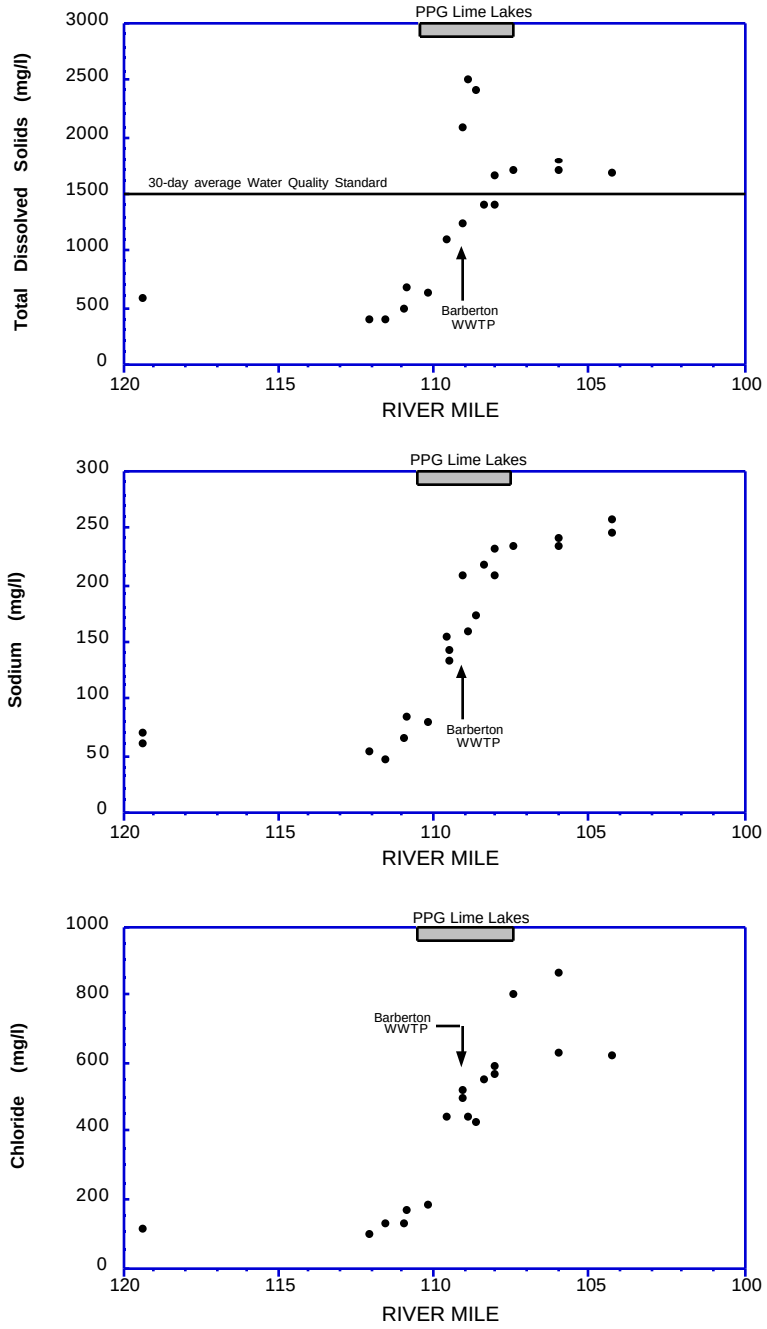

Figure 7. Longitudinal trend of sodium, total dissolved solids, and chloride surface water concentrations in the Tuscarawas River during the 1993 study period. Data includes results from Ohio EPA and PPG.

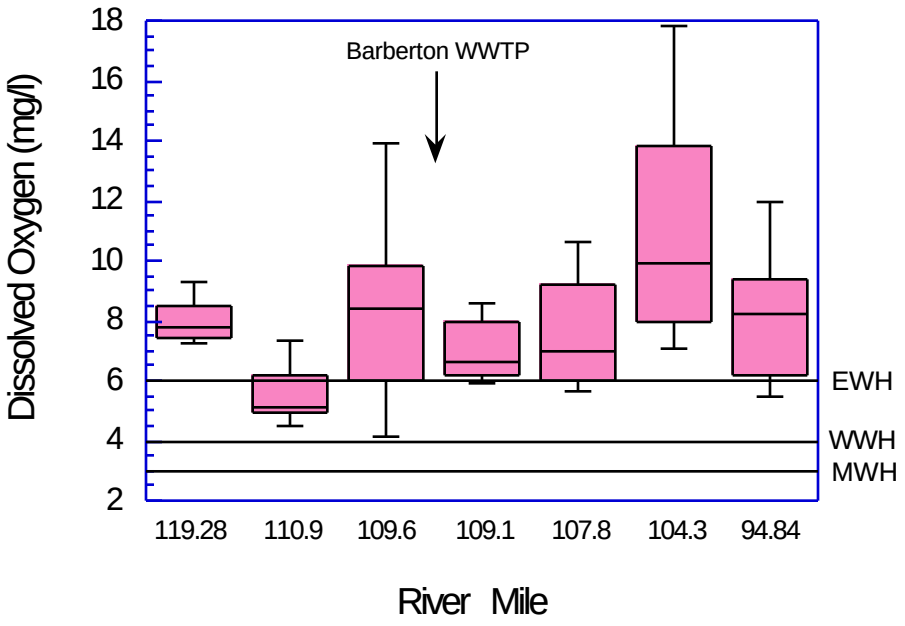

Figure 8 Boxplots of dissolved oxygen data (mg/l) recorded with Datasonde™ continuous monitors at seven locations in the Tuscarawas River during August 4-6, 1993. The minimum D.O. criteria for the MWH (3 mg/l), WWH (4 mg/l) and EWH (6 mg/l) use designations are indicated by horizontal lines.

Physical Habitat for Aquatic Life

Physical habitat was evaluated in the Tuscarawas River, Wolf Creek, and Hudson Run at 1993 biological sampling locations. Qualitative Habitat Evaluation Index (QHEI) scores are detailed in Table 6. Numerous areas in the Tuscarawas River, Wolf Creek, and Hudson Run were affected by soda ash waste from PPG lime lakes which formed a hard crust over much of the stream substrates. In many places, this crust formed a 'false bottom' which when broken, uncovered thick, slurry-like deposits.

Tuscarawas River

- Stream morphology in the upstream natural section of the Tuscarawas River (RM 119.4) consisted of excellent pool, riffle, and run development. Bottom substrates were predominated by gravel, with lesser amounts of cobble, boulder, sand, muck, and detritus. Good base flow conditions were observed in this reach of the Tuscarawas River, even during the summer low-flow time period. The QHEI score at RM 119.4 was 81.0, reflective of excellent stream habitat. This location did not record any MWH attributes.

- The Tuscarawas River between the Barberton city limits and Chippewa Creek (RM 110.3 - 103.2) was channelized in 1963. An additional 6,500 feet were ditched in 1982 and 1985 north of Pancake Creek (RM 105.6) (Summit County Engineers Office). A review of topographic maps between 1957 and 1967 documented that the Tuscarawas River between Long Lake and Barberton (RM 115.1 - approximately RM 113.0) was channelized between these years and the Tuscarawas River in Barberton (RM 113.0 - 110.3) appears to have been channelized before 1957. As a result of the channelization, physical habitat in the Tuscarawas River between sampling stations RM 110.9 and RM 104.5 consisted primarily of pool and glide areas. Some instream channel recovery has occurred (marginal riffle development, sinuosity) due to moderate river gradients. In addition to channelization, soda ash waste deposition and concretion of the Tuscarawas River bottom within the PPG lime lakes area (RM 110 - 107) has influenced physical habitat conditions. QHEI scores in the channelized section of the Tuscarawas River ranged between 36.5 and 56.5, indicative of poor to fair habitat quality.

- Natural habitat conditions occur in the lower end of the Tuscarawas River study area (RM 103.2 - 94.7). The sampling site at RM 94.7 consisted of predominantly gravel and sand substrates, moderate amounts of instream cover, and good channel development. The QHEI score at RM 94.7 was 74.5, with a substantial amount of warmwater habitat attributes in comparison to modified warmwater habitat attributes. Habitat conditions were adequate for supporting warmwater biological communities.

Wolf Creek

- Wolf Creek was channelized in the early to mid 1970's between Barberton Reservoir (RM 5.1) and the mouth. Sampling during this survey included RM's 1.1 and 0.3. QHEI scores were 40.5 and 51.0, indicative of poor to fair habitat conditions. The upstream site (an area outside of the PPG Lime Lakes influence) was characterized by a predominance of muck substrates, fairly uniform water depth, sparse instream cover

and one riffle. The riparian zone was very narrow, with one side of the stream flowing along an industrial site. Sampling adjacent to PPG Lime Lake 1 (RM 0.3) revealed a bottom predominated by soda ash concretion and sand. Instream cover was sparse, and channel development was fair to poor. Several riffles of fair quality were located in this reach of the stream. Few WWH attributes were recorded in Wolf Creek.

Hudson Run

- Natural habitat conditions occurred in Hudson Run (RM 4.1) upstream from Lake Dorothy. The QHEI score was 69.0, reflective of good stream habitat. Bottom substrates were predominated by gravel and sand, instream cover was moderate and warmwater habitat attributes predominated.

- Substantial modification of physical habitats has occurred in Hudson Run in the lower 0.3 miles. This modification appears to have occurred as early as the turn of the century, when PPG began to dispose of wastes in Lime Lakes 1 and 2. The stream bottom is predominated by soda ash concretion and sand, instream cover is sparse and the riparian zone was nearly devoid of woody vegetation. A high stream gradient provided for numerous pool/ riffle/ run complexes. The QHEI score was 42.0, reflective of poor to fair habitat quality.

Table 6. Qualitative Habitat Evaluation Index (QHEI) matrix showing modified and warmwater habitat characteristics for the Tuscarawas River study area, July - October, 1993.

Table 6. Qualitative Habitat Evaluation Index (QHEI) matrix showing modified and warmwater habitat characteristics for the Tuscarawas River study area, July - October, 1993.

River Mile	QHEI	Gradient (ft/mile)	WWH Attributes: No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low/Normal Overall Embeddedness	Max. Depth > 40 cm	Low/No Riffle Embeddedness	Total WWH Attributes	MWH High Influence: Channelized or No Recovery	Silt/Muck Substrates	Low Sinuosity	Sparse/No Cover	Max. Depth < 40 cm (WD/HW)	Total H.I. MWH Attributes	MWH Moderate Influence: Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low/No Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	Total M.I. MWH Attributes	MWH H.I./WWH Ratio	MWH M.I./WWH Ratio
(17-500) Tuscarawas River																																	
Year: 93																																	
119.4	**81.0** DJA	2.49	■■		■	■	■	■	■	■	■		9						0													0	0.10	0.10
110.9	**36.5** DJA	1.35					■			■			2	●	●				2	▲		▲▲				▲▲		▲				6	1.00	3.00
109.6	**47.5** DJA	1.35							■		■		2			●			1	▲▲		▲▲				▲▲						6	0.67	2.67
107.8	**56.5** DJA	1.35		■		■	■		■		■		5			●			1	▲		▲				▲▲						4	0.33	1.00
104.5	**54.5** DJA	1.35					■		■		■		3	●		●			2	▲▲		▲▲				▲▲						6	0.75	2.25
94.7	**74.5** DJA	1.04	■■		■		■	■		■	■		7						0		▲		▲				▲					3	0.13	0.50
(17-540) Wolf Creek																																	
Year: 93																																	
1.1	**40.5** DJA	2.54								■	■		2	●	●		●		3		▲		▲▲				▲▲						5	1.33	3.00
0.3	**51.0** DJA	2.50							■		■		2				●		1	▲▲		▲▲				▲▲						6	0.67	2.67
(17-541) Hudson Run																																	
Year: 93																																	
4.1	**69.0** DJA	18.18	■■		■	■	■			■	■		7						0								▲▲					2	0.13	0.38
0.1	**42.0** DJA	10.00								■			1	●		●	●		3	▲		▲▲				▲▲	▲					6	2.00	5.00

Macroinvertebrate Community

Macroinvertebrate communities were sampled at six locations in the Tuscarawas River and two locations each in Wolf Creek and Hudson Run between August and September, 1993. The sampling effort included the placement of modified Hester-Dendy artificial substrate samplers ($5ft^2$) and qualitative sampling of all available natural substrate types (Table 7, Figure 9). Lists of taxa collected at each sample location are included as Appendix Table A-10.

Tuscarawas River

- The most upstream sampling site in the Tuscarawas River, at Arlington Rd. (RM 119.4), located in an unmodified area with a WWH aquatic life use designation, supported an exceptional macroinvertebrate community as reflected by the ICI score of 48. This site is located approximately 0.6 miles downstream from the Summit Co. Upper Tuscarawas WWTP. The total number of taxa collected was 63 and included seven mayfly and six caddisfly taxa.

- The macroinvertebrate communities in the Tuscarawas River from RM 110.9 (Snyder Ave.) to RM 104.5 (Clinton Rd.) exhibited biological degradation. Due to physical habitat modifications, the Tuscarawas River from RM 112.9 to RM 103.2 is classified as Modified Warmwater Habitat (MWH). The ICI (16 - 18) scores through this area were reflective of marginally fair biological conditions and did not achieve the MWH biocriterion. Other dipterans and non-insect taxa composed a disproportionately large part (75 - 98%) of the collected organisms in the Tuscarawas River within and downstream from the Barberton/ PPG area of study (RMs 110.9 - 104.5). Pollution sensitive taxa such as mayflies, caddisflies, and tanytarsini midges composed a very small percentage of the collected organisms. While the physical habitat conditions in the Tuscarawas River between RMs 112.9 and 103.2 have been substantially altered by channel modifications (channel dipout, canopy removal), these conditions alone have not caused the degradation of the macroinvertebrate communities. The macroinvertebrate communities clearly were impacted by toxic stresses.

- The macroinvertebrate community in the Tuscarawas River at High Mill Road (RM 94.6) exhibited marginally good conditions as reflected by an ICI score of 32 (nonsignificant departure of the WWH biocriterion). The total number of taxa collected was 31 and included four mayfly and three caddisfly taxa. However, mayflies made up only a small percentage of the sample while other dipterans and non-insect taxa composed a proportionately large percentage (47) of the collected organisms. Pollution tolerant taxa made up a negligible percentage (1.2) of the organisms collected.

Wolf Creek

- Macroinvertebrate community sampling in Wolf Creek (RMs 1.1 - 0.3) indicated degraded biological conditions. The ICI scores (18 and 16 respectively) were reflective of marginally fair biological conditions and did not achieve the Modified Warmwater Habitat biocriterion. Total taxa collected was 44 at both sites including two mayfly and two caddisfly taxa. Other dipterans and non-insect taxa composed a disproportionately large part (97%) of the collected organisms while pollution tolerant taxa composed 72% and 69% of the sampled communities at the respective sites.

Hudson Run

- The upstream sampling site in Hudson Run at Hametown Rd. (RM 4.1), located in an unmodified area with a WWH aquatic life use, supported a good macroinvertebrate community as reflected by the ICI score of 36. The total number of taxa collected was 42 and included three mayfly and three caddisfly taxa. Pollution sensitive tanytarsini midges composed 69% of the organisms collected while pollution tolerant taxa made up only 4% of the sample. The macroinvertebrate community at the lower site, downstream from Hudson Run Reservoir (RM 0.1), indicated severe biological degradation in the highly modified stream channel. The ICI score of 10 indicated a macroinvertebrate community in the poor range and substantially below the MWH biocriterion. The total taxa collected was 26 with a relative density of only 86 organisms per square foot. There were no mayflies, caddisflies, or tanytarsini midges collected while other dipterans and non-insect taxa composed 64% of the collected organisms. Two genera (the beetle *Berosus* and the midge *Glyptotendipes*) comprised 60% of the total organisms collected.

Table 7. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the Tuscarawas river study area, July - September, 1993.

Stream River Mile	Relative Density	Total Taxa	Quant. Taxa	Qual. Taxa	Qual. EPT[a]	ICI	Narrative Evaluation
Tuscarawas River			**(WWH)**				
119.4	348	63	45	43	10	48	Exceptional
			(MWH)				
110.9	480	28	27	10	1	18*	Marg. Fair
109.6	577	40	21	30	3	16*	Marg. Fair
107.8	1894	32	23	26	3	16*	Marg. Fair
104.3	1077	39	28	24	3	18*	Marg. Fair
			(WWH)				
94.6	474	31	24	16	6	32[ns]	Marg. Good
Wolf Creek			**(MWH)**				
1.1	659	44	35	25	1	18*	Marg. Fair
0.3	395	44	31	28	2	16*	Marg. Fair
Hudson Run			**(WWH)**				
4.1	601	42	28	24	3	36	Good
			(MWH)				
0.1	86	26	17	18	1	10*	Poor

Ecoregional Biocriteria:
Erie Ontario Lake Plain (EOLP)

INDEX	WWH	EWH	MWH[b]
ICI	34	46	22

[a] - EPT = total Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) taxa.
[b] - Modified Warmwater Habitat for channel modified areas.
* - Significant departure from ecoregional biocriterion (>4 ICI units); poor and very poor results are underlined.
ns - Nonsignificant departure from ecoregional biocriterion (≤4 ICI units).

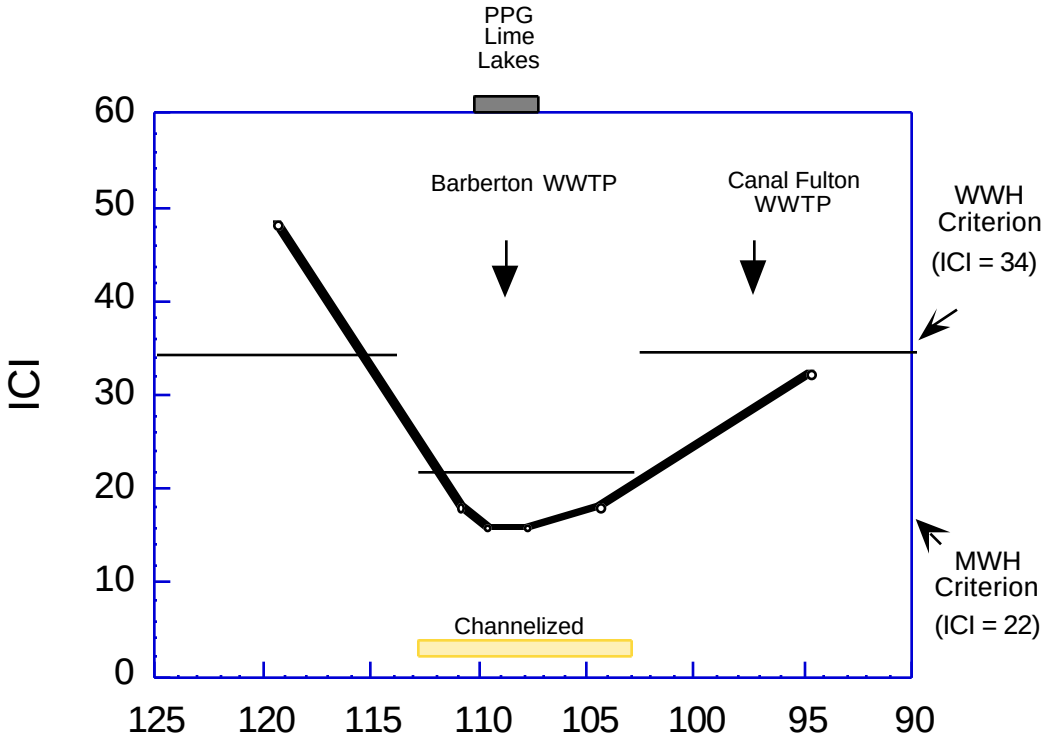

Figure 9. Longitudinal trend of the Invertebrate Community Index (ICI) in the Tuscarawas River study area, 1993.

Fish Community

Tuscarawas River

A total of 1,874 fish representing 32 species and six hybrids were collected from the Tuscarawas River between July and September, 1993. The sampling effort included a cumulative distanced electrofished of 7.80 km at six locations (Table 2, Figure 1). Relative numbers and species collected per location is presented in Appendix Table A-11.

- Gizzard shad (26.5%) and common carp (25.5%) predominated the catch numerically, while common carp dominated in weight (86.2%).

- The most upstream site in the Tuscarawas River at Arlington Rd. (RM 119.4), located in an unmodified area, had a fish community in the fair to good range with an IBI of 40 and an MIwb of 7.0 (Table 8, Figure 10). This site is located approximately 0.6 miles downstream from the Summit Co. Upper Tuscarawas WWTP. The IBI achieved the WWH biocriterion while the MIwb was below the biocriterion. The fish community was well represented by moderately pollution intolerant northern hog suckers and five darter species.

- The fish communities in the Tuscarawas River from RM 110.9 (Snyder Ave.) to RM 94.6 (High Mill Rd.) exhibited severe biological degradation. Due to physical habitat modifications, the Tuscarawas River from RM 112.9 to RM 103.2 is classified as Modified Warmwater Habitat. The IBI (17 - 24) and MIwb (3.4 - 5.4) scores were reflective of poor to very poor biological conditions and the entire stream reach was not fully achieving the appropriate biocriteria. Fish species highly tolerant to a wide variety of environmental disturbances predominated in the Tuscarawas River within and downstream from the Barberton/ PPG area of study (RM 110.9 - 94.6). Of the 13 fish species listed as highly tolerant in Ohio, ten were collected in the Tuscarawas River. The ten highly tolerant species comprised numerically 49% and in weight 95% of the Tuscarawas River catch. The most severe degradation occurred at RM 107.8, a site located 1.3 miles downstream from the Barberton WWTP and adjacent to PPG lime lake #5. Physical habitat conditions in the Tuscarawas River between RM 112.9 and 103.2 have been substantially altered due to past channel modifications (channel dipout, canopy removal); however, these conditions alone have not caused the severe disruption of the fish communities. The fish communities clearly were impacted by toxic stresses.

- The physical condition of fish was monitored at each sampling site by recording the incidence of gross DELT (deformities, fin erosion, lesions/ulcers and tumors) external anomalies. Biosurvey results collected by Ohio EPA from throughout the state show a high frequency of DELT anomalies is an accurate indication of pollution stress usually caused by multiple sublethal stresses as the result of degraded water quality (*i.e.*, often a combination of toxic impacts combined with marginal D.O. concentrations). Within Ohio, there also appears to be a positive relationship between sites containing chemically contaminated sediments (*e.g.*, metals, PAHs) and high percent occurrence of DELT anomalies (Yoder 1991). At RM 119.4, DELT anomalies were not observed

in the fish population. DELT anomalies were documented at all other Tuscarawas River sites, with the highest levels occurring between RM 107.8 and RM 94.6 (3.9% - 6.0%).

Wolf Creek

A total of 679 fish representing 19 species and two hybrids were collected from Wolf Creek between July and October, 1993. The sampling effort included a cumulative total of 1.40 km at two locations (Table 8, Figure 9).

- Bluntnose minnow (35.3%), white sucker (17.3%), and common carp (10.4%) predominated the catch numerically in Wolf Creek, while common carp (74.7%) and white sucker (14.8%) dominated in weight

- The fish communities in Wolf Creek from RM 1.1 (Wooster Ave.) to RM 0.3 (Snyder Ave.) exhibited severe biological degradation. Due to physical habitat modifications, Wolf Creek from RM 4.6 to RM 0.0 is classified as Modified Warmwater Habitat. The IBI (19 and 22) and MIwb (4.4 and 6.0) scores were reflective of poor to very poor biological condition and the entire stream reach was not fully achieving the MWH biocriteria.

Hudson Run

A total of 1,149 fish representing 20 species and one hybrid were collected from Hudson Run between July and September, 1993. The sampling effort included a cumulative total of 0.60 km at two locations (Table 8, Figure 9).

- Creek chub (22.3%), white sucker (19.1%), bluntnose minnow (15.5%), and blacknose dace (13.0%) predominated the catch numerically in Hudson Run.

- The upstream Hudson Run sampling location (RM 4.1) had fish communities in the fair range (IBI = 35), with a large proportion of pollution tolerant species present. However, three darter species were well represented and one least brook lamprey was collected.

- Fish sampling results downstream from Hudson Run reservoir (RM 0.1) documented a decline in the number of species, number of individuals and the complete absence of darter species compared with the upstream site at RM 4.1. Due to physical habitat modifications, Hudson Run from RM 0.4 to RM 0.0 is classified as Modified Warmwater Habitat. A marginally fair biological community (IBI = 28) existed at RM 0.1, with the sampling station meeting the modified warmwater habitat biocriterion. A fish kill was observed by Ohio EPA biologists on September 15, 1993 at RM 0.1. The second fish sampling pass at RM 0.1 was conducted on September 30, 1993, two weeks after the observed fish kill. A substantial reduction in numbers of fish was observed (133 vs. 44 individuals) in the second sampling pass results relative to the first pass results.

Table 8. Fish community indices based on pulsed D.C. electrofishing samples at 10 locations sampled by Ohio EPA in the Tuscarawas River, Hudson Run, and Wolf Creek during July - October, 1993. Sites were sampled using either wading or boat methods. Relative number and weight are per 1.0 km for boat sites and 0.3 km for wading sites.

