Biological and Water Quality Study of the West Fork Mill Creek

DuPont Lockland Works
2002

Hamilton County, Ohio

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TABLE OF CONTENTS

NOTICE TO USERS

Ohio EPA incorporated biological criteria into the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) regulations in February 1990 (effective May 1990). These criteria consist of numeric values for the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), both of which are based on fish assemblage data, and the Invertebrate Community Index (ICI), which is based on macroinvertebrate assemblage data. Criteria for each index are specified for each of Ohio's five ecoregions (as described by Omernik 1987), and are further organized by organism group, index, site type, and aquatic life use designation. These criteria, along with the existing chemical and whole effluent toxicity evaluation methods and criteria, figure prominently in the monitoring and assessment of Ohio's surface water resources.

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

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

Ohio Environmental Protection Agency. 1987b. Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Div. Water Qual. Monit. & Assess., Surface Water Section, Columbus, Ohio.

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

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

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

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

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

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

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

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

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

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

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

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

Ohio EPA, Division of Surface Water
Ecological Assessment Section
4675 Homer Ohio Lane
Groveport, Ohio 43125
(614) 836-8777

FOREWORD

What is a Biological and Water Quality Survey?

A biological and water quality survey, or "biosurvey", is an interdisciplinary monitoring effort coordinated on a waterbody specific or watershed scale. This effort may involve a relatively simple setting focusing on one or two small streams, one or two principal stressors, and a handful of sampling sites or a much more complex effort including entire drainage basins, multiple and overlapping stressors, and tens of sites. Each year Ohio EPA conducts biosurveys in 6-10 different study areas with an aggregate total of 350-400 sampling sites.

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

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

Hierarchy of Indicators

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

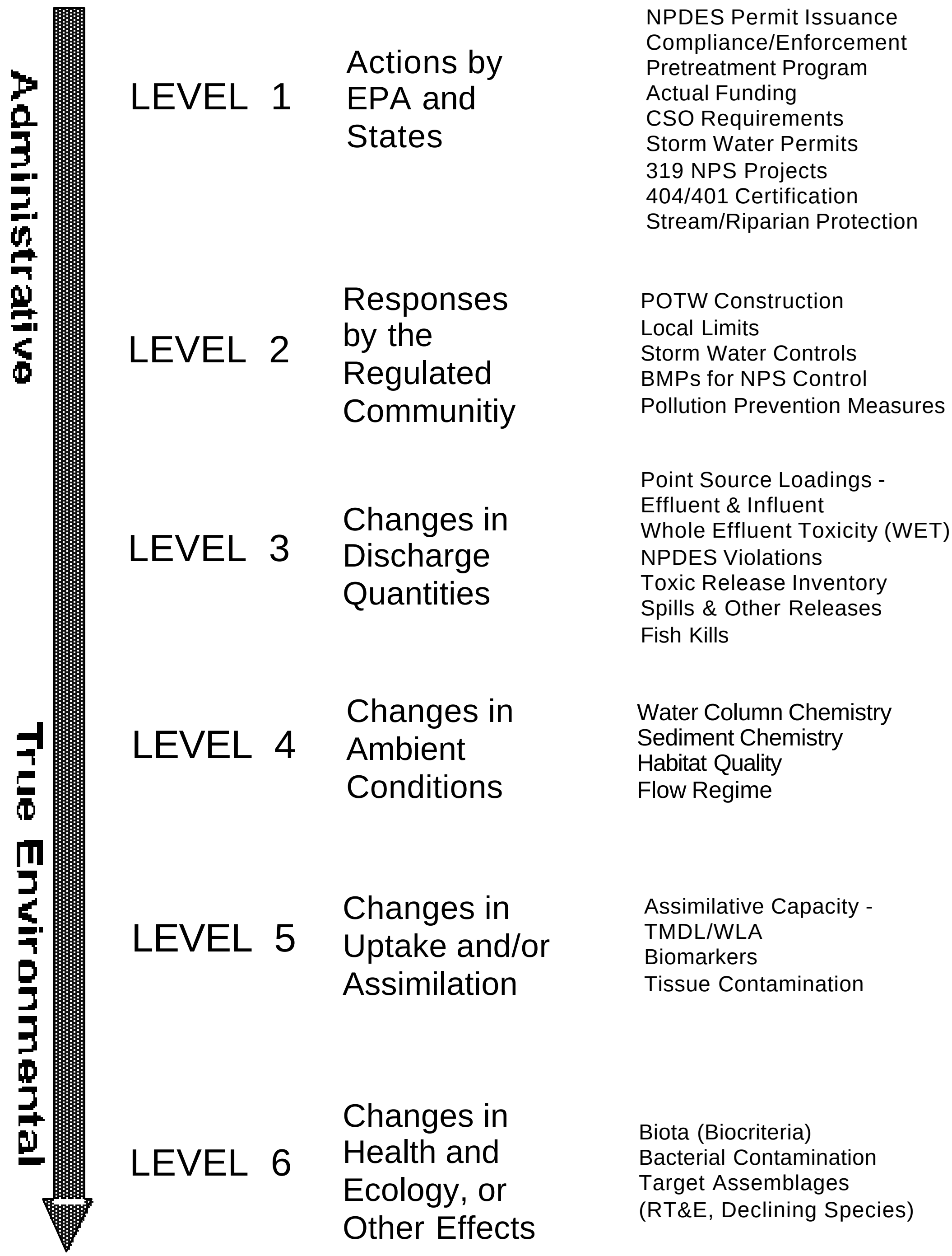

Figure 1. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by U.S. EPA (1995).

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

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

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

Ohio Water Quality Standards: Designated Aquatic Life Uses

The Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) consist of designated uses and chemical, physical, and biological criteria designed to represent measurable properties of the environment that are consistent with the goals specified by each use designation. Use designations consist of two broad groups, aquatic life and non-aquatic life uses. In applications of the Ohio WQS to the management of water resource issues in Ohio's rivers and streams, the aquatic life use criteria frequently result in the most stringent protection and restoration requirements, hence their emphasis in biological and water quality reports. Also, an emphasis on protecting for aquatic life generally results in water quality suitable for all uses.

The five different aquatic life uses currently defined in the Ohio WQS are described as follows:

1) *Warmwater Habitat (WWH)* - this use designation defines the "typical" warmwater assemblage of aquatic organisms for Ohio rivers and streams; *this use represents the principal restoration target for the majority of water resource management efforts in Ohio.*
2) *Exceptional Warmwater Habitat (EWH)* - this use designation is reserved for waters which support "unusual and exceptional" assemblages of aquatic organisms which are characterized by a high diversity of species, particularly those which are highly intolerant and/or rare, threatened, endangered, or special status (*i.e.,* declining species); *this designation represents a protection goal for water resource management efforts dealing with Ohio's best water resources.*
3) *Coldwater Habitat (CWH)* - this use is intended for waters which support assemblages of cold water organisms and/or those which are stocked with salmonids with the intent of providing a put-and-take fishery on a year round basis which is further sanctioned by the Ohio DNR, Division of Wildlife; this use should not be confused with the Seasonal Salmonid Habitat (SSH) use which applies to the Lake Erie tributaries which support periodic "runs" of salmonids during the spring, summer, and/or fall.
4) *Modified Warmwater Habitat (MWH)* - this use applies to streams and rivers which have been subjected to extensive, maintained, and essentially permanent hydromodifications such that the biocriteria for the WWH use are not attainable *and where the activities have been sanctioned and permitted by state or federal law;* the representative aquatic assemblages are generally composed of species which are tolerant to low dissolved oxygen, silt, nutrient enrichment, and poor quality habitat.
5) *Limited Resource Water (LRW)* - this use applies to small streams (usually <3 $mi.^2$ drainage area) and other water courses which have been irretrievably altered to the extent that no appreciable assemblage of aquatic life can be supported; such waterways generally include small streams in extensively urbanized areas, those which lie in watersheds with extensive drainage modifications, those which completely lack water on a recurring annual basis (*i.e.,* true ephemeral streams), or other irretrievably altered waterways.

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

Ohio Water Quality Standards: Non-Aquatic Life Uses

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

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

ACKNOWLEDGMENTS

The following Ohio EPA staff are acknowledged for their contribution to this report:

Surface Water - David Altfater
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Biological Assessment:
    Macroinvertebrate community - Mike Gray
    Fish community - David Altfater.
Data Management - Dennis Mishne
Report coordination - David Altfater
Reviewers - Jeff DeShon, Marc Smith

INTRODUCTION

The DuPont Lockland Works site is located in Hamilton County, Ohio on Shepherd Lane in the Anthony Wayne Industrial Park. The site is currently used by a variety of industrial and commercial enterprises. DuPont de Nemours & Company operated a chemical manufacturing facility at the site from 1929 to 1951. Sulfuric acid was produced by the lead chamber process. Lead sulfate sludge, the by-product of the process, was disposed of on-site and by sluicing through drainage ditches to the West Fork Mill Creek about 500 feet south of the chemical manufacturing facility. During an unknown period of time the City of Lockland used a portion of the site near the West Fork Mill Creek for municipal incineration and landfilling of municipal waste. Several studies have investigated possible exposure pathways to site-related contamination, including groundwater and soils. However, the surface water pathway was never adequately evaluated.

In this project, the Division of Surface Water evaluated surface water, sediment, and biological conditions in the West Fork Mill Ceek to assess the contribution of potential contaminants from the former DuPont Lockland Works site.

Specific objectives of this evaluation were to:

1) Establish biological conditions in the West Fork Mill Creek in the vicinity of the former DuPont Lockland Works property by evaluating fish and macroinvertebrate communities,

2) Evaluate the effects of hazardous wastes on the surface water, sediment quality, and biological health in the West Fork Mill Creek, and

3) Determine the aquatic life use attainment status of the West Fork Mill Creek with regard to the Warmwater Habitat (WWH) aquatic life use designation codified in the Ohio Water Quality Standards.

SUMMARY

A total of 3.4 miles of the West Fork Mill Creek was assessed by the Ohio EPA in 2002. Based on the performance of the biological communities, the entire 3.4 miles of the West Fork Mill Creek were in non-attainment of the Warmwater Habitat aquatic life use (Table 1). The non-attainment was caused by poor fish communities. Combined sewer overflows into the West Fork Mill Creek appeared to be the primary cause of impaired biological condition (sewage odors were noted at two sampling locations). To a lesser extent, elevated sediment levels of polycyclic aromatic hydrocarbons (PAHs) and lead contributed to the impaired biological communities. The highest sediment lead level during this study was recorded

immediately downstream from the former DuPont Lockland Works; however, overall lead levels have declined since 1992/1993. The highly elevated PAH concentrations noted in West Fork Mill Creek sediment downstream from the former DuPont Lockland Works are from an unknown source. It should be noted that fine-grained sediment depositional material (where contaminants are most likely to concentrate), which was sampled for this project, was very sparse within the study area. Overall PAH and lead levels would be expected to be lower across the entire stream bottom where sand, gravel, cobble, and boulder substrates predominated.

