RAPID BIOASSESSMENT
OF COMBINED SEWER OVERFLOW EFFECTS

WABASH RIVER
TIPPECANOE COUNTY, INDIANA

August 2009

by:

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Submitted to the Cities of Lafayette and West Lafayette, Indiana

September 2009

EXECUTIVE SUMMARY

Benthic macroinvertebrate samples were collected from the Wabash River in Tippecanoe County, Indiana in August 2009. The purpose of the study was to determine whether combined sewer overflows (CSOs) from the cities of Lafayette and West Lafayette contributed to impairment of the river's ability to support a well-balanced warmwater aquatic community. This was part of an ongoing monitoring study started at these sites in 1992.

Ten sites were examined for aquatic life, both upstream and downstream from the CSO discharge points on the east and west banks of the river over a 4 km area in central Tippecanoe County. Sampling methods and data analysis used a rapid bioassessment technique developed by U.S. EPA. Woody debris, such as submerged logs and branches, located in areas of strong current was the substrate selected for sampling at each site.

River flows during the twelve months preceding sampling were above normal most of the time., The benthic community of the river had an average biotic index value indicative of slightly impaired conditions. Caddisfly and mayfly larvae (which are relatively pollution intolerant) were common. Two of the ten sites examined had biological values indicative of no impairment; six other sites had "slight" impairment. Sites 8 (within the CSO zone on the Lafayette side) and Site 5 on the West Lafayette site (the site downstream from all wastewater and CSO discharges) had "moderate" biological impairment.

Benthic samples collected from this area of the Wabash River during the past 18 years have shown that water quality of the river is highly variable from year to year. Water quality was noticeably impaired in 2001 and 2002, but more recent studies from 2003 to 2009 have indicated improving water quality.

INTRODUCTION

The Cities of Lafayette and West Lafayette commissioned a study of the Wabash River to determine whether combined sewer overflows (CSOs) contribute to water quality problems in the river. Biological monitoring provides a more "integrated" approach for determining CSO effects than chemical sampling, since fish and benthos are continuously exposed to changing environmental conditions in the river. Studies by numerous investigators have shown that monitoring biological conditions in a waterbody is a more direct way of determining water quality than making individual chemical measurements. Identical studies were conducted on this segment of the Wabash River during 1992, 1997, and 1999 to 2008. Zones of impacted water quality associated with CSO events had been identified in some of the previous studies.

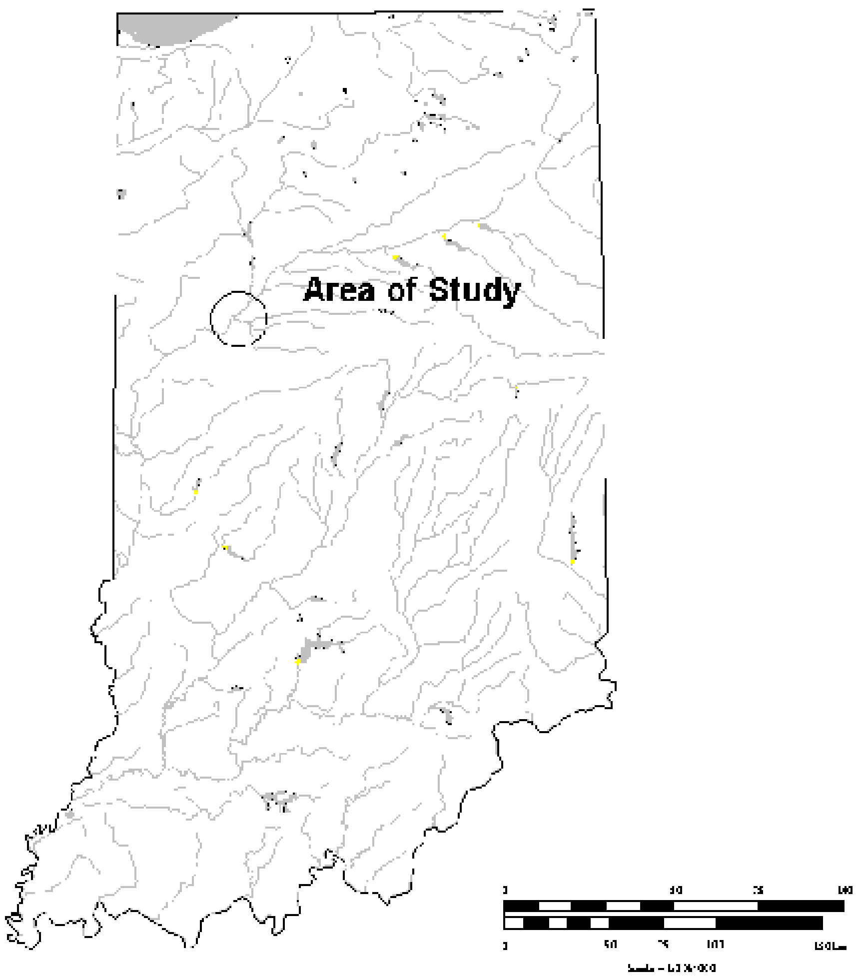
DESCRIPTION OF THE WABASH RIVER

The Wabash River in Tippecanoe County is a "sixth order" stream with a drainage area of nearly 20,000 square kilometers (Fig. 1). Average width of the river is about 60 meters, with pools up to 3 meters deep. None of the river is channelized but riffle areas are scarce and the zone of protective riparian vegetation along the river’s banks is very thin or absent in many areas. The Indiana Department of Environmental Management considers this segment of the Wabash River as fully supporting its aquatic life use designation but not supporting its recreational uses due to *E. coli* contamination [1].