Stream/ River Mile	Mean Number of Species	Cumulative Species	Mean Relative Number	Mean Relative Weight	QHEI	Mean Modified Index of Well-Being	Mean Index of Biotic Integrity	Narrative Evaluation[a]
Tuscarawas River								
119.4w	18.0	21	340	29.5	81.0	7.0*	40	Fair - Good
110.9b	11.3	14	188	60.4	36.5	5.4*	24	Poor
109.6b	11.0	14	286	97.4	47.5	4.9*	21*	V. Poor - Poor
107.8b	7.7	11	103	63.5	56.5	3.4*	17*	Very Poor
104.5b	10.7	17	151	108.9	54.5	4.3*	19*	V. Poor - Poor
94.7b	10.7	16	244	59.1	74.5	5.3*	23*	Poor
Hudson Run								
4.1w	14.0	16	972	-	69.0	NA	35*	Fair
0.1w	10.0	13	177	-	42.0	NA	28	Fair
Wolf Creek								
1.1b	10	12	267	70.0	40.5	6.0	19*	Poor
0.3w	12.5	16	324	17.1	51.0	4.4*	22*	V. Poor - Poor

Ecoregional Biocriteria: Erie Ontario Lake Plain (EOLP)

INDEX - Site Type	WWH	EWH	MWH[c]
IBI - Headwaters	40	50	24
IBI - Wading	38	50	24
IBI - Boat	40	48	24
Mod. Iwb - Wading	7.9	9.4	6.2
Mod. Iwb - Boat	8.7	9.6	5.8

* - Significant departure from applicable biological criterion (>4 IBI units or >0.5 MIwb units); underlined values are in the poor and very poor range.
ns - Nonsignificant departure from WWH biocriterion (≤4 IBI units or ≤0.5 MIwb units).
a - Narrative evaluation is based on both MIwb and IBI scores, when available.
b - Boat sampling method.
c - Modified Warmwater Habitat for channel modified areas.
w - Wading sampling method.
NA - Headwater site; MIwb is not applicable

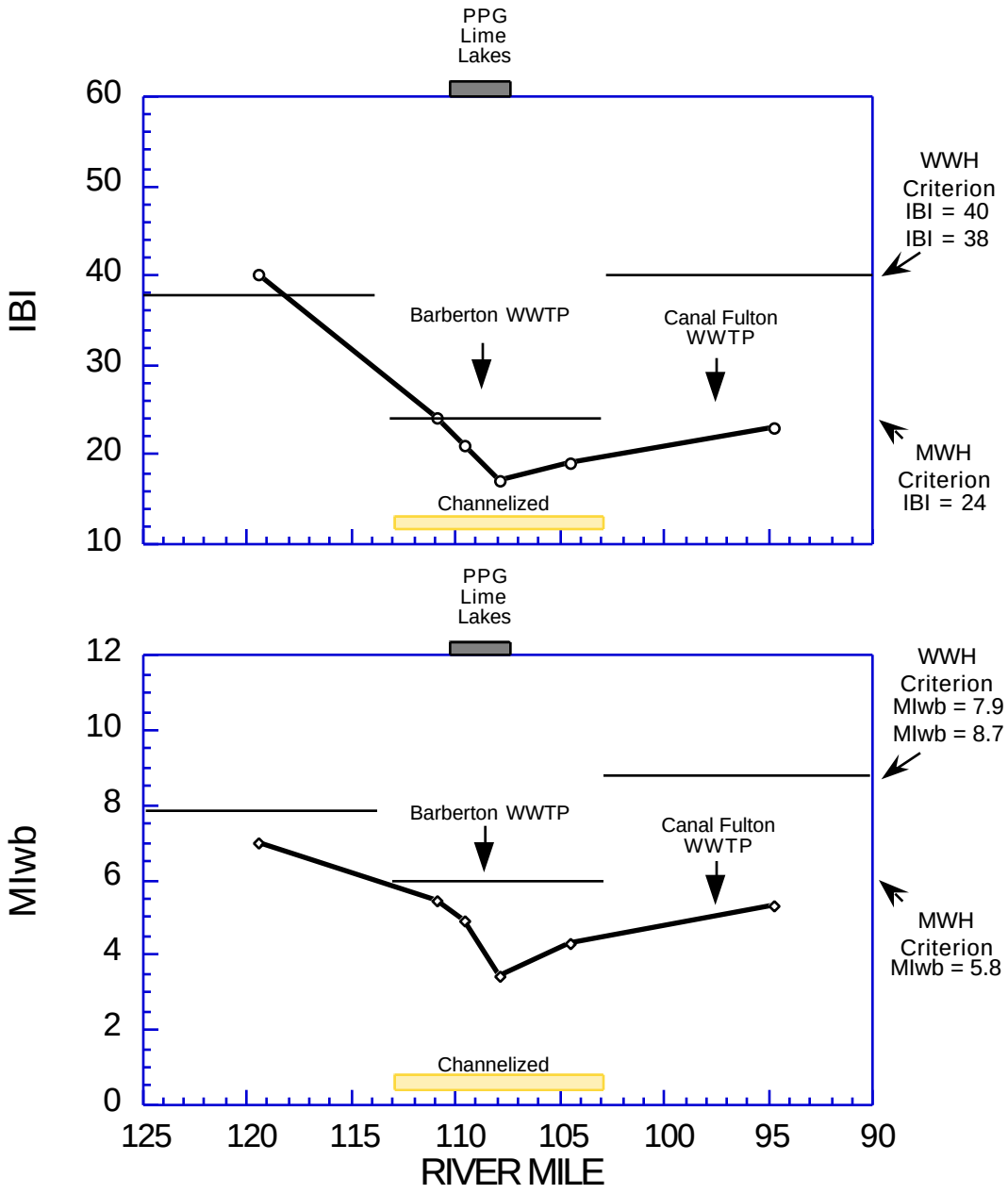

Figure 10. Longitudinal trend of the Index of Biotic Integrity (IBI) and the Modified Index of Well-Being (MIwb) in the Tuscarawas River study area during 1993.

Trend Assessment

Changes in Fish Community Performance: 1983 - 1993

- Tuscarawas River fish communities within the study area were sampled in 1983, 1989, and 1993 (Figure 11). Fish community results show improvement in IBI and MIwb scores between the 1983 and 1993 periods. The most substantial improvement occurred between RMs 112 and 108, where IBI and MIwb scores during 1983 ranged between 12 -16 (IBI) and 0.0 - 2.3 (MIwb). During 1993, this same area had IBI scores in the 17-24 range and MIwb scores in the 3.4-5.4 range; 1983 results were reflective of very poor biological integrity and 1993 results were indicative of poor to very poor conditions. The improvement noted appears attributable to reduced loadings of industrial and municipal wastewater.

- Two fish locations in Hudson Run were previously sampled by the Ohio EPA in 1989 (RMs 4.1 and 0.1) and 1983 (RM 0.1). Index of Biotic Integrity scores from the upstream background site at RM 4.1 were comparable between 1989 and 1993 (37 and 35, respectively), with results in the fair to marginally good range. Sampling results from RM 0.1 revealed a steady improvement in IBI scores between 1983 (12), 1989 (22) and 1993 (28), going from very poor to fair conditions. The improvement in the fish community from 1983 to 1993 coincides with a reduction in PPG effluent discharged into Hudson Run. In addition, in December 1993, USEPA required PPG to begin pumping leachate from lime lakes #1 and #2 to eliminate leachate seeps to Hudson Run and Wolf Creek. The elimination of these seeps should result in further improvement of biological communities of Hudson Run.

- Wolf Creek within the study area has consistently had poor to very poor fish communities from 1983, 1989, and 1993. IBI and MIwb scores between 1983 and 1993 ranged from 19 - 24 and 4.4 - 6.0, respectively. Fish community results indicate that toxic stresses are continually impairing the biological integrity of the lower mile of Wolf Creek.

- Area of Degradation Values (ADV) for the 1993, 1989, and 1983 sampling effort (Table 9) provides a relative measure of performance of the IBI and MIwb in the Tuscarawas River. The ADV/mile of the IBI and MIwb demonstrates the improvement noted between 1983, 1989, and 1993. IBI ADV/mile values improved substantially from 92.2 in 1983 to 35.8 in 1993. MIwb ADV/mile scores also showed significant improvement between 1983 and 1993 (153.0 and 61.4, respectively).

- A reduction in full attainment of the aquatic life uses in the Tuscarawas River from 1989 to 1993 (3.9 miles vs. 0.1 mile) was documented. This reduction occurred at the upstream site, an area located within 0.6 miles downstream from the Summit County Upper Tuscarawas WWTP.

Changes in Macroinvertebrate Performance: 1983- 1993

- Tuscarawas River macroinvertebrate communities within the study area were sampled in 1983, 1989, and 1993 (Figure 11). Macroinvertebrate community results show improvement in ICI scores between the 1983 and 1993 periods. The most substantial improvement occurred at RM 110.9, where the ICI score during 1983 was 0 and in 1989 scored a 4. During 1993, this same area had an ICI score 18; 1983 results were reflective of very poor biological conditions, in 1989 it exhibited poor conditions, and 1993 the results were indicative of marginally fair conditions. The improvements noted appears attributable to reduced loadings of industrial and municipal wastewater.

- The macroinvertebrate community in Wolf Creek was sampled in 1989 at RM 0.3 scoring an ICI of 4 indicating biological conditions in the poor range. The ICI score in 1993 of 16 at RM 0.3 was an improvement into the marginally fair range of biological community performance as was an 18 at RM 1.1. Macroinvertebrate community results indicate that toxic stresses continue to impair the biological integrity of the lower mile of Wolf Creek.

- Three macroinvertebrate locations in Hudson Run were previously sampled by the Ohio EPA in 1989 (RMs 4.1, 1.4, and 0.1). The Invertebrate Community Index scores from the upstream background site at RM 4.1 were comparable between 1989 and 1993 (34 and 36, respectively), with results in the marginally good to good range. Sampling results from RM 0.1 revealed a slight improvement in ICI scores between 1989 (4) and 1993 (10), but staying in the poor range of biological community performance.

- Area of Degradation Values (ADV) for the 1993, 1989, and 1983 sampling effort (Table 9) provides a relative measure of performance of the ICI in the Tuscarawas River. The ADV/mile of the ICI demonstrates the improvement noted between 1983, 1989, and 1993. ICI ADV/mile values improved substantially from 114.9 in 1983, 78.9 in 1989, to 22.9 in 1993.

Table 9. Area of Degradation (ADV) statistics for the Tuscarawas River, 1983, 1989 and 1993 (calculated using the ecoregion biocriteria as the background community performance).

	Biological Index Scores				ADV Statistics			Attainment Status (miles)			
Stream Index	Upper RM	Lower RM	Mini-mum	Maxi-mum	ADV	**ADV/ Mile**	Poor/VP ADV	FULL	PAR-TIAL	**NON**	POOR/ VP
Tuscarawas River (1993)											
IBI	119.4	94.6	17	40	927	**35.8**	474				
MIwb			3.4	7.0	1590	**61.4**	201	0.1	5.8	20.0	18.3
ICI			16	48	594	**22.9**	0				
Tuscarawas River (1989)											
IBI	119.4	94.2	14	42	2283	**86.8**	1353				
MIwb			2.8	7.7	2680	**101.9**	396	3.9	2.7	19.7	19.7
ICI			4	50	2075	**78.9**	260				
Tuscarawas River (1983)											
IBI	119.4	94.2	12	43	2426	**92.2**	1343				
MIwb			0.0	8.0	4025	**153.0**	581	1.2	1.4	23.7	21.6
ICI			0	44	3022	**114.9**	672				

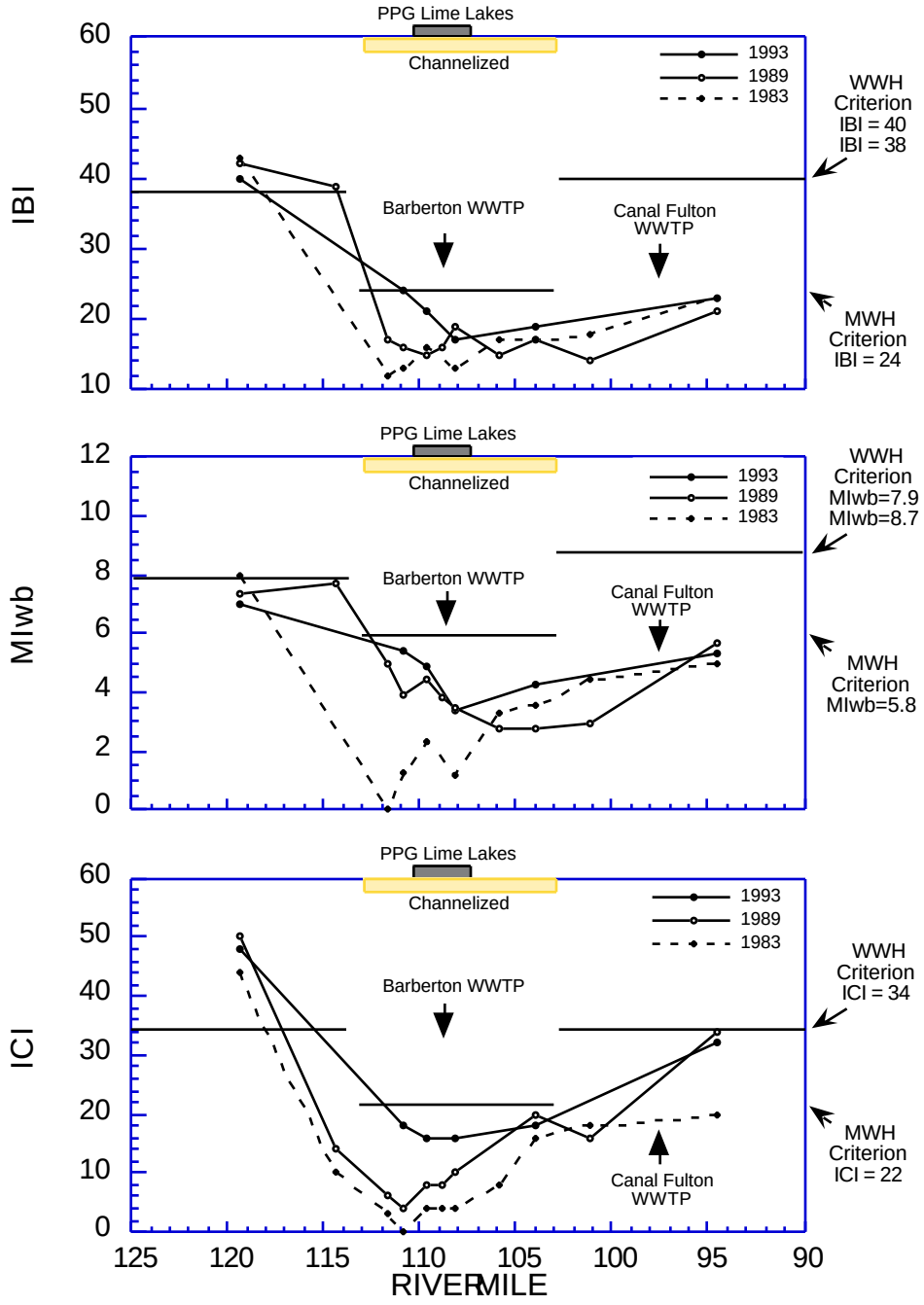

Figure 11. Longitudinal trend of Modified Index of Well-Being (MIwb), Index of Biotic Integrity (IBI), and Invertebrate Community Index (ICI) in the Tuscarawas River during 1983, 1989 and 1993.

Fish Tissue

Fish tissue samples were collected from the Tuscarawas River at six locations and Wolf Creek at one location within the study area by the Ohio EPA during 1993 (Table 10). Whole body composite and fillet samples representing three species were analyzed for pesticides, PCBs, metals, semivolatile organic compounds, volatile organic compounds, and percent lipid. In addition, samples collected for the Ohio Fish Consumption Program during 1993 in the Tuscarawas River (downstream from the study area) and fish tissue from the Tuscarawas River (RM 110.9 - 0.4) during 1989 were included in the evaluation (Appendix Table A-12).

- Based on the fish tissue results from 1989 and 1993, the Ohio Department of Health issued a fish consumption advisory for the Tuscarawas River from State Route 619 in Barberton to State Route 416 in New Philadelphia. The advisory was issued based on elevated levels of PCBs and hexachlorobenzene in fish tissue samples collected during 1989 and 1993 with the PCB levels being of particular concern. The Ohio Department of Health is recommending that certain types of fish be eaten in limited quantities. The species covered by the advisory include largemouth bass, rock bass, smallmouth bass, channel catfish, yellow bullhead, and common carp.

- Two PCB mixtures, Aroclors-1248 and -1260, were identified and quantified. Six whole body composite samples and 10 fillet composite samples were collected from the Tuscarawas River during 1993 within the RM 119 - RM 94 study area. In addition, 14 fillet composite samples were collected downstream between RM 87.8 and RM 78.1 as part of the Ohio Fish Consumption Program. All but two of the samples had detectable levels of PCBs, with detected values for Aroclor-1248 ranging from 21 ug/kg to 2,515 ug/kg and detected values for Aroclor-1260 ranging from 31 ug/kg to 584 ug/kg. One of the samples (RM 87.8) exceeded the Great Lakes Health Protection Value (no consumption level) of 1,900 ug/kg (Figure 12). Seven samples exceeded the Ohio Water Quality Standard (WQS) for PCBs (any whole sample of any representative organism shall not exceed 640 ug/kg total PCBs). The majority of Ohio WQS exceedances occurred between RMs 87.8 and 83.4. Eleven fish tissue samples were collected between RMs 110.9 and 78.1 during 1989. Elevated levels of PCBs during 1989 were recorded between RMs 90.3 and 78.1, with four samples exceeding Ohio WQS.

- Hexachlorobenzene, a compound which bioconcentrates extensively in a number of fish and invertebrates (Howard 1989), was detected in all 1993 fish tissue samples from the Tuscarawas River except at the most upstream location (RM 119.4 - background site). Relatively low levels were recorded in fish collected from RM 110.9, an area located 0.2 miles upstream from the Wolf Creek confluence. A substantial increase in hexachlorobenzene tissue levels was noted from RM 109.7 to RM 78.1, the most downstream extent of the 1993 Tuscarawas River fish tissue sampling (Figure 12). Hexachlorobenzene concentrations between RMs 109.7 and 78.1 ranged from none detected to 10,220 ug/kg. A screening value (SV) for hexachlorobenzene has been established by the USEPA (1993). A SV of 70 ug/kg was determined and is defined as the concentration in fish or shellfish tissue which is a potential public health concern and is a standard against which levels of contamination collected from the ambient environment can be compared. Exceedances of the SV should be taken as an indication that more intensive site-specific monitoring and/or evaluation of human health risk should be conducted. Within the Tuscarawas River, all but two edible tissue samples collected during 1993 from between RMs 109.7 and 78.1 were substantially higher than the 70 ug/kg SV. None of the edible tissue samples collected in the Tuscarawas River upstream from Wolf Creek exceeded the SV. The highest hexachlorobenzene (HCB) concentration in edible tissue recorded during 1993 was 3,809 ug/kg and occurred at RM 94.6. Fish tissue sampling results from 1989 revealed elevated levels of HCB from RM 109.7 to RM 0.4, with whole body concentrations ranging from none detected to 7,360 ug/kg.

- 4,4'-DDE was detected in fish tissue samples from a majority of the sampling locations tested during 1993. 4,4'-DDD and 4,4'-DDT were detected at several locations during 1993. All detected DDT and metabolites were below the USEPA total DDT screening value of 300 ug/kg. DDD, DDE, and/or DDT were reported from all samples collected between RM 110.0 and 78.1 during 1989; all samples were below the SV.

Table 10. Results of tissue analyses from fish collected by Ohio EPA in the Tuscarawas River during 1993.

		FISH TISSUE (Pesticides)				
Stream/ River Mile	Lipid (%)	Hexachloro-benzene (ug/kg)	4,4'-DDD (ug/kg)	4,4'-DDE (ug/kg)	4,4'-DDT (ug/kg)	Dieldrin (ug/kg)
Tuscarawas River						
119.4 (Reference - Arlington Rd.)						
Common carp, WBC	2.19	nd	nd	12.41	nd	nd
Common carp, SFFC	0.73	nd	nd	nd	nd	nd
110.9 (Snyder Ave.)						
Common carp, WBC	4.02	77.78	46.34	22.81	nd	nd
Common carp, SFFC	1.34	26.61	33.05	19.67	nd	nd
Common carp, SFFC (duplicate sample)	1.11	13.68	25.68	16.54	nd	nd
109.7 (Van Buren Rd.-N)						
Common carp, WBC	3.20	1,102.71	55.59	34.62	nd	4.00
Common carp, SFFC	1.35	469.94	18.33	13.84	nd	nd
107.7 (Van Buren Rd.-S)						
Common carp, WBC	4.02	1,720.07	55.14	48.02	nd	10.87
Common carp, SFFC	1.20	289.73	10.21	9.67	nd	nd
104.6 (Clinton, OH)						
Common carp, WBC	3.16	1,236.67	24.67	30.66	nd	5.45
Common carp, SFFC	1.63	836.58	14.21	13.60	nd	nd
Channel catfish, SFFC	3.33	1,036.67	26.64	36.92	5.29	10.83
Channel catfish, SFFC (duplicate sample)	3.55	1,394.90	46.17	57.37	nd	nd
94.6 (High Mill Rd.)						
Common carp, WBC	7.95	10,219.89	60.54	63.31	nd	4.38
Common carp, SFFC	2.14	2,475.12	17.06	23.02	nd	18.95
Common carp, SFFC	2.25	3,809.24	nd	27.22	nd	nd
Smallmouth bass, SOFC	0.69	735.99	nd	nd	nd	nd
87.8 (US 30, Massillon)						
Yellow bullhead, SFFC	0.40	279.84	nd	nd	nd	nd
Rock bass, SOFC	0.19	56.14	nd	nd	nd	nd
Common carp, SFFC	2.05	1,534.07	nd	35.75	nd	nd
Common carp, SFFC	4.68	2,946.22	nd	45.56	nd	nd

Table 10. Continued.

Stream/ River Mile	Lipid (%)	Hexachloro-benzene (ug/kg)	4,4'-DDD (ug/kg)	4,4'-DDE (ug/kg)	4,4'-DDT (ug/kg)	Dieldrin (ug/kg)
			FISH TISSUE (Pesticides)			
Tuscarawas River						
83.4 (Rt. 21, Navarre)						
Common carp, SFFC	1.63	1,456.58	nd	29.62	nd	nd
Common carp, SFFC	2.12	1,834.59	nd	36.34	nd	nd
Yellow bullhead, SFFC	0.13	23.98	nd	nd	nd	nd
82.4 (Riverland Ave.)						
Rock bass, SOFC	0.27	110.84	nd	nd	nd	nd
Smallmouth bass, SOFC	0.44	355.11	nd	nd	nd	nd
Smallmouth bass, SOFC	0.58	376.60	nd	18.81	nd	nd
Yellow bullhead, SFFC	0.54	228.74	nd	15.31	nd	nd
78.1 (SR 212)						
Smallmouth bass, SOFC	0.31	199.50	nd	nd	nd	nd
Common carp, SFFC	1.80	1,246.98	nd	41.62	nd	nd
Smallmouth bass, SOFC	0.44	217.99	nd	nd	nd	nd
Wolf Creek						
1.1 (Wooster Rd.)						
Common carp, WBC	5.03	17.68	22.92	25.09	nd	11.06
Common carp, SFFC	0.77	3.99	6.28	9.46	nd	nd

Table 10. Continued.

Stream/ River Mile	FISH TISSUE (Organic Compounds) PCB 1248 (ug/kg)	PCB 1260 (ug/kg)	Tetrachloroethene (ug/kg)	Toluene (ug/kg)	Naphthalene (ug/kg)
Tuscarawas River					
119.4 (Reference - Arlington Rd.)					
Common carp, WBC	nd	43.95	nd	nd	nd
Common carp, SFFC	nd	nd	nd	nd	nd
110.9 (Snyder Ave.)					
Common carp, WBC	225.71	148.76	nd	nd	nd
Common carp, SFFC	30.11	65.77	nd	nd	nd
Common carp, SFFC (duplicate sample)	21.22	50.73	nd	nd	nd
109.7 (Van Buren Rd.-N)					
Common carp, WBC	154.39	265.46	100	nd	nd
Common carp, SFFC	50.81	88.22	nd	nd	nd
107.7 (Van Buren Rd.-S)					
Common carp, WBC	134.59	325.74	nd	nd	112
Common carp, SFFC	30.02	72.43	nd	nd	190
104.6 (Clinton, OH)					
Common carp, WBC	50.96	273.70	nd	nd	nd
Common carp, SFFC	43.57	150.54	nd	nd	nd
Channel catfish, SFFC	84.49	287.64	nd	nd	nd
Channel catfish, SFFC (duplicate sample)	279.11	446.93	NA	NA	NA
94.6 (High Mill Rd.)					
Common carp, WBC	317.92	584.34	nd	127	nd
Common carp, SFFC	51.63	215.36	nd	nd	nd
Common carp, SFFC	nd	217.32	NA	NA	NA
Smallmouth bass, SOFC	328.51	66.31	NA	NA	NA
87.8 (US 30, Massillon)					
Yellow bullhead, SFFC	196.65	nd	NA	NA	NA
Rock bass, SOFC	77.58	nd	NA	NA	NA
Common carp, SFFC	1,263.21	188.44	NA	NA	NA
Common carp, SFFC	2,514.90	217.53	NA	NA	NA

Table 10. Continued.