Fish tissue sampling results from both whole-body (longear sunfish) and fillet (common carp) samples collected in the West Fork Mill Creek revealed lead at low or non-detect levels both upstream and downstream from the Dupont Lockland site. There was no evidence of increased lead levels in fish tissue collected adjacent to or downstream from Dupont Lockland.

In 1992, Ohio EPA assessed the West Fork Mill Creek at river miles (RMs) 4.5 and 2.0, sites resampled during the 2002 study. Macroinvertebrate results indicated a substantial improvement over the ten year period at both locations, while fish communities showed a slight improvement at the upstream site and no change at the downstream location.

Sampling during 2002 confirmed the appropriateness of the Warmwater Habitat aquatic life use designation for the West Fork Mill Creek.

RECOMMENDATIONS

Status of Aquatic Life Uses

The aquatic life use designation of Warmwater Habitat (WWH) for the West Fork Mill Creek has been confirmed in a previous Ohio EPA biological and water quality study. This study verified the appropriateness of the existing WWH use designation for the West Fork Mill Creek.

Status of Non-Aquatic Life Uses

This study verified that the Primary Contact Recreation use is appropriate for the West Fork Mill Creek. In addition to numerous locations with sufficient depth (3 feet deep over a 100 square foot area) to support the primary contact recreation use, several public parks are located along the West Fork Mill Creek with direct access to the stream.

Table 1. Attainment status of the existing aquatic life use for the West Fork Mill Creek based on biological sampling conducted during July and August, 2002.

RIVER MILE Fish/Invert.	IBI	MIwb	ICI[a]	QHEI	Attainment Status	Site Location
West Fork Mill Creek	*Interior Plateau (IP) - WWH Use Designation*					
4.5 / 4.5	26*	6.7*	28[ns]	82.5	NON	Background/ Riddle Road
3.1 / 3.1	21*	7.0*	26[ns]	80.0	NON	Upstream DuPont Lockland
2.6 / 2.6	25*	6.9*	30	74.0	NON	Immediately downstream Dupont Lockland
2.1 / 2.1	22*	6.5*	G	75.0	NON	Downstream DuPont Lockland

Ecoregion Biocriteria: Interior Plateau (IP)

INDEX	WWH	EWH	MWH[b]
IBI-Wading	40	50	24
MIwb - Wading	8.1	9.4	6.2
ICI	30	46	22

[a] The qualitative narrative evaluation is based on best professional judgment utilizing sample attributes such as taxa richness, EPT richness, and predominant organisms and is used when quantitative data is not available to calculate the Invertebrate Community Index (ICI) scores (G - Good).
[b] Modified Warmwater Habitat for channel modified areas.
* Significant departure from ecoregion biocriterion; poor and very poor results are underlined.
[ns] Nonsignificant departure from ecoregion biocriterion ($\leq$4 IBI and ICI units, $\leq$0.5 MIwb units).

Table 2. Sampling locations in the West Fork Mill Creek, 2002. Type of sampling included fish community (F), macroinvertebrate community (M), sediment (S) and surface water (W).

Stream/ River Mile	Type of Sampling	Latitude	Longitude	Landmark
West Fork Mill Creek				
4.5/ 4.37	F,M,S,W	39.25287	84.47149	Riddle Road/ Upstream DuPont Lockland
3.1/ 3.18	F,M,S,W	39.23760	84.46584	Park Place park/ Upstream DuPont Lockland
2.6/ 2.55	F,M,S,W	41.05040	80.57335	Wayne Ave./ Downstream DuPont Lockland
2.1/ 2.02	F,M,S,W	41.04978	80.57443	Gardner Park/ Downstream DuPont Lockland

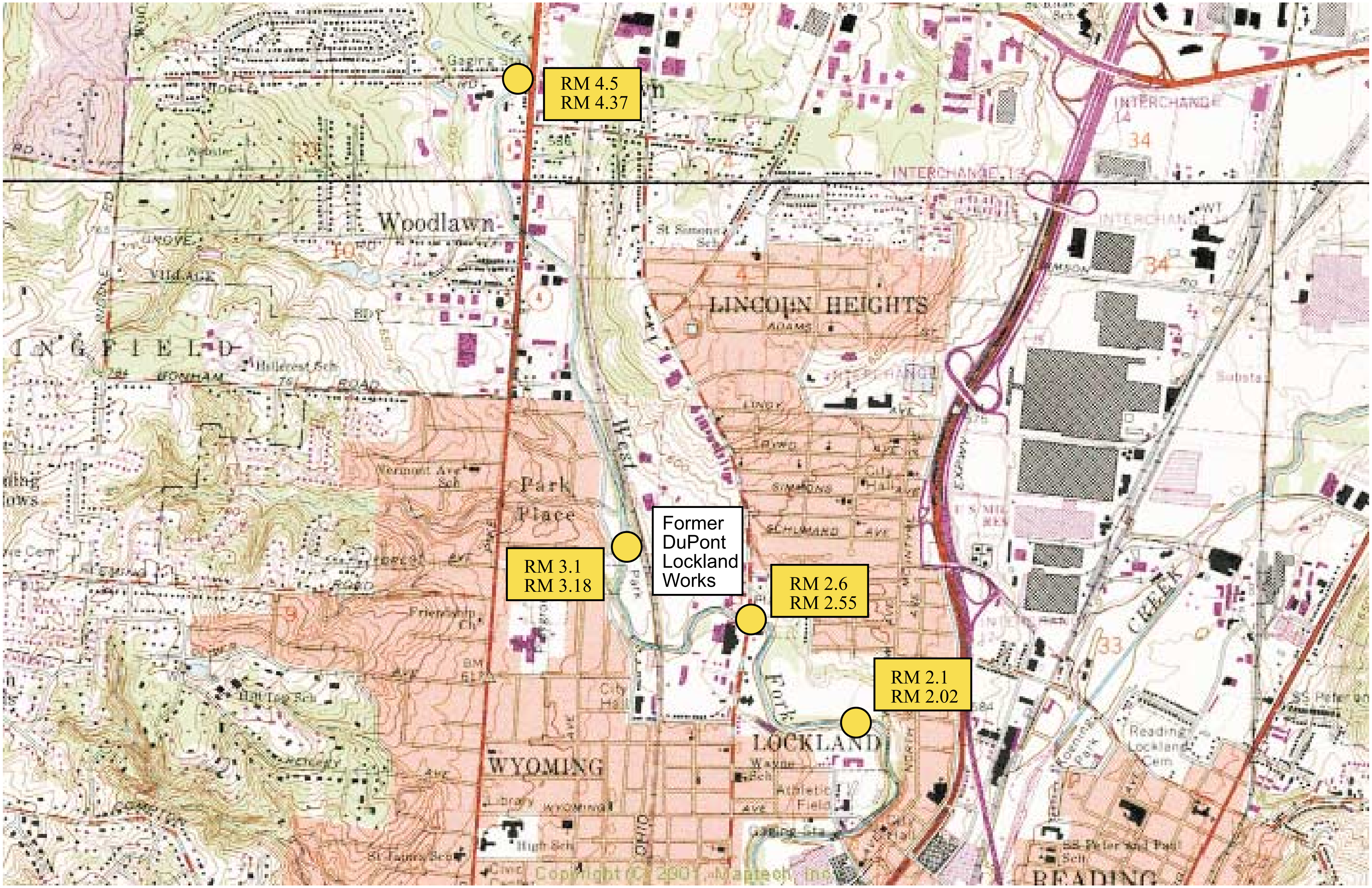

Figure 2. Map of West Fork Mill Creek study area showing sampling locations, 2002.

METHODS

All physical, chemical, and biological field, laboratory, data processing, and data analysis methodologies and procedures adhere to those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 1989a) and Biological Criteria for the Protection of Aquatic Life, Volumes I-III (Ohio Environmental Protection Agency 1987a, 1987b, 1989b, 1989c), The Qualitative Habitat Evaluation Index (QHEI): Rationale, Methods, and Application (Rankin 1989, 1995) for aquatic habitat assessment, and the Ohio EPA Sediment Sampling Guide and Methodologies (Ohio EPA 2001). Sampling locations are listed in Table 2.

Determining Use Attainment Status

Use attainment status is a term describing the degree to which environmental indicators are either above or below criteria specified by the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1). Assessing aquatic use attainment status involves a primary reliance on the Ohio EPA biological criteria (OAC 3745-1-07; Table 7-16). These are confined to ambient assessments and apply to rivers and streams outside of mixing zones. Numerical biological criteria are based on multimetric biological indices including the Index of Biotic Integrity (IBI) and modified Index of Well-Being (MIwb), indices measuring the response of the fish community, and the Invertebrate Community Index (ICI), which indicates the response of the macroinvertebrate community. Three attainment status results are possible at each sampling location - Full, partial, or non-attainment. Full attainment means that all of the applicable indices meet the biocriteria. Partial attainment means that one or more of the applicable indices fails to meet the biocriteria. Non-attainment means that none of the applicable indices meet the biocriteria or one of the organism groups reflects poor or very poor performance. An aquatic life use attainment table (Table 1) is constructed based on the sampling results and is arranged from upstream to downstream and includes the sampling locations indicated by river mile, the applicable biological indices, the use attainment status (*i.e.*, Full, partial, or non), the Qualitative Habitat Evaluation Index (QHEI), and a sampling location description.

Habitat Assessment

Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989, 1995). Various attributes of the habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrates, amount and quality of instream cover, channel morphology, extent and quality of riparian vegetation, pool, run, and riffle development and quality, and gradient are some of the habitat characteristics used to determine the QHEI score which generally ranges from 20 to less than 100. The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have indicated that values greater than 60 are *generally* conducive to the existence of warmwater faunas whereas scores less than 45 generally cannot support a warmwater assemblage consistent with the WWH biological criteria. Scores greater than 75 frequently typify habitat conditions which have the ability to support exceptional warmwater faunas.

Sediment and Surface Water Assessment
Fine grain sediment samples were collected in the upper 4 inches of bottom material at each location using decontaminated stainless steel scoops. Decontamination of sediment sampling equipment followed the procedures outlined in the Ohio EPA sediment sampling guidance manual (Ohio EPA 2001). Sediment grab samples were homogenized in stainless steel pans (material for VOC analysis was not homogenized), transferred into glass jars with teflon lined lids, placed on ice (to maintain 4^{o}C) in a cooler, and delivered to the Ohio EPA Division of Environmental Services lab. Sediment data is reported on a dry weight basis. Surface water samples were collected directly into appropriate containers, preserved and delivered to either an Ohio EPA contract lab or the Ohio EPA Division of Environmental Services. Surface water samples were evaluated using comparisons to Ohio Water Quality Standards criteria, reference conditions, or published literature. Sediment evaluations were conducted using guidelines established in MacDonald *et al.* (2000).