Aquatic habitat analysis conducted using Ohio EPA techniques [2] showed that habitat within the Tippecanoe County portion of the river was similar at each of the five sites (habitat scores of 90 out of a possible 100). This score indicates that aquatic habitat in the river is "good," according to EPA's scoring criteria. Habitat suffers somewhat from a paucity of cobble or gravel substrates in some areas. The most common stable substrate in the river is woody debris from submerged trees.

West Lafayette occupies the west side of the Wabash River in central Tippecanoe County, while the City of Lafayette sits on the river’s east side. There are 20 combined sewer overflow points in this area (4 from West Lafayette and 16 from Lafayette). Upstream from Tippecanoe County, the river also receives point source and/or CSO discharges from the Cities of Logansport, Peru, Wabash, Huntington, and Bluffton.

Figure 1.



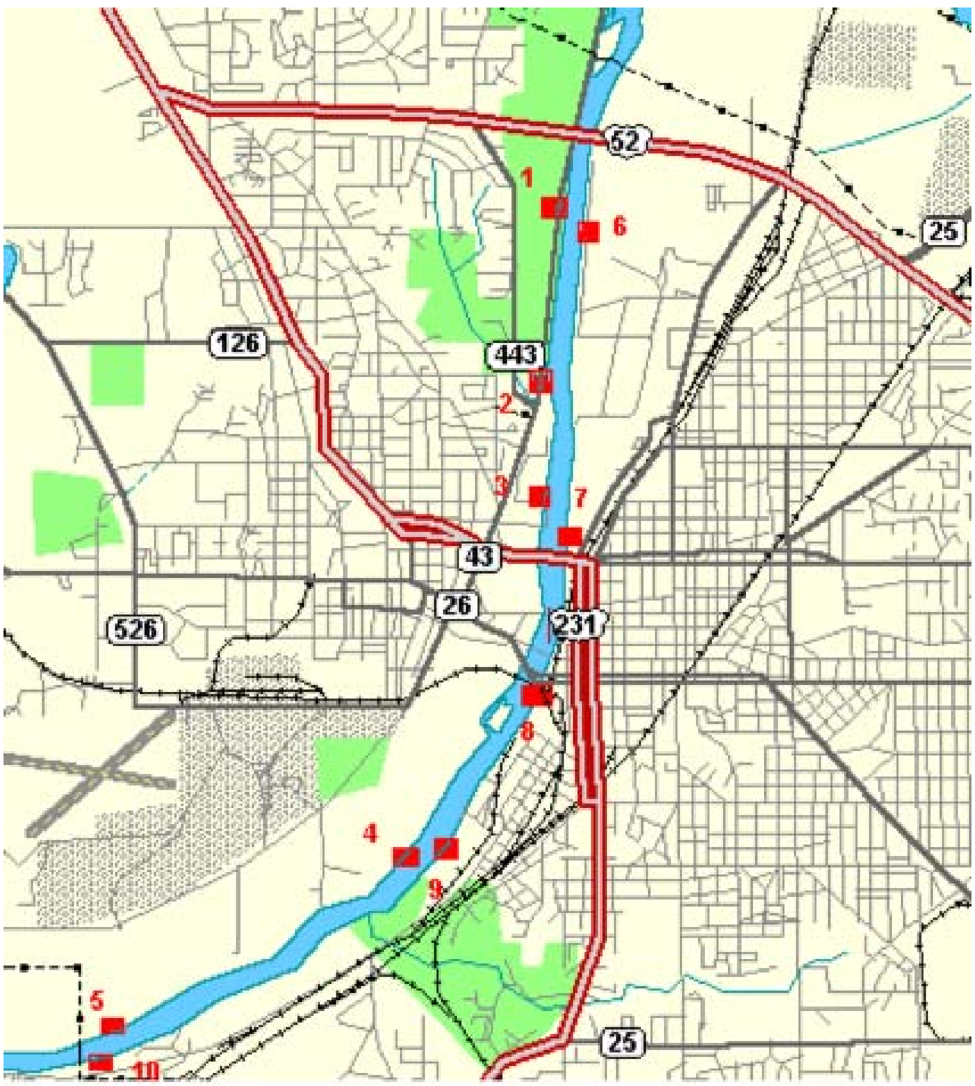
Site Map for the Wabash River

RAPID BIOASSESSMENT

SAMPLING SITES

Ten sites were chosen for study (Figure 2). Sampling was conducted on August 17, 2009. Sites 1 and 6 were upstream from all CSOs and point source discharges. Sites 2 - 4 were located within the zone of West Lafayette CSO influence (along the west bank of the river). Sites 7 - 9 were within the zone of Lafayette CSO influence (along the east bank of the river). Site 5 was downstream on the west side of the river near the Highway 231 bridge. Site 10 was downstream from the Lafayette WWTP and Durkee Run CSO discharges.

