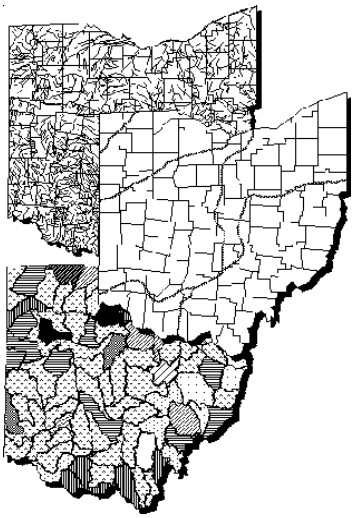
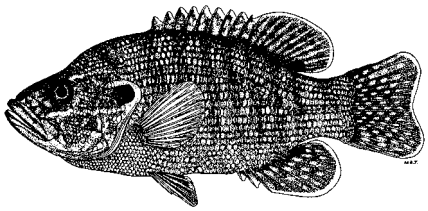
State of Ohio
Environmental Protection Agency

Division of Surface Water

Biological and Water Quality Study of the Clear Fork Mohican River

Richland County
Lexington, Ohio





January 3, 2005

Bob Taft, Governor
Joseph P. Koncelik, Director

Biological and Water Quality Study of the Clear Fork Mohican River

United Technologies
(formerly Hamilton Standard Controls)
2004

Richland County, Ohio

January 3, 2005

OEPA Report EAS/2005-1-1

prepared for

State of Ohio Environmental Protection Agency
Division of Emergency and Remedial Response
Northwest District Office

prepared by

State of Ohio Environmental Protection Agency
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NOTICE TO USERS

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

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

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

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

Ohio Environmental Protection Agency. 1989b. Addendum to Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Div. Water Qual. Plan. & Assess., 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 Integrated Water Quality Monitoring and Assessment Report (305[b], 303[j] 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,

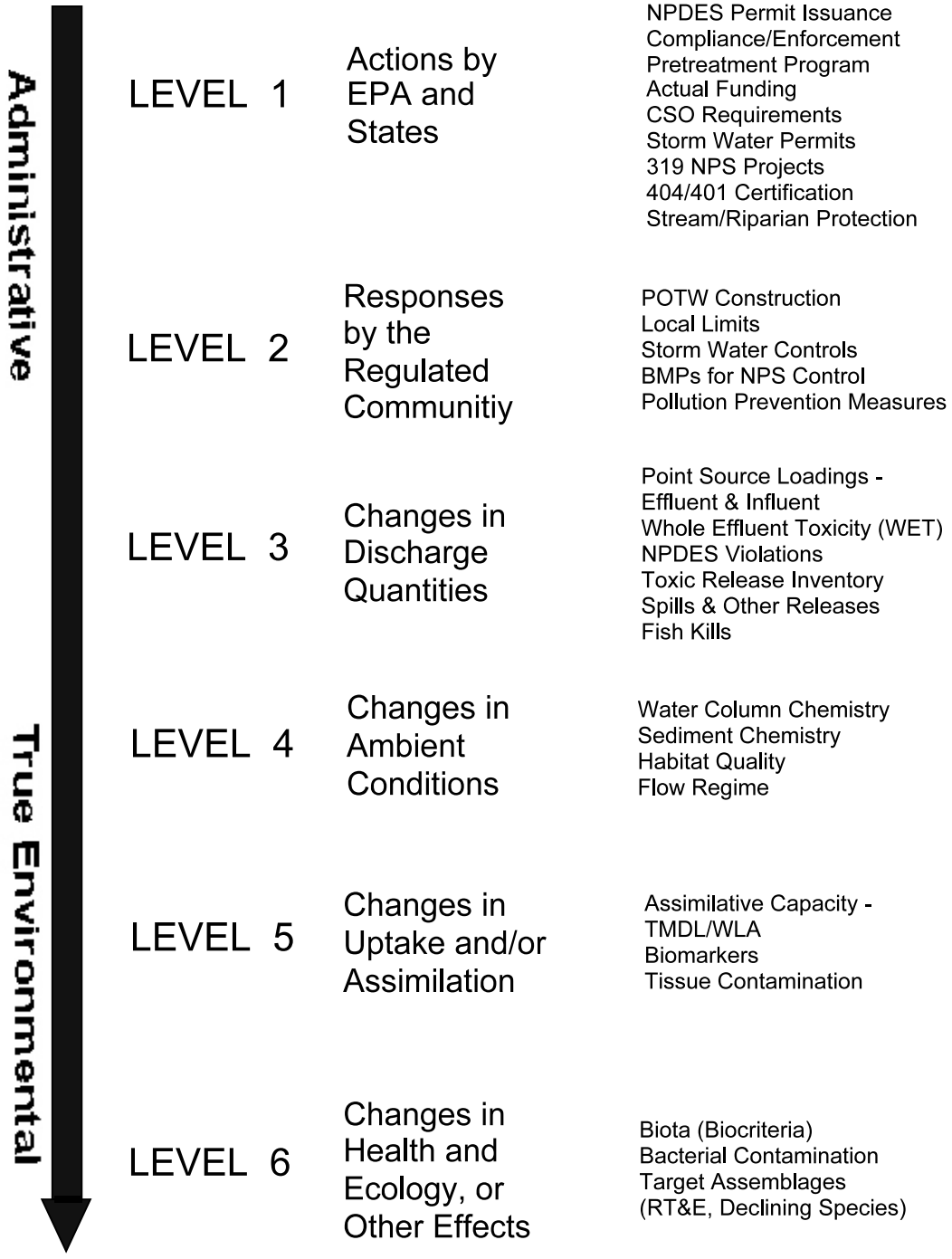


Figure 1. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by U.S. EPA (1995).

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 Integrated Water Quality Monitoring and Assessment Report (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, where canoeing is a feasible activity, or where contact recreation, regardless of stream size and depth, is readily apparent. 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 individuals contributed to field collections and/or report preparation: David Altfater, Mike Gray, and Sue Richards. Report review was conducted by Jeff DeShon and Marc Smith.

INTRODUCTION

The United Technologies (formerly Hamilton Standard Controls - HSC) facility in Lexington, Ohio, has been the subject of investigations of soil and ground water contamination since the late 1980s. In the course of those investigations, a plume of ground water contaminated with dissolved volatile organic compounds (VOCs), principally trichloroethene (TCE) and tetrachloroethene (PCE), was identified on and emanating from the former HSC facility. Low concentrations of cis-1,2-dichloroethene (1,2-DCE), a TCE degradation product, have also been detected in on- and off-site ground water. The off-site TCE and PCE plumes extend directly east and southeast of the HSC site, while DCE is detected northeast of the site, along the northern boundary of the TCE-PCE plume.