Macroinvertebrate Community Assessment
Macroinvertebrates were collected from artificial substrates and from the natural habitats at the West Fork Mill Creek sites. The artificial substrate collection provided quantitative data and consisted of a composite sample of five modified Hester-Dendy multiple-plate samplers colonized for six weeks. At the time of the artificial substrate collection, a qualitative multihabitat composite sample was also collected. This sampling effort consisted of an inventory of all observed macroinvertebrate taxa from the natural habitats at each site with no attempt to quantify populations other than notations on the predominance of specific taxa or taxa groups within major macrohabitat types (e.g., riffle, run, pool, margin). Detailed discussion of macroinvertebrate field and laboratory procedures is contained in Biological Criteria for the Protection of Aquatic Life: Volume III, Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities (Ohio EPA 1989b). The Hester-Dendy sampler placed in the stream at RM 2.1 was vandalized during the six-week colonization period. Consequently, only a qualitative sample was collected at RM 2.1

Fish Community Assessment
Fish were sampled twice at each site using pulsed DC electrofishing wading methods, with sampling distances of between 200 and 230 meters at each site. Fish were processed in the field, and included identifying each individual to species, counting, weighing, and recording any external abnormalities. Discussion of the fish community assessment methodology used in this report is contained in Biological Criteria for the Protection of Aquatic Life: Volume III, Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities (Ohio EPA 1989b).

Causal Associations
Using the results, conclusions, and recommendations of this report requires an understanding of the methodology used to determine the use attainment status and assigning probable causes and sources of impairment. The identification of impairment in rivers and streams is straightforward - the numerical biological criteria are used to judge aquatic life use attainment and impairment (partial and non-attainment). The rationale for using the biological criteria, within a weight of evidence framework, has been extensively

discussed elsewhere (Karr *et al*. 1986; Karr 1991; Ohio EPA 1987a,b; Yoder 1989; Miner and Borton 1991; Yoder 1991; Yoder 1995). Describing the causes and sources associated with observed impairments relies on an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, land use data, and biological results (Yoder and Rankin 1995). Thus the assignment of principal causes and sources of impairment in this report represent the association of impairments (based on response indicators) with stressor and exposure indicators. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified, or have been experimentally or statistically linked together. The ultimate measure of success in water resource management is the restoration of lost or damaged ecosystem attributes including aquatic community structure and function. While there have been criticisms of misapplying the metaphor of ecosystem "health" compared to human patient "health" (Suter 1993), in this document we are referring to the process for evaluating biological integrity and causes or sources associated with observed impairments, not whether human health and ecosystem health are analogous concepts.

RESULTS

Surface Water Quality

Chemical analyses were conducted on surface water samples collected on July 2 and August 14, 2002 from four locations in the West Fork Mill Creek (Table 3, Appendix Tables 1and 2). Surface water samples were analyzed for total analyte list inorganics. Parameters which were in exceedence of Ohio WQS criteria are reported in Table 3.

For all four West Fork Mill Creek sampling locations, there were no exceedences of Ohio WQS criteria for any of the tested parameters. Concentrations of over half of the parameters tested were reported as non-detected. Parameters with measurable concentrations were below applicable Ohio WQS criteria or were at or below reference levels (75^{th} percentile of reference sites, Ohio EPA 1999). Nutrients, ammonia-N, dissolved oxygen and bacteriological parameters were not tested as part of this evaluation. It should be noted that combined sewer overflows occur along the West Fork Mill Creek within the study area.

Sediment Chemistry

Sediment samples were collected at four locations in the West Fork Mill Creek by the Ohio EPA on July 2, 2002. All stream sampling locations are indicated by river mile in Figure 2. Samples were analyzed for volatile and semivolatile organic compounds, pesticides, PCBs, total analyte list inorganics, and percent solids. Specific chemical parameters tested and results are listed in Appendix Table 3.

Sediment data were evaluated using guidelines established in *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald *et.al*. 2000). The consensus-based sediment guidelines define two levels of ecotoxic effects. A *Threshold Effect Concentration* (TEC) is a level of sediment chemical quality below which harmful effects are unlikely to be observed. A *Probable Effect Concentration* (PEC) indicates a level above which harmful effects are likely to be observed.

Sediment collected from one location (RM 2.55) in the West Fork Mill Creek immediately downstream from Wayne Ave. and the former Dupont Lockland Works property was above *Probable Effect Concentrations* (PEC) and considered likely to be toxic to sediment-dwelling organisms (MacDonald *et.al*. 2000). At this sampling location, highly elevated levels of lead and polycyclic aromatic hydrocarbons (PAHs) were reported (Table 4). Further downstream, at RM 2.02, elevated levels of PAHs were recorded, but at much reduced concentrations. Within the study area, the highest concentrations of chemical parameters in sediment samples occurred in the West Fork Mill Creek at the site immediately downstream from Wayne Avenue (RM 2.55). Several additional chemicals exceeded TEC levels at all four West Fork Mill Creek sample locations (Table 4).

Past collections in the West Fork Mill Creek by Ohio EPA (Ohio EPA 1994a, 1994b) have noted elevated lead levels in sediments collected adjacent and downstream from the former DuPont Lockland Works property. This study confirmed the presence of elevated lead levels in the West Fork Mill Creek in the vicinity of the former DuPont Lockland site. This facility generated lead sulfate sludge waste on-site while in operation during 1929-1951 with some of the waste disposed of in the West Fork Mill Creek via drainage ditches. Although lead was documented at the PEC level from one location, results were improved from data collected in 1993.

Physical Habitat For Aquatic Life

Physical habitat was evaluated in the West Fork Mill Creek at each fish sampling location. Qualitative Habitat Evaluation Index (QHEI) scores are detailed in Table 5.

Similar physical habitat conditions were noted at all four sampling locations in the West Fork Mill Creek. Sand, gravel and cobble predominated the bottom substrates at three of the four sites. The most upstream site (RM 4.5) was predominated by cobble and boulder substrates. The river channel was natural within the study area and was represented by pool, run, and riffle areas. Fill encroachment along one or both banks was evident at three of the sites - RMs 4.5, 3.1, and 2.5. Instream channel development was good, and surrounding land use was largely suburban/commercial. QHEI scores for the West Fork Mill Creek sites ranged between 74.0 and 82.5. These scores are indicative of very good to excellent stream habitat.

Fish Community Assessment

Fish communities were assessed at four locations in the West Fork Mill Creek (Figure 2, Table 6, Appendix Tables 6 and 7). Sampling locations were selected to assess contributions of contaminants from the former DuPont Lockland property.

Fish communities ranged from poor to fair in the West Fork Mill Creek. Results from all four fish sampling locations were largely consistent, with no obvious trends associated with the former DuPont Lockland property. IBI scores were in the poor range at each location sampled in the West Fork Mill Creek, with scores of 21 - 26. These IBI values did not achieve the ecoregional biocriterion established for Warmwater Habitat (WWH) streams and rivers in Ohio (Table 1). Modified Index of Well-Being scores were in the fair range, with values of 6.5 to 7.0. These MIwb scores also did not achieve the ecoregional biocriterion established for Warmwater Habitat (WWH) streams and rivers in Ohio. The lack of darters, pollution sensitive suckers (e.g. golden redhorse, northern hog sucker), and pollution intolerant species contributed to the poor to fair fish performance. Past Ohio EPA fish collections included samples collected at RMs 4.5 and 2.0 during 1992. IBI values (22 and 24) and MIwb scores (6.4 and 6.6) from 1992 were comparable to conditions reported during 2002. In 1992, as noted during 2002, darters and sensitive sucker species were absent from the West Fork Mill Creek.

Macroinvertebrate Community Assessment

The macroinvertebrate communities at four West Fork Mill Creek sites were sampled in 2002 using qualitative (multi-habitat composite) and quantitative (artificial substrate) sampling protocols. The sampler at RM 2.1 was vandalized so only qualitative sample data is available from this site. Results are summarized in Table 7. The ICI metrics with the associated scores and the raw data are attached as Appendix Tables 4 and 5 .

The ICI scores for the West Fork Mill Creek sites ranged from 26 to 30, indicative of non-significant departure to full achievement of the WWH use as reflected by the macroinvertebrate community. ICI scores of 26 to 28 (marginally good) are a non-significant departure from achievement of the WWH use, while a score of 30 (good) is fully achieving the WWH use for the Interior Plateau ecoregion. The qualitative sample from RM 2.0 was evaluated as good (achieving the WWH use) based on best professional judgement. Sample characteristics including total taxa richness, EPT taxa richness (Ephemeroptera - mayfly, Plecoptera - stonefly, and Trichoptera - caddisfly), diptera taxa richness, relative abundance of EPT taxa (as noted on field sheet), and relative abundance of tolerant taxa were used to assess the sample in relation to the other West Fork Mill Creek samples. The macroinvertebrate sampling results did not show any trends related to the former DuPont Lockland site. The 2002 sampling results did document improvement in the macroinvertebrate community from previous samples. In 1992 a qualitative sample from RM 4.4 was evaluated as fair while in 2002 the site had an ICI score of 28 and was marginally good. In 1992 a qualitative sample from RM 2.0 was evaluated as poor while the 2002 sample was evaluated as good.

Fish Tissue Assessment

Fish tissue samples comprised of common carp skin off fillets and whole body longear sunfish were collected from the West Fork Mill Creek during the second fish sampling pass, August 2002. Common carp samples were collected from RMs 4.5, 3.1, and 2.1, and longear sunfish were collected from RMs 4.5, 3.1, 2.6, and 2.1. Common carp were not present in the West Fork Mill Creek at RM 2.6 during the August sampling. Analyses included lead, mercury, arsenic, cadmium, selenium, organochlorinated pesticides, and PCB aroclors. Results of the fish tissue analyses are presented in Table 8.

Lead was detected in four of the seven fish tissue samples. Three of the four longear sunfish samples had detectable levels of lead, however, these were all below a residue-based tissue toxicity screening value of 0.37 mg/kg (USEPA 2001). Additionally, there was no evidence of increased whole body lead levels in longear sunfish collected adjacent to or downstream from the Dupont Lockland site, compared with the upstream background locations. Common carp fillet samples had measurable levels of lead in only one sample, and this was located at RM 4.5, upstream from the Dupont Lockland site. The common carp sample with a detectable lead level (0.164 mg/kg) was within the *draft* Ohio fish consumption maximum allowance limit of one meal per week (above 0.086 mg/kg, below 0.375 mg/kg)(Ohio Dept. of Health 1999).

Of the other fish tissue chemical results presented in Table 8, only mercury was elevated, and appears to be consistent with other mercury values found throughout the state. There currently is a statewide mercury advisory to eat no more than one meal per week of fish (any species) from any Ohio body of water.

