State of Ohio
Environmental Protection Agency

Division of Surface Water

Biological and Water Quality Study of the Lower Little Miami River and Selected Tributaries 2007

Including the Todd Fork subwatershed

Watershed Assessment Units 05090202 06, 07, 08, 09 and 14.

Clermont, Clinton, Hamilton, and Warren Counties

OHIO EPA Technical Report EAS/2009-10-06

October 27, 2009

Ted Strickland, Governor, State of Ohio
Chris Korleski, Director

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Angela Dripps (614-836-8798) – report coordinator, executive summary, introduction, conclusions and recommendations, macroinvertebrate community assessment

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Copies of this report are located on the Ohio EPA internet web page (www.epa.state.oh.us/dsw/document_index/psdindx.aspx) or may be available on CD from:

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INTRODUCTION

As part of the five-year basin approach for NPDES permitting and the TMDL process, an intensive ambient assessment of the lower Little Miami River (LMR) watershed was conducted during the 2007 (and part of 2008) field sampling season. Figure 1 shows the location of the lower Little Miami River watershed – including the Todd Fork subwatershed - in the state of Ohio. The following subwatersheds, as represented by 10-digit Hydrologic Unit Codes (HUCs), were intensively sampled as part of the 2007 study:

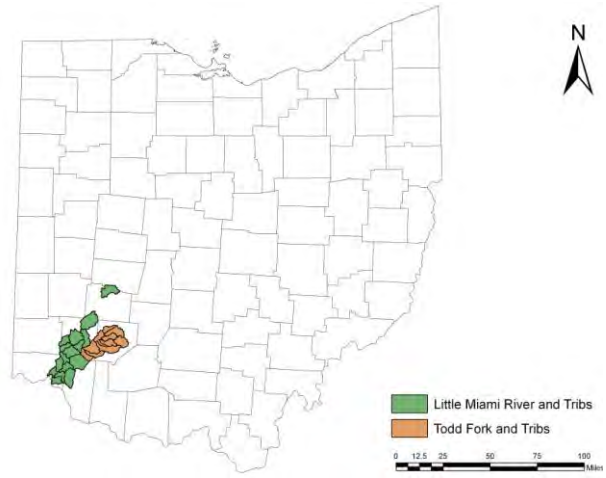


Figure 1. Location of the lower Little Miami River study area (including Todd Fork) in Ohio.

- 05090202 9001: Little Miami River Large River Assessment Unit (LRAU) / Caesar Creek to O'Bannon Creek
- 05090202 9002: Little Miami River LRAU / O'Bannon Creek to Ohio River
- 05090202 06: Headwaters Todd Fork
- 05090202 07: East Fork Todd Fork–Todd Fork
- 05090202 08: Turtle Creek-Little Miami River
- 05090202 09: O'Bannon Creek-Little Miami River
- 05090202 14: Sycamore Creek-Little Miami River

A State and National Scenic River, the lower Little Miami River and its tributaries were last assessed in 1998. The Todd Fork subwatershed was also last sampled in 1998; however, the 2007 sampling effort represents a much more intensive investigation than that conducted in 1998. With the exception of three monitoring stations in the lower three miles, the East Fork Little Miami River (EFLMR) was not included as part of this study. Table 1 includes a list of sampling stations, including geographical coordinates and the sampling protocols employed at each location. Selected sites on the upper LMR mainstem were also included from HUCs 0509020201 and 0509020205 in order to appraise the collective influence of the upper watershed on the water quality and biological integrity of the lower Little Miami River.

All information collected as part of this survey will support TMDL development for the study areas. The objectives of the TMDL process are to estimate pollutant loads from the various sources within the basin, define or characterize allowable loads to support the various beneficial uses, and to allocate pollutant loads among different pollutant sources through appropriate controls (e.g., NPDES permitting, storm water management, 319 proposals, nonpoint source controls or other abatement strategies). The components of the TMDL process supported by this survey are primarily the

identification of impaired waters, verification (and re-designation, if necessary) of beneficial use designations, and causes and sources of use impairment. These data are necessary precursors to the development of effective control or abatement strategies.

As such, the 2007 study of the lower Little Miami River and tributaries was conducted in order to satisfy the following objectives:

1. Monitor and assess the chemical, physical, and biological integrity of the water bodies within the lower Little Miami River study area;
2. Assess the physical habitat influences on stream biotic integrity;
3. Determine recreational water quality;
4. Evaluate the appropriateness of existing beneficial use designations and assign uses to undesignated streams;
5. Characterize any aquatic resource degradation attributable to various land uses, including agriculture and urbanization;
6. Determine any aquatic impacts from known sources, including point source dischargers and unsewered communities;
7. Assess changes in water quality and biological integrity by comparing the results of this survey with those from the 1998 survey.

Table 1. Sampling locations in the Lower Little Miami River study area, 2007 (M-macroinvertebrate qualitative sample, MT-macroinvertebrate quantitative sample, F-fish sample (1 pass), F2- fish sample (2 passes), T- fish tissue, C - conventional water chemistry, E- Effluent, O-organic water chemistry, B - bacteria, S - sediment, D-Datasonde© monitor, N - conventional water chemistry including dissolved phosphorus and chlorophyll a. [Latitude/longitude coordinates are provided in WGS84 datum.]

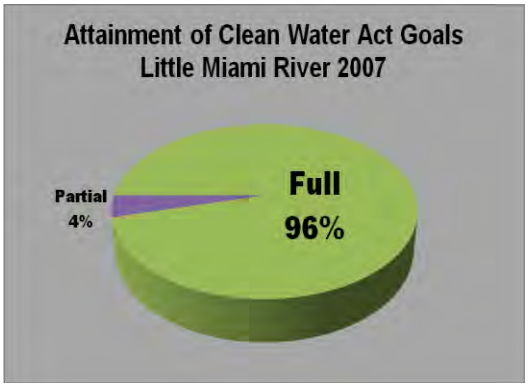
***Stream* RM**	**12 Digit WAU***	**Sample Type**	**Lat/Long (DD)**	**Location**	**USGS Quad**
Little Miami River Mainstem					
83.14	-	C,F2,MT	39.7642/-83.9018	Jacoby Rd (Dst Yellow Springs WWTP)	Yellow Springs
63.30	-	C,N,F2,MT,D,T	39.6056/-84.0137	Spring Valley at roadside park	Waynesville
54.3	-	F2,MT	39.5269/-84.0804	Corwin Road, ust Waynesville WWTP	Waynesville
53.84	-	C,B	39.5245/-84.0884	SR 73, Upstream Waynesville WWTP	Waynesville
53.15	-	C,F2,MT,D,B	39.5168/-84.0928	Adj. Corwin Rd, Dst Waynesville WWTP, Upstream Newman Run	Waynesville
51.20	-	C,F2,MT	39.4977/-84.1019	Upstream Middletown Rd, Upstream Caesar Cr	Oregonia
50.25	9001	C,F2,MT,D,B,S	39.4866/-84.1104	Dst Caesar Cr (Shaw property)	Oregonia
43.76	9001	C,N,F2,MT,D,B, S	39.3563/-84.1011	SR 350 (Ft Ancient)	Oregonia
38.50	9001	C,F2,MT,S	39.3633/-84.1316	Dst Todd Fork and SR 123 (Morrow)	S. Lebanon
35.98	9001	C,F2,MT,B,S	39.3688/-84.1739	Stubbs Mill Rd	S. Lebanon

Stream RM	12 Digit WAU*	Sample Type	Lat/Long (DD)	Location	USGS Quad
32.90	9001	C,F2,MT,B	39.3653/-84.2251	SR 48 (Upstream Lebanon WWTP)	S. Lebanon
32.1	9001	F2		Lebanon WWTP mix zone	S. Lebanon
31.96	9001	C,F2,MT,D,B	39.7642/-84.2413	Upstream Muddy Cr, Dst Lebanon WWTP	S. Lebanon
31.5	9001	S,F2,MT	39.3597/-84.2382	Upstream Peters Cartridge	S. Lebanon
30.80	9001	T		Upstream Grandin Rd	S. Lebanon
30.40	9001	S,F2,MT	39.3506/-84.2486	Adj Peter's Cartridge	S. Lebanon
28.90	9001	C,S,F2,MT,B	39.3317/-84.2533	Upstream Simpson Cr	Mason
27.90	9001	C,F2,MT,D,B	39.3182/-84.2520	Dst SR 22/3 (Little Miami State Park)	Mason
27.00	9001	T	39.3056/-84.2575	Dst Simpson Cr	Mason
24.10	9001	C,F2,MT	39.2713/-84.2594	Upstream O'Bannon Cr (Loveland)	Mason
22.30	9002	C,F2,MT,B	39.2537/-84.2798	Upstream Polk Run WWTP (Isaac Walton Park)	Mason
21.80	9002	MT	39.2505/-84.2893	Polk Run WWTP mixing zone	Mason
21.45	9002	C,F2,D,B	39.2469/-84.2948	Hopewell Rd (Bridge St)	Madeira
20.60	9002	C,F2,MT,B	39.2359/-84.2988	Adj Lake Isabella, Dst I-275	Madeira
18.14	9002	D	39.2105/-84.3119	SR 126 near Miamiville	Madeira
17.73	9002	C,N,F2,MT,B	39.2091/-84.3066	Kelly Nature Preserve (Miamiville)	Madeira
13.00	9002	C,F2,MT,D,B,S	39.1702/-84.2981	Wooster Pike (Milford)	Madeira
8.14	9002	C,F2,MT,T	39.1369/-84.3531	Newtown Rd	Madeira
3.50	9002	C,F2,MT	39.1107/-84.4000	Beechmont Ave	Newport
Todd Fork					
32.72	06-02	C,F,M	39.4771/-83.7868	Starbuck Rd	Wilmington
25.17	06-02	C,F2,MT	39.4698/-83.8833	SR 73 (Northwest of Wilmington)	Clarksville
19.48	06-06	C,F2,MT,B,S	39.4358/-83.9444	SR 22, Upstream Lytle Cr	Clarksville
17.10	06-06	C,F2,MT,B	39.4156/-83.9683	Dst Cowan Cr, Adj Creek Rd	Clarksville
15.10	06-06	C,F2,MT,D,B,S	39.4061/-83.9889	Spring Hill Rd, Dst Clarksville WWTP	Clarksville
12.20	07-04	C,F2,MT	39.3827/-84.0201	Gum Grove Rd	Oregonia
8.53	07-04	C,F2,MT	39.3624/-84.0579	Middleboro Rd	Pleasant Plain
5.60	07-04	C,F2,MT	39.3514/-84.0751	Roachester-Osceola Rd	Pleasant Plain
2.65	07-04	C,N,F2,MT,D	39.3407/-84.1039	Achterman Rd	Pleasant Plain
0.14	07-04	C,F2,MT,D,B,S	39.3534/-84.1293	SR 22/3 (Morrow)	S. Lebanon
Dutch Creek					
0.28	06-01	C,F,M	39.4619/-83.9133	Todd Fork Rd	Clarksville
Lytle Creek					
9.30	06-03	C,F,M,S	39.4378/-83.8189	Adj Townsend Field (Wilmington)	Wilmington
7.01	06-03	C,F,M,B	39.4383/-83.8514	Nelson Rd	Wilmington
6.83	06-03	E	39.4382/-83.8547	Wilmington WWTP effluent	Wilmington
5.94	06-03	C,F,M,D,B,S	39.4409/-83.8668	Dst Wilmington WWTP and landfill at ford	Wilmington
2.76	06-03	C,N,F,M,D	39.4301/-83.9099	Ogden Rd, near Wilmington	Clarksville
0.65	06-03	C,F2,MT,D,B,S	39.4275/-83.9406	Clarksville Rd	Clarksville

Stream RM	12 Digit WAU*	Sample Type	Lat/Long (DD)	Location	USGS Quad
Cowan Creek					
16.62	06-04	C,F,M	39.4031/-83.7542	School Rd	Wilmington
13.15	06-04	C,F2,MT	39.4072/-83.7978	Jenkins Rd, Upstream Indian Run	Wilmington
12.45	06-04	C,F2,MT,S,D,O	39.4029/-83.8013	Adj Jenkins Rd, Dst Indian Run	Wilmington
6.80	06-05	C,F2,MT,S	39.3809/-83.8649	Champlin Rd, Upstream Cowan Lake	Wilmington
2.82	06-05	C,F2,MT,S	39.3930/-83.9301	Old State Rd, Dst Cowan Lake	Clarksville
0.65	06-05	C,F2,MT,D,B,S	39.4133/-83.9586	Clarksville Rd	Clarksville
Indian Run					
0.7	06-04	M	39.4109/-83.7956	Ust trib.	Wilmington
0.2	06-04	C,F,M,S	39.4106/-83.7967	near mouth	Wilmington
East Fork Todd Fork					
18.29	07-01	C,F,M	39.3422/-83.8097	Greene Rd	Martinsville
17.28	07-01	C,F,M	39.3317/-83.8211	Gibson Rd	Martinsville
11.46	07-01	C,F2,MT	39.3458/-83.8894	US 68	Blanchester
7.12	07-01	C,F2,MT,B	39.3603/-83.9404	SR 730 (near Reeder Rd)	Blanchester
1.60	07-01	C,F2,MT,D,B	39.3986/-83.9827	SR 132 (Clarksville)	Clarksville
Lick Run					
1.28	07-04	C,F,M	39.3278/-84.0678	SR 132 (East of Morrow)	Pleasant Plain
Second Creek					
10.94	07-02	C,F,M,B	39.2992/-83.9869	Columbus St, Upstream Blanchester WWTP	Blanchester
9.45	07-02	C,F,M,D,B	39.2910/-84.0075	SR 123, Dst Blanchester WWTP	Pleasant Plain
6.55	07-02	C,F,M	39.3069/-84.0392	Gustin-Rider Rd.	Pleasant Plain
1.53	07-02	C,F,M	39.3237/-84.0907	Cozaddale Rd, (Near Butlerville)	Pleasant Plain
Whitacre Run					
1.15	07-02	C,M,O	39.2877/-83.9810	Old Broadway/Wright Rd	Blanchester
First Creek					
3.83	07-03	C,F,M	39.3111/-84.1167	Volkerding Rd	Pleasant Plain
Turtle Creek					
7.43	08-03	C,F,M	39.4311/-84.2042	East St (Lebanon)	Lebanon
6.23	08-03	C,F2,MT,B,S	39.4314/-84.2253	Glosser Rd	Lebanon
4.85	08-03	C,F2,MT	39.4217/-84.2425	McClure Rd	Lebanon
0.52	08-03	C,F2,MT,D,B,S	39.3718/-84.2266	SR 48 (Near South Lebanon)	S. Lebanon
Little Muddy Creek					
3.22	08-02	C,F,M	39.4107/-84.2956	Hamilton Rd	Monroe
1.00	08-02	C,F2,MT	39.3958/-84.2616	SR 42	Monroe
Dry Run					
1.79	08-03	C,F2,MT,B,S	39.3836/-84.2042	Snook Rd	Lebanon
0.18	08-03	C,F,M	39.3717/-84.2169	Main St (South Lebanon)	S. Lebanon
Muddy Creek					
2.50	09-01	C,F,M,B	39.3741/-84.2746	Mason-Morrow-Millgrove Rd, Upstream Mason WWTP	Mason
0.54	09-01	C,F,M,D,B,S	39.3703/-84.2486	Mason-Morrow-Millgrove Rd, Dst Mason WWTP	S. Lebanon

Stream RM	12 Digit WAU*	Sample Type	Lat/Long (DD)	Location	USGS Quad
O'Bannon Creek					
10.14	09-02	C,F,M	39.2217/-84.1397	Linton Rd	Goshen
8.27	09-02	C,F,M	39.2292/-84.1633	SR 132	Goshen
4.37	09-02	C,F2,MT,B	39.2492/-84.2014	Gibson Rd	Goshen
1.84	09-02	C,F2,MT,B	39.2647/-84.2325	O'Bannonville Rd	S. Lebanon
0.26	09-02	C,F2,MT,D,B,S	39.2689/-84.2561	SR 48 (Loveland)	Mason
Sycamore Creek					
1.10	14-01	C,F,M	39.2169/-84.3319	Adj Loveland-Madeira Rd, (south of Sleepy Hollow Rd) Dst tributary	Madeira
0.50	14-01	C,F2,MT,B	39.2229/-84.3265	Upstream Sycamore Cr WWTP; Dst North Branch	Madeira
0.05	14-01	C,F2,MT,B	39.2247/-84.3200	Dst Sycamore Creek WWTP (near mouth)	Madeira
Duck Creek					
3.36	14-04	C,F,M	39.1506/-84.4081	Rosslyn Rd (cement channel)	Cincinnati E.
1.18	14-04	C,F,M	39.1257/-84.4114	Wooster Ave, (Linwood Park end of Hutton)	Newport
Clough Creek					
0.42	14-06	C,F,M	39.1063/-84.3972	SR 125 (Beechmont Ave)	Newport
East Fork Little Miami River					
2.3	13-05	F2,MT	39.1662/-84.2732	Ust. Milford Parkway	Madeira
1.2	13-05	F2,MT	39.1636/-84.2851	Dst Milford WWTP at „S' curve	Madeira
0.77	13-05	C,D,B,S	39.1553/-84.2889	Dst South Milford Rd	Madeira

EXECUTIVE SUMMARY



The biological and water quality study of the lower Little Miami River watershed revealed positive changes over previous studies. Of those, no change was more significant than the achievement of full attainment of Exceptional Warmwater Habitat (EWH) criteria at 24 of the 25 sites sampled on the Little Miami River mainstem (Figure 2, Table 2). This achievement is a milestone regarding Ohio EPA's sampling history of the Little Miami River, as previous surveys consistently revealed less than 50 percent full attainment of EWH criteria on the mainstem. In 2007, this percentage leaped to 96 percent full attainment. Only the lowermost site, located near Beechmont Road at River Mile (RM) 3.5, was partially meeting EWH expectations due to a subpar Index of Biotic Integrity (IBI) score of 36. The underperformance at this location was attributed primarily to the continuing influence of urban runoff, Combined Sewer Overflows (CSOs), Sanitary Sewer Overflows (SSOs), and industrial discharges from Duck Creek. Secondarily, as the most downstream site on the mainstem, RM 3.5 was also subjected to the cumulative effect of upstream wastewater loadings.

Nevertheless, the overall turnaround of the Little Miami River's biotic integrity can be attributed to improved treatment and operations at several Wastewater Treatment Plants (WWTPs) in the watershed. Many facilities that were previously operating at or over capacity since the last survey in 1998 were upgraded, while others began actively removing phosphorus from treated effluent. These improvements, in turn, allowed for the rebound of the fish community, which has historically borne the brunt of impacts from nutrient over-enrichment in the river. In 1998, only 9 of 21 sites from RM 63.3 to RM 3.5 were in full attainment of EWH criteria for fish; in 2007, 19 of 20 sites were in full attainment for that same reach. The mean IBI rose nearly 10 points, from 42.6 in 1998 to 52.2 in 2007, and many pollution intolerant species of fish – including slenderhead darters, northern madtoms, mountain madtoms, and black redhorse - increased in abundance from 1998 and extended their range in the river. The percentage of DELT (Deformities, Erosions, Lesions, and Tumors) anomalies, another hallmark of chronically distressed fish communities, decreased markedly from 1998.

In spite of these improvements, caution must be maintained, as the Little Miami River still displayed chemical signs of nutrient enrichment. Mean phosphorus values were the highest of any previous survey in the reach downstream from the Lebanon WWTP (RM 32.1) to RM 3.5. Diel dissolved oxygen and pH swings were widest in this reach as well, further indicating the ongoing presence of nutrient enrichment. In order to preserve the strides made in the biotic integrity of the Little Miami River, nutrient enrichment must be kept in check by maintaining high standards of wastewater

treatment throughout the lower watershed. This includes the reduction or elimination of CSOs, SSOs, and of treatment bypasses.

The biological performance of the tributaries to the Lower Little Miami River was less straightforward than that of the mainstem. Out of 57 sites sampled, 30 were meeting applicable biocriteria (Table 2). Among these were 11 sites on Todd Fork, the largest and most extensively sampled of all of the lower Little Miami River tributaries. Much like the Little Miami River, Todd Fork also realized extensive improvement to its fish community, improving from mean index scores that were in the good range in 1998 to those that were exceptional in 2007. As a result, all 32.72 miles of Todd Fork that were sampled in 2007 were meeting WWH criteria. Much of this improvement was attributed to reduced silt loads in the stream. However, much like the Little Miami River, Todd Fork is also threatened by increasing nutrient inputs, particularly from Lytle Creek and Second Creek. These two streams alone accounted for the highest phosphorus and nitrate levels in the entire survey, respectively.

The 27 impaired sites tended to display a geographical pattern of distribution when the sources of impairment were categorized and then plotted as in Figure 2. The southern part of the watershed, where population densities were the highest, tended toward sources related to the effects of urbanization; namely CSOs (Duck Creek, Clough Creek) and urban runoff (Duck Creek, Clough Creek, Sycamore Creek and East Fork Little Miami River). The effects of stormwater or wastewater point source discharges were most apparent in the eastern portion of the basin, particularly in the Todd Fork watershed. There, biological communities were impacted by poorly treated stormwater from the Airborne Express Airpark in Indian Run, Cowan Creek and Lytle Creek. Nutrient enrichment added additional stress to macroinvertebrate communities in Lytle Creek and in Second Creek downstream from the Wilmington and Blanchester WWTPs, respectively. Basin-wide, low or interstitial flows affected nearly half of the impaired tributary sites. Most of the flow-related impacts occurred in smaller headwater streams that were most susceptible to the severe drought conditions present during the summer of 2007. In many cases, such as with upper O'Bannon Creek and lower East Fork Todd Fork, many stream miles were without visible surface flow, while other stream reaches were completely desiccated, such as Cowan Creek at RM 0.65. The far-reaching effects of reduced stream flow were also evident in the numerous

dissolved oxygen and temperature Water Quality Standards (WQS) exceedences for these and other tributaries (Tables 7 and 71; pages 21 and 151). As a likely consequence of reduced stream flow, potential impacts from agriculture were not apparent in 2007. Only two of the impaired sites had causes that could be linked to agriculture-related sources; Second Creek at RM 10.99 (nutrient enrichment) in the eastern part of the basin, and Little Muddy Creek in the western portion (channelization). A definitive cause and source of impairment could not be ascertained for First Creek at RM 3.83.

In addition to chemical and biological monitoring, bacteria monitoring was also conducted in the lower Little Miami River watershed in order to assess recreational water quality (Tables 9 and 23; pages 75 and 155). The most profoundly affected stream in the entire watershed was Lytle Creek, which saw 52% of all *E. coli* samples above the maximum criterion for Primary Contact Recreation (PCR) Class B. Geometric means also consistently exceeded PCR Class B criteria, indicating chronic problems with bacteria in that watershed. Sources in Lytle Creek range from agricultural runoff, SSOs, the Wilmington WWTP, and failing home septic systems. Overall, many of the controls recommended to address nutrient enrichment are also recommended to restore recreation use attainment in the affected areas throughout the lower Little Miami River watershed.

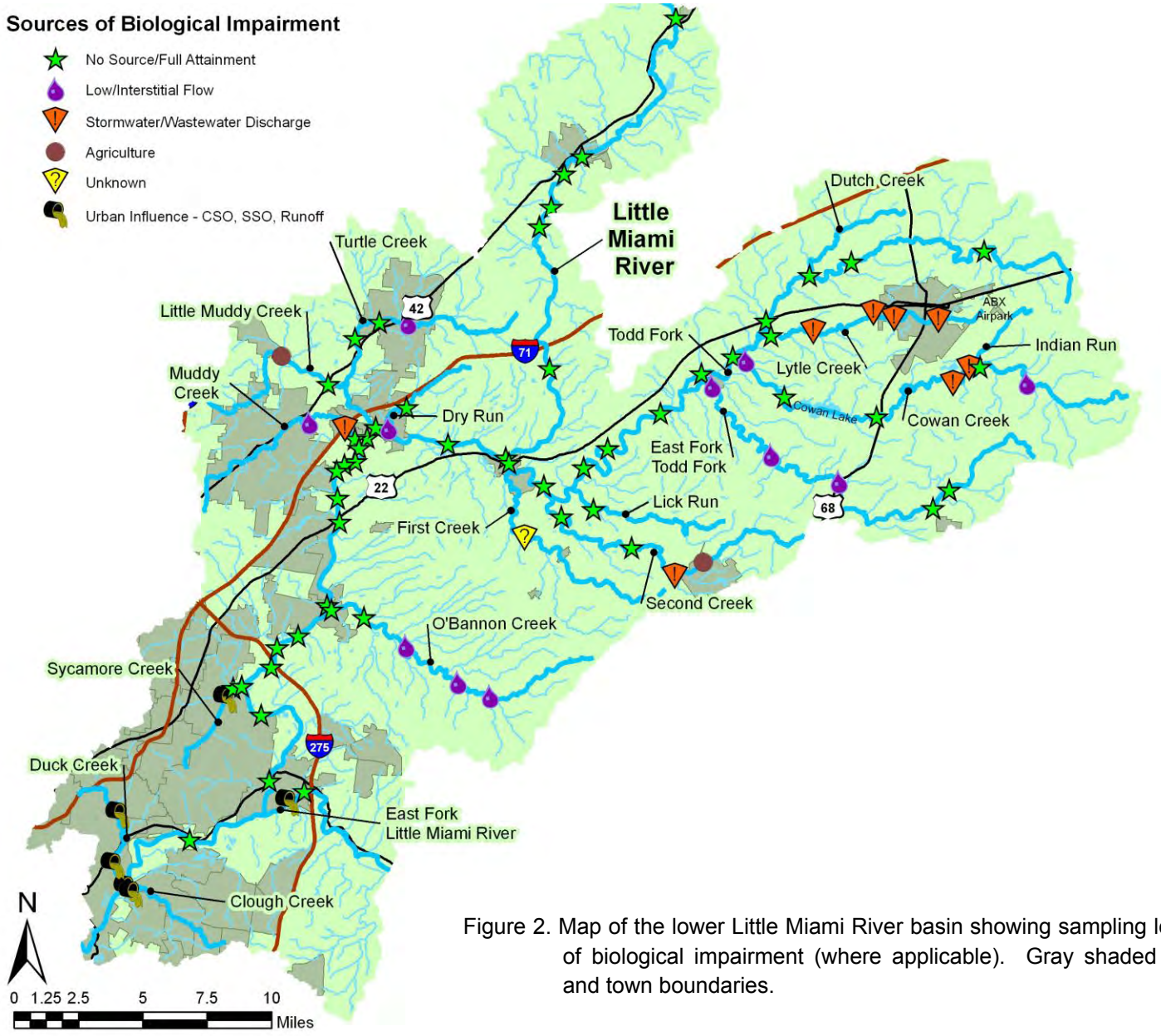


Figure 2. Map of the lower Little Miami River basin showing sampling locations and sources of biological impairment (where applicable). Gray shaded areas represent city and town boundaries.

Table 2. Aquatic life use attainment status for stations sampled in the Little Miami River basin based on data collected July-October 2007 and 2008. The Index of Biotic Integrity (IBI), Modified Index of well being (MIwb), and Invertebrate Community Index (ICI) are scores based on the performance of the biotic community. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biotic community. Gray fill indicates sites in the Eastern Cornbelt Plains ecoregion. White fill indicates sites in the Interior Plateau ecoregion. Sampling locations are further stratified by the 12-digit Hydrologic Unit Code (HUC 12) subwatershed as indicated in green.

Location	STORET (RM)	Drain. (mi^2)^	IBI	MIwb[a]	ICI[b]	QHEI	Status[c]	Causes	Sources
HUC 05090202 01 04 Yellow Springs Creek – Little Miami River									
Little Miami River @ Jacoby Road, dst. Yellow Springs Cr.	M01S09 (83.14)	118.0[W]	48[ns]	9.8	42[ns]	77.5	FULL [EWH]		
HUC 05090202 05 04 Newman Run – Little Miami River									
Little Miami River @ Spring Valley roadside park	M01W45 (63.3)	360.0[B]	56	10.2	48	83.0	FULL [EWH]		
Little Miami River @ Corwin Rd. upstream Waynesville WWTP	M01P29 (54.3)	395.0[B]	54	11.0	44[ns]	82.0	FULL [EWH]		
Little Miami River adj. Corwin Rd. dst. Waynesville WWTP	M01S29 (53.15)	402.0[B]	51	10.8	50	80.5	FULL [EWH]		
Little Miami River upstream Middletown Road	M01W55 (51.2)	413.0[B]	54	10.6	48	90.0	FULL [EWH]		
Large River Assessment Unit 05090202 9001 – Caesar Creek to O'Bannon Creek									
Little Miami River dst. Caesar Creek @ Shaw property	M05K01 (50.25)	658.0[B]	52	11.3	52	85.0	FULL [EWH]		
Little Miami River @ SR 350	M05S12 (43.76)	680.0[B]	53	10.8	E	87.0	FULL [EWH]		
Little Miami River dst .Todd Fork & SR 123	300361 (38.50)	949.0[B]	54	11.4	46	82.5	FULL [EWH]		
Little Miami River @ Stubbs Mill Road	610520 (35.98)	964.0[B]	57	10.8	50	91.5	FULL [EWH]		

Location	STORET (RM)	Drain. (mi²)^	IBI	Mlwb[a]	ICI[b]	QHEI	Status[c]	Causes	Sources
Little Miami River @ US 48	M05P03 (32.9)	1035.0[B]	52	10.1	54	--	FULL [EWH]		
Little Miami River @ Lebanon WWTP mix zone	M05S36 (32.1)	1036.0[B]	42	9.9	--	N/A	Mix Zone		
Little Miami River ust. Muddy Creek, N of King's Mill	M05W15 (31.96)	1036.0[B]	--	--	48	--	(FULL) [EWH]		
Little Miami River ust. Peter's Cartridge	M05W19 (31.5)	1050.0[B]	51	11.3	52	89.5	FULL [EWH]		
Little Miami River @ King's Mill Road	M05S09 (30.9)	1054.0[B]	--	--	52	--	(FULL) [EWH]		
Little Miami River adj. Peter's Cartridge	200516 (30.5)	1054.0[B]	54	11.5	50	85.5	FULL [EWH]		
Little Miami River dst. Grandin Road	M05W20 (30.0)	1055.0[B]	--	--	52	--	(FULL) [EWH]		
Little Miami River dst. Peter's Cartridge	M05W24 (29.0)	1059.0 [B]	54	11.0	54	85.0	FULL [EWH]		
Little Miami River dst. Simpson Creek	M05S07 (27.9)	1069.0 [B]	54	11.3	54	91.0	FULL [EWH]		
Little Miami River ust. O'Bannon Creek	M05W34 (24.10)	1085.0 [B]	50	10.2	48	81.0	FULL [EWH]		
Large River Assessment Unit 05090202 9002 – O'Bannon Creek to Ohio River									
Little Miami River adj. Loveland-Kemper Road	M05S39 (22.30)	1150.0 [B]	53	9.8	54	79.5	FULL [EWH]		
Little Miami River @ Polk Run WWTP mixing zone	300364 (21.7)	1150.0 [B]	--	--	14*	--	Mix Zone		
Little Miami River @ Branch Hill New Guinea Road	600540 (21.5)	1161.0 [B]	50	11.2	--	89.5	(FULL) [EWH]		
Little Miami River adj. Lake Isabella	M05S05 (20.6)	1161.0 [B]	56	10.4	52	88.5	FULL [EWH]		

Location	STORET (RM)	Drain. (mi²)^	IBI	MIwb[a]	ICI[b]	QHEI	Status[c]	Causes	Sources
Little Miami River @ canoe access area dst. SR 126	M05W47 (17.7)	1187.0 B	52	11.2	E	86.5	FULL EWH		
Little Miami River @ Wooster Pike Milford gage	M05P11 (13.07)	1203.0 B	51	10.2	52	90.5	FULL EWH		
Little Miami River @ Newtown Road	M05P12 (8.14)	1713.0 B	52	10.2	50	85.5	FULL EWH		
Little Miami River @ Beechmont Road	600580 (3.5)	1744.0 B	36*	9.7	VG ns	73.5	**PART. EWH**	Sedimentation/Siltation Nutrient/Organic enrichment (sewage) biological indicators	Combined sewer overflows Municipal point source discharges
HUC 05090202 06 02 Headwaters Todd Fork (*Tributary to Little Miami River at RM 38.54)*									
Todd Fork @ Starbuck Rd.	300325 (32.72)	14.4 H	36 ns	N/A	G	44.0	FULL WWH		
Todd Fork @ SR 73	200528 (25.2)	29.1 W	50	10.1	32 ns	84.0	FULL WWH		
HUC 05090202 06 06 Little Creek – Todd Fork									
Todd Fork @ SR 22, ust. Lytle Creek	M03S06 (19.5)	56.0 W	55	9.5	34 ns	74.5	FULL WWH		
Todd Fork adj. Creek Rd. dst. Cowan Creek	300326 (17.1)	135.0 W	48	9.3	44	70.5	FULL WWH		
Todd Fork @ Spring Hill Rd. dst. Clarksville WWTP	M03S20 (15.1)	142.0 W	56	10.0	40	69.0	FULL WWH		
HUC 05090202 07 04 Lick Run (*Tributary to Todd Fork at RM 4.52)* - Todd Fork									
Todd Fork @ Gum Grove Road	300314 (12.2)	192.0 W	54	10.6	46	72.5	FULL WWH		
Todd Fork @ Middleboro Road	M03S19 (8.53)	198.0 W	51	10.1	42	66.5	FULL WWH		
Todd Fork @ Roachester-Osceola Road	M99Q16 (5.6)	200.0 W	52	10.1	44	80.5	FULL WWH		

Location	STORET (RM)	Drain. (mi²)^	IBI	MIwb[a]	ICI[b]	QHEI	Status[c]	Causes	Sources
Todd Fork @ Achterman Road	M03S18 (2.65)	239.0 W	51	10.2	VG	77.5	FULL WWH		
Todd Fork @ SR 22/3	600530 (0.14)	261.0 W	50	9.2	42	57.5	FULL WWH		
Lick Run @ SR 132	M03P01 (1.28)	12.3 H	42	N/A	G	39.0	FULL WWH		
HUC 05090202 06 01 Dutch Creek (*Tributary to Todd Fork at RM 22.10)*									
Dutch Creek @ Todd Fork Road	M03P23 (0.28)	14.7 H	54	N/A	G	51.5	FULL WWH		
HUC 05090202 06 03 Lytle Creek (*Tributary to Todd Fork at RM 18.57)*									
Lytle Creek adj. Townsend Field	M03S26 (9.3)	3.0 H	26*	N/A	LF*	59.5	**NON** WWH	Sedimentation/Siltation Nutrient/Eutrophication Biological Indicators	Highways, Roads, Bridges, Infrastructure (New Construction) Industrial/Commercial Stormwater Discharge (Permitted)
Lytle Creek @ Nelson Road	M03P07 (7.01)	8.1 H	38 ns	N/A	LF*	66.5	**PART.** WWH	Sedimentation/Siltation Nutrient/Eutrophication Biological Indicators	Industrial/Commercial Stormwater Discharge (Permitted)
Lytle Creek dst. Wilmington WWTP	M03W03 (5.95)	9.3 H	48	N/A	LF*	77.0	**PART.** WWH	Sedimentation/Siltation Nutrient/Eutrophication & Organic Enrichment (Sewage) Biological Indicators	Municipal point source discharges Industrial/Commercial Stormwater Discharge (Permitted)
Lytle Creek @ Ogden Road	M03P08 (2.76)	15.9 H	56	N/A	F*	67.0	**PART.** WWH	Nutrient/Eutrophication & Organic Enrichment (Sewage) Biological Indicators	Municipal point source discharges Industrial/Commercial Stormwater Discharge (Permitted)
Lytle Creek @Clarksville Road	M03P09 (0.65)	19.8 H	55	N/A	32 ns	77.0	FULL WWH		
HUC 05090202 06 04 Headwaters Cowan Creek (*Tributary to Todd Fork at RM 17.15)*									
Cowan Creek @ School Road	300330 (16.62)	15.1 H	46	N/A	F*	65.0	**PART.** WWH	Natural conditions (Flow)	Natural

Location	STORET (RM)	Drain. (mi²)^	IBI	MIwb[a]	ICI[b]	QHEI	Status[c]	Causes	Sources
Cowan Creek @ Jenkins Road	M03S24 (13.2)	26.0 W	43	7.9	MG ns	60.5	FULL WWH		
Cowan Creek adj. Jenkins Road, dst. Indian Run	M03S23 (12.45)	32.0 W	38 ns	7.2*	LF*	58.0	**PART. WWH**	Sedimentation/Siltation Nutrient/Eutrophication Biological Indicators	Streambank Modification/Destabilization Industrial/Commercial Stormwater Discharge (Permitted)
Indian Run – Tributary to Cowan Creek at RM 13.06									
Indian Run @ Jenkins Road, ust. ABX outfalls	200524 (0.7)	2.3 H	--	--	LF*	--	Macro qual only-no status	Nutrient/Eutrophication Biological Indicators	Channelization
Indian Run @ Jenkins Road, dst. ABX outfalls	M03S25 (0.2)	4.1 H	42	N/A	P*	57.0	**NON WWH**	Low dissolved oxygen	Industrial/Commercial Stormwater Discharge (Permitted)
HUC 05090202 06 05 Wilson Creek – Cowan Creek									
Cowan Creek @ Champlin Road	M03P21 (6.8)	40.0 W	47	9.3	MG ns	67.0	FULL WWH		
Cowan Creek @ Old State Road	300331 (2.82)	51.0 W	49	9.2	MG ns	68.0	FULL WWH		
Cowan Creek @ Clarksville Road	M03P12 (0.6)	54.0 W	52	9.2	F*	78.0	**PART. WWH**	Natural conditions (Flow)	Natural
HUC 05090202 07 01 East Fork Todd Fork (*Tributary to Todd Fork at RM 14.07)*									
East Fork Todd Fork @ Greene Road	300316 (18.29)	7.8 H	50	N/A	G	42.5	FULL WWH		
East Fork Todd Fork @ Gibson Road	300317 (17.28)	14.6 H	52	N/A	MG ns	66.0	FULL WWH		
East Fork Todd Fork @ US 68	300318 (11.46)	27.9 W	50	8.7	F*	64.0	**PART. WWH**	Natural conditions (Flow)	Natural
East Fork Todd Fork @ Reeder Road	300319 (7.12)	35.0 W	49	10.0	F*	68.5	**PART. WWH**	Natural conditions (Flow)	Natural

Location	STORET (RM)	Drain. (mi²)^	IBI	MIwb[a]	ICI[b]	QHEI	Status[c]	Causes	Sources
East Fork Todd Fork @ SR 132	M03P19 (1.6)	37.3 W	54	9.6	F*	73.0	**PART.** WWH	Natural conditions (Flow)	Natural
HUC 05090202 07 02 Second Creek (*Tributary to Todd Fork at RM 3.02)*									
Second Creek @ Columbus Street	M03S16 (10.94)	6.8 H	32*	N/A	LF*	60.5	**NON** WWH	Nutrient/Eutrophication Biological Indicators	Agriculture
Second Creek dst. Blanchester WWTP	M03S14 (9.45)	11.0 H	36 ns	N/A	F*	56.5	**PART.** WWH	Organic Enrichment (Sewage) Biological Indicators Sedimentation/Siltation	Municipal point source discharges Unpermitted Discharge (Domestic Wastes) Sanitary Sewer Overflows
Second Creek @ Gustin-Rider Road	M03S13 (6.55)	13.2 H	38 ns	N/A	MG ns	77.0	FULL WWH		
Second Creek @ Cozaddale Road, near Butlerville	M03P14 (1.53)	19.0 H	42	N/A	G	65.5	FULL WWH		
Whitacre's Run – Tributary to Second Creek at RM 10.20									
Whitacre's Run dst. Blanchester PWS	300320 (1.15)	1.5 H	--	--	VP*	--	Macro qual only-no status	Intermittent flow Low Dissolved oxygen	Natural conditions Dam/Impoundment
HUC 05090202 07 03 First Creek (*Tributary to Todd Fork at RM 0.54)*									
First Creek @ Volkerding Rd.	300322 (3.83)	13.8 H	30*	N/A	MG ns	58.5	**PART.** WWH	Unknown	Unknown
HUC 05090202 01 04 Turtle Creek (*Tributary to Little Miami River at RM 33.19)*									
Turtle Creek @ East Street	300327 (7.43)	12.3 H	40	N/A	F*	47.5	**PART.** WWH	Natural conditions (Flow)	Natural
Turtle Creek @ Glosser Rd.	M05S17 (6.23)	21.3 W	44	8.5	34	70.0	FULL WWH		
Turtle Creek @ McClure Rd.	M05S21 (4.85)	30.0 W	41	8.6	28 ns	65.0	FULL WWH		
Turtle Creek @ US 48	M05S14 (0.52)	58.0 W	48	8.2	VG	61.0	FULL WWH		
Dry Run – Tributary to Turtle Creek at RM 0.9									

Location	STORET (RM)	Drain. (mi²)^	IBI	Mlwb[a]	ICI[b]	QHEI	Status[c]	Causes	Sources
Dry Run @ Snook Road	M05S19 (1.79)	4.2[H]	45	N/A	38	55.0	FULL [CWH]		
Dry Run @ Main St., S. Lebanon	M05S18 (0.18)	7.3[H]	26*	N/A	--	50.0	**(NON)** [WWH]	Natural conditions (Flow)	Natural
HUC 05090202 08 02 Little Muddy Creek (*Tributary to Turtle Creek at RM 2.73)*									
Little Muddy Creek @ Hamilton Road	300328 (3.22)	11.7[H]	48	N/A	LF*	44.0	**PART.** [WWH]	Sedimentation/Siltation	Channelization
Little Muddy Creek @ SR 42	300329 (1.02)	20.2 [W]	44	7.6	40	52.0	FULL [WWH]		
HUC 05090202 09 01 Muddy Creek (*Tributary to Little Miami River at RM 31.95)*									
Muddy Creek ust. Mason WWTP	M05S02 (2.5)	10.2[H]	52	N/A	F*	62.5	**PART.** [WWH]	Natural conditions (Flow)	Natural
Muddy Creek dst. Mason WWTP	M05P06 (0.54)	15.2[H]	54	N/A	F*	74.0	**PART.** [WWH]	Sedimentation/Siltation Nutrient/Organic Enrichment (Sewage) Biological Indicators	Municipal point source discharges
HUC 05090202 09 02 O'Bannon Creek (*Tributary to Little Miami River at RM 24.00)*									
O'Bannon Creek @ Linton Road	300323 (10.14)	8.1[H]	32*	N/A	LF*	48.5	**NON** [WWH]	Natural conditions (Flow)	Natural
O'Bannon Creek @ SR 132	300324 (8.27)	14.3[H]	44	N/A	F*	56.0	**PART.** [WWH]	Natural conditions (Flow)	Natural
O'Bannon Creek @ Gibson Road	M05W60 (4.37)	28.1 [W]	51	9.2	LF*	54.0	**PART.** [WWH]	Natural conditions (Flow)	Natural
O'Bannon Creek @ O'Bannonville Road	M05P19 (1.84)	55.6 [W]	55	10.4	40	75.5	FULL [WWH]		
O'Bannon Creek @ SR 48	M05P18 (0.26)	59.0 [W]	51	10.3	34	60.0	FULL [WWH]		
HUC 05090202 14 01 Sycamore Creek (*Tributary to Little Miami River at RM 19.22)*									
Sycamore Creek adj. Loveland Rd, dst. tributary	M05P17 (1.10)	10.4[H]	40	N/A	F*	63.5	**PART.** [WWH]	Organic Enrichment (Sewage) Biological Indicators	Urban Runoff/Storm Sewers

Location	STORET (RM)	Drain. (mi²)^	IBI	MIwb[a]	ICI[b]	QHEI	Status[c]	Causes	Sources
Sycamore Creek dst. North Fork Sycamore Creek	M05S41 (0.50)	20.7 W	54	8.9	44	69.5	FULL WWH		
Sycamore Creek at mouth, dst. Sycamore Creek WWTP	M05S37 (0.1)	23.3 W	54	9.4	32	76.5	FULL WWH		
HUC 05090202 13 05 Salt Run – East Fork Little Miami River (*Tributary to Little Miami River at RM 11.50)*									
East Fork Little Miami River @ Milford Parkway	M04S29 (2.3)	494.0 B	52	10.4	52	73.5	FULL EWH		
East Fork Little Miami River @ curve dst. Milford WWTP	M04W44 (1.2)	498.0 B	43*	9.7	50	66.0	**PART. EWH**	Sedimentation/Siltation	Streambank modification/destabilization
HUC 05090202 14 04 Duck Creek (*Tributary to Little Miami River at RM 3.87)*									
Duck Creek @ Rosslyn Drive	300311 (3.36)	7.3 H	12*	N/A	VP*	24.5	**NON LRW**	Direct habitat alteration	Channelization (CSO conveyance)
Duck Creek @ park at the end of Hutton Road	M05S24 (0.95)	15.1 H	20*	N/A	VP*	36.0	**NON WWH**	Sedimentation/Siltation Organic Enrichment (Sewage) Biological Indicators	Combined Sewer Overflows Urban Runoff/Storm Sewers
HUC 05090202 14 06 Clough Creek (*Tributary to Little Miami River at RM 3.36)* – Little Miami River									
Clough Creek @ SR 125	300313 (0.42)	8.3 H	38 ns	N/A	F*	55.0	**PART. WWH**	Sedimentation/Siltation	Combined Sewer Overflows Urban Runoff/Storm Sewers

a - MIwb is not applicable to headwater streams with drainage areas ≤ 20 mi^2.

b - An evaluation of the qualitative sample based on attributes such as EPT taxa richness, number of sensitive taxa, and community composition was used when quantitative data was not available or considered unreliable. VP=Very Poor, P=Poor, LF=Low Fair, F=Fair, MG=Marginally Good, G=Good, VG=Very Good, E=Exceptional

c - Attainment is given for the proposed aquatic life use when a change is recommended. Aquatic life use in superscript. EWH = Exceptional Warmwater Habitat; WWH = Warmwater Habitat; LRW = Limited Resource Water.

ns - Nonsignificant departure from biocriteria (≤4 IBI or ICI units, or ≤0.5 MIwb units).

* - Indicates significant departure from applicable biocriteria (>4 IBI or ICI units, or >0.5 MIwb units). Underlined scores are in the Poor or Very Poor range.

^ - Letters in superscript refer to the fish site type and associated biocriteria as indicated in the table below. B = boat; W = wading; and H = headwater.

Biological Criteria

	Eastern Corn Belt Plains			Interior Plateau			
Index – Site Type	**EWH**	**WWH**	**MWH**	**EWH**	**WWH**	**MWH**	**LRW**
IBI – Headwaters	50	40	24	50	40	24	18
IBI – Wading	50	40	24	50	40	24	18
IBI – Boat	48	42	24	48	38	24	16
MIwb – Wading	9.4	8.3	6.2	9.4	8.1	6.2	4.5
MIwb – Boat	9.6	8.5	5.8	9.6	8.7	5.8	5.0
ICI	46	36	22	46	30	22	8

CONCLUSIONS and RECOMMENDATIONS

Little Miami River

Perhaps the most important of the many objectives of the 2007 study of the Lower Little Miami River was the comparison of the results of this study to those of past studies. Historically, the Little Miami River mainstem has realized extensive impairment to the fish community in terms of index scores (Figure 3). In 1993, only 47% of sites sampled in the reach from Spring Valley (RM 63.3) to Beechmont Road (RM 3.5) met EWH criteria for fish. In 1998, that percentage declined to 43%. However, in 2007, the river showed remarkable improvement, with 95% of the fish communities meeting EWH criteria. This change resulted in 59.8 miles of FULL attainment of EWH biocriteria for the Little Miami River. Mean IBI scores increased nearly ten points, from 42.6 in 1998 to 52.2 in 2007. This turnaround in biological integrity represents one of the biggest comebacks of a large river system in the sampling history of Ohio EPA.

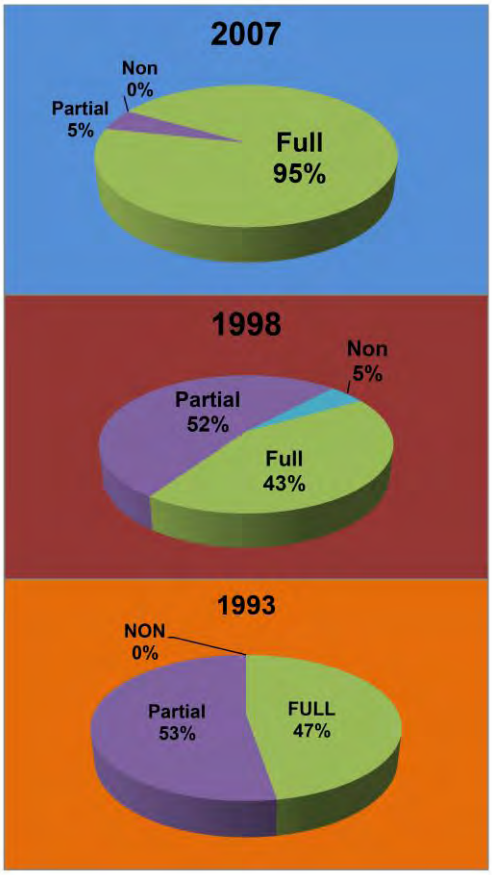


Figure 3. Attainment status of EWH criteria for fish communities sampled in the Little Miami River from RM 63.3 to RM 3.5, 1993-2007.

While the news of improved biological performance is certainly a cause for optimism, caution must be employed. As the Little Miami River watershed continues to grow in population, it remains to be seen whether the river will be able to continue to assimilate increased pollutant loadings. The 2000 technical report from Ohio EPA implicated nutrient enrichment as a primary cause of stress to the fish community in the Little Miami River in 1998. Chemically, the Little Miami River is still over-enriched, especially in the lower segment of the river where populations are the highest and most of the larger wastewater treatment facilities exist. Instream phosphorus median concentrations from RM 32.1 downstream from the Lebanon WWTP to RM 3.5 at Beechmont Avenue were more than double that of the reach upstream of Lebanon (0.40 mg/l vs. 0.18 mg/l), and were, respectively, the highest and lowest phosphorus medians ever recorded by Ohio EPA for those reaches of the river. Further, the widest diel dissolved oxygen and pH swings, as measured by a Datasonde© continuous monitor, were also located in the reach downstream from Lebanon. This chemical enrichment was also reflected in certain fish and macroinvertebrate attributes. While still within expected ranges, the percentage of intolerant fish species began to decline in concert with increases in omnivores downstream from Sycamore Creek (RM 19.22) to RM 3.5, signifying a shift in community stability related to increased pollutant loadings. In the benthic community,

high to very high densities of filter feeders were observed colonizing the natural substrates in the reach downstream from Todd Fork (RM 38.6) to RM 3.5. High production in the macroinvertebrate community, especially filter-feeding species, is considered indicative of nutrient enrichment. Obviously, none of these biological or chemical signatures were affecting overall biological performance as of 2007. However, they should be viewed as indicators of potential instability in the future.

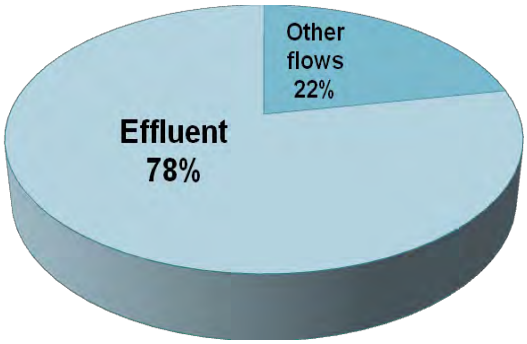


Figure 4. Proportion of treated effluent vs. other flow sources of the Little Miami River at the Milford gage (RM 13.07) on September 24, 2007. Proportions are based on 88 cfs of total discharge.

At the time of the 1998 survey, many wastewater treatment facilities were operating at or over capacity, resulting in increased loadings to the river, while others were experiencing collection system failures that sent raw sewage into the river via treatment bypasses. Additionally, no facility was actively removing phosphorus as part of their treatment train. By 2007, many of these variables had changed for the better. At the time of the 2007 survey, twelve „major' facilities (discharge ≥ 1 MGD) had been rebuilt, upgraded, or otherwise improved, and seven facilities were actively removing phosphorus (it is important to note that the process of removing phosphorus from effluent may additionally remove other unknown constituents that contribute to biological impairment). As a result of these improvements, loadings from these entities have either decreased or remained stable through time. Perhaps not coincidentally, six of the facilities that were removing phosphorus were located in the upper watershed where instream phosphorus levels were at their lowest of any survey by Ohio EPA. The sampling period in 2007 also occurred during a severe and protracted drought, which increased the effluent portion of the Little Miami River to nearly 80 percent by September and rendered the 2007 sampling results a more acute assessment of effluent and instream water quality (Figure 4). Since many treatment variables have changed at numerous wastewater facilities in the watershed between 1998 and 2007, it is difficult to ascertain if any one change was wholly responsible for the improvements noted in the fish community. Therefore, the *overall* higher quality discharge from these facilities must be implicated in part for the rebound of the fish community and the consequent restoration of biological integrity to the lower Little Miami River. As a result of these findings, it is important that the highest standard of wastewater treatment be employed by all NPDES facilities discharging into the Little Miami River watershed, including phosphorus removal when feasible. Because of the potential for further population growth in the watershed, the Little Miami River should be monitored more frequently in order to detect significant chemical and biological changes to the river.

Todd Fork Subwatershed

In step fashion with the Little Miami River, Todd Fork also realized widespread improvement to its fish community from the last survey in 1998. Outside of the headwaters, the mean IBI improved from 45 in 1998 to 52 in 2007 and the mean MIwb improved from 8.5 in 1998 to 9.9 in 2007. These changes correspond to an improvement from good to exceptional. Unlike the Little Miami River, the change in Todd Fork appears to be correlated to a reduction in silt loads rather than improved WWTP discharges. However, just like the Little Miami River, the stream is still chemically enriched, especially downstream from the confluence of Lytle Creek at RM 18.57, where mean phosphorus values increased from 0.06 mg/l to 0.22 mg/l. This effect was corroborated by the overall abundance of central stoneroller minnows in Todd Fork. This obligate herbivore, known for thriving in eutrophic streams, comprised close to half the total fish catch in Todd Fork. The combination of agricultural runoff from the surrounding land use and WWTP discharge from Lytle Creek and Second Creek contributed to the these nutrient loads. Lytle Creek and Second Creek alone accounted for the highest instream phosphorus and nitrate-n values (respectively) of the entire survey via the Wilmington WWTP (Lytle Creek RM 6.83) and the Blanchester WWTP (Second Creek RM 10.1). Additionally, the highest Primary Contact Recreation (PCR) exceedences occurred in Lytle Creek and Second Creek. In order to maintain the high biological integrity of Todd Fork, sedimentation control in the watershed must be a high priority. Controlling excessive nutrient and bacterial loads by addressing wastewater treatment problems (in particular, SSO overflows and wet weather bypasses) at both the Wilmington and the Blanchester WWTPs should be implemented as well.

Historically, Lytle Creek has been one of the more degraded streams in the Todd Fork watershed. While recovery is not yet complete, improvements have been realized since 1998. Lytle Creek still did not meet WWH criteria for neither fish nor macroinvertebrates at RM 9.3, which is downstream from one of Airborne Express Airpark's stormwater treatment outfalls. However, the fish community began its recovery at RM 7.01 and continued throughout the rest of the stream, culminating in exceptional IBIs in the lower three miles. The macroinvertebrate community did not show similar recovery. Degraded communities persisted throughout the stream until RM 0.65. While the fish community shows that some gains have been made in this stream since 1998, the macroinvertebrate community shows that improvements are still necessary. Continued progress in stormwater and wastewater treatment, in concert with urban and agricultural runoff controls, should help realize recovery to the benthic community.

In addition to Lytle Creek, Indian Run and Cowan Creek were also negatively affected by stormwater discharge from Airborne Express Airpark (ABX). Macroinvertebrates were not meeting WWH criteria in Indian Run downstream from ABX, and both fish and macroinvertebrates were impaired in Cowan Creek downstream from the confluence of Indian Run. Poor treatment of stormwater discharge was implicated in these findings, in addition to two fish kills in Cowan Creek downstream from Indian Run that have been reported to ODNR Division of Fish and Wildlife since May of 2008. Improvement in the treatment of glycol-based deicing compounds in stormwater at outfall 032 discharging to

Indian Run is recommended to restore aquatic life use attainment and eliminate the incidences of fish kills in Cowan Creek.

Lower Little Miami River Tributaries (excluding Todd Fork subwatershed)
Numerous streams in the lower watershed were impaired by the effects of urbanization (Table 1, Figure 2), particularly urban runoff, CSOs, SSOs, and/or municipal wastewater discharge. No stream epitomized this impact more than Duck Creek. As the recipient of numerous CSO discharges, industrial effluents and urban runoff, Duck Creek was the only stream to receive poor scores for both fish and macroinvertebrates. In turn, the poor quality of Duck Creek influenced the performance of the fish community of the Little Miami River downstream from its confluence at RM 3.87. The only impaired fish community on the Little Miami River in 2007 was found at RM 3.5, which was downstream from Duck Creek. Currently, Cincinnati Metropolitan Sewer District is negotiating a Long Term Control Plan to address water quality in Duck Creek. Sewer separation, maximizing storage of wastes in the collection system, and maximizing treatment of wastes are among the initiatives outlined in their plan, which must be approved by the regulating authorities (Ohio EPA, USEPA, and the Ohio River Valley Water Sanitation Commission) prior to implementation. In addition to these initiatives, it is also important that dry weather discharges be identified, and then reduced or eliminated altogether where they occur.

As evidenced by Duck Creek, the effects of urbanization on both the receiving tributary and the Little Miami River itself can be profound. Fortunately, in 2007, only Duck Creek was affected enough to also influence water quality in the Little Miami River. In order to improve and then the biological integrity and water quality of the Little Miami River tributaries, three priorities are important. First, no one stream should be permitted to receive so many discharges as Duck Creek, in terms of both the number of dischargers and the overall volume of discharge. Second, all tributaries must maintain the highest quality habitat in order to balance the effects of development with water quality expectations. Finally, urban runoff must be minimized as to not further confound the effects of WWTP discharge, CSOs and SSOs. Implementation of these priorities will improve not only the quality of the tributaries, but will also preserve the integrity of the Little Miami River as well.

Changes in Beneficial Uses
One of the other primary objectives of the study of the Lower Little Miami River watershed in 2007 was to evaluate the appropriateness of existing beneficial uses and to assign uses to undesignated streams. As such, six tributary streams evaluated in the 2007 study– Dutch Creek, Lick Run, Second Creek, First Creek, Little Muddy Creek, and Clough Creek - were originally assigned aquatic life use designations in the 1978 and 1985 Ohio Water Quality Standards (WQS) based largely on best professional judgment. The current biological assessment methods and numerical criteria did not exist then. The 2007 study, as an objective and robust evaluation of beneficial uses, is precedent setting in comparison to the 1978 and 1985 designations. The aforementioned streams were evaluated for the first time using a standardized biological approach in 2007. The changes in beneficial uses resulting from the study are outlined

below. Current and recommended aquatic life, water supply and recreation uses for the Little Miami River basin are outlined in Table 4.

