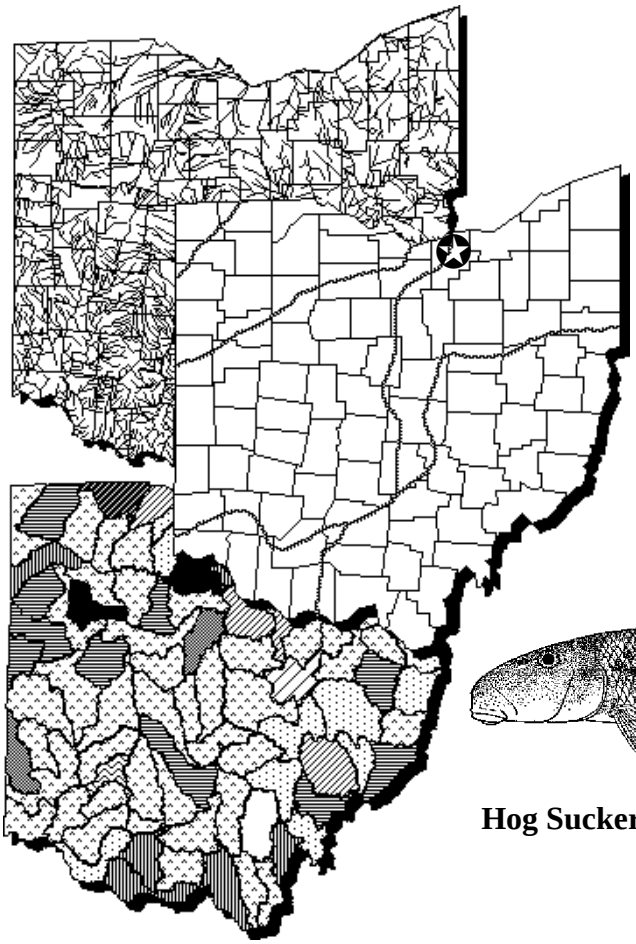
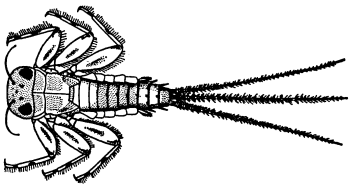
State of Ohio
Environmental Protection Agency

Ecological Assessment Section
Division of Surface Water

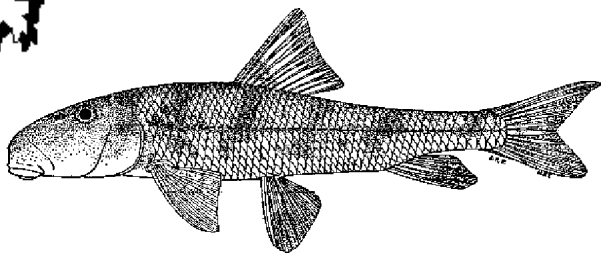
# Biological and Water Quality Study of the Black River (with selected tributaries) and Beaver Creek

## Lorain, Medina, Ashland, Huron, and Cuyahoga Counties, Ohio





**Mayfly (*Stenonema*)**



**Hog Sucker (*Hypentelium nigricans*)**

January 14, 1994

P.O. Box 1049, 1800 WaterMark Dr., Columbus, Ohio 43266-0149

# Biological and Water Quality Study of the Black River Basin (with select tributaries) and Beaver Creek

Lorain , Medina, Ashland, Huron, Cuyahoga Counties, Ohio

November, 1993

OEPA Technical Report EAS/1993-12-8

prepared by

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Division of Surface Water
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NOTICE TO USERS

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

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

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

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

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

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

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

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

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

Ohio EPA - WQP&A
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## Acknowledgments

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This evaluation and report would not have been possible without the assistance of the study team and numerous full and part time staff in the field and the chemical analyses provided by the Ohio EPA Division of Environmental Services. Considerable assistance was provided by Jim Boddy, Dan Reed, Cindy Babitt, and Julie McCarthy of the Lorain County Health Department and Bob Davic, Ken Frase, Steve Tuckerman, Suzy Wickham and Tod Chabuccos of the Ohio EPA.

Mary Ann Silagy of the Water Quality Modeling Section provided some of the chemical data used in this report. Major assistance with the preparation of the study area map was provided by Mark Wilson and Julio Perez.

## Introduction

The 1992 Black River basin survey extended from the area of Lake Erie enclosed by the Black River Harbor breakwaters to the southern headwaters and included the mainstem (both lentic and lotic portions) and French Creek; the East Branch and Willow Creek, East Fork, and West Fork; and the West Branch and Plum Creek, Wellington Creek, Charlemont Creek, and Buck Creek (Figure 1). Urban areas specifically targeted in the study were Lorain, Elyria, Oberlin, Wellington, and Lodi. This report also contains a special section dedicated to an evaluation of Beaver Creek and the impact of the Amherst waste water treatment plant (WWTP). Impacts of nonpoint source (NPS) pollution were also evaluated in the above listed Black River basin area.

Specific objectives of this study were to:

1) evaluate the affects of contaminated sediment removal in the lentic (Lake Erie affected) portion of the basin,

2) evaluate the status of the Lorain Harbor section of Lake Erie and gather baseline data from which to develop biological criteria for similar Lake Erie areas,

3) evaluate the possible impacts from the Lorain, Elyria, French Creek, Wellington, Oberlin, and Lodi WWTPs,

4) evaluate the effects of sanitary sewer overflows (SSO) and same sewer overflows (SSO) in the Elyria and Lorain municipal areas,

5) evaluate the possible impacts of agricultural NPS pollution within the basin and pinpoint problem areas,

6) evaluate the possible impacts of urban NPS pollution within the basin, identify problem areas and

7) assess the existing use designations of the principal streams in the study area.

8) evaluate any changes that have occured since the 1982 survey of the lower Black River.

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

## Summary

The Black River basin was observed to display a wide range of environmental conditions and trends. In general, much of the upper reaches in the East and West Branches have been severely impacted by NPS pollution as evidenced by degraded biological communities. The lower portions of the two main branches and the mainstem Black River have been historically impacted by point source discharges and municipal runoff. Though such sources of pollution continue to affect these areas, the severity of the impact was considerably less in the 1992 survey. Contaminated sediment problems in the lake affected area of the river have been addressed through removal thus reducing pollutant concentrations in the sediments. At present, insufficient time has elapsed to make a determination of the long term effect of sediment removal on aquatic biotas in the area.

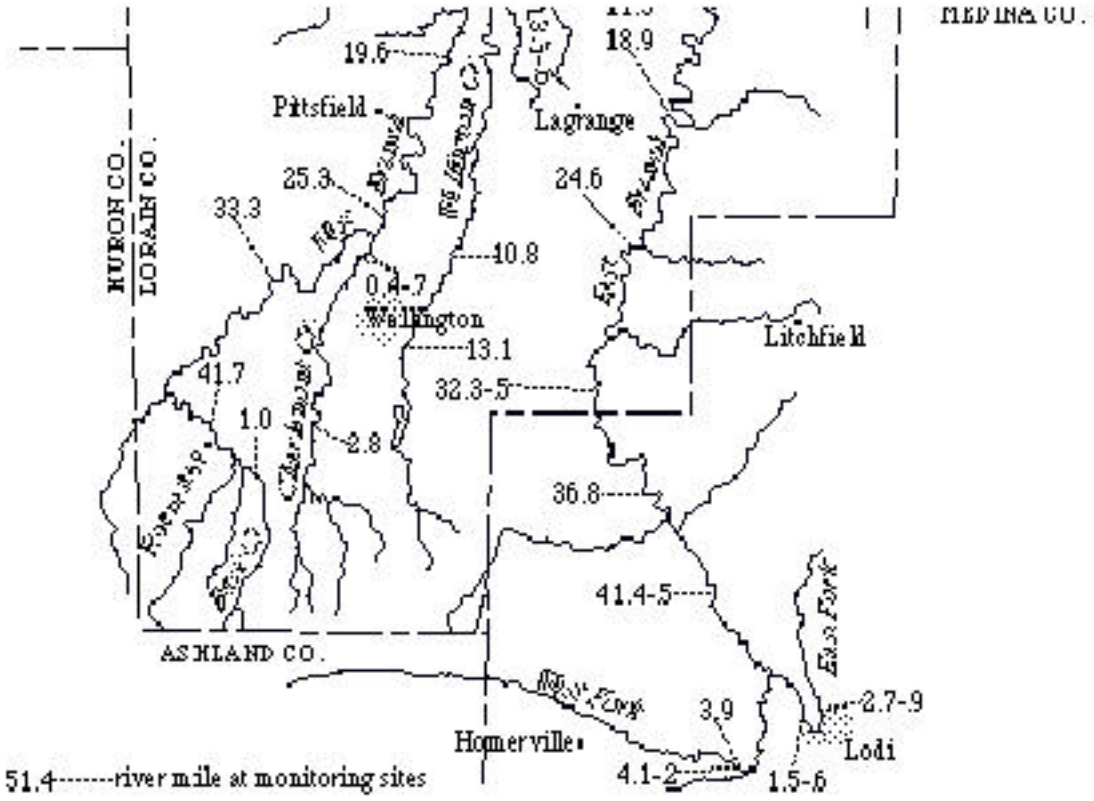


Figure 1. The Black River study area showing principal streams and tributaries, population centers, pollution sources, and water quality monitoring sites.

### *Black River Mainstem*

*Aquatic Life Use Attainment*
Significant trends of environmental improvement have been recorded for the Black River mainstem. In terms of miles of attainment, the 1982 survey showed zero miles of stream attaining FULL WWH or PARTIAL WWH and all 13.2 miles surveyed falling into the **NON** WWH attainment category (Table 9) versus the 1992 results of FULL attainment achieved on 6.4 miles of stream, PARTIAL WWH attainment achieved on 5.6 miles of stream, and **NON** WWHattainment on only 1.4 miles of stream.

*Point Source Pollution loadings*
Considerable reduction in peak loadings of copper and zinc from the Lorain East WWTP have been realized since the early to mid 1980s (Figure 12). Loadings for TKN, TSS, and phosphorus, were initially reduced in 1989 and 1990, but began to increase in 1991 and 1992. The Elyria WWTP decreased loadings of copper, TSS, phosphorus, ammonia, and zinc after 1989 (Figure 13). The most significant reduction in loadings was seen in peak loadings with peak ammonia loadings being damatically reduced. Changes in discharge loadings from the USS/KOBE Steel Company were variable. At the 001 outfall oil + grease and TSS loadings were greatly reduced (Figure 7); ammonia and TSS loadings were greatly reduced at the 002 outfall (Figure 8); ammonia was reduced and peak TSS declined but median TSS remained high at the 003 outfall (Figure 9); TSS increased while ammonia remained the same except for one elevated recording for 1991 at the 004 outfall (Figure 10); COD declined at the 006 outfall (Figure 11); and TSS increased at the 005 outfall (Figure 11). Overall loadings from the USS/KOBE Steel operations were reduced from previous years.

*Nonpoint Source Pollution*
In comparison to historic point source impacts of the 1980s, present nonpoint source impacts in the Black River mainstem are nearly undetectable. Only one site on the mainstem was rated as **NON** WWH attainment and was located on the east shoreline (RM 5.8) where an active slag pile exists. The presence of the slag pile was the only factor at this site that was different from the other sites that attained PARTIAL WWH or FULL WWH use. Potential runoff from the slag pile may be a possible factor resulting in the observed biological community degradation.

### *East Branch*

*Aquatic Life Use Attainment*
The reduced size and geographic coverage of the 1982 survey prevented comparison of total ADVs with the larger 1992 survey (refer to Table 9 for the 1992 ADV results). Results of the 1992 survey show that in the East Branch basin, 12.9 miles attained FULL WWH criteria, 19.8 miles achieved PARTIAL WWH attainment, and 9.4 miles displayed **NON** WWH attainment (Table 9). Impacts from both nonpoint and point source pollutants (see below) were present in this portion of the drainage even though the most stable, high quality communities in the Black River basin were recorded in this stream. Nonpoint impacts were evident in the upper 20 miles between Grafton and Lodi (RMs 36 through 11 in general). Point source impacts were evident downstream of Grafton and in the Brentwood area. Although numerous failed septic systems were observed in this lower portion of the stream and contributed to the overall degradation of the biological community, it is point source impacts that are believed to be the principal cause of the observed degradation.

*Point Source Pollution*
A moderate effect on the biological communities was associated with the Lodi WWTP (RM 41.5) while no impact was attributed to the Ross Environmental Services incinerator. The biological

communities downstream of the Lodi WWTP remained within the bounds of WWH attainment. An impairment was detected downstream from the Grafton WWTP (RMs 6.0, 5.4, and 5.2). Loadings at both the Lodi and Grafton WWTPs have been reduced since 1982 (Figure 16). The impairment downstream from the Grafton WWTP appeared to be from a problem with sludge handling.

*Nonpoint Source Pollution*
Agricultural activities (row crop) were impacting the upper portion of the East Branch and the one site on Willow Creek downstream of the Ross incinerator. The source of the impacts was excessive sediment runoff from adjacent cultivated fields.

### *West Branch*

*Aquatic Life Use Attainment*
An estimated 7.8 miles reached FULL WWH attainment, 7.2 miles reached PARTIAL WWH attainment, and 27.3 miles scored as **NON** WWH attainment in this portion of the basin in 1992. More miles of **NON** WWH attainment were recorded in the West Branch than in any other portion of the Black River study area (Table 9). Only one site reached FULL WWH attainment, one site reached PARTIAL WWH attainment, and five sites scored as **NON** WWH attainment. The most downstream site was impacted by urban runoff, failed septic systems, combined sewer overflows (CSOs), broken sewer lines and sanitary sewer overflows (SSOs). All other impacted sites were affected by nonpoint pollution in the form of excess sediments, both suspended and bedload (see embededness in Table 5). The most severe case of an agricultural nonpoint source impact ever recorded in Ohio was documented at RM 19.6, a site with locally low gradient and few riffles. These factors created conditions in which excess sediment and nutrient loads resulted in a strong suppression of biological communities.

*Point Source Pollution*
No point source discharges were located on the West Branch proper. Dischargers were located on tributaries and were not observed to have direct impacts on the mainstem. Chemical results (Figure 5) demonstrated a contribution of nutrients from WWTPs on the tributaries. Such facilities did add to the enrichment of the mainstem, the consequent increase in turbidity from algal growth, and the severity of impacts to the biota.

*Nonpoint Source Pollution*
Impacts from nonpoint source pollution dominated the West Branch. High bedload sediments and elevated turbidity were observed at most of the sampling sites (see embeddedness Table 5). Tolerant species of fish formed the principal components of the community. Some pollutants from septic systems, CSOs, SSOs, and WWTPs were present, but any effect from these sources were overshadowed by the nonpoint source effects at all sites except RM 1.2/0.1.

### *West Branch tributaries*

*Point Source Pollution*
Two point source discharges were located on West Branch tributaries. The Oberlin WWTP is located on Plum Creek and the Wellington WWTP is located on Charlemont Creek. Impacts from point source impacts to the associated biological communities of the streams were not detected although nutrients were elevated downstream from both facilities and nonpoint soure pollution impacts were pervasive. The lack of an impact downstream of the Oberlin WWTP indicates a significant improvement in biological conditions as a result of Treatment plant upgrades

*Nonpoint Source Pollution*
Plum Creek was found to be affected by both agricultural and urban runoff. Only the most downstream site (downstream from the Oberlin WWTP) attained the aquatic life biocriteria (Table 1). Wellington Creek was strongly affected by agricultural runoff. Neither of the two sites on this stream attained the established biocriteria. Charlemont Creek was impacted by agricultural runoff which was expressed primarily in the fish community results (Table 8, Figure 23). Communities at all sites sampled in Charlemont Creek reached PARTIAL attainment.

## Conclusions

- The Black River has shown significant chemical and biological community recovery in the areas below the Elyria WWTP (Figures 3, 19, and 21). Improving water quality trends are attributed primarily to the major treatment upgrade at the Elyria WWTP completed in late 1988.

- Reliable loading information for the USS/KOBE Steel Company is not available due to the current methods of estimating flows at several of the outfalls. Floating oil continues to be a problem below the USS/KOBE Steel Company 001 and 005 outfalls.

- Fecal coliform bacteria exceedences were common (25 individual exceedences at 14 stations) throughout the study area (Table 4) and included both primary and secondary violoations. The highest bacteria counts were noted in the Elyria area (RMs 14.3, 11.5 & 9.8), the lower West Branch upstream from Elyria (RMs 4.2 & 0.2), and the East Branch from upstream of Grafton to the confluence with the West Branch (RMs 11.3, 10.5, 5.2, 3.1, & 0.3). Exceedences upstream of Elyria and Grafton were probably the result of animal husbandry operations while those exceedences downstream from Grafton and Elyria were primarily the result of a combination of WWTP discharges, failing septic systems, and agricultural activities.

- Samples were collected under lower flow conditions (Figure 3) and thus do not reflect the expected higher levels of pollutants that would be observed for NPS pollutants during high flow conditions especially during the first flush. Heavy metals concentrations were generally at or below detection limits. Metals concentrations would most likely be higher if sampled under first flush high flow conditions. Suspended solids levels would also be much higher under high flow conditions.

- Nonpoint source pollution has had a strong influence in the basin. Degraded aesthetics were noted throughout the basin due to high suspended solids levels and the resulting turbidity. Much of the stream beds upstream from Elyria were covered with silt and bedload sediments including sand and gravel (Table 5). The greatest impacts to the biological community were observed in the East Branch upstream from the Grafton area (RMs 41.5-24.6) and throughout the West Branch (Figures 19, 22 and 23). The impacts to the West Branch and tributaries were the most severe ever observed in Ohio as a consequence of general agricultural activities.

- Water quality in the lower East Branch was impacted by the numerous small treatment plants, CSOs, SSOs, and unsewered areas with numerous failing septic systems (Table 4, Figures 19 and 22). Portions of the West Branch within Elyria are also affected by failing septic systems and raw sewage discharges from CSOs, SSOs, and broken sewer lines (from approximately RM 4.0 to the confluence with the East Branch).

- The Lodi WWTP had a moderate effect on macroinvertebrate communities apparently due to

residual chlorine toxicity and organic enrichment.

- Significant increases in phosphorus concentrations were noted in the East Branch Black River below the Grafton WWTP (Figure 4). Biological communities were degraded downstream from the plant (Figures 19 and 21).

- With the exception of nitrate concentrations the Oberlin WWTP had no impact on most of the existing water quality and biological communities of Plum Creek (Figures 15, and 23). Sand and grit from street runoff were impacting the stream above the WWTP.

- Due to limited resources and the resulting minimal sampling efforts it is difficult to conclude whether NPS runoff, the Ross Environmental Services complex, or some other unidentified source is responsible for the depressed IBI at the single Willow Creek sampling site.

- A toxic impact to instream biological communities was detected in French Creek at RM 3.2 upstream from the French Creek WWTP. The impact may have been from a fly ash disposal area or industrial operations just upstream from the sampling site.

- No 1992 fish tissue samples (Appendix Table C-2) contained PCB contaminant levels above the FDA action level (2.0 mg/kg) or Ohio EPA WQS for whole aquatic organisms (640ug/kg).

- Fish tissue contamination by PAHs documented by the historical record was not present in the 1992 samples (Appendix Table C-2). This indicates that the dredging of contaminated sediments by USS/KOBE Steel may have significantly reduced the source of contamination.

- Hydrocarbon compounds identified in the 1992 fish tissue samples indicate the ubiquitous nature of these chemicals in the environment.

## Recommendations

### *Status of Aquatic Life Uses*

- All areas of the Black River basin are presently designated WWH. Specific segments are also listed as State Resource Waters. All existing use designations should be maintained.

### *Status of Non-Aquatic Life Uses*

- All non-aquatic life uses should remain as presently designated in the Ohio Water Quality Standards.

### *Other Recommendations*

- The City of Elyria must continue its CSO/SSO evaluation and control program. Central sewers should be extended to the southern Elyria area.

- Additional treatment facilities may need to be constructed at Grafton to handle possible increases in future loadings if state corrections facilities are expanded. Phosphorus removal and de-chlorination capabilities must be a part of any expansion. Loadings should be kept near current levels to prevent degradation of the receiving stream.

- Landowners throughout the watershed should be encouraged to expand and improve the

riparian zones along the river and its tributaries especially in the upper East Branch and West Branch areas. Suspended and bedload sediments and nutrients must be reduced in these watersheds before attainment of the WWH use designation can occure. Implementation of conservation tillage systems, buffer strips and other agricultural best management practices needs to be continued. The agricultural community also needs to examine animal handling and pasturing activities for possible changes that would improve water quality.

- De-chlorination facilities should be installed at the Lodi WWTP to address instream chlorine problems.

- USS/KOBE Steel Company must prevent oil and grease from escaping at outfalls 001 and 005. The Company must establish sampling stations and install proper flow measuring devices to better characterize the various types of effluent released; this is especially important at outfalls 003, 004, and 005.

- Further fish tissue sampling over a period of several years should be performed in order to document the decrease in PAH contamination indicated by the 1992 sampling. The Ohio Department of Health requires at least three consecutive years of data with contamination levels below FDA action levels prior to lifting the current fish advisory. The 1992 sample data, as well as future data, should also be compared to forthcoming action levels or risk assessment methodologies in order to determine the safety of Black River fish for consumption.

- Nonessential lowhead dams should be removed to facilitate fish passage, improve degraded habitat, and alleviate areas of exaggerated environmental impact.

### *Future Monitoring Needs*

- Additional fish tissue samples should be collected as part of an ongoing monitoring program. Samples should also be collected in the southern portion of the basin. In order to evaluate the ODH fish consumption advisory that is currently in effect, three consecutive years of fish tissue data must be collected and evaluated. The advisory should then be reevaluated at that point in time.

- Further biological and organic sediment chemistry sampling should be conducted at additional sites on Willow Creek and the unnamed tributary leading from the Ross Environmental Services complex to determine if the Ross complex is having an effect on Willow Creek.

- Additional sampling is needed in the tributaries located in the upstream portion of the basin to further detail the sources of nonpoint agricultural runoff and the extent of problem areas.

- Nearshore Lake Erie and harbor monitoring must be expanded to identify the extent of impaired beneficial uses, specifically as they relate to the public beaches located to the east and west of the mouth of the river.

- The two Ohio EPA ambient water quality monitoring stations should be maintained. A flow gauge installed at the Ford Road station would aid in the calculation of stream loads.

- A follow-up investigation of the French Creek basin needs to be conducted to identify the area from which toxic impacts are originating followed by chemical monitoring to verify the chemical(s) involved.

- The unnamed tributary harboring a population of state endangered blacknose shiner (*Notropis*

*heterolepis*) should be monitored to determine population status and assign appropriate aquatic life use designation. Numerous other tributaries in the Black River basin either lack use designations or are improperly designated at present. These designations could be developed based on a minimal biological sampling effort.

- The location, density, and number of animal units in the present animal livestock handling operations in the basin need to be determined as a start on correcting operations which impact water quality.

- The progress or success of current nonpoint source phosphorus and sediment reduction activities within the basin should be reevaluated over the next five to ten years.

## Study Area Description

The Black River Watershed covers 467 square miles (298,880 Ac.) and drains 887 stream miles in Lorain County as well as portions of Ashland, Medina, Cuyahoga and Huron Counties (Figure 1). The Black River has two main branches: the East Branch, which drains 222 square miles of land in Medina and southeast Lorain Counties, and the West Branch, which drains 174 square miles of land primarily in southwest Lorain County. The East and West Branches meet to form the mainstem in Elyria, and then flow north for 15.6 miles to Lorain Harbor in Lake Erie. French Creek, tributary to the mainstem at RM 5.1, drains 31.6 square miles of land in northeastern Lorain County.

The entire Black River basin lies within the Erie/Ontario Lake Plain ecoregion. Like most of north central and northwest Ohio, geographic relief is flat to gently rolling due to past glacial activity. The gradient of the Black River ranges from about 0.8 ft. per mile at the French Creek confluence to 29.8 ft. per mile at Charlemont Creek.

The geology and ground water resources of the basin also have been affected by glaciation. Generally, unconsolidated glacial deposits overlie consolidated sandstone and shale bedrock. Ground water resources are limited in the basin, yielding only five to 25 gallons per minute from sandstone and shale bedrock and glacial end moraines. The exceptions to this are in the extreme southeast where 100 to 500 gallons per minute are available from a buried valley aquifer and in the area near the Black River's mouth where clay and silt deposits yield less than five gallons per minute.

The northeast Ohio climate where the Black River is located is characterized by moderate precipitation which is fairly evenly spread throughout the year. The total yearly precipitation averages about 34.5 inches. The average temperature is $50^0$F with values rarely exceeding $90^0$F or falling below $0^0$F.

Most streams in the Black River basin are designated Warmwater Habitat (WWH). Two streams, a portion of the West Branch of the Black River running from Parsons Road to US Route 20 and Wellington Creek in the boundaries of Findley State forest, are designated as State Resource Waters. The entire Black River and French Creek from Gulf Road to the creek's mouth are, also designated seasonal salmonid.

The International Joint Commission has designated the Black River and its harbor as one of four Areas of Concern (AOC) on Ohio's Lake Erie shore line. A Remedial Action Plan (RAP) is being prepared to resolve the pollution problems in the lower mainstem as well as additional watershed concerns.

The Ohio EPA Phosphorus Reduction Strategy for Lake Erie ranks this watershed as "Priority 1". The Black River is estimated to contribute 107 metric tons of phosphorus each year into Lake Erie.

### *Soils*

The soil associations of Mahoning, Trumbull and Ellsworth silt loams comprise 90% of the soils in the watershed. These glacial till soils are classified as somewhat poorly drained to moderately well drained. Wetness is the main limitation to crop production. The surface soil is a medium to fine textured silt loam or silty clay loam. These soils are typically found on nearly level to gently rolling landscapes with long slopes. The combination of soil texture and slope allow these soils to erode easily. However, soil erosion is not uniform across the watershed. It varies as a function of local soil type, land slope, and land use. The soils in the watershed have an average soil loss tolerance of 3 tons/acre/year.

Studies conducted by the Northeast Ohio Areawide Coordinating Agency (NOACA) indicate that the area of greatest soil loss is the rolling till plain of western Medina County and Southern Lorain County. This area comprises much of the upper portion of the Black River basin along both the East and West Branches. The sub-basins within this area have greater than 20 % of their land area eroding at a rate of more than 5 tons/acre/year. The most erosive of these highly eroding sub-basins are: East Branch (West Fork to Crow Creek), Coon Creek, Charlemont Creek, West Branch (Headwaters to Charlemont Creek) and Buck Creek.

NOACA grouped the Highly Erodible Land (HEL) within the upper portion of the Black River basin along both the East and West Branches according to land use type. Over 17,000 acres were eroding at "excessive" levels in these basins. Cropland accounted for 82% of this total, followed by open space categories (e.g. grasslands, forestlands, and pastures) at 14 % and developed lands at 4 %.

The open space categories are areas least disturbed by human activities and are representative of background erosion problems. Therefore, naturally occurring erosion and sedimentation rates are high in much of the upper basin along both the East and West Branches. Steep slopes and deep soil depth combine to create erosive conditions. Background erosion rates are considered to be one of the major sources of sediment in the Area of Concern.

Erosion on cropland can be substantial given that some commonly used agricultural practices result in the ground laying bare for extended periods of the year. Overall, agricultural erosion is believed to be a major source of sediment in the Area of Concern. In its Erosion and Sedimentation Study, Lorain, Ohio, August, 1982, the U.S. Army Corps of Engineers reported that cropland in the Black River watershed is eroding at an average rate of 4.7 tons/acre/year. According to the U.S. Army Corps study, 107,000 acres of cropland in the Black River watershed is eroding at approximately twice the tolerable soil loss rate. The Corps further determined 835,000 tons of sediment is produced annually within the watershed with 80% coming from cropland.

Soil erosion in the Black River basin is detrimental in many ways. Soil loss from fertile cropland not only harms productivity, but does considerable damage to the drainage network throughout the watershed. Furthermore, sediment deposited on stream bottoms interferes with the reproductive cycle of many fish species, thus reducing the diversity and numbers of species in the aquatic environment. Suspended sediments irritate and clog the gills of many fish species, and reduce the amount of light available to aquatic plants (see Fish Community section for further details).

### *Tillage Trends*

During the mid to late 1980's, no-till farming systems were used on approximately 5% of the tillable acres in the Black River basin, while less than 1% of the tillable acres were in other types of conservation tillage systems (i.e. greater than 30% residue cover). From 1988 through 1992, no-till and other conservation tillage systems began to increase, primarily in response to compliance with USDA Farm Bill requirements. Approximately 70% of the cropland in the Black River basin is planted to corn and soybeans because of poor internal drainage that restricts the growth of alfalfa. Presently only 7% of the row crops are planted no-till, while 30% are planted using other conservation tillage systems. Conventional tillage remains the most common method of tillage in the watershed. An estimated 40% of the conventional tilled fields are fall plowed.

Through the Lorain County Agricultural Stabilization and Conservation Service (ASCS) Office, Agricultural Conservation Practice (ACP) Special Project funds were obtained in 1988-89. Cost-share assistance was provided in the form of long term agreements and annual practices. From 1988 to 1989, $100,000 was appropriated toward 9 long term agreements that included cost-sharing for grassed waterways, erosion control structures and 2 animal waste holding facilities. Most of the cost-sharing dollars were spent on grassed waterways. These were determined to be "high priority" to reduce serious gully erosion.

Ohio EPA initiated another significant nonpoint source project for the Black river watershed in 1992. Cost-share incentives were provided to farmers that purchased no-till drills and planters, straight chisel points and chaff spreaders. Furthermore cost-share payments were made to farmers for establishment of winter cover crops, filter/buffer strips and 30% residue levels. These Best Management Practices are to be used for a minimum of 3 years.

### *Land Use*

There are an estimated 1,860 farms in the Black River Watershed with an average size of 95 acres. There are an estimated 200 Dairy farms in the Black River basin. A survey conducted in the West Branch of the Black River in 1987-88, found that nearly 65% of the dairy operations lacked adequate manure storage facilities and consequently had to rely on daily hauling and land application. The following information is from a land classification study, using a 1991 satellite image, conducted for the Black River by Ohio Department of Natural Resources (ODNR):

Agriculture . . . . . 66%
- Agricultural Land (bare fields, fields with crop residue and pasture) - 10%
- Green Vegetation (some agricultural areas and urban and suburban vegetated areas) - 48%
- Bare Soil (some agricultural areas and urban and suburban areas) - 8%

Woodland . . . . . 23%
Urban . . . . . 10%
Misc. (water and wetlands) . . 1%

The agricultural subcategories of green vegetation and bare soil represent transitional categories which do not clearly fall into either cropland or urban categories. These areas are best reflective of the large acreage that has been taken out of agricultural production in favor of residential, commercial, industrial and recreational development.

### *Point Sources*

No permitted point source dischargers exist on the upper West Branch mainstem. The City of Norts (21,522 residents, 1980 census) operates the 7.5 MGD French Creek WWTP that

discharges to RM 2.8 of French Creek. Flows are also contributed by the City of Avon (7,241 residents, 1980) and the Village of Sheffield (1,886 residents, 1980 census)

The City of Lorain (75,416 residents, 1980 census) operates the 15 MGD Lorain East WWTP that discharges to RM 0.2 in the ship channel. Flows are also contributed by the City of Sheffield Lake (10,484 residents, 1980 census).

The Moen Division operates a metal finishing facility and discharges non contact cooling water to RM 13.0 of the Black River. The USS/KOBE Steel works, a fully integrated steel mill, discharges cooling water and process wastewater through six outfalls between RM 5.0 and 2.5 of the Black River.

The City of Oberlin (8,660 residents, 1980 census) operates a 1.5 MGD contact stabilization activated sludge WWTP that discharges to RM 3.0 of Plum Creek. The Village of Grafton (2,231 residents, 1980 census) operates a 0.75 MGD bath treatment WWTP with effluent discharged to RM 11.2 of the East Branch of the Black River.

Cromwell Park was operated as a municipal landfill by the City of Lorain from 1963 to 1976 on 172 acres. Municipal sewage sludge as well as organic residues from industries were disposed of in 1974 and 1975. The Ford Road landfill was located on 15 acres of land on the west bank of the Black River opposite the Elyria WWTP. It served as a disposal site for domestic and industrial wastes from 1910 to 1974. Numerous leachate seepages were noted during a 1983 evaluation for Comprehensive Environmental Response and Liability Act (CERCLA) funding. The Garden Street landfill is located on 40 acres of land approximately 0.5 miles from the West Branch of the Black River in Elyria. This was operated as a municipal dump for the City of Elyria, but also accepted industrial wastes. An intermittent stream borders the southern end of the dump and discharges to RM 1.7 of the West Branch. Leachate pools were evident during a 1979 CERCLA evaluation with cadmium, copper, chromium, and zinc detected at trace levels in samples of the leachate.

The former Republic Steel Sandstone Quarry is located directly adjacent to the West Branch of the Black River, with an outlet at RM 1.8. Several thousand gallons per year of used pickle liquor were disposed of at this site between 1950 and 1972. No detectable contaminants were found in the surface waters, while groundwater from monitoring wells was contaminated with trace levels of chromium, cadmium, zinc, and arsenic during a CERCLA assessment in 1983.

Table 1. Aquatic life use attainment status for the existing Warmwater Habitat (WWH) aquatic life use designations in the Black River basin based on data collected from June to October, 1992.

| RIVER MILE Fish/Invert. | IBI | Modified Iwb | ICI[a] | QHEI | Attainment Status[b] | Comment |
|---|---|---|---|---|---|---|
| ***Black River (1992)*** | | | | | | |
| | *Erie-Ontario Lake Plain -* ***WWH*** *Use designation* | | | | | |
| 15.0/14.4 | 40 | 9.05 | 40 | 86.0 | FULL | Cascade Park |
| 11.9/11.2 | 31* | 8.65 | MG[ns] | 87.5 | PART. | Spring Valley CC |
| 10.6 | 25 | 6.45 | 28 | N/A | N/A | Elyria mix. zone |
| 10.5/10.2 | 26* | 6.80* | 40 | 87.0 | PART. | dst. Elyria WWTP |
| 8.8/8.3 | 31* | 8.20 | 40 | 77.0 | PART. | Detroit Rd. area |
| ***Black River estuary area*** | | | | | | |
| | *Erie-Ontario Lake Plain -* ***WWH*** *Use designation* | | | | | |
| 5.8[c] | 25.3* | 6.76* | -- | 58.0 | **(NON)** | east bank ust. D2 |
| 5.5/5.6[c] | 30[ns] | 6.46* | 34 | 58.0 | PART. | west bank ust. D2 |
| 5.2/5.3[c] | 25.3* | 7.06[ns] | 28 | 49.0 | PART. | dst. D2 landfill |
| 5.0[c] | | | 22 | N/A | N/A | 006 mix. zone |
| ***Black River estuary area*** | | | | | | |
| | *Erie-Ontario Lake Plain -* ***WWH*** *Use designation* | | | | | |
| 4.8[c] | 28[ns] | 6.50* | 24 | 59.5 | PART. | dst. 001/FrenchCr. |
| 3.6/3.7[c] | 28[ns] | 7.06[ns] | 20[ns] | 42.0 | FULL | dst. USS/KOBE 005 |
| 3.0[c] | 32.6 | 7.26[ns] | 22 | 57.0 | FULL | ust. 003/004 |
| 2.3/2.0[c] | 32.6 | 7.00[ns] | 14* | 55.0 | PART. | dst. 003/004 |
| 0.9/1.1[c] | 34.6 | 7.90 | 12* | 52.0 | PART. | ust. Erie St. |
| 0.1[c] | 28.6[ns] | 6.80* | 14* | 40.0 | PART. | dst. Lorain WWTP |
| ***Black River harbor area*** | | | | | | |
| | *Erie-Ontario Lake Plain -* ***WWH*** *Use designation* | | | | | |
| 0.3[c] | 32.6 | 7.26[ns] | -- | 59.5 | (FULL) | west breakwall |
| 0.2[c] | 31.3[ns] | 6.56* | -- | 54.5 | (PART.) | east breakwall |
| ***French Creek*** | | | | | | |
| | *Erie-Ontario Lake Plain -* ***WWH*** *Use designation* | | | | | |
| 3.2 | 18* | 5.50* | 22* | 71.0 | **NON** | Abbe Rd. |
| 0.4/0.5[c] | 30[ns] | 7.26 | 32[ns] | 58.0 | FULL | dst. French Cr. WWTP |
| ***East Branch Black River*** | | | | | | |
| | *Erie-Ontario Lake Plain -* ***WWH*** *Use designation* | | | | | |
| 41.5 | 33* | 7.90 | 48 | 54.5 | PART. | Shaw Rd. |
| 36.8 | 32* | 8.05 | -- | 75.0 | (PART.) | dst. Homer-River Rd. |
| 32.5/32.3 | 26* | 8.10 | 42 | 60.0 | **NON** | Smith Rd. |
| 24.6 | 25* | 7.35[ns] | -- | 57.0 | **(NON)** | Foster Rd. |
| 18.9 | 36[ns] | 7.40[ns] | 46 | 73.0 | FULL | Vermont Rd. |
| 11.3 | 41 | 8.05 | 46 | 65.5 | FULL | Parsons Rd. |
| 10.1/10.8 | 41 | 8.15 | 30[ns] | 90.0 | FULL | dst. Grafton WWTP |
| 6.0 | 27* | 7.35 | 38 | 53.5 | **NON** | ust. Brentwood trib. |
| 5.2/5.4 | 31* | 8.70 | 48 | 84.0 | PART. | dst. Willow Cr. |

Table 1. (cont.)

| RIVER MILE Fish/Invert. | IBI | Modified Iwb | ICI[a] | QHEI | Attainment Status[b] | Comment |
|---|---|---|---|---|---|---|
| 3.0 | 37[ns] | 8.25 | 42 | 63.5 | FULL | Fuller St. |
| 0.3/0.1 | 29* | 6.50* | 42 | 57.0 | PART. | Washington St. |
| ***Willow Creek*** | | | | | | |
| | *Erie-Ontario Lake Plain - **WWH** Use designation* | | | | | |
| 2.9/2.8 | 18* | N/A | MG | 72.5 | **NON** | dst. Ross Incinerator |
| ***East Fork East Branch*** | | | | | | |
| | *Erie-Ontario Lake Plain - **WWH** Use designation* | | | | | |
| 2.7/2.9 | 39[ns] | N/A | 46 | 70.5 | FULL | Lodi Community Park |
| 1.6/1.5 | 38[ns] | N/A | 40 | 70.5 | FULL | dst. Lodi WWTP |
| ***West Fork East Branch*** | | | | | | |
| | *Erie-Ontario Lake Plain - **WWH** Use designation* | | | | | |
| 4.1/4.2 | 36[ns] | 7.60[ns] | VG | 75.0 | FULL | Congress Rd. |
| ***West Branch Black River*** | | | | | | |
| | *Erie-Ontario Lake Plain - **WWH** Use designation* | | | | | |
| 41.7 | 35* | N/A | 54 | 58.0 | PART. | Oh.Rt. 511 |
| 33.3 | 35[ns] | 7.60[ns] | -- | 84.0 | (FULL) | dst. Oh.Rt. 18 |
| 25.3 | 29* | 5.30* | 38 | 49.5 | **NON** | Oh.Rt. 58 |
| 19.6 | 17* | 5.20* | -- | 64.0 | **(NON)** | Oh.Rt. 303 |
| 13.6/13.5 | 23* | 5.50* | MG[ns] | 51.5 | **NON** | dst. Parsons Rd. |
| 4.1/4.2 | 24* | 6.75* | 22* | 70.0 | **NON** | dst. U.S.Rt. 20 |
| 1.2/0.1 | 32* | 6.70* | 28* | 69.5 | **NON** | 3rd St./Lake Ave. |
| ***Plum Creek*** | | | | | | |
| | *Erie-Ontario Lake Plain - **WWH** Use designation* | | | | | |
| 7.0 | 23* | N/A | F* | 70.0 | **NON** | Hamilton Rd. |
| 3.3/3.1 | 21* | N/A | 34 | 69.5 | **NON** | ust. E. Lorain St. |
| 2.95 | 24* | N/A | -- | N/A | N/A | Oberlin WWTP mix. zone |
| 2.9 | 20* | N/A | 36 | 57.0 | **NON** | dst. Oberlin WWTP |
| 0.9/0.8 | 35[ns] | N/A | 44 | 87.5 | FULL | dst. old Oh.Rt. 20 |
| ***Wellington Creek*** | | | | | | |
| | *Erie-Ontario Lake Plain - **WWH** Use designation* | | | | | |
| 13.1 | 29* | N/A | F* | 69.0 | **NON** | Cemetery Rd. |
| 10.8 | 19* | N/A | F* | 55.0 | **NON** | Hawley Rd. |
| ***\Charlemont Creek*** | | | | | | |
| | *Erie-Ontario Lake Plain - **WWH** Use designation* | | | | | |
| 2.8 | 32* | 7.80[ns] | -- | 70.5 | (PART.) | ust. Oh.Rt. 18 |

Table 1. (cont.)

| RIVER MILE Fish/Invert. | IBI | Modified Iwb | ICI[a] | QHEI | Attainment Status[b] | Comment |
|---|---|---|---|---|---|---|
| 0.7/0.6 | 33* | 6.60* | MG[ns] | 74.5 | PART. | ust. Wellington WWTP |
| 0.5/0.4 | 32* | 7.05* | MG[ns] | 73.0 | PART. | dst. Wellington WWTP |
| ***Buck Creek*** | | | | | | |
| | *Erie-Ontario Lake Plain - **WWH** Use designation* | | | | | |
| 1.0 | 42 | N/A | MG[ns] | 67.5 | FULL | Bursley Rd. |

**Ecoregion Biocriteria:** Erie-Ontario Lake Plan (EOLP)

| INDEX - Site Type | WWH | EWH |
|---|---|---|
| IBI - Headwaters | 40 | 50 |
| IBI - Wading | 38 | 50 |
| Mod. Iwb - Wading | 7.9 | 9.4 |
| IBI - Boat | 40 | 48 |
| Mod. Iwb - Boat | 8.7 | 9.6 |
| IBI - interim estuary | 32 | 48 |
| Mod. Iwb - interim estuary | 7.5 | 9.6 |
| ICI - all lotic sites | 34 | 46 |
| ICI - interim estuary | 22 | |

* Significant departure from ecoregional biocriteria; poor and very poor results underlined.

ns Nonsignificant departure from ecoregional biocriteria($\leq$4 IBI or ICI units;$\leq$0.5 MIwb units ).

a Narrative evaluation used in lieu of ICI (E=Exceptional; VG=very good; G=Good; MG=Marginally Good; F=Fair; P=Poor; VP=Very Poor).

b Attainment status based on one organism group is parenthetically expressed.

N/A Non applicable.

c Interim estuary and harbor criteria apply.

Table 2. Stream Characteristics and Significant Identified Pollution Sources in the 1992 Black River Basin Study Areas (ODNR 1954 and Ohio EPA 1992).

| Stream | Length (Miles) | Avg. Fall (Ft./Mi.) | Drainage Area ($Mi^2$) | NPS Pollution type* | Point Sources Evaluated |
|---|---|---|---|---|---|
| Black River (West/East Branch to Lake Erie) | | | | | |
| | 15.55 | 9.7 | 470.00 | Ag; CP; L; U; SR; OS; IPP | Elyria WWTP<br>D2 Landfill; USS/KOBE<br>Lorain WWTP |
| French Creek | | | | | |
| | 15.8 | 13.1 | 31.60 | Ag; CP; CS; SR; H; OS; IPP | French Cr. WWTP |
| East Branch (West FK East BR to West Branch) | | | | | |
| | 45.1 | 3.5 | 166.94 | Ag; CP; L; SaS; SR; OS | Brentwood WWTP<br>Grafton WWTP |
| East Fork of the East Branch | | | | | |
| | 9.3 | 27.8 | 18.16 | Ag; OS; SR | Lodi WWTP |
| West Fork of the East Branch | | | | | |
| | 17.2 | 16.0 | 36.90 | Ag; L; OS; SR | |
| Willow Creek | | | | | |
| | 8.7 | 4.6 | 22.90 | | Ross Environmental Services |
| West Branch (Headwaters to East Branch) | | | | | |
| | 53.2 | 6.1 | 174.00 | Ag; CP; L; U; H; OS | |
| Plum Creek | | | | | |
| | 7.3 | 14.7 | 14.54 | Ag; U; OS; SaS; SL | Oberlin WWTP |
| Wellington Creek | | | | | |
| | 7.6 | 21.6 | 30.50 | Ag; L; OS | |
| Charlemont Creek | | | | | |
| | 1.5 | 29.8 | 25.19 | Ag; L; OS | Wellington WWTP |
| Buck Creek | | | | | |
| | 7.5 | 22.9 | 20.79 | Ag; | |

* Ag - General Agriculture
CP - Crop Production
L - Livestock
OS - On-site Septic Systems
I PP - In Place Pollutants
SL - Sanitary Landfill
SaS - Sanitary Sewers
H - Hydromodification
U - General Urban
SR - Surface Runoff
CS - Construction Sites

## Methods

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

Due to the lack of current in the estuary area (a lentic habitat) outside bends were not the primary criteria for selecting a sampling site for fish communities. In this study (and other estuary studies) the area of greatest habitat diversity in the river segment was selected. Macroinvertebrate community sampling followed Ohio EPA standard methods using Hester-Dendy multiple plate artificial substrate samplers, supplemented with a qualitative assessment of the available natural substrates.

At present the development of biological criteria for Lake Erie estuary areas has not been completed. An examination of the data available from the Lake Erie estuary areas reveals that an IBI of 32, a MIwb of 7.5, and an ICI of 22 are the levels of performance that can reasonably be expected at least impacted sites (Ohio EPA 1990). Areas which deviate from these values are classified as impaired and displaying non-attainment of the Warmwater Habitat (WWH) aquatic life use criteria for Lake Erie estuaries. Deviations of four or less points from an expected IBI and ICI value or 0.5 points from an expected MIwb value are considered to be insignificant departures from the expected value and within the range of attainment. These are interim criteria and have been set by OEPA as short term guidlines until formal biocriteria can be developed. Unlike the biological criteria for Ohio's inland rivers and streams these criteria are not codified in the Ohio Water Quality Standards (WQS).

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

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

Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989). Various attributes of the available habitat are scored based on their overall importance to the establishment of viable, diverse aquatic

faunas. Evaluations of type and quality of substrate, amount of instream cover, channel morphology, extent of riparian canopy, pool and riffle development and quality, and stream gradient are among the metrics used to determine the QHEI score which generally ranges from 20 to 100. The QHEI is used to evaluate the characteristics of a stream segment, not just the characteristics of a single sampling site. As such, individual sites may have much poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have indicated that values higher than 60 are generally conducive to the establishment of warmwater faunas while those scores in excess of 75-80 often typify habitat conditions which have the ability to support exceptional faunas.

During this survey, macroinvertebrates were primarily sampled using modified Hester-Dendy multiple-plate artificial substrate samplers supplemented with a qualitative assessment of the available natural substrates. Exceptions were the Black River at RM 11.2 and the West Branch at RM 13.5 where the artificial substrate samplers were lost. Also, at a number of sites on the smaller tributaries only qualitative natural substrate samples were taken.

Macroinvertebrate sites in the study area were also evaluated using a new assessment tool which utilizes the qualitative, natural substrate collections available from each site. This method relies on tolerance values derived for each macroinvertebrate taxon collected. Unlike tolerance values used in other common indices (e.g., the Hilsenhoff Biotic Index), these tolerance values are based on abundance data for a given taxon collected using artificial substrates. To determine the tolerance value of a given taxon, ICI scores at all locations where the taxon has been collected with artificial substrates are weighted by the abundance data of that taxon at those sites. The mean of the weighted ICI scores for the taxon results in the tolerance value of that taxon. Thus, a taxon's tolerance value represents its relative level of tolerance on the ICI's 0 to 60 scale. High tolerance values are calculated for the more intolerant taxa which tend to reach their greatest abundance at undisturbed sites (i.e., sites with highest ICI scores). Conversely, more pollution tolerant taxa attain their greatest abundances at highly disturbed sites with low ICI scores, which results in a lower tolerance value. For the qualitative macroinvertebrate collections in the Rocky River study area, the median tolerance value, based on all tolerance values of the organisms collected at a site, resulted in what has been termed the Qualitative Community Tolerance Value (QCTV). Though only in the developmental stage, the QCTV shows potential as a method to supplement existing assessment methods using the qualitatively collected macroinvertebrate information. Its use in evaluating sites in the Black River study area was restricted to relative comparisons between sites with no attempt to interpret quality of the sites or aquatic life use attainment status.

Fish were sampled 2 times using the pulsed DC electrofishing wading methodology (150 meter zones) or 3 times using the pulsed DC electrofishing boat methodology (500 meter zones). All chemical/physical and biological sampling locations are listed in Table 3. Fish tissue samples were collected as skin-on fillet composites of representative benthic feeders and sport species from each station (carp fillet samples were skin-off composites). Whole body composites of carp were collected at six stations to compare with whole body samples collected in previous years. Samples were made of two to six fish fillets of the same species and size class. All fish were collected using Ohio EPA electrofishing boats or sportyak. After collection fish were sorted by weight and length, with weight and abnormalities noted for each fish. The samples were later analyzed for percent lipid content, cadmium, chromium, lead, mercury, zinc, copper, organic "priority pollutants" (including PCBs and pesticides), and all other tentatively identified compounds (TICs) from Ohio EPA's National Bureau of Standards spectral library of organic compounds.

An Area Of Degradation Value (ADV; Rankin and Yoder 1991) was calculated for the study area based on the longitudinal performance of the biological communities. The ADV portrays the length

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

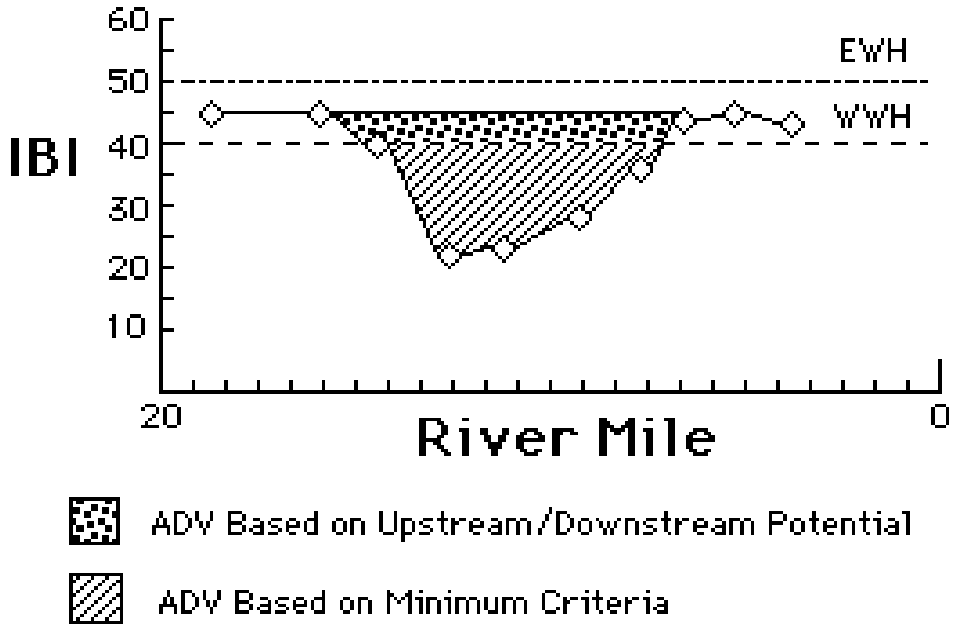


Figure 2. Graphic illustration of the calculation of Area of Degradation Values (ADV) based on upstream potential and the ecoregion warmwater habitat use or minimum criteria (WWH). Criteria for exceptional warmwater habitat use (EWH) is provided for reference.