Table 3. Exceedences of Ohio Water Quality Standards criteria (OAC 3745-1) for chemical/physical parameters from the West Fork Mill Creek study area during 2002 (units are ug/l).

River Mile	Parameter (value)
West Fork Mill Creek	
4.37	None
3.18	None
2.55	None
2.02	None

* Exceedence of Outside Mixing Zone Average criteria (OMZA).
** Exceedence of Outside Mixing Zone Maximum criteria (OMZM).

Table 4. Chemical parameters measured above screening levels in sediment samples collected by Ohio EPA from the West Fork Mill Creek, July, 2002. Contamination levels were determined for parameters using consensus-based sediment quality guidelines (MacDonald et.al. 2000).

Parameter	West Fork Mill Creek RM 4.37	West Fork Mill Creek RM 3.18	West Fork Mill Creek RM 3.18	West Fork Mill Creek RM 2.55	West Fork Mill Creek RM 2.02
			Duplicate		
Cadmium (mg/kg)	0.212	<0.084	<0.083	4.27^{T}	0.204
Lead (mg/kg)	<19	<17	19	196^{P}	41
Mercury (mg/kg)	<0.029	<0.028	<0.026	0.184^{T}	0.05
Zinc (mg/kg)	44.4	31.9	27.8	240^{T}	88.3
Anthracene (mg/kg)	<0.51	<0.51	<0.51	8.61^{P}	0.69^{T}
Benzo(a)anthracene (mg/kg)	<0.51	<0.51	0.73^{T}	24.7^{P}	2.5^{P}
Benzo(a)pyrene (mg/kg)	<0.51	<0.51	0.6^{T}	20.7^{P}	2.52^{P}
Chrysene (mg/kg)	0.51^{T}	0.61^{T}	0.95^{T}	29.5^{P}	3.78^{P}
Fluoranthene (mg/kg)	0.97^{T}	1.1^{T}	2.15^{T}	79.1^{P}	7.56^{P}
Fluorene (mg/kg)	<0.51	<0.51	<0.51	5.24^{P}	<0.60
Naphthalene (mg/kg)	<0.51	<0.51	<0.51	0.95^{P}	<0.60
Phenanthrene (mg/kg)	<0.51	<0.51	2.05^{P}	45.1^{P}	3.97^{P}
Pyrene (mg/kg)	0.80J^{T}	0.9^{T}	1.72^{P}	59.8^{P}	5.91J^{P}
4,4'-DDD (ug/kg)	<5.1	<5.1	<5.1	<5.8	7.6^{T}
4,4'-DDE (ug/kg)	<5.1	5.1^{T}	5.9^{T}	<5.8	6.5^{T}
Total PAHs (Calculated) - mg/kg	2.28^{T}	2.61^{T}	9.89^{T}	348.37^{P}	37.34^{P}

J - The analyte was positively identified, the quantitation is an estimation.
^{T} - Threshold Effect Concentration (below which harmful effects are unlikely to occur; MacDonald *et.al.* 2000).
^{P} - Probable Effect Concentration (above which harmful effects are likely to occur; MacDonald *et.al.* 2000).

Table 5. Qualitative Habitat Evaluation Index for the West Fork Mill Creek, 2002.

Key QHEI Components

WWH Attributes; MWH Attributes (High Influence; Moderate Influence)

River Mile	QHEI	Gradient (ft/mile)	No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max Depth > 40 cm	Low-Normal Riffle Embeddedness	Total WWH Attributes	Channelized or No Recovery	Silt/Muck Substrates	No 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 Sinuosity	Only 1-2 Cover Types	Intermittent and Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	Total M.I. MWH Attributes	(MWH H.I.+1)/(WWH+1) Ratio	(MWH M.I.+1)/(WWH+1) Ratio
(23-004) West Fork Mill Creek (Mill Cr. RM 11.57)																																		
Year: 2002																																		
4.5	**82.5**	13.33	■	■		■	■	■	■	■	■	■	9						0		■				■				■			3	0.10	0.40
3.1	**80.0**	13.70	■	■		■	■	■	■	■	■	■	9						0						■				■			2	0.10	0.30
2.6	**74.0**	7.25	■	■		■		■	■		■	■	7						0		■				■				■			3	0.13	0.50
2.1	**75.0**	7.25	■	■		■		■	■		■	■	7						0		■				■				■			3	0.13	0.50

Table 6. Fish community summaries based on pulsed DC electrofishing sampling conducted by Ohio EPA in the West Fork Mill Creek from June - August, 2002. Relative numbers and weight are based on 0.3 km.

Stream/ River Mile	Mean Number of Species	Total Number Species	Mean Relative Number	Mean Relative Weight (kg)	QHEI	Mean Modified Index of Well-Being	Mean Index of Biotic Integrity	Narrative Evaluation
West Fork Mill Creek (2002)								
4.5	13.0	15	624.6	14.41	82.5	6.7*	26*	Fair/Poor
3.1	9.5	11	1349.6	7.25	80.0	7.0*	21*	Fair/Poor
2.6	12.0	14	970.8	8.56	74.0	6.9*	25*	Fair/Poor
2.1	11.5	13	1251.5	16.62	75.0	6.5*	22*	Fair/Poor

Ecoregion Biocriteria: Interior Plateau (IP)
(Ohio Administrative Code 3745-1-07, Table 7-15)

INDEX	WWH	EWH	MWH[a]
IBI-Wading	40	50	24
MIwb - Wading	8.1	9.4	6.2

[a] Modified Warmwater Habitat for channel modified areas.
* Significant departure from ecoregion biocriterion; poor and very poor results are underlined.
[ns] Nonsignificant departure from ecoregion biocriterion (<4 IBI units, <0.5 MIwb units).

Table 7. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the West Fork Mill Creek during 2002.

River Mile	Density Number/ft^2	Total Taxa	Quantitative Taxa	Qualitative Taxa	Qualitative EPT[a]	ICI	Evaluation
				WWH Use Designation			
West Fork Mill Creek							
4.5	36	32	24	23	5	28	Marginal Good
3.1	454	35	25	23	6	26	Marginal Good
2.6	66	40	31	22	5	30	Good
2.1	NA	NA	NA	35	7	NA	Good

Ecoregion Biocriteria: Interior Plateau (IP)
(Ohio Administrative Code 3745-1-07, Table 7-15)

INDEX	WWH	EWH	MWH[b]
ICI	30	46	22

[a] EPT= total Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) taxa richness, a measure of pollution sensitive organisms.
[b] Modified Warmwater Habitat for channel modified areas.
NA Not available - Hester/Dendy sampler vandalized.

Table 8. Fish tissue sample results for the West Fork Mill Creek, August, 2002.

Sample Location	RM 4.5	RM 4.5	RM 3.1	RM 3.1	RM 2.6	RM 2.1	RM 2.1
Sample Number	251-2002	255-2002	257-2002	256-2002	254-2002	252-2002	253-2002
Fish Species	Longear sunfish	Common carp	Longear sunfish	Common carp	Longear sunfish	Longear sunfish	Common carp
Date Sampled	08/14/2002	08/14/2002	08/13/2002	08/13/2002	08/14/2002	08/13/2002	08/13/2002
Sample Type[a]	WBC	SFFC	WBC	SFFC	WBC	WBC	SFFC
Lead (mg/kg)	0.079	0.164	0.272	<0.037	<0.038 UJ	0.148	<0.039
Mercury (mg/kg)	0.082	0.146	0.113	0.204	0.127	0.145	0.095
Arsenic (mg/kg)	<0.035	<0.036	<0.038	<0.037	<0.038 UJ	<0.033	<0.039
Cadmium (mg/kg)	0.0241	0.0190	0.0310	0.0048	<0.0038 UJ	0.0158	<0.0039
Selenium (mg/kg)	0.097	0.106	0.143	0.156	0.168 J	0.107	0.198
Aldrin (ug/kg)	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
a-BHC (ug/kg)	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
b-BHC (ug/kg)	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
d-BHC (ug/kg)	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
y-BHC (ug/kg)	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
4,4'-DDD (ug/kg)	<4.0	<4.0	11.6	<4.0	5.7 UJ	5.9	4.1
4,4'-DDE (ug/kg)	35.6	9.4	120	20.7	31.4 UJ	44.9	13.3
4,4'-DDT (ug/kg)	<4.0	<4.0	12.1	<4.0	<4.0 UJ	<4.0	<4.0
Dieldrin (ug/kg)	16.6	8.9	15.0	<4.0	9.1	9.9	21.9
Endosulfan I (ug/kg)	<4.0	<4.0	<4.0	<4.0	<4.0 UJ	<4.0	<4.0
Endosulfan II (ug/kg)	<4.0	<4.0	<4.0	<4.0	<4.0 UJ	<4.0	<4.0
Endosulfan sulfate (ug/kg)	<4.0	<4.0	<4.0	<4.0	<4.0 UJ	<4.0	<4.0
Endrin (ug/kg)	<4.0	<4.0	<4.0	<4.0	<4.0 UJ	<4.0	<4.0
Heptachlor (ug/kg)	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Heptachlor epoxide (ug/kg)	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	6.0
Methoxychlor (ug/kg)	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Mirex (ug/kg)	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Hexachlorobenzene (ug/kg)	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0	<4.0
Alpha-Chlordane (ug/kg)	23.1	25.6	24.8	16.0	17.8	16.3	39.6
Gamma-Chlordane (ug/kg)	<4.0	13.5	<4.0	8.8	<4.0	<4.0	31.4
Oxychlordane (ug/kg)	25.4	<4.0	27.9	<4.0	10.4	8.9	4.3
cis-Nonachlor (ug/kg)	28.7	7.7	58.3	6.0	23.1	22.9	10.7
trans-Nonachlor (ug/kg)	104	22.4	226	16.8	75.8	81.3	29.4
PCB-1016 (ug/kg)	<20.0	<19.8	<19.7	<19.8	<19.8	<19.9	<19.9
PCB-1221 (ug/kg)	<20.0	<19.8	<19.7	<19.8	<19.8	<19.9	<19.9
PCB-1232 (ug/kg)	<20.0	<19.8	<19.7	<19.8	<19.8	<19.9	<19.9
PCB-1242 (ug/kg)	<20.0	<19.8	<19.7	<19.8	<19.8	<19.9	<19.9
PCB-1248 (ug/kg)	<20.0	<19.8	<19.7	<19.8	<19.8	<19.9	<19.9
PCB-1254 (ug/kg)	<20.0	<19.8	<19.7	<19.8	<19.8	<19.9	<19.9
PCB-1260 (ug/kg)	52.4	<19.8	71.4	<19.8	196	126	<19.9

a - WBC = whole-body composite, SFFC = skin-off fillet composite

UJ -The analyte was not detected above the sample quantitation limit (QL), however, the reported QL is estimated.

J - The analyte was positively identified, the associated numerical value is estimated.