Table 3 summarizes the assessments associated with the habitat and biological scores garnered at six streams that were sampled for the first time by Ohio EPA in 2007. Sampling conducted on these streams revealed biological communities that performed at or near the good level, which is typically associated with Warmwater Habitat (WWH) streams. Therefore, Second Creek, First Creek, Little Muddy Creek and Clough Creek are recommended to retain their WWH aquatic life use. Dutch Creek and Lick Run were previously assigned the Exceptional Warmwater Habitat (EWH) aquatic life use as a provisional designation that was not based upon any actual habitat or biological evaluation. The 2007 study revealed that the habitat quality of both streams likely precludes both biological indexes from attaining the exceptional scores necessary for the EWH use designation. As such, the combination of both habitat and biological performance justifies the recommendation of the WWH aquatic life use for Dutch Creek and Lick Run. Raw index scores and applicable biocriteria for every location sampled in the Lower Little Miami River watershed in 2007 are included in Table 2. Qualitative Habitat Evaluation Index (QHEI) matrix attributes are detailed in Appendix Table A-19.

Table 3. Streams with unverified aquatic life uses that were sampled in the lower Little Miami River basin in 2007. Evaluations are assigned to habitat, fish, and macroinvertebrate communities based on a combination of index scores, stream size, and ecoregion. Raw scores and applicable biocriteria are detailed further in the Aquatic Life Use Attainment Table.

Stream	# Sites	Size (mi^2)	Habitat Evaluation	Fish Evaluation	Macroinvertebrate Evaluation	ALU Current	ALU Rec.
Dutch Creek	1	14.8	Fair	Exceptional	Good	EWH	WWH
Lick Run	1	13.2	Poor	Good	Good	EWH	WWH
Second Creek	4	20.1	Good	Fair to Good	Low Fair to Good	WWH	WWH
First Creek	1	19.8	Good	Fair	Marginally Good	WWH	WWH
Little Muddy Creek	2	20.7	Fair	Marginally Good to Very Good	Low Fair to Good	WWH	WWH
Clough Creek	1	8.1	Good	Marginally Good	Fair	WWH	WWH

In addition to the changes described above, one sampling station in the 2007 survey produced data that warranted the re-designation of a previously verified stream. Macroinvertebrate sampling conducted on Dry Run at RM 1.79 revealed the presence of five coldwater-adapted macroinvertebrate taxa. The presence of this many coldwater taxa demonstrates that Dry Run within this reach is capable of supporting native cold water fauna and as such, should be designated Coldwater Habitat (CWH). The coldwater-adapted midges *Meropelopia sp.*, *Zavrelimyia sp.*, *Parametriocnemus sp.*, *Polypedilum aviceps*, and *Paratanytarsus n. sp. 1* were identified in both quantitative and qualitative samples. In addition, *Paratanytarsus n. sp. 1* was the second-most numerous individual taxa in the quantitative sample, comprising 21 percent of the total organisms collected on the artificial substrates. Dry Run from its headwaters to RM 1.2 (upstream from the City of South Lebanon) is recommended to have its aquatic life use revised from WWH to CWH due to the presence of these organisms.

Along with changes in aquatic life use, the 2007 survey of the Lower Little Miami River also revealed the need for changes in the recreation use of three streams. Dry Run, Little Muddy Creek, and Indian Run were previously designated as Secondary Contact Recreation (SCR). However, all three of these streams had pool depths that were deep enough for full body contact during summer low flows, and were located in areas readily accessible to people. Therefore, it is recommended that these streams revise their recreation use from SCR to Primary Contact Recreation (PCR), Class B.

In summary, it is recommended that Dutch Creek, Lick Run, Second Creek, First Creek, Little Muddy Creek, and Clough Creek receive the WWH aquatic life use. Dry Run is recommended to be re-designated from WWH to CWH from its headwaters to RM 1.2. Dry Run, Little Muddy Creek and Indian Run should have their recreation use changed from SCR to PCR Class B. All other beneficial uses for streams sampled in the 2007 survey of the Lower Little Miami River watershed are considered appropriate and should be retained.

Table 4. Waterbody use designations for the Little Miami River basin. Designations based on the 1978 and 1985 water quality standards appear as asterisks (*). Designations based on Ohio EPA biological field assessments appear as a plus sign (+). Designations based on the 1978 and 1985 standards for which results of a biological field assessment are now available are displayed to the right of existing markers. A delta (Δ) indicates a new recommendation based on the findings of this report. Waterbodies that have recommended changes are highlighted in yellow.

Water Body Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
Little Miami river - RM 3.0 (downstream of Beechmont ave.) to the mouth	+	+							+	+		+		
- headwaters to North fork (RM 91.64)	+	+							+	+		+		
- all other segments	+		+						+	+		+		
Cluff creek (Clough creek)		*+							*+	*+		*+		
McCullough run		*							*	*		*		
Duck creek - downstream Red Bank road (RM 2.4) to the mouth		+							*	*		+		
- confluence of East fork and West fork to Red Bank road							+		*	*			+	Small drainageway maintenance
East fork							+		*	*			+	Small drainageway maintenance
West fork							+		*	*			+	Small drainageway maintenance
Dry run		*							*	*		*		
East fork - RM 75 to W.H. Harsha lake	+		+					+	+	+		*		
- headwaters to RM 75		+						+	+	+		*		
- all other segments	+		+					+	+	+		+		
Hall run		+							+	+		*		
Wolfpen run		+							+	+		*		
Salt run		+							+	+		*		
Sugarcamp run		+							+	+		*		
Shayler run		+							+	+		*		
Unnamed tributary (Shayler run RM 4.4)		+							*	*		+		
Dry run		+							+	+		*		
Stonelick creek	+	+						+	+	+		+		
Lick fork		+							+	+		*		

Water Body Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
Brushy fork		+							+	+		*		
Rocky run		+							+	+		*		
Paterson run		+							+	+		*		
Moores fork		+							+	+		*		
Greenbush creek		+							+	+		*		
Hunter creek		+							+	+		*		
Backbone creek		+							+	+		*		
Lucy run		+							+	+		*		
Fourmile run		+							+	+		*		
Back run		+							+	+		*		
Ulrey run		+							+	+		*		
Slabcamp run		+							+	+		*		
Cloverlick creek - at RM 3.23		+						o	+	+		*		
- all other segments		+							+	+		*		
Barnes run		+							+	+		*		
Poplar creek		+							+	+		*		
Sugartree creek		+							+	+		*		
Town run		+							+	+		*		
Guest run		+							+	+		*		
Trible run		+							+	+		*		
Light run		+							+	+		*		
Snow run		+							+	+		*		
Polecat run		+							+	+		*		
Cabin run		+							+	+		*		
Kain run		+							+	+		*		
Todd run		+							+	+		*		
Indian Camp run		+							+	+		*		
Crane run		+							+	+		*		
Fourmile creek		+							+	+		*		

Water Body Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
Pleasant run		+							+	+		*		
Fivemile creek		+							+	+		*		
East fork		+							+	+		*		
Sixmile creek		+							+	+		*		
Howard run		+							+	+		*		
Grassy fork		+							+	+		*		
Glady run		+							+	+		*		
Saltlick creek		+							+	+		*		
Indian creek		+							+	+		*		
Little Indian creek		+							+	+		*		
Solomon run		+						+	+	+		*		
Murray run		+							+	+		*		
Sycamore creek		+							+	+		*		
Unnamed tributary (Sycamore creek RM 1.13)							+		*	*			+	Irretrievable flow modification
West fork		+						+	+	+		*		
Dodson creek			+						+	+		*		
Anthony run		+							+	+		*		
South fork		+							+	+		*		
Turtle creek		+							+	+		*		
Horner run		*							*	*		*		
Sycamore creek		+							+	+		+		
North branch		*							*	*		*		
Polk run		+							+	+		+		
O'Bannon creek		+							+	+		+		
Grog run		*							*	*		*		
Stony run		+							+	+		+		
Indiancamp creek		*							*	*		*		
Ertel run		*							*	*		*		
Salt run		*							*	*		*		

Water Body Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
Hen run		*							*	*		*		
Simpson creek		+							+	+		+		
Bear run		*							*	*		*		
Union run		*							*	*		*		
Muddy creek		+							+	+		+		
Turtle creek		+							+	+		+		
Dry run – headwaters to RM 1.2						Δ			+	+		Δ		
all other segments		+							+	+		Δ		
Little Muddy creek		*+							*+	*+		Δ		
Bigfoot run		*							*	*		*		
Halls creek			*						*	*		*		
Todd fork		+							+	+		+		
First creek		*+							*+	*+		*+		
Martin run		*							*	*		*		
Second creek		*+							*+	*+		*+		
Lick run			*+						*+	*+		*+		
Sugar run		*							*	*		*		
East fork (little East fork)		+							+	+		+		
Stony hollow		*							*	*		*		
Sewell run		*							*	*		*		
Cowan creek - Cowan lake (RM 6.3) to the mouth	*	+							+	+		+		
- at RM 11.6		+						o	+	+		+		
- all other segments		+							+	+		+		
Wilson creek		*							*	*		*		
Indian run		+							+	+		Δ		
Lytle creek		+							+	+		+		
Little creek		*							*	*		*		
Moore branch		*							*	*		*		
Dutch creek		Δ							*+	*+		*+		

Water Body Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
Dry run		*							*	*		*		
Stony run		*							*	*		*		
Cowen run		*							*	*		*		
Randall run		*							*	*		*		
Olive branch	*	+							+	+		*		
Caesar creek - headwaters to South branch (RM 23.78)		+							+	+		+		
- South branch to Anderson fork			+						+	+		+		
- Anderson fork to the mouth	*		+						+	+		+		
Flat fork	*	+							+	+		+		
Jonahs run	*	+							+	+		+		
Trace run	*	+							+	+		+		
Turkey run	*	*							*	*		*		
Buck run	*	+							+	+		+		
Anderson fork - Grog run to the mouth	*		+						+	+		+		
- all other segments	*	+							+	+		+		
Painters creek		+							+	+		+		
Grog run		*							*	*		*		
Love run		*							*	*		*		
Grassy run		*							*	*		*		
South branch - Paintersville-New Jaspar rd. (RM 4.0) to the mouth			+						+	+		+		
- all other segments		+							+	+		+		
North branch		+							+	+		+		
Newman run			+						+	+		+		
Mill run		+							+	+		+		
Unnamed tributary (Little Miami river RM 60.50)			+						+	+		+		
Unnamed tributary (Little Miami river RM 62.01)		+							+	+		+		

Water Body Segment	Use Designations													Comments
		Aquatic Life Habitat						Water Supply			Recreation			
	SRW	WWH	EWH	MWH	SSH	CWH	LRW	PWS	AWS	IWS	BW	PCR	SCR	
Glady run - Hedges rd. (RM 4.0) to the mouth		+							+	+		+		
- all other segments		+							+	+			+	
Glady run swale		+							*	*			+	
Sugar creek - within Sugar creek reserve	o	+							+	+		+		
- all other segments		+							+	+		+		
Little Sugar creek		+							+	+		+		
Unnamed tributary (Little Miami river RM 69.85)		+							+	+		+		
Beaver creek		+							+	+		+		
Little Beaver creek		+							+	+		+		
Unnamed tributary (RM 6.1)		+							+	+			+	
Shawnee creek		+							+	+		+		
Ludlow creek		+							+	+		+		
Massie creek		+						+	+	+		+		
Oldtown creek	*	+							+	+		+		
Clark run			+						+	+		+		
Unnamed tributary (Massie creek RM 5.3)			+						+	+		+		
North fork		+							+	+		+		
South fork		+							+	+		+		
Conner branch						+			+	+		+		
Jacoby branch			+						+	+		+		
Yellow Springs creek	*		+						+	+		+		
North fork	*	+							+	+		+		
Goose creek		+							+	+		+		
Lisbon fork		+							+	+		+		
Gilroy ditch		+							+	+			+	

SRW = state resource water; WWH = warmwater habitat; EWH = exceptional warmwater habitat; MWH = modified warmwater habitat; SSH = seasonal salmonid habitat;
CWH = coldwater habitat; LRW = limited resource water; PWS = public water supply; AWS = agricultural water supply; IWS = industrial water supply; BW = bathing water;
PCR = primary contact recreation; SCR = secondary contact recreation.

MATERIALS and METHODS

All physical, chemical, and biological field, laboratory, data processing, and data analysis methodologies and procedures adhere to those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 1989a) and Biological Criteria for the Protection of Aquatic Life, Volumes I-III (Ohio Environmental Protection Agency 1987a, 1987b, 1989b, 1989c, 2006, 2008a, 2008b), The Qualitative Habitat Evaluation Index (QHEI): Rationale, Methods, and Application (Rankin 1989, 1995, 2006) for aquatic habitat assessment, and the Ohio EPA Sediment Sampling Guide and Methodologies (Ohio EPA 2001). Sampling locations are listed in Table 1.

Determining Use Attainment Status

Use attainment status is a term describing the degree to which environmental indicators are either above or below criteria specified by the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1). Assessing aquatic use attainment status involves a primary reliance on the Ohio EPA biological criteria (OAC 3745-1-07; Table 7-15). These are confined to ambient assessments and apply to rivers and streams outside of mixing zones. Numerical biological criteria are based on multimetric biological indices including the IBI and MIwb, indices measuring the response of the fish community, and the ICI, which indicates the response of the macroinvertebrate community. Three attainment status results are possible at each sampling location - full, partial, or non-attainment. Full attainment means that all of the applicable indices meet the biocriteria. Partial attainment means that one or more of the applicable indices fails to meet the biocriteria. Non-attainment means that none of the applicable indices meet the biocriteria or one of the organism groups reflects poor or very poor performance. An aquatic life use attainment table (Table 2) is constructed based on the sampling results and is arranged from upstream to downstream and includes the sampling locations indicated by river mile, the applicable biological indices, the use attainment status (*i.e.,* full, partial, or non), the Qualitative Habitat Evaluation Index (QHEI), and a sampling location description.

Habitat Assessment

Physical habitat was evaluated using the QHEI developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989, 1995, 2006). Various attributes of the habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrates, amount and quality of instream cover, channel morphology, extent and quality of riparian vegetation, pool, run, and riffle development and quality, and gradient are some of the habitat characteristics used to determine the QHEI score which generally ranges from 20 to less than 100. The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have indicated that values greater than 60 are *generally* conducive to

the existence of warmwater faunas whereas scores less than 45 generally cannot support a warmwater assemblage consistent with the WWH biological criteria. Scores greater than 75 frequently reflect habitat conditions which have the ability to support exceptional warmwater faunas.

Sediment and Surface Water Assessment

Fine grain sediment samples were collected in the upper 4 inches of bottom material at each location using decontaminated stainless steel scoops and excavated using nitrile gloves. Decontamination of sediment sampling equipment followed the procedures outlined in the Ohio EPA sediment sampling guidance manual (Ohio EPA 2001). Sediment grab samples were homogenized in stainless steel pans (material for VOC analysis was not homogenized), transferred into glass jars with teflon® lined lids, placed on ice (to maintain 4^{o}C) in a cooler, and shipped to Ohio EPA Division of Environmental Services. Sediment data is reported on a dry weight basis. Surface water samples were collected, preserved and delivered in appropriate containers to Ohio EPA Division of Environmental Services. Surface water samples were evaluated using comparisons to Ohio Water Quality Standards criteria, reference conditions, or published literature. Sediment evaluations were conducted using guidelines established in MacDonald *et al.* (2000) and Ohio Specific Reference Values (2003).

Recreation Use Assessment

Recreation use attainment was determined using the draft criteria that will likely be adopted at the end of 2009 calendar year. This was done in order to facilitate agreement between discussions pertaining to recreation use in the 2007 Lower Little Miami River TSD and the subsequent lower Little Miami River TMDL that will be developed once the new criteria are officially adopted. The draft criteria (OAC 3745-1-41) will result in several changes when they become effective:

1) E. coli will be the only indicator organism used to evaluate recreation. The use of fecal coliform will be discontinued.
2) The recreation season will be May 1 – Oct. 31 instead of ending on Oct. 15.
3) Geometric mean content will be computed on a seasonal basis instead of monthly.
4) Geometric mean content will be the sole basis of use attainment status when 2 or more samples are taken.
5) Primary Contact Recreation (PCR) will be divided into three separate categories each with specific numerical criteria: Class A – high use paddling streams, Class B – most typical streams and Class C – historically channelized streams that drain < 3.1 mi^2.

The draft new rules and criteria associated with each class and sub-class use are provided in Appendix Tables A-9 and A-10.

Macroinvertebrate Community Assessment

Macroinvertebrates were collected from artificial substrates and from the natural habitats. The artificial substrate collection provided quantitative data and consisted of a

composite sample of five modified Hester-Dendy multiple-plate samplers colonized for six weeks. At the time of the artificial substrate collection, a qualitative multihabitat composite sample was also collected. This sampling effort consisted of an inventory of all observed macroinvertebrate taxa from the natural habitats at each site with no attempt to quantify populations other than notations on the predominance of specific taxa or taxa groups within major macrohabitat types (e.g., riffle, run, pool, margin). Detailed discussion of macroinvertebrate field and laboratory procedures is contained in Biological Criteria for the Protection of Aquatic Life: Volume III, Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities (Ohio EPA 1989b, 2008b).

Fish Community Assessment

Fish were sampled using pulsed DC electrofishing methods. Fish were processed in the field, and included identifying each individual to species, counting, weighing, and recording any external abnormalities. Discussion of the fish community assessment methodology used in this report is contained in Biological Criteria for the Protection of Aquatic Life: Volume III, Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities (Ohio EPA 1989b, 2008b).

Causal Associations

Using the results, conclusions, and recommendations of this report requires an understanding of the methodology used to determine the use attainment status and assigning probable causes and sources of impairment. The identification of impairment in rivers and streams is straightforward - the numerical biological criteria are used to judge aquatic life use attainment and impairment (partial and non-attainment). The rationale for using the biological criteria, within a weight of evidence framework, has been extensively discussed elsewhere (Karr *et al.* 1986; Karr 1991; Ohio EPA 1987a,b; Yoder 1989; Miner and Borton 1991; Yoder 1991; Yoder 1995). Describing the causes and sources associated with observed impairments relies on an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, land use data, and biological results (Yoder and Rankin 1995). Thus the assignment of principal causes and sources of impairment in this report represent the association of impairments (based on response indicators) with stressor and exposure indicators. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified, or have been experimentally or statistically linked together. The ultimate measure of success in water resource management is the restoration of lost or damaged ecosystem attributes including aquatic community structure and function. While there have been criticisms of misapplying the metaphor of ecosystem “health” compared to human patient “health” (Suter 1993), in this document we are referring to the process for evaluating biological integrity and causes or sources associated with observed impairments, not whether human health and ecosystem health are analogous concepts.

RESULTS and DISCUSSION

Little Miami River and Tributaries

(The Todd Fork subwatershed, a large and unique subwatershed in the lower Little Miami River basin, is discussed separately beginning on page 139)

Study Area Description

The portion of the Little Miami River studied in 2007 and 2008 includes the area downstream of the confluence with Caesar Creek (at RM 50.92) to its confluence with the Ohio River in Hamilton County east of Cincinnati. The Little Miami River flows southwesterly from Warren County to form a portion of the border between Clermont and Hamilton Counties before ending completely within Hamilton County. The watershed also encompasses a small portion of Butler County. Along its course the river drops from an elevation of 700 feet to 448 feet with an average gradient of 4.9 ft./mile and drains a total area of 1757 mi^2 at the confluence with the Ohio River. Major tributaries include Todd Fork, Turtle Creek, O'Bannon Creek, Sycamore Creek, and the East Fork Little Miami River. Table 5 lists the principal HUC 12 watersheds studied in 2007 and 2008. With the exception of three sites in the lower three miles, the East Fork Little Miami River and its watershed (drainage 499 mi^2) were not included in the current study. Selected LMR mainstem sites in the upper watershed were also included to provide information regarding upstream contributions to downstream water quality. A schematic representation of the lower Little Miami River watershed is provided in Figure 5.

The topography of the Little Miami River Watershed has been influenced by glaciation which left distinctive land forms and thick deposits of silt, sand, and gravel. The northwest part of the watershed is within the Eastern Corn Belt Plains ecoregion, which is characterized by level to gently sloping land, and relatively low gradient streams. The majority of the watershed lies within the Interior Plateau ecoregion which has greater relief and tributaries tend to have steeper gradients before entering the Little Miami flood plain. The valley of the mainstem through the study area is relatively narrow with steep sides. For most of its length the Little Miami flows atop a buried valley aquifer composed of highly permeable sands and gravel from past glacial events. Smaller tributaries in this area are known to disappear into the ground during dry periods due to high infiltration rates associated with the sand and gravel aquifer. This aquifer was designated a Sole Source Aquifer by USEPA. This designation requires extra review for any federally funded projects proposed for the surface above the aquifer. Many of the communities in the watershed close to the mainstem rely heavily on groundwater for a source of raw water. Some communities further away from the mainstem or in areas where the aquifer is less productive utilize surface water for supply. A combination of development pressures and limited supply have caused some communities to begin drawing water from the Caesar Creek and William Harsha Reservoirs and others purchase water from Cincinnati, which installed a water main along the river that reaches as far as Morrow.

The aquatic life use designation in effect for the majority of streams in the lower Little Miami River (LMR) watershed in 2007 was Warmwater Habitat (WWH). The LMR mainstem downstream to RM 3.0, Dutch Creek, Lick Run, and the East Fork LMR were

designated Exceptional Warmwater Habitat (EWH). The communities of Wilmington and Blanchester utilize Cowan Creek and Whitacre Run, respectively, as public water supplies. The Outstanding State Water (OSW) antidegradation category is also applicable to the Little Miami River due to its status as a State and National Scenic River.

While agriculture is the predominant land use with cultivated crop and pasture/hay respectively accounting for 31.43% and 13.65% of the total LLMR watershed area, a significant portion of the land is forested (28.4%) or developed (24.1%) (Table 6, Figure 6, Appendix Table A-8). Most of the agricultural (63.4%) and forested (36.4%) land use is found in the Todd Fork subwatershed while the majority of development (43.1%) occurs in the LLMR watershed downstream from O'Bannon Creek.

Communities in the watershed include Lebanon, South Lebanon, Mason, Loveland, Maineville, Milford, and portions of eastern Cincinnati. While it is difficult to accurately determine the population of a watershed, it is possible to analyze population growth by looking at census tracts wholly or partially within the LMR watershed. Comparing the 1990 and 2000 census figures shows that significant population increase has happened and probably continues. Total population in the watershed grew from 314,065 to 360,392 or 14.7%. Warren County tracts increased from a population of 62,660 in 1990 to 97,269 in 2000, an increase of 34,609 or 55% over the previous population. Clermont County increased by 9,955 or 21%. Hamilton County's watershed population only grew by 419 persons, which reflects the already well-developed nature of the area.

While most developing areas in the Little Miami watershed are not immediately adjacent to the river, the impacts of development are still a potential problem. Numerous residential, industrial, and commercial developments are recently completed, underway, or proposed within the watershed. Some local programs and the NPDES general permit for construction sites attempt to control sediment-laden runoff from these sites during construction. Enforcement of these regulations has not kept pace with the development, however, and a significant amount of sediment enters streams in the watershed as a result. This increased amount of sediment is eventually transported to the Little Miami via tributaries. Already developed areas contribute different types of pollutants to the watershed (oil & grease, lawn chemicals, PAHs). Problems have been reported from combined sewer overflows along Duck Creek.

There are three major environmental groups in the Lower LMR watershed. Little Miami Inc. (LMI) is a leader in citizen efforts related to the state and national Scenic River designation of the mainstem. Historically, LMI has focused on education and fundraising to purchase easements and land in the riparian zone. The Little Miami River Partnership (LMRP) was formed by individuals and government agencies in response to conditions in the watershed and the TMDL in the upper watershed. LMRP received grants from ODNR to hire a coordinator who is responsible for TMDL implementation, tracking development of watershed action plans, and education programs. Greenacres Foundation is a private environmental education facility in Hamilton County. Among its programs is the "Saturday Stream Snapshot" water quality monitoring program. In this

program, citizens collect water samples on Saturdays and bring them to the facility for analysis. While not a program with direct utility to Ohio EPA, these data can indicate trends in some parameters and raise concerns if particular problems are noted.

Table 5. Watershed Assessment Units (WAUs) in the 2007 lower Little Miami River study area.

10-Digit WAU: 05090202-06 Headwaters Todd Fork **12-digit WAU**	**Description**
05090202-06-01	Dutch Creek
05090202-06-02	Headwaters Todd Fork
05090202-06-03	Lytle Creek
05090202-06-04	Headwaters Cowan Creek
05090202-06-05	Wilson Creek-Cowan Creek
05090202-06-06	Little Creek-Todd Fork
10-Digit WAU: 05090202-07 East Fork Todd Fork - Todd Fork **12-digit WAU**	**Description**
05090202-07-01	East Fork Todd Fork
05090202-07-02	Second Creek
05090202-07-03	First Creek
05090202-07-04	Lick Run-Todd Fork
10-Digit WAU: 05090202-08 Turtle Creek-Little Miami River **12-digit WAU**	**Description**
05090202-08-01	Ferris Run-Little Miami River
05090202-08-02	Little Muddy Creek
05090202-08-03	Turtle Creek
05090202-08-04	Halls Creek-Little Miami River
10-Digit WAU: 05090202-09 O'Bannon Creek – Little Miami River **12-digit WAU**	**Description**
05090202-09-01	Muddy Creek
05090202-09-02	O'Bannon Creek
05090202-09-03	Salt Run-Little Miami River
10-Digit WAU: 05090202-14 Sycamore Creek – Little Miami River **12-digit WAU**	**Description**
05090202-14-01	Sycamore Creek
05090202-14-02	Polk Run-Little Miami River
05090202-14-03	Horner Run-Little Miami River
05090202-14-04	Duck Creek
05090202-14-05	Dry Run-Little Miami River
05090202-14-06	Clough Creek-Little Miami River

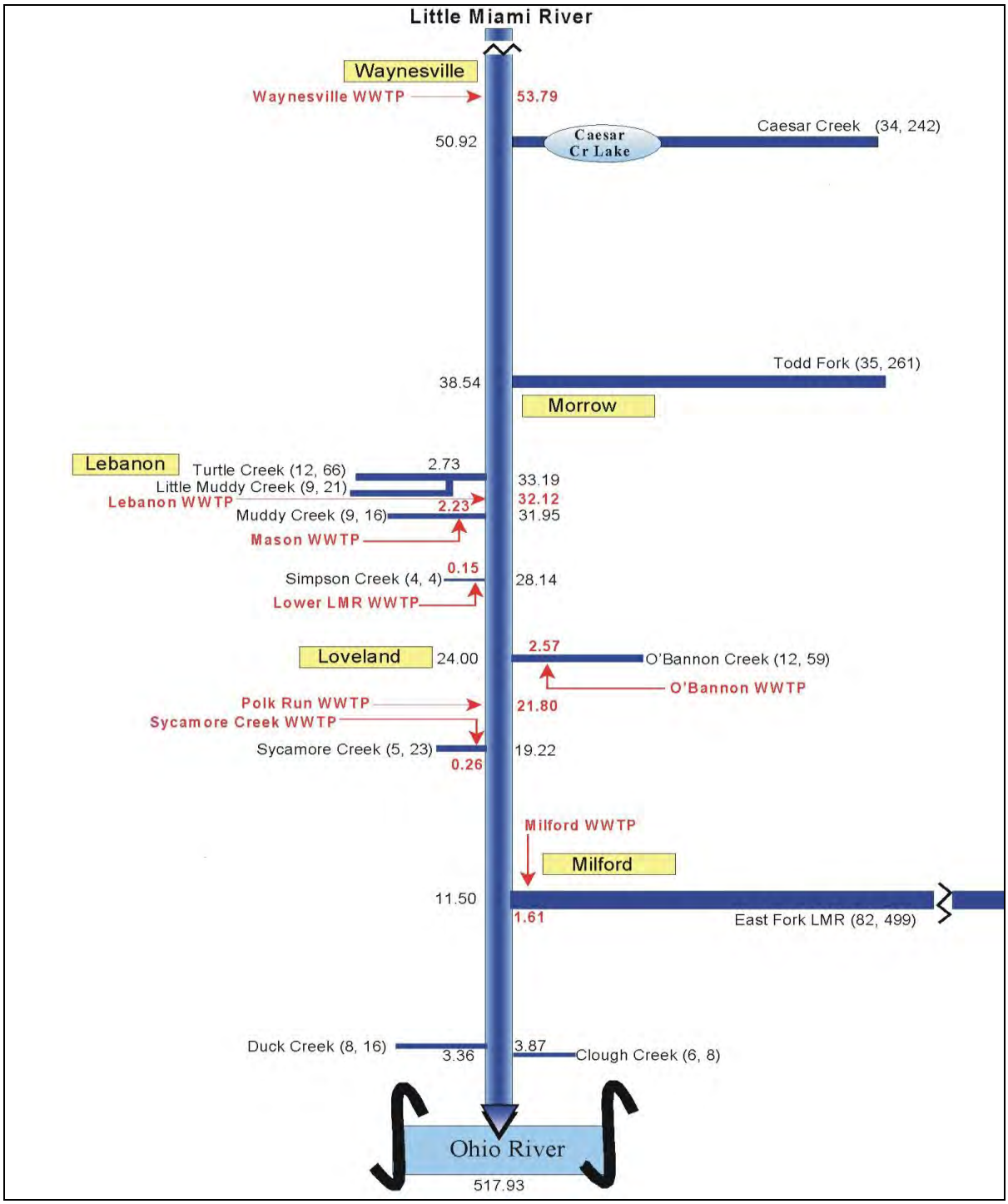


Figure 5. Schematic representation of the lower Little Miami River Watershed. Numbers in parentheses next to stream names represent stream length (miles) and drainage area (mi^2), respectively. River miles are indicated for stream confluences and WWTP discharges.

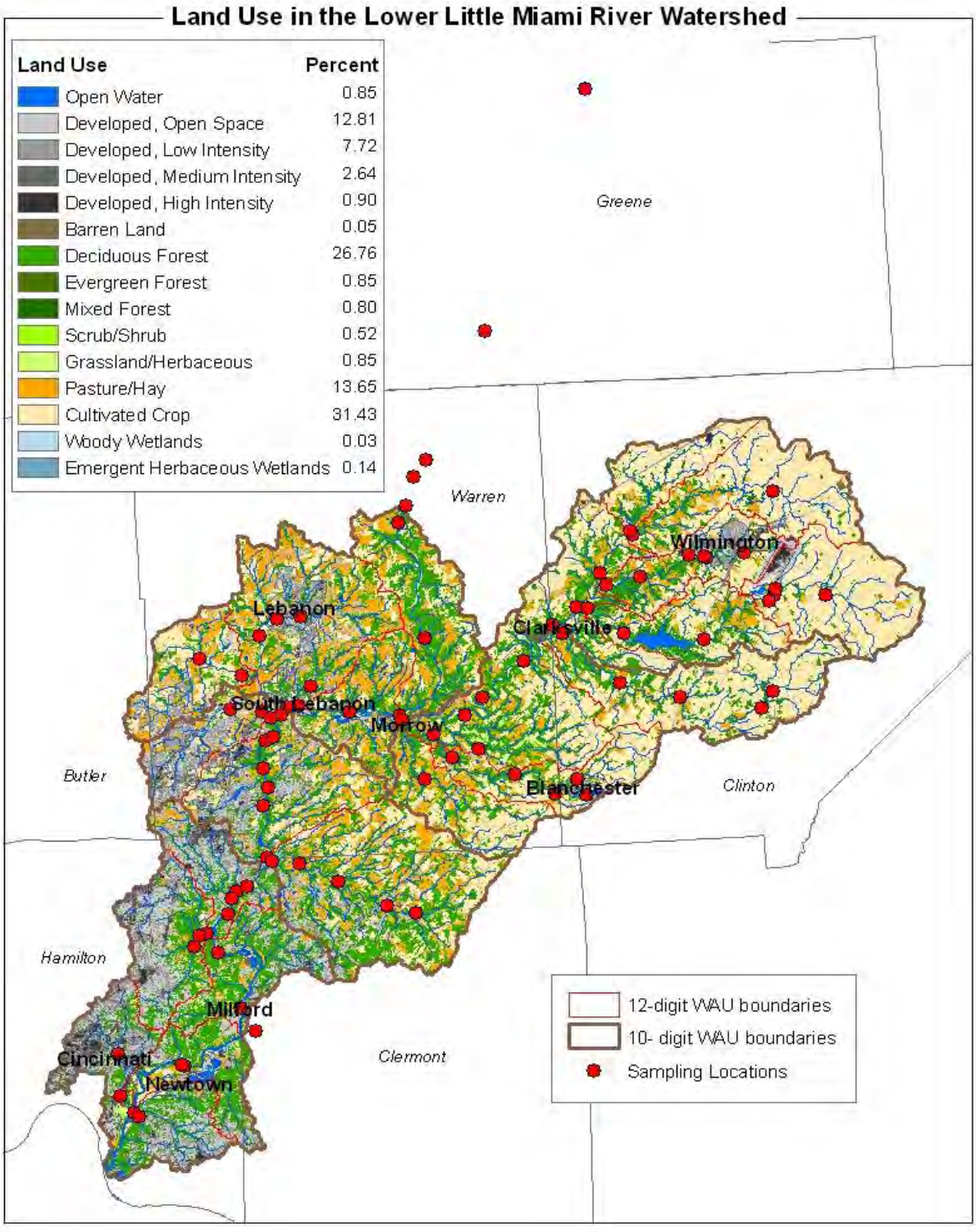
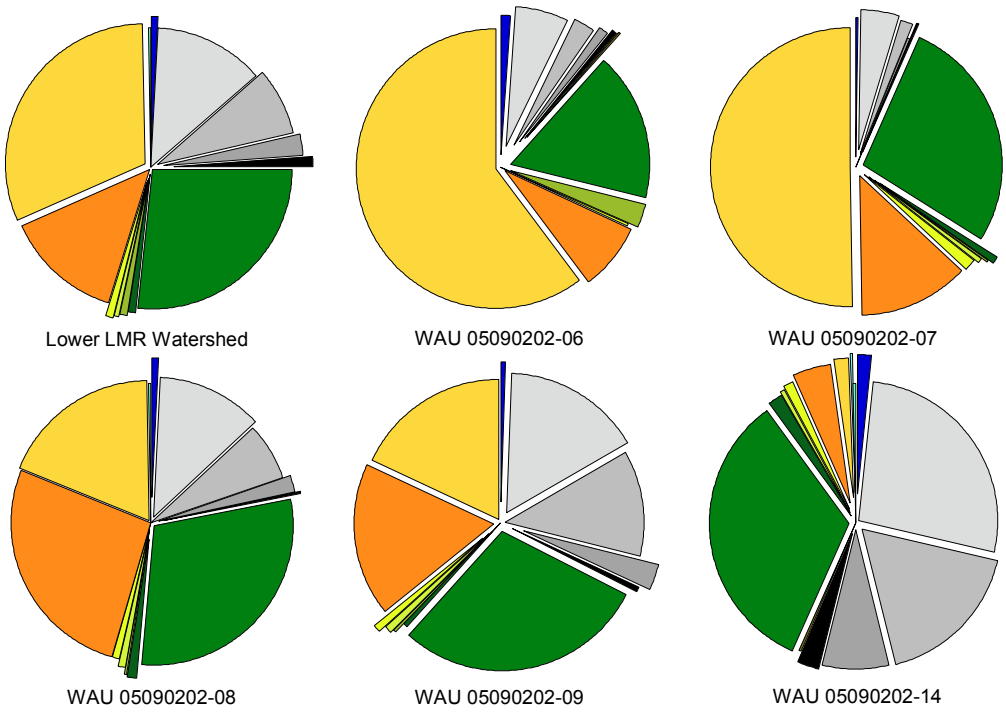


Figure 6. Land use in the lower Little Miami River Watershed (NLCD 2001).

Table 6. Percent land use in the lower Little Miami River watershed (NLCD 2001).

Land Use	Watershed Assessment Unit (WAU 05090202)					
	06	07	08	09	14	ALL
Open Water	1.02	0.18	0.77	0.65	1.60	0.85
Developed, Open Space	6.22	4.53	12.33	16.08	27.00	12.81
Developed, Low Intensity	2.62	1.48	6.69	12.08	17.41	7.72
Developed, Medium Intensity	0.87	0.32	1.79	3.00	7.79	2.64
Developed, High Intensity	0.69	0.12	0.37	0.71	2.67	0.90
Barren Land	0.13	0.00	0.01	0.00	0.09	0.05
Deciduous Forest	17.31	27.29	29.50	29.08	33.34	26.76
Evergreen Forest	0.09	0.76	1.14	0.75	1.71	0.85
Mixed Forest	2.75	0.42	0.07	0.07	0.11	0.80
Scrub/Shrub	0.04	0.57	0.87	0.87	0.37	0.52
Grassland/Herbaceous	0.20	1.24	0.94	0.77	1.29	0.85
Pasture/Hay	7.92	12.84	26.52	17.99	4.50	13.65
Cultivated Crop	60.12	50.16	18.76	17.82	1.68	31.43
Woody Wetlands	0.01	0.00	0.00	0.01	0.13	0.03
Emergent Herbaceous Wetlands	0.01	0.09	0.24	0.11	0.30	0.14



Point Sources - NPDES

The following includes summaries and loading information for National Pollutant Discharge Elimination System (NPDES) regulated dischargers in the Lower Little Miami River watershed - excluding those located in the Todd Fork subwatershed, which are listed beginning on page 142. The receiving stream and its pathway to the Little Miami River (where applicable) is included in *italics* (listed upstream to downstream on the Little Miami River stream network) following the name of the facility or entity. Outfall coordinates are listed alphabetically by facility in Appendix Table A-4.

Upper Little Miami River Dischargers

Various discharge points upstream from Little Miami River RM 63.0

Widespread biological non-attainment of Clean Water Act goals in both the 1993 and 1998 Little Miami River field surveys prompted discussions about the causes of these impairments. Nutrient over-enrichment –particularly phosphorus - was highlighted by Ohio EPA as a probable cause. In response to this finding, point source dischargers were informed by Ohio EPA that nutrient controls (namely, phosphorus removal) at these facilities may be necessary in the future, particularly at those facilities that were considering treatment plant expansions. Resultant from the Upper Little Miami River TMDL was the incorporation of phosphorus removal into the expansion permits of five major treatment facilities that discharge into the upper watershed of the Little Miami River.

First, the City of Xenia incorporated biological phosphorus removal into the expansion design of its Glady Run WWTP (Glady Run RM 4.93 to Little Miami River RM 63.72), which was completed around 1999. In addition to phosphorus removal, the Glady Run plant was also expanded to a design flow of 4.0 MGD. Around that same time, Xenia also modified its Ford Road WWTP (Little Miami River RM 77.03) in order to incorporate biological phosphorus removal. Design capacity remained at 3.6 MGD.

Next, Greene County expanded its Beavercreek WWTP (Little Miami River RM 72.74) and added new aeration tanks that could be modified at a future date to incorporate biological phosphorus removal. The expansion was completed around 1999 and the aforementioned modification of the new aeration tanks was made around 2006. Plant capacity was also increased from 4.0 MGD to 8.5 MGD, as the plant had been exceeding design flow for many years prior to its expansion. Greene County also expanded its Sugar Creek WWTP (Little Miami River RM 64.43) and incorporated biological phosphorus removal into the plant's current activated sludge treatment technology (counter current aeration), with chemical feed (ferric chloride) as a back-up. The expansion, which increased design flow from 4.9 MGD to 9.9 MGD, was completed in 2009. Sugar Creek had also been operating over design flow for nearly a decade prior to its expansion.

Lastly, Montgomery County began adding ferric chloride to the treatment process at its Eastern Regional WWTP (Little Beaver Creek RM 4.58 to Beaver Creek RM 1.2 to Little Miami River RM 72.74) since 2005. All of the improvements at these upper watershed treatment facilities have translated to reduced nutrient enrichment in the Little Miami

River mainstem, which in turn played a role in the recovery of the biotic integrity of the river.

Village of Waynesville WWTP

Little Miami River RM 53.77

The Village of Waynesville WWTP is located in Warren County at 444 US Route 42 North in Waynesville, Ohio. The facility receives wastewater from Waynesville, Corwin, Harveysburg and Caesar Creek State Park. The facility was built in 1962 and modified in 1983, with minor improvements added in 2000 and 2002. Improvements included influent pumping, screening, new activated sludge units and settling tanks. Treatment consists of bar screens, grit removal, counter-current aeration, secondary settling, disinfection through chlorination, de-chlorination, and sludge holding tanks. The current average design flow is 0.71 MGD. Phosphorus removal via chemical precipitation has been implemented in order to meet the summer permit limit of 1.0 mg/L as of September, 2008.

There are two lift stations with SSO potential inside the village of Waynesville and five outside the village limits. Waynesville is responsible for the monitoring and reporting of SSOs in town and have not reported any problematic areas. The county is responsible for the same outside of the village limits. Smoke testing as a component of an inflow and infiltration study was conducted on the collection system in 2003 and revealed problem areas such as downspouts, sewer cap issues and collapsed sewer laterals. More collection line camera work and smoke testing needs to be conducted at this facility.

Annual inspections by Ohio EPA field personnel in 2004 through 2007 were rated satisfactory. Unannounced inspections during the Ohio EPA stream survey in 2007 noted suspended flocculent in the final effluent chamber and downstream of the final outfall.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008 for outfall 001. For the nearly five years of data, evaluated through SWIMS (Surface Water Information Management System), seven violations were reported of primarily ammonia-N, occurring mostly in winter months. Thirty-six Reporting Frequency Violations for outfall 001 were documented for the same time period for chlorine, fecal coliform and pH in September through December, 2007.

Salvation Army - Camp Swoneky

Ferris Run RM 1.0 → Little Miami River RM 44.0

The Camp Swoneky Salvation Army Recreational Camp is located in Warren County at 605 Middleboro Rd in Oregonia Ohio. The current treatment system consists of a trash trap, flow equalization, parallel aeration tanks, double hopper clarifiers, fixed media clarifiers, a dosing tank, a sludge waste tank, slow surface sand filters and ultraviolet disinfection. The current design flow is 0.035 MGD.

In 2007, Ohio EPA personnel conducted an inspection of the facility. Results of the inspection found treatment plant equipment components in working order and effluent clear and free of solids.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, four ammonia-N violations were reported in September of 2007. Reporting Frequency Violations were also reviewed for the same time period. Between 2006 and 2008, more than 450 reporting violations have occurred for odor, flow rate, turbidity and temperature.

ODOT I-71 Motorist Rest Area 08-38
Unnamed tributary → Turtle Creek RM 11.55 → Little Miami River RM 33.19
The ODOT Rest Area is located in Warren County on I-71 southbound at mile marker 34.1 in Turtle Creek Township, Ohio. It is an extended aeration facility that consists of a trash trap, flow equalization, parallel aeration tanks, double hopper clarifiers, fixed media clarifiers, a dosing tank, slow surface sand filters and ultraviolet disinfection. The facility also has a waste sludge tank. The facility was built in 1986 with a design treatment capacity of 0.010 MGD. The facility underwent major modifications in 2006, and its design capacity was increased from 0.010 MGD to 0.040 MGD.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, 47 violations of ammonia-N were reported in 2006, with most occurring in summer. Over 2000 Reporting Frequency Violations were documented for the same time period and were mostly for water temperature, flow rate and turbidity.

Combs Country Kitchen Restaurant WWTP
Unnamed tributary → Turtle Creek RM 10.5 → Little Miami River RM 33.19
Comb's County Kitchen Restaurant WWTP is located in Warren County at 3150 SR 350 in Lebanon, Ohio. Combs Country Kitchen is a full-service breakfast, lunch and dinner restaurant. Treatment is provided via an antiquated package plant with a slow sand filter. The average design flow for the restaurant is 20,000 gpd.

An Ohio EPA inspection in 2005 found the facility in poor condition with a scum-covered clarifier, a solid-filled effluent channel, and both sand filters and concrete basins in need of replacement. A subsequent inspection in 2007 revealed similar conditions.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, nine violations were reported in 2005 only. Reporting Frequency Violations were also evaluated for the same time period. Thirty-seven violations were reported between 2004 and 2006 and were mostly flow rate, suspended solids, dissolved oxygen and temperature. Most of these violations occurred in the colder months of November, December and February.

Marathon Petroleum LLC Lebanon Terminal

Unnamed tributary → North Fork of Turtle Creek → Turtle Creek RM 7.02 → Little Miami River RM 33.19

Marathon Petroleum is located in Warren County at 999 W. Ohio Route 122 in Lebanon, Ohio. Manufacturing is not performed at this facility and the permit is for stormwater discharges with an average flow of 4000 gpd. The terminal is used for the storage of gasoline and fuel oil and the loading of these products into truck transports for delivery. Stormwater is collected into an oil and water separator and then discharged into a storm water retention pond before entering the unnamed tributary. Sludge generated at the terminal is then hauled to the Lebanon wastewater treatment facility.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, no violations were reported. Eleven Reporting Frequency Violations occurred in 2007.

TEPPCO (TE Products Pipeline Co, LP)

Foley's Run → Turtle Creek RM 5.76 → Little Miami River RM 33.19

TEPPCO is located in Warren County at 2700 Hart Road in Lebanon, Ohio. TEPPCO is an interstate refined petroleum products transmission company but does not manufacture, own, or sell the products in its pipeline system. The three main operations are transportation of products through the main system, storage of refined products in above-ground breakout storage tanks, and operation of two truck loading racks.

Treatment consists of oil and water separation and discharge. Past analytical data from outfall 002 suggest the presence of xylene and residuals from petroleum and other gasoline products. Outfall 002 receives stormwater flows from five product tank areas that are released to a discharge pipe after visual inspection. The total average flow rate for outfall 002 is approximately 14,702 gpd. Upgrades to the facility include a new oil and water separator.

Numeric violations of the National NPDES permit were evaluated from 2004 to a portion of 2008. No violations were reported for the nearly five years of data, as evaluated through SWIMS. Reporting Frequency Violations were also reviewed for the same time period. One violation was reported.

Shadow Lake Mobile Home Park

Unnamed tributary → Little Muddy Creek RM 4.5 → Turtle Creek RM 2.76 → Little Miami River RM 33.19

Shadow Lake Mobile Home Park is located in Warren County at 2479 Mason-Montgomery Rd in Mason, Ohio. Shadow Lake is a mobile home park with 277 mobile home pads. Shadow Lake WWTP was constructed in 1983 at an original average design flow of 0.032 MGD, expanding to the current 0.055 MGD. Treatment consists of one lift station, two extended aeration tanks, two double hopper clarifiers, a sludge tank, a dosing tank, four slow surface sand filters and UV disinfection. In 2004, the facility reported a sand filter bypass due to heavy rain and snow melt which likely exceeded the design by 10,000 gpd.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, 14 violations of predominately $cBOD_5$ were reported in 2005 and 2006, with most occurring in winter and spring. There were also 990 Reporting Frequency Violations documented for the same time period and were mostly for water temperature, D.O. and pH.

Lebanon WWTP

Little Miami River RM 32.1

The Lebanon WWTP is located in Warren County at 1525 Mason Morrow Millgrove Road in Lebanon Ohio. The Lebanon WWTP serves a population of approximately 19,500 at an average design flow of 6.0 MGD. Treatment consists of mechanical screening, grit removal, four aeration tanks with integral clarifiers, UV disinfection, cascade effluent aeration and eight aerobic digesters. Treatment for phosphorus is not currently underway for this facility. An upgrade in 2003 included hydraulic improvements, new anaerobic anoxic tanks, a new gravity belt thickener, a new aerobic digester and biosolids storage. Discharge was also doubled from 3.0 MGD to 6.0 MGD. South Lebanon is connected to the city of Lebanon collection system and contributes 850,000 gpd of the current 6.0 MGD

Operational issues included collection system overflows in 2006 and 2007 to the North Fork Turtle Creek and Baynums Run and historically large-volume dye spills from the JBS Company that were visible in Lebanon's clarifiers. Containment devices and cleanup procedures remediated the latter problem. Field crews have conducted unannounced inspections at this facility and noted pin floc and paper products in the effluent, as microscreens are not employed at this facility.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, eleven violations were reported primarily in the fall and winter months. Most violations were for suspended solids. Eleven Reporting Frequency Violations were also documented for the same time period for mostly demand parameters, suspended solids and phosphorus. Violations were attributed to overflows at the Glosser Road lift station and to construction activities at the facility. In December 2004, an equalization basin was installed at the Glosser Road lift station to remediate the overflows.

Ohio EPA conducted bioassays of Lebanon WWTP outfall 001 effluents, upstream and mixing zone waters in 1997 and 2003. Two acute bioassays from October of 1997 and 2003 demonstrated no toxicity to either test organism in any of the samples. In the winter months of 1997 and 2003, toxicity was present in the mixing zone and upstream samples.

Peak percentile flows (Figure 7) remained fairly constant before and after the upgrade and addition of the Equalization (EQ) basin, while median values were consistent throughout the period of record. Ammonia-N and TSS values were notably reduced after the EQ basin was brought online, whereas phosphorus percentiles increased.

Collection system overflow points could account for both the steady flow into the facility and the predictable median flows.

Mason Water Reclamation Plant

Muddy Creek RM 2.27 → Little Miami River RM 31.95

The Mason WWTP is located in Warren County at 3200 Mason-Morrow Millgrove Rd in Mason Ohio. The original facility was built in 1962 and upgraded in 1989 to a design of 2.5 MGD and then to 5.0 MGD by the mid 1990's. Mason built a new wastewater treatment facility which became operational by 2006 with an increase in design flow to 13 MGD. The facility is designed to handle a peak flow of 26 MGD. Current flow average from 2006 to date is approximately, 5.39 MGD. Approximately one MGD of flow is diverted through outfall 002 to a nearby golf course. The treatment works consists of mechanical screens, a grit chamber, two extended aeration oxidation ditches, settling tanks, UV disinfection, sludge processes and a 29 day storage silo for biosolids. Mason is currently removing phosphorus. Increases in loads are expected as development pressures continue in this region.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, 83 violations of predominately suspended solids and ammonia-N were reported mostly during the winter months prior to the installation of the new facility. Five violations for phosphorus occurred after the new facility began operations in 2006. A total of 173 reporting frequency violations were documented for the same time period at the old plant and were mostly for flow rate and ammonia-N.

Ohio EPA conducted bioassays of the Mason WWTP outfall 001 final effluents, and upstream and mixing zone waters in December 1997, September 1998, October 2003, December 2003, October 2007 and April 2008. Two of the six tests performed resulted in toxic endpoints. The September 1998 toxicity test revealed acute toxicity in final effluent to *Ceriodaphnia dubia*. Slight toxicity in upstream water and effluents occurred in the April of 2008 bioassay event.

Median and peak percentile flows showed little variance (Figure 8) after the new facility was brought online in 2006. Graphically, the benefits of the new facility were evident for all conventional parameters, including and especially phosphorus. Final outfall (001) bracketing of fixed stations 801 and 901 demonstrated significant departure from historical values after the plant upgrade. Upstream value reductions were likely due to the new location of the facility on the stream network.

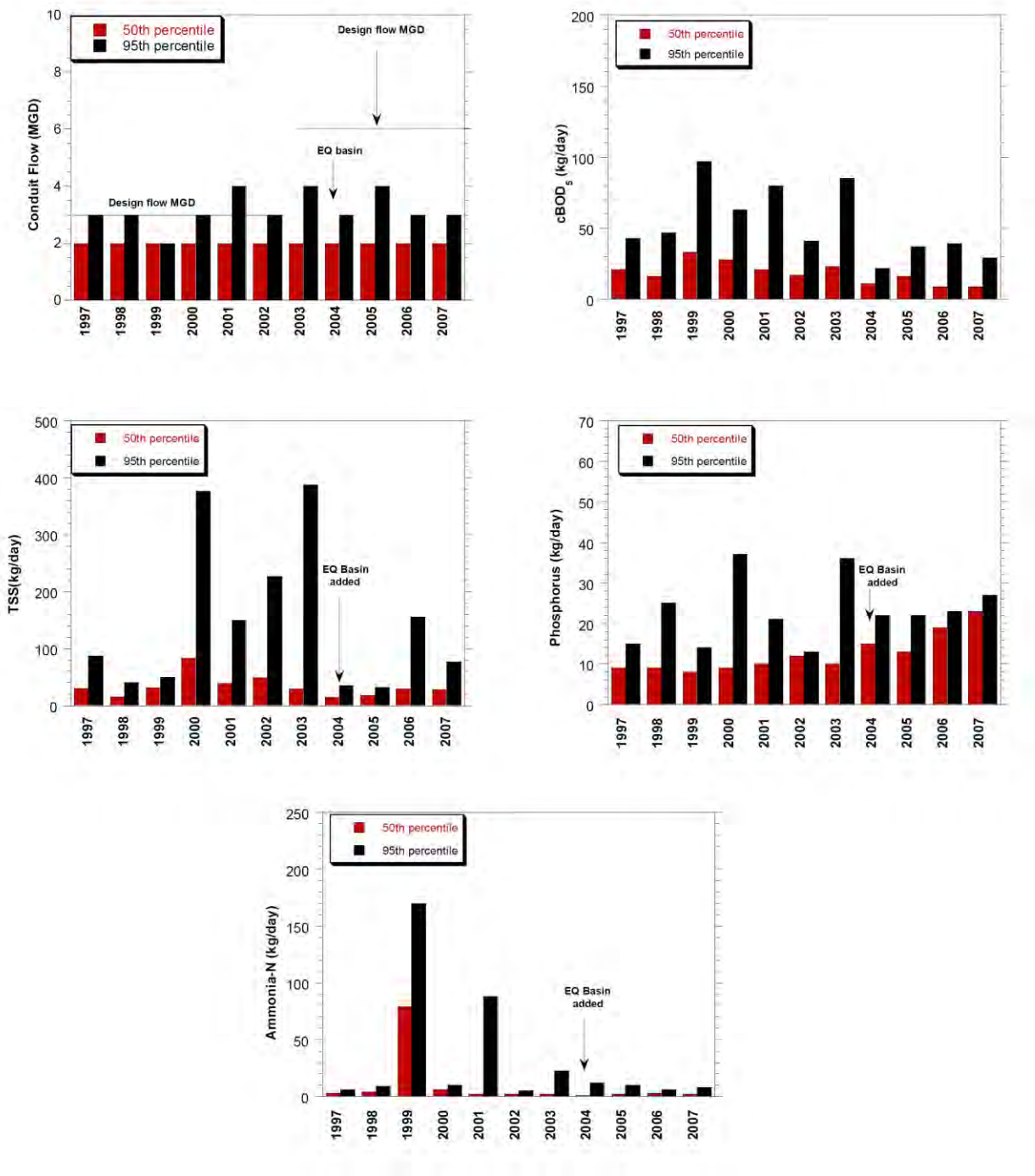


Figure 7. Annual Third-quarter loadings (kg/day) of conduit flow, cBOD5, Total Suspended Solids (TSS), phosphorus and ammonia-N at the Lebanon WWTP in the lower Little Miami River study area, 1997-2007.

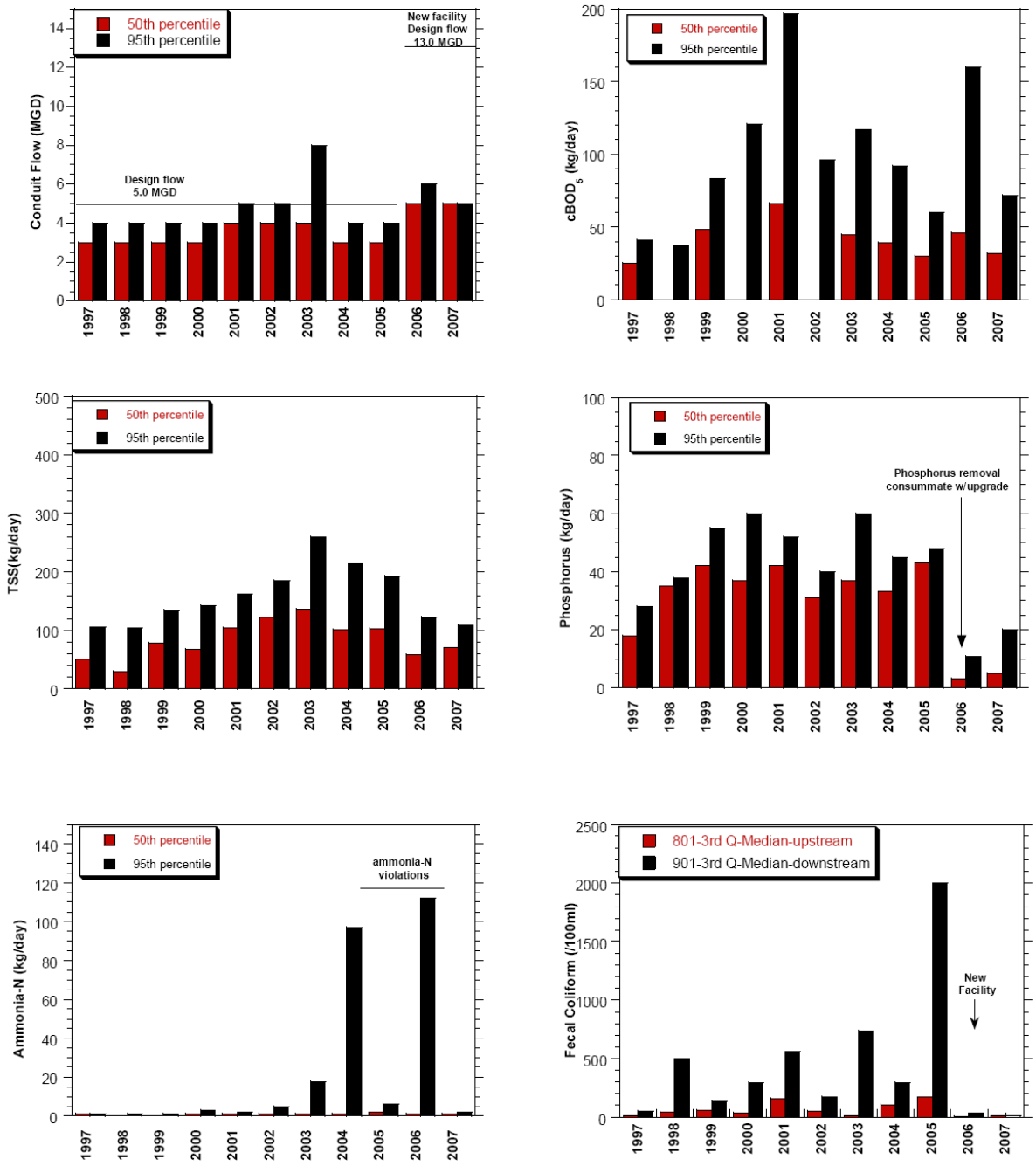


Figure 8. Annual Third-quarter loadings (kg/day) of conduit flow, cBOD5, Total Suspended Solids (TSS), phosphorus and ammonia-N; and concentrations of fecal coliform (CFU/100mL) at the Mason WWTP in the lower Little Miami River study area, 1997-2007.