Figure 2. Sampling Sites



SAMPLING METHODS - BIOASSESSMENT

The methods used for bioassessment were adapted from the U.S. EPA Technical Support Document Rapid Bioassessment Protocols for Use in Streams and Rivers [3]. Benthic macroinvertebrate samples were collected and analyzed according to Protocol III, which requires a standardized collection technique, a standardized sub-sampling technique, and identification to the genus or species level. Macroinvertebrates were collected from submerged woody debris located in where current speed was 20-30 cm/sec. A dipnet was placed in the river immediately downstream from a submerged log or branch and the attached animals were dislodged by hand. The drifting animals were trapped in the net, then transferred to a white pan. When at least 100 organisms were captured, they were passed through a sieve. The retained animals were preserved in the field with 70% isopropanol for subsequent processing in the laboratory.

In the laboratory, a 100-organism subsample was prepared from each site by evenly distributing the whole sample in a white pan with 100 grids of 1 square cm each. Grids were randomly selected and all organisms within grids were removed until 100 organisms had been selected from the sample. Each of the 100 organisms was identified to the lowest practical taxon (usually species).

MACROINVERTEBRATE DATA ANALYSIS

The macroinvertebrate data were analyzed using eight different biometric analyses of community structure, which, when added together, provide an ecological score for each site. The score of each potential impact site is compared to that of a reference site at which no known impacts are expected. The bioassessment technique provides a direct measurement of ecological integrity and allows various sites to be ranked according to degree of impact.

Because the EPA bioassessment protocol depends on data from a separate CPOM (coarse particular organic matter) sample which cannot be collected on artificial substrates, we substituted a metric from Ohio EPA's bioasessment protocol [2] for EPA’s shredder metric. Ohio EPA's protocol recognizes an increasing percentage of mayflies in the sample as being an indicator of biotic integrity.

The studies conducted from 1992 through 2008 have resulted in an increasingly large body of data for each metric (a total of 113 benthic collections have been made using the same technique in this stretch of river). With these data, it is possible to develop a set of benthic biotic integrity expectations for the Wabash River in Tippecanoe County. A summary of the data collected for each site is shown in the Appendix. Biotic integrity expectations were developed by dividing the data for each metric into quartiles. The upper quartile was assigned a value of 6, the second highest quartile a value of 4, the third highest quartile a value of 2, and the lowest quartile a value of 0. The resulting IBI scoring values for eight metrics are shown in Table 1. Adding the scores for each of eight metrics results in a score for each sample site studied to date.

RESULTS

MACROINVERTEBRATE IBI METRICS AND SCORING
BASED ON 93 SAMPLES IN TIPPECANOE COUNTY

Table 1.

	6 points	4 points	2 points	0 points
Number of Genera	>18	16-18	13-15	<13
Hilsenhoff Index	<5.3	5.3-5.8	5.8-6.3	>6.3
Scrapers:Filterers	>1.2	0.8-1.2	0.3-0.7	<0.3
EPT:Chironomids	>6	4-6	1-3	<1
% Dominant Taxon	<20	20-30	30-40	>40
EPT Genera	>8	7-8	5-6	<5
Community Loss Index	<0.5	0.5-1	1-1.5	>1.5
Percent Mayflies	>40	25-40	10-25	<10

TOTAL SCORE The sum of the scores for each of the eight metrics

	TOTAL SCORE
NO IMPACT	>36
SLIGHT IMPACT	26-36
MODERATE IMPACT	16-25
SEVERE IMPACT	<16

BENTHOS SAMPLING RESULTS

Benthic macroinvertebrates identified and enumerated at each site are shown in the Appendix. A total of 40 different genera were collected from the river during the sampling period. Mayfly and caddisfly larvae were common. These groups (called EPT Taxa) are relatively sensitive to water pollution. The most abundant organisms varied by site and included the tolerant midge larvae *Glyptotendipes*, and the mayfly *Tricorythodes*.

Bioassessment summaries are shown in Tables 2 and 3. The average biotic index score for the ten study sites was 28 out of a possible 48 points. This value is in the category of "slight impairment" (Table 1). The lowest index value (16) was at site 5, immediately downstream from the West Lafayette WWTP, and site 8 within the Lafayette CSO zone. The highest index value (40) was at site 6 (upstream from the Lafayette CSO zone). The next highest index value (38) was at site 9 (within the Lafayette CSO zone).

Table 2
A Bioassessment Summary
Metric Data Observed at Each Site

Metrics	Site 1	Site 2	Site 3	Site 4	Site 5
Taxa Richness (# of Genera)	19	17	16	19	13
HBI	5.7	5.5	5.8	6.9	7.4
Scrapers/Filterers	0.4	2.7	0.2	0.8	15
EPT/Chironomids	1.7	1.4	1.2	0.3	0.8
% Dominant Taxon	15	33	20	24	53
EPT Index	11	6	8	9	4
CLI	0.31	0.47	0.50	0.26	0.77
% Mayflies	21	48	33	15	26

Table 2, con't.
A Bioassessment Summary
Metric Data Observed at Each Site

Metrics	Site 6	Site 7	Site 8	Site 9	Site 10
Taxa Richness (# of Genera)	19	16	18	21	20
HBI	5.5	6.1	7.4	5.7	7.7
Scrapers/Filterers	1.0	0.6	0.6	1.7	1.7
EPT/Chironomids	1.4	1.1	0.3	0.9	0.3
% Dominant Taxon	13	21	44	15	46
EPT Index	10	7	6	10	9
CLI	0.26	0.37	0.30	0.19	0.40
% Mayflies	42	25	14	34	16