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APPENDICES

Appendix Table 1. Results of chemical surface water sampling conducted by Ohio EPA in the West Fork Mill Creek on July 2, 2002.

Stream	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**
River Mile	**4.37**	**3.18**	**3.18**	**2.55**	**2.02**
Date Sampled	07/02/02	07/02/02	07/02/02	07/02/02	07/02/02
Time Sampled	04:00 PM	06:10 PM	06:10 PM	12:55 PM	10:00 AM
TAL Metals (ug/l)			Duplicate		
Arsenic	<5.0	<5.0	<5.0	<5.0	<5.0
Aluminum	1190	843	953	843	<200
Barium	36	38	39	43	41
Beryllium	<5	<5	<5	<5	<5
Cadmium	<5	<5	<5	<5	<5
Calcium	49,000	52,000	53,000	57,000	55,000
Chromium	<30	<30	<30	<30	<30
Cobalt	<50	<50	<50	<50	<50
Copper	<10	<10	<10	<10	<10
Hardness, Total	159,000	171,000	174,000	188,000	183,000
Iron	731	539	647	552	564
Magnesium	9,000	10,000	10,000	11,000	11,000
Manganese	116	122	138	136	77
Nickel	<40	<40	<40	<40	<40
Potassium	2,000	3,000	3,000	3,000	3,000
Sodium	16,000	20,000	20,000	22,000	23,000
Strontium	161	181	180	197	211
Titanium	<50	<50	<50	<50	<50
Vanadium	<50	<50	<50	<50	<50
Zinc	<10	<10	<10	<10	<10
Lead	<2.0	<2.0	<2.0	<2.0	<2.0
Mercury	<0.20	<0.20	<0.20	<0.20	<0.20
Selenium	<5.0	<5.0	<5.0	<5.0	<5.0
Silver	<0.50	<0.50	<0.50	<0.50	<0.50

Appendix Table 2. Results of chemical surface water sampling conducted by Ohio EPA in the West Fork Mill Creek on August 13 and 14, 2002.

Stream	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**
River Mile	**4.37**	**3.18**	**2.55**	**2.55**	**2.02**
Date Sampled	08/14/02	08/13/02	08/14/02	08/14/02	08/13/02
Time Sampled	08:10 AM	04:35 PM	12:25 PM	12:25 PM	03:20 PM
TAL Metals (ug/l)				Duplicate	
Arsenic	2.67J	2.81J	2.76J	2.47J	2.30J
Aluminum	694	450	645	802	316
Barium	67.3	58.3	56	67.1	56.3
Beryllium	0.379J	ND (<10)	ND (<10)	ND (<10)	ND (<10)
Cadmium	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)
Calcium	43,100	43,400	46,800	45,000	43,300
Chromium	**2.86J**	**ND (<20)**	**ND (<20)**	**ND (<20)**	**ND (<20)**
Cobalt	**ND (<20)**	**ND (<20)**	**ND (<20)**	**ND (<20)**	**ND (<20)**
Copper	**ND (<20)**	**ND (<20)**	**ND (<20)**	**ND (<20)**	**ND (<20)**
Iron	714	596	818	789	431
Magnesium	8,130	8,320	9,100	8,590	8,350
Manganese	180	146	223	188	135
Nickel	ND (<40)	ND (<40)	ND (<40)	ND (<40)	ND (<40)
Potassium	3,000	3,160	3,670	3,260	3,100
Sodium	15,500	17,700	20,300	17,400	17,400
Antimony	0.517J	ND (<1.0)	ND (<1.0)	ND (<1.0)	ND (<1.0)
Thallium	ND (<0.2)	ND (<0.2)	ND (<0.2)	ND (<0.2)	ND (<0.2)
Vanadium	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)
Zinc	18.0J	9.95J	17.8J	9.49J	9.23J
Lead	3.27J	2.87J	4.17J	2.85J	3.2J
Mercury	ND (<0.2)	ND (<0.2)	ND (<0.2)	ND (<0.2)	ND (<0.2)
Selenium	ND (<1.0)	ND (<1.0)	0.515J	ND (<1.0)	ND (<1.0)
Silver	ND (<10)	ND (<10)	ND (<10)	ND (<10)	ND (<10)
Hardness, Total	141,000	143,000	154,000	148,000	143,000

J - Analyte present but below nominal reporting limit.

ND - Not detected at or above the reporting limit.

Appendix Table 3. Results of Ohio EPA sediment sampling conducted in the West Fork Mill Creek, July 2, 2002.

Stream	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**
River Mile	**4.37**	**3.18**	**3.18**	**2.55**	**2.02**
Date Sampled	07/02/02	07/02/02	07/02/02	07/02/02	07/02/02
Time Sampled	04:00 PM	06:10 PM	06:10 PM	12:55 PM	10:00 AM
TAL Metals (mg/kg)			Duplicate		
Arsenic	6.5	6.2	4.6	7.7	5.3
Cadmium	0.212	<0.084	<0.083	4.27	0.204
Aluminum	4,030	2,440	1,960	6,790	6,070
Barium	37.4J	34.2J	21.4J	94.5J	54.1J
Beryllium	<2.4	<2.1	<2.1	<2.7	<2.6
Calcium	66,200	82,400	114,000	46,600	59,700
Chromium	<14	<13	<13	<16	<15
Cobalt	<24	<21	<21	<27	<26
Copper	5.2	<4.2	<4.2	26.5	14
Iron	11,300	10,700	8,950	14,900	11,300
Lead	<19	<17	19	196	41
Magnesium	10,600J	15,500J	11,400J	9,100J	11,900J
Manganese	729	914	651	432	582
Nickel	<19	<17	<17	<22	<20
Potassium	<941	<840	<833	<1090	1320
Sodium	<2350	<2100	<2080	<2720	<2550
Strontium	123	118	158	98	108
Titanium	29	<21	<21	35	55
Vanadium	<24	<21	<21	<27	<26
Zinc	44.4	31.9	27.8	240	88.3
Mercury	<0.029	<0.028	<0.026	0.184	0.05
Selenium	<2.4	<2.1	<2.1	<2.7	<2.6
Silver	<0.24	<0.21	<0.21	<0.27	<0.26
Volatile Organic Analytes (mg/kg)					
Acetone	<0.063	<0.050	<0.057	0.11	0.12
Benzene	<0.050	<0.040	<0.045	<0.049	<0.059
Bromobenzene	<0.050	<0.040	<0.045	<0.049	<0.059
Bromochloromethane	<0.050	<0.040	<0.045	<0.049	<0.059
Bromodichloromethane	<0.050	<0.040	<0.045	<0.049	<0.059
Bromoform	<0.050	<0.040	<0.045	<0.049	<0.059
Bromomethane	<0.050	<0.040	<0.045	<0.049	<0.059
2-Butanone	<0.050	<0.040	<0.045	<0.049	<0.059
n-Butylbenzene	<0.050	<0.040	<0.045	<0.049	<0.059
sec-Butylbenzene	<0.050	<0.040	<0.045	<0.049	<0.059
tert-Butylbenzene	<0.050	<0.040	<0.045	<0.049	<0.059
Carbon disulfide	<0.050	<0.040	<0.045	<0.049	<0.059
Carbon tetrachloride	<0.050	<0.040	<0.045	<0.049	<0.059
Chlorobenzene	<0.050	<0.040	<0.045	<0.049	<0.059
Chloroethane	<0.050	<0.040	<0.045	<0.049	<0.059
Chloroform	<0.050	<0.040	<0.045	<0.049	<0.059

Appendix Table 3. Continued.

Stream	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**
River Mile	**4.37**	**3.18**	**3.18**	**2.55**	**2.02**
Date Sampled	07/02/02	07/02/02	07/02/02	07/02/02	07/02/02
Time Sampled	04:00 PM	06:10 PM	06:10 PM	12:55 PM	10:00 AM
Volatile Organic Analytes (mg/kg)					
Chloromethane	<0.050	<0.040	<0.045	<0.049	<0.059
2-Chlorotoluene	<0.050	<0.040	<0.045	<0.049	<0.059
4-Chlorotoluene	<0.050	<0.040	<0.045	<0.049	<0.059
Dibromochloromethane	<0.050	<0.040	<0.045	<0.049	<0.059
1,2-Dibromo-3-chloropropane	<0.050	<0.040	<0.045	<0.049	<0.059
1,2-Dibromoethane	<0.050	<0.040	<0.045	<0.049	<0.059
Dibromomethane	<0.050	<0.040	<0.045	<0.049	<0.059
1,2-Dichlorobenzene	<0.050	<0.040	<0.045	<0.049	<0.059
1,3-Dichlorobenzene	<0.050	<0.040	<0.045	<0.049	<0.059
1,4-Dichlorobenzene	<0.050	<0.040	<0.045	<0.049	<0.059
Dichlorodifluoromethane	<0.050	<0.040	<0.045	<0.049	<0.059
1,1-Dichloroethane	<0.050	<0.040	<0.045	<0.049	<0.059
1,2-Dichloroethane	<0.050	<0.040	<0.045	<0.049	<0.059
1,1-Dichloroethene	<0.050	<0.040	<0.045	<0.049	<0.059
cis-1,2-Dichloroethene	<0.050	<0.040	<0.045	<0.049	<0.059
trans-1,2-Dichloroethene	<0.050	<0.040	<0.045	<0.049	<0.059
1,2-Dichloropropane	<0.050	<0.040	<0.045	<0.049	<0.059
1,3-Dichloropropane	<0.050	<0.040	<0.045	<0.049	<0.059
2,2-Dichloropropane	<0.050	<0.040	<0.045	<0.049	<0.059
1,1-Dichloropropene	<0.050	<0.040	<0.045	<0.049	<0.059
cis-1,3-Dichloropropene	<0.050	<0.040	<0.045	<0.049	<0.059
trans-1,3-Dichloropropene	<0.050	<0.040	<0.045	<0.049	<0.059
Ethylbenzene	<0.050	<0.040	<0.045	<0.049	<0.059
Hexachlorobutadiene	<0.050	<0.040	<0.045	<0.049	<0.059
2-Hexanone	<0.050	<0.040	<0.045	<0.049	<0.059
Isopropylbenzene	<0.050	<0.040	<0.045	<0.049	<0.059
4-Isopropyltoluene	<0.050	<0.040	<0.045	<0.049	<0.059
Methylene chloride	<0.050	<0.040	<0.045	<0.049	<0.059
4-Methyl-2-pentanone	<0.050	<0.040	<0.045	<0.049	<0.059
Naphthalene	<0.050	<0.040	<0.045	<0.049	<0.059
n-Propylbenzene	<0.050	<0.040	<0.045	<0.049	<0.059
Styrene	<0.050	<0.040	<0.045	<0.049	<0.059
1,1,1,2-Tetrachloroethane	<0.050	<0.040	<0.045	<0.049	<0.059
1,1,2,2-Tetrachloroethane	<0.050	<0.040	<0.045	<0.049	<0.059
Tetrachloroethene	<0.050	<0.040	<0.045	<0.049	<0.059
Toluene	<0.050	<0.040	<0.045	<0.049	<0.059
1,2,3-Trichlorobenzene	<0.050	<0.040	<0.045	<0.049	<0.059
1,2,4-Trichlorobenzene	<0.050	<0.040	<0.045	<0.049	<0.059
1,1,1-Trichloroethane	<0.050	<0.040	<0.045	<0.049	<0.059
1,1,2-Trichloroethane	<0.050	<0.040	<0.045	<0.049	<0.059
Trichloroethene	<0.050	<0.040	<0.045	<0.049	<0.059
Trichlorofluoromethane	<0.050	<0.040	<0.045	<0.049	<0.059

Appendix Table 3. Continued.