Stream/ River Mile	PCB 1248 (ug/kg)	PCB 1260 (ug/kg)	Tetrachloroethene (ug/kg)	Toluene (ug/kg)	Naphthalene (ug/kg)
	FISH TISSUE (Organic Compounds)				
Tuscarawas River					
83.4 (Rt. 21, Navarre)					
Common carp, SFFC	1,278.88	181.69	NA	NA	NA
Common carp, SFFC	1,266.16	186.28	NA	NA	NA
Yellow bullhead, SFFC	nd	nd	NA	NA	NA
82.4 (Riverland Ave.)					
Rock bass, SOFC	141.53	nd	NA	NA	NA
Smallmouth bass, SOFC	404.82	61.13	NA	NA	NA
Smallmouth bass, SOFC	387.64	101.56	NA	NA	NA
Yellow bullhead, SFFC	267.65	90.06	NA	NA	NA
78.1 (SR 212)					
Smallmouth bass, SOFC	229.86	nd	NA	NA	NA
Common carp, SFFC	891.02	193.48	NA	NA	NA
Smallmouth bass, SOFC	183.24	nd	NA	NA	NA
Wolf Creek					
1.1 (Wooster Rd.)					
Common carp, WBC	149.18	73.32	nd	nd	nd
Common carp, SFFC	33.36	31.40	nd	nd	nd

WBC = whole body composite.
SFFC = skin off fillet composite.
SOFC = skin on fillet composite.
nd = not detected.
NA = not analyzed.

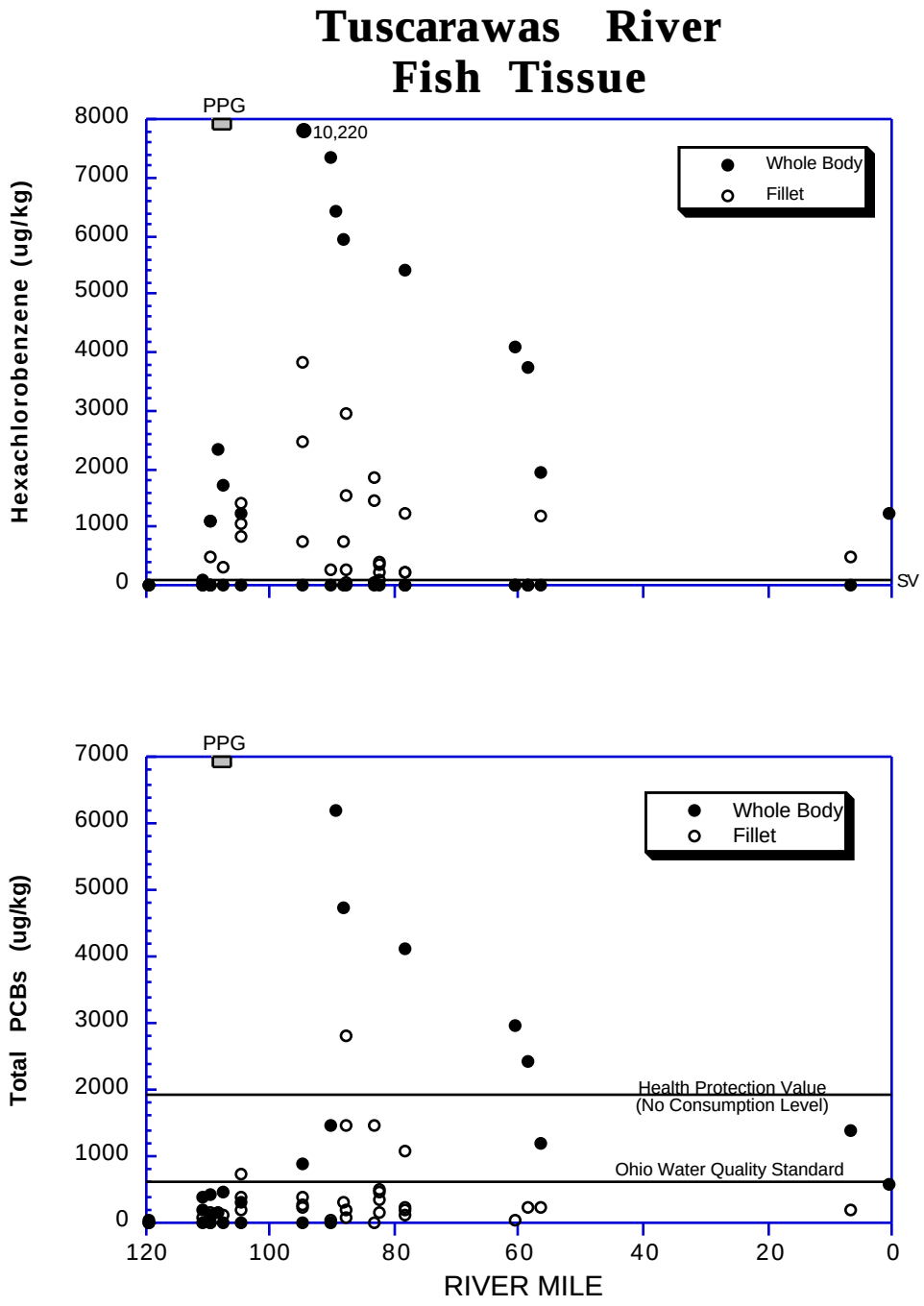

Figure 12. Scatter plots of PCBs and hexachlorobenzene concentrations in fillet and whole body fish samples from the Tuscarawas River collected during 1989 and 1993 by the Ohio EPA. Levels of concern are noted on each graph. SV = screening value risk level recommended by USEPA.

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APPENDIX TABLES

Table A-1.Semivolatile, volatile, pesticides, PCB's, dioxins and heavy metal compounds analyzed by Ohio EPA in 1993 Tuscarawas River sediment, fish tissue and surface water samples. Tentatively identified compounds (TICs) are not listed in this table but can be found on the raw data sheets.

METALS/ CYANIDE

Cyanide+•	Cadmium*+•	Iron+•	Selenium+•
Aluminum+•	Calcium+•	Lead*+•	Silver+•
Antimony +•	Magnesium+•	Mercury*+•	Sodium+•
Arsenic+•	Chromium+•	Manganese+•	Vanadium+•
Barium+•	Cobalt+•	Nickel+•	Zinc+•
Beryllium+•	Copper +•	Potassium+•	Thallium+•

SEMIVOLATILE COMPOUNDS

Acenaphthene*+•	Hexachloropentadiene*	Hexachlorocyclopentadiene+•
Acenaphthylene*+•	N-nitrosodimethylamine*+•	Indeno (1,2,3-CD) pyrene*+•
Anthracene*+•	Dibenzo(A,H) anthracene*+•	Isophorone*+•
Benzo (A) anthracene*+•	Dibenzofuran+•	2-Methyl-4,6-Dinitrophenol*+•
Benzo(A) pyrene*+•	1,2-Dichlorobenzene*+•	2-Methylnaphthalene+•
Benzo(B) fluoranthene*+•	1,3-Dichlorobenzene*+•	Naphthalene*+•
Benzo(G,H,I) perylene*+•	1,4-Dichlorobenzene*+•	2-Nitroaniline+•
Benzo(K) fluoranthene*+•	3,3'-Dichlorobenzidine+•	3-Nitroaniline+•
Benzylbutyl phthalate* •	2,4-Dichlorophenol*+•	4-Nitroaniline+•
Carbazole+•	Diethyl phthalate*+•	Nitrobenzene*+•
Butylbenzyl phthalate+	2,4-Dimethylphenol*+•	2-nitrophenol*+•
Bis(2-chloroethoxy) methane*+•	Dimethyl phthalate*+•	4-Nitrophenol*+•
Bis(2-chloroethyl) ether*+•	Di-N-butyl phthalate*+•	1-Chloropropane+•
Bis(2-chloroisopropyl)ether*	2,4-Dinitrophenol*+•	N-Nitroso-N-propylamine*+•
Bis(2-ethylhexyl) phthalate*+•	2,4-Dinitrotoluene+•	Pentachlorophenol*+•
4-Bromophenyl phenyl ether*+•	2,6-Dinitrotoluene*+•	Phenanthrene*+•
4-Chloroaniline+•	Di-N-octyl phthalate*+•	Phenol*+•
4-Chloro-3-methyl phenol*+•	Fluoranthene*+•	Pyrene*+•
2-Chloronaphthalene*+•	Fluorene*+•	1,2,4-Trichlorobenzene*+•
2-Chlorophenol*+•	Hexachlorobenzene*+•	2,4,5-Trichlorophenol+•
4-Chlorophenyl phenyl ether*+•	Hexachlorobutadiene+•	2,4,6-Trichlorophenol*+•
Chrysene*+•	Hexachloroethane*+•	2-Methylphenol+•4-Methylphenol+•

VOLATILE COMPOUNDS

Acetone+•	Chloroethane*+•	1,2-Dichloropropane*+•	Tetrachloroethene*+•
Benzene*+•	2-Chloroethylvinylether	cis-1,3-Dichloropropene+•	Toluene*+•
Bromobenzene*	Bromochloromethane*	N-Butylbenzene*	Sed-Butylbenzene*
Tert-Butylbenzene*	2-Chlorotoluene*	4-Chlorotoluene*	1,2-Dibromo-3-chloropropane*
1,2-Dibromomethane*	Dibromomethane*	N-Propylbenzene*	1,2,4-Trimethylbenzene*
Bromodichloromethane*+•	Chloroform*+•	Trans-1,3-dichloropropene+•	1,1,1-Trichloroethane*+•
Bromoform*+•	Chloromethane*+•	Ethylbenzene*+•	1,1,2-Trichloroethane*+•
Bromomethane*+•	Dibromochloromethane*+•	2-Hexanone+•	Trichloroethene*+•
2-Butanone+•	1,1-Dichloroethane*+•	Methylene chloride*+•	Vinyl acetate
Carbon disulfide+•	1,2-Dichloroethane*+•	4-Methyl-2-pentanone+•	Vinyl chloride*+•
Carbon tetrachloride*+•	1,1-Dichloroethene*+•	Styrene*+•	Total Xylenes+•
Chlorobenzene*+•	Trans-1,2-dichloroethene*	cis-1,2-Dichloroethene*	1,1,1,2-Tetrachloroethane*
1,2-Dichloroethene+•	Hexachlorobutadiene*	Isopropylbenzene*	1,1,2,2-Tetrachloroethane*+•
Trichlorofluoromethane*	1,2-Dichlorobenzene*	1,3-Dichlorobenzene*	1,4-Dichlorobenzene*
Dichlorodifluoromethane*	1,3-Dichloropropane*	2,2-Dichloropropane*	1,1-Dichloropropene*
4-Isopropyltoluene*	Naphthalene*	1,2,3-Trichlorobenzene*	1,2,4-Trichlorobenzene*
1,2,3-Trichloropropane*	1,3,5-Trimethylbenzene*	O-Xylene*	M-Xylene*

Table A-1. Continued.

PESTICIDES

a-BHC*+•	Aldrin*+•	Heptachlor*+•
b-BHC*+•	Dieldrin*+•	Heptachlor epoxide*+•
g-BHC*+•	Endrin*+•	Methoxychlor*+•
d-BHC*+•	Endrin Aldehyde*+•	Chlordane*
Endosulfan I*+•	Endrin ketone+•	Toxaphene*+•
Endosulfan II*+•	4,4'-DDT*+•	alpha-Chlordane+•
Endosulfan sulfate*+•	4,4'-DDD*+•	4,4'-DDE*+•
Mirex*	Hexachlorobenzene*	gamma-Chlordane+•

PCBs

Aroclor-1016*+•	Aroclor-1232*+•	Aroclor-1248*+•
Aroclor-1221*+•	Aroclor-1242*+•	Aroclor-1254*+•
		Aroclor-1260*+•

HERBICIDES

2,4-D+•	2,4,5-TP (Silvex)+•	2,4,5-T+•

DIOXINS AND FURANS (sediment only)

2378- TCDD	2378 - TCDF
12378- PeCDD	12378 - PeCDF
123478 - HxCDD	23478 - PeCDF
123678 - HxCDD	123678 - HxCDF
123789 - HxCDD	234678 - HxCDF
1234678 - HpCDD	123478 - HxCDF
OCDD	1234678 - HpCDF
Total TCDD	1234789 - HpCDF
Total PeCDD	123789 - HxCDF
Total HxCDD	OCDF
Total HpCDD	Total TCDF
	Total PeCDF
	Total HxCDF
	Total HpCDF

OTHER

	Nitrate-Nitrite, N+
BOD5+	Nitrite,N+
Ammonia-N+	Phosphorus, Total+
Chloride+	Conductivity+
TKN+	pH+
TSS+	TDS+
Sulfate+	

Other (fish)

Percent lipid

Sample type analyzed.
* - fish.
• - sediment .
+ - surface water.

Table A-2. Semivolatile organic parameter concentrations in sediment collected from the Tuscarawas River study area by Ohio EPA during 1993. nd = indicates compound was analyzed for but not detected. D = duplicate. NA = not analyzed. Detection limit for parameters measured at RM 94.84 was substantially higher (10,000 ug/kg) than other samples.

SEMIVOLATILE ORGANICS - ug/kg (ppb) dry weight

	Location (River Mile)									
	Tuscarawas River					Hudson Run			Wolf Creek	
Parameter	119.28	109.47	107.97	104.30	94.84	4.03	0.43*	0.05	0.27	0.27D
Phenol	nd	490J	950	nd	nd	nd	nd	2900	nd	220J
1,2-Dichlorobenzene	nd	130J	nd	nd	nd	nd	nd	nd	nd	nd
1,3-Dichlorobenzene	nd	3600	90J	nd	nd	nd	14,500	nd	nd	nd
1,4-Dichlorobenzene	nd	460J	nd	210J	nd	nd	34,800	nd	nd	nd
1,2,4-Trichlorobenzene	nd	1800	4600	nd	nd	nd	nd	nd	nd	nd
Hexachlorobenzene	120J	**190,000**	**18,000**	150J	**38,000**	160J	**473,000**	nd	nd	nd
2,2'-Oxybis(1-Chloropropane)	nd	320J	nd	nd	nd	nd	NA	nd	nd	nd
2-Methylphenol	nd	nd	nd	nd	nd	nd	nd	240J	nd	nd
4-Methylphenol	nd	3500	2700	270J	nd	140J	nd	490J	nd	100J
2,4-Dichlorophenol	nd	nd	nd	nd	nd	nd	nd	390J	nd	nd
Bis(2-ethylhexyl) phthalate	240J	2700	2700	410J	nd	70J	nd	nd	nd	nd
Di-n-butyl phthalate	nd	nd	nd	100J	nd	nd	nd	160J	nd	nd
Butylbenzyl phthalate	110J	130J	nd	nd	nd	nd	nd	110J	nd	nd
Hexachlorobutadiene	nd	790	1300	83J	nd	nd	nd	nd	nd	nd
N-nitrosodiphenylamine	nd	700J	nd	nd	nd	nd	NA	nd	nd	nd
4-Chlorophenyl-phenylether	nd	nd	720J	nd	nd	nd	nd	nd	nd	nd
4-Bromophenyl-phenylether	nd	nd	1600	nd	nd	nd	nd	nd	nd	nd
Carbazole	360J	190J	nd	nd	nd	nd	NA	nd	nd	nd
Naphthalene	nd	1200	180J	200J	nd	nd	700	nd	310J	380J
2-Methylnaphthalene	nd	1600	270J	140J	nd	nd	nd	nd	240J	210J
Acenaphthene	150J	170J	nd	100J	nd	nd	nd	nd	nd	nd
Anthracene	390J	250J	nd	240J	nd	nd	800	nd	140J	110J
Dibenzofuran	110J	290J	nd	120J	nd	nd	nd	nd	98J	nd
Fluorene	230J	230J	250J	60J	nd	nd	nd	nd	110J	120J
Fluoranthene	4200	2100	400J	1100	nd	180J	1400	nd	350J	400J
Phenanthrene	2800	1900	1600	350J	nd	100J	800	nd	680J	740J
Pyrene	2400	1300	940	1000	nd	100J	1300	nd	520J	760J
Benzo(a)anthracene	1400	850	990	630	nd	75J	nd	nd	620J	730J
Dibenz(a,h)anthracene	370J	nd	nd	120J	nd	nd	nd	nd	140J	nd
Chrysene	1500	800	nd	620	nd	71J	700	nd	660J	660J
Benzo(b)fluoranthene	1400	nd	nd	690X	nd	100J	nd	nd	440JX	400JX
Benzo(k)fluoranthene	1100	nd	nd	690X	nd	70J	nd	nd	440JX	400JX
Benzo(a)pyrene	1200	690J	nd	270J	nd	82J	nd	nd	300J	nd
Indeno(1,2,3-cd) pyrene	1000	690J	nd	240J	nd	67J	nd	nd	190J	210J
Benzo(g,h,i) perylene	920	710J	nd	340J	nd	64J	nd	nd	260J	nd
Pentachlorobenzene	NA	NA	NA	NA	NA	NA	2000	NA	NA	NA
1,2,4,5-Tetrachlorobenzene	NA	NA	NA	NA	NA	NA	1000	NA	NA	NA
TICs (Tentatively Identified Compounds)										
Trichlorobenzene	nd	nd	32,000	nd	nd	nd	NA	nd	nd	nd
Tetrachlorobenzene	nd	nd	23,000	nd	nd	nd	NA	nd	nd	nd
Benzenes	NA	NA	NA	NA	NA	NA	1,142,600	NA	NA	NA
PAHs	NA	NA	NA	NA	NA	NA	1.194.100	NA	NA	NA

J - Indicates an estimated value (result is less than the sample quantitation limit but greater than zero).
X - Denotes indistinguishable coeluting PAH isomers.
* - Hudson Run Reservoir sampling location.
Boldface values for hexachlorobenzene exceed Severe Effect Level (Persaud *et al.* 1992).

Table A-3. Volatile organic parameter concentrations in sediment collected from the Tuscarawas River study area by Ohio EPA during 1993. nd = indicates compound was analyzed for but not detected. D -= duplicate. NA = not analyzed.

VOLATILE ORGANICS - ug/kg (ppb) dry weight

	Location (River Mile)									
	Tuscarawas River					Hudson Run			Wolf Creek	
Parameter	119.28	109.47	107.97	104.30	94.84	4.03	0.43*	0.05	0.27	0.27D
Vinyl chloride	nd	nd	nd	nd	nd	nd	nd	4900	nd	nd
Toluene	7J	nd	nd	nd	nd	nd	nd	nd	nd	nd
1,1-Dichloroethane	nd	nd	nd	nd	nd	nd	nd	>200	53	35
1,2-Dichloroethane	nd	nd	nd	nd	nd	nd	nd	4J	nd	nd
1,1,1-Trichloroethane	nd	5J	nd	nd	nd	nd	nd	nd	8J	nd
1,1-Dichloroethene	nd	nd	nd	nd	nd	nd	nd	14J	8J	5J
1,2-Dichloroethene (total)	nd	nd	66	nd	nd	nd	nd	>200	nd	nd
Trichloroethene	nd	nd	56	nd	nd	nd	nd	4J	nd	nd
Tetrachloroethene	nd	nd	26	nd	nd	nd	nd	nd	nd	nd
Chlorobenzene	nd	nd	nd	nd	10J	nd	25,500	nd	nd	nd
2-Butanone	nd	19J	nd	nd	nd	13J	NA	nd	nd	nd
Carbon disulfide	nd	nd	nd	nd	nd	nd	NA	5J	4J	nd
1,2-Dichloropropane	nd	nd	nd	nd	nd	nd	NA	13J	nd	nd
Total Xylene	nd	3J	4J	nd	nd	nd	nd	nd	nd	nd
1,3-Dichlorobenzene	NA	NA	NA	NA	NA	NA	18,400	NA	NA	NA
1,4-Dichlorobenzene	NA	NA	NA	NA	NA	NA	36,600	NA	NA	NA

J - Indicates an estimated value (result is less than the sample quantitation limit but greater than zero).
* - Hudson Run Reservoir sampling location.

Table A-4. Dioxin and dibenzofuran levels in sediment collected from the Tuscarawas River study area, 1993 by Ohio EPA and PPG.

DIOXINS AND DIBENZOFURANS

Tuscarawas River

Parameter	PPG RM 119.4 Conc. (ppt)	PPG RM 119.4 Toxicity Equivalent[a] (ppt)	Ohio EPA RM 119.28 Conc. (ppt)	Ohio EPA RM 119.28 Toxicity Equivalent[a] (ppt)	PPG RM 112.1 Conc. (ppt)	PPG RM 112.1 Toxicity Equivalent[a] (ppt)	PPG RM 111.6 Conc. (ppt)	PPG RM 111.6 Toxicity Equivalent[a] (ppt)
Dioxins								
2378-TCDD	ND	0.30	0.90 (E)	0.90	8.0	8.00	ND	1.75
12378-PeCDD	ND	0.15	2.00 (E)	1.00	180.1	90.05	4.9 (E)	2.45
123478-HxCDD	ND	0.04	3.62	0.36	21.6	2.16	7.8	0.78
123678-HxCDD	ND	0.04	5.05 (E)	0.50	119	11.9	21.9 (E)	2.19
123789-HxCDD	ND	0.04	5.28	0.53	58.0	5.8	19.7 (E)	1.97
1234678-HpCDD	3.3	0.03	126	1.26	1340	13.4	495	4.95
OCDD	47.6	0.05	1190	1.19	2340	2.34	3640	3.64
Total TCDD	0.86		16.8		94.7		12.2	
Total PeCDD	ND		11.7		138		20.6	
Total HxCDD	2.9		33.5		1050		170	
Total HpCDD	7.0		234		2440		982	
Dibenzofurans								
2378-TCDF	ND	0.03	ND	0.14	14.3 (E)	1.43	8.6	0.86
12378-PeCDF	ND	0.01	ND	0.04	12.3 (E)	0.61	ND	0.19
23478-PeCDF	ND	0.12	ND	0.38	28.1	14.05	9.5 (E)	4.75
123478-HxCDF	ND	0.02	3.92 (E)	0.39	58.0	5.80	17.1 (E)	1.71
123678-HxCDF	ND	0.02	2.67	0.27	43.7	4.37	14.2	1.42
234678-HxCDF	0.64 (E)	0.06	3.00 (E)	0.30	99.5	9.95	25.9 (E)	2.59
123789-HxCDF	ND	0.03	ND	0.18	13.8 (E)	1.38	9.3	0.93
1234678-HpCDF	0.72	0.01	34.4	0.34	867	8.67	143	1.43
1234789-HpCDF	ND	0	ND	0.02	35.9	0.36	9.1 (E)	0.09
OCDF	ND	0	75.6	0.07	1310	1.31	379	0.38
Total TCDF	8.6 (E)		28.7		759		233	
Total PeCDF	6.8		13.8		917		658	
Total HxCDF	3.2		51.7		2120		546	
Total HpCDF	1.8		85.9		2740		474	
2378 TCDD Total Toxicity Equivalent (TTE)		0.95		7.87		181.58		32.08

Table A-4. Continued.

DIOXINS AND DIBENZOFURANS

Tuscarawas River

Parameter	PPG RM 110.2 Conc. (ppt)	PPG RM 110.2 Toxicity Equivalent[a] (ppt)	Ohio EPA RM 109.47[b] Conc. (ppt)	Ohio EPA RM 109.47[b] Toxicity Equivalent[a] (ppt)	PPG RM 109.1 Conc. (ppt)	PPG RM 109.1 Toxicity Equivalent[a] (ppt)	PPG RM 108.4 Conc. (ppt)	PPG RM 108.4 Toxicity Equivalent[a] (ppt)
Dioxins								
2378-TCDD	ND	0.40	5.25	5.25	17.1	17.1	0.67	0.67
12378-PeCDD	0.85 (E)	0.42	9.43	4.71	7.4 (E)	3.7	0.78 (E)	0.39
123478-HxCDD	ND	0.40	9.18	0.92	10.2 (E)	1.02	1.2	0.12
123678-HxCDD	3.0 (E)	0.30	28.45	2.84	19.3	1.93	4.5	0.45
123789-HxCDD	3.5	0.35	14.75	1.47	7.8	0.78	3.3	0.33
1234678-HpCDD	62.6	0.63	1115	11.15	312	3.12	91.8	0.92
OCDD	548	0.55	13,750	13.75	2730	2.73	560	0.56
Total TCDD	5.2		28.8		17.1		6.7	
Total PeCDD	1.5		7.6		39.3		2.7	
Total HxCDD	18.7		208.5		182		33.7	
Total HpCDD	126		2180		605		163	
Dibenzofurans								
2378-TCDF	3.2 (E)	0.32	177.5	17.75	129	12.9	2.6	0.26
12378-PeCDF	1.7 (E)	0.08	109.5	5.47	44.3	2.21	1.8	0.09
23478-PeCDF	2.1 (E)	1.05	62.65	31.32	36.4	18.2	1.3	0.65
123478-HxCDF	8.5	0.82	254.5	25.45	122	12.2	5.9	0.59
123678-HxCDF	3.9 (E)	0.39	75.15	7.51	51.8	5.18	2.8	0.28
234678-HxCDF	5.9	0.59	29.1	2.91	34.3	3.43	3.5	0.35
123789-HxCDF	3.8	0.38	12.9	1.29	7.4 (E)	0.74	1.2	0.12
1234678-HpCDF	43.9	0.44	469	4.69	462	4.62	34.2	0.34
1234789-HpCDF	13.7	0.14	137	1.37	197	1.97	9.4	0.09
OCDF	256	0.26	4550	4.55	3210	3.21	246	0.25
Total TCDF	54.0		909		2580		38.0	
Total PeCDF	61.2		775		538		39.4	
Total HxCDF	69.1		1004		748		57.5	
Total HpCDF	109		1230		1250		97.1	
2378 TCDD Total Toxicity Equivalent (TTE)		7.52		142.40		95.04		6.46

Table A-4. Continued.

