Biological and Water Quality Study of the Middle Scioto River and Alum Creek

Franklin, Delaware, Morrow, and Pickaway Counties, Ohio

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Ohio EPA Technical Report MAS/1997-12-12

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NOTICE TO USERS

Ohio EPA incorporated 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 assemblage data, and the Invertebrate Community Index (ICI), which is based on macroinvertebrate assemblage data. Criteria for each index are specified for each of Ohio's five ecoregions (as described by Omernik 1987), and are further organized by organism group, index, site type, and aquatic life use designation. These criteria, along with the existing chemical and whole effluent toxicity evaluation methods and criteria, figure prominently in the monitoring and assessment of Ohio’s surface water resources.

The following documents support the use of biological criteria by outlining the rationale for using biological information, the methods by which the biocriteria were derived and calculated, the field methods by which sampling must be conducted, and the process for evaluating results:

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

Ohio Environmental Protection Agency. 1989b. Addendum to Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Ohio Environmental Protection Agency. 1989c. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Div. Water Qual. Plan. Assess., Ecol. Assess. Sect., Columbus, Ohio.

Ohio Environmental Protection Agency. 1990. The use of biological criteria in the Ohio EPA surface water monitoring and assessment program. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI): rationale,methods, and application. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Since the publication of the preceding guidance documents new publications by Ohio EPA have become available. The following publications should also be consulted as they represent the latest information and analyses used by Ohio EPA to implement the biological criteria.

DeShon, J.D. 1995. Development and application of the invertebrate community index (ICI), pp. 217-243. *in* W.S. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Risk-based Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Rankin, E. T. 1995. The use of habitat assessments in water resource management programs, pp. 181-208. *in* W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995. Biological criteria program development and implementation in Ohio, pp. 109-144. *in* W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995. Biological response signatures and the area of degradation value: new tools for interpreting multimetric data, pp. 263-286. *in* W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. 1995. Policy issues and management applications for biological criteria, pp. 327-344. *in* W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C.O. and E.T. Rankin. 1995. The role of biological criteria in water quality monitoring, assessment, and regulation. Environmental Regulation in Ohio: How to Cope With the Regulatory Jungle. Inst. of Business Law, Santa Monica, CA. 54 pp.

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

Ohio EPA, Division of Surface Water
Monitoring and Assessment Section
1685 Westbelt Drive
Columbus, Ohio 43228-3809
(614) 728-3377

FOREWORD

What is a Biological and Water Quality Survey?

A biological and water quality survey, or "biosurvey", is an interdisciplinary monitoring effort coordinated on a waterbody specific or watershed scale. This effort may involve a relatively simple setting focusing on one or two small streams, one or two principal stressors, and a handful different study areas with an aggregate total of 250-300 sampling sites.

Ohio EPA employs biological, chemical, and physical monitoring and assessment techniques in biosurveys in order to meet three major objectives: 1) determine the extent to which use designations assigned in the Ohio Water Quality Standards (WQS) are either attained or not attained; 2) determine if use designations assigned to a given water body are appropriate and attainable; and 3) determine if any changes in key ambient biological, chemical, or physical indicators have taken place over time, particularly before and after the implementation of point source pollution controls or best management practices. The data gathered by a biosurvey is processed, evaluated, and synthesized in a biological and water quality report. Each biological and water quality study contains a summary of major findings and recommendations for revisions to WQS, future monitoring needs, or other actions which may be needed to resolve existing impairment of designated uses. While the principal focus of a biosurvey is on the status of aquatic life uses, the status of other uses such as recreation and water supply, as well as human health concerns, are also addressed.

The findings and conclusions of a biological and water quality study may factor into regulatory actions taken by Ohio EPA (*e.g.*, NPDES permits, Water Quality Support Documents [WQPSDs], Director's Orders, the Ohio Water Quality Standards [OAC 3745-1], and are eventually incorporated into Water Quality Permit Support Documents (WQPSDs), State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and the Ohio Water Resource Inventory (305[b] report).

Hierarchy of Indicators

A carefully conceived ambient monitoring approach, using cost-effective indicators comprised of ecological, chemical, and toxicological measures, can ensure that all relevant pollution sources are judged objectively on the basis of environmental results. Ohio EPA relies on a tiered approach in attempting to link the results of administrative activities with true environmental measures. This integrated approach is outlined in Figure 1 and includes a hierarchical continuum from administrative to true environmental indicators. The six "levels" of indicators include: 1) actions taken by regulatory agencies (permitting, enforcement, grants); 2) responses by the regulated community (treatment works, pollution prevention); 3) changes in discharged quantities (pollutant loadings); 4) changes in ambient conditions (water quality, habitat); 5) changes in uptake and/or assimilation (tissue contamination, biomarkers, wasteload allocation); and, 6)

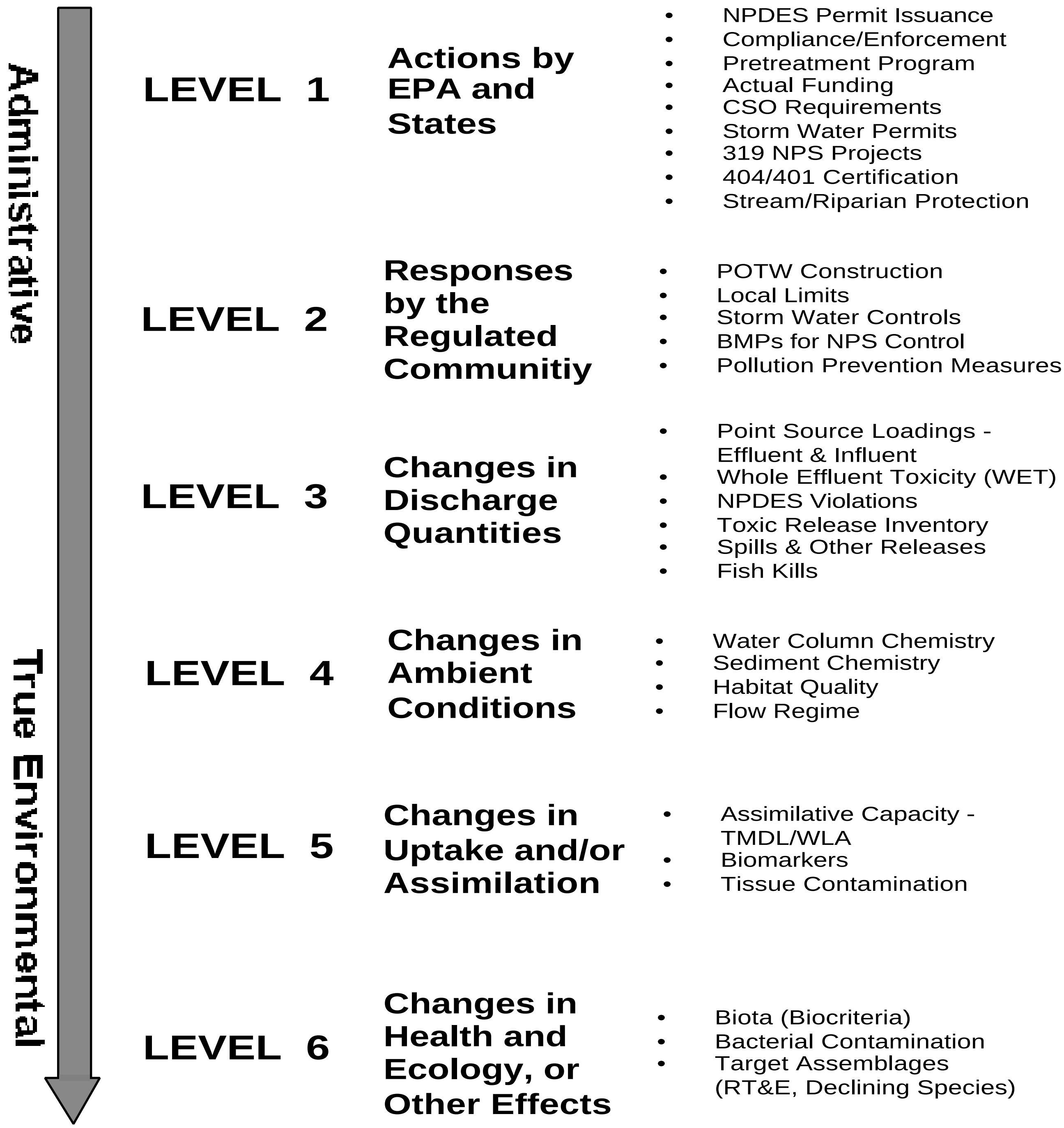

Figure 1. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by U.S. EPA (1995).

changes in health, ecology, or other effects (ecological condition, pathogens). In this process the results of administrative activities (levels 1 and 2) can be linked to efforts to improve water quality (levels 3, 4, and 5) which should translate into the environmental "results" (level 6). Thus, the aggregate effect of billions of dollars spent on water pollution control since the early 1970s can now be determined with quantifiable measures of environmental condition.

Superimposed on this hierarchy is the concept of stressor, exposure, and response indicators. *Stressor* indicators generally include activities which have the potential to degrade the aquatic environment such as pollutant discharges (permitted and unpermitted), land use effects, and habitat modifications. *Exposure* indicators are those which measure the effects of stressors and can include whole effluent toxicity tests, tissue residues, and biomarkers, each of which provides evidence of biological exposure to a stressor or bioaccumulative agent. *Response* indicators are generally composite measures of the cumulative effects of stress and exposure and include the more direct measures of community and population response that are represented here by the biological indices which comprise Ohio's biological criteria. Other response indicators could include target assemblages, *i.e.,* rare, threatened, endangered, special status, and declining species or bacterial levels which serve as surrogates for the recreational uses. These indicators represent the essential technical elements for watershed-based management approaches. The key, however, is to use the different indicators *within* the roles which are most appropriate for each.

Describing the causes and sources associated with observed impairments revealed by the biological criteria and linking this with pollution sources involves an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and biological response signatures within the biological data itself. Thus the assignment of principal causes and sources of impairment represents the association of impairments (defined by response indicators) with stressor and exposure indicators. The principal reporting venue for this process on a watershed or subbasin scale is a biological and water quality report. These reports then provide the foundation for aggregated assessments such as the Ohio Water Resource Inventory (305[b] report), the Ohio NPS Assessment, and technical bulletins.

Ohio Water Quality Standards: Designated Aquatic Life Uses

The Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) consist of designated uses and chemical, physical, and biological criteria designed to represent measurable properties of the environment that are consistent with the narrative goals specified by each use designation. Use designations consist of two broad groups, aquatic life and non-aquatic life uses. In applications of the Ohio WQS to the management of water resource issues in rivers and streams, the aquatic life use criteria frequently control the resulting protection and restoration requirements, hence their emphasis in biological and water quality reports. Also, an emphasis on protecting aquatic life generally results in water quality suitable for all uses. The five different aquatic life uses currently defined in the Ohio WQS with the general intent of each with respect to the role of biological criteria are described as follows:

1) *Warmwater Habitat (WWH)* - this use designation defines the "typical" warmwater assemblage of aquatic organisms for Ohio rivers and streams; *this use represents the principal restoration target for the majority of water resource management efforts in Ohio.* Biological criteria are stratified across five ecoregions for the WWH use designation.

2) *Exceptional Warmwater Habitat (EWH)* - this use designation is reserved for waters which support "unusual and exceptional" assemblages of aquatic organisms which are characterized by a high diversity of species, particularly those which are highly intolerant and/or rare, threatened, endangered, or special status (*i.e.,* declining species); *this designation represents a protection goal for water resource management efforts dealing with Ohio's best water resources.* Biological criteria for EWH apply uniformly across the state.

3) *Coldwater Habitat (CWH)* - this use is intended for waters which support assemblages of cold water organisms and/or those which are stocked with salmonids with the intent of providing a put-and-take fishery on a year round basis which is further sanctioned by the Ohio DNR, Division of Wildlife; this use should not be confused with the Seasonal Salmonid Habitat (SSH) use which applies to the Lake Erie tributaries which support periodic "runs" of salmonids during the spring, summer, and/or fall. No specific biological criteria have been developed for the CWH use although the WWH biocriteria are viewed as attainable for CWH designated streams.

4) *Modified Warmwater Habitat (MWH)* - this use applies to streams and rivers which have been subjected to extensive, maintained, and essentially permanent hydromodifications such that the biocriteria for the WWH use are not attainable *and where the activities have been sanctioned and permitted by state or federal law;* the representative aquatic assemblages are generally composed of species which are tolerant to low dissolved oxygen, silt, nutrient enrichment, and poor quality habitat. Biological criteria for MWH were derived from a separate set of habitat modified reference sites and are stratified across five ecoregions and three major modification types: channelization, run-of-river impoundments, and extensive sedimentation due to non-acidic mine drainage.

5) *Limited Resource Water (LRW)* - this use applies to small streams (usually <3 $mi.^2$ drainage area) and other water courses which have been irretrievably altered to the extent that no appreciable assemblage of aquatic life can be supported; such waterways generally include small streams in extensively urbanized areas, those which lie in watersheds with extensive drainage modifications, those which completely lack water on a recurring annual basis (*i.e.*, true ephemeral streams), or other irretrievably altered waterways. No formal biological criteria have been established for the LRW use designation.

Chemical, physical, and/or biological criteria are generally assigned to each use designation in accordance with the broad goals defined by each. As such the system of use designations employed in the Ohio WQS constitutes a "tiered" approach in that varying and graduated levels of protection are provided by each. This hierarchy is especially apparent for parameters such as dissolved oxygen, ammonia-nitrogen, temperature, and the biological criteria. For other parameters such as heavy metals, the technology to construct an equally graduated set of criteria has been lacking, thus the same water quality criteria may apply to two or three different use designations.

Ohio Water Quality Standards: Non-Aquatic Life Uses
In addition to assessing the appropriateness and status of aquatic life uses, each biological and water quality survey also addresses non-aquatic life uses such as recreation, water supply, and human health concerns as appropriate. The recreation uses most applicable to rivers and streams are the Primary Contact Recreation (PCR) and Secondary Contact Recreation (SCR) uses. The criterion for designating the PCR use is simply having a water depth of at least one meter over an area of at least 100 square feet or where canoeing is a feasible activity. If a water body is too small and shallow to meet either criterion the SCR use applies. The attainment status of PCR and SCR is determined using bacterial indicators (*e.g.*, fecal coliform bacteria, *E. coli)* and the criteria for each are specified in the Ohio WQS.

Water supply uses include Public Water Supply (PWS), Agricultural Water Supply (AWS), and Industrial Water Supply (IWS). Public Water Supplies are simply defined as segments within 500 yards of a potable water supply or food processing industry intake. The Agricultural Water Supply (AWS) and Industrial Water Supply (IWS) use designations generally apply to all waters unless it can be clearly shown that they are not applicable. An example of this would be an urban area where livestock watering or pasturing does not take place, thus the AWS use would not apply. Chemical criteria are specified in the Ohio WQS for each use and attainment status is based primarily on chemical-specific indicators. Human health concerns are additionally addressed with fish tissue data, but any consumption advisories are issued by the Ohio Department of Health are detailed in other documents.

ACKNOWLEDGEMENTS

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Study Area Description - Vince Mazeika
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  Physical Habitat for Aquatic Life - Charles Boucher
  Macroinvertebrate Community - Mike Bolton and Marty Knapp
  Fish Community - Charles Boucher
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The field work in support of this project would have not been possible without the capable assistance of the following 1996 seasonal field staff: Tom Holmes, Eric Corbin, Kevin Kish, Joellyn Enoch, and Chris Matney.

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(Franklin, Delaware, Morrow, and Pickaway Counties, Ohio)

INTRODUCTION

As part of the five-year basin approach for the National Pollution Discharge Elimination System (NPDES) permitting process, ambient biological, water column chemical and physical, and sediment samples were collected by Ohio EPA from the middle Scioto River, lower Olentangy River and Alum Creek during the summer and fall of 1996.

Specific objectives of this study were to:

1) Monitor and assess the overall chemical, physical, and biological integrity of the middle Scioto River, Alum Creek, and the lower Olentangy River,

2) Determine attainment status of beneficial use designations and recommend changes where appropriate,

3) Evaluate potential impacts to the water quality of the middle Scioto River from the Columbus Southerly WWTP, Jackson Pike WWTP, and Combined Sewer Overflows (CSOs) maintained and operated by the city of Columbus,

4) Evaluate potential impacts from Techneglas Inc. and minor permitted entities that discharge to the middle Scioto River,

5) Evaluate potential impacts to the water quality of Alum Creek from the Huber Ridge WWTP, the Alum Creek Storm Tank outfall (and other CSOs) and minor permitted entities that discharge to Alum Creek, and

6) Summarize previous studies by Ohio EPA to evaluate changes in environmental conditions within the study area and to expand Ohio EPA databases for statewide trend analysis (e.g., 305[b]).

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

SUMMARY

Scioto River (mainstem)

A total of 47.1 miles of the Scioto River mainstem was sampled and assessed as part of the 1996 survey. The effort included an aggregate total of 49 biological, chemical/physical, and sediment sampling stations, encompassing the mainstem from RM 145.0 (upstream from Griggs reservoir) to RM 97.9 (downstream from Circleville). This portion of the Scioto River has been subjected to annual study by the Ohio EPA since 1979. This historical effort has been limited mainly to the monitoring and assessment of the fish community, and has been performed to better understand annual variability in the biology of an effluent dominated river. In addition to the 1996 survey, intensive efforts (i.e., fish, macrobenthos, and chemical/physical sampling) were undertaken for the years: 1980, 1981, 1986, 1988, 1991, and 1996.

Two aquatic life use designations are currently in effect for the free flowing portions of the middle Scioto River. The river reach between the Olentangy River confluence (RM 132.3) and the Greenlawn dam (RM 129.6) has been extensively widened and channelized, and is effectively impounded for a distance of approximately 2.7 miles by the Town St. and the Greenlawn dams. In recognition of these compelling habitat limitations, this segment was designated MWH in the early 1990s. The remaining segments (upper and lower) of the middle Scioto River are currently designated WWH. The EWH aquatic use is the default designation for all publicly owned lakes and reservoirs, as the supporting chemical criteria are typically more protective of the resource than the more widely applied WWH criteria. As such, the impoundment formed by the Griggs water supply dam is designated EWH. However, supporting ambient biological criteria have yet to be developed for large impoundments or natural lakes within Ohio, as other environmental indicators are typically employed to index lake/reservoir condition. As an interim measure of biological performance, the results from ambient monitoring within the limits of the Griggs dam pool were compared against the WWH criteria to gauge aquatic life use attainment status of this water body. Aquatic life use attainment status for all of the water bodies evaluated as part of the 1996 middle Scioto River survey are presented in Table 1. A graphical presentation of ambient biological performance throughout the study area is provided in Figure 2.

Results from the 1996 biosurvey found 35.6 miles (75.6%) of the middle Scioto River in full attainment of existing aquatic life uses. Partial attainment was indicated for 11.5 miles (24.4%). Aquatic life use impairment (partial attainment) was limited to two discrete river segments. The first was located within the upper limits of the study area, contained entirely within the extensive impoundment (water supply reservoir) formed by the Griggs dam. The second was located between RM 129.2 (Greenlawn Ave./Whittier St. CSO) and RM 123.6 (downstream from I-270).

Table 1. Aquatic life attainment status of existing and recommended use designations (WWH and EWH) for the Scioto River, Olentangy River, and Alum Creek based on data collected by Ohio EPA, 1996.

RIVER MILE Fish/Macro.	IBI	Mod. Iwb	ICI[b]	QHEI	Use Attainment Status[a]	Comments
Scioto River(1996)						
		Eastern Corn Belt Plains - WWH Use Designation				
145.0[B]/144.8	49	10.1	G	83.0	FULL	Ust. Griggs Reservoir
144.5[B]/144.54	35*	8.6	F*	69.0	PARTIAL	Griggs Res.-Impounded/Ust. Overflow
-- /144.52	--	--	F*	--	(PARTIAL)	Griggs Res.-Impounded/Dst. Overflow
142.8[B]/ --	35*	8.7	--	62.0	(PARTIAL)	Griggs Res.-Impounded
140.0[B]/ --	35*	8.2[ns]	--	59.0	(PARTIAL)	Griggs Res.-Impounded
138.6[B]/ --	42	9.5	--	70.5	(FULL)	Dst. Griggs Reservoir
136.2[B]/136.3	50	10.4	48	75.0	FULL	5th Ave.
133.3[B]/133.4	48	9.6	E	69.0	FULL	Dst. Dublin Rd. WTP Dam
133.0[B]/	41[ns]	9.6	--	68.0	(FULL)	Ust. Olentangy River
		Eastern Corn Belt Plains - MWH Use Designation				
131.8[B]/	35	8.3	--	39.0	(FULL)	Dst. Olentangy R.-Impounded
		Eastern Corn Belt Plains - WWH Use Designation				
129.1[B]/129.0	50	11.1	22*	72.5	PARTIAL	Greenlawn Ave -Whittier St.CSO
-- /128.4[mz]	--	--	*VP/P*	*N/A*	*N/A*	*Techneglas Mixing Zone*
127.5[B]/127.8	48	9.1	18*	65.5	PARTIAL	Frank Rd.
127.2[B]/127.0[mz]	*34*	*9.1*	*VP/VP*	*N/A*	*N/A*	*Jackson Pike Mixing Zone*
126.5[B]/126.5	44	10.4	22*	82.0	PARTIAL	Dst. Jackson Pike WWTP
123.5[B]/123.2	40[ns]	10.4	32[ns]	70.5	FULL	Dst. I-270, Big Creek
119.0[B]/119.3	45	10.8	36	85.5	FULL	SR 665-Recovery
118.3[B]/118.3[mz]	*35*	*9.6*	*VP/P*	*N/A*	*N/A*	*Col. Southerly Mixing Zone*
118.1[B]/117.3	47	10.4	46	75.0	FULL	Dst. Col. Southerly WWTP
117.1[B]/ --	45	10.4	--	80.0	(FULL)	Dst. Big Walnut Creek
116.3[B]/116.3	48	10.9	40	87.5	FULL	Dst. Picway EGS
113.8[B]/114.0	44	10.8	44	80.5	FULL	SR 762
109.2[B]/109.4	43	10.9	54	81.5	FULL	SR 316
107.4[B]/ --	43	10.9	--	72.0	(FULL)	Ust. Walnut Creek
		Eastern Corn Belt Plains - WWH/EWH Use Designation (Existing/Recommended)				
105.9[B]/106.0	48	11.1	48	86.0	FULL/FULL	Dst. Walnut Creek
105.2[B]/ --	41[ns/*]	10.7	--	73.0	(FULL/PARTIAL)	Dst. Walnut Creek

Table 1. continued.

RIVER MILE Fish/Macro.	Mod. IBI	Iwb	ICI[b]	QHEI	Use Attain-ment Status[a]	Comments
Scioto River (1996)						
						Eastern Corn Belt Plains - WWH/EWH Use Designation (Existing/Recommended)
102.0B/102.0	49	10.3	54	76.0	FULL/FULL	Commercial Point Rd.
100.0B/100.0	47-/ns	10.7	56	87.5	FULL/FULL	SR 22-at Circleville
99.7B/ --	47-/ns	10.5	--	85.5	(FULL/FULL)	Dst. CCA
98.9B/ --	47-/ns	10.8	--	92.0	(FULL/FULL)	Dst. Circleville WWTP
97.9B/ --	51	11.0	--	85.5	(FULL/FULL)	Dst. Old Canal Dam
Olentangy River (1996)						
						Eastern Corn Belt Plains - WWH Use Designation
0.7B/0.6	43	9.5	30*	66.0	PARTIAL	Ust. MWH-free flowing
Alum Creek (1996)						
						Eastern Corn Belt Plains - EWH/WWH Use Designation (Existing/Recommended)
44.1W/44.0	49ns/ -	8.5*/ -	50	63.0	PARTIAL/FULL	West Liberty Rd.
42.8W/42.7	45*/ -	9.0ns/ -	48	81.0	PARTIAL/FULL	Myers Rd.
						Eastern Corn Belt Plains - WWH Use Designation
26.3W/26.2	40	8.6	44	75.0	FULL	Lewis Center Rd.-Dst.Reservoir
23.8W/24.0	42	8.3	40	58.0	FULL	Worthington Galena Rd.
22.6W/22.5	43	7.9ns	40	57.5	FULL	Cleveland Ave.-Dst Polaris
19.8W/19.8	45	8.9	42	77.5	FULL	Shrock Rd.
17.4W/17.3	38ns	7.7*	34ns	74.0	PARTIAL	Ust. Huber Ridge WWTP
17.2W/17.2mz	*40*	*9.0*	*P/P*	*N/A*	*N/A*	*Huber Ridge Mixing Zone*
15.4W/15.3	43	8.4	38	62.5	FULL	Morse Rd.-Dst HR WWTP
13.5W/13.5	36ns	7.9ns	34ns	75.5	FULL	Innis Rd., Suburban
9.2B/ --	28*	8.0ns	--	52.0	(PARTIAL)	Dst. Am. Ditch-Impounded, Urban
-- /8.6	--	--	<u>10</u>*	--	(**NON**)	Dst. Am. Ditch-Urban
7.5B/7.6	37*	9.2	20*	56.5	PARTIAL	Wolf Park-Ust. CSO, Urban
6.6B/6.2	35*	8.7	30*	52.5	PARTIAL	Livingston Ave.-Dst. CSO, Urban
3.9B/3.8	32*	9.0	28*	55.5	PARTIAL	Refugee Rd.-Urban
0.8B/0.7	38ns	9.2	42	67.0	FULL	Mouth

Table 1. continued.

RIVER MILE Fish/Macro.	IBI	Mod. Iwb	ICI[b]	QHEI	Use Attain-ment Status[a]	Comments
West Branch Alum Creek (1996)						
		Eastern Corn Belt Plains - WWH Use Designation				
0.6[W]/0.7	45	9.2	52	76.0	FULL	Worth.-New Haven Rd.

* -Significant departure from ecoregion biocriterion; poor and very poor results are underlined.
ns -Nonsignificant departure from biocriterion (≤4 IBI or ICI units; ≤0.5 MIwb units).
a -Use attainment status based on one organism group is parenthetically expressed.
b -Narrative evaluation based on qualitative benthic macroinvertebrate sample (E-exceptional, G-good, F-fair, P-poor, and VP-very poor).
W -Wadable fish sampling station.
B -Boatable fish sampling station.
MZ -Samples collected within the 001 mixing zone (biocriteria do not apply).

Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)
(OAC 3745-1-07, Table 7-14)

INDEX - Site Type	WWH	EWH	MWH[d]
IBI - Wading	40	50	24
MIwb - Wading	8.3	9.4	6.2
IBI - Boat	42	48	24
MIwb - Boat	8.5	9.6	5.8
ICI	36	46	22

d - Modified Warmwater Habitat for channelized habitats/impounded habitats.

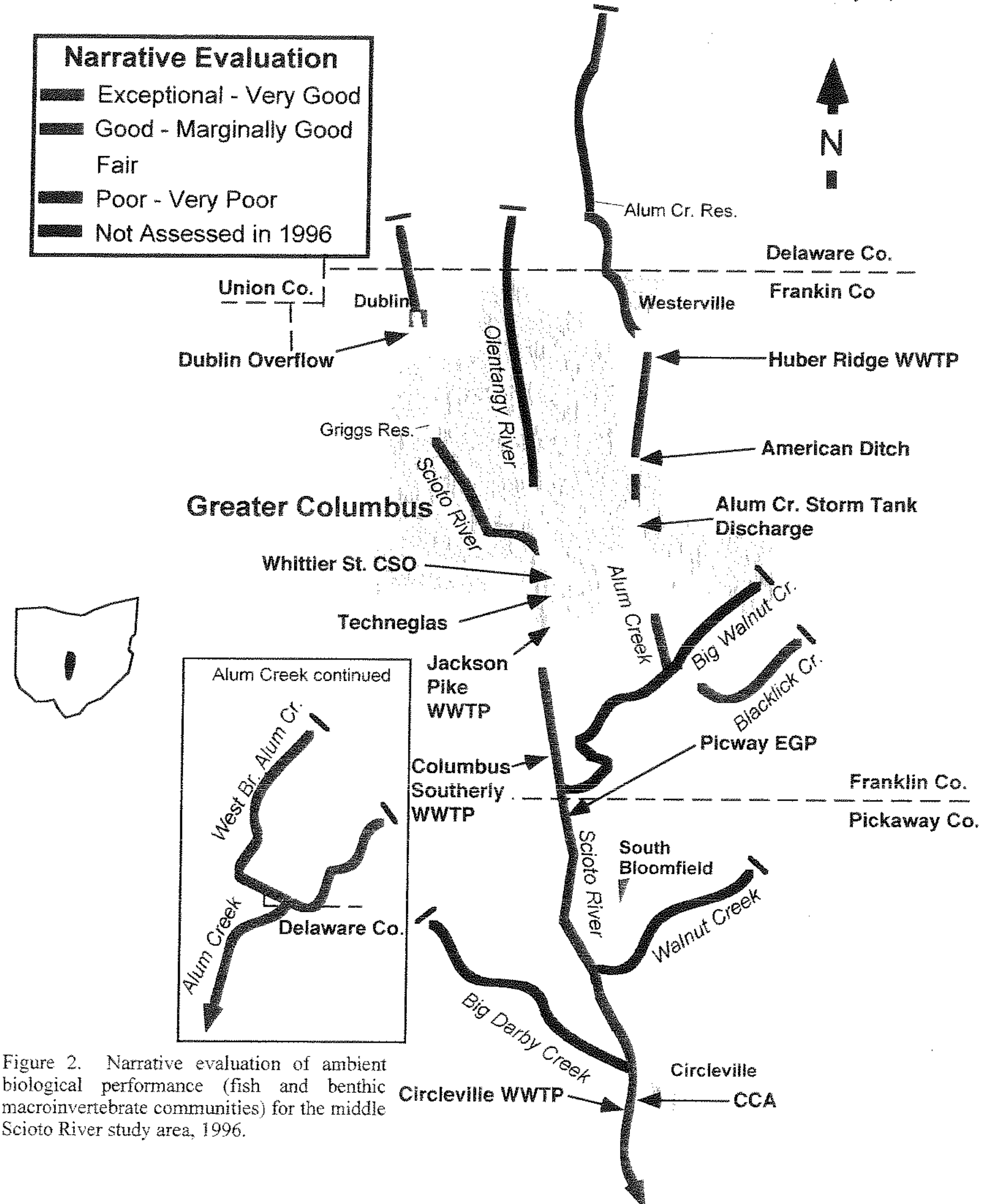


Figure 2. Narrative evaluation of ambient biological performance (fish and benthic macroinvertebrate communities) for the middle Scioto River study area, 1996.

Departure from the interim WWH biocriteria within the Griggs dam pool was attributed entirely to the modified habitat quality associated with large impoundments. No significant negative effects were evident downstream from the Dublin sanitary sewer overflow. Nearly every chemical and bacteriological measure indicated similar water quality up and downstream from the point of discharge. Exceedences of the Water Quality Standard (WQS) criteria below the overflow were limited to D.O. concentrations lower than the daily average WWH criterion. However, these values are likely reflective of the lentic environment--rather than an enrichment effect associated with the release of untreated sewage--as samples were collected from the static, warm, and shallow littoral zone of the upper reach of the Griggs dam pool. Qualitative benthic macroinvertebrate samples were collected immediately up and downstream from the outfall. Both stations were placed within the impoundment to remove any habitat bias (i.e., lentic vs. lotic). The results from this effort found nearly identical macroinvertebtrate communities at both stations. Although both stations supported simple benthic macroinvertebrate communities, typical of impoundments, a sewage impact was not indicated. The results from the fish sampling effort were largely confounded by contrasting macrohabitats between the two stations bracketing the discharge. The upstream station (RM 145.0) was located within the free flowing portion of the Scioto River, while the downstream station (RM 144.5) was contained within the upper limits of the impoundment. The compelling habitat differences (lotic vs. lentic) excluded a meaningful comparison of the fish assemblages between the two sites.

The remaining area of partial attainment, located between RM 129.2 (Greenlawn Ave./Whittier St. CSO) and RM 123.6 (downstream I-270), receives treated effluent and combined sewer discharges (overflow events) primarily from the Whittier St. CSO, Techneglas, and the Jackson Pike WWTP. Impairment of the WWH aquatic life use throughout this reach was driven entirely by fair performance of the benthic macroinvertebrate community, as the fish sampling consistently yielded results that met or surpassed the WWH biocriteria. The diversity, structure, and functional organization of the benthic macroinvertebrate community was indicative of significant organic enrichment at all non-mixing zone stations within this segment. The Whittier St. CSO was identified as the principal associated stressor, with the Jackson Pike WWTP considered secondary. At worst it appeared as though the wasteload from this facility maintained the existing impact, delaying downstream recovery. Although toxicity was indicated within the Techneglas mixing zone, there appeared no far field effect beyond that associated with the CSO.

The performance of the chemical and bacteriological indicators within this segment were not indicative of *gross* pollutant loadings; however, in comparison with background levels and/or regional norms many analytes were highly elevated. BOD and ammonia-N displayed marked increases immediately downstream from the Whittier St. CSO, likely indicating sewage overflows events. Additionally, copper, zinc, and lead were elevated, often exceeding the regional reference values, within and downstream of the greater Columbus metropolitan area. Actual exceedences of the Ohio WQS criteria (aquatic life and recreational) within this reach were few, and limited to fecal coliform and lead at RM 129.0. The level of bacteriological contamination was low, and similar to that documented upstream within unimpacted areas. Only one of six water samples collected at this station found lead at a concentration greater than criterion for the prevention of chronic toxicity. Although chemical, physical, and bacteriological indicators were reflective of CSOs and general urban runoff (elevated metals, demand, and nutrient parameters), serious impacts to the integrity of the water column were not indicated (i.e., pervasive bacteriological contamination, depressed D.O. regime, etc.).

The detrimental effects of pollutant loads within this reach were exacerbated by a combination of factors, mainly regulated flows and historically modified channel conditions. Water withdrawals by the city of Columbus at RM 133.5 (Dublin Rd. WTP dam) coupled with the regulated discharge of the Olentangy River and two impoundments upstream from Greenlawn Ave., deny the affected reach of the Scioto River sufficient assimilative/dilutional flows. Compounding the problem of diminished flow, are the highly artificial channel characteristics of this segment. The river is exceedingly wide and unusually deep downstream from the Whittier St. CSO for a distance of approximately 1.5 miles. During dry weather periods, the combined effects of upstream water withdrawals, impoundments, and past channel modification reduces this portion of the Scioto River, in effect, to a series of wide and deep pools. The lack of sufficient dilutional flow, coupled with the modified channel configuration, results in an extremely long turnover rate. Within this reach organic material and nutrients from the CSOs, urban runoff, and even agricultural sources upstream can become concentrated, resulting in an enriched aquatic environment. The fair condition of the macrobenthos within this reach appeared reflective of this suite of factors, in that the response signature indicated organic enrichment.

The remaining portions of the middle Scioto River were found to support fish and benthic macroinvertebrate communities fully consistent with, and at some stations well in excess of, the WWH biocriteria. Impairment of the aquatic life use was not associated with any of the remaining entities evaluated as part of the 1996 survey. Fully exceptional aquatic communities were typically encountered throughout the lower 8.1 miles of the study area.

Lower Olentangy River

The lower Olentangy River was evaluated at one sampling station at RM 0.7/0.6. The station was placed at this location to evaluate aquatic life use attainment for the lower free flowing (WWH designated) portion. The results from the 1996 survey indicated partial attainment of the WWH use. Impairment at this site was driven entirely by fair performance of the benthic macroinvertebrate community, as the fish sampling yielded results that met the WWH standard. The diversity, structure, and functional organization of the benthic fauna was suggestive of moderate toxicity, likely derived from a combination of urban runoff, CSOs, and minor industrial discharges located upstream.

Alum Creek

Excluding the approximately 13.6 mile impoundment formed by the Alum Creek reservoir, a total of 30.5 miles of Alum Creek was sampled and assessed as part of the 1996 survey. The effort included an aggregate total of 37 biological, chemical/physical, and sediment sampling stations, encompassing the mainstem from RM 44.1 (upstream from Alum Creek reservoir) to RM 0.8/0.7 (near the mouth). Additionally, the West Branch Alum Creek was sampled at one station located 0.6 miles upstream from its confluence with the mainstem. A portion of the 1996 study area was surveyed and assessed in 1986.

Two aquatic life use designations are currently in effect for Alum Creek and its principal tributary. The stream reach extending from the headwaters to the upper limits of the impoundment formed by the Alum Creek reservoir is currently designated EWH. The remaining segment of the mainstem, as well as the West Branch, are currently designated WWH.

Results from the 1996 biosurvey found 21.0 miles (68.9%) of the Alum Creek mainstem in full attainment of existing aquatic life uses. Partial attainment was indicated for 8.5 miles (27.8%) and non-attainment for the remaining 1.0 mile (3.3%). Areas of use impairment (partial and non-attainment) were limited to three stream segments. The first was located within the upper limits of the study area, contained entirely within the EWH designated segment, upstream from the Alum Creek reservoir. The second was located between RM 17.4 and RM 17.1 (immediately upstream from the Huber Ridge WWTP). The remaining and most significant impaired reach flows through the highly urbanized portions of east and southeast Columbus, between RM 9.2 and RM 3.8.

Impairment of the existing EWH aquatic life use within the upper limits of the study area was not the result of poor water quality or any other obvious stressor. On the contrary, ambient biological performance was typically in the good to very good range, macrohabitat quality was also very good, and no exceedences of chemical WQS criteria were observed. The communities (fish and benthic macroinvertebrate) typically performed above the WWH criteria, but were not fully exceptional. These data indicate that this reach, though high in quality, is not truly exceptional and therefore should be redesignated to the more appropriate WWH aquatic life use. The ramifications on the attainment status statistics for Alum Creek based upon the recommended WWH designation are further detailed in the Recommendations section.

Progressing downstream, the second area of aquatic life use impairment included only a small segment of Alum Creek (0.3 miles), located immediately upstream from the Huber Ridge WWTP, between RM 17.4 and 17.1. Within this reach, both the IBI and ICI remained within nonsignificant departure from the WWH criteria. Impairment (partial attainment) was driven solely by subpar performance of the MIwb. This index indicated a level of structural evenness within the fish community just below the minimum WWH criterion. The departure was very modest--deviating only 0.1 units--and did not appear to constitute a significant impact. Water quality at this site was considered good, as WQS criteria exceedences were limited to a few fecal coliform counts greater than the average PCR criterion. Ultimately, partial attainment through this reach was attributed to background stressors (urban/suburban and nonpoint sources and possibly habitat influences).

The remaining, and most significant, impaired segment of Alum Creek flows through the highly urbanized area of east and southeast Columbus, beginning at approximately RM 9.2 (downstream from American Ditch--Nelson Park dam pool) and extending downstream to RM 3.9/3.8 (Refugee Rd.--partially impounded). Largely channelized and frequently impounded by numerous, small lowhead dams, this segment exhibited obvious habitat limitations, as QHEI scores ranged between the mid and low 50s. Additional stressors present within this reach included urban runoff, the Alum Creek storm tank discharge, numerous minor CSOs, and to a lesser extent, runoff from the now defunct ASARCO complex (via American Ditch). In comparison with the less impacted stations upstream, community performance was depressed throughout, and was characterized by a high proportion of environmentally tolerant taxa, low taxa richness and elevated to highly elevated incidence of Deformities, Eroded fins/barbels, Lesions, and Tumors (DELT) anomalies within the fish assemblage. Chemical water quality indicators were also characteristic of the various associated stressors. The frequency and magnitude of fecal coliform exceedences increased significantly in comparison with the less impacted areas, with values greater than the SCR criterion observed. Also, D.O. concentrations as low as 2.5 mg/l (well below the 4.0 mg/l WWH minimum criterion) were documented. Although the Alum Creek storm tank discharge is the largest discrete pollution source, other factors also contributed to the degraded conditions observed. As stated above, modified habitat (channelized and impounded), urban runoff, and minor CSOs were pervasive influences throughout this segment.

Macrohabitat and water quality were significantly advanced near the Big Walnut Creek confluence. Full biological recovery was indicated at RM 0.8/0.7 (Watkins Rd.). All other intervening segments were found to support fish and benthic macroinvertebrate communities fully consistent with the WWH biocriteria. In particular, no impairment was evident downstream from the Huber Ridge WWTP.

Community performance within the West Branch Alum Creek was characterized as good to very good. The station located at RM 0.6/0.7 (Worthington New Haven Rd.) supported a diverse, functionally and structurally well organized assemblage of aquatic organisms, fully consistent with the WWH biocriteria.

Trend Assessment

Scioto River

A comprehensive survey of the fish assemblage of the middle Scioto River (Columbus to Circleville) has been performed nearly every year by the Ohio EPA since 1979. The purpose has been to track annual changes and to document annual variability in the recovery and status of an effluent dominated river. This nearly continuous effort provides an excellent opportunity to evaluate meaningful changes in environmental conditions of the middle Scioto River, as reflected in ambient water quality and the composition of the aquatic fauna, over the past 18 years. The majority of this historical effort was limited mainly to the monitoring and assessment of the fish community. However, comprehensive monitoring (involving multiple ambient indicators--chemical, physical, and biological) was undertaken for the years: 1979, 1980, 1981, 1986, 1988, 1991, and 1996. For the purposes of comparability, the analysis of trends will include the river reach between RM 136.2 (5th Ave.) and RM 100.0 (SR 22, at Circleville). Although this segment is smaller than the 1996 effort, much of these historical data have been collected from this portion of the middle Scioto River.

The results from the earliest intensive survey, which pooled data collected between 1979 and 1982, found significant use impairment for the river segment from the Greenlawn Ave. Dam (RM 129.6) to RM 102.0 (Commercial Point Rd.) (Ohio EPA 1986). Within this 27.6 mile reach the Whittier St. CSO (immediately downstream from the Greenlawn Ave. Dam), Jackson Pike WWTP, and the Columbus Southerly WWTP (including direct plant bypasses from both facilities) were all identified as the principal associated stressors. Chemical and physical water quality measures at that time were characteristic of the influence of large municipal wastewater treatment facilities--highly elevated to elevated concentrations of ammonia-N, BOD, and phosphorus, and significant bacteriological contamination. The effects of excessive loads of oxygen demanding waste and nutrients from the sources identified above were clearly reflected in the D.O. regime, which displayed the classic longitudinal pattern of decline and recovery downstream from both WWTPs. Instream biological performance was indicative of significant water quality impacts and was well correlated with the chemical water quality indicators (Ohio EPA 1986). Degraded conditions largely persisted within this portion of the Scioto River throughout the early 1980s. Incremental improvements were evident in the mid to late 1980s, although full attainment had yet to occur. These modest improvements were largely associated with improved sludge handling at the Columbus Southerly WWTP (Ohio EPA 1986).

Following treatment process upgrades, the implementation of pretreatment programs, and other process and/or operational improvements initiated at the Jackson Pike and Columbus Southerly WWTPs, ambient water quality and biological conditions of the Scioto River were significantly advanced. These activities were implemented by the City of Columbus to comply with the more stringent water quality standards set forth in the National Municipal Policy, contained within the

1984 CWA amendments. The issuance of NPDES permits, the awarding of funds for treatment improvements, and eventual compliance directly resulted in a significant reduction in the loading of oxygen demanding wastes, nutrients (excluding nitrate+nitrite-N), ammonia-N, and selected heavy metals to the Scioto River, with commensurate improvement in ambient biological performance.

By 1991 over 80% of the historically sampled portion of the middle Scioto River was found to contain fish and benthic macroinvertebrate communities fully consistent with the WWH biocriteria. Use impairment (partial and non-attainment) still persisted within the reach downstream from the Whittier St. CSO, although the length and magnitude was reduced to 5.6 miles. Furthermore, the obvious impacts associated with the Jackson Pike and Columbus Southerly WWTPs were largely ameliorated. As the gross pollution problems identified in the past were rectified at these WWTPs, the periodic discharge of untreated sewage from the Whittier St. CSO was left as the most prominent source of aquatic life use impairment. The influence of the Jackson Pike WWTP (located approximately two miles downstream) appeared only to protract the recovery process (Ohio EPA 1993).

The results from the 1996 survey indicated additional improvement in comparison with the 1992 assessment. The same 5.6 mile stretch of the Scioto River, downstream from the Whittier St. CSO remained impaired; however, the severity of impact was further reduced. Poor and very poor community performance documented in 1991 was improved to fair, upgrading the beneficial use status from non-attainment in 1991, to partial attainment in 1996. Moreover, the fish community appeared fully recovered in 1996, as the impact from the Whittier St. CSO was largely delineated by the macrobenthos. This positive trend is succinctly summarized and quantitatively described by the Area of Degradation Value (ADV) statistics generated for ambient biological data collected from the middle Scioto River between 1980 and 1996 (Figure 3).

The significant positive changes in the environmental conditions of the middle Scioto that have occurred over the past 18 years are truly remarkable. The initial use attainability analysis, developed in support of more stringent NPDES limits for the Jackson Pike and Columbus Southerly WWTPs, clearly stated that given sufficient pollution controls, the middle Scioto River would be fully capable of supporting communities of aquatic organisms consistent with the WWH aquatic life use designation (Ohio EPA 1986). It is important to consider that the assessment of the biological potential (use attainability analysis) was made at a time when the vast majority of the middle Scioto River (within and downstream from Columbus) was significantly impaired by excessive pollutant loadings, reflected in highly degraded water quality and depauperate aquatic communities. In addition, effluent dominated nature of this situation lead to speculation that the mainstem was simply overwhelmed by wastewater which lowered restorative expectations. The results to date from the intensive sampling efforts on the middle Scioto River fully validate both the attainability of the WWH aquatic life use and the appropriateness of the existing effluent limits for the major treatment facilities operated by the City of Columbus. These decisions and subsequent compliance activities have yielded significant, meaningful and measurable improvements to the water resource of the middle Scioto River which now supports the various designated beneficial uses through the majority of the 1996 study area. Moreover, in the lower ten miles of the 1996 study area, biological performance has been consistent with the EWH biocriteria since 1991, indicating the realization of the true potential of the Scioto River.

Lower Olentangy River

Much historical data have been collected from the lower portion of the Olentangy River over the past nine years. However, station placement, in particular discrepancies between fish and benthic macroinvertebrate stations has, in the past, confounded previous assessments--in terms of using multiple organism groups to determine the appropriateness and attainment status of designated aquatic life uses. In the past, fish community samples were collected from the portion of the lower Olentangy pooled by the segment of the Scioto River impounded by the Town St. Dam, from approximately RM 0.6 to the Scioto River confluence. This segment is currently designated MWH, in recognition of the limited physical habitat caused by the impoundment. In contrast, the benthic macroinvertebrate sampling has been consistently performed within the free flowing, WWH designated portion, between approximately RM 0.6 and RM 0.8. Given the contrasting habitat potentials of each segment, linking each sample (fish and macrobenthos) was precluded. As such trends in water quality, reflected in ambient biological conditions were evaluated solely upon the performance of the benthic macroinvertebrate community through time. The condition of the benthic macroinvertebrate community has improved, from very poor (ICI=12) in 1991 to fair (ICI=30) in 1996. The cause for improvement may include the elimination of a sewage discharge from the state fairgrounds, removal (by the City of Columbus) of illegal sanitary tie-ins to the storm sewers along the Olentangy River, and a reduction in spill events from Capital City Products located upstream.

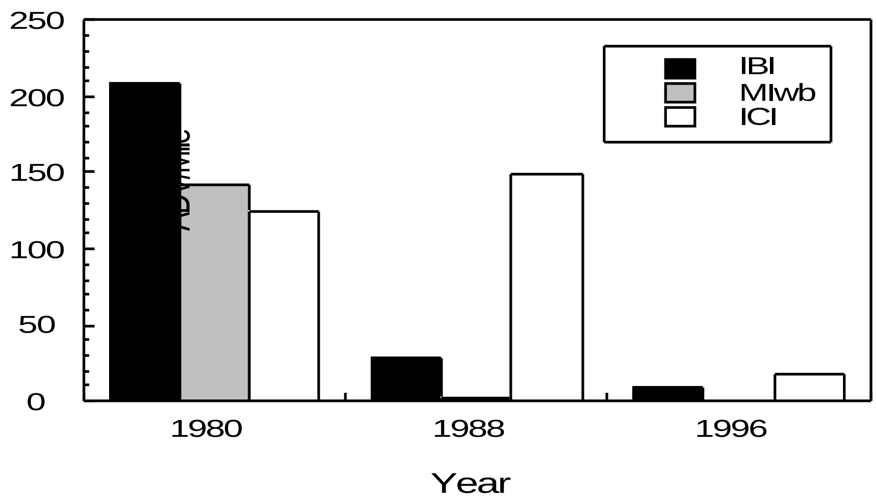


Figure 3. Area of Degradation Value (ADV) statistics for the Index of Biotic Integrity (IBI), Modified Index of well-being (MIwb), and Invertebrate Community Index (ICI) from the middle Scioto River, 1980 through 1996. These data were derived from the river reach between RM 136.2 (5th Ave.) and RM 100.0 (SR 22, at Circleville).

Alum Creek

Multiple data sets were employed to characterize ambient environmental conditions of Alum Creek since the late 1970s. Intensive surveys (i.e., the use of multiple ambient indicators) were performed in 1986 and 1996. The 1986 effort evaluated the stream reach between RM 18.1 (upstream from the Huber Ridge WWTP) and RM 0.8 (Watkins Rd.). The sampling effort was limited to the lower half of Alum Creek, evaluating the Huber Ridge WWTP, the Alum Creek Storm Tank (CSO), the residual effects from ASARCO (via American Ditch), and pervasive urban runoff and habitat stressors through the lower ten miles. The 1996 effort was more robust and evaluated the entire mainstem of Alum Creek from the headwaters at RM 44.1 (West Liberty Rd.) to near its confluence with Big Walnut Creek at RM 0.8 (Watkins Rd.), and its principal tributary (West Branch Alum Creek). Monthly ambient chemical/physical monitoring has been performed at RM 6.6 (Livingston Ave.) between 1990 and 1996. Finally, prior to 1986 small chemical/physical water quality surveys were performed between 1974 and 1976. These efforts were very limited in scope, and evaluated water quality downstream from the Huber Ridge

WWTP into Columbus. For the purposes of comparability, the analysis of trends will include the segment of Alum Creek between approximately RM 18.1 and RM 0.8. Although this segment is smaller than the entire 1996 effort, much of these historical data have been collected from this portion of Alum Creek.