Specific objectives of this evaluation were to:

1) Establish biological conditions in the Clear Fork Mohican River in the vicinity of the former Hamilton Standard Controls (HSC) facility by evaluating fish and macroinvertebrate communities,

2) Evaluate surface water and sediment chemical quality in the Clear Fork Mohican River, and

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

SUMMARY

A total of 1.1 miles of the Clear Fork Mohican River were assessed by the Ohio EPA in 2004. Based on the performance of the Clear Fork Mohican River biological communities, 0.3 miles were in non-attainment, 0.4 miles were in partial attainment, and 0.4 miles were in full attainment of the Warmwater Habitat aquatic life use (Table 1). Non-attainment was recorded upstream from the former Hamilton Standard Controls ground water plume site, and partial attainment occurred adjacent to the plume area. The partial and non-attainment were associated with poor to fair fish results and a fair macroinvertebrate community. The partial and non-attainment of the biological community was caused by reduced habitat diversity and a heavy silt layer covering the bottom substrates. This was particularly evident at the most upstream sampling station (RM 28.2). Fine grained sediment constitutes a major environmental factor in the degradation of stream fisheries.

Sediment and surface water chemical quality were good within the study segment, and did not negatively contribute to the impaired biological conditions within the Clear Fork Mohican River. Surface water results were below Ohio Water Quality Standards (WQS) criteria, and sediment chemical levels (aside from acetone) were below ecological screening values. The ground water plume associated with the former Hamilton Standard Controls facility is not having a negative influence on the fish and macroinvertebrate communities of the Clear Fork Mohican River.

Sampling during 2004 confirmed the appropriateness of the current Warmwater Habitat aquatic life use designation for the Clear Fork Mohican River in the Ohio WQS.

RECOMMENDATIONS

Status of Aquatic Life Uses

The aquatic life use designation of Warmwater Habitat (WWH) for the Clear Fork Mohican River has been confirmed in previous Ohio EPA biological and water quality studies. This study reaffirmed the WWH use designation for the Clear Fork Mohican River.

Status of Non-Aquatic Life Uses

This study verified that the Primary Contact Recreation use is appropriate for the Clear Fork Mohican River.

Table 1. Attainment status of the aquatic life use for the Clear Fork Mohican River based on biological sampling conducted during July and August, 2004. The Index of Biotic Integrity (IBI), Modified Index of Well-being (MIwb), and Invertebrate Community Index (ICI) are scores based on the performance of the biological community. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biological community.

RIVER MILE Fish/Invert.	IBI	MIwb	ICI	QHEI	Attainment Status	Sample Location
Ecoregion - *Erie Ontario Lake Plain (EOLP)*						
Clear Fork Mohican River *- WWH Use Designation (Existing)*						
28.2/ 28.2	32*	4.6*	26*	44.0	NON	Background location
28.0/ 28.0	38	5.9*	26*	62.5	PARTIAL	Adj. ground water plume
27.5/ 27.5	39	7.8^{ns}	38	76.0	FULL	Dst. ground water plume

Ecoregion Biocriteria: Erie-Ontario Lake Plain (EOLP)
(Ohio Administrative Code 3745-1-07, Table 7-15)

INDEX	WWH	EWH	MWH[a]
IBI-Wading	38	50	24
MIwb-Wading	7.9	9.4	6.2
ICI	34	46	22

[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 ($\leq$4 IBI and ICI units; $\leq$0.5 MIwb units).

Table 2. Sampling locations in the Clear Fork Mohican River, 2004. 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
Clear Fork Mohican River				
28.2	F,M,S,W	40.68413	82.58061	Upstream former Hamilton Standard Controls (HSC) plume/downstream ground water treatment discharge
28.0	F,M,S,W	40.68074	82.58020	Adjacent HSC ground water plume
27.5	F,M,S,W	40.67485	82.57894	Downstream HSC ground water plume