Table 3. Sampling locations (water chemistry-C, sediment chemistry-S, benthic community-B, fish community-F) in the Black River study area, 1992.

| Stream/ river mile | type of sampling | Latitude/Longitude | landmark | USGS topo map |
|---|---|---|---|---|
| **Black River** | | | | |
| 15.0 | F | 41˚22'37"/82˚06'43" | Cascade Park | Avon |
| 14.95 | C,S | 41˚22'50"/82˚06'17" | Cascade Park | Avon |
| 14.4 | B | 41˚22'55"/82˚06'12" | Cascade Park | Avon |
| 11.9 | F | 41˚23'46"/82˚06'12" | Spring Valley CC | Avon |
| 11.5 | C | 41˚23'49"/82˚05'52" | Spring Valley CC | Avon |
| 11.2 | B | 41˚23'53"/82˚05'42" | Spring Valley CC | Avon |
| 10.6 | F,B | 41˚24'39"/82˚05'25" | mix zone | Avon |
| 10.5 | S,F,B | 41˚24'30"/82˚05'34" | Elyria WWTP | Avon |
| 9.8 | C | 41˚24'42"/82˚05'45" | Ford Rd. | Avon |
| 8.8 | F,B | 41˚25'32"/82˚06'13" | ust. Detroit Rd. | Avon |
| 8.4/8.3 | C,B | 41˚25'31"/82˚05'50" | Detroit Rd. | Avon |
| 5.8 | F | 41˚26'53"/82˚06'30" | adj slag pile | Avon |
| 5.5/5.6 | F,B | 41˚27'16"/82˚06'48" | ust. D-2 | Avon |
| 5.3/5.2 | C,F,B | 41˚27'17"/82˚06'58" | adj D-2 | Avon |
| 5.0 | C,B | 41˚26'21"/82˚06'42" | 006 mix zone | Avon |
| 4.8 | C,F,B | 41˚27'33"/82˚07'42" | dst 001/Fr Cr | Avon |
| 3.7/3.6 | C,F,B | 41˚27'15"/82˚08'06" | dst 005 | Lorain |
| 3.0/2.9 | C,F,B | 41˚27'20"/82˚08'50" | ust 003/004 | Lorain |
| 2.3/2.0 | F,B | 41˚27'12"/82˚09'15" | dst 003/004 | Lorain |
| 1.8 | C | 41˚27'26"/82˚09'07" | dst 003/004 | Lorain |
| 1.05 | C | 41˚27'50"/82˚10'05" | RR bridge | Lorain |
| 0.9/1.1 | F,B | 41˚27'54"/82˚10'14" | ust. Erie St. | Lorain |
| 0.1/0.01 | C,S,F,B | 41˚28'18"/82˚10'57" | dst Lorain WWTP | Lorain |
| **Black River Harbor** | | | | |
| | S | 41˚28'28"/82˚11'08" | w. of breakwall | Lorain |
| 0.3 | S,F | 41˚28'29"/82˚11'19" | e. of w.brkwall | Lorain |
| 0.2 | S,F | 41˚28'38"/82˚11'09" | w. of e. brkwall | Lorain |
| | S | 41˚28'41"/82˚10'19" | east of CDF | Lorain |
| **French Creek** | | | | |
| 3.2 | C,S,F,B | 41˚27'50"/83˚04'34" | Abbe Rd. | Avon |
| 0.5/0.4 | C,F,B | 41˚27'30"/82˚06'21" | Gulf Rd. | Avon |
| **West Branch Black River** | | | | |
| 41.7 | C,S,F,B | 41˚08'00"/82˚18'24" | Rt. 511 | Brighton |
| 33.3 | F | 41˚10'15"/82˚16'54" | dst. Rt. 18 | Brighton |
| 25.3 | C,S,F,B | 41˚12'21"/82˚13'02" | Rt. 58 | Wellington |
| 19.6 | F | 41˚14'18"/82˚11'55" | Rt. 303 | Wellington |
| 14.4 | C | 41˚16'46"/82˚09'45" | Parsons Rd. | Oberlin |
| 13.6/13.5 | F,B | 41˚16'47"/82˚09'10" | dst. Parsons Rd. | Oberlin |
| 4.2/4.1 | C,S,F,B | 41˚20'13"/82˚07'11" | Rt. 20 | Grafton |
| 1.2 | F | 41˚20'18"/82˚06'41" | 3rd St. Bridge | Grafton |
| 0.2/0.1 | C,B | 41˚22'18"/82˚06'45" | Lake Ave. | Grafton |

Table 3. (cont.)

| Stream/ river mile | type of sampling | Latitude/Longitude | landmark | USGS topo map |
|---|---|---|---|---|
| **Plum Creek** | | | | |
| 7.0 | C,F,B | 41˚16'47"/82˚14'44" | Hamilton Rd. | Oberlin |
| 3.3/3.1 | F,B | 41˚17'35"/82˚11'14" | ust. E. Lorain St. | Oberlin |
| 2.95 | C | 41˚17'38"/82˚11'11" | ust. Oberlin WWTP | Oberlin |
| 2.9 | F | 41˚17'43"/82˚11'01" | WWTP mix zone | Oberlin |
| 2.8 | F,B | 41˚17'44"/82˚10'57" | dst. Oberlin WWTP | Oberlin |
| 0.9/0.8 | C,F,B | 41˚18'03"/82˚09'34" | Rt. 20 | Oberlin |
| **Charlemont Creek** | | | | |
| 2.8 | F | 41˚10'03"/82˚14'49" | ust. Rt. 18 | Wellington |
| 0.7/0.6 | C,F,B | 41˚11'19"/82˚13'38" | ust Wellington WWTP trib. | Wellington |
| 0.5/0.4 | C,F,B | 41˚11'19"/82˚13'36" | dst Wellington WWTP trib. | Wellington |
| **Wellington Creek** | | | | |
| 13.1 | C,F,B | 41˚09'28"/82˚12'35" | Cemetery Rd. | Wellington |
| 10.8 | C,F,B | 41˚10'39"/82˚11'38" | Hawley Rd. | Wellington |
| **Buck Creek** | | | | |
| 1.0 | C,F,B | 41˚06'55"/82˚17'00" | Bursley Rd. | Nova |
| **East Branch Black River** | | | | |
| 41.4/41.5 | C,F,B | 41˚05'11"/82˚04'08" | Shaw Rd. | Lodi |
| 36.8 | F | 41˚06'31"/82˚05'45" | dst. Homer-River Rd | Lodi |
| 32.5/32.4/32.3 | C,F,B | 41˚08'12"/82˚07'00" | Smith Rd. | LaGrange |
| 24.6 | F | 41˚11'23"/82˚06'00" | Foster Rd. | LaGrange |
| 18.9 | C,S,F,B | 41˚14'04"/82˚04'55" | Vermont Rd. | LaGrange |
| 11.3 | C,S,F,B | 41˚16'28"/82˚04'01" | Parsons Rd. | Grafton |
| 10.5/10.8 | C,F | 41˚16'18"/82˚04'35" | dst Grafton WWTP | Grafton |
| 10.1 | B | 41˚17'24"/82˚04'54" | dst Grafton WWTP | Grafton |
| 6.0 | C,F,B | 41˚19'30"/82˚04'38" | ust Brentwood trib | Grafton |
| 5.2/5.4 | C,F,B | 41˚19'58"/82˚04'11" | dst Willow Cr | Grafton |
| 3.07/3.0 | C,F,B | 41˚20'49"/82˚05'41" | Fuller St. | Grafton |
| 0.3/0.1 | C,S,F,B | 41˚22'07"/82˚06'24" | Washington St. | Grafton |
| **Willow Creek** | | | | |
| 2.85/2.9/2.8 | C,S,F,B | 41˚19'36"/82˚03'04" | dst Ross | Grafton |
| **East Fork of the East Branch of the Black River** | | | | |
| 2.7/2.9 | C,S,F,B | 41˚02'24"/82˚00'47" | Lodi Park | Lodi |
| 1.6/1.5 | C,F,B | 41˚02'19"/82˚01'13" | dst Lodi WWTP | Lodi |
| **West Fork of the East Branch of the Black River** | | | | |
| 3.9/4.1/4.2 | C,F,B | 41˚01'17"/82˚03'17" | Congress Rd. | Lodi |

Table 4. Exceedences of Ohio EPA Warmwater Habitat criteria (OAC 3745-1) for chemical/physical parameters measured in the Black River study area, 1993 (units are #/100 ml for fecal coliform, µg/l for metals, and mg/l for all other parameters).

| Stream Name | River Mile | Violation: Parameter (value) |
|---|---|---|
| **Black River** | 14.3 | Fecal coliform:(6100◊¥, 5800◊¥, 9200◊¥, 9800◊¥) |
| | 11.5 | Fecal coliform:(3100◊) |
| | 9.8 | Fecal coliform:(2650◊) |
| | 4.8 | Oil and grease (27.6*) |
| | 1.8 | D.O.(2.2B‡‡, 4.3M‡, 4.8B‡, 3.7B‡‡, 4.3B‡, 4.9M‡) |
| | 1.05 | D.O.(2.1B‡‡, 3.3B‡‡, 4.4M‡, 4.7S‡, 3.75B‡‡, 4.6M‡, 4.9S‡) |
| | 0.01 | Fecal coliform:(300,000◊) |
| **East Branch** | 11.3 | Fecal coliform:(4400◊) |
| | 10.5 | Fecal coliform:(5200◊¥) |
| | 5.2 | Fecal coliform:(2650◊) |
| | 3.1 | Fecal coliform:(2300◊, 3400◊) |
| | 0.3 | Fecal coliform:(10600◊¥, 6000◊¥, 3700◊, 5000◊¥, 3350◊) |
| **Willow Creek** | 2.85 | Fecal coliform:(5200◊¥) |
| **East Fork of East Branch** | 1.6 | Fecal coliform:(4400◊)<br>Copper: 59(62*)<br>Total residual chlorine:(0.3**) |
| **West Branch** | 4.2 | Fecal coliform:(3950◊) |
| | 0.2 | Fecal coliform:(4300◊, 25000◊¥, 13000◊¥, 11400◊¥) |
| **Plum Creek** | 7.0 | Fecal coliform:(2150◊) |
| **Buck Creek** | 1.0 | D.O. (4.6‡) |
| **Wellington Cr.** | 13.1 | D.O. (2.5‡‡, 4.4‡) |
| | 10.8 | D.O. (1.7‡‡, 4.4‡) |
| **Charlemont Cr.** | 0.5 | D.O. (4.0‡) |

* indicates an exceedence of numerical criteria for prevention of chronic toxicity (CAC)
** indicates an exceedence of numerical criteria for prevention of acute toxicity (AAC)
‡ violation of the average dissolved oxygen (D.O.) criterion
‡‡ violation of the minimum dissolved oxygen (D.O.) criterion
◊ exceedence of the Primary Contact Recreation criterion
¥ exceedence of the Secondary Contact Recreation criterion
S indicates surface sample
M indicates mid-depth sample
B indicates bottom sample

## Results and Discussion

### *Flows*

During the 1992 survey season the months of July, August, and September experienced above normal rain fall in the Black River basin area. June and October flows, on average, were below normal. All flows recorded during the study were above the 80% duration flow (Figure 3).

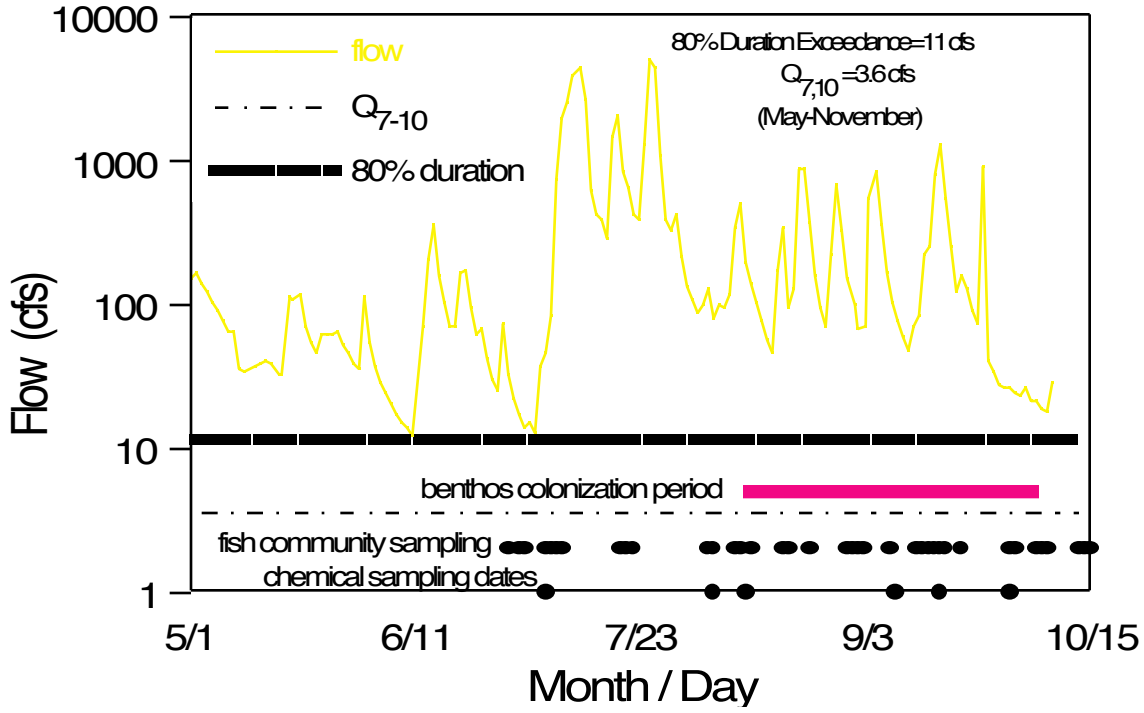


Figure 3. Flow hydrograph for the Black River at Cascade Park (Rm 14.92) just downstream of the East and Weast Branchs confluence. May 1992 to October 1992 with sampling dates for chemistry, benthos, and fish marked.

### *Chemical Water Quality*

*Black River Mainstem*

- Mean dissolved oxygen concentrations (based on daytime measurements) were in the 8-9 mg/l range from RM 14.3 to the head of the navigation channel where it declined to the 5-6 mg/l range (Figure 4). Dissolved oxygen readings from samples taken at bottom and mid-river depths in the lower section of the navigation channel were frequently below the 4.0 mg/l minimum WWH criterion.

- Datasonde™ surveys conducted on the mainstem showed a decline in dissolved oxygen (DO) concentrations downstream from the Elyria WWTP that extended about two miles downstream to the start of the estuarine portion of the river. None of the DO values recorded were violations of established criteria. Oxygen levels did not fall below 7.0 mg/l in this segment. Oxygen concentrations were generally lower in the estuary with levels approaching 6.0 mg/l at RM 1.05.

- Mean arsenic values ranged from <0.2 to 2.7 µg/l. The highest values were recorded at RM 1.8 (downstream from the USS/KOBE Steel complex). Mean cadmium concentrations were above detection limits (0.21 to 0.28 µg/l) throughout the mainstem. The highest levels were recorded below the Elyria WWTP. Mean chromium values were below detection limits in all mainstem samples. Mean copper values were below detection limits (10 µg/l) at all mainstem sites except for one sample at RM 0.01 (downstream Lorain-East WWTP) that had a value of 12 µg/l. Mean lead concentrations ranged from <2 to 3.7 µg/l with the highest value recorded at RM 4.8 (downstream French Creek and USS/KOBE Steel 001). Mean nickel values were below detection limits (40 µg/l) in all samples except for one reading of 42 at RM 3.7 (downstream USS/KOBE 005). Mean zinc concentrations ranged from <10 to 17 µg/l with the highest values generally found throughout the river segment adjacent to the USS/KOBE complex. None of the metal values recorded exceeded chronic water quality criteria.

- Mean chemical oxygen demand (COD) values ranged from 20.3 to 30.3 mg/l. The highest values were recorded at RM 4.8 (downstream French Creek and USS/KOBE 001) and the lowest were recorded at the mouth of the Black River.

- Mean nitrate concentrations increased below the Elyria WWTP from 1.4 mg/l to 6.03 mg/l then declined to 4.44 mg/l at RM 8.4. Levels rose slightly for the next five river miles then dropped to 2.5 mg/l and eventually dropped to 1.25 mg/l at the mouth Mean ammonia-N concentrations were at or near the detection limit of 0.05 mg/l from RM 14.3 to RM 4.8 (downstream French Creek and USS/KOBE 001). There was a gradual increase in concentrations through the navigation channel. The highest value (0.47 mg/l) was recorded at RM 0.01 which is downstream from the Lorain-East WWTP discharge. Mean total Kjeldahl nitrogen (TKN) values ranged from 0.7 to 0.95 mg/l throughout the mainstem. The highest values were at RM 9.8 (downstream Elyria WWTP) and at RM 4.8 (downstream French Creek and USS/KOBE 001). The highest individual sample result was from RM 0.01 which is downstream from the Lorain-East WWTP.

- Mean $cBOD_5$ ranged from 1.1 mg/l to 1.7 mg/l from RM 8.4 to the mouth.

- Mean phosphorus concentrations ranged from 0.08 to 0.24 mg/l with the highest levels downstream from the Elyria WWTP. (Figure 4).

- Mean total suspended solids values ranged from 17 mg/l at RM 0.01 to 35 at RM 2.9 (upstream USS/KOBE 003/004 and the navigation channel).

- Oil sheens were common from RM 4.8 to RM 3.0. Oil seeps were observed on the west bank of the river adjacent the USS/KOBE Steel area from approximately RM 5.5 to 5.0.

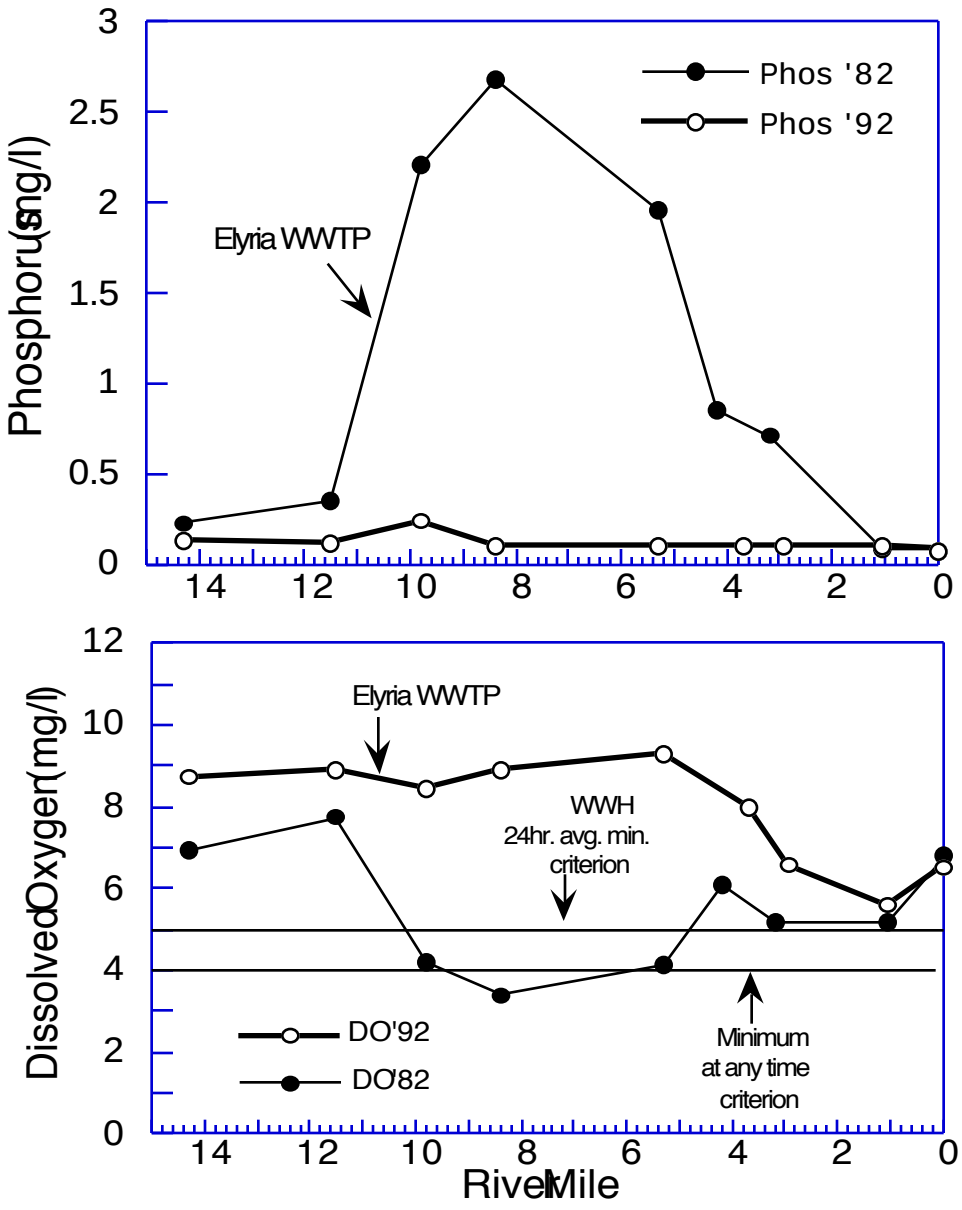


Figure 4. Phosphorus and Dissolved Oxygen (DO) concentrations in the Black River mainstem by river mile in 1982 and 1992.

*French Creek*

- There was no significant difference in data collected at the two French Creek sites. The French Creek WWTP is not having any noticable impact on the water quality in this segment.

*East Branch*

- None of the individual D.O. values recorded in this subbasin violated water quality standards. Mean dissolved oxygen concentrations did decline slightly (from 7.9 to 6.6 mg/l) between RM 41.45 and 32.4. Mean D.O. levels increased steadily, down to RM 6.0 (downstream Grafton WWTP) where another slight decline occurred. D.O. again increased slightly at the next downstream station then started another gradual decline through the balance of the East Branch, but remained well above the WQS criterion of 4.0 mg/l (Figure 5).

- Datasonde™ information showed oxygen concentrations steadally declining for four miles downstream from the Grafton WWTP. These values did not drop below 6.0 mg/l though.

- Mean phosphorus concentrations increased below the Grafton WWTP and then again below an unsewered area near RM 3.0 where the levels increased from 0.14 to 0.49 mg/l (Figure 4). Other nutrients concentrations increased slightly below the Grafton WWTP.

- Mean heavy metals values varied little throughout the length of the East Branch with most values at less than lab detection limits.

- Total suspended solids values were generally lower in the East Branch than in the West Branch.

*East Fork of the East Branch*

- There was a slight decrease in mean dissolved oxygen levels below the Lodi WWTP (9.35 to 8.57 mg/l)

- The Lodi WWTP had a slight effect on the East Fork of the East Branch as measured with the use of Datasonds™. Oxygen concentrations showed a decline downstream from the WWTP but did not fall below 6.0 mg/l.

- Mean cadmium, copper, lead, and zinc concentrations increased below the Lodi WWTP. Cadmium increased from <0.2 to 0.45 µg/l, copper increased from <10 to 24.5 µg/l, lead increased from <2 to 5.5 µg/l, and zinc increased from <10 to 25.5 µg/l.

- Nutrient concentrations increased significantly below the Lodi WWTP. Mean nitrate concentrations increased from 0.1 to 4.2 mg/l. Mean phosphorus concentrations increased from 0.2 to 0.86 mg/l.

- High total residual chlorine readings were noted below the Lodi WWTP and in the Lodi WWTP effluent. On one sample date the residual chlorine level was 0.30 mg/l downstream from the 001 outfall.

*West Branch*

- Nitrate concentrations increased steadily in a downstream direction. There was a noticeable

increase in phosphorus concentrations (from 0.06 to 0.28 mg/l) below Charlemont Creek (Figure 5). Other nutrients remained steady.

- Heavy metals levels showed little change throughout the basin.
- Mean temperature and dissolved oxygen readings increased steadily from upstream to downstream.

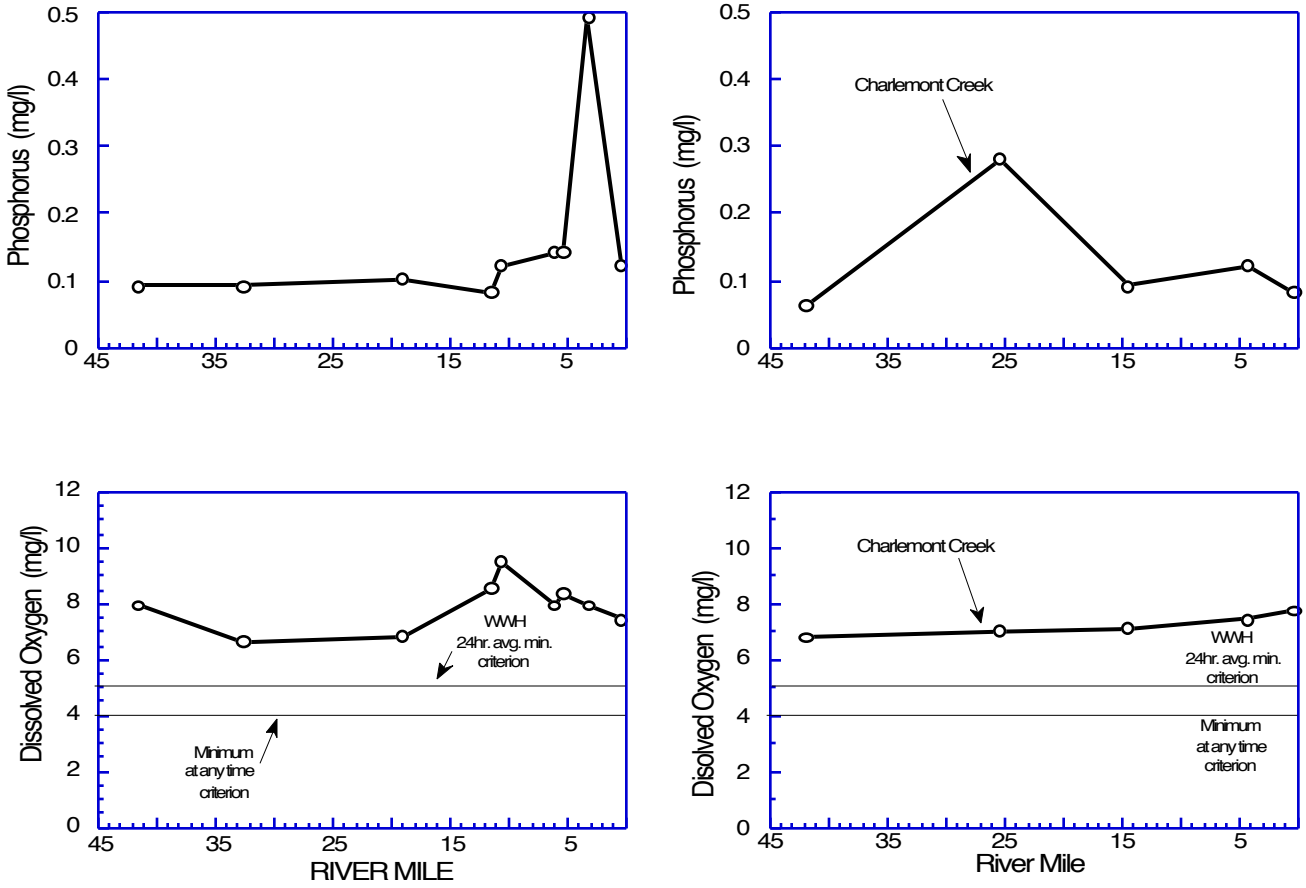


Figure 5. Phosphorus and dissolved oxygen concentrations in the East Branch (left hand figures) and the West Branch (right hand figures) of the Black River by river mile 1992.

- Mean suspended solids levels increased from 6.8 mg/l at river mile 41.7 to 39 mg/l at river mile 4.2 then dropped to 19.5 mg/l at the most downstream site (RM 0.2).

*Plum Creek*

- The site at RM 7.0 continues to suffer from low dissolved oxygen levels. Readings as low as 1.5 mg/l were recorded. The Datasond™ survey conducted on Plum Creek showed the Oberlin WWTP was not influencing the dissolved oxygen concentrations in the stream (Figure 5).

- Except for nitrate levels, which increase significantly (0.19 to 13.58 mg/) below the Oberlin WWTP, there was very little difference in the water quality in Plum Creek when comparing the sites located upstream and downstream of the Oberlin WWTP which is located at RM 2.85.

*Charlemont Creek*

- Mean nutrients concentrations, especially phosphorus and nitrate, increased significantly (nitrate increased from 0.76 to 6.0 mg/l and phosphorus increased from 0.1 to 0.9 mg/l) at the site downstream the Wellington WWTP tributary. No major differences were noted in other parameters.

### *Fish Tissue*

*Collection/Procedures*

- Thirty fish tissue samples collected from nine stations during the 1992 survey were analyzed.. Two stations were located in the East Branch (RM 3.07 and 0.3), two stations in the West Branch (RM 4.2 and 1.3), three stations in the main stem (RM 5.3, 2.9 and 1.05) and two stations in the Lake Erie harbor area just inside the east and west breakwalls.

*Results*

- The results of the 1992 fish collections and the tissue analytical results are shown in Appendix Table C-2.

- Carp (both whole-body and fillet) and brown bullhead collected during the survey usually had higher lipid content and higher concentrations of pollutants than either sport species or other benthic feeders. Carp fillet samples usually had lower lipid content and lower pollutant concentrations than whole-body samples. Tissue samples from all species collected in the East and West Branches generally had lower pollutant concentrations than those collected in the mainstem and harbor area.

- Reportable PCB concentrations were identified in 24 of 30 samples and ranged from non-detectable to 0.6 ppm (PCB 1260). No samples were identified with contaminant levels of PCBs greater than the FDA action level of 2 ppm.

- Only one volatile organic compound (VOC) priority pollutant (M-Xylene) was identified in one sample at a concentration of 0.208 ppm (detection limit of 0.189 ppm). A total of 14 non-priority pollutant VOC's were tentatively identified from GC/MS peaks. The highest concentration of a VOC in one sample was 5.85 ppm for the compound hexanal. Petroleum based VOC's were found in 27 of 30 samples.

- Priority pollutant pesticide compounds were identified in all 30 samples and ranged from non-detectable to 0.1 ppm (4,4-DDE). The pesticides identified consisted of dieldrin, methoxychlor and DDT and its metabolites (Table C-2).

- No base neutral acid extractible compounds (BNA's) were identified in the samples.

- At least one heavy metal was present in each sample. Concentrations ranged from non-detectable to 0.264 ppm (cadmium), 4.34 ppm (chromium), 1.98 ppm (copper), 0.297 ppm (lead), 0.549 ppm (mercury), and 90.1 ppm (zinc).

*Historical Data*

- Historical fish tissue results from the Black River are from whole body composite samples (both single and multi-species) collected from 1978-82 and analyzed for PCBs, pesticides,

and priority pollutants. Total PCB concentrations ranged from 0.1 to 12.6 ppm. Two samples contained PCB concentrations above the FDA action level of 2.0 ppm. Sixteen pesticide compounds were identified and quantified with concentrations from 0.002 to 0.174 ppm. Thirty-one organic compounds (consisting mainly of polyaromatic hydrocarbons or PAHs) were identified in concentrations ranging from non-detectable to 5.724 ppm (phenanthrene). Three other PAHs (acenapthylene, fluoranthene and pyrene) were found in brown bullhead composites at amounts greater than 1 ppm. All samples were collected in the mainstem or harbor area and consisted primarily of bottom dwelling species (carp, brown bullhead, channel catfish, freshwater drum).

### *Sediment Chemistry*

*Mainstem*

- The US EPA-Eastern District Office sampled 13 sites on the mainstem in 1992. That survey area covered RM 5.5 to RM 2.35. Samples were collected for heavy metals, BNAs, VOCs, PCBs, and pesticides. Ohio EPA sampled three additional mainstem sites, three sites each on the West and East Branches, and single sites on French Creek, Willow Creek, and the East Fork of the East Branch. Parameter coverage included heavy metals, BNAs, PCBs, and pesticides at the Black River mouth and French Creek-Abbe Road sites and heavy metals at the other sites. Metals results are presented in Appendix Table C-3 and organic results are presented in Appendix Table C-4.

- Unquantifiable and quantifiable concentrations of naphthalene, benzo(a) anthracene, benzo(a)pyrene, toluene, ethyl benzene, and total xylene was found throughout the study area. The highest sediment organics concentrations were detected at RM 3.8, which is just upstream of the upper limit for the 1990 USS/KOBE Steel contaminated sediment removal project.

- No PCBs were detected in any of the samples.

- The pesticides 4,4,-DDE and 4,4,-DDT were detected at 12 of 14 sites at concentrations up to 10 ppb.

- Elevated metals concentrations can be found throughout the US EPA sampled segment (RM 5.5-2.35) (using Kelly and Hite 1984). The site at RM 5.3 downstream from the USS/KOBE D-2 landfill had 6 of 7 metals in the highly elevated and \extremely elevated ranges. The sites at RMs 3.8, 3.45, and 2.35 had 5 of 7 metals in the highly elevated and extremely elevated ranges. Zinc, cadmium, and iron were the metals most often found in the highly elevated and extremely elevated ranges. The sample from the mouth of French Creek showed highly elevated levels of cadmium, chromium, iron, lead, and zinc. The West Branch, East Branch , East Fork, and Willow Creek results were all in the non-elevated, slightly elevated,, and elevated ranges except for one highly elevated cadmium result at RM 0.3 of the East Branch.

*Harbor*

- Four harbor/breakwall sites were sampled by Ohio EPA. Parameter coverage included heavy metals, BNAs, PCBs, and pesticides. Metals results are presented in Appendix Table C-3 and organic results are presented in Appendix Table C-4.

- The pesticide 4,4, -DDE was detected in low concentrations at all four harbor/breakwall sites.

- The PAH benzo (b) fluoranthene was found at 0.9 ppm at the site located on the east side of

the confined disposal facility (CDF).

- No other organic compounds, PCBs, or pesticides were found.

- Arsenic was found at heavily polluted levels at all four harbor breakwall sites. (Guidelines For The Pollutional Classification of Great lakes Harbor Sediments, US EPA,, 1977). Chromium, copper, and lead were found at moderatly polluted levels at two sites and at non-polluted levels at two sites. Iron was found at heavily polluted levels at two sites, moderatly polluted levels at one site, and non-polluted levels at one site. Zinc was found at moderatly polluted levels at all four sites.

### *Point Source Improvements: 1982 - 1992*

- 1983 - US Steel (now USS/KOBE) closed its coke plant, eliminating coking wastewater discharge from outfall 002.

- 1988 - Lorain West Side WWTP started operation. It receives 3 MGD of flow treated by the East Side WWTP prior to discharge to the Black River. The East Side WWTP discharges directly to Lake Erie.

- 1988 - Lodi, Wellington, Oberlin and Grafton WWTPs complete upgrades, resulting in significant improvement in quality of their discharges.

- 1988 - Stanadyne (now MOEN) eliminated a major industrial discharge by connecting to Elyria sanitary sewer system following pretreatment.

- 1989 - Elyria WWTP upgrade completed, resulting in significant improvement in the quality of its discharge.

- 1989 - GMC Fisher Body Elyria Plant closed, eliminating a major industrial wastewater discharge.

- 1990 - US Steel (now USS/KOBE) dredged PAH contaminated sediment from around the old coke plant outfall 002. Dredged material placed in D2 landfill on USS/KOBE property.

- 1992 - Lagrange WWTP upgrade completed.

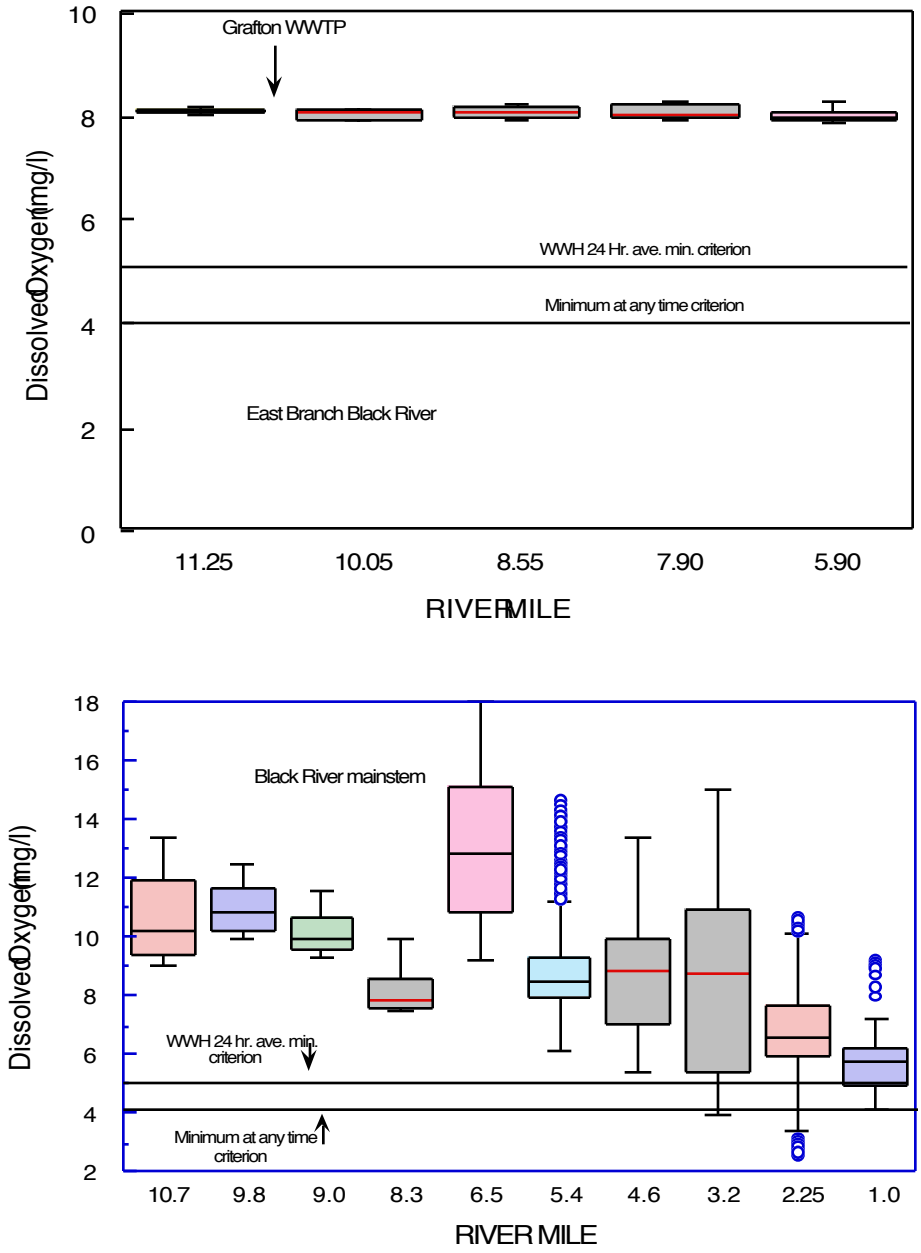


Figure 6. Boxplot results for dissolved oxygen in the East Branch and mainstem of the Black River showing medium, 25%, 75%, minimum, maximum, and outliers.

### *Collection System Overflows*

*City of Elyria*

- There are 37 combined sewer overflows (CSOs) and 58 separate sewer overflows (SSOs) in the Elyria collection system. Elyria has instituted an aggressive sewer rehabilitation/relief sewer construction program which has improved conditions by eliminating or reducing flows from four CSOs and twenty SSOs since 1986. Fifteen SSOs and one CSO are scheduled to be upgraded in 1993. Elyria is under a 1986 USEPA Consent Order to eliminate the SSOs by December, 1993. Elyria has not been able to meet this milestone and is expected to request an extension of the deadline. There are 9 pump station overflows in the collection system. The pump stations have been rehabilitated and now overflow less often. On a rotating basis Elyria monitors overflows from the CSOs/SSOs listed in its NPDES permit for cBOD, total suspended solids, volume, number of occurrences and duration.

*City of Lorain*

- There are five CSOs and one pump station in the Lorain collection system that discharge to the Black River. Fourteen CSO/SSOs are listed in the NPDES permit as discharging to Lake Erie. The completion of the Lorain West Side WWTP in 1988 was designed to reduce or eliminate discharges from these overflows. The NPDES permit requires Lorain to monitor and report overflows from these sources. This was not being performed in 1992. The city has contracted with a consulting firm to begin SSO monitoring and evaluation in late 1993.

### *Point Source Pollutant Loadings Trends*

*USS/KOBE Steel Company*

- 001-This outfall originates at the Pipe Mill lagoon. Flows have been significantly reduced due to increased efforts towards recycling the treated wastewater. There has been a major decrease in the loadings of suspended solids and oil+grease as a result (Figures 7).

- 002-The coke ovens that contributed flow to this outfall were shut down in 1983. This has resulted in significant decreases in the loadings for oil+grease, ammonia-N, PAHs, and suspended solids from this outfall (Figure 8).

- 003-This blast furnace outfall has had a steady to slightly declining flow rate over the last ten years. The blast furnace outfalls are among the largest contributors of suspended solids and ammonia-N in the basin (Figure 9).

- 004-Flows from this blast furnace outfall have increased significantly over the last ten years. It is a major source for suspended solids, Ammonia-N, and oil+grease (Figure 10).

- 005-Flows from the Bar Mill outfall have been incresing steadily since 1983. Loadings for oil and grease and suspended solids have been increasing with the increased flow (Figure 11).

- 006-This outfall services the leachate treatment system at the dredged sediment landfill. It has been in operation since 1989. Flows, as well as $BOD_5$, COD, ammonia-N, and total suspended solids have been decreasing steadily (Figure 11).

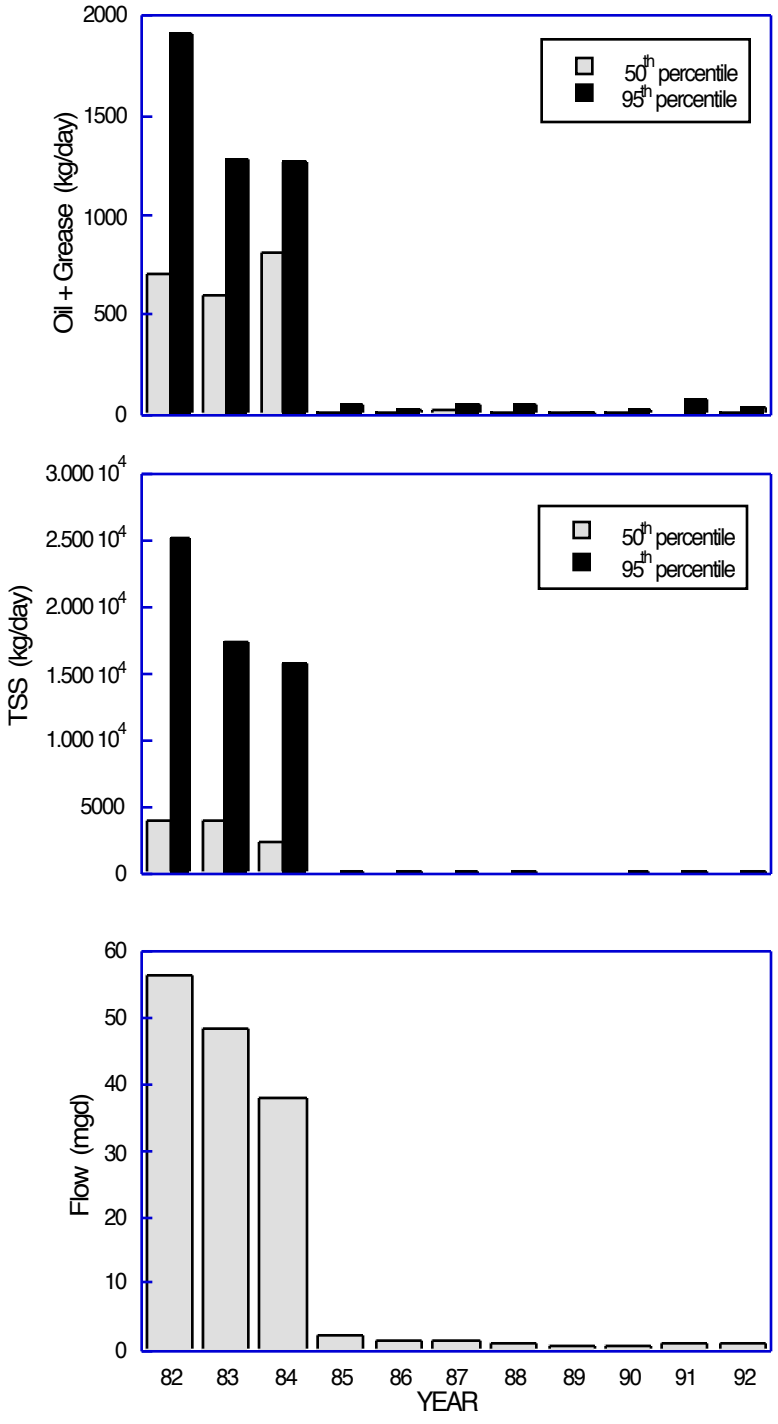


Figure 7. Annual trends in oil and grease, Total Suspended Solids and flow from the USS/KOBE Steel 001 discharge outfall, 1982-1992.

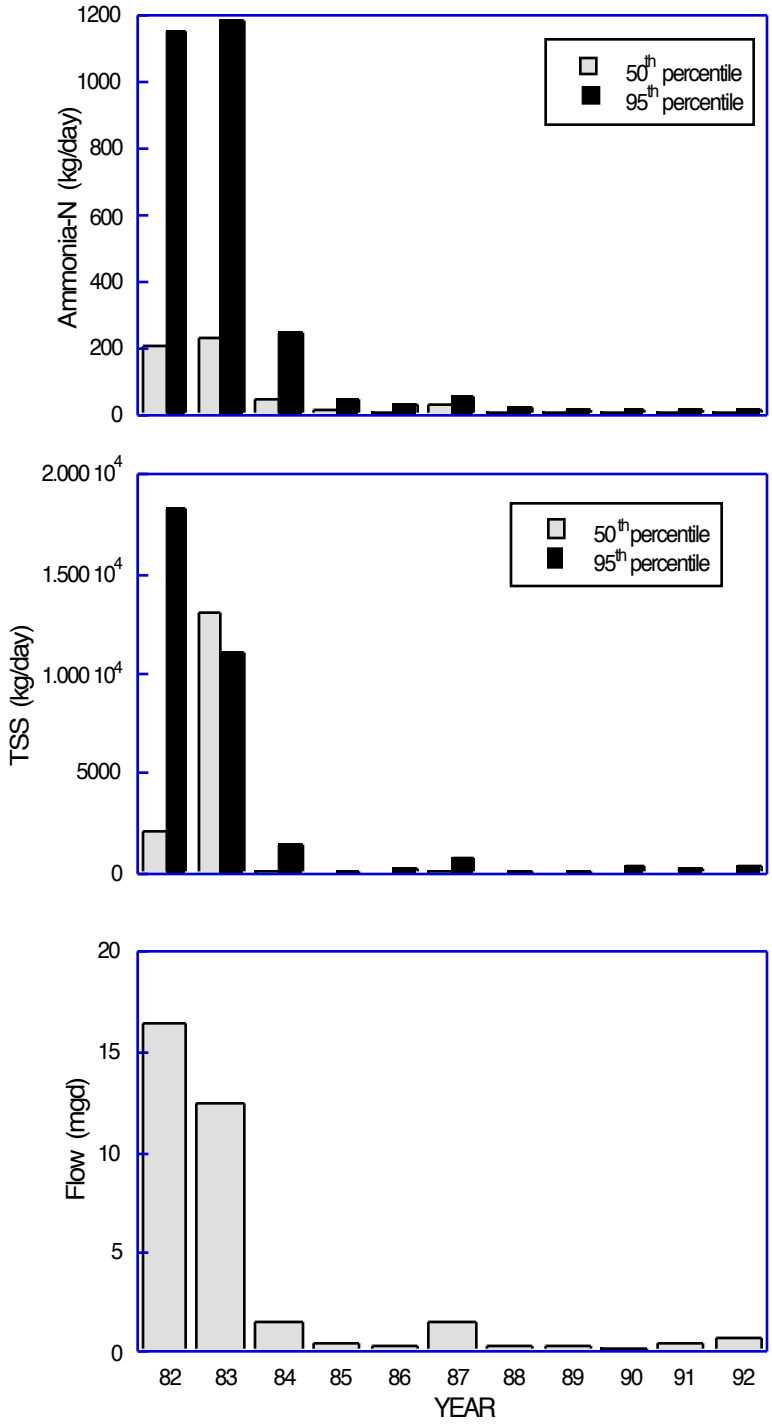


Figure 8. Annual trends in ammonia- N, Total Suspended Solids and flow from the USS/KOBE Steel 002 discharge outfall, 1982-1992.

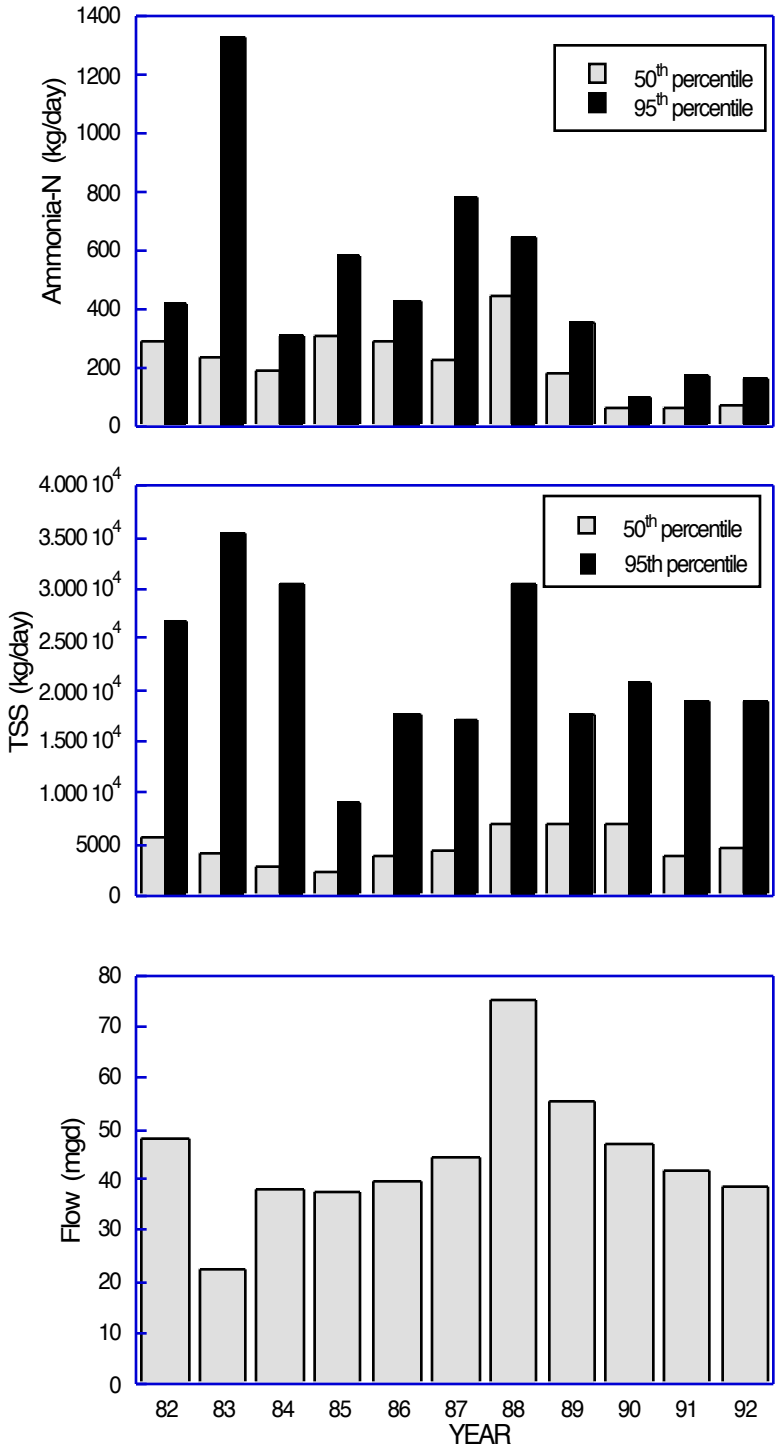


Figure 9. Annual trends in ammonia- N, Total Suspended Solids and flow from the USS/KOBE Steel 003 discharge outfall, 1982-1992.