DIOXINS AND DIBENZOFURANS

Tuscarawas River

Parameter	Ohio EPA RM 107.97 Conc. (ppt)	Ohio EPA RM 107.97 Toxicity Equivalent[a] (ppt)	PPG RM 107.4 Conc. (ppt)	PPG RM 107.4 Toxicity Equivalent[a] (ppt)	PPG RM 106.0 Conc. (ppt)	PPG RM 106.0 Toxicity Equivalent[a] (ppt)	Ohio EPA RM 104.30 Conc. (ppt)	Ohio EPA RM 104.30 Toxicity Equivalent[a] (ppt)
Dioxins								
2378-TCDD	7.51	7.51	20.0	20.0	0.98 (E)	0.98	6.14	6.14
12378-PeCDD	4.53	2.26	2.5	1.25	2.0 (E)	1.0	13.5	6.75
123478-HxCDD	5.33 (E)	0.53	3.2	0.32	2.8 (E)	0.28	7.11	0.71
123678-HxCDD	25.3	2.53	17.0	1.70	10.4	1.04	53.6	5.36
123789-HxCDD	7.47	0.75	8.0	0.80	8.4	0.84	38.4	3.84
1234678-HpCDD	902	9.02	477	4.77	192	1.92	416	4.16
OCDD	10,700	10.70	7200	7.2	1530	1.53	4810	4.81
Total TCDD	66.9		41.3		36.2		76.3	
Total PeCDD	92.4		68.0		7.2		196	
Total HxCDD	337		309		85.0		488	
Total HpCDD	2670		1070		370		917	
Dibenzofurans								
2378-TCDF	361	36.10	62.5	6.25	6.8	0.68	65.4	6.54
12378-PeCDF	54.0	2.70	38.4	1.92	5.4	0.27	33.4	1.67
23478-PeCDF	46.2	23.10	26.8	13.4	4.8	2.4	23.0	11.50
123478-HxCDF	111	11.10	135	13.5	27.8	2.78	52.9	5.29
123678-HxCDF	44.1	4.41	71.8	7.18	15.4	1.54	24.8	2.48
234678-HxCDF	17.4	1.74	51.1	5.11	14.2	1.42	11.6	1.16
123789-HxCDF	10.0 (E)	1.00	12.7	1.27	4.0	.0.40	6.53 (E)	0.65
1234678-HpCDF	645	6.45	909	9.09	162	1.62	162	1.62
1234789-HpCDF	136	1.36	355	3.55	59.2	0.59	34.4	0.34
OCDF	8650	8.65	6460	6.46	1270	1.27	916	0.92
Total TCDF	2640		1130		131		1100	
Total PeCDF	783		541		150		529	
Total HxCDF	1540		1110		244		453	
Total HpCDF	2130		2110		384		459	
2378 TCDD Total Toxicity Equivalent (TTE)		129.91		103.77		20.56		63.94

Table A-4. Continued.

DIOXINS AND DIBENZOFURANS

Parameter	Tuscarawas River PPG RM 94.84 Conc. (ppt)	Tuscarawas River PPG RM 94.84 Toxicity Equivalent[a] (ppt)	Hudson Run Ohio EPA RM 4.03 Conc. (ppt)	Hudson Run Ohio EPA RM 4.03 Toxicity Equivalent[a] (ppt)	Hudson Run PPG RM 3.7 Conc. (ppt)	Hudson Run PPG RM 3.7 Toxicity Equivalent[a] (ppt)	Hudson Run PPG RM 2.0 Conc. (ppt)	Hudson Run PPG RM 2.0 Toxicity Equivalent[a] (ppt)
Dioxins								
2378-TCDD	0.96	0.96	0.54	0.54	ND	0.24	3.5	3.5
12378-PeCDD	8.76 (E)	4.38	7.07 (E)	3.53	ND	0.09	0.57	0.28
123478-HxCDD	5.60	0.56	ND	0.02	ND	0.02	0.98	0.10
123678-HxCDD	16.8	1.68	0.76	0.08	ND	0.02	2.3	0.23
123789-HxCDD	8.77	0.88	0.65	0.06	ND	0.02	1.7 (E)	0.17
1234678-HpCDD	440	4.40	17.8	0.18	1.7	0.02	51.4	0.51
OCDD	7640	7.64	512	0.51	51.8	0.05	537	0.54
Total TCDD	28.5		2.67		ND		3.5	
Total PeCDD	29.8		2.53		ND		3.5	
Total HxCDD	152		6.46		ND		20.0	
Total HpCDD	889		35.1		3.2		101	
Dibenzofurans								
2378-TCDF	23.9	2.39	ND	0.13	ND	0.01	0.91	0.09
12378-PeCDF	32.7	1.63	0.28	0.01	ND	0.01	0.69 (E)	0.05
23478-PeCDF	11.3	5.65	0.43	0.21	ND	0.09	0.86	0.43
123478-HxCDF	170	17.0	1.08	0.11	ND	0.01	1.7	0.17
123678-HxCDF	71.4	7.14	0.41 (E)	0.04	ND	0.01	1.0 (E)	0.10
234678-HxCDF	9.89	0.99	0.55	0.05	0.44	0.04	2.6	0.26
123789-HxCDF	21.3	2.13	ND	0.01	ND	0.02	0.55	0.05
1234678-HpCDF	940	9.40	3.54	0.03	0.55	0.01	17.4	0.17
1234789-HpCDF	361	3.61	0.51	0.005	ND	0	0.98	0.01
OCDF	9400	9.40	10.3	0.01	ND	0	69.8	0.07
Total TCDF	725		7.96		1.5 (E)		20.6	
Total PeCDF	458		8.91		1.7 (E)		32.8	
Total HxCDF	931		5.46		1.7		34.3	
Total HpCDF	2100		13.5		0.69		54.6	
2378 TCDD Total Toxicity Equivalent (TTE)		79.84		5.52		0.66		6.73

Table A-4. Continued.

DIOXINS AND DIBENZOFURANS

Parameter	Hudson Run PPG RM 1.4 Conc. (ppt)	Hudson Run PPG RM 1.4 Toxicity Equivalent[a] (ppt)	Hudson Run Reservoir PPG RM 0.45 Conc. (ppt)	Hudson Run Reservoir PPG RM 0.45 Toxicity Equivalent[a] (ppt)	Hudson Run Reservoir PPG RM 0.45 Conc. (ppt)	Hudson Run Reservoir PPG RM 0.45 Toxicity Equivalent[a] (ppt)	Hudson Run Reservoir PPG RM 0.40 Conc. (ppt)	Hudson Run Reservoir PPG RM 0.40 Toxicity Equivalent[a] (ppt)
Dioxins								
2378-TCDD	0.23	0.23	128	128	ND	0.19	ND (at 159)	79.50
12378-PeCDD	0.83	0.41	1310 (E)	655	ND	0.13	5.1 (E)	2.55
123478-HxCDD	1.1 (E)	0.11	ND	0.49	ND	0.04	8.2	0.82
123678-HxCDD	4.0 (E)	0.40	274	27.4	ND	0.03	50.4	5.04
123789-HxCDD	2.9	0.29	511 (E)	51.1	ND	0.03	24.7 (E)	2.47
1234678-HpCDD	68.5	0.68	3620	36.2	6.4	0.06	2330	23.30
OCDD	994	0.99	43,500	43.5	199	0.20	18,200	18.20
Total TCDD	0.55		181		ND		7.1 (E)	
Total PeCDD	6.5		21.5		0.71 (E)		46.4	
Total HxCDD	27.6		998		2.2		338	
Total HpCDD	117		7240		16.1		4540	
Dibenzofurans								
2378-TCDF	1.0	0.10	475	47.5	0.50	0.05	27.6	2.76
12378-PeCDF	0.49	0.02	501	25.05	ND	0.01	7.4 (E)	0.37
23478-PeCDF	0.80	0.40	231	115.5	ND	0.10	9.0	4.50
123478-HxCDF	1.9	0.19	1020	102	ND	0.02	40.5	4.05
123678-HxCDF	0.99	0.10	445	44.5	ND	0.02	13.9	1.39
234678-HxCDF	2.4	0.24	376	37.6	0.41 (E)	0.04	15.9 (E)	1.59
123789-HxCDF	0.96	0.10	13,500 (E)	1350	ND	0.03	ND	0.04
1234678-HpCDF	15.9	0.16	7280	72.8	1.0	0.01	275	2.75
1234789-HpCDF	1.3	0.01	2940	29.4	ND	0	49.0	0.49
OCDF	87.8	0.09	262,000	262	7.6	0.01	2570	2.57
Total TCDF	17.2		5590		0.50		129	
Total PeCDF	31.3		7650		0.59 (E)		96.4	
Total HxCDF	44.4		6110		46		264	
Total HpCDF	71.2		19,500		1.3		1000	
2378 TCDD Total Toxicity Equivalent (TTE)		4.52		**3028.04**		0.97		152.39

Table A-4. Continued.

DIOXINS AND DIBENZOFURANS

Parameter	Hudson Run PPG RM 0.35 Conc. (ppt)	Hudson Run PPG RM 0.35 Toxicity Equivalent[a] (ppt)	Hudson Run Ohio EPA RM 0.05 Conc. (ppt)	Hudson Run Ohio EPA RM 0.05 Toxicity Equivalent[a] (ppt)	Wolf Creek PPG RM 2.0 Conc. (ppt)	Wolf Creek PPG RM 2.0 Toxicity Equivalent[a] (ppt)	Wolf Creek PPG RM 0.7 Conc. (ppt)	Wolf Creek PPG RM 0.7 Toxicity Equivalent[a] (ppt)
Dioxins								
2378-TCDD	0.23	0.23	ND	0.14	ND	0.48	64.8	64.8
12378-PeCDD	0.83	0.41	4.11	2.05	ND	0.35	17.3	8.65
123478-HxCDD	1.1 (E)	0.11	ND	0.03	ND	0.13	8.9	0.89
123678-HxCDD	4.0 (E)	0.40	7.36	0.74	ND	0.10	29.6	2.96
123789-HxCDD	2.9	0.29	1.45 (E)	0.14	ND	0.11	20.8	2.08
1234678-HpCDD	68.5	0.68	45.2	0.45	24.4	0.24	870	8.70
OCDD	994	0.99	308	0.31	551	0.55	10,700	10.70
Total TCDD	0.55		457		1.5 (E)		222	
Total PeCDD	6.5		47.7		3.2		102	
Total HxCDD	27.6		43.8		3.5		228	
Total HpCDD	117		81.4		84.3		1950	
Dibenzofurans								
2378-TCDF	1.0	0.10	ND	0.14	ND	0.04	514	51.4
12378-PeCDF	0.49	0.02	15.7	0.78	ND	0.03	177	8.85
23478-PeCDF	0.80	0.40	14.6	7.3	ND	0.27	189	94.5
123478-HxCDF	1.9	0.19	37.6	3.76	ND	0.07	194	19.40
123678-HxCDF	0.99	0.10	15.2	1.52	ND	0.05	71.0	7.10
234678-HxCDF	2.4	0.24	9.79	0.98	0.75 (E)	0.07	59.9	5.99
123789-HxCDF	0.96	0.10	ND	0.02	ND	0.07	14.4	1.44
1234678-HpCDF	15.9	0.16	91.2	0.91	ND	0.01	162	1.62
1234789-HpCDF	1.3	0.01	17.9	0.18	ND	0.01	25.7 (E)	0.26
OCDF	87.8	0.09	167	0.17	ND	0	693	0.69
Total TCDF	17.2		1810		ND		9880	
Total PeCDF	31.3		279		3.5		1900	
Total HxCDF	44.4		127		6.1 (E)		648	
Total HpCDF	71.2		151		2.2 (E)		558	
2378 TCDD Total Toxicity Equivalent (TTE)		4.52		19.62		2.58		290.03

Table A-4. Continued.

DIOXINS AND DIBENZOFURANS

Parameter	Wolf Creek Ohio EPA RM 0.27 Conc. (ppt)	Wolf Creek Ohio EPA RM 0.27 Toxicity Equivalent[a] (ppt)	Wolf Creek PPG RM 0.1 Conc. (ppt)	Wolf Creek PPG RM 0.1 Toxicity Equivalent[a] (ppt)
Dioxins				
2378-TCDD	ND	0.58	0.79	0.79
12378-PeCDD	ND	0.31	0.58	0.29
123478-HxCDD	ND	0.09	ND	0.06
123678-HxCDD	ND	0.06	1.5 (E)	0.15
123789-HxCDD	ND	0.07	1.6	0.16
1234678-HpCDD	27.2	0.27	35.5	0.35
OCDD	371	0.37	332	0.33
Total TCDD	ND		7.4	
Total PeCDD	ND		0.56	
Total HxCDD	ND		12.9	
Total HpCDD	61.2		71.9	
Dibenzofurans				
2378-TCDF	ND	1.03	3.2	0.32
12378-PeCDF	7.94	0.40	1.5	0.07
23478-PeCDF	5.98	2.99	0.10 (E)	0.05
123478-HxCDF	ND	0.04	3.4	0.34
123678-HxCDF	ND	0.03	1.7	0.17
234678-HxCDF	ND	0.03	2.6	0.26
123789-HxCDF	ND	0.05	1.6	0.16
1234678-HpCDF	2.84 (E)	0.03	17.3	0.17
1234789-HpCDF	ND	0.007	4.5	0.04
OCDF	ND	0.001	103	0.10
Total TCDF	292		34.7	
Total PeCDF	73.3		32.1	
Total HxCDF	ND		32.4	
Total HpCDF	ND		51.2	
2378 TCDD Total Toxicity Equivalent (TTE)		6.36		3.81

[a] - 2378 TCDD toxicity equivalents.

[b] - Results are based on average values calculated from regular and duplicate samples.

E - Estimated maximum possible concentration.

ND - Analyte not detected at or above the sample specific estimated detection limit.

TTE - Calculation of TTEs for none detect values was based on using one-half the detection limit and USEPA's 1989 methodology.

Table A-5. Heavy metal and cyanide levels in sediment collected from the Tuscarawas River study area, 1985, 1989 and 1993 by Ohio EPA and PPG. Sediment evaluations were based upon criteria in Kelly and Hite (1984) and Persaud *et al.*(1992). Evaluations with two letters (e.g. a and b) indicates that the reported less than value could be either non-elevated or slightly elevated.

Stream River Mile (Year)	METALS/ CYANIDE - mg/kg (ppm) dry weight								
	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Mercury	Nickel	Zinc
Tuscarawas River									
119.28 (1993-OEPA, 0-6")	**18.2 d**	nd	13.3 a	18.7 a	21,400 b	27.4 a	nd	13.8	114 c
115.34 (1989-OEPA)	6.00 a	0.074 a	<7.56 a	8.11 a	11,600 a	20.2 a	NA	7.26	41.9 a
112.50 (1985-OEPA)	5.24 a	0.376 a	26.1 c	15 a	27,600 c	**62.7 d**	NA	17	142 c
112.1 (1993-PPG, 0-6")	7.0 a	1.7 c	21.9 b	22.2 a	29,000 c	53.3 c	nd	19.2	130 c
112.1 (1993-PPG, 1-3')	10.0 b	1.8 c	**73.6 e**	39.7 b	19,900 b	**70.5 d**	**0.53 e**	26.4	139 c
111.6 (1993-PPG, 0-6")	**22.1 d**	1.7 c	**190 e,***	34.5 a	20,900 b	**189 e**	nd	36.9	**244 d**
111.6 (1993-PPG, 1-3')	11.7 c	1.5 c	33.5 c	36.7 a	**35,000 d**	27.2 a	nd	39.6	117 c
110.9 (1993-PPG, 0-6")	**55.7 e,***	**2.1 d**	**822 e,***	89.7 c	**40,800 d,***	**496 e,***	**0.53 e**	**104***	**525 e**
110.9 (1993-PPG, 1-3')	**40.6 e,***	1.5 c	**417 e,***	64.0 c	29,000 c	**325 e,***	**0.39 e**	**85.8***	**354 e**
110.84 (1989-OEPA)	4.09 a	0.0828 a	4.75 a	10.2 a	10,200 a	37.4 b	NA	11.4	65.2 a
110.70 (1985-OEPA)	5.64 a	0.224 a	14.7 a	17 a	14,800 a	43.2 c	NA	19	102 c
110.2 (1993-PPG, 0-6")	13.8 c	nd	15.1 a	17.0 a	28,800 c	15.6 a	nd	17.5	68.6 a
110.2 (1993-PPG, 1-3')	5.8 a	nd	20.7 b	16.3 a	20,900 b	21.6 a	**0.20 d**	16.5	67.9 a
109.6 (1993-PPG, 0-6")	10.1 b	nd	19.8 b	22.3 a	**36,700 d**	10.9 a	nd	31.3	60.7 a
109.6 (1993-PPG, 1-3')	12.2 c	nd	18.2 b	22.2 a	28,100 c	11.9 a	nd	29.8	55.2 a
109.47 (1993-OEPA, 0-6")	**269e,***	**2.9 d**	**137e,***	**125d,***	**62,800e,***	**264e,***	**0.33 e**	72.1	**463 e**
109.47 (1989-OEPA)	6.74 a	0.0791 a	2.96 a	18.8 a	22,500 b	26.4 a	NA	17.8	119 c
109.47 (1985-OEPA)	6.39 a	0.097 a	24.7 a	40 b	**36,500 d**	17.7 a	NA	**431***	63 a
109.1 (1993-PPG, 0-6")	15.2 c	nd	**44.5 d**	58.7 b	20,200 b	**138 e**	**0.78 e**	38.4	101 c
109.1 (1993-PPG, 1-3')	**27.3 d**	nd	**42.8 d**	50.2 b	18,100 b	**108 e**	**0.80 e**	30.7	115 c
108.95 (1993-PPG, 0-6")	7.2 a	nd	11.8 a	9.2 a	14,300 a	24.7 a	nd	9.9	52.9 a
108.95 (1993-PPG, 1-2')	11.7 c	nd	6.5 a	6.5 a	9690 a	**97.4 d**	nd	4.9	31.8 a
108.7 (1993-PPG, 0-6")	9.7 b	0.65 b	27.7 c	24.5 a	19,300 b	54.7 c	nd	16.3	100 c
108.7 (1993-PPG, 1-2')	3.4 a	nd	6.8 a	17.6 a	13,100 a	11.1 a	nd	8.8	43.3 a
108.4 (1993-PPG, 0-6")	11.6 c	0.78 b	20.1 b	16.3 a	21,200 b	25.1 a	nd	16.2	87.9 b
108.4 (1993-PPG, 1-3')	4.1 a	0.84 b	25.5 c	40.9 b	**44,000d,***	10.3 a	nd	24.3	61.6 a
107.97 (1993-OEPA, 0-6")	**46.7e,***	nd	**125e,***	55.3 b	9,120 a	**287e,***	**0.70 e**	20.7	102 c

Table A-5. Continued.

Stream River Mile (Year)	METALS/ CYANIDE - mg/kg (ppm) dry weight								
	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Mercury	Nickel	Zinc
Tuscarawas River									
107.8 (1993-PPG, 0-6")	5.4 a	nd	9.0 a	9.7 a	14,600 a	22.4 a	nd	9.7	43.9 a
107.8 (1993-PPG, 1-3')	6.9 a	nd	5.6 a	8.4 a	11,500 a	7.0 a	nd	9.6	48.4 a
107.4 (1993-PPG, 0-1')	4.4 a	nd	15.0 a	5.6 a	14,500 a	6.8 a	nd	11.1	32.3 a
107.4 (1993-PPG, 1-2')	**71.5e,***	0.78 b	11.1 a	20.3 a	26,900 c	11.7 a	nd	21.5	53.7 a
106.0 (1993-PPG, 0-6")	8.8 b	nd	21.9 b	14.3 a	17,200 a	33.1 b	nd	12.8	104 c
106.0 (1993-PPG, 0-6", Dup)	10.7 b	0.83 b	21.7 b	15.6 a	19,200 b	39.7 c	nd	14.9	129 c
106.0 (1993-PPG, 0-6")	10.1 b	nd	27.2 c	23.4 a	19,700 b	34.7 b	nd	17.2	67.8 a
106.0 (1993-PPG, 1-2')	5.7 a	nd	12.9 a	9.2 a	9450 a	22.1 a	nd	8.9	72.1 a
106.0 (1993-PPG, 1-2')	10.5 b	nd	15.3 a	11.7 a	28,800 c	7.7 a	nd	14.2	53.0 a
106.0 (1989-OEPA)	8.87 b	0.111 a	<9.18 a	11.1 a	28,600 c	30.6 b	NA	18.3	69.3 a
106.0 (1985-OEPA)	9.28 b	0.0816 a	14.6 a	12 a	27,400 c	12.0 a	NA	17	70 a
104.30 (1993-OEPA)	**39.2e,***	nd	**59.0 d**	63.1 c	13,200 a	**573e,***	**0.36 e**	20.8	**484 e**
100.18 (1985-OEPA)	12.7 c	0.168 a	9.10 a	10 a	31,600 c	10.9 a	NA	14	96 b
94.84 (1993-OEPA)	**18.8 d**	nd	32.5 c	34.9 a	24,500 c	**61.8 d**	**0.34 e**	22.9	**212 d**
90.37 (1989-OEPA)	NA	0.227 a	7.72 a	11.1 a	9,640 a	33.4 b	NA	9.35	130 c
Wolf Creek									
2.07 (1985-OEPA)	8.28 b	0.670 b	33.6 c	24 a	19,800 b	46.9 c	NA	18	**589 e**
2.0 (1993-PPG, 0-6")	7.2 a	nd	18.1 b	14.1 a	14,300 a	44.7 c	nd	8.3	93.5 b
2.0 (1993-PPG, 1-3')	9.3 b	nd	17.5 b	14.7 a	14,200 a	38.3 c	nd	10.2	**203 d**
1.6 (1993-PPG, 0-6")	12.3 c	1.5	**76.4 e**	38.1 b	21,000 b	**76.6 d**	nd	19.5	**422 e**
1.6 (1993-PPG, 1-2')	14.9 c	0.76	17.8 b	21.6 a	23,800 c	14.5 a	nd	25.1	84.8 b
1.2 (1993-PPG, 0-6")	5.3 a	0.77 b	13.3 a	11.6 a	17,800 a	12.5 a	nd	19.9	81.0 b
1.2 (1993-PPG, 1-2')	10.0 b	1.1 c	9.4 a	12.4 a	11,700 a	10.3 a	nd	17.7	50.5 a
0.7 (1993-PPG 0-6")	14.9 c	**2.3 d**	**102 e**	59.4 b	27,400 c	**127 e**	**0.50 e**	42.0	**235 d**
0.7 (1993-PPG)	**17.3 d**	1.8 c	**58.4 d**	58.9 b	23,900 c	**111 e**	**1.0 e**	39.0	**319 e**
0.4 (1993-PPG)	**24.6 d**	nd	**72.6 e**	**111d,***	20,900 b	**74.4 d**	**2.6e,***	47.5	**946e,***
0.4 (1993-PPG)	11.0 c	nd	**234e,***	**115d,***	8940 a	32.5 b	**7.3e,***	55.9	**354 e**
0.27 (1993-OEPA)	16.5 c	1.7 c	11.0 a	22.2 a	11,700 a	34.1 b	**0.42 e**	nd	**175 d**
0.27 (1993-OEPA, duplicate)	**17.8 d**	1.1 c	12.9 a	26.4 a	13,700 a	35.1 b	**0.35 e**	nd	169 c
0.19 (1985-OEPA)	5.72 a	**3.00 d**	19.8 b	26 a	**51,000e,***	10.1 a	NA	36	64 a
0.1 (1993-PPG, 0-6")	9.2 b	nd	15.7 a	11.7 a	**98,100e,***	31.3 b	nd	17.3	73.8 a
0.1 (1993-PPG, 0-6", dup.)	10.7 b	nd	24.6 c	21.2 a	**47,200d,***	44.3 c	nd	26.0	143 c
0.1 (1993-PPG, 0-6")	14.3 c	nd	26.2 c	27.4 a	**83,400e,***	16.5 a	nd	56.1	145 c

Table A-5. Continued.