Stream	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**
River Mile	**4.37**	**3.18**	**3.18**	**2.55**	**2.02**
Date Sampled	07/02/02	07/02/02	07/02/02	07/02/02	07/02/02
Time Sampled	04:00 PM	06:10 PM	06:10 PM	12:55 PM	10:00 AM
Volatile Organic Analytes (mg/kg)					
1,2,3-Trichloropropane	<0.050	<0.040	<0.045	<0.049	<0.059
1,2,4-Trimethylbenzene	<0.050	<0.040	<0.045	<0.049	<0.059
1,3,5-Trimethylbenzene	<0.050	<0.040	<0.045	<0.049	<0.059
Vinyl chloride	<0.050	<0.040	<0.045	<0.049	<0.059
o-Xylene	<0.050	<0.040	<0.045	<0.049	<0.059
m-,p-Xylenes	<0.050	<0.040	<0.045	<0.049	<0.059
Semi-volatile Organic Analytes (mg/kg)					
Acenaphthene	<0.51	<0.51	<0.51	3.76	<0.60
Acenaphthylene	<0.51	<0.51	<0.51	<0.58	<0.60
Acetophenone	<0.51	<0.51	<0.51	<0.58	<0.60
2-Acetylaminofluorene	<0.51	<0.51	<0.51	<0.58	<0.60
4-Aminobiphenyl	<2.5R	<2.5R	<2.5R	<2.9R	<3.0R
Aniline	<2.5R	<2.5	<2.5	<2.9	<3.0
Anthracene	<0.51	<0.51	<0.51	8.61	0.69
Benzo(a)anthracene	<0.51	<0.51	0.73	24.7	2.5
Benzo(a)pyrene	<0.51	<0.51	0.6	20.7	2.52
Benzo(b)fluoranthene	<0.51	<0.51	0.62	17.7	2.81
Benzo(g,h,i)perylene	<0.51	<0.51	0.51	13.9	2.08
Benzo(k)fluoranthene	<0.51	<0.51	0.56	17.3	1.9
Benzyl alcohol	<0.51	<0.51	<0.51	<0.58	<0.60
bis(2-Chloroethoxy)methane	<0.51	<0.51	<0.51	<0.58	<0.60
bis-(2-Chloroethyl) ether	<0.51	<0.51	<0.51	<0.58	<0.60
bis(2-Chloroisopropyl) ether	<0.51	<0.51	<0.51	<0.58	<0.60
bis(2-Ethylhexyl) phthalate	<0.51	<0.51	<0.51	<0.58	<0.60
4-Bromophenyl-phenylether	<0.51	<0.51	<0.51	<0.58	<0.60
Butylbenzylphthalate	<0.51	<0.51	<0.51	<0.58	<0.60
4-Chloro-3-methylphenol	<0.51	<0.51	<0.51	<0.58	<0.60
4-Chloroaniline	<0.51R	<0.51R	<0.51R	<0.58R	<0.60R
2-Chloronaphthalene	<0.51	<0.51	<0.51	<0.58	<0.60
2-Chlorophenol	<0.51	<0.51	<0.51	<0.58	<0.60
4-Chlorophenyl-phenyl ether	<0.51	<0.51	<0.51	<0.58	<0.60
Chrysene	0.51	0.61	0.95	29.5	3.78
Di-n-butylphthalate	<0.51	<0.51	<0.51	<0.58	<0.60
Di-n-octylphthalate	<0.51	<0.51	<0.51	<0.58	<0.60
Dibenz(a,h)anthracene	<0.51	<0.51	<0.51	5.73	<0.60
Dibenzofuran	<0.51	<0.51	<0.51	1.68	<0.60
1,3-Dichlorobenzene	<0.51	<0.51	<0.51	<0.58	<0.60
1,4-Dichlorobenzene	<0.51	<0.51	<0.51	<0.58	<0.60
1,2-Dichlorobenzene	<0.51	<0.51	<0.51	<0.58	<0.60
3,3'-Dichlorobenzidine	<2.5	<2.5	<2.5	<2.9	<3.0
2,6-Dichlorophenol	<0.51	<0.51	<0.51	<0.58	<0.60
2,4-Dichlorophenol	<0.51	<0.51	<0.51	<0.58	<0.60
Diethylphthalate	<0.51	<0.51	<0.51	<0.58	<0.60
p-Dimethylaminoazobenzene	<0.51	<0.51	<0.51	<0.58	<0.60
7,12-Dimethylbenz(a)anthracene	<2.5	<2.5	<2.5	<2.9	<3.0
3,3'-Dimethylbenzidine	<2.5R	<2.5R	<2.5R	<2.9R	<3.0R

Appendix Table 3. Continued.

Stream	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**
River Mile	**4.37**	**3.18**	**3.18**	**2.55**	**2.02**
Date Sampled	07/02/02	07/02/02	07/02/02	07/02/02	07/02/02
Time Sampled	04:00 PM	06:10 PM	06:10 PM	12:55 PM	10:00 AM
Semi-volatile Organic Analytes (mg/kg)					
2,4-Dimethylphenol	<0.51	<0.51	<0.51	<0.58	<0.60
Dimethylphthalate	<0.51	<0.51	<0.51	<0.58	<0.60
4,6-Dinitro-2-methylphenol	<0.51	<0.51	<0.51	<0.58	<0.60
1,3-Dinitrobenzene	<0.51	<0.51	<0.51	<0.58	<0.60
2,4-Dinitrophenol	<2.5	<2.5	<2.5	<2.9	<3.0
2,6-Dinitrotoluene	<0.51	<0.51	<0.51	<0.58	<0.60
2,4-Dinitrotoluene	<0.51	<0.51	<0.51	<0.58	<0.60
Dinoseb	<0.51	<0.51	<0.51	<0.58	<0.60
Diphenylamine	<0.51	<0.51	<0.51	<0.58	<0.60
Ethyl methanesulfonate	<0.51	<0.51	<0.51	<0.58	<0.60
Fluoranthene	0.97	1.1	2.15	79.1	7.56
Fluorene	<0.51	<0.51	<0.51	5.24	<0.60
Hexachlorobenzene	<0.51	<0.51	<0.51	<0.58	<0.60
Hexachlorobutadiene	<0.51	<0.51	<0.51	<0.58	<0.60
Hexachlorocyclopentadiene	<0.51	<0.51	<0.51	<0.58	<0.60
Hexachloroethane	<0.51	<0.51	<0.51	<0.58	<0.60
Hexachloropropene	<0.51	<0.51	<0.51	<0.58	<0.60
Indeno(1,2,3-cd)pyrene	<0.51	<0.51	<0.51	14.6	2.09
Isophorone	<0.51	<0.51	<0.51	<0.58	<0.60
Methyl methanesulfonate	<0.51	<0.51	<0.51	<0.58	<0.60
3-Methylcholanthrene	<0.51	<0.51	<0.51	<0.58	<0.60
2-Methylnaphthalene	<0.51	<0.51	<0.51	<0.58	<0.60
3&4-Methylphenol	<0.51	<0.51	<0.51	<0.58	0.77
2-Methylphenol	<0.51	<0.51	<0.51	<0.58	0.76
N-Nitroso-di-n-butylamine	<0.51	<0.51	<0.51	<0.58	<0.60
N-Nitroso-di-n-propylamine	<0.51	<0.51	<0.51	<0.58	<0.60
N-Nitromorpholine	<0.51	<0.51	<0.51	<0.58	<0.60
N-Nitrosopiperidine	<0.51	<0.51	<0.51	<0.58	<0.60
N-Nitrosopyrrolidine	<0.51	<0.51	<0.51	<0.58	<0.60
Naphthalene	<0.51	<0.51	<0.51	0.95	<0.60
1,4-Naphthoquinone	<0.51	<0.51	<0.51	<0.58	<0.60
1-Naphthylamine	<0.51R	<0.51R	<0.51R	<0.58R	<0.60R
2-Naphthylamine	<0.51R	<0.51R	<0.51R	<0.58R	<0.60R
5-Nitro-o-toluidine	<0.51R	<0.51R	<0.51R	<0.58R	<0.60R
2-Nitroaniline	<0.51	<0.51	<0.51	<0.58	<0.60
3-Nitroaniline	<0.51R	<0.51R	<0.51R	<0.58R	<0.60R
4-Nitroaniline	<0.51R	<0.51R	<0.51R	<0.58R	<0.60R
Nitrobenzene	<0.51	<0.51	<0.51	<0.58	<0.60
4-Nitrophenol	<2.5	<2.5	<2.5	<2.9	<3.0
2-Nitrophenol	<0.51	<0.51	<0.51	<0.58	<0.60
Pentachlorobenzene	<0.51	<0.51	<0.51	<0.58	<0.60
Pentachlorophenol	<0.51	<0.51	<0.51	<0.58	<0.60
Phenacetin	<0.51	<0.51	<0.51	<0.58	<0.60
Phenanthrene	<0.51	<0.51	2.05	45.1	3.97
Phenol	<0.51	<0.51	<0.51	<0.58	<0.60
2-Picoline	<0.51	<0.51	<0.51	<0.58	<0.60
Pronamide	<0.51	<0.51	<0.51	<0.58	<0.60

Appendix Table 3. Continued.