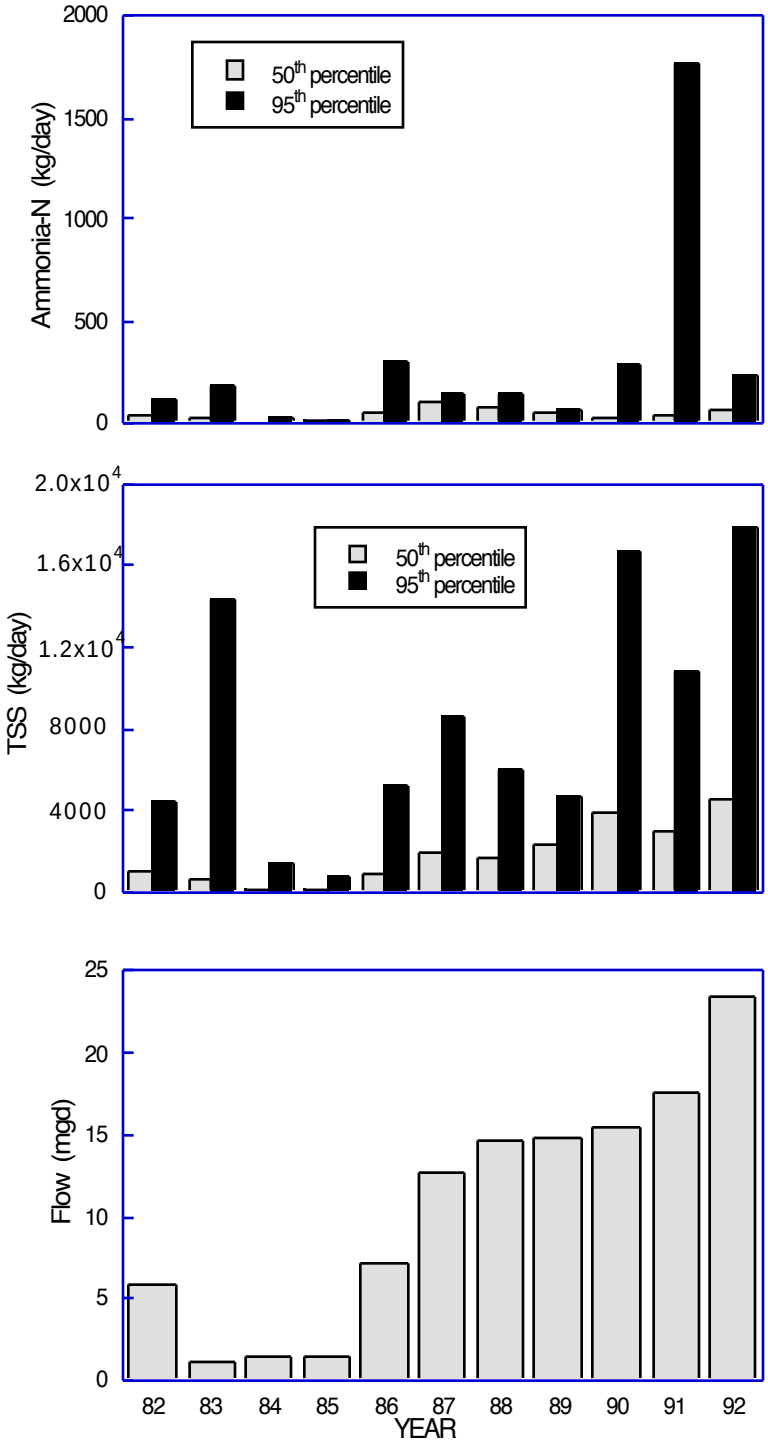


Figure 10. Annual trends in ammonia- N, Total Suspended Solids and flow from the USS/KOBE Steel 004 discharge outfall, 1982-1992.

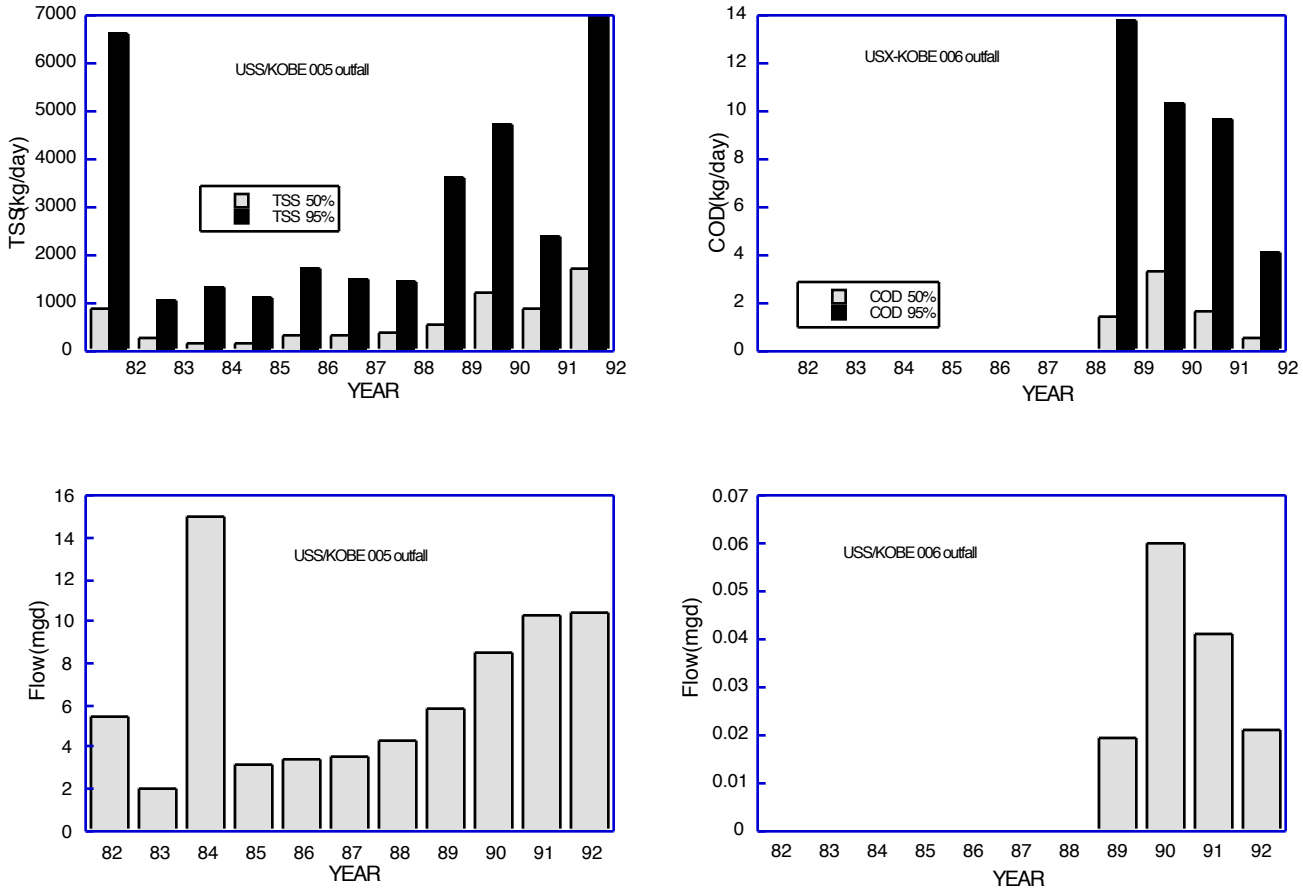


Figure 11. Annual trends in COD loadings and flows for the USS/KOBE Steel 005 outfall and annual trends for TSS loadings and flow for the USS/KOBE Steel 006 outfall 1982-1992.

*Lorain -East WWTP*

- Flows from the Eastside facility declined starting in 1988 when the Lorain West WWTP came on line and took over a portion of the flow originally going to the Eastside WWTP. Flows have begun to increase though in the last year. Total suspended solids, ammonia-N, , TKN, phosphorus, copper, lead, and zinc loadings (Figure 12)and $cBOD_5$ (Figure 14) all mirrored the increasing flow pattern .

*Elyria WWTP*

- Flows from the Elyria WWTP have been steady for the past ten years. A $38 million upgrade was completed in late 1988. Since that time, loadings for monitored nutrients and most metals have dropped significantly (Figure 13 and 14).

*Oberlin WWTP*

- Flows from the Oberlin WWTP have declined somewhat since the City started a sewer rehabilitation project in their service area. A $4.3 million upgrade was completed in 1988. Since that time loadings for most metals and nutrients have been declining (Figure 15).

*Grafton WWTP*

- The Grafton WWTP completed a $1.8 million expansion in 1988. Since that time, additional flows have been directed to the facility as smaller package plants and treatment systems have been tied into the Grafton facility. Two large prisons have recently been constructed in Grafton and a possible third is under consideration although planning is presently on hold. The WWTP may need to expand in the near future. Loadings of all permitted parameters have been increasing steadily (Figure 16). This WWTP has had a major problem with solids/sludge management. Sludge has been observed overflowing the drying beds.

*Lodi WWTP*

- A Lodi WWTP expansion and upgrade was completed in 1988. Mean flows have been relatilely constant, except in wet years when flows increase substantialy. Nutrient loadings have been declining in the last 2-3 years. Little monitoring information was available for the years prior to 1988 (Figure 16)

*French Creek WWTP*

- Flows from the French Creek WWTP have been increasing as sewers are extended further out into the service area. Loadings for certain heavy metals and total suspended solids have been increasing while loadings for nutrients have been decreasing (Figure 17). This WWTP is under-loaded at this time.

*Wellington WWTP*

- Flows and loadings for nutrient parameters have been increasing steadily since 1988 (Figure 18).

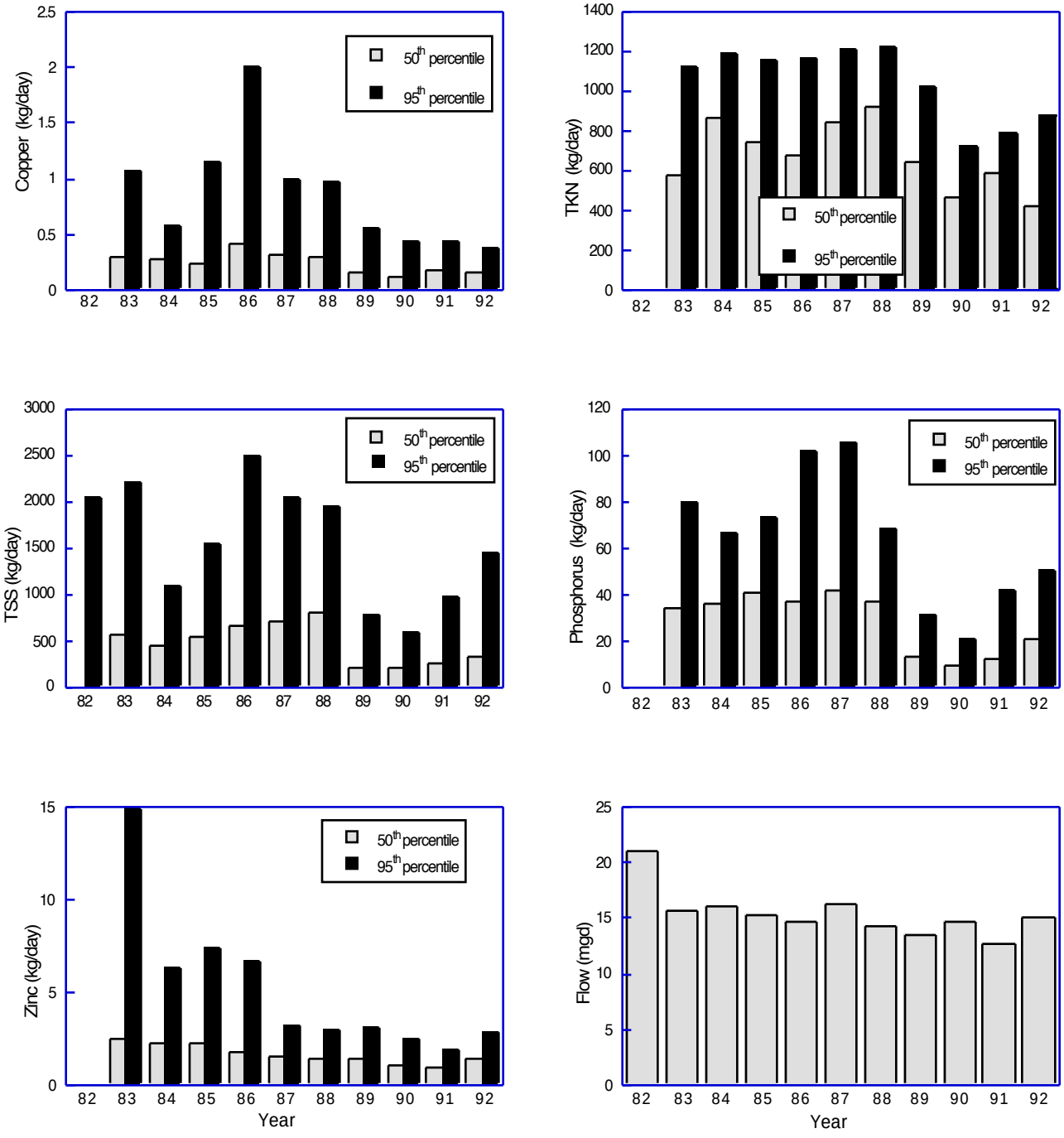


Figure 12. Yearly average loadings for copper, TKN (total Kjeldahl nitrogen, TSS (total suspended solids), phosphorus, and zinc with yearly average flows for the Lorain East WWTP 1982-1992.

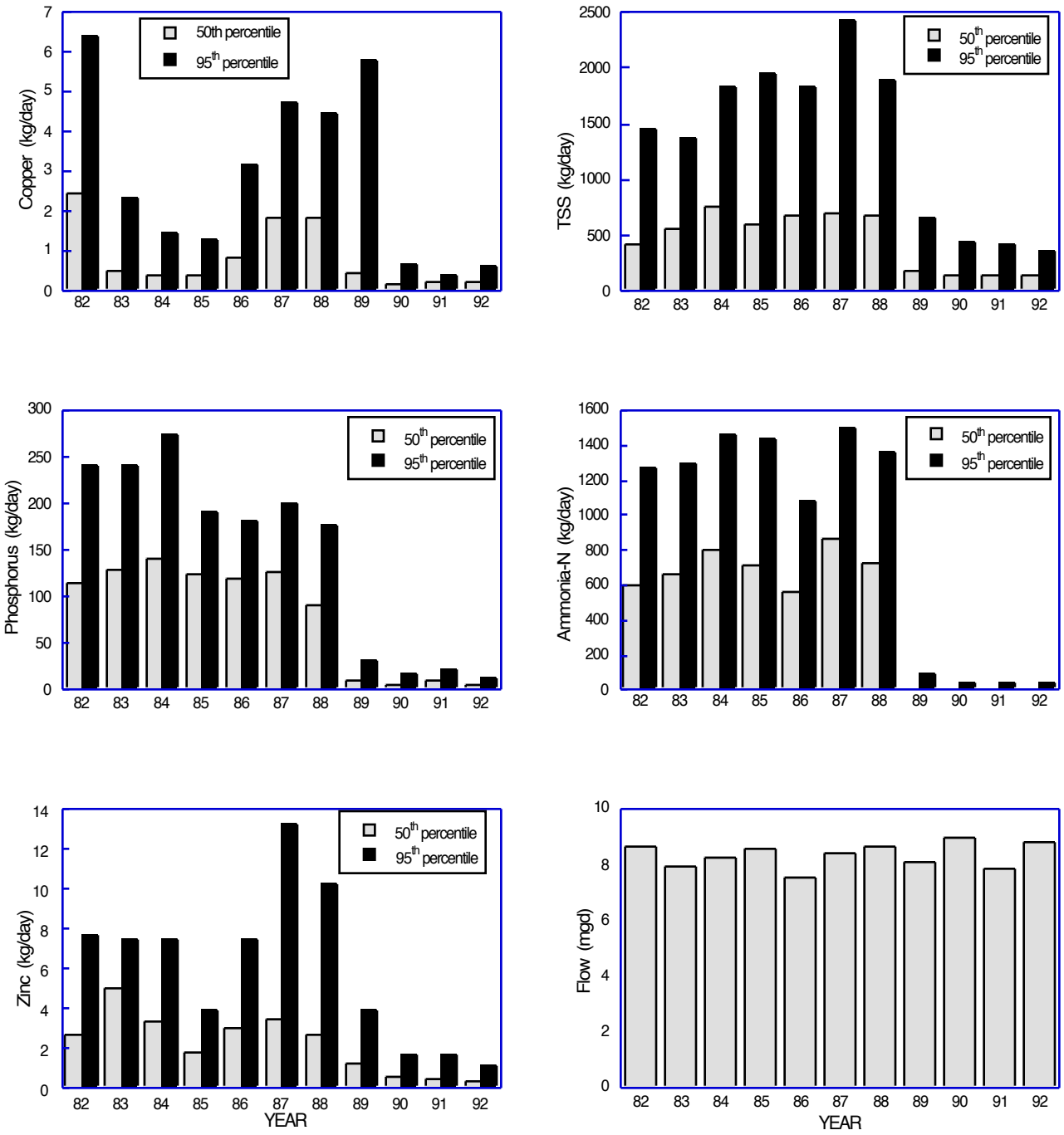


Figure 13. Yearly average loadings for copper, TSS, phosphorus, ammonia-N, and zinc with yearly average flows for the Elyria WWTP 1982 - 1992.

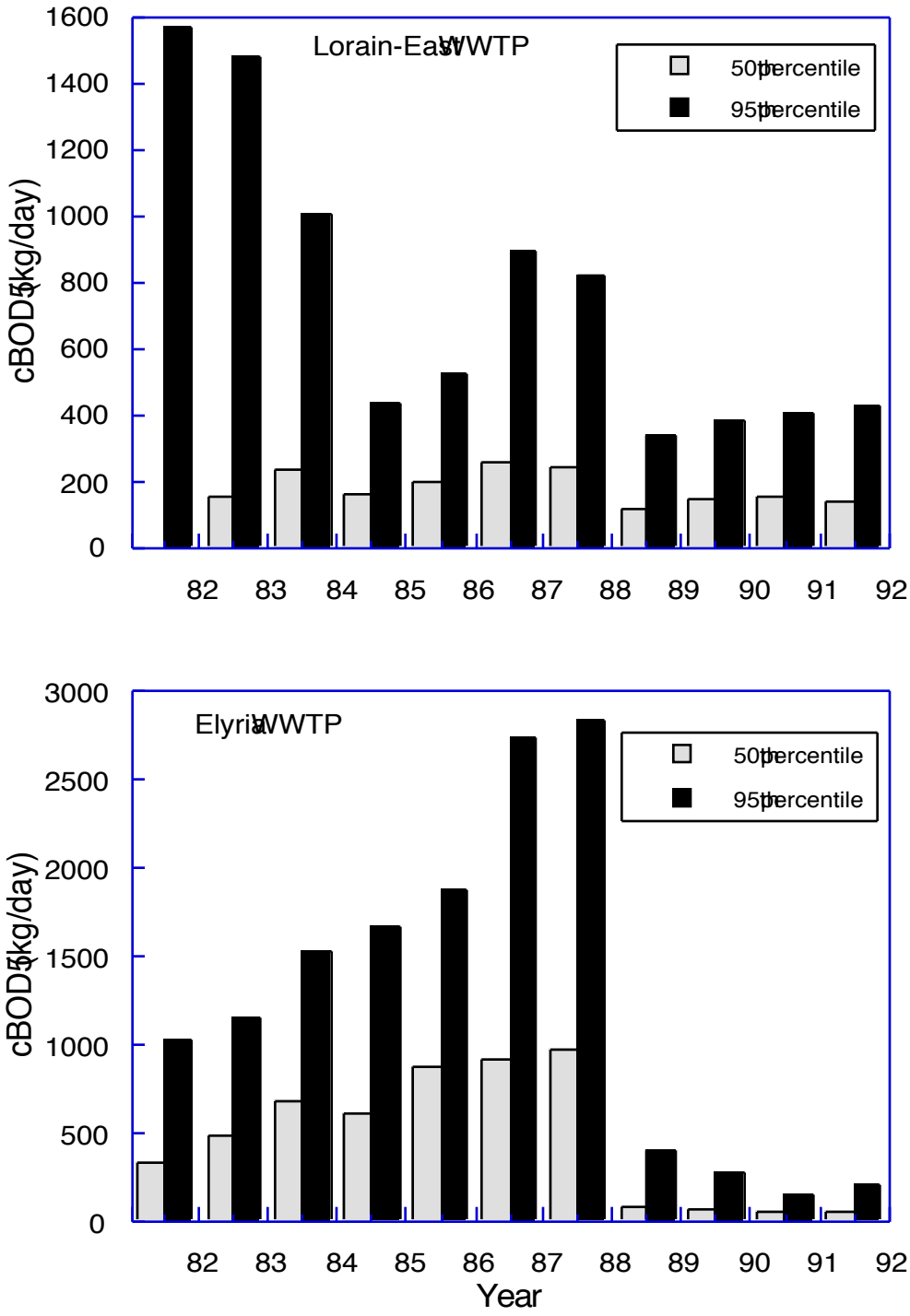


Figure 14. Yearly average $cBOD_5$ for the Lorain East and Elyria WWTPs 1982-1992.

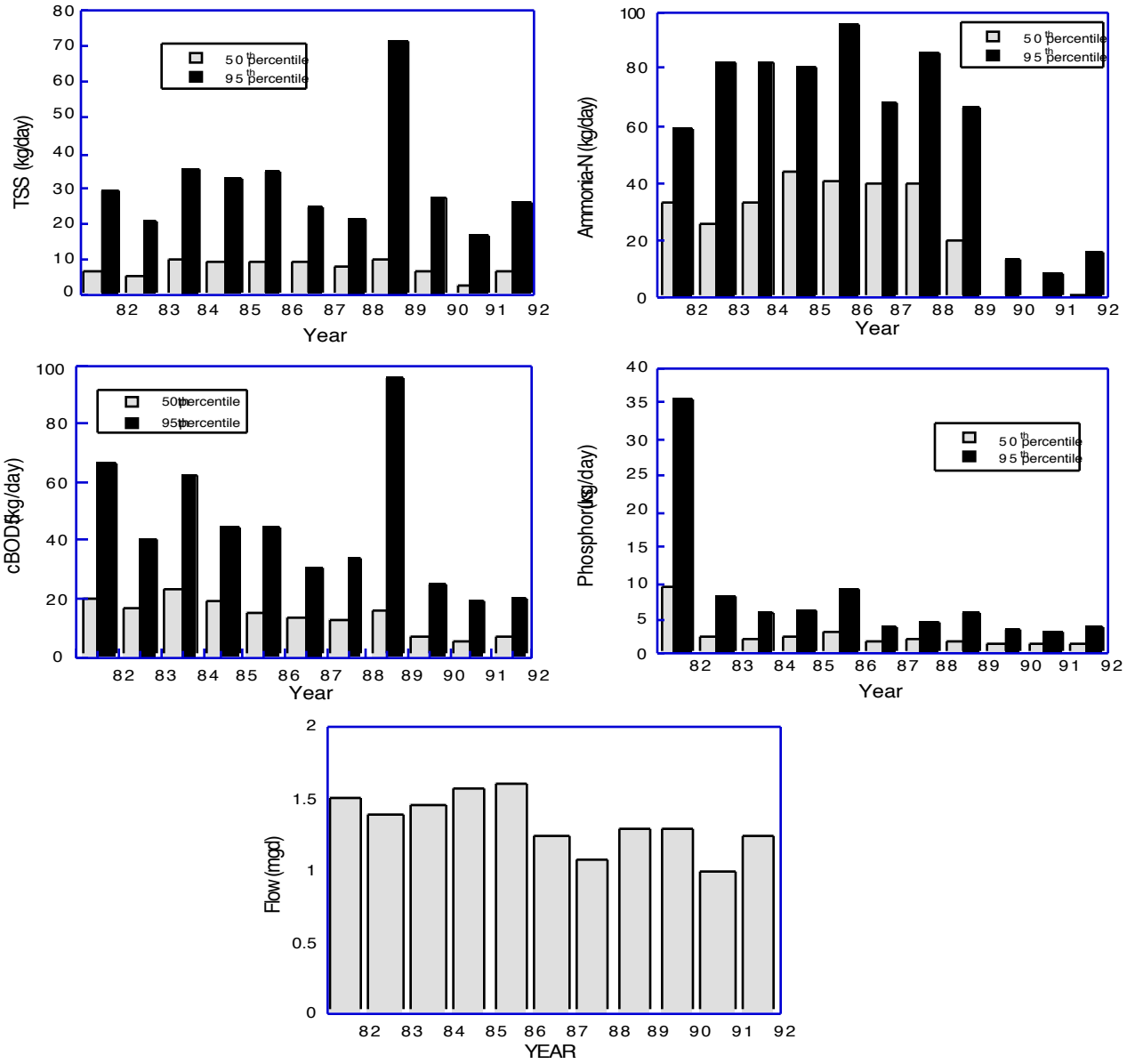


Figure 15. Yearly average loadings of ammonia-N, phosphorus, $cBOD_5$, and TSSwith yearly average flows for the Oberlin WWTP 1982-1992.

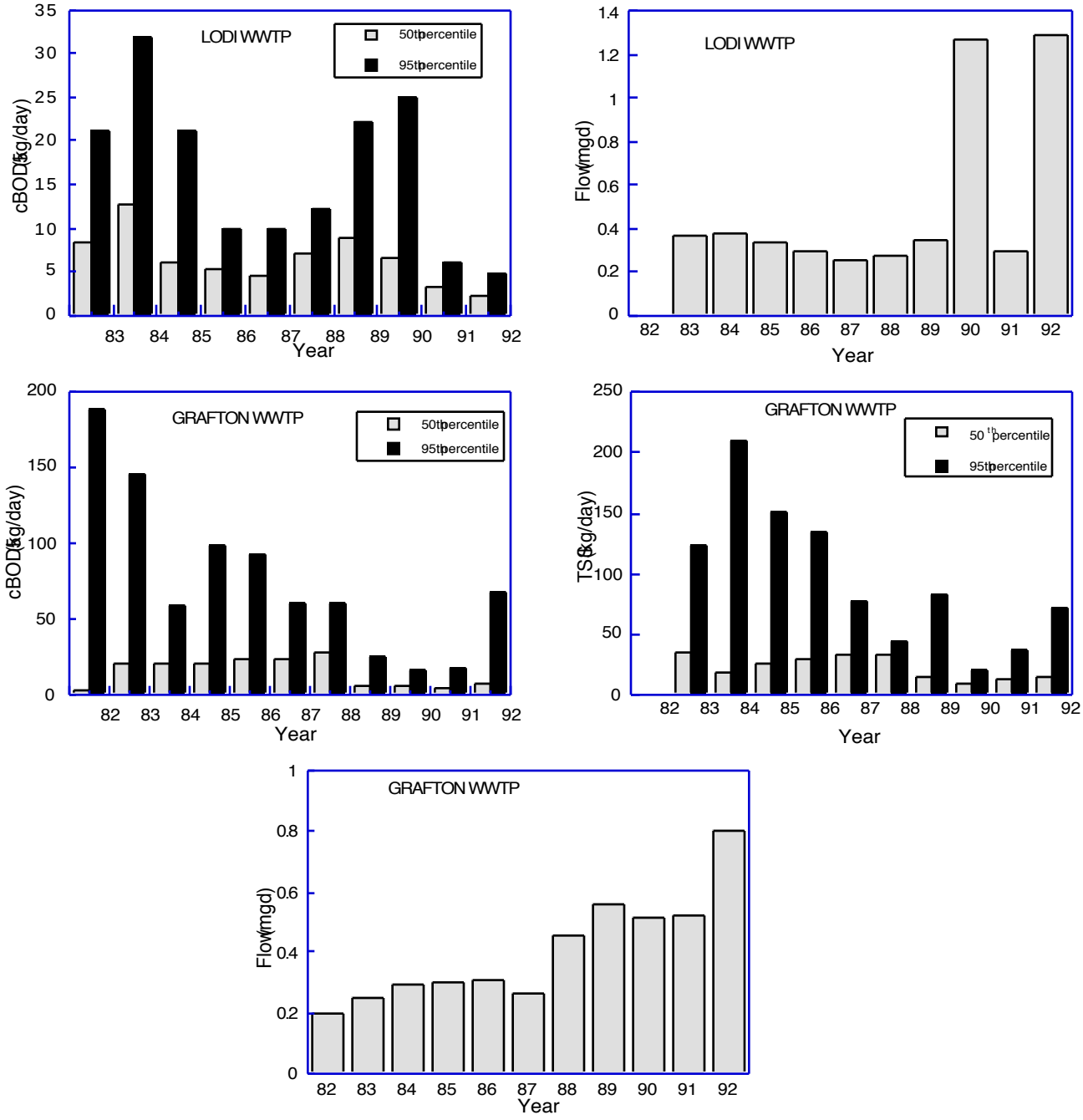


Figure 16. Yearly average loadings for $cBOD_5$ and yearly average flows for the Lodi WWTP and yearly average loadings for $cBOD_5$ and TSS with yearly average flows for the Grafton WWTP 1982-1992.

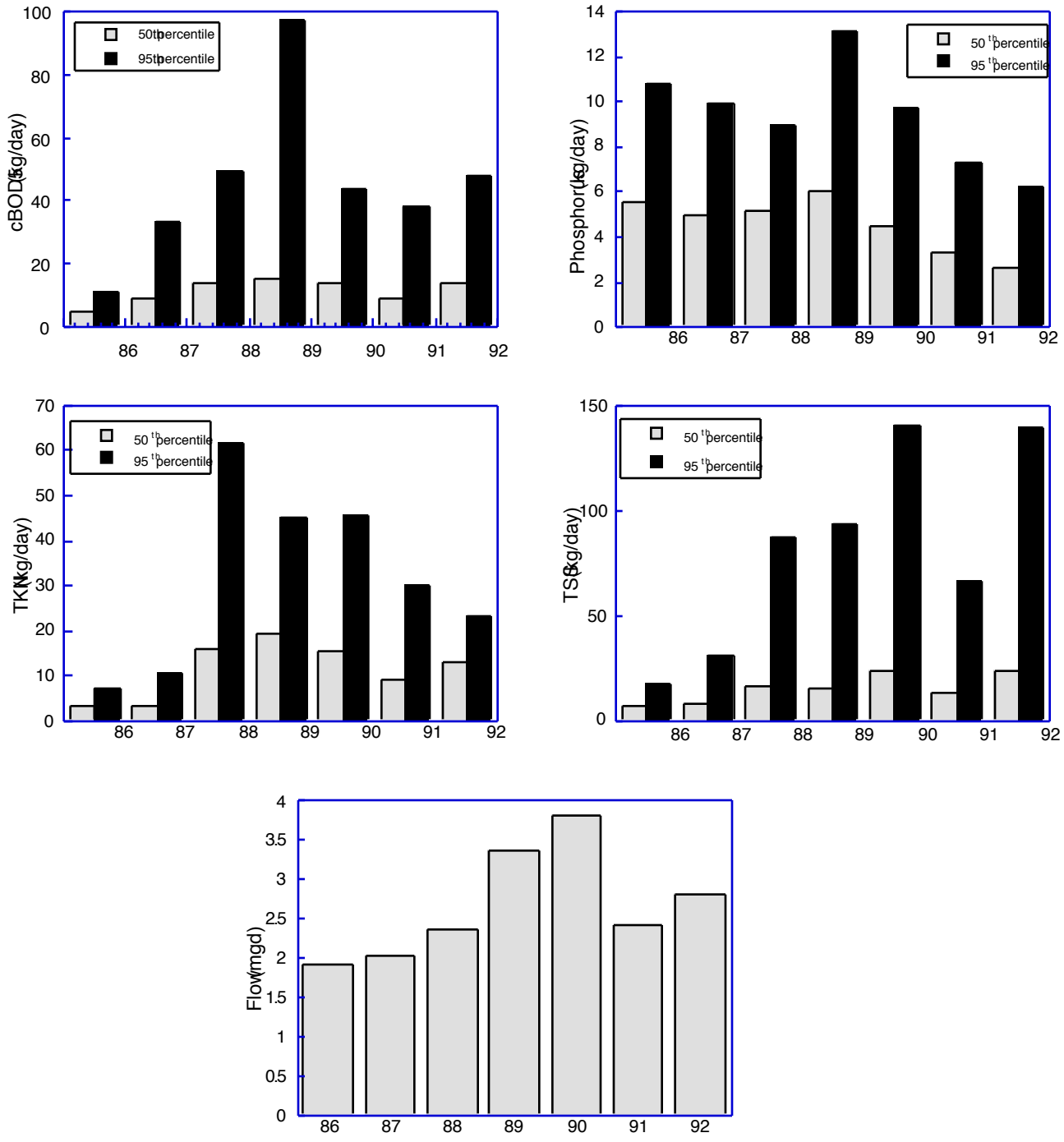


Figure 18. Yearly average loadings for $cBOD_5$, phosphorus,TKN, and TSS with yearly average flows for the French Creek WWTP 1986-1992.

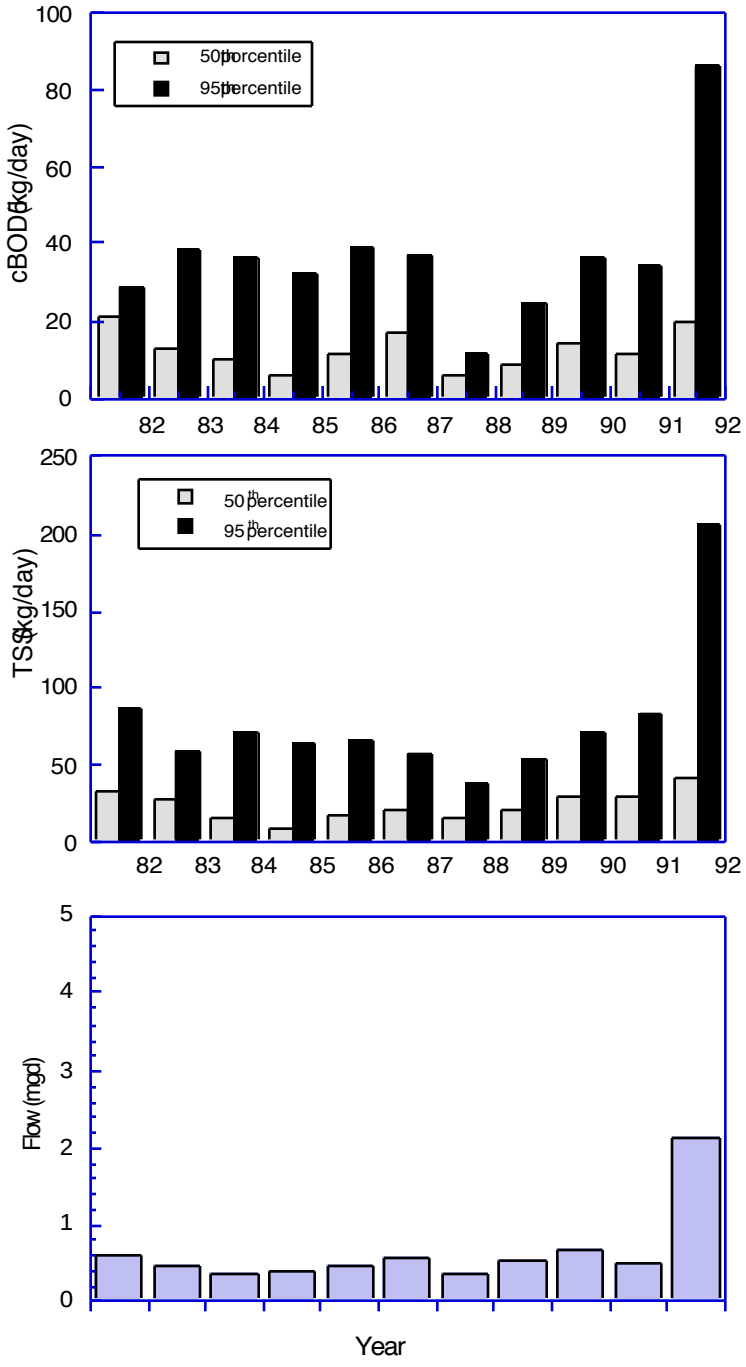


Figure 17. Yearly average loadings for $cBOD_5$ and TSS with yearly average flows for the Wellington WWTP 1982-1992.

### *Physical Habitat for Aquatic Life*

- Overall the fundamental habitat quality in the Black River basin is good. Very little direct channel modification has taken place in the system. The greatest concentration of habitat modification has occurred in the navigation channel (RMs 3.0 - 0.1) where shorelines have been modified with cement and steel sheetpiling seawalls and the channel has been dredged to approximately twenty-five feet. The lowest average QHEI scores are found in the lake affected portions of the river. On the other extreme, the highest quality habitat is found in the West Fork of the East Branch where gradients are high and nonpoint impacts from agriculture are consequently least.

- Most lotic sites in the basin display a well developed riffle/pool complex with a substrate derived primarily from glacial tills (sand, gravel, cobble, and boulders). Some sites have bedrock dominating the substrate (QHEI scores remained above fifty). Other sites, where boats were used to sample, pools were quite long and riffles were very few. These lower gradient areas (East Br. RM 24.6, West Br. RMs19.6 and 13.6) had increased sediment deposition and lower than average habitat quality scores.

- The most prevalent habitat deterioration was a consequence of substrate embededness as a result of runoff from farm fields, especially in the West Branch (RMs 41.7-1.2) and East Branch (RMs 41.5 - 18.9). Most of the tributaries in the upper reaches of the East and West Branch are affected by sediment runoff. Specifically French Creek Rm 3.0, East Fork East Branch Rm 1.6, Willow Creek RM 2.9, Plum Creek Rms 3.3 and 2.9, Wellington Creek RMs 13.1 and 10.9, Charlemont Creek RMs 2.8 and 0.5, and Buck Creek RM 1.0 all were affected by excess sediments. If siltation and embededness factors are removed from the QHEI matrix (Table 6) for these areas, the number of moderate Modified Warmwater Habitat influences is halved. If sediment associated impacts were reduced in the Black River basin, overal habitat quality would be much higher.

Table 5. Average QHEI scores for thirteen relatively homogenous segments of the Black River basin based on sampling conducted during July - October, 1992.

| Sample Location: Segment Description | | | | | |
|---|---|---|---|---|---|
| Upstream River Mile | Downstream River Mile | River Mile | Substrate Embeddedness | Sample Location QHEI | Segment Average QHEI |
| **Segment 1: Buck Creek** | | | | | |
| 1.0 | 1.0 | 1.0 | Moderate | 67.5 | 67.5 |
| **Segment 2: Charlemont Creek** | | | | | |
| 2.8 | 0.5 | 2.8 | Extensive | 70.5 | 72.7 |
| | | 0.7 | Normal | 74.5 | |
| | | 0.5 | Extensive | 73.0 | |
| **Segment 3: Wellington Creek** | | | | | |
| 13.1 | 10.8 | 13.1 | Moderate | 69.0 | 62.0 |
| | | 10.8 | Extensive | 55.0 | |

Table 5. (cont.)

| Sample Location: Segment Description | | | | | |
|---|---|---|---|---|---|
| Upstream River Mile | Downstream River Mile | River Mile | Substrate Embeddedness | Sample Location QHEI | Segment Average QHEI |
| **Segment 6: West Fork East Branch** | | | | | |
| 4.1 | 4.1 | 4.1 | None | 75.0 | 75.0 |
| **Segment 7: East Fork East Branch** | | | | | |
| 2.7 | 1.6 | 2.7 | None | 70.5 | 70.5 |
| | | 1.6 | Moderate | 70.5 | |
| **Segment 8: Willow Creek** | | | | | |
| 2.9 | 2.9 | 2.9 | Moderate | 72.5 | 72.5 |
| **Segment 9: East Branch** | | | | | |
| 41.5 | 0.3 | 41.5 | Extensive | 54.5 | 66.6 |
| | | 36.8 | Moderate | 75.0 | |
| | | 32.5 | Extensive | 60.0 | |
| | | 24.6 | Extensive | 57.0 | |
| | | 18.9 | Moderate | 73.0 | |
| | | 11.3 | Normal | 65.5 | |
| | | 10.1 | Normal | 90.0 | |
| | | 6.0 | Normal | 53.5 | |
| | | 5.2 | Normal | 84.0 | |
| | | 3.0 | None | 63.5 | |
| | | 0.3 | Moderate | 57.0 | |
| **Segment 10: French Creek** | | | | | |
| 3.2 | 0.4 | 3.2 | Moderate | 71.0 | 64.5 |
| | | 0.4 | Normal | 58.0 | |
| **Segment 11: East Branch West Branch confluence to lake affected area** | | | | | |
| 15.0 | 8.8 | 15.0 | Normal | 86.0 | 75.8 |
| | | 11.9 | Normal | 87.5 | |
| | | 10.5 | Normal | 87.0 | |
| | | 8.8 | Normal | 77.0 | |
| **Segment 12: Lake Erie affected area of Black River** | | | | | |
| 5.8 | 0.1 | 5.8 | Normal | 58.0 | 52.3 |
| | | 5.5 | Normal | 58.0 | |
| | | 5.2 | Normal | 49.0 | |
| | | 4.8 | Normal | 59.5 | |
| | | 3.7 | Normal | 42.0 | |
| | | 3.0 | Normal | 57.0 | |
| | | 2.3 | Normal | 55.0 | |
| | | 0.9 | Normal | 52.0 | |
| | | 0.1 | Moderate | 40.0 | |
| **Segment 13: Black River harbor area** | | | | | |
| N/A | N/A | 0.3 | Normal | 59.5 | 57.0 |
| | | 0.2 | Normal | 54.5 | |

Table 6. Qualitiative Habitat Evaluation Index (QHEI) matrix showing modified and warmwater habitat characteristics for the Black River study area, July-September, 1992.

| River Mile | QHEI | Gradient (ft/mile) | WWH Attributes: No Channelization or Recovered | WWH Attributes: Boulder/Cobble/Gravel Substrates | WWH Attributes: Silt Free Substrates | WWH Attributes: Good/Excellent Substrates | WWH Attributes: Moderate/High Sinuosity | WWH Attributes: Extensive/Moderate Cover | WWH Attributes: Fast Current/Eddies | WWH Attributes: Low/Normal Overall Embeddedness | WWH Attributes: Max. Depth > 40 cm | WWH Attributes: Low/No Riffle Embeddedness | Total WWH Attributes | MWH High Influence: Channelized or No Recovery | MWH High Influence: Silt/Muck Substrates | MWH High Influence: Low Sinuosity | MWH High Influence: Sparse/No Cover | MWH High Influence: Max. Depth < 40 cm (WD/HW) | Total H.I. MWH Attributes | MWH Moderate Influence: Recovering Channel | MWH Moderate Influence: Heavy/Moderate Silt Cover | MWH Moderate Influence: Sand Substrates (Boat) | MWH Moderate Influence: Hardpan Substrate Origin | MWH Moderate Influence: Fair/Poor Development | MWH Moderate Influence: Low/No Sinuosity | MWH Moderate Influence: Only 1-2 Cover Types | MWH Moderate Influence: Intermittent & Poor Pools | MWH Moderate Influence: No Fast Current | MWH Moderate Influence: High/Mod. Overall Embeddedness | MWH Moderate Influence: High/Mod. Riffle Embeddedness | MWH Moderate Influence: No Riffle | Total M.I. MWH Attributes | MWH H.L./WWH Ratio | MWH M.L./WWH Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (20-001) Black River | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 92 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 15.0 | **86.0** | 3.70 | ■■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | 9 | | | | | | 0 | | | | | | | | | | | | | | 0 | 0.10 | 0.10 |
| 11.9 | **87.5** | 5.62 | ■■ | | ■ | ■ | ■ | ■ | ■ | ■ | | | 8 | | | | | | 0 | | | | | | | | | | | | ▲ | | 1 | 0.11 | 0.22 |
| 10.5 | **87.0** | 5.62 | ■■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | 9 | | | | | | 0 | | | ▲ | | | | | | | | | | | 1 | 0.10 | 0.20 |
| 8.8 | **77.0** | 4.00 | ■■ | | ■ | ■ | ■ | ■ | ■ | ■ | | | 8 | | | | | | 0 | | | | | | | | | | | | ▲ | | 1 | 0.11 | 0.22 |
| 5.8 | **53.0** | 0.10 | ■ | | ■ | | ■ | | | ■ | | | 4 | | | | | | 0 | | | ▲ | ▲ | | | | ▲▲ | | ▲ | | | | 5 | 0.20 | 1.20 |
| 5.5 | **58.0** | 0.10 | ■ | | | ■ | ■ | | | ■ | ■ | | 5 | | | | | | 0 | | | ▲▲ | | | | | ▲ | | ▲ | | | | 4 | 0.17 | 0.83 |
| 5.2 | **49.0** | 0.10 | ■ | | | | ■ | | | ■ | ■ | | 4 | | | | | | 0 | | | ▲▲▲ | | | | | ▲ | | ▲ | | | | 5 | 0.20 | 1.20 |
| 4.8 | **59.5** | 0.10 | ■ | | ■ | ■ | ■ | | | ■ | ■ | | 6 | | | | | | 0 | | | ▲ | | | | | ▲ | | ▲ | | | | 3 | 0.14 | 0.57 |
| 3.0 | **57.0** | 0.10 | ■ | | ■ | ■ | ■ | | | ■ | ■ | | 6 | | | | | | 0 | | | ▲ | | | | | ▲ | | ▲ | | | | 3 | 0.14 | 0.57 |
| 2.3 | **55.0** | 0.10 | ■ | | ■ | | ■ | | | ■ | ■ | | 5 | | | | | | 0 | | | ▲ | ▲ | | | | ▲ | | ▲ | | | | 4 | 0.17 | 0.83 |
| 0.9 | **52.0** | 0.10 | ■■ | | | | ■ | | | ■ | ■ | | 5 | | | | | | 0 | | | ▲▲▲ | | | | | ▲ | | ▲ | | | | 5 | 0.17 | 1.00 |
| 0.3 | **59.5** | 0.10 | ■■■ | | | | ■ | | | | ■ | | 5 | | | | | | 0 | | | | ▲▲ | | | | ▲▲ | | ▲ | | | | 5 | 0.17 | 1.00 |
| 0.2 | **54.5** | 0.10 | ■ | ■ | | | ■ | | | | ■ | | 4 | | | | | | 0 | | | | ▲▲▲ | ▲ | | | ▲▲ | | ▲ | | | | 6 | 0.20 | 1.40 |
| 0.1 | **40.0** | 0.10 | | ■ | | | ■ | | | ■ | ■ | | 4 | ● | | | | | 1 | | | | ▲▲▲ | ▲ | | | ▲ | | ▲ | | | | 5 | 0.40 | 1.40 |
| (20-002) French Creek | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 92 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3.0 | **71.0** | 6.85 | ■■ | | ■ | ■ | ■ | ■ | | | ■ | | 7 | | | | | | 0 | | ▲ | | | | | | | | | ▲▲ | | | 3 | 0.13 | 0.50 |
| 0.4 | **58.0** | 0.10 | ■ | | | ■ | ■ | | | ■ | ■ | | 5 | | | | | | 0 | | | ▲▲ | | | | | ▲ | | ▲ | | | | 4 | 0.17 | 0.83 |
| (20-003) Beaver Creek | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 92 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11.0 | **61.0** | 15.15 | ■■ | | | | ■ | | | ■ | ■ | ■ | 6 | ● | ● | ● | | | 3 | | | | ▲▲ | | | | | ▲ | | | | | | 3 | 0.57 | 1.00 |
| 7.0 | **71.5** | 33.33 | ■■ | | ■ | ■ | ■ | ■ | ■ | ■ | | | 9 | | | ● | | | 1 | | | | | | | | | ▲ | | | | | 1 | 0.20 | 0.30 |
| 4.7 | **70.5** | 11.11 | ■■ | | | ■ | ■ | | | ■ | ■ | ■ | 7 | | | ● | | | 1 | | | | ▲ | | | | | ▲ | | | | | 2 | 0.25 | 0.50 |
| 3.0 | **68.5** | 13.16 | ■■ | | | | ■ | ■ | ■ | ■ | | | 6 | | | ● | | | 1 | | ▲ | | ▲▲ | | | | | | | ▲ | | | 4 | 0.29 | 0.86 |
| 1.8 | **70.0** | 7.35 | ■■ | | | ■ | ■ | ■ | ■ | ■ | ■ | | 8 | | | | | | 0 | | ▲ | | ▲ | | | | | | | | | | 2 | 0.11 | 0.33 |
| (20-010) East Branch Black River | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 92 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 41.5 | **54.5** | 3.34 | ■■ | | | ■ | ■ | ■ | | | ■ | | 6 | | | | | | 0 | | ▲ | | ▲ | | | | | | | ▲ | ▲ | ▲ | 5 | 0.14 | 0.86 |

Table 6. Qualitiative Habitat Evaluation Index (QHEI) matrix showing modified and warmwater habitat characteristics for the Black River study area, July-September, 1992.

| River Mile | QHEI | Gradient (ft/mile) | WWH Attributes: No Channelization or Recovered | Boulder/Cobble/Gravel Substrates | Silt Free Substrates | Good/Excellent Substrates | Moderate/High Sinuosity | Extensive/Moderate Cover | Fast Current/Eddies | Low/Normal Overall Embeddedness | Max. Depth > 40 cm | Low/No Riffle Embeddedness | Total WWH Attributes | MWH *High Influence*: Channelized or No Recovery | Silt/Muck Substrates | Low Sinuosity | Sparse/No Cover | Max. Depth < 40 cm (WD/HW) | Total H.I. MWH Attributes | MWH *Moderate Influence*: Recovering Channel | Heavy/Moderate Silt Cover | Sand Substrates (Boat) | Hardpan Substrate Origin | Fair/Poor Development | Low/No Sinuosity | Only 1-2 Cover Types | Intermittent & Poor Pools | No Fast Current | High/Mod. Overall Embeddedness | High/Mod. Riffle Embeddedness | No Riffle | Total M.I. MWH Attributes | MWH H.L./WWH Ratio | MWH M.L./WWH Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (20-010) East Branch Black River | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 92 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 36.8 | **75.0** | 3.05 | ■ | ■ | | ■ | ■ | ■ | ■ | | ■ | ■ | 8 | | | | | | 0 | ▲ | | | | | | | | ▲ | | | 2 | 0.11 | 0.33 |
| 32.5 | **60.0** | 1.55 | ■ | ■ | | | ■ | ■ | ■ | | ■ | | 6 | | | | | | 0 | ▲ | | ▲ | | | | | | ▲ | ▲ | ▲ | 5 | 0.14 | 0.86 |
| 24.6 | **57.0** | 1.95 | ■ | ■ | | | ■ | ■ | ■ | | ■ | | 6 | | | | | | 0 | ▲ | | ▲ | | ▲ | | | | ▲ | ▲ | | 5 | 0.14 | 0.86 |
| 18.9 | **73.0** | 2.98 | ■ | ■ | | ■ | ■ | ■ | ■ | | ■ | | 7 | | | | | | 0 | ▲ | ▲ | | | | | | | ▲ | ▲ | | 4 | 0.13 | 0.63 |
| 11.3 | **65.5** | 12.82 | ■ | ■ | | | | ■ | ■ | ■ | ■ | ■ | 7 | | | | | | 0 | | | ▲ | ▲ | ▲ | | | | | | | 3 | 0.13 | 0.50 |
| 10.1 | **90.0** | 12.82 | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | 9 | | | | | | 0 | | | | | | | | | | | | 0 | 0.10 | 0.10 |
| 6.0 | **53.5** | 8.33 | ■ | | | | | ■ | ■ | ■ | ■ | | 5 | | | ● | | | 1 | | | ▲ | ▲ | ▲ | | | | | | | 3 | 0.33 | 0.83 |
| 5.2 | **84.0** | 2.44 | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | 9 | | | | | | 0 | | | | | | | | | | | | 0 | 0.10 | 0.10 |
| 3.0 | **63.5** | 13.51 | ■ | ■ | ■ | | | ■ | | ■ | ■ | ■ | 7 | | | | | | 0 | | | ▲ | ▲ | ▲ | | ▲ | | | | | 4 | 0.13 | 0.63 |
| 0.3 | **57.0** | 21.74 | ■ | | | | ■ | ■ | | | | ■ | 4 | | | | | | 0 | ▲ | | ▲ | | | | | | ▲ | ▲ | | 5 | 0.20 | 1.20 |
| (20-014) East Fork East Branch Black River | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 92 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.7 | **71.5** | 30.30 | ■ | ■ | ■ | ■ | | ■ | ■ | ■ | | ■ | 8 | | | ● | | ● | 2 | | | | ▲ | ▲ | | | | | | | 2 | 0.33 | 0.56 |
| 1.6 | **70.5** | 21.90 | ■ | ■ | | ■ | ■ | ■ | ■ | | ■ | | 7 | | | | | | 0 | ▲ | ▲ | | | | | | ▲ | ▲ | ▲ | | 5 | 0.13 | 0.75 |
| (20-015) West Fork East Branch Black River | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 92 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4.1 | **75.0** | 18.52 | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | 10 | | | | | | 0 | | | | | ▲ | | | | | | | 1 | 0.09 | 0.18 |
| (20-018) Willow Creek | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 92 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.9 | **72.5** | 11.63 | ■ | ■ | | ■ | ■ | ■ | ■ | | ■ | | 8 | | ● | | | | 1 | ▲ | ▲ | | | | | | | ▲ | ▲ | | 4 | 0.22 | 0.67 |
| (20-020) West Branch Black River | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 92 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 41.7 | **58.0** | 8.47 | ■ | | | ■ | ■ | | | | ■ | | 4 | | | ● | | | 1 | ▲ | | ▲ | | | | | | ▲ | ▲ | ▲ | 6 | 0.40 | 1.60 |
| 33.3 | **84.0** | 14.71 | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | ■ | ■ | 9 | | | | | | 0 | | ▲ | | | | | | | | | | 1 | 0.10 | 0.20 |
| 25.3 | **49.5** | 3.62 | ■ | ■ | | | ■ | | | | ■ | | 4 | | | ● | | | 1 | ▲ | ▲ | ▲ | | | | | | ▲ | ▲ | ▲ | 7 | 0.40 | 1.80 |
| 19.6 | **64.0** | 2.92 | ■ | ■ | | ■ | ■ | | | | ■ | | 5 | | | | | | 0 | ▲ | ▲ | ▲ | | | | | | ▲ | ▲ | | 6 | 0.17 | 1.17 |
| 13.6 | **51.5** | 1.93 | ■ | | | ■ | ■ | | | | ■ | | 4 | | ● | | | | 1 | ▲ | | ▲ | | | | | | ▲ | ▲ | | 5 | 0.40 | 1.40 |
| 4.1 | **70.0** | 3.52 | ■ | ■ | ■ | | ■ | ■ | ■ | ■ | ■ | | 9 | | | | | | 0 | | | | ▲ | | | | | | | | 1 | 0.10 | 0.20 |

Table 6. Qualitiative Habitat Evaluation Index (QHEI) matrix showing modified and warmwater habitat characteristics for the Black River study area, July-September, 1992.

| | | | WWH Attributes | | | | | | | | | | MWH Attributes | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | *High Influence* | | | | | | | | | *Moderate Influence* | | | | | | | | | | | | | |
| Key QHEI Components | | | No Channelization or Recovered | Boulder/Cobble/Gravel Substrates | Silt Free Substrates | Good/Excellent Substrates | Moderate/High Sinuosity | Extensive/Moderate Cover | Fast Current/Eddies | Low/Normal Overall Embeddedness | Max. Depth > 40 cm | Low/No Riffle Embeddedness | **Total WWH Attributes** | Channelized or No Recovery | Silt/Muck Substrates | Low Sinuosity | Sparse/No Cover | Max. Depth < 40 cm (WD/HW) | **Total H.I. MWH Attributes** | Recovering Channel | Heavy/Moderate Silt Cover | Sand Substrates (Boat) | Hardpan Substrate Origin | Fair/Poor Development | Low/No Sinuosity | Only 1-2 Cover Types | Intermittent & Poor Pools | No Fast Current | High/Mod. Overall Embeddedness | High/Mod. Riffle Embeddedness | No Riffle | **Total M.I. MWH Attributes** | **MWH HL/WWH Ratio** | **MWH ML/WWH Ratio** |
| River Mile | QHEI | Gradient (ft/mile) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| (20-020) West Branch Black River | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 92 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.2 | **69.5** | 7.14 | ■■ | | | ■ | | | | ■ | | | 4 | | | | | | 0 | | ▲ | | ▲▲ | | | ▲▲▲ | ▲ | | | | 6 | 0.20 | 1.40 |
| (20-021) Plum Creek | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 92 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7.0 | **70.0** | 15.15 | ■■ | ■ | | ■ | | | ■■ | ■ | | | 7 | ● | | | | | 1 | | | | ▲ | | | ▲ | | | | | 2 | 0.25 | 0.50 |
| 3.3 | **69.5** | 9.43 | ■■ | ■ | ■■ | | | | | ■ | | | 6 | | | | | | 0 | | ▲ | | | | | ▲▲▲ | | | | | 4 | 0.14 | 0.71 |
| 2.9 | **57.0** | 10.42 | ■■ | | ■ | ■■ | | | | ■ | | | 6 | ● | | | | | 1 | | ▲ | | ▲ | | | ▲▲▲ | | | | | 5 | 0.29 | 1.00 |
| 0.9 | **87.5** | 17.24 | ■■ | ■ | ■■ | ■ | ■ | ■ | ■ | ■ | | | 9 | | | | | | 0 | | | ▲ | | | | | | | | | 1 | 0.10 | 0.20 |
| (20-023) Wellington Creek | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 92 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13.1 | **69.0** | 7.35 | ■■ | ■ | ■■ | ■ | | | | ■ | | | 7 | | | | | | 0 | | ▲ | ▲ | | | | ▲▲ | | | | | 4 | 0.13 | 0.63 |
| 10.8 | **55.0** | 8.33 | ■■ | | ■ | | | | | ■ | | | 4 | ● | | | | | 1 | | ▲ | | ▲ | | | ▲▲▲ | | | | | 5 | 0.40 | 1.40 |
| (20-024) Charlemont Creek | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 92 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2.8 | **70.5** | 16.13 | ■ | | ■■ | ■ | | | | ■ | | | 5 | | | | | | 0 | | ▲ | | | | | ▲▲▲ | | | | | 4 | 0.17 | 0.83 |
| 0.7 | **74.5** | 8.93 | ■■ | | ■■ | ■ | ■ | ■ | ■ | ■ | | | 9 | | | | | | 0 | | | | | | | | ▲ | | | | 1 | 0.10 | 0.20 |
| 0.5 | **73.0** | 8.93 | ■■ | | ■■ | ■ | | | | ■ | | | 7 | | | | | | 0 | | ▲ | ▲ | | | | ▲▲ | | | | | 4 | 0.13 | 0.63 |
| (20-025) Buck Creek | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Year: 92 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1.0 | **67.5** | 13.70 | ■■ | | ■■ | ■ | ■ | ■ | | ■ | | | 7 | ● | | | | | 1 | | ▲ | ▲ | | | | ▲▲ | | | | | 4 | 0.25 | 0.75 |

***Macroinvertebrate Community*** (Table 7, Figures 19 &20)

*Black River Mainstem*

- The macroinvertebrate community was evaluated at 14 sites on the Black River mainstem from RM 14.4 to 0.1. Communities in the free flowing segment (RM 14.4-8.3) upstream from the Lake Erie estuary were evaluated as good except for the site in the Elyria WWTP mixing zone (RM 10.6). Within the Elyria WWTP mixing zone, the community declined to the fair range due primarily to an increase in oligochaetes, a pollution tolerant group, and a decrease in the diversity of mayflies, a pollution sensitive group. This community shift was an indication of organic enrichment. Acute toxicity was not indicated by the results.