Between 1974 and 1976 the typical suite of water quality parameters associated with municipal sewage (e.g., ammonia-N, phosphorus, nitrate+nitrite-N, BOD, and TSS) were elevated to highly elevated downstream from the Huber Ridge WWTP. BOD was elevated within the lower, urbanized reach.

The results from the 1986 intensive survey indicated improvements in the chemical water quality of Alum Creek. Significant reductions in ammonia-N, nitrate+nitrite-N, phosphorus, and BOD were documented in comparison with previous survey results. Despite the pattern of overall improvement, water quality remained impacted downstream from the Huber Ridge WWTP. Numerous D.O. violations were observed for a distance of 2.7 miles downstream from the Huber Ridge WWTP, with individual values near or below 2.0 mg/l (Ohio EPA 1988). Additionally, instream ammonia-N values, though lower than previously documented, were elevated in comparison with upstream results, with concentrations greater than 2.0 mg/l.

Instream biological performance was well correlated with the chemical water quality indicators, as all 1986 biological sampling stations failed to support an assemblage of aquatic organisms consistent with the WWH biocriteria. Partial and non-attainment were indicated downstream from the Huber Ridge WWTP. Use impairment persisted through the remaining downstream segment of the study area, with an additional decline downstream from the Alum Creek Storm Tank discharge (Ohio EPA 1990). Modified habitat (channelization and impoundment) and urban runoff were identified as additional stressors.

In comparison with the results of the 1986 survey, considerable improvement in the environmental conditions of the lower portion of Alum Creek, as reflected by ambient chemical and biological indicators, was indicated in 1996. The reach historically impacted by the Huber Ridge WWTP was fully recovered, following treatment process upgrades implemented at the facility. The impacts associated with the Alum Creek Storm Tank and urban runoff, further downstream, were still apparent, although reduced both in term of magnitude and severity. Full recovery of the WWH aquatic life use for 9.4 miles (51.9%) of the historically sampled reach was indicated. These improvements were largely realized downstream from the Huber Ridge WWTP.

CONCLUSIONS

Scioto River

- As a result of treatment process upgrades, improvements to the collection system, and the implementation of an industrial pretreatment program at the Jackson Pike WWTP and Columbus Southerly WWTP, significant meaningful and measurable improvements in the chemical, physical, and biological integrity of the middle Scioto River have been realized. The 1996 survey documented reduced loadings of nutrients, oxygen demanding wastes, and metals from these wastewater treatment facilities, with commensurate improvements in the ambient water quality and instream biological performance within and downstream from the Columbus metropolitan area. Conditions have so improved that exceptional biological assemblages were indicated for the lower 8.4 miles of the study area.

- Impairment of the WWH aquatic life use still persists for approximately five miles downstream from the Whittier St. CSO. Although the magnitude and severity of the impairment appeared substantially reduced in comparison with previous assessments--evidenced by full recovery of the fish community, and generally good performance of most chemical/physical and bacteriological indicators--the macrobenthos still clearly defined an organic enrichment impact in 1996. While actual WQS criteria exceedences were few, highly elevated BOD and ammonia-N were indicated immediately downstream from the Whittier St. CSO. These data were indicative of the periodic release of untreated sewage/storm water. Additionally, selected metals were found at elevated concentrations within and downstream from the greater Columbus area. These likely have similar antecedents (i.e. ,urban runoff and CSO releases). However, at all non-mixing zone stations the level of metals contamination did not appear sufficient to elicit a toxic response within the benthic macroinvertebrate community. The structure and functional organization of this assemblage was indicative of organic enrichment, not toxicity associated with heavy metals. Moreover, it is important to reiterate that the fish community consistently performed at a WWH level throughout this reach. Ultimately, full recovery of this segment is contingent on the abatement of overflow events from the Whittier St. CSO *and* the maintenance of minimal assimilative/dilutional stream discharge during the critical low flow of the summer months, the latter being the most limiting factor at present.

- No far field impact was evident downstream from Techneglas Inc. in 1996. Although benthic macroinvertebrate sampling indicated a toxic response within the mixing zone, far field conditions were not attributable to this facility. The overriding influence of the Whittier St. CSO, coupled with regulated river discharge and modified channel features were identified as the principal associated stressors. Techneglas may be culpable for the elevated concentrations of selected metals documented within this portion of the Scioto River. However, pervasive urban runoff and the release of storm water and untreated sewage through the Whittier St.

CSO and other minor relief points within Columbus' collection system are equally probable sources. It is difficult to segregate, with confidence, the various source(s) of metals contamination documented in 1996.

- No significant impact to the Scioto River was attributed to the Dublin sanitary sewer overflow, despite the poor aesthetics observed immediately following bypass events. The performance of the benthic macroinvertebrate community at stations bracketing the outfall was nearly identical. Additionally, nearly every chemical and bacteriological measure indicated similar water quality up and downstream from the point of discharge (e.g., BOD, ammonia-N, and TSS). In particular, bacteriological measures were actually improved downstream from the release point. Several exceedences of the 24-hour average D.O. criterion were indicated within the reach affected by the overflow; however, these results were attributed to the lentic condition of the upper limits of the Griggs dam pool, rather than an enrichment effect associated with the release of untreated sewage.

Lower Olentangy River

- Impairment of the WWH designated lower Olentangy River was driven entirely by fair performance of the benthic macroinvertebrate community, as the fish community sampling yielded results fully consistent with the WWH standards. The diversity, structure and functional organization of the macrobenthos was suggestive of modest toxicity, possible reflective of the numerous CSOs, SSOs, and minor permitted discharges located upstream.

Alum Creek

- As a result of treatment process upgrades implemented at the Huber Ridge WWTP, meaningful and measurable improvements in the chemical, physical, and biological integrity of Alum Creek have been realized. The 1996 survey documented reduced loadings of nutrients and oxygen demanding wastes from this facility, with commensurate downstream improvements in the ambient water quality and instream biological performance. Full recovery of the approximately eight mile segment historically impaired by the Huber Ridge WWTP was documented in 1996.

- In comparison with previous assessments, impairment of the WWH use still persists through the lower portion of Alum Creek, contained within the highly urbanized area of east and southeast Columbus. Largely channelized and impounded by numerous, small lowhead dams, this segment exhibited obvious habitat limitations. Significant, non-habitat stressors, included pervasive urban runoff, the release of untreated sewage from the Alum Creek stormtank discharge (and other minor CSOs), and, to a lesser extent, runoff from the now defunct ASARCO complex (via American Ditch). This suite of factors (CSOs, urban runoff, and habitat modification) rendered the WWH aquatic life use impaired. Poor to fair performance of the fish and benthic macroinvertebrate communities within this reach were well correlated with chemical/physical and bacteriological indicators. Low D.O., including violations of the 4.0 mg/l WWH minimum criterion, and pervasive bacteriological contamination were indicated throughout this segment.

- Full recovery was indicated for approximately the remaining three miles, as ambient biological performance was advanced to full attainment status. The frequency of WQS criteria exceedences were reduced, limited to one fecal coliform count greater than the SCR standard, and adequate D.O. concentrations were maintained.

- Full attainment of the WWH aquatic life use was indicated within the previously unassessed West Branch Alum Creek. Community performance was in the very good range, fully consistent with riparian and instream habitat and ecoregional potential.

RECOMMENDATIONS

Status of Aquatic Life Uses

Many streams and rivers in the state were originally designated for aquatic life uses in the 1978 and 1985 Ohio Water Quality Standards. The techniques used then did not include standardized approaches to the collection of instream biological data or numerical biological criteria. This study represents the appropriate use of this type of biological data to evaluate and establish aquatic life use designations. While some of the changes may appear to constitute "downgrades" (*i.e.*, EWH to WWH, WWH to MWH, etc.) or "upgrades" (*i.e.*, LWH to WWH, WWH to EWH etc.), any changes should not be construed as such because this constitutes an objective and robust use evaluation system. Ohio EPA is under obligation by a 1981 public notice to review and evaluate all aquatic life use designations outside of the WWH use prior to basing any permitting actions on the existing, unverified use designations. Thus some of the following aquatic life use recommendations constitute a fulfillment of that obligation. The beneficial use designation matrix for the middle Scioto River study area is presented in Table 2.

The following segments of the middle Scioto River, Alum Creek, and lower Olentangy River evaluated in 1996 are recommended to retain their existing aquatic life use designations, as specified in the Ohio Water Quality Standards (OAC 3745-1-07).

Scioto River (mainstem)

- SR 161, RM 145.1 to Olentangy River confluence, RM 132.3 (WWH-existing)

- Olentangy River confluence, RM 132.3 to Greenlawn dam, RM 129.6 (MWH-existing)

- Greenlawn dam, RM 129.6 to Walnut Creek confluence, RM 106.1 (WWH-existing)

Olentangy River
- 5th Ave. dam, RM 1.9 to Conrail R&R crossing, RM 0.5 (WWH-existing)
- Conrail R&R crossing, RM 0.5 to Scioto River confluence (MWH-existing)

Alum Creek
- Alum Creek Reservoir spillway, RM 26.7 to the mouth (WWH-existing)

West Branch Alum Creek
- Entire length (WWH-existing)

The following segments of the Scioto River and Alum Creek evaluated as part of the 1996 middle Scioto River survey are recommended for redesignation, as specified in the Ohio Water Quality Standards (OAC 3745-1-07). The affected river/stream segments, justification for the use change, and ramifications on use attainment statistics are detailed below.

Scioto River
Affected Segment
- Walnut Creek confluence, RM 106.1 to Penn. Central R&R bridge RM 97.7 (WWH-existing/EWH recommended)

Environmental conditions of the middle Scioto River have improved considerably through time. The results from the 1996 survey found more than 70% of the miles assessed in full attainment of the WWH use. Biological recovery in the lower reaches of the study area has, in fact, advanced to the point that most stations now support aquatic communities of an exceptional nature. The substantial improvement of the middle Scioto River was primarily a result of treatment advances implemented by the City of Columbus at both the Jackson Pike and Columbus Southerly WWTPs. This significant pollution abatement effort coupled with the fact that much of the Scioto River downstream from Columbus contains a full compliment of high quality habitat features has allowed recovery of this magnitude to occur. This positive trend is most pronounced within the lower limits of the 1996 study area. In particular, the reach extending downstream from the Walnut Creek confluence (RM 106.1) to the abandoned Penn Central R&R bridge (RM 97.7) has consistently demonstrated the ability to support diverse and well organized assemblages of aquatic organisms, fully consistent with the EWH use designation. Additionally, several environmentally sensitive, threatened, rare or endangered fish species are now frequently encountered throughout this segment (e.g., bluebreast darter, tippecanoe darter, and spotted darter). Given that the lower portion of the middle Scioto River is now performing at, or very near its biological potential, it is therefore recommended that this segment, currently designated WWH, be redesignated to the more appropriate and representative EWH aquatic life use. Aggregate attainment statistics for the Scioto River mainstem, based upon the recommended

EWH aquatic life use are: 32.4 miles (68.8%) full attainment and 14.7 miles (31.2%) partial attainment.

Alum Creek

Affected Segment

- Headwaters to the upper limits of the Alum Creek reservoir (EWH-existing/WWH-recommended).

The EWH aquatic life use was initially imposed on the upper portion of Alum Creek (headwater to the upper limits of the Alum Creek reservoir) in 1978 (WQS; Ohio Administrative Code 3745-1). This designation was made--as many were at that time--without benefit of biological criteria to verify the appropriateness and/or attainability of the beneficial use. The sampling effort put forth in 1996 represented the first verification of the designated use for this reach since that time. The results from the most recent survey indicated that the upper portion of Alum Creek, though high in quality, is not fully exceptional, as each station failed to support an aquatic community fully consistent with the EWH biocriteria. Therefore, it is recommended that the existing EWH segment of Alum Creek be redesignated to the more appropriate WWH aquatic life use. This recommendation and the resultant change in attainment criteria would bring the entire upper segment of Alum Creek into full attainment. Aggregate attainment statistics based upon the recommended WWH aquatic life use are: 24.8 miles (81.3%) full attainment, 4.7 miles (15.4%) partial attainment, and 1.0 miles (3.3%) non-attainment.

Table 2. Existing and recommended beneficial use designations for the middle Scioto River study area.

River/Stream Affected Segment	**Beneficial Use Designations**												
		Aquatic Life Habitat						**Water Supply**			**Recreation**		
	SRW	**WWH**	**EWH**	**MWH**	**SSH**	**CWH**	**LRW**	**PWS**	**AWS**	**IWS**	**BW**	**PCR**	**SCR**
Scioto River													
SR 161 (RM 145.1) to Dublin Rd WTP (RM 133.4)	+	+						+	+	+		+	
Dublin Rd WTP (RM 133.4) Olentangy River (RM 132.3)	+	+							+	+		+	
Olentangy R. (RM 132.3) to Greenlawn Dam (RM 129.8)	+			+					+	+		+	
Greenlawn Dam (RM 129.8) to Frank Rd. (RM 127.7)	+	+							+	+		+	
Frank Rd. (RM 127.7) to Walnut Cr. (RM 106.1)		+							+	+		+	
Walnut Cr. (RM 106.1) to Penn Central R&R (97.7)	+	+	S						+	+		+	
Olentangy River													
5th Ave. Dam (RM 1.9) to Conrail R&R (RM 0.5)		+							*	*		+	
Conrail R&R (RM 0.5) to confluence with Scioto River				+					*	*		+	
Alum Creek													
Headwaters to Alum Creek Reservoir	*/+	S	*						*	*		*/+	
All other segments		*/+							*	*		*/+	
West Branch Alum Creek													
Entire Length		*/+							*	*		*/+	

+ - Designated beneficial use based on the results of an integrated assessment performed by Ohio EPA (verified).
* - Existing beneficial use designation based on the 1985 Ohio WQS.
s - Recommended beneficial use designation based on the results from the 1996 middle Scioto River sampling effort.

Status of Non-Aquatic Life Uses

All non-aquatic life uses (Recreational and Water Supply) should remain as presently designated in the Ohio Water Quality Standards (OAC 3745-1-07).

Future Sampling Needs

A re-evaluation of the areas investigated in 1996 should be conducted in 2002 or 2007 as provided in the modified Five-year Basin Monitoring Approach.

STUDY AREA DESCRIPTION

The Scioto River is a major tributary of the Ohio River. It originates in northwestern Ohio in a depressional area (Scioto Marsh) west of Kenton in Hardin County. Flowing east 60 miles then south 175 miles the Scioto River joins the Ohio River at Portsmouth. The basin drains 6,517 $miles^2$ in 31 central and southern Ohio counties. The basin displays a dendritic stream pattern with the mainstem flowing from north to south. The natural course is interrupted by two major impoundments (Griggs and O'Shaunghnessy Reservoirs) and three low head dams (Dublin Rd. Waterworks, Town St., and Greenlawn). In Columbus the river flows through a channel which has a modified geometry and is reinforced with concrete. Flood flows have been contained here by levee construction. During the period of this study additional flood wall construction on the rivers west bank, opposite downtown Columbus.

Flowing over a buried valley filled with glacial outwash materials of sand and course gravels, the Scioto River substrates vary from limestone bedrock and silt-muck above Columbus to coarse sand and gravel south of the city. Downstream of the Jackson WWTP the Scioto River appears as a large unimpounded river with good sinuosity and riffle-pool development. The river valley, broad and poorly defined south of Columbus, has been subject to extensive flooding in the floodplain area.

Both the state of Ohio and the Scioto River basin experience a humid continental climate regime with warm to hot humid summers and cold winters.The interplay of warm moist air masses from the Gulf of Mexico with colder, drier Canadian air results in strong seasonal contrasts and great weather variability. Because of proximity to Lake Erie in the north and the Ohio River valley in the south, this basin experiences the greatest range of weather variability of all Ohio’s major drainage areas.

The passing of frontal systems and more localized convectional thunderstorms are the drivers of precipitation in the basin. Greatest precipitation occurs in spring and early summer (February - July). Fall and winter months (August - January) show the least amounts for the basin.

The nonpoint source load of the Scioto River is attributable to all areas adjacent to and upstream of the study area. But these loads are not cumulative in determining load at a given location on the river. Stream assimilation and in - stream deposition combine with the effect of lakes and reservoirs in the basin to provide a mix of variables for which there is a notable lack of data. A treatment of load sources is the approach taken in this study.

North of Circleville, the Scioto River Basin shows a mix of agricultural and urban land uses. Although erosion from agricultural croplands is the main source of sediment in the river, rapid land use change-development may be increasing in importance. Development in Delaware and Franklin counties is among the most rapid in Ohio during the time of this study. Surface runoff from residential, commercial and transportation construction sites contributes to sediment load finding its way to the Scioto River.

Near river construction may be of particular note. At time of the study, major highway construction projects (Spring Sandusky) were underway along the banks of the Scioto and Olentangy near and upstream from the confluence.

The consequent removal of extensive areas of riparian vegetation as well as in- stream construction activity have provided additional opportunity for sediment introduction to the Scioto's water column. The subsequent post construction increases in impervious surface (traffic lanes, ramps, bridges, walkways) are expected to add to non point source loads of vehicle and vehicle related materials (oils, grease, brake dust, road salt, rubber).

The use of commercial fertilizers (principal ingredients: phosphorus and nitrogen) has potential to influence surface and groundwater quality. A review of total crop acres treated in the years 1987 and 1992 by watershed county is shown in Table 3a. Over this period, acres treated declined considerably in Delaware, Franklin and Union counties; reflecting in part the accelerating development and conversion of agriculture to other land uses. All the remaining watershed counties showed increases.

Conservation tillage practices can reduce the movement of commercial fertilizers to the water column. From 1992 to 1998 these practices increased in Pickaway County. For 1998, an estimated 74% of cropland acres in the county used some form of conservation tillage. Of these, no till practice contributed 40%. The extent of conservation practices observed in Pickaway County-Scioto River tributary watersheds varied. The tributaries above Big Darby show less frequency of conservation tillage and no till practice. (Personal conversation: Pickaway County NRCS staff.)

Though the primary source of sediment to the Scioto River is agricultural cropland, the rapid pace of land use change and highway expansion in some quarters of the watershed implies an increased contribution from construction site runoff . The proportionate increase in this contribution may be magnified further by reductions in agricultural soil loss from watershed counties. The acreage eroding above the T rate is one measure of soil loss. For Pickaway County the change in T rate from 1983 to 1998 is shown in Table 3b.

Post construction increase in impervious surfaces upstream (parking lots, highways, driveways, rooftops, etc.) can affect the river's peak flows as rainwater and snowmelt quickly move to the river with less chance of infiltration into the soil strata or uptake by plant roots. An increased frequency of high flows provides opportunity for erosion of banks (Particularly those denuded of tree cover.) and thus contributes additional sediments to the river.

Animal feedlot operations can contribute sediment, nutrients and bacterial contaminants to streams as wastes enter the water column through surface runoff, leaks in holding ponds, animal access to the stream or poorly designed holding and waste control systems. The number and size of animal feedlot operations in the study area are partly a function of economic variables including market price and interest rates. (In Spring of 1999, market hog prices were judged to be extremely low by Pickaway County NRCS staff). For Pickaway County, the ten year period 1988 -1998, showed a trend toward more small (less than 1000 animal units) feedlot operations. (Personal communication, Pickaway NRCS staff).

The location of all sampling stations, and types of monitoring performed at each location, within the middle Scioto River study area are presented in Table 3c and Figure 4.

Table 3a. Fertilizers used on Middle Scioto River area farms in 1987 and 1992 by County and Acreage.[a]

	Commercial Fertilizer Use		
County	**1987 (Acres)**	**1992 (Acres)**	**Percent Change**
Delaware	100,532	93,945	6.6%
Franklin	73,646	57,061	22.5%
Madison	157,613	175,498	11.3%
Pickaway	157,537	193,563	22.9%
Ross	101,557	126,081	24.1%
Union	120,673	114,825	5.0%

[a] - U.S. Department of Commerce, Bureau of Census, 1992 Census of Agriculture, Volume I, Geographic Area Series, part 35 - Ohio: State and County Data.

Table 3b. Erosion values for Pickaway County.

Year	Acres of Cropland	Percent Cropland Eroding >T[b]	Acres of Cropland Eroding > T[b]
1983	256,627	26%	66,071
1998[c]	247,037	10%	24,704

a - Ohio Environmental Protection Agency. 1983. Central Scioto River Mainstem - Comprehensive Water Quality Report.
b - T=Soil loss tolerance: Maximum amount of soil loss which can be tolerated and still permit a high level of soil productivity to be sustained economically and indefinitely.
c - Pers. comm. Pickaway County NRCS staff.

Table 3c. Sampling locations (effluent sample - E, water chemistry - C, Datasonde - D, sediment chemistry - S, macrobenthos - B, and fish - F) in the middle Scioto River and Alum Creek study area.

Stream River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 minute Quadrangle Map
Scioto River				
145.0	(F,C,S,D)	40° 06'02"/83° 06'41"	ust. Dublin pump station-free flowing	NW Columbus
144.8	(B)	40° 05'58"/83° 06'40"	ust. Dublin pump station-free flowing	NW Columbus
144.54	(B)	40° 05'38"/83° 06'38"	ust. Dublin pump station-impounded	NW Columbus
144.52	(B)	40° 05'37"/83° 06'38"	dst. Dublin pump station-impounded	NW Columbus
144.5	(F,C)	40° 05'36"/83° 06'38"	dst. Dublin pump station-impounded	NW Columbus
142.8	(F)	40° 05'36"/83° 06'38"	Griggs Reservoir-Mod. Reference station	NW Columbus
140.0	(F)	40° 01'53"/83° 05'38"	Griggs Reservoir-Mod. Reference station	NW Columbus
138.6	(F)	40° 00'41"/83° 05'29"	dst. Griggs Reservoir	NW Columbus
136.3	(B)	40° 59'10"/83° 03'59"	dst. 5th Ave.	SW Columbus
136.2	(F,C,S,D)	39° 59'05"/83° 03'59"	dst. 5th Ave.	SW Columbus
133.4	(B,C,S,D)	39° 58'01"/83° 02'04"	dst. Dublin Rd. WTP Dam	SW Columbus
133.3	(F)	39° 58'02"/83° 02'03"	dst. Dublin Rd. WTP Dam	SW Columbus
133.0	(F)	39° 57'52"/83° 01'23"	ust. Olentangy River	SW Columbus
131.8	(F)	39° 57'48"/83° 00'18"	dst. Olentangy River	SW Columbus
129.8	(C)	39° 56'33"/83° 00'17"	Greenlawn Ave. Dam pool	SW Columbus
129.1	(F)	39° 56'05"/83° 00'03"	Greenlawn Ave.-dst. Whittier St. CSO	SW Columbus
129.0	(B,C,S)	39° 55'51"/83° 00'12"	Greenlawn Ave.-dst. Whittier St. CSO	SW Columbus
128.4	(B)	39° 55'31"/83° 00'19"	Techneglas Mixing Zone	SW Columbus
127.8	(C,D,B)	39° 55'00"/83° 00'35"	Frank Rd.-dst. CSOs and Techneglas	SW Columbus
127.5	(F)	39° 54'52"/83° 00'38"	Frank Rd.-dst. CSOs and Techneglas	SW Columbus
127.1	(F,C,B)	39° 54'30"/83° 00'34"	Jackson Pike WWTP Mixing Zone	SW Columbus
127.0	(C)	39° 54'20"/83° 00'29"	dst. Jackson Pike WWTP	SW Columbus
126.5	(B)	39° 54'07"/83° 00'08"	dst. Jackson Pike WWTP	SW Columbus
126.4	(F)	39° 54'03"/83° 00'01"	dst. Jackson Pike WWTP	SW Columbus
124.4	(C,S,D)	39° 52'49"/83° 01'05"	at I 270	SW Columbus
123.5	(F)	39° 51'56"/83° 01'26"	dst. I 270 and Scioto Big Creek	Commercial Point
123.2	(B)	39° 51'55"/83° 01'26"	dst. I 270 and Scioto Big Run	Commercial Point
120.0	(C,S,D)	39° 49'56"/83° 00'31"	SR 665-Shadeville	Commercial Point
119.9	(F)	39° 49'52"/83° 00'39"	SR 665-Shadeville	Commercial Point

Table 3c. continued.

Stream River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 minute Quadrangle Map
Scioto River				
119.3	(B)	39˚ 49'26"/83˚ 00'40"	dst. SR 665	Commercial Point
118.4	(C)	39˚ 49'21"/83˚ 00'54"	ust. Columbus Southerly WWTP	Commercial Point
118.3	(F,B)	39˚ 48'48"/83˚ 00'53"	Col. Southerly WWTP Mixing Zone	Commercial Point
118.1	(F,C,D)	39˚ 48'38"/83˚ 00'59"	dst. Columbus Southerly WWTP	Commercial Point
117.3	(B,C,S)	39˚ 48'04"/83˚ 00'33"	ust. Big Walnut Creek	Commercial Point
117.1	(F)	39˚ 47'50"/83˚ 00'42"	dst. Big Walnut Creek	Commercial Point
116.3	(F,B)	39˚ 47'11"/83˚ 00'43"	dst. Picway EGP	Commercial Point
115.3	(C,S)	39˚ 46'27"/83˚ 00'27"	at SR 762	Commercial Point
114.0	(B)	39˚ 45'39"/82˚ 59'52"	dst. SR 762	Lockbourne
113.8	(F)	39˚ 45'33"/83˚ 00'11"	dst. SR 762	Commercial Point
109.4	(B,C,D)	39˚ 43'10"/83˚ 00'45"	dst. SR 316	Darbyville
109.2	(F)	39˚ 43'02"/83˚ 00'39"	SR 316	Darbyville
107.4	(F)	39˚ 41'39"/83˚ 00'02"	ust. Walnut Creek	Darbyville
106.0	(B)	39˚ 40'46"/82˚ 59'11"	dst. Walnut Creek	Ashville
105.9	(F)	39˚ 40'40"/82˚ 59'13"	dst. Walnut Creek	Ashville
105.2	(F)	39˚ 40'15"/82˚ 59'21"	dst. Walnut Creek	Ashville
102.0	(F,B,C,S,D)	39˚ 37'50"/82˚ 57'42"	dst Commercial Point Rd.	Ashville
100.0	(F,B)	39˚ 36'15"/82˚ 57'22"	SR 22-Circleville Riffle	Circleville
99.7	(F)	39˚ 35'53"/82˚ 57'16"	dst. CCA	Circleville
98.9	(F)	39˚ 35'57"/82˚ 57'58"	dst. Cicrleville WWTP	Circleville
97.9	(F)	39˚ 35'18"/82˚ 58'53"	ust. Penn Central R&R	Circleville
Olentangy River				
0.7	(F)	39˚ 58'24"/83˚ 02'17"	ust. R&R Bridge-free flowing	SW Columbus
0.6	(B,C)	39˚ 58'18"/83˚ 01'15"	at R&R bridge-free flowing	SW Columbus
Alum Creek				
44.1	(F.C)	40˚ 21'42"/82˚ 54'06"	West Liberty Rd.	Killbourne
44.0	(B)	40˚ 21'40"/82˚ 53'10"	West Liberty Rd.	Killbourne
42.8	(F,C,S)	40˚ 21'24"/82˚ 55'19"	N. Galena Rd.	Killbourne
42.7	(B)	40˚ 21'17"/82˚ 55'25"	N. Galena Rd.	Killbourne
26.3	(F,C,S)	40˚ 10'55"/82˚ 55'19"	Africa/Lewis Center Rd.	Galena
26.2	(B)	40˚ 10'53"/82˚ 57'42"	Africa.Lewis Center Rd.	Galena
24.0	(B)	40˚ 09'12"/82˚ 57'13"	Worthington Galena Rd.	Galena
23.8	(F,C,D)	40˚ 09'00"/82˚ 57'12"	Worthington Galena Rd.	Galena
22.6	(F)	40˚ 08'13"/82˚ 57'06"	Cleveland Ave.	Galena
22.5	(B)	40˚ 08'04"/82˚ 57'04"	Cleveland Ave.	Galena
22.1	(C,D)	40˚ 07'48"/82˚ 56'55"	Cleveland Ave.	Galena
21.6	(C)	40˚ 07'48"/82˚ 56'34"	Main St.(at WTP)	Galena
20.9	(D)	40˚ 07'24"/82˚ 56'17"	dst. Westerville WTP Dam	NE Columbus
20.2	(D)	40˚ 06'54"/82˚ 56'18"	dst. Noble Run	NE Columbus
19.8	(F,B,C)	40˚ 06'38"/82˚ 56'17"	Shrock Rd.	NE Columbus
19.4	(D)	40˚ 06'17"/82˚ 56'18"	ust. I 270	NE Columbus
17.4	(F,S)	40˚ 04'57"/82˚ 55'17"	ust. Huber Ridge WWTP	NE Columbus
17.3	(B,C,D)	40˚ 04'58"/82˚ 55'18"	ust. Huber Ridge WWTP	NE Columbus
17.23	(E)	39˚ 58'54"/82˚ 56'25"	Huber Ridge Effluent	NE Columbus
17.2	(F,B,C,S)	40˚ 04'55"/82˚ 55'10"	Huber Ridge WWTP Mixing Zone	NE Columbus
15.4	(F,C,D)	40˚ 03'32"/82˚ 55'31"	Morse Rd.	NE Columbus
15.3	(B)	40˚ 03'25"/82˚ 55'12"	Morse Rd.	NE Columbus
13.5	(F,C)	40˚ 01'59"/82˚ 56'04"	Innis Rd.	NE Columbus

Table 3c. continued.

Stream River Mile	Type of Sampling	Latitude/Longitude	Landmark	USGS 7.5 minute Quadrangle Map
Alum Creek				
9.2	(F)	39˚ 58'56"/82˚ 56'24"	dst. American Ditch-Impounded	SE Columbus
9.1	(C,S)	39˚ 53'23"/82˚ 56'25"	dst. American Ditch	SE Columbus
8.6	(B)	39˚ 58'32"/82˚ 56'43"	dst. American Ditch-Free Flowing	SE Columbus
7.6	(B)	39˚ 57'42"/82˚ 56'28"	Wolf Park	SE Columbus
7.5	(F,C)	39˚ 57'51"/82˚ 56'44"	Wolf Park	SE Columbus
6.6	(F,C,S,D)	39˚ 57'06"/82˚ 56'34"	Livingston Ave.	SE Columbus
6.2	(B)	39˚ 56'43"/82˚ 56'29"	Livingston Ave	SE Columbus
3.9	(F,C)	39˚ 55'08"/82˚ 55'31"	Refugee Rd.	SE Columbus
3.8	(B)	39˚ 55'03"/82˚ 55'31"	Refugee Rd.	SE Columbus
0.9	(C)	39˚ 53'23"/82˚ 56'18"	near mouth-Williams Rd.	SE Columbus
0.8	(F)	39˚ 53'17"/82˚ 54'55"	near mouth-Williams Rd.	SE Columbus
0.7	(B)	39˚ 53'15"/82˚ 54'50"	near mouth-Williams Rd.	SE Columbus
West Branch Alum Creek				
0.7	(B)	40˚ 21'49"/82˚ 55'30"	Worthington-New Haven Rd.	Killbourne
0.6	(F,C)	40˚ 21'47"/82˚ 55'22"	Worthington-New Haven Rd.	Killbourne

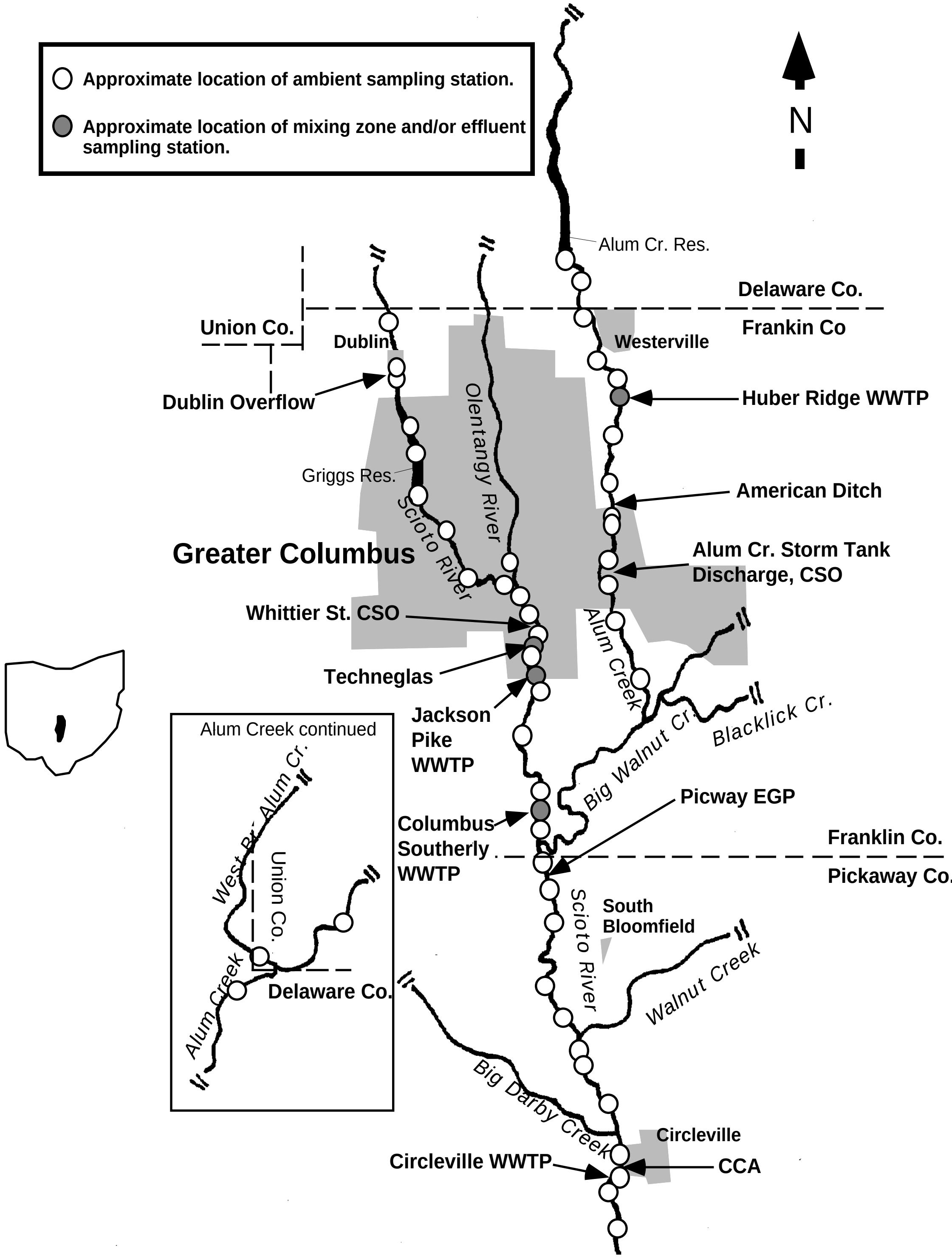


Figure 4.. The 1996 middle Scioto River study area showing principal streams and tributaries, population centers, major pollution sources and environmental monitoring stations.

METHODS

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

Determining Use Attainment Status

The attainment status of aquatic life uses (*i.e.*, FULL, PARTIAL, and **NON**) is determined by using the biological criteria codified in the Ohio Water Quality Standards (WQS; Ohio Administrative Code [OAC] 3745-1-07, Table 7-14). The biological community performance measures which are used include the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), based on fish community characteristics, and the Invertebrate Community Index (ICI) which is based on macroinvertebrate community characteristics. The IBI and ICI are multimetric indices patterned after an original IBI described by Karr (1981) and Fausch *et al.* (1984). The ICI was developed by Ohio EPA (1987b) and further described by DeShon (1994). The MIwb is a measure of fish community abundance and diversity using numbers and weight information and is a modification of the original Index of Well-Being originally applied to fish community information from the Wabash River (Gammon 1976; Gammon *et al.* 1981).

Performance expectations for the principal aquatic life uses in the Ohio WQS (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 the aquatic life use is FULL if all three indices (or those available) meet the applicable biocriteria, PARTIAL if at least one of the indices does not attain and performance at least fair, and **NON**-attainment if all indices fail to attain or any index indicates *poor* or *very poor* performance. Partial and non-attainment indicate that the receiving water is impaired and does not meet the designated use criteria specified by the Ohio WQS.

Habitat Assessment

Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989, 1994). Various attributes of the habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrates, amount and quality of in-stream cover, channel morphology, extent and quality of riparian vegetation, pool, run, and riffle development and quality, and gradient are some of the metrics used to determine the QHEI score which generally ranges from 20 to 100. The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have 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 greater than 60 are *generally* conducive to the existence of warmwater faunas. Scores greater than 75 frequently typify habitat conditions which have the ability to support exceptional warmwater faunas.

Macroinvertebrate Community Assessment

Macroinvertebrates were sampled quantitatively using multiple-plate, artificial substrate samplers (modified Hester/Dendy) in conjunction with a qualitative assessment of the available natural substrates.

Fish Community Assessment

Fish were sampled using wading or boat method pulsed DC electrofishing gear. The wading method was used at a frequency of one or two samples at each site. The boat method was used at a frequency of two samples at each site.

Area of Degradation Value (ADV)

An Area Of Degradation Value (ADV; Rankin and Yoder 1991; Yoder and Rankin 1994) was calculated for the study area based on the longitudinal performance of the biological community indices. The ADV portrays the length or "extent" of degradation to aquatic communities and is simply the distance that the biological index (IBI, MIwb, or ICI) departs from the applicable biocriterion or the upstream level of performance. The “magnitude” of impact refers to the vertical departure of each index below the biocriterion or the upstream level of performance. The total ADV is represented by the area beneath the biocriterion (or upstream level) when the results for each index are plotted against river mile. The results are also expressed as ADV/mile to normalize comparisons between segments and other streams and rivers.

Causal Associations

Using the results, conclusions, and recommendations of this report requires an understanding of the methodology used to determine the use attainment status and assigning probable causes and sources of impairment. The identification of impairment in rivers and streams is straightforward - the numerical biological criteria are the principal arbiter of aquatic life use attainment and impairment (partial and non-attainment). The rationale for using the biological criteria in the role of principal arbiter within a weight of evidence framework has been extensively discussed elsewhere (Karr *et al.* 1986; Karr 1991; Ohio EPA 1987a,b; Yoder 1989; Miner and Borton 1991;

Yoder 1991a; Yoder 1994). Describing the causes and sources associated with observed impairments relies on an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and the biological response signatures (Yoder and Rankin 1994) within the biological data itself. Thus the assignment of principal causes and sources of impairment in this report do not represent a true “cause and effect” analysis, but rather represent the association of impairments (based on response indicators) with stressor and exposure indicators whose links with the biosurvey data are based on previous research or experience with analogous situations and impacts. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified. The process is similar to making a medical diagnosis in which a doctor relies on multiple lines of evidence concerning patient health. Such diagnoses are based on previous research which experimentally or statistically linked symptoms and test results to specific diseases or pathologies. Thus a doctor relies on previous experience in interpreting symptoms (*i.e.*, multiple lines from test results) to establish a diagnosis, potential causes and/or sources of the malady, a prognosis, and a strategy for alleviating the symptoms of the disease or condition. As in medical science, where the ultimate arbiter of success is the eventual recovery and the well-being of the patient, the ultimate measure of success in water resource management is restoration of lost or damaged ecosystem attributes including aquatic community structure and function. While there have been criticisms of misapplying the metaphor of ecosystem “health” compared to human patient “health” (Suter 1993) here we are referring to the process for identifying biological integrity and causes/sources associated with observed impairment, not whether human health and ecosystem health are analogous concepts.

RESULTS AND DISCUSSION

Scioto River

Pollutant Loadings: 1976 -1996

Monthly effluent loadings are reported to Ohio EPA by all NPDES permitted discharging entities. Third quarter (July-September) Monthly Operating Report (MOR) data provided the quantity and character of pollutant loadings from 1976 through 1996 for each discharger evaluated within the 1996 Scioto River study area. Because of the large number of dischargers in the Scioto River study area, only those facilities classified as major dischargers (greater than 1 MGD) or significant minors were included in the loadings discussion of impacts to the Scioto River.

Pollutant loading trends analysis included the 95th and 50th percentiles of four parameters where available: Ammonia-nitrogen (NH_3-N), Five-day Biochemical Oxygen Demand (BOD_5)/ Five-day Carbonaceous Biochemical Oxygen Demand ($cBOD_5$), Total Suspended Solids (TSS), and Annual discharge (MGD). Note that BOD_5 and $cBOD_5$ are combined on the same graph and reflect permit parameter changes emphasizing only carbonaceous BOD_5 not total BOD_5.

Dublin Pump Station (Scioto River RM 144.7)

The Dublin raw sewage pump station is located at 6200 Dublin Road between Short Street and Karrer Place in Dublin (south of the Route 161 bridge on the west side of the Scioto River). The Ohio EPA discovered the sewage pump station overflows occurring during early 1989. A preliminary pump station upgrade was done in May 1989 but the overflows continued. In August 1990 a new greatly expanded pump station was placed into service.

The new pump station has a telemetering system which limits the amount of sewage flow that can be pumped based on the level of sewage in the sewer line on the east side of the Scioto River. Since the August 1990 upgrade the number of overflows have been significantly reduced. Prior to August 1990, there were 25 overflow events at the station in 1990 alone but since then only 14 overflow events have occurred. The City of Dublin has also undertaken an extensive inflow/infiltration (I/I) reduction program.

The long term solution to the overflow problem is the Upper Scioto West Interceptor Sewer (USWIS). This is a deep tunnel sewer which runs from Dublin down through Hilliard and into Columbus at Griggs Dam primarily running along Dublin Road. The USWIS is currently under construction and is expected to be completed by October 1998. When the sewer goes on-line, the Dublin sewage pump station will be abandoned.

Ponderosa Mobile Home Park (Unnamed Tributary to Scioto River RM 143.6)
Ponderosa MHP is located at 6333 Rings Road in Columbus. The plant was built in 1965 and was upgraded in 1988. Current design flow is 0.015 MGD serving 105 plots. The treatment process is comprised of extended aeration, fixed media upflow filters, a final clarifier, slow sand filter, and chlorination. It discharges into an unnamed tributary of the Scioto River at RM 143.6.

BP Oil Facility # 8184 (Unnamed Tributary to Scioto River RM 141.0)
The BP Oil facility located at 1927 Henderson Road operates a pump and treat system utilizing an activated carbon pump to treat contaminated groundwater. The pump has a capacity of 0.005 MGD and discharges into an unnamed tributary of the Scioto River.

American Aggregates Corp. Plant # 224 (Scioto River RM 138.2, 138.1, and 137.4)
The Marble Cliff Plant, located at 3250 Old Dublin Road, produces between 6,000-10,000 tons per day of limestone aggregates. The facility maintains three discharge points. Settling ponds are utilized to treat mine de-watering and recycled process wastewater before discharge into the Scioto River at several location between RM 138.2 and RM 137.4. Flows average between 1.15 MGD and 2.16 MGD. Also, discharge from this entity is partially rainfall dependent since surface runoff flows into the settling ponds. Monthly self-monitoring reports indicate no permit violations.

Dublin Road WTP (Scioto River RM 133.40)
The Dublin Road Water Plant, operated by the City of Columbus Division of Water, is located at 940 Dublin Road, Columbus. The plant produces potable water at a rate of 33 MGD for the Central and Northwest districts of Columbus. Water treatment processes include flocculation, primary settling, lime-soda softening, settling, filtration and disinfection. Lime sludge wastewater in a volume of 0.40 MGD is discharged into the quarry lake on McKinley Ave. and eventually reaches the Scioto River at RM 133.4, via groundwater seepage through limestone fractures.

Consolidated Railroad Corp. (Unnamed Tributaries to Scioto River, RM 135.75; 3.8, 2.4, 1.2)
Conrail Buckeye Yard is located at 4882 Trabue Road in Columbus. The rail yard maintains a service operation including maintenance, inspection, repair, and refueling of diesel locomotives. Treatment of surface water runoff is achieved through the use of settling ponds. Flow varies according to the amount of rainfall. Three outfalls discharge into unnamed tributaries (RMs 3.8, 2.47, 1.2) of the Scioto River at RM 135.75.

Shell Oil Company (Unnamed Tributary to Scioto River RM 134.43; 0.99)
Shell Oil Company, located at 3651 Fisher Road, is a petroleum bulk terminal operating an oil/water separator, holding tank, carbon treatment tank and holding pond. The facility has a design flow of 0.016 MGD but actual flow is dependent on rainfall and discharges into an unnamed tributary of the Scioto River at RM 0.99.

Marathon Oil Company (Dry Run to Scioto River RM 134.43; 4.2, 4.21)
Marathon Oil Company is located at 4125 Fisher Road. The plant is a bulk storage facility for petroleum products including gasoline, diesel fuel and kerosene. The plant obtains these products from a petroleum pipe line and by tanker truck. There are two (2) permitted outfalls. Outfall 001 discharges storm water collected in a diked tank farm secondary containment area after passing through a baffled holding pond. Flow averages 0.036 MGD. Outfall 002 discharges treated groundwater that was contaminated with raw petroleum product. The system was installed in 1991 and upgraded in 1993 and discharges an average of 0.002 MGD.

Clark Refining and Marketing Inc. - Columbus Terminal (Dry Run to Scioto River 134.43; 4.15)
Clark Refining and Marketing Inc., located at 4033 Fisher Road is a bulk storage facility for gasoline, ethanol and gasoline additives, however, no diesel fuel or kerosene is stored here. The plant obtains gasoline from a petroleum pipe line and ethanol and other additives by tanker truck. The facility operates 24 hours/day, 365 days/year but is staffed only during the day, 5 days/week. The facility had two permitted outfalls. Outfall 001 was the discharge from the loading rack oil-water separator but it has since been sealed. Waters removed from the loading racks, tank draw waters and tank condensate are hauled away for treatment. Outfall 002 discharges water collected in the storage tank secondary containment area, without treatment, to Dry Run at RM 4.15, which joins the Scioto River at RM 134.43.

Midwest Terminal Company Inc. (Dry Run to Scioto River RM 134.43; 1.15)
Midwest Terminal, located at 3866 Fisher Road in Columbus, is a petroleum bulk storage facility for gasoline, diesel fuel, and ethanol. Currently, Midwest maintains two outfalls. The facility provides limited treatment for storm water runoff. Drainage from impervious areas, including drainage from the covered loading racks and the vapor recovery system, is directed to Dry Run, via an aerated retention pond. Accumulated water within the tank farm’s secondary containment area is directly discharged to Dry Run with no treatment. Eventually outfall 002 will be routed to outfall 001 for treatment prior to discharge.

Ashland Petroleum Company-Columbus Terminal (Dry Run to Scioto River RM 134.43; 1.24)
Ashland Petroleum stores and distributes petroleum products at 3855 Fisher Road in Columbus. Oil/water separators and a retention pond are used to treat runoff and spill wastewater before release. Wastewater is discharged into Dry Run (RM 1.24), a tributary of the Scioto River RM

134.43. Flow is rainfall dependent.

Buckeye Emulsion Company (Unnamed Tributary to Scioto River RM 134.43; 0.90)
Buckeye Emulsion Company manufactures asphalt emulsions. It is located at 3737 Fisher Road in Columbus. The facility maintains one active discharge into an unnamed tributary of the Scioto River at RM 0.90 and confluences with the Scioto River at RM 134.43. Flow averages 0.001 MGD. Surface runoff at the site is collected by a dike that surrounds the facility. A sump pump is used to pump excess water into the discharge tributary. The wastewater is not treated, but the wastewater volume is visibly observed for a surface sheen prior to pumping.

Sun Company, Inc. (R&M)-Columbus Terminal (Unnamed Tributary to Dry Run to Scioto River RM 134.43)
Sun Refining is a petroleum bulk terminal which stores gasoline at 3499 West Broad Street in Columbus. The loading rack area drains to an oil-water separator before discharging to outfall 001. A large earthen diked area containing storage tanks drains to another oil-water separator and is discharged to outfall 002. The facility had a number of pH and oil and grease violations in the early 1990s. Flow is rainfall dependent with an average flow from outfall 001 of 0.0018 MGD and from 002 of 0.0026 MGD.

B.P. Oil Company (Dry Run to Scioto River RM 134.43)
B.P. Oil Company, located at 303 Wilson Road in Columbus is a wholesale marketing terminal for petroleum refining products. The loading rack area and paved lot flow to an oil-water separator. Discharge from a diked tank farm combines with the oil-water separator discharge and is sampled at outfall 001. Discharge is to Dry Run and is rainfall dependent.

GFS Chemicals, Inc. (via Storm Sewer to Scioto River RM 132.8)
GFS Chemicals is located at 867 McKinley Avenue in Columbus. The facility manufactures specialty chemicals such as perchloric acid and trichlormelamine. Treatment process for the discharge of scrubber-contact wastewater consisted of neutralization through two tanks of crushed limestone. This contact cooling water discharge was rerouted to the Columbus sanitary sewer in December, 1997. Now, outfall 002 discharges storm and non-contact cooling water in a volume of less than 0.045 MGD, and outfall 003 discharges non-contact cooling water in a volume of 0.005 MGD to a storm sewer at RM 132.8 of the Scioto River.

Capital Manufacturing (via storm sewer to Scioto River RM 130.90)
Capital Manufacturing operated a pump and treat system to remediate petroleum contaminated groundwater. The design capacity of the pump was 0.010 MGD and discharged via storm sewer to the Scioto River RM 130.90. Collected groundwater was treated by filtration for removal of suspended solids and residual oil droplets and activated carbon to remove dissolved organic

compounds. As of March 1995, approximately 500,000 gallons of water had been pumped, treated and discharged to the storm sewer. The treatment system was decommissioned and disassembled in April 1996.