Deerfield-Hamilton WTP
Unnamed tributary → Little Miami River RM 29.9
The Deerfield-Hamilton WTP is located in Warren County at 6193 Striker Road in Maineville, Ohio. The facility consists of ten production wells, aeration, filtration, chlorination, fluoridation and distribution. Both gravity filter and pressure filter backwash is filtered through sand beds and discharged to the receiving stream. Dry solids are removed from the surface of the sand beds and are landfilled.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, no violations were reported. Reporting Frequency Violations were also reviewed for the same time period. The majority of the 40 violations, occurring primarily in April and May of 2007 and 2008, were for flow, TSS, pH and metals.

SUMCO Phoenix Corporation – Cincinnati
Unnamed tributary → Little Miami River RM 29.2
SUMCO Phoenix Corporation (SUMCO) is located in Warren County at 537 Grandin Road in Maineville, Ohio. SUMCO manufactures single crystal silicon epitaxial wafers for semiconductors and for solar energy. Outfall 002 may have seasonal discharges of non-contact cooling water and reverse osmosis reject water, in addition to corrosion inhibitors, sodium hypochlorite, sodium bisulfate, and hydrochloric acid. Outfall 003 may have discharges of emergency cooling water from crystal growing furnaces. Outfall 004 may have reverse osmosis reject water discharges and condensate from the building's air conditioning system. Stormwater is also discharged through these outfalls. Currently, SUMCO is not discharging from any of its outfalls. Instead, discharges are going to the sanitary sewer. All of the NPDES outfalls discharge into an on-site pond, which then discharges its overflow into the unnamed tributary to the Little Miami River.

Numeric violations of the NPDES permit were reviewed from 2004 through December 1, 2008. Thirty-three violations for mostly residual chlorine and pH were reported at outfalls 002 and 004 in 2006 for almost every month. However, from December 1, 2007 through December 1, 2008, there were no violations of the NPDES permit. Sixty Reporting Frequency Violations were also documented for the same time period at these outfalls.

Warren County - Lower Little Miami WWTP
Simpson Creek RM 0.14 → Little Miami River RM 28.14
The Warren County Lower Little Miami WWTP is located in Warren County at 2086 West US Route 22 and 3 in Maineville, OH. This treatment plant discharges to Simpson Creek approximately 0.1 miles upstream from the Little Miami River (RM 28.1). The facility was built in 1981 and modified in 1992 and 2005. Annual average flow at the Lower Little Miami facility increased nearly 300 percent between 1983 and 1993. Flow volume increased steadily from 1983 to 1991, with values ranging from 0.77 to 2.54 MGD, respectively. Following an upgrade in 1992, flow volume declined to 2.22 MGD in 1993, which was well below the design capacity of 3.64 MGD. Current average design flow is 7.28 MGD with an expected increase to 12.0 MGD in the future.

In 2005, the treatment train included screening, grit removal, extended aeration, secondary settling, and disinfection by chlorination and dechlorination. Solid stream processes included aerobic sludge digestion, dewatering by belt filter press, storage on drying beds and disposal of stabilized sludge at a mixed solid waste landfill. Warren County currently has a permit-to-install on file for the proposed plant upgrade to 12.0 MGD. Clean-out and equipment repair (on the existing aeration tanks and settling tanks) is part of the upgrade work, as well as a new plant pretreatment building with operational grit removal units and screens that can handle high flow events. The current average daily flow is approximately 4.50 MGD, which accounts for approximately fifteen percent of the total effluent in the lower Little Miami River. The system has 17 lift stations and is completely sewered, with SSOs throughout the collection system. Inflow and infiltration (I/I) is estimated at 26,000 gpd. Phosphorus removal is slated to begin in 2010.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, 26 violations of predominately suspended solids, ammonia-N and $cBOD_5$ were reported, primarily in the spring months. Seventy-seven percent of the violations occurred in 2008. Sixteen Reporting Frequency Violations were documented for the same time period and were comprised mostly of metals, phosphorus and fecal coliform.

As a condition of the NPDES permit, Warren County was required to conduct monthly acute and quarterly chronic bioassay tests for one year at the Lower Little Miami plant. *Pimephales promelas*, fathead minnows, and *Ceriodaphnia dubia* were the test organisms utilized. No toxicity endpoints were noted for these tests. Bioassays of outfall 001, final effluent, upstream and mixing zone waters were conducted by Ohio EPA in spring and fall of 2004 and 2008. No toxicity to either test organism was demonstrated in any of the samples. Based on a review of the whole effluent toxicity data, the Lower Little Miami treatment plant has been placed in Category 4, "No Toxicity Problem", under Ohio EPA's toxics strategy.

Percentile flow variance was minimal over the period of record (Figure 9), although some variability was evident just prior to the flow expansion in 2005. Graphically, the benefits of the upgrade in 2005 were not apparent, as loadings of cBOD, TSS, and phosphorus continued to increase after the expansion. Increased loads for these

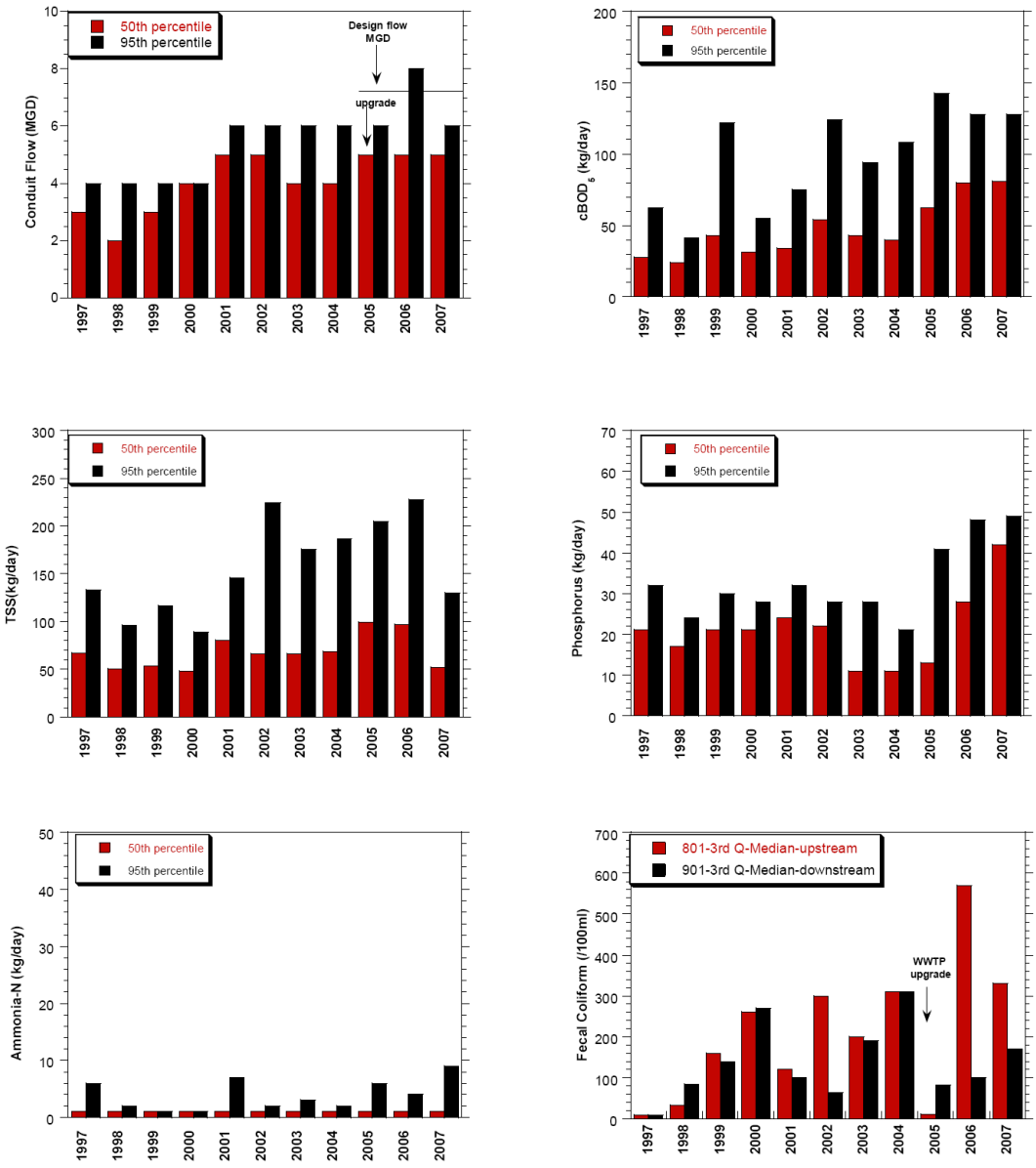


Figure 9. Annual Third-quarter loadings (kg/day) of conduit flow, cBOD5, Total Suspended Solids (TSS), phosphorus and ammonia-N; and concentrations of fecal coliform (CFU/100mL) at the Lower Little Miami River WWTP in the lower Little Miami River study area, 1997-2007.

parameters could be a result of elimination of overflow locations in the collection system, thus increasing loads to the facility. Final outfall (001) bracketing of fixed stations 801 and 901, with few exceptions, demonstrated that upstream concentrations of fecal coliform regularly exceeded downstream values for the period of record. After the upgrade in 2005, upstream values became significantly higher than downstream values. Median and peak loads graphically increased as SSOs were eliminated from the collection system, peaking in reported values by 2007 and 2008, respectively, for the period of record.

Midwestern Children's Home WWTP

Stony Run RM 4.45 → O'Bannon Creek RM 4.21 → Little Miami River RM 24.0

Midwestern Children's Home is located in Warren County at 4581 Long Spurling Road in Pleasant Plain, Ohio. Midwestern Children's Home is a school and home for children without families. The treatment system consist of a trash trap, a flow equalization tank, an aeration tank, a double hopper clarifier, a dosing tank, three slow surface sand filters, a chlorine contact tank and a dechlorination tank. The current average design flow is 0.016 MGD.

As of 2003, Midwestern was frequently violating its discharge permit, mostly due to inflow and infiltration. As of 2004, Midwestern completed significant sewer rehabilitation. In 2007 and 2008, heavy precipitation events created solids washouts due to clogged return lines, flooded sand filters and clogged filters.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, as evaluated through SWIMS, 105 violations of predominately ammonia-N, dissolved oxygen and suspended solids were reported over all seasons with yearly increases in frequency. Reporting Frequency Violations totaled over 1000 and were mostly for demand parameters, odor, temperature, color and flow rate.

Dale Acres WWTP

Ritter Creek RM 3.2 → O'Bannon Creek RM 3.69 → Little Miami River RM 24.0

Dale Acres WWTP is located in Warren County at the end of White Street in Cozaddale, Ohio. Dale Acres WWTP treats effluent for a subdivision at White and Elizabeth Streets and serves an approximate population of 85. Dale Acres is operated by the Warren County Department of Water and Sewer, was built in 1982, and has not had an upgrade. The treatment train consists of a bar screen, skimmer, extended aeration, secondary settling with sludge return, sand filtration, and disinfection. The average design flow for the facility is 0.015 MGD. The sludge produced is hauled to the Lower LMR WWTP facility for disposal. The collection system is completely separate from the storm sewer.

An inflow and infiltration study in 2005 estimated a wet weather contribution of approximately 1300 gpd entering the sanitary sewer. Dale Acres is currently investigating sources and potential pathways for wet weather inflow and infiltration. An

Ohio EPA inspection in 2005 rated the wastewater facility as satisfactory with no recommendations for change

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, nine violations were reported in 2007. All occurred in January and were for conventional parameters. Reporting Frequency Violations were also reviewed for the same time period. Reporting violations totaled 27 in 2007 and were for color, odor and turbidity.

O'Bannon WWTP

O'Bannon Creek RM 2.57 → Little Miami River RM 24.0

The O'Bannon WWTP is located in Clermont County at 1270 Neale Lane in Loveland, Ohio. Wastewater treatment consists of coarse and fine screening, flow equalization, activated sludge, final clarification, tertiary sand filters, post aeration and UV disinfection. This facility does not remove phosphorus as of 2008. O'Bannon WWTP was built in 1984 and was modified in 1994 and 2001. In 2001, additions to the treatment train included an oxidation ditch for activated sludge, a secondary clarifier, two sand filtration units, and UV disinfection. The current average design flow is 4.4 MGD.

An inflow and infiltration study conducted in 1999 estimated 60,000 gpd of infiltration entering the sewer system groundwater inflow. The collection system is entirely separate. O'Bannon Creek WWTP is not included in the county's approved industrial pretreatment program because it has no significant industrial users. No whole effluent biological testing is currently being submitted by the county.

During the 2007 summer field season, Ohio EPA field crews noted on numerous unannounced visits that the final effluent chamber was full of solids that were being discharged to O'Bannon Creek. Suspended and depositional solids were noted instream just downstream of outfall 001. A Notice of Violation (NOV) letter was issued to the facility during one of the visits. Subsequently, new sand for the tertiary sand filters and other approaches were implemented immediately and final effluent quality improved greatly. Additional unannounced visits by Ohio EPA personnel since have noted greatly improved conditions at the facility.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, a total of 15 violations of predominately copper, mercury and ammonia-N were reported for all months and years. Sixty-five Reporting Frequency Violations for mostly metals were documented for the same time period.

Ohio EPA conducted acute screening bioassays of O'Bannon outfall 001 effluents, upstream and mixing zone waters in 1998 and 2003. Of these, toxicity occurred in the November 2003 sampling event for the upstream, mixing zone and effluent grabs.

Median and peak percentile flows have remained fairly constant after the upgrade in 2001 (Figure 10), and loadings for most parameters were generally reduced. Bacterial

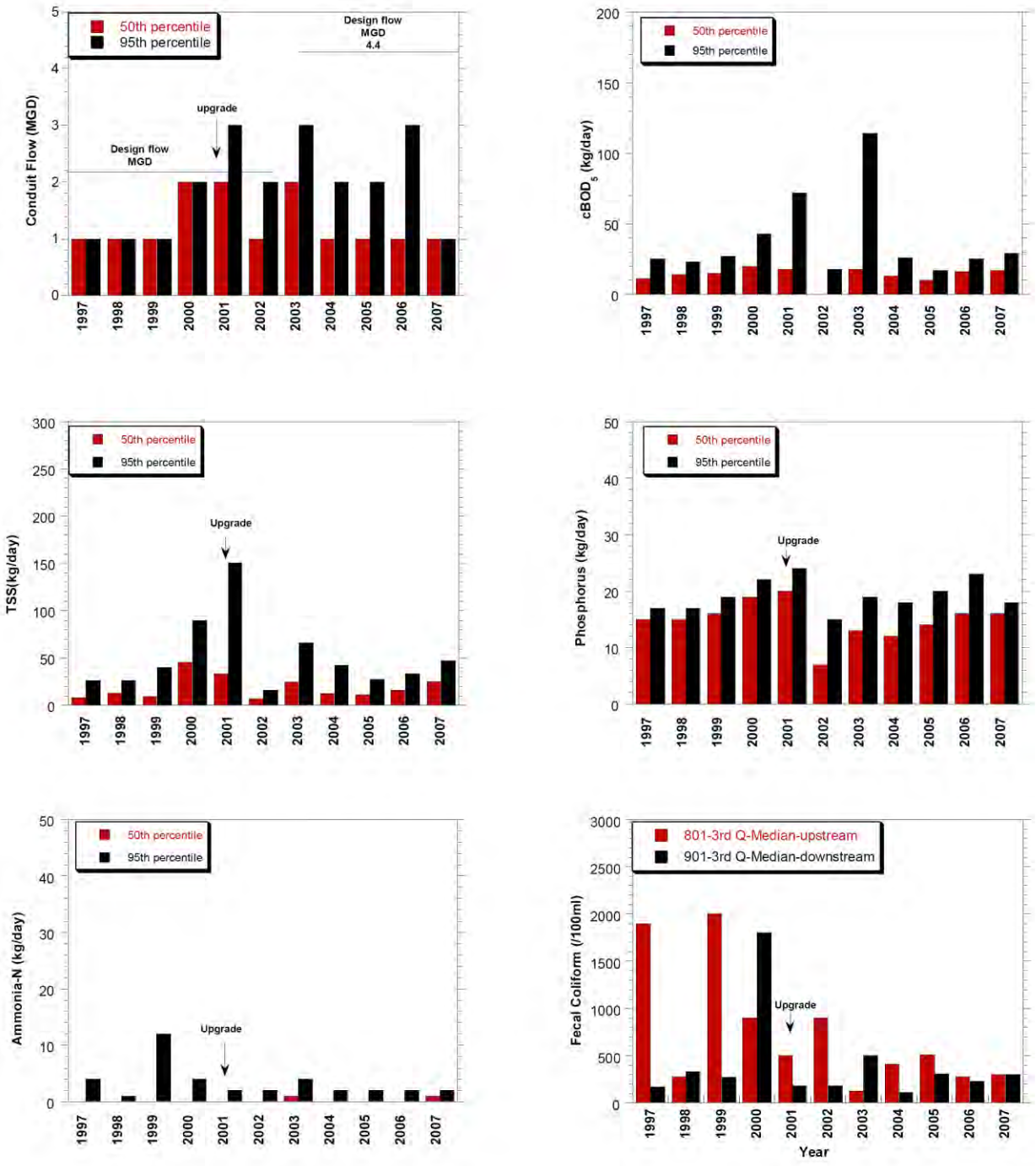


Figure 10. Annual Third-quarter loadings (kg/day) of conduit flow, cBOD5, Total Suspended Solids (TSS), phosphorus and ammonia-N; and concentrations of fecal coliform (CFU/100mL) at the O'Bannon WWTP in the lower Little Miami River study area, 1997-2007.

reductions downstream of outfall 001 weren't influenced notably by the expansion although upstream values fell sharply and gradually throughout the period of record. Final outfall (001) bracketing of fixed stations 801 and 901, with few exceptions, demonstrated that downstream concentrations of ammonia-N were commensurate with upstream values throughout the period of record.

Clermont County - Miami Trails WWTP

Unnamed tributary → Little Miami River RM 22.6

The Clermont County Miami Trails is located in Clermont County at 6652 Miami Trails Drive in Loveland, Ohio. The Miami Trails WWTP was built around 1988 to serve approximately 250 homes. The treatment process consists of a bar screen, flow equalization, extended aeration, secondary settling, sand filtration, and disinfection through chlorination and de-chlorination. The treatment plant was modified in 1992 to an average design capacity of 0.2048 MGD, and again in 2000 to an average design capacity of 0.40 MGD. An overflow event from a lift station in the plant's collection system was reported in September 2008 due to a massive area-wide power outage.

An Ohio EPA Inspection in 2006 found Miami Trails to be compliant with its permit effluent limitations; however it was noted that the clarifier needed better maintenance due to grease carryover to the final tank. The slow sand filters were not in service upon inspection and the disinfection system did not seem to be designed to handle peak flows. A follow-up inspection in 2008 resulted in a „satisfactory' rating for all areas.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, no violations were reported. Numerous sludge reporting violations were reported and approximately ten Reporting Frequency Violations, mostly for metals and ammonia-N, were documented in March of 2008.

MSD Polk Run WWTP

Unnamed tributary → Little Miami River RM 21.8

MSD Polk Run WWTP is located in Hamilton County at 9744 East Kemper Rd in Loveland, Ohio. Polk Run is an advanced treatment facility with a design flow of 8.0 MGD. The average daily flow as of 2006 was 5.07 MGD, with the last modification to the plant occurring in 2001. No expansion is slated for the future and loadings haven't significantly increased since the last survey in 1998. Treatment processes include grease and grit removal, primary settling, activated sludge aeration, final clarification, chlorination and dechlorination. Polk Run is not currently removing phosphorus and sludge generated at the facility is incinerated.

The facility has seven smaller lift/pump stations and two larger stations at Polk Run and Harper Ave. System bypasses have been reported at four lift/pump stations: Glen Lake, Harper Ave (upgraded), Bears Run Road and Polk Run Road. Polk Run pump station overflows were reported in 2000, 2001 and 2002 due to equipment failures. The collection system is predominately separate sewers with 50% of the service area sewered. Less than 1% of the collection system is combined storm and sanitary sewers

in “old” Loveland. Some equalization basin overflows have been reported to Ohio EPA. There have been ongoing discussions about a sewer connection at the Twenty Mile annexed area and the concern for exacerbated overflows.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, six violations were reported in the fall and winter months of predominantly suspended solids. A total of 540 Reporting Frequency Violations were documented for the same time period, with most occurring in 2004 to 2006. Parameters included metals, chlorine and various nutrients.

Bioassays of Polk Run WWTP outfall 001 final effluents, upstream and mixing zone waters were conducted by Ohio EPA in November of 2007. Toxicity was not apparent in any of the samples.

Median and peak percentile flows were constant before the upgrade (Figure 11); however, percentile variability appeared afterwards as system overflows continued and mechanical pump failures led to erratic flows into the plant. Graphically, the benefits of the upgrade were most evident for ammonia-N and $cBOD_5$, while other parameters acted independently or inversely to the expansion. Final outfall (001) bracketing of fixed stations 801 and 901, with few exceptions, demonstrated that concentrations of fecal coliform were stable throughout the period of record, although loads increased gradually. Median fecal coliform concentrations upstream were mostly higher than downstream concentrations which could be attributed to upstream overflows or to other unknown influences.

Arrowhead Park Apartments WWTP

Unnamed tributary → Little Miami River at RM 21.0

The Arrowhead Apartments are located in Clermont County, at 6783 Branch-Hill Guinea Park in Loveland, Ohio. The complex has 360 apartment units plus 303 single family equivalents. The wastewater facility was built in 1975 with subsequent modifications in 1986 and 1993 and includes one lift station. The facility includes two-stage extended aeration at a design of 0.140 MGD.

In the spring of 2008, partially treated wastewater was discharged after a 4.5 inch rain, resulting in an overflow of the secondary clarifiers. No other overflows have been reported. In 2008, an Ohio EPA inspection of the facility produced a satisfactory rating.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, no violations were reported. Reporting Frequency Violations were also reviewed for the same time period, with 17 violations for metals between 2004 and 2006.

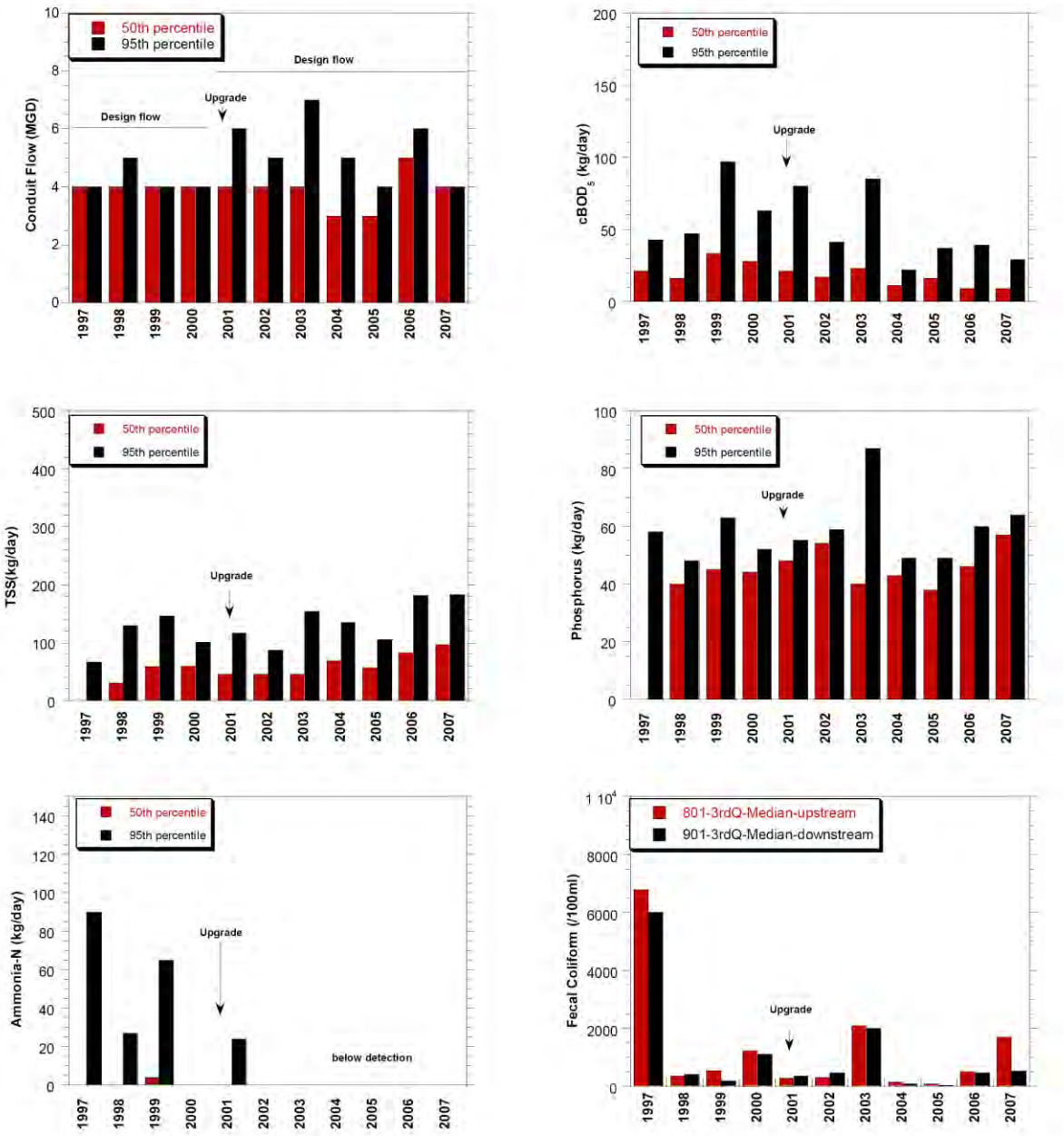


Figure 11. Annual Third-quarter loadings (kg/day) of conduit flow, cBOD5, Total Suspended Solids (TSS), phosphorus and ammonia-N; and concentrations of fecal coliform (CFU/100mL) at the Polk Run WWTP in the Lower Little Miami River study area, 1997-2007.

MSD - Hamilton County - Sycamore Creek WWTP

Sycamore Creek RM 0.2 → Little Miami River RM 19.22

The Sycamore Creek WWTP is located in Hamilton County at 9273 Old Remington Road in Cincinnati, Ohio. The average flow design for the facility in 2003 was 6.0 MGD. The design flow will increase to 9.0 MGD starting in February 2010 (upon completion of plant improvements). The current treatment process consists of mechanical screening, grit removal, primary settling, extended aeration with bio-P removal capability, secondary settling, tertiary filtration, UV disinfection, and post aeration. Upgrades included a fourth aeration tank in 2007. As of 2010, the facility will have phosphorus reduction treatment online in order to meet a monthly phosphorus limitation of 1.0 mg/l. No expansion for this facility is planned for the future.

Internal bypasses due to wet weather have occurred since 2002 with peak flows reaching 20 MGD. Flows up to 10 MGD receive secondary treatment. As of 2008, capital improvements to eliminate these events are underway. Bypassing during capital improvements construction is not uncommon and therefore ultra violet light (UV) disinfection was implemented to treat the combination of treated and bypassed flow. Construction improvements to help the facility deal with high and wet weather flows have been underway since 2005. In August of 2007, a sludge spill to Sycamore Creek occurred when a sludge storage tank overflowed during a sludge wasting event. The spilled sludge (both on the plant site and in the stream) was diluted by continued power washing of the affected areas.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, 68 violations of predominately suspended solids were reported in all months and were evenly distributed for all years. Reporting Frequency Violations were related to construction activities at the facility in 2007 and 2008.

Bioassays of Sycamore Creek WWTP outfall 001 effluents, upstream and mixing zone waters were conducted by Ohio EPA in December of 2003 and March of 2004. No toxicity endpoints occurred in either of the sampling events.

Median and peak percentile flows remained fairly constant before and after the facility expansion and were reduced to ten-year lows by 2007 after the implementation of system-wide inflow and infiltration upgrades (Figure 12). Other parameters were commensurate with the more predictable flows and were level by 2007 when flow levels fell below design capacity. Ammonia remained variable throughout the capital improvements period with nitrification perhaps hindered by the upgrade process. Final outfall (001) bracketing of fixed stations 801 and 901, with few exceptions, demonstrated that concentrations of fecal coliform were variable; however, from 2001 to 2007, downstream values exceeded upstream. Percentile variability was reduced dramatically by 2005 when work on the entire treatment system was underway.

H.B. Fuller

Unnamed tributary (prior to entrance at retention pond) → ~Little Miami River RM 19.0

H.B. Fuller is located in Hamilton County at 4440 Malsbury Rd in Blue Ash, Ohio. The facility produces water-based adhesives and emulsions used to make the adhesives for industrial customers. In the mid-1990s, a transfer pipe leak resulted in contamination of soils and groundwater with VOCs. The site has been investigated and a carbon adsorption, dual vacuum groundwater extraction system was installed, producing around 10,000 gpd of treated discharge. An Ohio EPA inspection of the facility in 2003 produced a satisfactory rating. In 2007, Ohio EPA personnel investigated the release of fire fighting foam resulting from the testing of the fire suppression system that was discharged into the unnamed tributary.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, no violations were reported. Further, no Reporting Frequency Violations were reported for the same time period.

Lake Remington MHP WWTP

Little Miami River RM 18.8

Lake Remington MHP is a mobile home park located in Clermont County at 70 Glendale Milford Road (SR 126) in Loveland, Ohio. Lake Remington MHP has approximately 85 approved mobile home trailer sites. Wastewater treatment consists of screening, aeration and clarification.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, 79 violations of conventional parameters including oxygen demand, suspended solids and ammonia-N occurred mostly from September through December. There were also 176 Reporting Frequency Violations documented from 2007 to 2008. Most violations were for flow rate and total residual chlorine.

Indian Lookout WWTP

Unnamed tributary → Little Miami River RM 16.8

The Indian Lookout WWTP is located in Clermont County at 6274 Ryan Circle in Loveland, Ohio. Indian Lookout WWTP was built in 1968 and serves a 180-lot subdivision. The treatment train includes extended aeration and utilizes chlorination and dechlorination. The average design flow for the package plant is 0.045 MGD. This facility will eventually be decommissioned and its service area tied into the Ward's Corner Regional WWTP.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, two violations for pH occurred in 2008. Reporting Frequency Violations were also reviewed for the same time period, with no violations reported since 2004.

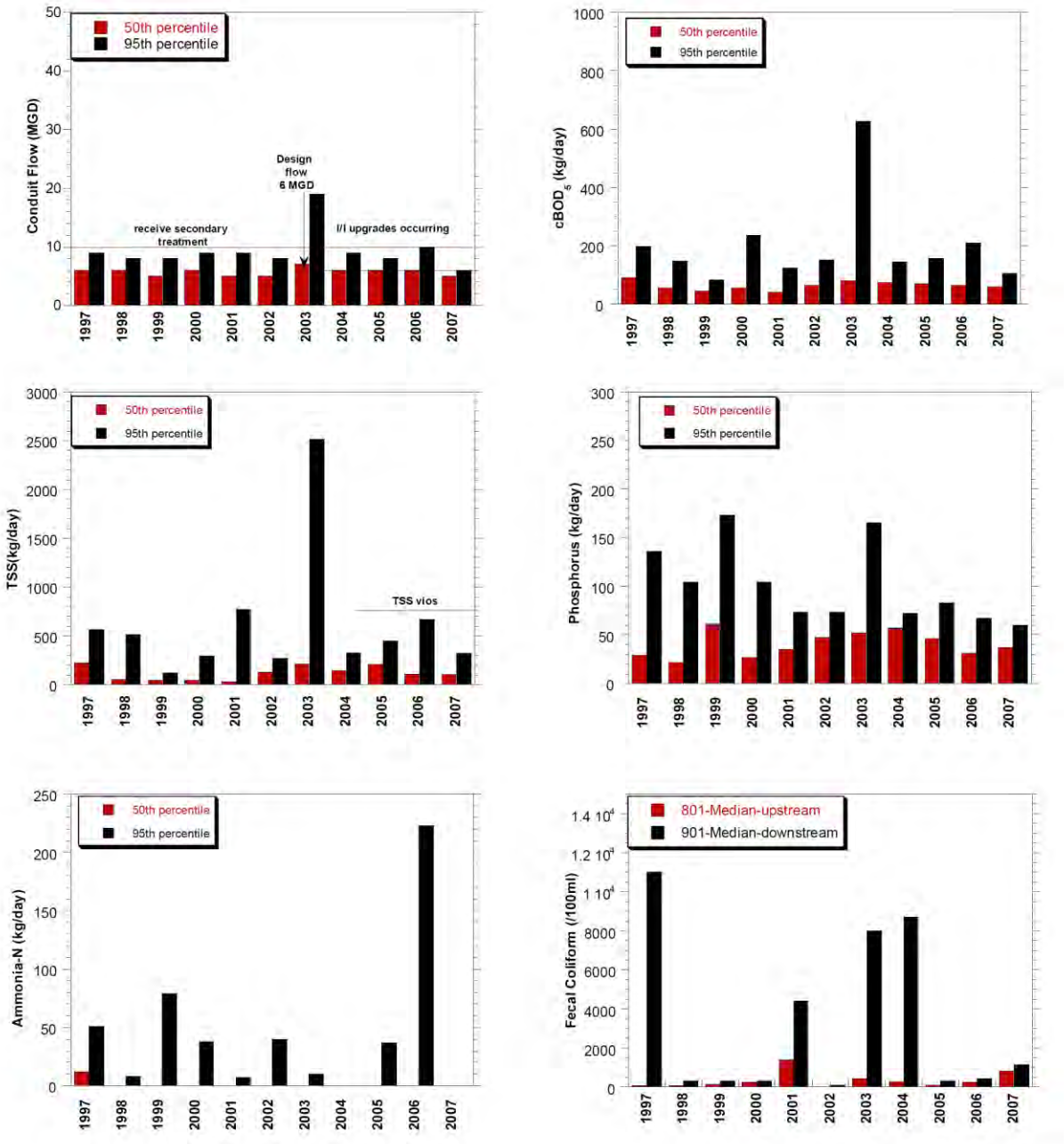


Figure 12. Annual Third-quarter loadings (kg/day) of conduit flow, cBOD5, Total Suspended Solids (TSS), phosphorus and ammonia-N; and concentrations of fecal coliform (CFU/100mL) at the Sycamore Creek WWTP in the Lower Little Miami River study area, 1997-2007.

Wards Corner Regional WWTP

Unnamed tributary → Little Miami River at RM 16.8

The Wards Corner Regional WWTP is located in Clermont County at 458 Loveland-Miamiville Rd in Miamiville, Ohio. The original facility, Ward's Corner Road WWTP, was constructed in 1986 at a design rate of 0.05 MGD and was upgraded to 0.135 MGD in 1996. In March 2009, the new regional WWTP was put on-line with a design capacity of 2.0 MGD. The old facility (Ward's Corner Road WWTP) was decommissioned soon afterwards. The new regional facility treats sanitary waste from local businesses, and plans to eventually connect local residences starting in late 2009. The treatment process at the new regional facility consists of flow equalization, fine screening, two extended aeration oxidation ditches, secondary settling, tertiary filtration, UV disinfection, and post aeration.

Numeric violations of the NPDES permit for the Ward's Corner Road WWTP were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, 11 violations of suspended solids, ammonia-N and copper were reported in the winter months. Up through 2005, dissolved oxygen violations were predominant, with minor activity in 2006 and 2007. Metals violations occurred in 2008. Approximately 163 Reporting Frequency Violations were documented for the same time period, comprised mostly of dissolved oxygen and metals.

Bramblewood Acres II Subdivision

Unnamed tributary → Horner Run → Little Miami River RM 15.8

Bramblewood Acres II Subdivision is located in Clermont County at 6230 Briar Cove Court in Loveland, Ohio. The wastewater works was built in 1974 with a major modification occurring in 1987. The Bramblewood WWTP is an extended aeration plant designed for 0.042 MGD. The treatment works consist of secondary settling, rapid sand filtration and disinfection by chlorine. All of the service area is sewered with separate sewers and moderate growth predicted. The average daily flow rate in 2006 was 0.041 MGD. In 1996, Ohio EPA requested that Bramblewood conduct an inflow and infiltration (I/I) study due to historical hydraulic overloading at the facility. In 2006, the estimated I/I was 602 gallons per day. This treatment plant is expected to be decommissioned in 2009 and its service area tied into the Ward's Corner Regional WWTP.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data - evaluated through SWIMS - one violation of dissolved oxygen in 2006 was reported. No Reporting Frequency Violations were documented for the same time period.

Indian Hill PWS

Little Miami River RM 14.8

The Indian Hill PWS is located in Hamilton County at 7100 Glendale Milford Road in Camp Dennison, Ohio. This facility is a municipally-owned water treatment plant utilizing ion exchange softening, chlorine disinfection, zinc orthophosphate corrosion control and fluoride addition. Average daily flow has been recorded at 0.118 MGD.

Historically, Indian Hills encountered problems with their brine discharge from the softening process water. It pooled near the banks of the river. The saline pools leached into the groundwater, migrated through fissures in the bedrock, went under the streambed and into Milford's wellfield. In a cooperative endeavor with the Army Corps of Engineers, the discharge pipe for the facility was moved to the center of the river, allowing for immediate mixing in the receiving waters.

Numeric violations of the NPDES permit were evaluated from 2004 to a portion of 2008. For the nearly five years of data - evaluated through SWIMS - four violations of pH and chlorine were reported. A total of three Reporting Frequency Violations were reported in 2006.

Milford Waterworks
Little Miami River RM 13.6
The Milford Waterworks is located in Clermont County at 101 Race Street in Milford, Ohio. Milford Waterworks is a water treatment facility utilizing lime softening at a design flow of 0.016 MGD. The lime sludge generated from the softening process is diverted to a settling lagoon which then discharges supernatant effluent to the river. Filter backwash water is sent through rapid sand filtration for treatment.

Historically, Milford encountered problems with Indian Hills' brine discharge from the softening process water. It pooled near the banks of the river. The saline pools seeped into the groundwater, migrated through fissures in the bedrock, under the streambed and into Milford's wellfield. In a cooperative endeavor with the Army Corp. of Engineers, the discharge pipe for the facility was moved to the center of the river, allowing for immediate mixing in the receiving waters.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, six violations of chlorine were reported in 2008. One Reporting Frequency Violation was reported for the same period of review.

St. Thomas Episcopal Church
Unnamed tributary → Little Miami River at RM 12.6
St. Thomas Episcopal Church is located in Hamilton County at 100 Miami Avenue in Terrace Park, Ohio. The church facility is utilized several times per week. A new treatment system was constructed in 2000 with a 25-year design period. This new secondary treatment plant consists of a trash trap with one aeration basin, one final settling tank, tertiary dosing and two surface slow sand filters. The average daily design flow is set at 1800 gpd with a peak design of 9000 gpd.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data - evaluated through SWIMS - 90 violations of predominately ammonia-N were reported mostly in 2005-2007. All months experienced violations; however winter months were the most common. Approximately 2261

Reporting Frequency Violations were documented for the same time period and were comprised mostly of turbidity, color, odor and flow rate.

Milford WWTP
East Fork Little Miami River RM 1.6 (outfall 001)→ Little Miami River RM 11.5 and Little Miami River RM 13.0 (CSOs)
The Milford WWTP is located in Clermont County at 100 Bay Rd, in Milford, Ohio. The City of Milford built this facility in 1959 to provide wastewater collection using both separate sanitary and combined sewers. Seventy-eight percent of the service area is sewered, eight percent is combined and twenty-two percent has no system. Treatment consists of bar screening, grit removal, two oxidation ditches, secondary settling, chlorination and dechlorination. The facility expanded in 2007 and flow was increased from 0.75 MGD to 1.2 MGD. A new oxidation ditch (for a total of three) and clarifier were added in 2007. Both facility and lift station bypasses were recorded due to wet weather, power outages and equipment failure. All CSOs in the area were eliminated by March 31, 2009

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008 for outfall 001. For the nearly five years of data - evaluated through SWIMS - four violations were reported in 2007 due to treatment equipment failures. There were also 223 Reporting Frequency Violations for 001 outfall for the same time period. Most recent violations in 2007 were for oil and grease, metals and ammonia-N. Violations since 2005 occurred in the fall and winter.

Ohio EPA conducted bioassays of Milford's WWTP outfall 001 effluents, upstream and mixing zone waters in 2002 and 2003. There were no toxicity endpoints for either test for any of the test organisms.

Senco Products, Inc. (a.k.a Broadwell Factory Group, LLC) - Plant No. 1 and No. 2
Unnamed tributaries → Little Miami River ~ RM 10.5
Senco Products, Inc., Plant No. 1 is located in Hamilton County at 8485 Broadwell Road, Cincinnati (Anderson Twp.). In early 2007, ownership of the facility changed from Senco to Broadwell Factory Group LLC, a Doug Evans company. Senco remained in the building as a tenant, retaining their manufacturing operations under a lease agreement with Broadwell Factory Group. Senco ended its operations and vacated the building at this location on April 1, 2009. Plant No. 1 manufactured pneumatic and electric tools (i.e. staplers, nail guns). Primary operations included machining, assembly, welding, packaging, and warehousing. Senco's corporate offices were also located here. There were two permitted outfalls, 001 for the sanitary wastewater treatment system discharge, and outfall 002 is a stormwater runoff discharge. No process wastewater was discharged at this location. The sanitary treatment system consisted of extended aeration, clarification, chlorination/dechlorination, and sand filtration. Average design flow was 10,000 gpd. The treated sanitary wastewater and the storm water discharged to an unnamed tributary which flows to an inactive gravel pit.

Numeric Violations of the NPDES permit were reviewed from 2004 to a portion of 2008 for Plant 1. Approximately 55 violations of predominately pH and ammonia-N were reported. Numerous Reporting Frequency Violations were documented for the same time period and were comprised of mostly color, turbidity, water temperature and odor. By 2008, the monthly reporting violations had been reduced significantly.

Senco Products Inc., Plant No. 2, is also located in Hamilton County at 8450 Broadwell Rd, Cincinnati (Anderson Twp). It manufactures and warehouses collated fasteners, specifically staples and nails. Primary operations include wire drawing and nail/staple cleaning, which generate process wastewater. There are two permitted outfalls, 001 for sanitary wastewater treatment system discharge, and 002, for the combined discharge from the process wastewater treatment system (pH adjustment and Dissolved Air Floatation, DAF), noncontact cooling water, and the stormwater runoff discharge. The sanitary WWTP design flow is 28,000 gpd. The DAF treatment system is designed to treat approximately 60,000 gpd of process wastewater. The permitted combined flow for outfall 002 is 0.205 MGD. Outfall 001 discharges to an unnamed tributary to the Little Miami River. Outfall 002 discharges to an unnamed pond, which flows to an unnamed tributary to the Little Miami River.

Numeric Violations of the NPDES permit were reviewed from 2004 to a portion of 2008 for Plant 2. Numerous violations of predominately ammonia-N, pH, TSS and cBOD5 were reported. The frequencies of violations were reduced to approximately 14 for each year by 2007-2008. Numerous Reporting Frequency Violations for all months were documented for the same time period. These violations consisted mostly of color, turbidity, and water temperature. The Reporting Frequency Violations decreased in number by 2008.

Walton Creek Condos WWTP
Walton Creek → Little Miami River at RM 7.75
Walton Creek Condos is located in Hamilton County at the intersection of Locust Street and Muchmore Close Ave., in Cincinnati, Ohio. Walton Creek Condos is a residential building. Treatment processes include; extended aeration, trash trap, tertiary treatment, chlorination and sand filters. An upgrade to the facility for ultraviolet light disinfection was added in 2007. A scheduled Ohio EPA inspection in 2000 found it to be operating satisfactorily.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data - evaluated through SWIMS - 77 violations occurred for chlorine prior to 2007. Numerous Reporting Frequency Violations for turbidity, color and flow were also reported for the same time period, for all years.

Cincinnati Steel Treating Company
Unnamed tributary → Little Miami River at RM 5.9
Cincinnati Steel Treating Company is located in Hamilton County at 5701 Mariemont Ave in Cincinnati, Ohio. Cincinnati Steel Treating Company is a service company that provides heat treating of steel for various manufacturing industries.

Cincinnati Steel Treating Co. holds an Ohio EPA NPDES discharge permit for non-contact cooling water with an average flow rate of 14,000 gpd. In August of 2007, Cincinnati Steel Treating Co. was slated to stop discharging non-contact cooling water and instead install a closed-loop cooling tower with no associated discharge.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data - evaluated through SWIMS - no violations were reported. Thirty Reporting Frequency Violations were documented for flow during the same time period.

Keebler and Co.
Unnamed tributary → Little Miami River at RM 5.9
Keebler Company is located in Hamilton County at One Trade Street in Mariemont, Ohio. Keebler bakes and packages cookies and crackers for distribution nationwide and discharges non-contact cooling water only.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, greater than 100 violations for water temperature occurred through 2007. Reporting Frequency Violations were also reviewed for the same time period. Two violations were reported since 2004.

Cincinnati Galbraith Road Metropolitan Sewer District
Various CSO outfalls on the Little Miami River, Duck Creek, Clough Creek
The Cincinnati Galbraith Road headquarters is located in Hamilton County at 225 West Galbraith Road in Cincinnati. The collection system is comprised of 30% Combined Sewer Overflows (CSOs) containing approximately 54 CSOs. Affected streams from the 2007 study include Clough Creek, Duck Creek, and the Little Miami River. Individual CSOs with receiving stream and outfall coordinates can be found in Appendix Table A-4.

As required by Global Consent Decree, Metropolitan Sewer District of Greater Cincinnati (MSD) submitted a Long Term Control Plan to USEPA, Ohio EPA and ORSANCO in 2006. This plan outlines MSD's proposed strategy to address CSO discharges; including sewer separation, storage and treatment. At the time of this report, the long-term control plan was not approved by the regulators, but MSD was still proceeding with certain projects.

EMD Chemicals Inc.
Storm sewer to Duck Creek RMs 4-6 → Little Miami River RM 3.36
EMD Chemicals is located at 2909 Highland Ave in Cincinnati, Hamilton County, Ohio. EMD Chemicals offers distillation and repackaging of bulk chemicals, dyes and stains and distributes chemical solvents such as alcohol, chloroform, tetrahydrofuran, hexane and isopropanol. The process wastewater from the facility is discharged to MSD of Greater Cincinnati Little Miami WWTP. Outfalls 001 and 002 have discharge limitations. Outfall 001 contains the non-contact cooling water from the facility as well as

stormwater from the central plant area. Outfall 002 discharges stormwater from a diked tanker loading area. The stormwater is discharged on a batch basis after it is sampled to ensure it is in compliance with the facility's NPDES permit. Outfalls 003 through 005 contain stormwater run-off from various areas of the plant. The facility maintains a Storm Water Pollution Prevention Plan (SWP3) for its site, and has an on-site HAZMAT team to respond to any spills or releases. All of the outfalls discharge to the storm sewer prior to going to Duck Creek.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, one violation was reported. Eight Reporting Frequency Violations were also reported for the same time period, with most occurring in 2004 and a few in 2007.

Hadronics Inc.
Storm sewer to Duck Creek RMs 4-6 → Little Miami River RM 3.36
Hadronics Inc. is located in Hamilton County at 4570 Steel Place in Cincinnati, Ohio. Hadronics Inc. performs job shop electroplating and metal finishing on press rolls and cylinders for the printing industry. Hadronics discharges non-contact cooling water from chrome plating processes at a rate of 2800 gallons per day (gpd), a reduction in quantity of 35,000 gpd in 1988. An Ohio EPA inspection of the facility wastewater plant in 2006 was rated satisfactory.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, two violations for pH were reported in 2008. Reporting Frequency Violations were also evaluated for the same time period. None were reported since 2004.

Milacron,Inc. - Cimcool industrial Fluids
I-71 ODOT drainage way to headwaters of Duck Creek → Little Miami River RM 3.36
Milacron, Inc. is located in Hamilton County at 2000 Disney Street in Cincinnati, Ohio. Milacron produces machine cutting and cooling fluids for machining, grinding, stamping, drawing and forming. The fluids are produced by combining liquid and powdered ingredients in mixing tanks in accordance with proprietary recipes. Treatment is through ultrafiltration and reverse osmosis after release from the holding tank. The industry is exploring a closed loop system for water reuse. The final effluent is combined with non-contact cooling water for the chiller on the ELC bending system. The final effluent discharges from the ELC tank prior to discharge to an unnamed waterway of Duck Creek. An Ohio EPA inspection of the facility in 2006 produced a satisfactory rating except for the reports, which were rated marginal.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data - evaluated through SWIMS - no violations were reported. Approximately 20 Reporting Frequency Violations for flow rate, pH and water temperature occurred in all seasons, mostly in 2007 and 2008.

Chemical and Recreational Water Quality

Many of the graphs included with the following summaries include dotted lines representing percentile concentrations from least impacted regional reference sites of similar size (Ohio EPA 1999). Statistical data were segregated by ecoregion (Interior Plateau (IP) and Eastern Corn Belt Plains (ECBP)) and further stratified by stream size for these analyses as follows: headwater streams (0-20 mi^2); wadeable streams (> 20-200 mi^2); small rivers (> 200-1000 mi^2) and large river (>1000 mi^2).

Monitoring Summary

Inorganic water chemistry grab samples and field measurements were collected every other week (six times) from mid-July to mid September at 79 sites in the watershed, including 36 sites in the Todd Fork subwatershed (Table 1). All samples were analyzed for a variety of parameters including nutrients and metals (Appendix Table A-1). Organic compounds were sampled at two sites (Whitacre Run RM 1.15 and Cowan Creek RM 12.45) during the summer survey while additional organic (and inorganic) sampling was conducted at select sites throughout the year (See Sentinel Site Monitoring Program). Bacteria samples (*E. coli*) were collected by Ohio EPA at 37 sites five times in 2007 and at eleven sites in 2008 (Figure 17, Table 9, Appendix Tables A-2 and A-3). Additionally, Datasonde© continuous monitors recorded hourly dissolved oxygen, temperature, pH, and specific conductivity for a 48-hour period at 23 sites (Figure 14, Appendix Tables A-5 and A-6).

Water chemistry results from daytime grab samples which exceeded State of Ohio Water Quality Standards (WQS) are presented in Table 7. Additionally, although nitrate and phosphorus water quality criteria for the protection of aquatic life have not yet been incorporated into the WQS, Ohio EPA has identified target levels for maintaining biological integrity in rivers (Ohio EPA 1999). An evaluation of ammonia, nitrate, and phosphorus data as compared to these recommended targets is detailed in Table 8.

Table 7. Exceedences of Ohio EPA Water Quality Standards (WQS) (OAC 3745-1) (and other chemicals not codified for which toxicity data is available) for chemical/physical water parameters measured in grab samples taken from the lower Little Miami River study area during the summer of 2007 (units are µg/l for metals and organics, C° for temperature, SU for pH, and mg/l for all other parameters).

Stream (use designation [b])		Parameter (value)
12-digit WAU [a]	River Mile	
Little Miami River Mainstem (EWH, PCR, AWS, IWS)		
-	29.0	Dissolved Oxygen (5.69‡)
-	27.90	Iron-T (6940∞)
Turtle Creek (WWH, PCR, AWS, IWS)		
08-03	6.23	Dissolved Oxygen (3.60‡‡, 4.03‡)
08-03	4.85	Dissolved Oxygen (3.85‡‡)
08-03	0.52	Dissolved Oxygen (4.36‡)
Little Muddy Creek (WWH, SCR, AWS, IWS)		
08-02	3.22	Dissolved Oxygen (3.54‡‡, 3.92‡‡)
08-02	1.02	Dissolved Oxygen (4.73‡)
Dry Run (WWH, SCR, AWS, IWS)		
08-03	1.79	Dissolved Oxygen (2.95‡‡, 4.55‡, 4.79‡)
08-03	0.18	Dissolved Oxygen (0.19‡‡)
Muddy Creek (WWH, PCR, AWS, IWS)		
09-01	2.50	Temperature (28.23*)
O'Bannon Creek (WWH, PCR, AWS, IWS)		
09-02	10.14	Dissolved Oxygen (4.28‡, 4.94‡, 2.86‡‡)
09-02	8.27	Dissolved Oxygen (4.60‡, 2.25‡‡)
09-02	4.37	Dissolved Oxygen (4.13‡, 3.42‡‡)
09-02	0.26	Temperature (28.50*)
Sycamore Creek (WWH, PCR, AWS, IWS)		
14-01	1.10	Dissolved Oxygen (4.90‡)
Duck Creek ***- Downstream Red Bank Rd (RM 2.4) to mouth: (WWH, PCR, AWS, IWS)*** ***- Confluence of East Fk and West Fk to Red Bank Rd: (LRW, SCR, AWS, IWS)***		
14-04	1.18	Dissolved Oxygen (4.69‡, 3.88‡‡) Temperature (30.34**, 29.21*)

a See Table 5.

b Use designations:

Aquatic Life Habitat	Water Supply	Recreation
LRW - limited resource water	IWS - industrial water supply	PCR - primary contact
WWH - warmwater habitat	AWS - agricultural water supply	SCR - secondary contact

Stream (use designation [b])		Parameter (value)
12-digit WAU [a]	River Mile	

EWH - exceptional warmwater habitat PWS- public water supply BWR -bathing water

Undesignated

└ [WWH criteria apply to „undesignated' surface waters.]

*	exceedence of numerical criteria for prevention of chronic toxicity (CAC).
**	exceedence of numerical criteria for prevention of acute toxicity (AAC).
***	exceedence of numerical criteria for prevention of lethality (FAV).
Δ	exceedence of the pH criteria (6.5-9.0).
#	exceedence of numerical criteria for the protection of human health (non-drinking-protective of people against adverse exposure to chemicals via eating fish).
■	exceedence of numerical criteria for the protection of human health (drinking water-public water supply).
∞	exceedence of agricultural water supply criterion.
‡	value is below the EWH minimum 24-hour average D.O criterion (6.0 mg/l) or value is below the WWH minimum 24-hour average D.O criterion (5.0 mg/l) or value is below the LRW minimum 24-hour average D.O criterion (3.0 mg/l) as applicable.
‡‡	value is below the EWH minimum at any time D.O. criterion (5.0 mg/l) or value is below the WWH minimum at any time D.O. criterion (4.0 mg/l) or value is below the LRW minimum at any time D.O. criterion (2.0 mg/l) as applicable.

Table 8. Nutrient sampling results in the lower Little Miami River watershed, 2007. Values above applicable reference values (targets) are highlighted in yellow.*

Stream (use designation) [a]				Ammonia-N (mg/l)		Nitrate-nitrite-N (mg/l)		Phosphorus-T (mg/l)	
RM	12-Digit WAU [b]	Ecoregion [c]	Drainage Area (mi^2)	Median#	Target*	Median#	Target*	Median#	Target*
Little Miami River mainstem (EWH)									
83.14	-	ECBP	118	0.050	0.096	2.80	0.84	0.10	0.08
63.30	-	ECBP	360	0.050	0.074	4.42	1.65	0.24	0.17
53.84	-	ECBP	395	0.050	0.074	3.46	1.65	0.20	0.17
53.15	-	ECBP	402	0.061	0.074	3.32	1.65	0.20	0.17
51.20	-	ECBP	413	0.058	0.074	3.52	1.65	0.20	0.17
50.25	-	ECBP	658	0.050	0.074	3.02	1.65	0.18	0.17
43.76	-	IP	680	0.050	0.100	2.54	1.00	0.18	0.10
38.50	-	IP	949	0.050	0.100	2.16	1.00	0.17	0.10
35.98	-	IP	964	0.050	0.100	2.39	1.00	0.17	0.10
32.90	-	IP	1035	0.050	0.200	1.99	1.50	0.16	0.15
31.96	-	IP	1036	0.050	0.200	2.87	1.50	0.31	0.15
28.90	-	IP	1059	0.068	0.200	2.27	1.50	0.22	0.15
27.90	-	IP	1069	0.058	0.200	3.38	1.50	0.57	0.15
24.10	-	IP	1085	0.050	0.200	2.96	1.50	0.34	0.15
22.30	-	IP	1150	0.052	0.200	3.50	1.50	0.39	0.15
21.45	-	IP	1160	0.050	0.200	2.93	1.50	0.35	0.15
20.60	-	IP	1161	0.050	0.200	2.91	1.50	0.41	0.15
17.73	-	IP	1187	0.050	0.200	2.93	1.50	0.44	0.15
13.00	-	IP	1203	0.050	0.200	2.92	1.50	0.51	0.15
8.14	-	IP	1713	0.050	0.200	3.01	1.50	0.51	0.15
3.70	-	IP	1744	0.050	0.200	2.62	1.50	0.45	0.15
Turtle Creek (WWH)									
7.43	08-03	IP	12.3	0.050	0.110	0.65	1.00	0.09	0.08
6.23	08-03	IP	21.3	0.051	0.100	0.19	1.00	0.06	0.10
4.85	08-03	IP	30	0.050	0.100	0.28	1.00	0.05	0.10
0.52	08-03	IP	58	0.051	0.100	0.23	1.00	0.09	0.10
Little Muddy Creek (WWH)									
3.22	08-02	IP	11.7	0.050	0.110	0.22	1.00	0.14	0.08
1.00	08-02	IP	20.2	0.078	0.100	0.23	1.00	0.12	0.10
Dry Run (WWH)									
1.79	08-03	IP	4.2	0.050	0.110	0.25	1.00	0.03	0.08
0.18	08-03	IP	7.3	0.050	0.110	0.32	1.00	0.11	0.08
Muddy Creek (WWH)									
2.50	09-01	IP	10.2	0.050	0.110	0.10	1.00	0.16	0.08
0.54	09-01	IP	15.2	0.050	0.110	1.85	1.00	0.22	0.08
O'Bannon Creek (WWH)									
10.14	09-02	IP	8.1	0.057	0.110	0.12	1.00	0.11	0.08
8.27	09-02	IP	14.3	0.079	0.110	0.14	1.00	0.18	0.08
4.37	09-02	IP	28.1	0.051	0.100	0.14	1.00	0.11	0.10
1.84	09-02	IP	55.6	0.070	0.100	14.40	1.00	3.52	0.10
0.26	09-02	IP	59	0.050	0.100	12.07	1.00	2.51	0.10
Sycamore Creek (WWH)									
1.10	14-01	IP	10.4	0.050	0.110	0.42	1.00	0.10	0.08
0.50	14-01	IP	20.7	0.050	0.100	0.29	1.00	0.07	0.10
0.05	14-01	IP	23.3	0.063	0.100	4.00	1.00	0.88	0.10

Stream (use designation) [a]				Ammonia-N (mg/l)		Nitrate-nitrite-N (mg/l)		Phosphorus-T (mg/l)	
RM	12-Digit WAU [b]	Ecoregion [c]	Drainage Area (mi^2)	Median#	Target*	Median#	Target*	Median#	Target*
Duck Creek (RM 3.36 LRW, RM 1.18 WWH)									
3.36	14-04	IP	7.3	0.094	0.110	1.73		0.15	
1.18	14-04	IP	15.1	0.199	0.110	0.50	1.00	0.22	0.08
Clough Creek (WWH)									
0.42	14-06	IP	8.3	0.050	0.110	0.15	1.00	0.04	0.08
East Fork Little Miami River (EWH)									
0.77	13-05	IP	498	0.050	0.100	4.33	1.00	0.66	0.10

* Target values per Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams – Tables 1 and 2, Appendix Table 1(Ohio EPA Technical Bulletin MAS/1999-1-1).