Stream River Mile (Year)	METALS/ CYANIDE - mg/kg (ppm) dry weight								
	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Mercury	Nickel	Zinc
Hudson Run/ Lake Dorothy/ Hudson Run Reservoir									
Hudson Run									
4.03 (1993-OEPA)	12.4 c	0.79 b	7.2 a	13.0 a	17,400 a	16.6 a	nd	12.5	57.8 a
Lake Dorothy									
3.6 (1993-PPG, 0-6")	5.1 a	nd	7.0 a	6.7 a	23,500 c	9.4 a	nd	11.5	62.9 a
3.6 (1993-PPG, 1-3')	3.7 a	nd	6.6 a	11.1 a	12,500 a	6.3 a	nd	9.9	56.9 a
3.0,0.4 (1993-PPG, 0-6")	10.3 b	nd	4.4 a	4.8 a	12,900 a	8.0 a	nd	6.7	26.8 a
3.0,0.4 (1993-PPG, 1-3')	7.9 a	1.2 c	4.2 a	4.7 a	**36,900 d**	8.5 a	nd	11.6	39.6 a
2.8 (1993-PPG, 0-6")	8.9 b	nd	6.7 a	14.6 a	21,200 b	13.6 a	nd	13.1	54.3 a
2.8 (1993-PPG, 0-6", dupl.)	11.7 c	nd	9.0 a	11.9 a	**32,600 d**	12.9 a	nd	19.6	50.9 a
2.8 (1993-PPG, 2-4')	7.8 a	nd	7.4 a	15.6 a	21,300 b	10.6 a	nd	13.2	58.7 a
2.8 (1993-PPG, 2-4', dupl.)	12.4 c	nd	8.4 a	17.3 a	27,200 c	17.3 a	nd	18.1	75.1 a
2.5 (1993-PPG, 0-6")	4.3 a	1.6 c	9.1 a	nd	8080 a	28.0 b	nd	16.4	42.7 a
2.5 (1993-PPG, 2-4')	3.7 a	1.5 c	9.6 a	nd	8320 a	22.9 a	nd	16.8	39.4 a
2.4 (1993-PPG, 0-6")	8.5 b	nd	10.4 a	19.0 a	23,000 c	39.3 c	nd	20.1	75.9 a
2.4 (1993-PPG, 2-4')	12.8 c	nd	11.4 a	18.3 a	**41,800d,***	12.1 a	nd	22.1	**338 e**
Hudson Run									
2.3 (1993-PPG, 0-6")	12.8 c	nd	16.3 b	27.4 a	**32,800 d**	14.7 a	nd	31.1	78.1 a
2.3 (1993-PPG, 2-4')	15.3 c	nd	15.6 a	27.3 a	**32,400 d**	14.6 a	nd	30.3	75.9 a
2.0 (1993-PPG, 0-6")	5.5 a	nd	6.6 a	9.8 a	11,500 a	8.5 a	nd	11.9	40.9 a
2.0 (1993-PPG, 1-3')	5.9 a	nd	8.6 a	9.2 a	13,200 a	6.9 a	nd	12.8	43.9 a
1.4 (1993-PPG, 0-6")	2.6 a	nd	8.0 a	10.7 a	**32,100 d**	10.2 a	nd	10.8	56.2 a
1.4 (1993-PPG, 1-3')	12.3 c	nd	17.3 b	17.3 a	28,600 c	**291e,***	nd	23.6	132 c
Hudson Run Reservoir									
1.05 (1993-PPG, 0-6")	8.7 a	nd	11.0 a	18.2 a	22,600 b	22.1 a	**0.21 d**	15.2	88.0 b
0.80 (1993-PPG, 0-6")	9.7 b	nd	13.0 a	18.3 a	21,200 b	31.4 b	**0.23 d**	16.2	83.9 b
0.80 (1993-PPG, 2-4')	**22.4 d**	nd	**75.6 e**	36.6 a	13,100 a	**262e,***	**0.52 e**	20.6	157 c
0.75 (1993-PPG, 0-6")	6.5 a	nd	11.6 a	12.2 a	17,200 a	33.1 b	nd	15.0	65.7 a
0.75 (1993-PPG, 2-4')	10.4 b	nd	35.3 c	26.1 a	16,900 a	**98.2 d**	**0.27 d**	17.4	119 c
0.65 (1993-PPG, 0-6")	**41.2e,***	nd	27.5 c	**171d,***	8820 a	**1990e,***	**0.57 e**	16.4	110 c
0.65 (1993-PPG, 2-4')	**20.9 d**	nd	22.6 b	70.3 c	12,500 a	**816e,***	**0.38 e**	14.8	75.7 a
0.5 (1993-PPG, 0-6")	**48.0e,***	nd	**244e,***	**207e,***	19,100 b	**3470e,***	**1.1 e**	38.6	**483 e**
0.5 (1993-PPG, 2-4')	**25.5 d**	nd	**151e,***	61.2 c	**39,800 d**	**378e,***	**0.59 e**	31.2	**233 d**
0.43 (1993-OEPA)	**25.1 d**	0.651 b	**72.2 e**	**149d,***	NA	**330e,***	**0.730 e**	36.4	**235 d**
0.4 (1993-PPG, 2-3')	**69.1e,***	nd	**157e,***	75.4 c	22,900 b	**350e,***	**1.1 e**	41.8	**338 e**

Table A-5. Continued.

Stream River Mile (Year)	METALS/ CYANIDE - mg/kg (ppm) dry weight								
	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Mercury	Nickel	Zinc
Hudson Run									
0.3 (1993-PPG, 1-6")	11.2 c	nd	10.8 a	22.5 a	16,600 a	**164 e**	0.15 c	15.1	67.2 a
0.3 (1993-PPG, 1-3')	5.0 a	nd	12.8 a	15.7 a	11,200 a	53.5 c	**0.22 d**	14.2	32.0 a
0.1 (1993-PPG, 0-6")	**146e,***	nd	11.5 a	11.8 a	30,400 c	43.1 c	nd	13.1	95.6 b
0.1 (1993-PPG, 1-3')	6.5 a	nd	8.4 a	8.7 a	15,700 a	27.0 a	nd	10.2	38.5 a
0.05 (1993-OEPA)	**30.1 e**	1.5 c	14.2 a	14.6 a	**43,400d,***	19.3 a	nd	nd	45.7 a
0.05 (1989-OEPA)	6.70 a	0.110 a	<9.18 a	11.4 a	19,700 b	**88.7 d**	NA	11.3	48.4 a
0.05 (1985-OEPA)	1.20 a	0.0798 a	7.68 a	13 a	13,800 a	**54.3 e**	NA	11	56 a

Table A-5. Continued.

Stream River Mile (Year)	METALS/ CYANIDE - mg/kg (ppm) dry weight								
	Barium	Beryllium	Cobalt	Cyanide	Manganese	Selenium	Silver	Thallium	Vanadium
Tuscarawas River									
119.28 (1993-OEPA)	106	nd	7.2	nd	1180 a,*	nd	nd	nd	20.0
115.34 (1989-OEPA)	NA	NA	NA	NA	368 a	NA	NA	NA	NA
112.50 (1985-OEPA)	117	NA	NA	NA	224 a	NA	NA	NA	NA
112.1 (1993-PPG, 0-6")	183	0.56	8.2		835 a	0.21	nd	10.5	16.7
112.1 (1993-PPG, 1-3')	80.1	0.36	5.8		352 a	BW	2.4	32.3	9.9
111.6 (1993-PPG, 0-6")	101	0.50	7.7		290 a	BW	nd	56.8	17.2
111.6 (1993-PPG, 1-3')	92.2	0.65	15.2		701 a	UW	nd	12.6	23.1
110.9 (1993-PPG, 0-6")	258	1.0	14.9		740 a	BW	nd	nd	33.4
110.9 (1993-PPG, 1-3')	185	0.66	10.3		541 a	BW	nd	nd	21.8
110.84 (1989-OEPA)	NA	NA	NA	NA	185 a	NA	NA	NA	NA
110.70 (1985-OEPA)	36.9	NA	NA	NA	265 a	NA	NA	NA	NA
110.2 (1993-PPG, 0-6")	80.6	0.53	7.6		309 a	BW	nd	nd	21.6
110.2 (1993-PPG, 1-3')	70.4	0.13	7.4		117 a	BW	nd	nd	17.3
109.6 (1993-PPG, 0-6")	55.4	0.72	12.4		686 a	nd	nd	nd	18.2
109.6 (1993-PPG, 1-3')	51.6	0.24	12.6		430 a	nd	nd	nd	17.7
109.47 (1993-OEPA)	247	4.1	19.2	nd	604 a	7.3	1.9	7.4	63.9
109.47 (1989-OEPA)	NA	NA	NA	NA	354 a	NA	NA	NA	NA
109.47 (1985-OEPA)	411	NA	NA	NA	251 a	NA	NA	NA	NA
109.1 (1993-PPG, 0-6")	83.1	0.49	4.4		753 a	BW	1.7	nd	8.6
109.1 (1993-PPG, 1-3')	87.9	0.43	5.6		688 a	BW	1.5	nd	10.1
108.95 (1993-PPG, 0-6")	52.6	0.43	4.0		463 a	nd	nd	nd	7.3
108.95 (1993-PPG, 1-2')	24.8	0.14	2.9		141 a	nd	nd	nd	6.9
108.7 (1993-PPG, 0-6")	77.7	0.38	5.8		281 a	nd	0.52	nd	9.5
108.7 (1993-PPG, 1-2')	17.5	0.35	4.1		263 a	nd	nd	nd	6.3
108.4 (1993-PPG, 0-6")	89.5	0.51	5.1		204 a	nd	nd	nd	10.8
108.4 (1993-PPG, 1-3')	155	2.4	11.4		163 a	nd	nd	nd	29.3
107.97 (1993-OEPA)	116	0.68	4.2	nd	281 a	nd	2.8	nd	14.3
107.8 (1993-PPG, 0-6")	39.3	0.36	3.9		196 a	nd	0.47	nd	6.6
107.8 (1993-PPG, 1-3')	16.1	nd	3.6		110 a	nd	nd	nd	7.9
107.4 (1993-PPG, 0-1')	36.0	0.13	2.9		184 a	nd	nd	nd	6.3
107.4 (1993-PPG, 1-3')	30.3	nd	9.9		521 a	nd	nd	nd	11.9

Table A-5. Continued.

Stream River Mile (Year)	Barium	Beryllium	Cobalt	Cyanide	Manganese	Selenium	Silver	Thallium	Vanadium
	METALS/ CYANIDE - mg/kg (ppm) dry weight								
Tuscarawas River									
106.0 (1993-PPG, 0-6")	120	nd	4.8		1320 b,*	nd	1.2	nd	6.6
106.0 (1993-PPG, 0-6", dupl)	118	0.17	6.3		1100 a,*	nd	0.10	nd	7.5
106.0 (1993-PPG, 0-6")	74.3	0.59	6.3		182 a	nd	nd	nd	15.9
106.0 (1993-PPG, 1-2')	69.9	nd	2.5		847 a	nd	0.60	nd	3.0
106.0 (1993-PPG, 1-2')	116	1.3	6.3		1360 b,*	nd	0.61	nd	17.1
106.0 (1989-OEPA)	NA	NA	NA	NA	358 a	NA	NA	NA	NA
106.0 (1985-OEPA)	155	NA	NA	NA	237 a	NA	NA	NA	NA
104.30 (1993-OEPA)	141	0.68	7.1	nd	544 a	nd	nd	nd	19.8
100.18 (1985-OEPA)	53	NA	NA	NA	602 a	NA	NA	NA	NA
94.84 (1993-OEPA)	134	0.67	10.9	nd	598 a	nd	nd	nd	26.0
90.37 (1989-OEPA)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Wolf Creek									
2.07 (1985-OEPA)	109	NA	NA	NA	386 a	NA	NA	NA	NA
2.0 (1993-PPG, 0-6")	31.3	0.26	3.8		183 a	0.16	nd	nd	8.1
2.0 (1993-PPG, 1-3')	42.5	0.37	3.4		397 a	0.16	nd	nd	8.4
1.6 (1993-PPG, 0-6")	106	0.37	8.8		424 a	BW	nd	nd	18.0
1.6 (1993-PPG, 1-2')	33.2	0.50	11.5		538 a	nd	nd	nd	18.0
1.2 (1993-PPG, 0-6")	43.1	0.46	13.8		151 a	nd	nd	nd	14.4
1.2 (1993-PPG, 1-2')	40.3	0.30	8.9		153 a	BW	nd	nd	9.8
0.7 (1993-PPG, 0-6")	160	2.0	12.1		262 a	BW	2.3	6.2	23.1
0.7 (1993-PPG, 1-2')	145	1.6	11.0		271 a	BW	2.4	nd	20.1
0.4 (1993-PPG, 1-6")	117	1.0	5.8		291 a	BW	1.4	nd	13.7
0.4 (1993-PPG, 1-3')	58.3	0.79	2.6		201 a	BW	0.79	nd	8.1
0.27 (1993-OEPA)	119	nd	nd	nd	640 a	nd	nd	nd	18.2
0.27 (1993-OEPA, duplicate)	135	nd	5.2	1.4	673 a	nd	nd	nd	17.8
0.19 (1985-OEPA)	110	NA	NA	NA	668 a	NA	NA	NA	NA
0.1 (1993-PPG, 0-6")	65.5	0.93	4.5		110 a	BW	nd	nd	5.4
0.1 (1993-PPG, 0-6", dupl)	358	2.4	10.7		352 a	nd	nd	nd	29.3
0.1 (1993-PPG, 1-3')	578	3.0	23.1		**4470 d,***	nd	nd	nd	35.9
Hudson Run/ Lake Dorothy/ Hudson Run Reservoir									
Hudson Run									
4.03 (1993-OEPA)	56.3	nd	7.8	nd	396 a	nd	nd	nd	17.0

Table A-5. Continued.

Stream River Mile (Year)	METALS/ CYANIDE - mg/kg (ppm) dry weight								
	Barium	Beryllium	Cobalt	Cyanide	Manganese	Selenium	Silver	Thallium	Vanadium
Lake Dorothy									
3.6 (1993-PPG, 0-6")	40.2	0.56	6.7		301 a	0.20	nd	nd	1.0
3.6 (1993-PPG, 1-3')	22.0	0.24	4.2		265 a	nd	nd	nd	7.1
3.0,0.4 (1993-PPG, 0-6")	28.5	0.24	3.7		234 a	0.24	nd	nd	5.2
3.0,0.4 (1993-PPG, 1-3')	21.2	0.37	4.1		470 a	0.52	nd	nd	6.2
2.8 (1993-PPG, 0-6")	22.2	0.24	5.4		280 a	nd	nd	nd	10.3
2.8 (1993-PPG, 0-6", dupl)	15.7	0.34	6.4		340 a	nd	nd	nd	10.4
2.8 (1993-PPG, 2-4')	24.2	0.24	5.7		351 a	0.15	nd	nd	11.9
2.8 (1993-PPG, 2-4', dupl)	27.6	0.35	8.2		475 a	0.18	nd	nd	13.8
2.5 (1993-PPG, 0-6")	41.1	0.57	6.8		343 a	nd	0.71	11.9	7.4
2.5 (1993-PPG, 2-4')	34.0	0.68	6.9		225 a	nd	0.82	nd	8.3
2.4 (1993-PPG, 0-6")	52.2	0.35	10.6		500 a	0.18	nd	nd	15.5
2.4 (1993-PPG, 2-4')	56.8	0.46	9.0		956 a	0.11	nd	nd	18.3
Hudson Run									
2.3 (1993-PPG, 0-6")	57.1	0.64	13.2		484 a	0.15	nd	nd	20.7
2.3 (1993-PPG, 2-4')	43.9	0.49	12.9		483 a	0.17	nd	nd	17.9
2.0 (1993-PPG, 0-6")	45.7	0.29	5.5		99.4 a	0.40	nd	nd	8.9
2.0 (1993-PPG, 1-3')	51.2	0.29	5.6		91.9 a	0.16	nd	nd	13.3
1.4 (1993-PPG, 0-6")	50.1	0.78	4.0		379 a	nd	nd	nd	7.7
1.4 (1993-PPG, 1-3')	40.6	0.46	5.8		227 a	nd	nd	nd	20.0
Hudson Run Reservoir									
1.05 (1993-PPG, 0-6")	94.7	0.60	5.4		143 a	0.32	nd	nd	16.7
0.80 (1993-PPG, 0-6")	50.5	0.52	5.5		765 a	BW	nd	9.1	13.8
0.80 (1993-PPG, 1-3')	81.0	0.54	5.0		555 a	nd	0.90	15.6	11.0
0.75 (1993-PPG, 0-6")	31.8	0.43	7.2		325 a	0.68	nd	14.1	10.1
0.75 (1993-PPG, 2-4')	61.8	0.37	5.9		521 a	0.35	nd	9.9	13.0
0.65 (1993-PPG, 0-6")	81.3	0.34	4.7		738 a	nd	nd	9.1	8.4
0.65 (1993-PPG, 2-4')	53.8	0.40	6.1		437 a	0.22	nd	8.6	11.9
0.5 (1993-PPG, 0-6")	152	0.62	8.2		554 a	nd	nd	19.1	19.5
0.5 (1993-PPG, 2-4')	139	1.7	9.4		427 a	0.99	nd	18.5	24.3
0.43 (1993-OEPA)	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.4 (1993-PPG, 2-3')	208	0.97	7.8		326 a	3.2	2.2	66.7	21.4

Table A-5. Continued.

Stream River Mile (Year)	METALS/ CYANIDE - mg/kg (ppm) dry weight								
	Barium	Beryllium	Cobalt	Cyanide	Manganese	Selenium	Silver	Thallium	Vanadium
Hudson Run									
0.3 (1993-PPG, 1-6")	232	0.59	5.8		336 a	BW	nd	nd	12.4
0.3 (1993-PPG, 1-3')	231	0.61	3.6		281 a	BW	nd	nd	8.6
0.1 (1993-PPG, 0-6")	133	0.64	4.9		704 a	nd	nd	nd	7.7
0.1 (1993-PPG, 1-3')	206	0.63	3.4		378 a	BW	nd	nd	7.0
0.05 (1993-OEPA)	260	nd	4.8	8.3	2380 c,*	nd	nd	nd	39.5
0.05 (1989-OEPA)	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.05 (1985-OEPA)	168	NA	NA	NA	331 a	NA	NA	NA	NA

nd = not detected.
NA = not analyzed.
a - non elevated; b - slightly elevated; c - elevated; d - highly elevated; e - extremely elevated above background levels (Kelly and Hite 1984).
BW = detected in blank, spike out of limits.
UW = not detected at given limit, spike out of limits.
* = exceeds Severe Effect Level (Persaud *et al.* 1992).

Table A-6. Chlorinated benzene levels in sediment collected from the Tuscarawas River study area, 1993 by PPG as reported in the RFI. **Boldface** hexachlorobenzene values exceed the Severe Effect Level (Persaud *et al.* 1992).

	Chlorinated Benzenes - mg/kg (ppm) dry weight								
Stream River Mile (Year)	Hexa chloro benzene	1,2,4-Tri chloro benzene	1,3-Di chloro benzene	1,2-Di chloro benzene	1,4-Di chloro benzene	1,2,4,5 Tetra chloro benzene	Penta chloro benzene	Chloro benzene	Percent Total Organic Carbon
Tuscarawas River									
112.1 (0-6")	nd	nd	nd	nd	nd	nd	nd	nd	1.1
112.1 (1-3')	nd	nd	nd	nd	nd	nd	nd	nd	0.7
111.6 0-6")	nd	nd	nd	nd	nd	nd	nd	nd	3.4
111.6 (1-3')	nd	nd	nd	nd	nd	nd	nd	nd	1.2
110.9 (0-6")	nd	nd	nd	nd	nd	nd	nd	nd	39.8
110.9 (1-3')	nd	nd	nd	nd	nd	nd	nd	nd	39.3
110.2 (0-6")	nd	nd	nd	nd	nd	nd	nd	nd	2.4
110.2 (1-3')	**2,300**	nd	66.6J	nd	nd	nd	nd	nd	1.3
109.6 (0-6")	nd	nd	nd	nd	nd	nd	nd	nd	0.8
109.6 (1-3')	nd	nd	nd	nd	nd	nd	nd	nd	1.2
109.1 (0-6")	**7,820**	100J	nd	nd	nd	nd	nd	nd	1.9
109.1 (1-3')	**19,800**	411J	nd	nd	nd	314J	362J	nd	2.1
108.95 (0-6")	**1,090**	nd	nd	nd	nd	nd	nd	nd	1.2
108.95 (1-2')	**735**	nd	nd	nd	nd	nd	nd	nd	0.6
108.7 (0-6")	**1,020**	nd	nd	nd	nd	nd	nd	nd	1.1
108.7 (1-2')	**2,800**	nd	nd	nd	nd	nd	nd	nd	0.3
108.4 (0-6")	nd	nd	nd	nd	nd	nd	nd	nd	1.7
108.4 (1-3')	**10,300**	nd	nd	nd	nd	nd	77.9J	nd	0.7
107.8 (0-6")	**284J**	nd	nd	nd	nd	nd	nd	nd	0.6
107.8 (1-3')	nd	nd	nd	nd	nd	nd	nd	nd	1.1
107.4 (0-1')	**90J**	nd	nd	nd	nd	nd	nd	nd	0.2
107.4 (1-2')	nd	nd	nd	nd	nd	nd	nd	52.8	1.6
106.0 (0-6")	**586**	nd	nd	nd	nd	nd	nd	nd	1.5
106.0 (0-6", Dup)	153J	nd	nd	nd	nd	nd	nd	nd	1.7
106.0 (0-6")	**3,970**	nd	1,040	nd	nd	nd	58.8J	9.9	0.8
106.0 (1-2')	**246J**	nd	nd	nd	nd	nd	nd	nd	0.8
106.0 (1-2')	**1,160**	nd	57.4J	nd	nd	nd	232J	nd	0.3

Table A-6.

	Chlorinated Benzenes - mg/kg (ppm) dry weight								
Stream River Mile (Year)	Hexa chloro benzene	1,2,4-Tri chloro benzene	1,3-Di chloro benzene	1,2-Di chloro benzene	1,4-Di chloro benzene	1,2,4,5 Tetra chloro benzene	Penta chloro benzene	Chloro benzene	Percent Total Organic Carbon
Wolf Creek									
2.0 (0-6")	nd	nd	nd	nd	nd	nd	nd	nd	0.6
2.0 (1-3')	nd	nd	nd	nd	nd	nd	nd	nd	0.4
1.6 (0-6")	nd	nd	nd	nd	nd	nd	nd	nd	4.4
1.6 (1-2')	nd	nd	nd	nd	nd	nd	nd	nd	1.5
1.2 (0-6")	nd	nd	nd	nd	nd	nd	nd	nd	1.1
1.2 (1-2')	nd	nd	nd	nd	nd	nd	nd	nd	1.5
0.7 (0-6")	249J	nd	nd	nd	nd	112J	nd	nd	3.4
0.7 (1-2')	258J	nd	nd	nd	nd	64.5J	nd	nd	3.5
0.4 (1-6")	nd	nd	nd	nd	nd	nd	nd	nd	6.3
0.4 (1-3')	nd	nd	nd	nd	nd	nd	nd	nd	2.6
0.1 (0-6")	**430**	nd	nd	nd	nd	nd	nd	nd	0.2
0.1 (0-6", dup.)	**2,160**	nd	nd	nd	nd	nd	62.1J	nd	0.2
0.1 (0-6")	**1,280**	nd	nd	nd	nd	nd	nd	nd	0.2
Hudson Run/ Lake Dorothy/ Hudson Run Reservoir									
Lake Dorothy									
3.6 (0-6")	nd	nd	nd	nd	nd	nd	nd	nd	0.8
3.6 (1-3')	nd	nd	nd	nd	nd	nd	nd	nd	0.1
3.0,0.4 (0-6")	nd	nd	nd	nd	nd	nd	nd	nd	0.1
3.0,0.4 (1-3')	nd	nd	nd	nd	nd	nd	nd	nd	0.1
2.8 (0-6")	nd	nd	nd	nd	nd	nd	nd	nd	0.04
2.8 (0-6", dupl.)	nd	nd	nd	nd	nd	nd	nd	nd	nd
2.8 (2-4')	nd	nd	nd	nd	nd	nd	nd	nd	0.05
2.8 (2-4', dupl.)	**90J**	nd	nd	nd	nd	nd	nd	nd	0.06
2.5 (0-6")	nd	nd	nd	nd	nd	nd	nd	nd	0.1
2.5 (2-4')	nd	nd	nd	nd	nd	nd	nd	nd	1.1
2.4 (0-6")	nd	nd	nd	nd	nd	nd	nd	nd	0.1
2.4 (2-4')	nd	nd	nd	nd	nd	nd	nd	nd	0.2

Table A-6.