Techneglas, Inc. (Scioto River RM 128.95)

Techneglas, Incorporated owns and operates a television picture tube manufacturing facility at 727 E. Jenkins Avenue, Columbus. The facility manufactures television picture tube funnels out of leaded glass. In 1995 Techneglas began modifying its manufacturing facility to increase production capacity from 422 tons of furnace pull per day to 700 tons of furnace pull per day from two existing glass melting furnaces. New forming and finishing lines were installed in 1995, each with their own wastewater treatment plant. A portion of each waste stream is treated and recycled while the remainder of the waste stream is discharged as needed. The effluent from both new treatment units combines and is sampled at a new internal station (602). Non-contact cooling water and storm water combines with the 602 waste stream and discharges through a new outfall 003 (Smith Road storm sewer). The existing system consists of treated process wastewater from internal station 601 and discharges through outfall 002 (19th Street storm sewer), which also contains treated storm water and other intermittent wastewater (cooling tower filter backwash and basement sump water). In November 1997, Techneglas was issued a PTI for improvements to their storm water treatment system. The facility discharges into the Scioto River via storm sewer at RM 128.95.

Several violations for hexavalent chromium, pH and lead were reported during 1996 for outfall 002 (storm sewer at 19th street) (Appendix Table A). Overall, numerous violations for lead, pH, oil and grease, and hexavalent chromium have been reported for this facility since 1992. Flow from outfall 002 has been relatively stable since 1976. No trends could be discerned due to the paucity of data for BOD and lead. Total suspended solids loadings have been extremely variable but low for outfall 002 (Figure 5).

Bioassay tests performed during 1995 of the Techneglas effluent were acutely toxic to fathead minnows and *Ceriodaphnia* (Table 4). Effluent grab samples were more toxic than the composite effluent sample. During the July 1995 test, an oily film was observed on the surface of the storm sewer outfall and in the mixing zone samples.

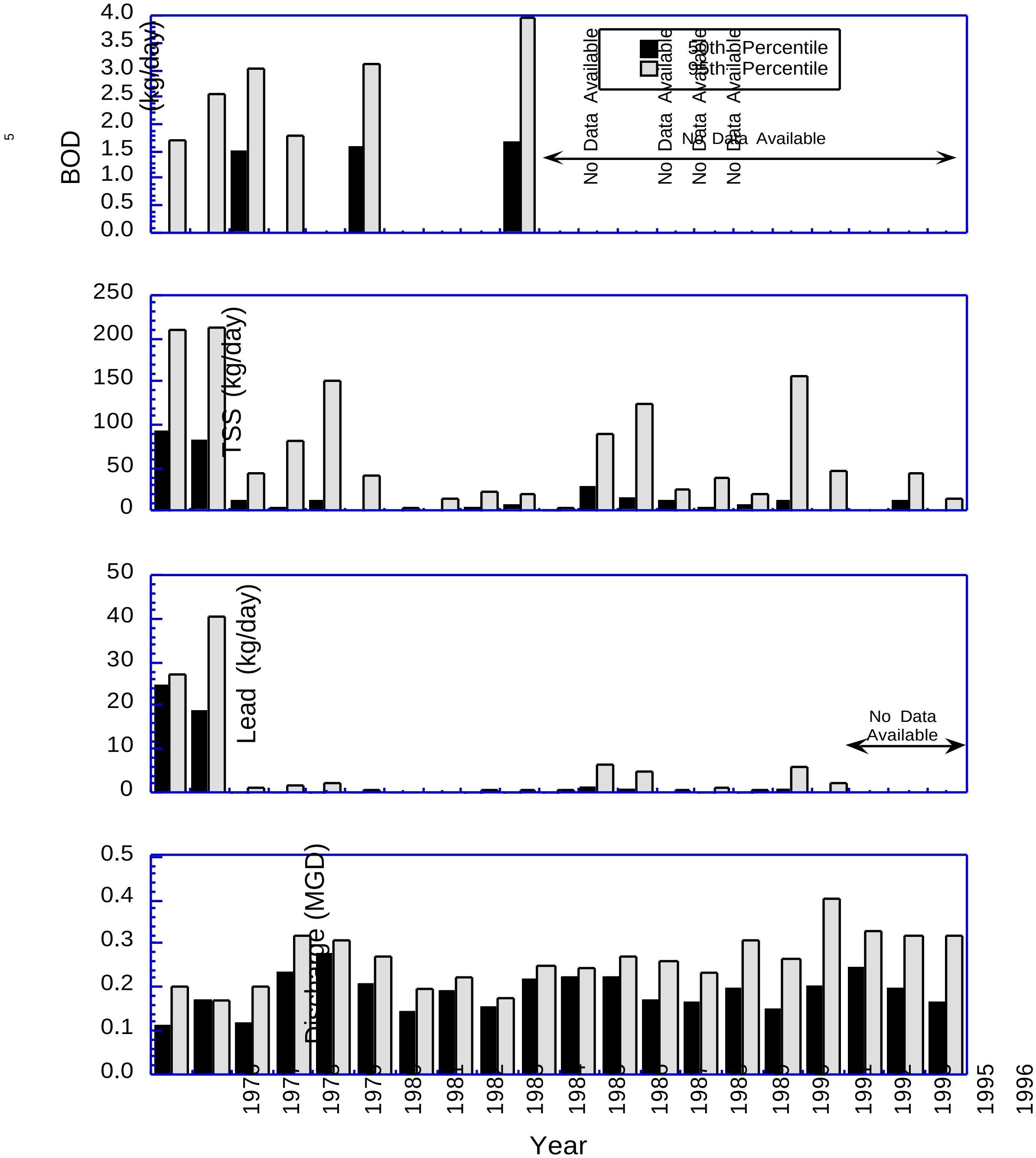


Figure 5. Third-quarter median and 95th percentile conduit flow (MGD) and pollutant loads (kg/day) of five-day Biochemical Oxygen Demand (BOD_5), Lead, and Total Suspended Solids (TSS) from Techneglas, 1976 through 1996.

Table 4. Acute (TUa) toxicity bioassay data collected from Techneglas. All tests were performed by Ohio EPA personnel.

Date	Cumulative Percent Mortality (cumulative percent affected) *Pimephales promelas*	*Ceriodaphnia dubia*
September 18-19, 1995		
Upstream	5(15)	0
Acute Mix Zone	5	0
Chronic Mix Zone	0(25)	0
Grab 002-Day 1	100	100
Grab @ Storm Sewer	10	0
Composite 002	20	10
Grab 002-Day2	50	0
Grab @ Storm Sewer	0	0
July 17-18, 1995		
Upstream	0	0
Acute Mix Zone	0	15
Chronic Mix Zone	0	5
Grab 002-Day 1*	100	100
Grab @ Storm Sewer	0	30
Composite 002	5	5
Grab 002-Day 2	0	0

*All effluent samples were clear with a yellow tinge, except for the Day 1- 002 grab which was opaque with approximately 2 mm oil coating on surface. An oil coating was observed on the surface of the storm sewer outfall, acute mix zone and chronic mix zone samples.

Delille Oxygen Company (via storm sewer to Scioto River RM 128.40)

Delille Oxygen Company is located at 772 Marion Rd. The facility generates acetylene gas from calcium carbide, and recompresses oxygen, nitrogen, and argon. Wastewater discharge consists of non-contact cooling water and hydrostatic test water. A design flow of 0.017 MGD discharges into the Scioto River via storm sewer at RM 128.4. No treatment process is currently utilized.

Franklin International, Inc. (via storm sewer to Scioto River RM 128.2)

Franklin International is located at 2020 Bruck Street in Columbus. The facility manufactures emulsion polymers, adhesives, caulks and sealants. The discharge consists of non-contact cooling water with an average flow of 0.01 MGD. Wastewater is discharged into a storm sewer at RM 128.2.

Jackson Pike WWTP (Scioto River RM 127.10)

The Jackson Pike WWTP is located at 2104 Jackson Pike in Columbus and is an advanced wastewater treatment facility. Under “Project 88” and into the years beyond (1989-1992) substantial upgrades were made to the original facility that was built in 1937. This included improvements to aeration tanks, and primary clarifiers, construction of two new final clarifiers, rehabilitation of influent pumps, new chlorination/dechlorination and post aeration facilities and major improvements to sludge handling and treatment (rehabilitation of incinerators, rehabilitation of digestors, upgrading of polymer feed systems and belt systems). In addition, as part of Project 88, a large interconnector sewer was constructed connecting the Jackson Pike WWTP with the Southerly WWTP thus enabling some sewage flow to be diverted to the Columbus Southerly WWTP for treatment and allowing the Jackson Pike WWTP to maintain a high degree of treatment. It currently has a design flow of 68 MGD during dry weather. A maximum wet weather flow analysis determined that the Jackson Pike WWTP could treat at least 70 MGD during “any condition flow” which is the maximum wet weather instantaneous flow the plant is expected to meet at all times. The ideal condition flow is to reflect the maximum wet weather treatment capabilities of the plant when everything is working at its best. The ideal condition flow was found to be 115 MGD. The plant discharges into the Scioto River at RM 127.1.

Current treatment consists of screening, aerated grit removal at a remote location, screening at the site, pre-aeration, primary settling, removal of BOD, and nitrification using extended aeration, secondary clarification, chlorination-dechlorination, and post aeration. No permit violations were reported during 1996 for the Jackson Pike facility (Appendix Table A). Since 1994, Jackson Pike has been operating above the design flow. Ammonia loadings have dropped dramatically since the facility was upgraded in 1988. Total suspended solids loadings have remained relatively constant since 1976 with several peaks in the mid 1980s (Figures 6 and 7).

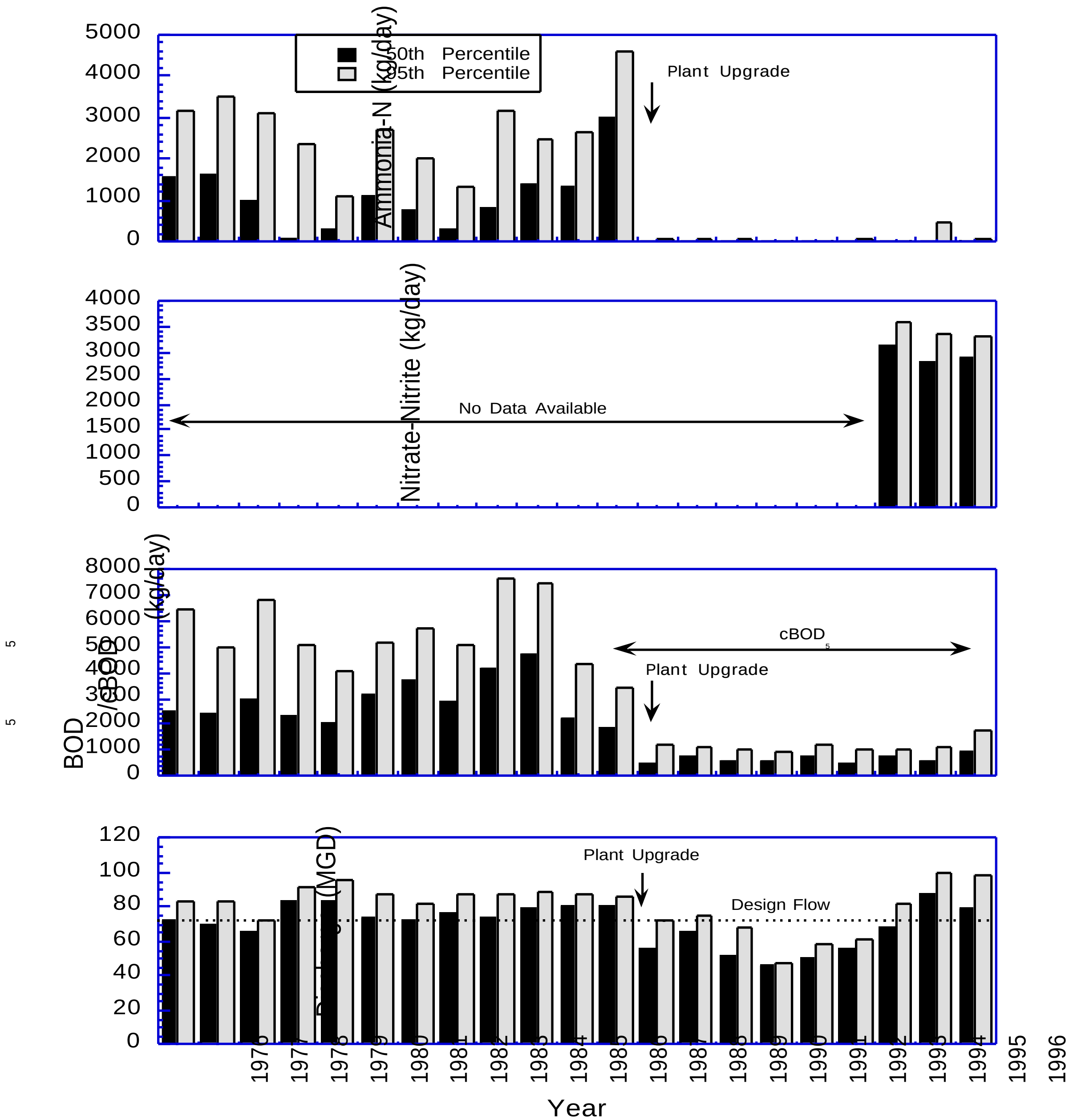


Figure 6. Third-quarter median and 95th percentile conduit flow (MGD) and pollutant loads (kg/day) of Ammonia-Nitrogen (NH_3-N), Nitrate and Nitrite-Nitrogen (NO_3+NO_2-N), and Biochemical Oxygen Demand (BOD_5 and $cBOD_5$) from the Jackson Pike WWTP, 1976 through 1996.

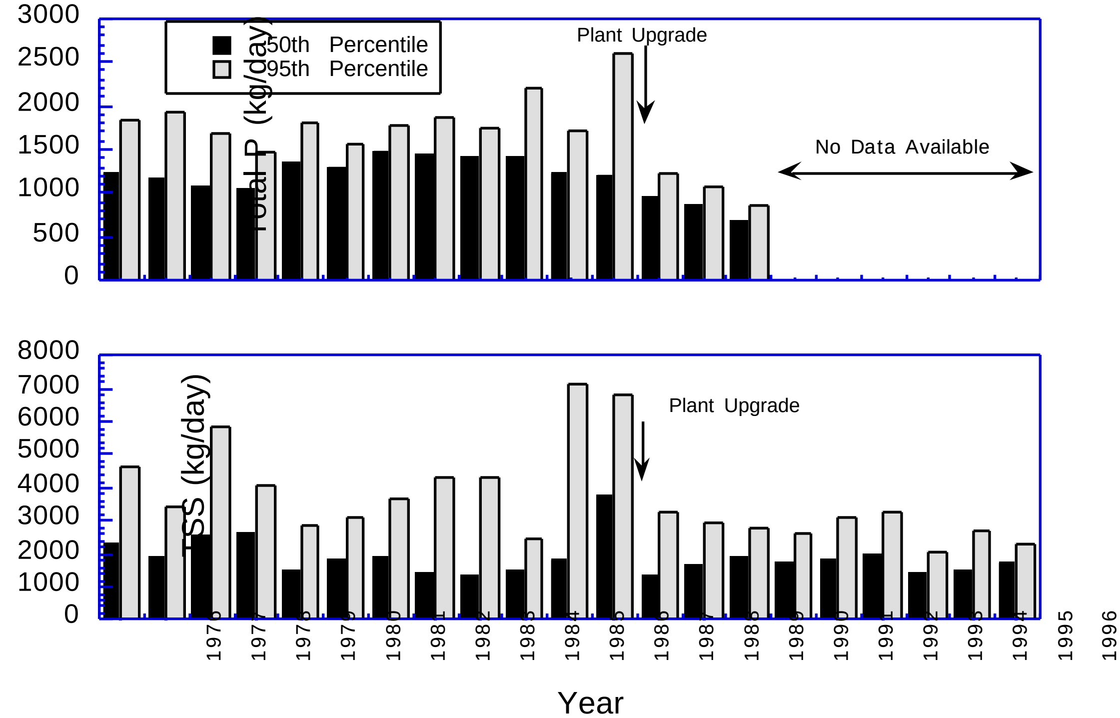


Figure 7. Third-quarter median and 95th percentile pollutant loads (kg/day) of Total Phosphorus (Total P) and Total Suspended Solids (TSS) from the Jackson Pike WWTP, 1976 through 1996.

Bioassay tests conducted by Ohio EPA in 1995 found the Jackson Pike WWTP effluent not acutely toxic to fathead minnows or *Ceriodaphnia* (Table 5). While some mortality was observed (less than or equal to 10%), no toxic effects were noted.

Table 5. Acute (TUa) toxicity bioassay data collected from Jackson Pike WWTP. All tests were performed by Ohio EPA personnel.

	Cumulative Percent Mortality	
Date	*Pimephales promelas*	*Ceriodaphnia dubia*
September 26-27, 1995		
Upstream	5	0
Acute Mix Zone	0	0
Chronic Mix Zone	5	0
Grab 001-Day 1	5	0
Composite 001	5	0
Grab 001-Day 2	5	0
August 21-22, 1995		
Upstream	0	0
Acute Mix Zone	0	5
Chronic Mix Zone	10	0
Grab 001-Day 1	0	5
Composite 001	0	0
Grab 001-Day 2	0	5

American Aggregates Corp. Plant # 216 (Scioto River)

American Aggregates Plant # 216, currently known as Limestone Incorporated, is located at 13124 Crownover Road. This facility utilizes sediment ponds to collect process and mine de-watering wastewater in addition to any surface runoff.

Spencer Allen Property (Unnamed Tributary to Scioto River RM 126.7)

Spencer Allen Property is located at 1388 Stimmel Road in Franklin Township. The site is currently subleased to Advantage Electric Company for outside storage space. The site previously contained underground storage tanks containing gasoline, diesel fuel and used oil. The wastewater system is for groundwater remediation in response to a corrective action plan required by the State Fire Marshall's Office for the clean-up of petroleum contaminants resulting from underground storage tank release. Effluent was discharge (0.0145 MGD average flow) to an unnamed tributary of the Scioto River at RM 126.0, however, was discontinued in 1996.

American Aggregates Corp. Plant # 221 (Scioto River RMs 126.69, 125.48 and Big Run to Scioto RV RM 124.40;1.0)

American Aggregates Plant #221 at 3300 Jackson Pike in Grove City washes sand and gravel, and discharges wastewater into settling ponds. Discharge is limited to recycled process-generated wastewater and surface runoff. Outfall 001 discharges to the Scioto River at RM 126.69, with an average discharge of 13.8 MGD. Outfall 002 has an average discharge of 11.5 MGD to Big Run at RM 1.0. Outfall 004 has an average discharge of 18.7 MGD into the Scioto River at RM 125.48.

American Aggregates Corp. Plant # 210 (Scioto River RMs 126.75,125.05 and 124.53)

Plant # 210 is at 385 Frank Road in Columbus. The facility washes sand, gravel, and limestone utilizing sediment ponds to collect process and mine de-watering wastewater in addition to runoff. Three outfalls (003, 006, 008) discharge into the Scioto River. Outfall 003 discharges an average 1.5 MGD at RM 126.75, 006 discharges 10.2 MGD at RM 125.05 and 008 discharges 0.15 MGD at RM 124.53.

Buckeye Steel Castings Company (Scioto River RM 126.43)

Buckeye Steel Castings Company, located at 2211 Parsons Avenue in Columbus, is a secondary foundry operation utilizing electric arc furnaces in the making of cast steel products. Buckeye Steel monitors the facility runoff through outfall 001 which discharges to Kian Run. Flow is variable and is dependent on the amount of precipitation.

T. Marzetti Company (via storm sewer to Scioto Big Run to Scioto River 124.40; 3.6)

T. Marzetti Company owns and operates the Allen Division facility at 1709 Frank Road. The facility manufactures Grade A sour cream, vegetable dip, fruit dip, gelatin products, and similar food products. Manufacturing processes used at this facility are pasteurizing, blending, mixing and packaging. The only discharge from the facility is non-contact cooling water. All process wastewater and sanitary wastewater are directed to the Columbus sewer system. The water used for cooling is obtained from a groundwater well. Cooling water additives are currently not used. The cooling water is collected within building piping and directed to a manhole located on the west side of the facility. This manhole is connected to a storm drain which runs south and drains to Scioto Big Run. Currently, the only storm water discharged from the facility is that which is accumulated in the shipping docks located on the south side. Storm water from the west side of the plant is directed to the sanitary sewer.

Agg Rock Materials (Scioto Big Run to Scioto River RM 124.40; 1.9)
Agg Rock Materials, a Division of Wapak Sand and Gravel Company, is located at 711 Frank Road in Columbus. The facility is a sand and gravel operation. The accumulated groundwater from the mining operation, washing operation and surface runoff is directed to three ponds connected in series. The final pond overflows into Scioto Big Run. Flow is based on the pump capacity and can be up to 8.64 MGD.

Enchanted Acres MHP (Scioto River RM 124.39)
Enchanted Acres was constructed in 1972 at the intersection of I-270 and Parsons Ave.. The treatment system consists of a bar screen, extended aeration, final settling, rapid sand filters, and chlorination. A design flow of 0.10 MGD is discharged into the Scioto River at RM 124.39.

Ramada Inn South (Unnamed Tributary to Scioto River RM 122.95; 2.03)
The Ramada Inn was constructed in 1970 at 1879 Stringtown Road in Grove City. It currently operates a lift station, extended aeration tank, and rapid sand filters. The facility has a design capacity of 0.06 MGD. It discharges into an unnamed tributary of the Scioto River at RM 2.03 and joins with the Scioto at RM 122.95.

Franklin County Landfill (unnamed Tributary to Grant Run to Scioto River RM 121.47; 3.25)
The Solid Waste Authority of Central Ohio operates the Franklin County Landfill located at 3851 London-Groveport Road. The facility has one sedimentation pond with a discharge to an unnamed tributary to Grant Run. Under landfill expansions occurring in 1997-1998 there will be up to five (5) sediment pond discharges which are all rainfall dependent. The landfill has a leachate collection system where the leachate is treated by the Columbus WWTPs.

Columbus Southerly WWTP (Scioto River RM 118.4)

The Columbus Southerly WWTP is one of two treatment facilities serving the Columbus metropolitan area. Wastewater from the eastern part of the metropolitan area, Grove City and excess flows from the Jackson Pike WWTP are treated at the Southerly WWTP. The plant is located at 6977 South High Street in southern Franklin County. Columbus Southerly was initially constructed in 1967 and became an advanced treatment facility in September, 1987. Under Project 88 improvements included constructing a new liquid treatment train, renovating primary and aeration facilities, constructing new effluent chlorination/dechlorination and post aeration facilities, upgrading electrical and process instrumentation, and improving solids handling. Beyond Project 88, two new clarifiers were constructed in 1992-1993. The plant has a current design flow of 120 MGD. A maximum wet weather flow analysis determined that the Southerly WWTP could treat at least 130 MGD during "any condition flow" which is the maximum wet weather instantaneous flow the plant is expected to meet at all times. The "ideal condition flow" is to reflect the maximum wet weather treatment capabilities of the plant when everything is working at its best. The "ideal condition flow" was found to be 180 MGD for the Southerly Plant.

The treatment process is comprised of screening, aerated grit removal, pre-aeration, primary settling, activated sludge aeration, secondary clarification, chlorination, dechlorination using sulfur dioxide, and post aeration. Discharge occurs directly into the Scioto River at RM 118.4. Only three violations for ammonia and pH were noted during September, 1996 (Appendix Table A). Ammonia and BOD loadings have dropped dramatically since 1986 and continue to remain low while flow increased after 1988. Like the Jackson Pike WWTP, total suspended solids loadings have remained consistent through time (Figures 8 and 9).

It is also important to consider the significant reduction of pollutant loadings achieved by the mid-1980s through the abatement of significant raw sewage bypasses (002) at the Columbus Southerly WWTP. Between 1979 and 1980 bypass events accounted for over 60% of the total BOD load from the Columbus Southerly WWTP. By the early 1980s it was reduced to 20-30%. The decreased bypass loads was partially a result of improved solids management capabilities with the installation of the southwesterly composting facility in 1980 (Ohio EPA 1985).

During 1995 and 1996, bioassay tests using Columbus Southerly WWTP effluent were not acutely toxic to fathead minnows. During the April 1996 test, the effluent was acutely toxic to *Ceriodaphnia.* The December 1995 test showed no toxicity to either test species. The cause of the toxicity is not known and is probably the result of a sporadic toxic slug entering the plant rather than a chronic operating problem. These tests should be repeated to see if the problem continues to exist (Table 6).

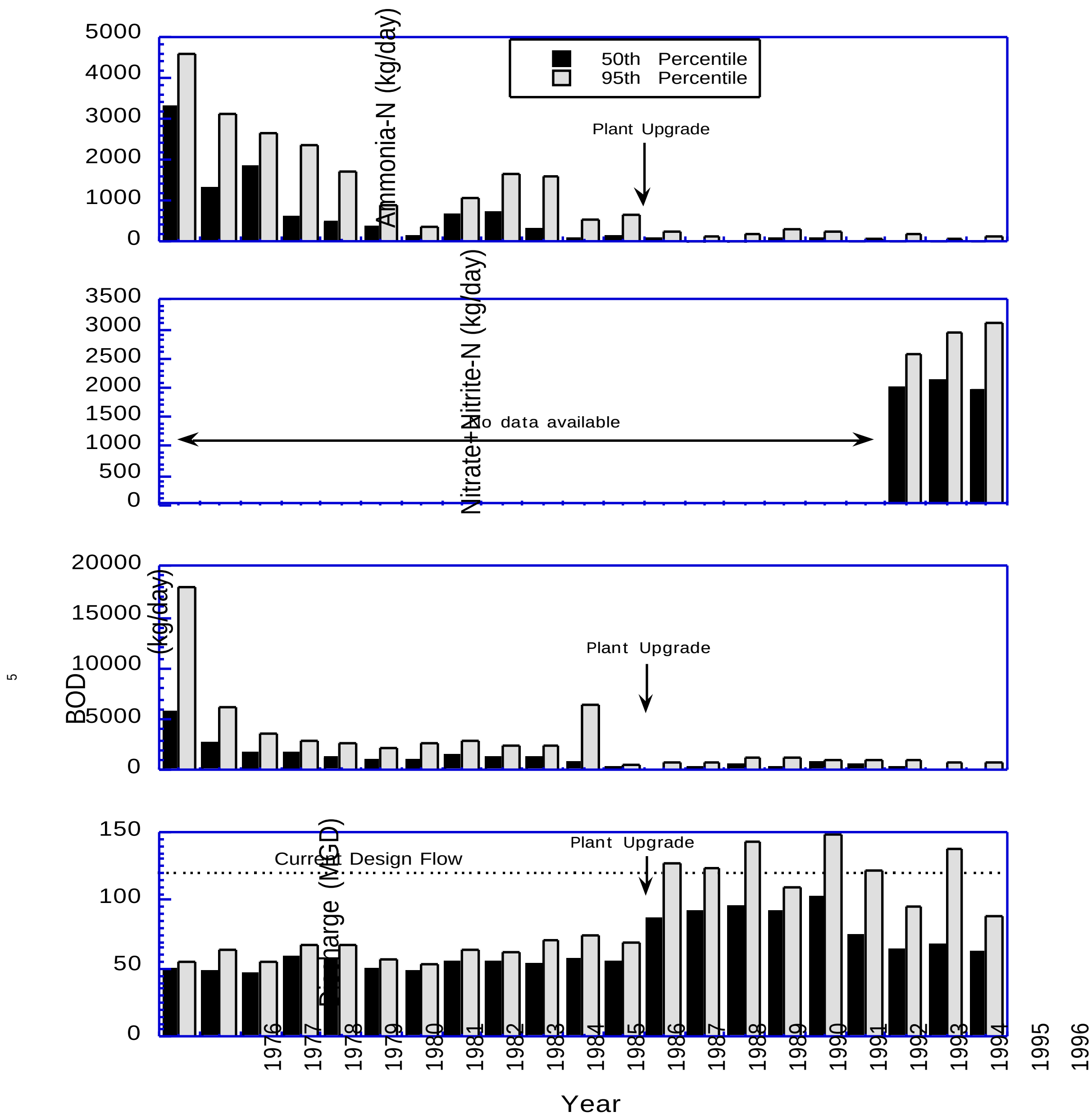


Figure 8. Third-quarter median and 95th percentile conduit flow (MGD) and pollutant loads (kg/day) of Ammonia-Nitrogen (NH_3-N), Nitrate and Nitrite-Nitrogen (NO_3+NO_2-N), and five-day carbonaceous Biochemical Oxygen Demand ($cBOD_5$) from the Columbus Southerly WWTP, 1976 through 1996.

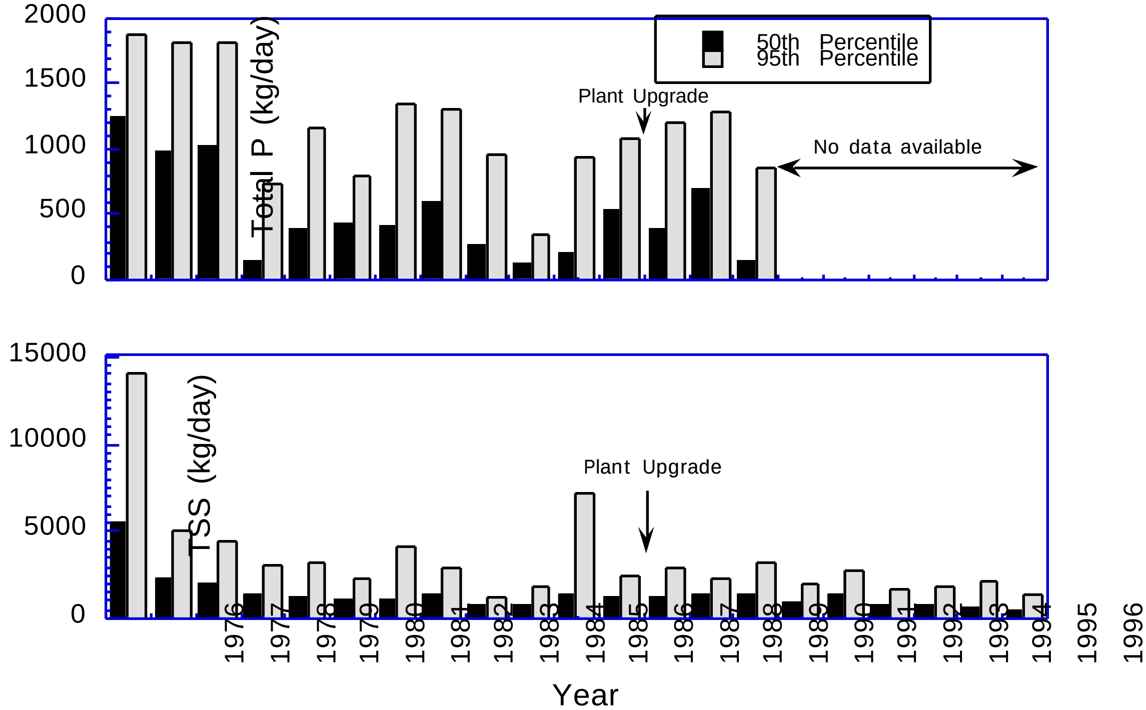


Figure 9. Third-quarter median and 95th percentile pollutant loads (kg/day) of Total Phosphorus (Total P) and Total Suspended Solids (TSS) from the Columbus Southerly WWTP, 1976 through 1996.

Table 6. Acute (TUa) toxicity bioassay data collected from Columbus Southerly WWTP. All tests were performed by Ohio EPA personnel.

	Cumulative Percent Mortality	
Date	*Pimephales promelas*	*Ceriodaphnia dubia*
April 15-16, 1996		
Upstream	0	0
Acute Mix Zone	0	90
Chronic Mix Zone	0	10
Grab @ Bldg 001-Day 1	0	100
Grab @ Pipe 001-Day 1	0	95
Composite 001	0	100
Grab @ Bldg 001-Day 2	0	100
Grab @ Pipe 001 -Day 2	0	100
December 4-5, 1995		
Upstream	5	0
Acute Mix Zone	0	0
Chronic Mix Zone	0	0
Grab 001-Day 1	0	0
Composite 001	0	0
Grab 001-Day 2	0	0

Columbus Collection System

The city of Columbus, Division of Sewerage and Drainage services a total area of approximately 100,000 acres. The current (1996) service area includes 5,286 acres of combined sewerage drainage, which represents 5.2 percent of the current service area. There are approximately 2,016 miles of sanitary sewers, 1,216 miles of storm sewer and 202 miles of combined sewers (9.1%) within the service area. Of these sewers, approximately 550 miles are major interceptors.

The sanitary sewer system for the City of Columbus consists of both combined and separate sewers. There are 34 permitted regulator discharges, relief structure overflows or storm tank overflows in the system known as combined sewers (CSOs)(Tables 7 and 8). The storm tank overflow structures at Whittier St. (Whittier St. storm tank-Scioto River) and Main St. (Alum Creek storm tank-Alum Creek) are the primary relief points for the entire collection system. Previous studies found that, by volume, the Whittier St. storm tank accounts for 90% of all CSO releases, and that the Alum Creek storm tank ranks second, accounting for 7% (Ohio EPA 1985). These structures were designed in the 1930s, predicated on the capture of large amounts of pollutants to improve local water quality. The tanks act as temporary holding basins during small storm events, holding sewage until the levels in the interceptor sewers subside, or, in the event of a large storm events, providing primary treatment prior to discharge. Solids and floatables are retained in the tank and are returned to the city's WWTPs for treatment. The effectiveness of the treatment during higher flows may be limited. During a compliance inspection conducted in February 1997, Columbus was finalizing a Sewer Capacity Study examining areas of high infiltration and inflow (I/I) and which areas of the sewer system are at or near capacity.

The City of Columbus is actively collecting information on suspected sanitary sewer relief locations throughout the Columbus sanitary sewer collection system. These "relief" sewers constitute separate sanitary sewer overflows (SSOs) which are designed to discharge directly to a storm sewer when the level in the "relief" sewer reaches a certain elevation. To date, the sanitary sewer collection system has approximately 100 unpermitted sanitary sewer "relief" discharge points which ultimately discharge to storm sewers or creeks and ditches. The frequency of these discharges is unknown and their effects to receiving streams is unclear. A list of SSOs including the relief location, type of discharge, and discharge location are provided in Table 9. The Sewer Maintenance Operations Center continues to investigate all suspected sanitary sewer relief locations.

The City of Columbus has four bypasses that are regularly monitored. Columbus Southerly has two monitored bypasses at outfall 002 at the treatment facility, and outfall 006 Alum Creek Storm Tank Overflow. The Jackson Pike WWTP uses outfall 018 Whittier Street Storm Tank Overflow and 019 Whittier Street Storm Tank Bypass.

Table 7. List of combined storm and sanitary sewer overflows (CSOs) located in the city of Columbus sanitary collection system. These discharge points are at combined sewer regulators.

Ref. No.	Location	Outfall No.	Receiving Stream
R-1	Markinson & Wilson	4PF00000029	Scioto River
R-2	Moler Street	4PF00000020	Scioto River
R-3	Whittier & Front	4PF00000033	Scioto River
R-4	Rich Street	4PF00000016	Scioto River
R-5	Town Street	4PF00000015	Scioto River
R-6	Broad Street	4PF00000017	Scioto River
R-7	Long Street	4PF00000012	Scioto River
R-8	Spring Street	4PF00000011	Scioto River
R-9	Chestnut Street	4PF00000010	Scioto River
R-10	Maple & West Street	4PF00000009	Scioto River
R-11	Spruce/Henry Street	4PF00000028	Scioto River
R-12	First & Perry	4PF00000032	Olentangy River
R-13	Third & Perry	4PF00000027	Olentangy River
R-14	King Avenue	4PF00000007	Olentangy River
R-15	Regulator at OSU/Indianola Ave.	4PF00000006	Olentangy River
R-16	Tuttle Park at Frambes	4PF00000031	Olentangy River
R-17	Frambes & Neil Avenue	4PF00000005	Olentangy River
R-18	Hudson Street	4PF00000004	Olentangy River
R-19	Short Street (Peters Run)	4PF00000034	Scioto River
R-22	Cozzin Street	4PF00000008	Scioto River
R-24	Harmon & Emig	4PF00000022	Scioto River
R-25	Spring & West	4PF00000035	Scioto River

Table 8. List of combined sanitary sewer overflows (CSOs) without regulators located within the city of Columbus sanitary collection system.

Location	**Outfall No.**	**Receiving Stream**
Civic Center Drive & Capital St.	4PF00000013	Scioto River
Civic Center Drive & State St.	4PF00000014	Scioto River
Whittier Street Storm Tanks (Discharge)	4PF00000018	Scioto River
Whittier Street Storm Tanks (Bypass)	4PF00000019	Scioto River
West Side Interceptor Gate Chamber Renick Run Storm Sewer Connection	4PF00000036	Scioto River
Old Dry Flow Sewer Connection to Renick Run Storm Sewer	4PF00000037	Scioto River
Scioto Interceptor Connection to Renick Run Storm Sewer	4PF00000038	Scioto River
Third Avenue Relief Structure Discharge	4PF00000039	Olentangy River
Main Interceptor Sewer, Discharge N of Hill Ave.	4PF00000040	Olentangy River
Crossing south of Roads End	4PF00001004	Alum Creek
Alum Creek Storm Tank	4PF00001006	Alum Creek

Table 9. City of Columbus Sanitary Sewer reoverflow relief points discharging to storm sewers or open waterways. Reference number refers to the numbering system used by the city to track the SSOs in the collection system. MH = manhole.

Ref. No.	Relief Location	Type	Receiving Waters
95	MH Sullivant Ave & e/o Dana Ave	A	Trib. to CSO
92	Canonby Pl	A	Scioto RV at Renick Run storm
96	MH alley n/o Broad St & e/o Glenwood	A	Trib. To CSO
109	MH s/s Third Ave, 490’ w/o Olentangy R. Rd.	A	Olentangy River s/o Third
111	MH s/s Third Ave, 690’ w/o Olentangy R. Rd.	A	Olentangy River s/o Third
103	MH s/s Third Ave, 290’ w/o Olentangy R. Rd.	A	Olentangy River s/o Third
100	MH Norhtwest Blvd & Hilo Lane	A	Olentangy River s/o Third
107	MH f/o 814 W Third Ave	A	Olentangy River s/o Third
126	MH f/o 722 E Mound Street	A	Scioto RV s/e Whittier tanks
133	MH Columbus & Linwood	A	Alum CR n/o Livingston
132	MH Columbus & Studer	A	Alum CR n/o Livingston
143	MH First Ave & Broadview Ave	A	ditch s/s RR Dublin Road
147	MH alley n/o King & w/o Star Ave	A	Olentangy R. s/o King
146	MH Third & Morning	A	Olentangy R. s/o Fifth
148	MH King Ave & alley w/o Virginia	A	Olentangy R. s/o King
151	MH Meadow Rd & Third Ave	A	Olentangy R. s/o Fifth
154	MH Third & Virginia	A	Olentangy R. s/o Fifth
149	MH Fifth Ave & North Star	A	Olentangy R. s/o Fifth
150	MH King & North Star	A	Olentangy R. s/o King
157	MH Fifth Ave & Eastview/Kenny	A	Olentangy R. s/o Fifth
156	MH alley n/o Hill Ave w/o Perry St	A	Olentangy R. & alley n/o Hill
110	MH Third Ave & Oxley (east)	A	Olentangy R. s/o Fifth
105	MH Third Ave & Oxley (west)	A	Olentangy R. s/o Fifth
181	MH Cole & alley e/o Seymour	A	Alum CR in Kenton
189	MH Cole & Bule	A	Alum CR in Kenton
177	MH Cole & alley w/o Seymour	B	Alum CR in Kenton
179	MH Cole & Seymour	A	Alum CR in Kenton
198	MH Bulen & Gault	A	Alum CR n/o Livingston
185	MH Gault & alley w/o Kelton	A	Alum CR n/o Livingston
188	MH 2nd Alley w/o Seymour, 80’ n/o Gault	A	Alum CR n/o Livingston
199	MH Gault & Alley w/o Miller	A	Alum CR n/o Livingston
194	MH Columbus & Miller	A	Alum CR n/o Livingston
192	MH Columbus & alley w/o Kelton	A	Alum CR n/o Livingston
193	MH Gault & alley e/o Kimball	A	Alum CR n/o Livingston
190	MH n/s Gault & alley w/o Lilley	A	Alum CR n/o Livinston
203	MH Lockbourne & Lawrence	A	Scioto R. w/o Barthman/High
201	MH Oakwood & Lawrence	A	Scioto R. w/o Barthman/High
210	MH Bruck & Woodrow	A	Scioto R. w/o Barthman/High
213	MH Hosack & Fourth	A	Scioto R. w/o Barthman/High
211	MH e/s Parsons @ 1354 Parsons	A	Scioto R. w/o Barthman/High
206	MH Bruck & Reeb	A	Scioto R. w/o Barthman/High

Table 9. continued

Ref. No.	Relief Location	Type	Receiving Waters
205	MH Bruck & alley n/o Hosack	A	Scioto R. w/o Barthman/High
207	MH Parsons & Kian Avenue	A	Scioto R. w/o Barthman/High
220	Regulator southeast of Harmon & Emig	B	Scioto R. at Renick Run storm
217	MH southeast of Harmon & Emig	A	Scioto R. at Renick Run storm
399	Structure r/o 2250 McKinley Ave	A	Scioto R. next to structure
382	S/o 1328 Dublin Road	D	to ground along Dublin Road
225	Dublin Road pump station (SA 6)	A	borrow pit s/w of pump station
241	MH Preston Rd & Fair Ave	A	Alum CR at Storm sewer at Fair
244	Regulator at Roads end	B	Alum CR w/o regulator
246	Castle Rd pump station (SA 2)	B	Kian Run w/o pump station
248	Frank Road pump station (SA 3)	C	Kian Run w/o pump station
249	MH e/o Route 104 JPWWTP	A	ditch next to structure
250	MH Hague Ave n/o Mound Street	A	Early Ditch e/o Mound/Wayne
252	MH Wicklow & Alley w/o Powell Ave	A	Early Ditch e/o Mound/Wayne
256	MH Binns Blvd & Alley s/o Palmetto St	A	Early Ditch e/o Mound/Wayne
254	MH Alley n/o Sullivant, e/o Roys Ave	A	Early Ditch e/o Mound/Wayne
266	M Howey & Briarwood	A	Glen Echo Ravine e/o I71
299	MH Akola & Alley w/o Azelda	A	Glen Echo Ravine e/o I71
273	MH Akola & Alley w/o Hiawatha	A	Glen Echo Ravine e/o I71
267	MH Akola & Alley w/o Atwood Terrace	A	Glen Echo Ravine e/o I71
264	MH Howey & Maynard	A	Olentangy n/o Woody Hayes Dr.
271	MH Azelda & Alley n/o Hudson	B	Olentangy n/o Woody Hayes Dr.
263	MH Velma & Alley s/o Hudson	B	Olentangy n/o Woody Hayes Dr.
381	MH Maynard & Velma	A	Olentangy n/o Woody Hayes Dr.
274	MH Republic & Ontario	A	Glen Echo Ravine e/o I71
380	MH Lexington & Alley n/o Hudson	B	Olentangy n/o Woody Hayes Dr.
276	MH Criarwood & Alley w/o McGuffy	A	Glen Echo Ravine e/o I71
275	MH Hamilton & Alley n/o Duxberry	B	Olentangy n/o Woody Hayes Dr.
279	MH Hudson & Parkwood	A	ditch Parkwood crosses s/o Mock Rd.
284	MH n/o Pacemont at Olentangy River	A	Olentangy R. n/o Placemont
288	MH e/o Olentangy St & Indianola	A	Glen Echo Ravine & Indianola
285	MH Midgard & Alley e/o Indianola	A	Walhalla Ravine At
292	MH Akola & Alley w/o Osceola	A	Glen Echo Ravine e/o I71
303	MH Akola & Alley e/o Homecroft	A	Glen Echo Ravine e/o I71
291	MH Osceola & alley s/o Weber	A	Glen Echo Ravine e/o I71
301	MH Alamo & alley w/o Osceola	A	Glen Echo Ravine e/o I71
304	MH Alamo & Alley w/o Pontiac	A	Glen Echo Ravine e/o I71
289	MH Akola & Alley w/o Pontiac	A	Glen Echo Ravine e/o I71
306	MH Brement & Alley n/o Melrose	A	Ditch e/o Perdue & n/o Aberdeen
314	MH s/s Weber & Alley w/o Cleveland	A	Ditch e/o Perdue & n/o Aberdeen
308	MH Minnesota & Hamilton	A	Glen Echo Ravine e/o I71
310	MH e/o McGuffey & Aberdeen	A	Glen Echo Ravine e/o I71

Table 9. continued

Ref. No.	Relief Location	Type	Receiving Waters
305	MH Lakeview & Alley w/o Cleveland Ave	A	Ditch e/o Perdue & n/o Aberdeen
307	MH Bremen & Alley n/o Weber	A	Ditch e/o Perdue & n/o Aberdeen
312	MH Alley e/o Bremen & Brighton Road	A	Ditch e/o Perdue & n/o Aberdeen
317	MH Aberdeen & Parkwood	A	Ditch e/o Perdue & n/oAberdeen
315	MH Eddystone & Suwanee	A	Ditch e/o Perdue & n/oAberdeen
318	MH Weber & Alley e/o Cleveland	A	Ditch e/o Perdue & n/o Aberdeen
322	Williams Rd Pump Station (SA 1)	B	Ditch e/o Perdue & n/o Aberdeen
325	MH n/o N. Broadway & e/o Olentangy R.	A	Olentangy R. n/o W N. Broadway
326	MH Olentangy Blvd & Montrose Way	A	Olentangy R. w/o relief
323	MH Webster PK & Olentangy Blvd	A	Ditch s/s Webster Park w/o Olentangy Blvd.
329	MH e/s Indianola & Alley E N. Broadway	A	Walhalla Ravine at Walhalla/Diana
330	MH Pauline & Atwood Terrace	A	Overbrook Ravine e/o Indianola
337	MH Richards & Granden	A	Olentangy R. n/o West N Broadway
338	MH Northridge & Atwood Terrace	A	Overbrook Ravine e/o Indianola
346	MH w/o Rustic Pl & Olentangy Blvd	A	Olentangy R. w/o relief
352	MH n/s Weisheimer & Starrett	A	Olentangy R. w/o relief
349	MH Alley e/o High & s/o Schreyer Pl	B	Cr. w/o High & s/o Croswell Whetstone Prk.
351	MH w/o Olentangy Blvd & n/o Royal Forest	A	Olentangy w/o relief
350	MH Wetmore & Alley e/o High Street	B	Ditch e/o Rustic Brdg & s/o Beechwold Blvd
360	MH s/o Rathbone & e/o Delawanda	A	Ditch s/o Rathbone & Delawanda
364	MH Plum Ridge n/o Lornaberry	A	Ditch n/s Main & w/o McNaughten
368	MH Alley e/o High & s/o Lincoln	A	Rush Run r/o 126 Sharon Springs

A-Discharge occurs when a manhole fills to a certain elevation
B-Discharge occurs when sewage flows over a weir
C-Discharge occurs when a pump station wetwell fills to a certain elevation
D-Discharge occurs when the sewer pipe fills to a certain level

The total volume of sewage released to the Scioto River since 1990, as reported in the Monthly Operating Reports (MOR) submitted by the City of Columbus, is presented in Table 10 and Figures 10 through 15. The 1990 data were used as a baseline for comparison since that year was considered to be the wettest year on record since 1948 (53.18 inches of precipitation in 1990 versus 45.56 inches in 1996). This information only exists for those bypasses that are permitted and monitored under the current NPDES permit. Additional bypasses exist but monitoring is not required, therefore these numbers may underestimate the amount of raw sewage actually reaching the Scioto River.

Most of the bypass events occur at the Whittier Street Storm Tank Overflow closely followed by Columbus Southerly 002 bypass. The Whittier Street Tank Overflow (018) also has the greatest percentage of untreated sewage released to the Scioto River. The Whittier Street Storm Tank Bypass has no flow measuring device therefore the volume of sewage released at this point is unknown. It is only used when the Whittier Street Storm Tank overflow cannot handle the volume of sewage, usually under high precipitation events.

Flow, $cBOD_5$, and suspended solids were reported by the City of Columbus for each day that the Whittier Street Storm Tank Overflow and Columbus Southerly 002 bypass discharged. According to these records 1993, followed closely by 1996, saw the highest loadings of $cBOD_5$ and suspended solids for both overflows. Flows were also higher in 1993 and 1996.

Since 1985, the city of Columbus has been implementing an Ohio EPA approved industrial pretreatment program at both wastewater treatment facilities. The Industrial Waste Pretreatment Section monitors and samples local industrial discharges to the sewer system. They also inspect industrial dischargers' facilities, evaluate compliance performance, issue Discharge Permits and Permits-to-Install, review spill control programs, and issue violation notices.

Approximately thirteen (13) percent of total volume of wastewater to the treatment plants is industrial. A total of 92 significant industrial users discharge into both the Southerly and Jackson Pike plants. Fifty eight (58) of these industrial users are listed as categorical industries which include metal fabricators, metal finishers, electroplaters, food processors, a paper products manufacturer, and a brewery.

Table 10. Annual listing of the amount of raw sewage bypassed within the City of Columbus sanitary sewer system. This information is reported in the Monthly Operating Reports (MORs). UNK= unknown; NA = not available.