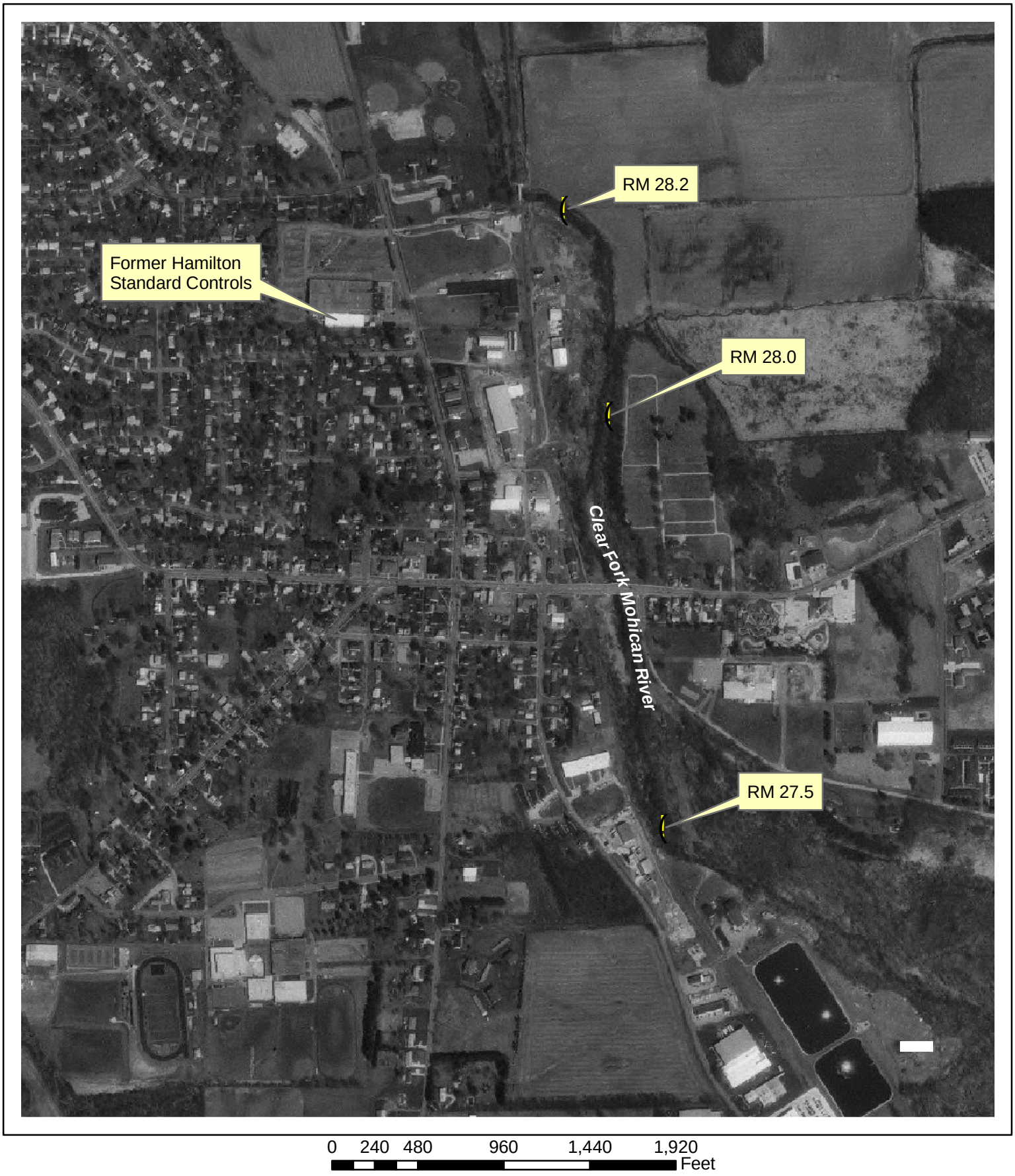


Figure 2. Map of the Clear Fork Mohican River study area, showing sampling locations by river mile (RM), 2004.

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 2003) and Biological Criteria for the Protection of Aquatic Life, Volumes I-III (Ohio Environmental Protection Agency 1987a, 1987b, 1989a, 1989b), 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 7-15). 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 0-2 inches and 2-4 inches of bottom material at each Clear Fork Mohnican River location using decontaminated stainless steel coring tubes. Decontamination of sediment sampling equipment followed the procedures outlined in the Ohio EPA sediment sampling guidance manual (Ohio EPA 2001). Sediment grab samples were placed directly into glass jars with teflon lined lids, placed on ice (to maintain 4^{o}C) in a cooler, and shipped to a contract lab. Sediment data is reported on a dry weight basis. Surface water samples were collected directly into appropriate containers, preserved and delivered to a contract lab. Field measurements were taken for pH, dissolved oxygen, and temperature. 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 USEPA Region 5 Ecological Screening Levels - ESLs (2003).

Macroinvertebrate Community Assessment

Macroinvertebrates were collected from artificial substrates and from the natural habitats at the three Clear Fork Mohican River 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 1989a).

Fish Community Assessment

Fish were sampled twice at each site using pulsed DC electrofishing wading methods, with sampling distances of 180 - 200 meters at each site in the Clear Fork Mohican River. 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 1989a).

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 8 and August 23, 2004, from three locations in the Clear Fork Mohican River (Table 3, Appendix Tables 1 and 2). Surface water samples were analyzed for nitrate-nitrite, TKN, ammonia-N, total phosphorus, pH, dissolved oxygen, and volatile organic compounds. Parameters which were in exceedence of Ohio WQS criteria are reported in Table 3.

For the three Clear Fork Mohican River locations, there were no exceedences of the Ohio WQS aquatic life or human health nondrinking criteria. Although slightly elevated trichloroethene concentrations were documented adjacent to and downstream from the HSC ground water plume, none of the measurements exceeded criteria protective of the Warmwater Habitat aquatic life use. Concentrations of nearly all of the organic parameters tested were reported as not detected. Total phosphorus and nitrate-nitrite concentrations at all three locations were within acceptable levels, with reported values below ecoregional reference conditions (less than 75th percentile) as determined in Ohio EPA 1999; Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams). Ammonia-N levels were below Ohio WQS criteria; however, values were above regional reference conditions.

Sediment Chemistry

Sediment samples were collected at three locations in the Clear Fork Mohican River on two different dates, July 8 and August 23, 2004. Sediment sampling locations are indicated by river mile in Figure 2. Samples were analyzed for volatile organic compounds. Detected chemical parameters, with results, are listed in Table 4.

Sediment data were evaluated using guidelines established in USEPA Region 5, RCRA Appendix IX compounds - Ecological Screening Levels (ESLs) (USEPA 2003). Ecological screening levels (ESLs) are initial screening levels used by USEPA to evaluate RCRA site constituents. One parameter (naphthalene) was 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 in the Clear Fork Mohican River upstream from the ground water plume was not contaminated. All parameters analysed were reported as not detected, with detection levels for most parameters below 7 ug/kg. Sediment chemical results from the sampling locations adjacent to and downstream from the ground water plume documented nearly all parameters at non-contaminated levels. Ten VOC compounds had detectable concentrations within the study area. Of these ten, eight were below lab instrument reporting limits and below ESL or TEC concentrations. 2-Butanone, although reported at detectable levels adjacent to and downstream from the ground water plume, was below ecological screening levels. Acetone was the only parameter measured adjacent to and

downstream from the plume area at levels exceeding an ecological screening benchmark (ESL = 9.9 ug/kg).

Physical Habitat For Aquatic Life

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

The three Clear Fork Mohican River sampling locations were represented by some significant habitat differences. These differences were largely related to channel modifications within the study segment. The most upstream sampling site, RM 28.2, had been previously channel modified, resulting in reduced habitat diversity and sparse instream cover. The predominant bottom substrates were muck and sand, with extensive embeddedness and a heavy silt layer. These conditions, combined with no riffle habitat, contributed to the poor QHEI score of 44. Improved stream habitat conditions were noted further downstream at RM 28.0, adjacent to the ground water plume area. Bottom substrates were predominated by sand and gravel, instream cover amounts and types improved, and a small riffle area occurred in the sampling zone. The QHEI score of 62.5 was indicative of marginally good habitat, although substrates were still heavily covered with silt and extensively embedded. The most downstream sampling location at RM 27.5 was largely comprised of a natural stream channel, and was well represented by pool, run, and riffle areas. Moderate amounts of instream cover were recorded, and bottom substrates were predominantly gravel and sand. The upper 40 meters of this site had been previously channel modified. The QHEI score at RM 27.5 was 76.0, indicative of excellent stream habitat. The QHEI scores from the lower two sites (RMs 28.0 and 27.5) were at levels capable of supporting WWH biological communities.

Fish Community Assessment

Fish communities were assessed at three locations in the Clear Fork Mohican River (Figure 2, Table 6, Appendix Tables 3 and 4). Sampling locations were selected to assess contributions of contaminants from the former Hamilton Standard Controls ground water plume area.