Ecoregion Eastern Corn Belt (ECBP)	Headwater (0-20mi^2)		Wadeable (>20-200 mi^2)		Small River (>200-1000 mi^2)		Large River (>1000 mi^2)	
	WWH	EWH	WWH	EWH	WWH	EWH	WWH	EWH
NO_3-NO_2-N (mg/l)	2.24	0.98	2.80	0.84	3.06	1.65	4.14	3.08
Phosphorus-T	0.07	0.05	0.11	0.08	0.17*	0.17	0.41	0.46
NH_3-N (mg/l) (90^{th} %ile)	0.1		0.096		0.074		0.299	

* Associations document has 0.16 mg/l; however the Upper LMR TMDL has 0.17 mg/l in Table 8 (p29) as the target.

Ecoregion Interior Plateau (IP) (USE STATEWIDE)	Headwater (0-20mi^2)		Wadeable (>20-200 mi^2)		Small River (>200-1000 mi^2)		Large River (>1000 mi^2)	
	WWH	EWH	WW	EWH	WWH	EWH	WW	EWH
NO_3-NO_2-N (mg/l)	1.0	0.5	1.0	0.5	1.5	1.0	2.0	1.5
Phosphorus-T	0.08	0.05	0.10	0.05	0.17	0.10	0.30	0.15
NH_3-N (mg/l)(90^{th} %tile)	0.11		0.1		0.1		0.2	

\# Data medians from summer sampling July- September 2007.

a Use designations (aquatic life habitat)
LRW - limited resource water
WWH - warmwater habitat
EWH - exceptional warmwater habitat
Undesignated (WWH criteria apply to „undesignated' surface waters)

b See Table 5

c Ecoregion: Interior Plateau (IP), Eastern Cornbelt Plain (ECBP)

Table 9. Ohio EPA bacteriological (*E. coli*) sampling results in the Lower Little Miami River study area during 2007 and 2008. All values are expressed as colony forming units (cfu) per 100 ml of water. Values above criteria are highlighted in red. *

Stream [a] RM	12- Digit WAU [b]	Location	Year	# of samples	*E. coli*		Attainment Status	Suspected Sources of Bacteria [c]
					Geometric Mean	Max Value		
Class A – Primary Contact Recreation (PCR) ***(lakes and popular paddling streams) – Geometric Mean ≤ 126 Maximum ≤ 298***								
Little Miami River - *PCR*								
53.84	-	SR 73, (Upst Waynesville WWTP)	2007	5	83	220	FULL	
53.15	-	Upst Newman Run, Dst Waynesvillle WWTP	2007	5	93	260	FULL	
50.25	-	Dst Caesar Cr (Shaw property)	2007	5	59	110	FULL	
			2008	5	**237**	**2300**	**NON**	H,J
43.76	-	SR 350- Near Fort Ancient	2007	5	40	70	FULL	
35.98	-	Stubbs Mill Rd	2007	5	40	230	FULL	
32.90	-	SR 48 (Upstream Lebanon WWTP)	2007	5	53	190	FULL	
31.96	-	Upst Muddy Cr., Dst Lebanon WWTP	2007	5	97	140	FULL	
29.0	-	Upst Simpson Cr	2007	5	105	**500**	FULL	
27.90	-	Dst SR 22/3 (Little Miami State Park)	2007	5	82	**640**	FULL	
22.30	-	Upst Polk Run (Isaac Walton Park)	2007	5	67	180	FULL	
21.45	-	Hopewell Rd (Bridge St)	2007	5	49	140	FULL	
20.60	-	Adjacent Lake Isabella	2007	5	62	210	FULL	
17.73	-	Dst SR 126 (Kelly Nature Preserve)	2007	5	28	100	FULL	
13.07	-	Wooster Pike (Milford gage)	2007	5	71	130	FULL	
			2008	5	**127**	**520**	**NON**	E,G,H,J
East Fork Little Miami River - *PCR*								
0.77	13-05	S. Milford Rd	2007	5	45	170	FULL	
			2008	3	**195**	**1200**	**NON**	C,G
Class B – Primary Contact Recreation (PCR) ***(most streams; those that are not Class A or C) – Geometric Mean ≤ 161 Maximum ≤ 523***								
Turtle Creek- *PCR*								
6.23	08-03	Glosser Rd	2007	5	66	370	FULL	
0.52	08-03	SR 48	2007	5	85	140	FULL	
			2008	5	**166**	**595**	**NON**	G,H,J
Muddy Creek – *PCR*								
2.50	09-01	Mason-Morrow Rd (Upst Mason WWTP)	2007	5	52	**900**	FULL	
0.54	09-01	Mason-Morrow Rd (Dst Mason WWTP)	2007	5	**279**	**3200**	**NON**	C,G
			2008	5	**441**	**10000**	**NON**	C,G

Stream [a] RM	12- Digit WAU [b]	Location	Year	# of samples	*E. coli* Geometric Mean	*E. coli* Max Value	Attainment Status	Suspected Sources of Bacteria [c]
O'Bannon Creek *– PCR*								
4.37	09-02	Gibson Rd (Upst O'Bannon WWTP)	2007	5	56	120	FULL	
1.84	09-02	O'Bannonville Rd (Dst O'Bannon WWTP)	2007	5	87	220	FULL	
0.26	09-02	SR 48 (Loveland)	2007	5	55	240	FULL	
			2008	5	138	**3900**	FULL	
Sycamore Creek *- PCR*								
0.50	14-01	Upst Sycamore Creek WWTP	2007	5	21	50	FULL	
0.1	14-01	Dst Sycamore Creek WWTP	2007	4	107	**1200**	FULL	
Dry Run *–SCR*								
1.79	08-03	Snook Rd	2007	5	71	540	FULL	

* Samples were collected from July 19 - August 16, 2007 and from May 22 - October 27, 2008. Attainment status (determined solely on *E. coli* samples) is based on the seasonal (May 1- October 31) geometric mean if more than one measurement is available and on the single sample maximum if only one measurement is available (Ohio Administrative Code 3745-1-41).

a Three sites outside of the Lower Little Miami River study area were sampled (RMs 53.84 and 53.15 in the Upper Little Miami River mainstem above the Caesar Creek confluence, and RM 0.77 in the East Fork Little Miami River).

b See Table 5

c **Suspected Sources of Bacteria:**

A - Failing home sewage treatment systems
B - Livestock access to stream
C - Wastewater treatment plant
D - Unsewered community
E - Combined sewer overflow (CSOs)
F - Sanitary sewer overflows (SSOs)
G -Urban runoff (city, village, etc.)
H - Agricultural runoff
I - Wildlife (geese, etc)
J - Unknown

Little Miami River

A popular recreational resource, the Little Miami River is designated a State and National Scenic River and contains some of Ohio's most scenic and diverse riverine habitat. Stream flow in the mainstem and throughout the lower LMR watershed during the summer of 2007 was generally below normal, reflecting below average precipitation. Total rainfall of only 12.35 inches was recorded from May through September, 2007 in the southwest region of Ohio, more than six inches below normal for the period (ODNR 2007). May precipitation in the region ranked in the top ten driest Mays on record (125 years). It was also the 6th driest August on record with the most significant precipitation for the month falling during August 19-22. The Palmer Drought Severity Index (PDSI) indicated the southwest region of Ohio progressed from a moderate drought in May and June to a severe drought from July through September (Table 10 Table 10).

Table 10. Precipitation (inches) in the Southwest region of Ohio May-September, 2007 (ODNR 2007).

Month	May	June	July	August	Sept
Average rainfall	1.53	2.83	3.28	1.71	3.00
Departure from Normal*	-2.95	-1.06	-0.82	-1.70	+0.13
% of normal rainfall	34%	73%	80%	50%	105%
PDSI**	-2.1	-2.9	-3.0	-3.9	-3.7

* Base period 1951 - 2000

** PDSI (Palmer Drought Severity Index)

Above +4 = Extreme Moist Spell	-0.5 to -0.9 = Incipient Drought
3.0 to 3.9 = Very Moist Spell	-1.0 to -1.9 = Mild Drought
2.0 to 2.9 = Unusual Moist Spell	-2.0 to -2.9 = Moderate Drought
1.0 to 1.9 = Moist Spell	-3.0 to -3.9 = Severe Drought
0.5 to 0.9 = Incipient Moist Spell	Below -4.0 = Extreme Drought
0.4 to -0.4 = Near Normal	

Stream flows from May through September 2007 as measured by the USGS gage station in the Little Miami River at Milford (RM 13.0) are presented in Figure 13. Seventy-eight percent of mean daily flows for the period fell below the 50% (median) duration exceedence flow of 399 cfs (USGS 2007 and 2000). The 50% duration exceedence flow represents the discharge which was equaled or exceeded 50% of the time over the period of record. Peak flows occurred following widely scattered showers and thunderstorms. On specific water chemistry sampling days in the entire lower LMR watershed during the summer survey, mean daily flows ranged from 98 cfs on September 6 to 1150 cfs on July 11. On Ohio EPA bacteria sampling days, mean daily flows ranged from 107 cfs on August 15 to 385 cfs on July 19.

Water samples collected at 21 sites in the mainstem reflected generally good water quality. Daytime grab dissolved oxygen (D.O.) concentrations remained stable with only one value minimally below the Ohio WQS criterion during the entire summer (Table 7, Figure 15). Median D.O. hourly concentrations, temperatures, and pH in the mainstem from July 17-19, as measured by Datasonde© continuous monitors at eight sites (Figure 14), gradually increased longitudinally (upstream to downstream). Datasonde© dissolved oxygen saturations and diurnal variability also increased longitudinally with

supersaturated levels and wide fluctuations observed at the three most downstream sites monitored (RMs 21.45, 18.14 and 13.00). The greatest D.O. variability of the survey was recorded at RM 13.00 in Milford with hourly saturations ranging from 91% to 176%. Supersaturated levels and wide diurnal swings were also documented by Datasondes© at this site in August and September. Supersaturated D.O. concentrations and wide swings in diel D.O. and pH in this lower reach are indicative of nutrient enrichment.

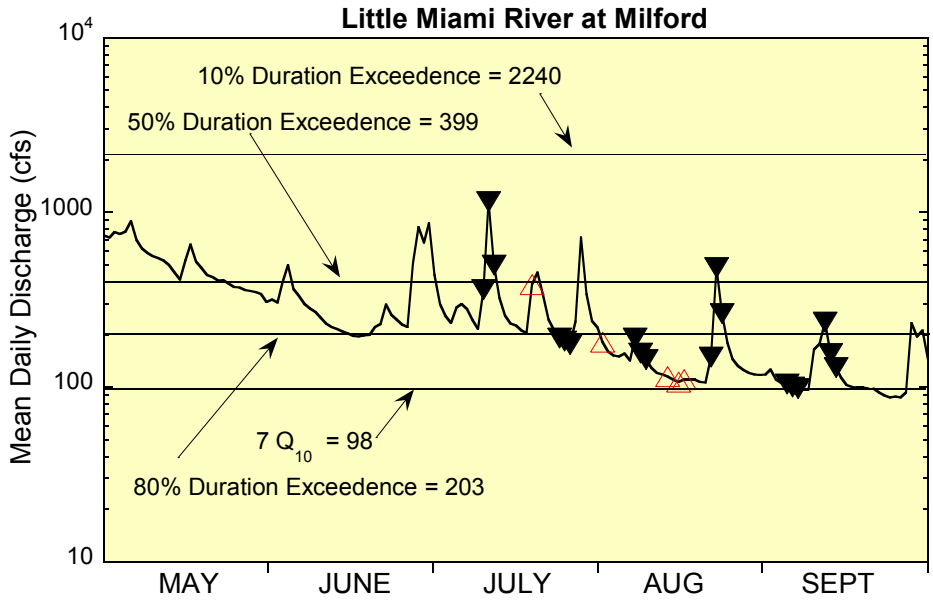


Figure 13. May through September, 2007 flow hydrograph for the Little Miami River at Milford (USGS station # 03245500) RM 13.0. Solid triangles indicate river discharge on water chemistry sampling days in the Little Miami River watershed. Open triangles indicate river discharge on bacteriological sampling days. (Duration exceedence and $7Q_{10}$ flow lines represent May-Nov period of record 1975-1997.)

While ammonia-N remained low with only two concentrations above applicable target reference values in the entire mainstem, nitrate-nitrite-N and total phosphorus concentrations were elevated above target values at all sites (Table 7, Figure 16). However, while nitrate-nitrite concentrations were relatively stable longitudinally, phosphorus levels were much higher in the lower mainstem. Phosphorus concentrations increased markedly at RM 31.96 downstream of the Lebanon WWTP discharge and then again at RM 27.90 downstream of Simpson Creek (The Lower LMR WWTP discharges to Simpson Creek at RM 0.15). Concentrations remained elevated to the mouth. The overall median phosphorus concentration for the ten upstream sites sampled (RMs 83.14 through RM 32.90) was 0.18 mg/l compared to 0.40 mg/l for downstream sites. Additionally, sediment phosphorus concentrations were elevated above the Ontario severe effect level at three locations in the lower mainstem. While the major wastewater facilities in the upper LMR watershed treat for phosphorus removal, most of the treatment plants in the lower watershed currently do not.

While total suspended solids (TSS) generally remained below reference target values, higher concentrations were noted in the lower mainstem (Figure 15). Levels gradually trended upward longitudinally with medians increasing from 5 mg/l in the upper reaches of the mainstem (RM 83.14) to 31 mg/l in Milford (RM 13.00).

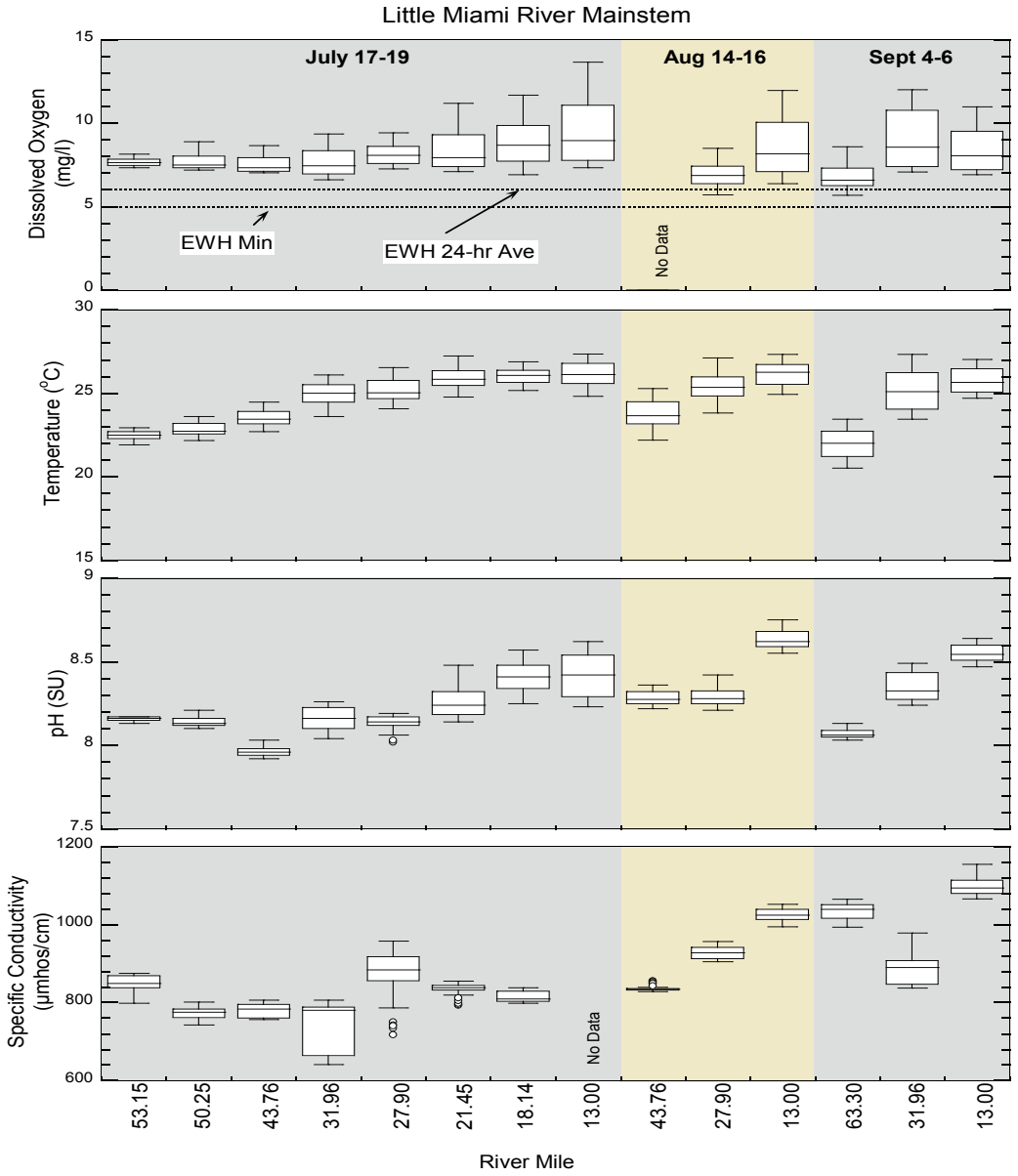


Figure 14. Dissolved oxygen, temperature, pH, and specific conductivity recorded hourly with Datasonde© continuous monitors in the mainstem of the Little Miami River, 2007. Each box encloses 50% of the data with the median value of the variable displayed as a line. The top and bottom of the box mark the limits of ± 25% of the variable population. The lines extending from the top and bottom of each box mark the minimum and maximum values within the data set that fall within an acceptable range. Values outside of this range are displayed as individual points.

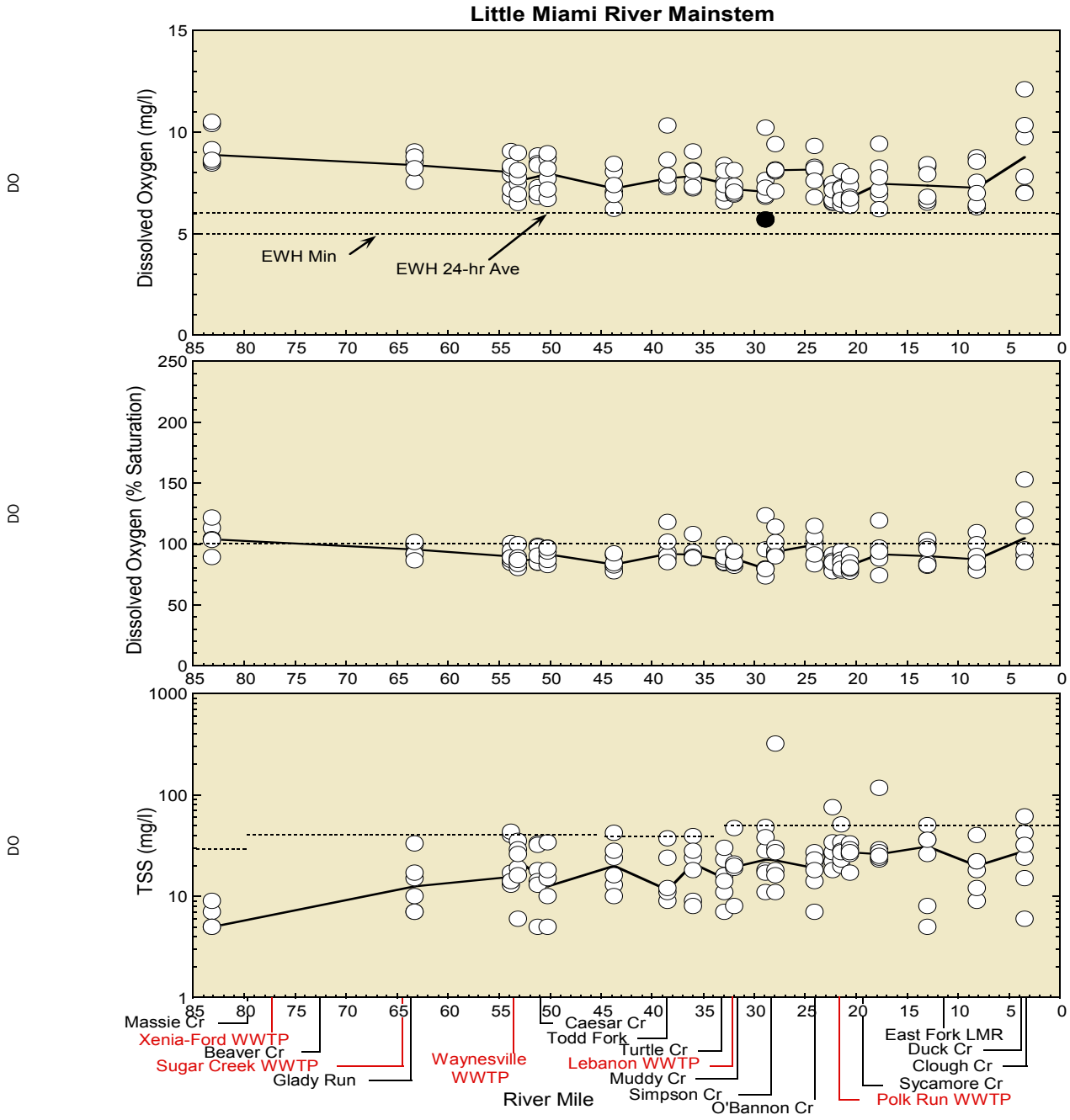


Figure 15. Longitudinal scatter plots of daytime grab dissolved oxygen concentration, dissolved oxygen percent saturation, and total suspended solids (TSS) in the mainstem Little Miami River during 2007. The solid line depicts the median value at each river mile sampled. Water quality criteria are shown in the dissolved oxygen concentration plot. (Values not meeting criteria are shown as solid circles.) Dashed horizontal lines in the TSS plot represent applicable reference values from sites of similar size in the Eastern Corn Belt Plains (ECBP) and Interior Plateau (IP) ecoregions. (Statewide reference values were used for IP sites).

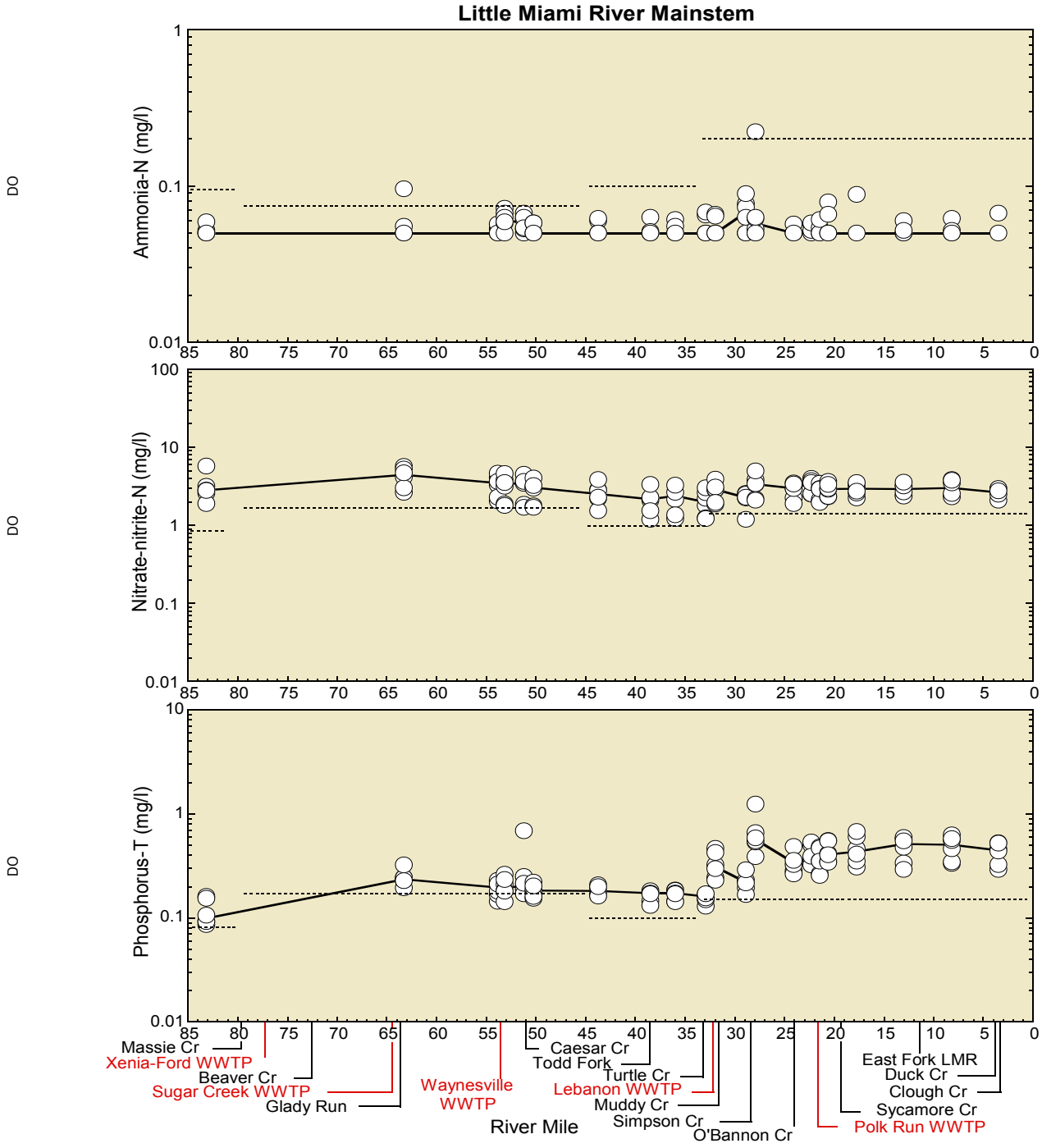


Figure 16. Longitudinal scatter plots of ammonia-Nitrogen, nitrate-nitrite-Nitrogen, and total phosphorus in the mainstem Little Miami River during 2007. The solid line depicts the median value at each river mile sampled. Dashed horizontal lines represent applicable reference values from sites of similar size in the Eastern Corn Belt Plains (ECBP) and Interior Plateau (IP) ecoregions. (Statewide reference values were used for IP sites).

Bacteria samples collected in the LMR mainstem indicate that the Primary Contact Recreation (PCR) Class A criterion was not attained (Table 9, Figure 17) at two sites. While RMs 50.25 and 13.07 were in full attainment in 2007, these sites did not attain in 2008. Possible sources of bacteria include general agricultural and urban runoff, as well as combined sewer overflows (in Milford) in the lower watershed.

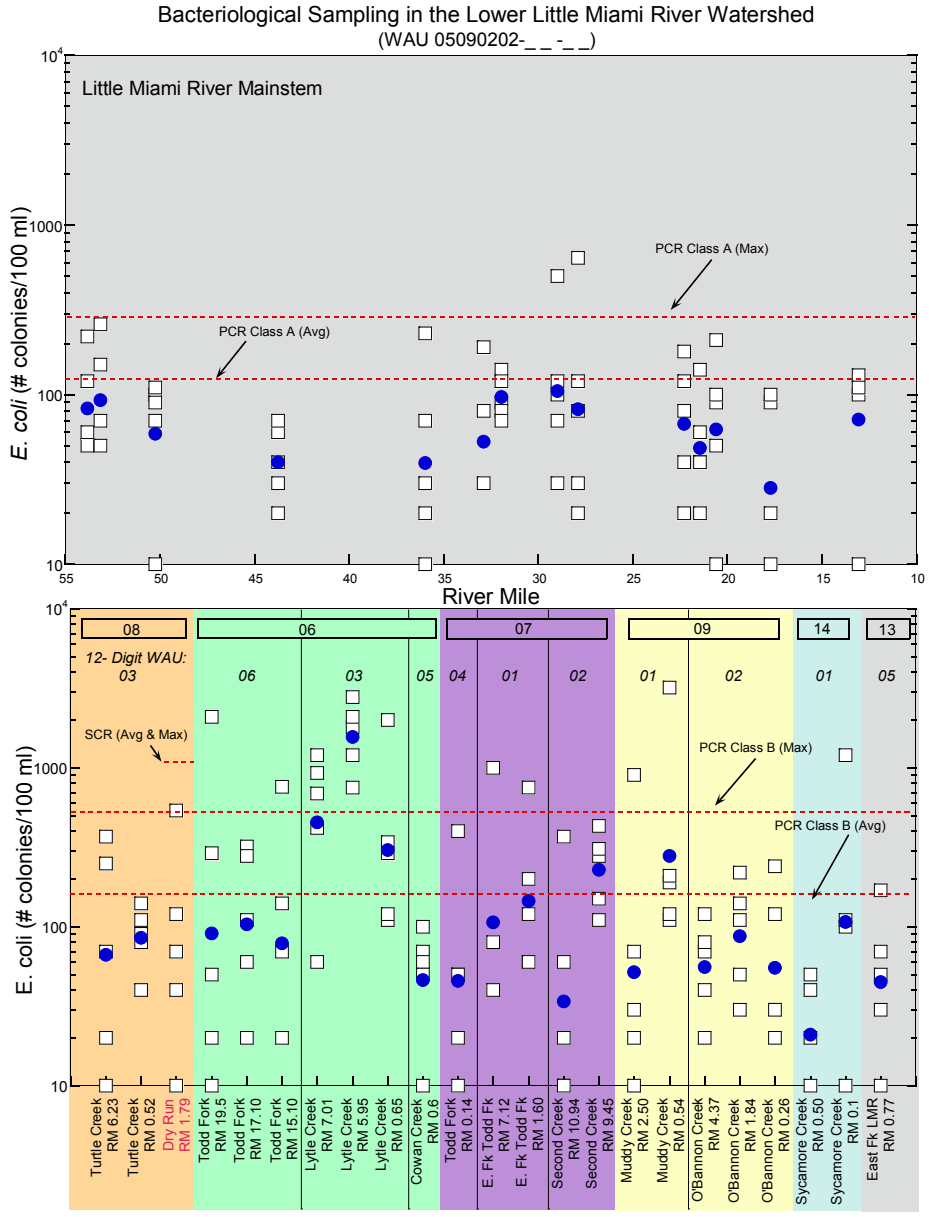


Figure 17. Scatter plots of *E. coli* concentrations in the mainstem of the lower Little Miami River (top graph) and select tributaries (bottom graph) during the 2007 survey. The 10-digit WAU is provided in the enclosed boxes near the top in the tributary graphic. Dotted lines represent primary contact recreational (PCR) use water quality criteria. Solid circles represent the geometric mean at each site sampled.

Turtle Creek, Little Muddy Creek, and Dry Run

Turtle Creek drains 66 mi^2, including the City of Lebanon, before entering the Little Miami River at RM 33.19 near South Lebanon. Its largest tributary, Little Muddy Creek (drainage area 20.7 mi^2), enters at RM 2.73. Another smaller tributary, Dry Run, drains 7.4 mi^2 and enters Turtle Creek near the mouth at RM 0.09. Water samples were collected at four sites in Turtle Creek and at two sites each in Little Muddy Creek and Dry Run (Table 1). Low flows impacted water quality in the streams of this watershed. The headwater site in Turtle Creek (RM 7.43) and one site in Dry Run (RM 0.18) both became totally dry by mid-summer. Dissolved oxygen fell below WWH criteria at all remaining sites as the summer progressed (Table 7, Figure 18).

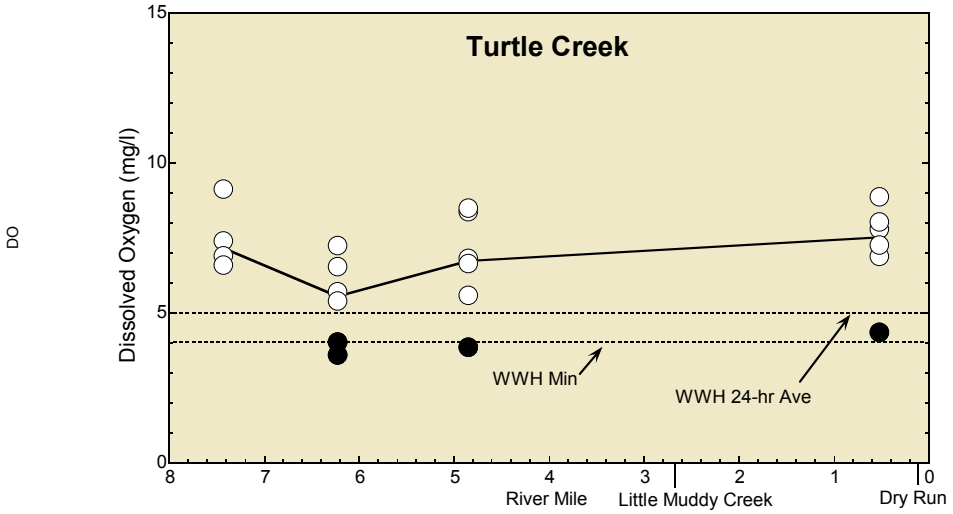


Figure 18. Longitudinal scatter plot of daytime grab dissolved oxygen in Turtle Creek, 2007. Values not meeting applicable criteria are shown as solid circles.

Ammonia-N and nitrate-nitrite-N were low throughout the watershed. Median total phosphorous concentrations, however, were minimally elevated above reference target values at both sites in Little Muddy Creek, in the headwaters of Turtle Creek (RM 7.43) and near the mouth of Dry Run (RM 0.18). Total suspended solids (TSS) were consistently elevated (median 35 mg/l) in Little Muddy Creek at RM 3.22 (Hamilton Road). Field notes indicate water clarity at the site was murky throughout the summer. This section of the stream is channelized with minimal riparian vegetation.

Bacteria samples collected in Dry Run at RM 1.79 indicate that the PCR Class B criterion was attained in 2007. While both sites sampled in Turtle Creek in 2007 were in attainment of the PCR Class B criterion, the downstream site (RM 0.52) did not attain in 2008. Possible sources of bacteria include general urban runoff (including the City of Lebanon) as well as agricultural runoff (Table 9, Figure 17).

Muddy Creek

Muddy Creek drains 15.6 mi^2, including the City of Mason, before entering the Little Miami River at RM 31.95 west of South Lebanon. Mason's new wastewater treatment plant (operational in June, 2006) discharges to Muddy Creek at RM 2.23, which is one mile downstream from its prior location. This new facility has a design flow of 13 mgd and treats for phosphorus removal. Two sites were sampled in Muddy Creek during the 2007 survey (RM 2.50 and RM 0.54).

Daytime grab dissolved oxygen concentrations were stable longitudinally and remained above minimum water quality criteria at both sites. A Datasonde© monitor deployed at RM 0.54 recorded relatively significant diurnal variability in both the July and September sampling events (Figure 14). Hourly dissolved oxygen saturations from July 17-19 ranged from 74% to 129% and pH (SU) ranged from 7.83 to 8.43. Similarly, saturations measured at the site from September 4-6 fluctuated from 65% to 127% while pH ranged from 7.84 to 8.56.

While ammonia-N and TSS concentrations were low at both sampling stations, total phosphorus levels were elevated above target reference values both upstream and downstream of the Mason WWTP discharge (Figure 19).

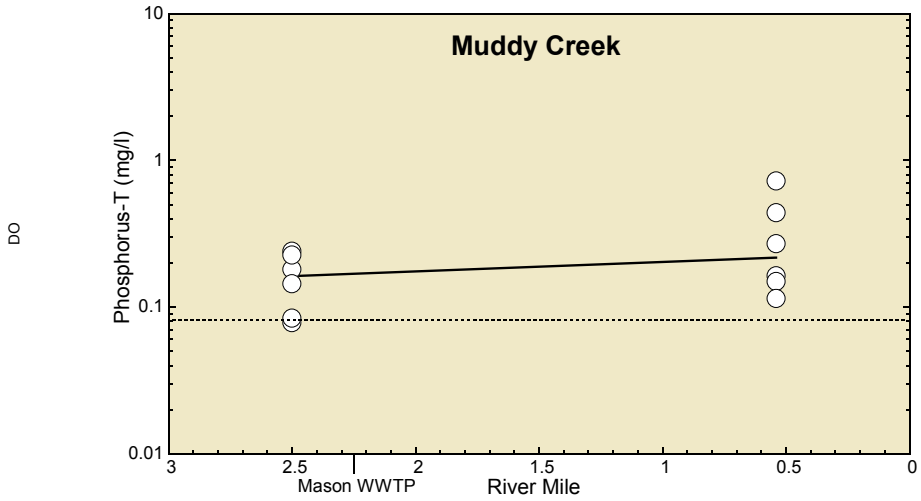


Figure 19. Longitudinal scatter plot of total phosphorus in Muddy Creek, 2007.

Bacteria sampling results in Muddy Creek (Table 9, Figure 17) indicate attainment of the PCR Class B criterion upstream of the Mason WWTP in 2007. However, the criterion was not attained downstream of the WWTP discharge at RM 0.54 in either 2007 or 2008. Possible sources of bacteria include the discharge from the Mason WWTP as well as general urban runoff.

O'Bannon Creek

O'Bannon Creek drains 59.1 mi^2, including portions of the City of Loveland. It enters the Little Miami River at RM 24.0 and is the receiving stream for the O'Bannon WWTP discharge at RM 2.57. Five sites were sampled in this tributary in 2007. Stream flows from May through September 2007 as measured by the USGS gage station in O'Bannon Creek near Loveland (RM 1.84) are presented in Figure 20. On conventional water chemistry sampling days in O'Bannon Creek, mean daily flows ranged from 1.2 cfs on July 24 to 5.5 cfs on September 11. On Ohio EPA bacteria sampling days in 2007, mean daily flows ranged from 1.7 cfs on August 13 to 4.2 cfs on July 19.

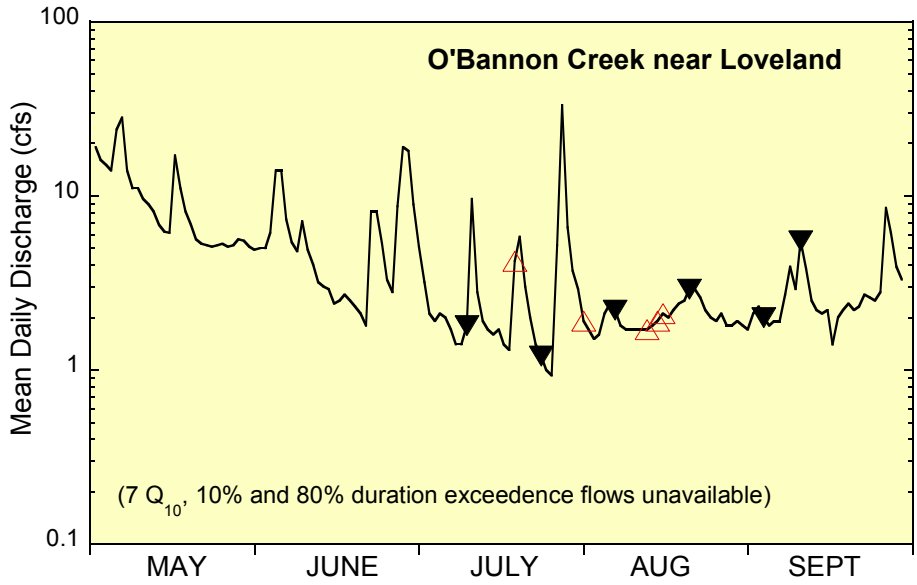


Figure 20. May through September, 2007 flow hydrograph for O'Bannon Creek near Loveland (USGS station # 03244936) RM 1.84. Solid triangles indicate river discharge on water chemistry sampling days in O'Bannon Creek. Open triangles indicate river discharge on bacteriological sampling days.

Lower flows contributed to low dissolved oxygen levels with numerous values falling below water quality criteria in the upper reaches of O'Bannon Creek (Table 7). While D.O. levels measured by a Datasonde© monitor at RM 0.26 from August 14-16 remained above minimum water quality criteria (Figure 14), the site experienced significant diurnal variability with concentrations and corresponding saturations ranging from 6.01 mg/l (73.65%) to 10.76 mg/l (139.2%). Field crews observed extensive algal mats at this site throughout much of the survey. Low flows and an open canopy (elevated temperatures) at the site accentuated the negative impact of heavy nutrient loads from the O'Bannon WWTP discharge upstream at RM 2.57.

Ninety percent of all phosphorus concentrations were elevated above target levels in O'Bannon Creek. However, concentrations spiked to exceptionally elevated levels downstream of the O'Bannon WWTP discharge (Table 8, Figure 21). The O'Bannon

WWTP does not treat for phosphorus removal. The overall median phosphorus concentration for sites upstream of the discharge was 0.13 mg/l compared to 3.3 mg/l for downstream sites. (The highest sediment phosphorus levels of the survey occurred at RM 0.26.) Nitrate-nitrite-N concentrations were also excessively high downstream of the wastewater facility (overall median 14.2 mg/l). While well within water quality criteria, zinc concentrations increased at sites downstream of the O'Bannon discharge as well with the highest levels of the survey documented at RM 1.84 (median 54 µg/l). Total suspended solids (TSS) and total phosphorus in the upper reaches of O'Bannon Creek (RMs 10.14, 8.27 and 4.37) were moderately but consistently above target and may reflect upstream agriculture.

Bacteria samples collected in O'Bannon Creek in 2007 indicate that the PCR Class B use was attained (Table 9, Figure 17).

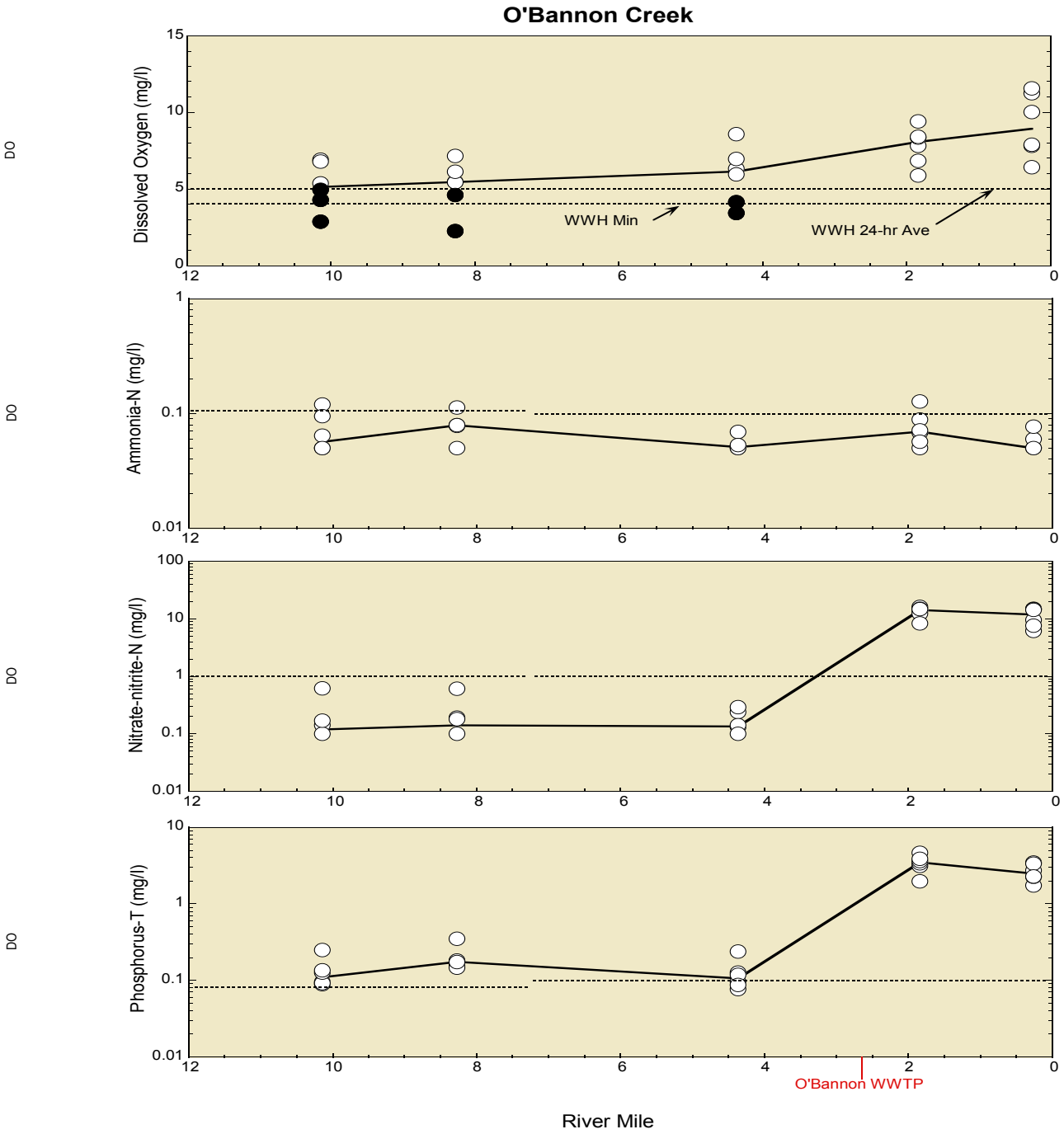


Figure 21. Longitudinal scatter plots of daytime grab dissolved oxygen, ammonia-Nitrogen, nitrate-nitrite-Nitrogen, and total phosphorus in O'Bannon Creek during 2007. The solid line depicts the median value at each river mile sampled. Dashed horizontal lines represent applicable reference values from sites of similar size in the Interior Plateau (IP) ecoregion. (Statewide reference values were used for IP sites). Water quality criteria are shown in the dissolved oxygen plot. (Values not meeting criteria are shown as solid circles.)

Sycamore Creek

Sycamore Creek, a high gradient stream, drains 23.3 mi^2 and enters the Little Miami River at RM 19.22. It is the receiving stream for the Sycamore Creek WWTP discharge at RM 0.26. Additionally, this predominately urban watershed has five designated sanitary sewer overflows (MSD 2009). Three sites were sampled in Sycamore Creek in 2007.

Dissolved oxygen remained generally stable longitudinally with daytime grab median saturations approaching 100%. D.O. concentrations fell below water quality criteria in the headwaters (RM 1.10) on one occasion (September 4), which reflected the interstitial flow conditions at the site on this date. Organic enrichment was also apparent at the site. In late May (prior to actual sampling), field crews observed extensive algal mats blanketing the stream (Figure 22). Given the Sycamore Creek WWTP collection system's significant infiltration and inflow (I/I) problems, it is possible that deterioration in the collection system near and under Sycamore Creek and its tributaries may be impacting the stream in this area by leaching waste to the stream. Total phosphorus and total suspended solids (TSS) concentrations were frequently above target at the site during the survey (respective medians of 0.10 mg/l and 26 mg/l). Nutrients were also elevated well above target levels near the mouth (RM 0.05) downstream of the Sycamore WWTP with respective nitrate-nitrite-N and total phosphorus medians of 4.00 mg/l and 0.88 mg/l (Figure 23).

Figure 22. Sycamore Creek adjacent Loveland-Madeira Rd (RM 1.10) May 30, 2007.

Sycamore Creek was in full attainment of the PCR Class B use at both sites in 2007 (Table 9).

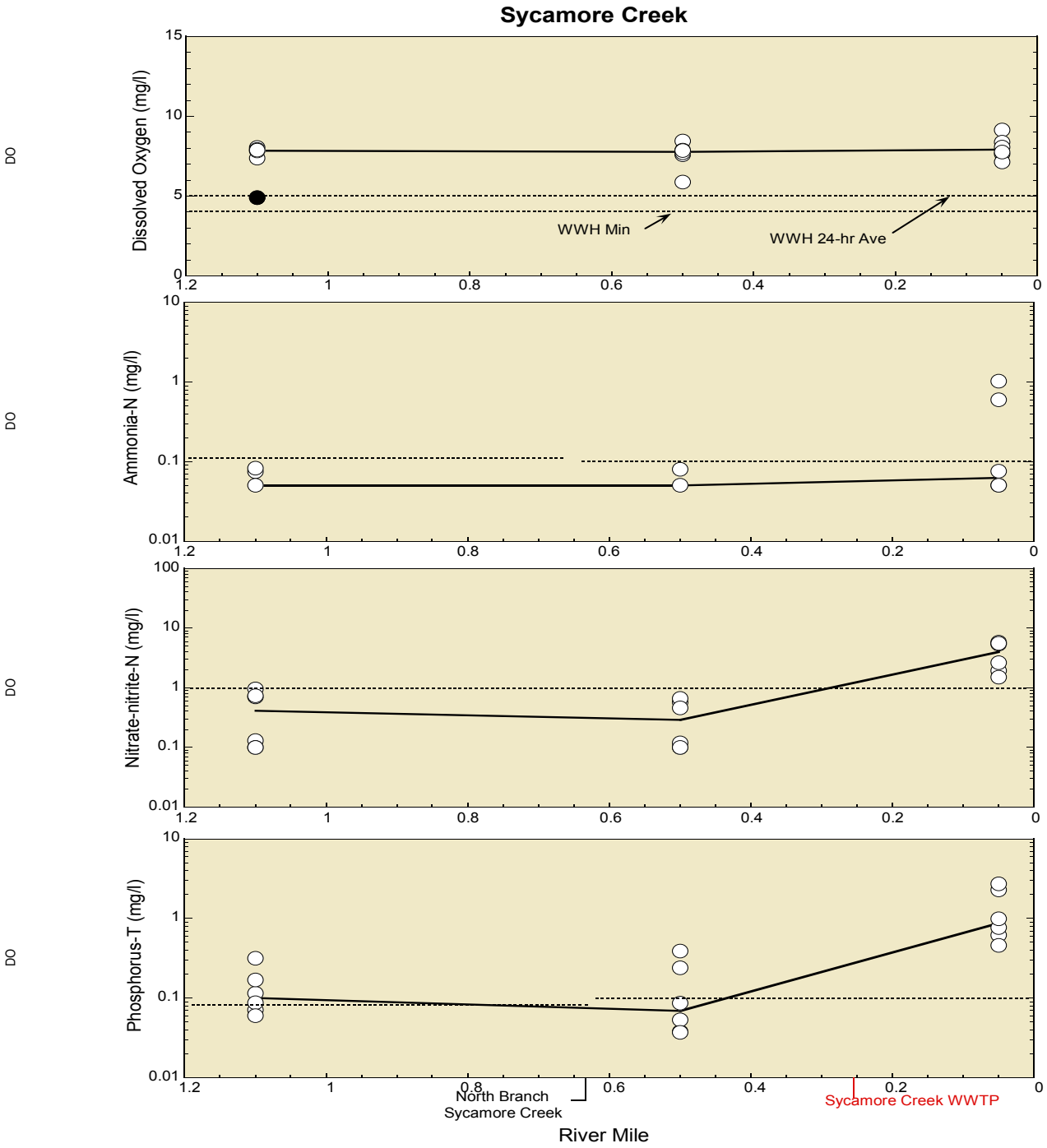


Figure 23. Longitudinal scatter plots of daytime grab dissolved oxygen, ammonia-Nitrogen, nitrate-nitrite-Nitrogen, and total phosphorus in Sycamore Creek during 2007. The solid line depicts the median value at each river mile sampled. Dashed horizontal lines represent applicable reference values from sites of similar size in the Interior Plateau (IP) ecoregion. (Statewide reference values were used for IP sites). Water quality criteria are shown in the dissolved oxygen plot. (Values not meeting criteria are shown as solid circles.)

East Fork Little Miami River

The largest tributary to the Little Miami River, the East Fork Little Miami River, is 82 miles long, drains 499 mi^2, and enters the Little Miami River at RM 11.50 near Milford. It is the receiving stream for several Clermont County wastewater treatment plants, including the Milford WWTP discharge at RM 1.61. The East Fork Little Miami River watershed was not part of the 2007 intensive stream survey. Hence, only one site (RM 0.77) was sampled during 2007. Stream flows from May through September 2007 as measured by the USGS gage station in the East Fork Little Miami River at Perintown (RM 6.5) are presented below in Figure 24. On conventional water chemistry sampling days in the East Fork Little Miami River, mean daily flows ranged from 42 cfs on September 4 to 65 cfs on July 10. On Ohio EPA bacteria sampling days in 2007, mean daily flows ranged from 44 cfs on August 13 to 92 cfs on July 19.

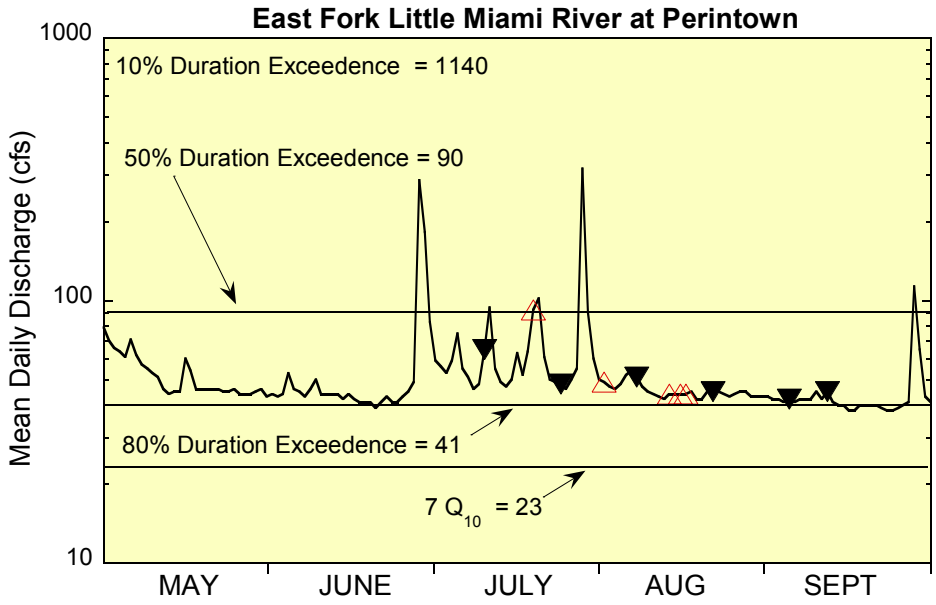


Figure 24. May through September, 2007 flow hydrograph for the East Fork Little Miami River at Perintown (USGS station # 03247500) RM 6.5. Solid triangles indicate river discharge on water chemistry sampling days in the East Fork Little Miami River. Open triangles indicate river discharge on bacteriological sampling days. (Duration exceedence and $7Q_{10}$ flow lines represent May-Nov period of record 1977-1997.)

Daytime grab dissolved oxygen at RM 0.77 remained above water quality criteria and levels measured by a Datasonde© monitor from July 17-19 exhibited normal diurnal variation (Figure 14). There were no exceedences of water quality criteria for any parameter sampled. Reflecting upstream nutrient loading from the Milford WWTP, nitrate-nitrite-N and total phosphorus were elevated above target concentrations with respective medians of 4.33 mg/l and 0.66 mg/l (Table 8).

While PCR Class A criteria were attained in 2007, samples collected in 2008 indicate that the PCR use was not attained due to higher flows (Table 9). Possible sources of bacteria include the discharge from the Milford WWTP as well as general stormwater runoff.

Duck Creek

Duck Creek drains 15.5 mi^2 before entering the Little Miami River at RM 3.87 upstream from Beechmont Avenue. This predominately urban watershed is severely impacted by direct habitat alteration (channelization) as well as numerous combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs). According to the Metropolitan Sewer District (MSD 2009), approximately 1,313 million gallons are discharged from 43 CSOs per year in the watershed, while another 13 million gallons are discharged from two (2) active SSOs. The watershed is also impacted by urban stormwater runoff. Ohio EPA sampled two sites (RM 3.36 and RM 1.18) in Duck Creek in 2007.

Figure 25. Duck Creek at Rosslyn Rd (RM 3.36) August 21, 2007 after precipitation.

Elevated temperatures and dissolved oxygen concentrations below criteria were recorded at RM 1.18 (Table 7). Both sites in Duck Creek experienced elevated levels of ammonia-N on occasion and total phosphorus concentrations were consistently elevated above target values (overall median 0.18 mg/l). Field crews observed significant algae growth at both sites as well as some of the highest daytime grab dissolved oxygen saturations of the survey (median 161% at RM 3.36). Additionally, while well within water quality criteria, the highest arsenic concentrations of the survey were measured in this tributary (overall median 19 µg/l).

Clough Creek
Clough Creek drains 8.31 mi^2 and enters the Little Miami River at RM 3.36. Per the Metropolitan Sewer District (MSD 2009), approximately 172 million gallons are discharged from two CSOs annually in the watershed, while another million gallons are discharged from two active SSOs. The watershed is also impacted by urban stormwater runoff.

There were no exceedences of water quality criteria at the one site sampled in Clough Creek (RM 0.42) during 2007. Daytime grab dissolved oxygen levels were stable (90% saturation) and nutrients generally remained below target reference values (Table 8) Concentrations of COD (54 mg/l), ammonia-N (0.242 mg/l), total phosphorus (0.282 mg/l), and TSS (157 mg/l) were elevated on August 21 following localized precipitation.

Sentinel Site Monitoring Program
Typically, Ohio EPA sampling occurs within the critical low flow period of the year during the summer season when the attainment status for biological water quality criteria can be assessed. However, recognizing the impact of non-point pollution sources on streams and the lack of water chemistry data available under varying flow and seasonal conditions, Ohio EPA developed a "sentinel site" approach in an effort to develop data sets over an annual period of varying climatic and flow conditions. In addition to assisting in the analysis of causes and sources of any observed non-attainment, the resulting data set supports water quality modeling efforts for pollutants where total maximum daily loads (TMDLs) may be necessary.

Sentinel site selection is based on several factors including proximity to the watershed boundary, drainage area size (≥ 20 mi^2), and varying land use (urban, agricultural, etc). If possible, locations are selected that have USGS flow stations. Typically, however, bridge to water measurements are taken at each site using a weighted tape in conjunction with periodic instream flow measurements in order to develop predictive gage height to stream flow relationships.