Year	Days of Bypass	Flow Bypassed (million gallons)	Duration of Bypass (hours)	% Gallons Bypassed vs. Gallons Treated	Annual Daily Average
Columbus Southerly Bypass (002)					
1990	59	2440.2	775	6.2	6.7
1992	35	560.7	408.7	1.5	1.5
1993	81	1732.9	1370.2	5.3	4.7
1994	18	659.5	194.5	2.4	1.8
1995	24	797.8	252	3.1	2.2
1996	54	2143.5	737	6.9	5.9
1997*	23	1299.8	275.5	NA	3.6
Alum Creek Storm Tank Bypass (006)					
1990	22	47.9	76.5	**	0.1
1992	5	21.9	25.1	**	0.06
1993	9	35.0	19.7	**	0.09
1994	2	11.9	11.3	**	0.03
1995	11	70.3	30.6	**	0.19
1996	13	38.7	35.9	**	0.11
1997*	7	91.2	>19.8	**	0.25
Whittier Street Storm Tank Overflow (018)					
1990	175	6770.3	2756	33.2	18.5
1992	63	1657.7	808	8.9	4.54
1993	141	4374.5	2482.	19.9	12.0
1994	39	1008.8	396	4.1	2.76
1995	110	3496.7	1531	11.3	9.58
1996	116	4130.0	1586	13.3	1.3
1997*	62	1926.5	816	NA	5.3
Whittier Street Storm Tank Bypass (019)					
1990	9	UNK	50.4	***	--
1992	NA	NA	NA	***	--
1993	NA	NA	NA	***	--
1994	0	0	0	***	--
1995	9	UNK	36	***	--
1996	16	UNK	69	***	--
1997*	7	UNK	19.3	***	--

* Data available through November 1997

** Calculated as part of the Columbus Southerly Bypass (002)

*** Calculated as part of the Whittier Street Storm Tank Overflow (018)

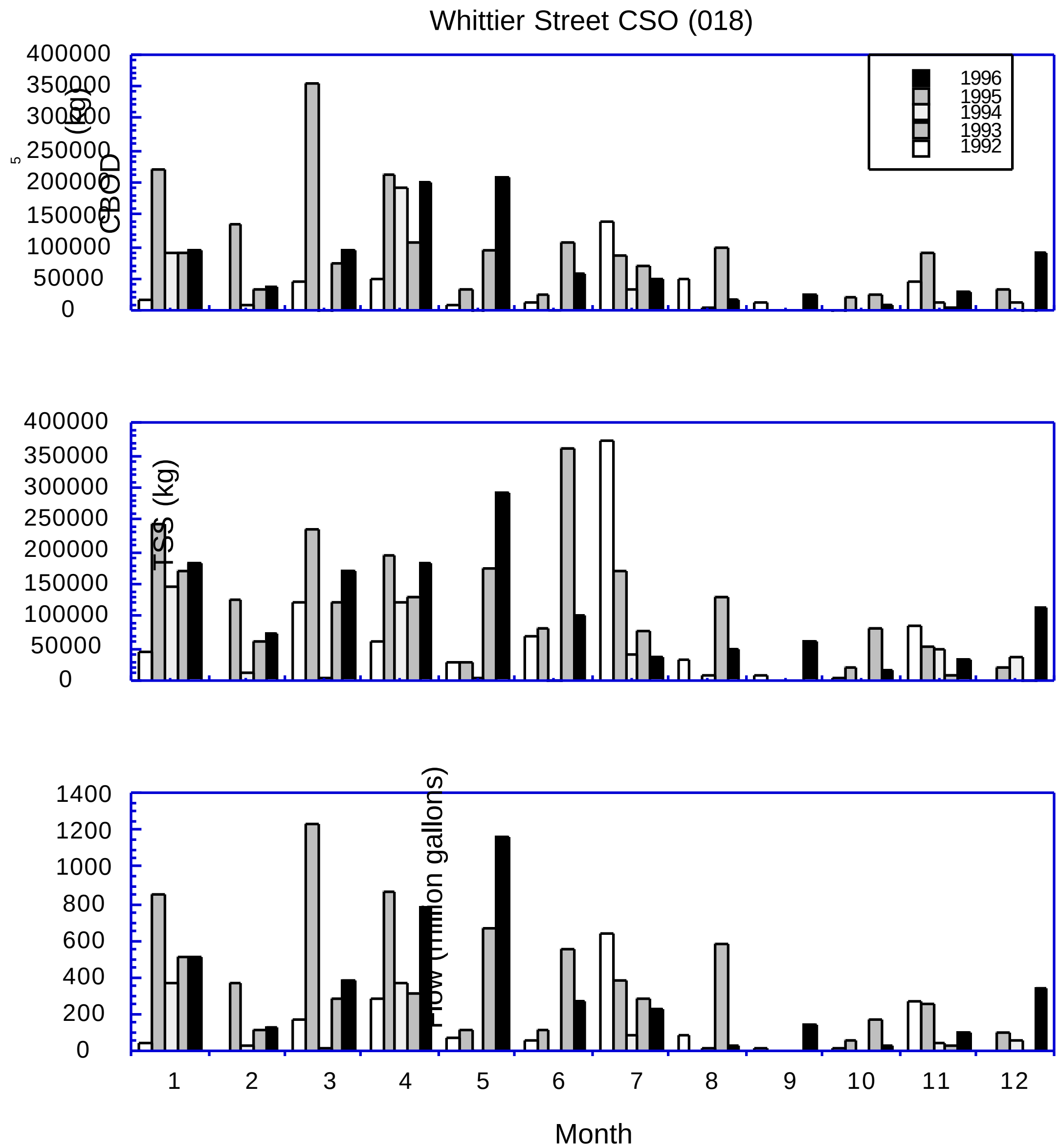


Figure 10. Monthly cumulative release volume and pollutant loads of five-day carbonaceous Biochemical Oxygen Demand ($cBOD_5$) and Total Suspended Solids (TSS), from the Whittier St. CSO, 1992 through 1996.

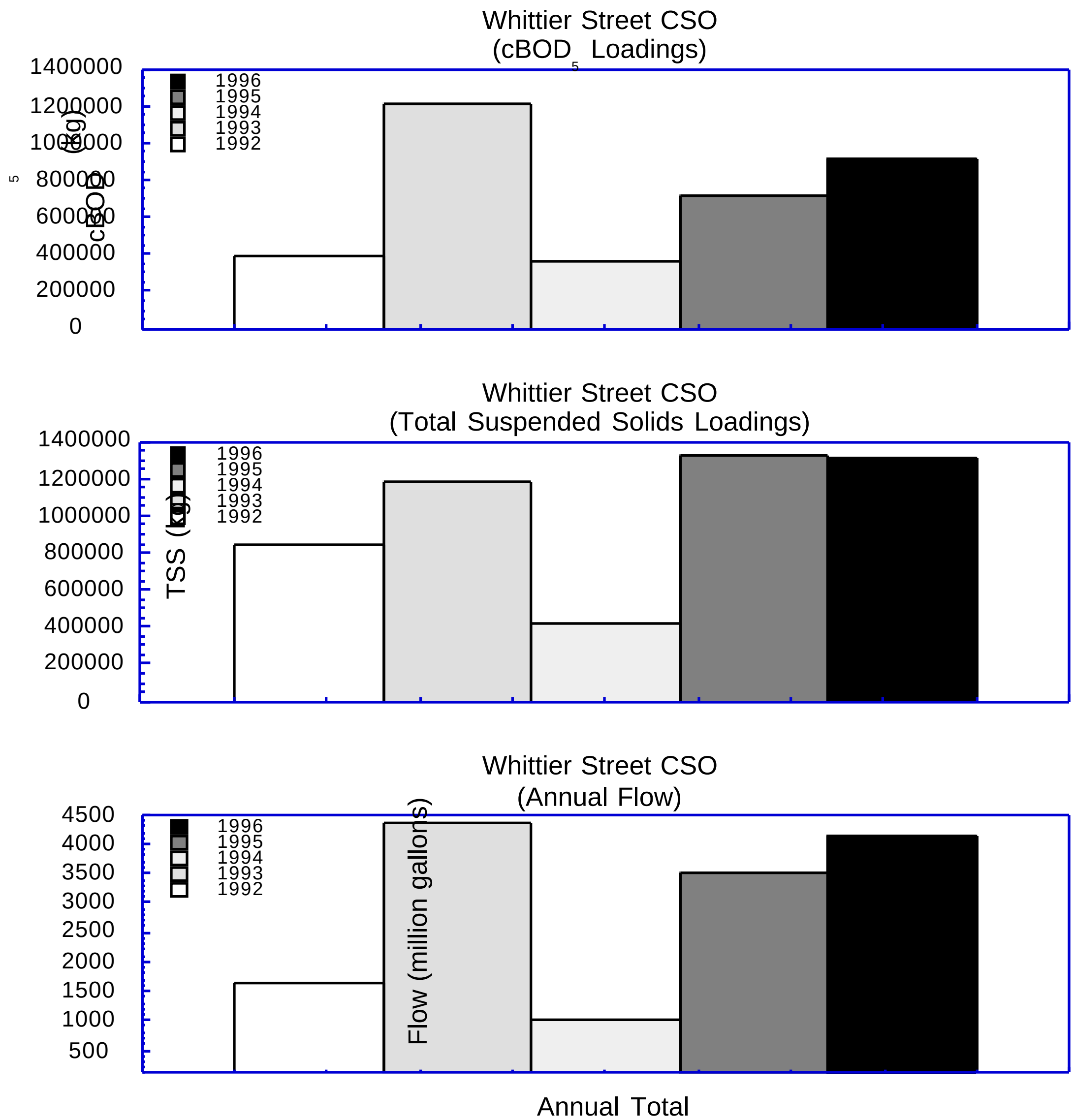


Figure 11. Annual cumulative release volume and pollutant loads of five-day carbonaceous Biochemical Oxygen Demand ($cBOD_5$) and Total Suspended Solids (TSS), from the Whittier St. CSO, 1992 through 1996.

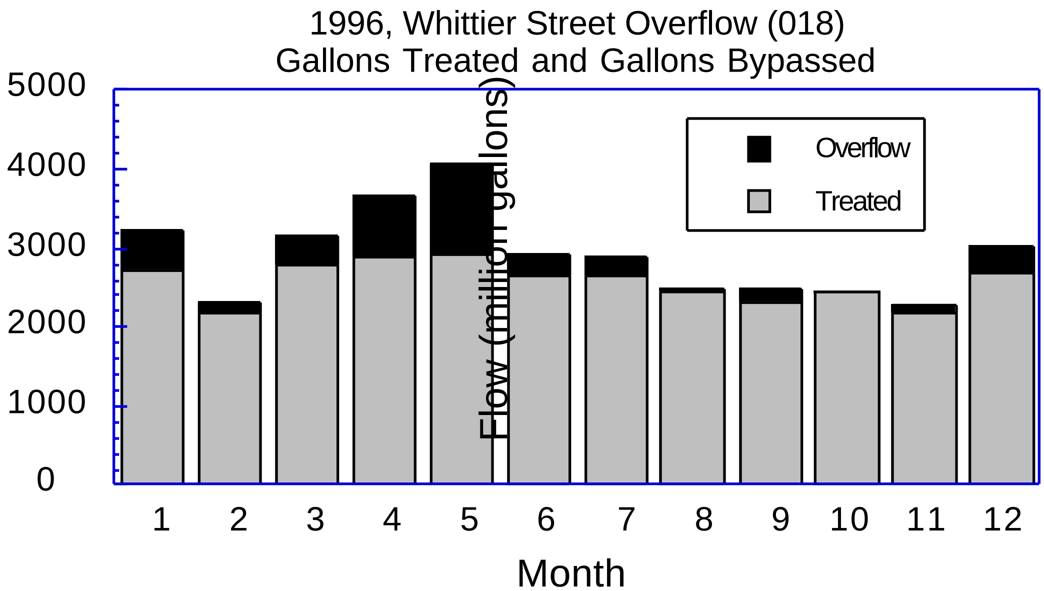


Figure 12.Monthly cumulative release (treated and bypassed) from the Whittier St. CSO, 1996.

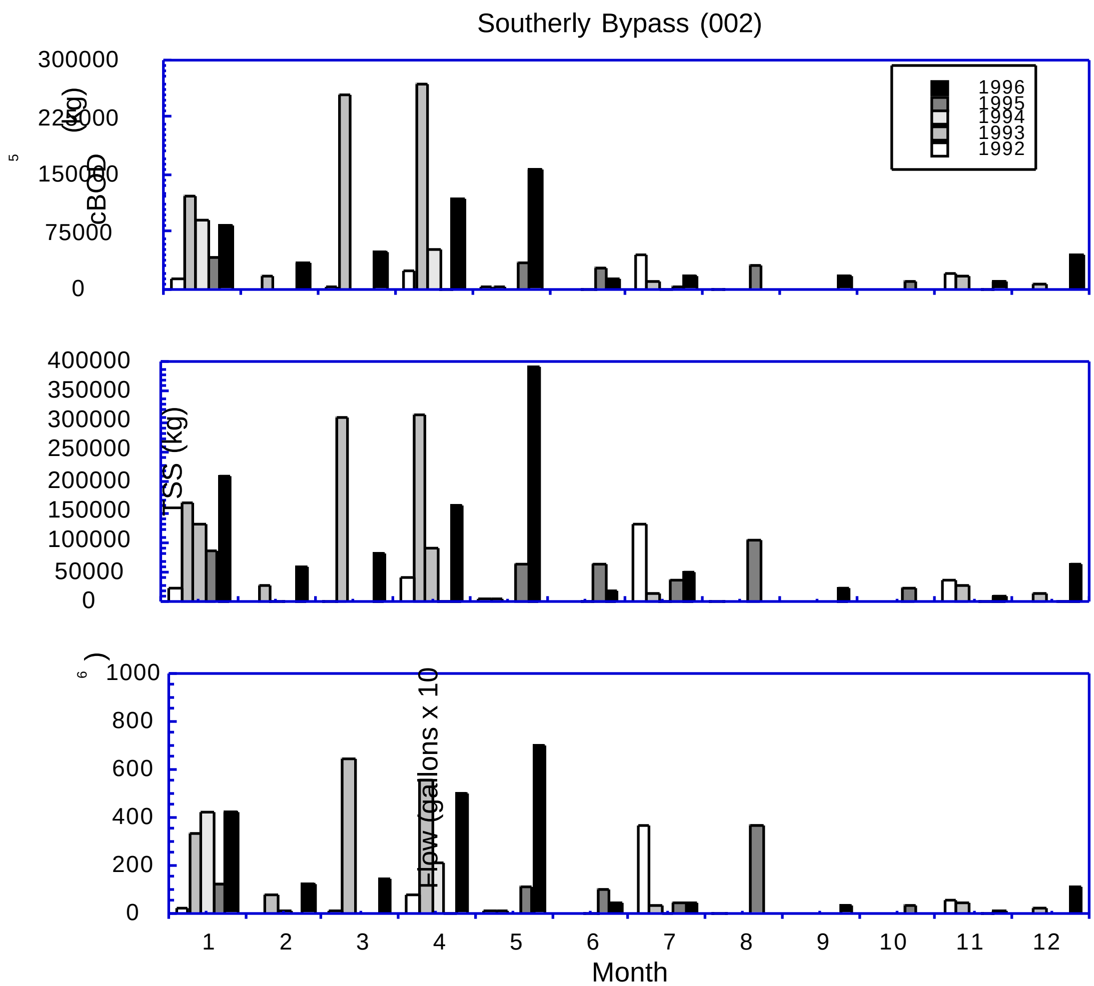


Figure 13. Monthly cumulative release volume and pollutant loads of five-day carbonaceous Biochemical Oxygen Demand ($cBOD_5$) and Total Suspended Solids (TSS), from the Columbus Southerly WWTP bypass (outfall 002), 1992 through 1996.

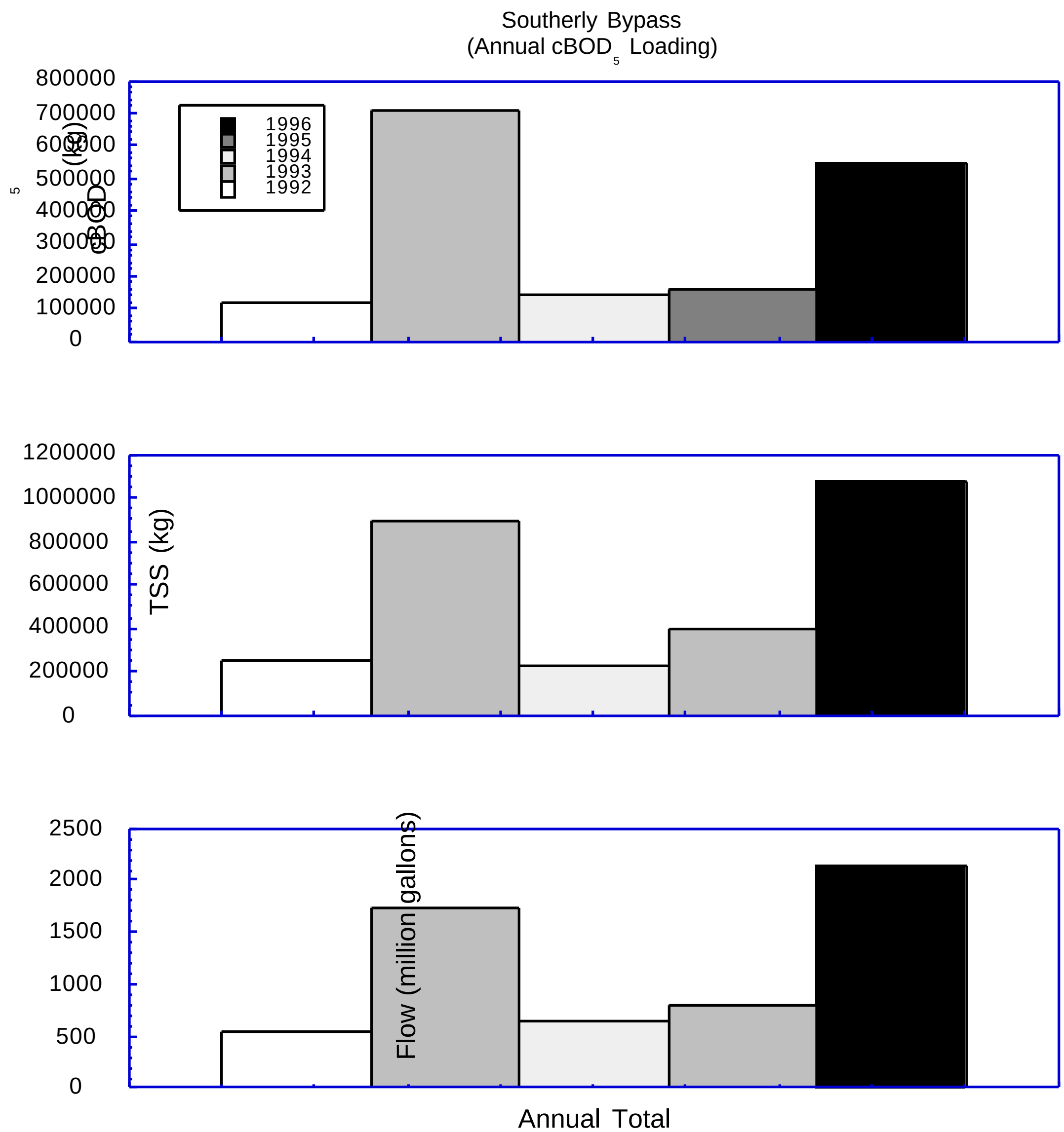


Figure 14. Annual cumulative release volume and pollutant loads of five-day carbonaceous Biochemical Oxygen Demand ($cBOD_5$) and Total Suspended Solids (TSS), from the Columbus Southerly Bypass (oufall 002), 1992 through 1996.

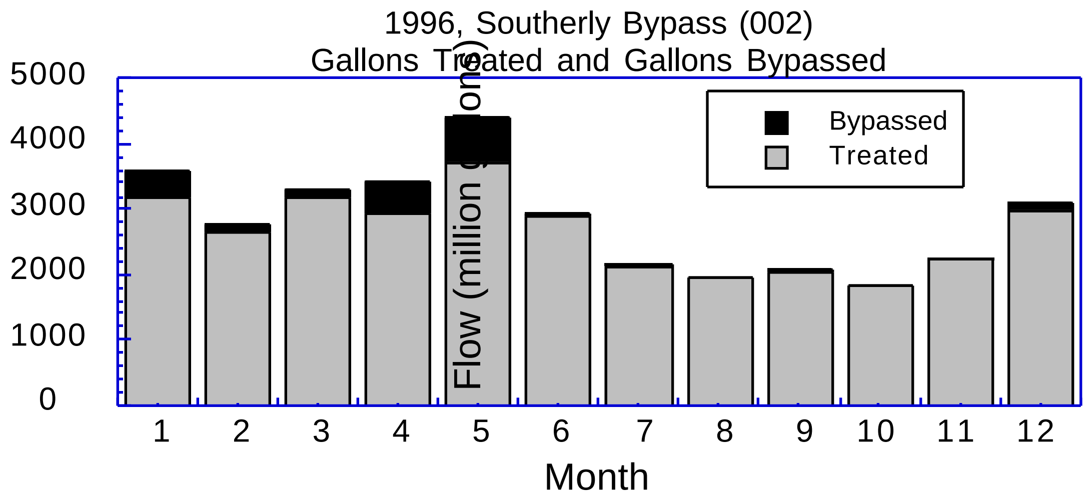


Figure 15.Monthly cumulative release (treated and bypassed) from the Columbus Southerly Bypass (outfall 002), 1996.

Columbus Southern Power Company (via canal to Scioto River RM 116.46)

Columbus Southern Power owns and operates the Picway Generating Station at 9301 Route 23 in Pickaway County. The facility consists of operating coal-fired boiler with a capacity of 107 megawatts (gross) of electricity. The plant releases combined non-contact cooling water and ash lagoon discharge into the cooling water canal that reaches the Scioto River at RM 116.46. The total volume of wastewater discharged to the Scioto River is 100 MGD. Wastewater routed to the ash lagoons is comprised of boiler blowdown/drainage, fly ash/bottom and transport water, drain sump, and water softener waste. The ash lagoons discharge through outfall 601 to the cooling water canal. The cooling water canal consists of intake screen wash water, plant roof drain water, turbine floor drain water, and once-through cooling water.

Lockbourne Lodge MHP (via Storm sewer to Unnamed Tributary to Scioto River RM 114.21; 3.35)

Lockbourne Lodge MHP WWTP was constructed in 1970 and upgraded in 1992. The plant is located at 10610 Ashville Pike in Lockbourne with a design flow of 0.054 MGD and serves 183 lots. The facility maintains a treatment process of extended aeration, fixed media clarification, dosing to sand filters, and chlorination prior to discharging into a storm sewer to an unnamed tributary of the Scioto River at RM 114.21. Both Lockbourne Lodge MHP and Meadowbrook Village MHP discharge into the same unnamed tributary of the Scioto River.

Meadowbrook Village MHP (Unnamed Tributary to Scioto River RM 114.21; 3.35)

The Meadowbrook facility was constructed in the 1960s at 10694 Ashville Road, Lockbourne Ohio and was originally known as Poplar Grove MHP. The existing system consists of a 1,100 gallon trash trap, a 25,500 gallon aeration unit, a 6,400 gallon clarifier, a polishing lagoon and chlorination. In November 1996, Ohio EPA received a proposed plan to upgrade the current plant. The plan was to add sand filters and sludge handling and dechlorination equipment. The Permit-to-Install to complete these upgrades was issued on April 14, 1997. During an inspection conducted by Ohio EPA and the Pickaway County Health Department during August 1997, an illegal bypass was discovered. Illegal stand pipes were observed in the sand filters. Dye testing demonstrated that the sand filters could be bypassed through the stand pipes. It was documented by the Ohio EPA that these pipes were removed on September 2, 1997. Inflow/infiltration is an existing problem resulting in a loss of solids and is currently being investigated. The existing plant has a design flow of 0.030 MGD for 115 lots and discharges into the same unnamed tributary of the Scioto River as the Lockbourne Lodge MHP facility.

Village of Commercial Point WWTP (Grove Run to Scioto River 111.72; 3.24)

The Village of Commercial Point WWTP is located on Walker Road. The existing plant, constructed in 1981, was designed for an average flow of 0.08 MGD with a current average flow of 0.102 MGD. Currently, the WWTP discharges to Grove Run. The treatment process utilizes flow equalization, extended aeration, twin clarifiers and chlorination. Projected growth in population prompted the

Village to submit a plan for a plant expansion and relocation. In December 1996, a PTI was submitted for the treatment facility which would be located at State Route 762 and discharge directly to the Scioto River. The new treatment system will consist of bar screens, a comminutor, and oxidation ditch, final clarifiers, aerated sludge holding, sludge drying beds, and a sludge storage area. Ultraviolet disinfection and post aeration are also proposed.

Village of South Bloomfield WWTP (Scioto River RM 109.35)

The activated sludge plant in South Bloomfield was constructed in 1992, and began operation in 1993. The treatment plant serves Scioto Estates MHP, the village of Millport, and a few fast food restaurants. Mostly domestic/residential sewage is treated; no significant industrial inputs contribute to the system. Treatment currently consists of a bar screen, comminutor, extended aeration tank, final clarification tank, chlorination/dechlorination, and aerobic sludge digestion. The facility has a design capacity of 0.162 MGD that is discharged to the Scioto River at RM 109.35.

Tink's Restaurant (Railway Ditch to Dry Run to Scioto River RM 103.01; 0.4)

Tink's Restaurant is located at 2815 North Court street in Circleville. The facility was constructed in 1989 with a design capacity of 0.0025 MGD. The treatment process involves a grease trap, trash trap, extended aeration, dosing chamber, surface sand filters and a chlorine contact tank. The effluent discharges to an old railroad ditch and then to Dry Run ultimately reaching the Scioto River at RM 103.01. The facility has a history of unacceptable wastewater treatment plant operations with sewage overflowing the sand filter beds and discharging into Dry Run.

Chemical Water Quality

Water samples were collected at eighteen sampling locations by Ohio EPA and City of Columbus personnel. Ohio EPA stations were sampled at least five times between June and October, 1996 while several of the stations sampled by the City were collected on a weekly basis. Not all chemical parameters were sampled every time by the City, but a minimum of five samples were used to calculate mean values for typical water quality measures. Results of the analysis are presented in Appendix Tables B.

Sampling stations were selected to provide information concerning ambient and effluent water quality, and to assess potential impacts from municipal and industrial discharges in the Scioto River study area. Analytical results were evaluated to document exceedences or violations of Ohio Water Quality Standards (Ohio Administrative Code Chapter 3745-1) based on appropriate aquatic life and recreational use designations and to document violations or exceedences of public water supply use criteria. Public water supply criteria are violated only if a stream segment is so designated . The Scioto River is designated as a public water supply between RM 148.8 and RM 133.4. The results are summarized in Table 11.

Numerical chemical WQS criteria exist for the prevention of chronic toxicity (CAC), prevention of acute toxicity (AAC), and prevention of lethality (FAV) for several pollutants analyzed. The CAC and AAC values apply to outside mixing zone samples, while the FAV values apply for inside mixing zone samples. Minimum and average criteria exist for dissolved oxygen concentrations. Primary and Secondary Contact Recreation (PCR and SCR) criteria apply to fecal coliform counts. Mean concentrations of DO (dissolved oxygen), BOD_5 (5-day biochemical oxygen demand), NH_3-N (ammonia-nitrogen), NO_3+NO_2-N (nitrate+nitrite-nitrogen), TP (total phosphorus), and TSS (total suspended solids) were determined and plotted in a longitudinal fashion to display trends in these physical and chemical properties (Figures 16 and 17). Longitudinal concentrations of heavy metals are presented in Figures 18 and 19.

Flow conditions recorded from the U.S. Geological Survey flow gage in Columbus (RM 127.4) indicated river flows well above the critical Q_{710} (98 cfs) throughout the third-quarter (May-October) of 1996. Additionally, river discharge was typically above the 80 percent flow duration between May and November. Flows less than the 80% duration were observed in early July and early September. Peak discharge during the 1996 sampling effort (July - October) occurred in late July and mid to late September (Table 12 and Figure 20).

Results from the 1996 chemical sampling effort did not reveal significant water quality problems. Results from daytime grab samples indicated mean instream dissolved oxygen concentrations were well above the minimum and average WWH criteria of 4 mg/l and 5 mg/l, respectively. However, on three of five sampling days, dissolved oxygen concentrations were below the average criterion at RM

Table 11. Exceedences of Ohio EPA WQS (OAC 3745-1) for chemical/physical parameters in the Scioto River study area, 1996. (Units are #/100/ ml for fecal coliform, µg/L for metals, cyanide and pesticides, and mg/L for all other parameters).

Stream	River Mile	Exceedence:Parameter (value)
Scioto River (1996)		
	145.0	Iron (1800)* Fecal Coliform (6636)◊◊◊
	Dublin Pump Station>	
	144.5	Dissolved Oxygen(4.25, 4.50, 4.60)‡ Fecal Coliform (2600)◊◊
	136.2	Dissolved Oxygen (4.40)‡ Iron (1230)* Fecal Coliform (11636)◊◊◊
	129.0	Fecal Coliform (1400)◊ (2000)◊◊
	Dublin Road WTP>	
	133.4	Iron (1120, 1120)* Fecal Coliform (11636)◊◊◊
	Whittier St. CSO>	
	129.0	Lead (27)* Fecal Coliform (2000)◊◊, (1400)◊
	Techneglas>	
	Jackson Pike WWTP>	
	127.0	Total Phosphorus(1.00§, 1.01§) Fecal Coliform (>60000)◊◊, (1300)◊
	124.4	Total Phosphorus (1.00, 1.20, 1.00, 1.30, 1.60, 1.10, 2.90, 1.50, 1.90, 1.50, 1.90, 1.40)§ y-BHC (0.014)*
	120.0	Total Phosphorus (1.10, 1.50, 1.70)§ y-BHC (0.014)*
	Columbus Southerly WWTP>	
	118.1	Fecal Coliform (22500)◊◊◊
	117.3	Fecal Coliform (2600, 3900)◊◊ y-BHC (0.013)*
	115.3	Total Phosphorus (1.10)§
	102.0	Fecal Coliform (4400)◊◊
Olentangy River (1996)		
	0.63	Fecal Coliform (6700)◊◊◊, (3600)◊◊

Table 11. continued.

- * exceedence of numerical criteria for prevention of chronic toxicity [Chronic Aquatic Conc. (CAC)].
- ** exceedence of numerical criteria for prevention of acute toxicity [Acute Aquatic Conc. (AAC)].
- *** exceedence of numerical criteria for prevention of acute toxicity inside the mixing zone[i.e., Final Acute Value (FAV)].
- ‡ exceedence of the average warmwater habitat dissolved oxygen criterion (5.0 mg/L).
- ‡‡ violation of the minimum warmwater habitat dissolved oxygen criterion (4.0 mg/L).
- ◊ exceedence of the average Primary Contact Recreation criterion (1000/100 mL).
- ◊◊ exceedence of the maximum Primary Contact Recreation criterion (2000/100mL).
- ◊◊◊ exceedence of the maximum Secondary Contact Recreation criterion (5000/100 mL).
- § exceedence of the WWH phosphorus guideline (1 mg/L).

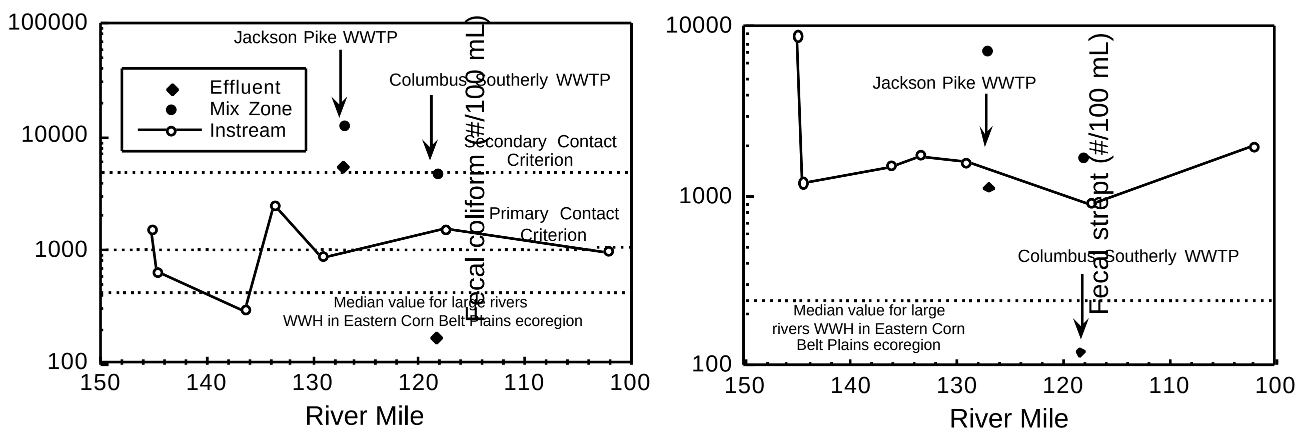


Figure 16.Mean longitudinal fecal coliform and fecal streptacoccus counts from the Scioto River, 1996.

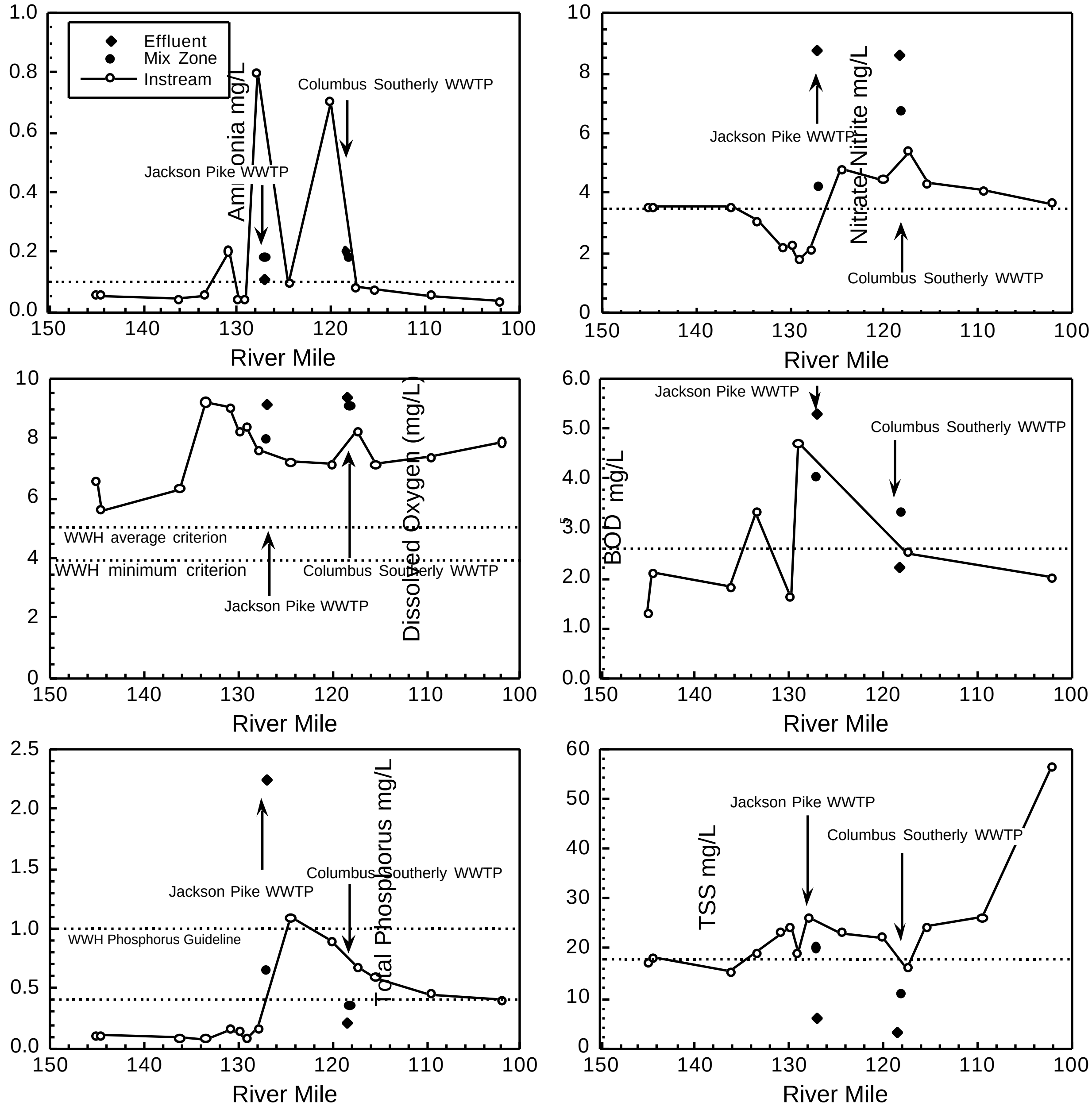


Figure 17. Mean longitudinal concentrations of Dissolved Oxygen, Ammonia-Nitrogen, Nitrate+Nitrite-Nitrogen, Five-day Biochemical Oxygen Demand (BOD_5), Total Phosphorus, and Total Suspended Solids (TSS), from the Scioto River, 1996. Unless otherwise noted dashed lines indicate median concentrations from large river, WWH reference stations within the Eastern Corn Belt Plains ecoregion.

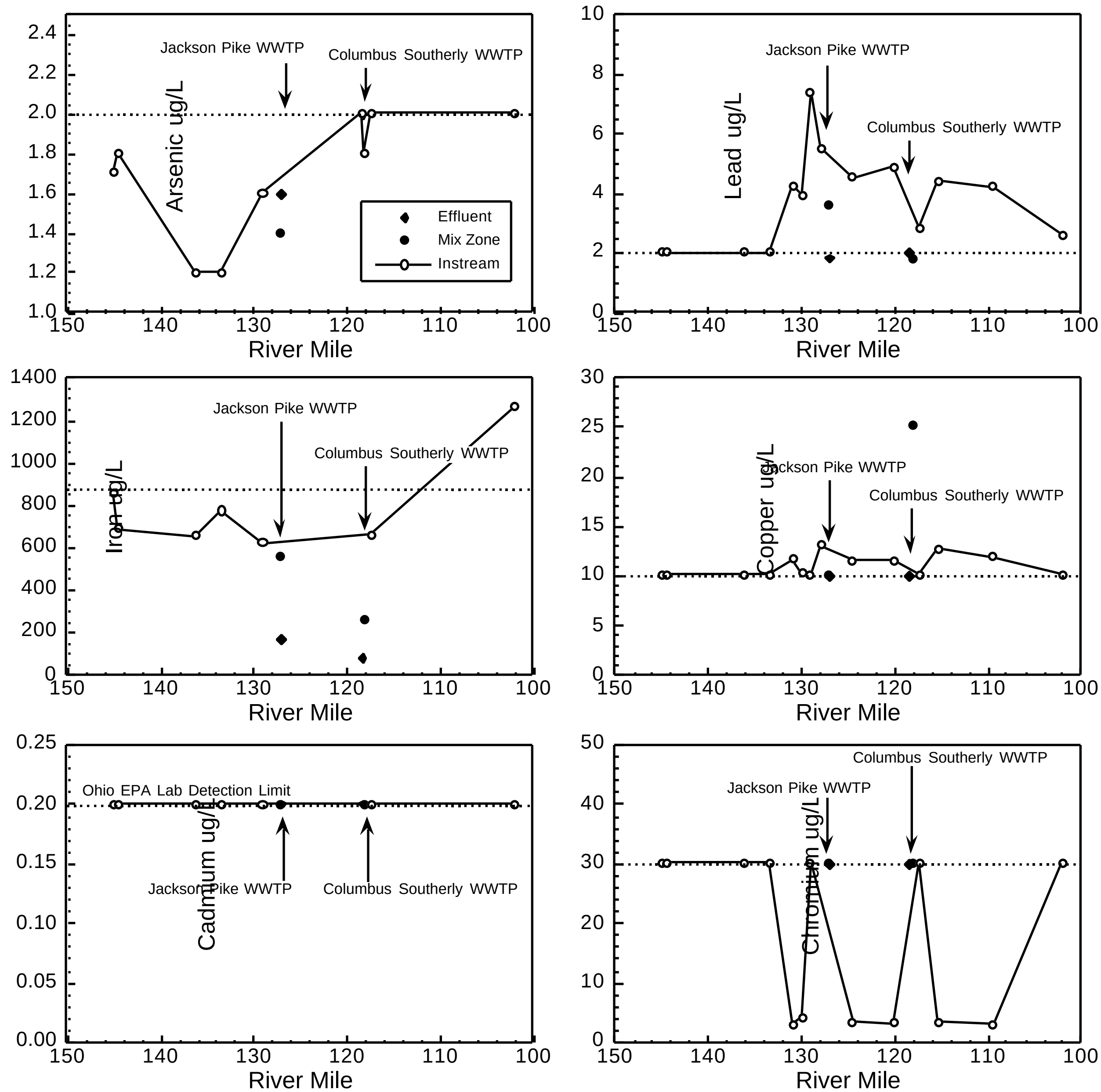


Figure 18. Mean longitudinal concentrations of selected metals from the Scioto River, 1996. Unless otherwise noted, dashed lines indicate median concentrations from large river WWH reference stations within the Eastern Corn Belt Plains ecoregion.

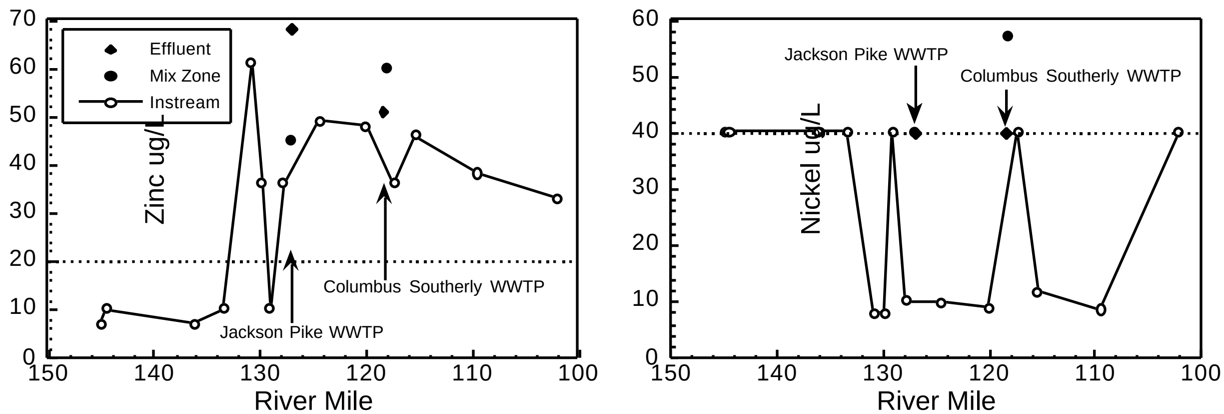


Figure 19. Mean longitudinal concentrations of selected metals from the Scioto River, 1996. Unless otherwise noted, dashed lines indicate median concentrations from large river, WWH reference stations within the Eastern Corn Belt Plains ecoregion.

Table 12. Stream flow from provisional records for the U.S. Geological Survey gage site on the Scioto River in Columbus (RM 127.4) for each chemical sampling field date (mainstem collections). Monthly precipitation information for the central Ohio region during the summer of 1996 is listed in the far right column.

Sampling Pass #	Month	Day	Flow (cfs)	Duration (%)[a]	Monthly Precipitation (in.) [% of Normal][b]
1	July	15	242	50-60%	4.65[117%]
1	July	16	197	60-70%	
1	July	17	302	40-50%	
2	July	30	901	10-20%	4.65[117%]
2	July	31	614	20-30%	
3	August	14	262	50-60%	1.29[36%]
4	August	27	196	60-70%	1.29[36%]
4	August	28	181	70-75%	
4	August	29	173	75-80%	
5	October	1	Flow data not available		1.69[79%]
5	October	2	Flow data not available		
6	October	21	Flow data not available		1.69[79%]
6	October	22	Flow data not available		

a - Flow exceeded by the given percentage listed for indicated percent of time during the period May-November based on information contained in Johnson and Metzger (1981).

b - Monthly Water Inventory Report for Ohio; ODNR; Division of Water, Water Inventory Unit; June to October 1996.

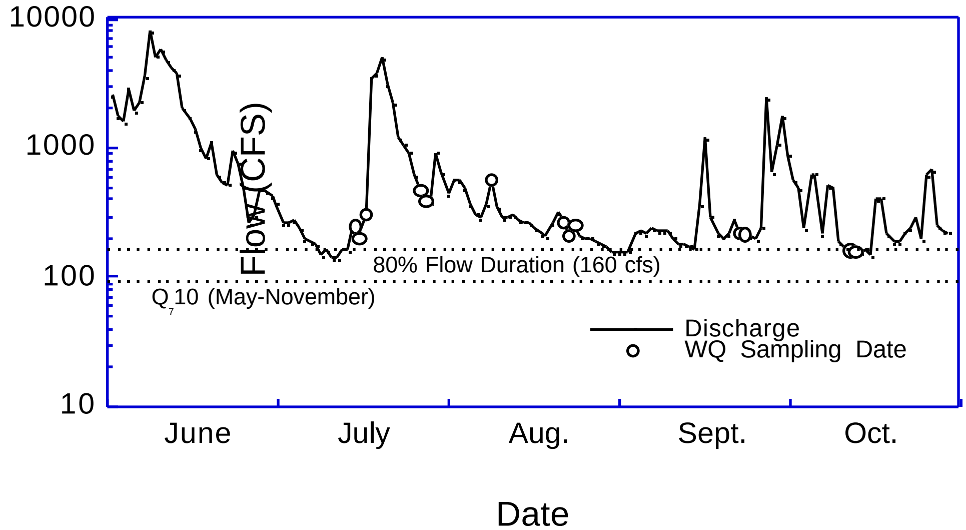


Figure 20. Flow hydrograph from the middle Scioto River at Columbus, Ohio (RM 127.4), May through October, 1996.

144.5, immediately downstream from the Dublin Pump station (Table 11). These low D.O. concentrations are possibly the result of a release of raw sewage from the Dublin Pump Station. However, other water quality indicators were not indicative of a sewage release--mainly fecal coliform measures, which remained near background levels downstream from the point of release. The lower D.O. values appeared a result of the lentic environment created by the Griggs dam. Samples were collected from the static, warm, and shallow littoral zone of the upper portion of Griggs reservoir. As such, D.O. values likely reflected these conditions, rather than an enrichment effect from overflow. Low dissolved oxygen concentrations were recorded at only one other location, RM 136.2. This station also has many lentic characteristics, derived mainly from the breaching of the west river bank that separated a complex of abandoned quarries. Although all of the D.O. exceedences were below the 5.0 mg/l 24-hour average WWH criterion, none of the readings were below the minimum WWH criterion of 4 mg/l and did not appear to indicate a significant oxygen deficit within the middle Scioto River.

Ammonia concentrations and BOD showed no discernible pattern longitudinally. Ammonia concentrations were below the median value for large WWH rivers in the Eastern Corn Belt Plains ecoregion except at RMs 127.8 and 120.0. Urban/suburban runoff from the storm sewer immediately upstream from Frank Road and the unsewered community of Shadeville near SR 665 contributed to increased ammonia-N. Five day-biochemical oxygen demand (BOD_5)

concentrations increased immediately downstream from Greenlawn Ave. (RM 129.0) and fell to below detection downstream from Columbus Southerly WWTP. As expected, nitrate concentrations were elevated downstream from both the Jackson Pike and Columbus Southerly WWTPs, as this compound is the end product of nitrification.

Fecal coliform counts greater than the PCR criterion were the most frequent exceedence observed in the Scioto River mainstem. Four samples had values that exceeded the SCR criterion of 5000 colonies per 100 mL. Fecal coliform bacteria levels are an indicator of sewage inputs and are a result of sewage spills, overflows, urban runoff and unsewered areas. Within urban areas, elevated fecal coliform counts may be related to CSO activity. The numbers observed indicate a chronic CSO problem as D.O. concentrations dropped downstream from the Whittier Street CSO and other chemical indicators were elevated (e.g. BOD, NH_3-N). Nearly all of the fecal coliform exceedences occurred during periods of increased surface runoff and elevated river discharge following extended periods of rainfall in mid to late July and again in mid to late September. During these periods, diffuse urban and rural non-point sources, as well as CSOs are typically the most active.

The Jackson Pike WWTP appears to be the main contributor of total phosphorus to this reach of the Scioto River. Concentrations of phosphorus were well below the Ohio EPA recommended phosphorus guideline of 1 mg/l upstream from the Jackson Pike WWTP. Downstream from the Jackson Pike facility, phosphorus concentrations peaked at slightly over 1 mg/l and dropped slowly from there. However, concentrations never decreased to match the phosphorus concentrations found upstream from the facility. Exceedences of the phosphorus guideline were also noted between RM 127.0 and RM 120.0, and at RM 115.3 (SR 762). The agency guideline of 1 mg/l is for prevention of nuisance algae growth and is not directly related to the protection of aquatic life. By comparison, median and 75th percentile phosphorus concentrations at WWH, large river WWH reference sites in the Eastern Corn Belt Plain ecoregion are 0.40 and 0.988 mg/l, respectively.

Most metal parameters did not appear to be of significant concern. Copper, lead and zinc concentrations were elevated throughout the mainstem often exceeding the ecoregional norms. Copper concentrations were elevated at Frank Road (RM 127.8) and remained elevated throughout the mainstem. Similarly, lead and zinc concentrations were elevated at Mound Street (RM 130.8) and lead was extremely elevated downstream from Greenlawn Ave. (RM 129.0) resulting in a violation of the WQS criterion. These metals remained elevated above ecoregional ECBP norms throughout the mainstem. Several iron exceedences were noted between RM 145.0 and RM 133.4.

Five grab water column samples were collected near the Olentangy River confluence at a railroad crossing off Hocking Street. During two sampling passes, exceedences of the bacteriological standards were observed. Both occurred during periods of high flow and are indicative of CSO overflows and other diffuse urban non-point sources. Dissolved oxygen concentrations were above the average WWH criterion. Ammonia was below detection in all samples. Nitrates and total phosphorus were detected but were below small WWH rivers ecoregional expectations. BOD_5 and COD were highly elevated on all sample days and were above ecoregional values; this may be related to CSO inputs. Several heavy metals were detected (arsenic, copper, lead and zinc) but none exceeded WQS criteria.

Organic analysis was performed on ten water column samples collected throughout the Scioto River study area during October 1996. The samples were analyzed for volatile and semivolatile compounds, pesticides and PCBs. A summary of the results are listed in Appendix Table B, for those sample sites where compounds were detected. Of the ten sites sampled, compounds were detected at only six of the sites. No semivolatile compounds and no PCBs were present in the water column at any of the sampling locations. The site with the most chemicals detected was at RM 124.4 (at I-270, downstream from the Jackson Pike WWTP). Chloroform was the most common volatile compound detected at five of the six sites.

Benzene hexachloride (BHC) was the most common pesticide detected in water samples. Concentrations of gamma BHC exceeded the chronic aquatic criterion at RMs 124.4 (I-270), 120.0 (SR 665) and 117.3 (downstream from Columbus Southerly). Gamma BHC, also known as lindane, is an organochlorine insecticide which has been used widely to fight insects including mosquitoes. Lindane enters surface waters as a result of runoff from agricultural land and from home and garden applications. Other pesticides detected were aldrin and endrin.

