

**Appendix B**  
**Aquatic Survey of the Hocking River**

**CITY OF LANCASTER WATER QUALITY STUDY  
AQUATIC SURVEY OF THE HOCKING RIVER AND TRIBUTARIES**

Lancaster, Ohio

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## EXECUTIVE SUMMARY

EnviroScience, Inc. completed an aquatic survey of nine sites in the Hocking River watershed between July 28<sup>th</sup> and September 16<sup>th</sup>, 1998. Five sites were located on the Hocking River, one on Ewing Run, one on Fetters Run, and two were on Baldwin Run. The survey was conducted to determine whether the City of Lancaster's Combined Sewer Overflows (CSOs) are impacting the streams in the study area. This report describes the methods used and the results of the survey.

Qualitative habitat analysis, pulsed DC electrofishing, and benthic macroinvertebrate sampling was performed at nine sampling sites. Electrofishing was performed twice during the sampling season. Qualitative habitat analysis was performed during the second electrofishing event. Benthic macroinvertebrate sampling began on July 28<sup>th</sup>, 1998 when Modified Hester-Dendy Artificial Substrate samplers were deployed. Supplemental qualitative macroinvertebrate sampling of the natural substrates was performed at the time of sampler collection.

Data was evaluated using indices developed by the Ohio Environmental Protection Agency (Ohio EPA). The indices include the Qualitative Habitat Evaluation Index (QHEI), the Index of Biotic Integrity (IBI), the Modified Index of Well Being (MIwb), and the Invertebrate Community Index (ICI).

The Hocking River study area has a drainage area of 97.5 square miles and is located within the Erie/Ontario Lake Plain ecoregion. Within the city limits of Lancaster, much of the Hocking River stream basin has been channelized and riparian zones are narrow. The Ohio Environmental Protection Agency (OEPA) has assigned a use designation of Modified Warm Water Habitat (MWH) for all Hocking River sampling sites included in the current study (OEPA, 1994) except for the downstream station at river mile 87. For this reason, biological data were compared to Warm Water Habitat (WWH) narrative ranges and evaluated against scores necessary for attainment of MWH. In contrast, all four tributary sites are considered headwater sites (drainage area <20 sq/miles) and were evaluated solely against Warm Water Habitat (WWH) criteria.

QHEI scores for the tributary sites were relatively low compared to the standard of 60 used for warm water habitat fish populations. This can be attributed to their status as headwater streams which often do not have the water volume to create deep pools and well defined riffles. The streams also flow through urban and residential areas where stream modifications have been made to facilitate human activities. Stream modifications included the depletion of instream cover and channelization which were common throughout the sampling sites.

Fish communities were relatively diverse in the tributaries with all sites having IBI scores indicative of "marginally good" or better communities. Fish populations consisted primarily of pioneering and headwater species and fish abundance was relatively high for headwater streams.

Macroinvertebrate sampling in Ewing Run resulted in an ICI score of 35, considered indicative of a "marginally good" community. Fetters Run produced the highest ICI score of 43, and is considered to be in the "good" range. ICI scores on Baldwin Run were considerably lower with a "poor" score of 10 at Site BR-0.7 and a "fair" score of 28 at Site BR-0.1. The lower ICI score may have been the result of sampler placement that was constrained by available depth.

Overall, two of the four tributary sampling sites were in FULL attainment of WWH criteria established by OEPA. Sites in FULL attainment included those on Ewing and Fetters Runs (ER-1.9 and FR-0.7), respectively. Baldwin Run was in NON attainment at the upstream sampling site (BR-0.7) and in PARTIAL attainment at the downstream site (BR-0.1).

Hocking River QHEI scores were indicative of MWH ranging from 38.5 at Site HR-91.8 to a score of 53.5 at HR 93. The downstream site met the WWH score of 60 at Site HR-87 despite the presence of an illegal ford constructed across the river in that reach. Generally, most Hocking River habitats have been altered by channelization for agricultural and urban land uses.

Fish collections in the Hocking River mainstem resulted in IBI and MIwb scores that varied

considerably between sampling sites. Upstream collections at Site HR-93 resulted in a “marginally good” IBI score of 35 and a “fair” MIwb score of 5.92. As the river flows into the city limits of Lancaster and behind a shopping center at Site HR-91.8, the IBI score decreased slightly into the “fair” range with a score of 32 and a “poor” MIwb score of 4.79. The river then flows into a wooded park area at Site HR-90.25 with more instream cover and a wider riparian zone. The IBI and MIwb score increased into the “good” range with a score of 42 and 8.08, respectively. The IBI and MIwb scores decreased into the “poor” range with an IBI of 26 and MIwb of 4.39 at Site HR-89.3. Site HR-87 had an IBI score and MIwb score in the “poor” range with scores of 24 and 5.17, respectively.

All Hocking River sampling sites, except one, had ICI scores that were indicative of MWH criteria. Site HR-93 had an ICI score of 32 and is considered to be in the “marginally good” range. Macroinvertebrate communities increased to “good” at Site HR-91.8 with an ICI score of 34. ICI scores decreased into the “fair” range with a score of 28 at Site HR-90.25. A significant decrease in ICI scores is noted at Site HR-89.3 which had a score of eight that fell into the “poor” range. Scores significantly increased to “good” at Site HR-87 with a score 38.

Overall, two of the Hocking River sampling sites, HR-93 and HR-90.25, were in FULL attainment of MWH criteria. Site HR-91.8 was in PARTIAL attainment while Sites HR-89.3 and HR-87 were in NON attainment of applicable criteria.

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## 1.0 INTRODUCTION

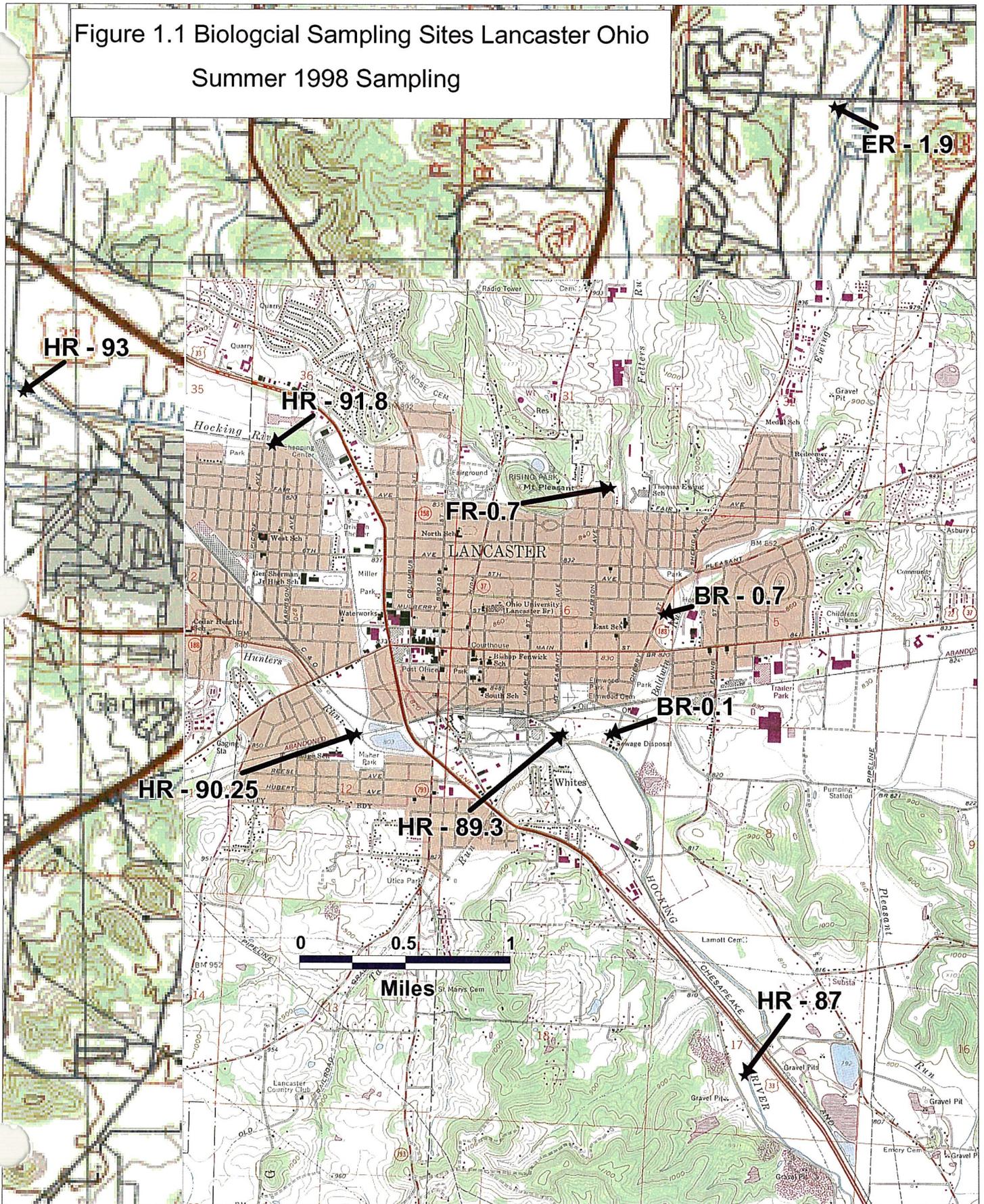
EnviroScience, Inc. completed an aquatic survey of nine sites in the Hocking River watershed area between July 28<sup>th</sup> and September 16<sup>th</sup>, 1998. Five sites were located on the Hocking River, one on Ewing Run, one on Fetter Run, and two on Baldwin Run (Figure 1.1). The Hocking River study area is located within the Erie/Ontario Lake Plain ecoregion. The total drainage area for the Hocking River within the study area is 97.5 square miles. River mile (and drainage area information is presented in Table 1.1.