Ten sites sampled during the intensive summer survey (July 10 - September 13) in the lower LMR watershed were also sampled throughout the year as part of the sentinel site program. Results for select parameters are presented in Table 11. Exceedences of water quality criteria for copper, lead, and iron occurred at most sites on October 23, 2007 during exceptionally elevated flows.

The ten sentinel sites were also sampled for organic compounds four times during 2007 (Table 12, Appendix Table A-7). Eighteen organic compounds were detected in the watershed. The plasticizer bis(2-ethylhexyl)phthalate accounted for 25% of the total detections (31 of 126) followed by atrazine (17%), 2,4-D (14%), and metolachlor (11%). Concentrations of aldrin, dieldrin, heptachlor epoxide, and benzo[a]pyrene exceeded non-drinking water human health water quality criteria on occasion. The Lytle Creek site (RM 0.65) accounted for 20% of the organic compound detections in the watershed (25 of 126).

Table 11. Sampling results for select parameters at ten sentinel sites in the lower Little Miami River watershed (January 11 - December 11, 2007). Values above applicable reference values are highlighted in yellow. (Exceedences of Ohio EPA water quality criteria (OAC 3745-1) occurring on October 23, 2007 are presented in the last three columns.)

Date	Sampling Results for Select Parameters						Exceedences on Oct 23, 2007		
	Bridge to water distance (ft) [a]	Flow (cfs) [a]	NH_3-N (mg/l)	Nitrate-nitrite-N (mg/l)	Phos-T (mg/l)	TSS (mg/l)	Iron-T (µg/l)	Cu-T (µg/l)	Pb-T (µg/l)
Little Miami River Downstream Caesar Creek (Shaw Property) (RM 50.25)									
1/11/07	22.10	-	<0.05	3.98	0.149	5			
3/21/07	20.80	-	<0.05	3.00	0.129	18			
4/26/07	22.97	-	<0.05	2.61	0.108	6			
5/17/07	22.78	-	<0.05	2.24	0.110	9			
7/12/07	23.35	-	0.058	1.77	0.154	34			
7/26/07	23.57	-	<0.05	3.06	0.178	15			
8/09/07	23.77	-	<0.05	2.98	0.188	18			
8/23/07	23.48	-	0.058	1.69	0.160	<5			
9/06/07	23.95	-	<0.05	4.02	0.221	10			
9/13/07	23.86	-	<0.05	3.23	0.203	10			
10/23/0	21.70	-	<0.05	1.95	0.433	241	5700 ∞		
11/27/0	21.97	-	0.098	1.40	0.216	48			
12/11/0	21.27	-	0.133	3.06	0.178	53			
Little Miami River @ Wooster Pike-Milford (RM 13.07)									
1/11/07	-	1540	<0.05	2.92	0.149	8			
3/21/07	-	3220	<0.05	2.66	0.140	22			
4/26/07	-	1143	<0.05	1.69	0.134	15			
5/17/07	-	754	0.059	1.88	0.230	26			
7/10/07	-	206	<0.05	2.43	0.337	36			
7/24/07	-	188	<0.05	2.36	0.293	8			
8/07/07	-	249	0.06	2.67	0.477	26			
8/21/07	-	114	0.05	3.20	0.578	50			
9/04/07	-	97	<0.05	3.16	0.592	5			
9/11/07	-	284	0.052	3.54	0.549	36			
10/23/0	-	6727	0.059	1.15	1.03	658	18100∞	21*	19.2*
11/27/0	-	2285	0.059	1.24	0.341	106			
12/11/0	-	2633	<0.05	3.40	0.206	41			
Todd Fork @ US 22/SR 3 (Morrow) (RM 0.14)									
1/11/07	20.22	-	0.053	2.70	0.115	<5			
3/21/07	18.95	-	<0.05	1.55	0.051	6			
4/26/07	21.23	-	<0.05	0.78	0.047	5			
5/17/07	21.55	-	<0.05	1.09	0.045	<5			
7/11/07	21.13	-	0.057	2.26	0.334	124			
7/25/07	22.22	-	<0.05	0.29	0.081	5			
8/08/07	22.39	-	<0.05	0.17	0.112	<5			

Date	Sampling Results for Select Parameters						Exceedences on Oct 23, 2007		
	Bridge to water distance (ft) [a]	Flow (cfs) [a]	NH_3-N (mg/l)	Nitrate-nitrite-N (mg/l)	Phos-T (mg/l)	TSS (mg/l)	Iron-T (µg/l)	Cu-T (µg/l)	Pb-T (µg/l)
8/22/07	22.38	-	<0.05	<0.10	0.080	<5			
9/05/07	22.59	-	<0.05	<0.10	0.058	<5			
9/12/07	22.41	-	<0.05	0.18	0.077	6			
10/23/0	18.39	-	<0.05	1.66	0.791	473	13100∞		
11/27/0	20.00	-	<0.05	2.15	0.363	37			
12/11/0	19.45	-	<0.05	5.29	0.167	21			
Lytle Creek @ Clarksville Rd (RM 0.65)									
1/11/07	15.85	-	<0.05	3.72	0.315	<5			
3/21/07	15.82	-	<0.05	2.08	0.292	<5			
4/26/07	15.98	-	<0.05	2.32	0.422	<5			
5/17/07	16.11	-	0.141	2.53	0.555	<5			
7/11/07	na	-	0.103	1.79	0.479	74			
7/25/07	16.38	-	<0.05	8.66	1.39	20			
8/08/07	16.39	-	<0.05	7.73	1.88	<5			
8/22/07	16.25	-	<0.05	4.62	1.29	14			
9/05/07	16.5	-	<0.05	9.23	1.98	<5			
9/12/07	na	-	<0.05	3.10	1.31	5			
10/23/0	12.28	-	0.18	0.97	1.08	1120	28700∞	47**	61.2*
11/27/0	15.49	-	<0.05	3.14	0.349	10			
12/11/0	15.55	-	0.159	5.17	0.275	<5			
Cowan Creek @ Clarksville Rd (RM 0.6)									
1/11/07	14.46	-	0.161	2.52	0.161	11			
3/21/07	15.02	-	<0.05	1.44	0.112	7			
4/26/07	15.29	-	<0.05	1.03	0.027	<5			
5/17/07	15.44	-	<0.05	0.72	0.052	5			
7/11/07	15.29	-	<0.05	<0.10	0.053	47			
7/25/07	16.11	-	<0.05	0.16	0.060	<5			
8/08/07	16.26	-	<0.05	<0.10	0.045	<5			
8/22/07	16.35	-	<0.05	<0.10	0.030	39			
9/05/07	16.45	-	0.055	<0.10	0.027	<5			
9/12/07	16.51	-	<0.05	<0.10	0.028	13			
10/23/0	15.03	-	<0.05	1.29	0.229	53			
11/27/0	15.69	-	<0.05	0.64	0.036	<5			
12/11/0	14.56	-	<0.05	0.71	0.041	8			
East Fork Todd Fork @ SR 132 (Clarksville) (RM 1.60)									
1/11/07	26.82	-	<0.05	3.63	0.066	<5			
3/21/07	26.83	-	<0.05	1.21	0.040	5			
4/26/07	27.06	-	<0.05	0.48	0.014	<5			
5/17/07	27.14	-	<0.05	0.15	0.022	5			
7/11/07	26.45	-	0.082	2.22	0.256	51			
7/25/07	27.45	-	<0.05	0.66	0.071	10			

Date	Sampling Results for Select Parameters						Exceedences on Oct 23, 2007		
	Bridge to water distance (ft) [a]	Flow (cfs) [a]	NH_3-N (mg/l)	Nitrate-nitrite-N (mg/l)	Phos-T (mg/l)	TSS (mg/l)	Iron-T (µg/l)	Cu-T (µg/l)	Pb-T (µg/l)
8/08/07	27.58	-	<0.05	<0.10	0.106	14			
8/22/07	27.75	-	0.211	<0.10	0.228	16			
9/05/07	27.8	-	0.083	<0.10	0.071	<5			
9/12/07	27.8(dr	-	na	na	na	na			
10/23/0	25.28	-	<0.05	0.88	0.491	291	8020∞		
11/27/0	26.43	-	0.06	2.64	0.396	29			
12/11/0	26.48	-	<0.05	4.39	0.190	10			
Turtle Creek @ SR 48 (RM 0.52)									
1/11/07	28.80	-	<0.05	1.29	0.636	<5			
3/21/07	28.86	-	<0.05	0.34	0.034	<5			
4/26/07	29.02	-	<0.05	0.34	0.034	5			
5/17/07	29.24	-	0.094	0.46	0.072	<5			
7/12/07	29.18	-	0.052	1.19	0.124	30			
7/26/07	29.55	-	<0.05	0.28	0.388	8			
8/09/07	29.59	-	<0.05	0.47	0.108	35			
8/23/07	29.73	-	<0.05	0.18	0.064	10			
9/06/07	29.84	-	0.091	0.14	0.037	21			
9/13/07	29.83	-	0.064	<0.10	0.063	7			
10/23/0	26.31	-	0.071	1.12	0.919	650	17200∞		
11/27/0	28.56	-	0.050	1.85	0.233	17			
12/11/0	28.59	-	<0.05	2.79	0.123	<5			
Muddy Creek @ Mason-Morrow Millgrove Rd (RM 0.54)									
1/11/07	18.05	-	<0.05	1.78	0.554	14			
3/21/07	17.88	-	<0.05	0.65	0.374	<5			
4/26/07	17.60	-	0.05	0.91	0.679	55			
5/17/07	18.14	-	<0.05	1.82	0.200	6			
7/12/07	18.09	-	<0.05	1.39	0.439	6			
7/26/07	18.21	-	<0.05	2.37	0.163	<5			
8/09/07	18.24	-	<0.05	1.72	0.149	<5			
8/23/07	18.3	-	<0.05	1.47	0.114	<5			
9/06/07	18.26	-	<0.05	2.30	0.270	<5			
9/13/07	18.24	-	<0.05	1.97	0.724	<5			
10/23/0	15.31	-	0.051	1.11	0.560	218	5910∞		
11/27/0	17.47	-	<0.05	1.50	0.158	6			
12/11/0	17.46	-	<0.05	2.74	0.465	<5			
O'Bannon Creek @ SR 48									
1/11/07	23.59	-	<0.05	1.47	0.721	<5			
3/21/07	23.55	-	<0.05	0.52	0.140	<5			
4/26/07	23.15	-	<0.05	0.50	0.172	14			
5/17/07	23.85	-	0.121	2.49	0.860	<5			
7/10/07	24	-	<0.05	6.16	1.74	119			

Date	Sampling Results for Select Parameters						Exceedences on Oct 23, 2007		
	Bridge to water distance (ft) [a]	Flow (cfs) [a]	NH_3-N (mg/l)	Nitrate-nitrite-N (mg/l)	Phos-T (mg/l)	TSS (mg/l)	Iron-T (µg/l)	Cu-T (µg/l)	Pb-T (µg/l)
7/24/07	25.73	-	<0.05	9.64	2.27	10			
8/07/07	24.2	-	<0.05	15.0	2.74	11			
8/21/07	24.16	-	0.06	14.9	3.47	8			
9/04/07	24.18	-	<0.05	14.5	3.37	<5			
9/11/07	23.97	-	0.077	7.60	2.28	29			
10/23/0	20.61	-	0.065	1.14	1.06	559	16200∞	15*	16.6*
11/27/0	23.07	-	<0.05	1.73	0.470	13			
12/11/0	23.13	-	<0.05	1.81	0.243	<5			
East Fork Little Miami River @ South Milford Rd (RM 0.77)									
1/11/07	-	985	<0.05	0.93	0.216	6			
3/21/07	-	260	<0.05	1.08	0.259	11			
4/26/07	-	123	0.117	1.29	0.238	15			
5/17/07	-	53	0.305	2.35	0.490	11			
7/10/07	-	49	<0.05	3.88	0.661	21			
7/24/07	-	46	<0.05	3.68	0.592	21			
8/07/07	-	49	<0.05	4.13	0.651	26			
8/21/07	-	44	<0.05	4.60	0.654	26			
9/04/07	-	42	<0.05	5.94	0.882	10			
9/11/07	-	53	0.053	4.52	0.862	77			
10/23/0	-	2880	0.056	0.94	0.922	79	25100∞	21*	20.8*
11/27/0	-	408	0.068	1.01	0.330	43			
12/11/0	-	1110	0.121	0.76	0.198	19			

[a] USGS flow measurements presented for the Little Miami River @ Wooster Pike in Milford are taken from USGS Station No. 03245500. USGS flow measurements presented for the East Fork Little Miami River @ South Milford Road are taken from USGS Station No. 03247500 (East Fork Little Miami River at Perintown). For the remaining sites, the relative flows are inversely related to bridge to water measurements (i.e. the greater the bridge to water measurement, the lower the flow and vice-versa).

* exceedence of numerical criteria for prevention of chronic toxicity (CAC).
** exceedence of numerical criteria for prevention of acute toxicity (AAC).
∞ exceedence of agricultural water supply criterion.

Table 12. Frequency of organic compounds detected in stream water samples at ten sentinel sites in the lower Little Miami River watershed during 2007. (Number of water quality criteria exceedences / Number of detections).

Stream	Little Miami River		Lytle Cr	Cowan Cr	East Fk Todd	Todd Fork	Turtle Cr	Muddy Cr	O'Bannon Cr	E FK Little Miami	Total
RM	**50.25**	**13.00**	**0.65**	**0.65**	**1.60**	**0.14**	**0.52**	**0.54**	**0.26**	**0.77**	
Acetochlor*	*/1	-	*/3	-	*/1	*/2	*/1	-	*/1	-	*/9
Aldrin	-	-	-	1/1	-	-	-	-	-	-	1/1
Atrazine*	*/1	*/2	*/4	*/1	*/1	*/3	*/2	*/1	*/3	*/4	*/22
α-Hexachlorocyclohexane	-	-	-	-	0/1	-	-	-	-	0/1	0/2
δ-Hexachlorocyclohexane*	*/1	*/1	*/1	-	-	-	*/2	*/1	*/1	*/1	*/8
γ-Hexachlorocyclohexane	-	-	-	-	-	-	-	0/1	0/1	-	0/2
bis(2-Ethylhexyl)phthalate	0/2	0/4	0/4	0/3	0/2	0/2	1/4	0/3	0/3	0/4	1/31
bis(2-Ethylhexyl)adipate*	-	-	*/1	-	*/1	-	-	-	-	-	*/2
Dieldrin	-	1/1	2/2	-	-	-	1/1	1/1	-	1/1	6/6
Endrin	-	-	-	-	-	-	-	0/1	-	-	0/1
Metolachlor*	*/1	-	*/3	-	*/1	*/2	*/1	*/1	*/2	*/3	*/14
Pentachlorophenol	-	-	0/1	-	-	-	-	-	-	-	0/1
Heptachlor epoxide	1/1	-	2/2	-	-	-	-	2/2	-	-	5/5
3-Hydroxycarbofuran*	-	-	-	*/1	-	-	-	-	-	-	*/1
Benzo[a]pyrene	-	-	1/1	-	-	-	-	-	-	-	1/1
Picloram*	-	-	*/1	-	-	-	-	-	-	-	*/1
Dicamba*	-	-	-	-	-	-	*/1	-	-	-	*/1
2,4-D*	*/2	*/2	*/2	-	-	*/2	*/3	*/3	*/3	*/1	*/18
TOTAL	**1/9**	**1/10**	**5/25**	**1/6**	**0/7**	**0/11**	**2/15**	**3/14**	**0/14**	**1/15**	**14/126**

* No applicable water quality criteria available for parameter.

Chemical Water Quality Trends 1993-2007

Ohio EPA previously conducted intensive biological and water quality studies of the Little Miami River watershed in 1998 and 1993. May through September stream flows for 2007, 1998 and 1993 as measured by the USGS gage station in the Little Miami River at Milford are compared in Figure 26 and Table 14. Generally, the highest flows were measured in 1998, followed by 1993 and 2007. On water chemistry sampling days in the watershed, 2007 flows ranged from 98 to 1150 cfs (median 228 cfs) compared to 1998 flows of 175 to 1600 cfs (median 272 cfs) and 1993 flows of 128 to 2500 cfs (median 196 cfs). During the May through September period, seventy-eight percent (78%) of 2007 mean daily flows were below the historical median (399 cfs) compared to 37% for 1998 and 49% for 1993.

A comparison of Little Miami River mainstem 2007, 1998 and 1993 water chemistry data for select parameters is presented in Table 13, Figure 27 and Figure 28. Water samples were collected at 21 sites in the mainstem during the 2007 survey compared to 37 sites in the 1998 survey and 34 sites in the 1993 survey. (For comparison to 2007 data, 1993 mixing zones are excluded and only sites from RM 83.14 (Jacoby Rd) to the mouth are represented in the table and graphs below.)

Dissolved oxygen concentrations (daytime grabs) generally remained above EWH criteria during all surveys. Longitudinally, D.O. levels were relatively comparable with 2007 medians, ranging from 6.8 mg/l to 8.9 mg/l compared to 1998 (6.7 mg/l to 8.8 mg/l) and 1993 (7.1 mg/l to 8.7 mg/l).

Ammonia-N levels in all three survey years remained low with most site medians approaching the minimum detection limit (MDL) of 0.05 mg/l. The highest median ammonia-N concentration (0.11 mg/l) for all three surveys was measured downstream of the Lebanon WWTP at RM 31.96 during the 1993 survey. Only one ammonia-N concentration exceeded water quality criteria during any of the three surveys (RM 28.0 downstream of Simpson Creek in 1998 following a spill of raw sewage from a manhole).

Overall concentrations of nitrate-nitrite-N and total phosphorus in the mainstem decreased in 2007 compared to earlier surveys. The highest levels for both parameters were measured in 1998, followed by 1993 and 2007 (Table 13). Longitudinally, 2007 median nitrate-nitrite-N and total phosphorus concentrations were typically well below both 1998 and 1993 levels upstream of the Lebanon WWTP discharge (RM 32.12). However, median concentrations in 2007 for both parameters increased markedly downstream of the Lebanon WWTP and again downstream of the confluence of Simpson Creek (RM 28.14), and remained elevated at or above both 1998 and 1993 levels to the mouth (Figure 28). The overall median phosphorus concentration in 2007 for sites upstream of the Lebanon discharge was 0.18 mg/l compared 0.40 mg/l for downstream sites. The reduction in levels in the upper mainstem can be attributed to phosphorus removal and overall improved treatment by the major wastewater facilities in the upper Little Miami River watershed subsequent to the 1998 survey. Currently, the majority of treatment plants in the lower watershed do not treat for phosphorus removal.

Median total suspended solids (TSS) levels remained below target reference values, but trended upward longitudinally in all three survey years, with the highest median values generally measured in 1993.

Table 13. Comparison of Ohio EPA data for select parameters from the 2007, 1998 and 1993 Little Miami River mainstem (RM 83.14 to the mouth). Units are C° for temperature and mg/l for other parameters.

Parameter	**50th%ile** (median)			**75th%ile**			**90th%ile**		
	2007	**1998**	**1993**	**2007**	**1998**	**1993**	**2007**	**1998**	**1993**
Temperature	24.2	22.5	22.0	25.9	24.3	24.0	27.9	25.0	27.0
Dissolved Oxygen	7.57	7.70	7.90	8.31	8.20	8.60	9.01	8.80	9.20
NH_3-N	0.05	0.05	0.05	0.06	0.06	0.05	0.07	0.09	0.08
NO_3-NO_2-N	2.82	3.46	3.19	3.39	3.95	3.72	3.84	4.46	4.25
Phosphorus-T	0.24	0.36	0.30	0.41	0.46	0.42	0.55	0.64	0.56
TSS	20	20	25	29	32	45	40	46	131

50th%ile (median)	All sites upstream Lebanon WWTP (RM 32.12)			All sites downstream Lebanon WWTP (RM 32.12)		
	2007	**1998**	**1993**	**2007**	**1998**	**1993**
NO_3-NO_2-N	2.79	3.69	3.63	2.89	3.10	2.67
Phosphorus-T	0.18	0.30	0.28	0.40	0.39	0.33

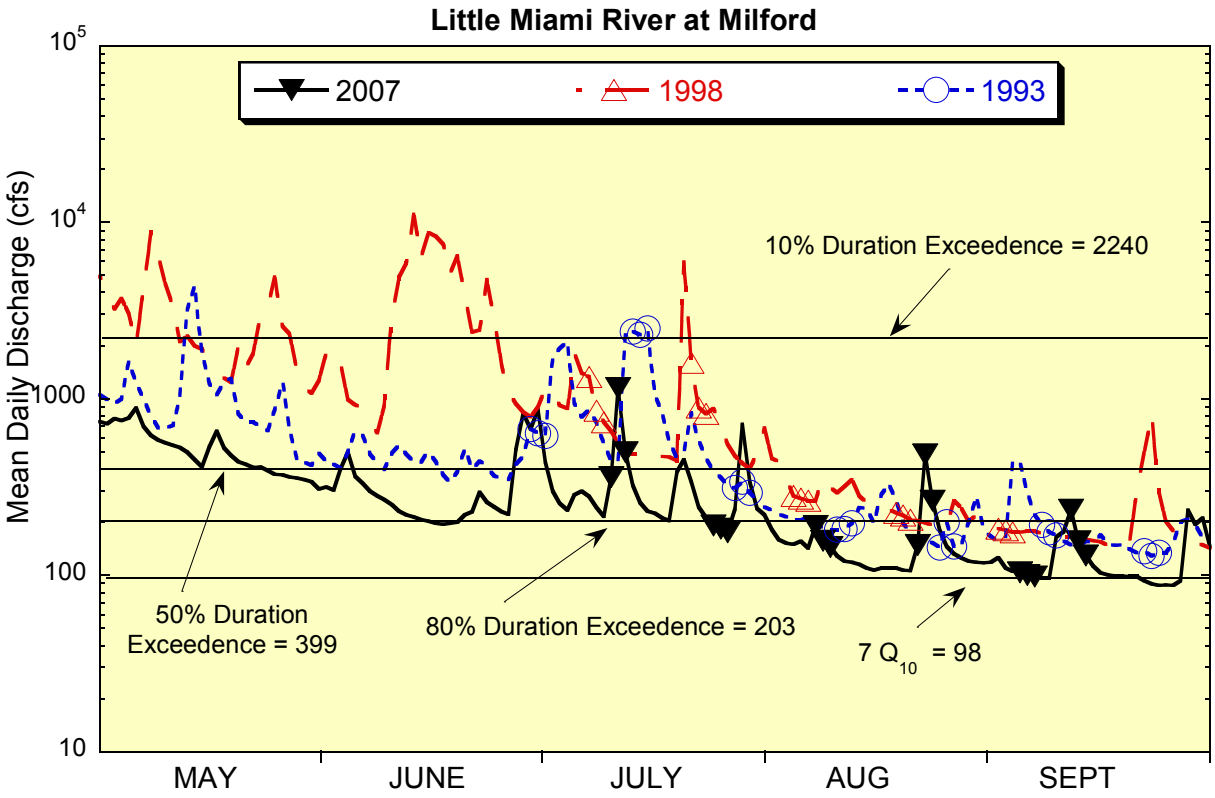


Figure 26. May through September, 2007, 1998, and 1993 flow hydrograph for the Little Miami River at Milford (USGS station # 03245500) RM 13.0. Markers indicate river discharge on water chemistry sampling days in the Little Miami River watershed for each year. (Duration exceedence and $7Q_{10}$ flow lines represent May-Nov period of record 1975-1997.)

Table 14. Median daily discharge flow (cfs) by month in the Little Miami River at Milford (USGS station #03245500).

Month	**2007**	**1998**	**1993**
May	498	2270	938
June	254	2120	440
July	255	680	578
August	128	245	197
Sept	102	165	156
May-Sept	228	680	412

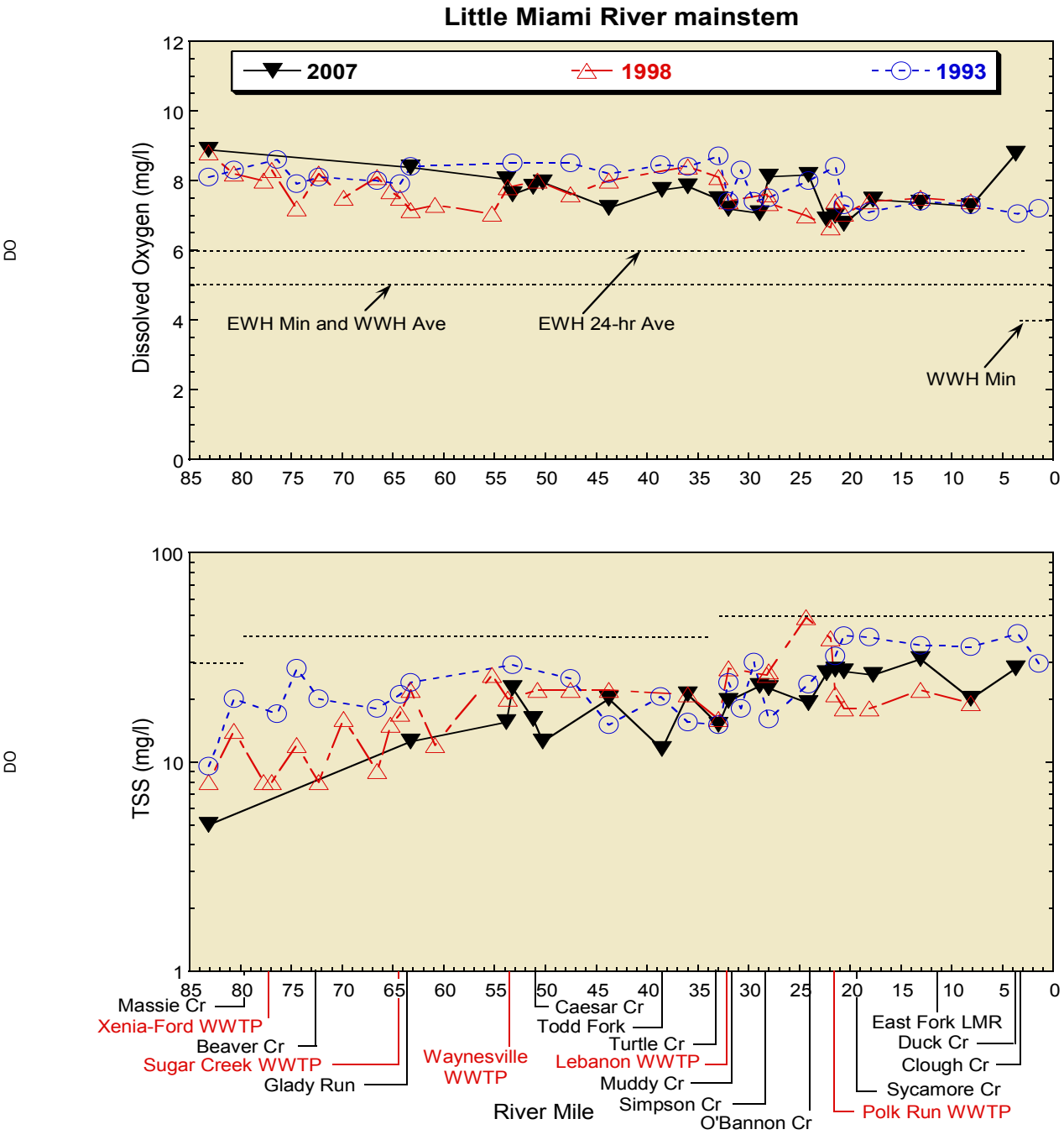


Figure 27. Longitudinal plots of median concentrations of dissolved oxygen and total suspended solids (TSS) in the mainstem Little Miami River (2007, 1998, and 1993). Water quality criteria are shown in the dissolved oxygen plot. Dashed horizontal lines in the TSS plot represent applicable reference values from sites of similar size in the Eastern Corn Belt Plains (ECBP) and Interior Plateau (IP) ecoregions. (Statewide reference values were used for IP sites.)

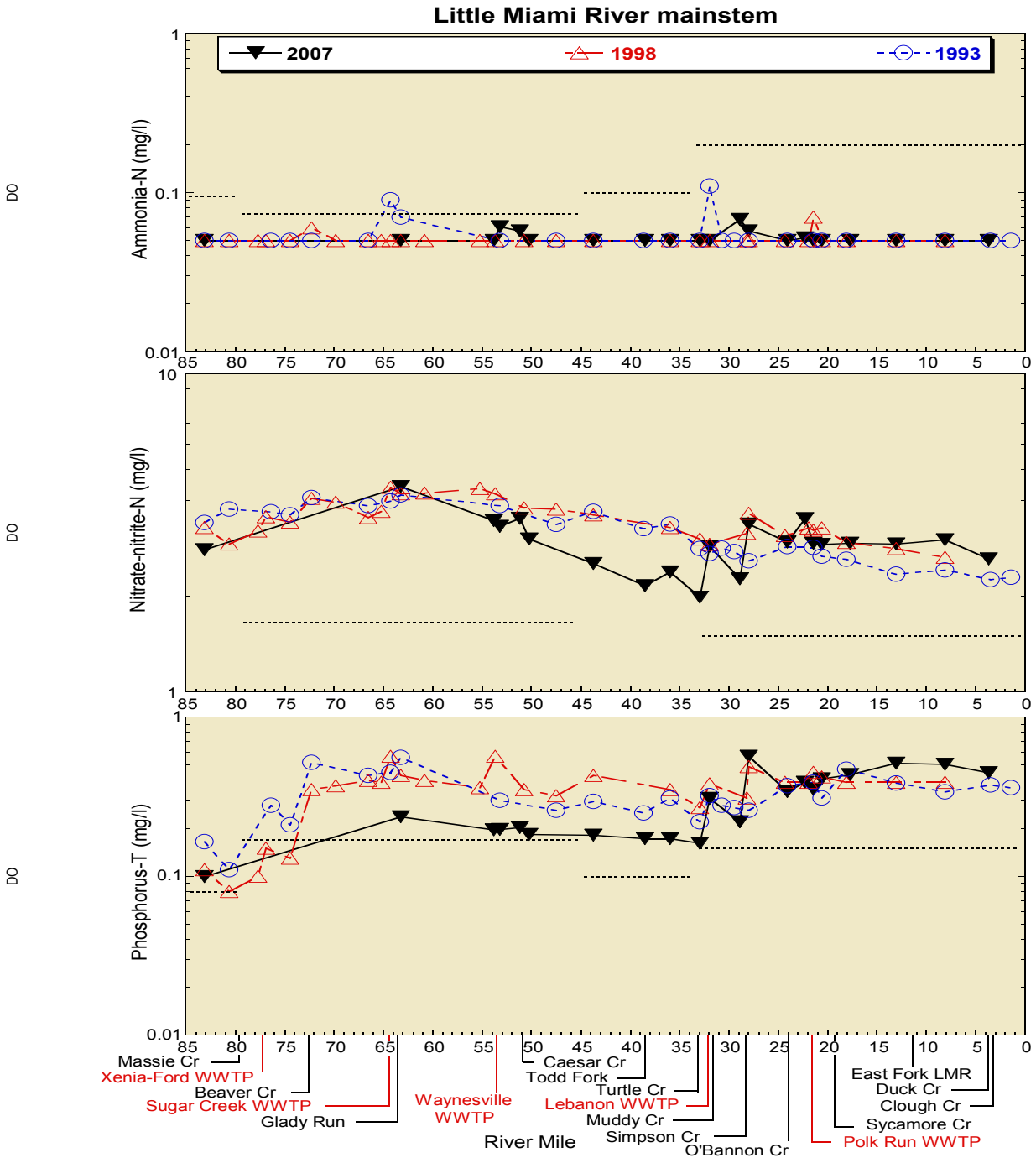


Figure 28. Longitudinal plots of median concentrations of ammonia-Nitrogen, nitrate-nitrite-Nitrogen, and total phosphorus in the mainstem Little Miami River (2007, 1998, and 1993). Dashed horizontal lines represent applicable reference values from sites of similar size in the Eastern Corn Belt Plains (ECBP) and Interior Plateau (IP) ecoregions. (Statewide reference values were used for IP sites.)

Turtle Creek and Dry Run

Turtle Creek and its tributary, Dry Run, were sampled in 2007 and 1993. Impacted by lower flows, daytime grab dissolved oxygen levels fell below critical levels on occasion in both streams during both surveys. In 1993, copper and ammonia-N concentrations frequently exceeded water quality criteria in the lower reaches of Turtle Creek downstream of the Cincinnati Milacron (Vickers) discharge (RM 0.59). Water quality in Turtle Creek has improved since this facility, a manufacturer of printed circuit boards, ceased its discharge to Turtle Creek in May of 1998.

Muddy Creek

Water samples were collected in Muddy Creek in 2007, 1998, and 1993. During the two previous surveys, the Mason WWTP discharged to Muddy Creek at RM 3.24. In June, 2006, the City's new facility at RM 2.23 became operational. This new facility treats for phosphorus removal. While the respective design flow for the Mason WWTP during the 1993, 1998, and 2007 surveys increased from 2.5 mgd to 4.95 mgd to 13 mgd, the corresponding annual median flow increased from 1.9 mgd to 3.1 mgd to 4.95 mgd.

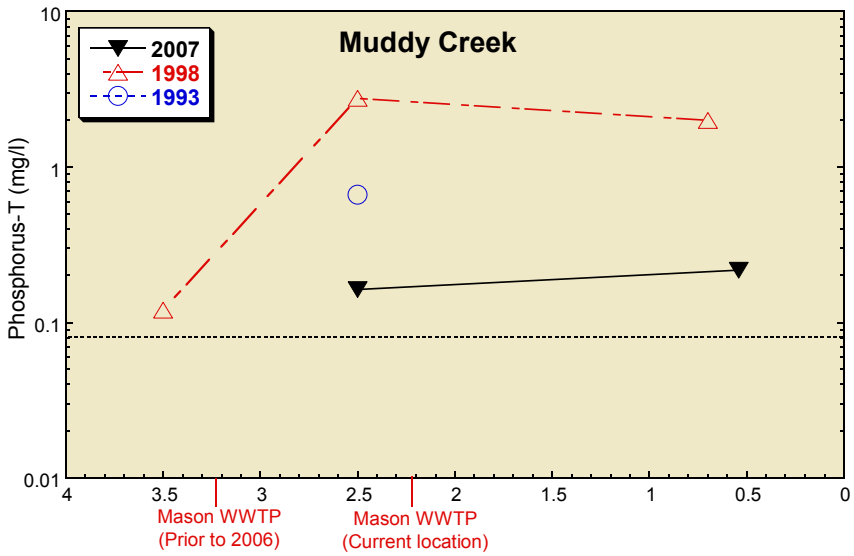


Figure 29. Longitudinal plot of median concentrations of total phosphorus in Muddy Creek (2007, 1998, and 1993).

Phosphorus levels were markedly reduced in 2007 downstream of the new wastewater plant compared to levels measured in prior surveys downstream of the older facility (Figure 29). The median 2007 phosphorus concentration at RM 0.54 downstream of the new Mason WWTP was 0.22 mg/l compared to respective 1993 and 1998 median concentrations of 0.66 mg/l and 2.76 mg/l at RM 2.50 downstream of the older facility. Median total phosphorus concentrations in all surveys, however, were above target reference values at all sites.

Daytime grab dissolved oxygen levels were relatively stable throughout Muddy Creek in all survey years while ammonia-N and TSS concentrations were typically below target

reference values. In the 1993 and 1998 surveys, respective median nitrate-nitrite-N levels at RM 2.50 downstream of the Mason WWTP discharge ranged from 2.67 mg/l to 19.2 mg/l compared to a median concentration of 1.85 mg/l in 2007 at RM 0.54 downstream of the new facility.

O'Bannon Creek

In addition to the 2007 and 1998 surveys, water samples were collected in O'Bannon Creek in 2003 and 2004 (Figure 30). While there was no stream flow gaging station in O'Bannon Creek prior to 2004, historical flow data from the USGS gaging station on the Little Miami River in Milford indicate that 2003 was a very high flow year compared to 2007, 2004, and 1998. The median daily discharge flow recorded for the May through September period in 2003 was 1150 cfs compared to 228 cfs (2007), 425 cfs (2004) and 680 cfs (1998).

While dissolved oxygen levels fell below water quality criteria in the upper reaches of O'Bannon Creek in 2007, all daytime grab D.O. concentrations measured in previous years remained above water quality criteria. Reflecting the impact of nutrient enrichment, extensive algal mats and D.O. supersaturation were frequently noted at sites downstream of the O'Bannon WWTP discharge (RM 2.57) in all surveys.

Ammonia-N levels throughout O'Bannon Creek were generally below target reference values in all years. However, concentrations on August 19, 2003 exceeded water quality criterion downstream of the WWTP at both RM 2.5 (8.22 mg/l) and RM 0.26 (1.83 mg/l). (Monthly operating reports from the O'Bannon WWTP on this day indicate a final effluent ammonia-N concentration of 12.4 mg/l, a violation of the permit.)

Both nitrate-nitrite-N and total phosphorus increased downstream of the O'Bannon WWTP discharge in all years. The highest concentrations (and greatest increase) were measured in 2007 while only nominal increases were observed in 2003. Median phosphorus levels were above target reference values throughout O'Bannon Creek in all surveys.

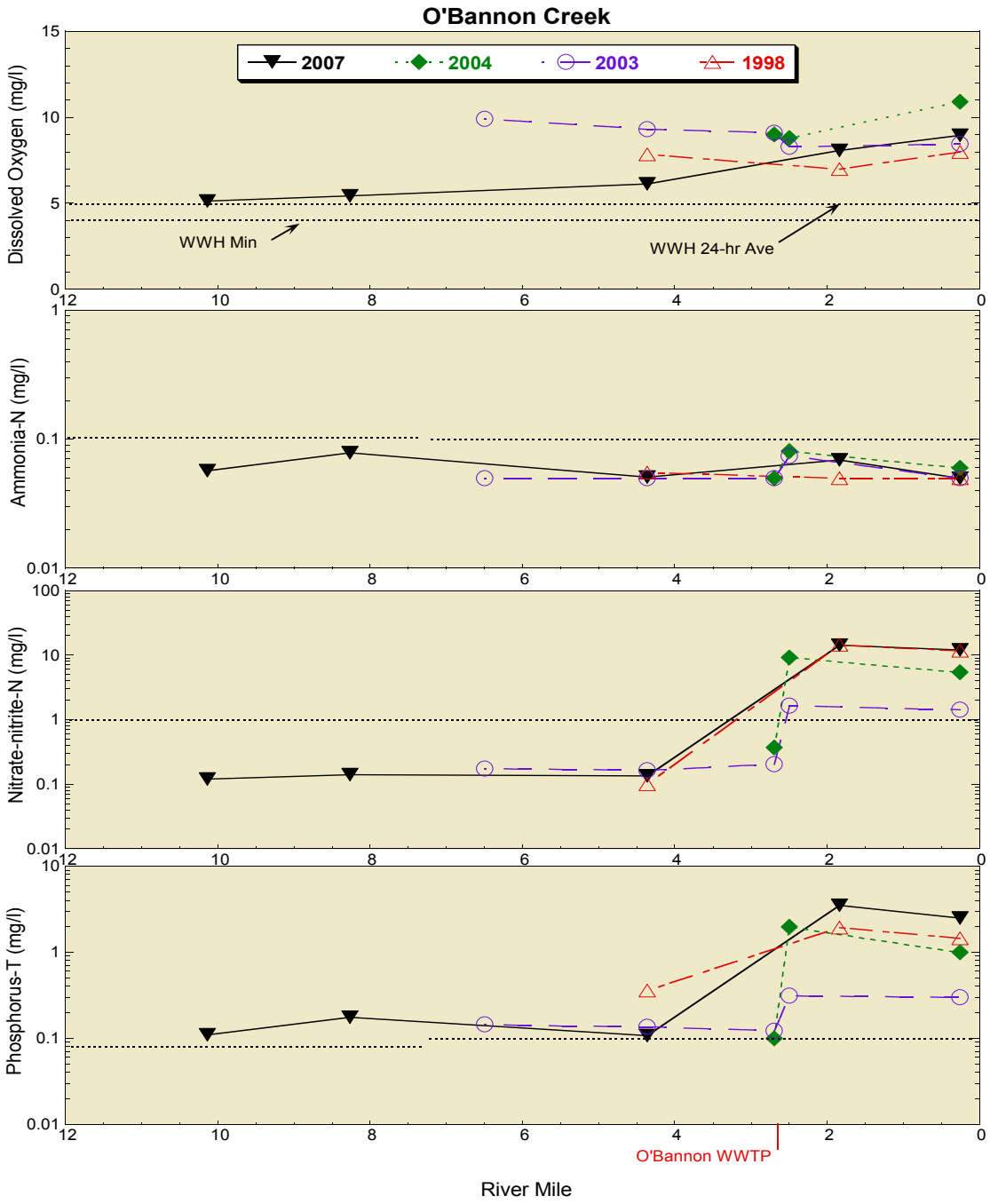


Figure 30. Longitudinal plots of median concentrations of dissolved oxygen, ammonia-Nitrogen, nitrate-nitrite-Nitrogen, and total phosphorus in O'Bannon Creek (2007, 2004, 2003, and 1998). Water quality criteria are shown in the dissolved oxygen plot. Dashed horizontal lines in other plots represent applicable reference values from sites of similar size in the Interior Plateau (IP) ecoregion. (Statewide reference values were used.)

Sycamore Creek

Water column chemistry samples were collected in Sycamore Creek in 2007, 1998, and 1993. The Sycamore Creek WWTP discharges to the stream at RM 0.26. Similar longitudinal patterns were observed in Sycamore Creek for most parameters in all three survey years. Dissolved oxygen daytime grab concentrations remained relatively stable and ammonia-N levels were generally below target reference levels.

Predictably, both nitrate-nitrite-N and total phosphorus increased downstream of the WWTP discharge in all survey years. Median nitrate-nitrite-N concentrations at sites upstream of the WWTP discharge ranged from 0.10 mg/l in 1998 to 0.42 mg/l in 2007 compared to median downstream values ranging from 2.43 mg/l in 1998 to 4.00 mg/l in 2007. Similarly, median total phosphorus at upstream sites was less than 0.11 mg/l in all years while downstream medians ranged from 0.39 mg/l in 1998 to 2.43 mg/l in 1993 (Figure 31).

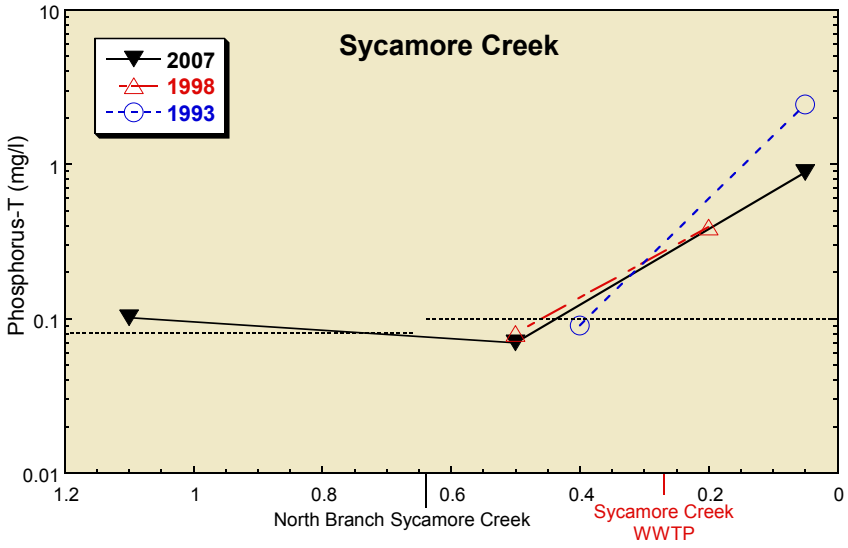


Figure 31. Longitudinal plot of median concentrations of total phosphorus in Sycamore Creek (2007, 1998, and 1993).

Chemical Sediment Quality

Sediment quality during the 2007 survey reflected the lack of precipitation over the survey period, which allowed sediments to collect in the stream bed without being redistributed (Table 15 and Table 16). The average sediment ammonia level in the 2007 lower Little Miami River tributaries was the highest level ever measured in the Southwest region of Ohio (238.2 mg/kg). The 2007 Lower Little Miami mainstem was the third highest average sediment ammonia measured (114.5 mg/kg) in southwest Ohio. Sediment ammonia results from the previous survey in 1998 documented the Little Miami mainstem average of 31.6 mg/kg and the lower and upper Little Miami tributaries averages of 30.28 and 30.66 mg/kg respectively. By comparison, the Mad River tributaries from the 2003 survey documented the second highest average sediment ammonia observed (169.2 mg/l) in southwest Ohio.

In an overall assessment of sediments in southwest Ohio streams, average sediment ammonia values are significantly lower than the Ontario Open Dumping Guidelines of 100 mg/kg (Persuad and Wilkins, 1976) in 14 of 17 rivers and tributaries sampled since 1998. Stillwater River mainstem average sediment ammonia concentrations were 33.45 mg/kg and tributaries were 44.8 mg/kg. The upper Little Miami River mainstem was 31.6 mg/kg and upper tributaries were 30.28 mg/kg. Both of these watersheds are dominated by agriculture. In the lower Little Miami River and tributaries, high sediment ammonia levels can be partially explained by the number of wastewater treatment plants and the urban/suburban areas, but the lack of high water events seems to be a mitigating factor.

Lower Little Miami River

The northernmost mainstem sediment sampling site was at RM 50.25. This site was located downstream of Caesar Creek and the Waynesville and Sugar Creek WWTPs. This is the only mainstem sediment site located in the Eastern Corn Belt Plains ecoregion. Overall there was low to normal embeddedness across the river with low to normal embeddedness in the riffles. There were pockets of moderate silt cover and embeddedness in the remainder of the stream. This site had no parameters above Ohio EPA or Ontario guidelines. Pentachlorophenol was found in the sediment at 2.93 mg/kg. This compound is used as a wood preservative and has not been evaluated in the guidelines.

The Little Miami River at RM 43.76, near SR 350 at Ft. Ancient, had heavy to moderate silt cover and high to moderate overall embeddedness. No parameters were found to be above Ohio EPA, MacDonald, or Ontario guidelines. No organic compounds were detected in the sediments.

At RM 38.5, Todd Fork enters the Little Miami River immediately upstream in the town of Morrow. The sediment bed was mostly boulder, gravel, and cobble substrate with only 2.5% of the sediment sample considered fine grained material. There were areas of heavy to moderate silt cover and high to moderate

embeddedness. None of the parameters were found to be above Ohio EPA, MacDonald, or Ontario guidelines. No organic compounds were detected in the sediments.

At RM 35.98, the Little Miami River sediment was noticeably more contaminated with nutrients. Levels of sediment ammonia (200 mg/kg) and phosphorus (2980 mg/kg) both were over the Ontario sediment guidelines. Fine tan sediment was found covering the surface of the macrophyte bed along the sampling location. This sampling site is next to the drainage from Big Foot Run Landfill at Stubbs Mill Road, is 2.56 miles downstream from the city of Morrow, and the mouth of Todd Fork. The landfill has been closed since 1996 and no sludge has been applied to promote ground cover. Sediments from Todd Fork were very high in ammonia contamination, which may have contributed to the ammonia at RM 35.98. Gravel mining operations are located along the flood plain downstream from Morrow and farming operations are also located in the uplands along this area.

The trend in elevated sediment ammonia and phosphorus continued at Little Miami River RM 29.0 downstream from Lebanon and Mason. Sediment ammonia (200 mg/kg) and phosphorus (2020 mg/kg) levels were above the Ontario sediment guidelines. None of the metals parameters were found to be above Ohio EPA or MacDonald guidelines. No sediment organics were detected in this sample. The Lebanon WWTP discharges at RM 32.12 and has had 11 suspended solid violations between 2003 and 2007.

The most downstream sediment site on the Little Miami mainstem was at RM 13.07 near Wooster Pike in Milford. There were few fine grained sediments (10.8%) in the sample, but the sediment phosphorus concentration was 2010 mg/kg, over the Ontario sediment guidelines. No metals or other nutrient parameters exceeded the guidelines. Sediment organic analysis detected fluoranthene at 0.68 mg/kg, over the MacDonald threshold effect concentration during which adverse affects frequently occur.

Turtle Creek

Turtle Creek at RM 6.23 (Glosser Rd) is in an urban stream with bricks, asphalt and urban debris present in the streambed. The sediment phosphorus concentration was 2100 mg/kg, over the Ontario sediment guideline. No metals or other nutrients exceeded the Ohio or MacDonald guidelines. The sediment organic analysis detected 10 different polyaromatic hydrocarbons for a total PAH concentration of 15.68 mg/kg. This level of total PAH is over the MacDonald threshold effect concentration (adverse affects frequently occur). This group of PAH compounds are frequently associated with asphalt and coal tar sealing materials.

Turtle Creek at RM 0.52 (SR 48 Bridge) is near the South Lebanon well field. No sediment nutrients were found to be above the Ontario sediment guidelines and

no sediment organics were detected. Sediment calcium (151,000 mg/kg) and magnesium (29,300 mg/kg) were detected over the Ohio Sediment Reference value. Magnesium and calcium are components of dolomitic limestone which is mined in the area. Fugitive emissions from the local limestone quarry may be a suspected source.

Dry Run
Dry Run at RM 1.79 flows under Main Street in South Lebanon. No sediment nutrients were found to be above the Ontario sediment guidelines and no sediment organics were detected. Calcium (98,700 mg/kg) was detected in the sediments over the Ohio Sediment Reference value. This site is 0.5 miles east of the Turtle Creek RM 0.52 site and is also downwind of the limestone quarry.

Muddy Creek
Sediment collected in Muddy Creek was upstream of a natural debris dam that allowed good sediment deposition which resulted in the collection of 48.1% fine grained material in the sample. The site was downstream from the Mason WWTP discharge. Freshly deposited sediment was grey overlying a black anoxic zone. No sediment metals or nutrients were detected over the Ohio or MacDonald sediment guidelines. The sediment organic analysis detected 9 different polyaromatic hydrocarbons for a total PAH concentration of 9.01 mg/kg. This level of total PAH is over the MacDonald threshold effect concentration (adverse effects frequently occur). This group of PAH compounds are frequently associated with asphalt and coal tar sealing materials. Mason-Morrow Milgrove Road was blacktopped earlier in the field season.

O'Bannon Creek
The O'Bannon Creek WWTP discharges to O'Bannon Creek 2.3 miles upstream of this site. Solids from the WWTP were found in the creek downstream of the outfall and the sampling site. The levels of elevated sediment ammonia and phosphorus observed in the Little Miami River mainstem are similar at this site. Sediment ammonia (160 mg/kg) and phosphorus (3650 mg/kg) were above the Ontario sediment guidelines. No other parameters exceeded Ohio EPA or MacDonald guidelines. No sediment organics were detected in this sample. In 1998 sediment phosphorus at this site was 2940 mg/kg, ammonia was 31 mg/kg, and COD was 100,000 mg/kg.

Plant bypasses due to rain events were documented 26 times from 2003 to 2007. In 2007, six bypasses were documented by March 26 but no bypasses were documented in the late spring, summer and fall. Median nutrient sludge values for O'Bannon Creek WWTP were 29,482 mg/kg for phosphorus and 1630 mg/kg for ammonia.

East Fork Little Miami River
East Fork Little Miami River at RM 0.77 has a drainage area of 498 square miles. The Harsha Lake reservoir is 19.7 miles upstream from the sediment sampling

location, and catches sediments behind the dam. The drainage area downstream of the dam has a large flood plain. Stream sediment was a tan sandy clay. No metals were found to be over the Ohio or MacDonald sediment guidelines. The sediment organic analysis detected two polyaromatic hydrocarbons (fluoranthene and Pyrene) for a total PAH concentration of 1.38 mg/kg. Both PAH compounds are over the MacDonald threshold effect concentration (adverse affects frequently occur). No sediment nutrients were over the Ontario sediment guidelines. Sediment phosphorus was high (1800 mg/kg) but below the MacDonald sediment guideline. The Milford WWTP has a discharge at RM 1.61 on East Fork of Little Miami River. The sampling location was downstream from the Milford WWTP. No bypasses were reported from 2003-2007.

Table 15. Concentrations (mg/kg unless otherwise noted) of metals and nutrients in sediment samples collected in the mainstem of Little Miami River (WAU 05090202) during 2007. Parameter concentrations were evaluated based on Ohio EPA sediment metal reference sites (2003), MacDonald (2000) Sediment Quality Guidelines (SQG) and Persuad (1993). Values above guidelines are highlighted.

Parameter	Little Miami River Mainstem River Mile (Ecoregion)						***Reference***	
	50.25 (ECBP)	43.76 (IP)	38.50 (IP)	35.98 (IP)	29.00 (IP)	13.07 (IP)		
							Ohio SRV ECBP / IP	**MacDonald** TEC -PEC
Al-T [O]	4120	4870	1880	4380	6380	2980	39000 / 28000	*
As-T [OM]	2.67	3.06	4.08	3.64	3.79	3.00	18 / 11	9.79-33
Ba-T [O]	59.5	61.6	32.6	52.7	59.5	32.9	240 / 170	*
Ca-T [O]	64500	55000	65900	69100	62100	53800	120000 / 94000	*
Cd-T [OM]	0.150	0.149	<0.082	<0.126	0.134	0.088	0.9 / 0.3	0.99-4.98
Cr-T [OM]	<13	<19	<12	<19	<16	<10	40 / 30	43.4-111
Cu-T [OM]	9.5	9.5	<4.1	<6.3	9.8	6.2	34 / 25	31.6-149
Fe-T [O]	8930	10000	8350	11100	12600	8350	33000 / 31000	*
Hg-T [OM]	<0.037	<0.038	<0.025	<0.032	0.029	0.050	0.12	0.18-1.06
K-T [O]	<896	<1260	<822	<1260	<1090	<636	11000 / 5900	*
Mg-T [O]	14200	11600	11000	10800	11400	8800	35000 / 20000	*
Mn-T [O]	370	416	502	425	453	382	780 / 1400	*
Na-T *	<2240	<3140	<2050	<3140	<2730	<1590	*	*
Ni-T [OM]	<18	<25 ?	<16	<25 ?	<22	<13	42 / 33	22.7-48.6
Pb-T [OM]	8.34	9.62	3.99	8.30	11.9	24.5	47	35.8-128
Se-T [O]	<0.90	<1.26	<0.82	<1.26	<1.09	<0.64	2.3 / 1.6	*
Sr-T [O]	76	75	111	107	104	91	390 / *	*
Zn-T [OM]	40.2	44.5	22.7	38.8	51.8	34.6	160 / 100	121-459
							Ohio	**Persuad**
NH_3-N [P]	84	49	41	200 [L]	240 [L]	73	*	100
TOC(%) [P]	4.4	4.3	2.6	4.1	4.5	2.7	*	10.0%
pH (SU) *	7.6	7.6	8.2	7.6	7.5	7.8	*	*
P-T [P]	860	1090	1060	2980▲	2020▲	2010▲	*	2000
%FGM [O]	38.6	39.6	2.5↘	21.1↘	28.8↘	10.8↘	30.0%	*

↘ Below the goal of 30% Fine Grain Material in sample
%FGM Percent Fine Grain Material in sediment sample (<60 micron or >30 seconds settling time)
NA Compound not analyzed. * Not evaluated
[O] Evaluated by Ohio EPA (2003) [M] Evaluated by MacDonald (2000)
[P] Evaluated by Persuad (1993)
? Detection limit is greater than guideline

Ohio Sediment Reference Values (SRV) Guidelines (2003)
+ above reference value for ecoregion

Ontario Sediment Guidelines (Persuad 1993)
L > Open Water Disposal Guidelines; equivalent to the Lowest Effect Level (LEL)-applicable to NH_3-N only.
▲ > severe effect level (disturbance in benthic community can be expected)

MacDonald (2000) Sediment Quality Guidelines (SQG)
**>** TEC (Threshold effect concentration) and ≤ PEC (Probable effect concentration)
Adverse effects frequently occur
■ > PEC (Probable effect concentration) -- Adverse effects usually or always occur

Table 16. Concentrations (mg/kg unless otherwise noted) of metals and nutrients in sediment samples collected in Turtle Creek, Dry Run, Muddy Creek, O'Bannon Creek, and the East Fork Little Miami River during 2007. Parameter concentrations were evaluated based on Ohio EPA sediment metal reference sites (2003), MacDonald (2000) Sediment Quality Guidelines (SQG) and Persuad (1993). Values above guidelines are highlighted.

Parameter	Stream River Mile (Ecoregion)						***Reference***	
	Turtle Cr 6.23	Turtle Cr 0.52	Dry Run 1.79 (IP)	Muddy 0.54 (IP)	O'Bannon 0.26 (IP)	EFKLMR 0.77	**Ohio SRV** ECBP / IP	**MacDonald**
Al-T ^{O}	7400	2660	4710	6380	9000	5220	39000 / 28000	*
As-T ^{OM}	4.90	4.16	6.83	5.16	3.12	3.75	18 / 11	9.79-33
Ba-T ^{O}	78.8	30.0	54.3	69.0	68.7	38.9	240 / 170	*
Ca-T ^{O}	68200	151000	98700 +	65600	32600	38000	120000 /	*
Cd-T ^{OM}	0.255	0.186	0.116	0.182	0.154	0.139	0.9 / 0.3	0.99-4.98
Cr-T ^{OM}	<19	<12	<12	<15	<21	<13	40 / 30	43.4-111
Cu-T ^{OM}	16.5	4.7	7.0	24.6	19.3	10.9	34 / 25	31.6-149
Fe-T ^{O}	16800	8670	16000	14200	16100	12500	33000 / 31000	*
Hg-T ^{OM}	0.042	<0.027	<0.029	0.027	0.038	<0.032	0.12	0.18-1.06
K-T ^{O}	<1280	<807	<776	<1000	1540	<862	11000 / 5900	*
Mg-T ^{O}	14700	29300 +	6260	17300	6130	7790	35000 / 20000	*
Mn-T ^{O}	541	590	589	662	582	544	780 / 1400	*
Na-T *	<3200	<2020	<1940	<2510	<3540	<2150	*	*
Ni-T ^{OM}	<26 ?	<16	<16	<20	<28 ?	<17	42 / 33	22.7-48.6
Pb-T ^{OM}	22.7	7.43	14.9	14.9	16.9	16.0	47	35.8-128
Se-T ^{O}	<1.28	<0.81	<0.78	<1.00	<1.42	<0.86	2.3 / 1.6	*
Sr-T ^{O}	99	169	208	97	82	71	390 / *	*
Zn-T ^{OM}	78.1	21.2	30.1	95.6	75.4	46.5	160 / 100	121-459
							Ohio	**Persuad**
NH_3-N ^{P}	69	55	38	80	160 ^{L}	78	*	100
TOC(%) ^{P}	4.2	5.1	4.3	3.9	4.5	2.7	*	10.0%
pH (SU)	NA	7.6	7.4	7.7	7.5	7.7	*	*
P-T ^{P}	2100▲	670	1620	533	3650▲	1800	*	2000
%FGM ^{O}	60.8	14.8↘	15.9↘	48.1	44.3	33.2	30.0%	*

↘ Below the goal of 30% Fine Grain Material in sample
%FGM Percent Fine Grain Material in sediment sample (<60 micron or >30 seconds settling time)
NA Compound not analyzed.
^{O} Evaluated by Ohio EPA (2003)
^{P} Evaluated by Persuad (1993)
? Detection limit is greater than guideline
* Not evaluated
^{M} Evaluated by MacDonald (2000)

Ohio Sediment Reference Values (SRV) Guidelines (2003)
+ above reference value for ecoregion

Ontario Sediment Guidelines (Persuad 1993)
L > Open Water Disposal Guidelines; equivalent to the Lowest Effect Level (LEL)-applicable to NH_3-N only.
▲ > severe effect level (disturbance in benthic community can be expected)

MacDonald (2000) Sediment Quality Guidelines (SQG)
**>** TEC (Threshold effect concentration) and ≤ PEC (Probable effect concentration) Adverse effects frequently occur
■ > PEC (Probable effect concentration) -- Adverse effects usually or always occur

Stream Physical Habitat

Stream habitat was evaluated at 44 fish sampling locations throughout the lower Little Miami River study area, excluding the Todd Fork subwatershed (Table 17). Within the lower Little Miami River mainstem, the sites were predominated by high quality bottom substrates, including cobble, gravel, boulder, bedrock, and sand. Good to excellent stream habitat was recorded at all sites (100%) on the lower Little Miami River mainstem and East Fork Little Miami River. The average Qualitative Habitat Evaluation Index (QHEI) score for the lower Little Miami River mainstem was 85.0, reflecting the overall excellent habitat quality. However, the lack of a riffle at the lower East Fork Little Miami River site (RM 1.2) diminished the habitat available to many pollution sensitive fish and macroinvertebrate species.