Diel dissolved oxygen, temperature, pH and conductivity data were collected with Datasonde continuous sampling units during October 1-4, 1996. Datasondes were placed at eight different stations on the Scioto River between RM 145.0 and RM 102.0 inclusive (Table 13 and Figure 21). These measurements are useful in evaluating nutrient enrichment, explaining the presence of nuisance growths of algae and/or extensive oxidation of organic and inorganic matter. The results from diel sampling found all stations exhibiting the typical oscillating pattern of dissolved oxygen (through time) commonly associated with algal photosynthesis and respiration. Dissolved oxygen concentrations were above the 5 mg/l WWH average DO criterion at all sampling sites. Only the sampling effort at RM 118.1, immediately downstream from Columbus Southerly WWTP, showed a somewhat different pattern, as the changes in dissolved oxygen concentrations were less pronounced than at any other site.

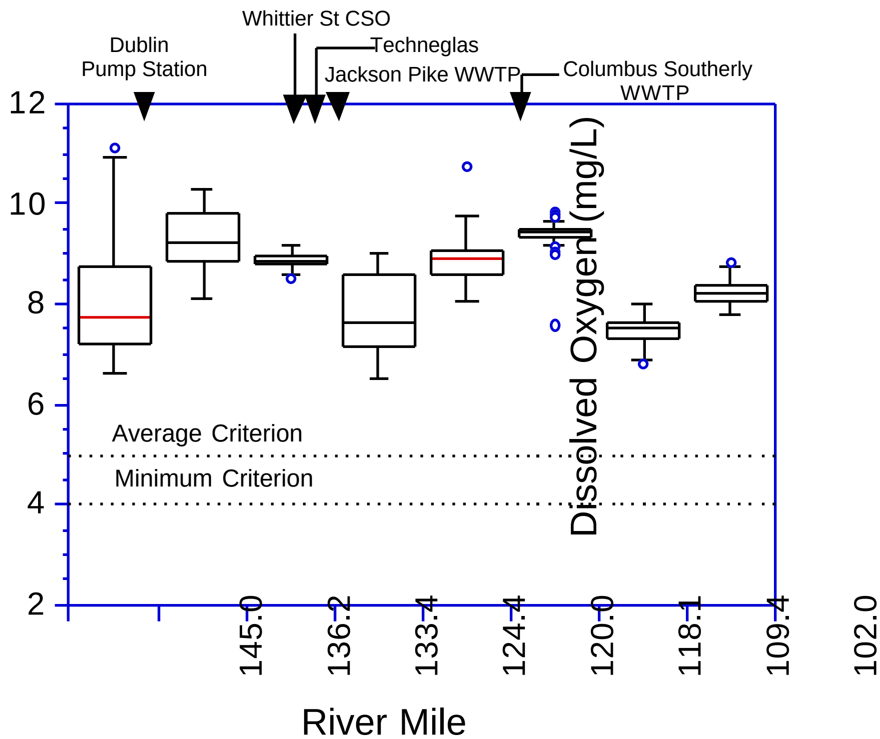


Figure 21.Box plots of diel Dissolved Oxygen concentrations through the middle Scioto River, 1996.

Table 13. Summary of diel dissolved oxygen (mg/l) data recorded with Datasonde continuous monitors at 8 locations in the Scioto River study area, October 1-4, 1996.

River Mile	Total Hours	Mean (mg/l)	Median (mg/l)	Minimum (mg/l)	Maximum (mg/l)	25th %tile (mg/l)	75th %tile (mg/l)
Scioto River							
145.0	71	8.05	7.72	6.63	11.12	7.27	8.83
136.2	72	9.27	9.24	8.12	10.28	8.88	9.65
133.4	70	8.87	8.85	8.49	9.16	8.77	8.97
124.4	70	7.81	7.65	6.51	9.03	7.24	8.38
120.0	69	8.88	8.89	8.05	10.73	8.59	9.17
118.1	69	9.39	9.42	7.57	9.81	9.18	9.60
109.4	72	7.47	7.52	6.82	8.02	7.29	7.64
102.0	71	8.23	8.29	7.77	8.81	8.07	8.38

Sediment Chemistry

During the fall of 1996, sediment samples were collected and analyzed for heavy metal concentrations and organic compounds along with pesticide/PCBs from nine locations along the Scioto River. Sediment contaminant levels were evaluated according to a statistically based sediment classification system described by Kelly and Hite (1984) and toxicity based guidelines described by Persaud et al. (1994). The Kelly and Hite (1984) guidelines are based on standard deviations from background means of a large number of stream sediment samples collected in Illinois. Values are categorized by four standard deviations of the mean for each parameter. Persaud et al. (1994) guidelines are based on documented toxicity to aquatic benthic organisms. Their classification system is divided into No Effect Level, Lowest Effect Level and Severe Effect Level. The Lowest Effect Level and Severe Effect Level are based on long-term effects contaminants may have on the benthic community. If a compound is above the LEL, it is likely to have an adverse effect on the benthic community. Contaminants found to be above the SEL will most likely negatively impact the benthos. The No Effect Level is based on chemical levels which are so low in concentration that contaminants are not passed through the food chain thus, no adverse effect on benthic biota is expected.

Extremely elevated metals were detected at Frank Road (RM 127.8) downstream from both The Whittier St. CSO and Techneglas. The sediment was described as “black and oily” by field personnel. Elevated levels of lead, zinc and mercury were also detected downstream from the Dublin Road Water Treatment Plant (WTP) dam where the sediment sample had a distinct white color presumably from the WTP lime sludge. Elevated levels of zinc were also detected at RMs 124.4-120.0 and at RM 102.0 (Commercial Point Road). The results of sediment metals analysis are presented in Table 14.

Numerous PAHs were observed throughout the Scioto River (Table 15). Only upstream from the Dublin WTP and downstream from Columbus Southerly WWTP were no semivolatile compounds detected. None of the compounds detected were ranked as greater than the SEL using the Persaud et al. 1994 classification system. However, concentrations appeared elevated in comparison with surrounding stations.

Table 14. Concentrations of heavy metals in the sediments of the Scioto River, 1996. All parameter concentrations were ranked based on a stream sediment classification system described by Kelly and Hite (1984) (top) and Persaud et al. (1994) (bottom). Concentrations are mg/kg (dry weight).

Kelly and Hite (1984)									
River Mile	As	Cu	Cd	Cr	Fe	Pb	Ni*	Zn	Hg
145.0	8.77b	15a	0.397a	26c	17400a	45c	<22	91b	<0.035
136.2	8.36b	10a	0.302a	<17	12800a	24a	<23	55a	0.0374a
133.4	10.1b	38a	1.39c	38c	18900b	**92d**	<36	**295d**	0.343c
129.0	7.88a	<17	<0.335	<50	5920a	<67	<67	17a	<0.944
127.8	**23.1d**	**448e**	**27.5e**	**361e**	**36900d**	**753e**	144	**1910e**	**3.81e**
124.4	5.43a	18a	0.509b	21b	12500a	52c	<22	**139d**	0.0831b
120.0	8.12b	19a	0.779b	31c	15500a	51c	<26	**160d**	0.146c
117.3	7.75a	43b	0.502b	<17	14300a	25a	NA	99b	<0.0329
115.3	4.67a	8a	0.563b	<16	10300a	<21	<21	96b	0.0561a
102.0	12.7c	23a	0.942b	33c	22600b	41c	<29	**166d**	0.0898b

a - Non-elevated, b - Slightly elevated, c - Elevated, **d -Highly elevated**, **e - Extremely elevated**, and NA= Not Analyzed. Note:The Kelly and Hite classification system addresses relative concentrations but does not directly assess toxicity and does not evaluate nickel concentrations.

Persaud et al. (1994)									
River Mile	As	Cu	Cd	Cr	Fe	Pb	Ni	Zn	Hg
145.0	8.77b	15a	0.397a	26b	17400	45b	<22	91a	<0.035
136.2	8.36b	10a	0.302a	<17	12800	24a	<23	55a	0.0374a
133.4	10.1b	38b	1.39b	38b	18900	92b	<36	295b	0.343b
129.0	7.88b	<17	<0.335	<50	5920	<67	<67	17a	<0.944
127.8	23.1b	**448c**	**27.5c**	**361c**	36900	**753c**	**144c**	**1910c**	**3.81c**
124.4	5.43a	18b	0.509a	21b	12500	52b	<22	139b	0.0831a
120.0	8.12b	19b	0.779b	31b	15500	51b	<26	160b	0.146a
117.3	7.75b	43b	0.502a	<17	14300	25a	NA	99a	<0.0329
115.3	4.67a	8a	0.563a	<16	10300	<21	<21	96a	0.0561a
102.0	12.7b	23b	0.942b	33b	22600	41b	<29	166b	0.0898a

a > No Effect Level and < Lowest Effect Level (NEL), b ≥ Lowest Effect Level (LEL),**c ≥Severe Effect Level (SEL)**, **and** NA not analyzed.

Table 15. Concentration (mg/kg) of semivolatile compounds in the sediments of Scioto River, 1996. All parameter concentrations were ranked according to the ecotoxic effects guideline described by Persaud et al. (1994).

	Sediment Concentration (mg/kg) River Mile									
Compound	145.0	136.2	133.4	129.0	127.8	124.4	120.0	117.3	115.3	102.0
Anthracene	ND	1.2	ND	1.1	2.5	0.7	ND	ND	ND	ND
Benzo[a]anthracene	2.1	2.7	ND	3.9	6.7	2.1	1.0	ND	0.9	0.8
Benzo[a]pyrene	2.0	2.3	ND	3.6	6.3	1.9	0.9	ND	0.7	0.9
Benzo[b]fluoranthene*	2.2	2.1	ND	4.1	6.3	1.9	1.1	ND	0.8	1.1
Benzo[g,h,i]perylene	1.5	1.4	ND	2.6	4.8	1.3	0.6	ND	ND	0.7
Benzo[k]fluoranthene	1.9	2.2	ND	3.3	7.0	1.8	0.8	ND	ND	0.8
Bis(2EH) phthalate*	ND	ND	5.0	33	0.9	ND	1.1	ND	ND	1.0
Chrysene	2.7	3.0	ND	5.1	10.8	2.4	1.2	ND	0.9	1.1
Di-n-octylphthalate*	ND	ND	ND	2.5	ND	ND	ND	ND	ND	ND
Dibenz[a,h] anthracene	ND	ND	ND	0.9	ND	ND	ND	ND	ND	ND
Fluoranthene	5.0	7.3	ND	10.6	16.0	4.9	2.5	ND	1.9	2.1
Fluorene	ND	0.6	ND	ND	3.8	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	1.5	1.6	ND	2.9	5.5	1.5	0.7	ND	0.5	0.8
Phenanthrene	2.7	5.6	ND	5.4	13.7	3.2	1.3	ND	1.1	1.0
Pyrene	4.0	5.7	ND	8.5	13.3	4.0	2.0	ND	1.6	1.7
TOC	2.4	2.1	2.8	1.5	15	3.2	2.8	2.4	1.6	2.9

a > No Effect Level and < Lowest Effect Level (NEL), b ≥ Lowest Effect Level (LEL), **c ≥ Severe Effect Level (SEL)**, * Not evaluated in Persaud et al. (1994), and ND - Not Detected or less than laboratory detection limit.

Chlordane along with PCB-1260 were the most detectedorganic compounds found in Scioto River sediments. Chlordane was extremely elevated between Fifth Ave. and I 270. Elevated levels of chlordane were also noted at RM 115.3 (SR 762). PCB-1260 was present at five of the nine sampling locations. The highest concentration was detected at Frank Road. DDD and DDE were also detected at Frank Road. The source of these pesticides and PCBs is unknown. These data are presented in Table 16.

Based solely on the guidelines developed by Persaud et. al. (1994), a potential for adverse effects on some of the benthic community in Scioto River is possible. This is based on the potential for these contaminants to persist in the sediments for long periods allowing for the possibility that these chemicals can be transferred up the food chain and accumulate in greater concentrations in other organisms.

Table 16. Dry weight concentrations of PCBs and Organochlorine Pesticides (µg/kg or ppb) in the sediments of the Scioto River, 1996. Concentrations were ranked according to the Kelly and Hite (1984) (top) and ecotoxic effects guideline described by Persaud et al. (1994) (bottom).

Kelly and Hite (1984)

River Mile	Alpha-Chlordane	Gamma-Chlordane	Trans-nonAchlor	PCB-1260	d-BHC	Endosulfan I	Dieldrin	4,4' DDD	4,4' DDE
145.0	ND	ND	ND	42[b]	ND	ND	**10[d]**	ND	ND
136.2	**10[d]**	9.7[c]	ND	ND	ND	ND	**13[d]**	ND	ND
133.4	ND	ND	ND	ND	0.005[f]	0.004[f]	ND	ND	ND
129.0	**18[d]**	**21[d]**	10[f]	160[c]	ND	ND	ND	ND	ND
127.8	ND	ND	ND	**610[d]**	48[f]	ND	ND	50[f]	180[f]
124.4	**15[d]**	**17[d]**	ND	110[c]	ND	ND	**14[d]**	ND	ND
120.0	8.1	8.9	ND	96	ND	ND	ND	ND	ND
117.3	ND	ND	ND	ND	ND	ND	ND	ND	ND
115.3	6.0[c]	8.8[c]	42[f]	ND	ND	ND	ND	ND	ND
102.0	ND	ND	ND	61[c]	ND	ND	ND	ND	ND

a Non-elevated, b Slightly elevated, c Elevated, d **Highly elevated**, **e Extremely elevated**
f Not evaluated, NA Data not available, and ND Concentrations below detection limit.

Persaud et al. (1994)

River Mile	Alpha-Chlordane	Gamma-Chlordane	Trans-nonAchlor	PCB-1260	d-BHC	Endosulfan I	Dieldrin	4,4' DDD	4,4' DDE
145.0	ND	ND	ND	42	ND	ND	10	ND	ND
136.2	10	9.7	ND	ND	ND	ND	13	ND	ND
133.4	ND	ND	ND	ND	0.005	0.004	ND	ND	ND
129.0	18	21	10	160	ND	ND	ND	ND	ND
127.8	ND	ND	ND	610	48	ND	ND	50	180
124.4	15	17	ND	110	ND	ND	14	ND	ND
117.3	ND	ND	ND	ND	ND	ND	ND	ND	ND
115.3	6.0	8.8	42	ND	ND	ND	ND	ND	ND
102.0	ND	ND	ND	61	ND	ND	ND	ND	ND

a > No effect Level and < Lowest Effect Level (NEL), b ≥ Lowest Effect Level (LEL), **c ≥ Severe Effect Level (SEL)**, d Not evaluated, e No LEL or SEL available, NA Data not available, and ND Concentrations below detection limits.

Spills

A review of the database of spills reported to the Ohio EPA Division of Emergency and Remedial Response revealed twenty seven spills to the Scioto River or its tributaries (Table 17). Sewage was the pollutant most often reported spilled. The individual spill reports indicated that most of the spills were a result of overflows or bypass events due to high rainfall. This would indicate a problem with inflow and infiltration (I/I) in the sewer system. Several spills were a result of maintenance and/or repairs to the sewer system. Two spills were petroleum products.

Table 17. Summary of Pollutants spilled into the Scioto River and its tributaries reported to the Ohio EPA Division of Emergency and Remedial Response from January 1996 - December 1996.

Date	**Entity**	**Material**	**Amount**	**Waterway**
01/05/96	Columbus WWTP	Sewage	UNK	Scioto River
01/17/96	Dublin WWTP	Sewage	1000 gallons	Scioto River
01/18/96	Columbus WWTP	Sewage	UNK	Scioto River
01/18/96	Dublin WWTP	Sewage	UNK	Scioto River
01/30/96	Columbus WWTP	Sewage	UNK	Scioto River
04/08/96	Columbus WWTP	Sewage	UNK	Scioto River
04/11/96	Unknown	Hydrocarbon Sheen	UNK	Renick Run
04/12/96	Dublin bypass	Sewage	UNK	Scioto River
04/23/96	Dublin bypass	Sewage	UNK	Scioto River
04/29/96	Dublin bypass	Sewage	UNK	Scioto River
05/11/96	Dublin bypass	Sewage	UNK	Scioto River
05/15/96	Jackson Pike WWTP	Sewage	UNK	Scioto River
05/22/96	Columbus WWTP	Sewage	UNK	Scioto River
05/22/96	Columbus WWTP	Sewage	UNK	Scioto River
05/31/96	Columbus WWTP	Sewage	UNK	Scioto River
06/03/96	Columbus WWTP	Sewage	UNK	Scioto River
07/18/96	Columbus WWTP	Sewage	UNK	Scioto River
07/22/96	Quick Fill Gas Stn.	Diesel Fuel	100 gallons	Sewer System
10/10/96	Columbus WWTP	Sewage	UNK	Scioto trib.
11/06/96	Columbus WWTP	Sewage	UNK	Scioto River
11/10/96	Columbus WWTP	Sewage	UNK	Scioto River
11/13/96	Columbus WWTP	Sewage	UNK	Scioto River
11/14/96	Columbus WWTP	Sewage	UNK	Scioto River
12/17/96	Dublin bypass	Sewage	UNK	Scioto River
12/17/96	Dublin bypass	Sewage	3200 gallons	Scioto River
12/24/96	Columbus WWTP	Sewage	UNK	Scioto River
12/26/96	Columbus WWTP	Sewage	UNK	Scioto River

Physical Habitat for Aquatic Life

As part of the 1996 fish sampling effort, the quality of near and instream macrohabitats of the middle Scioto River were evaluated at 27 locations. QHEI values ranged between 39.0 (RM 131.8--impounded, Town St. dam pool) and 92 (RM 98.9--free flowing, downstream from the Circleville WWTP), with a mean reach score of 75.3 (±11.1 SD) (Table 18). Mean QHEI values from rivers or large river segments greater than 60 generally indicate a level of macrohabitat quality sufficient to support an assemblage of aquatic organisms fully consistent with the WWH aquatic life use designation. Average reach values greater than 75 are generally considered adequate to support fully exceptional (EWH) aquatic communities (Rankin 1989 and Rankin 1995).

By and large, the condition of the macrohabitats of the middle Scioto River were found fully capable of supporting WWH aquatic communities. Over half of the stations exhibited exceptional habitat characteristics (QHEI≥75). The majority of the sampling stations clearly contained a full complement of positive habitat features. The channel configuration was typically in a natural or recovered state, possessing good-excellent channel development and adequate sinuosity. Substrates were typically coarse, derived mainly from glacial till, and were not excessively burdened with fine sediment. Most stations were well structured with a variety of instream cover types: woody debris, boulders, deep pools, and backwater areas.

Segments of poor macrohabitat quality were primarily limited to two areas that have been subjected to extensive channelization and/or impoundment. Progressing downstream from the upper limits of the study area, the first habitat limited segment would include the portion of the Scioto River impounded by Griggs Reservoir. The pool created by Griggs dam extends upstream from RM 138.8 for a distance of approximately 6.4 miles. Four stations were evaluated within this impounded segment. Reduced current velocities, increased sedimentation and embeddedness, and greater physical homogeny are the principal detrimental effects of impoundment. The extensive lentic environment created by the Griggs dam virtually precludes this segment from supporting a diverse and functional integrated community of aquatic organisms fully consistent with WWH ambient biological standards. The second habitat limited segment includes the river reach flowing through the Columbus metropolitan area, extending upstream from the Greenlawn Ave. dam to the Olentangy River confluence. Impounded by two lowhead dams (Greenlawn and Town St.) and highly channel modified, this reach contains the most depauperate physical conditions within the middle Scioto River study area (QHEI=39.0 at RM 131.8). In recognition of the simplified near and instream habitats, and the near certainty that the modified state will be maintained far into the foreseeable future, the MWH aquatic life use designation has been imposed on this segment.

Table 18. Qualitative Habitat Evaluation Index (QHEI) matrix showing positive and negative habitat attributes for the middle Scioto River study area, 1996.

Key QHEI Components

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-Normal Riffle Embeddedness	Total WWH Attributes	MWH Attributes, High Influence: Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth < 40 cm (WD, HW)	Total H.I. MWH Attributes	MWH Attributes, Moderate Influence: Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent and Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	Total M.I. MWH Attributes	(MWH H.I.+1)/(WWH+1) Ratio	(MWH M.I.+1)/(WWH+1) Ratio
(02-001) Scioto River																																		
Year: 96																																		
145.0	83.0	4.33	■	■		■	■	■	■	■	■	■	9						0		▲				▲				▲			3	0.10	0.40
144.5	69.0	0.10	■	■				■			■		4						0		▲			▲	▲			▲	▲		▲	6	0.20	1.40
142.8	62.0	0.10	■	■				■		■	■		5						0					▲	▲			▲			▲	4	0.17	0.83
140.0	59.5	0.10	■	■				■		■	■		5				●		1		▲			▲	▲			▲			▲	5	0.33	1.17
138.6	70.5	1.50		■					■	■	■		4				●		1	▲				▲	▲			▲		▲		5	0.40	1.40
136.2	77.0	1.50		■		■		■	■	■	■		6				●		1	▲	▲				▲			▲		▲		5	0.29	1.00
133.3	69.0	1.50		■		■		■			■	■	5				●		1	▲	▲			▲	▲			▲	▲			6	0.33	1.33
133.0	68.0	0.10		■			■	■		■	■		5						0	▲	▲			▲	▲			▲	▲		▲	7	0.17	1.33
131.8	39.0	0.10									■		1	●			●		2					▲	▲			▲	▲		▲	5	1.50	4.00
129.1	72.5	1.85		■		■	■	■			■		5						0	▲	▲			▲				▲	▲	▲		6	0.17	1.17
127.5	65.5	1.85		■				■			■		3	●			●		2	▲	▲			▲	▲			▲	▲	▲		7	0.75	2.50
126.4	82.0	1.85	■	■		■	■	■	■	■	■	■	9						0		▲								▲			2	0.10	0.30
123.5	70.5	2.50	■	■		■	■	■			■		6						0		▲			▲				▲	▲		▲	5	0.14	0.86
119.9	85.5	1.40	■	■		■	■	■	■		■	■	8						0		▲								▲			2	0.11	0.33
118.1	78.0	1.40	■	■		■		■		■	■		6						0						▲			▲		▲		3	0.14	0.57
117.1	80.0	1.40	■	■		■	■	■	■	■	■		8						0		▲			▲	▲				▲	▲		5	0.11	0.67
116.3	87.5	1.40	■	■		■	■	■	■		■	■	8						0										▲			1	0.11	0.22

Table 18. continued.

Key: QHEI Components

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-Normal Riffle Embeddedness	Total WWH Attributes	MWH High Influence: Channelized or No Recovery	Silt/Muck Substrates	No 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 Sinuosity	Only 1-2 Cover Types	Intermittent and Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	Total M.I. MWH Attributes	(MWH H.I.+1)/(WWH+1) Ratio	(MWH M.I.+1)/(WWH+1) Ratio
(02-001) Scioto River																																		
Year: 96																																		
113.8	80.5	1.40	■	■		■	■	■	■		■		8						0		▲				▲				▲	▲		4	0.11	0.56
109.2	81.5	0.98	■	■		■	■	■	■	■	■		8						0										▲	▲		2	0.11	0.33
107.4	72.0	0.98	■	■		■		■	■		■		6						0.		▲			▲	▲				▲	▲		5	0.14	0.86
105.9	86.0	0.98	■	■		■	■	■	■	■	■	■	9						0													0	0.10	0.10
105.2	73.0	0.98	■	■		■	■	■	■	■	■	■	9						0		▲								▲			2	0.10	0.30
102.0	76.0	1.43	■	■				■	■		■	■	6			●			1		▲			▲	▲				▲			4	0.29	0.86
100.0	87.5	1.43	■	■		■	■	■	■	■	■		9						0										▲			1	0.10	0.20
99.7	85.5	1.43	■	■		■	■	■	■		■		7						0		▲								▲	▲		3	0.13	0.50
98.9	92.0	2.40	■	■		■	■	■	■	■	■		9						0													0	0.10	0.10
97.9	85.5	2.40	■	■		■		■	■	■	■	■	8						0						▲				▲			2	0.11	0.33
(02-400) Olentangy River																																		
Year: 96																																		
27.9	68.5	5.68	■	■		■	■	■	■		■		7		●				1		▲				▲			▲	▲	▲		5	0.25	0.88
19.8	84.5	7.69	■	■		■	■	■	■	■	■		8						0										▲	▲		2	0.11	0.33
14.5	80.5	3.97	■	■		■		■	■	■	■	■	8						0						▲							1	0.11	0.22
13.6	68.5	5.99	■	■		■	■	■	■		■		7						0		▲			▲	▲			▲	▲	▲		6	0.13	0.88
5.5	43.5	0.10	■	■							■		3		●	●			2		▲			▲	▲			▲	▲		▲	6	0.75	2.25
0.6	66.0	2.00		■		■		■	■		■		5			●			1	▲	▲			▲	▲				▲	▲		6	0.33	1.33

Table 18. continued.

Key QHEI Components

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-Normal Riffle Embeddedness	Total WWH Attributes	MWH Attributes, High Influence: Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/No Cover	Max Depth < 40 cm (WD, HW)	Total H.I. MWH Attributes	MWH Attributes, Moderate Influence: Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent and Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	Total M.I. MWH Attributes	(MWH H.I.+1)/(WWH+1) Ratio	(MWH M.I.+1)/(WWH+1) Ratio
(02-110) Alum Creek																																		
Year: 96																																		
44.1	63.0	11.49	■				■	■		■	■	■	6				●		1					▲				▲				2	0.29	0.57
42.8	81.0	10.00	■	■	■	■	■	■	■	■	■		9						0									▲		▲		2	0.10	0.30
26.3	75.0	4.46	■	■				■			■		4						0		▲			▲	▲			▲	▲	▲		6	0.20	1.40
23.8	58.0	3.27		■							■		2				●		1	▲	▲			▲	▲			▲	▲	▲		7	0.67	3.00
22.6	57.5	3.27									■		1	●			●		2	▲	▲			▲	▲			▲	▲	▲		7	1.50	5.00
19.8	77.5	6.58	■	■		■	■	■	■		■		7						0					▲					▲	▲		3	0.13	0.50
17.4	74.0	4.08	■	■		■	■	■			■		6						0					▲				▲	▲	▲		4	0.14	0.71
15.4	62.5	4.08		■		■	■	■	■	■	■		7				●		1	▲				▲						▲		3	0.25	0.63
13.5	75.5	5.95	■	■		■	■	■	■		■		7						0										▲	▲		2	0.13	0.38
9.2	52.0	2.43									■		1	●			●		2	▲	▲			▲	▲			▲	▲		▲	7	1.50	5.00
7.5	56.5	4.41		■			■				■		3				●		1	▲	▲			▲				▲	▲		▲	6	0.50	2.00
6.6	52.5	4.41		■			■	■			■		4	●	●				2	▲	▲			▲	▲			▲	▲		▲	7	0.60	2.00
3.9	55.5	2.73		■							■		2	●			●		2	▲	▲			▲	▲			▲	▲	▲		7	1.00	3.33
0.8	67.0	2.98	■	■			■	■			■		5						0		▲			▲				▲	▲	▲		5	0.17	1.00
(02-118) West Branch Alum Creek																																		
Year: 96																																		
0.6	76.0	9.43	■			■	■	■		■	■		6						0									▲		▲		2	0.14	0.43

Macrohabitat quality of the lower Olentangy River was evaluated at one station located at RM 0.7 (upstream from the Conrail R&R bridge). The station was placed within the free flowing portion of the lower Olentangy River, immediately upstream from the Town St. dam pool (~RM 0.6). The upper limits of this impoundment demarcates the change in aquatic life use designation from WWH (free flowing) to MWH (impounded). Despite evidence of past channel modification, embedded substrates, and other detrimental habitat features typically associated with urban streams or stream segments, overall habitat complexity, as measured by the QHEI, appeared sufficient to support WWH communities (QHEI=66.0).

Biological Assessment: Benthic Macroinvertebrates

Macroinvertebrate communities were evaluated at 20 stations along the Scioto River from the City of Dublin (RM 144.8) to upstream from US 22 in Circleville (RM 100.0) (Table 19 and Figure 22). The Invertebrate Community Index (ICI) ranged from 56 (exceptional) upstream from US 22 in Circleville (RM 100.0) to a low of 18 (fair) at Frank Road in Columbus (RM 127.8). The station with the highest total mayfly (Ephemeroptera), stonefly (Plecoptera), and caddisfly (Trichoptera) taxa richness (EPT), a measure of the diversity of pollution sensitive taxa, was upstream from US 22 (RM 100.0) with 23 taxa. Overall, the macroinvertebrate communities were evaluated as very good or exceptional at eight sites, marginally good or good at four sites, fair at five sites, and very poor or poor at three sites (all within mixing zones).

Macroinvertebrate taxa collected in the Scioto River that are indicative of high quality streams in Ohio included the mayfly *Serratella deficiens* at RM 136.3, the stonefly *Agnetina capitata* complex at RM 144.8, and the caddisflies *Macrostemum zebratum* at RM 100.0 and *Protoptila* sp. at RMs 144.8 and 136.3. Fourteen species of freshwater mussels (Unionidae) were found to be extant in the Scioto River from Dublin to Circleville (Table 20). Freshwater mussels were not common at any of the sites. The highest diversity of taxa (eight) was documented at RM 116.3, downstream from the confluence of Big Walnut Creek and the AEP Picway EGS. Collection records from the Ohio State University Museum of Biodiversity unionid collection document 40 species as once inhabiting the Scioto River in Franklin and Pickaway Counties; however, there are collection records for live or fresh-dead specimens of only 11 species having been collected since 1971 (OSU Museum files). The collection records from this study indicate that the unionid community may be increasing since water quality improvements have been accomplished in this section of the river over recent years.

Macroinvertebrate stations were located immediately upstream and downstream from the Dublin sewage pump station (RM 144.53) in the upper reach of Griggs Reservoir to evaluate any impact from intermittent sewage overflows. Both communities had similar diversity and composition with organisms typical of the impounded habitat, showing no impact from sewage overflow pollution. Communities sampled upstream and downstream from the reservoir were representative of well balanced communities with no indication of a sewage pollution impact.

Macroinvertebrate community performance in the free flowing Scioto River upstream from the two downtown Columbus impoundments was in the exceptional range (RMs 136.3 and 133.4). The station located downstream from the Dublin Road WTP impoundment was maintaining an exceptional community despite moderate stream dewatering by the WTP. Minimal flow was maintained in the riffle habitat at this site during the macroinvertebrate collection visits. The community sampled downstream from the downtown impoundments and the Whittier Street CSO (located at RM 129.6) declined into the fair range with an ICI score of 22 at RM 129.0. Mayfly and tanytarsini midge diversity (1 and 0, respectively) and abundance (0.1 and 0.0%, respectively) were greatly reduced along with increases in the abundance of tolerant organisms (13.4%) and other dipterans and non-insects (69.8%). The community was impacted by organic enrichment (probably including low D.O. levels) and some sort of toxicity. The Whittier Street CSO was probably the major source of impairment, with stream dewatering by the Dublin Road WTP and urban runoff exacerbating the problem.

Macroinvertebrate samples were collected twice by qualitative methods within the Techneglas WWTP mixing zone (RM 128.4) to evaluate for effluent toxicity. Very poor (15-VII) and poor (26-VIII) communities were documented on the two visits. No to very low EPT taxa richness and a high predominance of tolerant organisms indicated that the Techneglas WWTP effluent was toxic to macroinvertebrates. The macroinvertebrate community sampling station located just downstream from Frank Road at RM 127.8 remained in the fair range with an ICI score of 18. The community was similar to the upstream station at RM 129.0 except for minor structural changes. There was no discernible impact from the Techneglas discharge outside the mixing zone.

Macroinvertebrate samples were collected twice by qualitative methods within the Jackson Pike WWTP mixing zone (RM 127.0) to evaluate for effluent toxicity. Very poor (15-VII and 27-VIII) community performance was documented on both visits. The absence of EPT taxa and a high predominance of tolerant organisms indicated that the Jackson Pike WWTP effluent was toxic to macroinvertebrates. The macroinvertebrate community sampling station located downstream from the Jackson Pike WWTP at RM 126.5 remained in the fair range with an ICI score of 22. The community was similar to the upstream stations at RMs 129.0 and 127.8 except for minor structural differences. The Jackson Pike WWTP contribution to the Scioto River's pollution burden was at a level that merely maintained the existing impact and prevented recovery of biological integrity. The macroinvertebrate community recovered to the good range by RM 119.3 with an ICI score of 36. However, the mayfly abundance (1.9%) remained depressed and the abundance of dipterans and non-insects (39.9%) continued to be elevated.

Macroinvertebrate samples were collected twice by qualitative methods within the Columbus Southerly WWTP mixing zone (RM 118.3) to evaluate for effluent toxicity. Very poor (16-VII) and poor (28-VIII) community performance was documented on both visits. No to very low EPT taxa richness and a high predominance of tolerant organisms indicated that the Columbus Southerly WWTP effluent was toxic to macroinvertebrates. The macroinvertebrate community sampling station located one mile downstream from the Columbus Southerly WWTP at RM 117.3 improved into the exceptional range with an ICI score of 48. Continued low abundance of mayflies (2.8%) and higher than expected abundance of dipterans and non-insects (26.4%) indicated that the community structure was not fully recovered. Community performance declined into the good range (ICI=40 at RM 116.3) downstream from the confluence of Big Walnut Creek and the Picway AEP EGS due to further increases in the abundance of dipterans and non-insects (50.5%) along with continued lower than expected abundance of mayflies (2.7%). This impact was probably the continued effect from upstream loadings. The community improved to the exceptional range by State Route 316 (RM 109.4) with an ICI value of 54. The community composition and structure at this station was considered recovered to background conditions and remained so at the remaining three downstream stations to US 22 (RM 100.0) in Circleville.

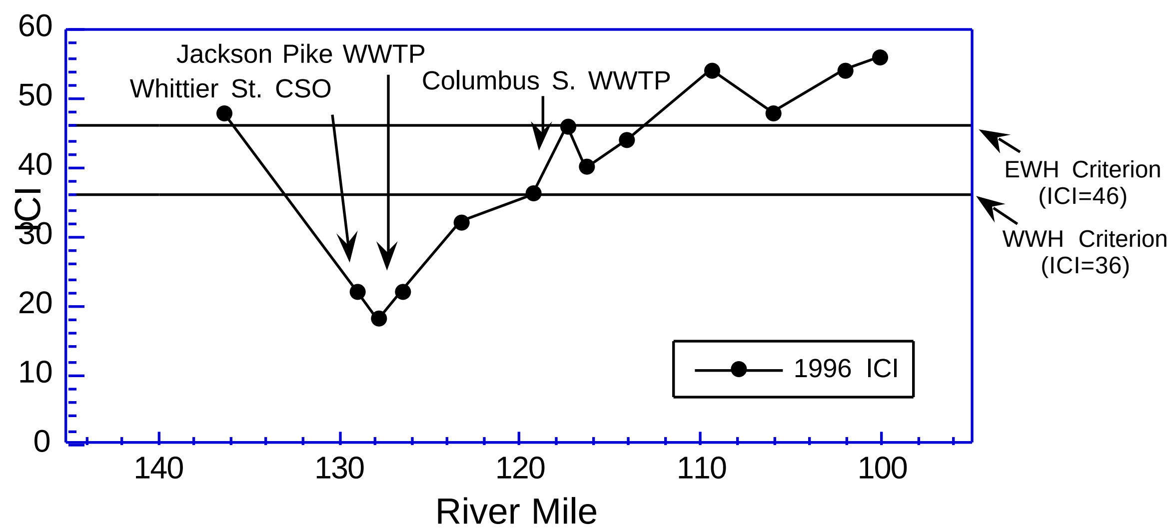


Figure 22. Longitudinal performance of the Invertebrate Community Index (ICI) from the middle Scioto River, 1996. Solid lines indicate the criteria in support of the existing WWH and recommended EWH aquatic life use designations--Eastern Corn Belt Plains Ecoregion.

One macroinvertebrate sampling station was located on the Olentangy River at RM 0.6 to evaluate the effect of industrial and urban sources. The macroinvertebrate community was performing in the fair range with an ICI score of 30. The community was structurally unbalanced with an abundance of dipterans and non-insects (80.8%) and tolerant organisms (10.5%) higher than expected and the abundance of mayflies (4.5%), caddisflies (6.2%), and tanytarsini midges (7.7%) lower than expected. This impairment was probably the result of moderate toxicity associated with urban runoff,CSOs, SSOs, and possibly upstream industrial discharges.

Table 19. Summary of macroinvertebrate data collected on artificial substrates (quantitative sampling) and from natural substrates (qualitative sampling) from the middle Scioto River and Alum Creek, 1996

			Quantitative Evaluation				
Stream/River River Mile	Density (No./ft^2)	Quant Taxa	Qual Taxa	Qual EPT[a]	Total EPT	ICI[b]	Evaluation
Scioto River (1996)							
			Eastern Corn Belt Plain - WWH Use Designation				
144.8	--	--	50	15	--	--	Good
144.54[c]	--	--	33	6	--	--	Fair
144.52[c]	--	--	35	8	--	--	Fair
136.3	1279	29	43	15	20	48	Exceptional
133.4	--	--	53	17	--	--	Exceptional
129.0	2095	27	44	6	7	22*	Fair
128.4A[d]	--	--	*26*	*0*	--	--	*Very Poor*
128.4B[d]	--	--	*29*	*2*	--	--	*Poor*
127.8	2072	18	36	5	7	18*	Fair
127.0A[d]	--	--	*13*	*0*	--	--	*Very Poor*
127.0B[d]	--	--	*13*	*0*	--	--	*Very Poor*
126.5	3176	28	34	4	7	22*	Fair
123.2	3478	36	42	6	10	32[ns]	M. Good
119.3	3317	32	50	9	16	36	Good
118.3A[d]	--	--	*15*	*0*	--	--	*Very Poor*
118.3B[d]	--	--	*27*	*3*	--	--	*Poor*
117.3	3165	34	52	11	15	46	Exceptional
116.3	2072	38	57	13	19	40	Good
114.0	1628	34	49	12	13	44	Very Good
109.4	1854	41	62	15	19	54	Exceptional
106.0	3820	30	54	17	21	48	Exceptional

Table 19. continued.

Stream/River River Mile	Density (No./ft^2)	Quant Taxa	Qual Taxa	Qual EPT[a]	Total EPT	ICI[b]	Evaluation
			Quantitative Evaluation				
Scioto River (1996)							
102.0	2044	29	61	17	19	54	Exceptional
100.0	1843	32	43	16	23	56	Exceptional
Olentangy River (1996)							
		Eastern Corn Belt Plain - WWH Use Designation					
0.6	671	44	46	16	17	30*	Fair

Stream/River Mile	Density (No./ft^2)	Quant Taxa	Qual Taxa	Qual EPT[a]	Total Taxa	QCTV Score	ICI[b]	Evaluation
			Quantitative Evaluation					
Alum Creek (1996)								
	Eastern Corn Belt Plain - EWH/WWH Use Designation (Existing/Recommended)							
44.0	526	44	55	16	76	39.1	50	Exceptional
42.7	1990	36	47	15	63	40.3	48	Exceptional
		Eastern Corn Belt Plain - WWH Use Designation						
26.2	981	30	46	14	62	39.2	44	Very Good
24.0	992	31	39	10	54	38.9	40	Good
22.5	1128	35	46	10	60	38.9	40	Good
19.8	1090	37	50	12	63	38.9	42	Very Good
17.3	1229	30	40	9	50	39.1	34[ns]	Marg. Good
17.22	-	-	*18*	*3*	-	*33.0*	-	*Poor*
17.22	--	*14*	*3*	-		*33.9*	-	*Poor*
15.3	1364	30	49	10	60	38.2	38	Good
13.5	5031	24	51	11	57	37.7	34	Marg. Good
8.6	761	21	31	3	41	30.3	10*	Poor
7.6	395	30	46	6	53	33.0	20*	Fair
6.2	1886	36	43	6	55	34.2	30*	Fair
3.8	2179	26	49	9	57	32.6	28*	Fair
0.7	2439	29	44	9	54	32.8	42	Very Good

Table 19. continued.

Quantitative Evaluation								
Stream/River River Mile	Density (No./ft^2)	Quant Taxa	Qual Taxa	Qual EPT[a]	Total EPT	QCTV Score	ICI[b]	Evaluation
Alum Creek (1986)								
Eastern Corn Belt Plain - WWH Use Designation								
17.9	771	32	43	13	54	38.9	36	Good
17.2	2886	28	42	7	48	32.9	18*	Fair
16.0	1012	28	52	9	56	33.0	[30][b]	Good
13.4	1793	40	42	14	58	39.3	42	Very Good
West Branch Alum Creek (1996)								
Eastern Corn Belt Plain - WWH Use Designation								
0.7	394	33	62	15	76	39.2	52	Exceptional

Qualitative Evaluation					
Stream River Mile	No. Qual. Taxa	Qual. EPT[a]	Relative Density	Predominant Organisms	Narrative Evaluation
Scioto River					
144.8	50	15	Low-Mod.	Mayflies, riffle beetles, hydropsychid caddisflies	Good
144.54[c]	33	6	Low	Heptageniid mayflies, midges, polycentropid caddisflies	Fair
144.52[c]	35	8	Low-Mod.	Heptageniid mayflies, midges, polycentropid caddisflies	Fair
133.4	53	17	Mod.-High	Caddisflies, riffle beetles, mayflies	Exceptional
128.4A[d]	*26*	*0*	*Moderate*	*Tolerant midges*	*Very Poor*
128.4B[d]	*29*	*2*	*Low*	*Tolerant midges*	*Poor*
127.0A[d]	*13*	*0*	*Low*	*Tolerant midges, oligochaet worms*	*Very Poor*
127.0B[d]	*13*	*0*	*Low-Mod.*	*Tolerant midges*	*Very Poor*
118.3A[d]	*15*	*0*	*Low-Mod.*	*Tolerant midges*	*Very Poor*
118.3B[d]	*27*	*3*	*Low-Mod.*	*Tolerant midges*	*Poor*

Table 19. continued.

			Qualitative Evaluation		
Stream River Mile	No. Qual. Taxa	Qual. EPT[a]	Relative Density	Predominant Organisms	Narrative Evaluation
Alum Creek (1996)					
17.22	18	3	Low	Red midges	*Poor*
17.22	14	3	Low	Red midges, *Ferrissia* snail	*Poor*

Ecoregion Biocriteria: Invertebrate Community Index (ICI)

Eastern Corn Belt Plains (ECBP)

WWH	EWH	MWH
36	46	22

a EPT = total Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) taxa richness.
b A qualitative narrative evaluation based on best professional judgement is used when quantitative data is not available to calculate the Invertebrate Community Index (ICI) scores.
c The sampling location was located within an impoundment with non-detectable current speed.
d Mixing zone sampling location.
* Significant departure from ecoregion biocriterion (>4 ICI units); poor and very poor results are underlined.
ns Nonsignificant departure from biocriterion (≤4 ICI units).

Table 20. Distribution of freshwater mussels (Unionidae) in the Scioto River from 5th Ave. in Columbus to US 22 in Circleville, excluding the mixing zones, during the 1996 sampling effort.[a]

Species	River Mile													
	136.3	133.4	129.0	127.8	126.5	123.2	119.3	117.3	116.3	114.0	109.4	106.0	102.0	100.0
Amblema plicata	X													
Anodonta suborbiculata								X						
Lampsilis radiata luteola	X	X							X					
Lampsilis venticosa				X					X					
Lasmigona complanata			X					X	X		X			X
Leptodea fragilis				X			X	X	X	X	X	X	X	X
Potamilus alatus							X					X		
Potamilus ohiensis						X							X	
Pyganodon grandis			X	X			X		X					
Quadrula quadrula							X		X	X	X			X
Tritogonia verrucosa										X	X		X	
Truncilla donaciformis								X	X	X	X			X
Truncilla truncata										X				
Utterbackia imbecillis									X					
Number of species	2	1	2	3	0	1	4	4	8	5	5	2	3	4

[a] Taxa were considered present at a station if fresh-dead specimens were collected or if live specimens were observed in the field.

Biological Assessment Fish Community

A total of 28,900 fish comprising 84 species and six hybrids were collected from the Scioto River between August and September, 1996. The fish sampling effort included 29 stations, evaluating the middle segment of the Scioto River from RM 145.0 (upstream from Griggs reservoir) to RM 97.9 (downstream from Circleville, at the old canal dam). Numerically, the predominant species were: gizzard shad (13.7%), smallmouth bass (9.7%), bluegill sunfish (9.0%), spotfin shiner (5.7%), bluntnose minnow (4.0%), and golden redhorse (3.5%). In terms of biomass, dominant species were: common carp (23.2%), smallmouth buffalo (15.6%), river carpsucker (9.7%), black buffalo (7.9%), golden redhorse (5.4%), and channel catfish (5.4%). Fish species listed as endangered, threatened, or special interest within the State of Ohio included silver lamprey, shortnose gar, mooneye, muskellunge, river redhorse, slenderhead darter, bluebreast darter, and tippecanoe darter (Ohio DNR 1998).

Community performance as measured by the IBI and MIwb, ranged between fair/good (IBI=35, MIwb=8.2) at RM 140.0 (Griggs reservoir) and exceptional (IBI=50, MIwb=11.1) at RM 129.1 (Greenlawn Ave.). Overall, the fish assemblage of the Scioto River was characterized as good/exceptional. All free flowing and non-mixing zone stations were found to supprt an assemblage of fishes with a species composition, diversity, and functional organization fully consistent with the WWH biocriteria (Table 21 and Figure 23). Moreover, fully exceptional level of community performance was indicated at 15 of the 29 Scioto River fish sampling stations.

Despite community performance consistent with or often in excess of the WWH biocriteria, the fish assemblage did show signs of stress that appeared associated with several point source issues within the study area. First, a marked decline in the performance of the IBI was observed between the Whittier St. CSO (RM 129.1) and SR 665 (RM 119.9). Diminished community performance appeared associated with organic and nutrient loadings from the Whittier St. CSO and Jackson Pike WWTP coupled with insufficient assimilative flows, due to water withdrawals by the Dublin WTP and regulated flows of the Olentangy River. In addition, the Whittier St. CSO discharges to a reach of the Scioto River that is largely pool. The negative effects of these loadings were enhanced by insufficient dilution and slow turnover rates associated with extensive pooled areas. Full recovery of the fish community, in terms of the IBI, was indicated at RM 119.9 (SR 665), where a very good-exceptional assemblage was again found. The second indication of chronic sublethal stress included the elevated incidence of Deformities, Eroded fin/barbels, Lesions, and Tumors (DELT) anomalies. Upstream from the metropolitan area of Columbus, the percent occurrence of these types of external anomalies typically remained at or below the benchmark reference value (i.e., non-elevated) (Ohio EPA 1989). As the Scioto River entered the urban center of the City of Columbus, percent DELTs were markedly increased, reaching highly elevated levels downstream from the Whittier St. CSO and Columbus Southerly WWTP (Figure 24). DELT anomalies remained elevated throughout most of the remaining segment downstream from Columbus.

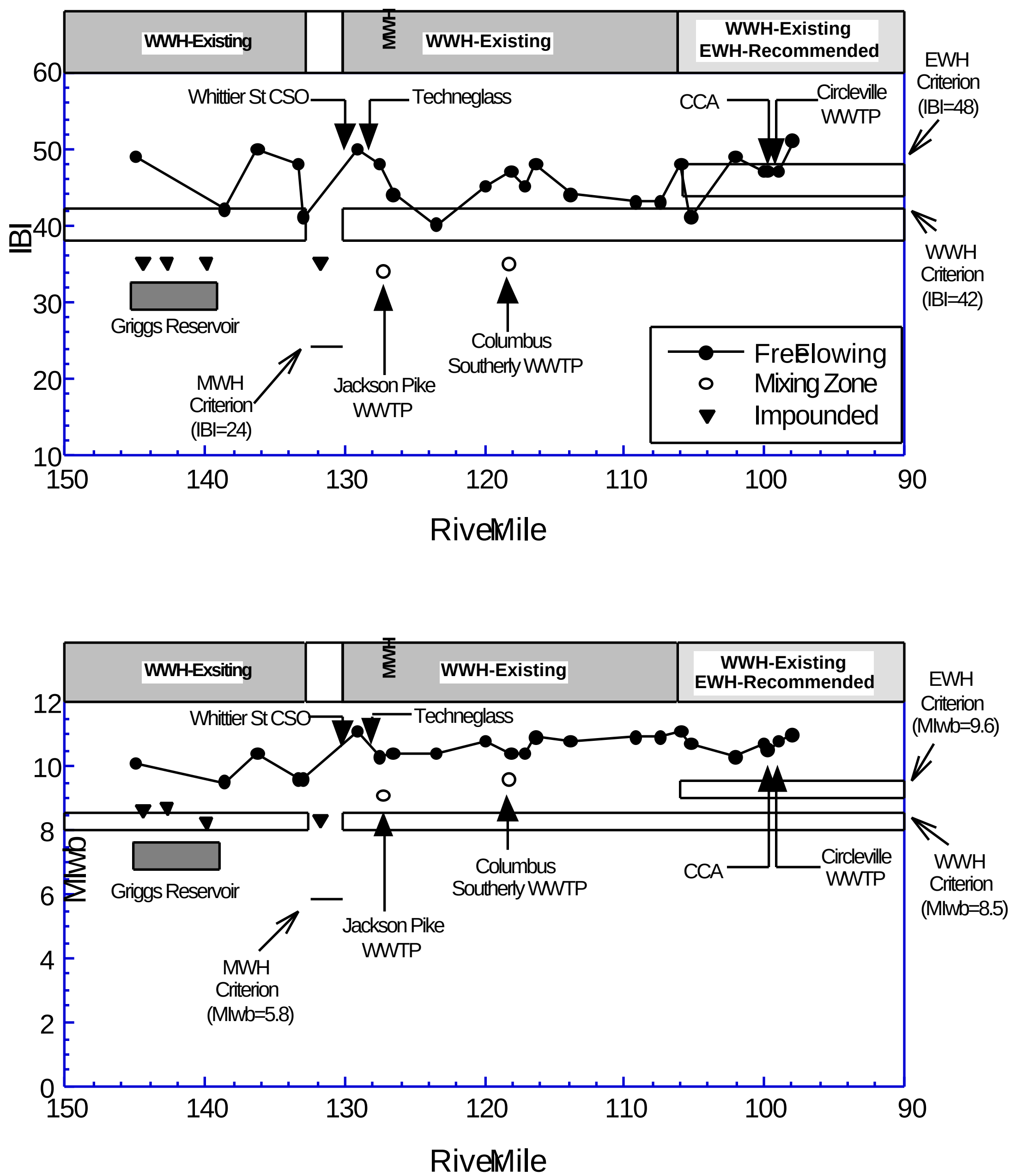


Figure 23. Longitudinal performance of the Index of Biotic Integrity (IBI) and the Modified Index of well-being (MIwb) through the middle Scioto River, 1996. The solid lines represent numerical biological criteria and the area of nonsignificant departure (where aplicable) in support of the existing and recommended aquatic life use designations-Eastern Corn Belt Plains ecoregion.