Chlorinated Benzenes - mg/kg (ppm) dry weight

Stream River Mile (Year)	Hexa chloro benzene	1,2,4-Tri chloro benzene	1,3-Di chloro benzene	1,2-Di chloro benzene	1,4-Di chloro benzene	1,2,4,5 Tetra chloro benzene	Penta chloro benzene	Chloro benzene	Percent Total Organic Carbon
Hudson Run									
2.3 (0-6")	nd	nd	nd	nd	nd	nd	nd	nd	1.4
2.3 (2-4')	nd	nd	nd	nd	nd	nd	nd	nd	1.5
2.0 (0-6")	nd	nd	nd	nd	nd	nd	nd	nd	1.3
2.0 (1-3')	nd	nd	nd	nd	nd	nd	nd	nd	1.1
1.4 (0-6")	nd	nd	nd	nd	nd	nd	nd	nd	0.9
1.4 (1-3')	nd	nd	nd	nd	nd	nd	nd	nd	0.5
Hudson Run Reservoir									
1.05 (0-6")	nd	nd	nd	nd	nd	nd	nd	nd	1.4
0.80 (0-6")	**195J**	nd	nd	nd	nd	nd	nd	nd	0.3
0.80 (2-4')	**987**	nd	nd	nd	91.6J	nd	95.2J	59.2	1.2
0.75 (0-6")	nd	nd	nd	nd	nd	nd	nd	nd	0.5
0.75 (2-4')	**969**	nd	nd	nd	71.3J	nd	nd	nd	1.6
0.65 (0-6")	**33,800**	nd	nd	nd	nd	nd	557J	nd	1.1
0.65 (2-4')	**1,120**	nd	nd	75.3J	nd	449	83.2J	nd	1.2
0.5 (0-6")	**9,240**	616J	1,400	nd	801	1,210	801	nd	3.1
0.5 (2-4')	**4,380**	nd	725J	nd	169J	nd	nd	nd	2.4
0.4 (2-3')	**438,000**	nd	22,100J	nd	48,700	nd	9730J	46,200	5.1
Hudson Run									
0.3 (1-6")	**20,700**	nd	nd	nd	nd	2,960	769J	nd	0.6
0.3 (1-3')	**3,730**	nd	nd	nd	nd	560J	199J	nd	0.6
0.1 (0-6")	**5,900**	nd	nd	nd	nd	nd	80.8J	nd	0.4
0.1 (1-3')	**16,300**	nd	nd	nd	nd	nd	364J	nd	0.2

Table A-7. Summary of pollutant discharges (spills) to the Tuscarawas River, Hudson Run and Wolf Creek within the study area reported to the Ohio EPA Division of Emergency and Remedial Response from January 1980 - December 1993.

Table A-8. Conventional and metal parameter levels in surface water collected from the Tuscarawas River study area, 1993.

	Surface Water Chemistry								
Stream River Mile (Year)	Chloride (mg/l)	TSS (mg/l)	TDS (mg/l)	Conduct. (umhos/cm)	Hard. (mg/l)	As (ug/l)	Cd (ug/l)	Cr (ug/l)	Cu (ug/l)
Tuscarawas River									
119.28 (1993-OEPA)	NA	NA	NA	NA	261	nd	nd	nd	3.9
119.28 (1993-OEPA)	110	<5	592	600	313	2	<0.2	<30	<10
112.1 (1993-PPG)	93	NA	400	NA	180	6.4	nd	nd	12
111.6 (1993-PPG)	130	NA	410	NA	190	9	nd	11	4
110.9 (1993-PPG)	130	NA	490	NA	250	3.6	nd	7	3
110.85 (1993-OEPA)	167	10	678	725	338	6	<0.2	<30	<10
110.2 (1993-PPG)	180	NA	630	NA	290	7.5	5*	nd	nd
109.6 (1993-PPG)	440	NA	1100	NA	400	5.5	nd	nd	3
109.47 (1993-OEPA)	NA	NA	NA	NA	353	nd	nd	5.1	4.5
109.47 (1993-OEPA)	NA	NA	NA	1000	404	4	0.2	<30	<10
109.1 (1993-PPG)	520	NA	2100*	NA	340	3.3	nd	nd	4
109.10 (1993-OEPA)	498	6	1240	1415	409	3	0.2	<30	<10
108.95 (1993-PPG)	440	NA	2500*	1810	400	3.3	nd	nd	nd
108.7 (1993-PPG)	420	NA	2400*	2050	420	3.5	nd	nd	5
108.4 (1993-PPG)	550	NA	1400	2360	480	3.6	nd	nd	4
108.0 (1993-PPG)	570	NA	1400	2620	480	3.5	nd	nd	5
107.97 (1993-OEPA)	NA	NA	NA	NA	510	nd	nd	nd	3.4
107.97 (1993-OEPA)	593	6	1650*	1550	NA	NA	NA	NA	NA
107.4 (1993-PPG)	800	NA	1700*	2500	580	1	nd	nd	nd
106.0 (1993-PPG)	860	NA	1700*	2290	620	1.7	nd	nd	8
106.0 (1993-PPG, duplic.)	630	NA	1800*	NA	620	nd	nd	nd	3
104.30 (1993-OEPA)	NA	NA	NA	NA	531	nd	nd	nd	nd
104.30 (1993-OEPA)	624	<5	1690*	1580	551	3	<0.2	<30	<10
94.84 (1993-OEPA)	NA	NA	NA	NA	411	nd	nd	nd	4.5
94.84 (1993-OEPA)	332	14	1090	1100	419	4	<0.2	<30	<10
Wolf Creek									
2.0 (1993-PPG)	90	NA	370	NA	260	3.3	nd	nd	nd
1.6 (1993-PPG)	100	NA	480	NA	240	3	4*	8	4

Table A-8. Continued.

Surface Water Chemistry

Stream River Mile (Year)	Chloride (mg/l)	TSS (mg/l)	TDS (mg/l)	Conduct. (umhos/cm)	Hard. (mg/l)	As (ug/l)	Cd (ug/l)	Cr (ug/l)	Cu (ug/l)
Wolf Creek									
1.2 (1993-PPG)	230	NA	720	NA	260	3.9	nd	8	7
1.15 (1993-OEPA)	94	13	556	550	310	3	<0.2	<30	<10
0.7 (1993-PPG)	94	NA	510	NA	240	3.5	nd	nd	4
0.4 (1993-PPG)	150	NA	470	NA	180	nd	nd	5	4
0.27 (1993-OEPA)	NA	NA	NA	NA	310	nd	nd	nd	4.5
0.27 (1993-OEPA- Duplicate)	NA	NA	NA	NA	306	nd	nd	nd	4.1
0.27 (1993-OEPA)	160	36	642	700	298	4	<0.2	<30	<10
0.1 (1993-PPG)	200	NA	700	NA	270	4.4	nd	nd	6
Hudson Run/ Lake Dorothy/ Hudson Run Reservoir									
Hudson Run									
4.03 (1993-OEPA)	NA	NA	NA	NA	217	nd	nd	nd	nd
4.03 (1993-OEPA)	60	<5	414	360	232	<2	<0.2	<30	<10
Lake Dorothy									
3.6 (1993-PPG)	78	NA	450	NA	220	3.8	nd	6	9
3.0,0.4 (1993-PPG)	96	NA	400	NA	180	4.2	nd	nd	2
2.8 (1993-PPG)	59	NA	330	NA	160	4.8	nd	nd	27*
2.5 (1993-PPG)	56	NA	340	NA	140	3.7	nd	nd	6
2.4 (1993-PPG)	56	NA	320	NA	140	4.8	nd	nd	2
Hudson Run									
2.3 (1993-PPG)	62	NA	360	NA	160	4.7	nd	nd	nd
2.0 (1993-PPG)	130	NA	680	NA	260	nd	nd	nd	nd
1.4 (1993-PPG)	94	NA	430	NA	230	2.3	nd	nd	7
Hudson Run Reservoir									
1.05 (1993-PPG)	69	NA	300	NA	160	2.5	nd	nd	3
0.90 (1993-PPG)	82	NA	330	NA	320	nd	nd	nd	5
0.90 (1993-PPG)	140	NA	330	NA	340	2	nd	nd	6
0.80 (1993-PPG)	94	NA	390	NA	170	3.2	nd	nd	3
0.75 (1993-PPG)	75	NA	400	NA	190	4.9	nd	nd	11
0.75 (1993-PPG)	78	NA	340	NA	150	3.8	nd	6	2
0.70 (1993-PPG)	90	NA	380	NA	160	4.6	nd	nd	11
0.70 (1993-PPG)	94	NA	360	NA	170	4.4	nd	nd	2
0.70 (1993-PPG)	86	NA	380	NA	190	4.9	nd	8	5

Table A-8. Continued.

	Surface Water Chemistry								
Stream River Mile (Year)	Chloride (mg/l)	TSS (mg/l)	TDS (mg/l)	Conduct. (umhos/cm)	Hard. (mg/l)	As (ug/l)	Cd (ug/l)	Cr (ug/l)	Cu (ug/l)
0.65 (1993-PPG)	90	NA	400	NA	180	5.1	nd	nd	2
0.5 (1993-PPG)	94	NA	390	NA	200	7.6	nd	nd	9
0.43 (1993-OEPA)	78	NA	346	589	NA	5	nd	nd	nd
0.4 (1993-PPG)	90	NA	380	NA	190	4.4	nd	nd	6
Hudson Run									
0.3 (1993-PPG)	82	NA	320	NA	180	2.7	nd	5	4
0.1 (1993-PPG)	180	NA	540	NA	180	4.6	nd	nd	4
0.05 (1993-OEPA)	NA	NA	NA	NA	174	nd	nd	nd	3.2
0.05 (1993-OEPA)	94	8	420	425	197	3	<0.2	<30	<10

Table A-8. Continued.

Surface Water Chemistry

Stream River Mile (Year)	Fe (ug/l)	Pb (ug/l)	Mn (ug/l)	Hg (ug/l)	Ni (ug/l)	Na (ug/l)	Zn (ug/l)	NH3N (mg/l)	NO2N (ug/l)
Tuscarawas River									
119.28 (1993-OEPA)	592	nd	132	nd	nd	68,900	nd	NA	NA
119.28 (1993-OEPA)	496	<2	NA	NA	<40	61,000	14	0.30	0.08
112.1 (1993-PPG)	894	4.5	162	nd	nd	54,400	62	nd	nd
111.6 (1993-PPG)	924	6.2	150	nd	nd	47,600	48	nd	nd
110.9 (1993-PPG)	1330*	6.9	243	nd	nd	65,800	35	nd	nd
110.85 (1993-OEPA)	1440*	5	NA	NA	<40	84,000	28	0.15	0.02
110.2 (1993-PPG)	1070*	4.6	227	nd	7	79,400	64	0.2	nd
109.6 (1993-PPG)	963	1.7	218	nd	nd	154,000	84	0.2	nd
109.47 (1993-OEPA)	870	nd	183	nd	nd	143,000	7.7	NA	NA
109.47 (1993-OEPA)	1200*	3	NA	NA	<40	134,000	51	0.29	NA
109.1 (1993-PPG)	574	nd	109	nd	nd	209,000	60	nd	nd
109.1 (1993-OEPA)	898	3	NA	NA	<40	NA	39	0.49	0.10
108.95 (1993-PPG)	941	3	225	nd	nd	158,000	45	0.7	nd
108.7 (1993-PPG)	975	2.5	244	nd	nd	172,000	35	1	nd
108.4 (1993-PPG)	1150*	2.4	296	nd	9	218,000	27	0.8	nd
108.0 (1993-PPG)	955	1.1	290	nd	nd	208,000	55	0.9	0.045
107.97 (1993-OEPA)	988	nd	232	nd	nd	232,000	8.3	NA	NA
107.97 (1993-OEPA)	NA	NA	NA	NA	NA	NA	NA	0.40	0.05
107.4 (1993-PPG)	1070*	nd	307	nd	nd	234,000	23	0.7	nd
106.0 (1993-PPG)	967	1.3	332	nd	18	234,000	68	0.4	nd
106.0 (1993-PPG, duplic.)	1250*	3.1	351	nd	16	240,000	58	0.3	nd
104.30 (1993-OEPA)	465	nd	248	nd	nd	256,000	nd	NA	NA
104.30 (1993-OEPA)	788	<2	NA	NA	<40	245,000	20	0.27	0.04
94.84 (1993-OEPA)	714	nd	329	nd	nd	166,000	11.4	NA	NA
94.84 (1993-OEPA)	1030*	3	NA	NA	<40	145,000	25	0.13	0.05
Wolf Creek									
2.0 (1993-PPG)	1120*	3.5	143	nd	nd	47,200	101	0.4	0.048
1.6 (1993-PPG)	1470*	3.7	343	nd	7	52,400	51	0.4	0.059
1.2 (1993-PPG)	1840*	7.3	319	nd	nd	119,000	173	0.8	0.05
1.15 (1993-OEPA)	1270*	4	NA	NA	<40	54,000	28	0.20	0.04

Table A-8. Continued.

Surface Water Chemistry

Stream River Mile (Year)	Fe (ug/l)	Pb (ug/l)	Mn (ug/l)	Hg (ug/l)	Ni (ug/l)	Na (ug/l)	Zn (ug/l)	NH3N (mg/l)	NO2N (ug/l)
Wolf Creek									
0.7 (1993-PPG)	1780*	4.3	304	nd	nd	42,800	56	0.4	0.061
0.4 (1993-PPG)	1430*	7.2	229	nd	nd	77,100	33	0.4	0.047
0.27 (1993-OEPA)	703	3.2	204	nd	nd	147,000	13.9	NA	NA
0.27 (1993-OEPA-Duplicate)	666	nd	201	nd	nd	144,000	12.7	NA	NA
0.27 (1993-OEPA)	1010*	<2	NA	NA	<40	90,000	26	0.28	0.03
0.1 (1993-PPG)	950	4.3	344	nd	13	112,000	42	0.6	nd
Hudson Run/ Lake Dorothy/ Hudson Run Reservoir									
Hudson Run									
4.03 (1993-OEPA)	247	nd	54.7	nd	nd	19,900	nd	NA	NA
4.03 (1993-OEPA)	649	<2	NA	NA	<40	33,000	12	<0.05	<0.02
Lake Dorothy									
3.6 (1993-PPG)	1460*	nd	297	nd	nd	43,400	24	0.2	nd
3.0,0.4 (1993-PPG)	1980*	nd	219	nd	nd	47,100	21	nd	nd
2.8 (1993-PPG)	744	nd	178	nd	nd	34,800	439*,**	nd	nd
2.5 (1993-PPG)	554	2.2	266	nd	nd	31,200	15	nd	nd
2.4 (1993-PPG)	396	nd	297	nd	nd	32,200	11	nd	nd
Hudson Run									
2.3 (1993-PPG)	453	nd	188	nd	nd	32,000	26	nd	nd
2.0 (1993-PPG)	591	1.3	623	nd	nd	47,100	324*,**	nd	0.093
1.4 (1993-PPG)	595	2.2	536	nd	nd	40,700	60	0.2	nd
Hudson Run Reservoir									
1.05 (1993-PPG)	792	2.8	737	nd	nd	36,400	39	nd	nd
0.90 (1993-PPG)	939	4.1	720	nd	nd	37,500	70	nd	0.098
0.90 (1993-PPG)	1060*	13.2	688	nd	nd	35,200	315*	nd	0.078
0.80 (1993-PPG)	1470*	8.2	417	nd	nd	41,600	15	nd	nd
0.75 (1993-PPG)	1890*	13.4	629	nd	9	46,700	46	nd	nd
0.75 (1993-PPG)	522	4.7	206	nd	nd	34,600	38	nd	nd
0.70 (1993-PPG)	1590*	13.1*	489	nd	8	45,800	93	nd	nd
0.70 (1993-PPG)	1480*	15.6*	474	nd	nd	44,000	20	nd	nd
0.70 (1993-PPG)	2320*	31.6*	611	nd	11	47,300	44	nd	nd

Table A-8. Continued.

Surface Water Chemistry

Stream River Mile (Year)	Fe (ug/l)	Pb (ug/l)	Mn (ug/l)	Hg (ug/l)	Ni (ug/l)	Na (ug/l)	Zn (ug/l)	NH3N (mg/l)	NO2N (ug/l)
Hudson Run Reservoir									
0.65 (1993-PPG)	1500*	9.8	488	nd	nd	50,300	14	nd	nd
0.5 (1993-PPG)	2240*	136*	673	nd	nd	45,200	79	nd	nd
0.43 (1993-OEPA)	NA	14	NA	NA	nd	43,000	11	NA	NA
0.4 (1993-PPG)	1700*	14.8	463	nd	nd	43,300	55	nd	nd
Hudson Run									
0.3 (1993-PPG)	997	8.7	304	nd	nd	38,100	78	nd	nd
0.1 (1993-PPG)	346	3.3	160	nd	nd	93,500	24	0.2	nd
0.05 (1993-OEPA)	181	nd	94.2	nd	nd	74,900	nd	NA	NA
0.05 (1993-OEPA)	318	3	NA	NA	<40	50,000	<10	0.07	<0.02

* - Exceedance of outside mixing zone 30-day average Modified Warmwater Habitat and Warmwater Habitat water quality criteria.

** - Exceedance of outside mixing zone maximum Modified Warmwater Habitat and Warmwater Habitat water quality criteria.

Table A-9. Select organic chemical parameter concentrations in surface water collected by Ohio EPA and PPG from the Tuscarawas River study area, 1993.

	Surface Water Chemistry								
Stream River Mile (Year)	Bis(2-ethylhexyl) phthalate (ug/l)	Di-n-butyl phthalate (ug/l)	Fluorene (ug/l)	Hexa chloro butadiene (ug/l)	Hexa chloro .benzene (ug/l)	1,1-Dichloro ethane (ug/l)	1,4-Dioxane (ug/l)	Chloro form (ug/l)	Tetra chloro ethene (ug/l)
Tuscarawas River									
119.28 (1993-OEPA)	nd	1J	nd	nd	nd	nd	NA	nd	nd
112.1 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
111.6 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
110.9 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
110.2 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	2.1J
109.6 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
109.47 (1993-OEPA)	nd	nd	nd	nd	0.036	1J	NA	nd	2J
109.1 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
108.95 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
108.7 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
108.4 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
108.0 (1993-PPG)	1J	nd	nd	nd	nd	nd	nd	nd	nd
107.97 (1993-OEPA)	nd	nd	nd	nd	0.059	nd	NA	nd	1J
107.4 (1993-PPG)	nd	1.1J	nd	nd	nd	nd	nd	nd	nd
106.0 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
106.0 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
104.30 (1993-OEPA)	nd	nd	nd	nd	0.17	nd	NA	nd	nd
94.84 (1993-OEPA)	nd	nd	nd	nd	0.42	nd	NA	nd	nd
Wolf Creek									
2.0 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
1.6 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
1.2 (1993-PPG)	nd	nd	nd	nd	nd	4.8J	nd	nd	nd
0.7 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
0.4 (1993-PPG)	nd	nd	nd	nd	nd	2.9J	nd	nd	nd

Table A-9. Continued.

Stream River Mile (Year)	Bis(2-ethylhexyl) phthalate (ug/l)	Di-n-butyl phthalate (ug/l)	Fluorene (ug/l)	Hexa chloro butadiene (ug/l)	Hexa chloro .benzene (ug/l)	1,1-Dichloro ethane (ug/l)	1,4-Dioxane (ug/l)	Chloro form (ug/l)	Tetra chloro ethene (ug/l)
				Surface Water Chemistry					
0.27 (1993-OEPA)	nd	nd	nd	nd	nd	4J	NA	nd	nd
0.27 (1993-OEPA- duplicate)	nd	nd	nd	nd	nd	3J	NA	nd	nd
0.1 (1993-PPG)	nd	nd	nd	nd	nd	3.9J	nd	nd	3.1J
Hudson Run/ Lake Dorothy/ Hudson Run Reservoir									
Hudson Run									
4.03 (1993-OEPA)	nd	nd	nd	nd	nd	nd	NA	nd	nd
Lake Dorothy									
3.6 (1993-PPG)	NA	NA	NA	NA	NA	nd	nd	nd	nd
3.0,0.4 (1993-PPG)	nd	nd	nd	nd	nd	nd	68J	nd	nd
2.8 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
2.8 (1993-PPG, duplicate)	nd	nd	nd	nd	nd	nd	nd	nd	nd
2.5 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
2.4 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
Hudson Run									
2.3 (1993-PPG)	2.3J	2J	nd	nd	nd	nd	nd	nd	nd
2.0 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
1.4 (1993-PPG)	nd	nd	nd	nd	nd	nd	450J	nd	nd
Hudson Run Reservoir									
1.05 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
0.90 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
0.90 (1993-PPG)	2.6J	nd	nd	nd	nd	nd	nd	nd	nd
0.80 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
0.75 (1993-PPG)	NA	NA	NA	NA	NA	nd	nd	nd	2.3J
0.75 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	nd
0.70 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	7.2
0.70 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	7.4
0.70 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	6.7
0.65 (1993-PPG)	nd	nd	nd	nd	nd	6.3	nd	nd	7.4

Table A-9. Continued.

Surface Water Chemistry

Stream River Mile (Year)	Bis(2-ethylhexyl) phthalate (ug/l)	Di-n-butyl phthalate (ug/l)	Fluorene (ug/l)	Hexa chloro butadiene (ug/l)	Hexa chloro .benzene (ug/l)	1,1-Dichloro ethane (ug/l)	1,4-Dioxane (ug/l)	Chloro form (ug/l)	Tetra chloro ethene (ug/l)
Hudson Run Reservoir									
0.5 (1993-PPG)	nd	nd	7.2J*	16	nd	nd	nd	2.3J	9.5
0.43 (1993-OEPA)	nd	nd	nd	nd	0.787	nd	NA	3.2	10.3
0.4 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	3J	11
Hudson Run									
0.3 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd	nd	7.8
0.1 (1993-PPG)	nd	nd	nd	nd	nd	12	nd	4.4J	32
0.05 (1993-OEPA)	nd	nd	nd	0.35	0.15	7J	NA	7J	36

Table A-9. Continued.

Stream River Mile (Year)	Trans-1,2-dichloro ethene (ug/l)	Tri chloro ethene (ug/l)	Vinyl Chloride (ug/l)	Acetone (ug/l)	Carbon tetra chloride (ug/l)	1,1,1-Trichloro ethane (ug/l)	Phenol (ug/l)
			Surface Water Chemistry				
Tuscarawas River							
119.28 (1993-OEPA)	nd	nd	nd	nd	nd	nd	4J
112.1 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd
111.6 (1993-PPG)	nd	nd	nd	6.5J	nd	nd	nd
110.9 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd
110.2 (1993-PPG)	nd	nd	3.2J	nd	nd	nd	nd
109.6 (1993-PPG)	nd	nd	2.9J	nd	nd	nd	nd
109.47 (1993-OEPA)	nd	1J	4J	nd	nd	nd	nd
109.1 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd
108.95 (1993-PPG)	nd	nd	2.2J	nd	nd	nd	nd
108.7 (1993-PPG)	nd	nd	2.3J	nd	nd	nd	nd
108.4 (1993-PPG)	nd	nd	2.1J	11J	nd	nd	nd
108.0 (1993-PPG)	nd	nd	nd	19J	nd	nd	nd
107.97 (1993-OEPA)	5J[1]	nd	nd	nd	nd	nd	nd
107.4 (1993-PPG)	nd	nd	nd	19J	nd	nd	nd
106.0 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd
106.0 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd
104.30 (1993-OEPA)	2J[1]	nd	nd	nd	nd	nd	nd
94.84 (1993-OEPA)	nd	nd	nd	nd	nd	nd	nd
Wolf Creek							
2.0 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd
1.6 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd
1.2 (1993-PPG)	nd	nd	nd	nd	nd	3.3J	nd
0.7 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd
0.4 (1993-PPG)	nd	nd	nd	20J	nd	nd	nd
0.27 (1993-OEPA)	4J[1]	nd	nd	nd	nd	1J	2J
0.27 (1993-OEPA- Duplicate)	3J[1]	nd	nd	nd	nd	nd	nd

Table A-9. Continued.

Stream River Mile (Year)	Trans-1,2-dichloro ethene (ug/l)	Tri chloro ethene (ug/l)	Vinyl Chloride (ug/l)	Acetone (ug/l)	Carbon tetra chloride (ug/l)	1,1,1-Trichloro ethane (ug/l)	Phenol (ug/l)
			Surface Water Chemistry				
0.1 (1993-PPG)	nd	nd	6.2J	nd	nd	nd	nd
Hudson Run/ Lake Dorothy/ Hudson Run Reservoir							
Hudson Run							
4.03 (1993-OEPA)	nd	nd	nd	nd	nd	nd	nd
Lake Dorothy							
3.6 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd
3.0,0.4 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd
2.8 (1993-PPG)	nd	nd	nd	4.9J	nd	nd	nd
2.8 (1993-PPG)	nd	nd	nd	4.9J	nd	nd	nd
2.5 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd
2.4 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd
Hudson Run							
2.3 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd
2.0 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd
1.4 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd
Hudson Run Reservoir							
1.05 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd
0.90 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd
0.90 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd
0.80 (1993-PPG)	nd	nd	nd	3.9J	nd	nd	nd
0.75 (1993-PPG)	nd	nd	nd	6.3J	nd	nd	nd
0.75 (1993-PPG)	nd	nd	nd	nd	nd	nd	nd
0.70 (1993-PPG)	nd	4.1J	nd	33J	2.5J	nd	nd
0.70 (1993-PPG)	nd	4.5J	nd	34J	2.8J	nd	nd
0.70 (1993-PPG)	nd	4.4J	nd	31J	2.7J	nd	nd
0.65 (1993-PPG)	nd	5.3	nd	nd	2.4J	nd	nd
0.5 (1993-PPG)	nd	3.5J	nd	nd	5.8	nd	nd

Table A-9. Continued.