Fish communities ranged from poor to good in the Clear Fork Mohican River. Results from all three fish sampling locations indicated improvement from upstream to downstream. IBI scores were in the fair to good range in the Clear Fork Mohican River, with scores of 32, 38, and 39, upstream to downstream, respectively. Two of the IBI values (38 and 39) met the ecoregional biocriterion established for Warmwater Habitat (WWH) streams and rivers in Ohio (Table 1). Modified Index of Well-Being scores were in the poor to marginally good range, with values of 4.6, 5.9, and 7.8. Two of these MIwb scores (4.6 and 5.9) did not meet the ecoregional biocriterion established for Warmwater Habitat (WWH) streams and rivers in Ohio. Pollution tolerant fish were very abundant at RM 28.2 (80%) and RM 28.0 (75%), compared to RM 27.5 (49%). Reduced habitat conditions, along with a heavy silt layer and extensive embeddedness, contributed to the lower fish index scores at RMs 28.2 and 28.0. Fine grained sediment constitutes a major environmental factor in the degradation of stream fisheries (Waters 1995). Past Ohio EPA fish collections included a sample collected at RM 27.6 during 1998, where the IBI and MIwb scores were 36 and 7.0, respectively. The 2004 results from RM 27.5 (IBI=39, MIwb=7.8) revealed a slight improvement in the fish community compared with 1998; however, sampling locations between years were not identical.

Macroinvertebrate Community Assessment

The macroinvertebrate communities in the Clear Fork Mohican River were sampled in 2004 using qualitative (multi-habitat composite) and quantitative (artificial substrate) sampling protocols. Results are summarized in Table 7. The ICI metrics with the associated scores for the Erie-Ontario Lake Plain ecoregion and the raw data are attached as Appendix Tables 5 and 6 .

The ICI scores for the three Clear Fork Mohican River sites (RMs 28.2, 28.0, and 27.5) were 26, 26, and 38, respectively. The upstream and adjacent sites with ICI scores of 26 and narrative evaluations of fair reflect non-attainment of the WWH use. The macroinvertebrate sampling results from the downstream site with an ICI score of 38 and a narrative evaluation of good reflected attainment of the WWH use. The lower ICI scores from the upstream and adjacent sites appeared to be related to lower habitat quality. The stream had been channelized at both sites, instream cover was sparse, and bottom substrates were predominantly muck and sand. A limited amount of functional riffles contributed to the poor habitat. Low stream velocity at the adjacent sampling location may have contributed to the low ICI. The downstream site had a natural channel, more instream cover and gravel and sand bottom substrates which contributed to the improved macroinvertebrate community.

Table 3. Exceedences of Ohio Water Quality Standards criteria (OAC 3745-1) for chemical/physical parameters from the Clear Fork Mohican River study area, 2004.

River Mile	Parameter (value)
Clear Fork Mohican River	
28.2	None
28.0	None
27.5	None

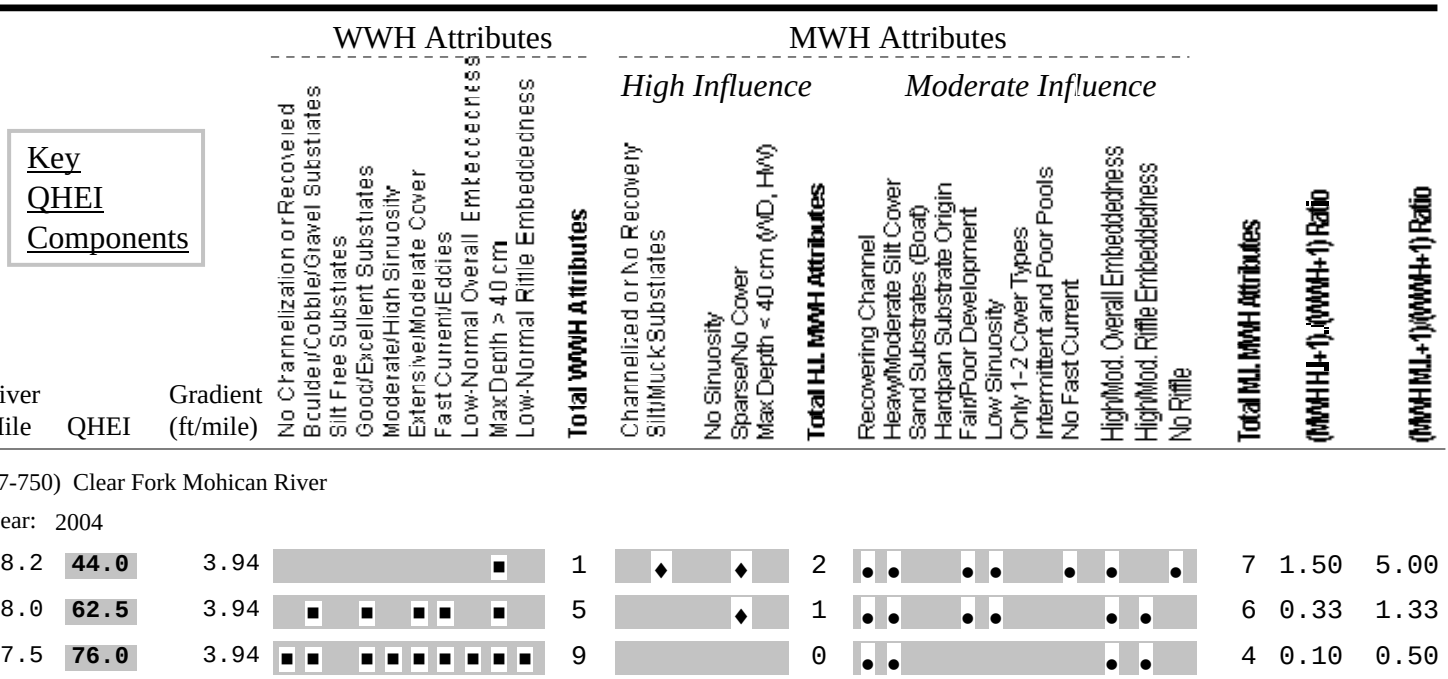
Table 4. Sediment sampling results for the Clear Fork Mohican River, 2004. Only volatile organic compounds with detectable concentrations were reported. RM = river mile.

Sample Location		Date	acetone	2-butanone	carbon disulfide	n-propylbenzene	1,2-dichlorobenzene	naphthalene	tetrachloroethene	trichloroethene	1,2,3-trimethylbenzene
	Depth (inches)		Concentrations in µg/Kg								
RM 27.5	0 to 2	7/8/2004	23.4 J	5.34 J	1.06 J	< 7.03	< 7.03	< 7.03	< 7.03	< 7.03	< 7.03
RM 27.5	0 to 2	8/23/2004	62.9 J	13.6 J	< 8.15	< 8.15	< 8.15	< 8.15	< 8.15	< 8.15	< 8.15
RM 27.5	2 to 4	7/8/2004	19.3 J	4.65 J	< 7.22	< 7.22	< 7.22	< 7.22	< 7.22	< 7.22	< 7.22
RM 27.5	2 to 4	8/23/2004	109 J	23.9 J	1.08 J	< 7.56	< 7.56	< 7.56	< 7.56	< 7.56	< 7.56
RM 28.0	0 to 2	7/8/2004	58.0 J	13.1 J	1.71 J	< 7.05	1.15 J	1.19 J	< 7.05	< 7.05	< 7.05
RM 28.0	0 to 2	8/23/2004	38.4 J	7.57 J	< 7.12	< 7.12	< 7.12	< 7.12	< 7.12	0.976 J	< 7.12
RM 28.0	2 to 4	7/8/2004	69.3 J	18.1 J	1.69 J	< 8.58	< 8.58	< 8.58	0.948 J	< 8.58	< 8.58
RM 28.0D	2 to 4	7/8/2004	124 J	33.9 J	< 8.68	< 8.68	< 8.68	< 8.68	< 8.68	< 8.68	< 8.68
RM 28.0	2 to 4	8/23/2004	104 J	17.4 J	< 8.55	< 8.55	< 8.55	< 8.55	< 8.55	< 8.55	< 8.55
RM 28.0D	2 to 4	8/23/2004	34.8 J	7.54 J	< 7.08	1.68 J	< 7.08	< 7.08	< 7.08	0.727 J	< 7.08
RM 28.2	0 to 2	7/8/2004	< 6.37	< 6.37	< 6.37	< 6.37	< 6.37	< 6.37	< 6.37	< 6.37	< 6.37
RM 28.2	0 to 2	8/23/2004	< 6.02	< 6.02	< 6.02	< 6.02	< 6.02	< 6.02	< 6.02	< 6.02	< 6.02
RM 28.2	2 to 4	7/8/2004	< 6.72	< 6.72	< 6.72	< 6.72	< 6.72	< 6.72	< 6.72	< 6.72	< 6.72
RM 28.2	2 to 4	8/23/2004	< 5.78	< 5.78	< 5.78	< 5.78	< 5.78	< 5.78	< 5.78	< 5.78	< 5.78

D = duplicate sample

J = A laboratory qualifer indicating that the compound was positively identified but below the RL (Reporting Limit)

Table 5. Qualitative Habitat Evaluation Index (QHEI) scores, and matrix of modified and warmwater attributes for sites in the Clear Fork Mohican River, 2004.



(17-750) Clear Fork Mohican River

Year: 2004

River Mile	QHEI	Gradient (ft/mile)	Total WWH Attributes	Total HL MWH Attributes	Total ML MWH Attributes	(MWH HL+1)/(WWH+1) Ratio	(MWH ML+1)/(WWH+1) Ratio
28.2	**44.0**	3.94	1	2	7	1.50	5.00
28.0	**62.5**	3.94	5	1	6	0.33	1.33
27.5	**76.0**	3.94	9	0	4	0.10	0.50

Table 6. Fish community summaries based on pulsed DC electrofishing sampling conducted by Ohio EPA in the Clear Fork Mohican River from July and August, 2004. Relative numbers and weight for the Clear Fork Mohican River sites are per 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
Clear Fork Mohican River (2004)								
28.2	11.5	16	305	16.53	44.0	4.6*	32*	Poor/Fair
28.0	20.0	27	447	15.53	62.5	5.9*	38	Fair/Good
27.5	23.5	29	661	14.80	76.0	7.8[ns]	39	M.Good/Good

Ecoregion Biocriteria: Erie-Ontario Lake Plain (EOLP)
(Ohio Administrative Code 3745-1-07, Table 7-15)

INDEX	WWH	EWH	MWH[a]
IBI-Wading	38	50	24
MIwb - Wading	7.9	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) by the Ohio EPA in the Clear Fork Mohican River, 2004.

River Mile	Density Number/ft^2	Total Taxa	Quantitative Taxa	Qualitative Taxa	Qualitative EPT[a]	ICI	Evaluation
			WWH Use Designation				
Clear Fork Mohican River							
28.2	660	52	38	34	1	26*	Fair
28.0	619	51	29	44	4	26*	Fair
27.5	627	49	35	31	4	38	Good

Ecoregion Biocriteria: Erie-Ontario Lake Plain (EOLP)
(Ohio Administrative Code 3745-1-07, Table 7-15)

INDEX	**WWH**	**EWH**	**MWH**[b]
ICI	34	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.
* Significant departure from ecoregional biocriterion; poor and very poor results are underlined.

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APPENDICES

Appendix Table 1. Surface water results, Clear Fork Mohican River, 2004.

Surface Water Samples
Clear Fork - Mohican River
Former Hamilton Standard
Lexington, Ohio

Sample Location	Date	Nitrate-Nitrite	TKN	Nitrogen - Ammonia	Phosphorous	acetone	2-butanone	carbon disulfide	n-propylbenzene	1,2-dichlorobenzene	naphthalene	tetrachloroethene	trichloroethene	1,2,3 trichlorobenezene	1,2,4 trichlorobenezene
		Concentrations in mg/L				Concentrations in µg/L									
RM 27.5	07/08/04	0.714	0.971	0.106	< 0.100	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	0.597 J	< 5.00	< 5.00
RM 27.5	08/23/04	0.814	0.381	0.271	< 0.100	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	0.261 J	< 1.00	1.33 J	0.253 J	< 1.00
RM 28.0	07/08/04	0.672	0.430	0.0800 J	< 0.100	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	0.476 J	< 5.00	< 5.00
RM 28.0D	07/08/04	0.669	0.591	0.0760 J	< 0.100	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	0.430 J	< 5.00	< 5.00
RM 28.0	08/23/04	0.652	0.490	0.207	< 0.100	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.26	< 1.00	< 1.00
RM 28.0D	08/23/04	0.653	0.417	0.175	< 0.100	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	0.997 J	< 1.00	< 1.00
RM 28.2	07/08/04	0.640	0.489	0.149	< 0.100	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
RM 28.2	08/23/04	0.688	0.227	0.152	0.0730 J	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00
Trip Blank	07/08/04	--	--	--	--	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00	< 5.00
Trip Blank	08/23/04	--	--	--	--	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	0.269 J	< 1.00

D = Duplicate sample
J = A laboratory qualifer indicating that the compound was positively identified but below the RL (Reporting Limit)

Appendix Table 2. Field measurements taken at biological sampling locations, 2004.