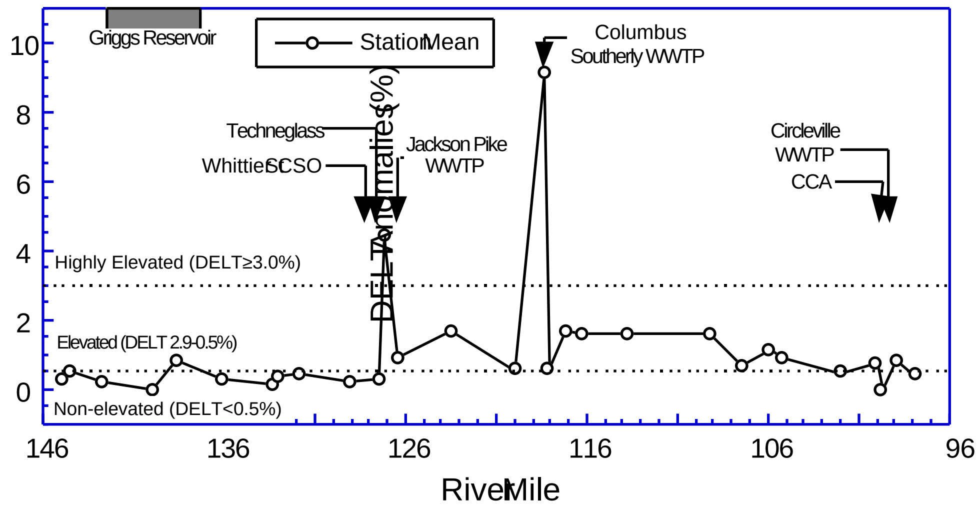


Figure 24. Longitudinal percent occurrence of Deformities, Eroded fins and/or barbels, Lesions, and Tumors (DELT anomalies) from the middle Scioto River study area, 1996. Dashed lines indicate magnitude, based on reference conditions (Ohio EPA 1987b).

Despite depressed community performance, as measured by the IBI, through the City of Columbus and elevated to highly elevated DELT anomalies within and downstream from Columbus, IBI and MIwb values from the segment did remain within nonsignificant departure of the WWH biocriteria. Moreover, the MIwb consistently surpassed the WWH standard at all free flowing or non-mixing zone sites, demonstrating remarkably little longitudinal variation.

One fish sampling station was located on the Olentangy River at RM 0.7 to evaluate the effect of industrial and urban nonpoint sources. A total of 1,033 fish comprised of 28 species and two hybrids were collected. Numerically predominant species included: gizzard shad (37.5%), golden redhorse (12.7%), smallmouth bass (12.1%), and green sunfish (5.5%). Dominant species in terms of biomass were: golden redhorse (39.2%), common carp (23.9%), black redhorse (20.0%), and smallmouth bass (4.9%). Given the modified and highly urbanized nature of the lower portion of the Olentangy River, the dominance, both in terms of abundance and biomass, of the environmentally intolerant and sensitive redhorse sucker species and smallmouth bass, were unexpected. Community performance as measured by the IBI and MIwb were in full agreement with the WWH biocriteria. Both indices indicated very good conditions (IBI=45 and MIwb=9.2).

Table 21. Fish community indices and descriptive statistics based on samples collected by Ohio EPA from the middle Scioto River, lower Olentangy River, and Alum Creek, 1996.

Stream River Mile	Mean Number Species	Cumulative Species	Mean Rel. No. (No./1.0km)[c]	Mean Rel. Wt. (Wt./1.0km)[c]	QHEI	Mean IBI	Mean MIwb	Narrative Evaluation
Scioto River (1996)								
			Eastern Corn Belt Plains - WWH Use Designation					
145.0[B]	25.0	30	1279.0	121.5	83.0	49	10.1	V.Good-Exceptional
144.5[B]	20.0	23	1332.0	113.0	69.0	35*	8.6	Fair-Good
142.8[B]	22.5	28	1371.0	71.1	62.0	35*	8.7	Fair-Good
140.0[B]	16.0	20	1187.0	56.5	59.0	35*	8.2[ns]	Fair-Good
138.6[B]	14.5	19	1450.0	382.9	70.5	42	9.5	Good-V.Good
136.2[B]	29.0	34	1057.5	113.5	75.0	50	10.4	Exceptional
133.3[B]	27.5	32	1001.5	47.1	69.0	48	9.6	Exceptional
133.0[B]	25.0	33	1223.0	155.3	68.0	41[ns]	9.6	M.Good-Exceptional
			Eastern Corn Belt Plains - MWH Use Designation					
131.8[B]	20.0	23	1260.5	165.0	39.0	35	8.3	M.Good-Good
			Eastern Corn Belt Plains - WWH Use Designation					
129.1[B]	38.5	45	1003.1	129.8	72.5	50	11.1	Exceptional
127.5[B]	38.0	45	907.1	88.8	65.5	48	9.1	Exceptional-V.Good
127.2[B,mz]	*17.0*	*22*	*339.5*	*240.7*	*N/A*	*34*	*9.1*	*Fair-V.Good*
126.5[B]	34.0	40	576.6	152.5	82.0	44	10.4	Good-Exceptional
123.5[B]	33.0	39	506.3	299.3	70.5	40[ns]	10.4	Good-Exceptional
119.9[B]	36.5	42	954.7	216.7	85.5	45	10.8	V.Good-Exceptional
118.3[B,mz]	*17.3*	*26*	*605.88*	*418.2*	*N/A*	*35*	*9.6*	*Fair-Exceptional*
118.1[B]	32.3	44	696.8	87.7	75.0	47	10.4	V.Good-Exceptional
117.1[B]	32.7	46	446.9	141.2	80.0	45	10.4	V.Good-Exceptional
116.3[B]	34.0	43	403.3	174.7	87.5	48	10.9	Exceptional
113.8[B]	37.3	48	528.5	151.4	80.5	44	10.8	V.Good-Exceptional
109.2[B]	33.7	43	744.9	241.8	81.5	43	10.9	Good-Exceptional
107.4[B]	35.3	49	728.0	274.2	72.0	43	10.9	Good-Exceptional
105.9[B]	36.0	41	778.0	268.3	86.0	48	11.1	Exceptional
105.2[B]	35.0	42	411.8	168.4	73.0	41[ns]	10.7	M.Good-Exceptional
102.0[B]	33.7	47	384.4	74.3	76.0	49	10.3	Exceptional
100.0[B]	42.3	54	757.6	121.7	87.5	47	10.7	V.Good-Exceptional
99.7[B]	35.5	46	391.8	133.5	85.5	47	10.5	V.Good-Exceptional

Table 21. continued.

Stream River Mile	Mean Number Species	Cumulative Species	Mean Rel. No. (No./km)[c]	Mean Rel. Wt. (Wt./km)[c]	QHEI	Mean IBI	Mean MIwb	Narrative Evaluation
Scioto River (1996)								
98.9[B]	33.0	40	509.0	185.6	92.0	47	10.8	V.Good-Exceptional
97.9[B]	41.5	49	699.0	164.5	85.5	51	11.0	Exceptional
Olentangy River (1996)								
Eastern Corn Belt Plains - WWH Use Designation								
0.7[B]	24.0	28	1033.0	193.0	66.0	43	9.5	Good-Very Good
Alum Creek (1996)								
Eastern Corn Belt Plains - EWH/WWH Use Designation (Existing/Recommended)								
44.1[W]	22.5	27	2041.5	10.9	63.0	49[ns]	8.5*	V.Good-Good
42.8[W]	25.0	31	1287.8	21.6	81.0	45*	9.0[ns]	Good-V.Good
Eastern Corn Belt Plains - WWH Use Designation								
26.3[W]	26.5	32	637.5	33.0	75.0	40	8.6	Good
23.8[W]	28.0	34	403.0	13.8	58.0	42	8.3	Good
22.6[W]	23.0	28	420.0	24.4	57.5	43	7.9[ns]	Good-M.Good
19.8[W]	26.5	29	675.8	29.8	77.5	45	8.9	Good-V.Good
17.4[W]	26.0	33	693.0	55.8	74.0	38[ns]	7.7*	M.Good-Fair
17.2[W,mz]	*18.0*	*21*	*804.0*	*18.5*	*N/A*	*40*	*9.0*	*Good-V.Good*
15.4[W]	25.0	29	1155.7	12.4	62.5	43	8.4	Good
13.5[W]	24.0	27	1124.3	53.1	75.5	36[ns]	7.9[ns]	M.Good
9.2[B]	18.5	22	684.0	146.1	52.0	28*	8.0[ns]	Fair-M.Good
7.5[B]	29.5	37	566.0	156.8	56.5	37*	9.2	Fair-V.Good
6.6[B]	25.0	33	566.0	191.7	52.5	35*	8.7	Fair-Good
3.9[B]	27.0	35	727.8	179.3	55.5	32*	9.0	Fair-V.Good
0.8[B]	29.5	38	441.7	171.1	67.0	38[ns]	9.2	M.Good-V.Good
West Branch Alum Creek (1996)								
Eastern Corn Belt Plains - WWH Use Designation								
0.6[W]		25	1674.8	14.8	76.0	45	9.2	Good-Very Good

* -Significant departure from ecoregion biocriterion; poor and very poor results are underlined.
ns -Nonsignificant departure from biocriterion (≤4 IBI or ICI units; ≤0.5 Iwb units).
a -Use attainment status based on one organism group is parenthetically expressed.
b -Narrative evaluation based on qualitative benthic macroinvertebrate sample (G-good, F-fair, and P-poor).
c -Relative abundance and relative weight estimates for boat and wading stations per 1.0 km and 0.3 km, respectively.
W -Wadable fish sampling station.
B -Boatable fish sampling station.
MZ -Samples collected with the 001 mixing zone (biocriteria do not apply).

Table 21. continued.

Ecoregion Biocriteria: E. Corn Belt Plains (ECBP)
(OAC 3745-1-07, Table 7-14)

INDEX - Site Type	WWH	EWH	MWH[d]
IBI - Headwater	40	50	24
IBI - Wading	40	50	25
MIwb - Wading	8.3	9.4	6.2
IBI - Boat	42	48	24
MIwb - Boat	8.5	9.6	5.8

[d] - Modified Warmwater Habitat for channelized habitats/impounded habitats.

Alum Creek

Pollutant Loadings

Monthly effluent loadings are reported to Ohio EPA by all NPDES permitted discharging entities. Third-quarter (July-September) Monthly Operating Report (MOR) data provided the quantity and character of pollutant loadings from 1976 through 1996 for each significant discharger within the 1996 Alum Creek study area.

Pollutant loading trends analysis included the 95th and 50th percentiles of four parameters where available: Ammonia-nitrogen (NH_3-N), Five-day Biochemical Oxygen Demand (BOD_5)/ Five-day Carbonaceous Biochemical Oxygen Demand ($cBOD_5$), Total Suspended Solids (TSS), and Annual discharge (MGD). Note that BOD_5 and $cBOD_5$ are combined on the same graph and reflect permit parameter changes emphasizing only carbonaceous BOD_5 not total BOD_5.

Certified Oil Company (Unnamed tributary RM 0.5, Alum Creek RM 17.15)

Certified Oil Company, at 5323 Westerville Road in Franklin County, operates a groundwater pump-and-treat facility for removal of gasoline related contaminants (benzene, toluene, ethylbenzene, xylene, lead). With a design capacity of 0.0072 MGD, the facility discharges into an unnamed tributary of Alum Creek at RM 0.5, joining Alum Creek at RM 17.15.

Delaware County Home (Unnamed tributary RM 1.47, Alum Creek RM 38.75)

The Delaware County Home utilizes extended aeration, clarification, sand filtration and chlorination to treat sanitary wastewater. The design flow of the plant is 0.02 MGD. The facility discharges into an unnamed tributary of Alum Creek at RM 1.47. This facility contributes a negligible waste load to Alum Creek when compared with other facilities. Both treatment and flows to the plant have remained relatively stable over time.

Huber Ridge WWTP (Alum Creek RM 17.23)

The WWTP at the Huber Ridge Subdivision was constructed in 1962 and upgraded with additional treatment capacity and modernized equipment in 1994, in accordance with a federal consent order. The facility utilizes a lift station, comminutor, extended aeration, clarification, flow metering, chlorination, and dechlorination. In addition, sludge-holding and aerobic digestion are operational and equipped with a belt filter press to dewater sludge. The plant has a design flow of 1.03 MGD and discharges into Alum Creek at RM 17.23.

The Huber Ridge WWTP contributes the vast majority of wastewater flow to Alum Creek when compared with the other dischargers. This is reflected in $cBOD_5$ and suspended solids loadings, where Huber Ridge contributes more than any other discharger to Alum Creek. While influent has increased slightly since 1990, loadings to the creek have been decreasing since 1991 (Figure 25) indicating increased treatment efficiency. Plant upgrades performed in 1994 have undoubtedly contributed to this trend.

Huber Ridge Water Treatment Facility (Alum Creek RM 17.90)

Huber Ridge WTP, located at 3471 Paris Boulevard in Westerville, treats groundwater for public consumption. It provides service to approximately 2180 residential customers and 80 commercial customers. The treatment process includes an aerator, a mud tank, and sand filters. Well water is aerated and filtered for iron removal, and chlorinated and fluoridated prior to distribution. Filter backwash is treated through slow sand filtration and discharges 0.0364 MGD into Alum Creek at RM 17.9.

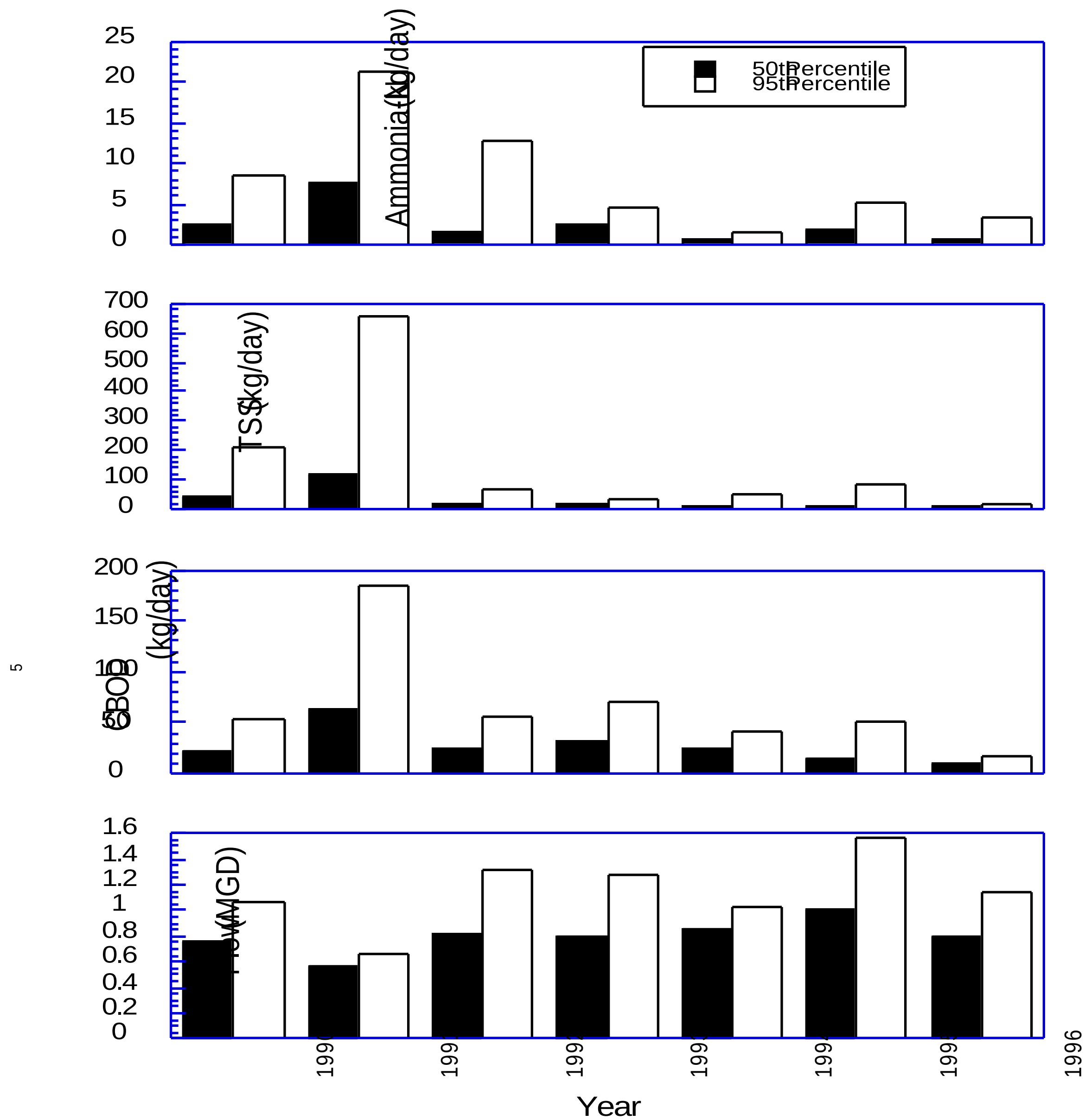


Figure 25. Third-quarter median and 95th percentile conduit flow (MGD) and pollutant loads (kg/day) of Ammonia-Nitrogen (NH_3-N), and five-day carbonaceous Biochemical Oxygen Demand ($cBOD_5$), and Total Suspended Solids (TSS) from the Huber Ridge WWTP, 1976 through 1996.

L&M Excavators, Inc.

L&M Excavators is located on Westerville Road in Columbus. The facility washes mined gravel and utilizes sediment ponds for wash runoff and mine de-watering. The hydraulic capacity of the sediment pond pump is 0.96 MGD. The rate at which the pump operates is largely dependent upon the amount of rainfall.

Ohio Department of Transportation Park # 6-25 and 6-26 (Unnamed tributary RM ~1.0 to Alum Creek RM 31.08)

ODOT Parks 6-25 and 6-26 are located on I-71 in Delaware county. Treatment at each plant consists of extended aeration, secondary settling, a 1500 gal. trash trap, 3,000 gal. flow equalization tank, sand filters, and chlorination. Both plants are designed to handle 0.010 MGD of wastewater and discharge into an unnamed tributary of Alum Creek. The NPDES permits require closing of these plants in September 1998. Wastewater will be diverted to the Olentangy Environmental Control Center WWTP.

Flow to these plants has generally been stable at around the design capacity of 0.010 MGD. Loadings of ammonia, suspended solids, and $cBOD_5$ have varied considerably showing a generally rising trend. Approximately 93% of the point source ammonia loading to Alum Creek is produced by these plants (ammonia loadings to the creek were higher in 1996 than in any other year. Assuming that the plants are abandoned when the sewer connection is made, further discharges will be discontinued.

Sun Refining and Marketing Company

The WWTP at Sun Refining and Marketing Company (SR 36 and Interstate 71) was constructed in 1991 to treat sanitary wastewater, but was abandoned in October of 1997 when the area was incorporated into the City of Delaware sewer system.

City of Westerville WTP (Alum Creek RM 21.20)

The Westerville WTP is located at 312 West Main Street in Westerville. It produces potable water using lime and caustic soda softening, settling, and chlorine and fluoride addition. Discharge of 0.033 MGD from a settling pond to Alum Creek occurs at RM 21.2.

ASARCO (American Ditch headwaters, Alum Creek RM 9.10)

The facility has an NPDES permit for untreated stormwater runoff. ASARCO formerly roasted zinc and disposed of waste dross on the facility grounds. Soils on site are contaminated with zinc and cadmium although other metals are present. The site will be undergoing remediation including capping and groundwater treatment. American Ditch joins Alum Creek at RM 9.10.

Alum Creek Storm Tanks (Alum Creek RM 7.00)

The City of Columbus operates a large sewage collection system including the Alum Creek interceptor sewer. This Alum Creek interceptor sewer includes combined sewers (storm and sanitary sewers in one pipe). During significant precipitation, these combined sewers may fill beyond their capacity to carry all of the stormwater and sewage. The Alum Creek Storm Tanks provide primary treatment of this combination of sewage and stormwater prior to overflow into Alum Creek. In 1996, approximately 30 million gallons of mixed stormwater and sewage overflowed from the tanks into Alum Creek. This totaled almost 6000 kg of $cBOD_5$ and nearly 40,000 kg of suspended solids. These data are summarized in Figures 26 and 27.

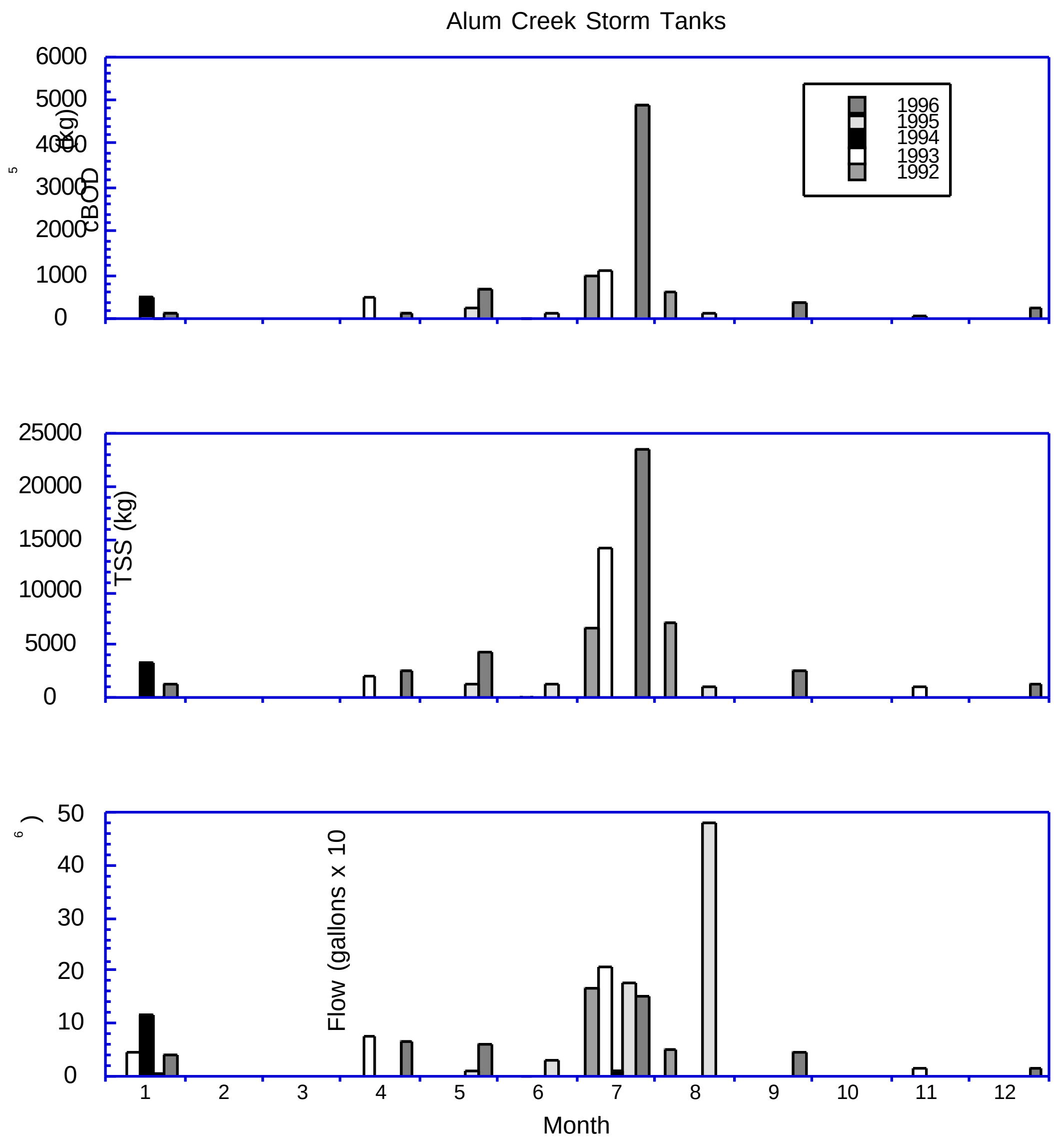


Figure 26. Monthly cumulative release volume and pollutant loads of five-day carbonaceous Biochemical Oxygen Demand ($cBOD_5$) and Total Suspended Solids (TSS), from the Alum Creek Storm Tank, 1992 through 1996.

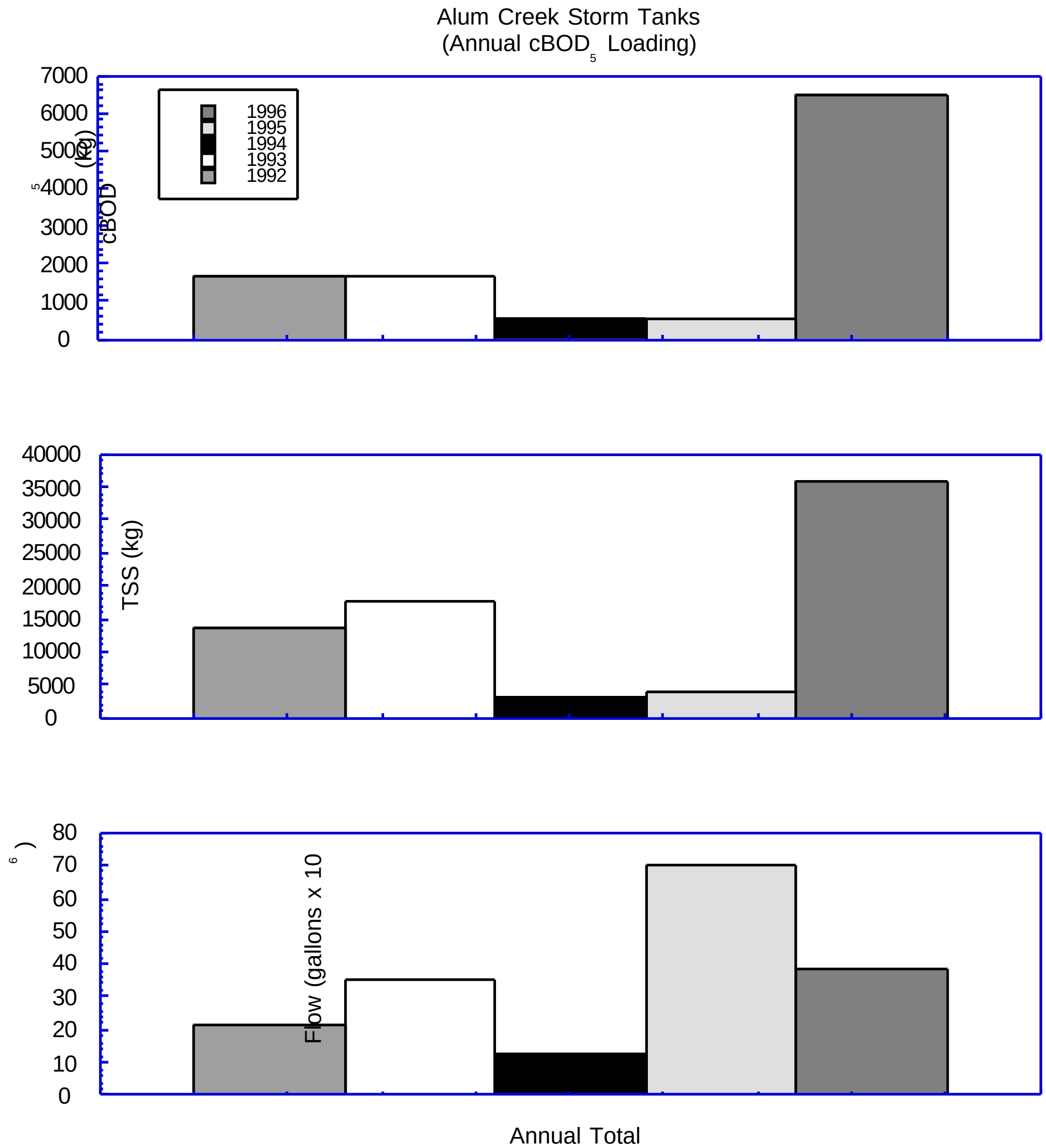


Figure 27. Annual cumulative release volume and pollutant loads of five-day carbonaceous Biochemical Oxygen Demand ($cBOD_5$) and Total Suspended Solids (TSS), from the Alum Creek Storm Tank, 1992 through 1996.

Chemical Water Quality

Between June and October 1996, five water column grab samples were collected from each Alum Creek site. Using sampling protocols specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio EPA, 1989), water samples were collected, preserved, and analyzed for a variety of pollutants including metals, nutrients, and demand parameters. Analytical results for the conventional and metals parameters are presented in Appendix Table B.

Sampling stations were selected to provide information concerning ambient and effluent water quality, and to assess impacts, if any, from municipal and industrial discharges in the Alum Creek study area. Ambient results were evaluated to determine instantaneous exceedences of or excursions from criteria in the Ohio Water Quality Standards (OAC Chapter 3745-1). Exceedences were based on WWH aquatic life, recreational standards (PCR and SCR), Agricultural Water Supply, and Industrial Water Supply beneficial uses. The Alum Creek Reservoir was not evaluated as part of the 1996 effort. Exceedences and violations based upon the various WQS criteria in support of applicable beneficial use are summarized in Table 22. Longitudinal concentration of selected WQS parameters are presented in Figures 28, 29, and 30.

Fecal coliform counts greater than the PCR and SCR criteria were the most frequent violations observed in the Alum Creek mainstem. These exceedences were associated exclusively with the portion of Alum Creek downstream from the reservoir, between RM 22.15 and RM 0.93. All sites between RM 22.15 and RM 0.93 inclusive, had at least one fecal coliform value in excess of the PCR maximum criterion of 2000 colonies per 100 ml. Additionally, at sites between RM 19.80 and RM 0.93 inclusive, counts exceeded even the SCR criterion of 5000 colonies per 100 ml.

Fecal streptococcus concentrations showed a similar pattern although there is no water quality standard for this bacteriological measure. Upstream, the concentrations were only slightly above the median for wadeable, WWH streams in the ECBP ecoregion. Downstream from RM 26.30 fecal strep concentrations increased dramatically and leveled off at significant populations near RM 6.60.

Although the Huber Ridge WWTP is the largest discharger in this bacteriologically contaminated stretch of the river, it does not contribute to the fecal coliform contamination problem. Much of this reach of Alum Creek flows through the Columbus/Westerville metropolitan area. Urban/suburban runoff and unsewered portions of Franklin County undoubtedly contributed to the bacteriological contamination of Alum Creek in addition to the Alum Creek Storm Tank CSO at RM 7.00.

Table 22. Exceedences of Ohio EPA Warmwater Habitat criteria (OAC 3745-1) for chemical/physical parameters measured in the Alum Creek study area, 1996.

Stream	River Mile	Exceedence: Parameter (value)
Alum Creek		
	23.8	Dissolved Oxygen (4.8, 4.7)‡[a]
	22.15	Fecal coliform (2200)◊◊
	21.60	Fecal coliform (4600)◊◊
	19.80	Fecal coliform (8454)◊◊◊
	17.30	Fecal coliform (1352, 2000)◊, (7820)◊◊◊
Huber Ridge WWTP>		
	15.37	Fecal coliform (5300, 49000)◊◊◊
	13.46	Fecal coliform (4500)◊◊, (>60000)◊◊◊
	9.10	Fecal coliform (6900, 52000)◊◊◊ Dissolved Oxygen (4.0)‡
Alum Creek Storm Tank>		
	7.50	Fecal coliform (2100, 2500, 4000, 4400)◊◊, (>60000)◊◊◊
	6.60	Fecal coliform (5000)◊◊, (49000)◊◊◊ Dissolved Oxygen (2.5‡‡)
	3.90	Fecal coliform (3800)◊◊, (60000)◊◊◊ Dissolved Oxygen (3.5‡‡)
	0.93	Fecal coliform (>60000)◊◊◊

‡ exceedence of the 24-hour average warmwater habitat dissolved oxygen criterion (5.0 mg/l).
‡‡ violation of the minimum warmwater habitat dissolved oxygen criterion (4.0 mg/l).
◊ exceedence of the average Primary Contact Recreation criterion (fecal coliform 1000/100 ml).
◊◊ exceedence of the maximum Primary Contact Recreation criterion (fecal coliform 2000/100 ml).
◊◊◊ exceedence of the Secondary Contact Recreation criterion (fecal coliform 5000/100 ml).
a instream concentration derived from Datasonde continuous monitoring unit.

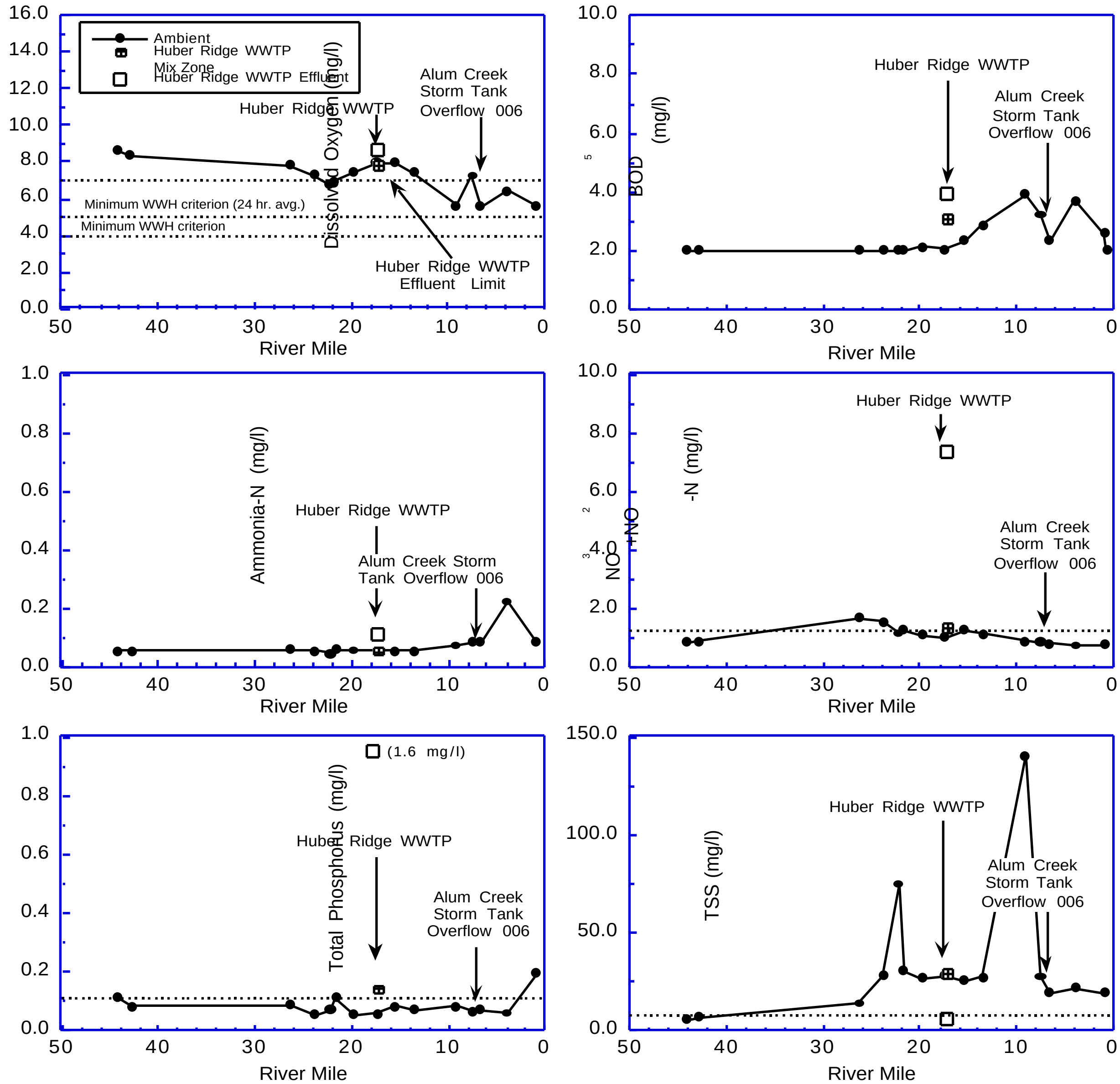


Figure 28. Mean longitudinal concentrations of Dissolved Oxygen, Ammonia-Nitrogen, Nitrate+Nitrite-Nitrogen (NO_3+NO_2-N, Five-day Biochemical Oxygen Demand (BOD_5), Total Phosphorus, and Total Suspended Solids (TSS), from Alum Creek, 1996. Unless otherwise noted, dashed lines indicate median concentrations from large river, WWH reference stations within the Eastern Corn Belt Plains ecoregion.

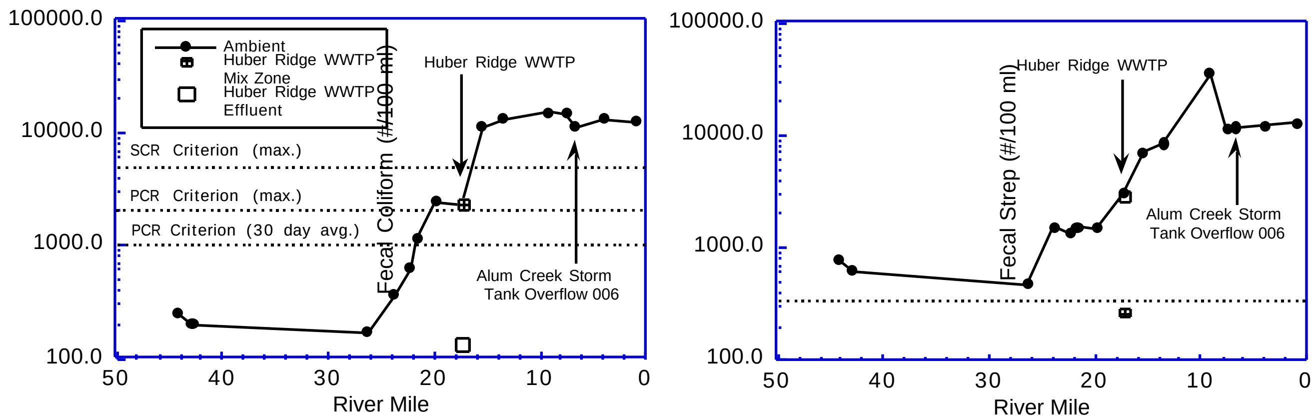


Figure 29. Mean longitudinal fecal coliform and fecal strep. counts from the Alum Creek, 1996. Dashed lines indicates median ECBP background level, unless otherwise noted.

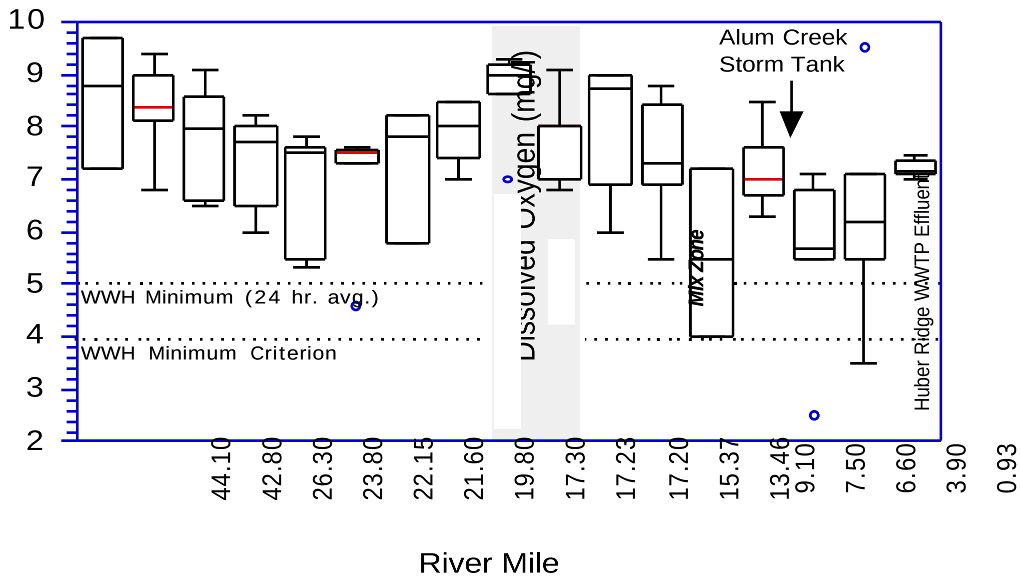


Figure 30. Box plots of day-time Dissolved Oxygen concentrations through the Alum Creek study area, 1996.

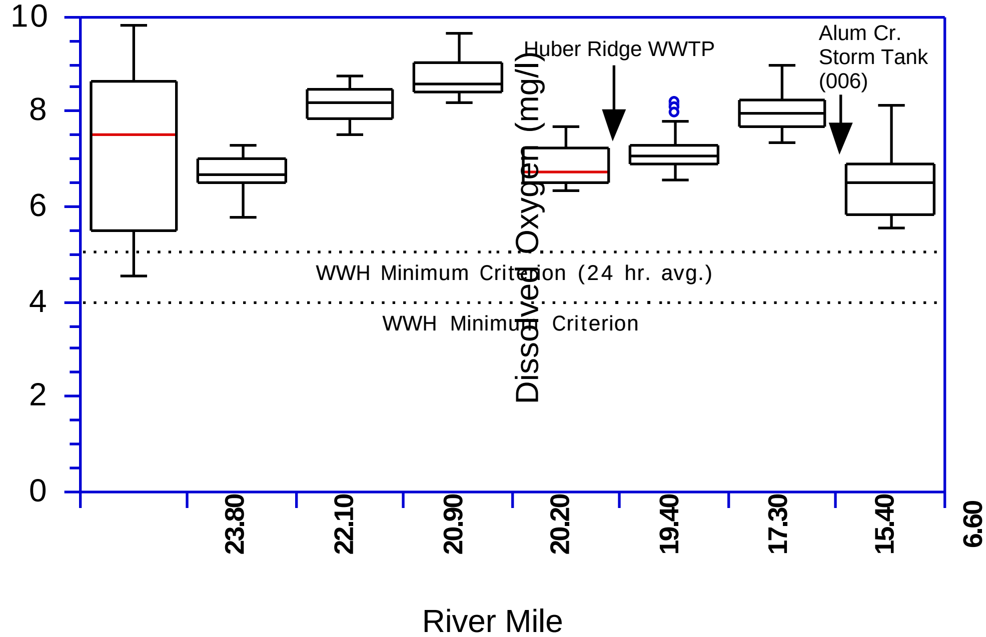


Figure 31. Box plots of diel Dissolved Oxygen concentrations through the Alum Creek study area, 1996.

Dissolved oxygen concentrations below the WWH criteria (minimum and average) were found at RMs: 23.8, 9.1, 6.6, and 3.9. Dissolved oxygen in these areas was most likely depleted due to the pooled, slow-flowing nature of the stream at these sites. Actual violations of the WWH minimum were limited to the lower seven miles, where numerous low head dams restrict riffle development where reaeration would normally occur. These factors coupled with oxygen demanding impacts from urban runoff, including the Alum Creek Storm Tanks CSO, deplete oxygen in this reach of Alum Creek.

Nutrient concentrations remained well within normal ranges during the study. Nitrates, ammonia, and phosphorus were all near the median value for wadeable WWH streams in the ECBP ecoregion.

Mean suspended solids concentrations exhibited two large peaks (RM 21.60 and RM 9.10). The site at RM 21.60 was downstream from the Polaris interchange area where there has been a large amount of construction activity. The site at RM 9.1 is downstream from American Ditch which receives runoff from ASARCO and other urban areas. These suspended solids peaks correlate with rain events noted when comparing individual sampling passes with stream flow data. Aside from these peaks, solids concentrations increased longitudinally from RM 44.10 to RM 13.46 and leveled off thereafter. In most cases (except the large peak at RM 9.10 and low values at RM 44.10 and 42.80), mean suspended solids concentrations remained near the median for wadable, WWH streams of the ECBP ecoregion.

Concentrations of metals were not found to be a concern in the waters of Alum Creek. Arsenic, cadmium, chromium, copper, lead, and nickel were either not detected or detected at very low concentrations. Although zinc concentrations increased due to the influence of the Huber Ridge WWTP discharge at RM 17.23, values dropped to background levels by RM 7.50.

Diel dissolved oxygen, temperature, pH, and conductivity data were collected with Datasonde continuous sampling units during October 1996. Datasondes were placed at eight different stations on Alum Creek between RM 23.80 and RM 6.60 inclusive. Dissolved oxygen concentrations were typically above the WWH criteria, except for RM 23.8, where two consecutive values dropped below the 24-hour criterion. (Figure 31).

Water column samples were collected at six different locations throughout the Alum Creek study area and analyzed for volatile and semivolatile organic compounds, pesticides, and PCBs. Only six different compounds were detected including the pesticides benzene hexachloride (both the beta and delta isomers), dieldrin, and endosulfan I, and the compounds naphthalene and 1,2,4-trimethylbenzene (Appendix Table B). All concentrations were well below the numerical criteria for the prevention of aquatic toxicity (e.g., Chronic Aquatic Concentration) except for 1,2,4-trimethylbenzene which has no criterion. The presence of low-level organic contaminants in the water column was most noteworthy at RM 9.10, just downstream from the confluence with American Ditch.

Sediment Chemistry

To evaluate the extent of possible sediment contamination within the Alum Creek study area, sediment samples were collected at 5 locations throughout the Alum Creek watershed. Selected parameters were ranked based on a sediment classification system described by Kelly and Hite (1984) and toxicity based guidelines described by Persaud et al. (1994) and Ohio EPA (1996). The Kelly and Hite classification system ranks pollutant concentrations from non-elevated to extremely elevated but the classification system does not address toxicity. Persaud et al. (1994) guidelines are based on potential toxicity to aquatic benthic organisms. Their classification system is divided into the No Effect Level, Lowest Effect Level and Severe Effect Level. The Lowest Effect Level and Severe Effect Level are based on the long-term effects which the contaminants may have on the benthic community. If a compound is found to be above the LEL, it is anticipated that it may have an adverse effect on some of the benthic community.

Contaminants found to be above the SEL are considered likely to negatively impact the benthos. The No Effect Level is based on concentrations of chemicals which are so low that contaminants are not passed through the food chain and no effect on water quality is expected. Evaluated against these various measures, the sediment results are presented in Tables 23 through 25.

Based solely on the sediment guidelines for metals developed by Ohio EPA (1996), a potential for adverse effects on the biological community in Alum Creek is possible. This is based on the fact that these contaminants persist in the sediments for long periods of time allowing for the possibility that these chemicals can bioconcentrate.

Sediment samples obtained from RM 42.8 contained highly elevated concentrations of cadmium and arsenic, elevated levels of chromium, iron, and nickel, and slightly elevated levels of copper and zinc. Organic chemicals and pesticides were not detected in sediments at this locale. Arsenic contamination has probably occured over time since arsenic based pesticides were used for agricultural purposes in the past and this portion of the Alum Creek drainage is rural and agricultural. The elevated iron concentrations are probably from a natural source(s) and is common in Ohio. The source(s) of the cadmium, chromium, zinc, and nickel unknown.

Sediments from RM 26.3 contained highly elevated concentrations of chromium and iron along with elevated nickel and slightly elevated copper and zinc. Organic contaminants were not detected in sediments from this location. As before, iron is probably from a natural source or the nearby water treatment plant. The source(s) of the other metals may also be from the water treatment plant. Elevated metals of any kind at this site are somewhat surprising since this site was directly downstream from the Alum Creek Reservoir. In most cases, reservoirs act as sinks for contaminants, especially metals.

The site upstream from the Huber Ridge WWTP (RM 17.40) revealed little evidence of metals or organic pesticides and PCBs in sediments. However, a variety of polynuclear aromatic hydrocarbons (PAHs, constituents of tar) were discovered in the sediments at concentrations greater than the lowest effect level (LEL) as defined by Persaud et. al. (1994). Recent road construction may be a source. In addition, low levels of the plasticizer bis [2-ethylhexyl] phthalate were also detected.

Table 23. Concentration of total metals in the sediments of Alum Creek, 1996. All parameter concentrations were ranked according to the guidelines developed by Ohio EPA (1996).

Metal Element	**River Mile**					
	42.8	**26.3**	**17.4**	**17.2**	**9.1**	**6.6**
	Sediment Concentration *(mg/kg unless otherwise noted)*					
Arsenic	**34.7**	1.25	8.58	**21.4**	<u>15.3</u>	7.69
Cadmium	**1.21**	0.13	0.42	*0.59*	<u>**4.41**</u>	**1.17**
Chromium	<u>30</u>	**44**	18	*24*	<u>31</u>	18
Copper	*21*	*23*	10	*23*	<u>34</u>	19
Iron	<u>37500</u>	**43600**	15000	*24900*	*24000*	13700
Lead	27	32	27	26	*50*	*65*
Mercury*	0.026	0.031	0.041	0.037	0.12	0.095
Nickel	<u>48</u>	<u>43</u>	24	*33*	*31*	23
Zinc	*131*	*127*	72	*125*	**351**	<u>175</u>

Plain value - not elevated
Italic value - slightly elevated
<u>Underlined value - elevated</u>
Bold value - highly elevated
<u>**Bold underlined value - extremely elevated**</u>
* - Mercury not included in sediment data set guidelines.