- Communities within the Lake Erie estuary demonstrated a gradual decline in ICI scores from the upstream sites which still had detectable current to farther downstream which was wider, deeper, and without detectable current. Macroinvertebrate communities within the Lake Erie affected area are evaluated using an interim ICI estuary criterion of 22. The communities sampled at RMs 5.6 and 5.3 retained a semblance of the riverine fauna present upstream. The declines in the ICI metric scores were best attributed to a gradual increase in lake effect (*i.e.*, lessening of current, more monotonous habitat conditions). There were no noticeable impacts from adjacent landfills or the USS/KOBE Steel 006 discharge.

- The macroinvertebrate community collected within the USS/KOBE 001 discharge mixing zone (RM 5.0) reflected the continued decline associated with the lake effect. The ICI at this site scored at the interim ICI estuary criterion of 22. The community response was not indicative of acute toxicity from the 001 discharge. However, this is the first estuary site where oil was observed in the natural substrates. Oil was evident at nearly all of the remaining downstream stations. The community located immediately downstream from the 001 discharge was similar to that collected in the mixing zone.

- The remaining two sites upstream from the turning basin scored just below (ICI=20 at RM 3.6) and at (ICI=22 at RM 3.0) the interim ICI estuary criterion. These are the last sites that have remnants of the upstream riverine fauna. The communities were predominated by the midge genus *Glyptotendipes* and oligochaetes (aquatic segmented worms); both were well adapted to the near lentic conditions prevalent at these sites.

- The communities downstream from the turning basin scored well below the interim ICI estuary criterion (ICI=12 at RM 1.1 and 14 at RMs 2.0 and 0.1) and were evaluated as fair. All sites were predominated by oligochaetes. The station downstream from the Lorain WWTP (RM 0.1) supported very high numbers of oligochaetes (*i.e.* 24,193/ft.$^2$) which was probably due to increased organic enrichment from the WWTP effluent. The collected community did not indicate a problem with acute toxicity from this discharge.

- Zebra mussels (*Dreissenapolymorpha*) were present in the Black River as far upstream as RM 5.6 where only a few individuals were collected. They were scarce in the upper part of the estuary until RM 3.0 where they became more common and remained common at all sampling stations downstream. They reach their highest numbers on artificial substrates (111/ft$^2$) at RM 0.1.

*French Creek*

- The community upstream from the French Creek WWTP (RM 2.8) was in the fair range (ICI=22 at RM 3.2). Mayfly and caddisfly diversity and density were low with midges and oligochaetes predominant. The collected community was of considerable lesser quality than

the one present in 1982. This decline may have been due to the construction of an upstream fly ash disposal site operated by Cleveland Electric Illuminating. The community downstream from the North Ridgeville WWTP improved to the marginally good range (ICI=32 at RM 0.5). The WWTP discharge did not have an adverse impact on this site.

*West Branch Black River*

- Macroinvertebrate communities were evaluated at five locations on the W. Br. Black River from RMs 41.7 to 0.1. The communities gradually declined from exceptional at RM 41.7 (ICI=54) to fair at RMs 4.2 and 0.1 (ICIs=22 and 28, respectively). The decline to the good range at RM 25.3 (ICI=38) may have been due to a combination of lower gradient, nonpoint runoff, and sedimentation. Further declines in the lower reaches of the West Branch were most likely due to on-site sewer systems, nonpoint runoff and CSOs associated with increased urbanization.

*Buck Creek*

- The macroinvertebrate community in Buck Creek at RM 1.0 was evaluated using qualitative methods. Mayfly and caddisfly diversity was relatively low (EPT=6) while the QCTV (35.6) was just below the lower 25th percentile of sites in the EOLP ecoregion that attain the WWH ICI criterion (QCTV = 35.7). The site was evaluated as marginally good.

*Charlemont Creek*

- Macroinvertebrate communities qualitatively collected upstream (RM 0.6) and downstream (RM 0.4) from the Wellington WWTP tributary were evaluated as marginally good. The communities at both sites may have been limited by nonpoint source runoff. Field observations at the downstream site noted increases in attached algae, midges, and oligochaetes which may have been due to organic enrichment from the Wellington WWTP. However, there was no significant change in macroinvertebrate community performance from the upstream condition.

*Wellington Creek*

- Two sites qualitatively collected on Wellington Creek had fair macroinvertebrate communities with a low diversity of mayflies and caddisflies (EPTs = 4 at RM 13.1 and 3 at RM 10.8) and low QCTVs (27.2 at RM 13.1 and 30.0 at RM 10.8). The community was assessed as fair at both sites, but no additional impact was detected downstream from Wellington. Nonpoint source runoff was the probable cause of the impaired communities.

*Plum Creek*

- Macroinvertebrate communities evaluated in Plum Creek ranged from fair upstream from Oberlin (RM 7.0) to very good (ICI=44 at RM 0.8) 2.2 miles downstream from the Oberlin WWTP discharge at RM 3.0. The upstream site was not very diverse with 27 taxa collected by qualitative methods including only two taxa of mayflies and caddisflies. This site was limited by periodic intermittent stream flow conditions and possibly nonpoint source runoff. The WWTP discharge did not have an additional adverse impact on the community. The ICI increased to 36 (good) downstream from the discharge at RM 2.9 compared to 34 (good) immediately upstream at RM 3.1.

*East Branch Black River*

- Macroinvertebrate communities were evaluated at nine locations on the E. Br. Black River from RMs 41.5 to 0.1. The communities were very good or exceptional at all stations except the two sites downstream from the Grafton WWTP (RM 11.2). The stonefly species *Acroneuriaevoluta* was present at the farthest upstream site. These relatively large and long-lived predators are usually found only in high quality streams. The community 0.4 mile

downstream from the Grafton WWTP was adversely impacted by the WWTP discharge. The ICI score declined to 30 (marginally good) which was significantly less than the score of 46 (exceptional) at RM 11.3, immediately upstream from the WWTP. The changes in the ICI were due to declines in the diversity of mayflies and caddisflies, a drop in the density of caddisflies, and an increase in pollution tolerant oligochaetes. Other evidence of an impact at this site was burned gills on hydropsychid caddisflies. This problem has been associated with chlorine toxicity from WWTPs in New York (Simpson 1980). The community recovered to conditions similar to those observed upstream at RM 5.4 (ICI=48). Septic tank discharges were observed entering the stream at RMs 6.0 and 3.0. The relatively high number of oligochaetes a pollution tolerant group, at RM 3.0 was probably due to organic enrichment from these on-site sewage systems.

*East Fork East Branch Black River*

- The macroinvertebrate community was evaluated upstream from Lodi (RM 2.9) and downstream from the Lodi WWTP (RM 1.7) at RM 1.5. The upstream station had an exceptional community (ICI=46) and consisted of a number of coolwater macroinvertebrate taxa including the caddisfly *Diplectrona modesta* and the midge taxa *Parachaetocladius*, *Parametriocnemus* , *Polypedilum (P.) albicorne*, *Polypedilum (P.) aviceps*, and *Paratanytarsus n. sp*. 1. These coolwater taxa reflected the influence of substantial groundwater recharge in this part of the stream. Also present at this site was the pollution sensitive stonefly species *Acroneuria evoluta*. The community sampled 0.2 mile downstream from the Lodi WWTP declined to the good range (ICI=40). Minor structural and compositional changes were attributed to organic enrichment from the WWTP. The stonefly *Acroneuria evoluta* was still present at this site; however, one specimen had burned gills a possible indication of chlorine contamination.

*West Fork East Branch Black River*

- The macroinvertebrate community in the W. Fk. E. Br. Black River (RM 4.2) was evaluated as very good. Seventeen EPT taxa were qualitatively collected at this site including the stonefly species *Acroneuria evoluta*.

*Willow Creek*

- The macroinvertebrate community qualitatively collected in Willow Creek (RM 2.8) was evaluated as marginally good. Forty taxa were collected including seven mayfly and caddisfly species; none of the taxa collected are particularly pollution sensitive. The community sampled reflected an impact from nonpoint source pollution and possibly the Ross Environmental Services incinerator.

Table 7. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the Black River study area, August 12 to October 6, 1992.

| | | *Quantitative Evaluation* | | | | | |
|---|---|---|---|---|---|---|---|
| ***Stream*** River Mile | Density ( /ft²) | Quant. Taxa | Qual. Taxa | Qual. EPT[a] | QCTV[b] | ICI | Evaluation |
| ***Black River*** | | | | | | | |
| 14.4 | 306 | 41 | 32 | 10 | 35.3 | 40 | Good |
| 11.2 | Qual. Only | NA | 32 | 9 | 37.5 | NA | Marg. Good |
| 10.6 (Mix Zone) | 489 | 40 | 31 | 9 | 32.0 | 28 | Fair |
| 10.5 | 471 | 40 | 41 | 10 | 35.8 | 40 | Good |
| 8.3 | 568 | 51 | 31 | 11 | 37.7 | 40 | Good |
| ***Black River Estuary*** | | | | | | | |
| 5.6 | 617 | 46 | 18 | 2 | 30.3 | 34 | Good |
| 5.3 | 854 | 48 | 17 | 3 | 30.1 | 28 | Good |
| 5.0 (Mix Zone) | 473 | 30 | 11 | 0 | 20.2 | 22 | Good |
| 4.8 | 1067 | 42 | 18 | 1 | 31.9 | 24 | Good |
| 3.6 | 2311 | 28 | 28 | 2 | 30.3 | 20[ns] | Marg. Good |
| 3.0 | 1708 | 33 | 24 | 3 | 32.7 | 22 | Good |
| 2.0 | 1061 | 21 | 11 | 0 | 23.0 | 14* | Fair |
| 1.1 | 952 | 25 | 21 | 1 | 21.9 | 12* | Fair |
| 0.1 | 5238 | 27 | 10 | 1 | 22.5 | 14* | Fair |
| ***W. Br. Black River*** | | | | | | | |
| 41.7 | 297 | 51 | 50 | 15 | 40.5 | 54 | Exceptional |
| 25.3 | 447 | 40 | 41 | 9 | 37.4 | 38 | Good |
| 13.5 | Qual. Only | NA | 37 | 9 | 37.8 | NA | Marg. Good |
| 4.2 | 487 | 33 | 34 | 5 | 32.1 | 22* | Fair |
| 0.1 | 384 | 43 | 22 | 7 | 34.0 | 28* | Fair |
| ***Plum Creek*** | | | | | | | |
| 7.0 | Qual. Only | NA | 27 | 2 | 31.4 | NA | Fair |
| 3.1 | 401 | 42 | 28 | 4 | 31.4 | 34 | Good |
| 2.9 | 288 | 39 | 23 | 3 | 30.3 | 36 | Good |
| 0.8 | 255 | 33 | 33 | 8 | 34.6 | 44 | V. Good |
| ***E. Fk. E. Br. Black River*** | | | | | | | |
| 2.9 | 256 | 46 | 42 | 15 | 38.9 | 46 | Exceptional |
| 1.5 | 526 | 46 | 44 | 10 | 36.3 | 40 | Good |
| ***E. Br. Black River*** | | | | | | | |
| 41.5 | 908 | 46 | 49 | 17 | 38.8 | 48 | Exceptional |
| 32.3 | 584 | 55 | 42 | 10 | 37.4 | 42 | V. Good |

Table 7. (cont.)

| ***Stream*** River Mile | Density ( /ft²) | Quant. Taxa | Qual. Taxa | Qual. EPT[a] | QCTV[b] | ICI | Evaluation |
|---|---|---|---|---|---|---|---|
| | | | ***Quantitative Evaluation*** | | | | |
| 18.9 | 510 | 48 | 32 | 11 | 39.1 | 46 | Exceptional1 |
| 11.3 | 941 | 47 | 47 | 14 | 38.9 | 46 | Exceptional |
| 10.8 | 1688 | 41 | 56 | 13 | 37.7 | 30[ns] | Marg.Good |
| 6.0 | 1166 | 33 | 54 | 19 | 38.8 | 38 | Good |
| 5.4 | 880 | 50 | 50 | 20 | 39.4 | 48 | Exceptional |
| 3.0 | 1054 | 44 | 44 | 19 | 39.0 | 42 | V. Good |
| 0.1 | 581 | 46 | 33 | 13 | 37.5 | 42 | V. Good |
| ***French Creek*** | | | | | | | |
| 3.2 | 426 | 43 | 32 | 1 | 30.0 | 22* | Fair |
| 0.5 | 263 | 36 | 29 | 4 | 32.0 | 32[ns] | Marg. Good |

| ***Stream*** River Mile | No. Qual. Taxa | QCTV[b] | Qual. EPT[a] | Relative Density | Predominant Organisms | Evaluation[c] |
|---|---|---|---|---|---|---|
| | | | ***Qualitative Evaluation*** | | | |
| ***Black River*** | | | | | | |
| 11.2 | 32 | 35.3 | 9 | Low | Hydropsychids, Riffle beetles | Marg. Good |
| ***W. Br. Black River*** | | | | | | |
| 13.5 | 37 | 37.8 | 9 | Low | Hydropsychids, Mayflies, Midges | Marg. Good |
| ***Buck Creek*** | | | | | | |
| 1.0 | 41 | 35.6 | 6 | Low | Hydropsychids, Midges,Heptageniids | Marg. Good |
| ***Charlemont Creek*** | | | | | | |
| 0.6 | 40 | 37.0 | 8 | Moderate | Hydropsychids, Heptageniids | Marg. Good |
| 0.4 | 30 | 35.6 | 8 | Moderate | Midges, Heptageniids, *Ferrissia* | Marg. Good |
| ***Wellington Creek*** | | | | | | |
| 13.1 | 42 | 27.2 | 4 | Low | Midges, Oligochaetes | Fair |
| 10.8 | 24 | 30.0 | 3 | Low | Hydropsychids, | Fair |

Table 7. (cont.)

| ***Stream*** River Mile | No. Qual. Taxa | QCTV[b] | Qual. EPT[a] | Relative Density | Predominant Organisms | Evaluation[c] |
|---|---|---|---|---|---|---|
| | | | ***Qualitative Evaluation*** | | | |
| | | | | | Oligochaetes, Heptageniids | |
| ***Plum Creek*** | | | | | | |
| 7.0 | 27 | 31.4 | 2 | Low | Blackflies, Hydropsychids, Isopods | Fair |
| ***W. Fk. E. Br. Black River*** | | | | | | |
| 4.2 | 44 | 38.7 | 17 | Moderate | Hydropsychids, Baetidae, Blackflies | V. Good |
| ***Willow Creek*** | | | | | | |
| 2.8 | 40 | 37.4 | 7 | Moderate | Hydropsychids, Midges, Heptageniids | Marg. Good |

**Ecoregion Biocriteria:** Erie Ontario Lake Plain (EOLP)

| INDEX | WWH | EWH | Interim Lake Erie Estuary |
|---|---|---|---|
| ICI | 34 | 46 | 22 |

a EPT = total Ephemeroptera (mayflies), Plecoptera (stoneflies) and Tricoptera (caddisflies).

b Qualitative Community Tolerance Value calculated as the median of the weighted ICI for each taxon.

c A qualitative narrative evaluation is based on best professional judgement and is used when quantitative data is not available to calculate the macroinvertebrate Community Index (ICI) scores.

* Significant departure from ecoregion biocriteria (>4 ICI units); poor and very poor results are underlined.

ns Nonsignificant departure from biocriterion (≤4 ICI units).

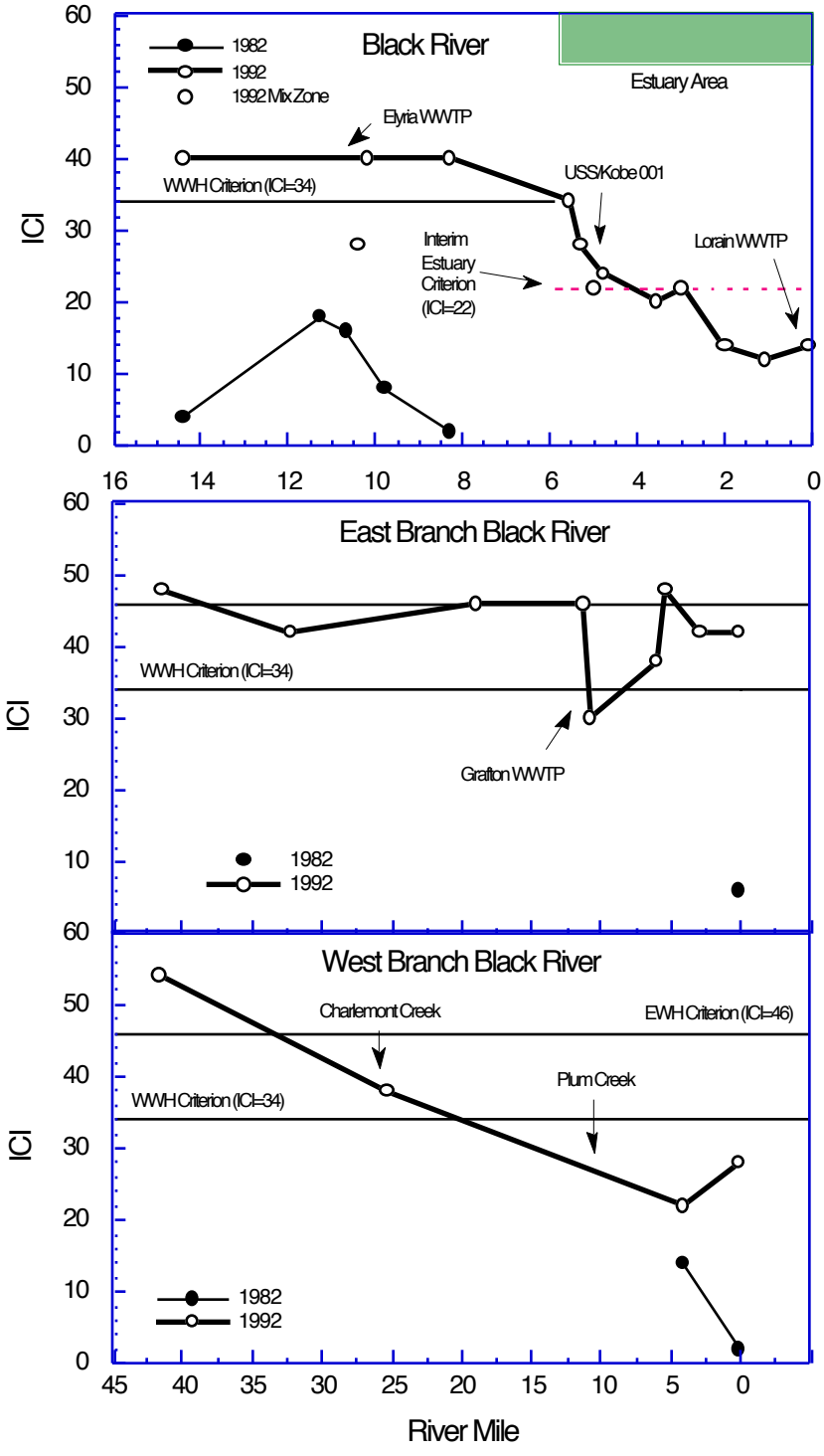


Figure 19. Invertebrate Community Index (ICI) values for the Black River mainstem (upper), East Branch (middle), and West Branch (lower) study areas during 1992 and 1982.

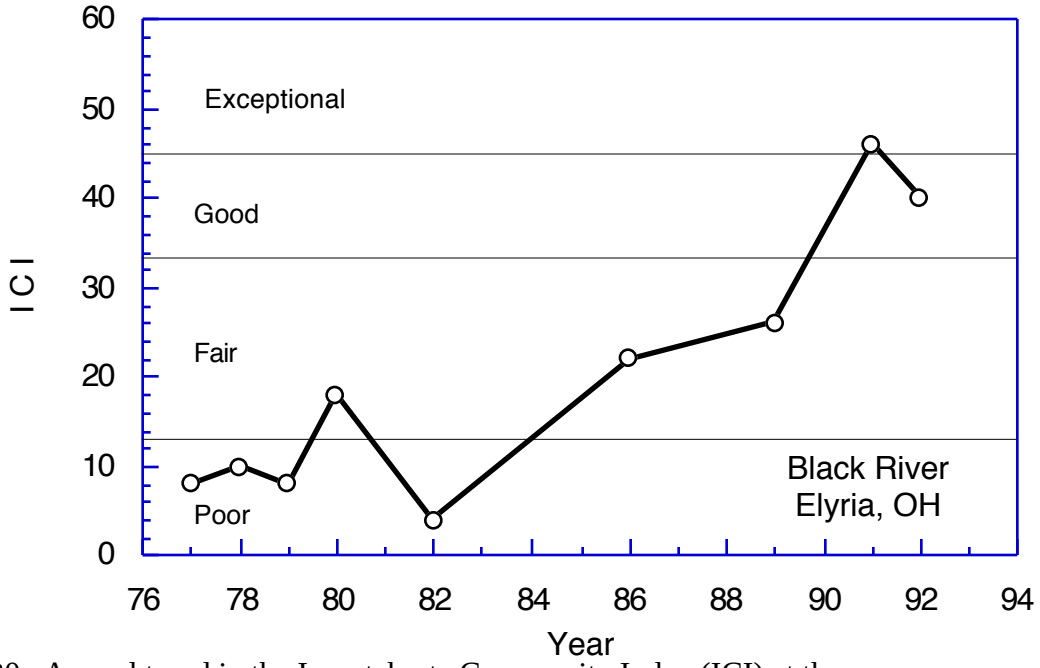


Figure 20. Annual trend in the Invertebrate Community Index (ICI) at the Black River National Ambient Water Quality Monitoring Network station at Elyria (RM 14.4).

***Fish Community*** (Table 8, Figures 21, 22, & 23)

- The fish communities of the Black River have been impacted by a broad range of environmental insults. Habitat modification, industrial waste, municipal waste, agricultural run-off, and failing septic systems were all documented in the system. Only the most upstream sites (at the southern most edge of the basin), a short section of the East Branch and one site in the estuary area were found to be fully attaining the criteria set for WWH fish communities. Impacts to the community were extreme with several sites having indices values that fell into the **POOR** range. However, none of the sites on the mainstem Black River were degraded to the classification of **POOR**, a common condition found during the 1982 survey.

- One of the more striking facts that illustrates the dramatic changes that have occurred in this basin is the loss of species. A historical review shows that eighteen previously recorded species of fish were not collected during this survey while only four new species were observed. In a normal survey of a minimally disturbed system the number of new species records usually far exceeds the number of previously known species not recorded. Species composition has also been disrupted. In the West Branch the creek chub (*Semotiles atromaculatus*) was the most abundant species recorded followed by common shiner (*Luxilus cornutus*), white sucker (*Catostomus commersoni*), green sunfish (*Lepomis cyanellus*) and

blacknose dace (*Rhinichthys atratulus*). For the most part, these species are associated with small headwater streams and are tolerant of most environmental disturbances common to Ohio. An undisturbed community in this basin would have river chubs (*Nocomis micropogon*) and hornyhead chubs (*Nocomis biguttatus*) dominating instead of creek chubs, more hog suckers (*Hypentelium nigricans*) than white suckers, striped shiners (*Luxilus chrysocephalus*) instead of common shiners, darter species (*Ethiostoma sp.*) more abundant than blacknose dace and longear sunfish (*Lepomis megalotis*) instead of green sunfish. Species composition in the East Branch was less disturbed with species such as smallmouth bass, rock bass, greenside darter and sand shiner showing the highest abundantces. In the mainstem, communities were comprised of both the tolerant and less tolerant species mentioned above, an indication of the improved conditions in the area but also a sign that more improvement is needed before full restoration of the community will be achieved.

- During the 1992 survey of the Black River, four species of fish were recorded for the basin that had not previously been recorded by Trautman (1981). The species were; smallmouth buffalo (*Ictiobus bubalus*, a difficult to collect species which most likely was always present in very low numbers), white perch (*Morone americana*, a recently established exotic species), black crappie (*Pomoxis nigromaculatus*, stocked in local ponds recently) and stickleback (*Culaea inconstans*, a highly localized coldwater species). This number of species record additions is low for a typical Ohio EPA survey and is an overall reflection of the level of environmental degradation that has occurred in the basin. A total of eighteen species of fish that had previously been recorded in the basin were not captured during the 1992 survey. The missing species can be broken into three groups related by their zoogeography and the type of environmental impact that has resulted in their demise.

- The first group is species found in the Black River mainstem (the basin area downstream of Elyria) and are mostly associated with aquatic vegetation and/or clean substrates. They are longnose gar (*Lepisosteus osseus*), bowfin (*Amia calva*), northern pike (*Esox lucius*), muskellunge (*Esox masquinongy*), tadpole madtom (*Noturus gyrinus*), silver chub (*Macrhybopsis storeriana*), mooneye (*Hiodon tergisus*), sand darter (*Ammocrypta pellucida*), and sauger (*Stizostedion canadense*). These fish were all victims of the historic excessively high levels of point source pollution discharged. The first five were also affected by the loss of submerged aquatic vegetation. The second group is comprised of species mostly associated with the mid-sections of the basin (primarily the East and West Branches upstream of Elyria). They are hornyhead chub (*Nocomis biguttatus*), river chub (*Nocomis micropogon*), bigeye chub (*Notropis amblops*), rosyface shiner (*Notropis rubellus*), black redhorse (*Moxostoma duquesnei*), stonecat, (*Noturus flavus*) and brindled madtom (*Noturus miurus*). They were principally affected by excess turbidity and bedload sediments originating from agricultural activities. The third group consit of the southern redbelly dace (*Phoxinus erythrogaster*) and blacknose shiner (*Notropis heterolepis*). Both species are normally found in small headwater streams with intact habitats and continuosly flowing water. The 1992 survey did not sample the tributary streams that these species had previously been recorded in and was therefore unlikely to record them. The present status of their populations is unknown, however both have shown declines on a statewide basis (Ohio EPA 1992).

*Black River mainstem*

- In general the fish community in this portion of the basin is on the verge of FULL attainment. Most of the sites are at or near the ecoregional criteria. Two areas notably depart from this status, the sites downstream of the Elyria WWTP discharge (RM 10.6 & 10.5) and the area around the USS/KOBE Steel 001 and 006 discharges, the mouth of French Creek and an extensive slag pile area (RMs 5.8, 5.2, 5.0, & 4.8). Because the system is already stressed

by pollutants and excess nutrients the fish community is also stressed (a condition that exists throughout most of the basin). Any additional pollutants added to the system will cause the fish community to further decline in quality. The four sites in the USS/KOBE - French Creek slag pile area displayed some of the highest percentages of DELT anomalies recorded in the basin (7.0 - 10.6 percent). The two sites downstream of the Elyria WWTP (RMs 10.5 and 8.8) exhibited a predominence of tolerant fishes (RM 10.5 also had high percentages of omnivors), a characteristic response to enrichment from municipal sewage.

- Considerable potential for improvement exists for the mainstem fish community. Faunal components that are presently suppressed include darter species, sucker species, round bodied suckers, intolerant species and simple lithophils. Except for a few metrics at some sites (top carnivores - RMs 15.0 and 0.9, omnivores - Rms 0.9 & 0.2, insectivores - RMs 15.0 and 0.9, and relative numbers - RM 0.9) all other metrics at all sites could show improvement.

- Both the IBI and MIwb exceed the WWH biocriteria at RMs 15.0 and 0.9. The site at RM 15.0 is above the principal discharges on the mainstem and is located in an area of high quality habitat. The site at RM 0.9 is upstream of the Lorain WWTP and far enough downstream from the USS/KOBE Steel area to have recovered. It should be noted that RM 0.9 is the only site in the river proper that had submerged aquatic vegetation.

*French Creek*

- Two sites were sampled in French Creek to evaluate the quality of the French Creek WWTP. Downstream of the plant (RM 0.4) the fish community did not show an additional impact from the WWTP discharge and scored an IBI of 30 and a MIwb of 7.26. A strong impact to the fish community was detected upstream of the plant (RM 3.2) at Abbe Rd where the IBI was 18 and the MIwb was 5.5 both well below ecoregion criteria. The fish community at RM 3.2 displayed all the signs of a toxic impact. Fish were absent from the riffle areas and were mostly found in the pools at the edge of the stream or in root-wad / root-mat areas. Further investigation will be needed to decern the specific cause of impact at this site.

*West Branch*

- Only one site (Buck Creek RM 1.0, IBI = 42) in this portion of the basin exceeded the IBI warmwater criteria of 40. The downstream site on Plum Creek (RM 0.9) and two sites on the West Branch proper (RMs 41.7 & 33.3) had IBIs of 35 which is a nonsignificant departure from the WWH criteria; all other sites violated the IBI criteria for WWH. Attainment of WWH criteria for the MIwb was FULL at the most upstream site on Charlemont Creek (RM 2.8, MIwb = 7.8) and non-significant departure (MIwb = 7.6) at RM 33.3 in the West Branch proper. All other sites in the West Branch basin did not attain WWH criteria.

- The overall status of the fish community in this portion of the basin is poor. The principal cause of impairment are silt, turbidity, bedload sediments and nutrient enrichment. The primary source is NPS pollution derived from agricultural activities (row crops and dairy operations). Plum Creek is uniquely impaired by urban runoff such as sand and grit. The most upstream site in Plum Creek (RM 7.0) is impaired by both urban and agricultural activities. The extreme severity of the NPS impact at the West Branch sites RM 19.6 and 13.6 is among the strongest agricultural NPS impacts recorded by Ohio EPA.

*Plum Creek*

- The Plum Creek subbasin is less than 20 sq mi. and therefore only IBI values are calculated for the sites sampled in the basin. The four upstream sites (RMs 7.0, 3.3, 2.9, and 2.8)

were all classified as poor with scores ranging between 20 and 24. At the most upstream site fish communities are already impacted by a golf course and an open pasture horse farm. The area was silted and nutrient enriched as evidenced by abundant algal growths in sunlit areas. The three next downstream sites were all affected by bedload sediments that appeared to have originated from urban runoff. The site at RM 2.9 was in the Oberlin WWTP mixing zone to determine the extent of any toxicity. No toxicity was detected at this site. The community downstream of the WWTP (RM 2.8) was not significantly different from what was observed upstream. At RM 0.9 much of the bedload sediments observed upstream were reduced or absent. In response to this environmental change the fish community was much improved. The fish community data from Plum Creek indicated that the Oberlin WWTP was not having a detectable impact while NPS pollution from city streets, a golf course, and farming activities was having a suppressing effect on the community.

*Charlemont Creek*

- Fish community results from three sites sampled in the subbasin suggest a basin wide impact from NPS pollution associated with agricultural activities. Differances in community attainments upstream (RM 0.7) and downstream (RM 0.5) of the Wellington WWTP tributary were indistinguishable. It is concluded from this data that the WWTP is not having an effect on the community. Overall community performance at the most upstream site (RM 2.8) was only slightly higher than the two downstream sites. Nonpoint source pollution was the most obvious cause of the decreased performance at this site. In the absence of the NPS impact, an effect from the WWTP might have been more evident.

*Wellington Creek*

- Only two sites were sampled in Wellington Creek. The upstream site (RM 13.1) was located 1.7 river miles downstream of the Findley Lake dam and the downstream site (RM 10.8) was located downstream of the village of Wellington . Although the community was impacted at the upstream site, it was not as severe as at the site farther downstream (RM 10.8). Much of the stream bed at RM 10.8 was covered with sand and the stream banks were actively eroding. It appeared that most of the sediments had been derived from agricultural runoff as opposed to urban runoff.

*Buck Creek*

- The Buck Creek site (the most upstream site in the West Branch basin) at RM 1.0 attained the WWH headwater IBI criteria. The fact that all of the headwater sites in the upper reaches of the East and West Branches had the highest IBI scores, illustrates the effect of basin wide NPS pollution. In the upper reaches of the system, bedload sediments and rowcrop runoff have not yet accumulated to the level at which an impairment to the fish community occures. The NPS pollution load builds with distance downstream to the point that it adversely effects community performance.

*East Branch*

- Degraded conditions in the East Branch were generally not as extensive as in the West Branch, although in a few areas they are just as severe. Nonpoint source problems exist upstream of Grafton and downstream of Lodi with RMs 32.5 and 24.6 suppressed to the POOR category of IBI performance. Conversely, the MIwb showed all sites either achieving or nonsignificantly departing from the WWH criteria. As discussed earlier, community structure was not as severely disrupted in this portion of the basin.

- Fish communities in the immediate area of Grafton achieved both IBI and MIwb WWH criteria. Further downstream at RM 6.0 the fish community was impaired. The impairment continued at the next downstream site (RM 5.2) which had a lower IBI while the MIwb

achieved the WWH criteria. The phenomenon of low IBI performance with higher MIwb scores occurs frequently in areas of impact due to nutrient enrichment which disrupts community function but does not affect the overall abundance of individuals and number of species. Full recovery occurred at RM 3.0 but the community declined again at RM 0.3. The decline at RM 0.3 was most likely in response to the large number of failing and improperly installed septic systems between Grafton and the mouth of the river. This entire reach of river needs to be investigated to locate the problem systems and have them repaired.

*Willow Creek*

- The fish community at the Willow Creek site (RM 2.9) was poor (IBI=18). The Ross incinerator is located upstream of this site, and there may be an impact to the fish community as a result of that facility. Also, heavy bedload sediments and large shallow water areas existed at the site. The origin of the sediments appeared to be row crop runoff. It is uncertain if the principal cause of the impairment was the Ross incinerator or NPS pollution. Further data is needed to make this distinction.

*East Fork*

- The two sites on the East Fork had similar IBI values. One site was located upstream of the Lodi WWTP (RM 2.7, IBI = 39) and one was located downstream of the WWTP (RM 1.6, IBI = 38). Both sites had some faunal components that are associated with high quality stream conditions. No impact from Lodi or it's WWTP were detected in the fish community.

*West Fork*

- The site on the West Fork was located upstream of the Lodi WWTP area. The West Fork forms the East Branch at its confluence with the East Fork. Conditions in this area were similar to those found in the East Fork with the IBI scoring 36 (classified marginally good as the East Fork sites were). Though some NPS pollution exist in both streams, it was not severe enough to cause the community to not attain the WWH criteria.

Table 8. Fish community indices based on pulsed D.C. electrofishing samples at fourty-nine locations sampled by Ohio EPA in the Black River study area during July - October, 1992.

| Stream River Mile | Number of Species | Mean Cumulative Species | Mean Rel. No. (No./Km) | Rel. Wt. (Kg/Km) | Mean Modified QHEI | Mean Index of Well-Being | Index of Biotic Integrity | Narrative Evaluation |
|---|---|---|---|---|---|---|---|---|
| ***Black River*** | | *Erie Ontario Lake Plain - WWH Use designation* | | | | | | |
| 15.0[b] | 23.5 | 28 | 887 | 35.0 | 86.0 | 9.05 | 40 | Good |
| 11.9[b] | 20.0 | 22 | 1182 | 27.8 | 87.5 | 8.65 | 31[*] | Good-Fair |
| 10.6[b] | 14.0 | 16 | 789 | 51.1 | - | - | - | (mz) |
| 10.5[b] | 21.0 | 21 | 1318 | 17.7 | 87.0 | 6.8[*] | 26[*] | Fair |
| 10.5[c] | 17.0 | 17 | 471 | 65.6 | 87.0 | 6.4[*] | 24[*] | Fair |
| 8.8[b] | 20.5 | 25 | 591 | 14.2 | 77.0 | 8.2 | 31[*] | Good-Fair |
| 5.8[c] | 16.0 | 22 | 316 | 108.0 | 58.0 | 6.76[*] | 25.3[*] | Fair |
| 5.5[c] | 15.0 | 21 | 391 | 116.3 | 58.0 | 6.46[*] | 30[ns] | Fair |
| 5.2[c] | 17.7 | 26 | 274 | 68.3 | 49.0 | 7.06[ns] | 25.3[*] | Fair |
| 4.8[c] | 15.7 | 21 | 374 | 106.2 | 59.5 | 6.5[*] | 28[ns] | Fair |
| 3.7[c] | 15.7 | 21 | 515 | 66.9 | 42.0 | 7.06[ns] | 28[ns] | Fair |
| 3.0[c] | 13.7 | 20 | 540 | 49.2 | 57.0 | 7.26[ns] | 32.6 | Good |
| 2.3[c] | 18.0 | 27 | 752 | 196.5 | 55.0 | 7.0[ns] | 32.6 | Good |
| 0.9[c] | 16.8 | 27 | 1001 | 67.4 | 52.0 | 7.9 | 34.6 | Good |
| 0.1[c] | 12.3 | 18 | 780 | 127.3 | 40.0 | 6.8[*] | 28.6[ns] | Fair |
| ***Black River Harbor*** | | | | | | | | |
| 0.3[c] | 15.5 | 25 | 782 | 220.9 | 59.5 | 7.26[ns] | 32.6 | Good |
| 0.2[c] | 11.0 | 18 | 335 | 75.8 | 54.5 | 6.56[*] | 31.3[ns] | Fair-Good |
| ***French Creek*** | | | | | | | | |
| 3.2[b] | 11.0 | 11 | 555 | 10.5 | 71.0 | 5.5[*] | 18[*] | Poor |
| 0.4[c] | 17.3 | 27 | 460 | 35.0 | 58 | 7.26 | 30[ns] | Good |
| ***East Branch*** | | | | | | | | |
| 41.5[b] | 21.0 | 24 | 863 | 8.3 | 54.5 | 7.9 | 33[*] | Marg. Good |
| 36.8[b] | 19.0 | 20 | 692 | 8.5 | 75.0 | 8.05 | 32[*] | Good-Fair |
| 32.5[b] | 20.0 | 22 | 490 | 17.8 | 60.0 | 8.1 | 26[*] | Good-Fair |
| 24.6[c] | 10.0 | 12 | 653 | 65.1 | 57.0 | 7.35[ns] | 25[*] | Fair-Poor |
| 18.9[b] | 18.5 | 21 | 283 | 8.0 | 73.0 | 7.4[ns] | 36[ns] | Marg.Good |
| 11.3[b] | 16.0 | 23 | 694 | 16.3 | 65.5 | 8.05 | 41 | Good |
| 10.1[b] | 17.0 | 17 | 717 | 8.1 | 90.0 | 8.15 | 41 | Good |
| 6.0[b] | 17.5 | 21 | 2022 | 7,8 | 53.5 | 735 | 27[*] | Pr.-M.G. |
| 5.2[c] | 18.3 | 22 | 871 | 161.1 | 84.0 | 8.7 | 31[*] | Good-Fair |
| 3.0[b] | 16.0 | 18 | 523 | 36.2 | 63.5 | 8.25 | 37[ns] | M.G.-Good |
| 0.3[c] | 11.7 | 13 | 456 | 51.8 | 57.0 | 6.5[*] | 29[*] | Fair |
| ***Willow Creek*** | | | | | | | | |
| 2.9[d] | 11.0 | 12 | 1415 | N/A | 72.5 | N/A | 18[*] | Poor |
| ***East Fork East Branch*** | | | | | | | | |
| 2.7[d] | 10.0 | 11 | 1745 | N/A | 70.5 | N/A | 39[ns] | M. Good |
| 1.6[d] | 17.5 | 20 | 1261 | N/A | 70.5 | N/A | 38[ns] | M. Good |

Table 8. (cont.)

| ***Stream*** River Mile | Mean Number of Species | Cumulative Species | Mean Rel. No. (No./Km) | Mean Rel. Wt. (Kg/Km) | QHEI | Mean MIwb | Mean IBI | Narrative Evaluation |
|---|---|---|---|---|---|---|---|---|
| ***West Fork East Branch*** | | | | | | | | |
| 4.1[b] | 13.0 | 15 | 2129 | 8.9 | 75.0 | 7.6[ns] | 36[ns] | M. Good |
| ***West Branch*** | | | | | | | | |
| 41.7[d] | 12.5 | 14 | 878 | N/A | 58.0 | N/A | 35[*] | Fair |
| 33.3[b] | 18.0 | 19 | 700 | 9.6 | 84.0 | 7.6[ns] | 35[ns] | M. Good |
| 25.3[b] | 16.0 | 19 | 270 | 11.3 | 49.5 | 5.3[*] | 29[*] | Fair-Poor |
| 19.6[c] | 10.5 | 13 | 754 | 46.5 | 64.0 | 5.2[*] | 17[*] | Poor |
| 13.6[c] | 13.0 | 14 | 225 | 41.5 | 51.5 | 5.5[*] | 23[*] | Poor |
| 4.1[b] | 15.0 | 16 | 422 | 9.5 | 70.0 | 6.75[*] | 24[*] | Fair-Poor |
| 1.2[b] | 15.5 | 19 | 447 | 20.7 | 69.5 | 6.7[*] | 32[*] | Fair |
| ***Plum Creek*** | | | | | | | | |
| 7.0[d] | 5.5 | 7 | 188 | N/A | 70.0 | N/A | 23[*] | Poor |
| 3.3[d] | 7.5 | 9 | 713 | N/A | 69.5 | N/A | 21[*] | Poor |
| 2.9[d] | 6.5 | 7 | 597 | N/A | 57.0 | N/A | 24[*] | Poor |
| 2.8[d] | 6.0 | 7 | 511 | - | - | - | - | (mz) |
| 0.9[d] | 16.0 | 18 | 846 | N/A | 87.5 | N/A | 35[ns] | Fair |
| ***Wellington Creek*** | | | | | | | | |
| 13.1[d] | 12.5 | 15 | 933 | N/A | 69.0 | N/A | 29[*] | Fair |
| 10.8[d] | 12.5 | 15 | 895 | N/A | 55.0 | N/A | 19[*] | Poor |
| ***Charlemont Creek*** | | | | | | | | |
| 2.8[b] | 17.0 | 17 | 498 | 6.7 | 70.5 | 7.8[ns] | 32[*] | F.-M.Good |
| 0.7[b] | 18.5 | 20 | 1036 | 15.6 | 74.5 | 6.6[*] | 33[*] | Fair |
| 0.5[b] | 17.0 | 19 | 1171 | 10.7 | 73.0 | 7.05[*] | 32[*] | Fair |
| ***Buck Creek*** | | | | | | | | |
| 1.0[d] | 14.0 | 17 | 580 | N/A | 67.5 | N/A | 42 | Good |

**Ecoregion Biocriteria:** Erie/Ontario Lake Plains (EOLP)

| INDEX - Site Type | WWH | EWH |
|---|---|---|
| IBI - Headwaters | 40 | 50 |
| IBI - Wading | 38 | 50 |
| IBI - Boat | 40 | 48 |
| Mod. Iwb - Wading | 7.9 | 9.4 |
| Mod. Iwb - Boat | 8.7 | 9.6 |

* - Significant departure from applicable biological criterion (>4 IBI units or >0.5 Iwb units); underlined values are in the poor and very poor range.

ns - Nonsignificant departure from biocriterion (<4 IBI units or < 0.5 MIwb units)

a - Narrative evaluation is based on both MIwb and IBI scores.

NA - Headwater site; MIwb is not applicable.

(mz) - Mixing Zone sample.

b - Wading methodology results

c - Boat methodology results

d - Headwater methodology results

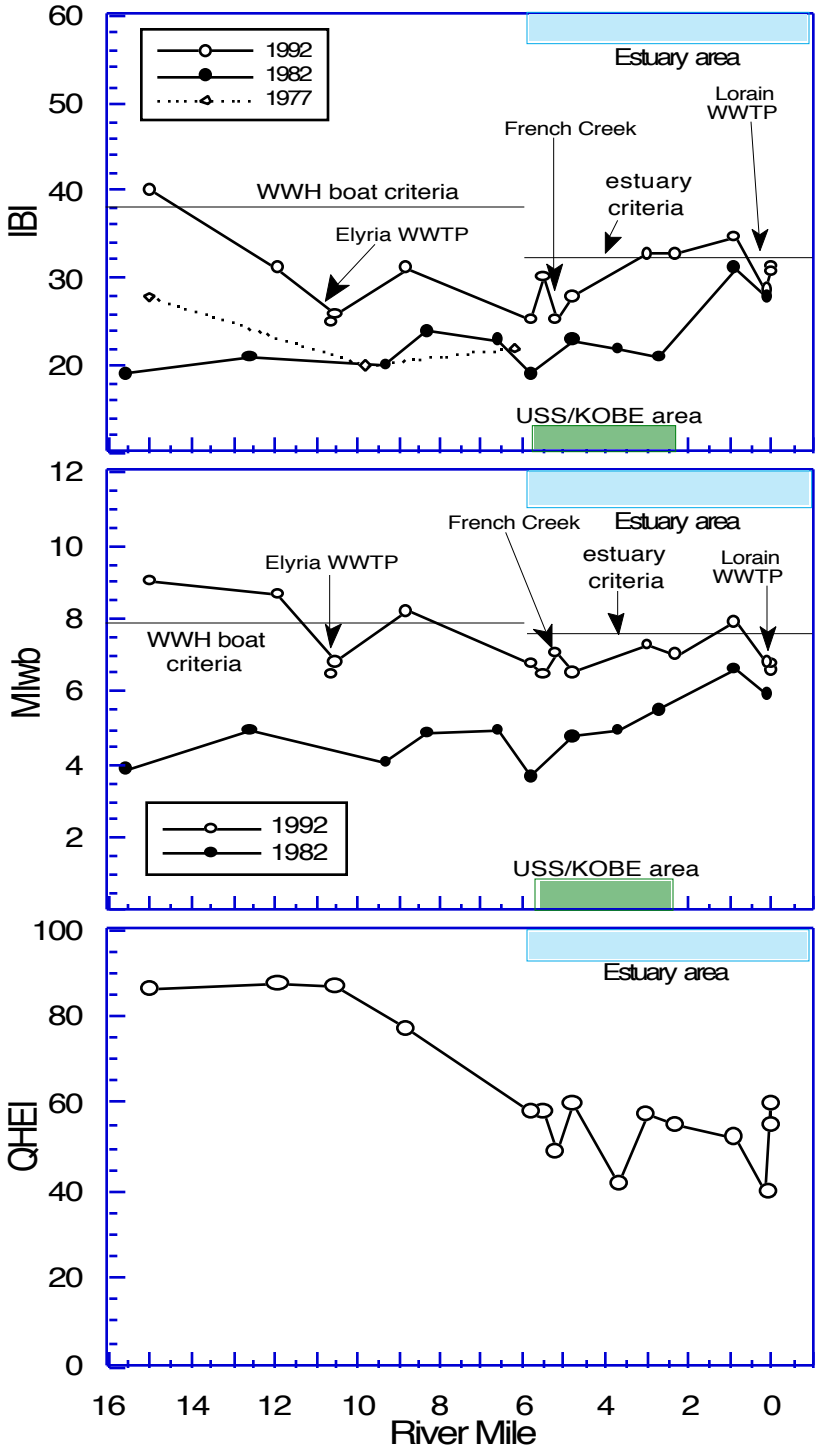


Figure 21. Longitudinal trend of the Index of Biotic Integrity (IBI; upper), the Modified Index of Well-Being (MIwb; middle), and the Qualitative Habitat Evaluation Index (QHEI; lower) in the Black River study area.