Clear Fork - Mohican River
Lexington, Ohio

Date	Time	Location	Temperature (°C)	DO (ppm)	pH (SU)
7/8/2004	8:45	RM 28.2	20.0	7.2	--
7/8/2004	15:30	RM 28.2	21.0	7.8	7.47
8/23/2004	12:30	RM 28.2	18.0	7.1	6.47
7/8/2004	9:05	RM 28.0	19.5	6.1	--
7/8/2004	14:30	RM 28.0	21.0	6.9	7.43
8/23/2004	14:05	RM 28.0	16.5	7.4	8.12
7/8/2004	9:18	RM 27.7	18.5	6.6	--
7/8/2004	10:40	RM 27.5	19.0	6.2	7.21
8/23/2004	11:00	RM 27.5	19.7	6.1	8.23

°C - degrees Celsius
ppm - parts per million
SU - Standards units
cfs - cubic feet per second
RM - river mile

Appendix Table 3. Fish species, numbers, and weight by sampling location, 2004.

River Code: **17-750**	Stream: **Clear Fork Mohican River**	Sample Date: **2004**
River Mile: **28.20**	Location: upst. Hamilton Standard	Date Range: 07/08/2004
Time Fished: 4800 sec	Drainage: 47.0 sq mi	Thru: 08/23/2004
Dist Fished: 0.38 km	Basin: Muskingum River 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	1.58	0.52	0.22	1.35	141.50
Central Mudminnow		I	C	T	2	1.58	0.52	0.00	0.02	2.00
Northern Hog Sucker	R	I	S	M	6	4.74	1.55	0.15	0.88	30.83
White Sucker	W	O	S	T	91	71.84	23.58	8.66	52.38	120.52
Common Carp	G	O	M	T	2	1.58	0.52	5.09	30.80	3,225.00
Creek Chub	N	G	N	T	14	11.05	3.63	0.57	3.48	51.96
Rock Bass	S	C	C		3	2.37	0.78	0.14	0.83	58.00
Largemouth Bass	F	C	C		5	3.95	1.30	0.27	1.65	69.20
Green Sunfish	S	I	C	T	201	158.68	52.07	1.06	6.43	6.69
Bluegill Sunfish	S	I	C	P	18	14.21	4.66	0.30	1.81	21.01
Pumpkinseed Sunfish	S	I	C	P	2	1.58	0.52	0.00	0.03	3.00
Logperch	D	I	S	M	1	0.79	0.26	0.01	0.07	15.00
Johnny Darter	D	I	C		8	6.32	2.07	0.01	0.06	1.50
Greenside Darter	D	I	S	M	2	1.58	0.52	0.00	0.02	1.50
Fantail Darter	D	I	C		27	21.32	6.99	0.03	0.17	1.30
Mottled Sculpin		I	C		2	1.58	0.52	0.00	0.03	3.00
Mile Total					386	304.74		16.53		
Number of Species					16					
Number of Hybrids					0					

River Code: **17-750**	Stream: **Clear Fork Mohican River**	Sample Date: **2004**
River Mile: **28.00**	Location: adj. Hamilton Standard	Date Range: 07/08/2004
Time Fished: 6840 sec	Drainage: 47.0 sq mi	Thru: 08/23/2004
Dist Fished: 0.40 km	Basin: Muskingum River 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		1	0.75	0.17	0.00	0.03	5.00
Central Mudminnow		I	C	T	10	7.50	1.68	0.01	0.08	1.60
Northern Hog Sucker	R	I	S	M	4	3.00	0.67	0.39	2.50	129.00
White Sucker	W	O	S	T	67	50.25	11.24	8.57	55.22	170.63
Common Carp	G	O	M	T	1	0.75	0.17	1.46	9.42	1,950.00
Blacknose Dace	N	G	S	T	8	6.00	1.34	0.01	0.05	1.29
Creek Chub	N	G	N	T	33	24.75	5.54	0.55	3.52	22.10
Fathead Minnow	N	O	C	T	3	2.25	0.50	0.01	0.05	3.00
Bluntnose Minnow	N	O	C	T	18	13.50	3.02	0.03	0.20	2.33
Central Stoneroller	N	H	N		2	1.50	0.34	0.02	0.10	10.00
Yellow Bullhead		I	C	T	1	0.75	0.17	0.01	0.06	13.00
Blackstripe Topminnow		I	M		1	0.75	0.17	0.00	0.01	2.00
Trout-perch		I	M		1	0.75	0.17	0.01	0.09	18.00
White Crappie	S	I	C		3	2.25	0.50	0.24	1.56	107.67
Rock Bass	S	C	C		9	6.75	1.51	0.54	3.50	80.44
Largemouth Bass	F	C	C		2	1.50	0.34	0.03	0.20	20.50
Green Sunfish	S	I	C	T	304	228.00	51.01	3.21	20.66	14.07
Bluegill Sunfish	S	I	C	P	16	12.00	2.68	0.09	0.60	7.78
Yellow Perch			M		5	3.75	0.84	0.12	0.74	30.80
Blackside Darter	D	I	S		1	0.75	0.17	0.00	0.03	5.00
Logperch	D	I	S	M	6	4.50	1.01	0.09	0.60	20.50
Johnny Darter	D	I	C		12	9.00	2.01	0.02	0.11	1.82
Greenside Darter	D	I	S	M	4	3.00	0.67	0.01	0.05	2.67
Rainbow Darter	D	I	S	M	7	5.25	1.17	0.01	0.07	2.11
Fantail Darter	D	I	C		74	55.50	12.42	0.08	0.51	1.43
Mottled Sculpin		I	C		2	1.50	0.34	0.01	0.06	6.00
Brook Stickleback		I	C		1	0.75	0.17	0.00	0.01	2.00
Mile Total					596	447.00		15.53		
Number of Species					27					
Number of Hybrids					0					