Table 24. Dry weight concentrations of PCBs and Organochlorine Pesticides in the sediments of Alum Creek, 1996. All parameter concentrations were ranked according to the ecotoxic effects guideline described by Persaud et al. (1994).

Chemical Parameter	**River Mile**					
	42.8	**26.3**	**17.4**	**17.2**	**9.1**	**6.6**
	Sediment Concentration (μg/kg)					
Dieldrin	ND	ND	ND	ND	ND	*13*
Methoxychlor*	ND	ND	ND	ND	23	ND
PCB-1260	ND	ND	ND	ND	*57*	*93*

Plain value - Between No effect Level (NEL) and Lowest Effect Level (LEL)
Italic value - Greater than or equal to Lowest Effect Level
Bold value - Greater than or equal to Severe Effect Level (SEL)
* - Not evaluated by Persaud et al. (1994)
ND - Concentrations below detection limits

Table 25. Concentration of semivolatile compounds in the sediments of Alum Creek, 1996. All parameter concentrations were ranked according to the ecotoxic effects guideline described by Persaud et al. (1994).

Compound	River Mile					
	42.8	**26.3**	**17.4**	**17.2**	**9.1**	**6.6**
	Sediment Concentration (mg/kg unless otherwise noted)					
Anthracene	ND	ND	ND	ND	*0.9*	*0.7*
Benzo[a]anthracene	ND	ND	*0.8*	*1.6*	*3.9*	*2.8*
Benzo[a]pyrene	ND	ND	*0.8*	*1.8*	*4.2*	*2.9*
Benzo[b,k]fluoranthene	ND	ND	*1.0*	*2.2*	*5.2*	*3.4*
Benzo[g,h,i]]perylene	ND	ND	*0.6*	*1.6*	*3.1*	*2.2*
Benzo[k]fluoranthene	ND	ND	*0.7*	*1.9*	*4.5*	*2.5*
Bis[2-ethylhexyl]phthalate*	ND	ND	1.3	0.7	2.1	1.2
Chrysene	ND	ND	*1.1*	*2.4*	*5.8*	*3.7*
Dibenz[a,h]anthracene	ND	ND	ND	ND	1.0	0.8
Fluoranthene	ND	ND	*2.6*	*4.5*	*11.8*	*7.6*
Indeno[1,2,3-cd]pyrene	ND	ND	*0.7*	*1.6*	*3.2*	*2.4*
Phenanthrene	ND	ND	*1.5*	ND	*6.6*	*4.2*
Pyrene	ND	ND	*1.9*	*3.6*	*9.1*	*5.9*
Total Organic Carbon **(%)**	2.2	1.7	2.7	2.4	3.6	1.4

ND - Not Detected or less than the laboratory detection limit
Plain text value- Less than lowest effect level (LEL)
Italic text value- Greater than or equal to the LEL
Bold text value- Greater than or equal to the Severe Effect Level (SEL)
* - Not evaluated by Persaud, et.al. (1994)

The site downstream from the Huber Ridge WWTP (RM 17.20) showed slightly elevated concentrations of most metal analytes but highly elevated concentrations of arsenic. PAH compounds were also detected in sediments at concentrations approximately double what was found upstream, and greater than the LEL defined by Persaud et. al. (1994). No pesticides or PCBs were detected at this site.

Cadmium sediment values were extremely elevated at RM 9.10 while zinc concentrations were highly elevated. Other sediment metals varied in concentrations from slightly elevated to elevated. Metals contamination at RM 9.10 was most likely due to drainage from the ASARCO site via American Ditch; the soils at the ASARCO site are heavily contaminated with metals including cadmium and zinc. Pesticides, PCBs, and PAHs were also detected in sediments at RM 9.10. Methoxychlor was the only pesticide detected. PCB-1260 and PAHs were found at concentrations greater than the LEL as defined by Persaud and Jaagumagi (1994). PAHs approximately doubled those found at RM 17.2. The source of PAH, PCB, and pesticide sediment contamination was unknown, but was most likely related to urban runoff or industrial inputs, such as ASARCO.

Physical Habitat for Aquatic Life

As part of the 1996 fish sampling effort, the quality of near and instream macrohabitats of the Alum Creek study area were evaluated at 14 locations. QHEI values ranged between 52.0 (RM 9.2, impounded) and 81.0 (RM 42.8, N. Galena Rd.), with a mean reach score of 64.8 ($\pm$9.99 SD) (Table 18). Mean QHEI values from streams or streams segments greater than 60 generally indicates a level of macrohabitat quality sufficient to support an assemblage of aquatic organisms fully consistent with the WWH aquatic life use designation. Average reach values greater than 75 are generally considered adequate to support fully exceptional (EWH) aquatic communities (Rankin 1989 and Rankin 1995).

Although the average QHEI for the Alum Creek study area was within the range of WWH, macrohabitat quality was not uniformly good throughout. An area of deficient habitats was indicated between RM 9.2 (Nelson Park dam pool, downstream from American ditch) and RM 3.9 (Refugee Rd.). This segment flows through the highly urbanized portion of east and south eastern Columbus, and is negatively affected by historic channelization, urban runoff, and impoundments, the latter being formed by several small lowhead dams scattered throughout this approximately five-mile reach. Although every effort was made to sample only free flowing portions of Alum Creek, two sampling stations at RM 9.2 and RM 3.9 were located within dam pools. The station at RM 9.2 was contained entirely within an impounded and channelized reach, and obviously habitat limited. The stream reach sampled at RM 3.9, straddled the upper limits of the ponded area formed by a small dam at Refugee Rd., thus approximately 150 meters of free flowing water were sampled. All stations within this modified segment displayed a predominance of high and moderate influence modified habitat attributes. Deficient stream features commonly encountered within this segment included extensive channelization, high overall substrate embeddedness, fair to poor channel development, and low sinuosity. The fair to poor condition of near and instream macrohabitats would likely exert a negative influence on ambient biological performance.

The remaining stations were found to contain, at a minimum, a compliment of habitat features capable of supporting WWH fish communities. The channel configuration at most of these stations was in a natural or recovering state, possessing adequate sinuosity and developed riffle-run-pool complexes. The substrates were typically coarse gravel and cobble and not excessively burdened with embedding fines. Given these positive characteristics, impairment of the WWH use driven solely by habitat quality did not appear likely at these sites.

The quality of near and instream macrohabitats of the West Branch Alum Creek were evaluated at one fish sampling station located at RM 0.6 (Worthington --New Haven Rd.). A QHEI score of 76.0 was achieved at this location. The station contained a full compliment of positive habitat features, and was clearly capable of supporting a community of aquatic organisms consistent with the WWH biocriteria.

Biological Assessment: Macroinvertebrate Community

Macroinvertebrate assemblages were sampled and evaluated at 15 sites on Alum Creek from headwaters (RM 44.0) to the mouth (RM 0.7). Narrative evaluations of the assemblages ranged from poor to exceptional quality. Invertebrate Community Index (ICI) scores ranged from a low of 10 (downstream from the Nelson Rd. dam, RM 8.6) to a high of 50 (West Liberty Rd., RM 44.0) (Table 19). Longitudinal performance of the ICI is presented in Figure 32.

Upstream from Alum Creek Reservoir, ICI scores were exceptional in Alum Creek at West Liberty Road (RM 44.0) and Myers Road (RM 42.7), and in the West Branch Alum Creek at Worthington-Havens Road (RM 0.7). These sites had high numbers of EPT taxa (15-16) collected from the natural substrates and high densities (39.7 % to 74.4 %) of tanytarsini midges on the artificial substrates. River Miles 44.0 and 42.7 were the only sites in the study area where pollution sensitive stoneflies were collected.

The ICI scores from Lewis Center Rd. (RM 28.2) to Innis Road (RM 13.5), at nonmixing zone sites, achieved or were in nonsignificant departure from the WWH biocriterion (ICI = 36) and were evaluated as marginally good to very good. The artificial substrates from these sites contained high densities of tanytarsini midges (61.4% to 81.0%) with correspondingly low densities of tolerant taxa (0.1% to 5.8%). Moderate numbers of mayfly and caddisfly taxa were collected from the natural substrates.

Macroinvertebrates were collected from the natural substrates in the Huber Ridge WWTP mixing zone twice during the 1996 survey and evaluated as poor. There were 14 to 18 total taxa and 3 EPT taxa collected during each sampling. Pollution tolerant red midges, were predominant. The benthic macroinvertebrate community was representative of an organic enrichment impact, but not an acutely toxic impact.

In the reach of Alum Creek from the Nelson Park dam (RM 8.6) to Refugee Road (3.8), ICI scores failed to achieved the WWH biocriterion. The site located just downstream from the Nelson Park dam had the lowest ICI score (10) on Alum Creek. Only one mayfly taxon, no caddisfly taxa, and a low percentage of tanytarsini midges were collected from the artificial substrates. Visual signs of enrichment at this site included an area of instream bacterial growth (*Sphaerotilus*) upstream from the dam wall and stream margins covered with algae. ICI scores improved slightly into the fair range at the next few sites (RMs 7.6, 6.2, and 3.8), but metric scores still showed negative influences on community structure due to low EPT taxa richness, high percentages of other dipterans, non-insects, and tolerant organisms.

The benthic assemblage collected from the artificial substrates in Alum Creek near the mouth (RM 0.7) were similar to communities collected upstream from the Nelson Rd. dam with high densities of tanytarsini midges and low densities of other dipterans, non-insects, and tolerant organisms. The ICI score of 42 was in the very good range.

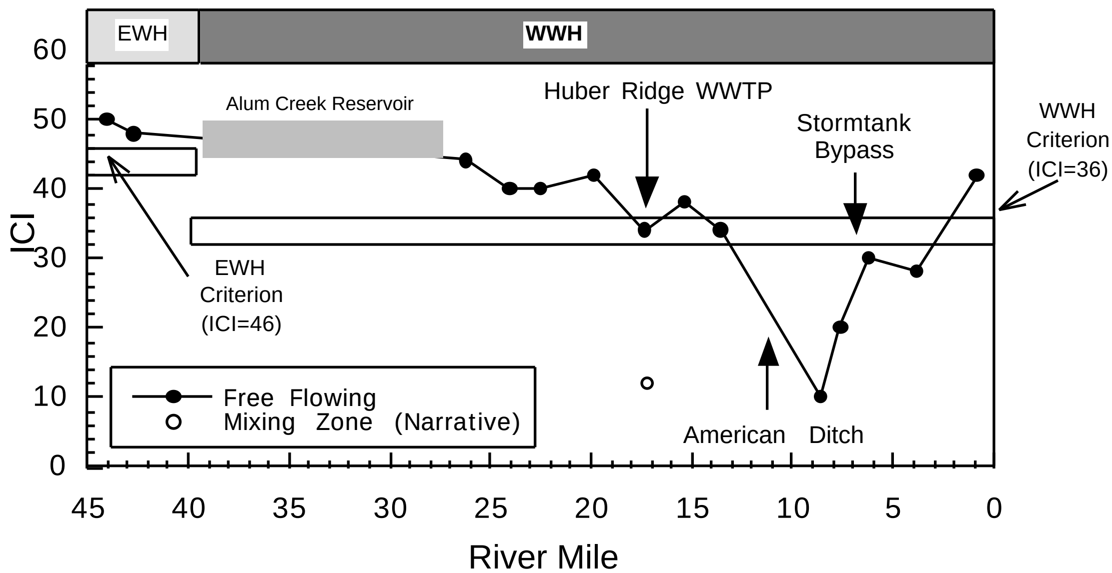


Figure 32. Longitudinal performance of the Invertebrate Community Index (ICI) and narrative equivalent from Alum Creek 1996. The solid lines represent the biocriteria and area of nonsignificant departure in support of the existing WWH and EWH aquatic life use designation--Eastern Corn Belt Plains ecoregion.

Biological Assessment: Fish Community

A total of 14,622 fish comprising 66 species and five hybrids were collected from Alum Creek between July and September, 1996. The fish sampling effort included 15 stations, evaluating the segment from RM 44.1 (West Liberty Rd.) to RM 0.8 (Watkins Rd., near mouth,). Numerically, the predominant species were: central stoneroller (17.2%), sand shiner (8.0%), green sunfish (6.8%), greenside darter (6.7%), and both longear and bluegill sunfish (5.8%). In terms of biomass, dominant species were: common carp (59.3%), golden redhorse (5.3%), river carpsucker (4.8%), white sucker (3.0%), and northern hog sucker (2.6%). Fish species listed as endangered, threatened, or special interest within the state of Ohio included only the muskellunge (Ohio DNR 1998).

Excluding the extensive impoundment created by the Alum Creek reservoir, two aquatic life use designations are currently imposed on the Alum Creek mainstem. The segment extending from the headwaters to the upper limits of the Alum Creek dam pool is designated EWH. The remaining reach, downstream from the reservoir spillway, is designated WWH.

Community performance as measured by the IBI, ranged between fair (IBI=28) at RM 9.2 (5th Ave, impounded) and very good (IBI=49) at RM 44.1 (West Liberty Rd.). MIwb scores ranged between fair (MIwb=7.7) at RM 17.4 (upstream from the Huber Ridge WWTP) and very good (MIwb=9.2) at RM 0.8 (Watkins Rd.) (Table 21). Overall, the fish assemblage of Alum Creek was characterized as marginally good to good.

Despite good to exceptional habitat quality, as measured by the QHEI, and good to very good community index scores, both stations contained within the EWH designated segment (RM 44.1 and RM 42.8) of Alum Creek failed to fully support exceptional fish communities. Either the IBI or the MIwb performed just below the area of nonsignificant departure for the EWH biocriteria. Departures from the EWH standards did not appear indicative of environmental degradation, rather, they can be explained by other factors.

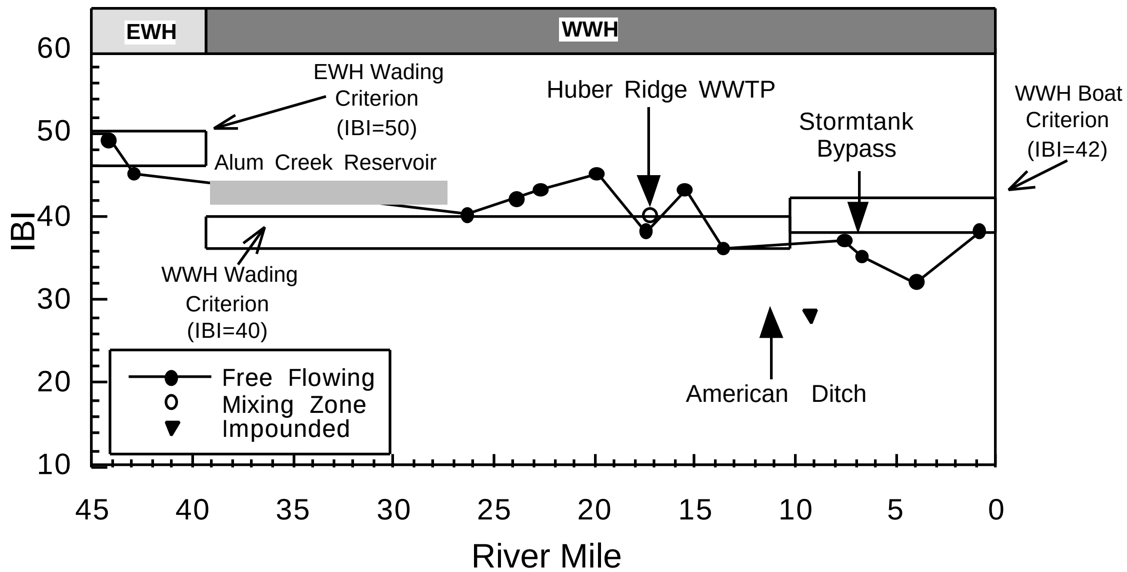
First, the drainage area and its effect on the biocriteria must be considered (i.e., headwater vs. wading). At the upper station (RM 44.1) the drainage area was 28 $miles^2$, just eight miles in excess of the 20 $miles^2$ drainage area break between headwater and wading stations criteria (Ohio EPA 1987[b]). Due to typically low or highly variable biomass and typically lower species richness, in comparison with nonheadwater stations, the MIwb is not applied to stations classified as headwaters (Ohio EPA 1987[b]). As the departure from the EWH criteria at this site was observed only in the MIwb, it is likely that this portion of Alum Creek is functioning as "true headwaters" despite a drainage area slightly greater than the prescribed upper limit. Given the exceptional performance of the IBI, the deficient MIwb score at RM 44.1 was likely an artifact of the headwater characteristics of this reach, rather than an indication of environmental degradation.

The remaining station contained within the EWH segment was located at RM 42.8. The drainage area at this point was well within the wading range (65 $miles^2$) and, as a result, the MIwb appeared to function well, achieving the EWH criterion (MIwb=9.0). The IBI, however, missed the minimum EWH criterion by only one unit (IBI=45). The structure and functional organization of the fish community, as well as the health of individual fish at this location, were very near an exceptional level, and the very modest departure of the IBI appeared almost trivial, and not necessarily indicative of a degraded or depauperate fauna.

Ultimately, none of the stations located within the upper portion of Alum Creek contained a fish assemblage fully consistent with the EWH criteria. The communities typically performed above the WWH standard, but were not fully exceptional. The EWH aquatic life use was initially imposed on this segment in 1985. However, this designation was made--as many were at that time--without benefit of instream biological data to verify its appropriateness (WQS; Ohio Administrative Code 3745-1). The results from the 1996 survey represent the first verification since that time. These data indicate that this reach, though high quality, is not truly exceptional, and therefore, should be redesignated to the more appropriate WWH aquatic life use.

Progressing downstream through the free flowing and unmodified portion of the WWH designated segment, upstream from the highly urbanized area of east and southeastern Columbus, community performance consistent with the WWH biocriteria was typically observed (Figure 33). This approximately 13 mile segment extended from the Alum Creek dam (RM 26.3) to Innis Rd. (RM 13.5) and contained nine stations. Departure from the WWH criteria was limited to only one of these sites, located immediately upstream from the Huber Ridge WWTP (RM 17.4). The IBI at this site remained within nonsignificant departure from the WWH standard, but the MIwb indicated a level of structural evenness just below the minimum criterion--a departure of only 0.1 units. The subpar score did not appear to constitute a significant impact and was attributed to background stressors (urban/suburban and nonpoint sources and possibly habitat influences). All other stations between the reservoir and metropolitan Columbus contained a fish assemblage that performed at or in excess of the minimum WWH criteria. Based on the results from near and far field sampling, effluents discharged by the Huber Ridge WWTP did not appear to have a negative effect on fish community performance in 1996.

The remaining downstream segment of Alum Creek flows through the highly urbanized area of east and southeast Columbus. Largely channelized and frequently impounded by numerous, small lowhead dams, this segment exhibited obvious habitat limitations. Community performance as measured by the IBI and MIwb yielded mixed results. The MIwb indicated a level of structural evenness, adjusted abundance, and adjusted biomass comparable with the ecoregionally derived WWH biocriterion. MIwb scores at all stations--including small impoundments--either met or exceeded the minimum WWH standard. In contrast, the IBI portrayed a marked decline in community performance, beginning at RM 9.2 (downstream from American Ditch--impounded) and extending downstream to RM 3.9 (Refugee Rd.--partial impoundment). In comparison with the unimpacted stations upstream, diminished community attributes observed throughout this reach included a high proportion of environmentally tolerant species and a low proportion of lithophils and round-bodied suckers. Additionally, the incidence of DELT anomalies was markedly increased at RM 9.2, and remained either elevated or highly elevated throughout the remainder of the study area. Although, a distinct impact was evident downstream from the Alum Creek storm tank discharge, other factors appeared culpable for diminished community



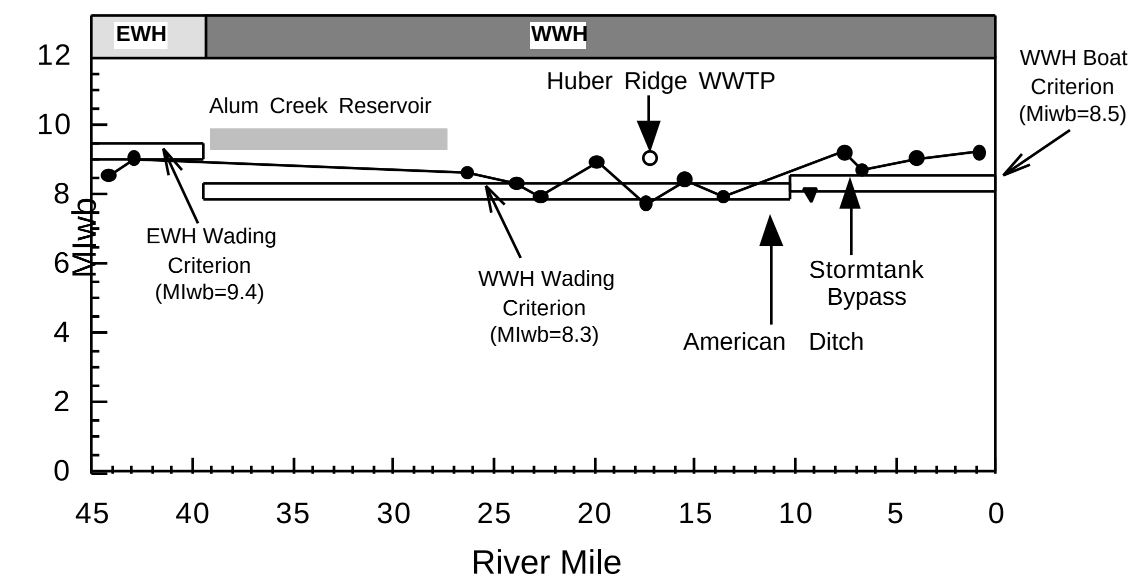


Figure 33. Longitudinal performance of the Index of Biotic Integrity (IBI) and the Modified Index of well-being (MIwb) for Alum Creek, 1996. The solid lines indicate the biocriteria and area of nonsignificant departure for the existing WWH and EWH aquatic life use designations--Eastern Corn Belt Plains ecoregion.

performance, including highly modified habitat (channelized and impounded) and urban runoff. These stressors were pervasive throughout this urbanized segment and undoubtedly contributed to the subpar community performance observed downstream from the Alum Creek storm tank. Macrohabitat quality was significantly advanced as Alum Creek neared the Walnut Creek confluence. Full recovery of the IBI was indicated at RM 0.8 (Watkins Rd.).

One fish sampling station was placed on the West Branch Alum Creek at RM 0.6 (Worthington-New Haven Rd.). Community performance as measured by the IBI and MIwb indicated good to very good conditions (IBI=45 and MIwb=9.2). The station supported a diverse, functionally and structurally well organized assemblage of fishes, fully consistent with the WWH biocriteria.

TREND ASSESSMENT

Scioto River

Chemical Water Quality:1971-1996

Historical water column chemistry data from the Scioto River mainstem was used to perform long term water quality trend assessment. Several sources were utilized in the compilation of the data. These sources already had established data and include Ohio EPA, City of Columbus Water Department, URS Consultants, Techneglas, Jackson Pike WWTP and Columbus Southerly WWTP. The City of Columbus Water Department established a surveillance program in 1980 which assessed nutrient, metals and organic loads to the Scioto River. URS Consultants were retained by the City of Columbus to evaluate the impacts of combined sewer overflows (CSOs) located in the Columbus area. Metals and nutrient data were collected in 1988. The three Scioto dischargers are involved in a self-monitoring program in cooperation with the Ohio EPA. Information from the late 1970s through 1995 was retrieved.

A problem with combining data from several diverse sources is maintaining quality control over the data and eliminating any biases that may be introduced. One outcome of the varied sources of data were multiple detection limits. For example, ammonia had several different detection limits depending on the source of data and the year the samples were anlyzed. Other parameters with multiple detection limits were not as critical as ammonia due to the limited availability of data for one of the detection limits. All attempts were made to reduce bias in the data through statistical regression and graphical analysis.

Mean concentrations of dissolved oxygen, ammonia-N, nitrate+nitrite, total phosphorus, fecal coliform, lead and zinc were determined and plotted in a longitudinal fashion to display trends in these physical and chemical properties.

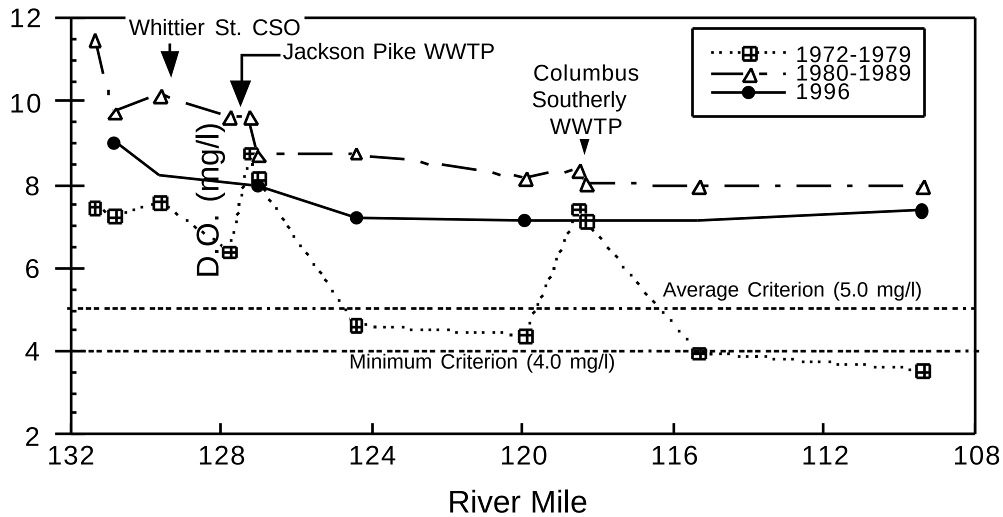


Figure 34. Longitudinal summary of the average Dissolved Oxygen (D.O.) in the middle Scioto River, 1972 through 1996.

The dissolved oxygen concentration has shown an overall increase over time (Figures 34 and 35). The mean dissolved oxygen concentration for three different time periods (1972-1979, 1980-1989, 1996) were plotted by river mile. Average concentrations have been significantly above the EWH criterion (6 mg/l) since 1980. A moderation in the magnitude of the dissolved oxygen sag downstream of Scioto River dischargers is also apparent over time. Box plots of data since 1971 showed improvements in dissolved oxygen concentration downstream from both Columbus WWTPs after 1978 and again in 1988 after major plant upgrades.

A dramatic decrease in the ambient ammonia concentration occurred in 1988 downstream from both the Jackson Pike WWTP and Columbus Southerly WWTP (Figures 36 through 39). This decrease was a direct result of plant improvements and upgrades to both facilities. Average ammonia concentrations were plotted longitudinal for four time periods (1971-1973, 1980-1982, 1990-1992, 1996). Significant improvements in ammonia concentrations downstream from the WWTPs were observed as early as 1982. In 1990, ammonia concentrations were at or near detection limits. During 1996, slight increases were detected at RM 127.8 (Frank Road) and at RM 120.0 (SR 665). The Whittier Street CSO is a likely source of increased ammonia concentrations upstream from Jackson Pike. The unsewered community of Shadeville may also account for the increased concentrations found at SR 665.

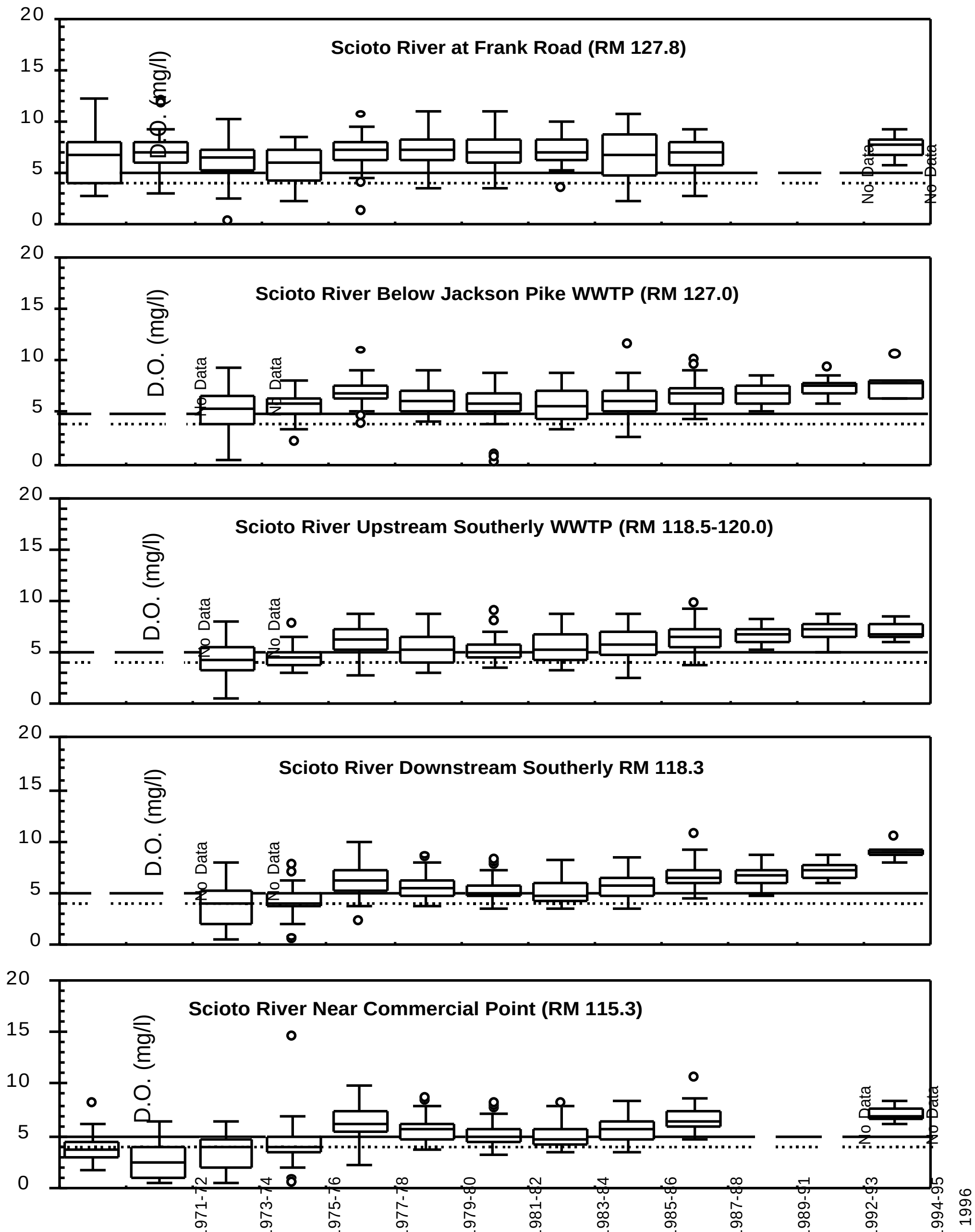


Figure 35. Temporal summary of summer (June through October) Dissolved Oxygen (D.O.) concentrations at five locations within the middle Scioto River study area, 1971 through 1996.

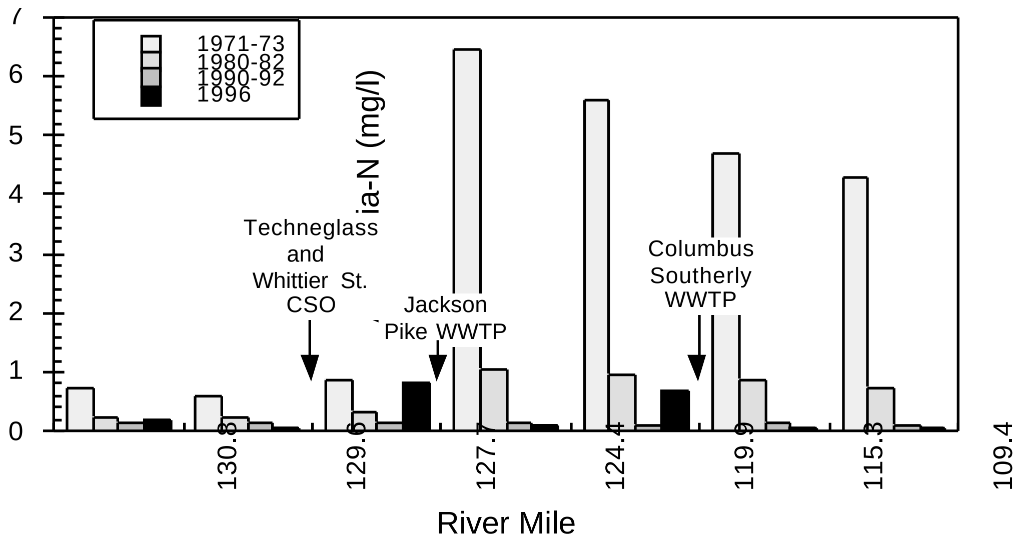


Figure 36. Longitudinal summary of the average Ammonia-Nitrogen (NH_3-N) at seven locations within the middle Scioto River study area, 1971 through 1996.

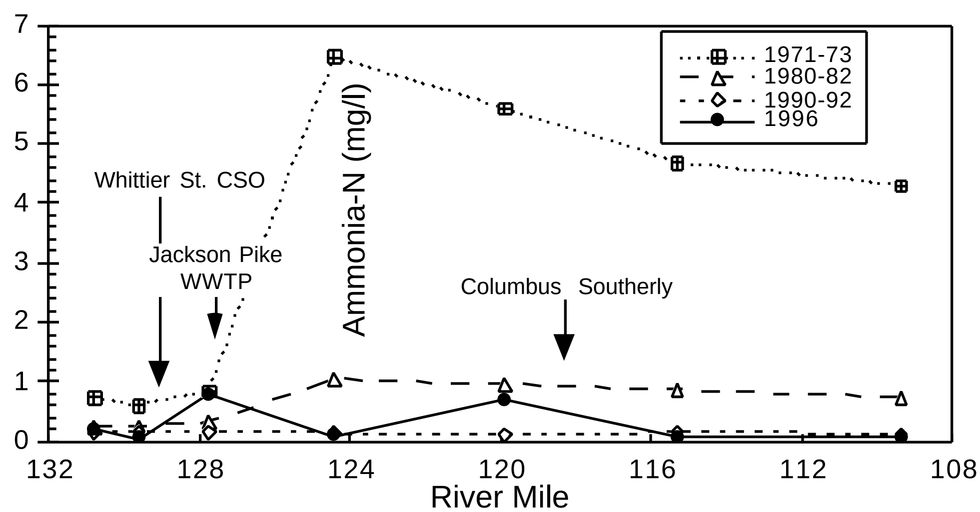


Figure 37.Longitudinal summary of the average Ammonia-Nitrogen (NH_3-N) in the middle Scioto River, 1972 through 1996.

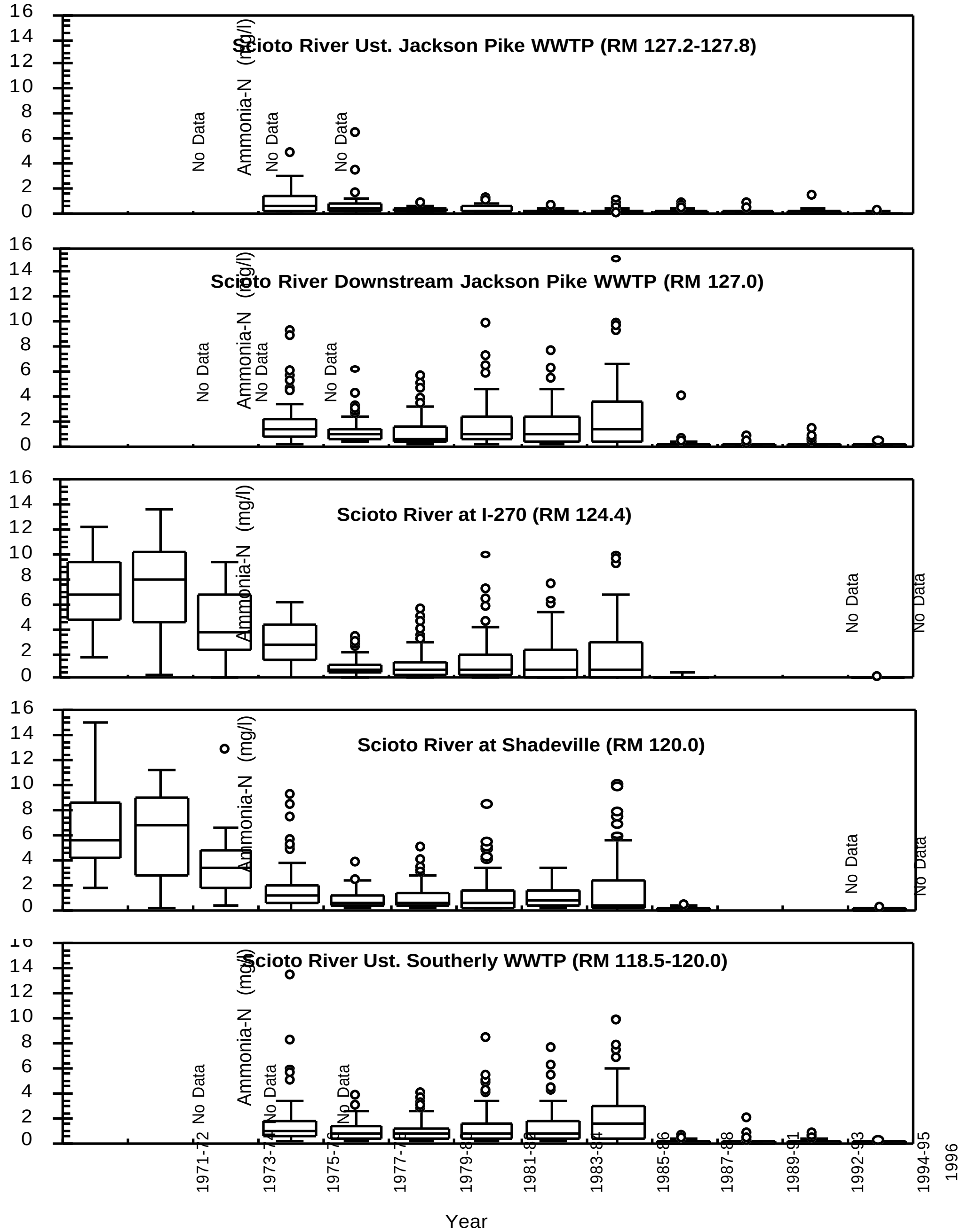


Figure 38. Temporal summary of summer (June through October) Ammonia-Nitrogen (NH_3-N) concentrations at five locations within the middle Scioto River study area, 1971 through 1996.

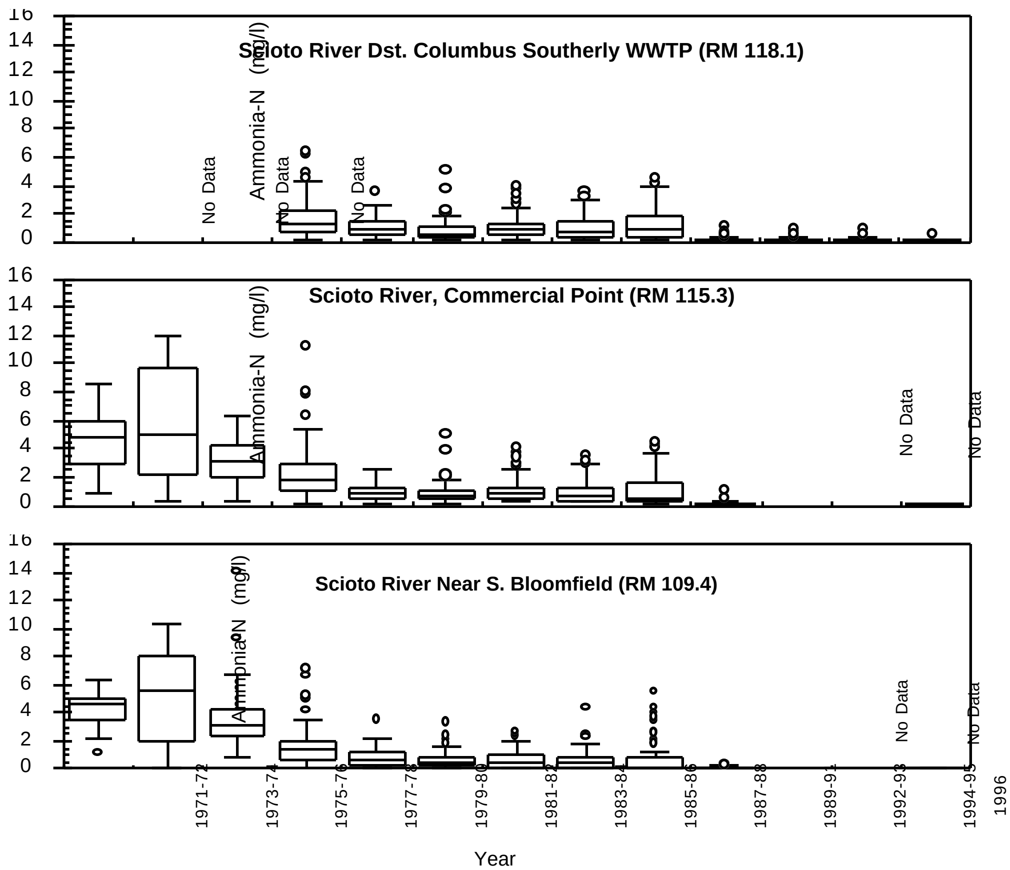


Figure 39. Temporal summary of summer (June through October) Ammonia-Nitrogen (NH_3-N) concentrations at three locations within the middle Scioto River study area, 1971 through 1996.

The level of nitrate has increased with time along the entire stream segment. This coincides with the decrease in ammonia due to the nitrification processes installed at the Columbus WWTPs. Figure 40 displays the distribution of nitrate data over time for four locations. The locations represent a site above a CSO, a site below the Whittier Street CSO but above the Jackson Pike WWTP, a site downstream from the Jackson Pike WWTP, and a site downstream from the Columbus Southerly WWTP.

Total phosphorus concentrations have declined over time throughout the study area (Figure 41). A significant difference in phosphorus concentrations was noted between the upstream (average concentration= 0.37 mg/l) and downstream sites (average concentration =1.44 mg/l). In 1996, average phosphorus concentrations were found to be below the Ohio EPA guideline (1 mg/l) for the prevention of nuisance algal growths at all sample sites.

A gradual decrease in the number of fecal coliform bacteria per sample occurred throughout most of the study area (Figure 42). This decline occurred both upstream and downstream from the Columbus WWTPs. Mean concentrations are still above Ohio WQS criteria and are most likely due to CSOs and other diffuse inputs.

A summary of the average lead concentrations for three time periods (1980-1981, 1989-1991, 1996) within the study area are shown in Figure 43. A dramatic decrease in the instream lead concentration was apparent in the late 1980s and early 1990s and continued in 1996. CSO improvements, decreased number of bypass events, and elimination of sources are factors contributing to the improvement.

Ambient zinc concentrations in the Scioto River are summarized in Figure 44. The average zinc concentration has decreased longitudinally (upstream to downstream) and over time. The most dramatic decrease was observed in the upper part of the Scioto River bracketing Techneglas, the Jackson Pike and the Columbus Southerly WWTPs.

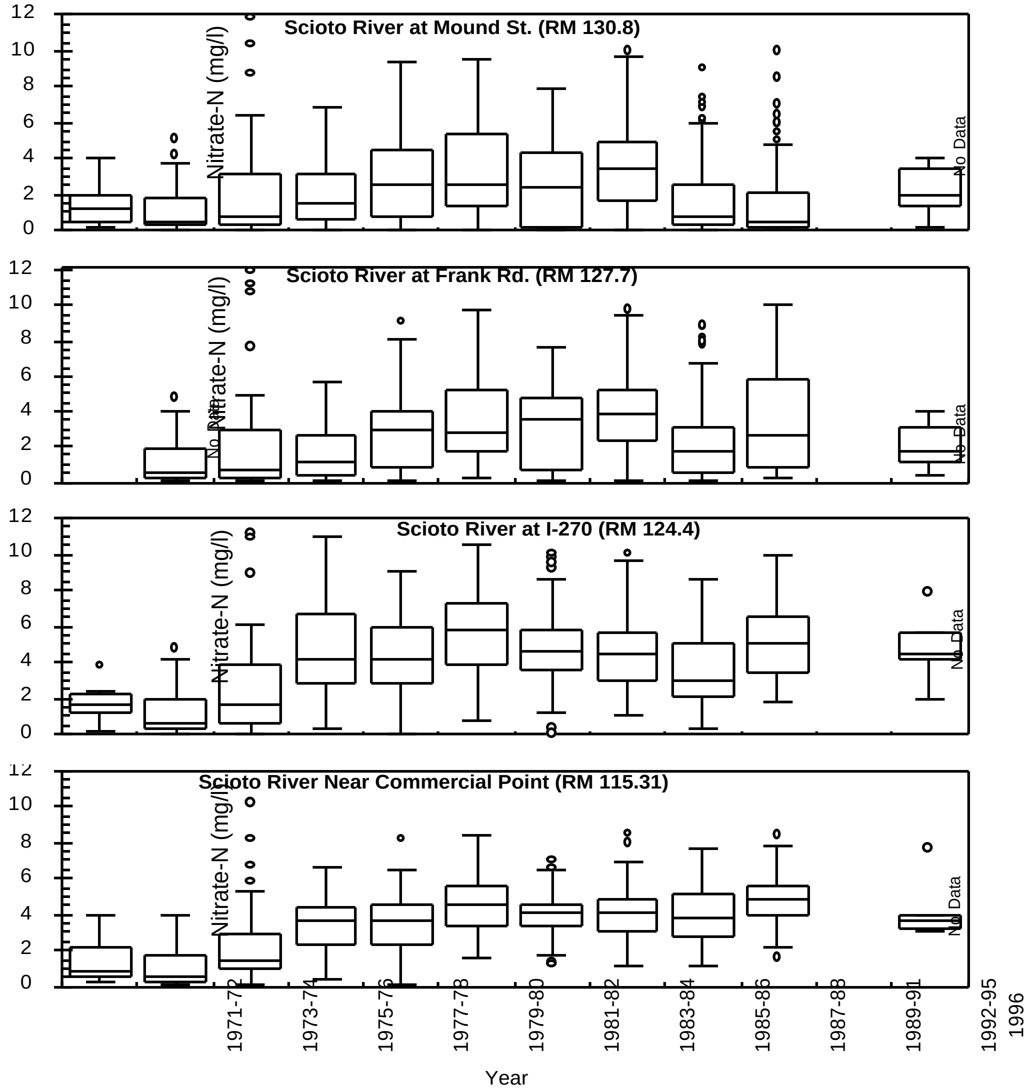


Figure 40. Temporal summary of summer (June through October) Nitrate-Nitrogen (NO_3-N) concentrations at four locations within the middle Scioto River study area, 1971 through 1996.

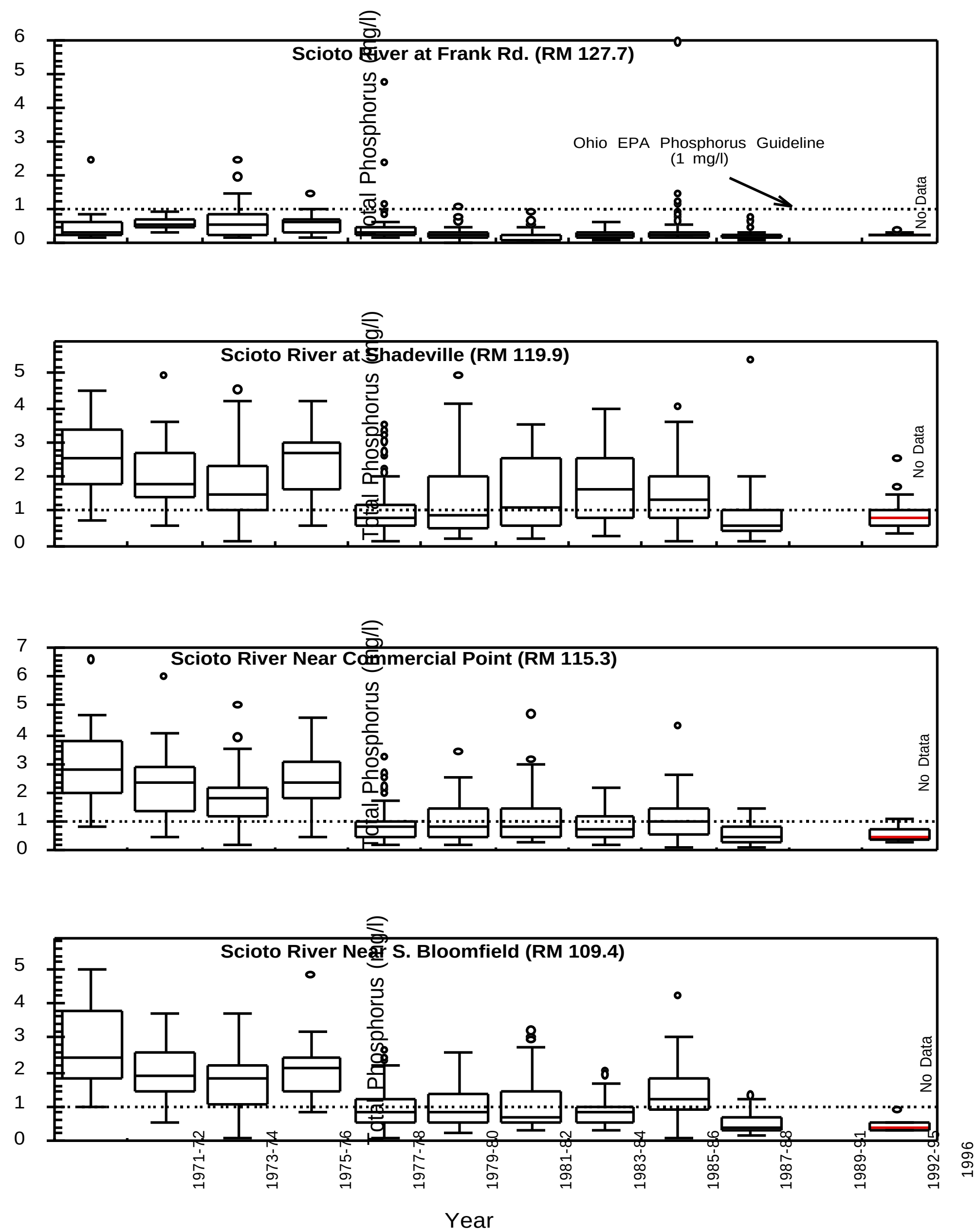


Figure 41. Temporal summary of summer (June through October) Total Phosphorus concentrations at four locations within the middle Scioto River study area, 1971 through 1996.