Table 3
A Bioassessment Summary
Metric Scores Observed at Each Site

	Site 1	Site 2	Site 3	Site 4	Site 5
Taxa Richness	6	4	4	6	2
HBI	4	4	4	0	0
Scrapers/Filterers	2	6	0	2	6
EPT/Chironomids	2	2	2	0	0
% Dominant Taxon	6	2	4	4	0
EPT Index	6	2	4	6	0
CLI	6	6	4	6	4
% Mayflies	2	6	4	2	4
TOTAL SCORE	34	32	26	26	16
IMPAIRMENT CATEGORY	S	S	S	S	M

N = no impairment
S = slight impairment
M = moderate impairment
Sv = severe impairment

Table 3, con't.

A Bioassessment Summary
Metric Scores Observed at Each Site

	Site 6	Site 7	Site 8	Site 9	Site 10
Taxa Richness	6	4	4	6	6
HBI	4	2	0	4	0
Scrapers/Filterers	4	2	2	6	6
EPT/Chironomids	2	2	0	0	0
% Dominant Taxon	6	4	0	6	0
EPT Index	6	4	2	6	6
CLI	6	6	6	6	6
% Mayflies	6	4	2	4	2
TOTAL SCORE	40	28	16	38	26
IMPAIRMENT CATEGORY	N	S	M	N	S

N = no impairment
S = slight impairment
M = moderate impairment
Sv = severe impairment

DISCUSSION

Figure 3 shows a summary of river flows during the 12 months preceding the sample collection. Flows were above average much of the year. River flows were near normal during the biological sampling period.

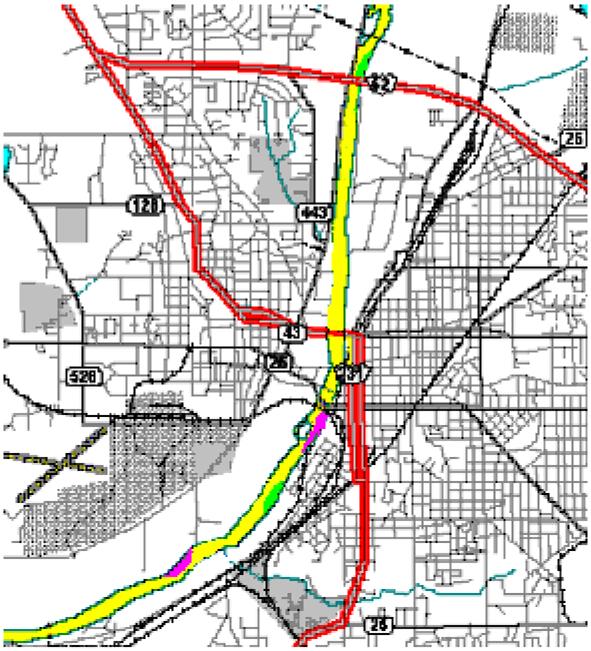
Site 1 (upstream from the West Lafayette CSO zone) had a biological integrity score (34) indicative of slight biological impairment. Sites 2, 3 and 4 had biological integrity scores (32, 26 and 26) indicative of slight biological impairment. Site 2 is downstream from CSO outfall 003, which experienced 57 overflow events during the time period from October 2008 through August 17, 2009, Site 3 is downstream from CSO outfalls 004 and 006, which experienced a combined total of 50 overflow events during the same time period. Site 4 is at the West Lafayette Wastewater Treatment Plant. Site 5 is the most downstream site on the West Lafayette side of the river. This site had a biological integrity score of 16, indicating moderate biological impairment.

Site 6, upstream from the Lafayette CSO zone, had no biological impairment (total score of 40). Site 7 is downstream from CSO outfall 003 and had slight biological impairment (total score 28). During the time period from October 2008 through August 17, 2009, this outfall experienced 63 overflow events. Site 8 is had biological integrity score (16) that indicated moderate impairment. Site 8 is downstream from CSO outfall 004, which experienced 62 overflow events. Site 9 (Shamrock Park) had a biological integrity score (38) that indicated no impairment. Outfall 008 at Shamrock Park is no longer in service and the next upstream outfall is 007 at Williams Street. This outfall only had 42 overflow events during the time period from October 2008 through August 17, 2009. The most downstream site, site 10, had slight biological impairment (total score 26). The site is affected by Durkee’s Run, which has five CSO outfall locations associated with it.

Figure 3. USGS Stream Flow Data Summary

Figure 4

Green areas represent No Biological Impairment
Yellow Areas represent Slight Biological Impairment
Violet Area represents Moderate Biological Impairment



Relation to Previous Studies

Similar studies conducted in this area of the Wabash River during the past 18 years [7-18] showed that water quality of the river is highly variable from year to year. Some local impacts observed in 1992 and 1997 were probably related to bypasses and CSO overflows in the City of Lafayette and West Lafayette. The 1999 study found that water quality conditions had deteriorated significantly, especially at the monitoring site upstream from West Lafayette. Impairment that year was thought to be related to the unusually low flow conditions and to unidentified sources of nutrients and oxygen-consuming pollutants upstream from the Lafayette/West Lafayette area. Conditions improved in 2000 and 2001, but another set back was observed in 2002. Data from 2003 to 2005 showed a return to improved conditions. Water quality deteriorated during 2006, but again showed an improvement from 2007 to 2009.