Fair to good habitat was noted at all lower Little Miami River tributary streams (excluding the Todd Fork subwatershed) except for Duck Creek (Table 17). The upper reach of Duck Creek (RM 3.36) received a QHEI of 24.5 (very poor). It was a concrete channel used as a conveyance for storm water and CSOs (Figure 32). The lower site on Duck Creek (RM 1.3) received a QHEI of 36.0 (poor). It had only sparse areas of instream habitat and poor channel development combined with effects of the upstream and adjacent CSOs. The tributary streams of the lower Little Miami River subwatershed - excluding Duck Creek - had an average QHEI of 60.9, which was consistent with fair to good overall habitat quality.

Figure 32. The concrete-lined portion of Duck Creek at Rosslyn Drive (RM 3.36), 2007.

Table 17. Stream physical habitat (QHEI) summarized results for the lower Little Miami River study area excluding the Todd Fork subwatershed, 2007. The East Fork Little Miami River site at Milford Parkway (RM 2.3) was evaluated in 2008.

Stream and Location	River Mile	Drainage (mi^2)	QHEI	Comments
EXCELLENT				
Little Miami River @ Jacoby Road, dst. Yellow Springs Cr.	83.14	118.0	77.5	
Little Miami River @ Spring Valley roadside park	63.3	360.0	83.0	
Little Miami River @ Corwin Rd. upstream Waynesville WWTP	54.3	395.0	82.0	
Little Miami River adj. Corwin Rd. dst. Waynesville WWTP	53.15	402.0	80.5	
Little Miami River @ Shaw property ust. Caesar's Creek	51.2	413.0	90.0	
Little Miami River @ Middletown Rd.	50.25	658.0	85.0	
Little Miami River @ SR 350	43.76	680.0	87.0	
Little Miami River dst .Todd Fork & SR 123	38.50	949.0	82.5	
Little Miami River @ Stubbs Mill Road	35.98	964.0	91.5	
Little Miami River ust. Peter's Cartridge	31.5	1050.0	89.5	
Little Miami River adj. Peter's Cartridge	30.5	1054.0	85.5	
Little Miami River dst. Peter's Cartridge	29.0	1059.0	85.0	
Little Miami River dst. Simpson Creek	27.9	1069.0	91.0	
Little Miami River ust. O'Bannon Creek	24.10	1085.0	81.0	
Little Miami River adj. Loveland-Kemper Road	22.30	1150.0	79.5	
Little Miami River @ Branch Hill New Guinea Road	21.5	1161.0	89.5	
Little Miami River adj. Lake Isabella	20.6	1161.0	88.5	
Little Miami River @ canoe access area dst. SR 126	17.7	1187.0	86.5	
Little Miami River @ Wooster Pike Milford gage	13.07	1203.0	90.5	
Little Miami River @ Newtown Road	8.14	1713.0	85.5	
Turtle Creek @ Glosser Rd.	6.23	21.3	70.0	
Muddy Creek dst. Mason WWTP	0.54	15.2	74.0	
O'Bannon Creek @ O'Bannonville Road	1.84	55.6	75.5	
Sycamore Creek at mouth, dst. Sycamore Creek WWTP	0.1	23.3	76.5	
GOOD				
Little Miami River @ Beechmont Road	3.5	1744.0	73.5	
Turtle Creek @ McClure Rd.	4.85	30.0	65.0	

Stream and Location	River Mile	Drainage (mi^2)	QHEI	Comments
Turtle Creek @ US 48	0.52	58.0	61.0	
Dry Run @ Snook Road	1.79	4.2	55.0	
Little Muddy Creek @ SR 42	1.02	20.2	52.0	
Muddy Creek ust. Mason WWTP	2.5	10.2	62.5	
O'Bannon Creek @ SR 132	8.27	14.3	56.0	No riffle
O'Bannon Creek @ SR 48	0.26	59.0	60.0	
Sycamore Creek adj. Loveland Rd, dst. tributary	1.10	10.4	63.5	
Sycamore Creek dst. North Fork Sycamore Creek	0.50	20.7	69.5	Concrete along right downstream bank.
East Fork Little Miami River @ Milford Parkway	2.3	494.0	73.5	
East Fork Little Miami River @ curve dst. Milford WWTP	1.2	498.0	66.0	
Clough Creek @ SR 125	0.42	8.3	55.0	
FAIR				
Turtle Creek @ East Street	7.43	12.3	47.5	Nearly absent instream cover due to interstitial conditions.
Dry Run @ Main St., S. Lebanon	0.18	7.3	50.0	Intermittent
Little Muddy Creek @ Hamilton Road	3.22	11.7	44.0	Poor channel development
O'Bannon Creek @ Linton Road	10.14	8.1	48.5	Intermittent with no riffle and poor channel development
O'Bannon Creek @ Gibson Road	4.37	28.1	54.0	No riffle and poor channel development
POOR				
Duck Creek @ park at the end of Hutton Road	0.95	15.1	36.0	Sparse instream cover and poor channel development
VERY POOR				
Duck Creek @ Rosslyn Drive	3.36	7.3	24.5	No riffle, concrete-lined channel.

General narrative ranges assigned to QHEI scores.

Narrative Rating	QHEI Range	
	Headwaters (≤20 sq mi)	Larger Streams
Excellent	≥70	≥75
Good	55 to 69	60 to 74
Fair	43 to 54	45 to 59
Poor	30 to 42	30 to 44
Very Poor	<30	<30

Fish Community

Fish Biocriteria Full Attainment

Watershed: 88%
Little Miami River: 96%
Tributaries: 84%

A total of 182,938 fish representing 83 species were collected from the lower Little Miami River watershed between July and October, 2007 and 2008. Relative numbers and species collected per location are presented in Appendix Table A-15. IBI and MIwb scores are presented in Appendix Tables A-12, A-13, and A-14. Sampling locations were evaluated using either Warmwater Habitat (WWH) or Exceptional Warmwater Habitat (EWH) biocriteria. A summary of the fish data are presented in Table 18 for the lower Little Miami River watershed excluding the Todd Fork subwatershed, while the summary fish data for the Todd Fork subwatershed is presented in Table 29 in the Todd Fork subwatershed section of this report.

Lower Little Miami River watershed sites sampled during 2007 and 2008 achieved the applicable fish biocriterion at 69 of the 78 sites evaluated (88%). Two sites were partially achieving the biocriterion. Seven sites were not achieving the applicable biocriterion, representing 9% of the watershed sites.

The Little Miami River is designated EWH and the fish community was in full attainment at all but the most downstream location along Beechmont Road (RM 3.5), which received an IBI of 36 and MIwb of 9.7 (Table 18). Therefore, 61.5 miles of the Little Miami River were fully achieving EWH biocriteria and 0.5 miles were partially meeting the EWH use. The lower three miles of the Little Miami River are designated WWH and were not sampled as part of this study. The average IBI and MIwb scores for the fully attaining sites within this reach were 52 and 10.7, respectively.

Twenty miles upstream from the fully attaining reach, one additional site was sampled along Jacoby Road (RM 83.14). The fish community fully met EWH expectations (IBI=48 and MIwb=9.8), though during the second sampling event the northern hog suckers appeared emaciated. As they are insectivorous, their emaciated condition may reflect low reproduction in the aquatic macroinvertebrate community. In addition, insectivorous fish comprised only 38% of the fish community in 2007 at this site. In years past, insectivorous fish comprised between 51% and 85% of the fish community.

Fish community evaluations, based on IBI and MIwb scores, are provided in Figure 33. Descriptive evaluations allow for the comparison of fish communities from site to site. The lower Little Miami River mainstem is shown to score in the exceptional category at all but the most downstream site near Beechmont Road (RM 3.5) which scored within the marginally good category. Six tributary sites also scored within the exceptional category, and fifteen of the sites met the designated ALU of WWH or CWH (Table 18 and Figure 33). Sites that were scored within the good and marginally good categories would meet WWH biocriterion for fish.

The East Fork Little Miami River was sampled upstream (RM 2.3) and downstream (RM 1.2) of the Milford WWTP. The upstream location fully met EWH expectations with an IBI of 52 and MIwb of 10.4. The downstream location

received an IBI of 43 and MIwb of 9.7, which did not meet EWH expectations. Thirty-six species including six darter species were collected at the upstream location, while twenty-five species with only one darter species were collected at the downstream location. The lack of diverse darter species at the downstream location is likely attributable to the poorer riffle quality compared to the upstream location. However, in the presence of suitable water quality, some darter species may be found to persist though habitat conditions that are less than ideal. The complete absence of any riffle species in the downstream location indicates that the effects of poor habitat may be exacerbated by poor chemical water quality.

A total of eight small tributary streams (21 sites) within the lower Little Miami River subwatershed were sampled during 2007. Five of these streams were fully achieving the applicable IBI biocriterion for fish. The fish communities at the downstream site on Dry Run (RM 0.18) and the most upstream site on O'Bannon Creek (RM 10.14) appeared to be impaired by low flow conditions, with the former site receiving an IBI of 26 and the latter site receiving an IBI of 32. Duck Creek, which is designated Limited Resource Water (LRW) in its upper reach, did not meet the appropriate LRW or WWH biocriterion at either sampling location. The site on Duck Creek near Rosslyn Drive (RM 3.36) received an IBI of 12 as a direct result the habitat alterations. The stream is a concrete channel designed to convey CSOs and other urban discharges. The site at Hutton Road received an IBI of 20 as a result of the organic and nutrient enrichment from the surrounding CSOs.

Several Ohio endangered (E), threatened (T), rare (R) or special concern (S) fish species were collected within the study area and included; mountain madtom (E), northern madtom (E), mooneye (R), river redhorse (S), and muskellunge (S). Fish species collected which are sensitive to water pollution included mooneye, black redhorse, river redhorse, hornyhead chub, river chub, silver shiner, rosyface shiner, mimic shiner, stonecat madtom, northern madtom, mountain madtom, slenderhead darter, variegate darter and banded darter. The presence of these species indicates a diverse community and reflect generally good habitat. However, the central stoneroller minnow comprised 41.6% of the total fish collected, indicating that nutrient enrichment continues to plague the lower Little Miami River watershed (including the Todd Fork subwatershed) in several locations.

Table 18. Fish community status for stations sampled in the lower Little Miami River basin excluding the Todd Fork subwatershed, based on data collected July-October 2007. The site on East Fork Little Miami River at Milford Parkway (RM 2.3) was electrofished in 2008. The Index of Biotic Integrity (IBI) and Modified Index of well being (MIwb) are scores based on the performance of the fish community. The fish evaluation (Exceptional, Very Good, etc.) were based upon the corresponding IBI and MIwb relative to the drainage area, ecoregion, and the assigned ALU. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biotic community

Location	River Mile	Drain. (mi^2)^	Species (Total)	Relative Number	Relative Weight (Kg)	IBI	MIwb[a]	QHEI
Exceptional								
Little Miami River @ Spring Valley roadside park	63.3	360.0[B]	34	1,090.0	157.6	56	10.2	83.0
Little Miami River @ Corwin Rd. upstream Waynesville WWTP	54.3	395.0[B]	35	680.0	169.7	54	11.0	82.0
Little Miami River adj. Corwin Rd. dst. Waynesville WWTP	53.15	402.0[B]	38	590.0	115.8	51	10.8	80.5
Little Miami River @ Middle town Road	51.2	413.0[B]	34	677.8	149.3	54	10.6	90.0
Little Miami River @ Shaw property dst. Caesar Creek	50.25	658.0[B]	33	990.0	210.4	52	11.3	85.0
Little Miami River @ SR 350	43.76	680.0[B]	39	660.0	143.3	53	10.8	87.0
Little Miami River dst .Todd Fork & SR 123	38.50	949.0[B]	37	704.0	190.5	54	11.4	82.5
Little Miami River @ Stubbs Mill Road	35.98	964.0[B]	43	821.0	172.6	57	10.8	91.5
Little Miami River @ US 48	32.9	1035.0[B]	29	672.0	92.4	52	10.1	--
Little Miami River ust. Peter's Cartridge	31.5	1050.0[B]	40	925.0	245.5	51	11.3	89.5
Little Miami River adj. Peter's Cartridge	30.5	1054.0[B]	42	849.0	290.0	54	11.5	85.5
Little Miami River dst. Peter's Cartridge	29.0	1059.0[B]	41	680.8	234.2	54	11.0	85.0
Little Miami River dst. Simpson Creek	27.9	1069.0[B]	37	813.0	197.3	54	11.3	91.0
Little Miami River ust. O'Bannon Creek	24.10	1085.0[B]	31	410.0	85.5	50	10.2	81.0
Little Miami River adj. Loveland-Kemper Road	22.30	1150.0[B]	36	756.0	71.5	53	9.8	79.5
Little Miami River @ Branch Hill New Guinea Road	21.5	1161.0[B]	43	719.0	199.1	50	11.2	89.5
Little Miami River adj. Lake Isabella	20.6	1161.0[B]	42	798.0	75.1	56	10.4	88.5
Little Miami River @ canoe access area dst. SR 126	17.7	1187.0[B]	37	800.0	180.8	52	11.2	86.5
Little Miami River @ Wooster Pike Milford gage	13.07	1203.0[B]	37	784.4	134.7	51	10.2	90.5
Little Miami River @ Newtown Road	8.14	1713.0[B]	39	600.0	148.1	52	10.2	85.5
Muddy Creek ust. Mason WWTP	2.5	10.2[H]	21	3,426.0	N/A	52	N/A	62.5
Muddy Creek dst. Mason WWTP	0.54	15.2[H]	27	8,046.0	N/A	54	N/A	74.0
O'Bannon Creek @ O'Bannonville Road	1.84	55.6[W]	31	6,763.5	89.0	55	10.4	75.5
O'Bannon Creek @ SR 48	0.26	59.0[W]	36	4,962.8	58.1	51	10.3	60.0
Sycamore Creek at mouth, dst. Sycamore Creek WWTP	0.1	23.3[W]	34	2,093.0	33.9	54	9.4	76.5

Location	River Mile	Drain. (mi²)^	Species (Total)	Relative Number	Relative Weight (Kg)	IBI	MIwb[a]	QHEI
East Fork Little Miami River @ Milford Parkway	2.3	494.0[B]	36	604.0	124.0	52	10.4	73.5
Very Good								
Little Miami River @ Jacoby Road, dst. Yellow Springs Cr.	83.14	118.0[W]	30	2,386.8	132.2	48	9.8	77.5
Little Muddy Creek @ Hamilton Road	3.22	11.7[H]	22	2,892.0	N/A	48	N/A	44.0
O'Bannon Creek @ Gibson Road	4.37	28.1[w]	22	1,283.3	15.2	51	9.2	54.0
Sycamore Creek dst. North Fork Sycamore Creek	0.50	20.7[w]	29	2,005.0	29.0	54	8.9	69.5
Good								
Turtle Creek @ East Street	7.43	12.3[H]	13	379.5	N/A	40	N/A	47.5
Turtle Creek @ Glosser Rd.	6.23	21.3[w]	29	2,969.3	10.08	44	8.5	70.0
Turtle Creek @ McClure Rd.	4.85	30.0[w]	31	9,827.3	261.5	41	8.6	65.0
Turtle Creek @ US 48	0.52	58.0[w]	29	2,748.6	11.1	48	8.2	61.0
Dry Run @ Snook Road	1.79	4.2[H]	15	3,184.5	N/A	45	N/A	55.0
O'Bannon Creek @ SR 132	8.27	14.3[H]	15	1,706.0	N/A	44	N/A	56.0
Sycamore Creek adj. Loveland Rd, dst. tributary	1.10	10.4[H]	8	8,196.0	N/A	40	N/A	63.5
East Fork Little Miami River @ curve dst. Milford WWTP	1.2	498.0[B]	29	523.0	108.1	43	9.7	66.0
Marginally Good								
Little Miami River @ Beechmont Road	3.5	1744.0[B]	26	617.8	259.8	36	9.7	73.5
Little Muddy Creek @ SR 42	1.02	20.2[w]	25	1,821.8	17.5	44	7.6	52.0
Clough Creek @ SR 125	0.42	8.3[H]	8	21,308.0	N/A	38	N/A	55.0
Fair								
O'Bannon Creek @ Linton Road	10.14	8.1[H]	12	2,714.0	N/A	32	N/A	48.5
Poor								
Dry Run @ Main St., S. Lebanon	0.18	7.3[H]	4	193.5	N/A	26	N/A	50.0
Duck Creek @ park at the end of Hutton Road	0.95	15.1[H]	9	632.0	N/A	20	N/A	36.0
Very Poor								
Duck Creek @ Rosslyn Drive	3.36	7.3[H]	1	6.0	N/A	12	N/A	24.5

a - MIwb is not applicable to headwater streams with drainage areas $\leq$ 20 mi^2.

^ - Letters in superscript refer to the fish site type and associated biocriteria as indicated in the table below. B = boat; W = wading; and H = headwater.

Biological Criteria

	Eastern Corn Belt Plains			Interior Plateau			
Index – Site Type	**EWH**	**WWH**	**MWH**	**EWH**	**WWH**	**MWH**	**LRW**
IBI – Headwaters	50	40	24	50	40	24	18
IBI – Wading	50	40	24	50	40	24	18
IBI – Boat	48	42	24	48	38	24	16
MIwb – Wading	9.4	8.3	6.2	9.4	8.1	6.2	4.5
MIwb – Boat	9.6	8.5	5.8	9.6	8.7	5.8	5.0

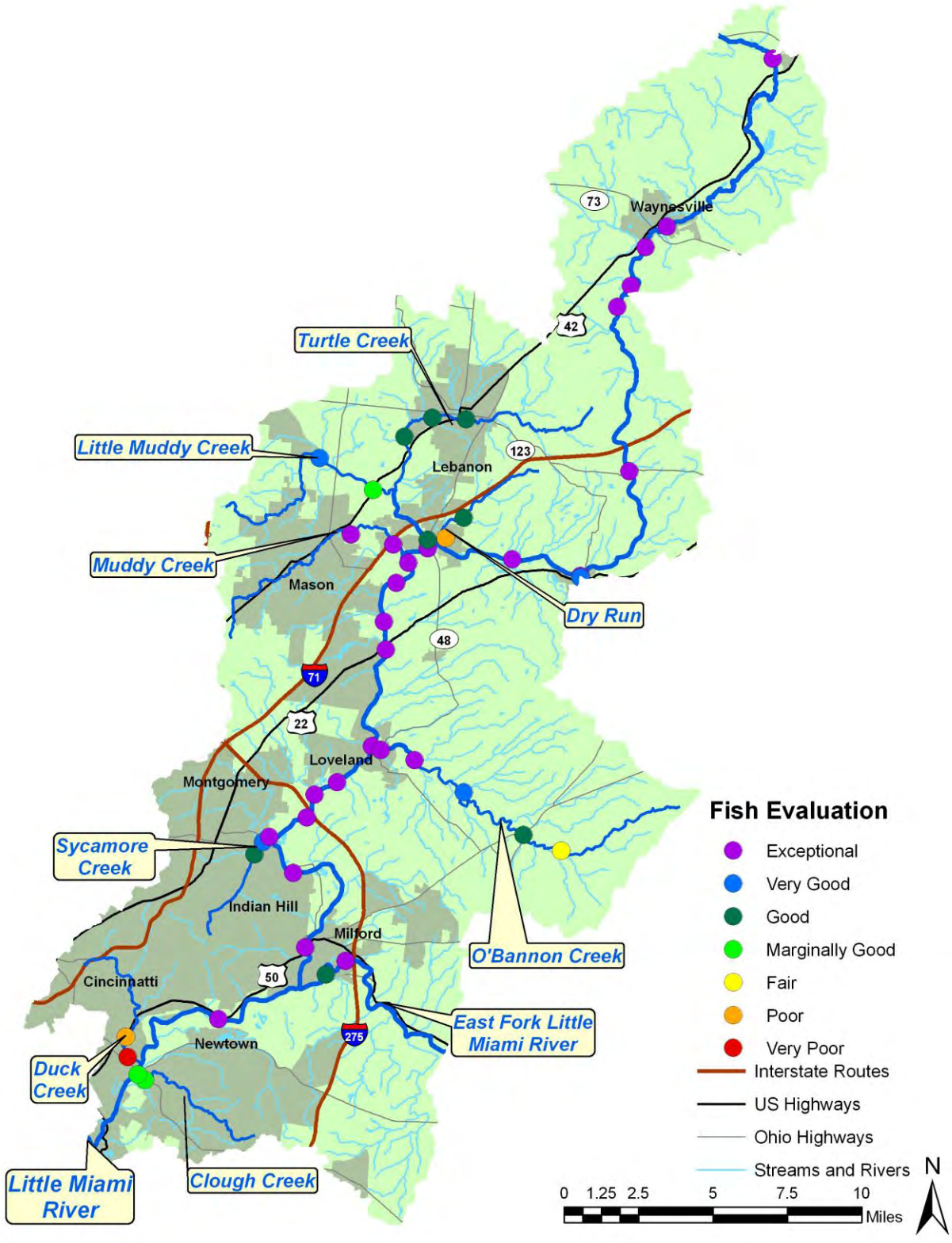


Figure 33. Fish community evaluations from the Lower Little Miami River study area, excluding the Todd Fork subwatershed, 2007-2008.

Fish Community Trends, 1998-2008

The fish community of the lower Little Miami River mainstem had been sampled extensively in 1983, 1993 and 1998. The report based on the 1998 data contains a detailed historical trend analysis through time and may be found at: http://www.epa.state.oh.us/dsw/document_index/psdindx.html (Ohio EPA, 2000). For the purposes of this report, an analysis of fish community performance between 1998 and 2007 is the only historical trend provided.

In 2007, fish community scores of the lower Little Miami River mainstem outperformed 1998 fish community scores in both the IBI and MIwb at nearly all locations (Figure 34). The most downstream location, Beechmont Road (RM 3.5), went below 1998 scores and did not meet EWH expectations with an IBI of 36 and MIwb of 9.7. The drop near Beechmont Road (RM 3.5) was attributed primarily to upstream CSOs and, to a lesser extent, municipal point source discharges.

The following excerpt from the 2000 report discusses the fish community response to organic enrichment, frequent low dissolved oxygen and episodic toxicity common in the lower Little Miami River at that time (Ohio EPA, 2000):

> Relatedly, the proportion of fish with DELTs increases, and, on average, several pollution intolerant species are lost within the reach subject to wastewater loadings. However, unlike the proportions of tolerant and omnivorous fishes, the DELT and Intolerant metrics do not recover to normal levels in the downstream reach. The increase in tolerant and omnivorous fishes with a corresponding loss of intolerant species suggests an acute effect from the cumulative loadings (e.g., organic enrichment, frequent low dissolved oxygen, episodic toxicity). However, the return to a normal trophic structure, but suppressed numbers of intolerant species and elevated occurrence of DELTs, demonstrates a chronic stress such as infrequent and episodically low dissolved oxygen concentrations…

A comparison of the metrics discussed above from both 1998 and 2007 is provided in Figure 35. The number of intolerant species collected in 2007 was well within the expected range between Spring Valley roadside park (RM 63.3) and Newtown Road (RM 8.14). The only area to dip below the expected number of intolerant species was at Beechmont Road (RM 3.5). This is likely a result of the continuing influence of CSOs leading to organic enrichment in the area. The presence of DELTs within the fish community has also decreased greatly compared to 1998. The improved scores of these two metrics reflect the enhanced water quality present in the lower Little Miami River as a result of incorporation of improved wastewater treatment at several WWTPs since 1998.

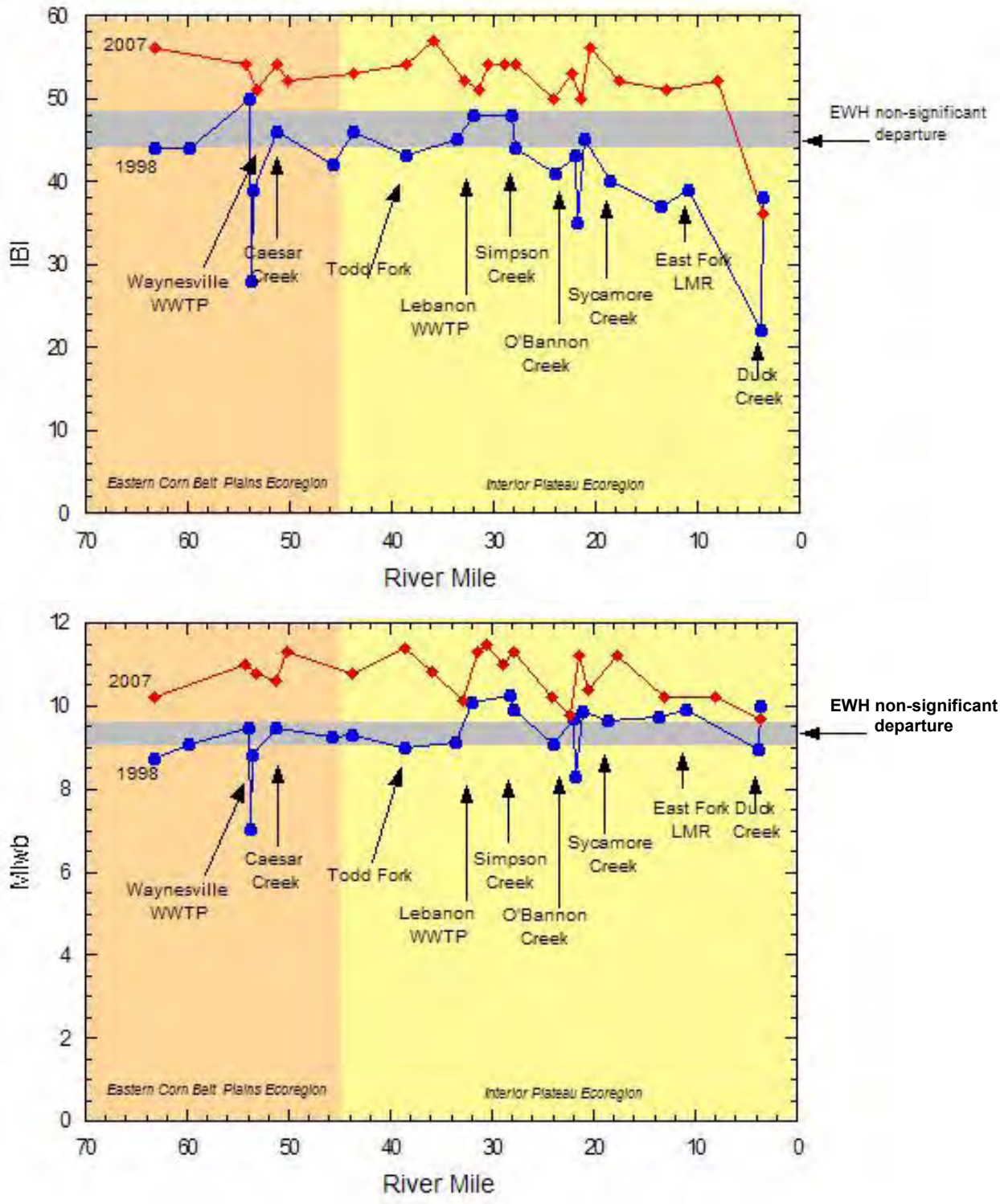


Figure 34. IBI and MIwb scores versus River Mile for the lower Little Miami River mainstem, 1998 and 2007.

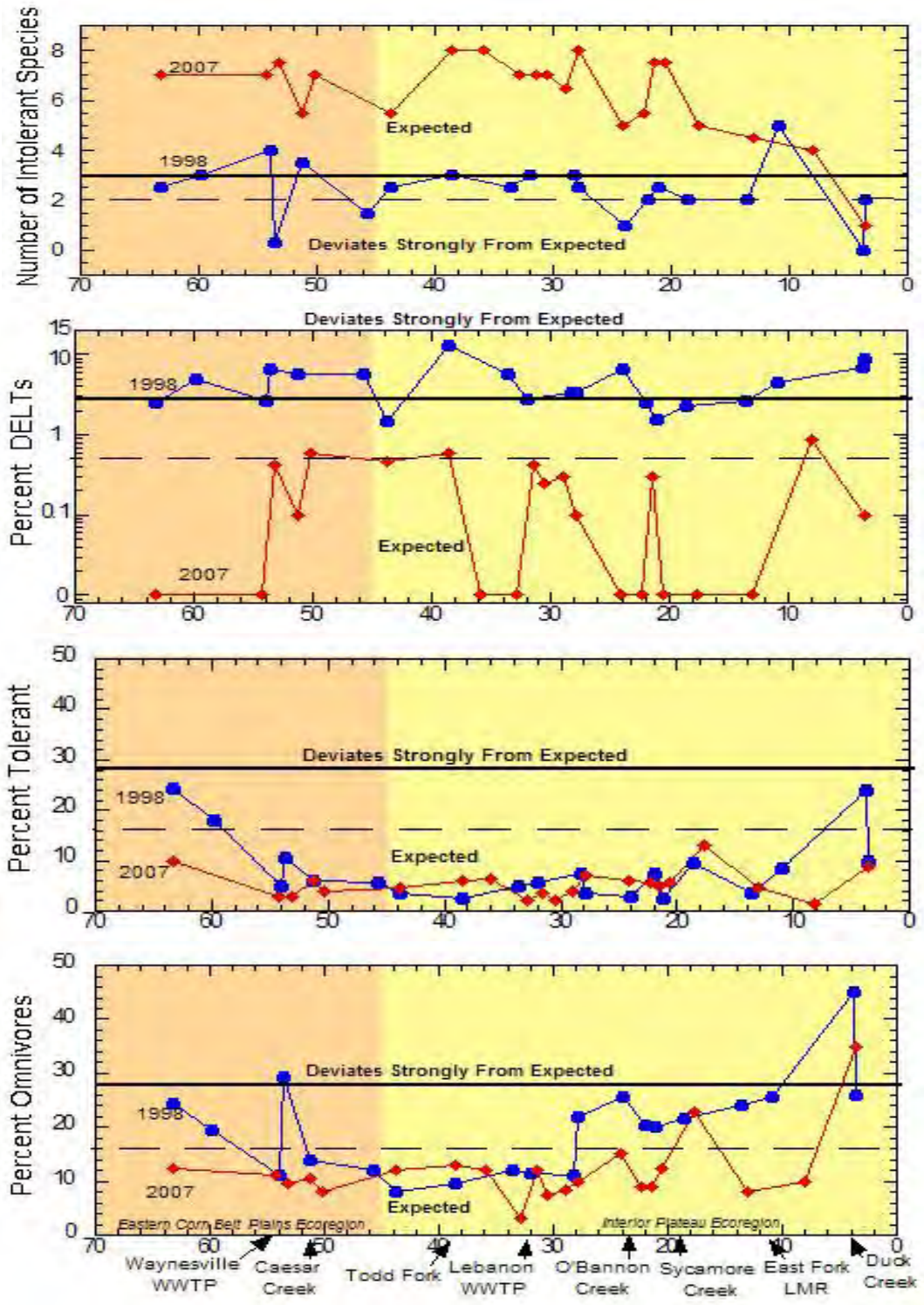


Figure 35. Plots of selected component IBI metrics. From the top, number of intolerant species, percent of fish with DELTs, proportion of pollution tolerant fishes, and proportion of omnivores in electrofishing catches from the lower Little Miami River, 1998 and 2007. Dashed horizontal lines show expected ranges derived from least impacted reference sites.

In addition to improved index scores, the fish community of 2007 realized significant increases in the abundance of several sensitive species since 1998. Slenderhead darters increased from 56 individuals captured in 1998 to 129 individuals in 2007 and also extended their range an additional 9.3 miles upstream, from RM 54.0 to RM 63.3 (Spring Valley, downstream of Glady Run). This upstream movement may reflect the improvements in treatment at several upper watershed WWTPs since 1998. Black redhorse also rebounded in 2007, increasing from 29 individuals captured in 1998 to 446 in 2007. Mountain and northern madtoms, both state endangered species, saw their numbers increase, from only eight mountain madtoms in 1998 to 50 in 2007. Northern madtoms, of which no individuals were captured in 1998, accounted for 27 individuals in 2007. Equal numbers of fish passes were employed in both survey years (37 each), so the increased abundance of these species is a further indication of improved water quality in the Little Miami River. All four species share a common preference for swift current, clear water, and silt-free sand and gravel bottoms (Trautman 1981).

The fish community of Sycamore Creek has been evaluated five times since 1983 (Figure 36). The upper reach of Sycamore Creek, from RM 0.7 to RM 1.4, has maintained consistent IBI scores over time (IBI=38 at RM 0.7 and 1.4 in 1991, and IBI=40 at RM 1.1 in 2007). Further downstream, an 18 to 24-inch high bedrock shelf limited fish migration into this area from the lower portion of Sycamore Creek.

Below the bedrock shelf, the fish community performance surrounding the Hamilton County Sycamore Creek WWTP has improved over time largely as a result of fish community improvements within the Little Miami River mainstem (Figure 34). The dramatic improvement in Sycamore Creek (IBI=54 and MIwb=8.9 and 9.4, respectively, at RMs 0.5 and 0.1 in 2007 from IBI=35 and 36, and MIwb=7.6 and 7.1, respectively, at RMs 0.4 and 0.2 in 1998) mirrors the improvement noted in the Little Miami River mainstem upstream of the confluence with Sycamore Creek (IBI=56 and MIwb=10.4 at RM 20.6 in 2007 from an IBI=45 and MIwb=8.3 at RM 21.1 in 1998). The fish community within the lower half mile of Sycamore Creek is comprised of species abundant in larger streams, such as black redhorse, golden redhorse, northern hog sucker, and emerald shiner. These species were absent or found infrequently at sites above the bedrock shelf.

Problems with inflow and infiltration and inadequate treatment at the Hamilton County Sycamore Creek WWTP have been evident over time. The decline in fish community scores downstream of the confluence with Sycamore Creek in the Little Miami River in 2007 were also present in 1998 (Figure 34). Pollution intolerant species within the Little Miami River dropped from eight species upstream of the Sycamore Creek confluence (RM 20.6) to five species at RMs 17.3, 13.1, and 8.2. The percent of round-bodied suckers also declined longitudinally from comprising 28% of the fish community upstream of the Sycamore Creek confluence (RM 20.6) to 24% at RM 17.3, 15% at RM 13.1, and 14% at RM 8.1. Infrastructure improvements are being undertaken at the facility in 2008 and should result in lower nutrient concentrations and less organic enrichment of the Little Miami River from the Hamilton County Sycamore Creek WWTP.

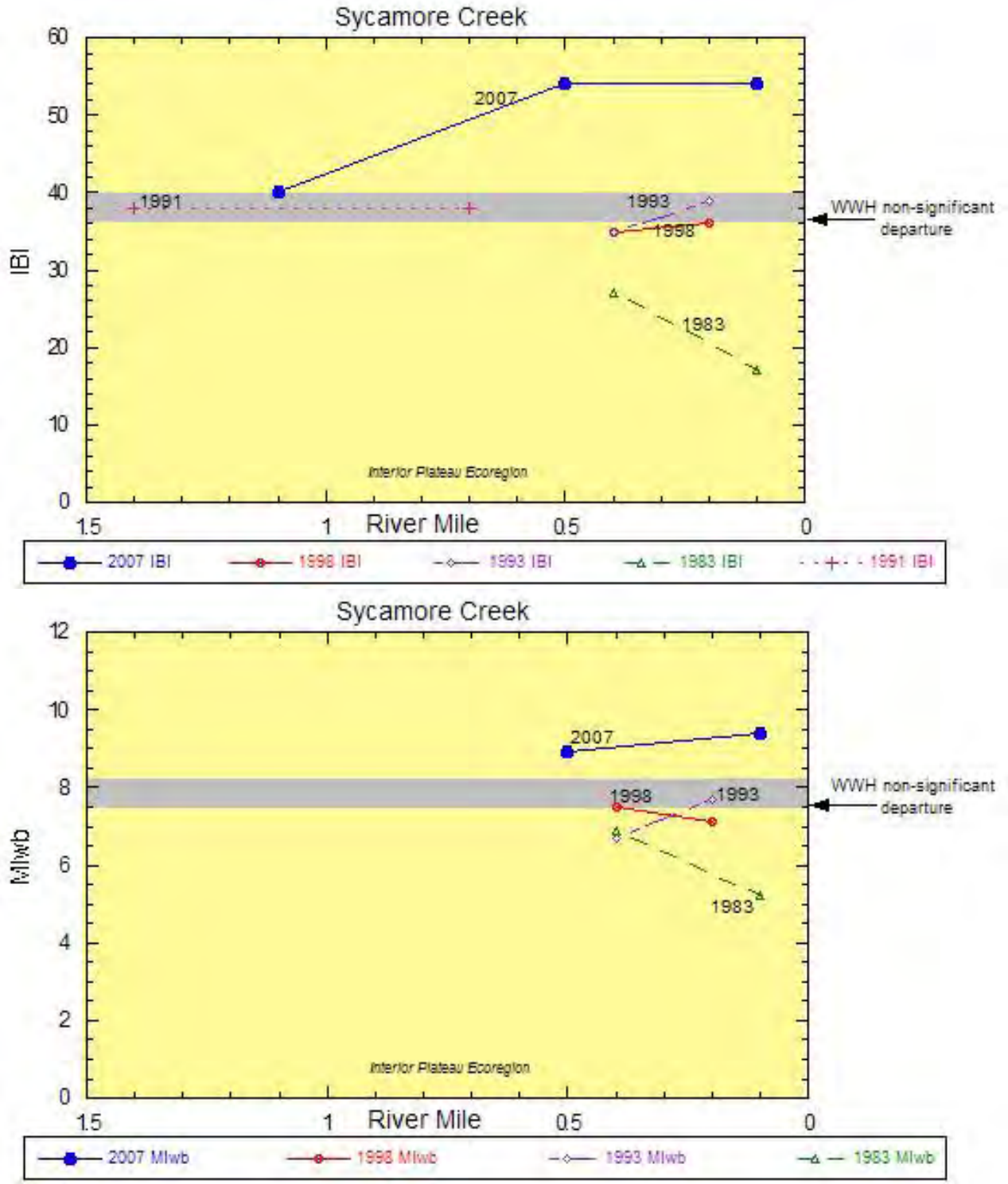


Figure 36. Sycamore Creek IBI and MIwb scores from 1983, 1991, 1993, 1998, and 2007. MIwb does not apply to drainage areas <20mi^2, therefore it was not calculated at sites upstream of RM 0.5.

The fish community within the headwaters of O'Bannon Creek was sampled for the first time in 2007 and directly reflected the habitat conditions present. The habitat received a QHEI of 48.5 and the fish community an IBI of 32 at RM 10.1, both categorized as fair range scores. Poor channel development, surrounding agriculture and encroaching residential areas contributed to the fair habitat present. Further downstream at RM 8.3, yet still within the headwaters, the QHEI of 56 and the IBI of 44 could be categorized as in the good range.

Downstream of RM 8.3, the fish community of O'Bannon Creek historically reflected impacts from the suburbanized landscape from RM 6.5 to the mouth, and nutrient enrichment from the O'Bannon Creek Regional WWTP within the lower three miles of the stream (Figure 37 and Figure 38). Between 1994 and 2001, agricultural lands decreased from 64.7% to 43.6% within the entire O'Bannon Creek watershed. The loss in agricultural lands was attributed to an increase in developed areas, which comprised 5.9% of the land in 1994 and increased to 17.0% in 2001. The remaining shift in land use was due to an increase in non-developed areas (forests, grasslands, and wetlands), which increased from 29.4% in 1994 to 39.2% in 2001 (Table 19). The increase in non-developed areas may have lessened the suburbanization influences on the fish community with the IBI improving from a 44 in 1998 at RM 4.3 to a 51 at RM 4.4 in 2007. In addition, simple lithophils comprised only 22% of the fish community in 1998 at RM 4.3, indicative of an impact from the surrounding suburbanized landscape. In 2007, simple lithophils comprised 52% of the fish community at RM 4.4. However, the continued absence of pollution intolerant species at RM 4.4 suggested that impacts from the surrounding landscape were still present.

The higher IBI scores recorded in the lower two miles during 2004 and 2007 are reflective of improved conditions within the Little Miami River mainstem during this time period (Figure 34). The average IBI score for sites between RMs 27.9 and 21.1 of the Little Miami River improved from IBI=41.6 (n=5) in 1998 to IBI=51.3 (n=4) in 2007.

Table 19. Land use within the O'Bannon Creek watershed based on National Land Cover Datasets, 1994 and 2001.

Land use for the O'Bannon Creek watershed			
Year	**Developed**	**Agricultural**	**Non-developed**
1994	5.9%	64.7%	29.4%
2001	17.0%	43.6%	39.2%

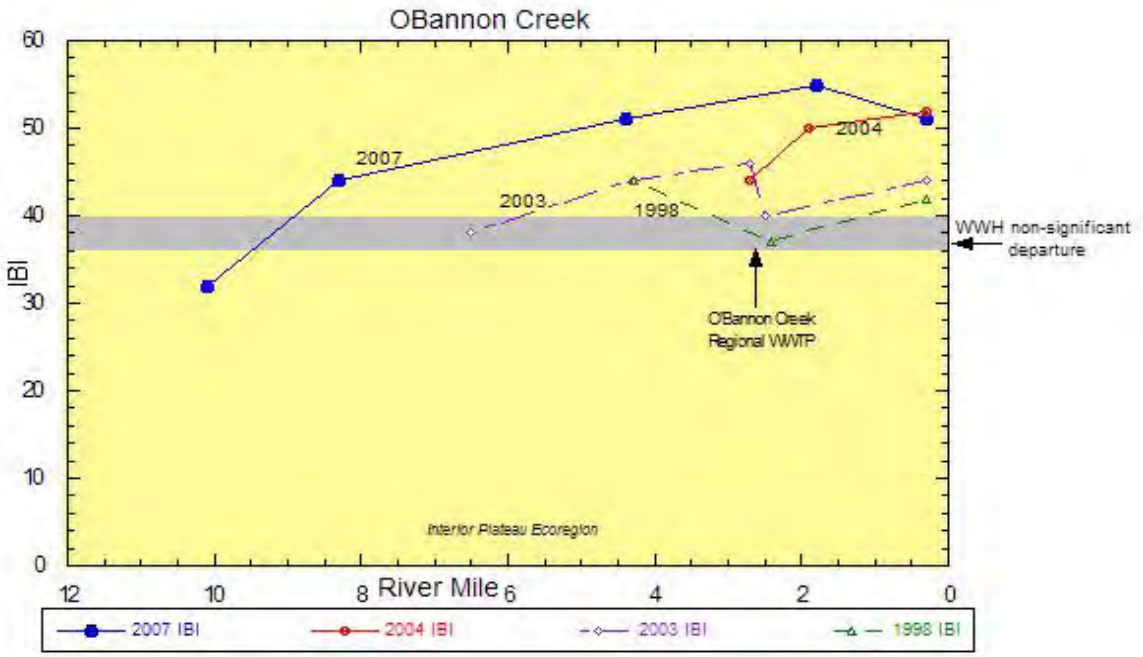


Figure 37. IBI scores for O'Bannon Creek from 1998, 2003, 2004, and 2007.

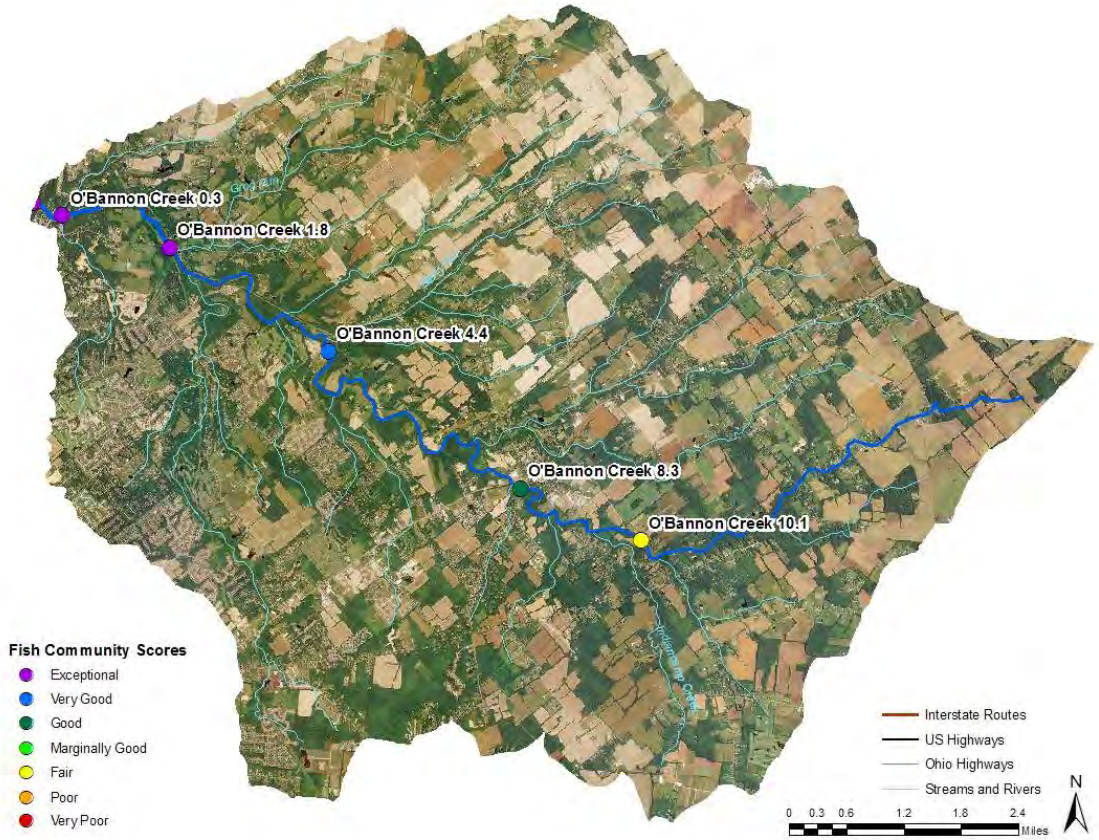


Figure 38. O'Bannon Creek fish community evaluations from 2007 overlaying 2006 aerial photography.

The overall improvement of fish community scores in Muddy Creek - from an average IBI of 36 between RMs 2.5 and RM 0.5 in 1998 to an average IBI of 53 in 2007 - are related to both Mason WWTP improvements and improvements in the aquatic community of the Little Miami River (Figure 39). The improvement in IBI score near RM 2.5 reflected increased species diversity, with 20 (RM 2.5 single pass) species collected in 2007, while only 12 (RM 2.5 average of two passes) species were collected in 1998. The improved diversity included five pollution sensitive fish species in 2007. Only one pollution sensitive species was collected from that location in 1998. Part of the improvement observed at RM 2.5 may be attributed to the relocation of the Mason WWTP from RM 3.3 to RM 2.3 in 2006.

The higher IBI score recorded near RM 0.5, from an IBI of 42 in 1998 to an IBI of 54 in 2007, is partially attributed to the improved conditions within the Little Miami River mainstem during this time period (Figure 34). The average IBI score for sites between RMs 30.5 and 32.1 of the Little Miami River improved from 48 (n=2) in 1998 to 52.5 (n=4) in 2007. However, part of the improvement is also likely due to improvements with the new Mason WWTP, as the number of pollution sensitive species increased from six species in 1998 to eleven species in 2007.

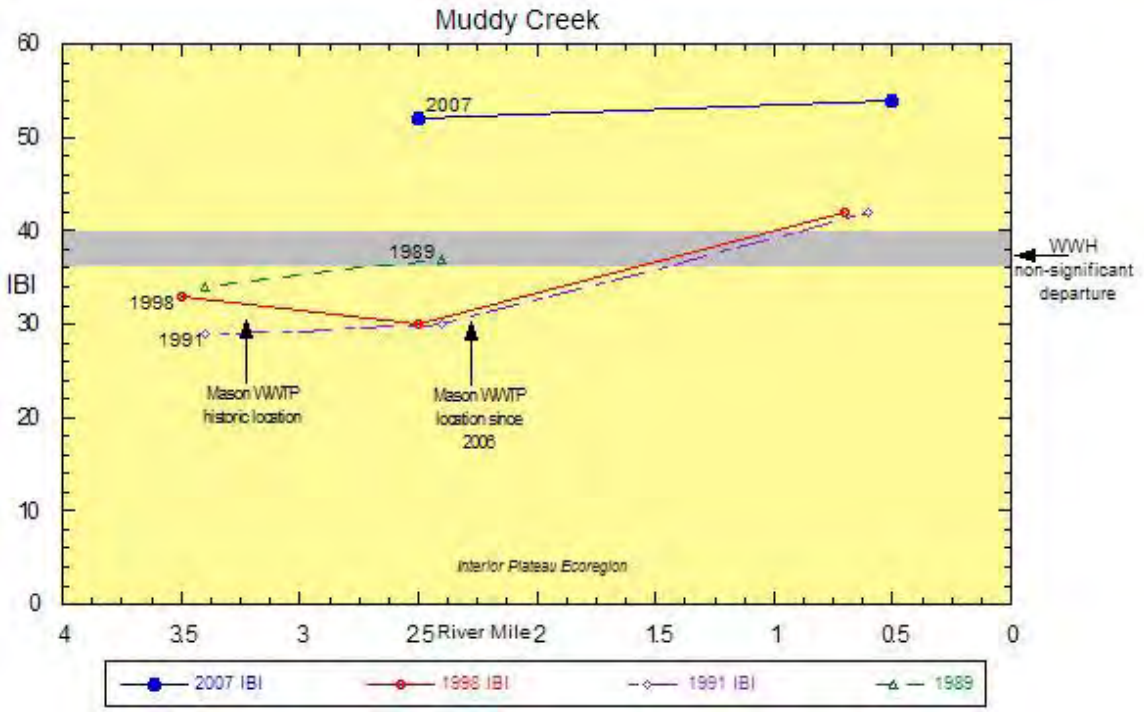


Figure 39. IBI scores for Muddy Creek from 1991, 1989, 1998, and 2007.

Macroinvertebrate Community

Little Miami River Mainstem

Macroinvertebrate Criteria Full Attainment

Watershed: 68%
Little Miami River: 100%
Tributaries: 55%

The Little Miami River was sampled for benthic macroinvertebrates at 25 stations as part of the 2007 sampling effort, including one mixing zone at RM 21.7 (Table 20). Although the focus of the 2007 survey was on the lower portion of the mainstem (downstream from the confluence of Caesar Creek), five sites were visited upstream from Caesar Creek in order to appraise the collective influence of the upper watershed, and to conduct a trends assessment. Overall, the Little Miami River exhibited extremely high resource quality as indicated by the Invertebrate Community Index (ICI). Scores ranged between 42 and 54, with both a mean and a median of 50. Outside of the mixing zone, 21 stations were within EWH criteria, and three were within non-significant departure of EWH criteria. The Stubbs Mill Road station at RM 36.0 represented the greatest diversity of total, sensitive, and EPT[1], taxa of the entire mainstem. This station, along with RM 22.8, were the only stations where the intolerant and infrequently-collected long-horned cased caddisfly, *Triaenodes perna*, was found. Other intolerant taxa that were common to the Lower Little Miami River included the stonefly *Agnetina flavescens*; the mayflies *Plauditis dubius/virilis*, and *Paracloedes species 2*; and the caddisflies *Psychomyia flavida* and *Protoptila sp*. Overall, 242 macroinvertebrate taxa were collected from the Little Miami River sampling reach in 2007.

While all sites were in attainment of EWH criteria on the Little Miami River mainstem, one site that was within non-significant departure of EWH warrants further discussion. The site at RM 83.14 was well outside the designated study area for the survey, but was included due to concerns about declining macroinvertebrate diversity that was related to nutrient enrichment. Sampling at the site, located downstream from the community of Yellow Springs and its wastewater treatment facility, uncovered no issues regarding nutrient enrichment. Benthic diversity and community composition were meeting EWH expectations with a very good ICI of 42. Slow current over the artificial substrates (< 0.3 f/s) probably prohibited the ICI from fully scoring within its potential. However, organism densities on the natural substrates were quite low. Substrates were coated by a layer of sand and silt, thereby reducing the interstitial space available for colonization. It also was noted in the fish community that northern hogsuckers – an insectivorous species – appeared emaciated at this site. This phenomenon may be due to ongoing recovery from a 2007 winter dam breach that released a heavy load of silt to downstream segments of the river.

[1] EPT stands for Ephemeroptera, Plecoptera, and Tricoptera – the orders of invertebrates commonly known as mayflies, stoneflies, and caddisflies, respectively. Their collective presence and abundance in the benthos is generally considered an indicator of high biotic integrity.

Lower Little Miami River Tributaries (excluding Todd Fork subwatershed)
Nine direct and indirect tributaries to the Lower Little Miami River watershed were sampled for macroinvertebrates in 2007. Sites on Turtle Creek, Little Muddy Creek, Dry Run, Muddy Creek, O'Bannon Creek, Sycamore Creek, East Fork Little Miami River, Duck Creek and Clough Creek accounted for 22 sampling stations that were located in mostly urbanized landscapes (Figure 40). Todd Fork and its tributaries, which were also sampled as part of the 2007 survey, are discussed separately in sections to follow due to its large watershed size, small population centers, and mostly agricultural land use.

Overall, there was a 50/50 split between sites that did achieve attainment of applicable biocriteria and those that did not. Turtle Creek at RMs 6.23, 4.85, and 0.52, Little Muddy Creek at RM 1.02, O'Bannon Creek at RMs 1.84 and 0.26, and Sycamore Creek at RMs 0.5 and 0.1 were within WWH criteria. Narrative scores for these sites ranged from very good to marginally good. Exceptional ICIs on East Fork Little Miami River at both RMs 2.3 and 1.2 met EWH criteria.

The remaining site on Dry Run at RM 1.79 was distinguished by having five coldwater-adapted taxa within the community. The coldwater-adapted midges *Meropelopia sp*., *Zavrelimyia sp.*, *Parametriocnemus sp.*, *Polypedilum aviceps*, and *Paratanytarsus n. sp. 1* were identified in quantitative and qualitative samples. *Paratanytarsus n. sp. 1* also was the second-most numerous individual taxa in the quantitative sample, having comprised 21 percent of the total organisms. As such, Dry Run from its headwaters to RM 1.2 should have its aquatic life use changed from WWH to CWH due to both the presence and abundance of these organisms.

The eleven sites that were not meeting applicable biocriteria received scores that were in the fair to very poor range (Table 20). Five of these sites, located on O'Bannon Creek, Turtle Creek, and Muddy Creek, were interstitial or near interstitial when sampled and were considered impaired due to the absence of riffle habitat. This reduction or elimination of visible surface flow typically precludes the collection of many rheophilic macroinvertebrate taxa, thus reducing both pollution-sensitive and EPT taxa and resulting in depressed performance. Both qualitative EPT and sensitive taxa averaged only six taxa respectively for the interstitial sites. Additionally, overall densities on the natural substrates were either low or very low.

The six remaining sites were primarily impaired by causes associated with urbanization. The first, Muddy Creek at RM 0.54, was located downstream from the newly-built Mason WWTP, which was completed in 2006. Flow was substantially higher at this site when compared to conditions upstream from the plant at RM 2.5. There, flow was nearly interstitial, but downstream from the plant, stream flow became much above what is likely normal for a stream of its size in August. Both Muddy Creek sites were sampled on the same day, thus eliminating temporal differences in flow. Substrates at RM 0.54 were embedded, with stringy masses of algae clinging to the larger substrates and foamy emulsions were collecting in the runs. While both sites were taxonomically

similar, RM 0.54 had a much greater abundance of flatworms on the natural substrates than its upstream counterpart. This may also indicate some enrichment associated with the wastewater treatment discharges.

Sites on Sycamore Creek, Duck Creek and Clough Creek were affected by either urban runoff or CSO-related effects. The Sycamore Creek and Clough Creek sites seemed to be only moderately impaired from the effects of urban runoff and CSOs, respectively, with fair-range numbers of both EPT and sensitive taxa. However, both sites on Duck Creek were profoundly impacted by CSOs. Both macroinvertebrate communities received qualitative evaluations of very poor. Neither community included any sensitive taxa nor were they diverse, being comprised almost entirely of facultative and tolerant dipteran and other non-insect taxa. EPT and total taxa numbers at these sites were the lowest in the entire survey. Organic enrichment was obvious via physical evidence at RM 0.95, with septic wastes on the margins and substrates, accompanied by a strong sewage odor. Duck Creek at RM 3.36 is designated LRW due to its cement channel, which is designed to convey storm water and CSO discharge. Biocriteria for LRW streams are considerably lower than for any other aquatic life use designation. Despite these lowered expectations, a narrative of very poor still did not meet LRW standards.

Habitat quality appeared to be the principal factor affecting community performance at Little Muddy Creek RM 3.22. Fingernail clams of the family Sphaeriidae were predominant in the riffles, along with a few hydropsychid caddisflies of the genus *Cheumatopsyche*. This assemblage in the riffle – reduced quantity and diversity of caddisflies and increased numbers of silt-burrowing mollusks – indicated that excessive siltation was depressing the macroinvertebrate community. Substrate quality consisted of mostly fine gravels, which were moderately embedded with silt. The reach just upstream from the sampling location was channelized, and the sampling location itself appeared to be in recovery from prior modification. The channel was lacking sinuosity and had little access to its floodplain, rendering the stream susceptible to excessive siltation.

Table 20. Summary of macroinvertebrate data collected from artificial substrates (quantitative data) and natural substrates (qualitative data) in the Lower Little Miami River basin (excluding Todd Fork), July-September, 2007 and 2008.

Location	Map #	River Mile [Δ]	Drain. (mi^2)	Total Taxa	Qual EPT	Total Sen*	Total Tol.*	Substrate Density[a]	ICI[b]	Observations[c]
Exceptional										
Little Miami River @ Spring Valley roadside park	7	63.3	360.0	77	13	30	8	Low	48	Baetid mayflies (F,MI) and midges (F,MI) predominant.
Little Miami River dst. Waynesville WWTP	9	53.15	402.0	72	15	33	7	High	50	Hydropsychid caddisflies (F,MI) and mayflies (F,MI) predominant.
Little Miami River @ Middletown Road	10	51.2	413.0	69	19	34	5	Moderate	48	*Elimia sp*.(MI) snails very abundant in all habitats.
Little Miami River dst. Caesar's Creek	11	50.25	658.0	67	19	36	4	Moderate	52	*Elimia sp*.(MI) snails predominant. Zebra mussels common on margin substrates.
Little Miami River @ SR 350	12	43.76	680.0	59	18	28	8	Moderate	--	Hydropsychid (F,MI) caddisflies, *Psychomyia flavida* (I) and *Elimia sp*. snails predominant.
Little Miami River dst. Todd Fork & SR 123	13	38.5	949.0	66	22	36	6	High	46	Elimia sp. snails (MI), hydropsychid caddisflies (F,MI), and waterpenny beetles (MI) predominant.
Little Miami River @ Stubbs Mill Road	14	36.0	964.0	81	28	42	8	Moderate	50	Hydropsychid caddisflies (F,MI) and baetid mayflies (F,I) predominant.
Little Miami River @ US 48	15	32.9	1035.0	75	23	38	4	High	54	Hydropsychid and Philopotamid caddisflies (F,MI), baetid and heptageiid mayflies (F-I), Elimia sp. snails (MI) predominant.
Little Miami River dst. Lebanon WWTP	16	31.96	1036.0	72	24	38	9	Moderate	48	Hydropsychid caddisflies (F,MI), riffle beetles (F,MI), *Elimia sp*. snails (MI), heptageniid mayflies (MI) predominant.
Little Miami River dst. Muddy Creek	17	31.5	1050.0	75	20	30	7	High	52	Hydropsychid caddisflies (F.MI) and *Tricorythodes sp*. mayflies (MI) predominant.
Little Miami River @ King's Mill Road	18	30.9	1054.0	68	17	26	9	High	52	Hydropsychid caddisflies (F,MI) and heptageniid mayflies (MI) predominant.
Little Miami River adj. Peter's Cartridge	19	30.5	1054.0	63	13	24	5	High	50	Hydropsychid caddisflies (F,MI), baetid mayflies (F,I), heptageniid mayflies (F,MI) predominant.
Little Miami River dst. Grandin Road	20	30.0	1055.0	65	18	29	7	High	52	Hydropsychid caddisflies (F,MI), baetid mayflies (F,I), heptageniid mayflies (F,MI) predominant.
Little Miami River dst. Peter's Cartridge	21	29.0	1059.0	58	16	23	8	High	54	Hydropsychid caddisflies (F,MI), baetid mayflies (F,I), heptageniid mayflies (F,MI) predominant.
Little Miami River dst. Lower LMR WWTP	22	27.9	1069.0	62	16	31	10	Very High	54	Hydropsychid and philopotamid caddisflies (F,MI), and baetid mayflies (F,MI) very predominant.
Little Miami River ust. O'Bannon Creek	23	24.1	1085.0	51	19	28	7	Moderate	48	Hydropsychid caddisflies (F,MI), baetid mayflies (F,I), flatworms (F), heptageniid mayflies (MI), and *Elimia sp.(*MI) snails predominant.

Location	Map #	River Mile [Δ]	Drain. (mi^2)	Total Taxa	Qual EPT	Total Sen*	Total Tol.*	Substrate Density[a]	ICI[b]	Observations[c]
Little Miami River adj. Loveland-Kemper Road	24	22.3	1150.0	77	23	36	10	High	54	Hydropsychid caddisflies (F,MI), bryozoan (F), flatworms (F), Elimia sp snails (MI), baetid and heptageniid mayflies (F-I) predominant.
Little Miami River adj. Lake Isabella	26	20.6	1161.0	70	17	37	9	Low	52	Hydropsychid and philopotamid caddisflies (F,MI), heptageniid mayflies (F-I), *Elimia sp*. snails (MI) predominant. Large mussel bed present.
Little Miami River @ canoe access area dst. SR 126	27	17.7	1187.0	52	18	25	7	Moderate	--	Hydropsychid and philopotamid caddisflies (F,MI), baetid mayflies (F,MI), bryozoans (F) predominant.
Little Miami River @ Wooster Pike Milford gage	28	13.07	1203.0	54	19	32	4	High	52	Hydropsychid caddisflies (F,MI), baetid mayflies (F,MI), *Rheotanytarsus sp*. midges (MI), *Elimia sp*. snails (MI) predominant. Fresh dead mussels abundant; none live.
Little Miami River @ Newtown Road	29	8.14	1713.0	49	12	25	5	Very High	50	Hydropsychid caddisflies (F,MI), baetid mayflies (F,MI), *Rheotanytarsus sp*. midges (MI), *Elimia sp*. snails (MI) very abundant..
East Fork Little Miami River @ Milford Parkway	5	2.3	494.0	62	17	29	9	Moderate	52	Hydropsychid caddisflies (F,MI), baetid mayflies (F,MI), *Elimia sp*. snails (MI) predominant.
East Fork Little Miami River @ Milford Parkway	6	1.2	497.0	95	20	35	16	Low	50	*Elimia sp*. snails (MI) and polycentropid caddisflies (F,MI) predominant. Much fewer filter-feeding caddisflies than upstream, which may reflect the absence of riffle habitat.
Very Good										
Little Miami River @ Jacoby Road	47	83.14	118.0	69	18	30	4	Low	42	Site sampled due to concern about reduced EPT taxa. EPT diversity was good, but overall densities were low.
Little Miami River ust. Waynesville WWTP	8	54.3	395.0	56	16	28	3	Low	44	Small gravel substrates in shallow riffle with few organisms. Baetid mayflies (F) and riffle beetles (MI) predominant.
Little Miami River @ Beechmont Road	30	3.5	1744.0	58	24	27	9	High	40	Very large populations of *Rheotanytarsus* midges (MI) and bryozoan (F), in addition to hydropsychid caddisflies (F,MI), baetid mayflies (F), and flatworms being common. ICI invalid due to vandalism.
Turtle Creek @ US 48	46	0.52	58.0	44	13	17	5	Moderate	--	Very low flow, but stable populations of hydropsychid and philopotamid caddisflies, heptageniid mayflies, waterpenny beetles, and *Elimia sp*. snails.
Sycamore Creek dst. North Fork Sycamore Creek	41	0.5	20.7	47	8	14	6	High	44	Margin habitat limited due to concrete layered banks. *Rheotanytarsus sp*. midges (MI) and heptageniid mayflies (F) predominant.
Good										
Turtle Creek @ Glosser Rd.	44	6.23	21.3	40	4	10	4	Low	34	Slow current over HDs (<0.3 f/s) . Hydropsychid caddisflies (F), flatworms (F), bryozoa (F), and oligochaetes (T) predominant.

Location	Map #	River Mile [Δ]	Drain. (mi^2)	Total Taxa	Qual EPT	Total Sen*	Total Tol.*	Substrate Density[a]	ICI[b]	Observations[c]
Dry Run @ Snook Road	2	1.79	4.2	61	11	22	8	Very Low	38	CWH potential– water temp 17.5°C – confirmed by the collection of 5 cold water midge taxa.
Little Muddy Creek @ SR 42	32	1.02	20.2	57	5	14	10	Low	40	Hydropsychid caddisflies (F) predominant.
O'Bannon Creek @ O'Bannonville Road	38	1.84	55.6	53	10	15	8	Moderate	40	Slow current over HDs(<0.3 f/s). *Rheotanytarsus sp*. (MI) midges predominant.
O'Bannon Creek @ SR 48	39	0.26	59.0	63	11	21	11	Moderate	34	HDs disturbed; 3 of 5 samplers analyzed. Hydropsychid and philopotamid caddisflies (F,MI), flatworms (F), waterpenny beetles (MI) and heptageniid mayflies (F) predominant. Algal mats abundant at water's surface.
Sycamore Creek dst. Sycamore Creek WWTP	42	0.1	23.3	51	5	9	11	High	32	HDs disturbed; 2 of 5 samplers analyzed. Gray silt covering substrates. Midges (T,F,MI) predominant.
Marginally Good										
Turtle Creek @ McClure Rd.	45	4.85	30.0	51	6	13	10	Low	28	Slow current over HDs(<0.3 f/s). Hydropsychid caddisflies (F) and midges (F,MI) predominant.
Fair										
Turtle Creek @ East Street	43	7.43	12.3	23	6	8	3	Very Low	n/a	Interstitial flow. Riffle beetles (F), waterpenny beetles (MI), and heptageniid mayflies (F) predominant.
Muddy Creek ust. Mason WWTP	33	2.5	10.2	33	7	4	9	Low	n/a	Near interstitial flow over bedrock substrates. Hydropsychid caddisflies (F,MI) and riffle beetles (F) predominant.
Muddy Creek dst. Mason WWTP	34	0.54	15.2	35	8	3	10	Moderate	n/a	Very strong flow with high algal density and embedded substrates. Baetid mayflies (F) and flatworms (F) predominant.
O'Bannon Creek @ SR 132	36	8.27	14.3	27	8	7	4	Low	n/a	Interstitial flow with very warm pools (29°C). Heptageniid mayflies (F) and waterpenny beetles (MI) predominant.
Sycamore Creek adj. Loveland Rd, dst. tributary	40	1.1	10.4	20	8	6	0	Moderate	n/a	Urban stream receiving SSO discharge. Flatworms (F), hydropsychid caddisflies (F,MI), and midges (F) predominant.
Clough Creek @ SR 125	1	0.42	8.3	28	8	4	5	High	n/a	Urban stream w/CSO discharge. Hydropsychid and philopotamid caddisflies (F,MI), flatworms (F), and midges (MT-MI) predominant.
Low Fair										
Little Miami River @ Polk Run WWTP mixing zone	25	21.7	1150.0	36	1	2	19	Moderate	14	Biocriteria do not apply. No indication of significant toxicity. Tolerant red midges predominant.
Little Muddy Creek @ Hamilton Road	31	3.22	11.7	43	5	5	9	Low	n/a	Recovering channelized stream. Hydropsychid caddisflies (F) and fingernail clams (F) predominant.
O'Bannon Creek @ Linton Road	35	10.14	8.1	30	4	5	5	Low	n/a	Interstitial flow with very warm pools (31°C). Snail case caddisflies (MI) and flatworms (F) predominant.

Location	Map #	River Mile Δ	Drain. (mi^2)	Total Taxa	Qual EPT	Total Sen*	Total Tol.*	Substrate Density[a]	ICI[b]	Observations[c]
O'Bannon Creek @ Gibson Road	37	4.37	28.1	29	5	6	5	Low	--	Interstitial flow. Heptageniid mayflies (F) and midges (T-MI) predominant.
Very Poor										
Duck Creek @ Rosslyn Drive	3	3.36	7.3	17	1	0	7	Moderate	n/a	CSO conveyance via cement channel. Community almost entirely facultative and tolerant dipteran/non-insect taxa.
Duck Creek @ park at the end of Hutton Road	4	0.95	15.1	18	3	0	6	Moderate	n/a	CSO conveyance. Community almost entirely facultative and tolerant dipteran/non-insect taxa.

Δ – The river mile indicated on this table may differ slightly from the river mile listed in the Appendix. The river miles in the Appendix are the Absolute Location Points (ALPs) and are indicative of the *actual* river mile where the data was collected and are thereby linked to the Point of Record (POR) river miles indicated in this and other tables throughout the main body of this document.
- Each macroinvertebrate sampling location corresponds to a color-coded, numbered point on a map of the watershed following this table.
***** - Sen = Sensitive taxa and are those listed on the Ohio EPA macroinvertebrate taxa list as being either Moderately Intolerant (MI) or Intolerant (I). Tol = Tolerant taxa and are those taxa listed on the Ohio EPA macroinvertebrate taxa list as being Moderately Tolerant (MT), Tolerant (T), or Very Tolerant (VT).
a – Observed relative density of the benthos on natural substrates. Please refer to Appendix table A-16 for relative densities on artificial substrates.
b – Invertebrate Community Index. ICI not available for sampling locations with drainage area <20mi^2 (excluding reference sites), and are indicated by n/a. Dashed lines (--) indicate sites where quantitative data were not available due to vandalism, dessication, or some other disturbance of Hester Dendy artificial substrates (HDs).
c – Predominant taxa are those observed on natural substrates. Please refer to Appendix table A-18 for predominant taxa on artificial substrates. Tolerance categories for taxa groups are parenthetically expressed: VT = Very Tolerant, T = Tolerant, MT = Moderately Tolerant, F = Facultative, MI = Moderately Intolerant, I = Intolerant.

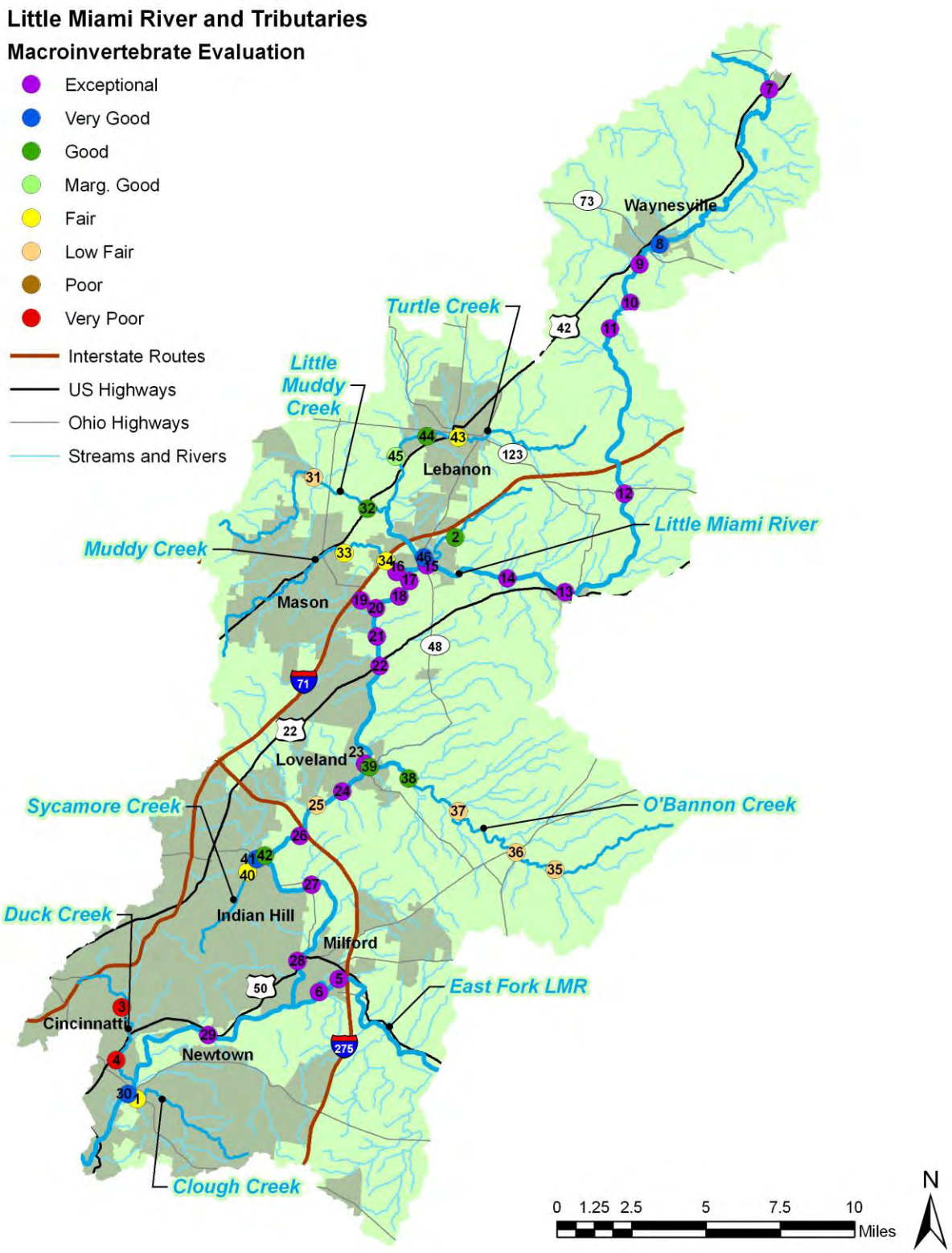


Figure 40. Lower Little Miami River and tributaries, showing the location and performance of macroinvertebrate communities across the watershed. Each point is labeled with a number that corresponds to a sampling location as indicated in the preceding macroinvertebrate summary table.

Macroinvertebrate Trends, 1998-2008

Macroinvertebrate communities collected in 2007 in the Little Miami River displayed a longitudinal trend of slightly higher ICI scores when compared to those of 1998 (Figure 41). However, both sampling years yielded communities that were in the very good to exceptional range, thus meeting EWH criteria at all sampling locations. The only significant change within the macroinvertebrate population of the Little Miami River documented in the 2007 survey was the frequent collection of *Dreissena polymorpha,* which was collected at ten sites. This invasive bivalve, commonly known as the zebra mussel, was not encountered in the 1998 survey. Zebra mussels were found in the Little Miami River from the confluence of Caesar Creek at RM 50.25 downstream to RM 27.9. Ecologically, this distribution could pose a threat to the remaining native mussel fauna in the river. A study by Hoggarth (2007) indicated that despite an overall decline in mussel populations in the Little Miami River, populations in the lower reach (defined ad hoc as downstream from the confluence of Caesar Creek) have remained stable. In Hoggarth's study, the lower reach of Caesar Creek (downstream from Caesar Creek Lake), was nearly depauperate of native bivalves, but hosted a great abundance of zebra mussels (~50 organisms/m^2), none of which were found in his previous study in 1990 and 1991. Zebra mussels were partly implicated as a source of decline to Caesar Creek's native mussel population due to resource competition with the invasive species. Not coincidentally, zebra mussels were most abundant on natural substrates at RM 50.25, which is less than a half mile downstream from Caesar Creek. Caesar Creek may be a source of zebra mussels to the Lower Little Miami River, thus potentially threatening the stability of its own native mussel population.

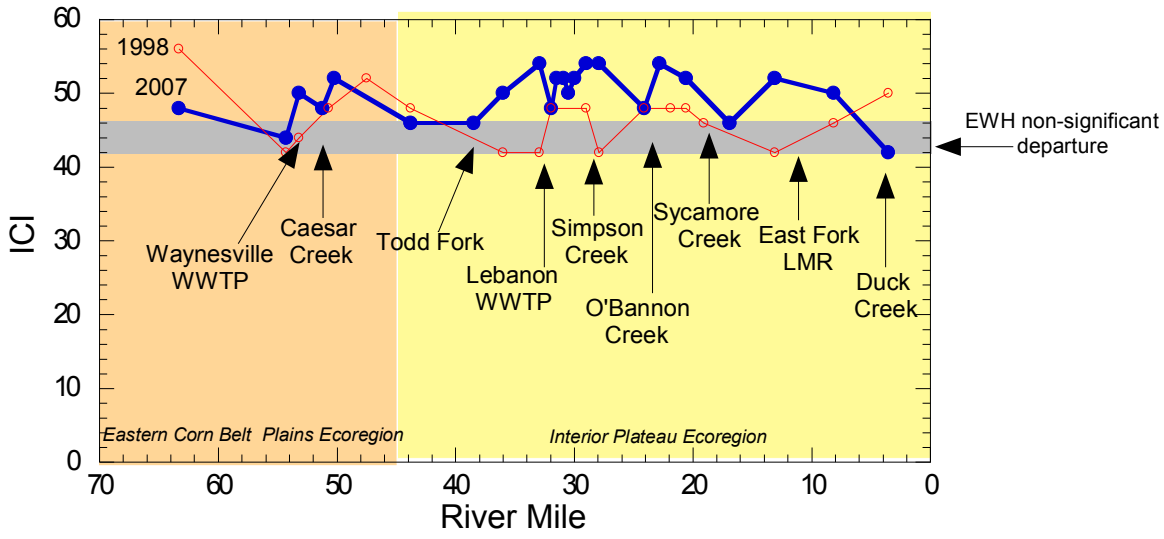


Figure 41. Longitudinal plots of ICI scores comparing survey years 1998 and 2007. ICIs are estimated where quantitative data are unavailable.

Five tributary streams have been re-sampled since the last comprehensive survey in 1998. The macroinvertebrate communities of Turtle Creek, Sycamore Creek, and East Fork Little Miami River that were collected in 2007 showed no appreciable changes with respect to those collected in 1998. O'Bannon Creek, which had additional sampling conducted in 2003 and 2004, also realized overall similar communities in 1998, 2004, and 2007, but revealed exceptional assemblages upstream from the O'Bannon Creek WWTP (RM 2.57) during sampling in 2003. Fair communities were collected in this reach in 1998 and 2007, and appeared to be related to disappearing flows. Flows were normal in 2003, and appeared to be the main factor contributing to the exceptional scores achieved during that year.

The only stream that showed significant differences between 1998 and 2007 was Muddy Creek. This was likely due to the expansion and relocation of the Mason WWTP in 2006. The station at RM 2.5, which was downstream from the plant's discharge in 1998 and received a narrative evaluation of good, was located upstream from the discharge in 2007. Without supplemental flow from the wastewater plant in 2007, the site was nearly interstitial and community response declined into the fair range. Community response also declined at RM 0.54, from good in 1998 to fair in 2007. It appears that there may be an enrichment effect that is exacerbated by the high rate of discharge, as flow in this reach is almost entirely composed of effluent. A decrease in hydropsychid caddisfly abundance, coupled with increased flatworm density and doubled total tolerant taxa (five in 1998, ten in 2007) suggest that issues with the effluent are responsible for this decline, although specific reasons why are unclear.

TODD FORK SUBWATERSHED

Study Area Description

The Todd Fork watershed (Figure 42) drains 261 mi^2 in Warren and Clinton counties (ODNR 2001). The topography of the Todd Fork watershed has been influenced by successive glaciations which left distinctive landforms and thick deposits of silt, sand, and gravel. The portion of the watershed (WAU 05090202-06) upstream of the confluence of East Fork Todd Fork (RM 14.07) lies in the Eastern Corn Belt Plain (ECBP) ecoregion and is characterized by level to gently sloping land and relatively low gradient streams. Soils tend to be silt loams or silty clay loams with low permeability. As a result most areas of the WAU are rated as severely limited for use with septic systems. Tributaries in this section include Dutch Creek, Lytle Creek, Cowan Creek, and Indian Run. Most of the lower Todd Fork watershed (WAU 05090202-07) lies in the Interior Plateau (IP) ecoregion and typically exhibits greater topographic relief. Soils in this WAU are similar to the upper WAU and there are similar restrictions for septic systems. Tributaries in this section include East Fork Todd Fork (ECBP), Lick Run, Second Creek, Whitacre Run, and First Creek. Water supplies in the watershed are from surface sources such as Caesar Creek and Cowan Creek.

The City of Wilmington is the largest community in the watershed with a population of approximately 11,920 year-round residents and 1,200 Wilmington College students each academic year (US Census Bureau, 2000). Other communities include Clarksville (497), Blanchester (4,220) and portions of Morrow (1,286).

While agriculture is the predominant land use (Table 6, Figure 43) with cultivated crop and pasture/hay respectively accounting for 55.75% and 10.08% of the total watershed area, a significant portion (23.81%) of the land is forest. Wilmington and Blanchester utilize Cowan Creek and Whitacre Run, respectively, as public water supplies. Additionally, in 1950 a dam was completed across Cowan Creek (near RM 3.3) creating a 700 acre lake. Cowan Lake was dedicated as a state park in 1968 (ODNR 2008).

During the 2007 survey, the aquatic life use designation in effect for the majority of streams in the Todd Fork watershed was Warmwater Habitat (WWH). Dutch Creek and Lick Run had a use designation of Exceptional Warmwater Habitat (EWH). With the exception of Indian Run, which was designated Secondary Contact Recreation (SCR), the recreation use designation in effect for all of the above streams was Primary Contact Recreation (PCR).

Among the municipal dischargers in the watershed are the Wilmington WWTP on Lytle Creek (RM 6.83), Clarksville WWTP on Todd Fork (RM 15.36), and the Blanchester WWTP on Second Creek (RM 10.10). The Airborne Express Airpark has multiple stormwater discharges to Lytle Creek and Indian Run. Additionally, the discharge from the Wilmington Sanitary Landfill storm water retention pond enters Lytle Creek near RM 6.4 downstream of the City's wastewater facility.

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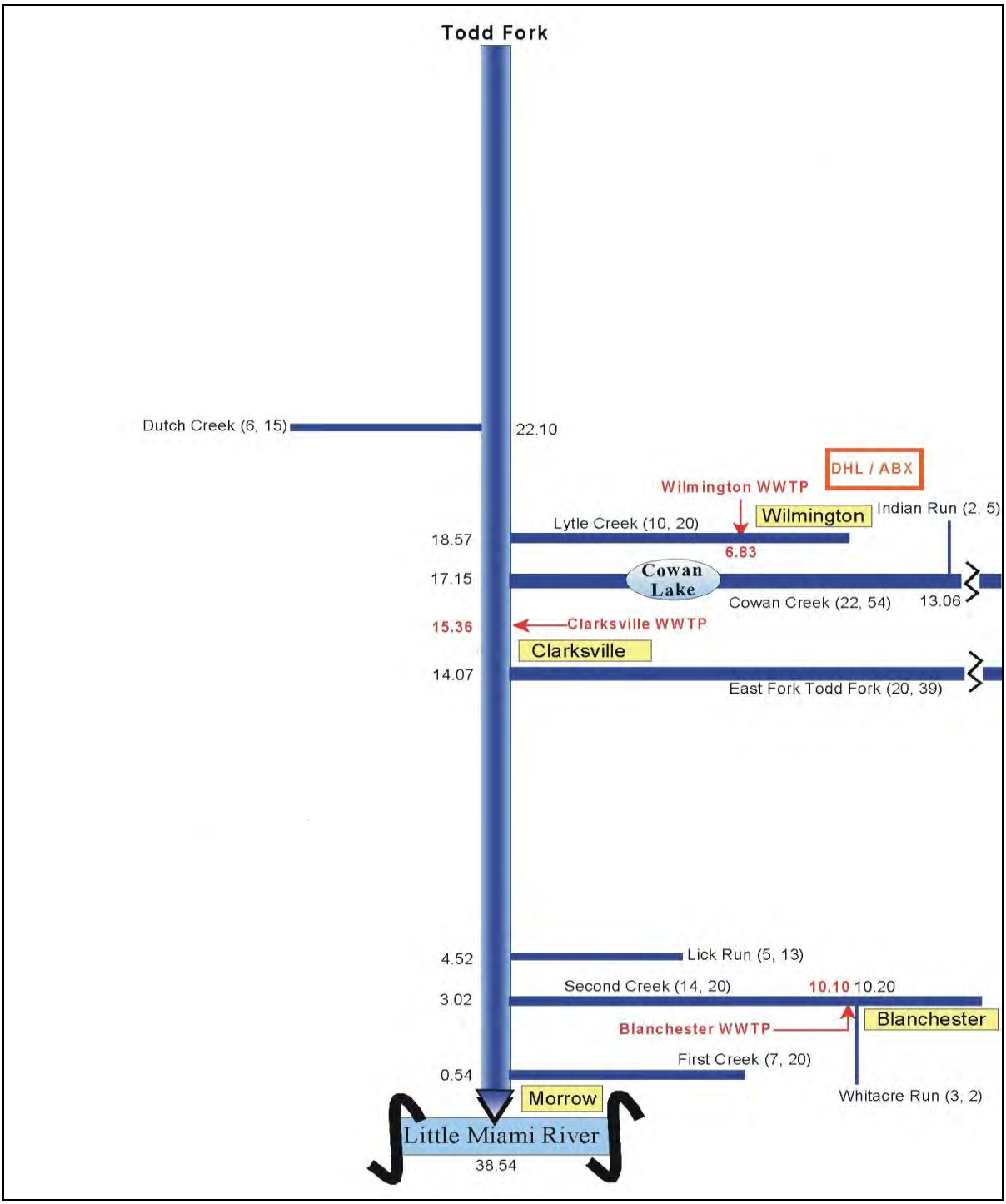

Figure 42. Schematic representation of the Todd Fork watershed. Numbers in parentheses next to stream names represent stream length (miles) and drainage area (mi2), respectively. River miles are indicated for stream confluences and WWTP discharges.

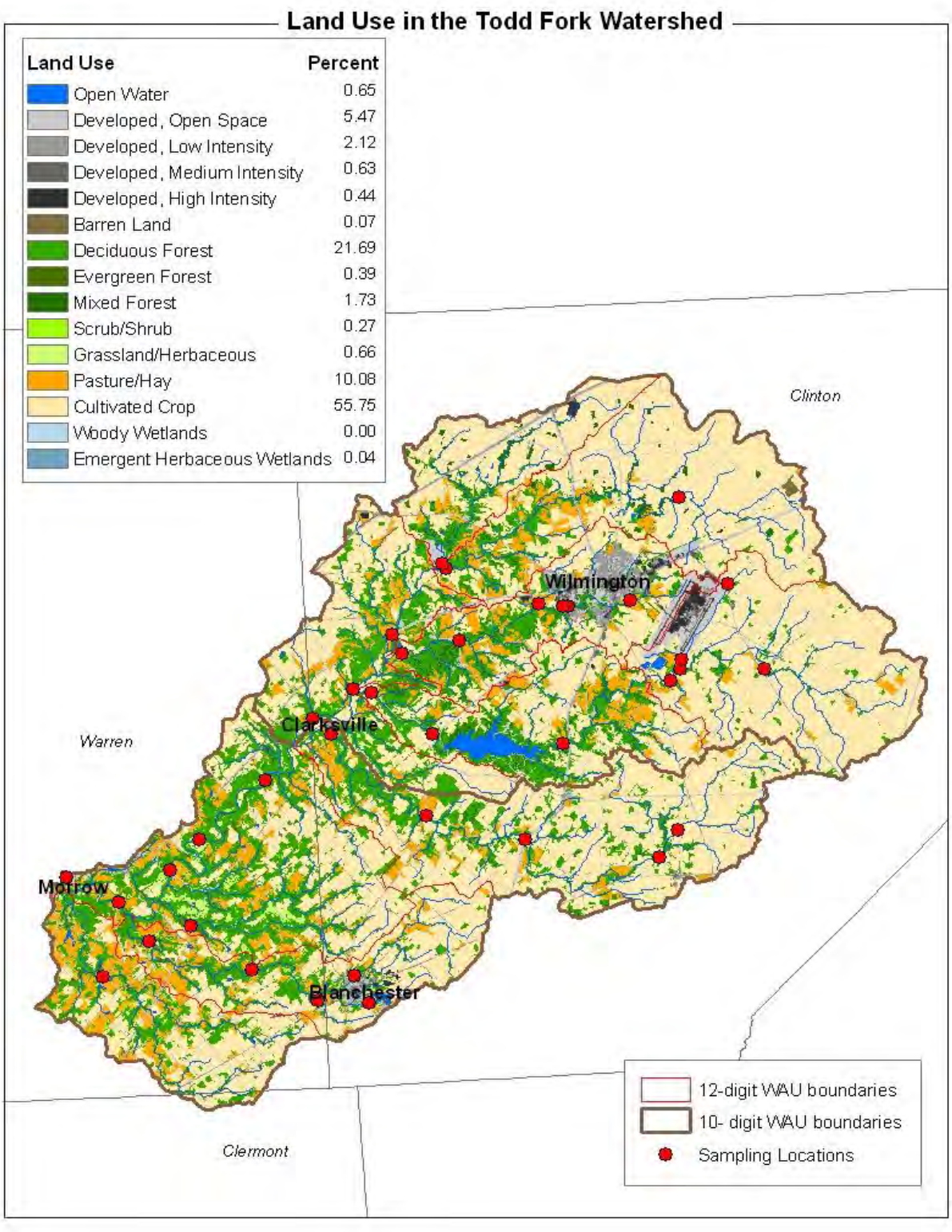

Figure 43. Land Use in the Todd Fork Watershed (WAUs 05090202-06 and 07) (NLCD 2001).

Point Sources - NPDES

The following includes summaries and loadings information for National Pollutant Discharge Elimination System (NPDES) regulated dischargers in the Todd Fork subwatershed. Receiving stream and connection to Todd Fork (where applicable) is included in *italics* following the name of the facility or entity. Outfall coordinates are listed alphabetically by facility in Appendix Table A-4.

Thousand Trails Inc. Wilmington Preserve WWTP

Unnamed Tributary → Todd Fork RM 20.9

Thousand Trails Inc is located in Clinton County at 295 Todd Fork Road in Wilmington, Ohio. Thousand Trails was built approximately in 1985 at an average design flow of 0.012 MGD to serve approximately 190 camper and RV sites during warm seasons only and remains such as of 2008. The expansion of 50 additional sites has been proposed since 1995. Wastewater treatment is served by a Sequestering Batch Reactor System utilizing a trash trap, equalization basin, reactor basin, dosing chamber, sand filter, chlorine contact chamber and de-chlorination chamber. There are three lift stations in the collections system with no bypassing capabilities.

In 2005, Ohio EPA personnel conducted an inspection of the facility to evaluate plant operation and performance. An overall marginal rating was documented at the facility due to the NPDES violations over the prior year and for spotty record-keeping.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008 for outfall 001. For the nearly five years of data, evaluated through SWIMS, 62 violations were reported for mostly ammonia-N, followed by cBOD5 and fecal coliform and occurred nearly equally from 2004 to 2007. Some violations were reported due to the decant system, which if failing can cause solids to spill over from the reactor chamber into the dosing chamber and then to the sand filters. The decant system was replaced in 2005, and the sand in the effluent filters was replaced in 2009. Four Reporting Frequency Violations for effluent were documented for the same time period.

Caesar Creek Flea Market

Unnamed tributary → Little Creek → Todd Fork RM 19.8

Caesar's Creek Flea Market is located in Clinton County at 7763 SR 73 in Wilmington, Ohio. This facility operates on weekends only throughout the year at a design flow of 10,000 gpd. The treatment system consists of a trash trap, a flow equalization tank, aeration tank, a single hopper clarifier, a dosing tank, two slow surface sand filters, a chlorine contact tank and a sludge waste tank.

Numeric NPDES permit violations were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, 111 violations were reported. Ammonia-N and suspended solids comprised the majority of the violations. Most years, the months of February, April and May recorded the most violations. All seasons except winter incurred ammonia-N violations. Reporting Frequency Violations were also evaluated for the same time period. From 2004 until 2007, monthly violations in excess of 1000 incidents for odor, color, flow and turbidity were reported. As of 2008, 13

violations had already been reported for the first two months of the year. These violations have been caused by flooded sand filters, stormwater runoff, cleaning products, infrequent use and winter freezing of lines and pipes.

ABX Air, Inc, Airborne Express Airpark, aka Wilmington Airpark
Stormwater outfalls to Lytle Creek watershed → Todd Fork RM 18.62; and
Stormwater outfalls to Indian Run → Cowan Creek → Todd Fork RM 17.15
Wilmington Airpark is located at 145 Hunter Dr., Wilmington, Ohio in Clinton County. The facility was originally owned by the U.S. Department of Defense and operated as the Clinton County US Air Force Base. It closed operations as a federal facility in 1971 and was purchased by Airborne Express in 1980 as a privately owned airport. DHL purchased the airpark in 2003 which is operated by its subsidiary, ABX Air, Inc. ABX Air is a cargo airline with a fleet of 115 aircraft that operated out of the Wilmington airpark. Several thousands of staff were employed at the Wilmington facility during the 2007 Ohio EPA biological and water quality stream survey. Due to economic conditions, operations at the airpark have been severely affected and the majority of the DHL employees were laid-off by the end of 2008.

Several stormwater outfalls drain the airpark and discharge to Indian Run and Lytle Creek subwatersheds. Indian Run flows into Cowan Creek which is a surface water source for public drinking water for the City of Wilmington. Sanitary wastes from the airpark is directed to the sanitary sewer system and treated at the Wilmington WWTP. There are no cross connections between the sanitary and storm water system from Airborne Airpark.

During the winter months, deicing chemicals are required to be applied to planes and runways for operations to continue. Numerous deicing chemicals have been used at the facility. Ethylene glycol and propylene glycol are listed in the NPDES permit as deicing chemicals used on airplanes. Urea, potassium acetate, sodium formate, sodium acetate, calcium magnesium acetate are listed in the NPDES permit for deicing runways. Due to the toxicity of urea, the NPDES permit specifies the use of urea was to be discontinued except in the case of an emergency. In 2001, a CERTALERT was issued by Airport Safety and Operations Division to discontinue the use of potassium formate as a runway deicing compound due to its corrosiveness to electrical components in wheel wells of jet airplanes. Additives to the deicing fluid such as the fatty alcohol ethoxylate, benzotriazole and sodium petroleum sulphonate are also toxic to aquatic life. Runoff from the deicing chemicals caused and continues to cause severe degradation of area streams. Biological surveys of the streams associated with this facility show significant impacts to the populations of both the fish and invertebrate biota.

Figure 44. Location of outfalls at the Wilmington Airpark.

Two large treatment facilities were constructed in 2001 utilizing attached biological growth to treat the deicing runoff. During the deicing season, runoff from areas designated for plane deicing and from some of the runway areas is collected for treatment in these attached biological growth systems. The contaminated storm water is collected at three existing storm outfalls (002, 003, & 018) by way of diversion structures. The diversion structures divert storm water to pump stations that send the water to storage lagoons ahead of the treatment systems.

The collected runoff in the storage lagoons is then metered through the treatment systems and discharged through outfall 031 (Lytle Creek) and outfall 032 (Indian Run). If the treated runoff doesn't meet the requirements of the NPDES permit prior to discharge, then it is rerouted back through the treatment system(s). Deicing runoff generally requires more than one pass through the treatment system before it can be discharged.

The plant operator visually monitors the water level in the storage lagoons. When the storage lagoons are full, he shuts down the pump stations and lets any further storm runoff (contaminated or not) go out the three existing storm water outfalls (002, 003, and

018). On numerous occasions, the storage lagoons have been at capacity due to the need to further recycle deicing runoff through the treatment systems. These "bypasses" have resulted in fish/wildlife kills and degradation of area streams. The streams receiving discharges from ABX/DHL are in non attainment of aquatic life use designations."

In 2004, DHL moved its eastern hub from the Greater Cincinnati/Northern Kentucky airport to Wilmington. Upgrades and expansions were made to the Indian Run treatment system in 2005 to accommodate the DHL expansion. Several bypasses and overflows have occurred in the Indian Run treatment system since the expansion, proving the system to be inadequate in size and treatment capability.

In May of 2006, a mercury shipment leaked, which resulted in mercury entering the under-drain system for the airpark. Mercury-contaminated runoff was discharged to Lytle Creek and Indian Run. The majority of the contaminated runoff appeared to have entered the Lytle Creek drainage. Cowan Lake State Park is downstream from the spill area of Indian Run. Fish tissue data from Cowan Lake in taken in 2004 (prior to the spill) and then again in late 2006 (after the spill) and 2007 indicate mercury levels increased in the tissue samples since 2004. The increased mercury levels in the fish tissue of Cowan Lake were not significant enough to impose a different fish consumption advisory than the one already in place state-wide for Ohio.

In May 2008, ODNR and Ohio EPA investigated a fish/wildlife kill and chemical Water Quality Standard violations in Cowan Creek. The kill and violations were the result of improperly treated effluent discharged from the deicing treatment system in the Indian Run watershed. In February 2009, the storage lagoons for the Indian Run system were at capacity and additional deicing runoff bypassed the treatment system into Indian Run. In March 2009, another discharge of improperly treated deicing runoff was released to Indian Run from the under-drain at the treatment system, resulting in another fish kill. The liner of one of the storage lagoons in the Indian Run treatment system was leaking into the under drain system.

In addition to the discharges of treated and untreated deicing chemicals, spills from airpark operations of jet fuel, diesel fuel, fire suppressants and other materials have been released to Lytle Creek and Indian Run. Numeric violations of the NPDES permit limits were evaluated from 2004 to 2008. The evaluation revealed 18 numeric violations during this period, 78% of the violations occurred from 2007 to 2008. The majority of the parameters violated were COD and pH. Most violations occurred in February and March, correlating to deicing applications. Reporting Frequency Violations occurred most frequently in 2004 and 2006. The Reporting Frequency Violations included nutrient, demand parameters, solids, and oxygen during various months.

Wilmington WTP

Unnamed tributary → Lytle Creek RM 7.9 → Todd Fork RM 18.62

Wilmington WTP is located in Clinton County at 1142 Prairie Avenue in Wilmington, Ohio. Wilmington has two sources of water supply. The primary source is withdrawn

from the Caesar Creek Reservoir and the secondary source is withdrawn from Cowan Creek. The water withdrawn from Cowan Creek is stored in the Burtonville reservoirs. Both water sources are treated with potassium permanganate to remove taste and odor constituents.

Numeric violations of the NPDES permit were reviewed from 2004 through a portion of 2008 for outfall 001. For the nearly five years of data, evaluated through SWIMS, no violations were reported for that period. Seventeen Reporting Frequency Violations for the final outfall were documented for the same time period occurring in all years except in 2008. Reporting violations were solely for pH, trihalomethane and suspended solids.

Wilmington WWTP
Lytle Creek RM 6.83 → Todd Fork RM 18.62
The Wilmington WWTP is located in Clinton County at 475 S. Nelson Ave., Wilmington, Ohio. The Wilmington WWTP is an activated sludge treatment facility that was constructed in 1936. The average design flow in 2005 was 3.0 MGD, with the last modification to this facility occurring in 1989. The current treatment train consists of mechanical screening, grit removal, primary settling, trickling filters, aerated solids contact, secondary settling, and disinfection with ultraviolet light. The primary settling tanks are occasionally used for wet weather flow storage. There is currently no phosphorus removal for this facility.

As of 2005, manual bypassing occurs at the facility due to wet weather events that generally exceed 626,000 gallons. The collection system has SSOs and the entire service area is sewered. Industrial dischargers include metal finishers, electroplaters, and paper manufacturers. Fish kills reported in Lytle Creek have been attributed to South Street lift station overflows. Overflows have been reported at thirteen manholes, one pump station and one splitter box due to blockages, grease, and wet weather. In 2007, Ohio EPA survey field crews noted small grease balls collecting in the final effluent channel just prior to entering the main channel of Lytle Creek.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, eight violations, mostly for ammonia-N, were noted. Sixty-five Reporting Frequency Violations were documented for the same time period and were comprised of mostly demand parameters, pH, nutrients, and mercury.

Ohio EPA conducted acute screening bioassays of the Wilmington WWTP outfall 001 effluents, upstream and mixing zone waters in 1998, 2002 and 2008. No toxicity endpoints occurred for any of the tests. Entity-conducted acute bioassay testing occurred in 1996 with no toxicity endpoints for either test organism.

Percentile flows were mostly below design capacity for the period of record (Figure 45). Overflow locations within the collection system will influence the predictability of facility flow reporting either by equalizing flow to the facility or increasing flow should mechanical failures associated at overflow locations (pumping stations, etc.) fail. The addition of an equalization basin also promoted more balanced flows that were reflected

in low percentile variance from 2003 through the record. Final outfall (001) bracketing of fixed stations 801 and 901, with few exceptions, indicated that median fecal coliform concentrations upstream were mostly higher than downstream concentrations which could be correlated to overflows within the same stream network upstream of the facility or other unknown influences.

Wilmington Landfill

Lytle Creek RM 6.4 → Todd Fork RM 18.62

The Wilmington Landfill is located in Clinton County at 397 South Nelson Avenue in Wilmington, Ohio. The landfill is a licensed sanitary landfill accepting residential waste. The treatment unit for the outfall consists of a sediment basin and outfall structure designed for maximum sediment retention and flow control. Maintenance is performed at least annually by removing accumulated sediment and disposing of it per permit requirements. Since 2001 there had been no significant leaks or spills or hazardous pollutants. A scheduled Ohio EPA inspection in 2008, reported the effluent to the sedimentation pond was clear and free of solids.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008 for outfall 001. For the nearly five years of data, evaluated through SWIMS, six violations of mostly suspended solids were reported from 2004 to 2007. The violations were attributed to extreme wet weather, moving compost, hydroseeding near the sedimentation pond, heavy snowfall, and frozen water in the sedimentation pond. Reporting Frequency Violations for outfall 001 were also reviewed for the same time period. Sixteen violations for flow, odor and color occurred from 2004 to 2007.

Clarksville WWTP

Todd Fork RM 15.4

The Clarksville WWTP is located in Clinton County at 160 Spring Hill Road in Clarksville, Ohio. The plant was constructed in 2001 to serve a population of approximately 500 at an average design flow of 0.09 MGD. Treatment consists of grit removal, screening, a Biolac aeration basin, secondary clarification, post aeration, an aerated sludge holding basin and ultraviolet disinfection.

In 2005, an Ohio EPA inspection revealed that the plant's laboratory employed neither a QA/QC program nor log books for instrument calibration. In addition, operational conditions at the WWTP relating to downtime of aeration blowers, condition of the clarifiers, and inoperable automatic fine screening were not reported from 2003 to 2005.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, eleven violations were reported; most were for oxygen demand and suspended solids. In the summer of 2005, violations were attributed to heavy use at the local car wash, high seasonal temperatures and low temperatures in the aeration basin. In 2007, a Main Street manhole overflowed to Todd Fork due to a blockage from a local carry-out without a grease trap. Reporting Frequency Violations were also reviewed for the same time period, with a total of 536 between 2004 and 2006. The violations were mostly for odor, water color and turbidity and commonly occurred in April and August.

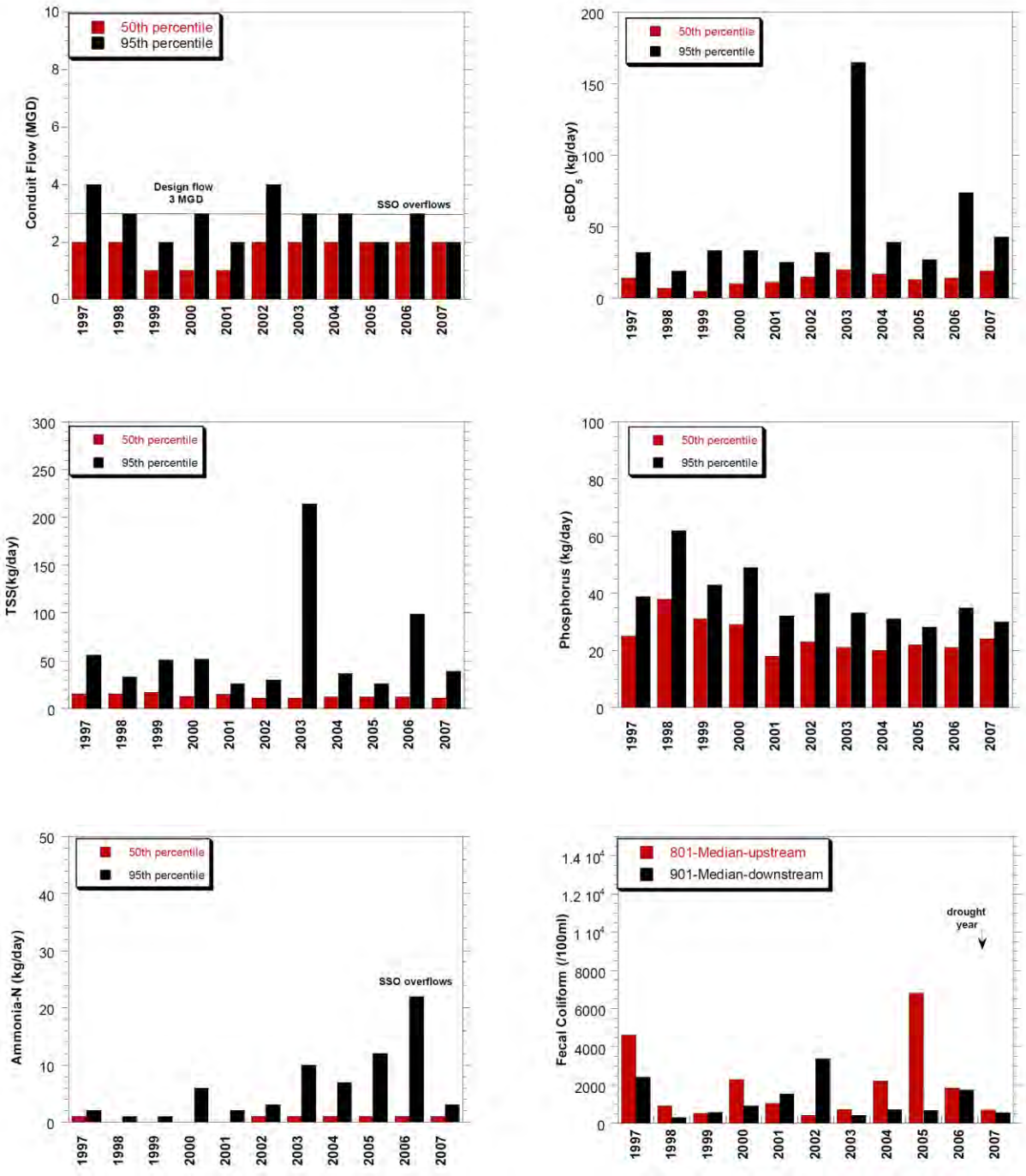

Figure 45. Annual Third-quarter loadings (kg/day) of conduit flow, cBOD5, Total Suspended Solids (TSS), phosphorus and ammonia-N; and concentrations of fecal coliform (CFU/100mL) at the Wilmington WWTP in the Todd Fork study area, 1997-2007.

Joy Outdoor Education Center - (aka-Camp Joy)
Unnamed Tributary → Todd Fork RM 12.71
Camp Joy is located in Warren County at 10117 Old 3C Highway in Clarksville, Ohio. Camp Joy was originally founded in 1938 as a weekend, outdoor and environmental education center and has grown into a year-round operation serving children, schools, families, businesses, and organizations. Camp Joy is a 315-acre campus located in Clarksville, Ohio (Warren County). An upgrade to the facility wastewater system occurred in 2008 and included the replacement of an equalization system, the addition of dechlorination and a new flow meter. The average flow design of the facility is currently 12,000 gpd.

Numeric Violations of the NPDES permit were reviewed from 2004 to a portion of 2008. For the nearly five years of data, evaluated through SWIMS, 16 violations were reported that consisted mostly of chlorine, ammonia-N and $cBOD_5$, occurring in all months except winter. The violations were attributed to facility renovations where tank numbers were limited and treatment was more difficult to predict.

Village of Blanchester WWTP
Second Creek RM 10.1 → Todd Fork RM 3.02
The Village of Blanchester WWTP is located in Clinton County at 600 West Main Street in Blanchester. A major upgrade of the facility was constructed in 1997 and a sewer separation project was constructed along Main Street in 2001. The treatment system consists of mechanical screening, grit removal, primary clarification, an oxidation ditch, secondary clarification, chlorination, post aeration and de-chlorination. Inflow and infiltration (I/I) is estimated at 300,000 gpd and the average flow rate in 2007 was 0.681 MGD. Potential Sanitary Sewer Overflow (SSO) areas are located at the Cherry Street and Bourbon Street lift stations, and at the sewage plant.

I/I problems regularly plague the facility and the sewage collection system. Overflows to Second Creek during heavy rains occurred in 2006 and 2007 at the Bourbon Street lift station and at two facility manholes. Further, during Ohio EPA's summer survey of 2007, raw sewage was observed emanating from a sanitary sewer riser upstream from the WWTP final outfall at SR 123, and also at a pipe just upstream from Blanchester's outfall. Blanchester is currently under Ohio EPA Director's Findings and Orders to remediate these raw sewage discharges and to construct an equalization basin to capture excessive wet weather inflow.

Numeric violations of the NPDES permit were reviewed from 2004 to a portion of 2008. Approximately 110 violations of suspended solids, copper, ammonia and $cBOD_5$ occurred over the period of review. Copper violations from 2004 and 2005 may be attributed to the use of copper sulfate to control excessive algal growth at the Blanchester Water Treatment Plant surface water reservoir. Although the Village stopped using copper sulfate as an algaecide in the summer of 2005 and switched to EarthTec (a liquid algaecide/bactericide with a lower copper content), the violations continued. In 2009, Blanchester plans to test two new methods to reduce the copper discharge. One method involves the application of PACTM27, a non-copper based algaecide. The second method involves removal of the copper from the slurry by

adding a polymer and subsequently routing the treated slurry through a geotextile woven bag before discharging the filtrate to the sanitary sewer. Approximately 70 Reporting Frequency Violations of mostly metals and suspended solids were also documented during the same time period. Violations were caused by I/I problems, *Nocardia* emulsions, clogged primary clarifiers, and equipment failures.

BP Amoco Oil Company - Blanchester Bulk Plant

Unnamed tributary → Second Creek RM 10.1 → Todd Fork RM 3.02

BP Amoco Oil Company is located in Clinton County at 210 South Wright Street in Blanchester, Ohio. This small, unmanned bulk oil terminal receives refined petroleum products by transport truck from a BP-owned terminal. Components of refined petroleum products from this facility are xylene, vanadium, xylenol, vinyl acetate, and zirconium. The product is stored in above ground or underground tanks and distributed to consumers by smaller tank trucks. The seven product storage tanks are underground and no blending takes place onsite. Unleaded, high sulfur and kerosene fuels are stored onsite.

All drains capturing spilled material at the facility flow into an oil/water separator and then to a recovery tank. The oily fraction discharges into an onsite lined containment pond and the water fraction discharges to an unnamed tributary to Second Creek. The oily material is trucked off-site for disposal twice a year.

Numeric NPDES permit violations, along with Reporting Frequency Violations, were reviewed from 2004 to a portion of 2008. For the nearly five years of data, as evaluated through SWIMS, no violations were reported.

Chemical and Recreational Water Quality

Inorganic water chemistry grab samples were collected at 36 sites in the watershed, including 10 sites on the mainstem of Todd Fork. Two sites (Whitacre Run RM 1.15 and Cowan Creek RM 12.45) were also sampled for organic compounds. Bacteria samples (*E. coli*) were collected at 12 sites five times in 2007. Additionally, Datasonde© continuous monitors recorded hourly dissolved oxygen, temperature, pH, and specific conductivity for a 48-hour period in July, August, and September at several sites.

Table 21. Exceedences of Ohio EPA water quality criteria (OAC 3745-1) (and other chemicals not codified for which toxicity data is available) for chemical/physical water parameters measured in grab samples taken from the Todd Fork study area during the summer of 2007 (units are µg/l for metals and organics, C° for temperature, SU for pH, and mg/l for all other parameters).

***Stream* (*use designation* [b])**		Parameter (value)
12-digit WAU [a]	River Mile	
Todd Fork (WWH, PCR, AWS, IWS)		
06-02	32.72	Dissolved Oxygen (4.85‡) Iron-T (11800∞)
07-04	12.20	Temperature (29.00*)
07-04	8.53	Temperature (30.02**)
07-04	5.60	Temperature (31.64**)
07-04	2.65	Temperature (30.70**, 28.60*, 29.25*)
07-04	0.14	Temperature (34.27**, 32.30**, 31.16**)
Dutch Creek (EWH, PCR, AWS, IWS)		
06-01	0.28	Dissolved Oxygen (5.15‡)
Cowan Creek ***- Cowan Lake (RM 6.3) to mouth: (WWH, PCR, AWS, IWS)*** ***- RM 11.6: (WWH, PCR, PWS, AWS, IWS)*** ***- All other segments: (WWH, PCR, AWS, IWS)***		
06-04	16.62	Dissolved Oxygen(2.73‡‡, 2.97‡‡, 2.00‡‡, 1.64‡‡,1.73‡‡,1.89‡‡)
06-04	13.2	Dissolved Oxygen (3.62‡‡) Temperature (27.81*)
06-04	12.45	Dissolved Oxygen (2.88‡‡, 3.62‡‡ , 3.95‡‡) Iron-T (6850∞)
06-05	6.80	Dissolved Oxygen (3.93‡‡, 3.55‡‡ , 4.64‡)
06-05	2.82	Temperature (29.44**)
06-05	0.6	Dissolved Oxygen (1.87‡‡, 2.78‡‡ , 2.80‡‡)
East Fork Todd Fork (WWH, PCR, AWS, IWS)		
07-01	18.29	Dissolved Oxygen (4.64‡, 4.05‡ , 4.35‡,4.93‡)
07-01	17.28	Dissolved Oxygen (4.38‡, 3.11‡‡ , 2.95‡‡, 2.88‡‡, 3.29‡‡)

***Stream* (*use designation* [b])**		Parameter (value)
12-digit WAU [a]	River Mile	
07-01	11.46	Dissolved Oxygen (4.81‡, 4.89‡, 4.69‡)
07-01	7.12	Dissolved Oxygen (2.84‡‡, 3.68‡‡, 3.29‡‡)
07-01	1.60	Dissolved Oxygen (3.85‡‡, 4.70‡)
Second Creek (WWH, PCR, AWS, IWS)		
07-02	10.94	Dissolved Oxygen (3.82‡‡, 3.43‡‡, 4.22‡)
07-02	9.45	Copper (22*, 28**)
07-02	1.53	Temperature (28.80*)
Whitacre Run (undesignated)		
07-02	1.15	Dissolved Oxygen (2.82‡‡, 1.50‡‡, 1.73‡‡, 2.70‡‡)
First Creek (WWH, PCR, AWS, IWS)		
07-03	3.83	Dissolved Oxygen (3.95‡‡, 4.97‡, 4.83‡)

a See Table 5 .

b Use designations:

Aquatic Life Habitat	Water Supply	Recreation
LRW - limited resource water	IWS - industrial water supply	PCR - primary contact
WWH - warmwater habitat	AWS - agricultural water supply	SCR - secondary contact
EWH - exceptional warmwater habitat	PWS- public water supply	BWR -bathing water
Undesignated		

└ [WWH criteria apply to „undesignated' surface waters.]