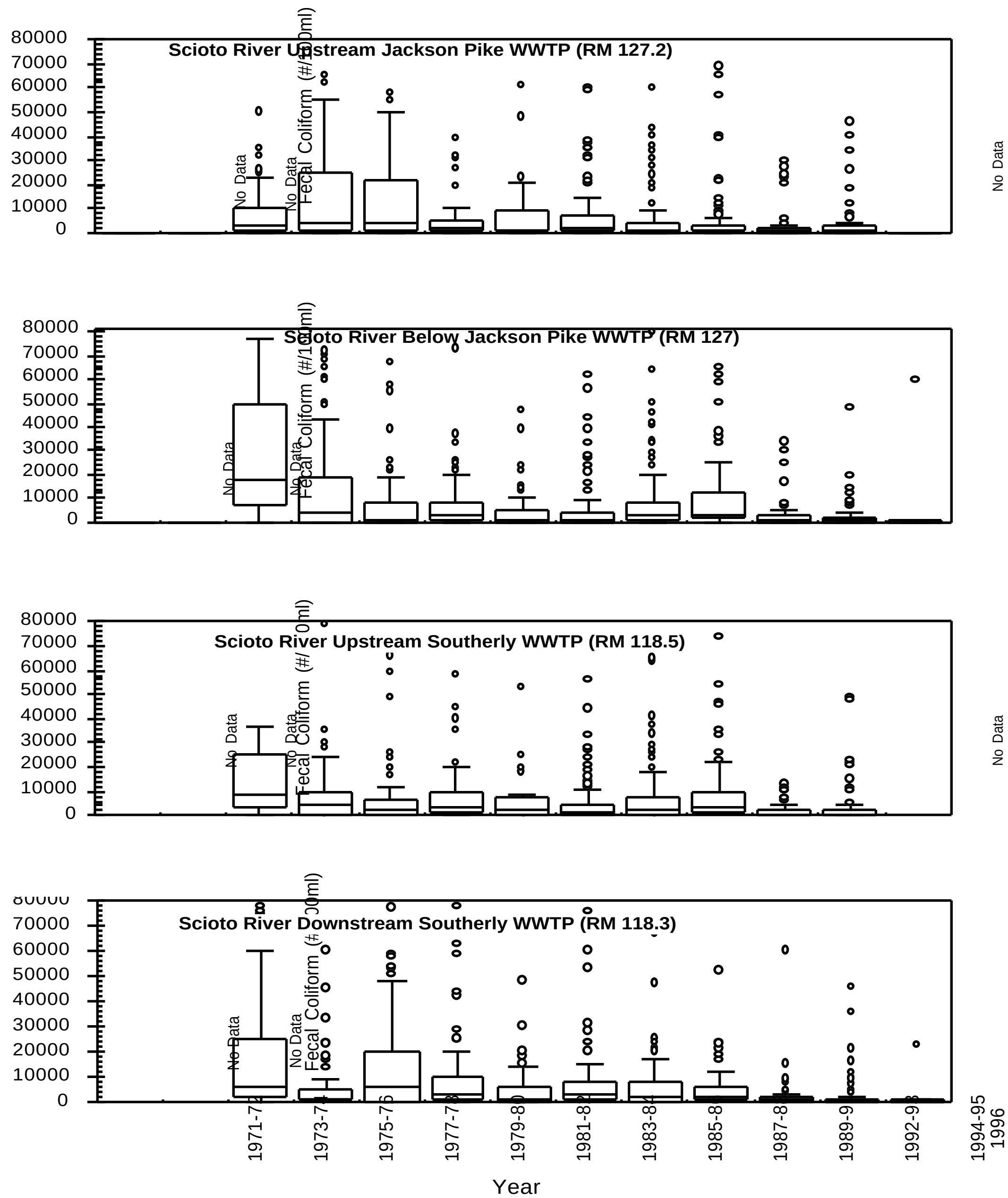


Figure 42. Temporal summary of summer (June through October) fecal coliform bacteria counts at four locations within the middle Scioto River study area, 1971 through 1996.

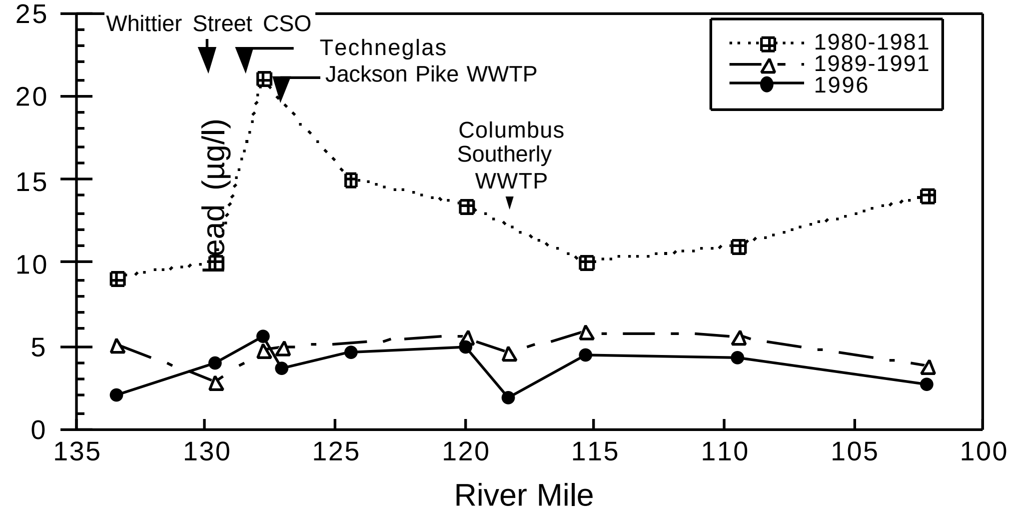


Figure 43. Longitudinal summary of the average lead concentrations in the middle Scioto River, 1980 through 1996.

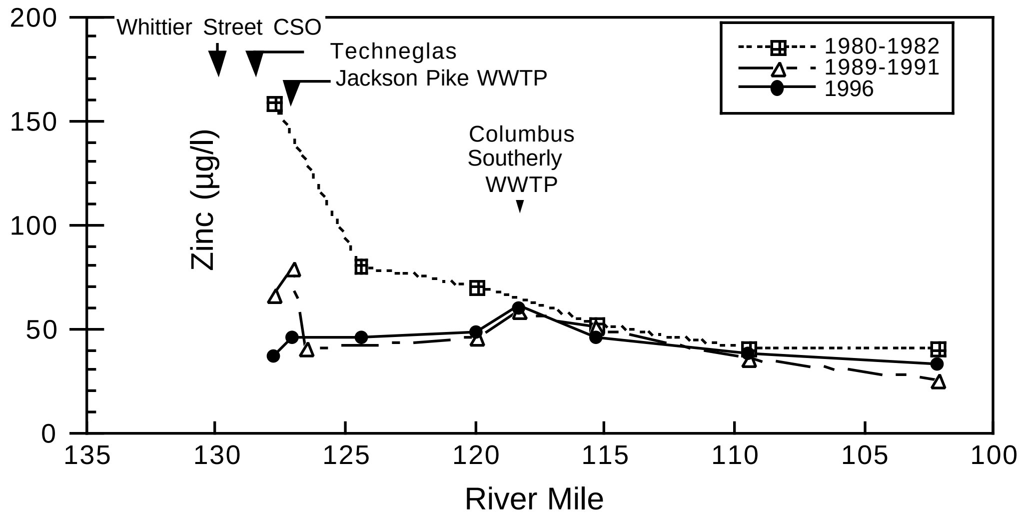


Figure 44. Longitudinal summary of the average zinc concentrations in the middle Scioto River, 1980 through 1996.

Macroinvertebrate Community: 1980-1996

Macroinvertebrate community performance in the Scioto River downstream from the Whittier Street CSO has consistently demonstrated a decline from good or exceptional in the free flowing portions upstream from the downtown impoundments to poor or fair downstream from Greenlawn Avenue and at Frank Road (Figure 45). Improvements in the biological integrity in this area are contingent on the elimination of the Whittier Street CSO and the maintenance of minimal stream flow from the Dublin Road WTP impoundment during periods of low precipitation.

The macroinvertebrate community downstream from the Jackson Pike WWTP has remained highly impacted immediately downstream from the discharge. However, since 1988 the communities have demonstrated an increased ability to at least partially recover by the time the river reaches the Columbus Southerly WWTP. From 1980 to 1988 only very limited recovery was realized by that point. This improvement in the biological integrity of the Scioto River is the direct result of improved wastewater treatment and reduced discharge flow by the Jackson Pike WWTP since 1988.

The Columbus Southerly WWTP has had only a moderate impact on macroinvertebrate community performance since 1980. Full recovery to upstream conditions was achieved by Circleville from 1980 to 1988 and by SR 762 (RM 114.0) or SR 316 (RM 109.4) in 1991 and 1996. The difference in recovery time or distance is attributed to pollutant loading reductions from the Jackson Pike WWTP discharge since 1988 without increases in the pollutant loadings from the Columbus Southerly WWTP. Prior to 1980 the macroinvertebrate community was highly degraded as far downstream as Circleville (Figure 46). Reductions in the pollutant loadings from both of Columbus' WWTPs in the late 1970s resulted in the ability of the macroinvertebrate community to recover by the time the Scioto River reached Circleville.

The Olentangy River macroinvertebrate sampling station at RM 0.6 in 1996 documented an improvement of the community performance into the fair range (ICI=30) compared to poor evaluations in 1991 (ICI=12) and 1988 (narrative evaluation; EPT=3). A sample collected in early June of 1987 achieved a similar level of community performance with an ICI score of 28 (fair). The cause of the improvement in biological integrity in 1996 may be due to the elimination of discharges to the storm sewer, such as a sewage discharge from the fairgrounds that was recently discovered and tied into the sewer system, and a reduction in spills from Abitec (RM 1.35). Additionally, the City of Columbus has made considerable progress in eliminating illegal sanitary tie-ins to the storm sewers surrounding the Olentangy River.

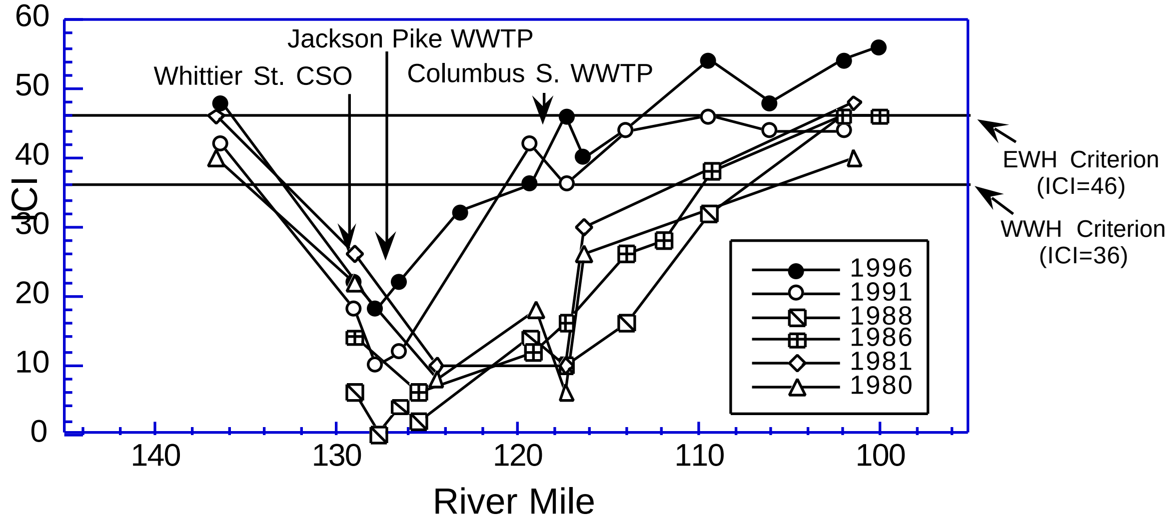


Figure 45. Longitudinal performance of the Invertebrate Community Index (ICI) from the middle Scioto River, 1980 through 1996. The solid lines represent WWH and EWH the biocriteria--Eastern Corn Belt Plains ecoregion.

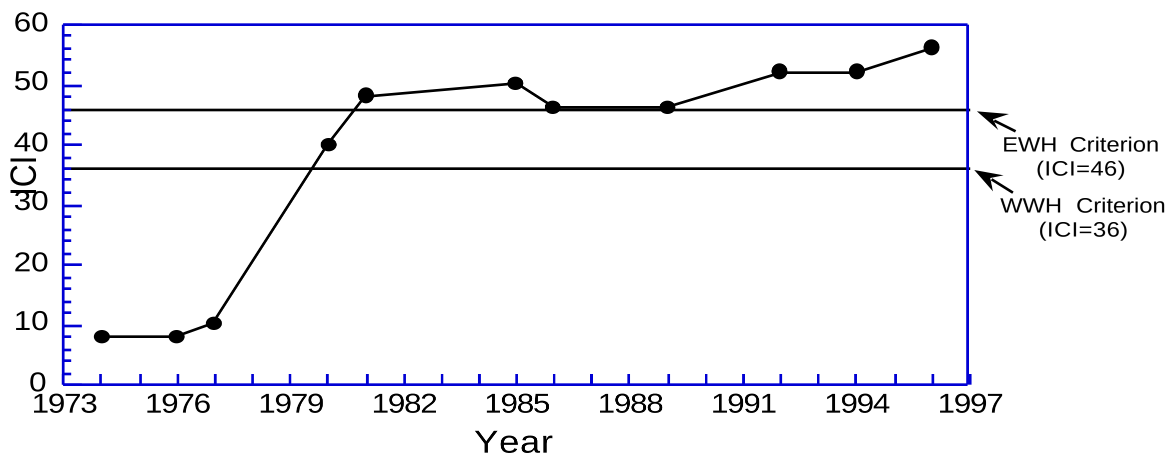


Figure 46. Historical trend of the Invertebrate Community Index (ICI) in the Scioto River at Circleville (RM 100.8 from 1974-1977, RM 101.4 in 1980 and 1981, and RM 100.0 from 1985 to present).

Fish Community: 1979-1996

A comprehensive survey of the fishes of the middle Scioto River (Columbus to Circleville) has been performed nearly every year by the Ohio EPA since 1979. This nearly continuous effort provides an excellent opportunity to evaluate meaningful changes in the environmental conditions, as reflected in the composition of the fish fauna, over an 18 year period. In order to succinctly summarize these voluminous data, this analysis will focus on aggregated annual trends, stressing cumulative performance for each field year since 1979; and a longitudinal trend, examining ambient biological performance (e.g., indices, community statistics, and condition) relative to the principal associated stressors (e.g., WWTPs, CSOs, and habitat conditions) for three sampling years: 1979, 1988, and 1996.

Annual cumulative community performance, summarized by box and whisker plots of the IBI and MIwb, portrayed a significant and positive trend through the period of record (Figure 47). Between 1979 and 1981 median IBI values for the middle Scioto River ranged between 21 and 25, all classified as poor. During this period only outlying IBI values were found fully consistent with the WWH biocriteria. A similar pattern was observed with the MIwb, as median values ranged between 5.8 (poor) and 6.9 (fair) and only yearly maximums (non-outliers) met the WWH standard. The condition of the fish community, as measured by the IBI and MIwb, during this period was indicative of severely degraded water quality.

Between 1985 and 1988 community performance was markedly advanced. Median IBI values remained consistent among years, ranging between 36 and 37, and narratively categorized as fair. The performance of the MIwb displayed more substantial improvement as median values ranged between 8.6 and 9.3, evaluated as good to very good. Although most stations failed to support a fish assemblage fully consistent with the WWH criteria, community performance was indicative of much improved water quality.

A disruption of these positive trends was observed in the 1989 and 1990 survey results. Median IBI values for these years declined to 31.5 and 33.0, respectively. Fully 75% of the stations during this period failed to yield IBI scores consistent with the minimum WWH standard. This decline was not nearly as pronounced in the MIwb score for 1989 and 1990, as most stations meet the MIwb WWH performance standard for this index. The decline in the performance of the IBI between 1989 and 1990 appeared correlated with treatment disruption at the Jackson Pike WWTP associated with a large scale upgrade of the facility.

The period between 1991 and 1996 marked additional improvements in fish community performance. During this time median IBI scores ranged from 43 to 47, narratively characterized as good to very good--fully consistent with the WWH criterion. In terms of the IBI, near complete recovery was indicated in 1996. The MIwb portrayed further improvements.

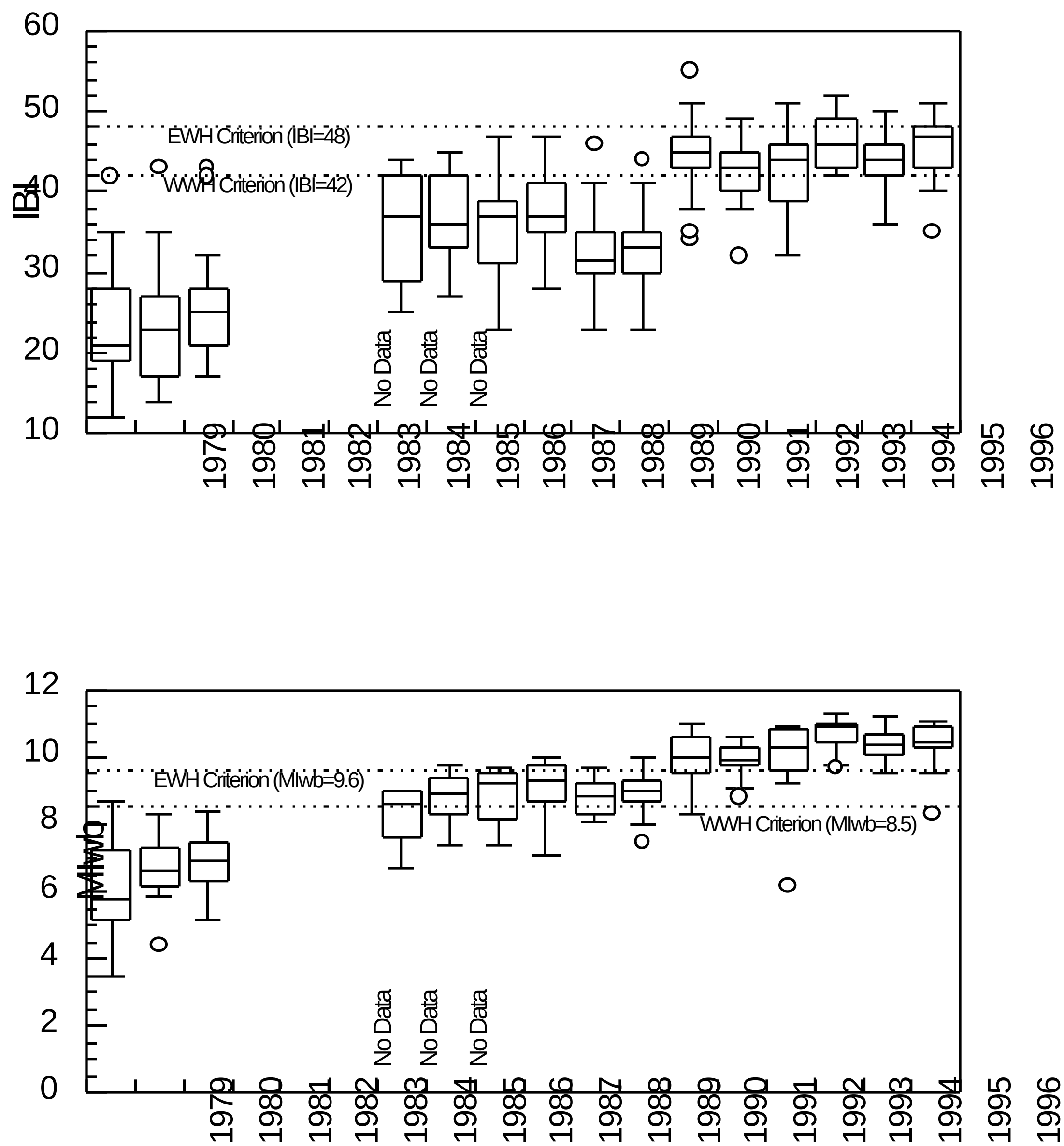


Figure 47. Boxplots of the Index of Biotic Integrity (IBI) and Modified Index of well-being (MIwb) for the Scioto River between Columbus and Circleville for all years sampled between 1979 and 1996.

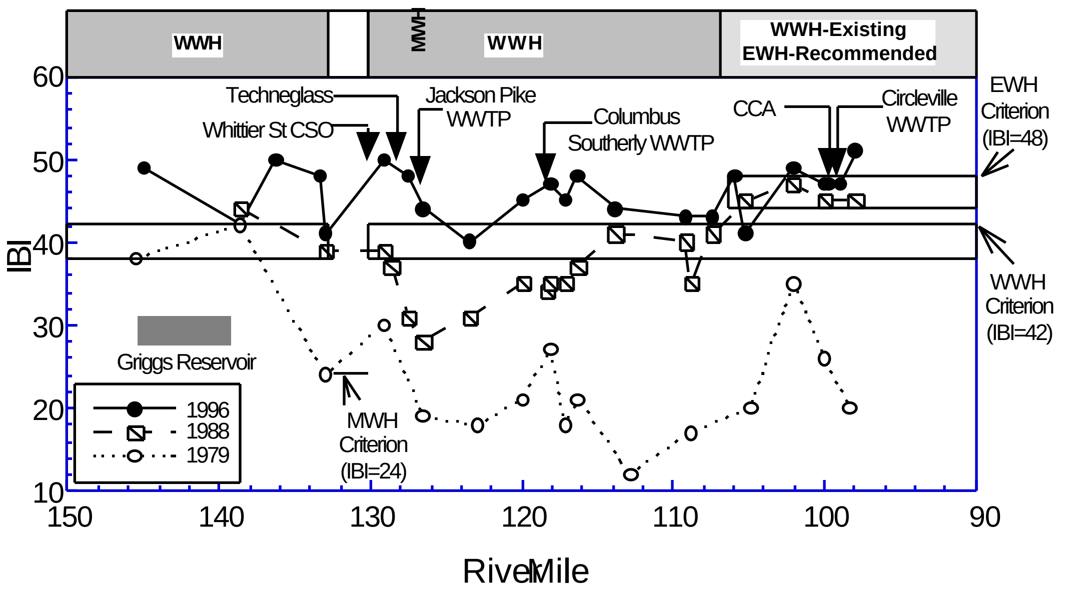
During these six field years, MIwb values were typically found in the very good to exceptional range.

A simple comparison of the IBI and MIwb box plots, between 1979 and 1996, succinctly characterized substantial and positive changes in the environmental conditions of the middle Scioto River over the past 18 years, as reflected in the diversity, structure and functional organization of the resident fish fauna. In 1979, index values (IBI and MIwb) displayed a range of quality from very poor to good. Median IBI and MIwb indicated that fully 50% of the stations supported fish communities that were characterized as poor. These data indicated highly variable conditions, but low medians. Additional aggregate community statistics were also indicative of environmental degradation. A total of 51 species was found during the 1979 sampling effort, and mean relative abundance and biomass estimates were 117.1/km and 74.5 kg/km, respectively. In stark contrast, complete recovery of the fish community was indicated in 1996. Index variability was significantly reduced, particularly the MIwb, and median values were within the exceptional range (i.e., very good to exceptional performance). Eighty-four fish species were collected from this segment in 1996, including eight rare, threatened, or endangered taxa. Additionally, mean relative abundance and biomass estimates improved considerably to 732/km and 187.0 kg/km, respectively.

Aggregated annual community performance statistics portrayed a significant temporal trend for the middle Scioto River. However, it is also important to examine longitudinal community performance, through time, relative to the principal stressors within the study area. These data for the field years: 1979, 1988, and 1996 are presented in Figure 48.

In 1979 longitudinal performance of the IBI and MIwb portrayed a pattern of severe degradation throughout the majority of the study area. At this time only one of 16 sampling stations supported a fish community fully consistent with the WWH biocriteria, located immediately downstream from Griggs reservoir. Pronounced impacts were evident downstream from the combined influences of the Whittier St. CSO and the Jackson Pike WWTP, the Columbus Southerly WWTP, and municipal and industrial entities in Circleville. Nearly every attribute of the fish community was depressed (e.g., species richness, diversity, relative abundance, and biomass).

Following various treatment improvements implemented at the WWTPs within the study area performance of the fish community was markedly improved by 1988. Although distinct impacts were still evident downstream from the Whittier St. CSO, the Jackson Pike WWTP, and the Columbus Southerly WWTP, the severity and magnitude were significantly lessened in comparison with the 1979 results. Additionally, impacts associated with the Circleville discharges appeared completely abated.



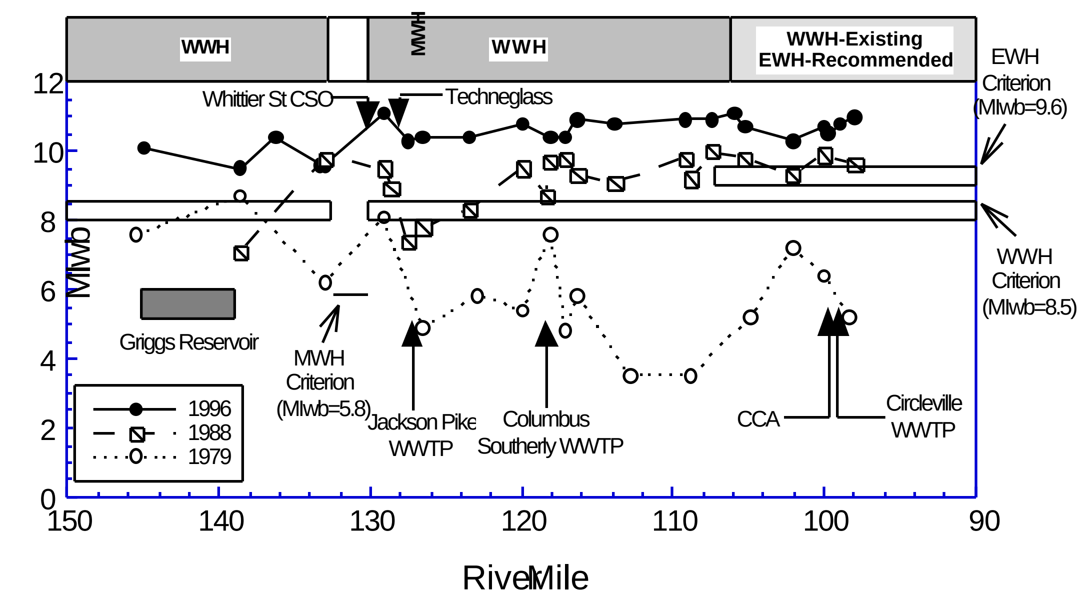


Figure 48. Longitudinal performance of the Index of Biotic Integrity (IBI) and the Modified Index of well-being (MIwb) through the middle Scioto River for selected years. The solid lines represent numerical biological criteria and area of nonsignificant departure (where applicable) in support of the existing and recommended aquatic life use designations--Eastern Corn Belt Plains ecoregion.

Complete recovery of the fish community, in terms of the WWH biocriteria, was indicated in 1996. All non-mixing zone and free flowing stations were found again to support an assemblage of fishes consistent with the WWH standard. Conditions have so improved, that much of the middle Scioto River now supports fully exceptional communities throughout the historically degraded reach within and downstream from Columbus. This was particularly evident in the longitudinal performance of the MIwb, which remained in the very good to exceptional range from the Greenlawn Ave. dam (RM 129.1) to the lower limits of the study area, downstream from Circleville (RM 97.9). The recovery of the WWH use was directly linked with additional treatment advances implemented by the City of Columbus at both the Jackson Pike and Columbus Southerly WWTPs.

Alum Creek

Chemical Water Quality: 1974-1996

Historical water column chemistry data from the Alum Creek mainstem were used to evaluate long-term water quality trends. Data were taken from limited studies done in 1974, 1975, 1976, and 1986. Each of the 1970s studies assessed the area downstream from Westerville into Columbus and downstream to the mouth. The 1986 study was used to assess the performance of the Huber Ridge WWTP. These data are summarized in Figure 50. Additionally, monthly ambient monitoring was performed by Ohio EPA at RM 6.60 (Livingston Ave.) from 1990 through 1994 (Figure 49).

Ammonia concentrations in Alum Creek have been reduced to insignificance over the years. The 1975 results indicated a significant loading of ammonia to Alum Creek via the Huber Ridge WWTP. Even the results from 1986 indicated a small increase downstream from the plant. Plant upgrades have certainly improved water quality over the last 20 years. Trends at RM 6.60 did not show anything other than very modest fluctuations around median ambient concentrations.

Phosphorus concentrations show trends similar to ammonia. The 1975 results showed very high phosphorus concentrations instream (6.63 mg/l). The 1986 phosphorus values are much reduced, but still show a noticeable spike downstream from the WWTP. The 1996 results show no unnatural inputs of phosphorus. Again, upgrades performed at the Huber Ridge WWTP are responsible for the reduced loadings of pollutants, including phosphorus, to the creek. Phosphorus trends at RM 6.60 showed decreasing concentrations after 1991.

Trends in nitrate concentrations during survey years were not apparent due to limited data. However, data from monthly monitoring at RM 6.60 did not show any particular trend, although nitrate concentrations in all years were below the 1.27 mg/l median for wadeable WWH streams in the ECBP ecoregion.

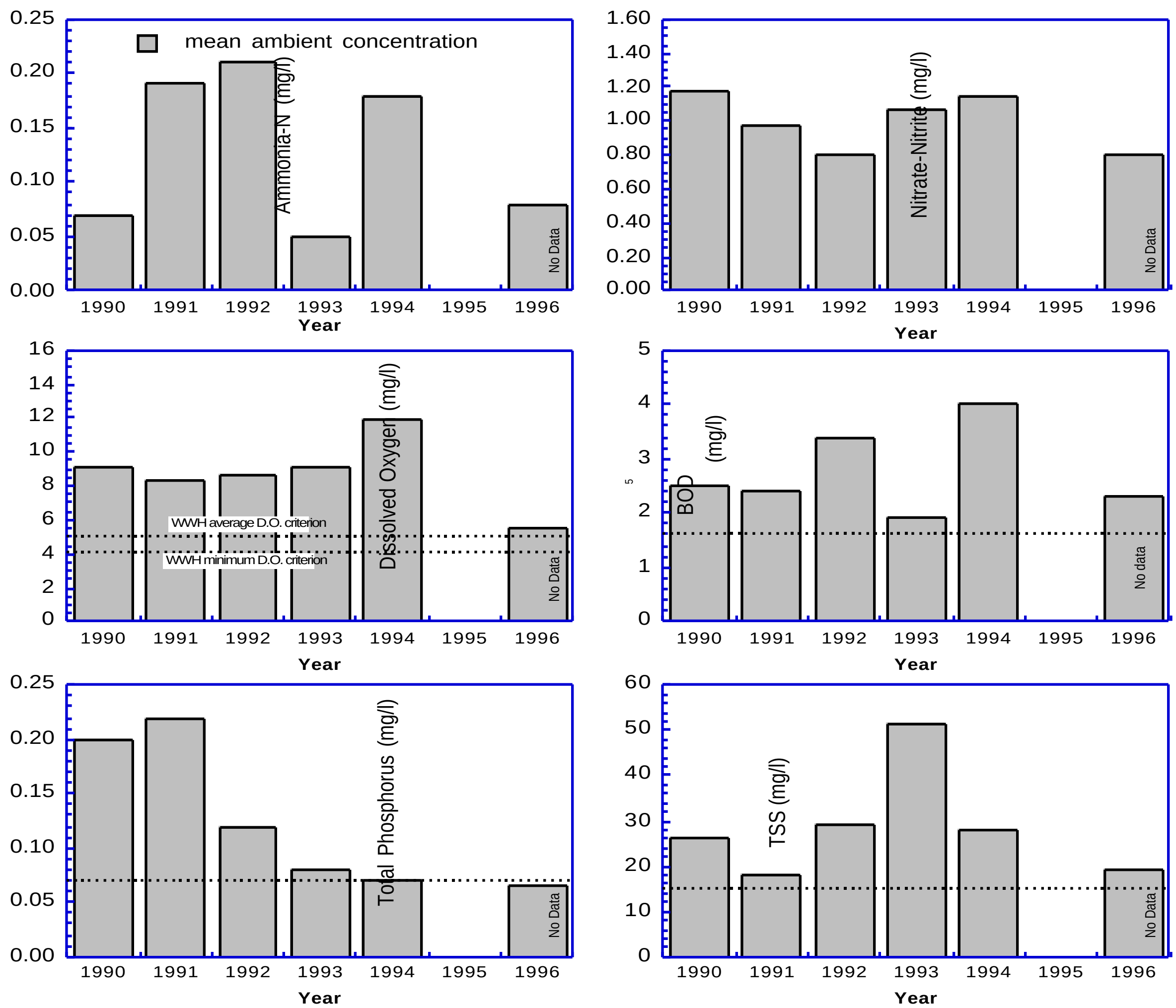


Figure 49. Mean concentrations of Dissolved Oxygen, Ammonia-Nitrogen, Nitrate+Nitrite-Nitrogen, Five-day Biochemical Oxygen Demand (BOD_5), Total Phosphorus, and Total Suspended Solids (TSS), from Alum Creek at RM 6.6 (Livingston Ave.), 1990 through 1996. Unless otherwise noted dashed lines indicate median concentrations from large river, WWH reference stations within the Eastern Corn Belt Plains ecoregion.

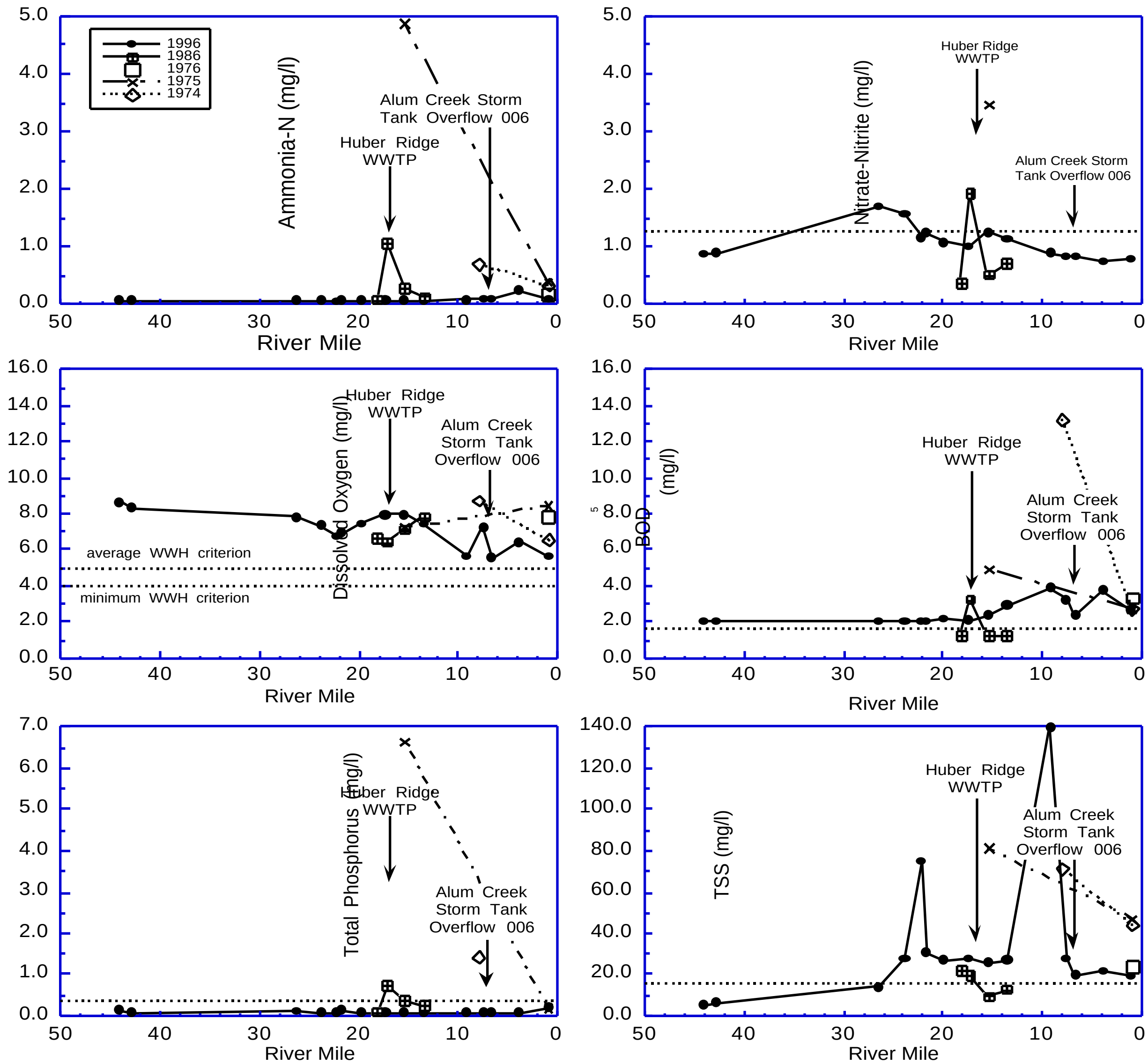


Figure 50. Mean longitudinal concentrations of Dissolved Oxygen, Ammonia-Nitrogen, Nitrate+Nitrite-Nitrogen, Five-day Biochemical Oxygen Demand (BOD_5), Total Phosphorus, and Total Suspended Solids (TSS), from Alum Creek, 1974 through 1996. Unless otherwise noted dashed lines indicate median concentrations from WWH reference stations within the Eastern Corn Belt Plains ecoregion.

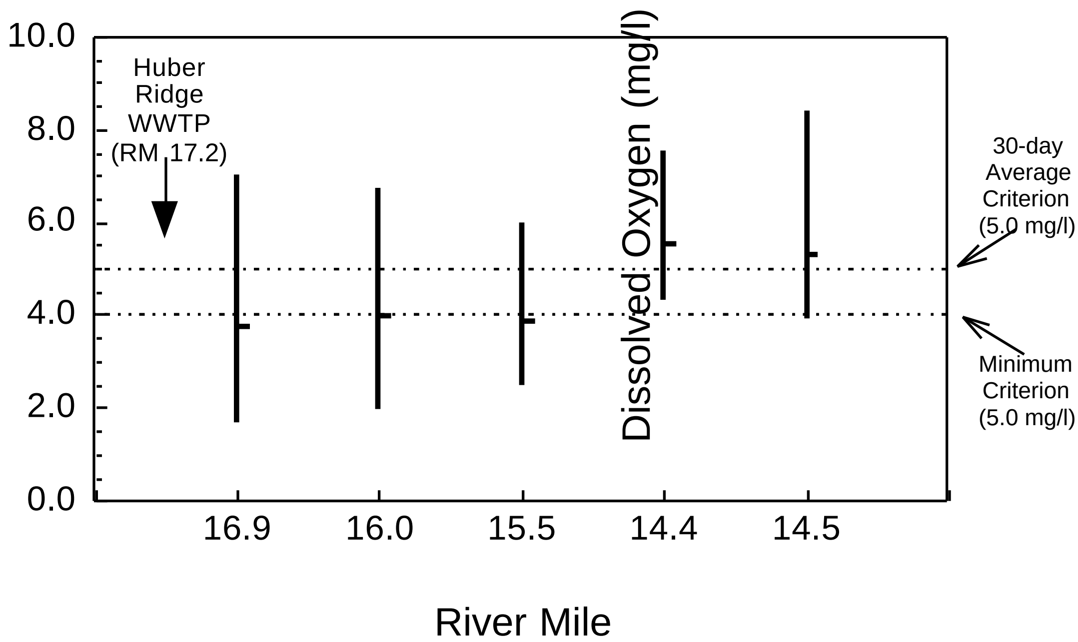


Figure 51. Summarized (mean, maximum, and minimum) diel dissolved oxygen profile for Alum Creek downstream from the Huber Ridge WWTP, August 19-21, 1986.

Generally, trends in total suspended solids were not clearly defined due to a lack of data, although indications are that concentrations were higher in the 1970s and have since decreased. Trends at RM 6.60 showed a general increase from 1990 to 1993 followed by a decrease back to median ambient levels.

Day-time D.O. values revealed no historical trend and were stable around the 6 to 8 mg/l range in each year. However, diel sampling in mid August, 1886 revealed significantly depressed D.O. concentrations-- including numerous violations of the WWH minimum criterion--for at least 2.7 miles downstream from the Huber Ridge WWTP (Figure 51). Trends at RM 6.6 were generally stable accounting for the seasonal sampling performed in 1994 (January-April, values are proportionately higher due to higher solubility of oxygen at lower water temperatures) and 1996 (June-October, values are proportionately lower due to lower solubility of oxygen at higher temperatures).

Macroinvertebrate Community: 1986-1997

Previous to 1996, macroinvertebrates were collected in Alum Creek in 1986 at four sites from RM 17.9 to RM 13.4. Comparable sites were similar in both survey years with ICI scores and narrative evaluations in the good to very good range, except for poor and fair evaluations immediately downstream from or in the Huber Ridge WWTP mixing zone. Longitudinal performance of the ICI through time is presented in Figure 52.

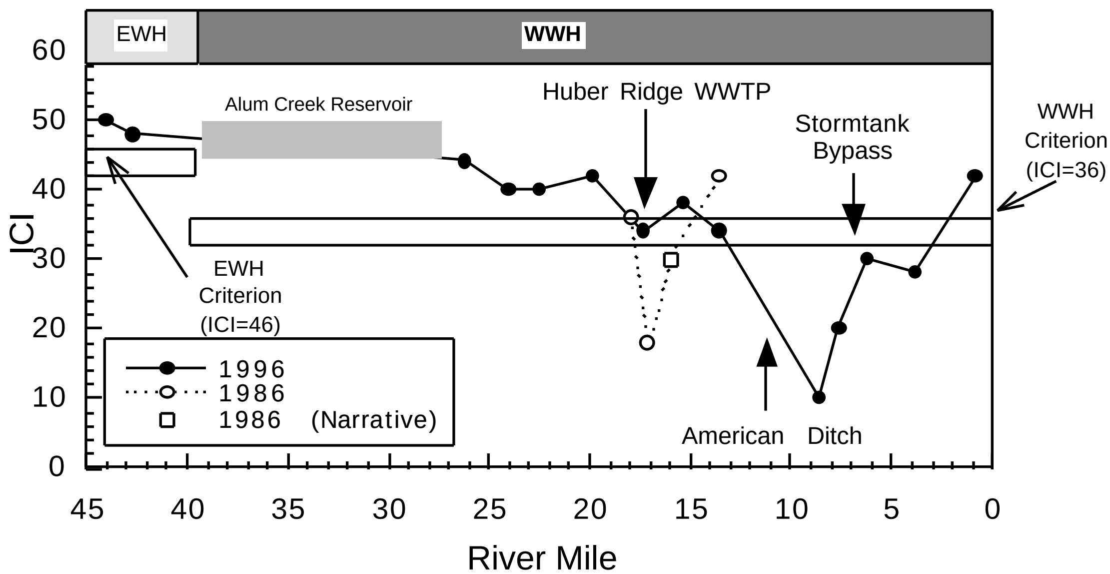


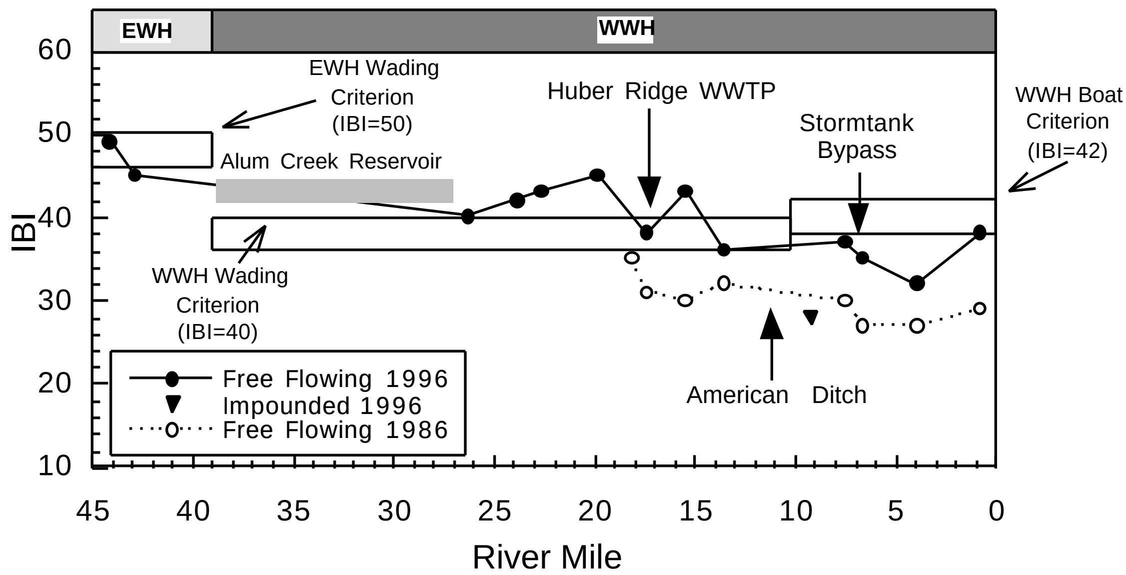
Figure 52. Longitudinal performance of the Invertebrate Community Index (ICI) from Alum Creek, 1986 and 1996. Solid lines indicate the criteria in support of existing aquatic life use designations (WWH and EWH), Eastern Corn Belt Plains Ecoregion.

Fish Community:1986-1996

Fish community data were collected from Alum Creek in 1986 and 1996. In 1986 collections were made at eight locations evaluating the stream reach between RM 18.1 (upstream from the Huber Ridge WWTP) and RM 0.8 (Watkins Rd.). The sampling effort was limited to the lower half of Alum Creek and evaluated the Huber Ridge WWTP, the Alum Creek Storm Tank (CSO), and the residual effects from ASARCO (via American Ditch). The 1996 effort was much more robust and evaluated the entire mainstem of Alum Creek, from the headwaters at RM 44.1 (West Liberty Rd.) to near its confluence with Walnut Creek at RM 0.8 (Watkins Rd.).

In 1986, all sampling stations failed to support an assemblage of fishes fully consistent with the WWH biocriteria. The fish communities portrayed a marked decline downstream from the Huber Ridge WWTP, and an additional decline downstream from the Alum Creek Storm Tank discharge (Figure 53). Contaminated runoff from ASARCO (via American Ditch) may have been an additional stressor, but direct biological assessment of the impact to Alum Creek from this facility was hindered by the fact that American Ditch discharges to an impoundment on Alum Creek formed by the Nelson Park dam. Modified habitat (channelization and impoundment) and urban runoff were also identified additional stressors.

In comparison with the results of the 1986 survey, considerable improvement in the environmental conditions of the lower portion of Alum Creek, as reflected in the diversity and functional and structural organization of the fish community, were indicated in 1996. The approximately eight mile reach historically impacted by the Huber Ridge WWTP appeared fully recovered, following treatment advances implemented at the facility. The impact associated with the Alum Creek Storm Tank, further downstream, was still apparent, though reduced both in term of magnitude and severity. Other stressors still present within the highly urbanized, lower segment of Alum Creek included historic channelization, impoundment, and urban runoff. Despite these positive trends, impacted fish communities were still associated with the Alum Creek storm tank, and to a lesser extent pervasive habitat modification and general urban runoff.



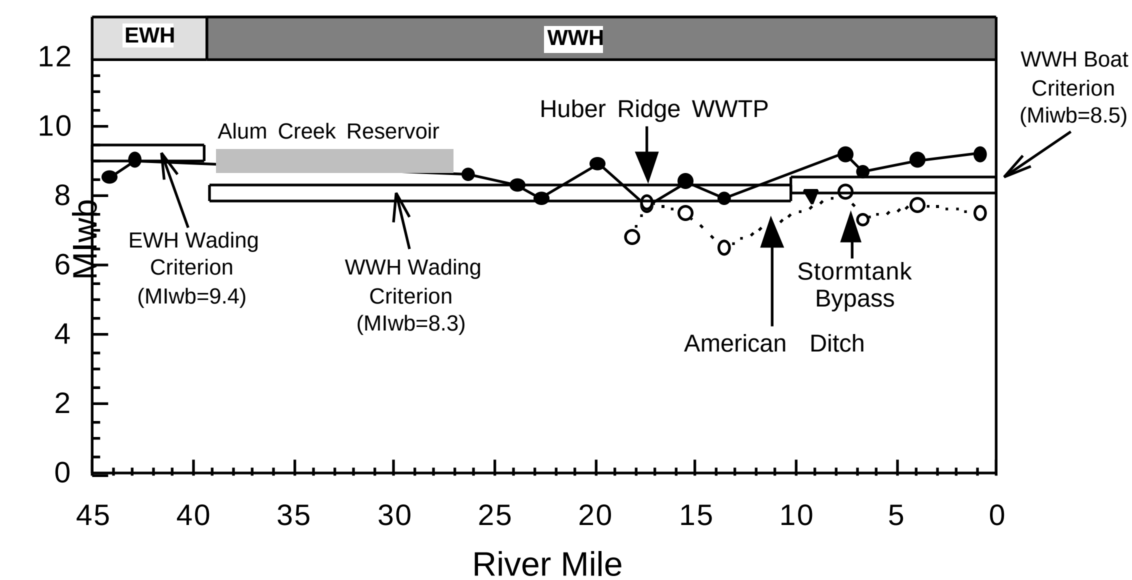


Figure 53. Longitudinal performance of the Index of Biotic Integrity (IBI) and the Modified Index of well-being (MIwb) for Alum Creek, 1986 and 1996. The solid lines indicate the biocriteria and area of nonsignificant departure for the existing WWH and EWH aquatic life use designations--Eastern Corn Belt Plains ecoregion.

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