Stream River Mile (Year)	Trans-1,2-dichloro ethene (ug/l)	Tri chloro ethene (ug/l)	Vinyl Chloride (ug/l)	Acetone (ug/l)	Carbon tetra chloride (ug/l)	1,1,1-Trichloro ethane (ug/l)	Phenol (ug/l)
			Surface Water Chemistry				
Hudson Run Reservoir							
0.43 (1993-OEPA)	nd	2.9	nd	NA	6.0	nd	nd
0.4 (1993-PPG)	nd	4.4J	nd	nd	6.5	nd	nd
Hudson Run							
0.3 (1993-PPG)	nd	2.2J	nd	nd	nd	nd	nd
0.1 (1993-PPG)	2.9J	15	88	nd	nd	nd	nd
0.05 (1993-OEPA)	130[1]	15	54	nd	2J	nd	2J

1- Value is for 1,2-dichloroethene (total).
* - Exceedance of human health 30-day average water quality criteria.

Table A-10. Macroinvertebrate collections at each location (by RM) sampled in the Tuscarawas River study area during 1993.

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/15/93 River Code: 17-500 River: Tuscarawas River RM: 119.40

Taxa Code	Taxa	Quan/Qual	
03600	*Oligochaeta*	22	
05800	*Caecidotea sp*	6	+
06800	*Gammarus sp*	0	+
08250	*Orconectes (Procericambarus) rusticus*	0	+
11120	*Baetis flavistriga*	4	+
11130	*Baetis intercalaris*	12	+
12200	*Isonychia sp*	9	+
13400	*Stenacron sp*	108	+
13560	*Stenonema pulchellum group*	12	
15000	*Paraleptophlebia sp*	26	
17200	*Caenis sp*	2	
21200	*Calopteryx sp*	13	+
21300	*Hetaerina sp*	6	+
22001	*Coenagrionidae*	0	+
24910	*Gomphus descriptus*	0	+
34400	*Paragnetina sp*	0	+
42700	*Belostoma sp*	0	+
44501	*Corixidae*	0	+
50804	*Lype diversa*	22	
51600	*Polycentropus sp*	5	
52200	*Cheumatopsyche sp*	70	+
52430	*Ceratopsyche morosa group*	46	+
52440	*Ceratopsyche slossonae*	0	+
52450	*Ceratopsyche sparna*	2	+
52530	*Hydropsyche depravata group*	24	+
67000	*Helophorus sp*	0	+
68601	*Ancyronyx variegata*	2	
68700	*Dubiraphia sp*	49	+
68901	*Macronychus glabratus*	23	
69400	*Stenelmis sp*	19	+
71100	*Hexatoma sp*	0	+
71900	*Tipula sp*	1	+
74100	*Simulium sp*	0	+
77500	*Conchapelopia sp*	42	+
77750	*Hayesomyia senata or Thienemannimyia norena*	56	
77800	*Helopelopia sp*	56	
78450	*Nilotanypus fimbriatus*	28	
78650	*Procladius sp*	0	+
80204	*Brillia flavifrons group*	14	
80420	*Cricotopus (C.) bicinctus*	0	+
80430	*Cricotopus (C.) tremulus group*	0	+
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	14	
81650	*Parametriocnemus sp*	0	+
81690	*Paratrichocladius sp*	14	+
81825	*Rheocricotopus (Psilocricotopus) robacki*	84	+
82141	*Thienemanniella xena*	14	+
82730	*Chironomus (C.) decorus group*	0	+
83002	*Dicrotendipes modestus*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	14	
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*	28	+
84300	*Phaenopsectra obediens group*	42	+
84450	*Polypedilum (P.) convictum*	14	+
84460	*Polypedilum (P.) fallax group*	154	
84470	*Polypedilum (P.) illinoense*	14	+
85500	*Paratanytarsus sp*	14	
85625	*Rheotanytarsus exiguus group*	434	+
85720	*Stempellinella n.sp nr. flavidula*	14	
85800	*Tanytarsus sp*	140	
85814	*Tanytarsus glabrescens group*	28	
86401	*Atherix lantha*	0	+
87501	*Empididae*	32	
95100	*Physella sp*	2	+
96900	*Ferrissia sp*	7	+

No. Quantitative Taxa:	45	Total Taxa:	63
No. Qualitative Taxa:	43	ICI:	**48**
Number of Organisms:	1742	Qual EPT:	**10**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/15/93 River Code: 17-500 River: Tuscarawas River RM: 110.90

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	48	+
03600	*Oligochaeta*	448	
06800	*Gammarus sp*	10	+
17200	*Caenis sp*	1	
22001	*Coenagrionidae*	1	+
22300	*Argia sp*	10	+
52200	*Cheumatopsyche sp*	1	
52530	*Hydropsyche depravata group*	1	+
68702	*Dubiraphia bivittata*	0	+
74501	*Ceratopogonidae*	1	
77120	*Ablabesmyia mallochi*	56	+
77130	*Ablabesmyia rhamphe group*	56	
77750	*Hayesomyia senata or Thienemannimyia norena*	616	
78401	*Natarsia species A (sensu Roback, 1978)*	28	
78650	*Procladius sp*	28	
81229	*Nanocladius (N.) crassicornus*	84	
81240	*Nanocladius (N.) distinctus*	140	+
83040	*Dicrotendipes neomodestus*	56	
83051	*Dicrotendipes simpsoni*	252	
83300	*Glyptotendipes (Phytotendipes) sp*	168	
84030	*Parachironomus directus*	28	+
84300	*Phaenopsectra obediens group*	56	
84450	*Polypedilum (P.) convictum*	28	
84460	*Polypedilum (P.) fallax group*	28	
84470	*Polypedilum (P.) illinoense*	112	+
84540	*Polypedilum (Tripodura) scalaenum group*	112	
85814	*Tanytarsus glabrescens group*	28	
96900	*Ferrissia sp*	5	

Taxa Code	Taxa	Quan/Qual

No. Quantitative Taxa: 27 Total Taxa: 28

No. Qualitative Taxa: 10 ICI: **18**

Number of Organisms: 2402 Qual EPT: **1**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/15/93 River Code: 17-500 River: Tuscarawas River RM: 109.60

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	8	+
03600	*Oligochaeta*	248	+
05800	*Caecidotea sp*	0	+
06800	*Gammarus sp*	40	+
11130	*Baetis intercalaris*	0	+
17200	*Caenis sp*	2	
22001	*Coenagrionidae*	0	+
22300	*Argia sp*	18	
28500	*Libellula sp*	0	+
28511	*Libellula luctuosa*	0	+
52200	*Cheumatopsyche sp*	83	+
52530	*Hydropsyche depravata group*	19	+
52580	*Hydropsyche valanis*	4	
63700	*Ilybius sp*	0	+
63900	*Laccophilus sp*	0	+
65800	*Berosus sp*	0	+
66700	*Helochares maculicollis*	0	+
67800	*Tropisternus sp*	0	+
68700	*Dubiraphia sp*	4	
69400	*Stenelmis sp*	2	+
74100	*Simulium sp*	0	+
74501	*Ceratopogonidae*	4	
77500	*Conchapelopia sp*	360	+
77750	*Hayesomyia senata or Thienemannimyia norena*	1520	+
80420	*Cricotopus (C.) bicinctus*	0	+
80510	*Cricotopus (Isocladius) sylvestris group*	0	+
81240	*Nanocladius (N.) distinctus*	80	
81650	*Parametriocnemus sp*	40	
82730	*Chironomus (C.) decorus group*	0	+
82820	*Cryptochironomus sp*	0	+
83040	*Dicrotendipes neomodestus*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	120	
84450	*Polypedilum (P.) convictum*	160	+
84470	*Polypedilum (P.) illinoense*	0	+
84540	*Polypedilum (Tripodura) scalaenum group*	120	+
85814	*Tanytarsus glabrescens group*	40	
89501	*Ephydridae*	6	+
96900	*Ferrissia sp*	5	
97601	*Corbicula fluminea*	0	+
98600	*Sphaerium sp*	0	+

Taxa Code	Taxa	Quan/Qual

No. Quantitative Taxa:	21	Total Taxa:	40
No. Qualitative Taxa:	30	ICI:	**16**
Number of Organisms:	2883	Qual EPT:	**3**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/15/93 River Code: 17-500 River: Tuscarawas River RM: 107.80

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	2	+
03600	*Oligochaeta*	0	+
05800	*Caecidotea sp*	1	
06800	*Gammarus sp*	2	+
11130	*Baetis intercalaris*	2	
16700	*Tricorythodes sp*	2	
22001	*Coenagrionidae*	0	+
45300	*Sigara sp*	0	+
52200	*Cheumatopsyche sp*	890	+
52530	*Hydropsyche depravata group*	786	+
52580	*Hydropsyche valanis*	36	+
63600	*Hygrotus sp*	0	+
63900	*Laccophilus sp*	0	+
65800	*Berosus sp*	4	+
68601	*Ancyronyx variegata*	2	+
69400	*Stenelmis sp*	4	+
71900	*Tipula sp*	0	+
74100	*Simulium sp*	4	+
77750	*Hayesomyia senata or Thienemannimyia norena*	1612	+
80420	*Cricotopus (C.) bicinctus*	1116	+
80430	*Cricotopus (C.) tremulus group*	124	+
81229	*Nanocladius (N.) crassicornus*	248	
82730	*Chironomus (C.) decorus group*	0	+
82820	*Cryptochironomus sp*	0	+
83300	*Glyptotendipes (Phytotendipes) sp*	124	
84450	*Polypedilum (P.) convictum*	3472	+
84470	*Polypedilum (P.) illinoense*	248	+
84540	*Polypedilum (Tripodura) scalaenum group*	124	+
85625	*Rheotanytarsus exiguus group*	496	+
85814	*Tanytarsus glabrescens group*	124	
87501	*Empididae*	45	+
95100	*Physella sp*	0	+

Taxa Code	Taxa	Quan/Qual

No. Quantitative Taxa: 23 Total Taxa: 32
No. Qualitative Taxa: 26 ICI: **16**
Number of Organisms: 9468 Qual EPT: **3**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/15/93 River Code: 17-500 River: Tuscarawas River RM: 104.50

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	20	+
03360	*Plumatella sp*	4	
03600	*Oligochaeta*	208	+
05800	*Caecidotea sp*	0	+
06800	*Gammarus sp*	136	+
11200	*Callibaetis sp*	0	+
16700	*Tricorythodes sp*	4	
22001	*Coenagrionidae*	0	+
22300	*Argia sp*	50	+
42700	*Belostoma sp*	0	+
45300	*Sigara sp*	0	+
52200	*Cheumatopsyche sp*	352	+
52530	*Hydropsyche depravata group*	8	
52570	*Hydropsyche simulans*	0	+
53800	*Hydroptila sp*	8	
60900	*Peltodytes sp*	0	+
65800	*Berosus sp*	9	+
67800	*Tropisternus sp*	0	+
68700	*Dubiraphia sp*	4	
69400	*Stenelmis sp*	0	+
74501	*Ceratopogonidae*	32	
77500	*Conchapelopia sp*	51	+
77750	*Hayesomyia senata or Thienemannimyia norena*	1224	
80410	*Cricotopus (C.) sp*	51	
80420	*Cricotopus (C.) bicinctus*	612	+
80430	*Cricotopus (C.) tremulus group*	255	+
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	51	
81240	*Nanocladius (N.) distinctus*	306	+
82730	*Chironomus (C.) decorus group*	0	+
83040	*Dicrotendipes neomodestus*	357	+
83300	*Glyptotendipes (Phytotendipes) sp*	867	+
84040	*Parachironomus frequens*	102	
84450	*Polypedilum (P.) convictum*	255	
84470	*Polypedilum (P.) illinoense*	51	+
85500	*Paratanytarsus sp*	51	
85625	*Rheotanytarsus exiguus group*	102	
85814	*Tanytarsus glabrescens group*	204	
86202	*Tabanus atratus*	0	+
87501	*Empididae*	12	

Taxa Code	Taxa	Quan/Qual

No. Quantitative Taxa:	28	Total Taxa:	39
No. Qualitative Taxa:	24	ICI:	**18**
Number of Organisms:	5386	Qual EPT:	**3**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/15/93 River Code: 17-500 River: Tuscarawas River RM: 94.60

Taxa Code	Taxa	Quan/Qual	
03360	*Plumatella sp*	5	
03600	*Oligochaeta*	20	
04964	*Mooreobdella microstoma*	0	+
06700	*Crangonyx sp*	0	+
08250	*Orconectes (Procericambarus) rusticus*	0	+
11130	*Baetis intercalaris*	8	+
13550	*Stenonema mexicanum integrum*	30	+
13570	*Stenonema terminatum*	14	
16700	*Tricorythodes sp*	108	+
22001	*Coenagrionidae*	0	+
22300	*Argia sp*	22	+
47600	*Sialis sp*	1	
52200	*Cheumatopsyche sp*	308	+
52560	*Hydropsyche orris*	56	+
52570	*Hydropsyche simulans*	20	+
65800	*Berosus sp*	1	
68300	*Cyphon sp*	0	+
68700	*Dubiraphia sp*	8	
74501	*Ceratopogonidae*	8	
77120	*Ablabesmyia mallochi*	24	
77500	*Conchapelopia sp*	72	
77750	*Hayesomyia senata or Thienemannimyia norena*	504	
83300	*Glyptotendipes (Phytotendipes) sp*	96	+
84450	*Polypedilum (P.) convictum*	24	
84470	*Polypedilum (P.) illinoense*	0	+
84540	*Polypedilum (Tripodura) scalaenum group*	120	
84790	*Tribelos fuscicorne*	216	
85625	*Rheotanytarsus exiguus group*	672	+
87501	*Empididae*	24	
93900	*Elimia sp*	0	+
96900	*Ferrissia sp*	8	

Taxa Code	Taxa	Quan/Qual

No. Quantitative Taxa: 24 Total Taxa: 31
No. Qualitative Taxa: 16 ICI: **32**
Number of Organisms: 2369 Qual EPT: **6**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/15/93 River Code: 17-540 River: Wolf Creek RM: 1.10

Taxa Code	Taxa	Quan/Qual	
01320	*Hydra sp*	1	
01801	*Turbellaria*	42	+
03600	*Oligochaeta*	2040	+
05800	*Caecidotea sp*	3	+
17200	*Caenis sp*	1	
22001	*Coenagrionidae*	5	+
52200	*Cheumatopsyche sp*	1	+
60900	*Peltodytes sp*	0	+
63900	*Laccophilus sp*	0	+
65700	*Anacaena sp*	0	+
65800	*Berosus sp*	0	+
68700	*Dubiraphia sp*	1	
69400	*Stenelmis sp*	0	+
71800	*Pseudolimnophila sp*	1	
71900	*Tipula sp*	0	+
74100	*Simulium sp*	0	+
74501	*Ceratopogonidae*	1	
77120	*Ablabesmyia mallochi*	36	
77500	*Conchapelopia sp*	108	+
77800	*Helopelopia sp*	36	+
78401	*Natarsia species A (sensu Roback, 1978)*	24	
78402	*Natarsia baltimoreus*	12	
80420	*Cricotopus (C.) bicinctus*	0	+
80510	*Cricotopus (Isocladius) sylvestris group*	0	+
81250	*Nanocladius (N.) minimus*	24	+
82730	*Chironomus (C.) decorus group*	48	
83040	*Dicrotendipes neomodestus*	108	
83051	*Dicrotendipes simpsoni*	108	
83300	*Glyptotendipes (Phytotendipes) sp*	36	
83410	*Harnischia curtilamellata*	12	
84300	*Phaenopsectra obediens group*	24	+
84302	*Phaenopsectra punctipes*	12	
84450	*Polypedilum (P.) convictum*	12	+
84460	*Polypedilum (P.) fallax group*	144	+
84470	*Polypedilum (P.) illinoense*	12	+
84540	*Polypedilum (Tripodura) scalaenum group*	156	+
85500	*Paratanytarsus sp*	60	+
85814	*Tanytarsus glabrescens group*	12	
85840	*Tanytarsus guerlus group*	12	
87501	*Empididae*	1	
94201	*Lymnaeidae*	3	
95100	*Physella sp*	6	+
95501	*Planorbidae*	156	
96900	*Ferrissia sp*	38	+

No. Quantitative Taxa:	35	Total Taxa:	44
No. Qualitative Taxa:	25	ICI:	**18**
Number of Organisms:	3296	Qual EPT:	**1**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/15/93 River Code: 17-540 River: Wolf Creek RM: 0.30

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	80	+
03360	*Plumatella sp*	0	+
03600	*Oligochaeta*	984	+
05800	*Caecidotea sp*	0	+
06800	*Gammarus sp*	0	+
08250	*Orconectes (Procericambarus) rusticus*	0	+
11200	*Callibaetis sp*	1	
22001	*Coenagrionidae*	4	+
22300	*Argia sp*	1	
28208	*Erythemis simplicicollis*	1	
28500	*Libellula sp*	1	
45300	*Sigara sp*	0	+
52200	*Cheumatopsyche sp*	1	+
52530	*Hydropsyche depravata group*	0	+
60900	*Peltodytes sp*	0	+
63300	*Hydroporus sp*	0	+
65700	*Anacaena sp*	0	+
65800	*Berosus sp*	5	
69400	*Stenelmis sp*	0	+
74501	*Ceratopogonidae*	3	
77120	*Ablabesmyia mallochi*	12	
77500	*Conchapelopia sp*	36	+
77800	*Helopelopia sp*	24	
79020	*Tanypus neopunctipennis*	12	+
79085	*Telopelopia okoboji*	12	
80420	*Cricotopus (C.) bicinctus*	120	+
80430	*Cricotopus (C.) tremulus group*	24	
81231	*Nanocladius (N.) crassicornus or N. (N.) rectinervus*	36	
81250	*Nanocladius (N.) minimus*	72	+
82730	*Chironomus (C.) decorus group*	36	+
82820	*Cryptochironomus sp*	0	+
83040	*Dicrotendipes neomodestus*	12	
83051	*Dicrotendipes simpsoni*	108	+
83300	*Glyptotendipes (Phytotendipes) sp*	36	+
84450	*Polypedilum (P.) convictum*	12	
84460	*Polypedilum (P.) fallax group*	12	
84470	*Polypedilum (P.) illinoense*	24	+
84540	*Polypedilum (Tripodura) scalaenum group*	180	+
85500	*Paratanytarsus sp*	36	
87501	*Empididae*	0	+
95100	*Physella sp*	2	+
95501	*Planorbidae*	2	
96900	*Ferrissia sp*	84	+
98600	*Sphaerium sp*	0	+

No. Quantitative Taxa: 31 Total Taxa: 44

No. Qualitative Taxa: 28 ICI: **16**

Number of Organisms: 1973 Qual EPT: **2**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/15/93 River Code: 17-541 River: Hudson Run RM: 4.10

Taxa Code	Taxa	Quan/Qual	
01320	*Hydra sp*	11	
01801	*Turbellaria*	0	+
03600	*Oligochaeta*	36	
11115	*Baetis brunneicolor*	0	+
13560	*Stenonema pulchellum group*	1	
13570	*Stenonema terminatum*	1	
15000	*Paraleptophlebia sp*	1	
21200	*Calopteryx sp*	7	+
21300	*Hetaerina sp*	4	
43570	*Neoplea sp*	0	+
45300	*Sigara sp*	0	+
45900	*Notonecta sp*	0	+
50804	*Lype diversa*	2	
51600	*Polycentropus sp*	4	
52200	*Cheumatopsyche sp*	1	+
52530	*Hydropsyche depravata group*	0	+
61400	*Agabus sp*	1	
63900	*Laccophilus sp*	0	+
68707	*Dubiraphia quadrinotata*	19	+
71900	*Tipula sp*	1	+
71910	*Tipula abdominalis*	0	+
74100	*Simulium sp*	0	+
74501	*Ceratopogonidae*	1	
77500	*Conchapelopia sp*	78	+
80204	*Brillia flavifrons group*	0	+
80370	*Corynoneura lobata*	136	
80430	*Cricotopus (C.) tremulus group*	0	+
82220	*Tvetenia discoloripes group*	0	+
82730	*Chironomus (C.) decorus group*	0	+
83000	*Dicrotendipes sp*	52	
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*	338	+
84300	*Phaenopsectra obediens group*	26	
84315	*Phaenopsectra flavipes*	0	+
84450	*Polypedilum (P.) convictum*	26	+
85260	*Cladotanytarsus vanderwulpi group*	26	
85500	*Paratanytarsus sp*	520	+
85625	*Rheotanytarsus exiguus group*	286	
85800	*Tanytarsus sp*	338	+
85814	*Tanytarsus glabrescens group*	806	+
85840	*Tanytarsus guerlus group*	104	
87501	*Empididae*	100	
95100	*Physella sp*	78	

No. Quantitative Taxa: 28 Total Taxa: 42
No. Qualitative Taxa: 24 ICI: **36**
Number of Organisms: 3004 Qual EPT: **3**

Ohio EPA Water Quality Monitoring and Assessment Section
Macroinvertebrate Collection

Collection Date: 09/15/93 River Code: 17-541 River: Hudson Run RM: 0.10

Taxa Code	Taxa	Quan/Qual	
01801	*Turbellaria*	6	+
03360	*Plumatella sp*	2	
03600	*Oligochaeta*	62	
06700	*Crangonyx sp*	0	+
11200	*Callibaetis sp*	0	+
22001	*Coenagrionidae*	2	+
22300	*Argia sp*	2	+
28208	*Erythemis simplicicollis*	1	+
28511	*Libellula luctuosa*	0	+
28705	*Pachydiplax longipennis*	1	
28955	*Libellula lydia*	0	+
60900	*Peltodytes sp*	0	+
65800	*Berosus sp*	142	+
67700	*Paracymus sp*	0	+
67800	*Tropisternus sp*	0	+
69400	*Stenelmis sp*	8	+
74100	*Simulium sp*	2	+
79085	*Telopelopia okoboji*	3	
80420	*Cricotopus (C.) bicinctus*	15	+
82220	*Tvetenia discoloripes group*	3	
83051	*Dicrotendipes simpsoni*	57	
83300	*Glyptotendipes (Phytotendipes) sp*	117	+
84050	*Parachironomus hirtalatus*	3	
85625	*Rheotanytarsus exiguus group*	0	+
95100	*Physella sp*	0	+
98600	*Sphaerium sp*	4	

Taxa Code	Taxa	Quan/Qual

No. Quantitative Taxa: 17 Total Taxa: 26
No. Qualitative Taxa: 18 ICI: **10**
Number of Organisms: 430 Qual EPT: **1**

Table A-11. Summary of relative numbers of fish and species collected at each location (by RM) sampled in the Tuscarawas River study area during 1993. Stream codes are as follows: Tuscarawas River - 17500, Hudson Run - 17541, Wolf Creek - 17540.