**Table 1.1 Sampling Sites**

<b>Sampling Site</b>	<b>Stream</b>	<b>River Mile (RM)</b>	<b>Drainage Area (mi<sup>2</sup>)</b>
ER-1.9	Ewing Run	1.9	3
FR-0.7	Fetters Run	0.7	6.6
BR-0.7	Baldwin Run	0.7	13.3
BR-0.1	Baldwin Run	0.1	14
HR-93	Hocking River	93	22.3
HR-91.8	Hocking River	91.8	28.2
HR-90.25	Hocking River	90.25	41.1
HR-89.3	Hocking River	89.3	45.4
HR-87	Hocking River	87	97.5

The Hocking River watershed has been extensively used for both urban and agricultural land uses. The drainage areas of the three tributaries evaluated in this study include areas that are rural, urban, and commercial in nature. All four tributary sites are considered headwater sites (drainage area <20 sq/miles) and will be evaluated against Warm Water Habitat (WWH) criteria. Within the city limits

Figure 1.1 Biological Sampling Sites Lancaster Ohio  
Summer 1998 Sampling



of Lancaster, much of the Hocking River stream basin has been well channelized and has narrow riparian zones. The Ohio Environmental Protection Agency (OEPA) has assigned a use designation of Modified Warm Water Habitat (MWH) for all Hocking River sampling sites included in the current study (OEPA, 1994) except HR-87.

## **2.0 METHODS**

This section of the report describes the methodology used during the aquatic survey of the Hocking River study area. These descriptions include methods used for qualitative habitat analysis, fish collection and identification, fish population data, macroinvertebrate collection and processing, macroinvertebrate population data, and water chemistry collection and analysis.

Methods used to assess the biotic communities included the Qualitative Habitat Evaluation Index (QHEI), pulsed DC electrofishing, Modified-Hester Dendy Multiple Plate Artificial Substrate Samplers, qualitative "kick" macroinvertebrate sampling, and in-field chemistry for a limited set of parameters. All methods were in compliance with EnviroScience, Inc. standard operating procedures (SOPs), and adhere to those stated in the *Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices* (Ohio EPA, 1991) and *Biological Criteria for the Protection of Aquatic Life*, Volumes I-V (Ohio EPA, 1987, updated January 1, 1989).

### **2.1 Qualitative Habitat Evaluation Index (QHEI)**

To evaluate stream habitat quality, a Qualitative Habitat Evaluation Index (QHEI) score was calculated at each site. The QHEI, as developed by the Ohio EPA, is a physical habitat index which provides a quantified evaluation of the lotic macrohabitat characteristics important to fish communities (Ohio EPA, 1989b). The index is calculated by assigning scores for each of the following six metrics:

- Quality of Substrate, maximum 20 points

- Type of Instream Cover, maximum 20 points
- Channel Morphology, maximum 20 points
- Riparian Zone and Bank Erosion, maximum 10 points
- Pool/Glide and Riffle/Run Quality, maximum 20 points
- Gradient, maximum 10 points

The sum of the scores from these metrics yield a total score that numerically rates the habitat of a particular stream reach. The QHEI is based on a scale of 100 possible points. The maximum score was determined by the Ohio EPA to represent undisturbed habitats similar in structure to the Hocking River study sites (Ohio EPA, 1989b). Sites having QHEI scores >60 are expected to sustain fish and macroinvertebrate populations indicative of Warm Water Habitat (WWH). Sites with scores <60 are expected to meet biological water quality criterion for Modified Warm Water Habitat (MWH). QHEI scoring sheets are presented in Appendix A.

## **2.2 Fish Populations**

### **2.2.1 Electrofishing**

A Smith-Root® 2.5 GPP Portable DC Pulsed Electrofisher was used to sample fish populations at each site between July 28 to August 8<sup>th</sup>, and September 14<sup>th</sup>- 16<sup>th</sup>, 1998. The available peak current from the unit is 1,000 volts and 5,000 watts. The output of the unit is adjusted according to the conductivity of the water being sampled. The current flowing through the water is directly related to the voltage applied: the higher the voltage the greater the current. Based on an average conductivity of 640 µmhos in the Hocking River Study area, the voltage of the electrofishing unit was adjusted to approximately 30-40% of the total available power. This power output was adequate to representatively sample the smaller individuals, while minimizing adverse effects on larger individuals.

Sampling sites were approximately 200 meters in length, and included all representative habitats

within each sampling site. Riffle and pool depth determined the type of electrofishing apparatus used. At sites having numerous riffles and in areas <10 centimeters in depth, the long-line configuration was used. Deeper sites required the use of the sport-yak configuration. Electrofishing started at the downstream-end of each sampling site and proceeded upstream. The electrofishing crew consisted of two netters; an individual controlling the anode ring, and one person identifying, weighing, and recording specimens from a livewell at the streamside field station.

### 2.2.2 Identification/Enumeration

Immediately after collection, stunned fish were taken to shore where they were identified, weighed to the nearest 1/10 (0.10) of a gram, measured, and examined for external anomalies. Total lengths were recorded to the nearest 0.10 centimeter. Mass and length measurements were taken for fifty (50) randomly selected individuals of each species. Length, mass and anomaly data were recorded on EnviroScience Fish Data Sheets (Appendix D). Except for those retained for laboratory confirmation, all collected fish were released upon total recovery from the initial shock.

Fish collected during the course of this study were identified in the field by experienced aquatic biologists. Representative samples having uncertain identity were preserved in borax-buffered 10% formalin and returned to the EnviroScience lab for further examination.

### 2.2.3 Fish Data Analysis

The biological community assessment methods used to evaluate fish populations in this study were the Index of Biotic Integrity (IBI) and the Modified Index of Well Being (MIwb). The IBI was calculated at all sampling sites, whereas the MIwb was only calculated at sites which had drainage areas greater than 20 square miles (the minimum drainage basin where Ohio EPA has calibrated MIwb Scores). The IBI is a multi-metric index patterned after an original described by Karr (1981) and Fausch et al. (1984). The metric scoring range is from one to five, where one, three, or five are

the only metric scores possible. The higher metric score is considered more favorable and the sum of the metrics becomes the IBI score, where the maximum possible is 60. The twelve IBI metrics for wading sites (>20 square mile drainage areas) are listed below:

- Total Number of Indigenous Fish Species
- Number of Darter Species (Wading Sites)
- Number of Sunfish Species (Wading Sites)
- Number of Sucker Species (Wading Sites)
- Number of Intolerant Species (Wading Sites)
- Percent Abundance of Tolerant Species
- Percent Omnivores
- Proportion as Insectivores
- Percent Top Carnivores (Wading Sites)
- Percent Simple Lithophilic Spawners
- Relative Number of Individuals
- Percent DELT Anomalies

The twelve IBI metrics used for Headwater sites (<20 square mile drainage areas) are listed below:

- Total Number of Indigenous Fish Species
- Number of Darter Species
- Number of Headwater Species (Headwater)
- Number of Minnow Species (Headwater)
- Number of Sensitive Species (Headwater)
- Percent Abundance of Tolerant Species
- Omnivore Metric
- Proportion of Insectivores
- Proportion of Pioneering Species (Headwater)
- Number of Individuals
- Number of Simple Lithophils
- Percent DELT Anomalies on All Species

The Modified Index of Well Being incorporates four measures of fish communities that have traditionally been used separately: numbers of individuals, biomass, and the Shannon Diversity Index based on numbers and weights (OEPA, 1987). All relative numbers and relative weights are adjusted so as to represent a .3 kilometer sampling pass at non-headwater sampling sites. The maximum score for the MIwb is 10.0.

The sites were evaluated against WWH criteria by compiling and interpreting the values of the IBI indices and the MIwb. The values from these indexes at each site were used to classify sites as representative of "very good", "good", "marginally good", "fair", "poor", or "very poor" fish community condition (Table 2.1).

**Table 2.1 Water Quality Criteria Ranges for the Erie/Ontario Lake Plain Ecoregion**

Index	Community Condition						
	Exceptional	Very Good	Good	Marginally Good	Fair	Poor	Very Poor
IBI	50-60	46-49	38-45	34-37	28-33	18-27	12-17
MIwb	≥9.4	8.9-9.3	7.9-8.8	7.4-7.8	5.9-7.3	4.5-5.8	0.0-4.4
ICI	46-60	40-44	34-38	30-32	14-28	2-12	<2

\*In order to be in Full attainment of WWH, a sampling site must have scores for fish population indices (IBI and MIwb) and the benthic macroinvertebrate index (ICI) scores in at least the "marginally good" category. Partial attainment of WWH is achieved if any of three scores reach the "marginally good" threshold with the remaining indices scoring in the "fair" or better category. Sites must have all three scores in the "fair" range or better in order to be in attainment of MWH.