Figure 5. Biotic integrity in the Wabash River, Tippecanoe County, Indiana 1992 through 2009.

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MACROINVERTEBRATE DATA FROM PREVIOUS SAMPLES FROM THE WABASH RIVER IN TIPPECANOE COUNTY - 1992-2008

	Sample #	1	2	3	4	5	6	7	8
Genera		15	13	16	17	25	19	18	22
HBI		5.3	5.3	5.6	5.6	5	5	6.4	5.4
S/F		1.6	0.8	1.2	0	2.9	0.1	0.5	0.1
EPT/Chir		0.8	1	0.7	0.4	2.3	9.5	2	1
% Dominant		30	22	36	57	27	18	25	27
EPT Genera		7	7	9	10	11	9	9	8
CLI		0	0.5	0.3	0.4	0	0.5	0.6	0.6
% Mayflies		30	14	20	8	36	14	19	4
Genera		2	2	4	4	6	6	6	6
HBI		6	6	4	4	6	6	0	4
S/F		4	4	4	0	6	0	2	0
EPT/Chir		0	2	0	0	2	6	2	2
% Dominant		2	6	2	0	4	6	4	4
EPT Genera		4	2	6	6	6	6	6	4
CLI		6	6	6	6	6	6	4	6
% Mayflies		4	2	2	0	4	2	2	0
Total Score		28	30	28	20	40	38	26	26

	Sample #	9	10	11	12	13	14	15	16
Genera		18	16	16	20	14	15	21	16
HBI		5.6	5	5.4	5.2	5.7	5.5	5.3	5.4
S/F		4.4	0.3	0.6	2.7	0.2	2.4	1.1	2
EPT/Chir		5.4	15	3.1	4.6	7.5	24	7	5.3
% Dominant		38	20	33	17	30	24	36	41
EPT Genera		8	9	8	11	6	7	10	9
CLI		0	0.5	0.4	0.5	0.8	0.5	0.3	0.4
% Mayflies		70	31	45	55	25	54	57	69
Genera		6	4	4	6	2	2	6	2
HBI		4	6	4	6	4	4	6	4
S/F		6	2	2	6	2	6	4	6
EPT/Chir		4	6	2	4	4	6	6	4
% Dominant		0	6	2	6	2	4	0	0
EPT Genera		4	6	4	6	2	2	6	6
CLI		6	6	6	6	4	6	6	6
% Mayflies		6	4	6	6	4	6	6	6
Total Score		36	40	30	46	24	36	40	34

	Sample #	17	18	19	20	21	22	23	24
Genera		18	11	18	15	19	12	11	17
HBI		5	5.7	6.9	6.2	6.4	7.9	5.8	6.5
S/F		1.8	0.4	0.8	0.2	1.2	0.1	0.1	1
EPT/Chir		17	4.2	0.5	1.3	1.4	0.3	2.8	1.6
% Dominant		17	26	22	15	18	38	21	18
EPT Genera		10	6	7	9	8	3	4	8
CLI		0.6	1.1	0.3	0.4	0.2	0.8	0.8	0
% Mayflies		61	41	12	7	14	2	5	15
Genera		6	0	6	2	6	0	0	4
HBI		6	4	0	2	0	0	4	0
S/F		4	2	2	2	4	0	0	4
EPT/Chir		6	4	0	2	2	0	2	2
% Dominant		6	4	4	6	6	2	4	6
EPT Genera		6	2	4	6	4	0	0	4
CLI		4	2	6	6	6	4	4	6
% Mayflies		6	6	2	0	2	0	0	2
Total Score		44	24	24	26	30	6	14	28

	Sample #	25	26	27	28	29	30	31	32
Genera		16	18	13	13	13	13	14	19
HBI		6.3	5.6	6.8	5.4	6.9	5.7	7.3	7.2
S/F		0.2	1.2	0.1	0	3.3	0.3	13	0.5
EPT/Chir		1.4	3.5	1.5	6.2	0.8	13	0.7	0.5
% Dominant		20	27	25	19	33	60	28	26
EPT Genera		7	9	8	4	4	8	4	6
CLI		0.4	0.3	0.5	0.7	0	0.3	0.3	0.1
% Mayflies		7	34	4	0	38	72	30	30
Genera		2	6	0	0	0	0	2	6
HBI		2	4	0	4	0	4	0	0
S/F		2	4	0	0	6	2	6	2
EPT/Chir		2	2	2	4	0	6	0	0
% Dominant		6	4	4	6	2	0	4	4
EPT Genera		4	6	4	0	0	4	0	2
CLI		6	6	6	4	6	6	6	6
% Mayflies		0	4	0	0	4	6	4	4
Total Score		24	36	16	18	18	28	22	24

	Sample #	33	34	35	36	37	38	39	40
Genera		12	14	17	12	7	12	14	18
HBI		8	8.8	7.7	7.9	5.1	5.6	5.3	5
S/F		0.3	3	1.1	0.1	0.2	0.2	0.1	0.3
EPT/Chir		0.4	0.1	0.1	0.2	99	24	22	10
% Dominant		46	20	34	28	20	25	18	29
EPT Genera		5	2	4	4	6	8	9	11
CLI		0	0.5	0.3	0.4	0	0.3	0.3	0.4
% Mayflies		1	0	0	1	36	21	24	30
Genera		2	2	4	2	0	2	2	6
HBI		0	0	0	0	6	4	6	6
S/F		2	6	2	0	2	2	0	2
EPT/Chir		0	0	0	0	6	6	6	6
% Dominant		0	4	2	4	6	4	6	4
EPT Genera		2	0	0	0	2	4	6	6
CLI		6	6	6	6	6	6	6	6
% Mayflies		0	0	0	0	4	2	2	4
Total Score		12	18	14	12	32	30	34	40

Sample #	41	42	43	44	45	46	47	48
Genera 14	16	12	18	25	10	16	11	
HBI	5.3	5.5	5.3	5.2	5.5	5.0	6.9	5.6
S/F	0.1	1.2	2.0	1.3	0.9	0.1	1.0	2.8
EPT/Chir	23	6.5	90	11	2.8	98	1.1	3.4
% Dominant	21	27	40	26	18	28	38	34
EPT Genera	8	9	8	10	10	8	7	7
CLI	0.1	0	0.4	0.3	0.4	0.1	0.0	0.9
% Mayflies	31	50	80	64	31	25	35	62

Genera 2	4	2	6	6	0	4	0	
HBI	6	4	6	6	4	6	0	4
S/F	0	4	6	6	40	4	6	
EPT/Chir	6	4	6	6	26	2	4	
% Dominant	4	4	2	4	64	2	2	
EPT Genera	4	6	4	6	64	4	4	
CLI	6	6	6	6	66	6	4	
% Mayflies	4	6	6	6	44	4	6	
Total Score	32	38	38	46	38	30	26	30

Sample #	49	50	51	52	53	54	55	56
Genera 12	14	15	13	14	13	18	13	
HBI	6.7	5.6	5.7	6.5	5.5	5.5	6.7	7.8
S/F	0.1	0.2	0.1	0.1	0.3	0.3	0.4	0.9
EPT/Chir	2.0	2.2	5.4	3.0	5.9	4.5	1.0	0.4
% Dominant	33	19	42	39	29	39	20	58
EPT Genera	5	4	8	5	8	6	9	6
CLI	0.4	0.6	0.6	0.4	0.4	0.7	0.4	0.4
% Mayflies	8	19	47	41	32	20	23	15

Genera 2	2	4	2	2	2	6	2	
HBI	0	4	4	0	4	4	0	0
S/F	0	2	0	0	22	2	4	
EPT/Chir	2	2	4	2	44	2	0	
% Dominant	2	6	0	2	42	6	0	
EPT Genera	2	0	4	2	42	6	2	
CLI	6	4	4	6	64	6	6	
% Mayflies	0	2	6	6	42	2	2	
Total Score	14	22	26	20	30	22	30	16

Sample #	57	58	59	60	61	62	63	64	65	66
Genera 10	15	11	6	10	12	9	11	12	13	
HBI	7.3	5.6	5.6	5.2	5.5	6.4	5.8	6.1	6.3	6.3
S/F	0.1	0.0	0.1	0.1	0.1	0.2	0.5	0.1	0.3	0.3
EPT/Chir	0.7	4.8	2.4	4.5	3.9	1.3	1.5	1.3	1.0	1.1
% Dominant	48	28	22	29	28	36	18	29	34	18
EPT Genera	5	6	5	2	6	6	4	5	4	5
CLI	0.0	0.3	0.3	0.4	0.1	0.0	0.4	0.3	0.4	0.1
% Mayflies	3	11	6	2	6	11	8	8	18	10

Genera 0	4	0	0	0	2	0	0	2	2	
HBI	0	4	4	6	4	0	2	2	2	2
S/F	0	0	0	0	02	2	0	2	2	
EPT/Chir	0	4	2	4	42	2	2	2	2	
% Dominant	0	4	4	4	42	6	4	2	6	
EPT Genera	2	2	2	0	22	0	2	0	2	
CLI	6	6	6	6	66	6	6	6	6	
% Mayflies	0	2	0	0	02	0	0	2	2	
Total Score	8	26	18	20	20	18	18	16	18	24

Sample #	67	68	69	70	71	72	73	74	75
Genera 16	20	16	25	16	13	22	13	13	
HBI	6.0	6.0	5.1	6.3	5.3	5.5	5.5	5.4	5.3
S/F	0.1	1.0	0.1	0.8	0.1	1.1	0.8	0.1	0.1
EPT/Chir	4.3	3.7	15	1.6	18	22	16	23	8.0
% Dominant	20	11	34	22	23	18	17	28	13
EPT Genera	10	10	10	13	10	8	13	9	8
CLI	0.4	0.3	0.3	0.4	0.1	0.4	0.3	0.4	0.1
% Mayflies	10	36	23	25	20	47	51	12	11

Genera 4	6	4	6	4	2	6	2	2	
HBI	2	2	6	2	6	4	4	4	6
S/F	0	4	0	4	04	4	0	0	
EPT/Chir	4	4	6	2	66	6	6	6	
% Dominant	6	6	2	4	46	6	4	6	
EPT Genera	6	6	6	6	64	6	6	4	
CLI	6	6	6	6	66	6	6	6	
% Mayflies	2	4	2	4	26	6	2	2	
Total Score	30	38	32	34	34	38	44	30	32

Sample	76	77	78	79	80	81	82	83	84	85
Genera	17	20	14	17	14	21	17	19	15	19
HBI	5.0	5.5	5.12	5.5	5.2	5.0	4.7	4.7	5.2	5.0
S/F	0.1	0.2	0.0	0.0	0.0	0.6	0.2	0.7	0.2	0.1
EPT/Chir	8.7	3.4	5.7	5.2	15.5	3.3	5.3	3.4	8.8	2.5
% Dominant	34	25	19	47	30	15	19	18	30	18

EPT genera	8	11	9	9	10	10	10	11	9	10
CLI	0.5	0.2	0.5	0.4	0.6	0.1	0.5	0.2	0.3	0.2
% Mayflies	18	45	35	58	8	31	33	41	17	14

Sample	76	77	78	79	80	81	82	83	84	85
Genera	4	6	2	4	2	6	4	6	2	6
HBI	6	4	6	4	6	6	6	6	4	6
S/F	0	0	0	0	0	2	0	2	0	0
EPT/Chir	6	2	4	4	6	2	4	2	6	2
% Dominant	2	4	6	0	4	6	6	6	4	6
EPT genera	4	6	6	6	6	6	6	6	6	6
CLI	6	6	4	6	4	6	6	6	6	6
% Mayflies	2	6	4	6	0	4	4	6	2	2
Total	30	34	32	30	28	38	36	40	30	34

Sample	86	87	88	89	90	91	92	93
Genera	15	15	20	18	14	18	18	18
HBI	4.1	8.3	4.6	4.4	2.5	3.6	5.0	3.4
S/F	1.0	0.2	1.4	0.4	0.5	0.4	1.2	0.1
EPT/CHIR	22	0.3	5.2	6.5	31.7	4.1	2.7	5.2
% DOM	53	57	27	47	52	52	19	53
EPT Genera	10	5	9	11	10	9	10	11
CLI	0.7	0.7	0.4	0.5	0.7	0.6	0.5	0.3
% Mayflies	73	6	55	55	10	7	29	9

Sample	86	87	88	89	90	91	92	93
Genera	2	2	6	4	2	4	4	4
HBI	6	0	6	6	6	6	6	6
S/F	4	0	6	2	2	2	4	0
EPT/CHIR	6	0	4	6	6	4	2	4
% DOM	0	0	4	0	0	0	6	0
EPT Genera	6	2	6	6	6	6	6	6
CLI	4	4	6	6	4	4	6	6
% Mayflies	6	0	6	6	2	0	4	0
Total	34	8	38	36	28	26	38	32

Sample	94	95	96	97	98	99	100	101	102	103
Genera	15	15	19	18	15	21	16	14	16	13
HBI	6.79	6.89	5.85	5.24	6.46	5.60	5.74	5.34	4.66	7.46
S/F	6.5	0.17	0.33	0.26	0.23	0.62	1.75	0.26	0.33	0.54
EPT/CHIR	1.0	0.8	1.2	2.2	0.8	2.28	2.50	3.26	14.30	0.37
% DOM	34	30	23	20	26	19	27	13	36	54
EPT Genera	7	7	9	11	7	9	8	7	12	7
CLI	0.53	0.53	0.26	0.22	0.60	0.14	0.31	0.43	0.31	0.54
% Mayflies	34	18	22	39	5	43	26	41	66	13

Sample	94	95	96	97	98	99	100	101	102	103

Genera	2	2	6	4	2	6	4	2	4	2
HBI	0	0	2	6	0	4	4	4	6	2
S/F	6	0	2	0	0	2	6	0	2	2
EPT/CHIR	2	0	2	2	0	2	2	2	6	0
% DOM	2	4	4	4	4	6	4	6	2	0
EPT Genera	4	4	6	6	4	6	4	4	6	4
CLI	4	4	6	6	4	6	6	6	6	4
% Mayflies	4	2	2	4	0	6	4	6	6	4
Total	24	16	30	32	14	38	34	30	38	18

Sample	104	105	106	107	108
Taxa Richness	16	19	16	14	22
HBI	5.4	7.1	6.3	5.2	4.3
Scrapers/Filterers	0.4	0.4	0.1	0.1	0.2
EPT/Chironomids	4.3	0.4	1.4	6.0	1.9
% Dominant Taxon	23	37	35	32	18
EPT Index	9	7	6	8	11
CLI	0.6	0.3	0.5	0.6	0.2
% Mayflies	26	5	40	20	36

Sample	104	105	106	107	108
Taxa Richness	4	6	4	2	6
HBI	4	0	2	6	6
Scrapers/Filterers	2	2	0	0	6
EPT/Chironomids	4	0	2	6	2
% Dominant Taxon	4	2	2	2	6
EPT Index	6	4	2	4	6
CLI	4	6	4	4	6
% Mayflies	4	0	4	2	4
TOTAL SCORE	32	20	20	26	42

Sample	109	110	111	112	113
Taxa Richness	17	23	20	22	17
HBI	5.3	6.1	5.5	5.1	6.3
Scrapers/Filterers	0.3	0.4	1.0	0.5	0.8
EPT/Chironomids	23	1.4	1.9	2.4	0.3
% Dominant Taxon	20	13	14	11	34
EPT Index	6	8	9	10	6
CLI	0.5	0.3	0.3	0.3	0.6
% Mayflies	25	28	31	36	4