Stream	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**	**West Fork Mill Creek**
River Mile	**4.37**	**3.18**	**3.18**	**2.55**	**2.02**
Date Sampled	07/02/02	07/02/02	07/02/02	07/02/02	07/02/02
Time Sampled	04:00 PM	06:10 PM	06:10 PM	12:55 PM	10:00 AM
Semi-volatile Organic Analytes (mg/kg)					
Pyrene	0.80J	0.9	1.72	59.8	5.91J
Safrole	<0.51	<0.51	<0.51	<0.58	<0.60
1,2,4,5-Tetrachlorobenzene	<0.51	<0.51	<0.51	<0.58	<0.60
2,3,4,6-Tetrachlorophenol	<0.51	<0.51	<0.51	<0.58	<0.60
o-Toluidine	<2.5	<2.5	<2.5	<2.9	<3.0
1,2,4-Trichlorobenzene	<0.51	<0.51	<0.51	<0.58	<0.60
2,4,6-Trichlorophenol	<0.51	<0.51	<0.51	<0.58	<0.60
2,4,5-Trichlorophenol	<0.51	<0.51	<0.51	<0.58	<0.60
PCBs (ug/kg)					
Aroclor 1016	<25.4	<25.4	<25.4	<29.1	<30.2
Aroclor 1221	<25.4	<25.4	<25.4	<29.1	<30.2
Aroclor 1232	<25.4	<25.4	<25.4	<29.1	<30.2
Aroclor 1242	<25.4	<25.4	<25.4	<29.1	<30.2
Aroclor 1248	<25.4	<25.4	<25.4	<29.1	<30.2
Aroclor 1254	<25.4	<25.4	<25.4	<29.1	<30.2
Aroclor 1260	<25.4	<25.4	<25.4	<29.1	<30.2
Pesticides (ug/kg)					
Aldrin	<5.1	<5.1	<5.1	<5.8	<6.0
alpha-BHC	<5.1	<5.1	<5.1	<5.8	<6.0
beta-BHC	<5.1	<5.1	<5.1	<5.8	<6.0
delta-BHC	<5.1UJ	<5.1	<5.1	<5.8	<6.0
gamma-BHC (Lindane)	<5.1	<5.1	<5.1	<5.8	<6.0
4,4'-DDD	<5.1	<5.1	<5.1	<5.8	7.6
4,4'-DDE	<5.1	5.1	5.9	<5.8	6.5P
4,4'-DDT	<5.1	<5.1	<5.1	<5.8	<6.0
Dieldrin	7.2UJ	<5.1	<5.1	<5.8	<6.0
Endosulfan I	<5.1	<5.1	<5.1	<5.8	<6.0
Endosulfan II	<5.1	<5.1	<5.1	<5.8	<6.0
Endosulfan sulfate	<5.1	<5.1	<5.1	<5.8	<6.0
Endrin	<5.1	<5.1	<5.1	<5.8	<6.0
Endrin aldehyde	<5.1	<5.1	<5.1	<5.8	<6.0
Heptachlor	<5.1	<5.1	<5.1	<5.8	<6.0
Heptachlor epoxide	<5.1UJ	<5.1	<5.1	<5.8	<6.0
Methoxychlor	<5.1	<5.1	<5.1	41.9P	<6.0
Mirex	<5.1	<5.1	<5.1	<5.8	<6.0
Hexachlorobenzene	<5.1	<5.1	<5.1	<5.8	<6.0
Other					
Percent Solids	78.3	78.6	78.5	68.1	65.6

J - The analyte was positively identified, the quantitation is an estimation.

UJ- The analyte was not detected above the sample quantitation limit (QL). However, the reported QL is estimated

P- Analyte is quantitated and there is >40% difference for detected concentrations from the two GC columns use for analysis.

R- The analyte result is unusable because quality control criteria was not met.

Appendix Table 4. Raw macroinvertebrate data by river mile for the West Fork Mill Creek study area, 2002.

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Collection Date: 08/14/2002 River Code: 23-004 RM: 4.50 Site: West Fork Mill Creek

Taxa Code	Taxa	Quant	Qual
01801	*Turbellaria*	5	+
03360	*Plumatella sp*		+
03600	*Oligochaeta*	19	+
08250	*Orconectes (Procericambarus) rusticus*		+
13400	*Stenacron sp*	33	+
13521	*Stenonema femoratum*	31	+
14950	*Leptophlebia sp or Paraleptophlebia sp*	1	
17200	*Caenis sp*	20	+
22001	*Coenagrionidae*		+
22300	*Argia sp*	8	+
52200	*Cheumatopsyche sp*	3	+
52530	*Hydropsyche depravata group*		+
66500	*Enochrus sp*		+
68075	*Psephenus herricki*	2	+
69400	*Stenelmis sp*	6	+
77120	*Ablabesmyia mallochi*	1	+
77130	*Ablabesmyia rhamphe group*		+
77500	*Conchapelopia sp*	11	
77750	*Hayesomyia senata or Thienemannimyia norena*	2	
82820	*Cryptochironomus sp*	1	
83051	*Dicrotendipes simpsoni*		+
83300	*Glyptotendipes (G.) sp*	10	+
83590	*Kiefferulus sp*		+
84210	*Paratendipes albimanus or P. duplicatus*	1	
84450	*Polypedilum (Uresipedilum) flavum*	4	
84460	*Polypedilum (P.) fallax group*	2	+
84470	*Polypedilum (P.) illinoense*	2	
84540	*Polypedilum (Tripodura) scalaenum group*	12	+
85821	*Tanytarsus glabrescens group sp 7*	3	
96120	*Menetus (Micromenetus) dilatatus*	1	+
96900	*Ferrissia sp*	1	
98600	*Sphaerium sp*	1	+

No. Quantitative Taxa: 24 Total Taxa: 32

No. Qualitative Taxa: 23 ICI: **28**

Number of Organisms: 180 Qual EPT: 5

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Collection Date: 08/13/2002 River Code: 23-004 RM: 3.10 Site: West Fork Mill Creek

Taxa Code	Taxa	Quant/Qual	
01801	*Turbellaria*	145	+
03360	*Plumatella sp*	5	
03451	*Urnatella gracilis*	4	
03600	*Oligochaeta*	12	
05900	*Lirceus sp*		+
08250	*Orconectes (Procericambarus) rusticus*		+
11130	*Baetis intercalaris*	51	
13400	*Stenacron sp*		+
13521	*Stenonema femoratum*	8	+
17200	*Caenis sp*	6	+
21200	*Calopteryx sp*		+
22001	*Coenagrionidae*		+
22300	*Argia sp*	58	+
50315	*Chimarra obscura*		+
52200	*Cheumatopsyche sp*	36	+
52530	*Hydropsyche depravata group*	1	+
65800	*Berosus sp*		+
69400	*Stenelmis sp*	59	+
77500	*Conchapelopia sp*		+
77750	*Hayesomyia senata or Thienemannimyia norena*	140	+
77800	*Helopelopia sp*	52	+
82141	*Thienemanniella xena*	8	
83040	*Dicrotendipes neomodestus*	35	
83051	*Dicrotendipes simpsoni*	17	
83300	*Glyptotendipes (G.) sp*	210	+
84450	*Polypedilum (Uresipedilum) flavum*	140	+
84460	*Polypedilum (P.) fallax group*		+
84470	*Polypedilum (P.) illinoense*	192	+
84540	*Polypedilum (Tripodura) scalaenum group*	542	+
85500	*Paratanytarsus sp*	17	
85625	*Rheotanytarsus sp*	52	
85800	*Tanytarsus sp*	52	
85821	*Tanytarsus glabrescens group sp 7*	384	
96900	*Ferrissia sp*	44	
98600	*Sphaerium sp*		+

No. Quantitative Taxa:	25	Total Taxa:	35
No. Qualitative Taxa:	23	ICI:	**26**
Number of Organisms:	2270	Qual EPT:	6

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection
Collection Date: 08/14/2002 River Code: 23-004 RM: 2.60 Site: West Fork Mill Creek

Taxa Code	Taxa	Quant/Qual
01801	*Turbellaria*	38 +
03600	*Oligochaeta*	25
08250	*Orconectes (Procericambarus) rusticus*	+
11130	*Baetis intercalaris*	43 +
13400	*Stenacron sp*	9 +
13521	*Stenonema femoratum*	17 +
17200	*Caenis sp*	2
22001	*Coenagrionidae*	1
22300	*Argia sp*	20 +
52200	*Cheumatopsyche sp*	19 +
52530	*Hydropsyche depravata group*	+
65800	*Berosus sp*	1
68075	*Psephenus herricki*	+
69400	*Stenelmis sp*	11 +
71300	*Limonia sp*	+
77120	*Ablabesmyia mallochi*	5
77500	*Conchapelopia sp*	3
77750	*Hayesomyia senata or Thienemannimyia norena*	15 +
80370	*Corynoneura lobata*	40
80410	*Cricotopus (C.) sp*	4
80420	*Cricotopus (C.) bicinctus*	+
80430	*Cricotopus (C.) tremulus group*	1
82141	*Thienemanniella xena*	16
83040	*Dicrotendipes neomodestus*	5
83300	*Glyptotendipes (G.) sp*	1 +
84210	*Paratendipes albimanus or P. duplicatus*	5
84300	*Phaenopsectra obediens group*	3
84450	*Polypedilum (Uresipedilum) flavum*	1 +
84460	*Polypedilum (P.) fallax group*	+
84470	*Polypedilum (P.) illinoense*	5 +
84540	*Polypedilum (Tripodura) scalaenum group*	17 +
85500	*Paratanytarsus sp*	1
85625	*Rheotanytarsus sp*	1
85821	*Tanytarsus glabrescens group sp 7*	14
94400	*Fossaria sp*	+
95100	*Physella sp*	1
96120	*Menetus (Micromenetus) dilatatus*	+
96900	*Ferrissia sp*	3
97601	*Corbicula fluminea*	2 +
98600	*Sphaerium sp*	+

No. Quantitative Taxa: 31 Total Taxa: 40
No. Qualitative Taxa: 22 ICI: **30**
Number of Organisms: 329 Qual EPT: 5

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection
Collection Date: 08/13/2002 River Code: 23-004 RM: 2.00 Site: West Fork Mill Creek

Taxa Code	Taxa	Quant/Qual
01801	*Turbellaria*	+
03600	*Oligochaeta*	+
04901	*Erpobdellidae*	+
08250	*Orconectes (Procericambarus) rusticus*	+
11130	*Baetis intercalaris*	+
13400	*Stenacron sp*	+
13521	*Stenonema femoratum*	+
17200	*Caenis sp*	+
22300	*Argia sp*	+
45300	*Sigara sp*	+
45400	*Trichocorixa sp*	+
52200	*Cheumatopsyche sp*	+
52430	*Ceratopsyche morosa group*	+
52530	*Hydropsyche depravata group*	+
65800	*Berosus sp*	+
66500	*Enochrus sp*	+
67703	*Paracymus subcupreus*	+
68201	*Scirtidae*	+
69400	*Stenelmis sp*	+
71300	*Limonia sp*	+
71900	*Tipula sp*	+
77750	*Hayesomyia senata or Thienemannimyia norena*	+
78401	*Natarsia species A (sensu Roback, 1978)*	+
82820	*Cryptochironomus sp*	+
83040	*Dicrotendipes neomodestus*	+
83840	*Microtendipes pedellus group*	+
84450	*Polypedilum (Uresipedilum) flavum*	+
84470	*Polypedilum (P.) illinoense*	+
84540	*Polypedilum (Tripodura) scalaenum group*	+
85625	*Rheotanytarsus sp*	+
85821	*Tanytarsus glabrescens group sp 7*	+
94400	*Fossaria sp*	+
95100	*Physella sp*	+
97601	*Corbicula fluminea*	+
98600	*Sphaerium sp*	+

No. Quantitative Taxa: 0 Total Taxa: 35
No. Qualitative Taxa: 35 ICI:
Number of Organisms: 0 Qual EPT: 7

Appendix Table 5. Invertebrate Community Index (ICI) scores and metrics for the West Fork Mill Creek, 2002.