## **2.3 Macroinvertebrates**

The primary sampling apparatus used for the collection of benthic macroinvertebrates was the Modified Hester-Dendy Multiple-Plate Artificial Substrate sampler. Each sampler was constructed of 1/8 inch tempered hardboard cut into eight three-inch square plates, separated by twelve round nylon spacers. The plates and spacers were placed on a 1/4 inch eyebolt with three single spaces, three double spaces, and one triple space between the plates. The total surface area of the sampler, excluding the eyebolt, was 145.6 square inches. A set of samplers consists of five multiple-plate samplers (approximately five square feet), at each sampling location. Two sets of Hester-Dendy samplers were installed at each site to provide a backup set in case one set was lost. However, only one set was processed. Hester-Dendy samplers were deployed on July 28<sup>th</sup>, 1998. The samplers were allowed to colonize for six weeks before collection.

### **2.3.1 Procedure for Sampling with a Hester-Dendy Sampler**

Hester-Dendy samplers (Figure 2.1) were positioned in the euphotic zone (one to two feet below the water surface) and in adequate flow to obtain maximum abundance and diversity of macroinvertebrates. Samplers were positioned as to be located midway in the water column at low flow. Samplers were placed on 8 inch cement blocks and anchored to the bottom of the stream to avoid loss during floods. Care was taken not to allow the samplers to touch the stream bottom which would permit siltation, and increase the chance of sampling error.

When retrieving multi-plate samplers, loss of macroinvertebrates was minimized by approaching from downstream and by placing a sieve under the samplers before lifting them from the stream. The samplers were then quickly removed from the block and placed in polyethylene containers containing 10% formalin. Organisms which fell from the samplers were picked from the sieve and placed in the containers with the samplers. Each container was labeled with the location, habitat, date, and time of collection.

### 2.3.2 Supplemental Qualitative Sampling

When samplers were removed from the stream, qualitative "kick" samples were collected at each site from all available natural substrates. For each kick sample, at least thirty (30) minutes was spent disturbing the substrate immediately upstream of a D-frame net fitted with U.S. Standard Number Thirty (#30) mesh. At each site, qualitative sampling was performed until no new taxa were evident in gross examination. The qualitative samples were collected to obtain data to supplement the quantitative data collected by the Hester-Dendy samplers.

### 2.3.3 Labeling and Record Keeping

All samples were labeled in the field at the time of collection. Sample labels were made of water-resistant paper and were placed inside the sample container. A lead based soft pencil or water resistant ink was used to protect against bleeding or discoloration from the sample preservative. The outside of each container and lid were also labeled with the same information. All labels included sample identification information corresponding to that entered on the EnviroScience, Inc. chain of custody forms. The Chain of Custody forms included the date, name of client, sampling method, weather, and other physical or environmental conditions.

Upon arrival at the laboratory, each sample was assigned a unique sequential identification (ID) number. This number identified the sample in a permanent ledger. The chain of custody form was copied, and one copy retained for permanent record. The chain of custody, sample ID number, and ledger document the transfer of the sample from the field to the laboratory. The sample ID number was placed prominently on and in the sample container before storing. This ID number was also placed on all specimen vials and microscope slides connected with the sample.

### 2.3.4 Sample Processing

The Hester-Dendy samplers were placed into a tray of laboratory water and dismantled. The individual tiles were scrubbed with a soft brush and carefully rinsed into the tray. The tiles were also visually inspected, and clinging organisms were removed.

The water in the tray was then washed through a No. 30 sieve that was placed on top of a No. 40 sieve. The organisms were then picked from the screens with forceps and placed into sample vessels containing 90% ethanol. The remaining debris in the sieves was inspected under a dissecting microscope for the presence of additional small organisms.

As noted, samplers were initially fixed in 10-15% formalin in the field to help preserve and sustain body parts important to identification. After fixing and sorting, they were placed in small screw-cap vials and preserved in 90% ethanol. Because some amount of rinse water is carried over with the organisms, 90% ethanol was used to insure that the final solution would be strong enough to preserve the specimens. Containers used for holding preserved organisms were sized so that they were not over one-half full of the washed sample before the preservative was added.

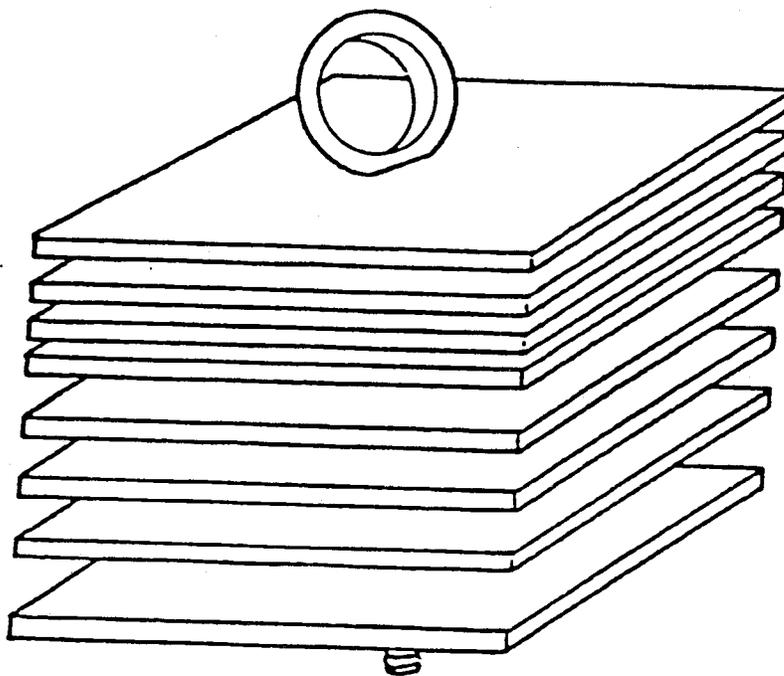
After each sample was sorted, notations were made in the sample log book. These included, the date and the initials of the sorter. Samples were checked by the macroinvertebrate supervisor to confirm that organisms were not overlooked.

### 2.3.5 Macroinvertebrate Identification

Identifications were carried to the lowest taxonomic level required by EnviroScience's standard operating procedures (SOP's) and the Ohio EPA. When necessary, identified specimens were compared to EnviroScience's permanent reference collection which has been verified by an outside authority in benthic macroinvertebrate identification.

Subsampling techniques were used when the number of individuals from a specific group (Order) was expected to exceed a standard recommended by the Ohio EPA. According to this protocol, a minimum of 70 mayfly, 70 caddisfly, and 100 chironomid larvae must be collected before subsampling techniques are initiated. Subsampling was completed by random extraction of organisms from the sample until adequate numbers were counted. Remaining organisms were extrapolated and recorded to obtain a relative number for the sample.

Figure 2.1 One Modified Hester-Dendy Multiple Plate Artificial Substrate Sampler.



Members of the Dipteran family Chironomidae (midges) were cleared in 10% potassium hydroxide and mounted in water on microscope slides for identification.

As organisms were identified, the individuals in each taxonomic group were counted. These numbers and taxa were recorded on Aquatic Invertebrate Bench Sheets (Appendix E), on labels inserted in the bottles, and on the slides.

### 2.3.6 Macroinvertebrate Data Analysis

The principle measure of overall macroinvertebrate community condition used by EnviroScience, Inc. is the ICI, a measurement derived by the Ohio EPA. The ICI is a modification of the Index of Biotic Integrity (IBI) for fish developed by Karr (Ohio EPA, 1987). The ICI consists of ten structural community metrics, each with four scoring categories. The ICI metrics are as follows:

- Total Number of Taxa
- Number of Mayfly Taxa
- Number of Caddisfly Taxa
- Number of Dipteran Taxa
- Percent Mayflies
- Percent Caddisflies
- Percent Tanytarsini Midges
- Percent Other Diptera and Non-Insects
- Percent Tolerant Organisms
- Qualitative Ephemeroptera, Plecoptera, and Trichoptera Taxa

The metric scoring range is from zero to six, where zero, two, four, or six are the only metric scores possible. Like the IBI, a higher score for each metric is considered favorable and the total possible score is 60. After the metrics are summed, the sample is evaluated against a database of comparable reference sites within the Erie/Ontario Lake Plain Ecoregion (Table 2.1).

## **2.4 In-field Chemistry and Site Characterization**

At the time of electrofishing, in-field chemistry was performed for a limited set of parameters including dissolved oxygen, pH, conductivity, water temperature, and air temperature. At this time, pertinent details regarding each sample site were also recorded on EnviroScience's Fish Data Sheets (Appendix D).

In-field testing was performed in accordance with *Standard Methods For The Examination of Water and Wastewater* (Standard Methods, 1992.) and EnviroScience, Inc.'s SOPs, which are available upon request. A Hydrolab® Scout II/Recorder II was used for all water quality parameters sampled. The Hydrolab® was calibrated at the start of the workday and the results recorded in a bound notebook.

## **3.0 RESULTS**

Hand scored QHEI sheets are included in Appendix A. Spreadsheets summarizing the results from fish sampling performed during the first and second round of sampling are included in Appendix B. IBI scoring sheets are presented in Appendix C. Complete fish data results can be found on the Fish Data Sheets included as Appendix D. Complete macroinvertebrate data for quantitative and qualitative samples can be found on the Aquatic Invertebrate Bench Sheets in Appendix E. The hand scored ICI sheets are located in Appendix F.