River Code: **17-750**	Stream: **Clear Fork Mohican River**	Sample Date: **2004**
River Mile: **27.50**	Location: upst. Lexington WWTP, dst. U.S. Rt. 42	Date Range: 07/08/2004
Time Fished: 6000 sec	Drainage: 53.0 sq mi	Thru: 08/23/2004
Dist Fished: 0.36 km	Basin: Muskingum River 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		1	0.83	0.13	0.01	0.03	6.00
Rainbow Trout	E		N		1	0.83	0.13	0.07	0.47	83.00
Central Mudminnow		I	C	T	3	2.50	0.38	0.02	0.14	8.00
Northern Hog Sucker	R	I	S	M	28	23.33	3.53	1.86	12.56	79.64
White Sucker	W	O	S	T	49	40.83	6.18	3.92	26.49	95.98
Common Carp	G	O	M	T	1	0.83	0.13	1.96	13.23	2,350.00
Golden Shiner	N	I	M	T	6	5.00	0.76	0.06	0.42	12.50
Blacknose Dace	N	G	S	T	39	32.50	4.92	0.09	0.64	2.90
Creek Chub	N	G	N	T	149	124.17	18.79	4.27	28.83	34.36
Striped Shiner	N	I	S		3	2.50	0.38	0.15	1.01	60.00
Common Shiner	N	I	S		28	23.33	3.53	0.34	2.32	14.75
Sand Shiner	N	I	M	M	21	17.50	2.65	0.05	0.32	2.76
Fathead Minnow	N	O	C	T	1	0.83	0.13	0.00	0.02	3.00
Bluntnose Minnow	N	O	C	T	38	31.67	4.79	0.12	0.81	3.78
Central Stoneroller	N	H	N		36	30.00	4.54	0.33	2.20	10.86
Blackstripe Topminnow		I	M		1	0.83	0.13	0.00	0.02	3.00
Rock Bass	S	C	C		2	1.67	0.25	0.17	1.17	103.50
Largemouth Bass	F	C	C		1	0.83	0.13	0.01	0.09	16.00
Green Sunfish	S	I	C	T	104	86.67	13.11	0.75	5.07	8.66
Bluegill Sunfish	S	I	C	P	6	5.00	0.76	0.05	0.34	10.00
Pumpkinseed Sunfish	S	I	C	P	1	0.83	0.13	0.07	0.47	83.00
Logperch	D	I	S	M	3	2.50	0.38	0.03	0.22	12.67
Johnny Darter	D	I	C		24	20.00	3.03	0.03	0.17	1.26
Greenside Darter	D	I	S	M	29	24.17	3.66	0.07	0.47	2.90
Banded Darter	D	I	S	I	3	2.50	0.38	0.01	0.03	2.00
Rainbow Darter	D	I	S	M	67	55.83	8.45	0.09	0.59	1.58
Fantail Darter	D	I	C		125	104.17	15.76	0.19	1.25	1.78
Mottled Sculpin		I	C		22	18.33	2.77	0.09	0.60	4.86
Brook Stickleback		I	C		1	0.83	0.13	0.00	0.01	2.00
	Mile Total				793	660.83		14.80		
	Number of Species				29					
	Number of Hybrids				0					

Appendix Table 4. Index of Biotic Integrity scores for samples collected in the Clear Fork Mohican River, 2004.

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Sunfish species	Sucker species	Intolerant species	Darter species	Percent of Individuals: Simple Lithophils	Tolerant fishes	Omni-vores	Top carnivores	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)		IBI	Modified Iwb
Clear Fork Mohican R - (17750)																		
Year: 2004																		
28.20	E	08/23/2004	47	14(3)	4(5)	2(3)	0(1)	4(3)	32(3)	78(1)	30(3)	2.0(3)	65(5)	0.0(5)	104(1)		36	5.4
28.20	E	07/08/2004	47	8(1)	2(3)	1(1)	0(1)	1(1)	3(1)	87(1)	5(5)	2.5(3)	89(5)	0.0(5)	16(1)	*	28	3.8
28.00	E	08/23/2004	47	25(5)	4(5)	2(3)	0(1)	6(5)	18(3)	76(1)	17(5)	1.5(3)	73(5)	0.0(5)	171(1)		42	6.0
28.00	E	07/08/2004	47	14(3)	4(5)	2(3)	0(1)	3(3)	8(1)	67(1)	5(5)	3.6(3)	85(5)	0.9(3)	56(1)	*	34	5.8
27.50	E	08/23/2004	53	26(5)	3(3)	2(3)	1(1)	6(5)	29(3)	55(1)	12(5)	0.2(1)	54(3)	0.5(3)	422(3)		36	8.1
27.50	E	07/08/2004	53	19(3)	3(3)	2(3)	1(1)	6(5)	38(5)	36(3)	9(5)	0.9(1)	74(5)	0.0(5)	250(3)		42	7.4

na - Qualitative data, Modified Iwb not applicable.

♦ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample

● - One or more species excluded from IBI calculation.

Appendix Table 5. Macroinvertebrate taxa collected by sampling location, 2004.

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Collection Date: 08/23/2004 River Code: 17-750 RM: 28.20 Site: Clear Fork Mohican River upst. plume

Taxa Code	Taxa	Quant/Qual
00401	*Spongillidae*	+
01801	*Turbellaria*	10
03360	*Plumatella sp*	+
03600	*Oligochaeta*	296 +
05900	*Lirceus sp*	8 +
08250	*Orconectes (Procericambarus) rusticus*	+
08601	*Hydracarina*	+
11120	*Baetis flavistriga*	1
11130	*Baetis intercalaris*	3
21200	*Calopteryx sp*	+
22001	*Coenagrionidae*	+
47600	*Sialis sp*	+
52200	*Cheumatopsyche sp*	199 +
52430	*Ceratopsyche morosa group*	2
59300	*Mystacides sp*	5
68601	*Ancyronyx variegata*	+
68700	*Dubiraphia sp*	3
69400	*Stenelmis sp*	+
74100	*Simulium sp*	1 +
77120	*Ablabesmyia mallochi*	25
77500	*Conchapelopia sp*	253 +
78140	*Labrundinia pilosella*	25
78401	*Natarsia species A (sensu Roback, 1978)*	+
78450	*Nilotanypus fimbriatus*	25
80350	*Corynoneura sp*	8
80420	*Cricotopus (C.) bicinctus*	101 +
80430	*Cricotopus (C.) tremulus group*	379
82141	*Thienemanniella xena*	16
82730	*Chironomus (C.) decorus group*	+
82820	*Cryptochironomus sp*	51 +
83040	*Dicrotendipes neomodestus*	101
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*	51 +
83840	*Microtendipes pedellus group*	51
84155	*Paralauterborniella nigrohalteralis*	25
84210	*Paratendipes albimanus or P. duplicatus*	25 +
84300	*Phaenopsectra obediens group*	126 +
84450	*Polypedilum (Uresipedilum) flavum*	354 +
84460	*Polypedilum (P.) fallax group*	253
84470	*Polypedilum (P.) illinoense*	25 +
84480	*Polypedilum (P.) laetum group*	+
84540	*Polypedilum (Tripodura) scalaenum group*	177 +
84750	*Stictochironomus sp*	+
85500	*Paratanytarsus sp*	51
85625	*Rheotanytarsus sp*	126 +
85800	*Tanytarsus sp*	51 +
85821	*Tanytarsus glabrescens group sp 7*	405 +
87540	*Hemerodromia sp*	16 +
93900	*Elimia sp*	+
95100	*Physella sp*	3 +
96900	*Ferrissia sp*	36
97601	*Corbicula fluminea*	+
97710	*Dreissena polymorpha*	2 +
98001	*Sphaeriidae*	10

No. Quantitative Taxa: 38 Total Taxa: 53
No. Qualitative Taxa: 34 ICI: **26**
Number of Organisms: 3299 Qual EPT: 1