Species List

River Code: **17-500**	Stream: **Tuscarawas River**	Sample Date: **1993**
River Mile: **119.40**	Basin: Muskingum River	Date Range: 07/20/93
Data Source: 01	Time Fished: 4656 sec Drain Area: 35.0 sq mi	Thru: 09/30/93
Purpose:	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD (C)		O	M		1	0.75	0.22	0.02	0.08	31.00
GRASS PICKEREL (C)		P	M	P	1	0.75	0.22	0.01	0.05	18.00
NORTHERN HOG SUCKER (C)	R	I	S	M	176	132.00	38.85	14.61	49.61	110.66
WHITE SUCKER (C)	W	O	S	T	6	4.50	1.32	0.26	0.87	57.00
COMMON CARP (C)	G	O	M	T	14	10.50	3.09	11.37	38.61	1,082.80
BLACKNOSE DACE (C)	N	G	S	T	4	3.00	0.88	0.01	0.02	2.00
CREEK CHUB (C)	N	G	N	T	14	10.50	3.09	0.25	0.86	24.21
BLUNTNOSE MINNOW (C)	N	O	C	T	127	95.25	28.04	0.22	0.73	2.26
CENTRAL STONEROLLER (C)	N	H	N		4	3.00	0.88	0.01	0.03	2.50
YELLOW BULLHEAD (C)		I	C	T	23	17.25	5.08	1.81	6.13	104.61
ROCK BASS (A)	S	C	C		1	0.75	0.22	0.24	0.82	320.00
ROCK BASS (B)	S	C	C		3	2.25	0.66	0.06	0.22	28.33
LARGEMOUTH BASS (A)	F	C	C		2	1.50	0.44	0.13	0.46	89.50
WARMOUTH SF (C)	S	C	C		1	0.75	0.22	0.01	0.05	18.00
GREEN SUNFISH (C)	S	I	C	T	6	4.50	1.32	0.14	0.46	30.00
BLUEGILL SUNFISH (C)	S	I	C	P	6	4.50	1.32	0.09	0.29	19.00
PUMPKINSEED SUNFISH (C)	S	I	C	P	2	1.50	0.44	0.02	0.06	11.00
GREEN SF X HYBRID (C)					1	0.75	0.22	0.05	0.16	63.00
LOGPERCH (C)	D	I	S	M	7	5.25	1.55	0.05	0.17	9.29
JOHNNY DARTER (C)	D	I	C		2	1.50	0.44	0.00	0.01	2.00
GREENSIDE DARTER (C)	D	I	S	M	13	9.75	2.87	0.06	0.19	5.59
BANDED DARTER (C)	D	I	S	I	34	25.50	7.51	0.04	0.13	1.44
RAINBOW DARTER (C)	D	I	S	M	5	3.75	1.10	0.01	0.03	2.00
Mile Total					453	339.75		29.44		
Number of Species					21					
Number of Hybrids					1					

River Code: **17-500**	Stream: **Tuscarawas River**	Sample Date: **1993**
River Mile: **110.90**	Basin: Muskingum River	Date Range: 07/21/93
Data Source: 01	Time Fished: 4911 sec Drain Area: 74.0 sq mi	Thru: 09/29/93
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD (C)		O	M		12	8.00	4.26	0.61	1.01	75.92
WHITE SUCKER (C)	W	O	S	T	41	27.33	14.54	5.35	8.85	195.58
COMMON CARP (C)	G	O	M	T	95	63.33	33.69	49.62	82.13	783.54
GOLDFISH (C)	G	O	M	T	5	3.33	1.77	0.97	1.61	292.20
GOLDEN SHINER (C)	N	I	M	T	17	11.33	6.03	0.23	0.37	19.88
BLUNTNOSE MINNOW (C)	N	O	C	T	2	1.33	0.71	0.00	0.01	2.50
COM. CARP X GOLDFISH (C)	G	O		T	1	0.67	0.35	0.17	0.28	258.00
YELLOW BULLHEAD (C)		I	C	T	1	0.67	0.35	0.08	0.14	124.00
BROOK SILVERSIDE (C)		I	M	M	3	2.00	1.06	0.00	0.01	1.67
WHITE CRAPPIE (C)	S	I	C		1	0.67	0.35	0.03	0.05	46.00
LARGEMOUTH BASS (A)	F	C	C		8	5.33	2.84	1.17	1.94	219.75
WARMOUTH SF (C)	S	C	C		9	6.00	3.19	0.34	0.57	57.33
GREEN SUNFISH (C)	S	I	C	T	6	4.00	2.13	0.08	0.13	19.00
BLUEGILL SUNFISH (C)	S	I	C	P	53	35.33	18.79	1.12	1.86	31.75
PUMPKINSEED SUNFISH (C)	S	I	C	P	27	18.00	9.57	0.60	0.99	33.37
B'GILL X PUMPKINSEED (C)					1	0.67	0.35	0.04	0.06	56.00
Mile Total					282	188.00		60.42		
Number of Species					14					
Number of Hybrids					2					

River Code: **17-500**	Stream: **Tuscarawas River**	Sample Date: **1993**
River Mile: **109.60**	Basin: Muskingum River	Date Range: 07/21/93
Data Source: 01	Time Fished: 4339 sec Drain Area: 154.0 sq mi	Thru: 09/29/93
Purpose:	Dist Fished: 1.40 km No of Passes: 3	Sampler Type: A

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
BOWFIN (C)		P	C		1	0.67	0.23	0.20	0.20	296.00
GIZZARD SHAD (C)		O	M		169	124.81	43.62	2.62	2.69	21.28
GRASS PICKEREL (C)		P	M	P	3	2.07	0.72	0.12	0.13	59.00
WHITE SUCKER (C)	W	O	S	T	13	9.63	3.37	1.97	2.03	205.00
COMMON CARP (C)	G	O	M	T	107	77.19	26.97	89.76	92.15	1,168.33
BLUNTNOSE MINNOW (C)	N	O	C	T	30	22.00	7.69	0.05	0.05	2.30
YELLOW BULLHEAD (C)		I	C	T	11	7.63	2.67	0.91	0.93	116.82
WHITE CRAPPIE (C)	S	I	C		3	2.22	0.78	0.06	0.06	25.00
LARGEMOUTH BASS (A)	F	C	C		9	6.52	2.28	0.90	0.92	136.33
WARMOUTH SF (C)	S	C	C		1	0.74	0.26	0.06	0.06	76.00
GREEN SUNFISH (C)	S	I	C	T	12	8.82	3.08	0.16	0.17	18.58
BLUEGILL SUNFISH (C)	S	I	C	P	11	7.93	2.77	0.25	0.26	31.55
PUMPKINSEED SUNFISH (C)	S	I	C	P	19	13.70	4.79	0.29	0.30	21.16
WARMOUTH X PUMP'SEED (C)					1	0.74	0.26	0.05	0.05	61.00
GREENSIDE DARTER (C)	D	I	S	M	2	1.48	0.52	0.01	0.01	6.00
Mile Total					392	286.15		97.41		
Number of Species					14					
Number of Hybrids					1					

River Code: **17-500**	Stream: **Tuscarawas River**	Sample Date: **1993**
River Mile: **107.80**	Basin: Muskingum River	Date Range: 07/21/93
Data Source: 01	Time Fished: 4172 sec Drain Area: 158.0 sq mi	Thru: 09/29/93
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD (C)		O	M		8	5.33	5.19	0.26	0.40	47.88
WHITE SUCKER (C)	W	O	S	T	34	22.67	22.08	4.86	7.64	214.26
COMMON CARP (C)	G	O	M	T	73	48.67	47.40	56.57	89.04	1,162.41
CREEK CHUB (C)	N	G	N	T	1	0.67	0.65	0.05	0.08	76.00
BLUNTNOSE MINNOW (C)	N	O	C	T	2	1.33	1.30	0.01	0.01	4.50
YELLOW BULLHEAD (C)		I	C	T	7	4.67	4.55	1.11	1.75	238.57
WHITE CRAPPIE (C)	S	I	C		4	2.67	2.60	0.06	0.10	23.50
LARGEMOUTH BASS (A)	F	C	C		3	2.00	1.95	0.15	0.23	73.00
GREEN SUNFISH (C)	S	I	C	T	3	2.00	1.95	0.02	0.03	10.67
BLUEGILL SUNFISH (C)	S	I	C	P	12	8.00	7.79	0.32	0.50	39.58
PUMPKINSEED SUNFISH (C)	S	I	C	P	7	4.67	4.55	0.14	0.22	29.57
Mile Total					154	102.67		63.54		
Number of Species					11					
Number of Hybrids					0					

River Code: **17-500**	Stream: **Tuscarawas River**	Sample Date: **1993**
River Mile: **104.50**	Basin: Muskingum River	Date Range: 07/21/93
Data Source: 01	Time Fished: 3514 sec Drain Area: 173.0 sq mi	Thru: 09/29/93
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD (C)		O	M		40	26.67	17.62	0.81	0.75	30.46
QUILLBACK CARPSUCKER (C)	C	O	M		9	6.00	3.96	0.64	0.59	106.78
NORTHERN HOG SUCKER (C)	R	I	S	M	2	1.33	0.88	0.19	0.17	140.50
WHITE SUCKER (C)	W	O	S	T	25	16.67	11.01	3.45	3.17	207.11
COMMON CARP (C)	G	O	M	T	108	72.00	47.58	101.92	93.60	1,415.50
CREEK CHUB (C)	N	G	N	T	1	0.67	0.44	0.00	0.00	5.00
BLUNTNOSE MINNOW (C)	N	O	C	T	1	0.67	0.44	0.00	0.00	5.00
CHANNEL CATFISH (C)	F		C		3	2.00	1.32	0.62	0.57	310.67
YELLOW BULLHEAD (C)		I	C	T	4	2.67	1.76	0.17	0.16	65.25
BROWN BULLHEAD (C)		I	C	T	1	0.67	0.44	0.32	0.29	475.00
WHITE CRAPPIE (C)	S	I	C		1	0.67	0.44	0.01	0.01	20.00
LARGEMOUTH BASS (A)	F	C	C		3	2.00	1.32	0.15	0.14	74.00
LARGEMOUTH BASS (B)	F	C	C		1	0.67	0.44	0.01	0.01	10.00
GREEN SUNFISH (C)	S	I	C	T	1	0.67	0.44	0.01	0.00	8.00
BLUEGILL SUNFISH (C)	S	I	C	P	12	8.00	5.29	0.28	0.25	34.42
PUMPKINSEED SUNFISH (C)	S	I	C	P	11	7.33	4.85	0.21	0.19	28.82
GREEN SF X BLUEGILL (C)					1	0.67	0.44	0.02	0.02	36.00
GR'N SF X PUMPKINS'D (C)					1	0.67	0.44	0.01	0.01	16.00
YELLOW PERCH (C)			M		1	0.67	0.44	0.06	0.05	84.00
GREENSIDE DARTER (C)	D	I	S	M	1	0.67	0.44	0.01	0.01	10.00
Mile Total					227	151.33		108.88		
Number of Species					17					
Number of Hybrids					2					

River Code: **17-500**	Stream: **Tuscarawas River**	Sample Date: **1993**
River Mile: **94.70**	Basin: Muskingum River	Date Range: 07/21/93
Data Source: 01	Time Fished: 4337 sec Drain Area: 435.0 sq mi	Thru: 09/29/93
Purpose:	Dist Fished: 1.50 km No of Passes: 3	Sampler Type: A

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD (C)		O	M		229	152.67	62.57	0.46	0.78	3.00
NORTHERN HOG SUCKER (C)	R	I	S	M	14	9.33	3.83	2.40	4.07	257.50
WHITE SUCKER (C)	W	O	S	T	28	18.67	7.65	5.06	8.57	271.11
COMMON CARP (C)	G	O	M	T	56	37.33	15.30	46.97	79.52	1,258.03
SPOTFIN SHINER (C)	N	I	M		1	0.67	0.27	0.01	0.01	9.00
BLUNTNOSE MINNOW (C)	N	O	C	T	3	2.00	0.82	0.01	0.01	2.67
CHANNEL CATFISH (C)	F		C		1	0.67	0.27	1.40	2.37	2,100.00
YELLOW BULLHEAD (C)		I	C	T	4	2.67	1.09	0.75	1.27	281.75
WHITE CRAPPIE (C)	S	I	C		5	3.33	1.37	0.06	0.09	16.80
SMALLMOUTH BASS (A)	F	C	C	M	1	0.67	0.27	0.24	0.40	356.00
LARGEMOUTH BASS (A)	F	C	C		5	3.33	1.37	1.37	2.32	410.80
LARGEMOUTH BASS (B)	F	C	C		2	1.33	0.55	0.01	0.02	7.00
WARMOUTH SF (C)	S	C	C		1	0.67	0.27	0.04	0.07	66.00
GREEN SUNFISH (C)	S	I	C	T	2	1.33	0.55	0.01	0.02	9.00
BLUEGILL SUNFISH (C)	S	I	C	P	3	2.00	0.82	0.07	0.11	33.33
PUMPKINSEED SUNFISH (C)	S	I	C	P	9	6.00	2.46	0.21	0.35	34.56
GREENSIDE DARTER (C)	D	I	S	M	2	1.33	0.55	0.01	0.01	5.50
Mile Total					366	244.00		59.06		
Number of Species					16					
Number of Hybrids					0					

River Code: **17-540**	Stream: **Wolf Creek**	Sample Date: **1993**
River Mile: **1.10**	Basin: Muskingum River	Date Range: 09/30/93
Data Source: 01	Time Fished: 2690 sec Drain Area: 63.0 sq mi	Thru: 10/26/93
Purpose:	Dist Fished: 1.00 km No of Passes: 2	Sampler Type: A

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD (C)		O	M		47	47.00	19.03	3.15	4.62	67.02
QUILLBACK CARPSUCKER (C)	C	O	M		2	2.00	0.81	0.25	0.37	125.00
WHITE SUCKER (C)	W	O	S	T	68	68.00	27.53	9.98	14.64	146.75
COMMON CARP (C)	G	O	M	T	46	46.00	18.62	52.46	76.96	1,140.33
CREEK CHUB (C)	N	G	N	T	1	1.00	0.40	0.06	0.09	58.00
SAND SHINER (C)	N	I	M	M	1	1.00	0.40	0.00	0.00	3.00
BLUNTNOSE MINNOW (C)	N	O	C	T	23	23.00	9.31	0.02	0.03	0.78
COM. CARP X GOLDFISH (C)	G	O		T	1	1.00	0.40	0.21	0.31	210.00
LARGEMOUTH BASS (A)	F	C	C		3	3.00	1.21	0.59	0.86	195.00
WARMOUTH SF (C)	S	C	C		5	5.00	2.02	0.32	0.47	64.00
GREEN SUNFISH (C)	S	I	C	T	10	10.00	4.05	0.15	0.22	15.00
BLUEGILL SUNFISH (C)	S	I	C	P	17	17.00	6.88	0.51	0.75	30.00
PUMPKINSEED SUNFISH (C)	S	I	C	P	23	23.00	9.31	0.47	0.69	20.58
Mile Total					247	247.00		68.16		
Number of Species					12					
Number of Hybrids					1					

River Code: **17-540**	Stream: **Wolf Creek**	Sample Date: **1993**
River Mile: **0.30**	Basin: Muskingum River	Date Range: 07/20/93
Data Source: 01	Time Fished: 6220 sec Drain Area: 77.0 sq mi	Thru: 09/30/93
Purpose:	Dist Fished: 0.40 km No of Passes: 2	Sampler Type: D

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
GIZZARD SHAD (C)		O	M		2	1.50	0.46	0.01	0.06	7.00
WHITE SUCKER (C)	W	O	S	T	41	30.75	9.49	2.61	15.28	84.92
COMMON CARP (C)	G	O	M	T	18	13.50	4.17	11.27	65.94	834.72
GOLDEN SHINER (C)	N	I	M	T	1	0.75	0.23	0.00	0.01	1.00
CREEK CHUB (C)	N	G	N	T	9	6.75	2.08	0.14	0.84	21.33
SUCKERMOUTH MINNOW (C)	N	I	S		2	1.50	0.46	0.01	0.06	7.00
SAND SHINER (C)	N	I	M	M	5	3.75	1.16	0.01	0.04	1.80
BLUNTNOSE MINNOW (C)	N	O	C	T	238	178.50	55.09	0.30	1.74	1.66
CENTRAL STONEROLLER (C)	N	H	N		2	1.50	0.46	0.01	0.08	9.50
YELLOW BULLHEAD (C)		I	C	T	50	37.50	11.57	2.14	12.53	57.12
WHITE CRAPPIE (C)	S	I	C		2	1.50	0.46	0.05	0.28	32.00
ROCK BASS (A)	S	C	C		1	0.75	0.23	0.07	0.39	89.00
GREEN SUNFISH (C)	S	I	C	T	29	21.75	6.71	0.28	1.63	12.79
BLUEGILL SUNFISH (C)	S	I	C	P	2	1.50	0.46	0.01	0.04	4.00
PUMPKINSEED SUNFISH (C)	S	I	C	P	16	12.00	3.70	0.10	0.60	8.56
GR'N SF X PUMPKINS'D (C)					1	0.75	0.23	0.04	0.21	48.00
GREENSIDE DARTER (C)	D	I	S	M	13	9.75	3.01	0.05	0.27	4.69
Mile Total					432	324.00		17.09		
Number of Species					16					
Number of Hybrids					1					

River Code: **17-541**	Stream: **Hudson Run**	Sample Date: **1993**
River Mile: **4.10**	Basin: Muskingum River	Date Range: 07/20/93
Data Source: 01	Time Fished: 4574 sec Drain Area: 4.1 sq mi	Thru: 08/30/93
Purpose:	Dist Fished: 0.30 km No of Passes: 2	Sampler Type: D

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
LEAST BROOK LAMPREY (C)		F	N		1	1.00	0.10			
WHITE SUCKER (C)	W	O	S	T	198	198.00	20.37			
COMMON CARP (C)	G	O	M	T	8	8.00	0.82			
BLACKNOSE DACE (C)	N	G	S	T	149	149.00	15.33			
CREEK CHUB (C)	N	G	N	T	253	253.00	26.03			
BLUNTNOSE MINNOW (C)	N	O	C	T	163	163.00	16.77			
CENTRAL STONEROLLER (C)	N	H	N		50	50.00	5.14			
YELLOW BULLHEAD (C)		I	C	T	3	3.00	0.31			
LARGEMOUTH BASS (A)	F	C	C		2	2.00	0.21			
LARGEMOUTH BASS (B)	F	C	C		9	9.00	0.93			
GREEN SUNFISH (C)	S	I	C	T	7	7.00	0.72			
BLUEGILL SUNFISH (C)	S	I	C	P	2	2.00	0.21			
PUMPKINSEED SUNFISH (C)	S	I	C	P	22	22.00	2.26			
JOHNNY DARTER (C)	D	I	C		43	43.00	4.42			
RAINBOW DARTER (C)	D	I	S	M	25	25.00	2.57			
FANTAIL DARTER (C)	D	I	C		35	35.00	3.60			
BROOK STICKLEBACK (C)		I	C		2	2.00	0.21			
Mile Total					972	972.00				
Number of Species					16					
Number of Hybrids					0					

River Code: **17-541**	Stream: **Hudson Run**	Sample Date: **1993**
River Mile: **0.10**	Basin: Muskingum River	Date Range: 07/20/93
Data Source: 01	Time Fished: 3799 sec Drain Area: 13.4 sq mi	Thru: 09/30/93
Purpose:	Dist Fished: 0.30 km No of Passes: 2	Sampler Type: D

Species Name / Stage / ODNR Status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
WHITE SUCKER (C)	W	O	S	T	22	22.00	12.43			
CREEK CHUB (C)	N	G	N	T	3	3.00	1.69			
SUCKERMOUTH MINNOW (C)	N	I	S		1	1.00	0.56			
BLUNTNOSE MINNOW (C)	N	O	C	T	15	15.00	8.47			
CENTRAL STONEROLLER (C)	N	H	N		14	14.00	7.91			
YELLOW BULLHEAD (C)		I	C	T	21	21.00	11.86			
BLACK BULLHEAD (C)		I	C	P	1	1.00	0.56			
WHITE CRAPPIE (C)	S	I	C		2	2.00	1.13			
BLACK CRAPPIE (C)	S	I	C		4	4.00	2.26			
LARGEMOUTH BASS (A)	F	C	C		4	4.00	2.26			
LARGEMOUTH BASS (B)	F	C	C		5	5.00	2.82			
GREEN SUNFISH (C)	S	I	C	T	24	24.00	13.56			
BLUEGILL SUNFISH (C)	S	I	C	P	53	53.00	29.94			
PUMPKINSEED SUNFISH (C)	S	I	C	P	7	7.00	3.95			
GREEN SF X HYBRID (C)					1	1.00	0.56			
Mile Total					177	177.00				
Number of Species					13					
Number of Hybrids					1					

Table A-12. Results of tissue analyses from fish collected in the Tuscarawas River during 1989.

	FISH TISSUE ug/kg (ppb)				
	Sampling Locations (by River Mile)				
	RM 110.9	**RM 109.7**	**RM 109.7**	**RM 108.2**	**RM 90.3**
Parameter	Common carp Whole body	Common carp Whole body	Yellow bullhead Fillet	Common carp Whole body	Common carp Whole body
Percent Lipids	3.9	2.0	0.6	2.0	4.1
Volatile Organic Compounds [a]	nd	-	nd	-	nd
Tetrachloroethene	nd	108	nd	106	nd
Semivolatile Organic Cmpnds.	nd		nd		
Hexachlorobenzene	nd	1,080	nd	2,320	7,360
Pesticides/ PCBs					
y-BHC	nd	nd	nd	nd	nd
d-BHC	nd	nd	nd	nd	nd
Heptachlor epoxide	nd	nd	nd	nd	nd
Endosulfan I	nd	nd	nd	9.4	nd
Endosulfan sulfate	nd	3.3	nd	nd	nd
Dieldrin	8.6	5.3	2.1	7.0	12.1
Endrin	2.9	nd	nd	4.2	5.2
4,4'-DDE	36.2	20.3	12.2	25.6	102
4,4'-DDD	36.5	23.9	8.1	22.8	40.9
4,4'-DDT	nd	8.0	11.2	12.0	32.3
Methoxychlor	nd	nd	nd	nd	13.1
PCB-1248	nd	nd	nd	nd	1,050
PCB-1260	200	105	87	170	415
Mirex	nd	nd	nd	nd	nd

Table A-12. Continued.

	FISH TISSUE ug/kg (ppb)				
	Sampling Locations (by River Mile)				
	RM 90.3	**RM 89.3**	**RM 88.3**	**RM 88.3**	**RM 78.1**
Parameter	Warmouth Fillet	Common carp Whole body	Common carp Whole body	Yellow bullhead Fillet	Common carp Whole body
Percent Lipids	0.1	5.1	4.8	1.3	6.3
Volatile Organic Compounds [a]	nd	nd	nd	nd	nd
Tetrachloroethene	nd	nd	nd	nd	nd
Semivolatile Organic Cmpnds.	-				
Hexachlorobenzene	260	6,430	5,920	740	5,410
Pesticides/ PCBs					
y-BHC	nd	2.7	nd	nd	2.6
d-BHC	nd	2.8	nd	nd	nd
Heptachlor epoxide	0.7	203	136	22.8	nd
Endosulfan I	nd	nd	nd	nd	nd
Endosulfan sulfate	nd	3.0	nd	nd	nd
Dieldrin	nd	13.7	12.7	2.9	13.3
Endrin	nd	2.7	2.8	0.4	0.7
4,4’-DDE	1.6	nd	nd	nd	nd
4,4’-DDD	nd	78.2	59.5	5.4	78.4
4,4’-DDT	nd	73.2	51.6	6.0	62.6
Methoxychlor	nd	31.1	20.9	nd	27.8
PCB-1248	21.2	5,100	4,000	250	3,290
PCB-1260	nd	1,110	740	69	840
Mirex	nd	nd	nd	nd	nd

Table A-12. Continued.

	FISH TISSUE ug/kg (ppb)				
	Sampling Locations (by River Mile)				
	RM 78.1	**RM 60.8**	**RM 60.8**	**RM 58.4**	**RM 58.4**
Parameter	Largemouth bass Fillet	Rock bass Fillet	Common carp Whole Body	Smallmouth bass Fillet	Common carp Whole body
Percent Lipids	0.4	0.1	9.4	0.5	9.5
Volatile Organic Compounds	nd	nd	nd	nd	nd
Tetrachloroethene	nd	nd	nd	nd	nd
Semivolatile Organic Cmpnds.	nd	nd	-	nd	-
Hexachlorobenzene	nd	nd	4,100	nd	3,760
Pesticides/ PCBs					
y-BHC	nd	nd	4.7	0.4	4.0
d-BHC	nd	nd	nd	nd	nd
Heptachlor epoxide	3.4	4.3	nd	7.1	nd
Endosulfan I	nd	nd	nd	nd	nd
Endosulfan sulfate	nd	nd	nd	nd	nd
Dieldrin	3.1	0.5	16.4	3.1	17.6
Endrin	nd	nd	2.1	nd	1.6
4,4’-DDE	7.4	nd	nd	nd	nd
4,4’-DDD	2.1	1.3	59.2	4.3	nd
4,4’-DDT	2.0	1.4	42.9	4.4	nd
Methoxychlor	nd	nd	24.0	2.2	nd
PCB-1248	88.9	34.4	2,280	170	1,950
PCB-1260	43.5	19.7	700	65	492
Mirex	nd	nd	nd	nd	18.0

Table A-12. Continued.

	FISH TISSUE ug/kg (ppb)				
	Sampling Locations (by River Mile)				
	RM 56.6	**RM 56.6**	**RM 6.7**	**RM 6.7**	**RM 0.4**
Parameter	Channel catfish Fillet	Common carp Whole body	Common carp Whole Body	Channel catfish Fillet	Common carp Whole body
Percent Lipids	4.0	7.0	11.6	4.8	6.8
Volatile Organic Compounds	NA	NA	NA	NA	NA
Tetrachloroethene	NA	NA	NA	NA	NA
Semivolatile Organic Cmpnds.	-	-	nd	-	-
Hexachlorobenzene	1,190	1,920	nd	470	1,240
Pesticides/ PCBs					
a-BHC	19.7	29.4	24.5	13.1	14.6
b-BHC	4.2	6.5	3.8	2.9	3.6
y-BHC	4.0	5.1	6.7	3.6	3.6
d-BHC	nd	nd	nd	nd	nd
Heptachlor epoxide	25.2	33.1	57.0	16.8	21.9
Endosulfan I	nd	nd	nd	nd	nd
Endosulfan sulfate	nd	nd	nd	nd	nd
Dieldrin	9.5	10.0	14.3	10.2	15.6
Endrin	nd	3.0	8.5	1.1	16.3
4,4’-DDE	nd	nd	nd	nd	75.3
4,4’-DDD	nd	24.2	nd	13.2	21.0
4,4’-DDT	nd	nd	nd	nd	nd
Methoxychlor	4.9	11.5	23.9	5.2	8.2
PCB-1248	99.8	951	821	80.8	344
PCB-1260	114	243	554	128	233
Mirex	nd	nd	nd	nd	nd

Table A-12. Continued.

	FISH TISSUE ug/kg (ppb)
	Sampling Locations (by River Mile)
	RM 0.4
	Smallmouth bass
Parameter	Fillet
Percent Lipids	0.5
Volatile Organic Compounds	NA
Tetrachloroethene	NA
Semivolatile Organic Cmpnds.	nd
Hexachlorobenzene	nd
Pesticides/ PCBs	
a-BHC	1.9
b-BHC	nd
y-BHC	nd
d-BHC	nd
Heptachlor epoxide	2.2
Endosulfan I	nd
Endosulfan sulfate	nd
Dieldrin	nd
Endrin	nd
4,4'-DDE	nd
4,4'-DDD	nd
4,4'-DDT	nd
Methoxychlor	nd
PCB-1248	26.6
PCB-1260	15.6
Mirex	nd

[a] The method for analysis of fish tissue samples for volatile organic compounds during the time of analysis was largely experimental, therefore, sample results are qualitative or semi-quantitative at best.