### **3.1 Hocking River Tributaries**

Tables 3.1 through 3.4 show Qualitative Habitat Evaluation Index (QHEI), Index of Biotic Integrity (IBI), Invertebrate Community Index (ICI), and In-field chemistry results collected on the tributaries of the Hocking River. MIwb scores were not calculated due to the headwater classification of the Hocking River tributary sampling sites.

**Table 3.1 Hocking River Tributary QHEI Metric Scores**

<b>Metric</b>	<b>Sampling Sites</b>				<b>Max. Possible</b>
	<b>ER-1.9</b>	<b>FR-0.7</b>	<b>BR-0.7</b>	<b>BR-0.1</b>	
<b>1. Substrate</b>	15	15	12	12	20
<b>2. Instream Cover</b>	13	6	3	7.5	20
<b>3. Channel Morphology</b>	13	12.5	9	8.5	20
<b>4. Riparian Zone</b>	6.5	6	6	5.5	10
<b>5a. Pool Quality</b>	7	4	3	5	12
<b>5b. Riffle Quality</b>	2.5	2.5	1	1	8
<b>6. Gradient</b>	10	10	8	8	10
<b>Total</b>	<b>67</b>	<b>56</b>	<b>42</b>	<b>47.5</b>	<b>100</b>

\* QHEI scores >60 are expected to sustain fish and macroinvertebrate populations representative of WWH

**Table 3.2 Hocking River Tributary IBI Metric Scores**

IBI Metric	ER-1.9		FR-0.7		BR-0.7		BR-0.1	
	Rnd 1	Rnd 2						
<b>1. Total Number of Indigenous Fish Species</b>	3	3	5	5	5	3	3	3
<b>2. Number of Darter Species</b>	3	3	3	5	3	3	3	1
<b>3. Number of Headwater Species</b>	3	3	3	3	3	3	3	3
<b>4. Number of Minnow Species</b>	3	3	5	5	5	5	3	5
<b>5. Number of Sensitive Species</b>	1	1	1	3	1	3	1	1
<b>6. Percent Tolerant Species</b>	1	1	1	1	1	1	1	1
<b>7. Percent Omnivores</b>	5	5	5	5	3	5	5	5
<b>8. Percent Insectivorous Species</b>	1	1	1	1	1	1	1	1
<b>9. Percent Pioneering Species</b>	3	1	3	3	3	3	5	5
<b>10. Number of Individuals</b>	5	3	3	5	3	5	3	1
<b>11. Proportion of Simple Lithophilic Species</b>	5	5	5	5	5	5	3	3
<b>12. Percent DELT Anomalies on All Species</b>	3	5	5	5	5	5	5	5
<b>Total for each round</b>	36	34	40	46	38	42	36	34
<b>Mean IBI Scores</b>	<b>35</b>		<b>43</b>		<b>40</b>		<b>35</b>	

\* IBI scores >34 are considered representative of WWH  
 Maximum score for each IBI metric is five

**Table 3.3 Hocking River Tributary ICI Metric Scores**

<b>ICI Metric</b>	<b>ER-1.9</b>	<b>FR-0.7</b>	<b>BR-0.7</b>	<b>BR-0.1</b>
<b>1.Total number of taxa</b>	2	4	2	4
<b>2. Number of Mayfly taxa</b>	2	0	0	0
<b>3 .Number of Caddisfly taxa</b>	6	6	0	6
<b>4. Number of Dipteran taxa</b>	4	6	4	6
<b>5. Percent Mayflies</b>	2	2	2	0
<b>6. Percent Caddisflies</b>	6	6	0	6
<b>7. Percent Tanytarsini midges</b>	4	4	2	4
<b>8. Percent other Diptera and non-insects</b>	0	0	0	0
<b>9. Percent tolerant organisms</b>	4	2	0	0
<b>10. Qualitative EPT taxa</b>	6	4	0	2
<b>Total ICI Scores</b>	<b>36</b>	<b>34</b>	<b>10</b>	<b>28</b>

\* ICI scores  $\geq 30$  are considered representative of WWH.

Maximum score for each ICI metric is six

**Table 3.4 Hocking River Tributary Field Chemistry Data**

<b>Parameter</b>	<b>ER-1.9</b>		<b>FR-0.7</b>		<b>BR-0.7</b>		<b>BR-0.1</b>	
	<b>8/5/98</b>	<b>9/16/98</b>	<b>8/5/98</b>	<b>9/16/98</b>	<b>7/30/98</b>	<b>9/15/98</b>	<b>7/28/98</b>	<b>9/14/98</b>
<b>Water Temperature, ° C</b>	19.2	18.29	19.80	17.58	19.63	23.24	27.04	23.48
<b>Conductivity, uhmos</b>	630	689	596	646	602	676	624	721
<b>Dissolved Oxygen, ppm</b>	N/A	9.58	N/A	7.82	9.04	14.12	N/A	12.4
<b>PH, S.U.</b>	8.1	7.66	8.01	7.61	7.90	7.87	8.2	7.62
<b>Flow, ft/sec</b>	N/A	0.2	N/A	<0.1	N/A	0.2	0.2	0.4

N/A= Not Available

### 3.2 Hocking River

Tables 3.5 through 3.8 show Qualitative Habitat Evaluation Index (QHEI), Index of Biotic Integrity (IBI), Modified Index of Well Being (MIwb), Invertebrate Community Index (ICI), and In-field chemistry results collected on the Hocking River.

**Table 3.5 Hocking River QHEI Metric Scores**

<b>Metric</b>	<b>HR-93</b>	<b>HR-91.8</b>	<b>HR-90.25</b>	<b>HR-89.3</b>	<b>HR-87</b>	<b>Max.</b>
<b>1. Substrate</b>	12	8	13	10.5	11.5	20
<b>2. Instream Cover</b>	8	8	6	9	11.5	20
<b>3. Channel Morphology</b>	9.5	7.5	11.5	7.5	13.5	20
<b>4. Riparian Zone</b>	7.5	5	8	4.5	7	10
<b>5a. Pool Quality</b>	9.5	4	5	8	10	12
<b>5b. Riffle Quality</b>	3	2	4	2	2.5	8
<b>6. Gradient</b>	4	4	4	4	4	10
<b>Total</b>	<b>53.5</b>	<b>38.5</b>	<b>51.5</b>	<b>45.5</b>	<b>60</b>	<b>100</b>

QHEI Scores  $\leq 60$  are representative of Modified Warm Water Habitat

**Table 3.6 Hocking River IBI Metric Scores and MIwb Scores**

IBI Metric	HR-93		HR-91.8		HR-90.25		HR-89.3		HR-87	
	Rnd 1	Rnd 2								
1. Total Number of Indigenous Fish Species	5	3	3	3	3	5	3	3	3	1
2. Number of Darter Species	5	3	5	1	5	5	1	1	3	1
3. Number of Sunfish Species	3	3	3	3	3	1	3	3	3	3
4. Number of Sucker Species	3	3	5	3	3	3	3	3	1	1
5. Number of Intolerant Species	1	1	1	1	3	3	1	1	1	1
6. Percent Tolerant Species	1	3	1	1	3	3	1	1	1	1
7. Percent Omnivores	3	3	1	1	5	5	1	1	1	1
8. Percent Insectivorous Species	5	5	5	5	5	3	3	1	3	3
9. Percent Top Carnivores Species	1	1	3	3	1	1	3	1	3	1
10. Number of Individuals	3	3	1	1	3	3	1	1	1	1
11. Proportion of Simple Lithophilic Species	3	1	5	1	5	5	5	5	5	5
12. Percent DELT Anomalies on All Species	3	5	3	5	3	5	3	3	1	3
<b>Total for each round</b>	<b>36</b>	<b>34</b>	<b>36</b>	<b>28</b>	<b>42</b>	<b>42</b>	<b>28</b>	<b>24</b>	<b>26</b>	<b>22</b>
<b>Mean IBI Scores</b>	<b>35</b>		<b>32</b>		<b>42</b>		<b>26</b>		<b>24</b>	
<b>MIwb Scores</b>	<b>6.36</b>	<b>5.48</b>	<b>5.63</b>	<b>3.96</b>	<b>7.90</b>	<b>8.26</b>	<b>5.50</b>	<b>3.29</b>	<b>6.50</b>	<b>3.85</b>
<b>Mean MIwb Scores</b>	<b>5.92</b>		<b>4.79</b>		<b>8.08</b>		<b>4.39</b>		<b>5.17</b>	

\* IBI scores  $\geq 24$  and MIwb scores  $\geq 6.2$  are considered representative of MWH  
 Maximum IBI score for each metric is five

**Table 3.7 Hocking River ICI Metric Scores**

ICI Metric	HR-93	HR-91.8	HR-90.25	HR-89.3	HR-87
1. Total number of taxa	4	4	6	2	6
2. Number of Mayfly taxa	4	4	4	0	0
3. Number of Caddisfly taxa	4	4	4	0	4
4. Number of Dipteran taxa	4	6	6	4	4
5. Percent Mayflies	2	2	2	0	2
6. Percent Caddisflies	2	2	2	0	6
7. Percent Tanytarsini midges	2	4	2	2	6
8. Percent other Diptera and non-insects	0	0	0	0	4
9. Percent tolerant organisms	4	4	0	0	4
10. Qualitative EPT taxa	6	4	2	0	2
<b>Total ICI Scores</b>	<b>32</b>	<b>34</b>	<b>28</b>	<b>8</b>	<b>38</b>

\* ICI scores  $\geq 22$  are considered representative of MWH. Maximum score for each ICI metric is six

**Table 3.8 Hocking River Field Chemistry Data**

Parameter	HR-93		HR-91.8				HR-89.3		HR-87	
	7/29/98	9/15/98	7/29/98	9/15/98	7/29/98	9/15/98	7/28/98	9/14/98	7/30/98	9/14/98
Water Temperature, ° C	20.4	24.35	22.36	22.30	25.42	21.35	20.90	21.90	21.62	23.95
Conductivity, uhmos	618	659	593	628	546	626	614	659	879	1750
Dissolved Oxygen, ppm	7.6	11.97	8.37	7.43	N/A	6.16*	8.30	9.8	6.19	11.77
PH, S.U.	7.9	8.84	8.1	7.72	8.39	7.62	7.7	7.4	7.73	7.76
Flow, ft/sec	.1	1.5	.1	.1	.2	.2	.1	.2	N/A	.2

N/A= Not Available

\*= reading suspect due to equipment error

## 4.0 DISCUSSION

As previously noted, the water quality of the Hocking River and tributaries is being evaluated using a combination of QHEI scores measuring habitat quality, IBI and MIwb scores measuring fish communities, and ICI scores measuring benthic macroinvertebrate communities. All of these ecological assessment tools are extensively used by the Ohio EPA and the resulting data are compared to previously studied reference sites within Ohio. This allows for valid comparisons between the Hocking River and tributary study sites and other Erie/Ontario Lake Plain reference sites previously studied by the Ohio EPA.

Two different use designations need to be considered when evaluating the attainment status of the Hocking River and tributary sampling sites. Due to the use designation (MWH) assigned by the OEPA, all Hocking River sampling sites are compared to MWH biocriteria and to WWH criteria at RM 87. The WWH narrative ranges are still used but the criteria required to be in attainment of MWH is less stringent. In order to be in FULL attainment of MWH, a sampling site must have scores for fish population indices (IBI and MIwb) and the benthic macroinvertebrate index (ICI) in at least the "fair" category. PARTIAL attainment of WWH is achieved if any of the three scores reach the "fair" threshold with the remaining indices scoring in the "poor" or better category.

The four sampling sites located on various tributaries of the Hocking will be compared to WWH biological criteria for the Erie/Ontario Lake Plain ecoregion. In order to be in FULL attainment of WWH, a sampling site must have scores for fish population indices (IBI and MIwb) and the benthic macroinvertebrate index (ICI) at least in the "marginally good" category. PARTIAL attainment of MWH is achieved if any of the three scores reach the "marginally good" threshold with the remaining indices scoring in the "fair" or better category.

## **4.1 Tributaries of the Hocking River**

### **4.1.1 QHEI Scores**

Habitat quality varied between sampling sites. The Ewing Run Site (ER-1.9) had the most conducive habitat for fish populations with a QHEI score of 67. The Fetters Run sampling site (FR-0.7) had a QHEI score of 56. Baldwin Run sampling sites had habitat scores of 42 and 47.5 at sites BR-0.7 and BR-0.1, respectively. All habitat scores are presented graphically in Figure 4.1.

The habitat at site ER-1.9 had substantially more instream cover when compared to other sampling sites. Instream cover was determined to be moderate and included six different components including undercut banks and overhanging vegetation. The resulting metric score at Site ER-1.9 was a 13 compared to the 6, 3, and 7.5 at sites FR-0.7, BR-0.7, and BR-0.1, respectively.

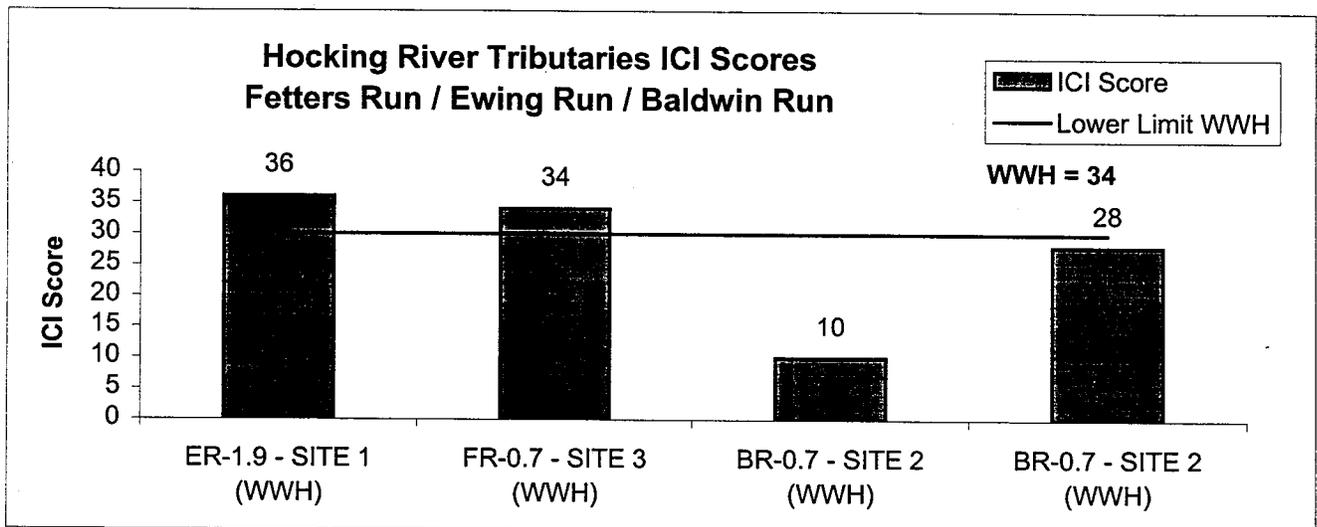
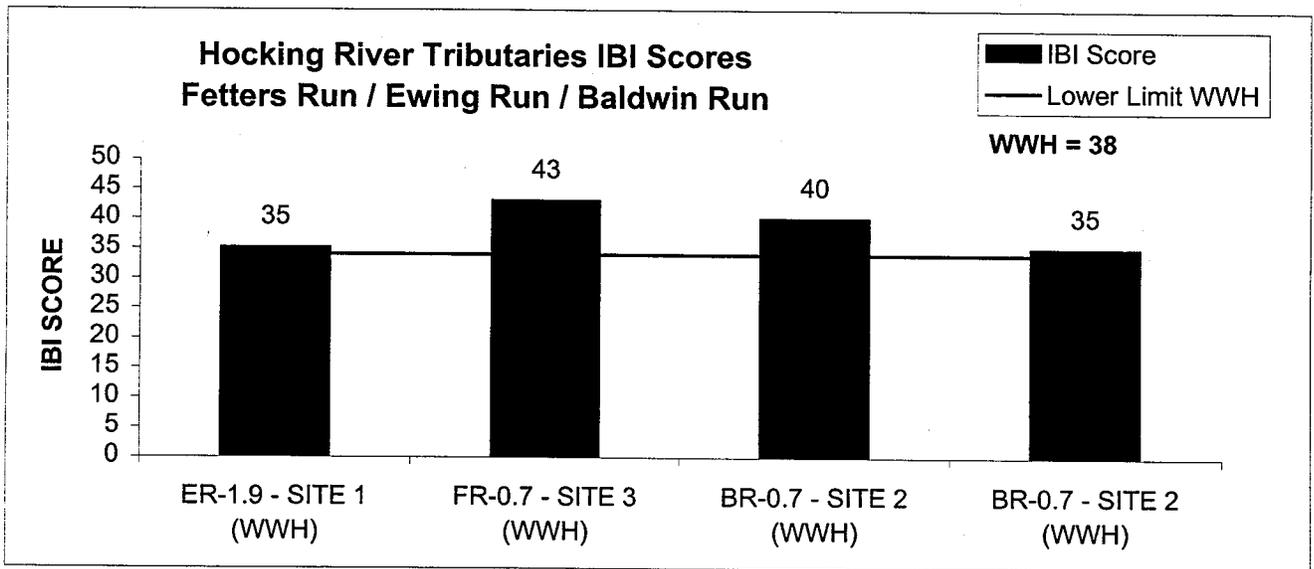
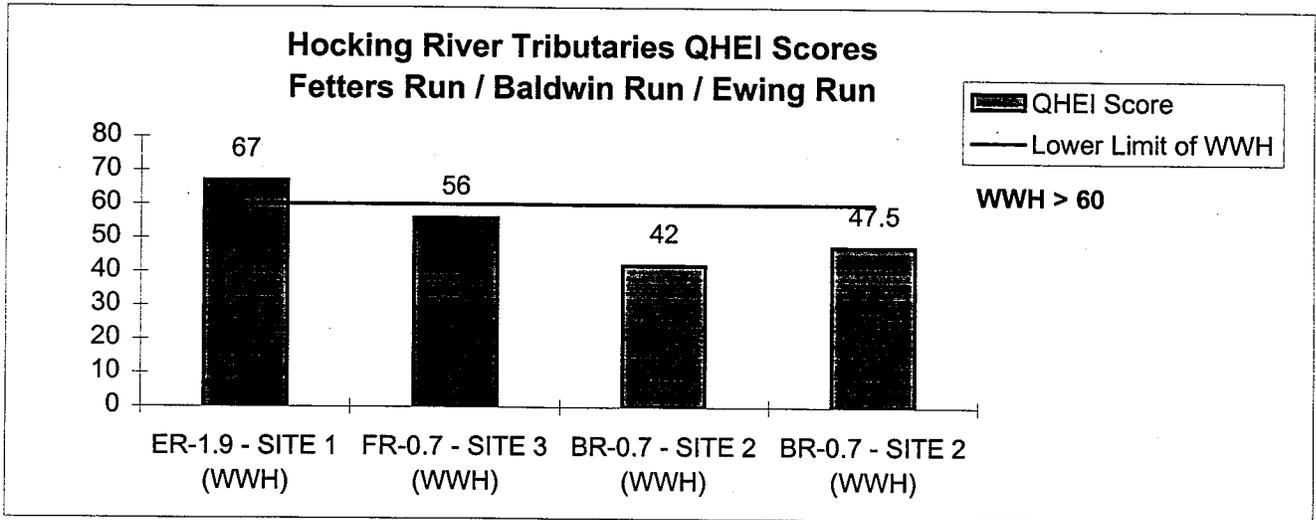
Pool quality was better at Site ER-1.9 when compared to other sites and included pools which were .7 to 1.0 meters in depth. Overall, Ewing Run was not as wide as the other streams, and water flow was constricted into a well defined stream channel. The constriction of water flow results in well defined riffles, runs and pools when compared to the wider stream channels of Fetters Run and Baldwin Run. Pool depth resulted in a metric score of seven at Site ER-1.9 compared to four, three, and five at Sites FR-0.7, BR-0.7, and BR-0.1, respectively.

### **4.1.2 IBI Scores**

The overall IBI score was calculated as the sum of the individual IBI metrics. Following Ohio EPA methods, the IBI scores were calculated for each electrofishing pass, averaged and then compared to WWH criteria.

Overall, IBI scores for the Hocking River Tributaries sites are "marginally good" to "good" and indicate attainment of WWH. IBI Scores for all Hocking River tributary sites are summarized in Figure 4.1. Site ER-1.9 on Ewing Run had an IBI score of 35 which is considered to be in

Figure 4.1 Biological Data for Hocking River Tributaries



WWH = Warmwater Habitat

SOURCE: EnviroScience Inc.  
Project No. 4980102-00

the "marginally good" range when compared to reference sites studied by the OEPA.

Fish collections at Site FR-0.7 resulted in the highest IBI score for the entire study with a score of 43 which is considered to be in the "good" category. The upstream Baldwin Run site (BR-0.7) had an IBI score of 40 which is considered to be in the "good" range. The IBI score drops slightly downstream with a score of 35 at Site BR-0.1. Although slightly lower, this score is still considered to be in the "marginally good" range when compared to water quality criteria.

Only eight IBI points separated the high and low score for the Hocking River Tributary sites, thus metric scores were relatively similar. However, slight differences were noted in the total number of indigenous species (Metric One). This metric is based on the well-documented observation that the number of indigenous fish species in a given size stream or river will decline with increasing environmental disturbance (Karr 1981; Karr *et al.* 1986). The number of species is also strongly affected by the drainage areas, especially headwater streams. Two sites having identical species diversity may have different scores because of a drainage area difference of only a few square miles. Site FR-0.7 and BR-0.7 had 15-16 species during both sampling events. However, Site FR-0.7 earned a metric score of five compared to the score of four at site BR-0.7. The drainage area was the only observable difference between the two sites for this metric. Sites ER-1.9 and BR-0.1 both had IBI metric scores of three for the number of indigenous species.

Another slight difference between sampling sites was in the number of darter species encountered at Hocking River tributary sites. Darters are insectivores that depend on specific habitats and are sensitive to physical and chemical environmental disturbances. Although a large diversity of darters are not found in Ohio headwater streams, a few species are typically encountered in headwater streams with good water quality. The most common darter species encountered at tributary sampling sites were the Central Johnny Darter (*Etheostoma nigrum*) and the Barred Fantail (*Etheostoma flabellare*). At Site FR-0.7, four darter species were encountered which translated into a score of five compared to a score of three at Sites ER-1.9

and BR-0.7. The downstream Baldwin Run Site (BR-0.1) scored slightly lower than the upstream site with a metric score of two.

#### 4.1.3 ICI Scores

The Invertebrate Community Index (ICI) evaluates macroinvertebrate communities using a series of metrics derived from IBI scoring techniques. The sum of these metric scores is the final ICI score. Appendix F contains the hand-scored ICI sheets from this study.

The Hocking River Tributaries produced a wide range of ICI scores. These are presented in Figure 4.1. The Ewing Run Site (ER-1.9) had the healthiest macroinvertebrate community resulting in an ICI score of 36 which is considered "good" when compared to OEPA biocriteria. Site FR-0.7 was also in the "good" category with an ICI score of 34. Baldwin Run ICI scores ranged from 10 ("poor") at Site BR-0.7 to a score of 28 ("fair") at Site BR-0.1.

Mayflies are an important component of relatively undisturbed streams macroinvertebrate fauna. As a group, they are decidedly pollution sensitive and are often first to disappear with the onset of perturbation (OEPA, 1987.). Metric Two of the ICI evaluates the number of mayfly taxa encountered at a particular sampling site. Site ER-1.9 scored a two for this metric compared to the score of zero found at all other Hocking River tributary sampling sites.

The ICI score for Site BR-0.7 was greatly influenced by the absence of caddisflies. Caddisflies are often a predominant component of the macroinvertebrate fauna in larger, relatively unimpacted Ohio streams and rivers. Though tending to be more pollution tolerant as a group than mayflies, they display a wide range of tolerance. However, few tolerate heavy pollutional stress and, as such, can be good indicators of environmental conditions (OEPA, 1987.). The absence of caddisflies at Site BR-0.7 affected three different ICI metric scores. This site received a metric score of zero for the number of caddisfly metric (Metric Three) and the percent composition of caddisfly metric (Metric Six). All other sampling sites received a metric score of 6 for both of these metrics. The number of caddisflies also affected the qualitative EPT taxa metric (Metric Ten) for Site BR-0.7 with a score of zero compared to the

metric scores of six, four, and two at Sites ER-1.9, FR-0.7, and BR-0.1, respectively.

#### 4.1.4 In-field Chemistry

The results of the in-field chemistry parameters measured at each of the tributary sites indicate that stream conditions are within ranges conducive to aquatic life. No discernable trends or patterns were noted (Table 3.4).

### 4.2 *Hocking River*

#### 4.2.1 QHEI Scores

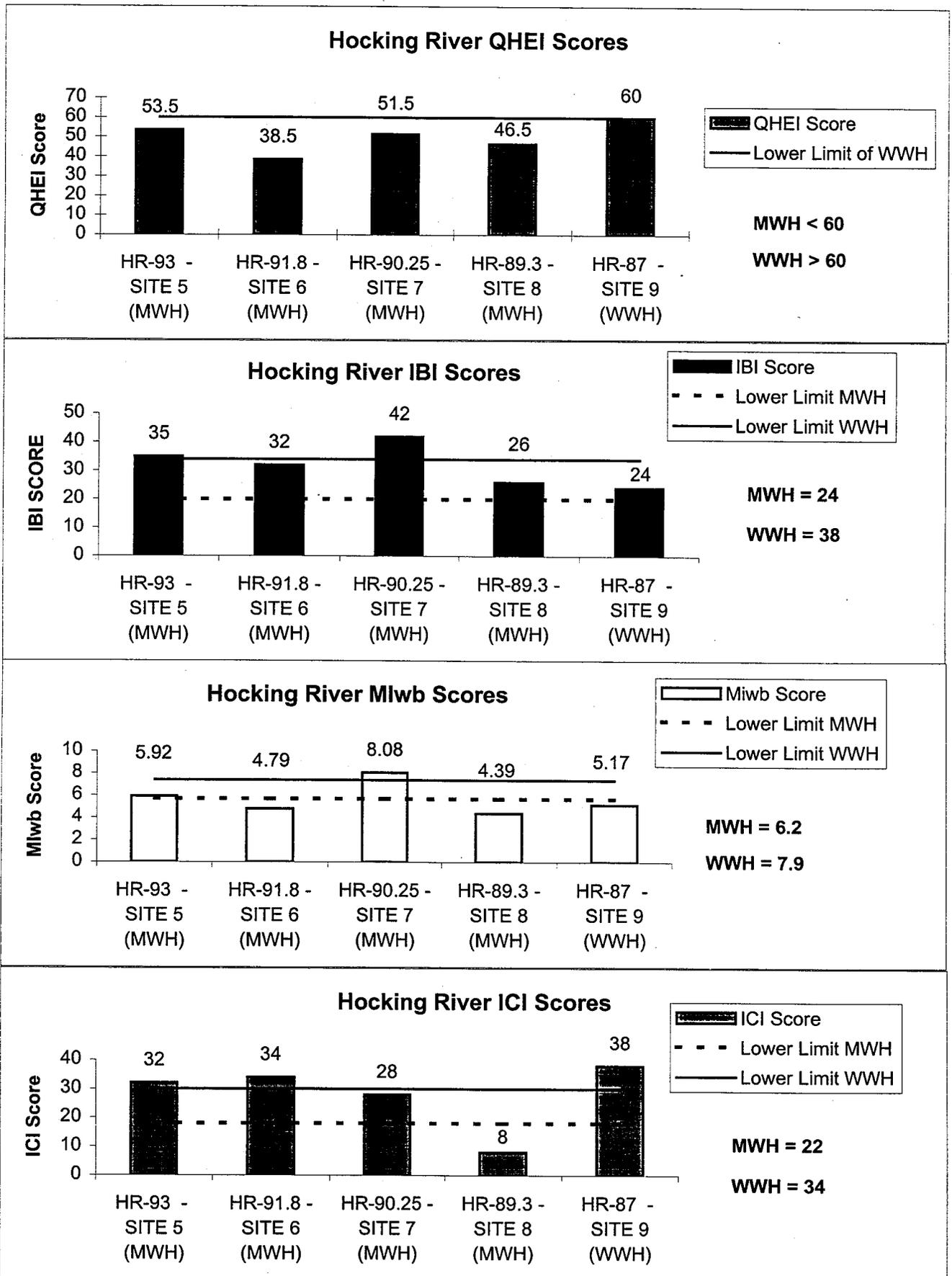
All Hocking River habitats are similar and indicate that habitat in the mainstem Hocking River is conducive to supporting MWH criteria. The river is heavily channelized by agricultural activities before it enters the city limits where it has been altered to support urban land uses. Scores range from 38.5 at Site HR-91.8 to 60 at Site HR-87. Sites HR-93, HR-90.25, and HR-89.3 had similar habitats with QHEI scores of 53.5, 51.5, and 45.5, respectively. QHEI scores and a summary of biological data for the Hocking River Sites are presented graphically in Figure 4.2.

Habitat differences were most apparent at Site HR-87 when compared to other sampling sites. This sampling site is located outside the city limits in an area where sand and gravel operations have occurred recently. Instream cover available to fish communities is moderate and is reflected in the metric score of 11.5 when compared to Sites HR-93 (8), HR-91.8 (8), HR-89.3 (6), and HR-87 (9). Site HR-87 also has higher metric scores for channel morphology and pool quality. Habitat is slightly better at this site but other factors such as the temporary ford at this site may limit attainment of the designated WWH criteria..

#### 4.2.2 IBI and MIwb Scores

The upstream reference site for the Hocking River (HR-93) had an IBI score of 35, which is in the "marginally good" range and an MIwb score of 5.92, which is in the "fair" category (Figure 4.2). Both are representative of MWH conditions. IBI and MIwb scores decreased

Figure 4.2 Biological Data for Hocking River



MWH = Modified Warmwater Habitat  
 WWH = Warmwater Habitat

SOURCE: EnviroScience Inc.  
 Project No. 4980102-00

slightly at the downstream Site HR-91.8 with an IBI score of 32 which is in the “fair” range, and an MIwb score of 4.79 which is in the “poor” category. Fish populations then increased at Site HR-90.25 with an IBI score of 42 and a MIwb score of 8.08. Both are considered to be in the “good” range when compared to water quality standards for MWH. Longitudinally, IBI and MIwb scores decreased at Sites HR-89.3 and HR-87. Site HR-89.3 had an IBI score of 26 which is in the “poor” category and an MIwb score of 4.39 which is in the “very poor” category. Site HR-87 had an IBI and MIwb score in the “poor” category with scores of 24 and 5.17, respectively.

Notable differences in IBI metric values between sites are seen in number of sucker species (metric four), number of intolerant species (metric five), percent omnivores (metric seven), and number of individuals (metric ten).

Most stream reaches of the Hocking River are dominated by sucker species. The general intolerance of most sucker species to habitat and water quality degradation results in a metric with a sensitivity at the high end of environmental quality (OEPA, 1987.). Based on life history information, suckers have one of the longest life spans when compared to other fish species of the Hocking River. This makes them ideal indicators of water quality and long term effects of stream degradation. The two most common sucker species encountered in the Hocking River were the Common White Sucker (*Catostomus commersoni*) and the Northern Hog Sucker (*Hypentelium nigricans*).

Most sampling sites scored a three out of a possible five points for the number of sucker species metric. Exceptions to this were encountered at Sites HR-91.8 and HR-87. During the first round of electrofishing at Site HR-91.8, the EnviroScience field team collected Golden Redhorse (*Moxostoma erythrurum*) and Quillback Carpsucker (*Carpiodes cyprinus*) in addition to the Common White Sucker (*C. commersoni*) and Northern Hog Sucker (*H. nigricans*). This produced a metric score of five out of a possible five points for this metric. In contrast, Site HR-87 scored a one out of a possible five points in both sampling rounds. Although both the White Sucker (*C. commersoni*) and Northern Hog Sucker (*H. nigricans*) were encountered at this site, the larger drainage area (97.5 square miles) lowered the metric score.

Three intolerant species were encountered at Hocking River study sites. These included the Eastern Banded Darter (*Etheostoma zonale*), Stonecat Madtom (*Noturus flavus*), and the Silver Shiner (*Notropis photogenis*). The Eastern Banded Darter (*E. zonale*) was the only one collected at most sampling sites and this resulted in a metric score of one out of five possible points for this metric. The exception was at Site HR-90.25 which had all three intolerant species in both rounds of sampling. This was reflected in a higher metric score of three of five possible points.

Omnivores have the ability to exploit a wide variety of food sources. High percentages of omnivores (metric seven) are often associated with streams with disturbed benthic macroinvertebrate communities. Site HR-90.25 had the lowest percentage of omnivores (8%) and this produced a metric score of five out of a possible five points for both sampling rounds. Omnivores contributed 27% of the population at Site HR-93 which resulted in a metric score of 3 out of five possible points. Sites HR-91.8, HR-89.3, and HR-87 all had metric scores of one (out of five possible points), with percent contributions of 41%, 56%, and 44%, respectively.

Fish abundance is closely related to stream degradation in small to medium sized streams. Streams impacted by pollution sources commonly display lower diversity and fish abundance. All Hocking River sampling sites scored a one out of five possible points for this metric except for Sites HR-93 and HR-90.25. Sites HR-93 and HR-90.25 both scored a three of five possible points with fish abundance of 275/.3 km and 554/.3 km.

Hocking River MIwb scores tended to follow the same trend as IBI scores. Longitudinally, MIwb scores started in the "fair" range with a score of 5.92 at Site HR-93. A slight decrease was noted at Site HR-91.8 with a score of 4.79 which is considered to be in the "poor" range. Scores then increased into the "good" range at Site HR-90.25 with a MIwb score of 8.08. MIwb scores then decreased significantly to the "very poor" range with a score of 4.39 at Site HR-89.3. A slight improvement was noted at Site HR-87 with a score of 5.17 which is considered to be in the "poor" range.

Two IBI metrics heavily influenced the MIwb scores for the Hocking River. The percentage of

tolerant species has a direct relationship with the MIwb calculation. When calculating a MIwb score, fish that are considered tolerant (such as the Common Carp (*Cyprinus carpio*) and Common White Sucker (*C. commersoni*)) are removed as required by the MIwb formula. The higher the abundance of tolerant species, the lower the MIwb score and the lower the metric score for the tolerant species metric (metric six). It is noted that the same sites that scored comparatively well for the percentage of tolerant species had relatively high MIwb scores.

The same trend is noted when comparing MIwb scores to the total number of individuals metric (metric ten) of the IBI. This is because tolerant individuals are discounted when calculating the relative abundance of fish per .3 kilometers and the calculation of the MIwb.

Overall, IBI and MIwb scores are closely related to QHEI scores (Figure 4.2). Habitat scores decreased slightly at Site HR-91.8 as do IBI and MIwb scores. Habitat quality increased at Site HR-90.25, and so did the fish metric scores. As the habitat decreased in quality at Site HR-89.3, the IBI and MIwb scores also decreased. However, when the habitat score increased close to WWH criteria at Site HR-87, IBI scores decreased and the MIwb score only increased slightly. These changes may have been related to the local effects of the ford illegally installed in this reach.

#### 4.2.3 ICI Scores

Overall, all Hocking River sampling sites, except one, have scores that are in attainment of MWH criteria. Site HR-93 had an ICI score of 32 which is considered to be in the "marginally good" range. Macroinvertebrate communities increased in quality at Site HR-91.8 with an ICI score of 34 which is considered to be in the "good" category. ICI scores decreased into the "fair" range with a score of 28 at Site HR-90.25. A significant decrease in ICI scores is noted at Site HR-89.3 which had a score of eight which falls into the "poor" range. Scores significantly increased at Site HR-87 with a score 38 which is considered "good" when compared to OEPA biocriteria.

ICI metric scores varied between sites with the most notable differences in the two mayfly

related metrics (metrics two and five), the two caddisfly related metrics (metrics three and six), and the percent other diptera and non-insects (metric eight).

Mayflies are a very good indicator of even slight environmental changes. They are very sensitive to minor pollution influences and are often the first to disappear with the onset of stream degradation. Two metrics are directly affected by the number of mayflies encountered in a sampling site. The number of mayfly taxa at a sampling site (metric two) varied between sampling sites. Sites HR-93, HR-91.8, and HR-90.25 all had six different species of mayflies in Hester-Dendy collections. This is reflected in the ICI metric scores of four of six possible points for the number of mayfly taxa metric (metric two). Mayfly composition also influenced the metric score for percent mayflies as represented in the two of six possible points scored for Sites HR-93, HR-91.8, and HR-90.25 for this metric. Site HR-89.3 did not have any mayfly taxa and resulted in a score of zero for both the number of taxa metric and the percent mayfly metric. In comparison, Site HR-87 had two mayfly taxa and scored a zero for the number of mayfly taxa metric and a two for the percent mayfly composition metric.

Caddisfly larvae are not as sensitive as mayflies to pollutional changes but are equally important as biological indicators. Caddisfly populations are also directly related to two ICI metrics. Metric three considers the number of caddisfly taxa and metric six evaluates the percentage of caddisflies in the macroinvertebrate community. Hocking River sampling sites had between zero to three species of caddisflies and showed little variation between sampling sites. All sampling sites scored a four of six possible points for the number of caddisfly taxa metric except Site HR-89.3. Caddisflies were not encountered at this site which resulted in a metric score of zero. Caddisflies contributed a relatively small percent composition to communities at Sites HR-93, HR-91.8, and HR-90.25 which resulted in ICI metric scores of 2 of six possible points for this metric. Caddisflies contributed 17% of the population at Site HR-87 which was reflected in the relatively high metric score of six for this metric. In comparison, Site HR-89.3 which did not have caddisflies in the collection, scored a zero for this metric.

The percent other diptera and non-insect metric (metric eight) is one of two negative metrics of the ICI. Taxa in these groups of macroinvertebrates, though often present as part of a healthy stream community, are those that generally tend to become predominant under adverse water

quality conditions (OEPA, 1987). On average, other diptera and non-insects contributed 75% of the macroinvertebrate communities at Sites HR-93, HR-91.8, HR-90.25, and HR-89.3. This caused the low score of zero for all of these sampling sites for this metric. In comparison, other diptera and non-insects only contributed 37% of the population at Site HR-87 which resulted in a six of six possible points for this ICI metric.

#### 4.2.4 In-field Chemistry

The results of the in-field chemistry monitoring at each of the Hocking River sites indicate that water quality is generally favorable for supporting MWH communities. Although within water quality standards, specific conductance was considerably higher at Site HR-87 compared to other sites. During the first round of fish sampling specific conductance was 879  $\mu\text{mhos}$  compared to an average of 592  $\mu\text{mhos}$  at upstream sites (Table 3.8). Specific conductance during the second round of fish sampling indicated an even greater difference between sampling sites. The specific conductance at Site HR-87 was 1,750  $\mu\text{mhos}$  compared to the average of 643  $\mu\text{mhos}$  at upstream sites. Although this may not be considered harmful to aquatic communities, the difference in specific conductance is an indicator that the chemical make-up of the Hocking River may be different in downstream reaches.

## 5.0 CONCLUSION

In total, nine sites were sampled for habitat evaluations, fish populations, and benthic macroinvertebrates. Table 5.1 details QHEI, IBI, MIwb, and ICI scores, their narrative range, and attainment status. Attainment status of Hocking River tributary sites was determined by comparing scores to biocriteria for WWH. All Hocking River sampling sites were compared to WWH narrative ranges but evaluated against appropriate scores necessary for attainment.

QHEI scores for the tributary sites were relatively low compared to the standard of 60 used for WWH fish populations. This may be attributed to their status as headwater streams which

often do not have the water volume to create deep pools and well defined riffles. The streams also flow through urban and residential areas which have been altered to facilitate human activities. For this reason, instream cover and some channelization has occurred throughout the sampling sites.

Fish populations were relatively healthy in the tributaries with all sites having IBI scores in the "marginally good" or better range. Fish populations consisted primarily of pioneering and headwater species and had relatively high fish abundance for headwater streams.

**Table 5.1 Comparative Results for Hocking River Tributary / Mainstem Sampling Sites**

Site	QHEI	IBI	MIwb	ICI	Attainment Status
ER-1.9	67	35 "marginally good"	N/A	36 "marginally good"	FULL Attainment
FR-0.7	56	43 "good"	N/A	34 "good"	FULL Attainment
BR-0.7	42	40 "good"	N/A	10 "poor"	NON Attainment
BR-0.1	47.5	35 "marginally good"	N/A	28 "fair"	PARTIAL Attainment
HR-93	53.5	35 "marginally good"	5.92 "fair"	32 "marginally good"	FULL Attainment*
HR-91.8	38.5	32 "fair"	4.79 "poor"	34 "good"	PARTIAL Attainment*
HR-90.25	51.5	42 "good"	8.08 "good"	28 "fair"	FULL Attainment*
HR-89.3	45.5	26 "poor"	4.39 "poor"	8 "poor"	NON Attainment*
HR-87	60	24 "poor"	5.17 "poor"	38 "good"	NON Attainment

\*Attainment is based on Modified Warm Water Habitat (MWH)

ICI scores for the Hocking River tributary sites were variable ranging from "poor" at Site BR-0.7 to "good" at Site FR-0.7. Since all fish scores were in the "marginally good" range or better, FULL attainment status was dependent on ICI scores.

Overall, two of the four tributary sampling sites were in FULL attainment of WWH criteria established by OEPA. Sites in FULL attainment included ER-1.9 and FR-0.7. Baldwin Run

was in NON attainment at the upstream sampling site and in PARTIAL attainment at the downstream site.

Hocking River QHEI scores were indicative of MWH ranging from 38.5 at Site HR-91.8 to 60 at Site HR-87. Generally, most Hocking River habitats have been altered by channelization for agricultural and urban land uses.

Hocking River fish collections resulted in IBI and MIwb scores which varied between sampling sites. Upstream collections at Site HR-93 resulted in a "marginally good" IBI score and a "fair" MIwb score. As the river flows into the city limits of Lancaster and behind a shopping center at Site HR-91.8, the IBI score decreased slightly into the "fair" range and a "poor" MIwb score. Further downstream the IBI and MIwb score first increased into the "good" range and then decreased into the "poor" range.

All Hocking River sampling sites, except one, had ICI scores that were in attainment of MWH criteria. A significant decrease in ICI scores was noted at Site HR-89.3 which had an score of 8 which falls into the "poor" range. Scores significantly increase further downstream at Site HR-87, falling into the "good" range.

Overall, two of the Hocking River sampling sites, HR-93 and HR-90.25, were in FULL attainment of MWH criteria. Site HR-91.8 was in PARTIAL attainment while Sites HR-89.3 and HR-87 were in NON attainment of MWH criteria.

## 6.0 ACRONYMS AND TERMS

DELT: DELT Anomalies- the presence of externally visible skin or subcutaneous disorders in the sampled fish community; included are, Deformities, Eroded Fins, Lesions and Ulcers, and Tumors

EPT: Ephemeroptera, Plecoptera, Trichoptera- commonly called mayflies, stoneflies, and caddisflies; these are collected in conjunction with the artificial substrates and are a measure of the quality of the macroinvertebrate communities in the naturally occurring habitats

IBI: Index of Biotic Integrity- the index most commonly used by the Ohio EPA to evaluate the fish community of a stream (used in conjunction with the MIWB for wading and boat electrofishing sites only)

ICI: Invertebrate Community Index- the index most commonly used by the Ohio EPA to evaluate the macroinvertebrate assemblage of a stream

MIWB: Modified Index of well being- index for the fish community of a stream used in conjunction with the IBI

QHEI: Qualitative Habitat Evaluation Index- index designed as a measure of macro-habitat quality that generally corresponds to those physical factors that affect fish communities and are generally important to other aquatic life

RM: River Mile- standard measurement of stream length, beginning at the mouth or confluence and ending at the headwaters

WQS: Ohio Water Quality Standards- designated uses and chemical, physical, and biological criteria designed to represent measurable properties of the environment consistent with the goals of a particular use designation; In reference to resource water management, aquatic life use criteria most often control the protection and restoration requirements.

WWH: Warmwater Habitat- the aquatic life use designation developed by the Ohio EPA to define the "typical" warmwater assemblage of Aquatic Organisms for Ohio rivers and streams; this use represents the principal restoration target for the majority of resource water management efforts in Ohio; Biological Criteria are stratified across five ecoregions for the WWH use designation.

Benthic Macroinvertebrates- animals without a backbone that are large enough to be seen with an unaided eye and can be retained in a U.S. Standard No. 30 sieve (28 meshes per inch) and live at least part of their life cycles within or on the available substrates in a body of water (e.g. snails, clams, worms, and adult and larval insects).

Diversity- the variety of species within a community

Ecoregion- a relatively homogeneous geographical area where several key geographic variables coincide; The variables define the general characteristics of the watersheds within the ecoregion

Hester-Dendy Sampler- the Modified Hester-Dendy multiple-plate artificial substrate sampler is the principle device used by the Ohio EPA for the quantitative collection of benthic macroinvertebrates.

Insectivore- metric eight of the IBI, species which feed primarily on insects; In reference to aquatic habitats, the insectivores are the fish that subsist on the adult and larval insects in the benthic macroinvertebrate community.

Lithophilic Spawners- metric eleven of the IBI, fish that require clean gravel and/or cobble for successful reproduction since the eggs develop in the interstitial spaces of the substrate

Omnivores- metric seven of the IBI, species which feed indiscriminately on available food sources; In reference to aquatic habitats, the omnivores are fish which are consistently generalist feeders throughout their existence.

Taxa- hierarchical categories of organisms containing one or more group of organisms

Top Carnivores- metric nine of the IBI, fish species which feed primarily on other vertebrates or crayfish

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