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Collection Date: 08/23/2004 River Code: 17-750 RM: 28.00 Site: Clear Fork Mohican River adj. plume

Taxa Code	Taxa	Quant/Qual
00401	*Spongillidae*	+
01801	*Turbellaria*	3
03360	*Plumatella sp*	+
03600	*Oligochaeta*	114 +
05900	*Lirceus sp*	8 +
06700	*Crangonyx sp*	+
08250	*Orconectes (Procericambarus) rusticus*	+
13570	*Stenonema terminatum*	1 +
21200	*Calopteryx sp*	18 +
22001	*Coenagrionidae*	+
22300	*Argia sp*	+
45900	*Notonecta sp*	+
49400	*Sisyra sp*	+
50804	*Lype diversa*	1
52200	*Cheumatopsyche sp*	31 +
52430	*Ceratopsyche morosa group*	+
57400	*Neophylax sp*	+
68601	*Ancyronyx variegata*	+
68708	*Dubiraphia vittata group*	+
69400	*Stenelmis sp*	1 +
77500	*Conchapelopia sp*	128 +
77800	*Helopelopia sp*	26 +
78350	*Meropelopia sp*	+
78401	*Natarsia species A (sensu Roback, 1978)*	+
79400	*Zavrelimyia sp*	26
80370	*Corynoneura lobata*	88
80420	*Cricotopus (C.) bicinctus*	205 +
80430	*Cricotopus (C.) tremulus group*	589 +
81825	*Rheocricotopus (Psilocricotopus) robacki*	26
82141	*Thienemanniella xena*	40 +
82730	*Chironomus (C.) decorus group*	205 +
82820	*Cryptochironomus sp*	+
83300	*Glyptotendipes (G.) sp*	26 +
83840	*Microtendipes pedellus group*	26 +
84210	*Paratendipes albimanus or P. duplicatus*	26 +
84300	*Phaenopsectra obediens group*	77 +
84450	*Polypedilum (Uresipedilum) flavum*	+
84460	*Polypedilum (P.) fallax group*	51 +
84470	*Polypedilum (P.) illinoense*	+
84480	*Polypedilum (P.) laetum group*	+
84540	*Polypedilum (Tripodura) scalaenum group*	128
84750	*Stictochironomus sp*	+
85500	*Paratanytarsus sp*	102 +
85625	*Rheotanytarsus sp*	26 +
85800	*Tanytarsus sp*	179 +
85821	*Tanytarsus glabrescens group sp 7*	922 +
93900	*Elimia sp*	+
96900	*Ferrissia sp*	3 +
97601	*Corbicula fluminea*	17
97710	*Dreissena polymorpha*	+
98600	*Sphaerium sp*	+

No. Quantitative Taxa: 29 Total Taxa: 51
No. Qualitative Taxa: 44 ICI: **26**
Number of Organisms: 3093 Qual EPT: 4

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Collection Date: 08/23/2004 River Code: 17-750 RM: 27.50 Site: Clear Fork Mohican River dst. plume

Taxa Code	Taxa	Quant/Qual
01320	*Hydra sp*	1
01801	*Turbellaria*	25 +
03600	*Oligochaeta*	57 +
05900	*Lirceus sp*	1 +
08250	*Orconectes (Procericambarus) rusticus*	+
08601	*Hydracarina*	+
11120	*Baetis flavistriga*	3 +
11130	*Baetis intercalaris*	16 +
11430	*Diphetor hageni*	3
21200	*Calopteryx sp*	+
47600	*Sialis sp*	+
52200	*Cheumatopsyche sp*	446 +
52430	*Ceratopsyche morosa group*	2 +
69400	*Stenelmis sp*	7 +
74100	*Simulium sp*	+
77500	*Conchapelopia sp*	155 +
77750	*Hayesomyia senata or Thienemannimyia norena*	26
77800	*Helopelopia sp*	26 +
80204	*Brillia flavifrons group*	26
80370	*Corynoneura lobata*	16
80420	*Cricotopus (C.) bicinctus*	+
80430	*Cricotopus (C.) tremulus group*	181
80490	*Cricotopus (Isocladius) intersectus group*	+
81825	*Rheocricotopus (Psilocricotopus) robacki*	52
82101	*Thienemanniella taurocapita*	16
82141	*Thienemanniella xena*	48
82730	*Chironomus (C.) decorus group*	+
82820	*Cryptochironomus sp*	+
83300	*Glyptotendipes (G.) sp*	26
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*	+
84300	*Phaenopsectra obediens group*	+
84430	*Polypedilum (P.) albicorne*	26
84450	*Polypedilum (Uresipedilum) flavum*	233 +
84460	*Polypedilum (P.) fallax group*	129 +
84470	*Polypedilum (P.) illinoense*	77
84540	*Polypedilum (Tripodura) scalaenum group*	26 +
84750	*Stictochironomus sp*	+
85500	*Paratanytarsus sp*	26
85625	*Rheotanytarsus sp*	543 +
85752	*Sublettea coffmani*	26
85800	*Tanytarsus sp*	77
85821	*Tanytarsus glabrescens group sp 7*	801
87540	*Hemerodromia sp*	16
93900	*Elimia sp*	+
95100	*Physella sp*	1 +
96900	*Ferrissia sp*	10
97601	*Corbicula fluminea*	+
97710	*Dreissena polymorpha*	2 +
98600	*Sphaerium sp*	9 +

No. Quantitative Taxa: 35 Total Taxa: 49
No. Qualitative Taxa: 31 ICI: **38**
Number of Organisms: 3135 Qual EPT: 4

Appendix Table 6. Invertebrate Community Index (ICI) scores for samples collected in the Clear Fork Mohican River, 2004.

River Mile	Drainage Area (sq mi)	Number of				Percent:					Qual. EPT	Eco-region	ICI
		Total Taxa	Mayfly Taxa	Caddisfly Taxa	Dipteran Taxa	Mayflies	Caddis-flies	Tany-tarsini	Other Dipt/NI	Tolerant Organisms			
Clear Fork Mohican River (17-750)													
Year: 2004													
28.20	47.0	38(6)	2(0)	3(4)	25(6)	0.1(2)	6.2(4)	19.2(4)	74.4(0)	21.6(0)	1(0)	3	26
28.00	47.0	29(4)	1(0)	2(4)	19(4)	0.0(2)	1.0(2)	39.7(6)	58.6(2)	18.7(2)	4(0)	3	26
27.50	53.0	35(4)	3(2)	2(4)	21(6)	0.7(2)	14.3(6)	47.0(6)	37.8(4)	8.7(4)	4(0)	3	38