River Mile	Drainage Area (sq mi)	Number of: Total Taxa	Mayfly Taxa	Caddisfly Taxa	Dipteran Taxa	Percent: Mayflies	Caddis-flies	Tany-tarsini	Other Dipt/NI	Tolerant Organisms	Qual. EPT	Eco-region	ICI
West Fork Mill Creek (Mill Cr. RM 11.57) (23-004)													
Year: 2002													
4.50	32.2	24(2)	4(2)	1(2)	11(2)	47.2(6)	1.7(2)	1.7(2)	40.6(4)	13.3(4)	5(2)	2	28
3.10	34.0	25(4)	3(2)	2(4)	13(2)	2.9(2)	1.6(2)	22.2(4)	68.1(0)	11.7(4)	6(2)	2	26
2.60	35.0	31(4)	4(2)	1(2)	17(4)	21.6(4)	5.8(4)	4.9(2)	57.8(2)	10.3(4)	5(2)	2	30

Appendix Table 6. Fish Species List

River Code: **23-004**	Stream: **West Fork Mill Creek (Mill Cr. RM 11.57)**		Sample Date: **2002**
River Mile: **4.50**	Location: Riddle Rd.		Date Range: 07/02/2002
Time Fished: 6060 sec	Drainage: 32.2 sq mi		Thru: 08/14/2002
Dist Fished: 0.46 km	Basin: Mill Creek	No of Passes: 2	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
Gizzard Shad		O	M		2	1.30	0.21	0.06	0.43	47.00
White Sucker	W	O	S	T	21	13.70	2.19	0.97	6.72	70.76
Common Carp	G	O	M	T	15	9.78	1.57	6.48	44.99	662.74
Golden Shiner	N	I	M	T	1	0.65	0.10	0.02	0.14	30.00
Blacknose Dace	N	G	S	T	3	1.96	0.31	0.00	0.03	2.33
Creek Chub	N	G	N	T	36	23.48	3.76	0.44	3.03	18.57
Striped Shiner	N	I	S		3	1.96	0.31	0.04	0.29	21.33
Spotfin Shiner	N	I	M		211	137.61	22.03	0.56	3.89	4.07
Bluntnose Minnow	N	O	C	T	216	140.87	22.55	0.30	2.07	2.12
Central Stoneroller	N	H	N		12	7.83	1.25	0.05	0.38	7.00
Yellow Bullhead		I	C	T	7	4.57	0.73	0.33	2.27	71.54
Largemouth Bass	F	C	C		5	3.26	0.52	0.26	1.83	80.80
Green Sunfish	S	I	C	T	288	187.83	30.06	2.85	19.79	15.19
Bluegill Sunfish	S	I	C	P	1	0.65	0.10	0.01	0.06	12.00
Longear Sunfish	S	I	C	M	137	89.35	14.30	2.03	14.10	22.74
Mile Total					958	624.78		14.41		
Number of Species					15					
Number of Hybrids					0					

Appendix Table 6. Fish Species List

River Code: **23-004**	Stream: **West Fork Mill Creek (Mill Cr. RM 11.57)**	Sample Date: **2002**
River Mile: **3.10**	Location:	Date Range: 07/02/2002
Time Fished: 5504 sec	Drainage: 34.0 sq mi	Thru: 08/13/2002
Dist Fished: 0.46 km	Basin: Mill Creek No of Passes: 2	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
White Sucker	W	O	S	T	33	21.52	1.59	1.14	15.67	52.80
Common Carp	G	O	M	T	4	2.61	0.19	0.95	13.08	363.50
Blacknose Dace	N	G	S	T	117	76.30	5.65	0.16	2.25	2.14
Creek Chub	N	G	N	T	130	84.78	6.28	0.62	8.53	7.30
Spotfin Shiner	N	I	M		446	290.87	21.55	0.87	11.95	2.98
Bluntnose Minnow	N	O	C	T	1,002	653.48	48.41	1.31	18.00	2.00
Central Stoneroller	N	H	N		223	145.44	10.77	0.64	8.81	4.39
Yellow Bullhead		I	C	T	9	5.87	0.43	0.03	0.36	4.44
Largemouth Bass	F	C	C		3	1.96	0.14	0.19	2.61	97.00
Green Sunfish	S	I	C	T	50	32.61	2.42	0.43	5.89	13.11
Longear Sunfish	S	I	C	M	53	34.57	2.56	0.93	12.87	27.00
	Mile Total				2,070	1,350.00		7.25		
	Number of Species				11					
	Number of Hybrids				0					

Appendix Table 6. Fish Species List

River Code: **23-004**	Stream: **West Fork Mill Creek (Mill Cr. RM 11.57)**	Sample Date: **2002**
River Mile: **2.60**	Location:	Date Range: 07/02/2002
Time Fished: 5956 sec	Drainage: 35.0 sq mi	Thru: 08/14/2002
Dist Fished: 0.46 km	Basin: Mill Creek No of Passes: 2	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
White Sucker	W	O	S	T	55	35.87	3.69	2.03	23.73	56.66
Common Carp	G	O	M	T	4	2.61	0.27	1.26	14.66	481.25
Blacknose Dace	N	G	S	T	8	5.22	0.54	0.01	0.11	1.75
Creek Chub	N	G	N	T	51	33.26	3.43	0.40	4.65	11.98
Striped Shiner	N	I	S		11	7.17	0.74	0.16	1.85	22.09
Spotfin Shiner	N	I	M		345	225.00	23.17	0.56	6.58	2.50
Bluntnose Minnow	N	O	C	T	724	472.17	48.62	0.92	10.72	1.94
Central Stoneroller	N	H	N		85	55.43	5.71	0.28	3.26	5.04
Yellow Bullhead		I	C	T	16	10.44	1.07	0.51	5.92	48.56
Largemouth Bass	F	C	C		1	0.65	0.07	0.01	0.09	12.00
Green Sunfish	S	I	C	T	87	56.74	5.84	0.73	8.49	12.82
Bluegill Sunfish	S	I	C	P	1	0.65	0.07	0.01	0.06	8.00
Longear Sunfish	S	I	C	M	99	64.57	6.65	1.67	19.49	25.85
Pumpkinseed Sunfish	S	I	C	P	1	0.65	0.07	0.01	0.06	8.00
Green Sf X Longear Sf					1	0.65	0.07	0.03	0.32	42.00
	Mile Total				1,489	971.09		8.56		
	Number of Species				14					
	Number of Hybrids				1					

Appendix Table 6. Fish Species List

River Code: **23-004**	Stream: **West Fork Mill Creek (Mill Cr. RM 11.57)**	Sample Date: **2002**
River Mile: **2.10**	Location:	Date Range: 06/25/2002
Time Fished: 6060 sec	Drainage: 35.6 sq mi	Thru: 08/13/2002
Dist Fished: 0.43 km	Basin: Mill Creek No of Passes: 2	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
White Sucker	W	O	S	T	48	31.50	2.52	2.31	13.88	72.93
Common Carp	G	O	M	T	12	8.80	0.70	6.34	38.11	712.67
Blacknose Dace	N	G	S	T	3	2.05	0.16	0.00	0.02	1.67
Creek Chub	N	G	N	T	18	11.84	0.95	0.16	0.94	13.06
Striped Shiner	N	I	S		3	1.96	0.16	0.03	0.15	12.67
Spotfin Shiner	N	I	M		287	204.00	16.30	0.58	3.47	2.80
Fathead Minnow	N	O	C	T	1	0.65	0.05	0.00	0.01	2.00
Bluntnose Minnow	N	O	C	T	1,117	787.27	62.90	2.13	12.80	2.65
Central Stoneroller	N	H	N		112	76.17	6.09	0.50	2.99	6.49
Yellow Bullhead		I	C	T	20	13.63	1.09	1.79	10.79	128.20
White Crappie	S	I	C		1	0.75	0.06	0.05	0.28	62.00
Green Sunfish	S	I	C	T	37	25.30	2.02	0.28	1.71	11.39
Longear Sunfish	S	I	C	M	122	87.00	6.95	2.43	14.62	27.98
Green Sf X Longear Sf					1	0.75	0.06	0.04	0.23	52.00
Mile Total					1,782	1,251.69		16.62		
Number of Species					13					
Number of Hybrids					1					

Appendix Table 7. Modified Index of Well-being (MIwb) and Index of Biotic Integrity (IBI) scores and metrics for the West Fork Mill Creek, 2002.

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Number of: Sunfish species	Number of: Sucker species	Number of: Intolerant species	Percent of Individuals: Rnd-bodied suckers	Percent of Individuals: Simple Lithophils	Percent of Individuals: Tolerant fishes	Percent of Individuals: Omni-vores	Percent of Individuals: Top carnivores	Percent of Individuals: Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(1.0 km)	IBI	Modified Iwb
West Fork Mill Creek - (23-004)																	
Year: 2002																	
4.50	E	07/02/2002	32	12(3)	2(3)	1(1)	0(1)	0(0)	2(1)	55(1)	21(3)	0(1)	73(5)	1.8(1)	274(3)	24	6.5
4.50	E	08/14/2002	32	12(3)	3(3)	1(1)	0(1)	0(0)	4(1)	67(1)	32(3)	1(3)	62(5)	0.7(3)	210(3)	28	6.9
3.10	E	07/02/2002	34	8(1)	2(3)	0(1)	0(1)	0(0)	6(1)	54(1)	41(1)	0(1)	36(3)	0.0(5)	584(3)	22	7.0
3.10	E	08/13/2002	34	10(3)	2(3)	1(1)	0(1)	0(0)	8(1)	75(1)	58(1)	0(1)	19(1)	0.2(3)	361(3)	20	6.9
2.60	E	07/02/2002	35	10(3)	2(3)	1(1)	0(1)	0(0)	3(1)	58(1)	48(1)	0(1)	40(3)	0.1(5)	420(3)	24	7.2
2.60	E	08/14/2002	35	13(3)	4(5)	1(1)	0(1)	0(0)	7(1)	70(1)	57(1)	0(1)	35(3)	0.0(5)	289(3)	26	6.6
2.10	E	06/25/2002	35	10(3)	3(3)	1(1)	0(1)	0(0)	0(1)	69(1)	67(1)	0(1)	29(3)	0.3(3)	423(3)	22	6.3
2.10	E	08/13/2002	35	11(3)	2(3)	1(1)	0(1)	0(0)	6(1)	72(1)	65(1)	0(1)	23(1)	0.1(5)	318(3)	22	6.7

♦ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample