

## **Fish Community Assessment**

### **Introduction**

In 2006, three electrofishing passes were conducted on the Cuyahoga River upstream and downstream of the Southerly WWTC and upstream and downstream of Big Creek. The purpose of the surveys was to evaluate the fish community at these locations and assign a characterization of the overall fish community health using indices developed by the Ohio Environmental Protection Agency (Ohio EPA).

Figure 1 identifies the locations of the four sampling reaches that were surveyed. The most upstream reach was located at river mile (RM) 10.75 and is upstream of the river's confluence with the Southerly Wastewater Treatment Center (WWTC) effluent channel. The second zone that was sampled was at RM 10.10, which is downstream of the river's confluence with the Southerly WWTC effluent channel. Electrofishing was also conducted upstream and downstream of the confluence with Big Creek at RM 7.75 and RM 7.00, respectively.

### **Methods**

Electroshocking was accomplished by utilizing the Northeast Ohio Regional Sewer District (NEORS) 17' Coffelt aluminum electrofishing boat. Boat electrofishing consists of shocking all habitat types within a sampling zone that is 0.5 kilometers in length, while moving from upstream to downstream. Electrofishing was completed on the river under normal flow conditions. The average daily flows recorded by the United States Geological Survey gage station in Independence for each of the three passes were 321, 326 and 383 cubic feet per second, respectively.

Fish collected during the surveys were identified, weighed, and examined for the presence of DELT anomalies (deformities, eroded fins, lesions and tumors). All fish were then released to the waters from which they were collected, except for vouchers and those that could not be easily identified in the field. A detailed description of the sampling methods utilized in the fish surveys can be found in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life Volume II* (1987, Updated January 1, 1988) and *Volume III* (1989).

In addition to fish sampling, a Qualitative Habitat Evaluation Index (QHEI) score was also determined for each of the four electrofishing zones on the Cuyahoga River. The QHEI, developed by Ohio EPA, is used to assess the aquatic habitat conditions at each sample location by providing an evaluation of the physical components of a stream. The index is based on six metrics: stream substrate, instream cover, stream channel morphology, riparian and bank condition, pool and riffle quality and stream gradient. These metrics describe the physical attributes of a stream and may be important in explaining why fish

species are present or absent. A more detailed description of the QHEI can be found in Ohio EPA's *The Qualitative Habitat Evaluation Index (QHEI): Rationale, Methods, and Application* (1989). The QHEI scores for the four sites that were sampled are listed in Table 1.

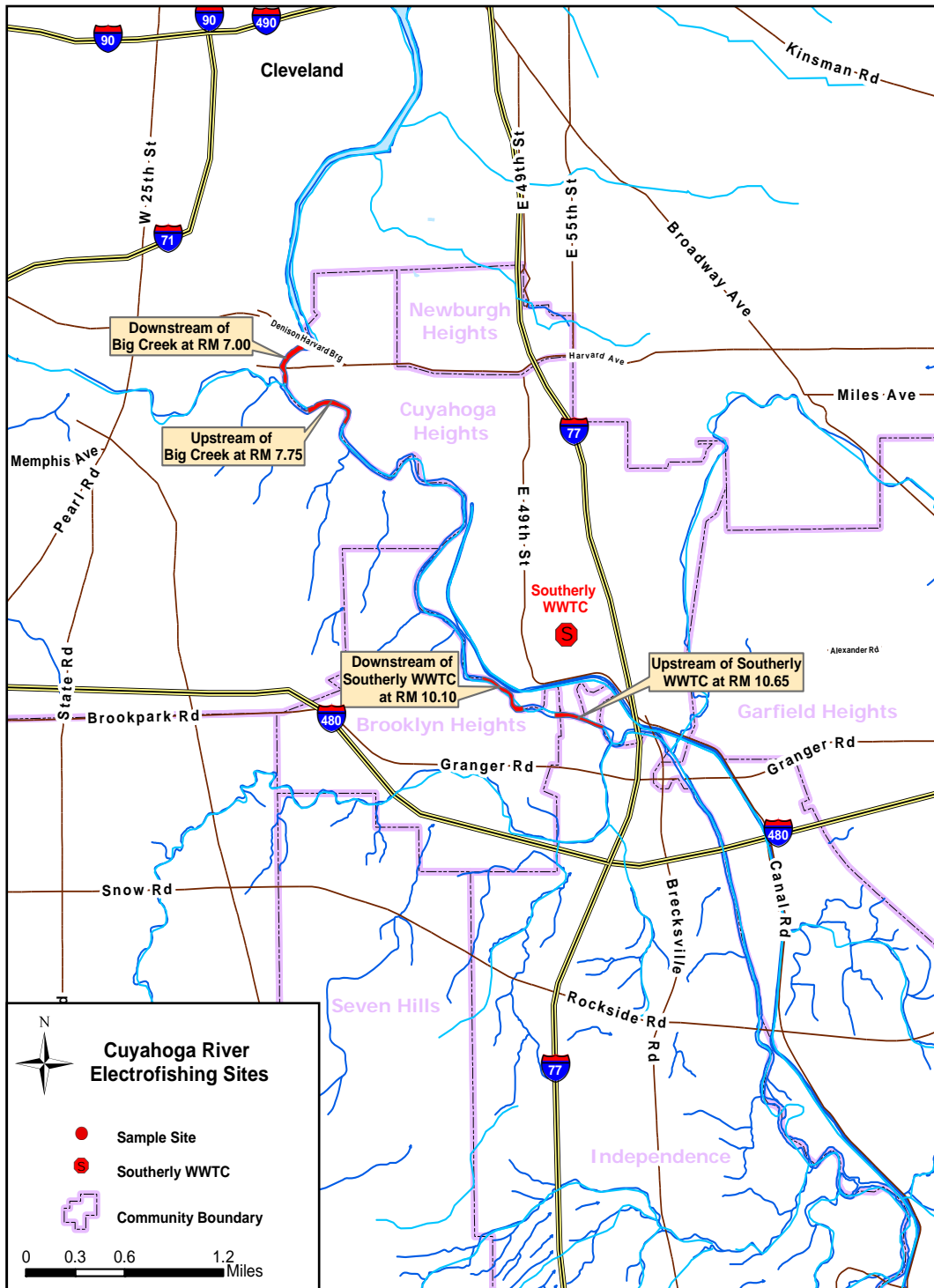


Figure 1. NEORSD Cuyahoga River Electrofishing Sites

Table 1. Cuyahoga River, 1997-2006 Qualitative Habitat Evaluation Index Scores							
Cuyahoga River	1997	1998	1999	2001	2003	2004	2006
Upstream of Southerly WWTC	73(G)	69(G)	77(E)	75(E)	76(E)	70(G)	75(E)
Downstream of Southerly WWTC	64(G)	66(G)	67(G)	69(G)	67(G)	68(G)	72(G)
Upstream of Big Creek	--	--	--	65(G)	--	--	57(F)
Downstream of Big Creek	64(G)	66(G)	66(G)	67(G)	--	--	66(G)
E - Excellent      G – Good      F- Fair							

The electrofishing results for each pass were compiled and utilized to evaluate fish community health through the application of two Ohio EPA indices, the Index of Biotic Integrity (IBI) and the Modified Index of Well Being (MIwb). The IBI incorporates 12 community metrics representing structural and functional attributes. The structural attributes are based upon fish community aspects such as fish numbers and diversity. Functional attributes are based upon fish community aspects such as feeding strategies, environmental tolerances and disease symptoms. These metrics are individually scored by comparing the data collected at the survey site with values expected at reference sites located in a similar geographical region. The maximum possible IBI score is 60 and the minimum possible score is 12. The summation of the 12 individual metrics scores provides a single-value IBI score, which corresponds to a narrative rating of *Exceptional, Good, Marginally Good, Fair, Poor or Very Poor*.

The Modified Index of Well Being (MIwb) incorporates four fish community measures: numbers of individuals, biomass, and the Shannon Diversity Index (H) based on numbers and weight of fish. Unlike the IBI score, the MIwb is a result of a mathematical calculation based upon the formula:

$$MIwb = 0.5 \ln N + 0.5 \ln B + \bar{H}(No.) + \bar{H}(Wt.)$$

where:

- $N =$  Relative numbers of all species excluding species designated as highly tolerant, hybrids, or exotics
- $B =$  Relative weights of all species excluding species designated as highly tolerant, hybrids, or exotics

$\bar{H}(\text{No.}) =$  Shannon Diversity Index based on numbers

$\bar{H}(\text{Wt.}) =$  Shannon Diversity Index based on weight

Shannon Diversity Index

$$\bar{H} = - \sum \left[ \left( \frac{n_i}{N} \right) \log_e \left( \frac{n_i}{N} \right) \right]$$

where:

$n_i =$  Relative numbers or weight of species

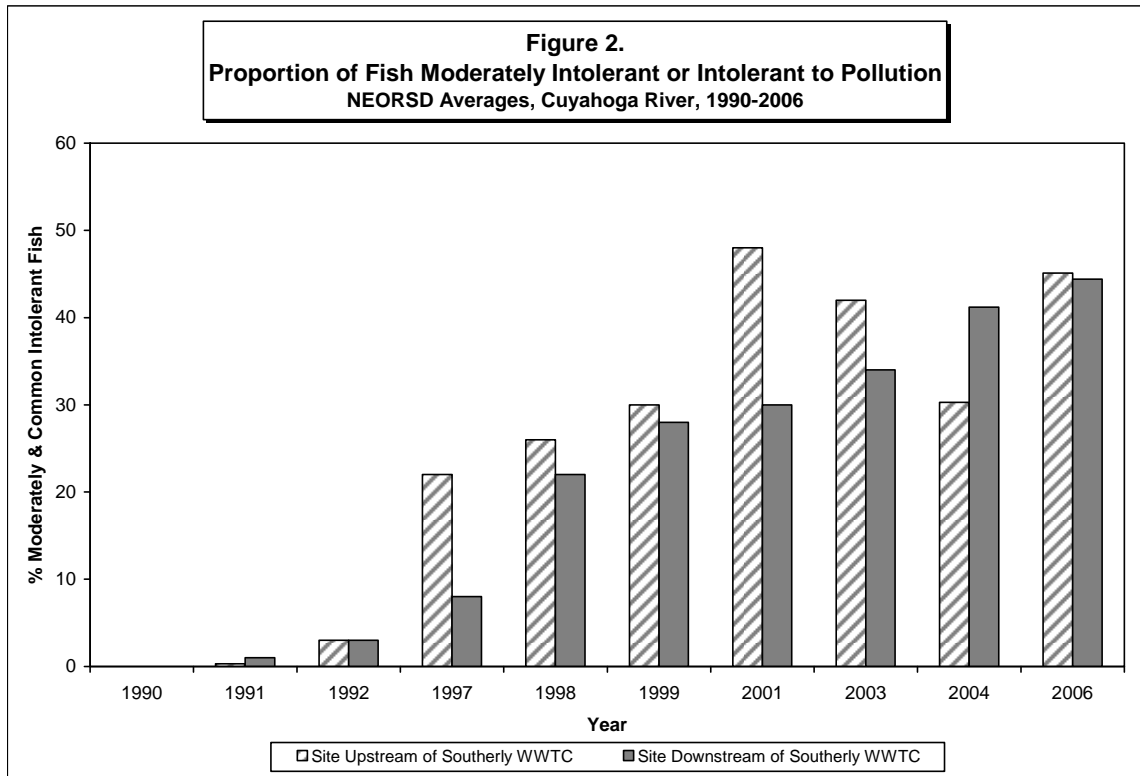
$N =$  Total number or weight of the sample

### **Results and Discussion**

Data tables located in Appendix A list the species, numbers, weights, pollution tolerances and incidence of DELT anomalies for fish collected during the three electrofishing passes at each site.

In 2006, 561 fish representing 30 different species were collected on the Cuyahoga River at the site upstream from the Southerly WWTC effluent. Also, 511 fish representing 28 different species were collected on the Cuyahoga River at the site downstream from the Southerly WWTC effluent. The predominant fish species collected at both sites was the northern hog sucker, comprising 35 percent and 15 percent of the total fish collected, respectively. Of the total fish collected both upstream and downstream from the Southerly WWTC effluent, 45 percent and 44 percent were designated “moderately intolerant” or “common intolerant” to pollution, respectively. This continues the increase in these categories of fish over the last fifteen years (Figure 2).

Additionally encountered in 2006 were five species of fish that were previously never collected through NEORSD sampling. These species included the brook silverside, flathead catfish, silverjaw minnow, rainbow darter and mimic shiner. The brook silverside and rainbow darter are designated as being “moderately intolerant” to pollution, while the mimic shiner is designated “common intolerant” and is found in streams of highest quality (Ohio EPA’s *Biological Criteria for the protection of Aquatic Life Volumes II* (1987, Updated January 11, 1988) and III (1989)).



In 2006, 298 fish representing 23 different species were collected on the Cuyahoga River at the site upstream from Big Creek. Also, 574 fish from 24 different species were collected on the river at the site downstream from Big Creek. The predominant species collected at the upstream and downstream sites were the common carp and emerald shiner, respectively. Of the total fish collected near Big Creek, 21 percent upstream and 18 percent downstream were designated “moderately intolerant” to pollution (Figure 3). The silver redhorse, brook silverside, spotted sucker and lake trout were four species of fish collected for the first time during NEORSD sampling. The silver redhorse and brook silverside are fish species designated as being “moderately intolerant” to pollution (Ohio EPA’s *Biological Criteria for the protection of Aquatic Life Volumes II* (1987, Updated January 11, 1988) and III (1989)).

Cuyahoga River average IBI and MIwb scores from 1990 through 2006 are listed in Tables 2 and 3 and shown in Figures 4 through 7. The average IBI fish community score on the Cuyahoga River site upstream from the Southerly WWTC effluent in 2006 was 39 (*Marginally Good*). This fell within the range of nonsignificant departure ( $\leq 4$  IBI units) from the applicable biological criterion of 40, effectively attaining the criterion. The average MIwb score for 2006 at the site upstream from the Southerly WWTC effluent was 8.8 (*Good*), above the applicable MIwb biological criterion of 8.7.

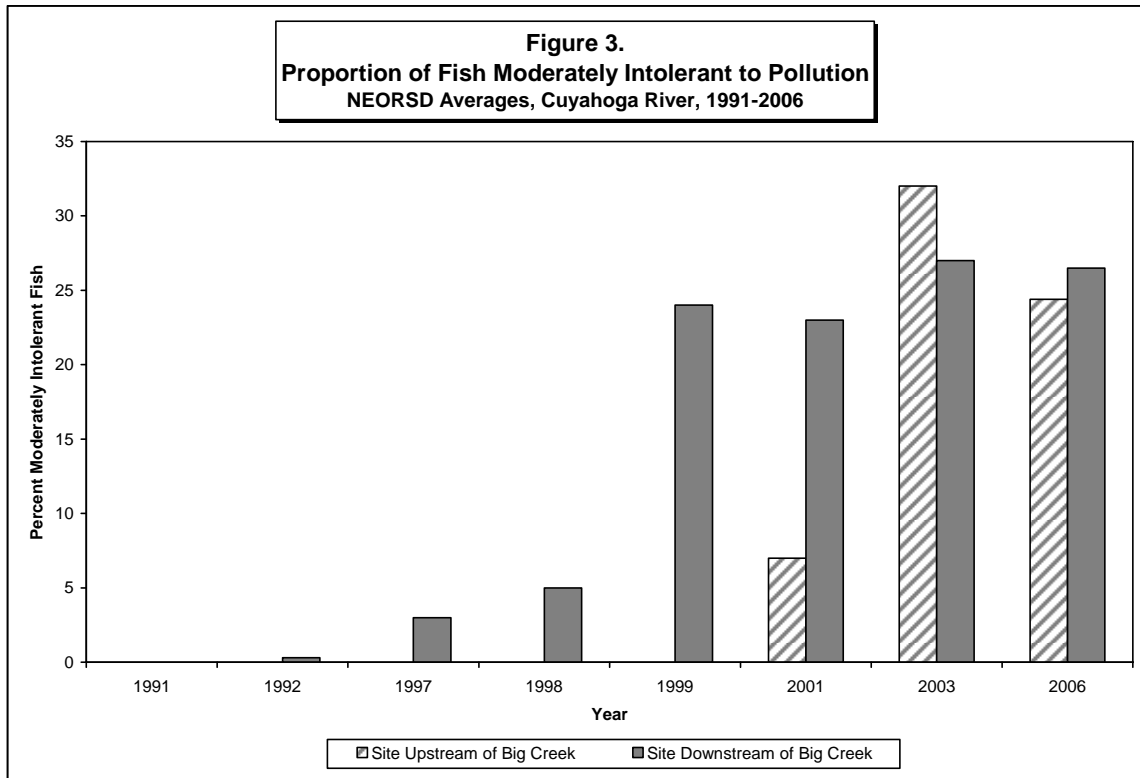


Table 2. Cuyahoga River, 1990-2006  
Average Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb) Scores

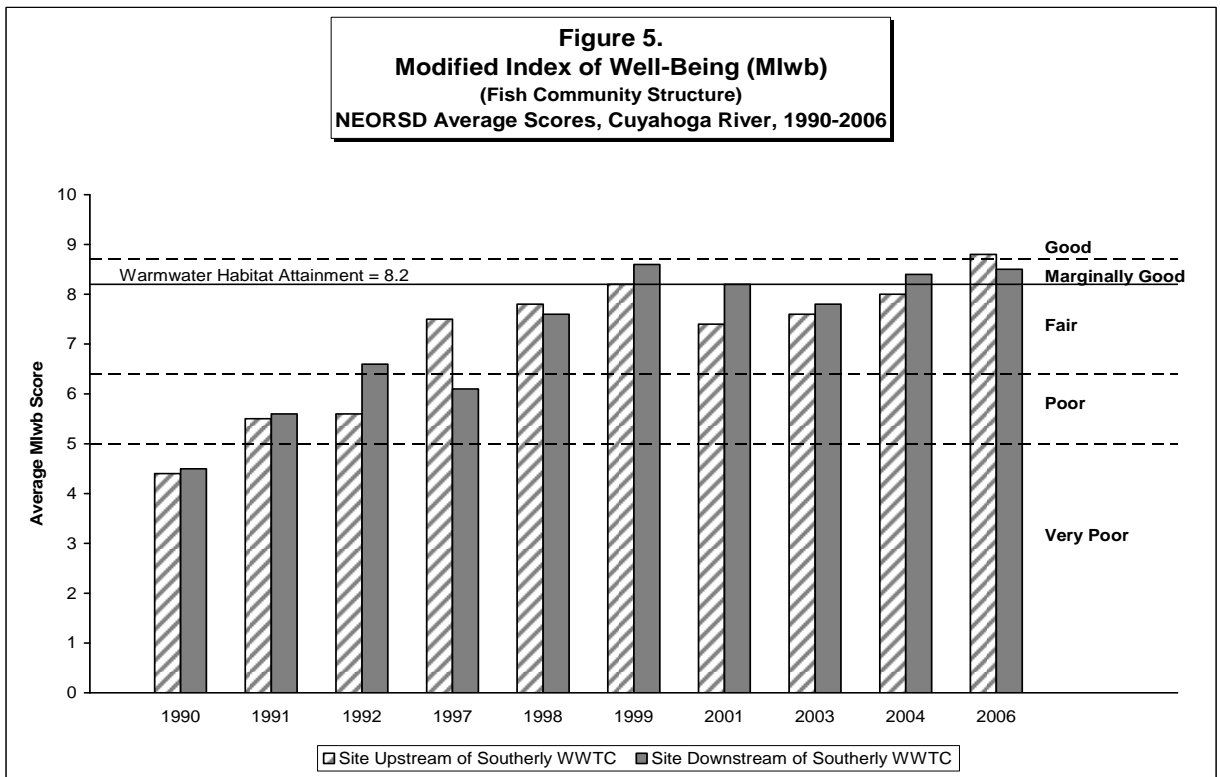
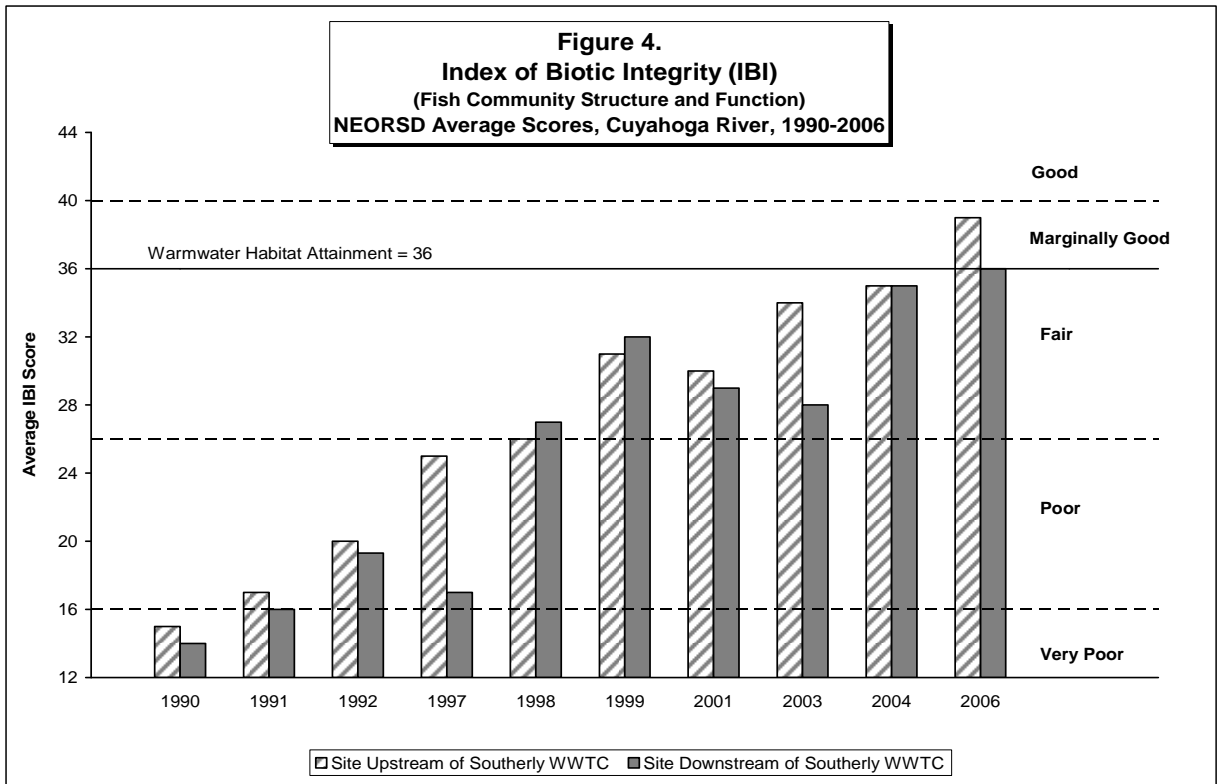
Site Upstream of Southerly WWTP			Site Downstream of Southerly WWTP			Site Upstream of Big Creek			Site Downstream of Big Creek		
Date	IBI	MIwb	Date	IBI	MIwb	Date	IBI	MIwb	Date	IBI	MIwb
1990	15	4.4	1990	14	4.5	--	--	--	--	--	--
1991	17	5.5	1991	16	5.6	--	--	--	1991	18	6.1
1992	20	5.6	1992	19	6.6	--	--	--	1992	21	5.8
1997	25	7.5	1997	17	6.1	--	--	--	1997	18	6.1
1998	26	7.8	1998	27	7.6	--	--	--	1998	21	5.5
1999	31	8.2	1999	32	8.6	--	--	--	1999	24	7.0
2001	30	7.4	2001	29	8.2	2001 <sup>^</sup>	18	5.6	2001 <sup>^</sup>	22	6.1
2003	34	7.6	2003	28	7.8	2003	27	6.8	2003	23	7.0
2004	35	8.0	2004	35	8.4	--	--	--	--	--	--
2006*	39	<b>8.8</b>	2006*	36	8.5	2006	30	7.0	2006	32	7.8

**Bold** indicates attainment of applicable biocriteria ( $\geq 40$  IBI units, or  $\geq 8.7$  MIwb units).  
*Italics* indicate nonsignificant departure from applicable biocriteria ( $\leq 4$  IBI units, or  $\leq 0.5$  MIwb units).  
 \* indicates attainment of applicable biocriteria.  
 -- indicates surveys not performed.  
 ^ indicates one electrofishing pass

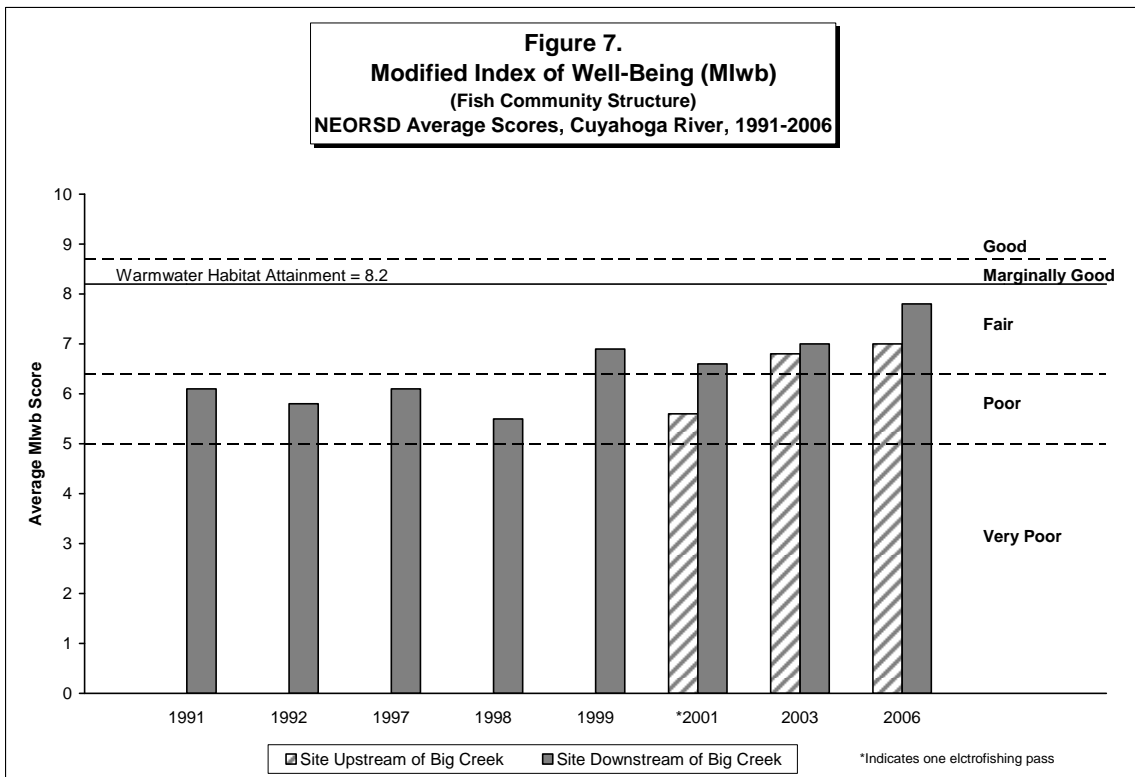
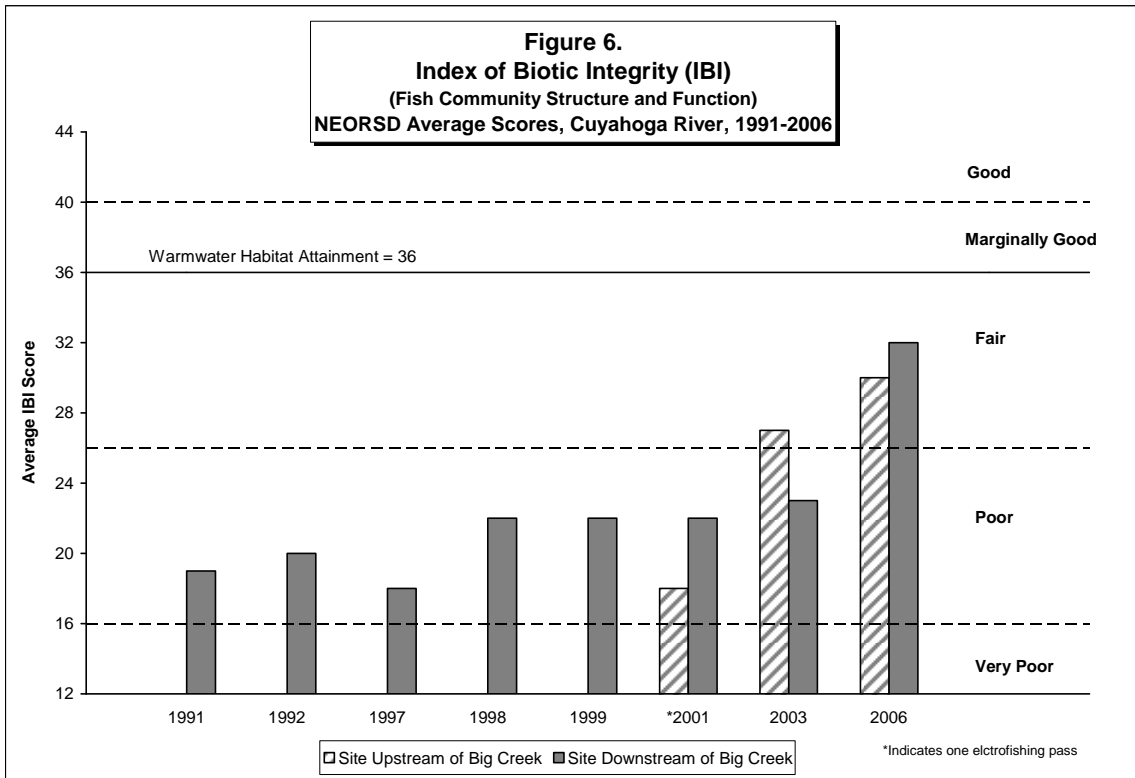
Table 3. Cuyahoga River, 1990-2006  
Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb) Scores

Site Upstream of Southerly WWTC			Site Downstream of Southerly WWTC			Site Upstream of Big Creek			Site Downstream of Big Creek		
Date	IBI	MIwb	Date	IBI	MIwb	Date	IBI	MIwb	Date	IBI	MIwb
08/30/90	16	4.3	08/30/90	18	4.7	--	--	--	--	--	
09/28/90	14	4.6	09/28/90	12	4.4	--	--	--	--	--	
Average	15	4.4	Average	14	4.6	--	--	--	--	--	
06/25/91	12	3.9	06/25/91	14	4.8	--	--	--	06/26/91	16	5.8
08/22/91	16	5.7	08/22/91	16	6.1	--	--	--	08/25/91	18	6.1
09/30/91	22	6.9	09/30/91	18	5.8	--	--	--	10/01/91	20	6.5
Average	17	5.5	Average	16	5.6	--	--	--	Average	18	6.1
07/01/92	18	5.7	07/01/92	22	6.9	--	--	--	07/06/92	22	5.9
09/09/92	22	6.1	09/09/92	18	6.0	--	--	--	--	--	--
10/09/92	20	5.1	10/09/92	18	6.9	--	--	--	10/13/92	20	5.8
Average	20	5.6	Average	19	6.6	--	--	--	Average	21	5.8
09/15/97	26	7.0	09/15/97	12	4.7	--	--	--	09/16/97	16	6.4
10/16/97	24	7.9	10/16/97	22	7.5	--	--	--	10/17/97	20	6.0
Average	25	7.4	Average	17	6.1	--	--	--	Average	18	6.1
08/04/98	24	7.4	08/04/98	26	7.6	--	--	--	08/05/98	18	4.9
09/30/98	28	8.1	09/30/98	28	7.6	--	--	--	10/02/98	24	6.1
Average	26	7.8	Average	27	7.6	--	--	--	Average	21	5.5
06/25/99	32	8.5	06/25/99	30	8.3	--	--	--	06/24/99	16	6.8
08/05/99	30	7.6	08/05/99	34	8.3	--	--	--	07/28/99	24	6.5
09/08/99	32	8.6	09/08/99	30	<b>9.2</b>	--	--	--	09/10/99	32	7.7
Average	31	8.2	Average	32	8.6	--	--	--	Average	24	7.0
07/25/01	26	6.9	07/25/01	32	8.1	07/27/01 <sup>^</sup>	18	5.6	07/27/01 <sup>^</sup>	22	6.1
10/01/01	34	7.9	10/01/01	26	8.2	--	--	--	--	--	--
Average	30	7.4	Average	29	8.2	Average	--	--	Average	--	--
08/25/03	32	8.0	08/25/03	30	7.5	08/29/03	28	6.8	08/29/03	28	7.5
10/09/03	36	7.1	10/09/03	26	8.1	10/09/03	26	6.7	10/09/03	18	6.5
Average	34	7.6	Average	28	7.8	Average	27	6.8	Average	23	7.0
09/07/04	32	8.3	09/07/04*	36	8.5	--	--	--	--	--	--
10/12/04	38	7.7	10/12/04	34	8.3	--	--	--	--	--	--
Average	35	8.0	Average	35	8.4	--	--	--	--	--	--
08/11/06*	<b>40</b>	<b>8.7</b>	08/11/06	34	7.3	08/11/06	30	6.1	08/11/06	34	7.0
09/08/06*	<b>40</b>	<b>8.9</b>	09/08/06*	<b>40</b>	<b>9.0</b>	09/08/06	30	6.8	09/08/06	28	8.1
10/09/06*	38	<b>8.7</b>	10/09/06*	34	<b>9.3</b>	10/09/06	30	8.1	10/09/06	30	8.2
Average*	39	<b>8.8</b>	Average*	36	8.5	Average	30	7.0	Average	31	7.8

**Bold** indicates attainment of applicable biocriteria ( $\geq 40$  IBI units, or  $\geq 8.7$  MIwb units).  
*Italics* indicate nonsignificant departure from applicable biocriteria ( $\leq 4$  IBI units, or  $\leq 0.5$  MIwb units).  
 \* indicates attainment of applicable biocriteria.  
 -- indicates surveys not performed.  
 ^ indicates one electrofishing pass







The average IBI fish community score on the Cuyahoga River at the site downstream from the Southerly WWTC in 2006 was 36 (*Marginally Good*). This

fell within the range of nonsignificant departure ( $\leq 4$  IBI units) from the applicable biological criterion of 40, effectively attaining the criterion. The average MIwb score for 2006 at the site downstream from the Southerly WWTC was 8.5 (*Marginally Good*), falling within the range of nonsignificant departure ( $\leq 0.5$  MIwb units) from the biological criterion of 8.7, also effectively attaining the applicable criterion.

The characteristics of the fish community that scored well at both locations according to the IBI were the proportion of insectivores and the number of sunfish species. The upstream site also had a high percentage of simple lithophils, while the downstream site had a relatively high percentage of top carnivores. For both sites, the metric for the number of intolerant species scored the poorest, although the presence of the mimic shiner at the site downstream of Southerly provides an indication that improvement within this metric may be imminent. Another metric in which both sites have not scored well in the past is the percentage of DELT anomalies. However, only 1.9% and 2.7% of the fish on average in 2006 had some anomaly at the sites upstream and downstream from the Southerly WWTC, respectively, and these percentages are substantially better than past results. In 1991, 9.1% and 5.8% of the fish at the sites upstream and downstream from the Southerly WWTC, respectively, had at least one DELT anomaly.

In 2006, average IBI fish community scores on the Cuyahoga River at the site upstream and the site downstream from Big Creek were 30 (*Fair*) and 31 (*Fair*), respectively. Average MIwb fish community scores on the river at the sites upstream and downstream from Big Creek were 7.0 and 7.8, respectively, both falling into the *Fair* range.

Upstream of Big Creek, the IBI metrics that had the best scores were the number of sucker species and the percentage of top carnivores. The site downstream of Big Creek had only one metric that received a relatively good score, the proportion of fish considered to be tolerant. The metrics that scored poorly at both sites were the number of intolerant species and the proportions of omnivores and round-bodied suckers. The site upstream of Big Creek also scored poorly in the number of individuals and the proportions of tolerant fish, insectivores, and simple lithophils. Similar to the sites near Southerly WWTC, the metric measuring the percentage of fish with DELT anomalies has not scored well in the past at these two sites. However, there has been a substantial reduction in the number of DELT anomalies, with the site downstream of Big Creek having, on average in 2006, 1.5% of the fish with anomalies, compared to 5.3% in 1991. The same comparison could not be made for the site upstream of Big Creek because sampling at that location was not started until more recently.

This is the first year that the Cuyahoga River sites upstream and downstream of Southerly WWTC have been in full attainment, as defined by Ohio EPA, of the applicable biological criteria for warmwater habitat aquatic life use. Historical fish data on the Cuyahoga River have demonstrated the presence of one or two numbers of individual pollution-sensitive species collected in previous years. In contrast, the current data shows that it is now not uncommon to collect seventy or more of these same individuals of pollution-sensitive species in a single electroshocking pass. Based on these findings, it appears that the river may be undergoing a modification or transition stage of fish fauna in response to improved water quality. The fish species complex is changing from one previously dominated by pollution-tolerant species to one comprising species more sensitive to pollution stresses. Some of the new fishes collected, including the flathead catfish, mimic shiner, and silver redhorse, inhabit Lake Erie and are seeking the improving waters of the Cuyahoga River. The result of this new fish assemblage is a healthier community as shown by the IBI and MIwb results.

A total of 16 water chemistry samples were collected from the river. Seven samples each were collected upstream and downstream of Southerly WWTC and 1 sample each was collected upstream and downstream of Big Creek. Results obtained from the water chemistry sampling during the periods that the electrofishing surveys were completed also indicate that the water is cleaner, as there were no water quality exceedances (Appendix B).

Although the sites upstream and downstream of Big Creek are not in attainment of applicable biological criteria for warmwater habitat, the IBI and MIwb scores have increased in recent years. One of the reasons that the scores at these sites are not as high as those near Southerly WWTC, especially at the site upstream of Big Creek, may be the suitability of physical habitat. As seen in Table 1, the QHEI scores at these locations were lower than the two sites further upstream near the Southerly WWTC. Therefore, given the physical habitat conditions, achieving attainment may be more challenging at these sites, even with improving water quality.

The improved water quality in the Cuyahoga River may be the result of many recent endeavors. Upgrades to the Southerly WWTC, including treatment processes for nitrification and dechlorination, and successes in the industrial pretreatment program have resulted in a cleaner effluent to the river. In addition, the construction of the NEORS Mill Creek stormwater storage tunnel has aided in the reduction of the number of combined sewer overflows to Mill Creek, a tributary flowing into the Cuyahoga River upstream of the Southerly WWTC effluent. Further upstream, upgrades to the Akron Wastewater Treatment Plant and the decommissioning of smaller wastewater treatment (package) plants, whose

flows are now conveyed to Southerly WWTC via the NEORSD Cuyahoga Valley Interceptor, have also reduced the amount of pollution entering the river.

### **Conclusion**

Overall, the health of the fish community in the Cuyahoga River has improved substantially over the past sixteen years. This is most likely due to cleaner conditions in the river resulting from pollution reduction projects completed by NEORSD and other communities. While this is true, there are still pollution inputs to the Cuyahoga River that may be impacting the health of the fish community. Continued efforts at reducing pollution impacts are needed to ensure that, in upcoming years, fish community index scores continue to improve and maintain attainment of biological criteria.

Appendix A. 2006 NEORSD Cuyahoga River Electrofishing IBI Sheets

**Upstream of Southerly WWTC  
August 8, 2006  
Collection Distance: 0.5 km  
Collection Method: Boat Electroshocking  
Drainage Area: 743 miles<sup>2</sup>  
River Mile: 10.75**

<u>Species</u>	<u>Number</u>	<u>Weight (kg)</u>	<u>Pollution Tolerance</u>	<u>#</u>	<u>DELT Anomalies Description</u>
<i>Dorosoma cepedianum</i> Eastern gizzard shad	7	0.426	--	0	--
<i>Ictiobus bubalus</i> Smallmouth buffalo	3	10.020	--	1	lesion
<i>Carpiodes cyprinus</i> Central quillback carpsucker	1	0.850	--	0	--
<i>Moxostoma macrolepidotum</i> Shorthead redhorse	7	0.400	Moderately Intolerant	0	--
<i>Hypentelium nigricans</i> Northern hog sucker	70	4.856	Moderately Intolerant	1	lesion
<i>Catostomus commersonii</i> Common white sucker	10	1.740	Highly Tolerant	1	lesion
<i>Cyprinus carpio</i> Common carp	14	36.960	Highly Tolerant	0	--
<i>Carassius auratus</i> Goldfish	1	0.200	Highly Tolerant	0	--
<i>Notemigonus crysoleucas</i> Golden shiner	1	0.042	Highly Tolerant	0	--
<i>Notropis cornutus</i> Common shiner	1	0.070	--	0	--
<i>Cyprinella spiloptera</i> Spotfin shiner	7	0.062	--	0	--
<i>Ictalurus punctatus</i> Channel catfish	10	9.370	--	2	eroded barbel

<i>Ictalurus natalis</i> Yellow bullhead	6	0.640	Highly Tolerant	1	lesion
<i>Pylodictis olivaris</i> Flathead Catfish	1	4.100	--	1	deformed head
<i>Morone americana</i> White perch	3	0.144	--	0	--
<i>Ambloplites rupestris</i> Northern rockbass	1	0.068	--	0	--
<i>Micropterus dolomieu</i> Smallmouth bass	6	1.174	Moderately Intolerant	0	--
<i>Lepomis cyanellus</i> Green sunfish	1	0.033	Highly Tolerant	0	--
<i>Lepomis macrochirus</i> Northern bluegill sunfish	3	0.054	Moderately Tolerant	0	--
<i>Lepomis gibbosus</i> Pumpkinseed sunfish	3	0.088	Moderately Tolerant	0	--
<i>Percina caprodes</i> Northern logperch darter	1	0.044	Moderately Intolerant	0	--
<i>Aplodinotus grunniens</i> Freshwater drum	2	1.375	Moderately Tolerant	0	--
Totals	<u>159</u>	<u>72.716</u>		<u>7</u>	

\*DELT anomalies were observed on 4.403 % of the fish collected.  
Index of Biotic Integrity (IBI) = 40 (Good)  
Modified Index of Well-Being (MIwb) = 8.7 (Good)  
Shannon Diversity Index, wt. 2.193  
Shannon Diversity Index, no. 1.681  
N 246  
B 65.91

**Upstream of Southerly WWTC**  
**September 8, 2006**  
**Collection Distance: 0.5 km**  
**Collection Method: Boat Electroshocking**  
**Drainage Area: 743 miles<sup>2</sup>**  
**River Mile: 10.75**

<u>Species</u>	<u>Number</u>	<u>Weight (kg)</u>	<u>Pollution Tolerance</u>	<u>#</u>	<u>DELT Anomalies Description</u>
<i>Dorosoma cepedianum</i> Eastern gizzard shad	27	0.480	--	0	--
<i>Moxostoma erythrurum</i> Golden redhorse	2	1.365	Moderately Intolerant	1	deformed body
<i>Moxostoma macrolepidotum</i> Shorthead redhorse	3	0.222	Moderately Intolerant	0	--
<i>Hypentelium nigricans</i> Northern hog sucker	77	5.594	Moderately Intolerant	0	--
<i>Catostomus commersonii</i> Common white sucker	15	2.480	Highly Tolerant	1	lesion
<i>Cyprinus carpio</i> Common carp	7	14.194	Highly Tolerant	0	--
<i>Carassius auratus</i> Goldfish	1	0.200	Highly Tolerant	0	--
<i>Cyprinella spiloptera</i> Spotfin shiner	12	0.080	--	0	--
<i>Pimephales notatus</i> Bluntnose minnow	1	0.010	Highly Tolerant	0	--
<i>Ictalurus punctatus</i> Channel catfish	6	4.371	--	0	--
<i>Morone americana</i> White perch	8	0.385	--	0	--
<i>Pomoxis nigromaculatus</i> Black crappie	1	0.038	--	0	--
<i>Ambloplites rupestris</i> Northern rockbass	2	0.122	--	0	--

<i>Micropterus dolomieu</i> Smallmouth bass	10	2.022	Moderately Intolerant	0	--
<i>Micropterus salmoides</i> Largemouth bass	1	0.004	--	0	--
<i>Lepomis cyanellus</i> Green sunfish	2	0.038	Highly Tolerant	0	--
<i>Lepomis macrochirus</i> Northern bluegill sunfish	32	0.634	Moderately Tolerant	0	--
<i>Lepomis gibbosus</i> Pumpkinseed sunfish	11	0.185	Moderately Tolerant	0	--
<i>HYBRID</i> Bluegill X Pumpkinseed	2	0.012	--	0	
<i>HYBRID</i> Green SF X Pumpkinseed	4	0.058	--	0	
<i>Percina caprodes</i> Northern logperch darter	3	0.040	Moderately Intolerant	0	--
<i>Etheostoma blenniodes</i> Greenside darter	1	0.010	Moderately Intolerant	0	--
<i>Aplodinotus grunniens</i> Freshwater drum	2	1.296	Moderately Tolerant	0	--
Totals	<u>230</u>	<u>33.840</u>		<u>2</u>	

\*DELT anomalies were observed on 0.87 % of the fish collected.  
Index of Biotic Integrity (IBI) = 40 (Good)  
Modified Index of Well-Being (MIwb) = 8.9 (Good)  
Shannon Diversity Index, wt. 2.333  
Shannon Diversity Index, no. 1.896  
N 380  
B 32.93



**Upstream of Southerly WWTC**  
**October 9, 2006**  
**Collection Distance: 0.5 km**  
**Collection Method: Boat Electroshocking**  
**Drainage Area: 743 miles<sup>2</sup>**  
**River Mile: 10.75**

<u>Species</u>	<u>Number</u>	<u>Weight (kg)</u>	<u>Pollution Tolerance</u>	<u>#</u>	<u>DELT Anomalies Description</u>
<i>Dorosoma cepedianum</i> Eastern gizzard shad	10	0.902	--	0	--
<i>Moxostoma erythrurum</i> Golden redhorse	4	0.242	Moderately Intolerant	0	--
<i>Hypentelium nigricans</i> Northern hog sucker	50	5.390	Moderately Intolerant	0	--
<i>Catostomus commersonii</i> Common white sucker	17	3.812	Highly Tolerant	0	--
<i>Cyprinus carpio</i> Common carp	6	16.330	Highly Tolerant	0	--
<i>Notropis atherinoides</i> Common Emerald shiner	21	0.052	--	0	--
<i>Cyprinella spiloptera</i> Spotfin shiner	15	0.038	--	0	--
<i>Notropis stramineus</i> Sand shiner	3	0.018	Moderately Intolerant	0	--
<i>Pimephales notatus</i> Bluntnose minnow	1	0.004	Highly Tolerant	0	--
<i>Ictalurus punctatus</i> Channel catfish	11	12.788	--	1	eroded barbels
<i>Ictalurus natalis</i> Yellow bullhead	2	0.032	Highly Tolerant	0	--
<i>Labidesthes sicculus</i> Brook silverside	1	0.006	Moderately Intolerant	0	--
<i>Morone americana</i> White perch	1	0.060	--	0	--

<i>Pomoxis nigromaculatus</i> Black crappie	1	0.050	--	0	--
<i>Micropterus dolomieu</i> Smallmouth bass	12	3.170	Moderately Intolerant	0	--
<i>Lepomis macrochirus</i> Northern bluegill sunfish	9	0.250	Moderately Tolerant	0	--
<i>Lepomis gibbosus</i> Pumpkinseed sunfish	8	0.250	Moderately Tolerant	0	--
Totals	<u>172</u>	<u>43.394</u>		<u>1</u>	

\*DELT anomalies were observed on 0.581 % of the fish collected.  
Index of Biotic Integrity (IBI) = 38 (Marginally Good)  
Modified Index of Well-Being (MIwb) = 8.7 (Marginally Good)  
Shannon Diversity Index, wt. 2.328  
Shannon Diversity Index, no. 1.602  
N 290  
B 46.31

**Downstream of Southerly WWTC**  
**August 11, 2006**  
**Collection Distance: 0.5 km**  
**Collection Method: Boat Electroshocking**  
**Drainage Area: 744 miles<sup>2</sup>**  
**River Mile: 10.10**

<u>Species</u>	<u>Number</u>	<u>Weight (kg)</u>	<u>Pollution Tolerance</u>	<u>#</u>	<u>DELT Anomalies Description</u>
<i>Dorosoma cepedianum</i> Eastern gizzard shad	1	0.250	--	0	--
<i>Moxostoma macrolepidotum</i> Shorthead redhorse	5	0.975	Moderately Intolerant	0	--
<i>Hypentelium nigricans</i> Northern hog sucker	23	1.375	Moderately Intolerant	0	--
<i>Catostomus commersonii</i> Common white sucker	6	2.562	Highly Tolerant	2	eroded tail
<i>Cyprinus carpio</i> Common carp	19	37.190	Highly Tolerant	1	eroded tail
<i>Carassius auratus</i> Goldfish	3	1.650	Highly Tolerant	0	--
<i>Cyprinella spiloptera</i> Spotfin shiner	3	0.030	--	0	--
<i>Notropis stramineus</i> Sand shiner	4	0.032	Moderately Intolerant	0	--
<i>Ictalurus natalis</i> Yellow bullhead	6	0.992	Highly Tolerant	1	lip lesion
<i>Morone americana</i> White perch	2	0.212	--	0	--
<i>Pomoxis nigromaculatus</i> Black crappie	5	0.460	--	1	eroded tail
<i>Ambloplites rupestris</i> Northern rockbass	2	0.150	--	0	--
<i>Micropterus dolomieu</i> Smallmouth bass	13	2.190	Moderately Intolerant	1	deformed jaw

<i>Lepomis macrochirus</i> Northern bluegill sunfish	8	0.110	Moderately Tolerant	0	--
<i>Lepomis gibbosus</i> Pumpkinseed sunfish	3	0.150	Moderately Tolerant	0	--
<i>HYBRID</i> Bluegill X Pumpkinseed	2	0.040	--	0	
<i>HYBRID</i> Green SF X Pumpkinseed	1	0.032	--	0	
<i>Percina caprodes</i> Northern logperch darter	4	0.072	Moderately Intolerant	0	--
Totals	<u>110</u>	<u>48.472</u>		<u>6</u>	

\*DELT anomalies were observed on 5.455 % of the fish collected.

Index of Biotic Integrity (IBI) =	34	(Fair)
Modified Index of Well-Being (MIwb) =	7.3	(Fair)
Shannon Diversity Index, wt.	2.512	
Shannon Diversity Index, no.	1.047	
N	142	
B	11.59	

**Downstream of Southerly WWTC  
September 8, 2006  
Collection Distance: 0.5 km  
Collection Method: Boat Electroshocking  
Drainage Area: 744 miles<sup>2</sup>  
River Mile: 10.10**

<u>Species</u>	<u>Number</u>	<u>Weight (kg)</u>	<u>Pollution Tolerance</u>	<u>#</u>	<u>DELT Anomalies Description</u>
<i>Dorosoma cepedianum</i> Eastern gizzard shad	14	1.994	--	0	--
<i>Moxostoma erythrurum</i> Golden redbhorse	1	0.072	Moderately Intolerant	0	--
<i>Moxostoma macrolepidotum</i> Shorthead redbhorse	1	0.572	Moderately Intolerant	0	--
<i>Hypentelium nigricans</i> Northern hog sucker	35	2.400	Moderately Intolerant	0	--
<i>Catostomus commersonii</i> Common white sucker	8	2.950	Highly Tolerant	1	eroded tail
<i>Cyprinus carpio</i> Common carp	8	10.050	Highly Tolerant	0	--
<i>Cyprinella spiloptera</i> Spotfin shiner	8	0.042	--	0	--
<i>Ictalurus punctatus</i> Channel catfish	4	4.127	--	0	--
<i>Ictalurus natalis</i> Yellow bullhead	2	0.100	Highly Tolerant	1	lesion
<i>Pylodictis olivaris</i> Flathead Catfish	1	2.200	--	0	--
<i>Morone americana</i> White perch	17	1.104	--	0	--
<i>Ambloplites rupestris</i> Northern rockbass	3	0.322	--	0	--
<i>Micropterus dolomieu</i> Smallmouth bass	27	4.594	Moderately Intolerant	0	--

<i>Lepomis cyanellus</i> Green sunfish	3	0.040	Highly Tolerant	0	--
<i>Lepomis macrochirus</i> Northern bluegill sunfish	20	0.320	Moderately Tolerant	0	--
<i>Lepomis gibbosus</i> Pumpkinseed sunfish	7	0.160	Moderately Tolerant	0	--
<i>HYBRID</i> Green SF X Pumpkinseed	2	0.060	--	0	
<i>Percina caprodes</i> Northern logperch darter	1	0.020	Moderately Intolerant	0	--
<i>Etheostoma caeruleum</i> Rainbow darter	1	0.004	Moderately Intolerant	0	--
Totals	<u>163</u>	<u>31.131</u>		<u>2</u>	

\*DELT anomalies were observed on 1.227 % of the fish collected.

Index of Biotic Integrity (IBI) = 40 (Good)

Modified Index of Well-Being (MIwb) = 9.0 (Good)

Shannon Diversity Index, wt. 2.413

Shannon Diversity Index, no. 2.081

N 246

B 33.65

**Downstream of Southerly WWTC**  
**October 9, 2006**  
**Collection Distance: 0.5 km**  
**Collection Method: Boat Electroshocking**  
**Drainage Area: 744 miles<sup>2</sup>**  
**River Mile: 10.10**

<u>Species</u>	<u>Number</u>	<u>Weight (kg)</u>	<u>Pollution Tolerance</u>	<u>#</u>	<u>DELT Anomalies Description</u>
<i>Dorosoma cepedianum</i> Eastern gizzard shad	15	2.410	--	0	--
<i>Salmo gairdneri</i> Rainbow trout	1	0.510	--	0	--
<i>Moxostoma erythrurum</i> Golden redhorse	3	3.150	Moderately Intolerant	0	--
<i>Moxostoma macrolepidotum</i> Shorthead redhorse	2	1.350	Moderately Intolerant	0	--
<i>Hypentelium nigricans</i> Northern hog sucker	20	1.740	Moderately Intolerant	0	--
<i>Catostomus commersonii</i> Common white sucker	15	5.900	Highly Tolerant	0	--
<i>Cyprinus carpio</i> Common carp	9	22.230	Highly Tolerant	1	deformed eye
<i>Notropis atherinoides</i> Common Emerald shiner	22	0.050	--	0	--
<i>Cyprinella spiloptera</i> Spotfin shiner	10	0.042	--	0	--
<i>Notropis stramineus</i> Sand shiner	64	0.158	Moderately Intolerant	0	--
<i>Notropis volucellus</i> Mimic Shiner	1	0.004	Common Intolerant	0	
<i>Ericymba buccata</i> Silverjaw minnow	1	0.004	--	0	--
<i>Pimephales notatus</i> Bluntnose minnow	11	0.020	Highly Tolerant	0	--

<i>Ictalurus punctatus</i> Channel catfish	19	27.380	--	1	deformed tail
<i>Ictalurus natalis</i> Yellow bullhead	2	0.092	Highly Tolerant	0	--
<i>Labidesthes sicculus</i> Brook silverside	1	0.004	Moderately Intolerant	0	--
<i>Morone americana</i> White perch	2	0.100	--	0	--
<i>Ambloplites rupestris</i> Northern rockbass	3	0.162	--	0	--
<i>Micropterus dolomieu</i> Smallmouth bass	24	3.800	Moderately Intolerant	1	deformed fin
<i>Micropterus salmoides</i> Largemouth bass	1	0.030	--	0	--
<i>Lepomis macrochirus</i> Northern bluegill sunfish	9	0.210	Moderately Tolerant	0	--
<i>Lepomis gibbosus</i> Pumpkinseed sunfish	3	0.054	Moderately Tolerant	0	--
Totals	<u>238</u>	<u>69.400</u>		<u>3</u>	

\*DELT anomalies were observed on 1.261 % of the fish collected.  
Index of Biotic Integrity (IBI) = 34 (Fair)  
Modified Index of Well-Being (MIwb) = 9.3 (Very Good)  
Shannon Diversity Index, wt. 2.487  
Shannon Diversity Index, no. 1.649  
N 396  
B 81.1



**Upstream of Big Creek**  
**August 11, 2006**  
**Collection Distance: 0.5 km**  
**Collection Method: Boat Electroshocking**  
**Drainage Area: 749 miles<sup>2</sup>**  
**River Mile: 7.55**

<u>Species</u>	<u>Number</u>	<u>Weight (kg)</u>	<u>Pollution Tolerance</u>	<u>#</u>	<u>DELT Anomalies Description</u>
<i>Dorosoma cepedianum</i> Eastern gizzard shad	4	0.400	--	0	--
<i>Moxostoma erythrurum</i> Golden redbhorse	1	0.070	Moderately Intolerant	0	--
<i>Moxostoma macrolepidotum</i> Shorthead redbhorse	1	0.450	Moderately Intolerant	0	--
<i>Hypentelium nigricans</i> Northern hog sucker	9	0.224	Moderately Intolerant	0	--
<i>Catostomus commersonii</i> Common white sucker	2	0.850	Highly Tolerant	0	--
<i>Cyprinus carpio</i> Common carp	12	29.710	Highly Tolerant	1	eroded tail
<i>Carassius auratus</i> Goldfish	1	0.400	Highly Tolerant	0	--
<i>Cyprinella spiloptera</i> Spotfin shiner	1	0.030	--	0	--
<i>HYBRID</i> Common Carp x Goldfish	1	0.820	Highly Tolerant	0	
<i>Ctenopharyngodon idella</i> Grass carp	1	8.620	--	0	--
<i>Morone americana</i> White perch	1	0.030	--	0	--
<i>Pomoxis nigromaculatus</i> Black crappie	2	0.140	--	1	eroded mouth
<i>Ambloplites rupestris</i> Northern rockbass	1	0.120	--	0	--

<i>Micropterus dolomieu</i> Smallmouth bass	6	0.720	Moderately Intolerant	0	--
<i>Lepomis macrochirus</i> Northern bluegill sunfish	1	0.072	Moderately Tolerant	0	--
<i>Percina caprodes</i> Northern logperch darter	1	0.034	Moderately Intolerant	0	--
<i>Neogobius melanostomus</i> Round goby	1	0.030	--	0	--
Totals	<u>46</u>	<u>42.720</u>		<u>2</u>	

\*DELT anomalies were observed on 4.348 % of the fish collected.  
 Index of Biotic Integrity (IBI) = 30 (Fair)  
 Modified Index of Well-Being (MIwb) = 6.1 (Poor)  
 Shannon Diversity Index, wt. 2.336  
 Shannon Diversity Index, no. 1.039  
 N 54  
 B 4.52

**Upstream of Big Creek**  
**September 8, 2006**  
**Collection Distance: 0.5 km**  
**Collection Method: Boat Electroshocking**  
**Drainage Area: 749 miles<sup>2</sup>**  
**River Mile: 7.55**

<u>Species</u>	<u>Number</u>	<u>Weight (kg)</u>	<u>Pollution Tolerance</u>	<u>#</u>	<u>DELT Anomalies Description</u>
<i>Dorosoma cepedianum</i> Eastern gizzard shad	59	3.240	--	0	--
<i>Ictiobus bubalus</i> Smallmouth buffalo	1	1.350	--	0	--
<i>Moxostoma anisurum</i> Silver Redhorse	1	1.000	Moderately Intolerant	0	
<i>Moxostoma erythrurum</i> Golden redhorse	1	0.162	Moderately Intolerant	0	--
<i>Catostomus commersonii</i> Common white sucker	4	1.500	Highly Tolerant	0	--
<i>Cyprinus carpio</i> Common carp	30	87.700	Highly Tolerant	0	--
<i>Carassius auratus</i> Goldfish	1	1.810	Highly Tolerant	1	deformed tail
<i>Notropis atherinoides</i> Common Emerald shiner	2	0.020	--	0	--
<i>Cyprinella spiloptera</i> Spotfin shiner	12	0.090	--	0	--
<i>Ictalurus punctatus</i> Channel catfish	3	3.000	--	0	--
<i>Morone americana</i> White perch	3	0.160	--	0	--
<i>Ambloplites rupestris</i> Northern rockbass	4	0.584	--	0	--
<i>Micropterus dolomieu</i> Smallmouth bass	11	2.920	Moderately Intolerant	0	--

<i>Lepomis macrochirus</i> Northern bluegill sunfish	3	0.056	Moderately Tolerant	0	--
<i>Neogobius melanostomus</i> Round goby	1	0.020	--	0	--
Totals	<u>136</u>	<u>103.612</u>		<u>1</u>	

\*DELT anomalies were observed on 0.735 % of the fish collected.  
Index of Biotic Integrity (IBI) = 30 (Fair)  
Modified Index of Well-Being (MIwb) = 6.8 (Fair)  
Shannon Diversity Index, wt. 1.816  
Shannon Diversity Index, no. 0.749  
N 194  
B 24.84

**Upstream of Big Creek**  
**October 9, 2006**  
**Collection Distance: 0.5 km**  
**Collection Method: Boat Electroshocking**  
**Drainage Area: 749 miles<sup>2</sup>**  
**River Mile: 7.55**

<u>Species</u>	<u>Number</u>	<u>Weight (kg)</u>	<u>Pollution Tolerance</u>	<u>#</u>	<u>DELT Anomalies Description</u>
<i>Dorosoma cepedianum</i> Eastern gizzard shad	38	2.412	--	0	--
<i>Ictiobus bubalus</i> Smallmouth buffalo	1	1.850	--	0	--
<i>Moxostoma erythrurum</i> Golden redbreast	2	0.150	Moderately Intolerant	0	--
<i>Moxostoma macrolepidotum</i> Shorthead redbreast	1	0.144	Moderately Intolerant	0	--
<i>Hypentelium nigricans</i> Northern hog sucker	3	0.180	Moderately Intolerant	0	--
<i>Catostomus commersonii</i> Common white sucker	11	4.384	Highly Tolerant	0	--
<i>Minytrema melanops</i> Spotted Sucker	1	0.072	--	0	--
<i>Cyprinus carpio</i> Common carp	22	49.730	Highly Tolerant	2	deformed tail, deformed head
<i>Notropis atherinoides</i> Common Emerald shiner	13	0.040	--	0	--
<i>Cyprinella spiloptera</i> Spotfin shiner	2	0.014	--	0	--
<i>Notropis stramineus</i> Sand shiner	1	0.004	Moderately Intolerant	0	--
<i>Ctenopharyngodon idella</i> Grass carp	1	17.240	--	0	--
<i>Ictalurus punctatus</i> Channel catfish	10	7.920	--	1	eroded barbel

<i>Ictalurus natalis</i> Yellow bullhead	1	0.250	Highly Tolerant	0	--
<i>Pomoxis nigromaculatus</i> Black crappie	1	0.050	--	0	--
<i>Ambloplites rupestris</i> Northern rockbass	3	0.382	--	0	--
<i>Micropterus dolomieu</i> Smallmouth bass	24	6.400	Moderately Intolerant	0	--
<i>HYBRID</i> Bluegill X Pumpkinseed	1	0.052	--	0	
	<hr/>	<hr/>			
Totals	<u>136</u>	<u>91.274</u>		<u>3</u>	

\*DELT anomalies were observed on 2.206 % of the fish collected.  
Index of Biotic Integrity (IBI) = 30 (Fair)  
Modified Index of Well-Being (MIwb) = 8.1 (Fair)  
Shannon Diversity Index, wt. 2.158  
Shannon Diversity Index, no. 1.456  
N 200  
B 39.24

**Downstream of Big Creek**  
**August 11, 2006**  
**Collection Distance: 0.5 km**  
**Collection Method: Boat Electroshocking**  
**Drainage Area: 786 miles<sup>2</sup>**  
**River Mile: 7.00**

<u>Species</u>	<u>Number</u>	<u>Weight (kg)</u>	<u>Pollution Tolerance</u>	<u>#</u>	<u>DELT Anomalies Description</u>
<i>Dorosoma cepedianum</i> Eastern gizzard shad	9	0.800	--	0	--
<i>Moxostoma erythrurum</i> Golden redhorse	1	1.500	Moderately Intolerant	0	--
<i>Moxostoma macrolepidotum</i> Shorthead redhorse	9	2.243	Moderately Intolerant	0	--
<i>Hypentelium nigricans</i> Northern hog sucker	9	0.732	Moderately Intolerant	1	eroded tail
<i>Catostomus commersonii</i> Common white sucker	2	0.622	Highly Tolerant	0	--
<i>Cyprinus carpio</i> Common carp	10	30.390	Highly Tolerant	1	lesion
<i>Carassius auratus</i> Goldfish	1	0.234	Highly Tolerant	0	--
<i>Notropis atherinoides</i> Common Emerald shiner	1	0.004	--	0	--
<i>Cyprinella spiloptera</i> Spotfin shiner	13	0.093	--	0	--
<i>Ictalurus punctatus</i> Channel catfish	1	0.650	--	0	--
<i>Ictalurus natalis</i> Yellow bullhead	1	0.190	Highly Tolerant	0	--
<i>Morone americana</i> White perch	1	0.150	--	0	--
<i>Micropterus dolomieu</i> Smallmouth bass	20	2.238	Moderately Intolerant	0	--

<i>Lepomis cyanellus</i> Green sunfish	1	0.030	Highly Tolerant	0	--
<i>Lepomis macrochirus</i> Northern bluegill sunfish	1	0.012	Moderately Tolerant	0	--
	<hr/>	<hr/>			
Totals	<u>80</u>	<u>39.888</u>		<u>2</u>	

\*DELT anomalies were observed on 2.5 % of the fish collected.

Index of Biotic Integrity (IBI) = 34 (Fair)

Modified Index of Well-Being (MIwb) = 7.0 (Fair)

Shannon Diversity Index, wt. 2.17

Shannon Diversity Index, no. 1.037

N 128

B 16.54



**Downstream of Big Creek**  
**September 8, 2006**  
**Collection Distance: 0.5 km**  
**Collection Method: Boat Electroshocking**  
**Drainage Area: 786 miles<sup>2</sup>**  
**River Mile: 7.00**

<u>Species</u>	<u>Number</u>	<u>Weight (kg)</u>	<u>Pollution Tolerance</u>	<u>#</u>	<u>DELT Anomalies Description</u>
<i>Dorosoma cepedianum</i> Eastern gizzard shad	111	4.520	--	0	--
<i>Moxostoma erythrurum</i> Golden redhorse	1	0.072	Moderately Intolerant	0	--
<i>Moxostoma macrolepidotum</i> Shorthead redhorse	4	1.270	Moderately Intolerant	0	--
<i>Hypentelium nigricans</i> Northern hog sucker	20	1.406	Moderately Intolerant	0	--
<i>Catostomus commersonii</i> Common white sucker	6	1.700	Highly Tolerant	0	--
<i>Cyprinus carpio</i> Common carp	4	17.220	Highly Tolerant	0	--
<i>Notropis atherinoides</i> Common Emerald shiner	9	0.070	--	0	--
<i>Ictalurus punctatus</i> Channel catfish	3	5.970	--	1	eroded lip
<i>Ictalurus natalis</i> Yellow bullhead	2	0.262	Highly Tolerant	0	--
<i>Morone americana</i> White perch	3	0.290	--	0	--
<i>Ambloplites rupestris</i> Northern rockbass	2	0.360	--	1	eroded fin
<i>Micropterus dolomieu</i> Smallmouth bass	10	3.000	Moderately Intolerant	0	--
<i>Lepomis macrochirus</i> Northern bluegill sunfish	1	0.020	Moderately Tolerant	0	--

<i>Percina caprodes</i> Northern logperch darter	1	0.012	Moderately Intolerant	0	--
<i>Neogobius melanostomus</i> Round goby	1	0.010	--	0	--
<i>Salvelinus namaycush</i> Lake Trout	1	3.800	--	0	
Totals	<u>179</u>	<u>39.982</u>		<u>2</u>	

\*DELT anomalies were observed on 1.117 % of the fish collected.  
Index of Biotic Integrity (IBI) = 28 (Fair)  
Modified Index of Well-Being (MIwb) = 8.1 (Fair)  
Shannon Diversity Index, wt. 1.519  
Shannon Diversity Index, no. 1.815  
N 326  
B 41

**Downstream of Big Creek**  
**October 9, 2006**  
**Collection Distance: 0.5 km**  
**Collection Method: Boat Electroshocking**  
**Drainage Area: 786 miles<sup>2</sup>**  
**River Mile: 7.00**

<u>Species</u>	<u>Number</u>	<u>Weight (kg)</u>	<u>Pollution Tolerance</u>	<u>#</u>	<u>DELT Anomalies Description</u>
<i>Dorosoma cepedianum</i> Eastern gizzard shad	118	5.834	--	0	--
<i>Salmo gairdneri</i> Rainbow trout	1	0.652	--	0	--
<i>Moxostoma macrolepidotum</i> Shorthead redhorse	2	0.900	Moderately Intolerant	0	--
<i>Hypentelium nigricans</i> Northern hog sucker	13	1.532	Moderately Intolerant	1	eroded tail
<i>Catostomus commersonii</i> Common white sucker	11	5.215	Highly Tolerant	0	--
<i>Cyprinus carpio</i> Common carp	3	14.970	Highly Tolerant	0	--
<i>Notropis atherinoides</i> Common Emerald shiner	142	0.326	--	0	--
<i>Cyprinella spiloptera</i> Spotfin shiner	1	0.002	--	0	--
<i>Pimephales notatus</i> Bluntnose minnow	2	0.005	Highly Tolerant	0	--
<i>Ictalurus punctatus</i> Channel catfish	3	3.630	--	0	--
<i>Labidesthes sicculus</i> Brook silverside	8	0.028	Moderately Intolerant	0	--
<i>Morone americana</i> White perch	1	0.090	--	0	--
<i>Micropterus dolomieu</i> Smallmouth bass	7	2.230	Moderately Intolerant	1	tumor

<i>Lepomis macrochirus</i> Northern bluegill sunfish	1	0.008	Moderately Tolerant	0	--
<i>Lepomis gibbosus</i> Pumpkinseed sunfish	1	0.010	Moderately Tolerant	0	--
<i>Aplodinotus grunniens</i> Freshwater drum	1	1.600	Moderately Tolerant	1	eroded tail
Totals	<u>315</u>	<u>37.032</u>		<u>3</u>	

\*DELT anomalies were observed on 0.952 % of the fish collected.  
Index of Biotic Integrity (IBI) = 30 (Fair)  
Modified Index of Well-Being (MIwb) = 8.2 (Fair)  
Shannon Diversity Index, wt. 1.416  
Shannon Diversity Index, no. 1.827  
N 594  
B 32.2

## Appendix B. Water Quality Sampling Results

### Site Upstream of Southerly WWTC

Parameter	Units	7/26/06	8/9/06	8/23/06	9/6/06	9/8/06	9/20/06	10/4/06
BOD	(mg/L)	1	1	1	1	3	1	2
COD	(mg/L)	10	0.5	10	16	18	31	21
Suspended Solids	(mg/L)	33	21	15	30	29	34	96
Dissolved Solids	(mg/L)	477	478	568	472	522	560	363
Total Solids	(mg/L)	597	567	641	509	604	605	489
Total Phosphorus	(mg/L)	0.13	0.12	0.14	0.24	0.48	0.22	0.25
Soluble Phosphorus	(mg/L)	0.07	0.06	0.09	0.14	0.34	0.14	0.06
Ammonia-N	(mg/L)	0.04	0.02	0.05	0.03	0.13	0.06	0.05
Nitrite	(mg/L)	0.01	0.02	0.02	0.01	AE	0.02	0.01
Nitrate	(mg/L)	1.97	2.38	3.81	2.89	-	4.09	1.73
Nitrite + Nitrate	(mg/L)	1.98	2.4	3.83	2.9	2.93	4.11	1.74
Alkalinity	(mg/L)	126	140	158	136	147	147	123
<i>E. coli</i>	(CFU/100 mL)	457	610	1260	330	-	640	406
Fecal Coliform	(CFU/100 mL)	540	560	1680	530	-	1260	520
Turbidity	(NTU)	-	6.71	7.03	19.85	14.7	28.2	82.6
Hardness	(mg/L)	157	215	245	206	221	236	183
ICP Aluminum	(ug/l)	14	360	202	464	444	722	1750
ICP Nickel	(ug/l)	10	2	3	2.1	2.4	3	4.5
ICP Copper	(ug/l)	6	10	8	7.6	5.7	10.2	10.5
ICP Chromium	(ug/l)	2	1	0.15	1.1	j1	1.7	3.1
Hexavalent Chromium	(ug/l)	j2.14	0.5	j2.84	j2.45	j1.52	j2.39	j2.37
ICP Iron	(ug/l)	46	857	599	1230	1190	1440	3720
ICP Cadmium	(ug/l)	0.1	0.1	0.1	j0.5	j0.5	j0.5	j1
ICP Silver	(ug/l)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
ICP Arsenic	(ug/l)	2	3	j1	2.8	2.4	2	4.2
ICP Selenium	(ug/l)	j2	j3	j2	j2.2	j1.3	j1.3	0.3
ICP Beryllium	(ug/l)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
ICP Lead	(ug/l)	0.025	0.025	0.25	0.25	j0.7	j1.5	5.5
ICP Zinc	(ug/l)	19	11	14	11.6	13.6	25	30.8
ICP Antimony	(ug/l)	j3	j1	0.1	j0.7	j0.9	j1.4	j0.3
ICP Calcium	(ug/l)	44300	62700	70400	59100	62800	67000	52000
ICP Cobalt	(ug/l)	0.1	0.1	0.1	j0.7	j0.8	j0.8	1.7
ICP Magnesium	(ug/l)	11300	14100	16900	14100	15600	16600	13000
ICP Manganese	(ug/l)	10	72	73	78.7	79.2	84.2	154
ICP Molybdenum	(ug/l)	27	5	5	3.9	4.5	5.1	3.3
ICP Potassium	(ug/l)	10200	5300	6540	4970	5990	7060	5410
ICP Sodium	(ug/l)	82800	77400	93800	67200	80500	100000	58600
ICP Thallium	(ug/l)	10	12	12	8.7	7.8	7.4	5.5
ICP Tin	(ug/l)	0.1	j9	j5	2.15	j4.6	j5.7	2.15
ICP Titanium	(ug/l)	0.1	6	2	5.8	5.7	13.1	20.1
ICP Vanadium	(ug/l)	0.1	0.1	0.1	j0.7	j0.7	1.5	3.2
Mercury	(ng/l)	0.025	0.025	0.025	0.025	0.025	0.025	0.025

Parameter	Units	7/26/06	8/9/06	8/23/06	9/6/06	9/8/06	9/20/06	10/4/06
pH	(s.u.)	7.9	7.7	8.1	8.1	8	8.1	7.9
Field Conductivity	(uS/cm)	752	885	1006	776	860	965	631
Field D.O.	(mg/L)	8.2	8.51	8.59	8.82	7.79	9.23	10.21
Field Temperature	(°C)	24.1	23.5	22.15	19.58	20.1	17.61	17.11
Field pH	(s.u.)	8.1	8.8	8.25	8.16	8.24	8.31	7.93

j= The reported value is greater than the MDL but less than the PQL and is an estimated result.

Values below MDL reported as 1/2 MDL.

#### Site Downstream of Southerly WWTC

Parameter	Units	7/26/06	8/9/06	8/23/06	9/6/06	9/8/06	9/20/06	10/4/06
BOD	(mg/L)	1	2	1	1	2	1	1
COD	(mg/L)	8	0.5	12	23	21	30	22
Suspended Solids	(mg/L)	28	9	10	24	23	21	27
Dissolved Solids	(mg/L)	519	519	592	555	587	556	409
Total Solids	(mg/L)	680	628	673	584	657	597	450
Total Phosphorus	(mg/L)	0.16	0.26	0.3	0.37	0.51	0.44	0.23
Soluble Phosphorus	(mg/L)	0.1	0.22	0.25	0.26	0.36	0.36	0.15
Ammonia-N	(mg/L)	0.06	0.05	0.14	0.04	0.1	0.12	0.09
Nitrite	(mg/L)	0.02	0.02	0.02	0.01	AE	0.03	0.01
Nitrate	(mg/L)	3.77	5.08	7.63	5.39	-	9.42	3.53
Nitrite + Nitrate	(mg/L)	3.78	5.1	7.65	5.4	5.76	9.45	3.54
Alkalinity	(mg/L)	120	128	137	126	129	112	119
<i>E. coli</i>	(CFU/100 mL)	323	233	453	640	-	226	440
Fecal Coliform	(CFU/100 mL)	400	220	507	550	-	273	660
Turbidity	(NTU)	-	4.57	5.3	15.95	12.5	17.1	20.2
Hardness	(mg/L)	189	216	230	210	221	215	190
ICP Aluminum	(ug/l)	475	230	140	376	368	450	394
ICP Nickel	(ug/l)	5	7	7	4.6	6.3	8.3	4.2
ICP Copper	(ug/l)	11	8	9	7.9	5.4	9	9.4
ICP Chromium	(ug/l)	2	1	1	1.3	1.1	1.9	1.2
Hexavalent Chromium	(ug/l)	j3.27	j1.86	j3.24	j2.65	j3.27	j3.01	j2.43
ICP Iron	(ug/l)	1140	519	421	1000	946	925	1140
ICP Cadmium	(ug/l)	0.1	0.1	0.1	j0.5	j0.4	j0.5	j0.4
ICP Silver	(ug/l)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
ICP Arsenic	(ug/l)	3	2	j2	2.5	2.3	2.1	3
ICP Selenium	(ug/l)	j2	j3	j2	j1.8	j1.9	j2.1	j1.1
ICP Beryllium	(ug/l)	0.1	0.1	0.01	0.1	0.1	0.1	0.1
ICP Lead	(ug/l)	j1	0.025	0.025	0.025	j0.6	j1.6	j1.6
ICP Zinc	(ug/l)	18	15	20	15.4	25.1	39	17.4
ICP Antimony	(ug/l)	j2	j1	j2	j0.9	j1.2	j2	j0.3
ICP Calcium	(ug/l)	54100	62100	65700	59600	62500	60800	54000
ICP Cobalt	(ug/l)	1	0.1	0.01	j0.7	j0.9	1.1	j0.7
ICP Magnesium	(ug/l)	13200	14700	16000	14800	15700	15400	13300
ICP Manganese	(ug/l)	77	54	56	65.7	65.8	57.7	91.5

Parameter	Units	7/26/06	8/9/06	8/23/06	9/6/06	9/8/06	9/20/06	10/4/06
ICP Molybdenum	(ug/l)	9	10	10	5.7	9.6	14	5.2
ICP Potassium	(ug/l)	9990	11000	12400	6830	10400	20500	9970
ICP Sodium	(ug/l)	73600	89100	98900	75300	93800	107000	72400
ICP Thallium	(ug/l)	11	13	10	8	9.7	6.8	7.2
ICP Tin	(ug/l)	j8	j11	j6	2.15	j5.6	2.15	2.15
ICP Titanium	(ug/l)	7	4	2	4.5	4.7	7.7	5.3
ICP Vanadium	(ug/l)	0.1	0.1	0.1	1.2	1.4	2.9	1.7
Mercury	(ng/l)	0.025	0.025	0.025	0.025	0.025	0.0025	0.025
pH	(s.u.)	7.9	7.7	7.7	7.8	7.7	7.7	7.9
Field Conductivity	(uS/cm)	825	993	1059	822	946	1032	734
Field D.O.	(mg/L)	8.03	5.6	8.54	8.15	7.95	8.85	9.82
Field Temperature	(°C)	23.63	23.51	22.21	20.14	20.73	18.74	17.14
Field pH	(s.u.)	7.69	7.68	7.98	8.01	8.02	8.32	7.44

j= The reported value is greater than the MDL but less than the PQL and is an estimated result.

Values below MDL reported as 1/2 MDL.

#### Site Upstream of Big Creek

Parameter	Units	9/8/06
BOD	(mg/L)	1
COD	(mg/L)	39
Suspended Solids	(mg/L)	21
Dissolved Solids	(mg/L)	560
Total Solids	(mg/L)	643
Total Phosphorus	(mg/L)	0.5
Soluble Phosphorus	(mg/L)	0.34
Ammonia-N	(mg/L)	0.18
Nitrite	(mg/L)	AE
Nitrate	(mg/L)	-
Nitrite + Nitrate	(mg/L)	5
Alkalinity	(mg/L)	136
<i>E. coli</i>	(CFU/100 mL)	-
Fecal Coliform	(CFU/100 mL)	-
Turbidity	(NTU)	14.7
Hardness	(mg/L)	221
ICP Aluminum	(ug/l)	332
ICP Nickel	(ug/l)	5.2
ICP Copper	(ug/l)	6.2
ICP Chromium	(ug/l)	1
Hexavalent Chromium	(ug/l)	j2.86
ICP Iron	(ug/l)	871
ICP Cadmium	(ug/l)	j0.3
ICP Silver	(ug/l)	0.1
ICP Arsenic	(ug/l)	2.7
ICP Selenium	(ug/l)	j1.7

Parameter	Units	9/8/06
ICP Beryllium	(ug/l)	0.1
ICP Lead	(ug/l)	0.25
ICP Zinc	(ug/l)	20.7
ICP Antimony	(ug/l)	j1.1
ICP Calcium	(ug/l)	62900
ICP Cobalt	(ug/l)	j0.8
ICP Magnesium	(ug/l)	15600
ICP Manganese	(ug/l)	67
ICP Molybdenum	(ug/l)	8.3
ICP Potassium	(ug/l)	9460
ICP Sodium	(ug/l)	89400
ICP Thallium	(ug/l)	9.4
ICP Tin	(ug/l)	2.15
ICP Titanium	(ug/l)	4.7
ICP Vanadium	(ug/l)	1.1
Mercury	(ng/l)	0.025
pH	(s.u.)	7.7
Field Conductivity	(uS/cm)	921
Field D.O.	(mg/L)	7.59
Field Temperature	(°C)	20.65
Field pH	(s.u.)	8.07

j= The reported value is greater than the MDL but less than the PQL and is an estimated result.

Values below MDL reported as 1/2 MDL.

AE= Analytical Error

#### Site Downstream of Big Creek

Parameter	Units	9/8/06
BOD	(mg/L)	1
COD	(mg/L)	24
Suspended Solids	(mg/L)	27
Dissolved Solids	(mg/L)	571
Total Solids	(mg/L)	
Total Phosphorus	(mg/L)	0.48
Soluble Phosphorus	(mg/L)	0.33
Ammonia-N	(mg/L)	0.08
Nitrite	(mg/L)	AE
Nitrate	(mg/L)	-
Nitrite + Nitrate	(mg/L)	4.99
Alkalinity	(mg/L)	133
<i>E. coli</i>	(CFU/100 mL)	-
Fecal Coliform	(CFU/100 mL)	-
Turbidity	(NTU)	14.8
Hardness	(mg/L)	221
ICP Aluminum	(ug/l)	377



Parameter	Units	9/8/06
ICP Nickel	(ug/l)	6.4
ICP Copper	(ug/l)	5.8
ICP Chromium	(ug/l)	1.1
Hexavalent Chromium	(ug/l)	j2.88
ICP Iron	(ug/l)	986
ICP Cadmium	(ug/l)	j0.4
ICP Silver	(ug/l)	0.1
ICP Arsenic	(ug/l)	2.8
ICP Selenium	(ug/l)	j1.3
ICP Beryllium	(ug/l)	0.1
ICP Lead	(ug/l)	j0.6
ICP Zinc	(ug/l)	21.1
ICP Antimony	(ug/l)	j1
ICP Calcium	(ug/l)	62600
ICP Cobalt	(ug/l)	j0.9
ICP Magnesium	(ug/l)	15600
ICP Manganese	(ug/l)	72.9
ICP Molybdenum	(ug/l)	8.5
ICP Potassium	(ug/l)	9550
ICP Sodium	(ug/l)	89900
ICP Thallium	(ug/l)	7.5
ICP Tin	(ug/l)	2.15
ICP Titanium	(ug/l)	4.9
ICP Vanadium	(ug/l)	1.3
Mercury	(ng/l)	0.025
pH	(s.u.)	7.8
Field Conductivity	(uS/cm)	927
Field D.O.	(mg/L)	8.15
Field Temperature	(°C)	20.85
Field pH	(s.u.)	8.29

j= The reported value is greater than the MDL but less than the PQL and is an estimated result.

Values below MDL reported as 1/2 MDL.

AE= Analytical Error

# Macroinvertebrate Community Assessment

## Introduction

During 2006, the Northeast Ohio Regional Sewer District (NEORS) conducted quantitative and qualitative benthic macroinvertebrate sampling, upstream (RM 10.75) and downstream (RM 10.30) of Southerly Wastewater Treatment Center (WWTC). The purpose of the sampling was to assess the macroinvertebrate communities on the Cuyahoga River upstream and downstream Southerly WWTC. Additionally, beginning in 2006, three more macroinvertebrate sample locations were added: RM 16.20, RM 11.50 and RM 10.10. RM 16.20, located upstream of Southerly WWTC, served as a reference site as it has been in known Warmwater Habitat (WWH) biological attainment according to the Ohio Environmental Protection Agency (EPA) since 2000 (*Total Maximum Daily Loads for the Lower Cuyahoga River*, 2003). RM 11.50, also located upstream of Southerly WWTC, but downstream of the Mill Creek confluence with the Cuyahoga River, was sampled to establish what influence Mill Creek has on the macroinvertebrate community in the Cuyahoga River. RM 10.10, located downstream of Southerly WWTC, is in an area more conducive to macroinvertebrate colonization compared to RM 10.30, due to the presence of a functional, cobble/gravel riffle located in shallow water of moderate flow. Furthermore, this location is within the NEORS electrofishing sample zone.

Macroinvertebrates in the Cuyahoga River were sampled quantitatively for a six-week period in 2006 using multi-plate, artificial substrate samplers (modified Hester-Dendy) in conjunction with a qualitative assessment of Ephemeroptera, Plecoptera, and Trichoptera (EPT) taxa inhabiting the available natural substrates at the time of artificial substrate retrieval (NEORS *Cuyahoga River Electrofishing and Macroinvertebrate Surveys Study Plan*, 2006). The location of sites that were sampled are listed in Table 1 and shown in Figure 1.

Site Description	River Mile	Latitude (°N)	Longitude (°W)
Downstream of Tinkers Creek	16.20	41.3653	81.6127
Downstream of Mill Creek Confluence	11.50	41.4162	81.6400
Upstream of Southerly WWTC	10.75	41.4192	81.6520
Downstream of Southerly WWTC	10.30	41.4213	81.6590
Downstream of RM 10.30	10.10	41.4234	81.6636

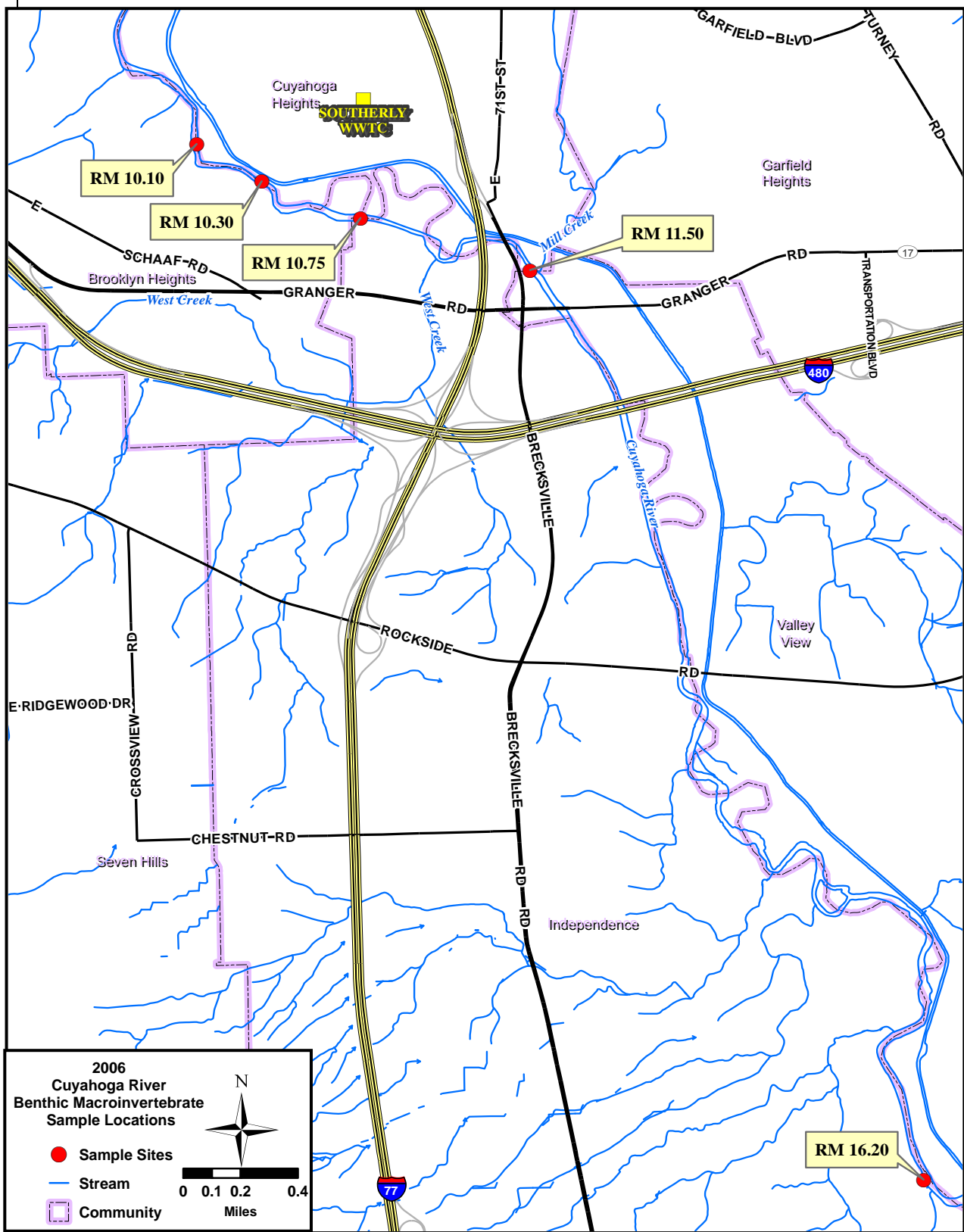


Figure 1.

All macroinvertebrate samples were collected by members of the NEORSD Water Quality and Industrial Surveillance (WQIS) staff. Quantitative and qualitative macroinvertebrate samples were shipped to EA Engineering, Science and Technology for identification and enumeration. EA Engineering, Science and Technology identified the specimens to the lowest practical taxonomic level and whenever possible, to the level of taxonomy recommended in Ohio EPA's *Biological Criteria for the Protection of Aquatic Life, Volume III* (1987, updated September 30, 1989).

## Results

Ohio EPA uses the Invertebrate Community Index (ICI) to evaluate the overall aquatic macroinvertebrate community in streams. The ICI consists of ten functional and structural community metrics, each with four scoring categories. Metrics 1-9 are based on the quantitative sample while Metric 10, number of EPT taxa, is based on the qualitative sample. Eight of the ten metrics are positive metrics, where an increase in the metric value indicates a *positive* increase, or beneficial increase, in the biological quality of the site. However, Metric #8 (Percent Other Dipteran and Non-insect Composition) and Metric #9 (Percent Tolerant Organisms) are classified as negative metrics. Therefore, an increase in either metric value indicates a *negative* increase, or beneficial decrease, in the biological quality of the site. The total of the individual metric scores result in the ICI score; where the higher the score, the less impacted the site. This point system evaluates the sample against Ohio EPA's relatively unimpacted reference sites. It should be noted that use of the ICI alone can only determine partial attainment of WWH biocriteria. In order to determine full attainment, an ICI score must be paired with Index of Biotic Integrity (IBI) and Modified Index of Well Being (MIwb) data, which are based on a survey of the fish community, for the same site. IBI and MIwb data for RM 10.75, RM 10.30 and RM 10.10 can be found in the NEORSD *Cuyahoga River Electrofishing Report, 2006*.

Results for sampling from 2006 are presented in Table 2. A list of collected taxa is in Appendix A.

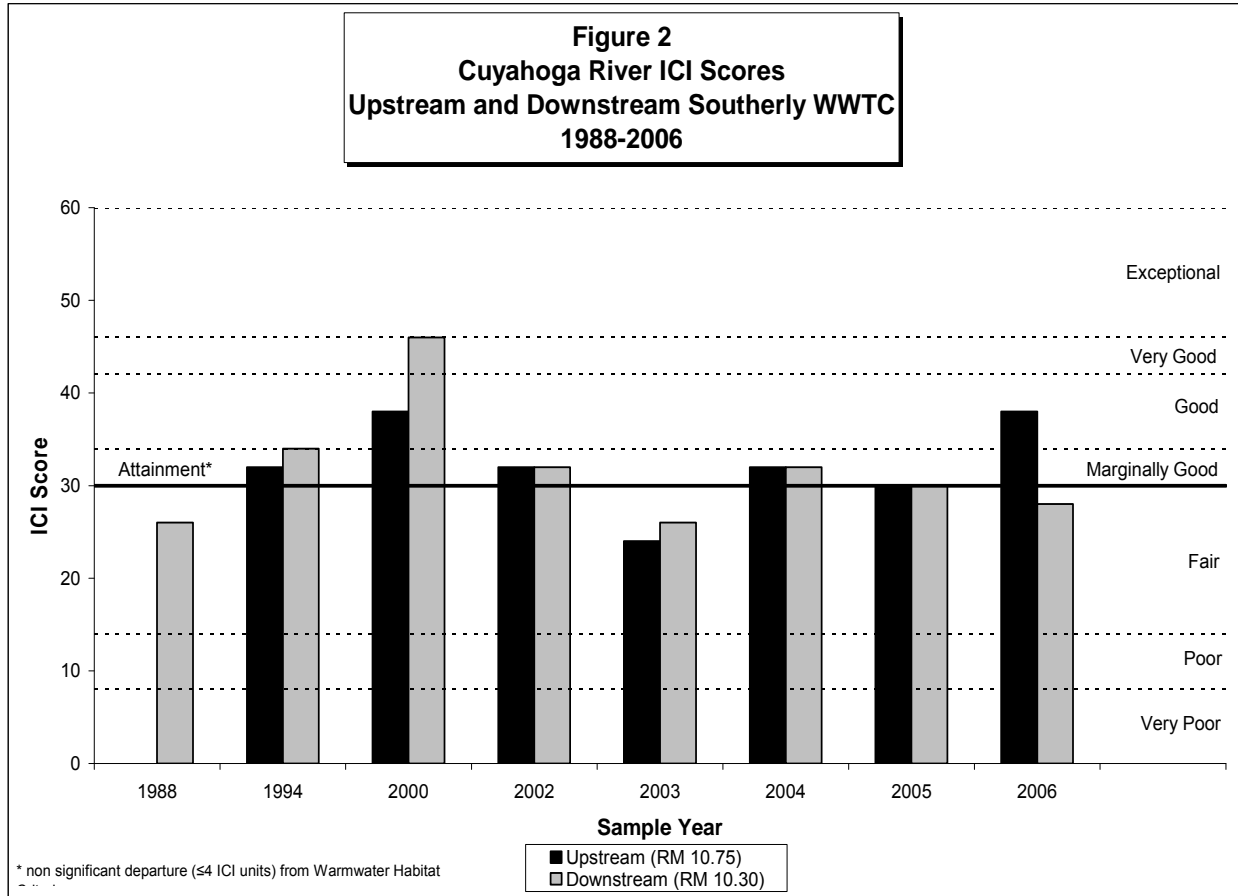
	RM 16.20	RM 11.50	RM 10.75	RM 10.30	RM 10.10
Index/Metric	Value (Score)	Value (Score)	Value (Score)	Value (Score)	Value (Score)
Total Organisms	2330	397	2303	352	3332
Total Taxa	22 (2)	32 (4)	23 (4)	25 (4)	20 (2)
Mayfly Taxa	2 (0)	5 (2)	2 (0)	3 (2)	2 (0)
Caddisfly Taxa	4 (4)	5 (4)	4 (4)	3 (4)	5 (4)
Dipteran Taxa	9 (4)	15 (6)	13 (6)	16 (6)	9 (4)
% Mayfly Composition	5.2 (2)	15.6 (4)	14.7 (4)	14.5 (4)	3.9 (2)
% Caddisfly Composition	55.7 (6)	23.7 (4)	44.9 (6)	14.5 (2)	68.2 (6)
% Tanytarsini Composition	9.6 (2)	6.0 (2)	9.7 (2)	15.9 (4)	7.7 (2)

Table 2. 2006 Cuyahoga River ICI Metric and Index Scores

	RM 16.20	RM 11.50	RM 10.75	RM 10.30	RM 10.10
% Other Dipteran Composition	26.7 (4)	43.3 (0)	25.8 (4)	50.3 (0)	18.3 (6)
% Tolerant Organisms	0.7 (6)	11.8 (0)	1.4 (6)	13.6 (0)	0.5 (6)
Qualitative EPT Taxa	9 (2)	7 (2)	6 (2)	7 (2)	6 (2)
Total ICI Scoring	32	28	38	28	34
Narrative Rating	Marginally Good	Fair	Good	Fair	Good

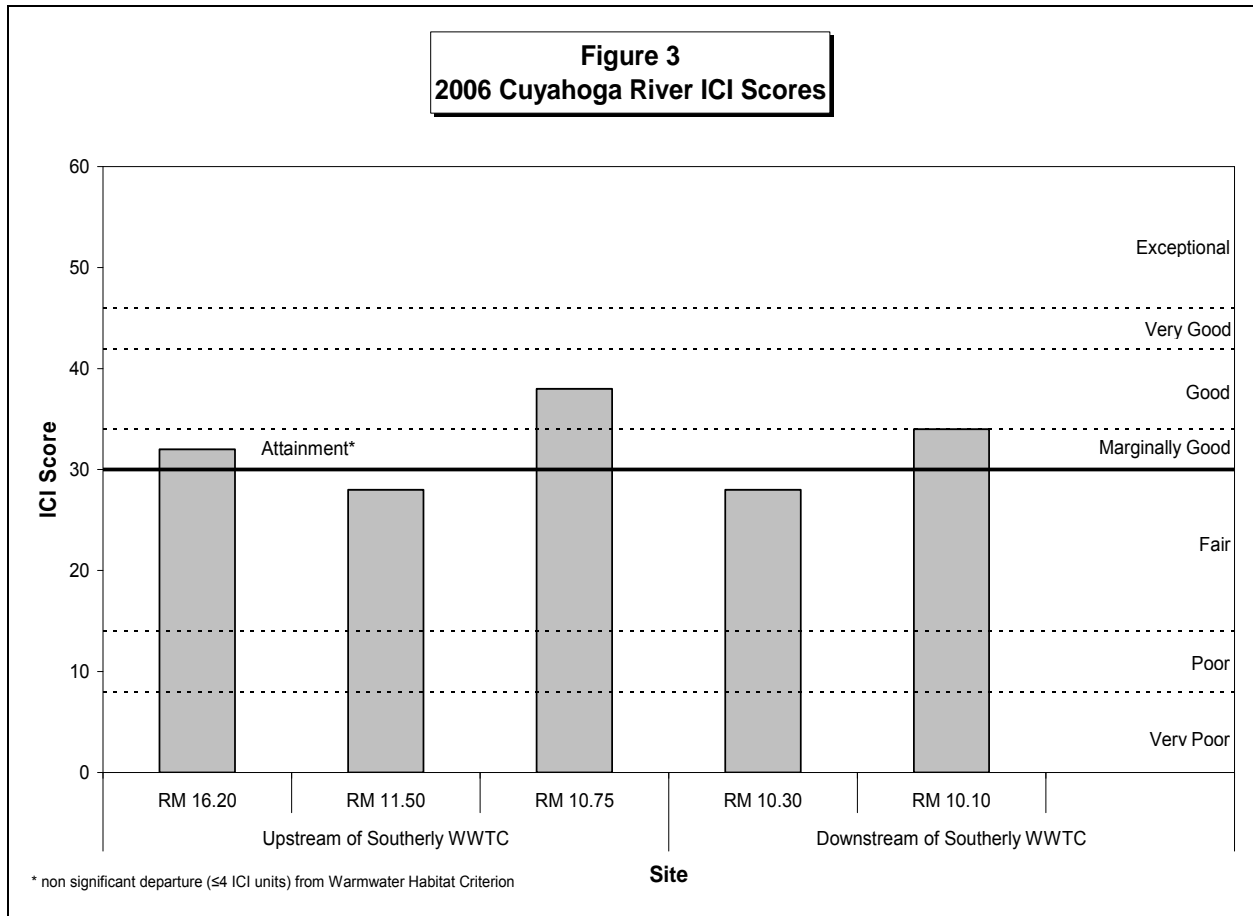
**Sites RM 10.75 and RM 10.30**

Historic ICI scores from 1988 to 2006 are displayed graphically in Figure 2. Recently, in 2004, Cuyahoga River sites upstream and downstream of Southerly WWTC, RM 10.75 and RM 10.30 respectively, both resulted in ICI scores of 32, a higher score for each site than in 2003. A score of 32 falls within the *Good* range and also within non-significant departure ( $\leq 4$  ICI units) of the WWH attainment criterion of 34 for the Erie/Ontario Drift and Lake Plain ecoregion. ICI scores at both sites decreased to 30 or *Marginally Good* in 2005, but remained within non-significant departure of the criterion. In 2006, the ICI score for RM 10.75 increased from 30 to 38 or *Good*, while RM 10.30 decreased from 30 to 28 or *Fair*. In general, ICI scores for RM 10.75 have increased since 2003 and therefore, have remained in attainment, either entirely or within non-significant departure. On the contrary, the ICI scores for RM 10.30 have decreased since 2004 to the *Fair* range. Individual metric values and scores are presented in Table 2.



### **Supplemental Sites RM 16.20, RM 11.50 and RM 10.10**

RM 16.20, the furthest upstream site on the Cuyahoga River, resulted in an ICI score of 32, within non-significant departure ( $\leq 4$  ICI units) of the WWH attainment criterion of 34 for the Erie/Ontario Drift and Lake Plain ecoregion. This location is meant to serve as a reference site for the study as it has been in an area of known attainment by the Ohio EPA since 2000. RM 11.50 is located upstream of RM 10.75 and downstream of the confluence of Mill Creek with the Cuyahoga River. RM 11.50 received an ICI score of 28, and therefore, is not in attainment. Site RM 10.10 is located downstream of RM 10.30, in an area more conducive to macroinvertebrate colonization, due to the presence of a functional, cobble/gravel riffle located in shallow water of moderate flow. This site received an ICI score of 34 and, as a result, is in attainment. The ICI scores for these sites in comparison to upstream and downstream of Southerly WWTC are depicted graphically in Figure 3.



## **Individual Biological Metrics**

### **Taxa Richness**

Of the five sites sampled in 2006, the greatest number of taxa, 32, occurred at RM 11.50, while the lowest number, 20, occurred at RM 10.10. RM 16.20 had 22 taxa and taxa richness increased from 2005 to 2006 at RM 10.75 and RM 10.30.

### **Total Caddisfly Taxa**

The number of caddisfly taxa was highest at sites RM 11.50 and RM 10.10, compared to all of the sites sampled in 2006. Both sites, representing locations upstream and downstream of Southerly WWTC, had five caddisfly taxa. RM 16.20 had four caddisfly taxa. RM 10.30 had the lowest number of caddisfly taxa, three. The total number of caddisfly taxa remained the same from 2005 to 2006 at both RM 10.75 and RM 10.30.

### **Percent Caddisfly Composition**

In 2006, of the five sites sampled, the largest percent of caddisflies, 68.2%,

occurred at RM 10.10, located downstream of Southerly WWTC, compared to RM 16.20, located upstream of Southerly WWTC, which had 55.7%. RM 11.50 had 23.7%. RM 10.30 had the smallest percent of caddisflies, 14.5%. The percent of caddisflies from 2005 to 2006 decreased at RM 10.75, from 70.6% to 44.9% and, most notably, at RM 10.30, from 63.4% to 14.5%.

#### Total Mayfly Taxa

The largest number of mayfly taxa, five, occurred at RM 11.50 in 2006 at the sites sampled and the smallest number, two, occurred at RM 16.20 and RM 10.10. At RM 10.75, the number of mayfly taxa, two, remained consistent from 2005 to 2006. The number of mayfly taxa increased from 2005 to 2006 at RM 10.30, from two to three.

#### Percent Mayfly Composition

Of the five sites sampled in 2006, the largest percent of mayflies, 15.6% occurred at RM 11.50 and the smallest, 3.9% at RM 10.10. RM 16.20 had 5.2%. RM 10.75 and RM 10.30 had similar percent mayfly compositions of 14.7% and 14.5%, both of which were increases from 2005 percentages of 1.7% and 3.0%, respectively.

#### Total Diptera Taxa

Of the five sites sampled in 2006, RM 10.30 had the largest number of Dipteran taxa, 16, while RM 10.75 had 13 taxa. RM 10.75 and RM 10.30 had substantial increases of total Dipteran taxa in 2006, compared to 2005, with nine and seven taxa, respectively. RM 16.20 and RM 10.10 had the lowest number of Dipteran taxa, both with nine. RM 11.50 had 15 Dipteran taxa.

#### Percent Tanytarsini Composition

RM 10.30 had the largest percent Tanytarsini composition, 15.9%, in 2006 compared to the five other sites sampled. RM 10.75 had 9.7%. Again for RM 10.75 and RM 10.30, 2006 percentages were great increases compared to 2005 where RM 10.75 had 0.4% and RM 10.30 had 1.8%. RM 11.50 had the smallest percent Tanytarsini composition, 6.0%. RM 16.20 had 9.6% and RM 10.10 had 7.7%.

#### Percent Other Dipterans and Non-Insects Composition

In 2006, of the five sites sampled, RM 10.10 had the smallest percent other composition with 18.3%, while RM 11.50 had 43.3% and RM 16.20 had 26.7%. RM 10.30 had the largest percent other composition with 50.3%. RM 10.75 had 25.8%. This is a decrease for RM 10.75 compared to 30.3% in 2005, but an increase for RM 10.30 compared to 23.1% in 2005.



## Percent Tolerant Organism Composition

RM 10.10 had the lowest percent of tolerant organisms, 0.5%, in 2006 of the five sites sampled. RM 16.20 had 0.7% and RM11.50 had 11.8%. RM 10.30 had the largest percent of tolerant organism composition, 13.6%. RM 10.75 had 1.4%. This is an increase in the percent tolerant organisms for RM 10.75 compared to 0.2% in 2005 and an increase for RM 10.30 compared to 0.6% in 2005.

## Qualitative EPT

RM 16.20 had the highest number of EPT taxa, nine, of the five sites sampled in 2006. RM 11.50 and RM 10.30 had seven EPT taxa and RM 10.10, while RM 10.75 had the lowest number of EPT taxa, six. Both RM 10.75 and RM 10.30 had six EPT taxa in 2005. Compared to 2005 results, RM 10.75 remained constant with six EPT taxa while the EPT taxa at RM 10.30 increased from 6 to 7 in 2006.

## **Discussion and Conclusions**

### **Sites RM 10.75 and RM 10.30**

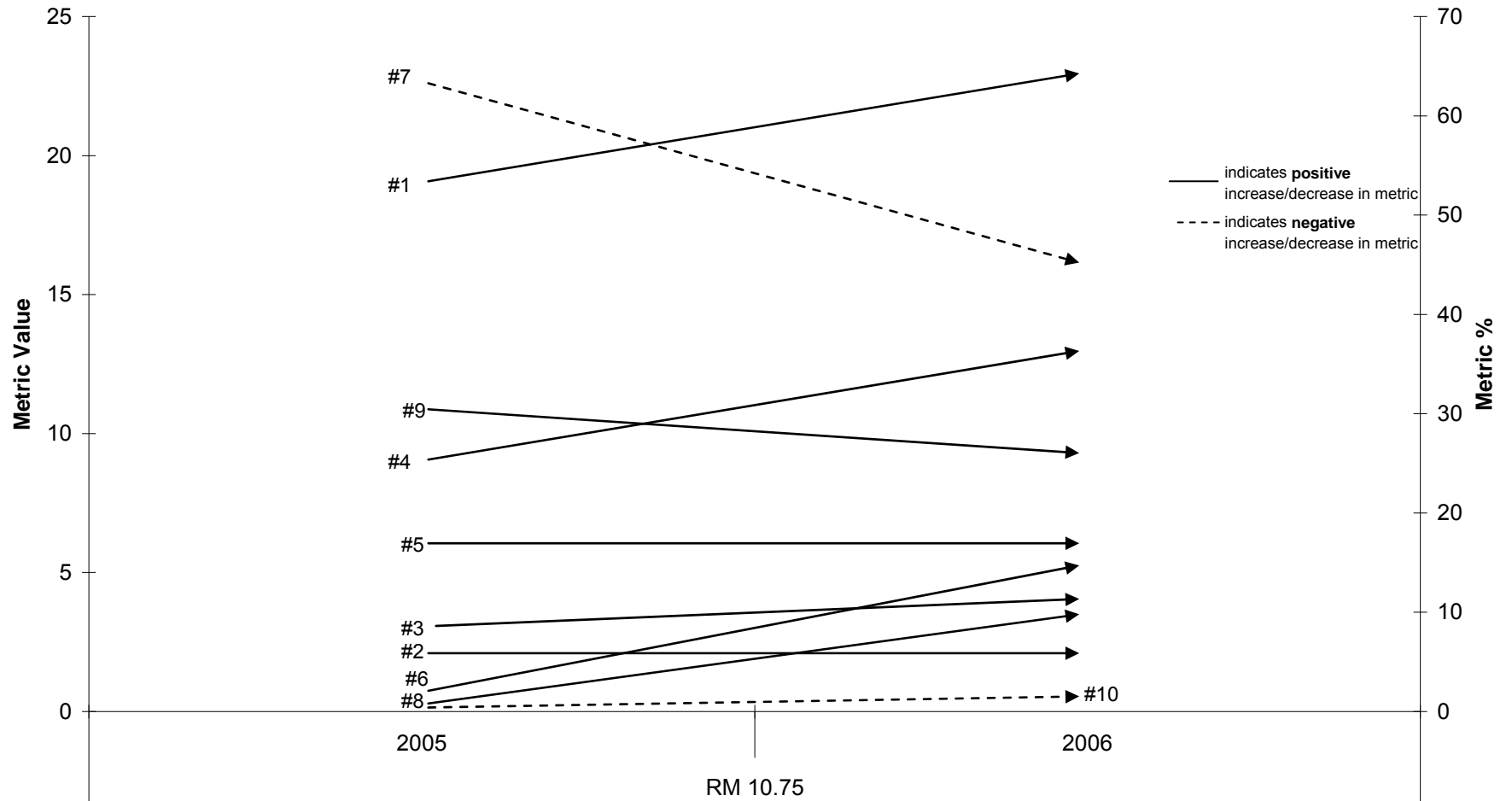
A large increase in the ICI score at RM 10.75, resulting in WWH attainment, indicates an improvement in upstream water quality, either from upstream tributaries and/or the river itself. Trends since 2000 at RM 10.75 show specifically that the percent other and non-insect composition metric has *positively* decreased, with scores at zero in 2002 and 2003, increasing to two in 2004 and 2005 and increasing again in 2006 to four. The improvement in the macroinvertebrate community at RM 10.75, as seen in Figure 4, resulted from eight of the ICI metrics remaining constant since 2005, *positively* increasing from 2005 or *positively* decreasing in 2005. Only two of the metrics decreased since 2005, percent caddisfly composition *negatively* decreased and percent tolerant composition *negatively* increased. Due to the metrics that *positively* increased and *positively* decreased, the ICI score from 2005, 30, increased in 2006 to 38.

As the ICI score at RM 10.30 decreased from 2005 to 2006, the general decrease over the past three years of sampling can be summarized as a reduction of four metric points. While this may be attributed to a number of factors, a primary reason would be the increase of pollution tolerant organisms. This increase would indicate impairment of the water quality, from organic pollution or a toxic load, at RM 10.30 (DeShon, 1995). Since 2000, percent other Dipteran and non-insect composition at RM 10.30 have *negatively* increased, resulting in scores of two in 2002, decreasing to zero in 2003 and 2004, temporarily increasing to four in 2005 and again decreasing to zero in 2006. This additionally suggests that organic and other pollution inputs upstream are increasing and altering water quality conditions to be more conducive to organisms more tolerant to pollution.

The decline in ICI scores in 2005 to 2006, from 30 to 28, at RM 10.30 are depicted in Figure 5. This decrease resulted from two *negative* increases, percent tolerant organism composition and other Dipteran and non-insect composition, and two *negative* decreases, % caddisfly composition and number of caddisfly taxa. All other metrics *positively* increased from 2005 to 2006. However, as the decrease in the ICI score from 2005 to 2006 was less than 7%, the decrease may be attributed to natural variability from year to year and not necessarily due to impacts of pollution or toxics.

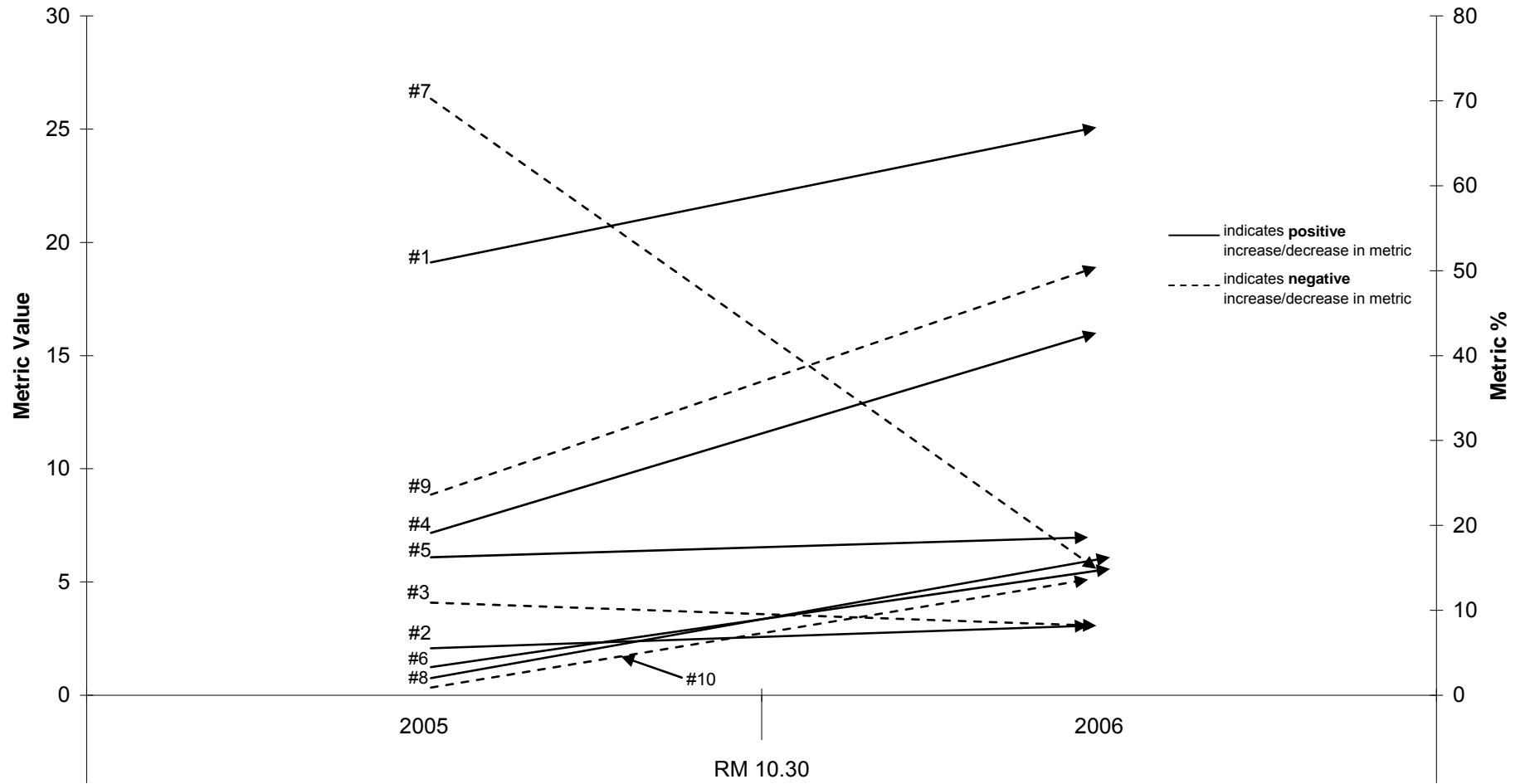
Appropriately, additional monitoring is necessary to determine if the increase and decrease in ICI scores at RM 10.75 and RM 10.30, respectively, are the beginning of new macroinvertebrate community trends or are temporary as a result of natural variation. One variation may be the changing flow rate of the Cuyahoga River. In 2005, the average flow during the HD colonization period, as recorded at the United States Geological Survey gage located in Independence, Ohio was 1,418 cubic feet per second (cfs), compared to 718 cfs in 2006. Increased average flow rates, due to periods of high rainfall, have the ability to scour the HD samplers, thereby reducing the number and diversity of macroinvertebrates collected.

**Figure 4**  
**2005 v. 2006 ICI Metrics for Cuyahoga River Upstream of Southerly WWTC**



#1 Total Taxa	#2 Mayfly Taxa	#3 Caddisfly Taxa	#4 Dipteran Taxa	#5 Qualitative EPT Taxa
#6 % Mayfly Composition	#7 % Caddisfly Composition	#8 % Tanytarsini Composition	#9 % Other Dipteran Composition	#10 % Tolerant Organisms

**Figure 5**  
**2005 v. 2006 ICI Metrics for Cuyahoga River Downstream of Southerly WWTC**



#1 Total Taxa	#2 Mayfly Taxa	#3 Caddisfly Taxa	#4 Dipteran Taxa	#5 Qualitative EPT Taxa
#6 % Mayfly Composition	#7 % Caddisfly Composition	#8 % Tanytarsini Composition	#9 % Other Dipteran Composition	#10 % Tolerant Organisms

### **Supplemental Sites RM 16.20, RM 11.50 and RM 10.10**

Of the three supplemental sites, RM 10.10 had the highest ICI score, 34, and was in attainment along with RM 16.20, which had an ICI score of 32 and was therefore, within non-significant departure of the WWH criterion. RM 11.50 received one of the two lowest ICI scores of all the Cuyahoga River sites in 2006, 28, due to a high percentage of other dipterans and non-insects and pollution tolerant organisms. This would indicate that the confluence of Mill Creek and/or other point/non-point source(s) upstream of the sampling sites, but downstream of RM 16.20, are negatively influencing the water quality of the Cuyahoga River receiving water, though not to the extent of negatively affecting RM 10.75.

Evaluation of the data from the supplemental sites is rudimentary, as little to no additional data exists for comparison purposes. The macroinvertebrate community at RM 15.60, located about one-half mile downstream of RM 16.20, was sampled in 2000 by the Ohio EPA and was found to be in attainment with an ICI score of 44 (*Total Maximum Daily Loads for the Lower Cuyahoga River*, 2003). The condition of the macroinvertebrate community in 2000 at RM 15.60 was similar to the community found at RM 16.20 in 2006. While the ICI score was lower at RM 16.20 in 2006 compared to RM 15.60 in 2000, the ICI score remained within non-significant departure of attainment. As both sites are located upstream of Mill Creek, the resulting ICI score at RM 11.50 of 28 indicates the presence of a negative impact source between RM 16.20 and RM 11.50, one of which may be Mill Creek.

Downstream of Southerly WWTC, the ICI score at RM 10.10, 34, indicated a macroinvertebrate community in attainment as compared to a score of 28 at RM 10.30, which is approximately 0.2 miles upstream of RM 10.10. The six point difference in ICI scores between sites RM 10.30 and RM 10.10 warrants further sampling. Due to the short distance between the two sites and as there are no known point sources within this distance, the difference in scoring may be attributable to differences in physical habitat quality and/or non-point sources causing adverse water quality conditions. The physical habitat at RM 10.10 is more conducive to macroinvertebrate colonization compared to RM 10.30, as RM 10.10 has a functional, cobble/gravel riffle located in shallow water of moderate flow, and RM 10.30 is located in an area of a deep run.

Collection of additional data in 2007 and subsequent years is necessary to determine long term trends of ICI scores at each site. More supplemental sites are scheduled to be added in 2007 in order to better understand the overall macroinvertebrate community health in the river in relation to potential impacts from point and non-point sources of pollution, which may facilitate the identification of impairment sources. All supplemental sites will also be within the NEORSD electrofishing zones on the Cuyahoga River, allowing for the determination of biocriteria attainment status at each site.