Sample	109	110	111	112	113
Taxa Richness	4	6	4	2	6
HBI	4	0	2	6	6
Scrapers/Filterers	2	2	0	0	6

EPT/Chironomids	4	0	2	6	2
% Dominant Taxon	4	2	2	2	6
EPT Index	6	4	2	4	6
CLI	4	6	4	4	6
% Mayflies	4	0	4	2	4
TOTAL SCORE	32	20	20	26	42

Macroinvertebrate data August, 2009 by site number

	1	2	3	4	5
Chironomidae (midges)					
Thienemannimyia spp.	3	5	13	8	10
Glyptotendipes lobiferus	15	12	15	24	53
Polypedilum convictum	7	7	6		
Dicrotenidpes spp.		1	2	6	
Phaenospectra dyari		1			
Cryptochironomus fulvus		2			
Parachironomus frequens					
Cricotopus bicinctus			2	3	
C. tremulus				8	
Nanoladius spp.					
Paratanytarsus spp.	5		2		
Rheotanytarsus distinctissimus	1	12	3	21	
Simuliidae (blackflies)					
Simulium spp.	4				
Empididae (aquatic danceflies)					
Hemerodromia spp.	1				
Ephydridae (shoreflies)		1			
Ephemeroptera (mayflies)					
Baetis amplus	1			1	
B. intercalaris			8		
B. flavistriga				6	
Baetis spp.	2				4
Caenis hilaris	1	2	3	3	
Isonychia spp.	3			1	
Potamanthus spp.					
Stenonema integrum		2	1		4

S. pulchellum	4			1	3
S. terminatum	1	7	1		
Stenacron interpunctatum		3			5
Heptagenia spp.		1		1	
Tricorythodes spp.	9	33	20	2	10
Trichoptera (caddisflies)					
Cheumatopsyche spp.	12		3	4	
Hydropsyche aerata	10	5	9	1	
H. orris	5	2	4		
H. simulans					
Potamyia flava	1			2	
Ceratopsyche bifida					
Macrostenum spp.	1				
Cyrnellus fraternus					
Polycentropis spp.	3		4		
Ochotrichia spp.			1		
Leptoceridae					
Coleoptera (beetles)					
Stenelmis spp.	11	2		3	2
Macronychus glabratus		1	3		

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Macroinvertebrate data August 2009 by site number, con't.

	1	2	3	4	5
Odonata (damsel & dragonflies					
Gomphus spp.				1	1
Argia spp.				1	3
Macromia spp.		1			1
Lepidoptera (aquatic caterpillars)					
Pyralidae					
Mollusca (snails & mussels)					
Dreissena polymorpha					1
Elimia spp.				1	1
Oligochaeta (aquatic worms)				1	1
Total	100	100	100	100	100

Macroinvertebrate data August 2009 by site number, con't.

	6	7	8	9	10
Chironomidae (midges)					

Thienemannimyia spp.	8	3	3	13	3
Glyptotendipes lobiferus	13	21	44	6	46
Polypedilum convictum	9	11	3	4	3
Dicrotenidpes spp.	5		6	4	6
Phaenospectra dyari					9
Cryptochironomus fulvus	2				
Parachironomus frequens	2	2	6	6	3
Cricotopus bicinctus			3	2	3
C. tremulus					
Nanoladius spp.			1		
Paratanytarsus spp.					
Rheotanytarsus distinctissimus		3	6	15	
Simuliidae (blackflies)					
Simulium spp.	1	1		1	
Empididae (aquatic danceflies)					
Hemerodromia spp.					
Ephydridae (shoreflies)					
Ephemeroptera (mayflies)					
Baetis amplus	6	1		2	
B. intercalaris		10	4		
B. flavistriga				1	
Baetis spp.					
Caenis hilaris	3	3		14	2
Isonychia spp.	8	1	1		
Potamanthus spp.	1				1
Stenonema integrum		1	1		
S. pulchellum	10				1
S. terminatum	5	1	1	7	5
Stenacron interpunctatum				1	1
Heptagenia spp.	1			1	
Tricorythodes spp.	8	8	7	8	6
Trichoptera (caddisflies)					
Cheumatopsyche spp.	6	6		2	3
Hydropsyche aerata	4	12	3	4	
H. orris	1	2	2		1
H. simulans			2		
Potamyia flava	1				
Ceratopsyche bifida				1	
Macrostenum spp.				1	
Cyrnellus fraternus					1
Polycentropis spp.					
Ochotrichia spp.			1		
Leptoceridae					1
Coleoptera (beetles)					
Stenelmis spp.	6	9	1	5	2
Macronychus glabratus	1	3	2		

Macroinvertebrate data August 2009 by site number, con't.

6	7	8	9	10

Odonata (damsel & dragonflies)					
Gomphus spp.		1			1
Argia spp.			1		
Macromia spp.					
Lepidoptera (aquatic caterpillars)					
Pyralidae			1		
Mollusca (snails & mussels)					
Dreissena polymorpha					
Elimia spp.				1	1
Oligochaeta (aquatic worms)				1	1
Total	100	100	199	100	100