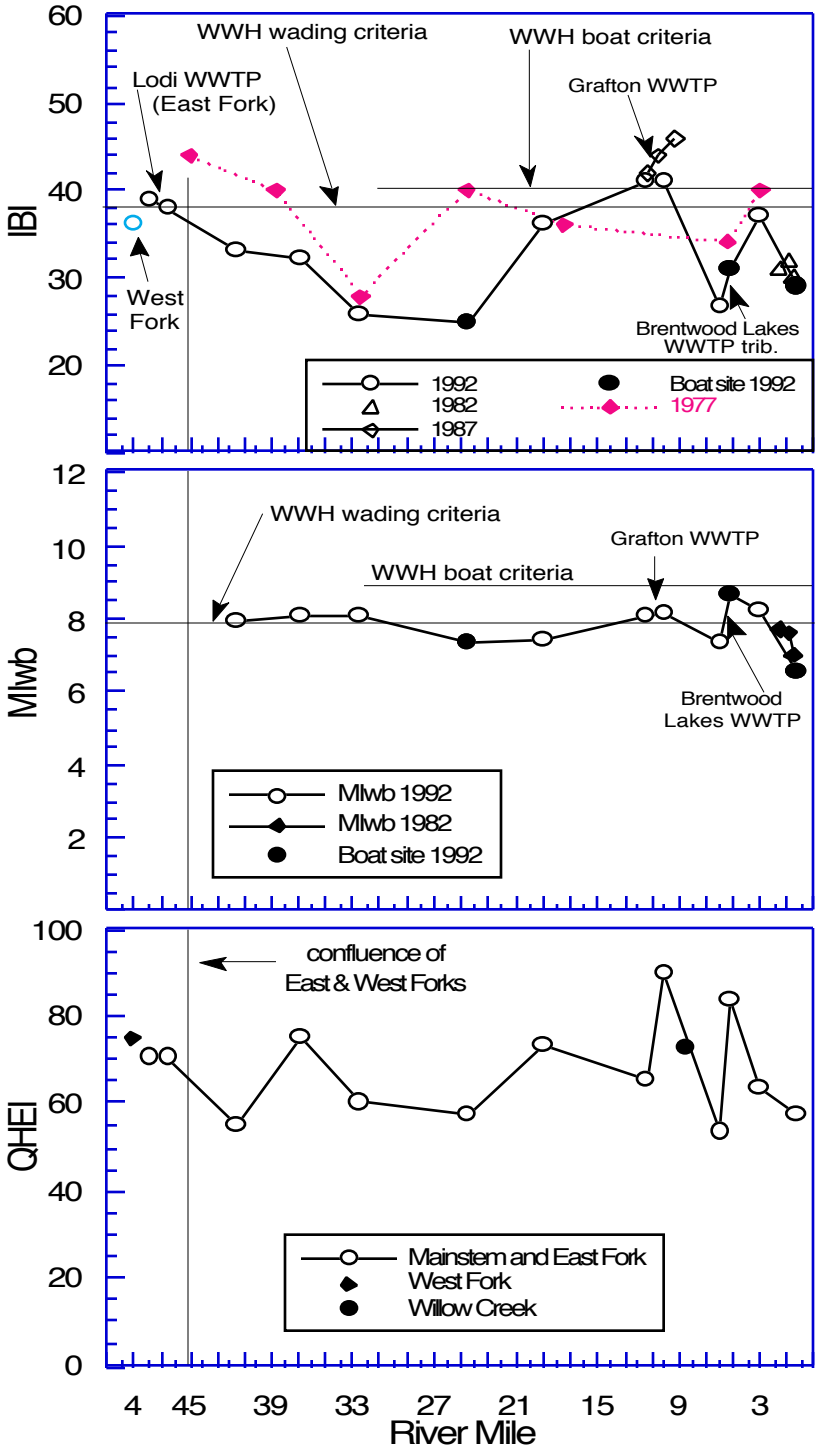


Figure 22. Longitudinal trend of the Index of Biotic Integrity (IBI; upper), the Modified Index of Well-Being (MIwb; middle) and the Qualitative Habitat Evaluation Index (QHEI; lower) in the East Branch of the Black River study area.

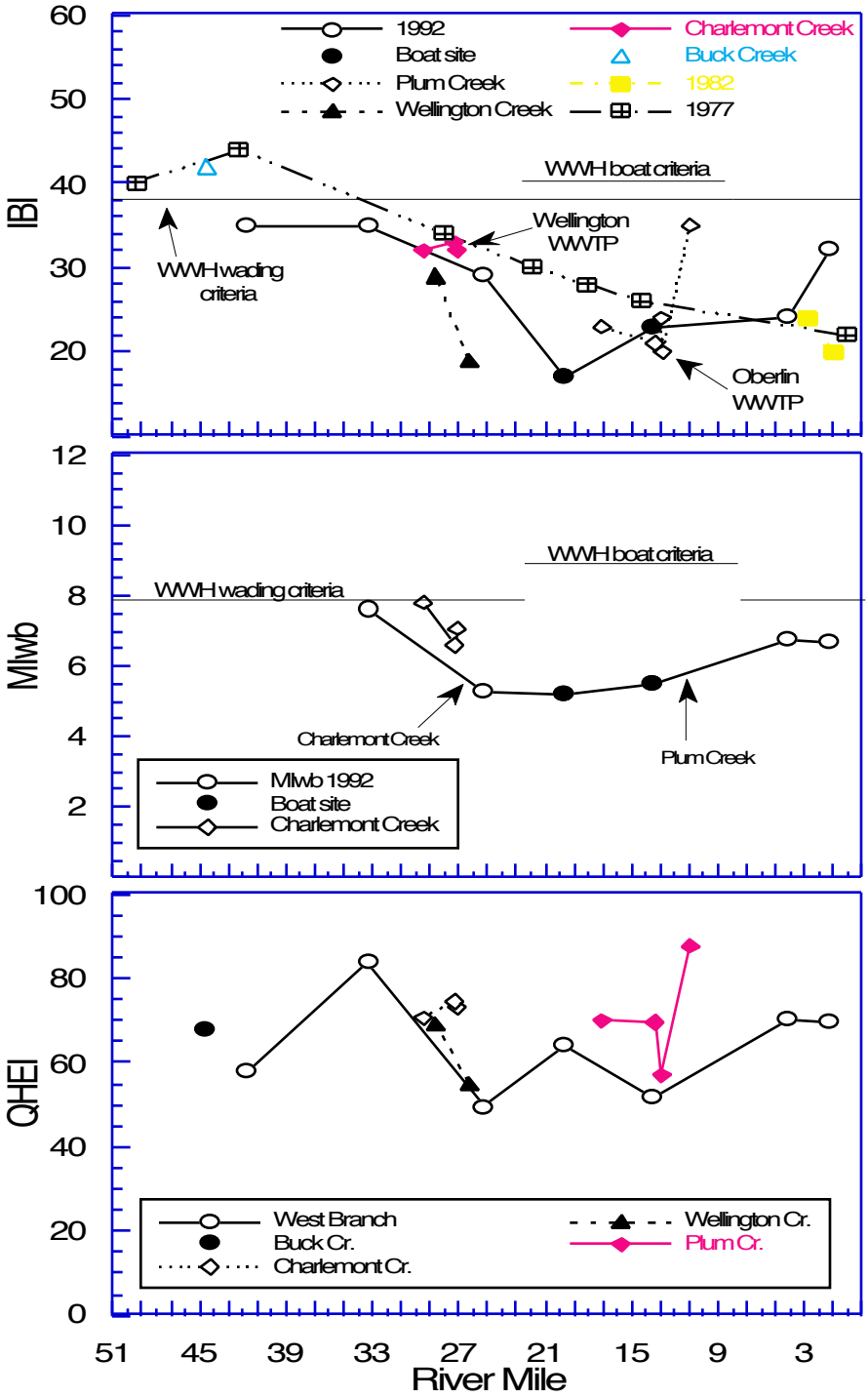


Figure 23. Longitudinal trend of the Index of Biotic Integrity (IBI; upper), the Modified Index of Well-Being (MIwb; middle), and the Qualitative Habitat Evaluation Index (QHEI; lower) in the West Branch of the Black River study area, 1992.

### *Other Wildlife*

- During the summer of 1992 terrestrial wildlife populations were investigated (as part of the Black River Remedial Action Plan) by Mr. C. William Limpach, a private consultant. The study was unable to document effects on mammal populations in the Area of Concern but did conclude that effects were present in the bird populations. Limpach concluded that Great Blue Heron populations were increasing while Yellow Warbler and Redwinged Blackbird populations were "severely" impacted. No conclusion was drawn as to the cause of impact to the two species.

## Trend Assessment

### *Chemical Water Quality Trends*

*Ambient Sites*

- Ford Road: Water quality data have been collected by Ohio EPA at Ford Road (RM 9.8) since 1973. This site is located approximately one mile downstream from the Elyria WWTP. Heavy metals concentrations declined in the mid-1980s after initiation of the industrial pre-treatment program. Water quality trends showed a dramatic improvement following the 1988 upgrade of the Elyria WWTP. Concentrations of ammonia-N, phosphorus, and TKN, have dropped significantly. Prior to1988 significant exceedences of water quality criteria were commonplace Suspended solids and fecal coliform bacteria levels have held steady over the period (Figure 24).

- Cascade Park: Water quality data have been collected by Ohio EPA at Cascade Park (RM 14.3) since 1975. Water quality trends show a steady decline in the concentrations of lead, zinc, copper, cadmium, ammonia-N, TKN, and phosphorus over the past 18 years. Concentrations of total suspended solids, fecal coliform bacteria, and COD have held steady. This site is downstream from the CSO/SSO area in Elyria (Figure 25).

*Mainstem Surveys (1982 /1992):*

- The mainstem of the Black River has seen some of the most dramatic positive changes in water quality of any river in northeast Ohio in recent years. These changes can be directly attributed to the upgrade of the Elyria WWTP which was completed in late 1988. During the intensive survey conducted in the summer of 1982, dissolved oxygen levels were below the 4.0 mg/l minimum standard for five miles downstream from the Elyria WWTP. The river showed some recovery from RM 5.3 to RM 2.9 where the D.O. levels again showed a decrease due to the U.S. Steel 002 coke oven outfall (RM 3.4). Readings approached 5.0 mg/l in this segment. Dissolved oxygen levels recovered somewhat in the lower two miles of the river. During the 1992 survey the D.O. concentrations were generally above 8.0 mg/l downstream as far as the navigation channel. From that point on the D.O. declined to the 5.5-7.0 mg/l range, values that are common in the navigation channel.

- Nutrients such as phosphorus and ammonia-N showed similar trends. In 1982 the concentrations of these parameters were very high downstream from the Elyria WWTP . Ammonia-N concentrations exceeded water quality criteria in 80% of the samples. Phosphorus readings were consistantly above 2.5 mg/l. These high values continued downstream to the estuarine portion of the river where the concentrations increased somewhat due to the multiple discharges from USS/KOBE. Chemical results from the 1992 survey showed the levels of these nutrients were much lower. Mean ammonia-N concentrations were at or near the detection limit (0.05mg/l) down to RM 3.7, adjacent to the USS/KOBE Steel complex, where the mean values increased to the 0.1-0.5 mg/l range. Concentrations

increased to 0.47 mg/l at the mouth of the river, just downstream from the Lorain-East WWTP discharge. Mean phosphorus concentrations ranged from 0.08-0.24 mg/l throughout the mainstem (Figure 4).

- Heavy metals concentrations also showed dramatic improvements in the Black River mainstem (Figure 24). Copper concentrations approached 32 µg/l below the Elyria WWTP in 1982. Concentrations declined steadily to 10 µg/l at RM 1.05. In 1992 the mean concentration for copper was at or just above the detection limit of 10 µg/l throughout the mainstem. In 1982, zinc values approached 50 µg/l from RM 9.8 to RM 2.9. Dischargers in this segment included the Elyria WWTP and the USS/KOBE Steel complex. In 1992, zinc readings were near the detection limit of 10 µg/l from RM 14.3 to RM 8.4. Concentrations increased to 18 µg/l at RM 5.3 and remained near that level throughout the balance of the mainstem.

*French Creek*

- Water quality in the lower 3.2 miles of French Creek has remained essentially unchanged since 1982. Nitrate values were higher in 1992, but ammonia-N and phosphorus concentrations were much lower. Heavy metal values were similar. Dissolved oxygen readings were much higher in 1992 than in 1982.

*Plum Creek*

- Water quality in Plum Creek in 1992 was very similar to data collected during a survey in 1987. The only differences were increased dissolved oxygen levels and decreased ammonia-N concentrations at the site below the Oberlin WWTP. A major upgrade of the Oberlin WWTP was completed in 1989.

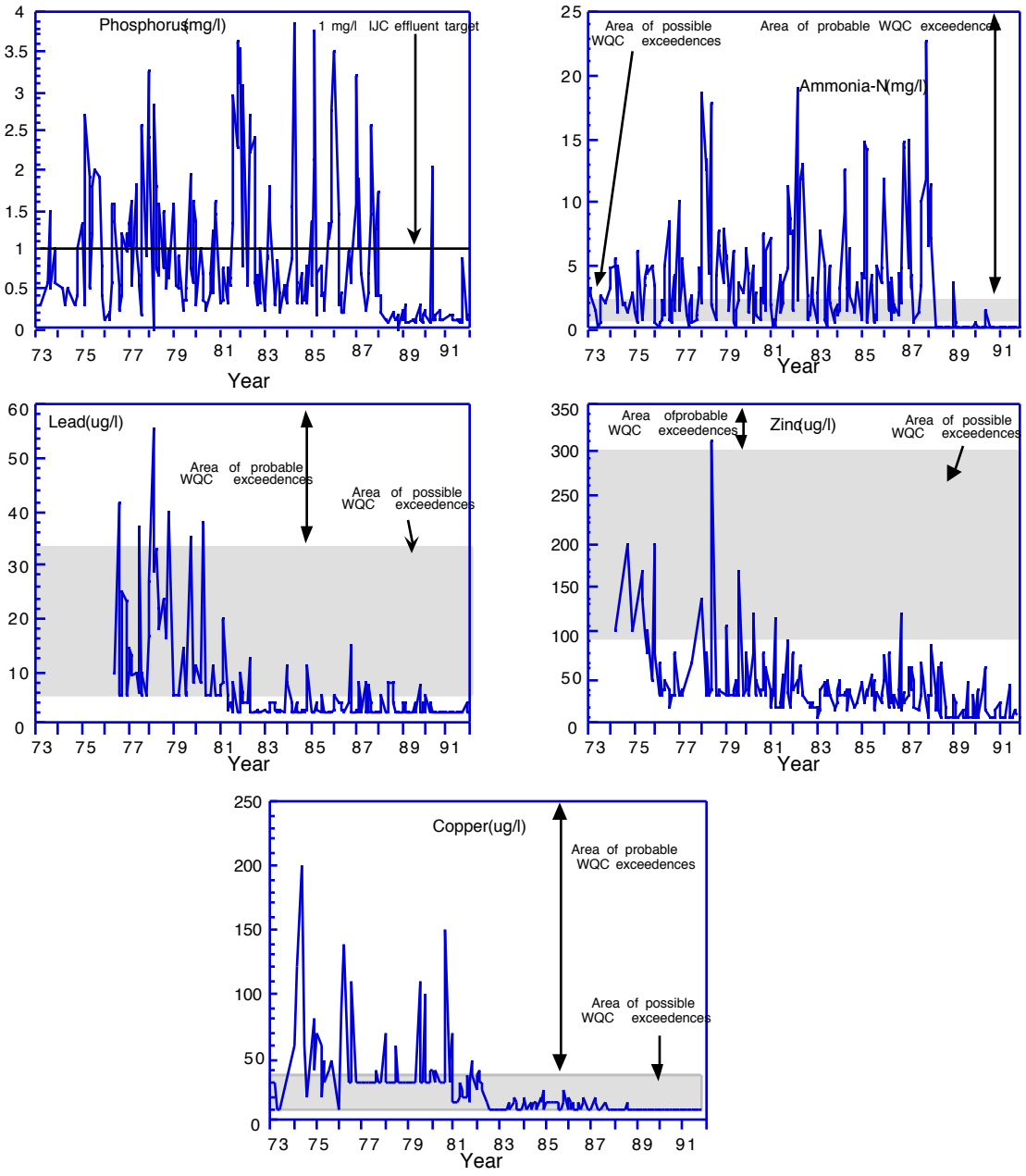


Figure 24. Monthly sampling results from fixed monitoring station at Ford Road (RM 9.8) for ambient concentrations phosphorus, ammonia-N, lead, zinc, and copper from 1973 through 1992.

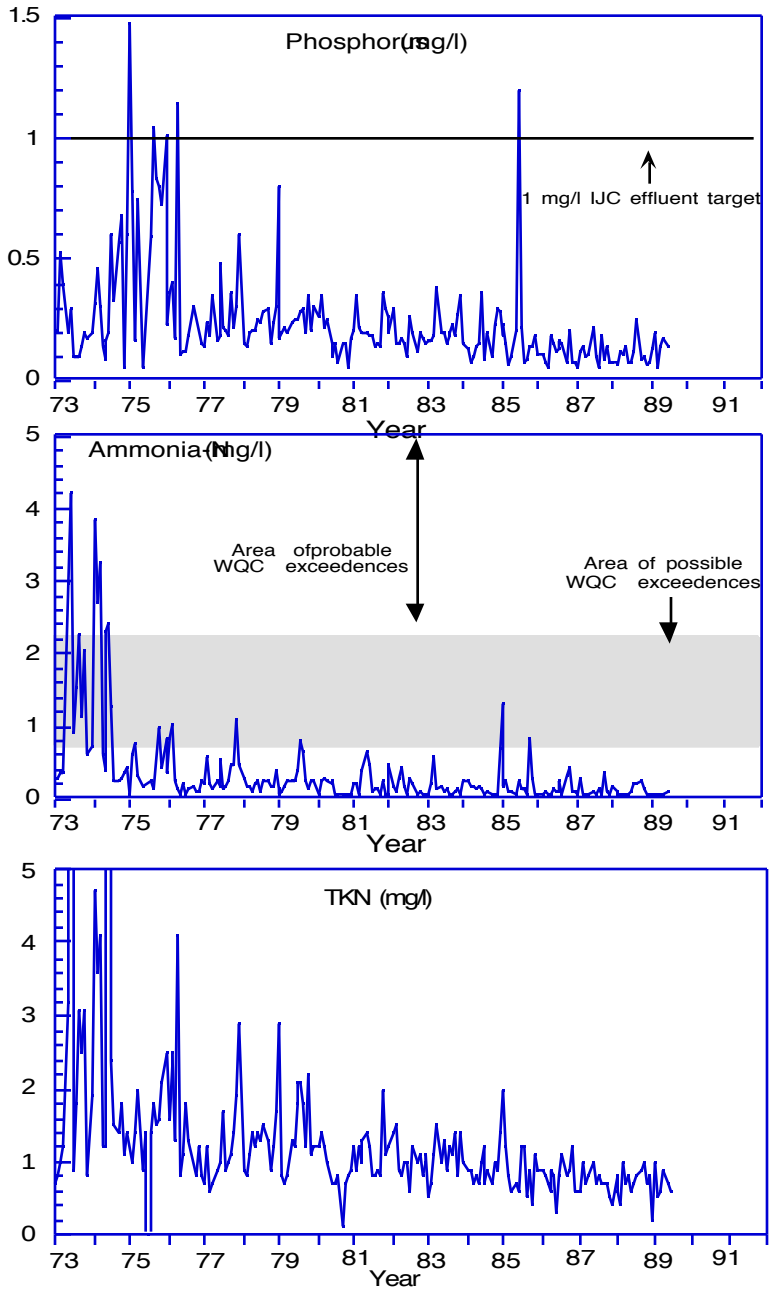


Figure 25. Monthly sampling results from fixed monitoring station at Cascade Park (RM 14.95) for ambient concentrations phosphorus, ammonia-N, and TKN from 1973 through 1992.

### *Sediment Chemistry Trends (1982 vs. 1992)*

- Ohio EPA sampled five mainstem sites in 1982. An Ekman dredge was used to collect the samples. Sites were located from RM 3.8 to RM 1.8 and at the mouth of French Creek. Twenty organic compounds, primarily PAHs and VOCs, and seven heavy metals were included in the analysis. Two organic compounds were found above detection limits, toluene at the mouth of French Creek and naphthalene downstream from the USS/KOBE 002 outfall, the former coke oven outfall . All other organic results were below detection limits. Most of the metals results were classified as highly elevated per the Kelly and Hite (1984) classification system. Metals concentrations gradually increased from upstream to downstream.

- US EPA-Eastern District Office sampled 13 sites on the mainstem in 1992. A core sampler was used to collect the samples. Their survey area covered RM 5.5 to RM 2.35 concentrating on the portion of the river that had been dredged by USS/KOBE Steel Company. Samples were collected using core samplers. Samples were analyzed for heavy metals, BNAs, VOCs, PCBs, and pesticides. Sample analysis was done at US EPA contract labs. Ohio EPA sampled three additional mainstem sites, four harbor/breakwall sites, three sites each on the West and East Branches, and single sites on French Creek, Willow Creek, and the East Fork of the East Branch. Parameter coverage included heavy metals, BNAs, PCBs, and pesticides at the harbor/breakwall and Black River mouth sites and heavy metals at the other sites. Metals results are presented in Appendix Table C-3. Organic results are presented in Appendix Table C-4.

- Unquantifiable amounts of naphthalene, benzo(a) anthracene, benzo(a)pyrene, toluene, ethyl benzene, and total xylenes were found throughout the US EPA study area.

- Improvements in analytical capabilities and sampling techniques are a part of the reason that these compounds were detected in 1992 and not in 1982. The 1982 samples were collected using an Ekman dredge which scooped samples from the upper two to three inches of the substrate while the 1992 US EPA samples were collected using coring devices which could bore as deep as three feet. Thus these results must be interpreted with these cautions.

- There was little change in the metals results. Sites that were classified as heavily polluted in 1982 generally remained so in 1992. There was no pattern as to where the more contaminated sediments were found. High metals concentrations were found throughout the segment (RM 5.5-2.35) The 1992 sample from the mouth of French Creek also showed highly elevated levels of cadmium, chromium, iron, lead, and zinc. In 1982, cadmium, iron, and zinc were considered highly elevated.

### *Fish Tissue Trend Analysis*

- The type of historical samples (whole-body and multi-species composites) and the lower analytical detection levels now utilized call for care in making direct comparisons between the 1992 data and the historical record. The lack of historical analytical data for metals also precludes comparisons for those parameters.

- The number of PCB and pesticide compounds found in the 1992 fish tissue samples and their concentrations have decreased from those reported in earlier collections. Other priority pollutant concentrations decreased from historical levels. No quantifiable PAHs or BNAs were identified in the 1992 samples.

- The presence of several hydrocarbon compounds in the 1992 samples is likely due to the lower detection levels and analytical methods now utilized. These tentatively identified compounds (TICs) were probably not analyzed for previously and thus were not identified in historical collections.

### ***Macroinvertebrate Community Trends*** (Table 9, Figures 19 &20)

*Black River Mainstem*

- A long-term fixed station is located on the Black River at RM 14.7. Sampling at this site from 1977 to 1982 found primarily poor community performance. Starting in 1986 the community gradually improved until 1991 when an exceptional community was present. The 1992 sampling confirmed the improved community which was attributed to the elimination of industrial discharges due to plant closures, WWTP tie-ins, improved industrial pretreatment and decreases in CSO discharges. The 1982 intensive survey documented a slight improvement downstream from the fixed station into the fair range. This slight recovery was interrupted downstream from the Elyria WWTP discharge which drove the community back into the poor range. The 1992 data in this area documented significant water resource improvement subsequent to upgrades at the Elyria WWTP. Macroinvertebrate community performance was in the good range.

*French Creek*

- The macroinvertebrate communities in 1982 were evaluated as good upstream (ICI=40 at RM 3.2) and downstream (qualitative samples only at RM 0.5) from the French Creek WWTP (RM 2.8) with no detectable impact from the WWTP. The 1992 data likewise did not document an impact from the WWTP. However, the upstream community in 1992 was significantly degraded compared to results from 1982. Metals contamination from a recently constructed fly ash landfill upstream from this site was the most likely cause of this decline.

*West Branch Black River*

- The communities in the lower reach of the West Branch were evaluated in 1982 as marginally fair (ICI=14) at RM 4.2 and poor (ICI=2) at RM 0.1. Communities in the same area in 1992 demonstrated a modest improvement at RM 4.2 (ICI=22) and a substantial improvement at RM 0.1 (ICI=28). The continued violation of the ICI biocriterion at the uppermost of these sites suggested continued impairment from urban nonpoint sources of pollution (primarily failing on-site treatment systems). The improving trend at the downstream site was attributed to the elimination of industrial discharges due to plant closure, improved industrial pretreatment, WWTP tie-ins, decreases in CSO discharges due to upgrades at the Elyria WWTP, and the extension of a major interceptor sewer line.

*Plum Creek*

- The 1987 community evaluation of Plum Creek assessed the upstream community at RM 7.0 as marginally fair due to intermittent flow and enrichment. The community declined from marginally good (RM 3.2) upstream from the Oberlin WWTP (RM 3.0) to poor downstream from the WWTP (RM 2.9) due to chlorination and organic enrichment from sewage sludge. The community recovered to the fair range at RM 0.8 but appeared to still be impacted from the WWTP. The 1992 data documented significant water resource improvement since recent upgrades at the Oberlin WWTP. The uppermost site was much the same and still appeared similarly impacted by periodic intermittent stream flows and possible nonpoint source pollution influences.

*East Branch Black River*

- The communities in the lower reach of the East Branch were evaluated in 1982 as good at RM 3.1 and poor (ICI=6) at RM 0.2. The 1992 data documented significant water resource improvement at the lower site which was attributed to decreases in CSO discharges.

***Fish Community Trends*** (Table 9, Figures 21, 22 & 23)

*Black River Mainstem*

- Significant trends in improvement were observed in the mainstem portion of the Black River. A total of sixteen sites were sampled in 1992. All sites were evaluated as fair to good and at or near attainment of the WWH criteria for the IBI and MIwb. In the 1982 survey eleven sites were sampled. Conditions were evaluated then as very poor to fair. None of the sites were within attainment of the WWH criteria. Changes in the ADV values for 1982/1992 were.IBI = 1215/202 and MIwb = 1240/20 in the free flowing sections and IBI = 1021/17 and MIwb = 1165/135 in the estuary portion. The total number of river miles attaining for all of the mainstem 1982/1992 were FULL = 0/6.4, PARTIAL = 0/5.6, and **NON** = 13.2/1.4 A 1977 survey, conducted by students of Dr. Andrew White, corroborated the results of the 1982 survey. The three 1977 sites scored from fair to poor.

- The composition of the fauna realized improvements in six of the twelve metrics evaluated. The total number of species, number of sunfish species, percentage of top carnivores, and percentage of insectivores all increased while the percent tolerant species and percent omnivores decreased. In general, the metrics comprised of sucker species, intolerant species, round-bodied suckers, simple lithophiles, DELT anomalies, and the relative number of individuals did not improve. Considerable potential improvement still exists for the Black River fish community. Some of the improvements are likely to come with time as the system continues to recover from changes which have already been implemented.

*French Creek*

- Fish communities in French Creek improved to full attainment of the IBI and MIwb criteria downstream of the French Creek WWTP. Historically, all sites in French Creek violated the criteria. The site immediately upstream of the WWTP remained in violation of the criteria. The data from this site indicate the presence of a toxic impact possibly from an upstream fly ash disposal facility.

*West Branch*

- The most downstream site in the West Branch showed improvement between 1982 and 1992. The site at the upstream edge of Elyria remained similar to the 1982 survey results. A comparison of 1992 and 1982 West Branch fish communities outside the immediate area of Elyria was not possible as biological samples were not taken in the upper reaches during 1982. Upstream of Elyria, when comparing the 1992 survey to the 1977 results of White (NOACA unpublished data), a declining trend in community condition was evident. All sites upstream of Elyria scored lower in 1992 than in 1977. Again, as in the East Branch, the cause of the declining communities appears to be silt and turbidity from agricultural practices which are prevalent throughout the West Branch subbasin. In general, all IBI metrics made some contribution to the deterioration of the index scores.

*Plum Creek*

- Improvement in the Plum Creek fish community was recorded at RM 0.9, the furthest most downstream site where the IBI criteria were exceeded. All other sites in this stream basin violated the criteria. The improvement at RM 0.9 was the consequence of Oberlin WWTP upgrades. The continued criteria violation were due to NPS runoff, agricultural upstream of

Oberlin and urban within.

*East Branch*

- Little change has occurred in the stream section within the Elyria municipal area since 1982. The area sampled in 1992 scored the same general level of IBI and MIwb as in the 1982 survey. A comparison of 1992 and 1982 East Branch fish communities outside the immediate area of Elyria was not possible as biological samples were not taken in the upper reaches during 1982. In comparing the 1992 survey with the 1977 survey (NOACA unpublished data) the East Branch appears to be declining in quality especially in the segment upstream of Grafton. The level of turbidity and bedload sediments in this area indicates that the declining biological communities are the result of agricultural runoff. Community level changes occurred primarily in the tolerant species and omnivore metrics which both increased in percentage they comprised of the total fish community.

### *Area of Degradation Values (ADV)*

- The Area of Degradation Value (ADV) is a numerical value calculated for each biological index (IBI, MIwb, ICI) which quantifies the area that each index falls below the applicable WQS criterion (see Methods section; page 16). Decreases in ADV scores are an indication of improving biological performance. The greater the ADV score the more impaired biological conditions are, while an ADV of zero is an indication that no degradation exists in terms of biocriteria. Within the Black River basin ADV scores are high (Table 9). The highest ADV scores (IBI = 3142, MIwb = 2970, ICI = 629) and the greatest number of stream miles not attaining the WWH use designation in 1992 (27.3 miles) were recorded from the West Branch. Most of the **NON** attainment in this portion of the basin was a consequence of nonpoint source pollution originating from agricultural activities. In contrast ADVs and miles not meeting criteria were much less in the East Branch (IBI = 1497, MIwb = 305, ICI = 0 and 9.4 miles in **NON** attainment). An extensive comparison of the trends from 1982 to 1992 in the East and West Branches is not possible because a greater area of the two streams was sampled in 1992. In the downstream sections of the streams that were sampled in both 1982 and 1992, ADVs remained approximately the same with some improvement displayed in the West Branch.

- In the mainstem of the Black River 1992 ADV scores were much lower and showed considerable improvement over the 1982 survey results (Table 9). Ecologically, the mainstem has two distinct areas, a free-flowing upper portion and a Lake Erie affected (estuarine) lower portion. In the free flowing portion ADVs were IBI = 202, MIwb = 20, and ICI = 0. Only one mile fell into the **NON** attainment category. In the Lake Erie affected area ADV scores were IBI = 17, MIwb = 135, and ICI = 111. It should be noted here that the biological criteria for the estuary area of Lake Erie are interim and thus are only illustrative of general condition and possible trends in the area studied. For the ICI there are no 1982 values for the estuary and thus no historical trend assessment is possible. For the IBI, MIwb, and ICI in the free flowing section ADV values for 1982 were 1215, 1240, and 427 respectively. In comparison to the 1992 results, a considerable change was evident. For the estuarine area the 1982 ADVs were IBI = 1021 and MIwb = 1165. Again, a considerable change (in a positive direction) was evident. In terms of miles attaining/not attaining WWH criteria, in 1982 all 13.2 miles of the mainstem (both free flowing and lake affected) were classified as in **NON** attainment. In 1992 6.4 miles was in FULL attainment, 5.6 miles in PARTIAL attainment, and 1.4 miles in **NON** attainment (out of a total of the 13.4 miles sampled).

- In French Creek an improvement in fish communities was observed while macroinvertebrates declined. The 1982/1992 ADV results were IBI = 346/286, MIwb = 480/145, and ICI = 0/91. Overall use attainment in this stream was improved. FULL attainment occured in 0.5 miles of

stream, PARTIAL attainment in 0.5 miles of stream and **NON** attainment in 2.3 miles. In 1982 these numbers were 0.0 FULL, 0.0 PARTIAL, and 3.3 **NON**.

- The only other stream in the survey area that had sufficient data to allow the calculation of ADVs was Plum Creek. The MIwb was not applicable to this stream as the drainage area is less than twenty square miles. All historical Plum Creek biological data are from 1987. The ICI showed no degradation while the IBI had an ADV of 824. Miles of attainment were 0.1 FULL, 1.0 PARTIAL, and 6.2 **NON**. Problems in Plum Creek were the result of habitat impacts from bedload sediments derived from urban and agricultural nonpoint runoff. Artificial substrates, used to sample macroinvertebate populations, are not normally affected by bedload sediments and thus can demonstrate attainment of the ICI in areas where water column impacts are low or non-existent while, fish communities are more reliant on substrate quality and thus sensitive to bedload sediments.

Table 9. Area of Degradation (ADV) statistics for the Black River study area, 1992 (calculated using ecoregion criteria as the background community performance).

| | Biological Index Scores | | | | ADV Statistics | | | Attainment Status (miles) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Stream*** Index | Upper RM | Lower RM | Mini-mum | Maxi-mum | **ADV** | ADV/ Mile | Poor/VP ADV | FULL | PARTIAL | **NON** | Poor/VP |
| ***Black River (WWH designation)*** | | | | | | | | | | | |
| **1992** | | | | | | | | | | | |
| IBI | 15.0 | 8.3 | 26 | 40 | **202** | 30.1 | 3 | 2.8 | 3.5 | **1.0** | 1.0 |
| MIwb | | | 6.8 | 9.0 | **20** | 3.0 | 0 | | | | |
| ICI | | | 40 | 40 | **0** | 0 | 0 | | | | |
| **1982** | | | | | | | | | | | |
| IBI | 15.6 | 6.6 | 18 | 20 | **1215** | 202.5 | 434 | 0 | 0 | **9.1** | 9.1 |
| MIwb | | | 3.9 | 5.0 | **1240** | 206.7 | 108 | | | | |
| ICI | | | 2 | 18 | **1501** | 166.8 | 283 | | | | |
| ***Black River (Interim Estuary WWH designation)*** | | | | | | | | | | | |
| **1992** | | | | | | | | | | | |
| IBI | 5.8 | 0.1 | 25 | 35 | **17** | 3.0 | 0 | 3.6 | 2.1 | **0.4** | 0.4 |
| MIwb | | | 7.5 | 10.1 | **135** | 20.5 | 0 | | | | |
| ICI | | | 12 | 34 | **111** | 19.5 | 0 | | | | |
| **1982** | | | | | | | | | | | |
| IBI | 5.8 | 0 | 12 | 27 | **1021** | 176.0 | 494 | 0 | 0 | **6.1** | 5.8 |
| MIwb | | | 1.0 | 6.6 | **1165** | 200.9 | 129 | | | | |
| ICI | | | N/A | N/A | N/A | N/A | N/A | | | | |
| ***French Creek (WWH designation)*** | | | | | | | | | | | |
| **1992** | | | | | | | | | | | |
| IBI | 3.2 | 0.4 | 18 | 30 | **286** | 102.1 | 99 | 0.5 | 0.5 | **2.3** | 2.3 |
| MIwb | | | 5.5 | 7.3 | **145** | 58.9 | 0 | | | | |
| ICI | | | 22 | 32 | **91** | 32.5 | 0 | | | | |
| **1982** | | | | | | | | | | | |
| IBI | 3.2 | 0.1 | 19 | 32 | **346** | 11.6 | 119 | 0 | 0 | **3.3** | 2.9 |
| MIwb | | | 3.1 | 5.4 | **480** | 51.8 | 47 | | | | |
| ICI | | | 40 | 40 | **0** | 0 | 0 | | | | |

Table 9. (cont.)

| Biological Index Scores | | | | | ADV Statistics | | | Attainment Status (miles) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Stream*** Index | Upper RM | Lower RM | Mini-mum | Maxi-mum | **ADV** | ADV/ Mile | Poor/VP ADV | FULL | PARTIAL | **NON** | Poor/VP |
| ***East Branch (WWH designation)*** | | | | | | | | | | | |
| **1992** | | | | | | | | | | | |
| IBI | 41.5 | 0.1 | 25 | 42 | **1497** | 36.2 | 121 | 12.9 | 19.8 | **9.4** | 9.4 |
| MIwb | | | 6.5 | 8.7 | **305** | 7.4 | 0 | | | | |
| ICI | | | 30 | 48 | **0** | 0 | 0 | | | | |
| **1982** | | | | | | | | | | | |
| IBI | 1.7 | 0.2 | 28 | 31 | **159** | 106.0 | 0 | 0 | 0 | **2.3** | 0.8 |
| MIwb | | | 7.0 | 7.7 | **80** | 53.3 | 0 | | | | |
| ICI | | | 6 | 6 | **192** | 128.0 | 0 | | | | |
| ***West Branch (WWH designation)*** | | | | | | | | | | | |
| **1992** | | | | | | | | | | | |
| IBI | 41.7 | 0.1 | 17 | 35 | **3142** | 75.5 | 396 | 7.8 | 7.2 | **27.3** | 21.7 |
| MIwb | | | 5.2 | 7.6 | **2970** | 71.4 | 146 | | | | |
| ICI | | | 22 | 54 | **629** | 15.1 | 0 | | | | |
| **1982** | | | | | | | | | | | |
| IBI | 2.8 | 0.1 | 18 | 24 | **450** | 166.7 | 120 | 0 | 0 | **3.4** | 3.4 |
| MIwb | | | 4.7 | 5.9 | **435** | 161.1 | 32 | | | | |
| ICI | | | 2 | 14 | **1004** | 244.9 | 176 | | | | |
| ***Plum Creek (WWH designation)*** | | | | | | | | | | | |
| **1992** | | | | | | | | | | | |
| IBI | 7.0 | 0.8 | 20 | 35 | **824** | 132.9 | 260 | 0.1 | 1.0 | **6.2** | 5.7 |
| MIwb | | | N/A | N/A | N/A | N/A | N/A | | | | |
| ICI | | | 34 | 44 | **0** | 0 | 0 | | | | |
| ***Plum Creek (WWH designation)*** | | | | | | | | | | | |
| **1987** | | | | | | | | | | | |
| IBI | 7.0 | 0.9 | 20 | 22 | **904** | 143.5 | 337 | 0.0 | 0.0 | **6.3** | 6.3 |
| MIwb | | | N/A | N/A | N/A | N/A | N/A | | | | |
| ICI | | | N/A | N/A | N/A | N/A | N/A | | | | |

# BEAVER CREEK SURVEY

## Introduction

The specific objectives of this 1992 survey were:

1) To determine the aquatic life and recreational use status of the Beaver Creek mainstem immediately upstream and downstream from the city of Amherst WWTP discharge.

2) To provide baseline data throughout the Beaver Creek basin to assess long term biological trends in areas potentially effected by nonpoint sources of pollution.

Beaver Creek is listed in the Black River basin of the Ohio EPA water quality standards, Chapter 3745-1-27 of the Ohio Administrative Code. Beaver Creek is assigned a Warmwater Habitat (WWH) use designation for protection of aquatic life. It is also assigned Agricultural and Industrial Water Supply uses and the Primary Contact Recreation (PCR) use.

The 1992 Beaver Creek survey extended from Russia Road (RM 11.0) to Longbrook Road (RM 1.75). Water chemistry, fish, and macroinvertebrate samples were collected from five stations along the Beaver Creek mainstem during summer months under low-medium flow conditions (ranged from 0.465 to 13.387 cfs at RM 4.65). Water chemistry samples only were collected at the mouth of Willow Creek, a tributary that empties into Beaver Creek at RM 2.01. Bacteria samples were collected under low and high flow stream conditions. Due to time limitations, fish were collected once at each sampling station. Qualitative samples of macroinvertebrates were also collected at each station.

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

## Study Area Description

Beaver Creek is a tributary of Lake Erie located in Lorain County, Ohio. It has a drainage area of 43.92 square miles, has a 12.2 mile long mainstem, and has an average gradient of 19.1 feet/mile. The stream subbasin is located in the northern most reach of the Eastern Corn Belt Plains (ECBP) ecoregion. Topography is characterized by low rolling hills except for areas adjacent to the main channel, which is rough and wooded . Soil composition in the watershed is mostly lacustrine sandstone and shale, predominantly of the Caneadea Series. These soils are low in organic matter, acidic, and difficult to drain (October 1991, General Plan for Wastewater Treatment Plant Improvements, Amherst. McDonnell, Proudfoot, and Associates, Inc).

Land use in the headwaters of the Beaver Creek watershed above RM 10.0 is mostly low density residential and rural agriculture. The discharges from on-site septic systems have the potential to impact streams and ditches. Beaver Creek receives urban runoff from the unsewered South Amherst area (between RMs 10.0 and 9.0), plus agricultural and on-site septic system drainage from Schramm Ditch.

The only major point source discharge is from the city of Amherst WWTP (RM 3.85), which has a design flow of 2.0 mgd. Since the early 1980s, the Amherst WWTP has regularly exceeded the design flow (Figure 26). The city of Amherst has invested approximately 2.0 million dollars in WWTP upgrades between 1985 and 1990. A new primary clarifier, final effluent filter, and tertiary rapid sand filter were put on line in July 1985. However, due to operation problems, the tertiary filters have not been used since 1988. A new secondary clarifier was put on line in September of 1987. In September 1988 the WWTP was converted from single-step to two-stage

trickling filters for ammonia removal; a new chlorine contact tank was also installed. The trickling filter media was replaced in October, 1990.

Since 1988, occasional NPDES permit violations for TSS, BOD, and ammonia-N have been reported. No CSOs exist in the Amherst WWTP sewerage system, however, by-passes at three pump stations are possible. The city of Amherst and the State of Ohio reached a consent decree in May of 1991 over final NPDES discharge limits. Additional improvements to the treatment of wastewater are included in the 1991 agreement.

The estimated summer $Q_{30-10}$ flow (May-Nov) of Beaver Creek just above the Amherst WWTP is 0.18 cfs. The Amherst WWTP design flow is 3.09 cfs, thus, under low stream flow conditions, the Amherst WWTP represents about 94% of the total flow in Beaver Creek. The discharge from three small WWTPs enters Beaver Creek between RM's 7.0 and 5.0 (Pinecrest STP (0.033 mgd; RM 6.9); Westwood MHP (0.08 mgd; RM 5.72,1.1); and Ohio Turnpike Plaza #5 (0.150 mgd; RM 5.25;1.3)). This stream segment also receives urban runoff from the city of Amherst.

Willow Creek empties into Beaver Creek at RM 2.01. This tributary receives urban runoff from the city of Amherst, discharge from the Amherst MHP WWTP (0.046 mgd; RM 2.15), discharge from numerous small commercial WWTPs, and agricultural runoff.

Historical water chemistry data for Beaver Creek is limited to the monthly self monitoring data that has been collected by the city of Amherst. A biological site survey of Beaver Creek was conducted by the Ohio EPA, Northeast District Office on October 5, 1977. Fish and macroinvertebrates were collected at two stations, one immediately above the WWTP (about RM 4.0) and a second at Longbrook Road at RM 1.75. Fish were collected using a seine, macroinvertebrates were collected using a Surber Sampler. The results of the 1977 survey suggested that the Amherst WWTP, perhaps in combination with other sources, was having an adverse effect on both fish and macroinvertebrates.

## *Summary and Conclusions*

*Water Chemistry*

Analysis of water chemistry data collected along the mainstem of Beaver Creek in 1992 showed relatively good water quality with only a few inconsequential violations of the total iron 1.0 mg/l standard throughout the basin (5 of 18 total samples). Samples were collected under low to medium flow conditions. Flow values at RM 4.65 on the sample dates were: July 6 (0.465 cfs); July 27(13.387cfs); September 15 (3.03 cfs). A dissolved oxygen value of 3.25 mg/l was recorded at the most upstream station (RM 11.0) at a time when the stream flow was intermittant. This number is below the daily minimum WQS dissolved oxygen criteria of 4.0 mg/l.

There was a significant increase in the concentrations of COD and nitrate-N immediately below the Amherst WWTP (Figures 27). No water quality standards exist for these parameters. Ammonia-N also increased below the WWTP, but the concentrations were well below toxic levels. Results of continuous dissolved oxygen measurements collected immediately above and below the Amherst WWTP showed a decrease of about 1 mg/l from an average of 8.5 mg/l to 7.5 mg/l (Figure 28). No values were below 6.0 mg/l at the two stations below the WWTP at RM stations 2.9 and 1.75.

Results of fecal coliform sampling showed violations throughout the basin under high stream flow conditions on September 21, 1992. Under lower flow conditions on October 7, 1992 the highest level of fecal coliform (29,000/100 ml) was found at RM 4.65, above the Amherst WWTP discharge. On the same day, very low fecal coliform counts were found at RM 7.0, above the

Middleridge Road bridge, thus the source(s) of contamination on October 7th was limited to the section of Beaver Creek between RMs 7.0 and 4.65. Potential sources in the area include on-site home/commercial septic tank systems, the Westwood MHP WWTP, and the Ohio Turnpike Plaza #5 WWTP. Monthly fecal coliform data collected by the city of Amherst in 1991 and 1992 also shows consistently higher levels of fecal coliform in Beaver Creek above the WWTP than below (Figure 28).

*Biological Communities and Stream Habitat*

Analysis of biological data at the most upstream station along Beaver Creek (RM 11.0) indicated a poor fish community (IBI = 24; Table 10, Figure 29) associated with a marginally good macroinvertebrate community. This station is potentially impacted by agricultural runoff and scattered on-site septic system discharges. Only five species of fish were collected at RM 11.0, with low relative numbers (120). Grass Pickerel was the most common species collected. This species is associated with low gradient streams that have extensive macrophyte growth.

Although the stream reach had good overall habiat quality (QHEI = 61.0), it was observed to be completely dry during the smmer of 1992. This intermittant flow condition could exert a significant negative affect on the fish community, even though the overall habitat quality as measured by the QHEI was sufficient to support a WWH fish community. Low dissolved oxygen (3.25 mg/l) was also measured at RM 11.0, most likely due to low gradient and decay of algae and other aquatic plants.

A total of 40 qualitative macroinvertebrate taxa were collected at RM 11.0 including 8 EPT taxa. Predominant taxa were the mayfly genus *Stenonema*, the pulmonate snail genus *Physella*, and various hemiptera taxa. Seven different mayfly taxa were collected. This is the only station where stoneflies (genus *Perlesta*) were collected. The overall narrative rating for macroinvertebrates was marginally good. However, based on the poor performance of the fish community, RM 11.0 was in **NON** attainment of the WWH use designation.

Results of biological sampling at the next downstream station at RM 7.0, which is below the South Amherst unsewered area, continued to show a marginally good community of macroinvertebrates. A total of 36 qualitative taxa were collected. Predominant taxa were the mayfly genera *Stenomema* and *Isonychia* and the water penny beetle species (*Psephenus herrick*). The overall narrative rating for macroinvertebrates was the same as RM 11.0, marginally good. Thus it did not appear that the South Amherst unsewered area was having a significant impact on the benthic macroinvertebrate community.

The fish community at RM 7.0 improved (IBI score of 32), however this value is still below the ECBP ecoregion potential of 40 IBI points. A total of nine species of fish were collected. RM 7.0 station had the highest relative proportion of sensitive fish (29.5%), which would suggest that toxic pollutants are not a problem at this site. Continuuous flow was observed at RM 7.0 throughout the survey. The QHEI at this station was 71.5, which indicated that some factor other than overall habitat quality is responsible for the lack of attainment of fish at this station. Non-point source pollution and urban runoff from the South Amherst area is a likely cause of non attainment for fish at the RM 7.0. Based on a fair fish community and a marginally good macroinvertebrate community, the overall use attainment rating was (PARTIAL) at RM 7.0.

The next two sample stations (RM 4.65 and 2.95) were located above and below the city of Amherst WWTP discharge, which empties into Beaver Creek at RM 3.85. Results from RM 4.65 and 2.95 indicated that the city of Amherst WWTP was having a significant negative impact on the fish and macroinvertebrate communities of Beaver Creek. The number and types of species sensitive to pollutants was sharply reduced at RM 2.95, immediately downstream from the

Amherst WWTP discharge. The total number of qualitative macroinvertebrate taxa declined from 36 to 18 (Figure 29). Caddisflies, a group of macroinvertebrates that show sensitivity to chlorine, were completely eliminated at the RM 2.95 station. The number of pollution sensitive EPT taxa was reduced from 9 to 2. Predominant macroinvertebrate taxa at RM 4.65, above the Amherst WWTP discharge, were the mayfly genera *Stenonema* and *Caenis* the crayfish species *Orconectes sanborniisanbornii*. Predominant taxa below the Amherst WWTP at RM 2.95 were flatworms, aquatic segmented worms, and various tolerant midge taxa. Crayfish numbers were greatly reduced at the RM 2.95 station. The overall macroinvertebrate evaluation was marginally good above the WWTP and poor below the WWTP. The near absence of sensitive species indicated a toxic effect on the macroinvertebrate community.

The fish community above the WWTP at the RM 4.65 station was in the fair range, (IBI = 34), however, the fish community immediately below the WWTP showed poor performance (IBI = 24). The percent of sensitive fish species was reduced from 13% to 0.2% (reduction in rainbow darters and smallmouth bass). Although the fish community below the Amherst WWTP showed a significant reduction in the IBI, the relative number of fish doubled at the downstream station (623 to 1301/0.3 m), an indication of organic enrichment. The overall aquatic life attainment of Beaver Creek dropped from PARTIAL attainment at RM 4.65 to **NON** attainment at RM 2.95. Given the close proximity of the Amherst WWTP to the RM 2.95 station, and the lack of any other significant sources of pollutants, the discharge from the Amherst WWTP is the most likely cause of the biological degradation observed at RM 2.95.

Partial biological recovery was observed at the most downstream station (RM 1.75). The number of macroinvertebrate EPT taxa increased to 5 and the total number of qualitative macroinvertebrate taxa increased to 22, however, the overall macroinvertebrate community remained poor. The fish community remained in the poor range with no recovery of the darter and smallmouth bass populations found above the Amherst WWTP. An IBI of 26 and MIwb 6.7 indicated **NON** attainment of the WWH aquatic life use at RM 1.75.

In addition to the Amherst WWTP discharge, the station at RM 1.75 also receives urban runoff from the city of Amherst, and is below the confluence of Willow Creek, the largest tributary of Beaver Creek. The Amherst MHP WWTP and numerous unpermitted semi-public commercial entities discharge to Willow Creek.

Results of effluent bioassay tests conducted in 1992 for the Amherst WWTP using fathead minnows (*Pimephalespromelas*) and *Ceriodaphnia dubia* showed conflicting results. No toxicity was observed in March 1992, however an August 1992 sample showed 100% mortality of *C. dubia* in one grab sample and 25% of the *P. promelas* showed loss of equilibrium in a 24-hour composite effluent sample. The source of the August 1992 toxicity is unknown; all metals and ammonia-N were well below acutely toxic concentrations, and all samples were dechlorinated prior to testing. Although twelve tentatively identified non-priority semivolatile organic chemicals were found in the August 1992 effluent sample, their potential toxic effect is unknown. Because no adverse effect was observed in the mixing zone sample, it is unlikely that the results of the August 1992 bioassay tests help explain the significant adverse effects on biological communities observed in Beaver Creek downstream from the WWTP discharge.

Analysis of Beaver Creek water chemistry data submitted by the city of Amherst suggests that one potential source of instream toxicity is from residual chlorine, which has been detected in Beaver Creek at concentrations 100 times above the chronic water quality criteria (WWH 30 day average chlorine WQS = 18 µg/l). The current NPDES effluent limit for residual chlorine at Amherst WWTP is 500 µg/l, and monthly data indicate that the WWTP maintains residual chlorine concentrations in the 400-500 µg/l range. Under critical low flow conditions, the Amherst WWTP

represents about 94% of the total flow in Beaver Creek below RM 3.85, thus the potential exists for significant chlorine toxicity to aquatic life in Beaver Creek below the Amherst WWTP discharge. The biological impact observed at RM 2.95 during this 1992 survey may well be due, at least in part, to high levels of instream residual chlorine.

In summary, the present day impact of the Amherst WWTP on the biological communities of Beaver Creek appears to be a mixture of the toxic effect of chlorine and organic enrichment (most likely nitrogenous compounds and oxygen demanding wastes).

*Status of Aquatic Life Uses*

Beaver Creek shows **NON** attainment (Table 10) of the WWH aquatic life use at the most headwater station (RM 11.0), due to a combination of intermittent flow, low dissolved oxygen, low gradient, and runoff from non-point source pollutant. This **NON** attainment status most likely extends upstream for 1.2 river miles to the headwaters at RM 12.2.

The aquatic life status from RM 11.0 to RM 7.0 is UNKNOWN (4 river miles), however, Beaver Creek shows PARTIAL attainment of aquatic life from RM 7.0 to where to city of Amherst WWTP discharges at RM 3.85 (a total of 3.15 river miles).

Below the city of Amherst WWTP, there is a significant decline in biological diversity. Both fish and macroinvertebrate communities were judged to be in the poor range and the stream showed **NON** attainment of aquatic life potential. The impact continues to RM 1.75, which is 2.10 river miles below the Amherst WWTP. The aquatic life status from RM 1.75 to the mouth of Beaver Creek is unknown.

In summary, of the total 12.2 river miles in Beaver Creek, the aquatic life attainment status is UNKNOWN for 5.75 miles, PARTIAL for 3.15 miles, and **NON** attainment for 3.3 miles.

## Recommendations

The results of the 1992 biological survey indicate a potential toxic effect on the fish and macroinvertebrates downstream from the city of Amherst WWTP discharge, most likely due to excessive residual chlorine at levels well above water quality criteria. It is recommended that the city of Amherst WWTP add de-chlorination to eliminate the discharge of residual chlorine during summer months, or that some alternative method of disinfection be found.

The results of the 1992 bacteria survey indicate elevated fecal coliform bacteria under low flow between RM 7.0 and 4.65. The source(s) of these bacteria should be identified.

## *Future Monitoring Needs*

Beaver Creek should be monitored in 1997 at the stations upstream and downstream from the Amherst WWTP to determine potential recovery of biological communities. Additional bacteria sampling under low stream flow conditions should be conducted to identify sources. More stations upstream from RM 7.0 need to be evaluated to determine the appropriate recreational use.

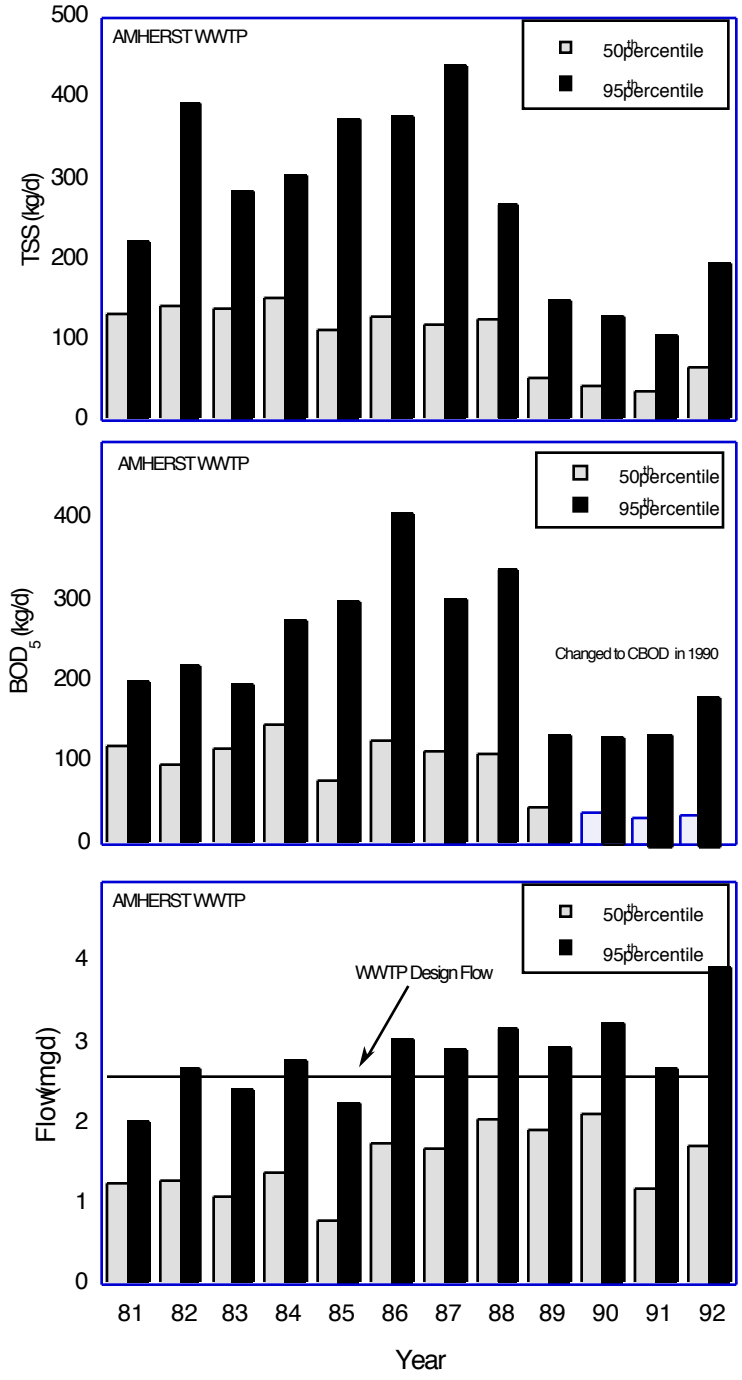


Figure 26. Average annual flow and loadings for TSS and $BOD_5$ for the Amherst WWTP 1981-1992.

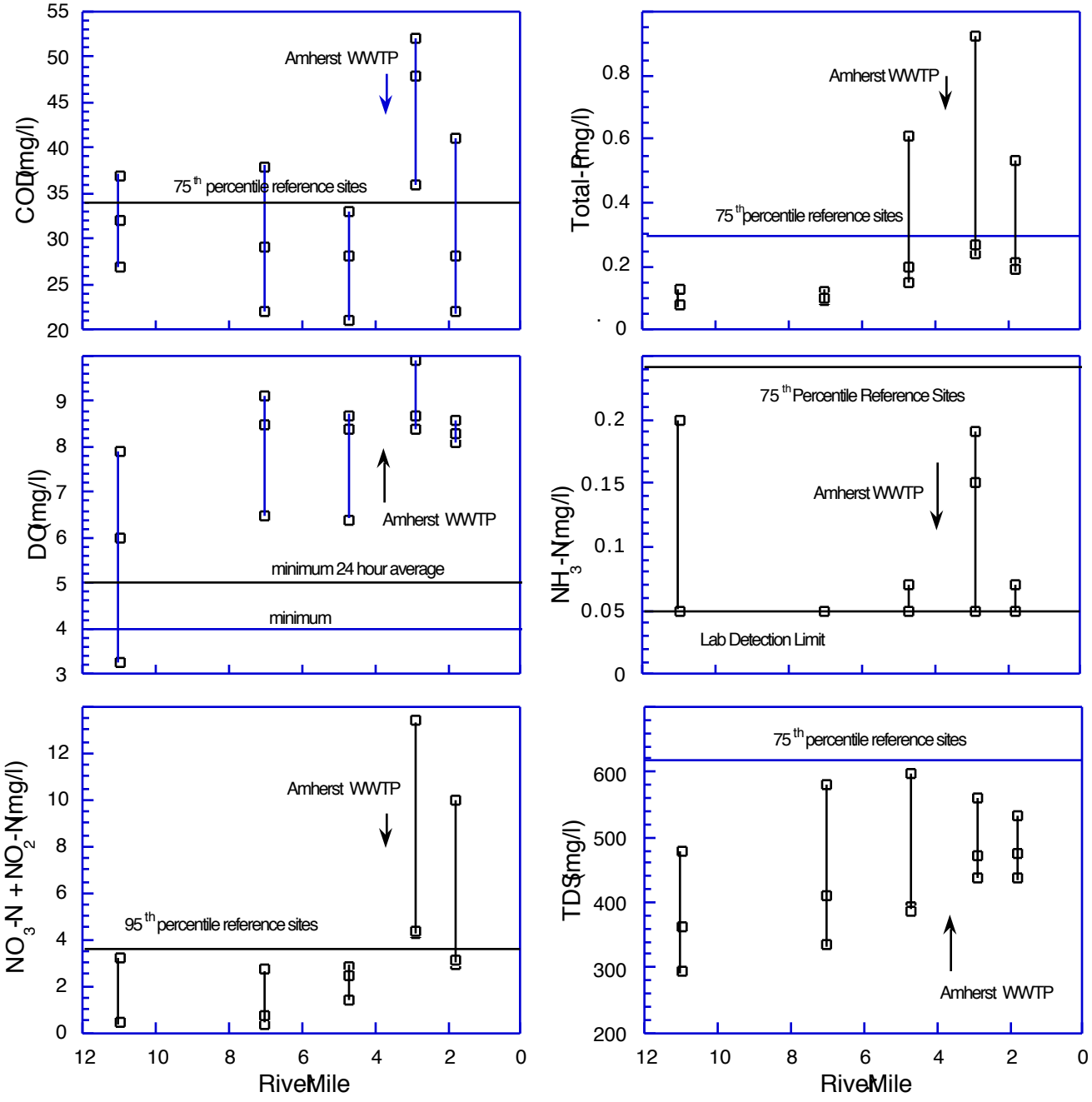


Figure 27. Concentrations of selected chemicals from grab water samples for the Beaver Creek mainstem by river mile during the 1992 survey.

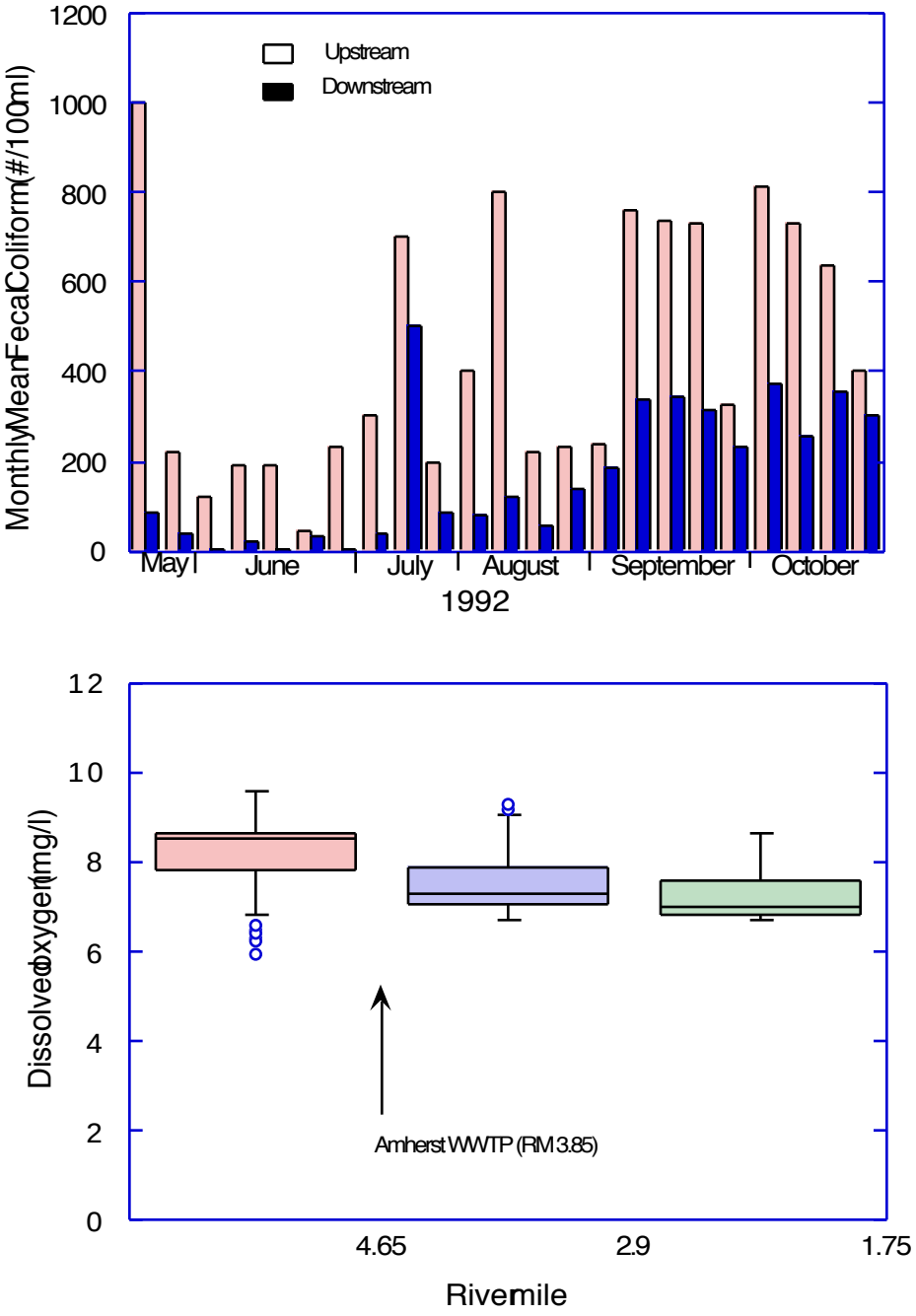


Figure 28. Fecal coliform counts by month (1992), upstream and downstream from the Amherst WWTP and 24 hour diel dissolved oxygen concentrations on the mainstem of Beaver Creek.

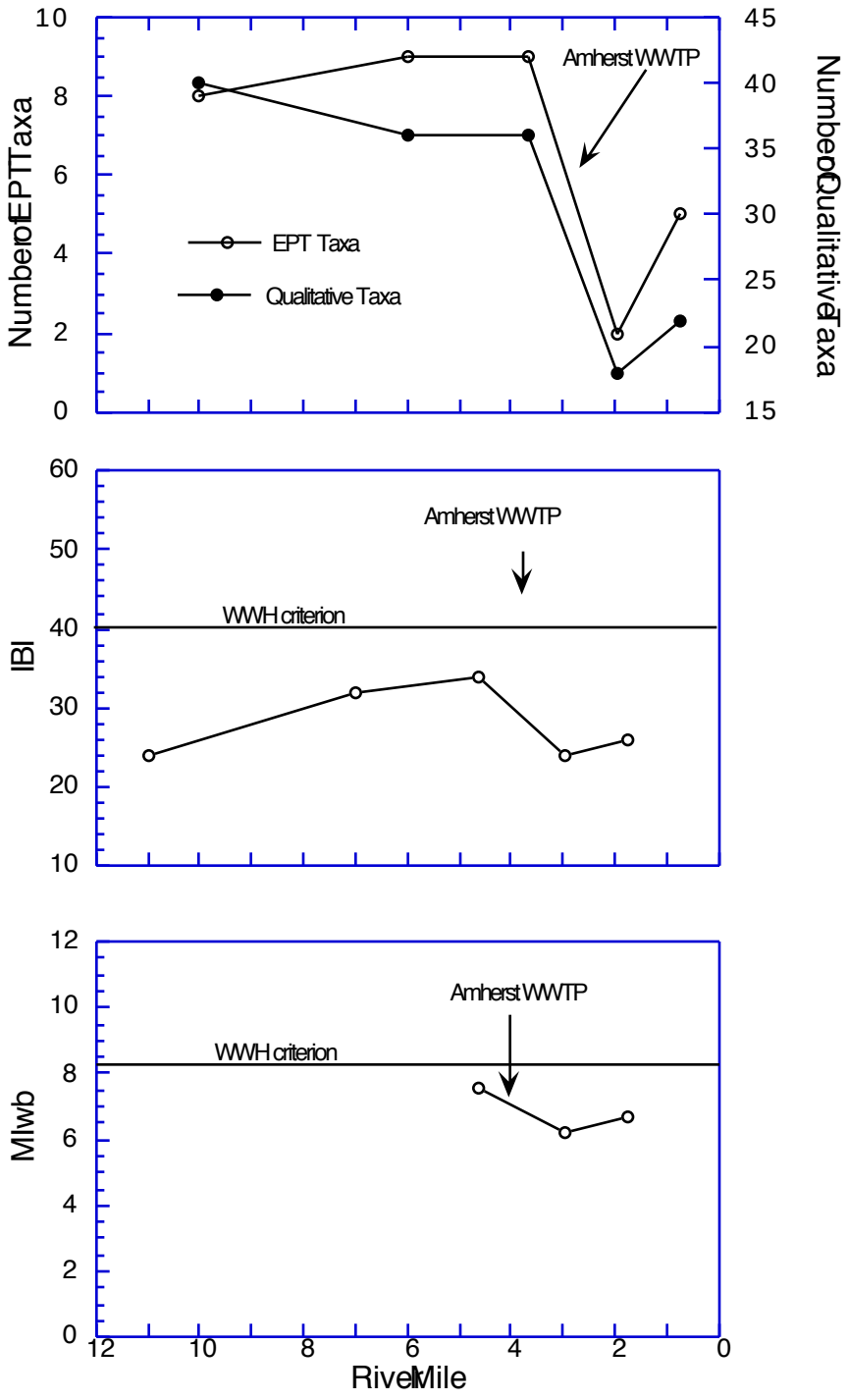


Figure 29. Macroinvertebrate community EPT taxa and qualitative taxa (upper figure) and fish community IBI and MIwb results for Beaver Creek mainstem during 1992.

Table 10. Aquatic life use attainment status for the Exceptional/Modified/Warmwater Habitat (WWH) use designation in Beaver Creek based on data collected during June - September 1992.

| River Mile (Fish/Ivt) | IBI | Mod. Iwb | ICI[a] | QHEI[b] | Attainment Status | Attainment Comments |
|---|---|---|---|---|---|---|
| ***Beaver Creek (1992)*** | | | | | | |
| 11.0/11.0 | 24* | n/a | MG | 61.0 | **NON** | Habitat effects |
| 7.0/7.0 | 32* | n/a | MG | 71.5 | PARTIAL | Dst. S. Amherst |
| 4.65/4.65 | 34* | 7.6* | MG | 70.5 | PARTIAL | Ust. Amherst WWTP |
| 2.95/2.95 | 24* | 6.2* | P | 68.5 | **NON** | Dst. Amherst WWTP |
| 1.75/1.75 | 26* | 6.7 | P | 70.0 | **NON** | Dst. Willow Creek |

Ecoregion Biocriteria: E. Corn Belt Plains (ECBP).

| INDEX - Site Type | WWH | EWH | MWH[d] |
|---|---|---|---|
| IBI - HW/Wading | 40 | 50 | 24 |
| Mod. Iwb - Wading | 8.3 | 9.4 | 5.8 |

* - significant departure from interim biocriteria; poor and very poor results are underlined.

ns - nonsignificant departure from interim biocriteria for WWH or EWH (4 IBI or ICI units; 0.5 Iwb units).

na - MIwb does not apply to sites <20 sq.mi. drainage area.

a - Narrative evaluation used in lieu of ICI (E=Exceptional; G=good; MG=Marginally good; F=Fair; P=Poor; VP=Very Poor).

b - Qualitative Habitat Evaluation Index (QHEI) values based on the new version (Rankin 1989).

c - Attainment status based on one organism group is parenthetically expressed.

Table 11. Sampling locations (water chemistry-C, benthos-B, fish-F) in the Beaver Creek study area, 1992.

| Stream/ River Mile | Type of Sampling | Latitude/Longitude | Landmark | Quad Map |
|---|---|---|---|---|
| ***Beaver Creek*** | | | | |
| 11.0 | C,B,F | 41°20'18"/82°14'40" | Russia Rd | Oberlin |
| 7.0 | C,B,F | 41°22'50"/82°14'25" | MiddleRidge Rd | Lorain |
| 4.65 | C,B,F | 41°24'08"/82°14'00" | West Martin St | Lorain |
| 3.85 | E | 41°24'33"/82°13'54" | WWTP Amherst | Lorain |
| 2.70 | C,B,F | 41°25'00"/82°13'32" | Cooper Foster | Lorain |
| 1.75 | C,B,F | 41°25'34"/82°13'59" | Longbrook Rd | Lorain |
| ***Willow Creek*** | | | | |
| 7.0 | C | 41°25'32"/82°13'40" | Kolbe Rd | Lorain |

Table 12. Exceedences of Ohio EPA Warmwater Habitat criteria (OAC 3745-1) for chemical / physical parameters measured in the Beaver Creek study area, 1992.

| Stream Name | River Mile | Violation: Parameter (value) |
|---|---|---|
| Beaver Creek | 11.00 | Dissolved Oxygen (3.25) |
| | 4.65 | Fecal coliform (29000, 13600) |
| | 2.90 | Fecal coliform (72600, 3250) |
| | 1.75 | Fecal coliform (41800) |
| | | Iron (5 of 18 samples (28%) exceeded 1.0 mg/l throughout the study area. |

Table 13. Stream characteristics and significant identified pollution sources in the Beaver Creek basin study area.

**Stream: Beaver Creek**
Length: 12.2 miles

Average Fall: 19.1 foot/mile

Drainage area: 43.93 square miles

Non Point Pollution Sources:
Agricultural, Urban runoff,unsewered urban, septic systems

Point Sources:
Major NPDES: Amherst WWTP
Minor NPDES: Westwood MHP WWTP
Ohio Turnpike Plaza 5 WWTP
Pinecrest Apt WWTP

## References

Fausch, D.O., Karr, J.R. and P.R. Yant. 1984. Regional application of an index of biotic integrity based on stream fish communities. Trans. Amer. Fish. Soc. 113:39-55.

Gammon, J.R. 1976. The fish populations of the middle 340 km of the Wabash River. Tech. Report No. 86. Purdue University. Water Resources Research Center, West Lafayette, Indiana. 73 pp.

Gammon, J.R., A. Spacie, J.L. Hamelink, and R.L. Kaesler. 1981. Role of electrofishing in assessing environmental quality of the Wabash River. pp. 307-324. In: Ecological assessments of effluent impacts on communities of indigenous aquatic organisms. ASTM STP 703, J.M. Bates and C.I. Weber (eds.). Philadelphia, PA.

Hughes, R. M., D. P. Larsen, and J. M. Omernik. 1986. Regional reference sites: a method for assessing stream pollution. Env. Mgmt. 10(5): 629-635.

Karr, J.R. 1981. Assessment of biotic integrity using fish communities. Fisheries 6 (6): 21-27.

Karr, J.R. and D.R. Dudley. 1981. Ecological perspective on water quality goals. Env. Mgmt. 5(1): 55-68.

Kelly, M. H., R. L. Hite. 1984. Evaluation of Illinois stream sediment data: 1974-1980. Illinois Environmental Protection Agency, Division of Water Pollution Control. Springfield, Illinois.

Limpach, C. W., 1993. Black River ripaian wildlife census summer-fall, 1992 Lorain County, Ohio. 61 pp. unpublished manuscript.

Ohio Department of Natural Resources. 1960. Gazetteer of Ohio streams. Ohio Dept. Natural Resources, Division of Water, Ohio Water Plan Inventory Report No. 12.

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

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

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

Ohio Environmental Protection Agency. 1989c. Ohio EPA policy for implementing chemical specific water quality based effluent limits and whole effluent toxicity controls in NPDES permits. Divisions of Water Pollution Control and Water Quality Planning and Assessment, Columbus, Ohio.

Ohio Environmental Protection Agency. 1990. A preliminary assessment of Ohio's Lake Erie fish communities. Division of Water Quality Planning and Assessment, Columbus, Ohio.

Ohio Environmental Protection Agency. 1992. Ohio water resource inventory. Volume I: Summary, Status, & Trends. Division of Water Quality Planning and Assessment, Columbus, Ohio.

Omernik, J. M. 1988. Ecoregions of the conterminous United States. Ann. Assoc. Amer. Geogr. 77(1): 118-125.

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

Rankin, E.T. and C.O. Yoder. 1991. Calculation and uses of the area of degradation value (ADV). Division of Water Quality Planning and Assessment, Columbus, Ohio.

Simpson, K.W. 1980. Abnormalities in the tracheal gills of aquatic insects collected from streams receiving chlorinated or crude oil waste. Freshwater Biology 10: 581-583.

Trautman, Milton B. 1981. The Fishes of Ohio. Ohio State University Press, Columbus, Ohio. 782 pp.

## Appendix tables:

Table C-1a. Values for the 1992 Black River study area by site and date for temperature ($^0$C), pH (S.U.), dissolved oxygen (ppm), conductivity (umhos/cm), arsenic (µg/l), cadmium (µg/l), calcium (mg/l), and chromium (µg/l).

| River | river mile | Date | temp. | pH | DO | Cond. | As | Cd | Ca | Cr |
|---|---|---|---|---|---|---|---|---|---|---|
| Black River | RM 0.01 | 92/07/08 | 23.0 | 8.01 | 6.8 | 403 | <2 | <2.0 | 40 | <30 |
| Black River | RM 0.01 | 92/08/06 | 21.5 | 7.70 | 6.9 | 350 | <2 | 0.3 | 38 | <30 |
| Black River | RM 0.01 | 92/08/12 | 23.7 | 8.00 | 6.6 | 422 | <2 | 0.2 | 38 | <30 |
| Black River | RM 0.01 | 92/09/09 | 21.5 | 7.50 | 5.7 | 403 | <2 | <0.2 | 41 | <30 |
| Black River | RM 0.01 | 92/09/17 | 21.5 | 7.60 | 6.4 | 401 | <2 | <0.2 | 39 | <30 |
| Black River | RM 0.01 | 92/10/01 | 17.5 | 7.40 | 6.3 | 250 | 2 | <0.2 | 42 | <30 |
| Black River | RM 1.05 | 92/07/08 | 23.0 | 7.85 | 4.5 | 480 | <2 | <0.2 | 48 | <30 |
| Black River | RM 1.05 | 92/08/06 | 21.0 | 7.80 | 7.0 | 470 | <2 | <0.2 | 47 | <30 |
| Black River | RM 1.05 | 92/08/12 | 24.5 | 7.90 | 6.6 | 515 | 2 | <0.2 | 52 | <30 |
| Black River | RM 1.05 | 92/09/09 | 22.0 | 7.30 | 4.1 | 518 | <2 | 0.2 | 48 | <30 |
| Black River | RM 1.05 | 92/09/17 | 21.0 | 7.50 | 4.6 | 490 | 2 | 0.2 | 46 | <30 |
| Black River | RM 1.05 | 92/10/01 | 18.0 | 7.60 | 6.1 | 300 | <2 | <0.2 | 47 | <30 |
| Black River | RM 1.84 | 92/07/08 | 23.0 | 7.68 | 3.9 | 543 | <2 | 0.2 | 50 | <30 |
| Black River | RM 1.84 | 92/08/06 | 21.5 | 7.90 | 7.1 | 466 | <2 | <0.2 | 52 | <30 |
| Black River | RM 1.84 | 92/08/12 | 24.8 | 7.80 | 5.5 | 575 | 3 | <0.2 | 57 | <30 |
| Black River | RM 1.84 | 92/09/09 | 22.3 | 7.40 | 4.6 | 536 | 4 | 0.3 | 49 | <30 |
| Black River | RM 1.84 | 92/09/17 | 21.0 | 7.50 | 4.7 | 523 | 2 | 0.2 | 49 | <30 |
| Black River | RM 1.84 | 92/10/01 | 17.9 | 7.70 | 6.2 | 337 | 3 | <0.2 | 49 | <30 |
| Black River | RM 2.9 | 92/07/08 | 24.5 | 7.83 | 5.4 | 650 | <2 | <0.2 | 54 | <30 |
| Black River | RM 2.9 | 92/08/06 | 22.0 | 7.80 | 7.4 | 440 | <2 | <0.2 | 52 | <30 |
| Black River | RM 2.9 | 92/08/12 | 25.8 | 8.00 | 7.6 | 610 | 3 | <0.2 | 60 | <30 |
| Black River | RM 2.9 | 92/09/09 | 23.3 | 7.50 | 5.7 | 530 | 2 | <0.2 | 50 | <30 |
| Black River | RM 2.9 | 92/09/17 | 22.5 | 7.50 | 5.7 | 572 | <2 | 0.3 | 52 | <30 |
| Black River | RM 2.9 | 92/10/01 | 17.1 | 7.75 | 6.9 | 400 | 2 | <0.2 | 51 | <30 |
| Black River | RM 3.7 | 92/07/08 | 25.0 | 8.31 | 8.7 | 900 | <2 | <0.2 | 68 | <30 |
| Black River | RM 3.7 | 92/08/06 | 19.8 | 7.80 | 8.4 | 447 | 3 | <0.2 | 61 | <30 |
| Black River | RM 3.7 | 92/08/12 | 9.5 | 7.80 | 24.5 | 790 | 3 | 0.3 | 67 | <30 |
| Black River | RM 3.7 | 92/09/09 | 21.2 | 7.50 | 6.7 | 585 | <2 | <0.2 | 51 | <30 |
| Black River | RM 3.7 | 92/09/17 | 21.0 | 7.70 | 7.0 | 575 | <2 | <0.2 | 57 | <30 |
| Black River | RM 3.7 | 92/10/01 | 17.0 | 8.15 | 7.5 | 455 | 2 | <0.2 | 51 | <30 |
| Black River | RM 4.2 | 92/07/08 | 23.5 | 8.55 | 12.7 | 1000 | <2 | 0.3 | 70 | <30 |
| Black River | RM 4.2 | 92/08/06 | 20.5 | 7.80 | 8.3 | 570 | 2 | <0.2 | 64 | <30 |
| Black River | RM 4.2 | 92/08/12 | 23.7 | 7.80 | 7.8 | 685 | 2 | <0.2 | 70 | <30 |
| Black River | RM 4.2 | 92/09/09 | 21.0 | 7.50 | 6.9 | 590 | <2 | <0.2 | 59 | <30 |
| Black River | RM 4.2 | 92/09/17 | 21.5 | 7.80 | 7.8 | 575 | <2 | 0.2 | 58 | <30 |
| Black River | RM 4.2 | 92/10/01 | 13.5 | 8.05 | 9.7 | 430 | 2 | 0.2 | 61 | <30 |
| Black River | RM 5.3 | 92/07/08 | 22.0 | 8.80 | 14.4 | 1100 | 2 | 0.5 | 66 | <30 |
| Black River | RM 5.3 | 92/08/06 | 18.0 | 7.80 | 8.7 | 480 | 2 | 0.2 | 56 | <30 |
| Black River | RM 5.3 | 92/08/12 | 23.0 | 8.20 | 8.0 | 635 | 2 | <0.2 | 67 | <30 |
| Black River | RM 5.3 | 92/09/09 | 20.0 | 7.70 | 7.4 | 590 | <2 | 0.2 | 52 | <30 |
| Black River | RM 5.3 | 92/09/17 | 21.5 | 7.80 | 7.8 | 575 | <2 | <0.2 | 57 | <30 |
| Black River | RM 5.3 | 92/10/01 | 13.0 | 8.10 | 9.5 | 450 | 2 | 0.2 | 61 | <30 |
| Black River | RM 8.35 | 92/07/08 | 21.2 | 8.10 | 9.8 | 1024 | <2 | 0.5 | 67 | <30 |
| Black River | RM 8.35 | 92/08/06 | 19.0 | 7.90 | 8.5 | 451 | 2 | <0.2 | 54 | <30 |
| Black River | RM 8.35 | 92/08/12 | 21.8 | 8.30 | 8.4 | 643 | <2 | <0.2 | 68 | <30 |
| Black River | RM 8.35 | 92/09/09 | 19.5 | 8.00 | 8.3 | 520 |  | 0.2 | 50 | <30 |
| Black River | RM 8.35 | 92/09/17 | 19.0 | 8.20 | 8.4 | 525 | <2 | <0.2 | 55 | <30 |
| Black River | RM 8.35 | 92/10/01 | 10.0 | 8.30 | 9.9 | 460 | 2 | 0.3 | 59 | <30 |

Table C-1a. (cont.)

| River | river mile | Date | temp. | pH | DO | Cond. | As | Cd | Ca | Cr |
|---|---|---|---|---|---|---|---|---|---|---|
| Black River | RM 9.8 | 92/07/08 | 21.5 | 8.10 | 9.0 | 1150 | <2 | 0.5 | 66 | <30 |
| Black River | RM 9.8 | 92/08/06 | 19.0 | 7.70 | 8.1 | 446 | 2 | <0.2 | 54 | <30 |
| Black River | RM 9.8 | 92/08/12 | 22.0 | 8.25 | 8.2 | 702 | <2 | <0.2 | 70 | <30 |
| Black River | RM 9.8 | 92/09/09 | 19.7 | 7.90 | 8.3 | 550 | | 0.3 | 52 | <30 |
| Black River | RM 9.8 | 92/09/17 | 19.0 | 8.10 | 7.8 | 700 | <2 | <0.2 | 56 | <30 |
| Black River | RM 9.8 | 92/10/01 | 11.0 | 8.20 | 9.4 | 600 | <2 | 0.3 | 61 | <30 |
| Black River | RM 11.5 | 92/07/08 | 22.0 | 8.45 | 10.6 | 563 | <2 | 0.4 | 70 | <30 |
| Black River | RM 11.5 | 92/08/06 | 18.8 | 7.50 | 8.5 | 400 | <2 | <0.2 | 52 | <30 |
| Black River | RM 11.5 | 92/08/12 | 22.0 | 8.37 | 8.2 | 515 | <2 | <0.2 | 69 | <30 |
| Black River | RM 11.5 | 92/09/09 | 19.6 | 7.80 | 8.3 | 270 | | 0.3 | 48 | <30 |
| Black River | RM 11.5 | 92/09/17 | 18.0 | 8.30 | 8.2 | 390 | <2 | <0.2 | 54 | <30 |
| Black River | RM 11.5 | 92/10/01 | 10.0 | 8.30 | 10.0 | 360 | 3 | 0.2 | 61 | <30 |
| Black River | RM 14.95 | 92/07/08 | 22.0 | 8.70 | 10.3 | 598 | <2 | 0.2 | 76 | <30 |
| Black River | RM 14.95 | 92/08/06 | 18.5 | 7.00 | 8.8 | 381 | <2 | <0.2 | 52 | <30 |
| Black River | RM 14.95 | 92/08/12 | 22.5 | 8.32 | 7.9 | 545 | <2 | <0.2 | 71 | <30 |
| Black River | RM 14.95 | 92/09/09 | 19.8 | 8.00 | 7.8 | 390 | | <0.2 | 48 | <30 |
| Black River | RM 14.95 | 92/09/17 | 19.0 | 8.30 | 8.1 | 400 | 3 | <0.2 | 55 | <30 |
| Black River | RM 14.95 | 92/10/01 | 11.0 | 8.30 | 9.5 | 360 | 2 | 0.3 | 62 | <30 |
| Buck Creek | RM 0.95 | 92/07/08 | 17.0 | 8.00 | 4.6 | 1110 | 2 | <0.2 | 82 | <30 |
| Buck Creek | RM 0.95 | 92/08/12 | 17.0 | 8.30 | 5.7 | 510 | 2 | <0.2 | 89 | <30 |
| Buck Creek | RM 0.95 | 92/09/09 | 16.0 | 8.00 | 5.4 | 520 | <2 | <0.2 | 90 | <30 |
| Buck Creek | RM 0.95 | 92/09/30 | 8.0 | 7.80 | 6.4 | 440 | <2 | 1.1 | 85 | <30 |
| Charlemont Creek | RM 0.5 | 92/07/08 | 17.0 | 7.70 | 4.0 | 860 | 3 | 0.2 | 98 | <30 |
| Charlemont Creek | RM 0.5 | 92/08/12 | 18.0 | 8.00 | 6.4 | 660 | <2 | <0.2 | 94 | <30 |
| Charlemont Creek | RM 0.5 | 92/09/09 | 17.0 | 8.10 | 7.1 | 590 | <2 | <0.2 | 83 | <30 |
| Charlemont Creek | RM 0.5 | 92/09/30 | 8.0 | 7.90 | 8.5 | 505 | <2 | <0.2 | 83 | <30 |
| Charlemont Creek | RM 0.6 | 92/07/08 | 18.0 | 8.00 | 5.4 | 740 | 2 | <0.2 | 72 | <30 |
| Charlemont Creek | RM 0.6 | 92/08/12 | 18.0 | 8.10 | 5.2 | 660 | <2 | <0.2 | 97 | <30 |
| Charlemont Creek | RM 0.6 | 92/09/09 | 17.0 | 8.10 | 7.6 | 505 | <2 | <0.2 | 82 | <30 |
| Charlemont Creek | RM 0.6 | 92/09/30 | 8.0 | 8.00 | 8.6 | 300 | <2 | <0.2 | 83 | <30 |
| E. FK. E. BR. | RM 1.6 | 92/07/08 | 21.8 | 8.00 | 9.0 | 1550 | 2 | 0.3 | 90 | <30 |
| E. FK. E. BR. | RM 1.6 | 92/08/12 | 19.0 | 7.80 | 8.0 | 918 | <2 | <0.2 | 87 | <30 |
| E. FK. E. BR. | RM 1.6 | 92/09/09 | 20.0 | 8.00 | 8.6 | 1140 | <2 | 0.6 | 92 | <30 |
| E. FK. E. BR. | RM 1.6 | 92/09/30 | 10.0 | 8.00 | 8.7 | 750 | 2 | 0.7 | 89 | <30 |
| E. FK. E. BR. | RM 2.67 | 92/07/08 | 22.5 | 8.40 | 5.7 | 908 | <2 | <0.2 | 92 | <30 |
| E. FK. E. BR. | RM 2.67 | 92/08/12 | 18.0 | 8.00 | 9.4 | 520 | <2 | <0.2 | 74 | <30 |
| E. FK. E. BR. | RM 2.67 | 92/09/09 | 19.2 | 8.50 | 12.3 | 800 | <2 | <0.2 | 85 | <30 |
| E. FK. E. BR. | RM 2.67 | 92/09/30 | 8.0 | 8.20 | 10.0 | 395 | <2 | <0.2 | 78 | <30 |
| E.Br.Black R. | RM 0.36 | 92/07/08 | 22.5 | 8.50 | 6.4 | 690 | <2 | 0.2 | 76 | <30 |
| E.Br.Black R. | RM 0.36 | 92/08/12 | 23.0 | 8.36 | 7.2 | 545 | <2 | 0.3 | 71 | <30 |
| E.Br.Black R. | RM 0.36 | 92/09/09 | 20.5 | 7.80 | 7.0 | 364 | <2 | 0.5 | 45 | <30 |
| E.Br.Black R. | RM 0.36 | 92/10/01 | 11.0 | 8.30 | 9.1 | 380 | 2 | 0.6 | 63 | <30 |
| E.Br.Black R.. | RM 3.07 | 92/07/08 | 20.7 | 7.90 | 6.6 | 460 | <2 | <0.2 | 54 | <30 |
| E.Br.Black R.. | RM 3.07 | 92/08/12 | 21.0 | 8.08 | 7.7 | 574 | <2 | <0.2 | 79 | <30 |
| E.Br.Black R.. | RM 3.07 | 92/09/09 | 19.5 | 8.00 | 7.8 | 400 | 2 | <0.2 | 46 | <30 |
| E.Br.Black R.. | RM 3.07 | 92/10/01 | 10.0 | 8.30 | 9.6 | 380 | <2 | <0.2 | 68 | <30 |
| E.Br.Black R.. | RM 5.2 | 92/07/08 | 21.1 | 7.30 | 6.8 | 458 | 2 | <0.2 | 49 | <30 |
| E.Br.Black R.. | RM 5.2 | 92/08/12 | 23.5 | 8.20 | 9.8 | 612 | <2 | <0.2 | 79 | <30 |
| E.Br.Black R.. | RM 5.2 | 92/09/09 | 19.1 | 8.00 | 6.9 | 390 | <2 | <0.2 | 51 | <30 |
| E.Br.Black R.. | RM 5.2 | 92/09/30 | 12.0 | 8.10 | 9.6 | 480 | 2 | <0.2 | 66 | <30 |

Table C-1a. (cont.)

| River | river mile | Date | temp. | pH | DO | Cond. | As | Cd | Ca | Cr |
|---|---|---|---|---|---|---|---|---|---|---|
| E.Br.Black R.. | RM 6.0 | 92/07/08 | 21.2 | 7.40 | 6.9 | 424 | <2 | <0.2 | 46 | <30 |
| E.Br.Black R.. | RM 6.0 | 92/08/12 | 23.3 | 8.10 | 8.5 | 612 | <2 | <0.2 | 82 | <30 |
| E.Br.Black R.. | RM 6.0 | 92/09/09 | 20.0 | 8.00 | 6.8 | 380 | 2 | <0.2 | 49 | <30 |
| E.Br.Black R.. | RM 6.0 | 92/09/30 | 12.5 | 8.10 | 9.5 | 495 | 2 | <0.2 | 66 | <30 |
| E.Br.Black R.. | RM 10.5 | 92/07/08 | 21.8 | 7.70 | 9.2 | 398 | <2 | <0.2 | 47 | <30 |
| E.Br.Black R.. | RM 10.5 | 92/08/12 | 24.7 | 8.40 | 10.1 | 600 | 2 | <0.2 | 73 | <30 |
| E.Br.Black R.. | RM 10.5 | 92/09/09 | 19.5 | 8.20 | 8.5 | 445 | <2 | <0.2 | 57 | <30 |
| E.Br.Black R.. | RM 10.5 | 92/09/30 | 12.0 | 8.10 | 10.0 | 500 | <2 | <0.2 | 72 | <30 |
| E.Br.Black R.. | RM 11.3 | 92/07/08 | 21.8 | 7.50 | 7.5 | 397 | 4 | <0.2 | 50 | <30 |
| E.Br.Black R.. | RM 11.3 | 92/08/12 | 22.7 | 8.20 | 8.9 | 570 | <2 | <0.2 | 72 | <30 |
| E.Br.Black R.. | RM 11.3 | 92/09/09 | 19.0 | 8.10 | 7.7 | 410 | <2 | <0.2 | 55 | <30 |
| E.Br.Black R.. | RM 11.3 | 92/09/30 | 12.0 | 8.10 | 9.8 | 480 | 3 | <0.2 | 73 | <30 |
| E.Br.Black R.. | RM 18.94 | 92/07/08 | 20.8 | 7.50 | 5.9 | 602 | 3 | <0.2 | 70 | <30 |
| E.Br.Black R.. | RM 18.94 | 92/08/12 | 21.9 | 7.90 | 6.6 | 570 | <2 | <0.2 | 79 | <30 |
| E.Br.Black R.. | RM 18.94 | 92/09/09 | 19.1 | 8.00 | 6.3 | 575 | <2 | <0.2 | 73 | <30 |
| E.Br.Black R.. | RM 18.94 | 92/09/30 | 11.0 | 7.90 | 8.5 | 480 | 2 | <0.2 | 74 | <30 |
| E.Br.Black R.. | RM 32.42 | 92/07/08 | 21.1 | 7.70 | 5.4 | 806 | <2 | <0.2 | 93 | <30 |
| E.Br.Black R.. | RM 32.42 | 92/08/12 | 21.8 | 7.80 | 6.5 | 540 | <2 | <0.2 | 73 | <30 |
| E.Br.Black R.. | RM 32.42 | 92/09/09 | 19.5 | 7.90 | 6.2 | 760 | 3 | <0.2 | 90 | <30 |
| E.Br.Black R.. | RM 32.42 | 92/09/30 | 11.0 | 7.90 | 8.4 | 520 | 2 | <0.2 | 81 | <30 |
| E.Br.Black R.. | RM 41.45 | 92/07/08 | 20.7 | 7.70 | 8.0 | 826 | <2 | <0.2 | 104 | <30 |
| E.Br.Black R.. | RM 41.45 | 92/08/12 | 21.0 | 7.90 | 7.3 | 612 | 2 | <0.2 | 87 | <30 |
| E.Br.Black R.. | RM 41.45 | 92/09/09 | 19.5 | 8.00 | 7.5 | 800 | <2 | 0.2 | 101 | <30 |
| E.Br.Black R.. | RM 41.45 | 92/09/30 | 10.5 | 8.00 | 8.7 | 570 | <2 | <0.2 | 88 | <30 |
| French Creek | RM 0.54 | 92/07/08 | 19.2 | 8.12 | 8.9 | 862 | <2 | <0.2 | 70 | <30 |
| French Creek | RM 0.54 | 92/08/12 | 21.5 | 8.07 | 7.1 | 851 | <2 | <0.2 | 86 | <30 |
| French Creek | RM 0.54 | 92/09/09 | 18.8 | 8.00 | 8.7 | 630 | <2 | <0.2 | 75 | <30 |
| French Creek | RM 0.54 | 92/10/01 | 9.0 | 8.30 | 9.0 | 700 | <2 | <0.2 | 82 | <30 |
| French Creek | RM 3.2 | 92/07/08 | 20.5 | 8.13 | 8.4 | 931 | <2 | <0.2 | 87 | <30 |
| French Creek | RM 3.2 | 92/08/12 | 20.5 | 8.13 | 8.1 | 801 | 2 | <0.2 | 85 | <30 |
| French Creek | RM 3.2 | 92/09/09 | 18.5 | 8.00 | 8.7 | 700 | <2 | <0.2 | 84 | <30 |
| French Creek | RM 3.2 | 92/10/01 | 8.0 | 8.50 | 9.5 | 600 | 2 | <0.2 | 87 | <30 |
| Plum Creek | RM 0.83 | 92/07/08 | 18.0 | 8.10 | 7.8 | 900 | 2 | <0.2 | 77 | <30 |
| Plum Creek | RM 0.83 | 92/08/12 | 18.0 | 8.00 | 7.8 | 800 | <2 | <0.2 | 80 | <30 |
| Plum Creek | RM 0.83 | 92/09/09 | 18.0 | 8.00 | 7.6 | 750 | <2 | <0.2 | 81 | <30 |
| Plum Creek | RM 0.83 | 92/09/30 | 10.0 | 8.00 | 9.6 | 650 | <2 | <0.2 | 77 | <30 |
| Plum Creek | RM 3.19 | 92/07/08 | 19.0 | 8.20 | 7.9 | 770 | 2 | <0.2 | 77 | <30 |
| Plum Creek | RM 3.19 | 92/08/12 | 18.0 | 8.10 | 6.9 | 690 | <2 | <0.2 | 87 | <30 |
| Plum Creek | RM 3.19 | 92/09/09 | 17.0 | 8.10 | 7.5 | 610 | 2 | <0.2 | 87 | <30 |
| Plum Creek | RM 3.19 | 92/09/30 | 8.0 | 8.20 | 9.7 | 520 | <2 | <0.2 | 97 | <30 |
| Plum Creek | RM 7.0 | 92/07/08 | 12.0 | 7.60 | 1.7 | 920 | 5 | <0.2 | 108 | <30 |
| Plum Creek | RM 7.0 | 92/08/12 | 13.0 | 7.70 | 1.5 | 850 | 5 | <0.2 | 107 | <30 |
| Plum Creek | RM 7.0 | 92/09/09 | 16.0 | 7.80 | 3.9 | 580 | 3 | <0.2 | 76 | <30 |
| Plum Creek | RM 7.0 | 92/09/30 | 8.0 | 7.70 | 8.0 | 530 | 3 | <0.2 | 83 | <30 |
| W. FK. E. BR. | RM 4.13 | 92/07/08 | 21.9 | 8.00 | 9.9 | 663 | <2 | <0.2 | 68 | <30 |
| W. FK. E. BR. | RM 4.13 | 92/08/12 | 21.0 | 8.30 | 10.3 | 500 | <2 | <0.2 | 57 | <30 |
| W. FK. E. BR. | RM 4.13 | 92/09/09 | 19.0 | 8.40 | 10.8 | 575 | <2 | <0.2 | 65 | <30 |
| W. FK. E. BR. | RM 4.13 | 92/09/30 | 8.5 | 8.10 | 10.1 | 465 | <2 | <0.2 | 70 | <30 |
| W.Br.Black R. | RM 0.24 | 92/07/08 | 21.6 | 8.00 | 6.7 | 575 | <2 | <0.2 | 69 | <30 |
| W.Br.Black R. | RM 0.24 | 92/08/12 | 21.5 | | 7.3 | 545 | <2 | <0.2 | 74 | <30 |

Table C-1a. (cont.)

| River | river mile | Date | temp. | pH | DO | Cond. | As | Cd | Ca | Cr |
|---|---|---|---|---|---|---|---|---|---|---|
| W.Br.Black R. | RM 0.24 | 92/09/09 | 18.7 | 8.00 | 8.0 | 400 | 2 | <0.2 | 53 | <30 |
| W.Br.Black R. | RM 0.24 | 92/10/01 | 10.0 | 8.10 | 8.8 | 332 | 3 | <0.2 | 59 | <30 |
| W.Br.Black R. | RM 4.18 | 92/07/08 | 20.7 | 8.00 | 7.7 | 494 | <2 | <0.2 | 74 | <30 |
| W.Br.Black R. | RM 4.18 | 92/08/12 | 21.8 | 7.70 | 7.4 | 573 | <2 | <0.2 | 75 | <30 |
| W.Br.Black R. | RM 4.18 | 92/09/09 | 19.5 | 7.80 | 7.4 | 364 | 2 | <0.2 | 56 | <30 |
| W.Br.Black R. | RM 4.18 | 92/10/01 | 11.0 | 8.00 | 6.7 | 360 | 2 | <0.2 | 63 | <30 |
| W.Br.Black R. | RM 14.39 | 92/07/08 | 19.0 | 8.30 | 7.0 | 600 | 2 | <0.2 | 76 | <30 |
| W.Br.Black R. | RM 14.39 | 92/08/12 | 19.0 | 8.30 | 6.8 | 630 | 2 | <0.2 | 95 | <30 |
| W.Br.Black R. | RM 14.39 | 92/09/09 | 18.0 | 8.20 | 6.5 | 460 | <2 | <0.2 | 69 | <30 |
| W.Br.Black R. | RM 14.39 | 92/09/30 | 9.0 | 8.10 | 8.0 | 392 | 2 | <0.2 | 73 | <30 |
| W.Br.Black R. | RM 25.3 | 92/07/08 | 18.0 | 8.00 | 6.1 | 700 | 3 | <0.2 | 83 | <30 |
| W.Br.Black R. | RM 25.3 | 92/08/12 | 18.0 | 8.10 | 6.1 | 680 | <2 | <0.2 | 97 | <30 |
| W.Br.Black R. | RM 25.3 | 92/09/09 | 17.0 | 8.20 | 7.5 | 500 | 2 | <0.2 | 78 | <30 |
| W.Br.Black R. | RM 25.3 | 92/09/30 | 8.0 | 7.90 | 8.6 | 465 | <2 | <0.2 | 80 | <30 |
| W.Br.Black R. | RM 41.67 | 92/07/08 | 16.0 | 8.10 | 5.6 | 700 | <2 | <0.2 | 110 | <30 |
| W.Br.Black R. | RM 41.67 | 92/08/12 | 18.0 | 8.20 | 6.3 | 610 | <2 | <0.2 | 103 | <30 |
| W.Br.Black R. | RM 41.67 | 92/09/09 | 16.0 | 8.10 | 6.3 | 600 | <2 | <0.2 | 106 | <30 |
| W.Br.Black R. | RM 41.67 | 92/09/30 | 8.0 | 7.80 | 8.8 | 500 | <2 | <0.2 | 102 | <30 |
| Wellington Creek | RM 10.83 | 92/07/08 | 19.0 | 8.00 | 1.7 | 510 | 6 | <0.2 | 177 | <30 |
| Wellington Creek | RM 10.83 | 92/08/12 | 17.0 | 7.90 | 4.4 | 600 | 2 | <0.2 | 88 | <30 |
| Wellington Creek | RM 10.83 | 92/09/09 | 18.0 | 7.90 | 9.3 | 430 | 4 | <0.2 | 64 | <30 |
| Wellington Creek | RM 10.83 | 92/09/30 | 8.0 | 7.80 | 8.2 | 355 | 4 | <0.2 | 62 | <30 |
| Wellington Creek | RM 13.09 | 92/07/08 | 19.0 | 8.70 | 2.5 | 387 | 4 | <0.2 | 77 | <30 |
| Wellington Creek | RM 13.09 | 92/08/12 | 18.0 | 7.90 | 4.4 | 590 | <2 | <0.2 | 81 | <30 |
| Wellington Creek | RM 13.09 | 92/09/09 | 17.0 | 8.10 | 5.9 | 370 | 4 | <0.2 | 52 | <30 |
| Wellington Creek | RM 13.09 | 92/09/30 | 9.0 | 7.90 | 7.3 | 305 | 4 | <0.2 | 52 | <30 |
| Willow Creek | RM 2.85 | 92/07/08 | 18.2 | 7.70 | 6.9 | 552 | 6 | <0.2 | 65 | <30 |
| Willow Creek | RM 2.85 | 92/08/12 | 20.0 | 7.68 | 5.5 | 446 | <2 | <0.2 | 53 | <30 |
| Willow Creek | RM 2.85 | 92/09/09 | 18.5 | 7.90 | 6.0 | 430 | 4 | <0.2 | 58 | <30 |
| Willow Creek | RM 2.85 | 92/10/01 | 8.0 | 7.70 | 7.9 | 425 | 3 | <0.2 | 61 | <30 |

Table C-1b. Values for the 1992 Black River study area by site and date for copper (µg/l), lead (µg/l), magnesium (mg/l), nickel (µg/l), zinc (µg/l), hardness (mg/l), $cBOD_5$ (mg/l), and COD (mg/l).

| River | river mile | Date | Cu | Pb | Mg | Ni | Zn | Hardness | $cBOD_5$ | COD |
|---|---|---|---|---|---|---|---|---|---|---|
| Black River | RM 0.01 | 92/07/08 | <10 | <2 | 10 | <40 | <10 | 141 | | <10 |
| Black River | RM 0.01 | 92/08/06 | <10 | <2 | 10 | <40 | 25 | 136 | 2.0 | 25 |
| Black River | RM 0.01 | 92/08/12 | <10 | <2 | | <40 | 11 | 136 | 1.3 | 23 |
| Black River | RM 0.01 | 92/09/09 | 12 | 3 | 10 | <40 | 30 | 144 | 1.1 | 27 |
| Black River | RM 0.01 | 92/09/17 | <10 | <2 | 10 | <40 | 18 | 139 | 1.4 | 24 |
| Black River | RM 0.01 | 92/10/01 | <10 | <2 | 11 | <40 | <10 | 150 | 1.1 | 13 |
| Black River | RM 1.05 | 92/07/08 | <10 | <2 | 13 | <40 | <10 | 173 | | <10 |
| Black River | RM 1.05 | 92/08/06 | <10 | <2 | 11 | <40 | 18 | 163 | 1.4 | 24 |
| Black River | RM 1.05 | 92/08/12 | <10 | <2 | 13 | <40 | 10 | 183 | 2.6 | 33 |
| Black River | RM 1.05 | 92/09/09 | <10 | 4 | 11 | <40 | 22 | 165 | | 32 |
| Black River | RM 1.05 | 92/09/17 | <10 | 3 | 12 | <40 | 15 | 164 | 1.1 | 24 |
| Black River | RM 1.05 | 92/10/01 | <10 | 3 | 12 | <40 | <10 | 167 | <1.0 | 14 |
| Black River | RM 1.84 | 92/07/08 | <10 | <2 | 13 | <40 | 20 | 178 | | <10 |
| Black River | RM 1.84 | 92/08/06 | <10 | <2 | 12 | <40 | <10 | 179 | <1.0 | 26 |
| Black River | RM 1.84 | 92/08/12 | <10 | <2 | 14 | <40 | <10 | 200 | 1.8 | 30 |
| Black River | RM 1.84 | 92/09/09 | <10 | 4 | 12 | <40 | 21 | 172 | <1.0 | 32 |
| Black River | RM 1.84 | 92/09/17 | <10 | 2 | 12 | <40 | 13 | 172 | 1.0 | 26 |
| Black River | RM 1.84 | 92/10/01 | <10 | 2 | 12 | <40 | 11 | 172 | <1.0 | 15 |
| Black River | RM 2.9 | 92/07/08 | <10 | <2 | 15 | <40 | <10 | 197 | | <10 |
| Black River | RM 2.9 | 92/08/06 | <10 | <2 | 13 | <40 | <10 | 183 | <1.0 | 34 |
| Black River | RM 2.9 | 92/08/12 | <10 | <2 | 15 | <40 | <10 | 212 | 2.1 | 34 |
| Black River | RM 2.9 | 92/09/09 | <10 | 4 | 11 | <40 | 15 | 170 | <1.0 | 34 |
| Black River | RM 2.9 | 92/09/17 | <10 | 5 | 14 | <40 | 22 | 187 | 1.4 | 21 |
| Black River | RM 2.9 | 92/10/01 | <10 | 2 | 14 | <40 | 12 | 185 | 1.0 | 15 |
| Black River | RM 3.7 | 92/07/08 | <10 | <2 | 23 | 42 | <10 | 265 | | 16 |
| Black River | RM 3.7 | 92/08/06 | <10 | <2 | 15 | <40 | <10 | 214 | <1.0 | 26 |
| Black River | RM 3.7 | 92/08/12 | <10 | 3 | 18 | <40 | 11 | 241 | 3.6 | 34 |
| Black River | RM 3.7 | 92/09/09 | <10 | 3 | 12 | <40 | 15 | 177 | <1.0 | 27 |
| Black River | RM 3.7 | 92/09/17 | <10 | 2 | 14 | <40 | 11 | 200 | 1.0 | 26 |
| Black River | RM 3.7 | 92/10/01 | <10 | <2 | 13 | <40 | 12 | 181 | 1.0 | 18 |
| Black River | RM 4.2 | 92/07/08 | <10 | 4 | 23 | <40 | <10 | 270 | | 26 |
| Black River | RM 4.2 | 92/08/06 | <10 | 6 | 13 | <40 | 11 | 213 | 2.9 | 38 |
| Black River | RM 4.2 | 92/08/12 | <10 | 4 | 19 | <40 | <10 | 253 | 1.8 | 28 |
| Black River | RM 4.2 | 92/09/09 | <10 | 3 | 13 | <40 | 18 | 201 | 2.0 | 36 |
| Black River | RM 4.2 | 92/09/17 | <10 | 3 | 15 | <40 | <10 | 207 | 1.1 | 26 |
| Black River | RM 4.2 | 92/10/01 | <10 | <2 | 19 | <40 | <10 | 231 | <1.0 | 28 |
| Black River | RM 5.3 | 92/07/08 | <10 | <2 | 30 | <40 | <10 | 288 | | 13 |
| Black River | RM 5.3 | 92/08/06 | <10 | <2 | 14 | <40 | <10 | 197 | 2.9 | 36 |
| Black River | RM 5.3 | 92/08/12 | <10 | <2 | 19 | <40 | 41 | 246 | 1.5 | 31 |
| Black River | RM 5.3 | 92/09/09 | <10 | <2 | 14 | <40 | 13 | 187 | <1.0 | 40 |
| Black River | RM 5.3 | 92/09/17 | <10 | <2 | 17 | <40 | 13 | 212 | 1.6 | 28 |
| Black River | RM 5.3 | 92/10/01 | <10 | <2 | 20 | <40 | <10 | 235 | <1.0 | 15 |
| Black River | RM 8.35 | 92/07/08 | <10 | <2 | 31 | <40 | <10 | 295 | | 19 |
| Black River | RM 8.35 | 92/08/06 | <10 | <2 | 15 | <40 | <10 | 197 | 1.6 | 31 |
| Black River | RM 8.35 | 92/08/12 | <10 | <2 | 20 | <40 | <10 | 252 | 1.8 | 32 |

Table C-1b. (cont.)

| River | river mile | Date | Cu | Pb | Mg | Ni | Zn | Hardness | $cBOD_5$ | COD |
|---|---|---|---|---|---|---|---|---|---|---|
| Black River | RM 8.35 | 92/09/09 | <10 | 2 | 14 | <40 | <10 | 182 | <1.0 | 29 |
| Black River | RM 8.35 | 92/09/17 | <10 | <2 | 16 | <40 | <10 | 203 | <1.0 | 20 |
| Black River | RM 8.35 | 92/10/01 | <10 | <2 | 18 | <40 | <10 | 221 | <1.0 | 15 |
| Black River | RM 9.8 | 92/07/08 | <10 | <2 | 32 | <40 | <10 | 297 | | 18 |
| Black River | RM 9.8 | 92/08/06 | <10 | 2 | 15 | <40 | <10 | 197 | | 33 |
| Black River | RM 9.8 | 92/08/12 | <10 | <2 | 21 | <40 | <10 | 261 | | 33 |
| Black River | RM 9.8 | 92/09/09 | 10 | 4 | 15 | <40 | 15 | 192 | 1.1 | 30 |
| Black River | RM 9.8 | 92/09/17 | <10 | <2 | 19 | <40 | 11 | 218 | 1.0 | 24 |
| Black River | RM 9.8 | 92/10/01 | <10 | <2 | 22 | <40 | <10 | 243 | | 14 |
| Black River | RM 11.5 | 92/07/08 | <10 | <2 | 23 | <40 | <10 | 270 | | 23 |
| Black River | RM 11.5 | 92/08/06 | <10 | <2 | 14 | <40 | <10 | 187 | | 28 |
| Black River | RM 11.5 | 92/08/12 | <10 | <2 | 18 | <40 | <10 | 246 | | 34 |
| Black River | RM 11.5 | 92/09/09 | 10 | 2 | 12 | <40 | <10 | 169 | <1.0 | 22 |
| Black River | RM 11.5 | 92/09/17 | <10 | <2 | 14 | <40 | <10 | 192 | 1.2 | 26 |
| Black River | RM 11.5 | 92/10/01 | <10 | <2 | 16 | <40 | <10 | 218 | | 17 |
| Black River | RM 14.95 | 92/07/08 | <10 | <2 | 23 | <40 | <10 | 284 | | 19 |
| Black River | RM 14.95 | 92/08/06 | <10 | 2 | 14 | <40 | <10 | 187 | | 27 |
| Black River | RM 14.95 | 92/08/12 | <10 | <2 | 18 | <40 | <10 | 251 | | 32 |
| Black River | RM 14.95 | 92/09/09 | <10 | <2 | 12 | <40 | <10 | 169 | <1.0 | 25 |
| Black River | RM 14.95 | 92/09/17 | <10 | <2 | 14 | <40 | <10 | 195 | 1.2 | 22 |
| Black River | RM 14.95 | 92/10/01 | <10 | <2 | 16 | <40 | <10 | 221 | | 15 |
| Buck Creek | RM 0.95 | 92/07/08 | <10 | 4 | 21 | <40 | <10 | 291 | | 22 |
| Buck Creek | RM 0.95 | 92/08/12 | 11 | <2 | 24 | <40 | 14 | 321 | | 34 |
| Buck Creek | RM 0.95 | 92/09/09 | <10 | <2 | 23 | <40 | <10 | 319 | | 21 |
| Buck Creek | RM 0.95 | 92/09/30 | <10 | <2 | 24 | <40 | <10 | 311 | | 22 |
| Charlemont Creek | RM 0.5 | 92/07/08 | <10 | <2 | 31 | <40 | <10 | 372 | | 44 |
| Charlemont Creek | RM 0.5 | 92/08/12 | <10 | 2 | 27 | <40 | 46 | 346 | | 32 |
| Charlemont Creek | RM 0.5 | 92/09/09 | <10 | <2 | 23 | <40 | 13 | 302 | | 23 |
| Charlemont Creek | RM 0.5 | 92/09/30 | <10 | <2 | 26 | <40 | <10 | 314 | | 25 |
| Charlemont Creek | RM 0.6 | 92/07/08 | <10 | <2 | 25 | <40 | <10 | 283 | | 18 |
| Charlemont Creek | RM 0.6 | 92/08/12 | <10 | <2 | 29 | <40 | 11 | 362 | | 32 |
| Charlemont Creek | RM 0.6 | 92/09/09 | <10 | <2 | 22 | <40 | 11 | 295 | | 23 |
| Charlemont Creek | RM 0.6 | 92/09/30 | <10 | <2 | 24 | <40 | <10 | 306 | | 13 |
| E. FK. E. BR. | RM 1.6 | 92/07/08 | <10 | <2 | 24 | <40 | 13 | 324 | | 20 |
| E. FK. E. BR. | RM 1.6 | 92/08/12 | <10 | <2 | 22 | <40 | <10 | 308 | | 30 |
| E. FK. E. BR. | RM 1.6 | 92/09/09 | 59 | 10 | 27 | <40 | 56 | 341 | | 24 |
| E. FK. E. BR. | RM 1.6 | 92/09/30 | 19 | 8 | 24 | <40 | 23 | 321 | | <10 |
| E. FK. E. BR. | RM 2.67 | 92/07/08 | <10 | <2 | 31 | <40 | <10 | 357 | | 12 |
| E. FK. E. BR. | RM 2.67 | 92/08/12 | <10 | <2 | 23 | <40 | <10 | 279 | <1.0 | 26 |
| E. FK. E. BR. | RM 2.67 | 92/09/09 | <10 | <2 | 29 | <40 | <10 | 332 | <1.0 | 20 |
| E. FK. E. BR. | RM 2.67 | 92/09/30 | <10 | <2 | 23 | <40 | <10 | 289 | <1.0 | 10 |
| E.Br.Black R. | RM 0.36 | 92/07/08 | <10 | <2 | 24 | <40 | <10 | 289 | | 24 |
| E.Br.Black R. | RM 0.36 | 92/08/12 | <10 | <2 | 18 | <40 | <10 | 251 | | 38 |
| E.Br.Black R. | RM 0.36 | 92/09/09 | <10 | 2 | 11 | <40 | <10 | 158 | | 30 |
| E.Br.Black R. | RM 0.36 | 92/10/01 | <10 | <2 | 17 | <40 | 11 | 227 | | 13 |
| E.Br.Black R.. | RM 3.07 | 92/07/08 | <10 | <2 | 16 | <40 | <10 | 201 | | 19 |

Table C-1b. (cont.)

| River | river mile | Date | Cu | Pb | Mg | Ni | Zn | Hardness | $cBOD_5$ | COD |
|---|---|---|---|---|---|---|---|---|---|---|
| E.Br.Black R.. | RM 3.07 | 92/08/12 | <10 | <2 | 19 | <40 | <10 | 276 | | 37 |
| E.Br.Black R.. | RM 3.07 | 92/09/09 | <10 | <2 | 12 | <40 | <10 | 164 | | 33 |
| E.Br.Black R.. | RM 3.07 | 92/10/01 | <10 | <2 | 18 | <40 | <10 | 244 | | 17 |
| E.Br.Black R.. | RM 5.2 | 92/07/08 | <10 | <2 | 14 | <40 | <10 | 180 | | 19 |
| E.Br.Black R.. | RM 5.2 | 92/08/12 | <10 | <2 | 20 | <40 | 22 | 280 | | 34 |
| E.Br.Black R.. | RM 5.2 | 92/09/09 | <10 | <2 | 13 | <40 | <10 | 181 | | 39 |
| E.Br.Black R.. | RM 5.2 | 92/09/30 | <10 | <2 | 18 | <40 | <10 | 239 | | 18 |
| E.Br.Black R.. | RM 6.0 | 92/07/08 | <10 | <2 | 12 | <40 | <10 | 164 | | 21 |
| E.Br.Black R.. | RM 6.0 | 92/08/12 | <10 | <2 | 21 | <40 | <10 | 291 | | 30 |
| E.Br.Black R.. | RM 6.0 | 92/09/09 | <10 | <2 | 13 | <40 | <10 | 176 | | 39 |
| E.Br.Black R.. | RM 6.0 | 92/09/30 | <10 | <2 | 18 | <40 | <10 | 239 | | 12 |
| E.Br.Black R.. | RM 10.5 | 92/07/08 | <10 | <2 | 12 | <40 | <10 | 167 | | 21 |
| E.Br.Black R.. | RM 10.5 | 92/08/12 | <10 | <2 | 18 | <40 | <10 | 256 | | 30 |
| E.Br.Black R.. | RM 10.5 | 92/09/09 | <10 | <2 | 16 | <40 | <10 | 208 | | 32 |
| E.Br.Black R.. | RM 10.5 | 92/09/30 | <10 | <2 | 19 | <40 | <10 | 258 | | 15 |
| E.Br.Black R.. | RM 11.3 | 92/07/08 | <10 | <2 | 19 | <40 | <10 | 203 | | 20 |
| E.Br.Black R.. | RM 11.3 | 92/08/12 | <10 | <2 | 18 | <40 | <10 | 254 | 1.1 | 29 |
| E.Br.Black R.. | RM 11.3 | 92/09/09 | <10 | <2 | 16 | <40 | <10 | 203 | <1.0 | 27 |
| E.Br.Black R.. | RM 11.3 | 92/09/30 | <10 | <2 | 19 | <40 | <10 | 261 | 1.0 | 15 |
| E.Br.Black R.. | RM 18.94 | 92/07/08 | <10 | <2 | 20 | <40 | <10 | 257 | | 31 |
| E.Br.Black R.. | RM 18.94 | 92/08/12 | <10 | <2 | 20 | <40 | <10 | 280 | | 36 |
| E.Br.Black R.. | RM 18.94 | 92/09/09 | 10 | <2 | 21 | <40 | 13 | 269 | | 32 |
| E.Br.Black R.. | RM 18.94 | 92/09/30 | <10 | <2 | 20 | <40 | <10 | 267 | | 12 |
| E.Br.Black R.. | RM 32.42 | 92/07/08 | <10 | <2 | 27 | <40 | <10 | 343 | | 18 |
| E.Br.Black R.. | RM 32.42 | 92/08/12 | <10 | <2 | 18 | <40 | <10 | 256 | | 15 |
| E.Br.Black R.. | RM 32.42 | 92/09/09 | <10 | <2 | 25 | <40 | <10 | 328 | | 32 |
| E.Br.Black R.. | RM 32.42 | 92/09/30 | <10 | <2 | 21 | <40 | <10 | 289 | | 11 |
| E.Br.Black R.. | RM 41.45 | 92/07/08 | <10 | <2 | 27 | <40 | 10 | 371 | | 20 |
| E.Br.Black R.. | RM 41.45 | 92/08/12 | <10 | <2 | 21 | <40 | <10 | 304 | | 40 |
| E.Br.Black R.. | RM 41.45 | 92/09/09 | <10 | <2 | 27 | <40 | <10 | 363 | | 26 |
| E.Br.Black R.. | RM 41.45 | 92/09/30 | <10 | <2 | 23 | <40 | <10 | 314 | | 21 |
| French Creek | RM 0.54 | 92/07/08 | <10 | <2 | 18 | <40 | <10 | 249 | | 23 |
| French Creek | RM 0.54 | 92/08/12 | <10 | <2 | 19 | <40 | 78 | 293 | | 46 |
| French Creek | RM 0.54 | 92/09/09 | 10 | <2 | 15 | <40 | 19 | 249 | | 30 |
| French Creek | RM 0.54 | 92/10/01 | <10 | <2 | 18 | <40 | <10 | 279 | | 13 |
| French Creek | RM 3.2 | 92/07/08 | <10 | <2 | 24 | <40 | <10 | 316 | | 30 |
| French Creek | RM 3.2 | 92/08/12 | <10 | <2 | 18 | <40 | <10 | 286 | | 33 |
| French Creek | RM 3.2 | 92/09/09 | 15 | <2 | 17 | <40 | 116 | 280 | | 31 |
| French Creek | RM 3.2 | 92/10/01 | <10 | <2 | 19 | <40 | <10 | 295 | | 14 |
| Plum Creek | RM 0.83 | 92/07/08 | <10 | <2 | 19 | <40 | 15 | 271 | | 16 |
| Plum Creek | RM 0.83 | 92/08/12 | <10 | <2 | 21 | <40 | 30 | 286 | | 45 |
| Plum Creek | RM 0.83 | 92/09/09 | <10 | <2 | 20 | <40 | 13 | 285 | | 18 |
| Plum Creek | RM 0.83 | 92/09/30 | <10 | <2 | 21 | <40 | 11 | 279 | | 17 |
| Plum Creek | RM 3.19 | 92/07/08 | <10 | <2 | 24 | <40 | <10 | 291 | | 21 |
| Plum Creek | RM 3.19 | 92/08/12 | <10 | <2 | 24 | <40 | 22 | 316 | | 27 |
| Plum Creek | RM 3.19 | 92/09/09 | <10 | <2 | 22 | <40 | 14 | 308 | | 24 |

Table C-1b. (cont.)

| River | river mile | Date | Cu | Pb | Mg | Ni | Zn | Hardness | $cBOD_5$ | COD |
|---|---|---|---|---|---|---|---|---|---|---|
| Plum Creek | RM 3.19 | 92/09/30 | <10 | <2 | 26 | <40 | <10 | 349 | | 14 |
| Plum Creek | RM 7.0 | 92/07/08 | <10 | <2 | 64 | <40 | <10 | 533 | | 20 |
| Plum Creek | RM 7.0 | 92/08/12 | <10 | <2 | 62 | <40 | 15 | 522 | | 24 |
| Plum Creek | RM 7.0 | 92/09/09 | <10 | <2 | 28 | <40 | <10 | 305 | | 24 |
| Plum Creek | RM 7.0 | 92/09/30 | <10 | <2 | 35 | <40 | <10 | 351 | | 22 |
| W. FK. E. BR. | RM 4.13 | 92/07/08 | <10 | <2 | 20 | <40 | <10 | 252 | | 19 |
| W. FK. E. BR. | RM 4.13 | 92/08/12 | <10 | <2 | 17 | <40 | <10 | 212 | | 29 |
| W. FK. E. BR. | RM 4.13 | 92/09/09 | <10 | <2 | 21 | <40 | <10 | 249 | | 26 |
| W. FK. E. BR. | RM 4.13 | 92/09/30 | <10 | <2 | 22 | <40 | <10 | 265 | | 15 |
| W.Br.Black R. | RM 0.24 | 92/07/08 | <10 | <2 | 21 | <40 | <10 | 259 | | 22 |
| W.Br.Black R. | RM 0.24 | 92/08/12 | <10 | <2 | 19 | <40 | <10 | 163 | | 34 |
| W.Br.Black R. | RM 0.24 | 92/09/09 | <10 | 2 | 13 | <40 | <10 | 186 | | 24 |
| W.Br.Black R. | RM 0.24 | 92/10/01 | <10 | <2 | 15 | <40 | <10 | 209 | | 14 |
| W.Br.Black R. | RM 4.18 | 92/07/08 | <10 | <2 | 20 | <40 | <10 | 267 | | 20 |
| W.Br.Black R. | RM 4.18 | 92/08/12 | <10 | <2 | 19 | <40 | 15 | 266 | | 37 |
| W.Br.Black R. | RM 4.18 | 92/09/09 | <10 | 3 | 14 | <40 | <10 | 197 | | 30 |
| W.Br.Black R. | RM 4.18 | 92/10/01 | <10 | <2 | 16 | <40 | 27 | 223 | | 14 |
| W.Br.Black R. | RM 14.39 | 92/07/08 | <10 | <2 | 20 | <40 | <10 | 272 | | 16 |
| W.Br.Black R. | RM 14.39 | 92/08/12 | <10 | <2 | 25 | <40 | 18 | 340 | | 40 |
| W.Br.Black R. | RM 14.39 | 92/09/09 | <10 | <2 | 18 | <40 | 12 | 246 | | 22 |
| W.Br.Black R. | RM 14.39 | 92/09/30 | <10 | <2 | 20 | <40 | 10 | 265 | | 19 |
| W.Br.Black R. | RM 25.3 | 92/07/08 | <10 | <2 | 25 | <40 | <10 | 310 | | 22 |
| W.Br.Black R. | RM 25.3 | 92/08/12 | <10 | <2 | 27 | <40 | 12 | 353 | | 32 |
| W.Br.Black R. | RM 25.3 | 92/09/09 | <10 | <2 | 21 | <40 | 17 | 281 | | 21 |
| W.Br.Black R. | RM 25.3 | 92/09/30 | <10 | <2 | 23 | <40 | <10 | 294 | | 53 |
| W.Br.Black R. | RM 41.67 | 92/07/08 | <10 | <2 | 31 | <40 | <10 | 402 | | 15 |
| W.Br.Black R. | RM 41.67 | 92/08/12 | <10 | <2 | 30 | <40 | <10 | 381 | | 30 |
| W.Br.Black R. | RM 41.67 | 92/09/09 | <10 | <2 | 28 | <40 | 13 | 380 | | 21 |
| W.Br.Black R. | RM 41.67 | 92/09/30 | <10 | <2 | 28 | <40 | 13 | 370 | | 20 |
| Wellington Creek | RM 10.83 | 92/07/08 | <10 | <2 | 69 | <40 | <10 | 726 | | 25 |
| Wellington Creek | RM 10.83 | 92/08/12 | <10 | <2 | 29 | <40 | 12 | 339 | | 41 |
| Wellington Creek | RM 10.83 | 92/09/09 | <10 | <2 | 19 | <40 | 17 | 238 | | 23 |
| Wellington Creek | RM 10.83 | 92/09/30 | <10 | <2 | 19 | <40 | <10 | 233 | | 21 |
| Wellington Creek | RM 13.09 | 92/07/08 | <10 | <2 | 28 | <40 | 29 | 308 | | 28 |
| Wellington Creek | RM 13.09 | 92/08/12 | <10 | <2 | 26 | <40 | <10 | 309 | | 39 |
| Wellington Creek | RM 13.09 | 92/09/09 | <10 | <2 | 15 | <40 | 20 | 192 | | 28 |
| Wellington Creek | RM 13.09 | 92/09/30 | <10 | <2 | 16 | <40 | <10 | 196 | | 22 |
| Willow Creek | RM 2.85 | 92/07/08 | <10 | <2 | 19 | <40 | <10 | 241 | | 28 |
| Willow Creek | RM 2.85 | 92/08/12 | <10 | <2 | 12 | <40 | <10 | 182 | | 49 |
| Willow Creek | RM 2.85 | 92/09/09 | 22 | <2 | 15 | <40 | <10 | 207 | | 36 |
| Willow Creek | RM 2.85 | 92/10/01 | <10 | <2 | 15 | <40 | <10 | 214 | | 16 |

Table C-1c. Values for the 1992 Black River study area by site and date for chloride (mg/l), cyanide (µg/l), NO2-NO3 (mg/l), NO2 (mg/l), NH3 (mg/l), total Kjeldahl nitrogen (mg/l), oil and grease (mg/l), and phosphorus (mg/l), total desolved solids (mg/l), total suspended solids (mg/l), and fecal colliform bacteria (#/100 ml).

| River | river mile | Date | Chloride | CN | NO2-NO3 | NO2 | NH3 | TKN | O+G | Phos | TDS | TSS | Fec coli |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Black River | RM 0.01 | 92/07/08 | | | 1.91 | 0.06 | 0.14 | 0.4 | | 0.07 | 243 | 10 | |
| Black River | RM 0.01 | 92/08/06 | 20 | | 1.17 | 0.05 | <0.05 | 0.6 | | 0.08 | 202 | 14 | |
| Black River | RM 0.01 | 92/08/12 | 21 | | 1.19 | 0.04 | 0.16 | 0.5 | | 0.12 | 226 | 8 | |
| Black River | RM 0.01 | 92/09/09 | 25 | | 1.19 | 0.19 | 0.30 | 0.8 | | 0.06 | 246 | 23 | |
| Black River | RM 0.01 | 92/09/17 | 23 | <5 | 1.00 | 0.11 | 0.37 | 0.9 | | 0.07 | 224 | 20 | |
| Black River | RM 0.01 | 92/10/01 | 30 | | 1.05 | 0.04 | 1.81 | 2.1 | | 0.11 | 262 | 25 | 300000 |
| Black River | RM 1.05 | 92/07/08 | | | 3.11 | 0.14 | 0.36 | 0.7 | | 0.11 | 320 | 12 | |
| Black River | RM 1.05 | 92/08/06 | 26 | | 1.49 | 0.06 | 0.07 | 0.8 | | 0.10 | 274 | 12 | |
| Black River | RM 1.05 | 92/08/12 | 32 | | 1.81 | 0.06 | 0.08 | 0.8 | | 0.06 | 320 | 16 | |
| Black River | RM 1.05 | 92/09/09 | 34 | | 1.52 | 0.36 | 0.10 | 0.9 | | 0.09 | 310 | 32 | |
| Black River | RM 1.05 | 92/09/17 | 31 | <5 | 1.43 | 0.24 | 0.12 | 0.8 | | 0.12 | 294 | 33 | |
| Black River | RM 1.05 | 92/10/01 | 30 | | 1.43 | 0.07 | 0.21 | 0.7 | | 0.15 | 280 | 16 | 340 |
| Black River | RM 1.84 | 92/07/08 | | | 2.91 | 0.14 | 0.45 | 0.9 | | 0.14 | 330 | 42 | |
| Black River | RM 1.84 | 92/08/06 | 31 | | 1.62 | 0.06 | <0.05 | 0.7 | | 0.14 | 304 | 18 | |
| Black River | RM 1.84 | 92/08/12 | 41 | | 2.22 | 0.07 | 0.10 | 0.8 | | 0.08 | 376 | 20 | |
| Black River | RM 1.84 | 92/09/09 | 34 | | 1.55 | 0.28 | 0.07 | 0.7 | | 0.10 | 326 | 40 | |
| Black River | RM 1.84 | 92/09/17 | 33 | <5 | 1.59 | 0.27 | <0.05 | 1.0 | | 0.17 | 310 | 27 | |
| Black River | RM 1.84 | 92/10/01 | 33 | | 1.82 | 0.07 | 0.23 | 0.8 | | 0.16 | 310 | 22 | |
| Black River | RM 2.9 | 92/07/08 | | | 4.59 | 0.14 | 0.31 | 0.9 | | 0.08 | 410 | 16 | |
| Black River | RM 2.9 | 92/08/06 | 32 | | 1.64 | 0.06 | <0.05 | 0.7 | | 0.14 | 298 | 20 | |
| Black River | RM 2.9 | 92/08/12 | 49 | | 2.54 | 0.07 | 0.08 | 0.9 | | 0.07 | 408 | 31 | |
| Black River | RM 2.9 | 92/09/09 | 36 | | 1.68 | 0.23 | 0.07 | 0.9 | | 0.11 | 332 | 28 | |
| Black River | RM 2.9 | 92/09/17 | 40 | <5 | 2.07 | 0.18 | 0.06 | 0.8 | | 0.16 | 946 | 82 | |
| Black River | RM 2.9 | 92/10/01 | 38 | | 2.39 | 0.06 | 0.20 | 0.9 | | 0.14 | 338 | 34 | |
| Black River | RM 3.7 | 92/07/08 | | | 7.92 | 0.12 | 0.16 | 1.2 | | 0.08 | 596 | 19 | |
| Black River | RM 3.7 | 92/08/06 | 34 | | 7.66 | 0.05 | <0.05 | 0.6 | | 0.12 | 336 | 25 | |
| Black River | RM 3.7 | 92/08/12 | 63 | | 3.35 | 0.04 | <0.05 | 0.8 | | 0.08 | 468 | 53 | |
| Black River | RM 3.7 | 92/09/09 | 44 | | 2.47 | 0.07 | 0.09 | 0.8 | | 0.09 | 356 | 38 | |
| Black River | RM 3.7 | 92/09/17 | 49 | <5 | 2.64 | 0.06 | <0.05 | 1.0 | | 0.13 | 372 | 36 | |
| Black River | RM 3.7 | 92/10/01 | 38 | | 2.24 | 0.06 | 0.17 | 0.9 | | 0.14 | 342 | 20 | |
| Black River | RM 4.2 | 92/07/08 | | | 7.00 | 0.14 | 0.06 | 1.4 | 27.6 | 0.09 | 678 | 18 | |
| Black River | RM 4.2 | 92/08/06 | 59 | | 1.22 | 0.06 | 0.08 | 0.8 | | 0.08 | 394 | 24 | |
| Black River | RM 4.2 | 92/08/12 | 64 | | 3.05 | 0.03 | <0.05 | 0.7 | | 0.07 | 466 | 16 | |
| Black River | RM 4.2 | 92/09/09 | 61 | | 3.69 | 0.07 | 0.06 | 0.9 | 1.18 | 0.06 | 440 | 21 | |
| Black River | RM 4.2 | 92/09/17 | 55 | <5 | 3.55 | 0.06 | <0.05 | 1.0 | | 0.11 | 410 | 27 | |
| Black River | RM 4.2 | 92/10/01 | 93 | | 3.72 | < 0.02 | 0.05 | 0.9 | | 0.12 | 452 | 16 | 1000 |
| Black River | RM 5.3 | 92/07/08 | | | 11.50 | 0.04 | <0.05 | 1.0 | | 0.09 | 770 | 31 | |
| Black River | RM 5.3 | 92/08/06 | 29 | | 1.41 | 0.05 | <0.05 | 0.6 | | 0.10 | 320 | 38 | |
| Black River | RM 5.3 | 92/08/12 | 56 | | 3.02 | 0.02 | <0.05 | 0.6 | | 0.06 | 446 | 12 | |
| Black River | RM 5.3 | 92/09/09 | 48 | | 4.99 | 0.08 | <0.05 | 0.7 | | 0.11 | 418 | 24 | |
| Black River | RM 5.3 | 92/09/17 | 55 | <5 | 3.49 | 0.03 | <0.05 | 0.8 | | 0.11 | 406 | 28 | |
| Black River | RM 5.3 | 92/10/01 | 57 | | 4.09 | < 0.02 | <0.05 | 0.7 | | 0.13 | 461 | 16 | 590 |
| Black River | RM 8.35 | 92/07/08 | | | 11.60 | 0.03 | <0.05 | 1.2 | | 0.10 | 794 | 24 | |
| Black River | RM 8.35 | 92/08/06 | 31 | | 1.53 | 0.05 | <0.05 | 0.6 | | 0.16 | 308 | 46 | |

Table C-1c. (cont.)

| River | river mile | Date | Chloride | CN | NO2-NO3 | NO2 | NH3 | TKN | O+G | Phos | TDS | TSS | Fec coli |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Black River | RM 8.35 | 92/08/12 | 52 | | 3.32 | 0.02 | <0.05 | 0.6 | | 0.06 | 464 | 12 | |
| Black River | RM 8.35 | 92/09/09 | 43 | | 3.84 | 0.03 | <0.05 | 0.9 | | 0.13 | 406 | 22 | |
| Black River | RM 8.35 | 92/09/17 | 50 | <5 | 3.08 | 0.02 | <0.05 | 0.7 | | 0.10 | 388 | 24 | 310 |
| Black River | RM 8.35 | 92/10/01 | 52 | | 3.29 | < 0.02 | 0.05 | 0.9 | | 0.14 | 426 | 10 | 1900 |
| Black River | RM 9.8 | 92/07/08 | | | 12.70 | 0.03 | <0.05 | 1.2 | | 0.10 | 830 | 20 | |
| Black River | RM 9.8 | 92/08/06 | 30 | | 1.59 | 0.05 | <0.05 | 0.6 | | 0.08 | 310 | 50 | |
| Black River | RM 9.8 | 92/08/12 | | | 4.68 | < 0.02 | <0.05 | 0.6 | | 0.90 | 498 | 14 | |
| Black River | RM 9.8 | 92/09/09 | 52 | | 6.53 | 0.03 | <0.05 | 1.0 | | 0.12 | 470 | 25 | |
| Black River | RM 9.8 | 92/09/17 | 5 | | 5.30 | 0.03 | <0.05 | 1.0 | | 0.14 | 461 | 10 | 1500 |
| Black River | RM 9.8 | 92/10/01 | | | 5.43 | < 0.02 | 0.05 | 0.7 | | 0.15 | 494 | 8 | 2650 |
| Black River | RM 11.5 | 92/07/08 | | | 4.11 | 0.03 | <0.05 | 1.1 | | 0.12 | 486 | 34 | |
| Black River | RM 11.5 | 92/08/06 | 22 | | 0.99 | 0.06 | <0.05 | 0.5 | | 0.16 | 278 | 54 | |
| Black River | RM 11.5 | 92/08/12 | | | 0.94 | 0.02 | <0.05 | 0.6 | | 0.07 | 396 | 14 | |
| Black River | RM 11.5 | 92/09/09 | | | 0.94 | 0.03 | <0.05 | 0.8 | | 0.14 | 302 | 26 | |
| Black River | RM 11.5 | 92/09/17 | 26 | | 0.97 | 0.03 | <0.05 | 0.8 | | 0.13 | 296 | 16 | 3100 |
| Black River | RM 11.5 | 92/10/01 | | | 0.96 | < 0.02 | <0.05 | 0.6 | | 0.11 | 336 | 12 | 9800 |
| Black River | RM 14.95 | 92/07/08 | | | 3.94 | 0.06 | 0.05 | 1.0 | | 0.13 | 513 | 21 | |
| Black River | RM 14.95 | 92/08/06 | 24 | | 0.99 | 0.06 | <0.05 | 0.5 | | 0.20 | 280 | 64 | |
| Black River | RM 14.95 | 92/08/12 | | | 0.91 | 0.03 | <0.05 | 0.6 | | <0.05 | 400 | 16 | |
| Black River | RM 14.95 | 92/09/09 | | | 0.95 | 0.04 | <0.05 | 0.9 | | 0.14 | 306 | 30 | |
| Black River | RM 14.95 | 92/09/17 | 25 | | 1.10 | 0.13 | <0.05 | 0.7 | | 0.12 | 310 | 17 | 6100 |
| Black River | RM 14.95 | 92/10/01 | | | 0.96 | < 0.02 | 0.08 | 0.6 | | 0.14 | 332 | 21 | 9800 |
| Buck Creek | RM 0.95 | 92/07/08 | | | 0.21 | 0.04 | 0.30 | 0.7 | | 0.08 | 1010 | 5 | |
| Buck Creek | RM 0.95 | 92/08/12 | | | 0.68 | 0.05 | <0.05 | 0.8 | | <0.05 | 394 | 6 | |
| Buck Creek | RM 0.95 | 92/09/09 | | | 1.14 | 0.04 | <0.05 | 0.7 | | <0.05 | 472 | 8 | |
| Buck Creek | RM 0.95 | 92/09/30 | | | 0.45 | < 0.02 | <0.05 | 0.5 | | 0.08 | 412 | 5 | |
| Charlemont Creek | RM 0.5 | 92/07/08 | | | 15.60 | 0.51 | 0.61 | 2.3 | | 2.33 | 892 | 21 | |
| Charlemont Creek | RM 0.5 | 92/08/12 | | | 2.95 | 0.16 | <0.05 | 1.0 | | 0.39 | 518 | 20 | |
| Charlemont Creek | RM 0.5 | 92/09/09 | | | 1.91 | 0.04 | 0.07 | 0.7 | | 0.17 | 482 | 12 | |
| Charlemont Creek | RM 0.5 | 92/09/30 | | | 3.52 | 0.21 | 0.18 | 1.1 | | 0.71 | 510 | 8 | 1050 |
| Charlemont Creek | RM 0.6 | 92/07/08 | | | 1.96 | 0.08 | 0.05 | 0.6 | | 0.23 | 572 | 51 | |
| Charlemont Creek | RM 0.6 | 92/08/12 | | | 0.42 | 0.07 | <0.05 | 0.8 | | 0.07 | 508 | 22 | |
| Charlemont Creek | RM 0.6 | 92/09/09 | | | 0.38 | < 0.02 | <0.05 | 0.6 | | <0.05 | 460 | 19 | |
| Charlemont Creek | RM 0.6 | 92/09/30 | | | 0.28 | < 0.02 | <0.05 | 0.6 | | <0.05 | 450 | 10 | 340 |
| E. FK. E. BR. | RM 1.6 | 92/07/08 | | | 5.20 | 0.11 | 1.35 | 2.6 | | 1.59 | 994 | 5 | |
| E. FK. E. BR. | RM 1.6 | 92/08/12 | | | 3.54 | 0.02 | <0.05 | 0.5 | | 0.58 | 660 | 5 | |
| E. FK. E. BR. | RM 1.6 | 92/09/09 | | | 4.12 | 0.02 | <0.05 | 0.8 | | 0.82 | 758 | 5 | |
| E. FK. E. BR. | RM 1.6 | 92/09/30 | | | 3.94 | < 0.02 | <0.05 | 0.8 | | 0.47 | 650 | 5 | 730 |
| E. FK. E. BR. | RM 2.67 | 92/07/08 | | | <0.10 | < 0.02 | <0.05 | 0.4 | | 0.65 | 666 | 5 | |
| E. FK. E. BR. | RM 2.67 | 92/08/12 | 54 | | 0.11 | < 0.02 | <0.05 | 0.3 | | <0.05 | 464 | 5 | |
| E. FK. E. BR. | RM 2.67 | 92/09/09 | 69 | | <0.10 | 0.02 | <0.05 | 0.3 | | <0.05 | 578 | 5 | |
| E. FK. E. BR. | RM 2.67 | 92/09/30 | 55 | | <0.10 | < 0.02 | <0.05 | 0.4 | | <0.05 | 484 | 5 | 1700 |
| E.Br.Black R. | RM 0.36 | 92/07/08 | | | 2.28 | 0.09 | <0.05 | 1.0 | | 0.13 | 530 | 14 | |
| E.Br.Black R. | RM 0.36 | 92/08/12 | | | 0.88 | 0.03 | <0.05 | 0.6 | | 0.08 | 387 | 20 | |
| E.Br.Black R. | RM 0.36 | 92/09/09 | | | 0.82 | 0.06 | 0.14 | 0.9 | | 0.15 | 294 | 20 | |
| E.Br.Black R. | RM 0.36 | 92/10/01 | | | 0.92 | < 0.02 | 0.07 | 0.7 | | 0.14 | 366 | 12 | 3350 |

Table C-1c. (cont.)

| River | river mile | Date | Chloride | NO2-NO3 | NH3 | O+G | TDS | Fec coli |
|---|---|---|---|---|---|---|---|---|
| | | | CN | NO2 | TKN | Phos | TSS | |
| E.Br.Black R.. | RM 3.07 | 92/07/08 | | 3.52 | 0.05 | <0.05 | 0.8 | 0.14 | 378 | 6 | |
| E.Br.Black R.. | RM 3.07 | 92/08/12 | | 0.91 | 0.02 | <0.05 | 0.5 | 1.54 | 408 | 14 | |
| E.Br.Black R.. | RM 3.07 | 92/09/09 | | 0.81 | 0.04 | 0.09 | 0.9 | 0.17 | 300 | 24 | |
| E.Br.Black R.. | RM 3.07 | 92/10/01 | | 0.87 | < 0.02 | 0.05 | 0.7 | 0.13 | 374 | 6 | 3400 |
| E.Br.Black R.. | RM 5.2 | 92/07/08 | | 3.80 | 0.04 | <0.05 | 0.9 | 0.20 | 338 | 16 | |
| E.Br.Black R.. | RM 5.2 | 92/08/12 | | 0.91 | 0.03 | <0.05 | 0.6 | 0.08 | 442 | 12 | |
| E.Br.Black R.. | RM 5.2 | 92/09/09 | | 0.93 | 0.04 | <0.05 | 0.8 | 0.15 | 314 | 21 | |
| E.Br.Black R.. | RM 5.2 | 92/09/30 | | 0.86 | < 0.02 | <0.05 | 0.6 | 0.14 | 372 | 11 | 2650 |
| E.Br.Black R.. | RM 6.0 | 92/07/08 | | 3.98 | 0.04 | 0.05 | 0.8 | 0.22 | 324 | 20 | |
| E.Br.Black R.. | RM 6.0 | 92/08/12 | | 0.86 | 0.04 | <0.05 | 0.5 | 0.09 | 462 | 14 | |
| E.Br.Black R.. | RM 6.0 | 92/09/09 | | 0.80 | 0.05 | 0.05 | 0.7 | 0.13 | 287 | 27 | |
| E.Br.Black R.. | RM 6.0 | 92/09/30 | | 0.82 | < 0.02 | <0.05 | 0.6 | 0.13 | 372 | 14 | 1300 |
| E.Br.Black R.. | RM 10.5 | 92/07/08 | | 5.00 | 0.11 | 0.07 | 0.7 | 0.16 | 312 | 24 | |
| E.Br.Black R.. | RM 10.5 | 92/08/12 | | 0.61 | < 0.02 | <0.05 | 0.6 | 0.09 | 406 | 12 | |
| E.Br.Black R.. | RM 10.5 | 92/09/09 | | 0.60 | 0.06 | 0.33 | 0.9 | 0.07 | 338 | 14 | |
| E.Br.Black R.. | RM 10.5 | 92/09/30 | | 0.88 | < 0.02 | <0.05 | 0.6 | 0.19 | 392 | 13 | |
| E.Br.Black R.. | RM 11.3 | 92/07/08 | | 5.29 | 0.11 | 0.06 | 0.7 | 0.13 | 310 | 46 | |
| E.Br.Black R.. | RM 11.3 | 92/08/12 | 31 | 0.66 | 0.02 | <0.05 | 0.5 | 0.09 | 416 | 16 | |
| E.Br.Black R.. | RM 11.3 | 92/09/09 | 24 | 0.55 | 0.03 | <0.05 | 0.6 | <0.05 | 312 | 20 | |
| E.Br.Black R.. | RM 11.3 | 92/09/30 | 30 | 0.73 | < 0.02 | <0.05 | 0.6 | <0.05 | | 10 | 610 |
| E.Br.Black R.. | RM 18.94 | 92/07/08 | | 4.14 | 0.06 | 0.07 | 0.8 | 0.14 | 438 | 43 | |
| E.Br.Black R.. | RM 18.94 | 92/08/12 | | 0.53 | < 0.02 | <0.05 | 0.4 | 0.09 | 442 | 32 | |
| E.Br.Black R.. | RM 18.94 | 92/09/09 | | 0.47 | 0.03 | 0.05 | 0.5 | <0.05 | 408 | 28 | |
| E.Br.Black R.. | RM 18.94 | 92/09/30 | | 0.58 | < 0.02 | <0.05 | 0.5 | 0.10 | 386 | 11 | 570 |
| E.Br.Black R.. | RM 32.42 | 92/07/08 | | 1.60 | 0.04 | 0.12 | 0.6 | 0.10 | 610 | 50 | |
| E.Br.Black R.. | RM 32.42 | 92/08/12 | | 1.61 | 0.07 | <0.05 | 0.8 | 0.08 | 420 | 28 | |
| E.Br.Black R.. | RM 32.42 | 92/09/09 | | 0.42 | 0.03 | <0.05 | 0.6 | 0.08 | 526 | 24 | |
| E.Br.Black R.. | RM 32.42 | 92/09/30 | | 0.66 | < 0.02 | <0.05 | 0.5 | 0.10 | 428 | 11 | |
| E.Br.Black R.. | RM 41.45 | 92/07/08 | | 2.50 | 0.02 | <0.05 | 0.8 | 0.10 | 654 | 34 | |
| E.Br.Black R.. | RM 41.45 | 92/08/12 | | 1.56 | 0.03 | <0.05 | 0.5 | 0.10 | 508 | 16 | |
| E.Br.Black R.. | RM 41.45 | 92/09/09 | | 0.48 | 0.03 | <0.05 | 0.5 | <0.05 | 572 | 6 | |
| E.Br.Black R.. | RM 41.45 | 92/09/30 | | 0.98 | < 0.02 | <0.05 | 0.4 | 0.12 | 482 | 5 | |
| French Creek | RM 0.54 | 92/07/08 | | 13.00 | 0.03 | 0.06 | 1.4 | 0.16 | 622 | 12 | |
| French Creek | RM 0.54 | 92/08/12 | | 11.80 | 0.32 | 0.68 | 4.2 | 0.13 | 600 | 5 | |
| French Creek | RM 0.54 | 92/09/09 | 68 | 3.19 | 0.03 | <0.05 | 0.9 | 0.13 | 506 | 6 | |
| French Creek | RM 0.54 | 92/10/01 | | 9.71 | < 0.02 | <0.05 | 0.9 | 0.15 | 588 | 5 | 840 |
| French Creek | RM 3.2 | 92/07/08 | | 14.50 | 0.46 | 0.10 | 2.2 | 0.16 | 704 | 16 | |
| French Creek | RM 3.2 | 92/08/12 | | 7.80 | 0.52 | 2.26 | 4.7 | 0.09 | 580 | 10 | |
| French Creek | RM 3.2 | 92/09/09 | 80 | 3.29 | 0.05 | <0.05 | 1.0 | 0.21 | 570 | 7 | |
| French Creek | RM 3.2 | 92/10/01 | | 4.62 | < 0.02 | <0.05 | 0.7 | 0.16 | 548 | 5 | 1150 |
| Plum Creek | RM 0.83 | 92/07/08 | | 21.80 | 0.03 | <0.05 | 0.8 | 0.31 | 668 | 5 | |
| Plum Creek | RM 0.83 | 92/08/12 | | 12.60 | 0.03 | <0.05 | 1.0 | 0.19 | 576 | 19 | |
| Plum Creek | RM 0.83 | 92/09/09 | 70 | 9.04 | 0.03 | <0.05 | 0.8 | 0.32 | 578 | 5 | |
| Plum Creek | RM 0.83 | 92/09/30 | | 10.90 | < 0.02 | <0.05 | 0.8 | 0.26 | 602 | 5 | 770 |
| Plum Creek | RM 3.19 | 92/07/08 | | <0.10 | 0.02 | <0.05 | 0.6 | 0.08 | 580 | 5 | |
| Plum Creek | RM 3.19 | 92/08/12 | | 0.18 | < 0.02 | <0.05 | 0.5 | <0.05 | 466 | 6 | |

Table C-1c. (cont.)

| River | river mile | Date | Chloride | NO2-NO3 | NH3 | O+G | TDS | Fec coli |
|---|---|---|---|---|---|---|---|---|
| | | | CN | NO2 | TKN | Phos | TSS | |
| Plum Creek | RM 3.19 | 92/09/09 | 34 | 0.40 < 0.02 | 0.05 | 0.6 | 0.06 | 470 | 5 | |
| Plum Creek | RM 3.19 | 92/09/30 | | <0.10 < 0.02 | <0.05 | 0.5 | <0.05 | 514 | 5 | 880 |
| Plum Creek | RM 7.0 | 92/07/08 | | 0.16 | 0.05 | 1.60 | 1.8 | 0.28 | 770 | 6 | |
| Plum Creek | RM 7.0 | 92/08/12 | | 0.18 | 0.02 | 0.20 | 0.5 | <0.05 | 642 | 6 | |
| Plum Creek | RM 7.0 | 92/09/09 | | 0.14 | < 0.02 | <0.05 | 0.7 | 0.08 | 435 | 5 | |
| Plum Creek | RM 7.0 | 92/09/30 | | <0.10 | < 0.02 | 0.15 | 0.6 | 0.09 | 510 | 5 | 2150 |
| W. FK. E. BR. | RM 4.13 | 92/07/08 | | 1.86 | < 0.02 | <0.05 | 0.6 | 0.05 | 416 | 5 | |
| W. FK. E. BR. | RM 4.13 | 92/08/12 | | 0.53 | < 0.02 | <0.05 | 0.5 | <0.05 | 366 | 5 | |
| W. FK. E. BR. | RM 4.13 | 92/09/09 | | <0.10 | 0.02 | <0.05 | 0.5 | <0.05 | 390 | 5 | |
| W. FK. E. BR. | RM 4.13 | 92/09/30 | | 0.29 | < 0.02 | <0.05 | 0.5 | 0.06 | 392 | 5 | |
| W.Br.Black R. | RM 0.24 | 92/07/08 | | 7.20 | 0.13 | 0.08 | 1.3 | 0.07 | 450 | 9 | |
| W.Br.Black R. | RM 0.24 | 92/08/12 | | 0.98 | 0.03 | <0.05 | 0.7 | <0.05 | 420 | 13 | |
| W.Br.Black R. | RM 0.24 | 92/09/09 | | 0.97 | 0.04 | 0.06 | 0.8 | 0.11 | 322 | 34 | |
| W.Br.Black R. | RM 0.24 | 92/10/01 | | 1.10 | < 0.02 | 0.05 | 0.6 | 0.12 | 330 | 22 | 11400 |
| W.Br.Black R. | RM 4.18 | 92/07/08 | | 7.09 | 0.11 | 0.11 | 1.0 | 0.08 | 452 | 14 | |
| W.Br.Black R. | RM 4.18 | 92/08/12 | | 1.08 | 0.03 | <0.05 | 0.6 | 0.08 | 422 | 34 | |
| W.Br.Black R. | RM 4.18 | 92/09/09 | | 0.86 | 0.04 | 0.09 | 1.0 | 0.16 | 324 | 63 | |
| W.Br.Black R. | RM 4.18 | 92/10/01 | | 1.20 | 0.02 | 0.14 | 0.6 | 0.15 | 352 | 44 | 3950 |
| W.Br.Black R. | RM 14.39 | 92/07/08 | | 2.43 | 0.04 | <0.05 | 0.7 | 0.11 | 448 | 33 | |
| W.Br.Black R. | RM 14.39 | 92/08/12 | | 0.93 | 0.02 | <0.05 | 0.6 | <0.05 | 460 | 28 | |
| W.Br.Black R. | RM 14.39 | 92/09/09 | | 0.74 | 0.02 | 0.07 | 0.7 | 0.07 | 392 | 32 | |
| W.Br.Black R. | RM 14.39 | 92/09/30 | | 0.87 | < 0.02 | <0.05 | 0.6 | 0.13 | 394 | 16 | 880 |
| W.Br.Black R. | RM 25.3 | 92/07/08 | | 4.11 | 0.07 | <0.05 | 0.8 | 0.60 | 566 | 38 | |
| W.Br.Black R. | RM 25.3 | 92/08/12 | | 0.94 | 0.02 | <0.05 | 0.6 | 0.16 | 548 | 14 | |
| W.Br.Black R. | RM 25.3 | 92/09/09 | | 1.13 | 0.05 | <0.05 | 0.8 | 0.12 | 444 | 18 | |
| W.Br.Black R. | RM 25.3 | 92/09/30 | | 1.60 | 0.04 | 0.06 | 0.8 | 0.26 | 464 | 7 | 500 |
| W.Br.Black R. | RM 41.67 | 92/07/08 | | 0.75 | 0.06 | 0.06 | 0.5 | <0.05 | 632 | 10 | |
| W.Br.Black R. | RM 41.67 | 92/08/12 | | 0.32 | 0.02 | <0.05 | 0.5 | 0.08 | 532 | 6 | |
| W.Br.Black R. | RM 41.67 | 92/09/09 | | 0.41 | 0.02 | <0.05 | 0.5 | <0.05 | 530 | 6 | |
| W.Br.Black R. | RM 41.67 | 92/09/30 | | 0.23 | < 0.02 | 0.06 | 0.6 | <0.05 | 506 | 5 | |
| Wellington Creek | RM 10.83 | 92/07/08 | | 0.24 | 0.04 | 0.24 | 0.8 | 0.13 | 462 | 6 | |
| Wellington Creek | RM 10.83 | 92/08/12 | | 1.52 | 0.06 | 0.07 | 0.8 | 0.07 | 485 | 5 | |
| Wellington Creek | RM 10.83 | 92/09/09 | | 0.59 | 0.05 | <0.05 | 1.0 | 0.08 | 374 | 5 | |
| Wellington Creek | RM 10.83 | 92/09/30 | | 0.74 | 0.02 | 0.09 | 0.6 | 0.12 | 242 | 5 | |
| Wellington Creek | RM 13.09 | 92/07/08 | | <0.10 | < 0.02 | <0.05 | 0.7 | 0.05 | 328 | 5 | |
| Wellington Creek | RM 13.09 | 92/08/12 | | 0.84 | 0.05 | <0.05 | 0.7 | <0.05 | 434 | 10 | |
| Wellington Creek | RM 13.09 | 92/09/09 | | 0.41 | 0.04 | <0.05 | 1.0 | 0.06 | 324 | 12 | |
| Wellington Creek | RM 13.09 | 92/09/30 | | 0.47 | < 0.02 | 0.05 | 0.7 | 0.08 | 286 | 5 | |
| Willow Creek | RM 2.85 | 92/07/08 | | 0.40 | 0.03 | 0.28 | 1.0 | 0.51 | 490 | 32 | |
| Willow Creek | RM 2.85 | 92/08/12 | | 1.82 | 0.04 | <0.05 | 0.9 | 0.23 | 330 | 14 | |
| Willow Creek | RM 2.85 | 92/09/09 | | 0.87 | 0.04 | 0.05 | 0.8 | 0.22 | 338 | 12 | |
| Willow Creek | RM 2.85 | 92/10/01 | | 1.09 | < 0.02 | 0.45 | 1.2 | 0.32 | 372 | 19 | 5200 |

Table C-2. Fish tissue results from collections in the Black River study area by the Ohio EPA during 1992.

| PARAMETER | SITE#1 LAKE ERIE INSIDE E. BREAKWALL ROCK BASS | SITE#1 LAKE ERIE INSIDE E. BREAKWALL CARP FILLET | SITE#2 LAKE ERIE INSIDE W. BREAKWALL ROCK BASS |
|---|---|---|---|
| LIPID CONTENT (%) | 0.62 | 4.51 | 0.38 |
| VOLATILE ORGANIC COMPOUNDS - VOC's (ug/kg) | | | |
| N-(3-BUTENYL)DIMETHYLAMINE | ND | ND | 1704 |
| HEXANE | 100 | 280 | 93 |
| HEXANAL | 360 | 3000 | 130 |
| PENTANE | ND | 100 | ND |
| PROPANAL | ND | 240 | ND |
| HEPTANAL | ND | 160 | ND |
| BASE NEUTRAL ACIDS - BNA's (mg/kg) | | | |
| NO SIGNIFICANT COMPOUNDS FOUND | | | |
| PESTICIDES (ug/kg) | | | |
| 4, 4-DDE | 6.31 | 53.42 | 8.33 |
| DIELDRIN | ND(1.98) | 6.61 | ND(1.98) |
| 4, 4-DDD | ND(1.98) | 20.25 | ND(1.98) |
| 4, 4-DDT | ND(1.98) | ND(3.99) | <2.00 |
| METHOXYCHLOR | <3.06 | ND(3.99) | ND(1.98) |
| POLYCHLORINATED BIPHENYLS - PCB's (ug/kg) | | | |
| PCB 1260 | 40.54 | 286.89 | 91.70 |
| HEAVY METALS (mg/kg) | | | |
| CADMIUM | <0.00536 | <0.00609 | <0.005 |
| CHROMIUM | 1.205 | <0.795 | 1.35 |
| COPPER | 0.509 | <0.834 | 0.298 |
| LEAD | <0.0535 | <0.0530 | <0.0518 |
| MERCURY | 0.220 | 0.0888 | 0.235 |
| ZINC | 15.5 | 9.21 | 16.2 |

Table C-2 . (cont.)

| PARAMETER | SITE#2 LAKE ERIE INSIDE W. BREAKWALL LM BASS | SITE#2 LAKE ERIE INSIDE W. BREAKWALL CARP FILLET | SITE#2 LAKE ERIE INSIDE W. BREAKWALL WHOLE CARP |
|---|---|---|---|
| LIPID CONTENT (%) | 0.90 | 7.75 | 13.52 |
| VOLATILE ORGANIC COMPOUNDS - VOC's (ug/kg) | | | |
| ACETALDEHYDE | ND | 109 | ND |
| PENTANE | ND | 91 | 154 |
| METHYLCYCLOPENTANE | ND | 109 | ND |
| PROPANAL | 93 | 182 | 250 |
| HEXANE | 130 | 873 | 1212 |
| HEXANAL | 519 | 1491 | 1923 |
| a-METHYLCYCLOHEXANE | ND | ND | 115 |
| BASE NEUTRAL ACIDS - BNA's (mg/kg) | | | |
| NO SIGNIFICANT COMPOUNDS FOUND | | | |
| PESTICIDES (ug/kg) | | | |
| 4, 4-DDE | 13.77 | 54.07 | 106.09 |
| DIELDRIN | 2.45 | 9.57 | 6.75 |
| 4, 4-DDD | 5.54 | 22.44 | 50.33 |
| 4, 4-DDT | <2.88 | ND(3.98) | ND(3.98) |
| POLYCHLORINATED BIPHENYLS - PCB's (ug/kg) | | | |
| PCB 1248 | ND(9.91) | ND(19.90) | 71.20 |
| PCB 1260 | 91.65 | 301.00 | 624.46 |
| HEAVY METALS (mg/kg) | | | |
| CADMIUM | <0.00550 | <0.00540 | 0.112 |
| CHROMIUM | 0.825 | <0.811 | 1.32 |
| COPPER | 0.256 | 0.635 | 1.26 |
| LEAD | <0.0550 | <0.0541 | 0.220 |
| MERCURY | 0.115 | 0.0662 | <0.0175 |
| ZINC | 11.9 | 10.1 | 90.1 |

Table C-2. (cont.)

| PARAMETER | SITE#3 BLACK RIVER ERIE AVE. RM 1.05 BR BULLHEAD | SITE#3 BLACK RIVER ERIE AVE. RM 1.05 LM BASS MED | SITE#3 BLACK RIVER ERIE AVE. RM 1.05 LM BASS LG |
|---|---|---|---|
| LIPID CONTENT (%) | 4.31 | 0.38 | 0.39 |
| VOLATILE ORGANIC COMPOUNDS - VOC's (ug/kg) | | | |
| PENTANE | 96 | ND | ND |
| PROPANAL | 231 | ND | ND |
| HEXANE | 519 | ND | ND |
| HEXANAL | 1019 | ND | 115 |
| BASE NEUTRAL ACIDS - BNA's (mg/kg) | | | |
| NO SIGNIFICANT COMPOUNDS FOUND | | | |
| PESTICIDES (ug/kg) | | | |
| 4, 4-DDE | 68.87 | 7.03 | 11.15 |
| DIELDRIN | 15.18 | ND(1.97) | ND(1.99) |
| 4, 4-DDD | 33.35 | 2.60 | 4.21 |
| 4, 4-DDT | 4.04 | ND(1.97) | <2.39 |
| POLYCHLORINATED BIPHENYLS - PCB's (ug/kg) | | | |
| PCB 1248 | ND(19.80) | ND(9.86) | ND(9.94) |
| PCB 1260 | 397.42 | 45.94 | 99.76 |
| HEAVY METALS (mg/kg) | | | |
| CADMIUM | <0.00503 | <0.00550 | <0.00528 |
| CHROMIUM | 0.788 | 1.07 | 0.844 |
| COPPER | 0.381 | 0.349 | 0.359 |
| LEAD | <0.0508 | <0.0549 | <0.0528 |
| MERCURY | 0.0683 | 0.130 | 0.150 |
| ZINC | 9.99 | 13.5 | 11.0 |

Table C-2. (cont.)

| PARAMETER | SITE#3 BLACK RIVER ERIE AVE. RM 1.05 Carp/Goldfish | SITE#4 BLACK RIVER Upst Turn Basin RM 2.9 Br Bullhead | SITE#4 BLACK RIVER Upst Turn Basin RM 2.9 Carp Fillet |
|---|---|---|---|
| LIPID CONTENT (%) | 1.94 | 4.31 | 2.53 |
| VOLATILE ORGANIC COMPOUNDS - VOC's (ug/kg) | | | |
| a-METHYLCYCLOHEXANE | 212 | ND | ND |
| ACETIC ACID, ANHYDRIDE | 500 | ND | ND |
| HEXANE | 115 | 353 | ND |
| HEXANAL | 423 | 216 | 2600 |
| PROPANAL | ND | ND | 100 |
| BASE NEUTRAL ACIDS - BNA's (mg/kg) | | | |
| NO SIGNIFICANT COMPOUNDS FOUND | | | |
| PESTICIDES (ug/kg) | | | |
| 4, 4-DDE | 25.52 | 55.87 | 31.53 |
| DIELDRIN | ND(4.00) | 13.08 | 4.90 |
| 4, 4-DDD | 6.71 | 32.68 | 13.68 |
| POLYCHLORINATED BIPHENYLS - PCB's (ug/kg) | | | |
| PCB 1248 | ND(20.02) | 48.98 | 39.92 |
| PCB 1260 | 47.03 | 244.20 | 67.94 |
| HEAVY METALS (mg/kg) | | | |
| CADMIUM | <0.00551 | <0.00556 | <0.00556 |
| CHROMIUM | 1.27 | <0.833 | 1.32 |
| COPPER | 0.799 | 0.289 | 0.681 |
| LEAD | <0.0551 | <0.0556 | <0.0556 |
| MERCURY | 0.0216 | 0.0362 | 0.0467 |
| ZINC | 12.0 | 7.64 | 13.6 |

Table C-2. (cont.)

| PARAMETER | SITE#4 BLACK RIVER UPST TURN BASIN RM 2.9 WHOLE CARP | SITE#4 BLACK RIVER UPST TURN BASIN RM 2.9 LM BASS | SITE#5 BLACK RIVER ADJ D2 LANDFILL RM 5.3 LM BASS |
|---|---|---|---|
| LIPID CONTENT (%) | 4.50 | 0.26 | 0.36 |
| VOLATILE ORGANIC COMPOUNDS - VOC's (ug/kg) | | | |
| a-METHYLCYCLOHEXANE | 208 | ND | ND |
| PENTANE | 358 | ND | ND |
| PENTANAL | 264 | ND | ND |
| PROPANAL | 396 | ND | ND |
| HEPTANAL | 208 | ND | ND |
| HEXANAL | ND | 481 | ND |
| BASE NEUTRAL ACIDS - BNA's (mg/kg) | | | |
| NO SIGNIFICANT COMPOUNDS FOUND | | | |
| PESTICIDES (ug/kg) | | | |
| 4, 4-DDE | 86.09 | 6.46 | 3.01 |
| DIELDRIN | 7.08 | ND(2.00) | ND(1.97) |
| 4, 4-DDD | 29.90 | ND(2.00) | ND(1.97) |
| METHOXYCHLOR | ND(3.96) | <2.09 | ND(1.97) |
| POLYCHLORINATED BIPHENYLS - PCB's (ug/kg) | | | |
| PCB 1248 | 65.14 | ND(9.99) | ND(9.87) |
| PCB 1260 | 432.15 | 24.53 | 10.00 |
| HEAVY METALS (mg/kg) | | | |
| CADMIUM | 0.0940 | <0.00532 | <0.00558 |
| CHROMIUM | 1.18 | 1.04 | 1.17 |
| COPPER | 0.637 | 0.356 | 0.351 |
| LEAD | 0.297 | <0.0532 | <0.0558 |
| MERCURY | 0.0540 | 0.0794 | 0.102 |
| ZINC | 44.3 | 11.4 | 11.4 |

Table C-2. (cont.)

| PARAMETER | SITE#5 BLACK RIVER ADJ D2 LANDFILL RM 5.3 WHOLE CARP | SITE#5 BLACK RIVER ADJ D2 LANDFILL RM 5.3 CARP FILLET | SITE#6 E BR BLK RIVER WASHINGTON ST RM 0.3 LM BASS |
|---|---|---|---|
| LIPID CONTENT (%) | 6.14 | 2.25 | 0.71 |
| VOLATILE ORGANIC COMPOUNDS - VOC's (ug/kg) | | | |
| PENTANE | 100 | 167 | ND |
| PROPANAL | 140 | 117 | ND |
| HEXANE | 700 | 183 | ND |
| HEXANAL | 5600 | 2833 | 360 |
| HEPTANAL | ND | 100 | ND |
| BASE NEUTRAL ACIDS - BNA's (mg/kg) | | | |
| NO SIGNIFICANT COMPOUNDS FOUND | | | |
| PESTICIDES (ug/kg) | | | |
| 4, 4-DDE | 91.43 | 39.05 | 9.77 |
| DIELDRIN | 12.00 | 4.23 | ND(3.90) |
| 4, 4-DDD | 63.12 | 10.94 | ND(3.90) |
| POLYCHLORINATED BIPHENYLS - PCB's (ug/kg) | | | |
| PCB 1248 | 58.02 | 44.53 | ND(19.49) |
| PCB 1260 | 318.06 | 131.81 | ND(19.49) |
| HEAVY METALS (mg/kg) | | | |
| CADMIUM | 0.264 | <0.00538 | <0.00546 |
| CHROMIUM | 1.23 | 1.45 | 4.34 |
| COPPER | 1.20 | 0.578 | 0.409 |
| LEAD | 0.137 | <0.0538 | <0.0546 |
| MERCURY | 0.0425 | 0.0845 | 0.167 |
| ZINC | 62.6 | 11.0 | 9.82 |

Table C-2. (cont.)

| PARAMETER | SITE#6 E BR BL R. Washington St. RM 0.3 WHOLE CARP | SITE#6 E BR BL R. Washington St. RM 0.3 CARP FILLET | SITE#6 E BR BL R. Washington St. RM 0.3 Y BULLHEAD |
|---|---|---|---|
| LIPID CONTENT (%) | 3.40 | 1.49 | 1.36 |
| VOLATILE ORGANIC COMPOUNDS - VOC's (ug/kg) | | | |
| M-XYLENE* | 208 | ND(172) | ND(196) |
| PROPANAL | 302 | 86 | ND |
| HEXANE | 321 | ND | 118 |
| HEXANAL | 5849 | 2414 | 275 |
| HEPTANAL | 208 | ND | ND |
| BASE NEUTRAL ACIDS - BNA's (mg/kg) | | | |
| NO SIGNIFICANT COMPOUNDS FOUND | | | |
| PESTICIDES (ug/kg) | | | |
| 4, 4-DDE | 43.51 | 12.19 | 10.11 |
| DIELDRIN | 6.42 | ND(3.94) | ND(3.96) |
| 4, 4-DDD | 12.16 | ND(3.94) | ND(3.96) |
| METHOXYCHLOR | ND(4.00) | 5.17 | ND(3.96) |
| POLYCHLORINATED BIPHENYLS - PCB's (ug/kg) | | | |
| PCB 1248 | 100.98 | 44.52 | ND(19.78) |
| PCB 1260 | 66.18 | ND(19.69) | 35.21 |
| HEAVY METALS (mg/kg) | | | |
| CADMIUM | 0.185 | <0.00745 | 0.0171 |
| CHROMIUM | 1.34 | 1.05 | 1.01 |
| COPPER | 1.52 | 0.745 | 0.392 |
| LEAD | 0.167 | <0.0552 | <0.0560 |
| MERCURY | 0.0321 | 0.0729 | 0.103 |
| ZINC | 67.4 | 12.2 | 8.60 |

Table C-2. (cont.)

| PARAMETER | SITE#7 E BR BL R. FULLER RD RM 3.07 WHOLE CARP | SITE#7 E BR BL R. FULLER RD RM 3.07 CARP FILLET | SITE#7 E BR BL R. FULLER RD RM 3.07 SM BASS |
|---|---|---|---|
| LIPID CONTENT (%) | 3.52 | 0.52 | 0.52 |
| VOLATILE ORGANIC COMPOUNDS - VOC's (ug/kg) | | | |
| ACETALDEHYDE | 109 | ND | ND |
| PROPANAL | 509 | ND | ND |
| BUTANAL | 145 | ND | ND |
| PENTANAL | 309 | ND | ND |
| HEPTANAL | 309 | ND | ND |
| HEXANAL | ND | 632 | ND |
| BASE NEUTRAL ACIDS - BNA's (mg/kg) | | | |
| NO SIGNIFICANT COMPOUNDS FOUND | | | |
| PESTICIDES (ug/kg) | | | |
| 4, 4-DDE | 36.46 | 8.09 | 6.78 |
| DIELDRIN | 9.97 | ND(4.00) | ND(1.99) |
| 4, 4-DDD | 6.84 | ND(4.00) | ND(1.99) |
| 4, 4-DDT | <4.77 | ND(4.00) | 2.04 |
| POLYCHLORINATED BIPHENYLS - PCB's (ug/kg) | | | |
| PCB 1260 | 20.80 | ND(19.98) | ND(9.93) |
| HEAVY METALS (mg/kg) | | | |
| CADMIUM | 0.0349 | <0.00509 | <0.00562 |
| CHROMIUM | 1.28 | 0.865 | 1.15 |
| COPPER | 1.98 | 0.878 | 0.320 |
| LEAD | <0.0558 | <0.0509 | <0.0562 |
| MERCURY | 0.0744 | 0.132 | 0.252 |
| ZINC | 76.8 | 9.31 | 10.4 |

Table C-2. (cont.)

| PARAMETER | SITE#7 E BR BL R. FULLER RD RM 3.07 ROCK BASS | SITE#8 W BR BL R. UPST W 3RD St RM 1.3 CARP FILLET | SITE#8 W BR BL R. UPST W 3RD St RM 1.3 Y BULLHEAD |
|---|---|---|---|
| LIPID CONTENT (%) | 0.52 | 1.41 | 1.66 |
| VOLATILE ORGANIC COMPOUNDS - VOC's (ug/kg) | | | |
| ACETIC ACID, ANHYDRIDE | 365 | ND | ND |
| CARBAMIC ACID | 212 | ND | ND |
| HEXANE | 96 | ND | ND |
| HEXANAL | 154 | 1462 | 170 |
| BASE NEUTRAL ACIDS - BNA's (mg/kg) | | | |
| NO SIGNIFICANT COMPOUNDS FOUND | | | |
| PESTICIDES (ug/kg) | | | |
| 4, 4-DDE | 4.30 | 9.61 | 15.95 |
| 4, 4-DDD | ND(2.00) | ND(3.99) | 5.57 |
| POLYCHLORINATED BIPHENYLS - PCB's (ug/kg) | | | |
| PCB 1248 | ND(9.98) | 110.59 | 61.06 |
| PCB 1260 | ND(9.98) | 29.70 | 64.78 |
| HEAVY METALS (mg/kg) | | | |
| CADMIUM | <0.00546 | <0.00556 | <0.00562 |
| CHROMIUM | 0.873 | 1.31 | 1.21 |
| COPPER | 0.300 | 0.486 | 0.489 |
| LEAD | <0.0546 | <0.0556 | <0.0562 |
| MERCURY | 0.226 | 0.220 | 0.275 |
| ZINC | 15.0 | 10.4 | 8.40 |

Table C-2. (cont.)

| PARAMETER | SITE#9 W BR BL R. RUSSIA RD RM 4.2 LM BASS | SITE#9 W BR BL R. RUSSIA RD RM 4.2 CARP FILLET | SITE#9 W BR BL R. RUSSIA RD RM 4.2 WHOLE CARP |
|---|---|---|---|
| LIPID CONTENT (%) | 0.50 | 0.94 | 3.19 |
| VOLATILE ORGANIC COMPOUNDS - VOC's (ug/kg) | | | |
| HEXANE | 100 | ND | ND |
| HEXANAL | 360 | 720 | 4800 |
| PROPANAL | ND | ND | 260 |
| 3-METHYL-PENTANE | ND | ND | 340 |
| a-METHYLCYCLOHEXANE | ND | ND | 180 |
| HEPTANAL | ND | ND | 220 |
| BASE NEUTRAL ACIDS - BNA's (mg/kg) | | | |
| NO SIGNIFICANT COMPOUNDS FOUND | | | |
| PESTICIDES (ug/kg) | | | |
| 4, 4-DDE | 3.50 | 10.44 | 25.05 |
| DIELDRIN | ND(1.98) | ND(3.94) | 4.15 |
| 4, 4-DDD | ND(1.98) | 11.39 | 19.35 |
| POLYCHLORINATED BIPHENYLS - PCB's (ug/kg) | | | |
| PCB 1260 | ND(9.91) | ND(19.69) | 60.60 |
| HEAVY METALS (mg/kg) | | | |
| CADMIUM | <0.00554 | <0.00561 | 0.0465 |
| CHROMIUM | <0.832 | <0.842 | 2.19 |
| COPPER | 0.286 | 0.533 | 1.17 |
| LEAD | <0.0555 | <0.0561 | 0.0637 |
| MERCURY | 0.549 | 0.148 | 0.101 |
| ZINC | 10.5 | 10.2 | 65.5 |

NOTES:

ND = Not Detectable. Detection limits, if applicable, are given in parentheses.

No detection limits are given for tentatively identified VOC's, which are determined from GC/MS peaks. Names listed represent the best fit as determined by library identification by computer. The name listed is not necessarily the name of the actual compound.
Detection limits are based on sample weight, final extract volume, and dilution.
All reported VOC's are non-priority pollutant tentatively identified compounds, with the exception of the one asterisked (*) compound.

Table C-3. Concentrations of heavy metals in sediments of the Black River study area, 1992. All parameter concentrations were ranked based on a stream sediment classification system described by Kelly and Hite (1984). Samples were collected by Ohio EPA and US EPA-EDO.

| River Mile | As | Cd | Cr | Cu | Fe | Pb | Zn |
|---|---|---|---|---|---|---|---|
| Black River Mainstem | | | | | | | |
| 14.95 | 12.3c | **14.4**d | 24.1c | 41.1b | 23100c | **88.4**d | 120c |
| 10.1 | 10.9b | 1.08c | 15.8b | 23.5a | 20700b | 29.6b | 118c |
| 5.5 | 9.6b | **3.6**d | **39.2**d | 58b | 29700c | 43.7c | **199**d |
| 5.3 | **17.4**d | **87.8**d | **723**e | 58b | **45800**e | **202**e | **2060**e |
| 4.85 | 8.6b | **3.2**d | **39.2**d | 55.1b | 30500c | 39.0c | **189**d |
| 3.8 | 12.0c | **5.9**d | **76.3**e | 70.4c | **44300**d | **73.9**d | **273**d |
| 3.55 | 10.8c | 1.9c | 35.9c | 50.4b | **38800**d | 50.5c | **174**d |
| 3.45 | **19.5**d | **3.5**d | **39.0**d | 61.3c | **35700**d | 47.2c | **211**d |
| 3.4 | 14.9c | 1.4c | 37.7c | 58.1b | **34600**d | 47.1c | **193**d |
| 3.3 | 12.2c | **2.4**d | **39.5**d | 58.6b | **34000**d | 44.3c | **204**d |
| 3.2 | 12.8c | **2.0**d | **39.1**d | 60.8c | **40900**d | **87.1**d | **202**d |
| 3.1 | 12.6c | **2.2**d | **38.4**d | 59.5b | **35700**d | 52.7c | **210**d |
| 3.0 | 10.6b | 1.2c | 29.6c | 49.4b | 28900c | 46.5c | **170**d |
| 2.58 | 14.1c | **2.7**d | 36.2c | 57.3b | **35000**d | 46.5c | **209**d |
| 2.35 | 13.2c | **3.4**d | **43.4**d | 64.2c | **37500**d | **60.0**d | **236**d |
| 0.01 | 10.5b | 0.84b | 14.0a | 17.4a | 18500b | 31.4b | 103c |
| French Creek | | | | | | | |
| 3.2 | 14.9c | **2.88**d | **59.5**d | 54.7b | **33500**d | **61.5**d | **203**d |
| West Branch | | | | | | | |
| 41.6 | 9.83b | .30a | 10.1a | 13.4a | 14200a | 15.8a | 49.1a |
| 25.3 | 2.02a | .06a | 6.32a | 3.85a | 4550a | <15.8a | 25.0a |
| 4.2 | 10.1b | .226a | 14.5a | 39.6b | 21400b | 29.3b | 77.0a |
| East Branch | | | | | | | |
| 18.9 | 10.4b | .133a | 11.4a | 10.9a | 17000a | 19.1a | 59.5a |
| 11.3 | 13.6c | .07a | 13.7a | 8.34a | 22000b | 16.7a | 49.4a |
| 0.3 | 5.48a | **3.01**d | 17.1b | 24.9a | 9220a | 46.3c | 88.6b |
| East Fork of the East Branch | | | | | | | |
| 2.67 | 16.1c | .10a | 12.4a | 12.5a | 32000c | 24.8a | 74.9a |
| Willow Creek | | | | | | | |
| 2.85 | 12.4c | .157a | 10.2a | 6.27a | 15000a | 22.4a | 73.6a |
| Harbor-west side of east breakwall | | | | | | | |
| 16.8HP | 1.36** | 26.7MP | 32.8MP | 29800HP | 42.6MP | 192MP | |

Table C-3. (cont.)

| River Mile | As | Cd | Cr | Cu | Fe | Pb | Zn |
|---|---|---|---|---|---|---|---|
| Harbor-east side of west breakwall | | | | | | | |
| 12.6HP | | 0.91** | 16.7N | 18.8N | 19000MP | 27.2N | 124MP |
| Lake Erie-west side of west breakwall | | | | | | | |
| 12.7HP | | 1.65** | 37.1MP | 34.4MP | 51100HP | 47.8MP | 188MP |
| Lake Erie-east of the confined disposal facility (CDF) | | | | | | | |
| 8.49HP | | 0.80** | 13.5N | 15.7N | 16700N | 32.9N | 183MP |
| ***EOLP Least Impacted Sites Mean (12 sites)*** | | | | | | | |
| 7.67 | | 0.18 | | 8.23 | 10.86 | 17,900 | 11.68 |
| 60.3 | | | | | | | |

[a]Non-elevated; [b] Slightly elevated; [c] Elevated; [d] **Highly elevated**; [e] **Extremely elevated**

Note: The Kelly and Hite classification system addresses relative concentrations but does not directly assess toxicity.

US EPA guidelines: (used in this table for the harbor and Lake Erie sites)
**lower limits not established
N non-polluted
MP moderalty polluted
HP heavily polluted

Table C-4. Concentration (mg/kg dry weight) of Base-Neutral-Acid Compounds in the sediments of the Black River study area, 1992.a

| Location River Mile | Phenol | 2-Methyl phenol | 4-Methyl phenol | 2,4-Dimethyl-alene | Napth thalene | 2-Methylnap- |
|---|---|---|---|---|---|---|
| Black River | | | | | | |
| 5.5 | --- | --- | --- | --- | --- | --- |
| 5.3 | --- | --- | --- | --- | --- | --- |
| 4.85 | --- | 1.2 | --- | --- | --- | --- |
| 3.8 | --- | --- | --- | --- | 4J | --- |
| 3.55 | --- | --- | --- | --- | .13J | .05J |
| 3.45 | --- | --- | --- | --- | 1.1 | .55J |
| 3.4 | --- | --- | --- | --- | .42J | .09J |
| 3.3 | --- | --- | --- | --- | .12J | .03J |
| 3.2 | --- | --- | --- | --- | .85 | .14J |
| 3.1 | --- | --- | --- | --- | .1J | --- |
| 3.0 | --- | .13J | --- | --- | .1J | --- |
| 2.58 | --- | --- | --- | --- | .22J | --- |
| 2.35 | --- | --- | --- | --- | .14J | --- |
| 0.01 | --- | --- | --- | --- | --- | --- |
| French Creek | | | | | | |
| 3.2 | --- | --- | --- | --- | --- | --- |
| Harbor-west side of east breakwall | | | | | | |
| | --- | --- | --- | --- | --- | --- |
| Harbor-east side of west breakwall | | | | | | |
| | --- | --- | --- | --- | --- | --- |
| Lake Erie-west side of west breakwall | | | | | | |
| | --- | --- | --- | --- | --- | --- |
| Lake Erie-east of the confined disposal area (CDF) | | | | | | |
| | --- | --- | --- | --- | --- | --- |

a J = Estimated Value (compound is present but is less than sample quantitation limit)
--- indicates the compound was not found in the sample
A total of 65 Priority Pollutant BNA's were analyzed
For TIC's: The number in ( ) indicates the number of TIC's found up to a maximum of 21
TIC J's = concentration found assuming a 1:1 response

Table C-4. (Cont.)

| Location River Mile | Acenap-hylene | | Dibenzo-furan | Fluorene | Phenan-threne | Anthra-cene | Fluoran thene |
|---|---|---|---|---|---|---|---|
| Black River | | | | | | | |
| 5.5 | --- | .04J | .069J | .72 | .18J | .069J | |
| 5.3 | --- | --- | --- | --- | --- | --- | |
| 4.85 | --- | --- | --- | .73 | .20J | 1.2 | |
| 3.8 | --- | 2.3J | 3.8J | 15.0J | 4.9J | 21.0 | |
| 3.55 | .09J | .06J | .11J | .53J | .18J | .74 | |
| 3.45 | .4J | .75J | 1.1J | 3.9 | 1.3J | 4.4 | |
| 3.4 | 1.1 | .18J | .23J | 1.3 | .65 | 2.3 | |
| 3.3 | .06J | .057J | .90J | .68 | .23J | 1.2 | |
| 3.2 | .51J | --- | .34J | 1.1 | 2.6 | 1.3 | |
| 3.1 | .05J | .053J | .081J | .52J | .26J | .97 | |
| 3.0 | --- | --- | .08J | .57J | .16J | 1.1 | |
| 2.58 | .11J | .081J | .15J | .85 | .26J | 1.5 | |
| 2.35 | .099J | .084J | .15J | .79 | .26J | 1.4 | |
| 0.01 | --- | --- | 1.6 | 7.0 | 1.9 | 10.9 | |
| French Creek | | | | | | | |
| 3.2 | --- | --- | --- | --- | --- | --- | |
| Harbor-west side of east breakwall | | | | | | | |
| | --- | --- | --- | --- | --- | --- | |
| Harbor-east side of west breakwall | | | | | | | |
| | --- | --- | --- | --- | --- | --- | |
| Lake Erie-west side of west breakwall | | | | | | | |
| | --- | --- | --- | --- | --- | --- | |
| Lake Erie-east of the confined disposal area (CDF) | | | | | | | |
| | --- | --- | --- | --- | --- | --- | |

a J = Estimated Value (compound is present but is less than sample quantitation limit)
--- indicates the compound was not found in the sample
A total of 65 Priority Pollutant BNA's were analyzed
For TIC's: The number in ( ) indicates the number of TIC's found up to a maximum of 21
TIC J's = concentration found assuming a 1:1 response

Table C-4. (Cont.)

| Location River Mile | Pyrene | Benzo(a)-Anthracene | Chrysene | bis(2-Ethyl-hexyl) Phthalate | Di-n-Octyl Phthalate | Benzo-(b)Fluor-anthene |
|---|---|---|---|---|---|---|
| Black River | | | | | | |
| 5.5 | 1.5 | .67J | .78 | 1.2 | .11J | |
| 5.3 | 1.9J | .79J | .78J | 3.5J | --- | |
| 4.85 | 1.2 | .59J | .75 | .90 | --- | |
| 3.8 | 15.0J | 7.4J | 6.8J | 17.0J | --- | |
| 3.55 | 1.1 | .43J | .66 | .54 | .55J | |
| 3.45 | 4.2 | 2.0J | 1.8J | .91J | --- | |
| 3.4 | 3.7 | 2.5 | 2.4 | 1.3 | --- | |
| 3.3 | 1.4 | .47J | .74 | .89 | --- | |
| 3.2 | 2.5 | 2.3 | 2.0 | 1.1 | --- | |
| 3.1 | 1.1 | .50J | .55J | .74J | --- | |
| 3.0 | .95 | .44J | .49J | .71 | --- | |
| 2.58 | 1.4 | .68 | .76 | .82 | --- | |
| 2.35 | 1.4 | .66J | .73 | .94 | --- | |
| 0.01 | 4.7 | 2.2 | 3.3 | 1.5 | --- | 5.2 |
| French Creek | | | | | | |
| 3.2 | --- | --- | --- | --- | --- | --- |
| Harbor-west side of east breakwall | | | | | | |
| | --- | --- | --- | --- | --- | --- |
| Harbor-east side of west breakwall | | | | | | |
| | --- | --- | --- | --- | --- | --- |
| Lake Erie-west side of west breakwall | | | | | | |
| | --- | --- | --- | --- | --- | --- |
| Lake Erie-east of the confined disposal area (CDF) | | | | | | |
| | --- | --- | --- | --- | --- | 0.9 |

a J = Estimated Value (compound is present but is less than sample quantitation limit)
--- indicates the compound was not found in the sample
A total of 65 Priority Pollutant BNA's were analyzed
For TIC's: The number in ( ) indicates the number of TIC's found up to a maximum of 21
TIC J's = concentration found assuming a 1:1 response

Table C-4. (Cont.)

| Location River Mile | Benzo(k)-Fluor- | Benzo(a)-Pyrene anthene | Indeno 1(,2,3-cd) | Dibenz(a,h) Anthracene | Benzo | TIC's-(g,h,i) Perylene |
|---|---|---|---|---|---|---|
| Black River | | | | | | |
| 5.5 | .63J | .64J | --- | --- | --- | |
| 5.3 | --- | --- | --- | --- | .73J | |
| 4.85 | .62J | .64J | .31J | --- | .30J | |
| 3.8 | 2.4J | 6.7J | 4.3J | --- | 4.2J | |
| 3.55 | .57 | .54 | .29J | --- | .28J | |
| 3.45 | 1.4J | 1.9J | .85J | --- | .69J | |
| 3.4 | 3.2 | 3.1 | 2.1 | .37J | 1.8 | |
| 3.3 | .81 | .57J | .39J | --- | .38J | |
| 3.2 | 2.8 | 2.2 | 1.4 | --- | 1.2 | |
| 3.1 | .55J | .52J | .28J | --- | .75 | |
| 3.0 | .21J | .50J | .16J | --- | .27J | |
| 2.58 | .49J | .72 | .50J | .86J | .32J | |
| 2.35 | .37J | .79 | .45J | .99J | .37J | |
| 0.01 | | 3.6 | 1.7 | --- | 2.3 | |
| French Creek | | | | | | |
| 3.2 | | --- | --- | --- | --- | |
| Harbor-west side of east breakwall | | | | | | |
| | | --- | --- | --- | --- | |
| Harbor-east side of west breakwall | | | | | | |
| | | --- | --- | --- | --- | |
| Lake Erie-west side of west breakwall | | | | | | |
| | | | --- | --- | --- | --- |
| Lake Erie-east of the confined disposal area (CDF) | | | | | | |
| | | | --- | --- | --- | --- |

a J = Estimated Value (compound is present but is less than sample quantitation limit)
--- indicates the compound was not found in the sample
A total of 65 Priority Pollutant BNA's were analyzed
For TIC's: The number in ( ) indicates the number of TIC's found up to a maximum of 21
TIC J's = concentration found assuming a 1:1 response

Table C-5. Concentration (µg/kg dry weight) of PCB's and Pesticide Compounds in the sediments of the Black River study area, 1992.a

| Location River Mile | 4-4'-DDE | 4-4'DDT | Aroclor 1248 | Aroclor 1260 |
|---|---|---|---|---|
| Black River | | | | |
| 5.5 | 7.5J | 5.3J | --- | --- |
| 5.3 | 41J | --- | --- | --- |
| 4.85 | 10 | 4.8J | --- | --- |
| 3.8 | --- | --- | --- | --- |
| 3.55 | 11J | --- | --- | --- |
| 3.45 | 13J | 7.8J | --- | --- |
| 3.4 | 13J | 11J | --- | --- |
| 3.3 | 8.5 | 3.8J | --- | --- |
| 3.2 | 17J | 8.5J | --- | --- |
| 3.1 | 3.3J | 1.4J | --- | --- |
| 3.0 | 12J | 5.9J | --- | --- |
| 2.58 | 13J | 7.7J | --- | --- |
| 2.35 | --- | --- | --- | --- |
| 0.01 | 6.21 | 3.42 | --- | --- |
| French Creek | | | | |
| 3.2 | 6.55 | 6.47 | --- | --- |
| Harbor-west side of east breakwall | | | | |
| | 3.21 | --- | --- | --- |
| Harbor-east side of west breakwall | | | | |
| | 2.29 | --- | --- | --- |
| Lake Erie-west side of west breakwall | | | | |
| | 0.70 | --- | --- | --- |
| Lake Erie-east of the confined disposal area (CDF) | | | | |
| | 2.07 | --- | --- | --- |

a J = Estimated Value (compound is present but is less than sample quantitation limit)
--- indicates the compound was not found in the sample
A total of 27 Priority Pollutant Pesticide/PCBCompounds were analyzed

Table C-6. Concentration (µg/kg dry weight) of Volatile Compounds in the sediments of the Black River study area, 1992.a

| Location River Mile | Carbon Disulfide | 1,1-Di-chloro-ethene | 1,2-Di-chloro-ethene | 2-Buta-none | 1,1,1-Tri-chloro-ethane | Benzene |
|---|---|---|---|---|---|---|
| Black River | | | | | | |
| 5.5 | --- | --- | --- | 13J | --- | --- |
| 5.3 | --- | --- | --- | 20J | --- | --- |
| 4.85 | --- | --- | --- | 31 | --- | --- |
| 3.8 | --- | --- | --- | 38 | --- | --- |
| 3.55 | --- | --- | --- | 17J | --- | --- |
| 3.45 | --- | --- | --- | 9J | --- | --- |
| 3.4 | --- | --- | --- | --- | --- | --- |
| 3.3 | --- | --- | --- | 13J | --- | --- |
| 3.2 | --- | --- | --- | 13J | --- | --- |
| 3.1 | --- | --- | --- | --- | --- | --- |
| 3.0 | --- | --- | --- | --- | --- | --- |
| 2.58 | --- | --- | --- | 3J | --- | --- |
| 2.35 | --- | --- | --- | 19J | --- | --- |
| 0.01 | | | | | | |
| French Creek | | | | | | |
| 3.2 | | | | | | |
| Harbor-west side of east breakwall | | | | | | |
| Harbor-east side of west breakwall | | | | | | |
| Lake Erie-west side of west breakwall | | | | | | |
| Lake Erie-east of the confined disposal area (CDF) | | | | | | |

a J = Estimated Value (compound is present but is less than sample quantitation limit)
--- indicates the compound was not found in the sample
A total of 34 Priority Pollutant Volatile Compounds were analyzed
For TIC's: The number in ( ) indicates the number of TIC's found up to a maximum of 21
TIC J's = concentration found assuming a 1:1 response

Table C-6. (Cont.)

| Location River Mile | Tetra-chloro-ethene | Toluene | Chloro-benzene | Ethyl Benzene | Total Xylenes | TICS |
|---|---|---|---|---|---|---|
| Black River | | | | | | |
| 5.5 | --- | 13J | --- | --- | --- | |
| 5.3 | --- | --- | --- | --- | --- | |
| 4.85 | --- | 34 | --- | --- | --- | |
| 3.8 | --- | 3J | --- | --- | --- | |
| 3.55 | --- | 3J | --- | --- | --- | |
| 3.45 | --- | 12J | --- | 3J | 5J | |
| 3.4 | --- | 4J | --- | --- | --- | |
| 3.3 | --- | 2J | --- | --- | --- | |
| 3.2 | --- | 2J | --- | --- | --- | |
| 3.1 | --- | 23J | --- | --- | --- | |
| 3.0 | --- | 5J | --- | --- | --- | |
| 2.58 | --- | 5J | --- | --- | --- | |
| 2.35 | --- | 3J | --- | --- | 2J | |
| 0.01 | | | | | | |
| French Creek | | | | | | |
| 3.2 | | | | | | |
| Harbor-west side of east breakwall | | | | | | |
| Harbor-east side of west breakwall | | | | | | |
| Lake Erie-west side of west breakwall | | | | | | |
| Lake Erie-east of the confined disposal area (CDF) | | | | | | |

a J = Estimated Value (compound is present but is less than sample quantitation limit
--- indicates the compound was not found in the sample
A total of 34 Priority Pollutant Volatile Compounds were analyzed
For TIC's: The number in ( ) indicates the number of TIC's found up to a maximum of 21
TIC J's = concentration found assuming a 1:1 response Table C-3

Table C-7. Status of CSO and SSO points associated with the city of Elyria in 1992.

**City of Elyria Collection System Overflows**

| Location/Type | Status |
|---|---|
| Gulf Road @ Dilworth (SSO) | Inactive |
| Glenwood St. @ Washington (SSO) | Inactive |
| Columbus @ St. Clair (CSO) | No Action |
| Washington Ave. @ Bridge (CSO) (north bank) | No Action |
| Washington Ave. @ Bridge (CSO) (south bank) | Leakage fixed |
| 12th Street near Middle Ave. (CSO) | No Action |
| 12th Street near Middle Ave. (SSO) | Rehabilitated in 1993 |
| Middle Ave. @ 12th (CSO) | No Action |
| Floradale siphon head chamber (SSO) | Inactive |
| West River Rd. @ Turnpike (SSO) siphon head chamber | Inactive |
| West Bridge St. bridge (SSO) | Inactive |
| West River Rd. between Hazel (SSO) and Turner Streets | Inactive |
| Dewey Avenue @ Lorain Blvd. (CSO) | No Action |
| Bond St. @ Jefferson St. Alley (CSO) | No Action |
| Foster Ave. between Lake Ave. (SSO) and Adams Street | Eliminated |
| Furnace St. @ Florence Ct. (CSO) | Eliminated |
| Lake Ave. @ bridge (south bank) (SSO) | Inactive |
| Cascade Ct. @ Lake Ave. (CSO) | Eliminated |
| Lake Ave. @ Tremont St. (CSO) | No Action |
| Fourth Street @ West Avenue (CSO) | No Action |
| West Ave. @ Barres Lane (SSO) | Inactive |
| West Ave. @ Fifth St. (CSO) | No Action |

Table C-7. (Cont.)

**City of Elyria Collection System Overflows**

| Location/Type | Status |
|---|---|
| West Ave. @ Elyria H.S. (CSO) | No Action |
| West Ave. @ Ninth St. (CSO) | No Action |
| West Ave. between Oberlin Rd. (SSO) and 18th St. | Inactive |
| East Ave. @ Fourth St. (CSO) | Inactive |
| East Ave. @ Fourth St. (SSO) siphon head chamber | No Action |
| Fifth St. @ East Ave. (CSO) | No Action |
| Sixth St. @ East Ave. (CSO) | No Action |
| East Ave. @ Seventh St. (SSO) | Rehabilitated in 1993 |
| East Ave. @ Seventh St. (SSO) | Rehabilitated in 1993 |
| Seventh St. @ East Ave. (CSO) | No Action |
| Eighth St. @ East Ave. (CSO) | Rehabilitated in 1993 |
| East Ave. @ Eighth St. (SSO) | Rehabilitated in 1993 |
| East Ave. between Eighth St. (SSO) and Eighth Place | Rehabilitated in 1993 |
| Ninth St. @ East Ave. (CSO) | No Action |
| Gates Ave. @ East Ave. (CSO) | No Action |
| Howe St. East Ave. (CSO) | No Action |
| George St. @ East Ave. (CSO) | No Action |
| Wooster St. (mid) (CSO) | No Action |
| Wooster St. E. of East Ave. (CSO) | No Action |
| 1241 East Ave. (CSO) | No Action |
| East Ave. @ George St. (CSO) | No Action |
| East Ave. @ Depot St. (CSO) | No Action |
| Temple Ct. @ East Ave. (CSO) | No Action |

Table C-7. (Cont.)

**City of Elyria Collection System Overflows**

| Location/Type | Status |
|---|---|
| Holly Lane @ East Ave. (CSO) | No Action |
| Third St. @ Chestnut St. (CSO) | No Action |
| Second St. @ Water St. (CSO) | No Action |
| Broad St. @ Water St. (CSO | No Action |
| Lincoln @ Blaine (SSO) | No Action |
| East River St. between Smith Ct. (SSO) and E. Bridge St. | No Action |
| Buckeye St. @ East River St. (CSO) | No Action |
| East River St. @ Denison Ave. (SSO) | No Action |
| East River St. @ Riverdale Ct. (SSO) | No Action |
| East River St. @ Columbia Ave. (SSO) | No Action |
| Sherman St. @ Harvard Ave. (SSO) | No Action |
| Sherman St. @ Cornell Ave. (SSO) | No Action |
| Sherman St. @ Denison Ave. (SSO) | No Action |
| Sherman St. @ Columbia Ave. (SSO) | No Action |
| Park Ave. @ Kenyon Ave. (SSO) | No Action |
| Park Ave. @ Oxford Ave. (SSO) | No Action |
| Park Ave. @ Cambridge Ave. (SSO) | No Action |
| Park Ave. @ Princeton Ave. (SSO) | No Action |
| Park Ave. @ Eastern Hts. Ave. (SSO) | No Action |
| Park Ave. @ Harvard Ave. (SSO) | No Action |
| Park Ave. @ Cornell Ave. (SSO) | No Action |
| Park Ave. @ Denison Ave. (SSO) | No Action |
| Park Ave. @ Columbia Ave. (SSO) | No Action |

Table C-7. (Cont.)

**City of Elyria Collection System Overflows**

| Location/Type | Status |
|---|---|
| Columbia Ave. between Park Ave. (SSO) and Garford Ave. | No Action |
| Garford Ave. @ Columbia Ave. (SSO) | No Action |
| Denison Ave. between Park Ave. (SSO) and Garford Ave. | No Action |
| Fairlawn @ Harvard (SSO) | Plugged in 1993 |
| Fairlawn @ Cornell (SSO) | Plugged in 1993 |
| Winkles @ Clark (SSO) | Inactive |
| Woodland Ave. @ Foster St. (SSO) | Eliminated |
| Woodland Ave. @ Spruce St. (SSO) | Eliminated |
| Woodland Ave. @ Oak St. (SSO) | Eliminated |
| Woodland Ave. @ Walnut St. (SSO) | Eliminated |
| High St. @ Adams St. (SSO) | Eliminated |
| High St. between Lake Ave. and RR (SSO) | Eliminated |
| 840 Livermore (SSO) | Eliminated |
| NW corner Salem & Salem (SSO) | Inactive |
| Gulf Rd. @ Lafayette St. (SSO) | Inactive |
| West River Rd. @ W. Third St. (SSO) | Rehabilitated in 1993 |
| Turner St. Alley (SSO) | Rehabilitated in 1993 |
| Turner St. @ siphon head chamber (SSO) | Rehabilitated in 1993 |
| West end of West Sixth St. (SSO) | Rehabilitated in 1993 |
| Between West Sixth St. and Earl Ct. (SSO) | Rehabilitated in 1993 |
| West end of Earl Ct. (SSO) | Rehabilitated in 1993 |
| Cross St. between Mound St. (SSO) and Quincy St. | No Action |
| Overbrook Rd. @ West Rd. (SSO) | Rehabilitated in 1993 |

Table C-7. (Cont.)

**City of Elyria Collection System Overflows**

| Location/Type | Status |
|---|---|
| Winkles south of Cleveland St. (SSO) | Rehabilitated in 1993 |
| West Eighth St. Pump Station | Improved |
| Elizabeth St. Pump Station | Improved |
| Mound St. Pump Station | Improved |
| Tannery St. Pump Station | Improved |
| Water St. Pump Station | Improved |
| West River Rd. Pump Station | Improved |
| Pinewood Dr. Pump Station | Improved |
| Greenfield Estates Pump Station | Improved |
| Holiday Inn Pump Station | Eliminated |
| Locust St. Pump Station | Improved |

Table C-8. Status of Combined Sewer Overflow points associated with the city of Lorain in 1992.

| City of Lorain Collection System Overflows to the Black River | |
|---|---|
| Location/Type | Status |
| Idaho Pump Station | Unknown |
| East Ave. & E. 22nd St. | Unknown |
| Broadway & W. 17th St. | Unknown |
| Broadway & W. 12th St. | Unknown |
| Broadway & W. 8th St. | Unknown |
| First Street Siphon | Unknown |

| City of Lorain Collection System Overflows to Lake Erie | |
|---|---|
| Location/Type | Status |
| Leavitt Rd. & Grace St. | Unknown |
| Oberlin Ave. & W. 17th St. | Unknown |
| Oberlin Ave. & W. 5th St. | Unknown |
| Hamilton Ave. & 20th St. | Unknown |
| Hamilton Ave. & 19th St. | Unknown |
| Washington Ave. & W. 20th St | Unknown |
| Washington Ave. & W. 5th St. | Unknown |
| Oakdale Ave. & W. 23rd St. | Unknown |
| Oakdale Ave. & W. 18th St. | Unknown |
| Reid Ave. & W. 23rd St. | Unknown |
| Reid Ave. & W. 22nd St. | Unknown |
| Reid Ave. & W. 20th St. | Unknown |
| "G" St. & Euclid Ave. | Unknown |
| E. Erie Ave. & Kansas Ave. | Unknown |

Table C-9. Black River basin Waste Water Treatment plants and associated design flows in 1992.

| Black River Basin WWTPs | |
|---|---|
| WWTP | Design Flow (mgd), |
| Lorain - East | 15.00 |
| Elyria | 13.00 |
| French Creek | 7.50 |
| Oberlin | 0.50 |
| Grafton | 0.75 |
| Wellington | 0.75 |
| Lodi | 0.34 |
| LaGrange | 0.16 |