* exceedence of numerical criteria for prevention of chronic toxicity (CAC).
** exceedence of numerical criteria for prevention of acute toxicity (AAC).
*** exceedence of numerical criteria for prevention of lethality (FAV).
Δ exceedence of the pH criteria (6.5-9.0).
exceedence of numerical criteria for the protection of human health (non-drinking-protective of people against adverse exposure to chemicals via eating fish).
■ exceedence of numerical criteria for the protection of human health (drinking water-public water supply).
∞ exceedence of agricultural water supply criterion.
‡ value is below the EWH minimum 24-hour average D.O criterion (6.0 mg/l) or value is below the WWH minimum 24-hour average D.O criterion (5.0 mg/l) or value is below the LRW minimum 24-hour average D.O criterion (3.0 mg/l) as applicable.
‡‡ value is below the EWH minimum at any time D.O. criterion (5.0 mg/l) or value is below the WWH minimum at any time D.O. criterion (4.0 mg/l) or value is below the LRW minimum at any time D.O. criterion (2.0 mg/l) as applicable.

Table 22. Nutrient sampling results in the Todd Fork watershed, 2007. Values above applicable reference values (targets) are highlighted in yellow.*

Stream (use designation) [a]				Ammonia-N (mg/l)		Nitrate-nitrite-N (mg/l)		Phosphorus-T (mg/l)	
RM	12-Digit WAU [b]	Ecoregion[c]	Drainage Area (mi^2)	Median[#]	Target*	Median[#]	Target*	Median[#]	Target*
Todd Fork (WWH)									
32.72	06-02	ECBP	14.4	0.115	0.100	0.17	2.24	0.04	0.07
25.17	06-02	ECBP	29.1	0.052	0.096	0.17	2.80	0.07	0.11
19.48	06-06	ECBP	56	0.050	0.096	0.20	2.80	0.04	0.11
17.10	06-06	ECBP	135	0.086	0.096	2.13	2.80	0.59	0.11
15.10	06-06	ECBP	142	0.092	0.096	1.78	2.80	0.49	0.11
12.20	07-04	ECBP	192	0.082	0.096	1.65	2.80	0.32	0.11
8.53	07-04	IP	198	0.052	0.100	0.17	1.00	0.21	0.10
5.60	07-04	IP	200	0.054	0.100	0.13	1.00	0.16	0.10
2.65	07-04	IP	239	0.050	0.100	0.23	1.50	0.12	0.17
0.14	07-04	IP	261	0.050	0.100	0.18	1.50	0.08	0.17
Dutch Creek (EWH)									
0.28	06-01	ECBP	14.7	0.050	0.100	0.10	0.98	0.05	0.05
Lytle Creek (WWH)									
9.30	06-03	ECBP	3	0.100	0.100	1.29	2.24	0.12	0.07
7.01	06-03	ECBP	8.1	0.080	0.100	0.29	2.24	0.11	0.07
6.83**	06-03	ECBP	-	0.050	-	14.80	-	3.93	-
5.94	06-03	ECBP	9.3	0.052	0.100	12.15	2.24	2.99	0.07
2.76	06-03	ECBP	15.9	0.050	0.100	7.52	2.24	1.95	0.07
0.65	06-03	ECBP	19.8	0.050	0.100	6.18	2.24	1.35	0.07
Cowan Creek (WWH)									
16.62	06-04	ECBP	15.1	0.118	0.100	0.10	2.24	0.13	0.07
13.15	06-04	ECBP	26	0.061	0.096	0.10	2.80	0.09	0.11
12.45	06-04	ECBP	32	0.119	0.096	0.24	2.80	0.05	0.11
6.80	06-05	ECBP	40	0.094	0.096	0.22	2.80	0.08	0.11
2.82	06-05	ECBP	51	0.050	0.096	0.11	2.80	0.05	0.11
0.65	06-05	ECBP	54	0.050	0.096	0.10	2.80	0.04	0.11
Indian Run (WWH)									
0.2	06-04	ECBP	4.1	0.050	0.100	0.37	2.24	0.03	0.07
East Fork Todd Fork (WWH)									
18.29	07-01	ECBP	7.8	0.081	0.100	0.12	2.24	0.03	0.07
17.28	07-01	ECBP	14.6	0.117	0.100	0.14	2.24	0.07	0.07
11.46	07-01	ECBP	27.9	0.050	0.096	0.10	2.80	0.05	0.11
7.12	07-01	ECBP	35	0.094	0.096	0.18	2.80	0.08	0.11
1.60	07-01	ECBP	37.3	0.082	0.096	0.10	2.80	0.11	0.11
Lick Run (EWH)									
1.28	07-04	IP	12.3	0.050	0.110	0.10	0.50	0.04	0.05
Second Creek (WWH)									
10.94	07-02	IP	6.8	0.211	0.110	0.41	1.00	0.35	0.08
9.45	07-02	IP	11	0.055	0.110	18.70	1.00	0.62	0.08
6.55	07-02	IP	13.2	0.050	0.110	13.00	1.00	0.45	0.08
1.53	07-02	IP	19	0.050	0.110	0.67	1.00	0.21	0.08
Whitacre Run (undesignated-WWH apply)									

Stream (use designation) [a]				Ammonia-N (mg/l)		Nitrate-nitrite-N (mg/l)		Phosphorus-T (mg/l)	
RM	12-Digit WAU [b]	Ecoregion [c]	Drainage Area (mi^2)	Median#	Target*	Median#	Target*	Median#	Target*
1.15	07-02	IP	1.5	0.257	0.110	0.15	1.00	0.47	0.08
First Creek (WWH)									
3.83	07-03	IP	13.8	0.087	0.110	0.16	1.00	0.12	0.08

* Target values per *Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams* –Tables 1 and 2, Appendix Table 1(Ohio EPA Technical Bulletin MAS/1999-1-1).

Ecoregion **Eastern Corn Belt (ECBP)**	**Headwater (0-20mi²)**		**Wadeable (>20-200 mi²)**		**Small River (>200-1000 mi²)**		**Large River (>1000 mi²)**	
	WWH	**EWH**	**WWH**	**EWH**	**WWH**	**EWH**	**WWH**	**EWH**
NO_3-NO_2-N (mg/l)	2.24	**0.98**	2.80	**0.84**	3.06	**1.65**	4.14	**3.08**
Phosphorus-T (mg/l)	0.07	**0.05**	0.11	**0.08**	0.17*	**0.17**	0.41	**0.46**
NH_3-N (mg/l) (90 th%tile)	0.1		0.096		0.074		0.299	

* Associations document has 0.16 mg/l; however the Upper LMR TMDL has 0.17 mg/l in Table 8 (p29) as the target.

Ecoregion **Interior Plateau (IP) (USE STATEWIDE)**	**Headwater (0-20mi²)**		**Wadeable (>20-200 mi²)**		**Small River (>200-1000 mi²)**		**Large River (>1000 mi²)**	
	WWH	**EWH**	**WWH**	**EWH**	**WWH**	**EWH**	**WWH**	**EWH**
NO_3-NO_2-N (mg/l)	1.0	**0.5**	1.0	**0.5**	1.5	**1.0**	2.0	**1.5**
Phosphorus-T (mg/l)	0.08	**0.05**	0.10	**0.05**	0.17	**0.10**	0.30	**0.15**
NH_3-N (mg/l) (90 th%tile)	0.11		0.1		0.1		0.2	

** Wilmington WWTP effluent sample
\# Data medians from summer sampling July- September 2007.

a Use designations (aquatic life habitat)
LRW - limited resource water
WWH - warmwater habitat
EWH - exceptional warmwater habitat
Undesignated (WWH criteria apply to „undesignated' surface waters)

b See Table 5
c Ecoregion: Interior Plateau (IP), Eastern Cornbelt Plain (ECBP)

Table 23. Ohio EPA bacteriological (*E. coli*) sampling results in the Todd Fork study area during 2007 and 2008. All values are expressed as colony forming units (cfu) per 100 ml of water. Values above criteria are highlighted in red. *

Stream RM	12- Digit WAU [a]	Location	Year	# of samples	*E. coli*		Attainment Status	Suspected Sources of Bacteria [b]
					Geometric Mean	Max Value		
Class B – Primary Contact Recreation (PCR) ***(most streams; those that are not Class A or C) – Geometric Mean ≤ 161 Maximum ≤ 523***								
Todd Fork - *PCR*								
19.5	06-06	SR 22, Upst Lytle Cr	2007	5	91	**2100**	FULL	
17.10	06-06	Adjacent Creek Rd, Dst Cowan Cr	2007	5	103	320	FULL	
15.10	06-06	Spring Hill Rd, Dst Clarksville WWTP	2007	5	78	**760**	FULL	
0.14	07-04	SR 22/3 (Morrow)	2007	5	46	400	FULL	
			2008	5	**209**	**1300**	**NON**	H,J
Lytle Creek- *PCR*								
7.01	06-03	Nelson Rd, Upst Wilmington WWTP	2007	5	**455**	**1200**	**NON**	F,G
			2008	3	**783**	**8400**	**NON**	F,G
5.95	06-03	Dst Wilmington WWTP and landfill at ford	2007	5	**1570**	**2800**	**NON**	C,F,G,H
0.65	06-03	Clarksville Rd	2007	5	**304**	**2000**	**NON**	A,C,F,G,H
			2008	5	**701**	**7800**	**NON**	A,C,F,G,H
Cowan Creek - *PCR*								
0.6	06-05	Clarksville Rd	2007	5	46	100	FULL	
			2008	3	84	250	FULL	
East Fork Todd Fork - *PCR*								
7.12	07-01	SR 730	2007	4	106	**1000**	FULL	
1.60	07-01	SR 132 (Clarksville)	2007	5	145	**750**	FULL	
			2008	3	**233**	310	**NON**	G,H
Second Creek- *PCR*								
10.94	07-02	Columbus Ave (Upst Blanchester WWTP)	2007	5	34	370	FULL	
9.45	07-02	SR 123 (Dst Blanchester WWTP)	2007	5	**228**	430	**NON**	C,F,H

Stream RM	12- Digit WAU [a]	Location	Year	# of samples	*E. coli*		Attainment Status	Suspected Sources of Bacteria [b]
					Geometric Mean	Max Value		

* Samples were collected from July 19 - August 16, 2007 and from May 22 - October 27, 2008. Attainment status (determined solely on *E. coli* samples) is based on the seasonal (May 1- October 31) geometric mean if more than one measurement is available and on the single sample maximum if only one measurement is available (Ohio Administrative Code 3745-1-41).

a See Table **5**

b **Suspected Sources of Bacteria:**

A - Failing home sewage treatment systems
B - Livestock access to stream
C - Wastewater treatment plant
D - Unsewered community
E - Combined sewer overflow (CSOs)
F - Sanitary sewer overflows (SSOs)
G -Urban runoff (city, village, etc.)
H - Agricultural runoff
I - Wildlife (geese, etc)
J - Unknown

Todd Fork

While water quality in the mainstem of Todd Fork was generally good, the lower reaches reflected the impact of nutrient enrichment. Dissolved oxygen, relatively stable in the upper mainstem with all values above minimum water quality criteria, reached supersaturated levels at downstream sites (RMs 2.65 and 0.14). The lower mainstem also experienced high temperatures with numerous values above water quality criteria (Table 21). Datasonde© continuous monitors also recorded elevated temperatures and significant dissolved oxygen diurnal flux at the two most downstream sites as the summer progressed (Figure 46).

Nitrate-nitrite-N and phosphorus levels spiked downstream of the Lytle Creek confluence (Figure 47, Table 22), reflecting the remarkably sustained impact of nutrient loading from the Wilmington WWTP discharge (RM 6.83 on Lytle Creek). The overall median phosphorus concentration for all samples collected in Todd Fork at sites upstream of Lytle Creek was 0.06 mg/l compared to 0.22 mg/l for downstream sites. The Clarksville WWTP (RM 15.36) as well as the nutrient load delivered from Second Creek and First Creek (confluences at RMs 3.02 and 0.54, respectively) may also have contributed to the phosphorus load in the lower mainstem. Algae-covered substrates were observed at several downstream sites throughout the summer, most notably near the mouth (RM 0.14). Persistent drought conditions, lower flows and an open canopy (elevated temperatures) in this lower reach of Todd Fork exacerbated the negative impact of existing nutrient loads. Phosphorus concentrations remained elevated well above target reference values before becoming largely assimilated near the mouth (median 0.08 mg/l).

There were no exceedences of water quality criteria for ammonia and the majority of concentrations were well below target reference levels. The highest levels occurred in the headwaters at Starbuck Road (RM 32.72) where values were minimally above the target value (median 0.115 mg/l).

Bacteria samples collected in 2007 at four sites in Todd Fork indicate that the PCR Class B criterion was attained. Possible sources of bacteria include general agricultural runoff.

Dutch Creek

Dutch Creek drains 15 mi^2 and enters Todd Fork at RM 22.10. Water quality as represented by the one site sampled (RM 0.28) was good (Figure 47). Ammonia, nitrate-nitrite, and total phosphorus were all low with the majority of values well below reference targets. Dissolved oxygen dropped below average EWH criterion once late in the survey when flows were at their lowest.

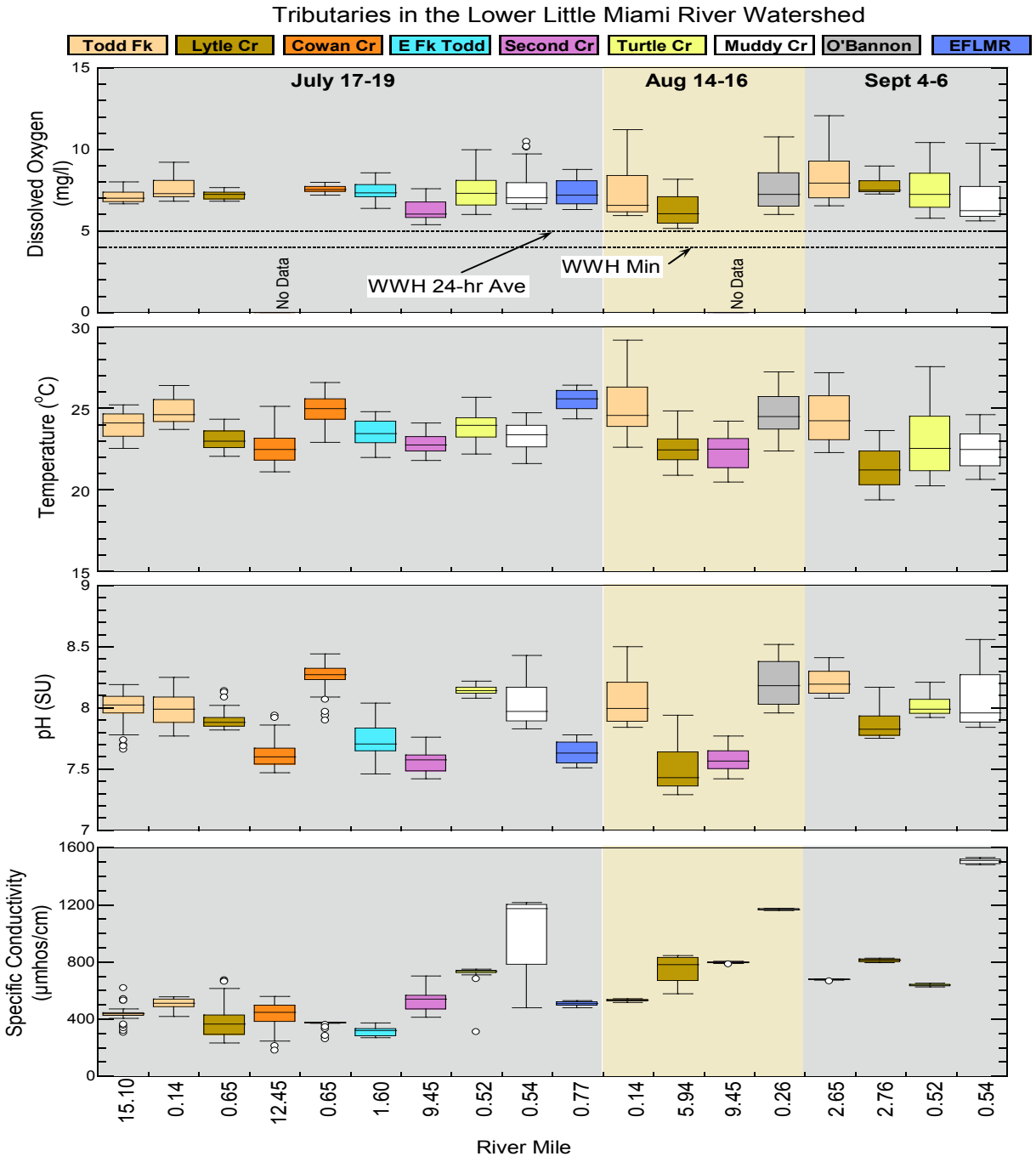

Figure 46. Dissolved oxygen, temperature, pH, and specific conductivity recorded hourly with Datasonde© continuous monitors in select tributaries in the Todd Fork watershed, 2007. Each box encloses 50% of the data with the median value of the variable displayed as a line. The top and bottom of the box mark the limits of ± 25% of the variable population. The lines extending from the top and bottom of each box mark the minimum and maximum values within the data set that fall within an acceptable range. Values outside of this range are displayed as individual points.

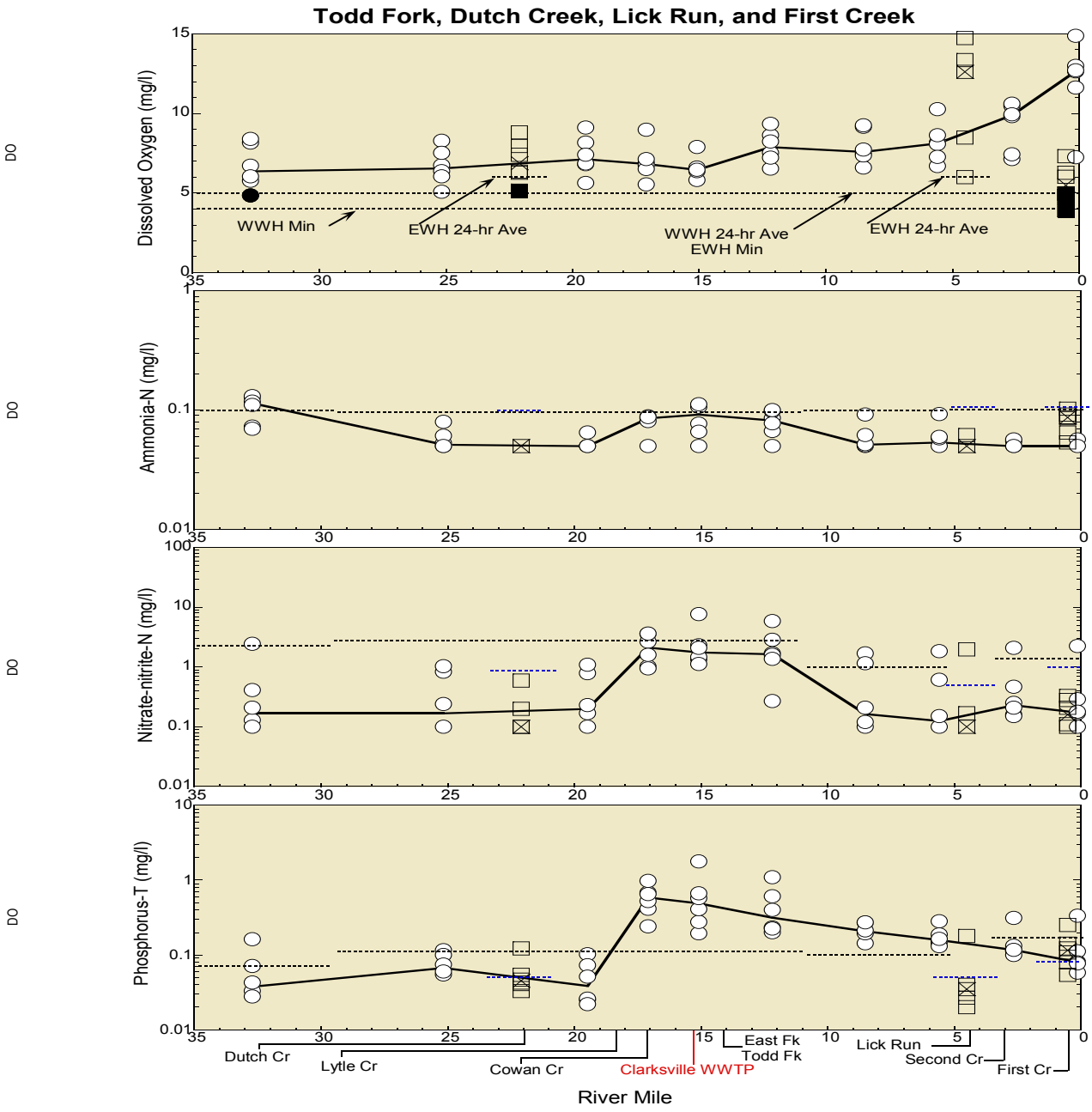

Figure 47. Longitudinal scatter plots of daytime grab dissolved oxygen, ammonia-Nitrogen, nitrate-nitrite-Nitrogen, and total phosphorus in Todd Fork (circles), Dutch Creek RM 0.28 (squares), Lick Run RM 1.28 (squares), and First Creek RM 3.83 (squares) during 2007. The solid line depicts the median value at each river mile sampled in Todd Fork while an 'X' depicts the median in the tributaries. Water quality criteria are shown in the dissolved oxygen concentration plot. (Values not meeting criteria are shown as solid circles or squares.) Dashed horizontal lines represent applicable reference values from sites of similar size in the Eastern Corn Belt Plains (ECBP) and Interior Plateau (IP) ecoregions. (Statewide reference values were used for IP sites).

Lytle Creek

Lytle Creek drains 20 mi^2, including the City of Wilmington, before entering Todd Fork at RM 18.57. Airborne Express Air (ABX) currently has several NPDES permitted stormwater discharges to Lytle Creek. Additionally, the discharge from the Wilmington Sanitary Landfill storm water retention pond enters near RM 6.4 downstream of the City's wastewater facility discharge at RM 6.83. Six sites were sampled in Lytle Creek, including effluent from the Wilmington WWTP.

Daytime grab dissolved oxygen concentrations remained stable longitudinally with no apparent sag downstream from the Wilmington WWTP discharge. Results from Datasonde© continuous monitors deployed at RM 0.65 (July 17-19), RM 5.94 (August 14-16), and RM 2.76 (September 4-6) were also generally unremarkable (Figure 46). All Datasonde© D.O. concentrations remained above minimum water quality criteria with the most diurnal variability observed at RM 5.94 downstream from the Wilmington discharge.

While well within water quality criteria, ammonia-N was somewhat higher in the headwaters at RM 9.30 as compared to downstream sites, with several values above target reference values. This location also experienced the highest single nitrate-nitrite-N concentration of the entire survey (25.8 mg/l) on July 25, a day of lower flows. This site is downstream from several ABX stormwater outfalls. Water discharging from the stormwater system at the Airborne Express Airpark appears to originate from both runoff after precipitation and dry weather flow (ground water discharge). Additionally, throughout the survey field crews observed minimal but continuous flow discharging from two tiles on the north side of the stream adjacent to Wilmington College's Townsend Field. Samples collected from one of these tiles on September 12, 2007 indicated nitrate-nitrite-N (2.12 mg/l) approaching the target value and total phosphorus (0.147 mg/l) above target.

Nitrate-nitrite-N and phosphorus concentrations increased sharply downstream from the Wilmington WWTP in Lytle Creek (Figure 48) and remained elevated well above target reference values to the mouth. Some of the highest nutrient levels of the entire survey occurred in this reach of Lytle Creek. The overall median nitrate-nitrite concentration for the two sites upstream of the Wilmington discharge was 0.59 mg/l compared to 8.2 mg/l for downstream sites. Total phosphorus was elevated above target reference values in 90% of the samples collected in Lytle Creek. Overall median levels increased from 0.11 mg/l at the two sites upstream to 1.95 mg/l for sites downstream of the wastewater plant. Nutrients were conserved and delivered to Todd Fork where concentrations remained elevated well downstream.

Bacteria samples collected in Lytle Creek indicate that the PCR Class B use was not attained. Concentrations in 2007 and 2008 were consistently elevated with 52% of all *E. coli* values above the maximum criteria. Possible sources include runoff from the City of Wilmington, the Wilmington wastewater treatment discharge, sanitary sewer overflows (SSOs), agricultural runoff, and home sewage systems in the lower

watershed. Excluding bacteria, there were no other exceedences of water quality criteria in Lytle Creek.

On May 5, 2006, a shipment containing 79.8 lbs of elemental mercury (quicksilver) leaked onboard an ABX plane enroute from California to Wilmington. Before the leaking shipment was detected it was unloaded and transported to another plane enroute to Chicago. According to ABX documents, of the estimated total six pounds lost, approximately one pound was spilled either to the ground or in the hazmat sort area at the ABX facility in Wilmington. The remaining five pounds were spilled on the two airplanes. Hazmat response crews worked on spill mitigation in the hazmat sort building, but it is unknown how much material was recovered. At the time there was no rain. The area where the aircraft was parked drains to the Lytle Creek watershed through Outfall 002. The hazmat sort area drains to Indian Run (and subsequently Cowan Creek) through Outfall 012. Samples collected by ABX Air and Ohio EPA are presented in
Table 24. All ABX water samples were less than the Ohio water quality criterion for mercury of 12 ng/l. Ohio EPA sediment mercury concentrations were below the Ohio Sediment Reference Value (SRV) of 0.12 mg/kg. Additionally, sediments collected in Lytle Creek, Indian Run, and Cowan Creek during the 2007 survey were below the mercury SRV. (See also *Cowan Creek and Indian Run*.)

Table 24. Water and sediment mercury sampling results following the May 5, 2006 mercury spill at ABX Air in Wilmington, Ohio.*

Date	Weather Conditions	Outfall 002 (ng/l)	Outfall 012** (ng/l)	Lytle Creek RM 10.5*** (mg/kg)	Cowan Creek RM 12.45 (mg/kg)
Water samples collected by ABX Air					
5/11/06	-	11.93	2.82	-	-
5/26/06	-	6.12	2.34	-	-
11/20/06	dry	8.67	-	-	-
11/21/06	dry	1.27	-	-	-
11/22/06	dry	2.79	-	-	-
12/21/06	wet	10.20	-	-	-
Sediment samples collected by Ohio EPA					
12/18/06	-			0.032	< 0.022

* Water Quality Criterion for mercury (human health) = 12 ng/l
Ohio Sediment Reference Value (SRV) for mercury = 0.12 mg/kg
** Older stormwater outfall location not in current NPDES permit
*** Immediately downstream of Outfall 002

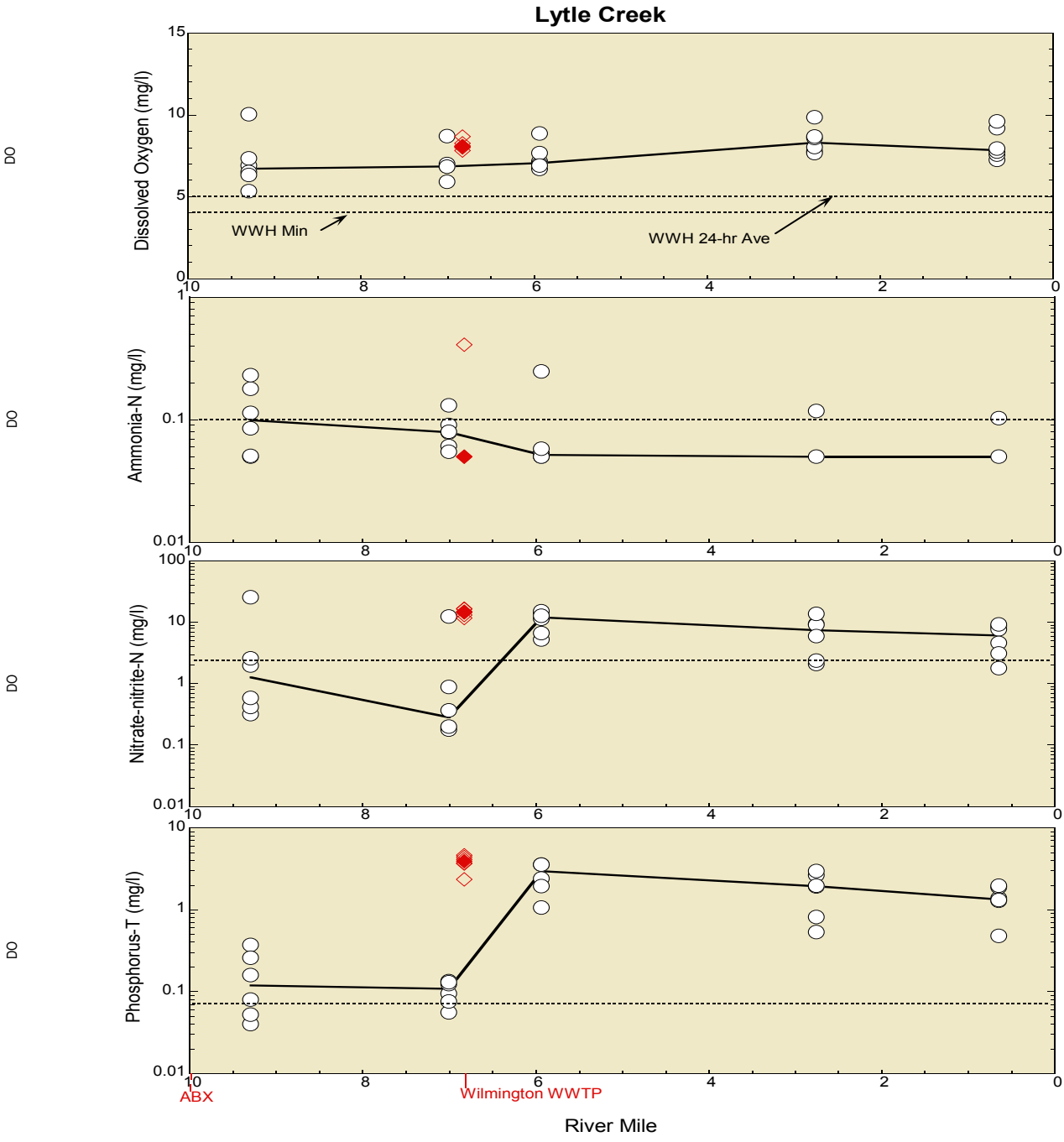

Figure 48. Longitudinal scatter plots of daytime grab dissolved oxygen, ammonia-Nitrogen, nitrate-nitrite-Nitrogen, and total phosphorus in Lytle Creek (circles) and the Wilmington WWTP effluent (diamonds) during 2007. The solid line depicts the median value at each river mile sampled in Lytle Creek while a solid diamond depicts the median in the effluent. Water quality criteria are shown in the dissolved oxygen concentration plot. Dashed horizontal lines represent applicable reference values from sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

Cowan Creek and Indian Run

Cowan Creek drains 54 mi^2 and enters Todd Fork at RM 17.15. Indian Run (drainage area 5 mi^2) enters Cowan Creek at RM 13.06 and is the receiving stream for several ABX Air stormwater outfalls, including a stormwater deicing treatment system. In 1950, a dam was completed across Cowan Creek near RM 3.3 creating Cowan Lake (700 acres), a popular fishing and boating destination. The area was established as Cowan Lake State Park in 1968 with over 1,700 acres. Additionally, the City of Wilmington has a water intake on Cowan Creek downstream of Indian Run. Inorganic water samples were collected in Cowan Creek at six sites and in Indian Run at RM 0.2 downstream of ABX Air outfalls. Atrazine, bis(2-ethylhexyl)phthlate, delta-hexachlorocyclohexane, and 2,4-D were detected once each at the one site on Cowan Creek (RM 12.45) sampled for organics (Appendix Table A-7).

Lower flows contributed to critically low dissolved oxygen levels (< 4.0 mg/l) at five of the six sites in Cowan Creek, most notably in the headwaters at RM 16.62. While D.O. concentrations measured by a Datasonde© monitor deployed at RM 0.65 from July 17-19 remained well above minimum water quality criteria with minimal diurnal variability (Figure 46), flows at the site became interstitial by mid-summer and daytime grab D.O. levels fell below minimum criterion. Overall, 44 percent of all daytime grab dissolved oxygen concentrations in Cowan Creek dropped below water quality criteria (Table 21, Figure 49). Daytime grab D.O. in Indian Run remained above minimum criterion throughout the survey.

A fish kill discovered the next year on May 7, 2008 in Cowan Creek at Cuba Pike (RM 8.38) during a follow-up D.O. survey was attributed to excessively low dissolved oxygen levels caused by the discharge from ABX's deicing treatment cells on Indian Run (outfall 032). Ohio EPA staff also noted very strong odors and excessive amounts of filamentous bacteria in Indian Run downstream of this outfall. ABX uses propylene glycol for aircraft deicing and potassium acetate and sodium formate for pavement deicing. It is not unusual for deicing runoff waters to be treated on-site well into the spring. Grab samples collected on May 8, 2008 by Ohio EPA revealed glycols and high BOD_5 (54 mg/l) downstream of outfall 032 in Indian Run. Additionally, Datasonde© monitors deployed from May 7-9, 2008 indicated critically low D.O. in Indian Run downstream of outfall 032 and in Cowan Creek from RM 12.45 to RM 6.80 (Champlin Road) above Cowan Lake.

Ammonia-N concentrations in Cowan Creek during the 2007 survey were frequently elevated above target reference values in the headwaters (RM 16.62) and downstream of Indian Run (RM 12.45). Concentrations in Indian Run, however, remained low. Nitrate-nitrite-N and total phosphorus concentrations were generally low in both streams. Total phosphorus, however, was consistently elevated above target in Cowan Creek at RM 16.62 (median 0.13 mg/l).

Bacteria samples collected in Cowan Creek at RM 0.65 indicate that PCR Class B criteria were attained in 2007 and 2008.

In May 2006, a mercury shipment leaked at the Airborne Express Airpark in Wilmington (see *Lytle Creek*). A portion of the mercury was spilled in the hazmat sort area which drains to Indian Run and subsequently Cowan Creek. Water and sediment sample results collected by ABX and Ohio EPA are presented in Table 24. Inorganic mercury is converted by bacteria in the water and sediments into the more toxic and bioavailable methylmercury. This process occurs much more quickly in anaerobic conditions such as those found in the wetland areas in the upper portion of Cowan Lake. Methylmercury can accumulate in microorganisms, aquatic plants, and eventually fish tissue. While water quality criteria are devised to be protective of fish consumers, the criteria are based on bioaccumulation factors that can be highly variable from system to system. Fish tissue sample results for mercury collected in Cowan Lake in 2004, 2006, and 2007 are presented in Table 25.

Table 25. Mercury concentration in fish tissue taken from Cowan Lake in 2004, 2006, and 2007.

Species	Date Collected	Number of Samples	Ave Length (inches)	Ave Conc (ppb)	Max Conc (ppb)
Bluegill Sunfish	9/24/2004	4	6	47	50
	11/14/2006	ns	ns	ns	ns
	7/12/2007	2	7	67	70
Channel Catfish	9/24/2004	ns	ns	ns	ns
	11/14/2006	4	14	91	117
	7/12/2007	ns	ns	ns	ns
Common Carp	9/24/2004	4	23	84	102
	11/14/2006	ns	ns	ns	ns
	7/12/2007	2	22	68	69
Largemouth Bass	9/24/2004	ns	ns	ns	ns
	11/14/2006	ns	ns	ns	ns
	7/12/2007	2	11	149	172
Saugeye	9/24/2004	4	12	47	56
	11/14/2006	4	18	143	210
	7/12/2007	ns	ns	ns	ns

ns – no sample

Given these levels, no more stringent advisories for mercury beyond the statewide advisory (1 meal per week) were recommended. Average mercury levels in a species must be greater than 220 ppb to issue a one meal per month advisory. The lake is scheduled for resampling in 2009.

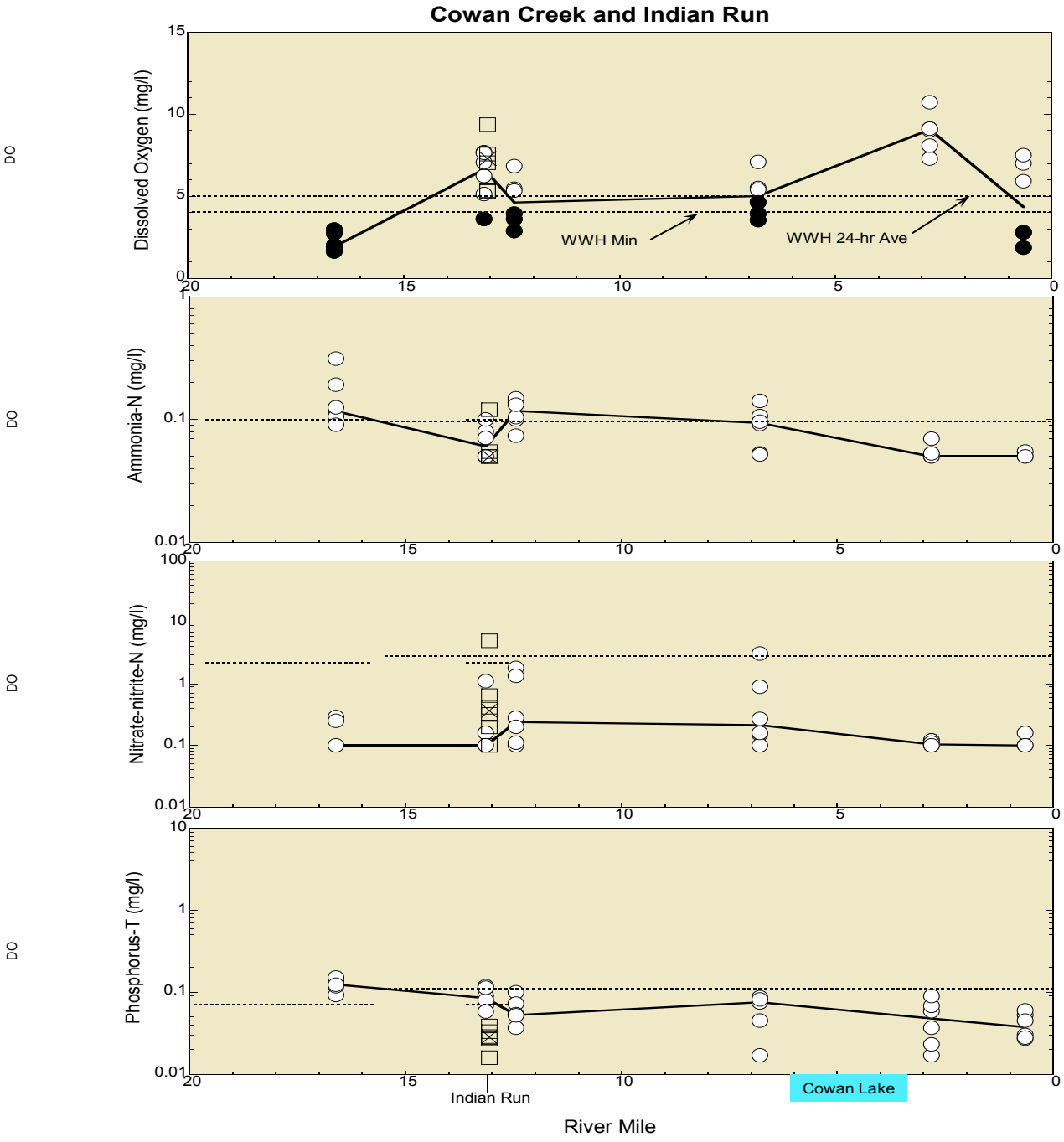

Figure 49. Longitudinal scatter plots of daytime grab dissolved oxygen, ammonia-Nitrogen, nitrate-nitrite-Nitrogen, and total phosphorus in Cowan Creek (circles) and Indian Run RM 0.2 (squares) during 2007. The solid line depicts the median value at each river mile sampled in Cowan Creek while an 'X' depicts the median in Indian Run. Water quality criteria are shown in the dissolved oxygen plot. (Values not meeting criteria are shown as solid circles or squares.) Dashed horizontal lines represent applicable reference values from sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

East Fork Todd Fork

East Fork Todd Fork drains 39 mi^2 before entering Todd Fork at RM 14.07 near Clarksville. Water quality was impacted by drought conditions and resultant low flows. Daytime grab dissolved oxygen levels fell below criteria at all sites (Table 21). While dissolved oxygen as measured by a Datasonde© monitor deployed at RM 1.60 from July 17-19 remained well above minimum water quality criterion and exhibited minimal diurnal variability, the site became interstitial and then totally dry later in the summer.

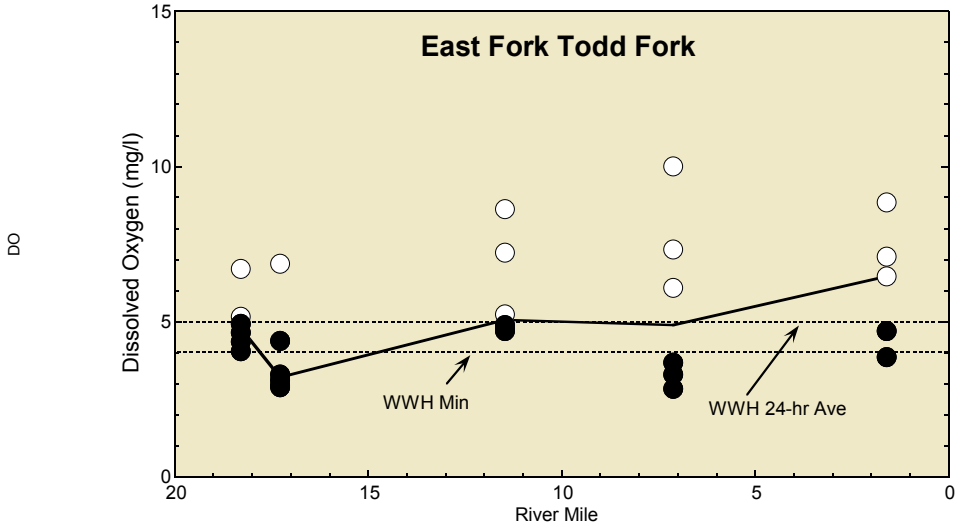

Figure 50. Longitudinal scatter plot of daytime grab dissolved oxygen in East Fork Todd Fork, 2007. Values not meeting criteria are shown as solid circles.

Ammonia-N, nitrate-nitrite-N, and total phosphorus were generally below reference target levels (Table 22). While bacteria samples collected at two sites in 2007 indicated attainment of the PCR Class B use, samples collected in 2008 at RM 1.60 exceeded PCR Class B criteria. Possible sources of bacteria include agriculture and runoff from the village of Clarksville.

Lick Run

Lick Run, a high gradient bedrock stream draining 13.2 mi^2, enters Todd Fork at RM 4.52. One site (RM 1.28) was sampled in this stream during the survey (Figure 47). Exacerbated by an open canopy and progressively lower flows, excessive algal growth pushed daytime grab D.O. to supersaturated levels (median 147%) throughout much of the summer. Flow became interstitial later in the summer. There were no exceedences of water quality criteria and target reference levels for nutrients were generally met.

Second Creek and Whitacre Run

Second Creek drains 20.1 mi^2, including the Village of Blanchester, before entering Todd Fork at RM 3.02. Whitacre Run (drainage area 2 mi^2) enters Second Creek at RM 10.2 and is one of three streams used by Blanchester as a public water supply source (The other streams are in the East Fork Little Miami River watershed). Inorganic water samples were collected in Second Creek at four sites and in Whitacre Run at RM 1.15, downstream of one of Blanchester's water reservoirs (gravity flow from Whitacre Run fills this reservoir). Organic samples were also collected at the Whitacre Run site and revealed atrazine, bis(2-ethylhexyl)phthlate, and 2,4-D (Appendix Table A-7).

Water quality in Second Creek was negatively impacted by excessive nutrient loading (Figure 51). All phosphorus and the majority (67%) of nitrate-nitrite-N concentrations were elevated well above respective target values. Consistently elevated levels of ammonia-N and total phosphorus in both the headwaters of Second Creek (RM 10.94) and in Whitacre Run may reflect upstream agriculture. Nitrate-nitrite-N and total phosphorus increased markedly downstream of the Blanchester WWTP discharge (RM 10.1) and remained elevated for miles downstream. The highest nitrate-nitrite-N levels of the entire survey (median 18.70 mg/l) occurred at RM 9.45.

Dissolved oxygen, pH, conductivity and temperature measured by Datasonde© continuous monitors deployed at RM 9.45 (July 17-19 and August 14-16) downstream of the Blanchester WWTP were relatively stable, demonstrating normal diurnal variability (Figure 46, Tables A-5 and A-6). Exacerbated by increasingly lower flows, daytime grab dissolved oxygen concentrations in both the headwaters of Second Creek (RM 10.94) and in Whitacre Run fell below critical levels as the summer progressed (Table 21, Figure 51). Conversely, daytime concentrations reached supersaturated levels (median 149%) in Second Creek at Cozaddale Road (RM 1.53) where a prodigious amount of algae covered the bedrock substrates throughout most of the summer. Low flows and an open canopy (elevated temperatures) at the site accentuated the negative impact of existing nutrient loads.

Copper exceeded water quality criteria on two occasions at RM 9.45 in Second Creek downstream of the Blanchester WWTP (Table 21). Historically, the wastewater facility has reported numerous copper violations of its NPDES permit. It is believed that the primary source of copper is the Village's water treatment plant slurry discharge to the sewer system (copper sulfate was traditionally used to treat the water treatment plant reservoirs). Although the Village stopped using copper sulfate as an algaecide in the summer of 2005 and switched to EarthTec (a liquid algaecide/bactericide with a lower copper content), the violations continued. In 2009, Blanchester plans to test two new methods to reduce the copper discharge. One method involves the application of PAC^{TM}27, a non-copper based algaecide. The second method involves removal of the copper from the slurry by adding a polymer and subsequently routing the treated slurry through a geotextile woven bag before discharging the filtrate to the sanitary sewer.

During the summer of 2007, Ohio EPA field crews noted a variety of problems at the Blanchester WWTP. Sludge deposits were observed in Second Creek immediately downstream of the facility's outfall. The clarifier effluent contained a considerable amount of pin floc and significant algae growth was observed in the overflow weirs and effluent channel. Historically, Blanchester has consistently violated its NPDES permit for total suspended solids. Inflow and infiltration (I/I) has been a significant problem and wet weather flow can cause solids washout at the plant.

Raw sewage in Whitacre Run downstream SR 28 (September 5, 2007).

On September 5, raw sewage was observed emanating from a sanitary sewer overflow (SSO) to Whitacre Run near RM 0.2 underneath the SR 28 bridge near the wastewater facility entrance. When Blanchester's combined sewer separation project (Main Street) was completed in 2001, two building laterals apparently were not reconnected to the new sanitary sewer and subsequently continued to discharge through the storm sewer to Whitacre Run. As of April 22, 2008, all known illicit cross connections to this storm sewer have been repaired.

Ohio EPA staff also observed a sanitary sewer manhole/riser on Whitacre Run just downstream of this same bridge (SR 28) which showed signs of raw sewage overflow. There have also been documented overflows elsewhere in the Village collection system. Overflows occur during wet weather events and are caused by limitations at the WWTP headworks. The Village has taken significant steps to address its I/I issues. Additionally, on Oct 29, 2008 a Permit to Install (PTI) was issued to the Village of Blanchester for a flow equalization basin. Construction is expected to begin in the spring of 2009.

Bacteria samples collected in Second Creek indicate that the PCR Class B criteria were attained upstream from the Blanchester WWTP (RM 10.94) but not downstream at RM 9.45 (Table 23). Possible sources of bacteria include the Blanchester WWTP, SSOs, as well as general urban and agricultural runoff.

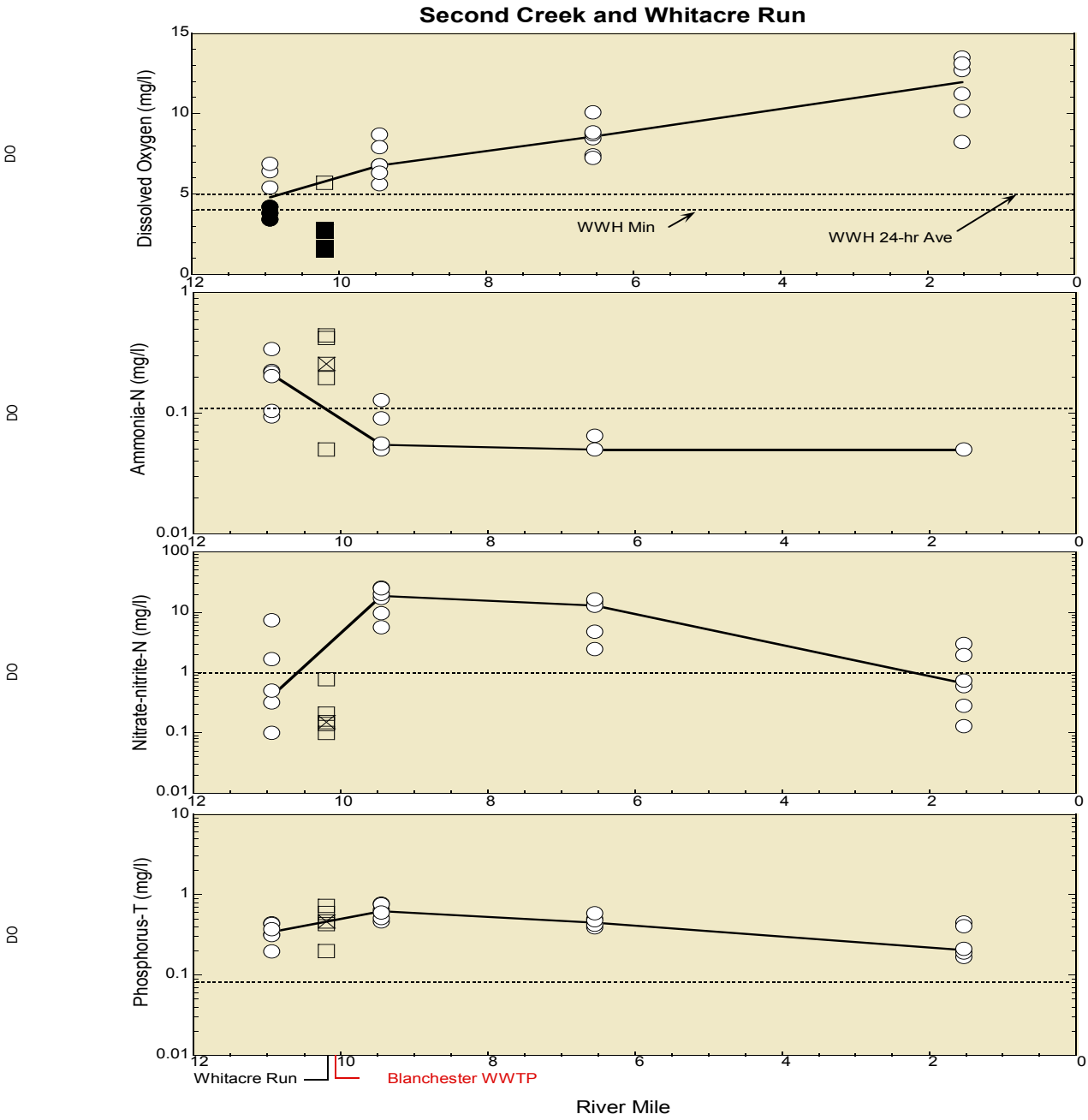

Figure 51. Longitudinal scatter plots of daytime grab dissolved oxygen, ammonia-Nitrogen, nitrate-nitrite-Nitrogen, and total phosphorus in Second Creek (circles) and Whitacre Run RM 1.15 (squares) during 2007. The solid line depicts the median value at each river mile sampled in Second Creek while an „X' depicts the median in the tributary. Water quality criteria are shown in the dissolved oxygen concentration plot. (Values not meeting criteria are shown as solid circles or squares.) Dashed horizontal lines represent applicable reference values from sites of similar size in the Interior Plateau (IP) ecoregion. (Statewide reference values were used for IP sites).

First Creek
First Creek drains 19.8 mi^2 and enters Todd Fork near Morrow at RM 0.54. Water quality in this stream as represented by the one site sampled (RM 3.83) was negatively impacted by stagnant flows. Field crews noted a film on the water's surface and fine silt covering the substrates throughout much of the summer. While daytime grab dissolved oxygen frequently fell below water quality criteria (Figure 47,Table 21), there were no other exceedences of water quality criteria. With the exception of total phosphorus which was minimally elevated above target at the site (median 0.12 mg/l), nutrient levels were generally low.

Chemical Water Quality Trends 1993-2007
Todd Fork and East Fork Todd Fork
Water samples were collected in Todd Fork in 2007 (ten sites) and in 1998 (five sites). While five sites were sampled in the East Fork Todd Fork in the 2007 survey, only one site (RM 1.60) was sampled in 1998. A comparison of water chemistry data for select parameters for the two survey years is presented in Figure 52.

Water quality in Todd Fork in both survey years reflects the ongoing impact of nutrient loading from the Wilmington WWTP discharge (Lytle Creek RM 6.83). Dissolved oxygen concentrations (daytime grabs) were remarkably similar in the two survey years with values reaching supersaturated levels at the most downstream sites both years. Similar longitudinal patterns were also observed in 2007 and 1998 for nutrients, with both nitrate-nitrite-N and total phosphorus increasing significantly downstream of the Lytle Creek confluence (RM 18.57). Total phosphorus remained elevated well above target reference values in both survey years before becoming largely assimilated near the mouth.

All dissolved oxygen concentrations in the East Fork Todd Fork at RM 1.60 were above minimum water quality criterion in 1998 with continuous stream flows in contrast to the interstitial flow and numerous low D.O. values observed during the 2007 survey. Water chemistry results were otherwise similar for both surveys.

Lytle Creek
Water samples collected in Lytle Creek in 2007 and 1998 indicate little change in water quality between the two surveys (Figure 53). Longitudinally, median 2007 concentrations mirrored 1998. Some of the highest nutrient concentrations documented in either survey occurred in Lytle Creek in the reach downstream of the Wilmington WWTP discharge (RM 6.83). Nitrate-nitrite-N and total phosphorus levels remained excessively elevated above target reference values to the mouth in both years.

Cowan Creek and Indian Run
Water samples were collected in both Cowan Creek and Indian Run in 2007 and 1998 (Figure 54). While low and interstitial flows frequently resulted in critically low dissolved oxygen concentrations in Cowan Creek in 2007, higher DO levels were generally measured in 1998. Lower ammonia-N and higher nitrate-nitrite-N levels were measured in Cowan Creek in 1998 compared to 2007. Nitrate-nitrite-N and total phosphorus

concentrations were typically below target reference levels in both Cowan Creek and Indian Run during both survey years.

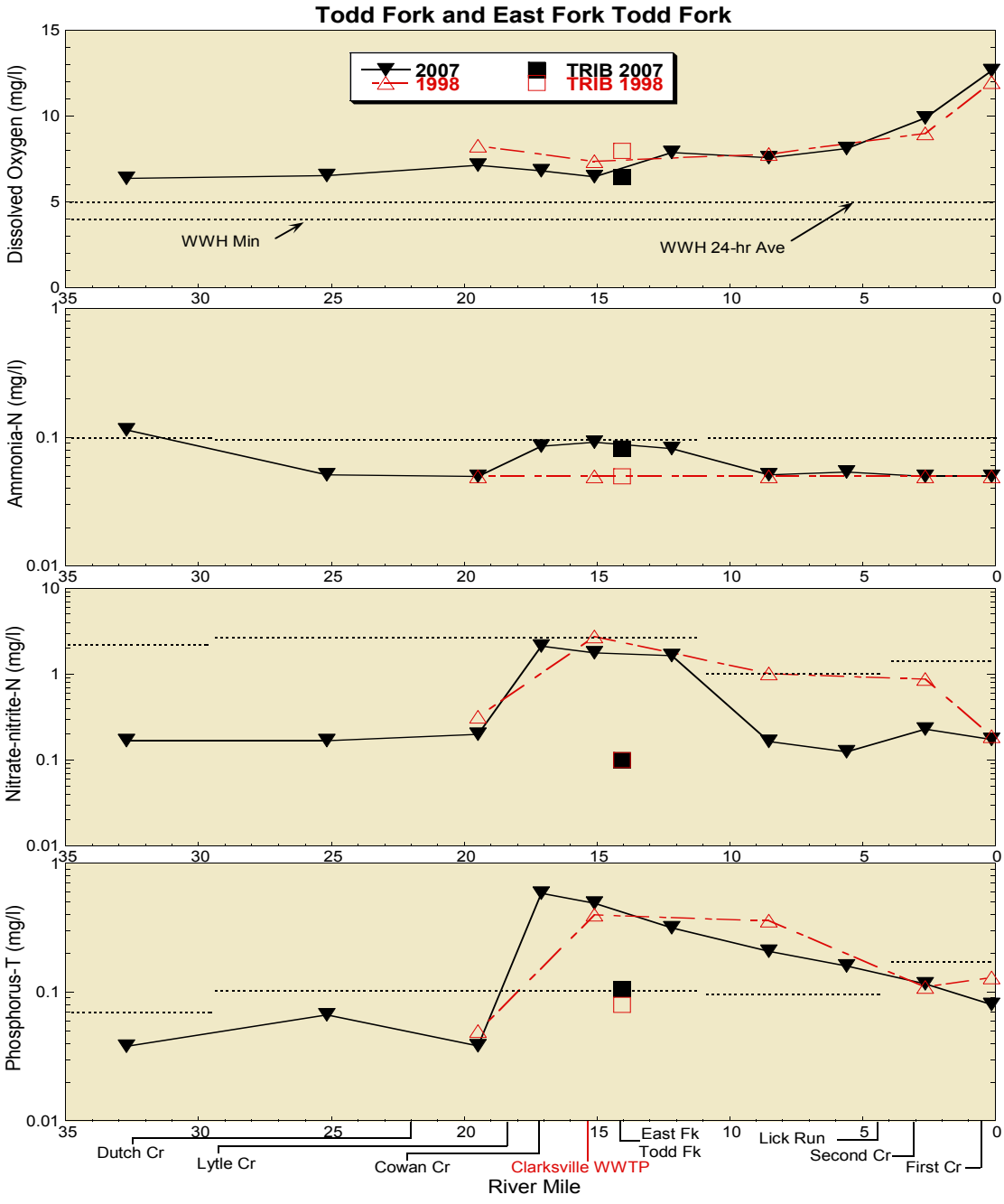

Figure 52. Longitudinal plots of median concentrations of dissolved oxygen, ammonia-Nitrogen, nitrate-nitrite-nitrogen, and total phosphorus in Todd Fork and in East Fork Todd Fork at RM 1.60 (2007 and 1998). Water quality criteria are shown in the dissolved oxygen plot. Dashed horizontal lines in other plots represent applicable reference values from sites of similar size in the Eastern Corn Belt Plains (ECBP) and Interior Plateau (IP) ecoregions. (Statewide reference values were used for IP sites.)

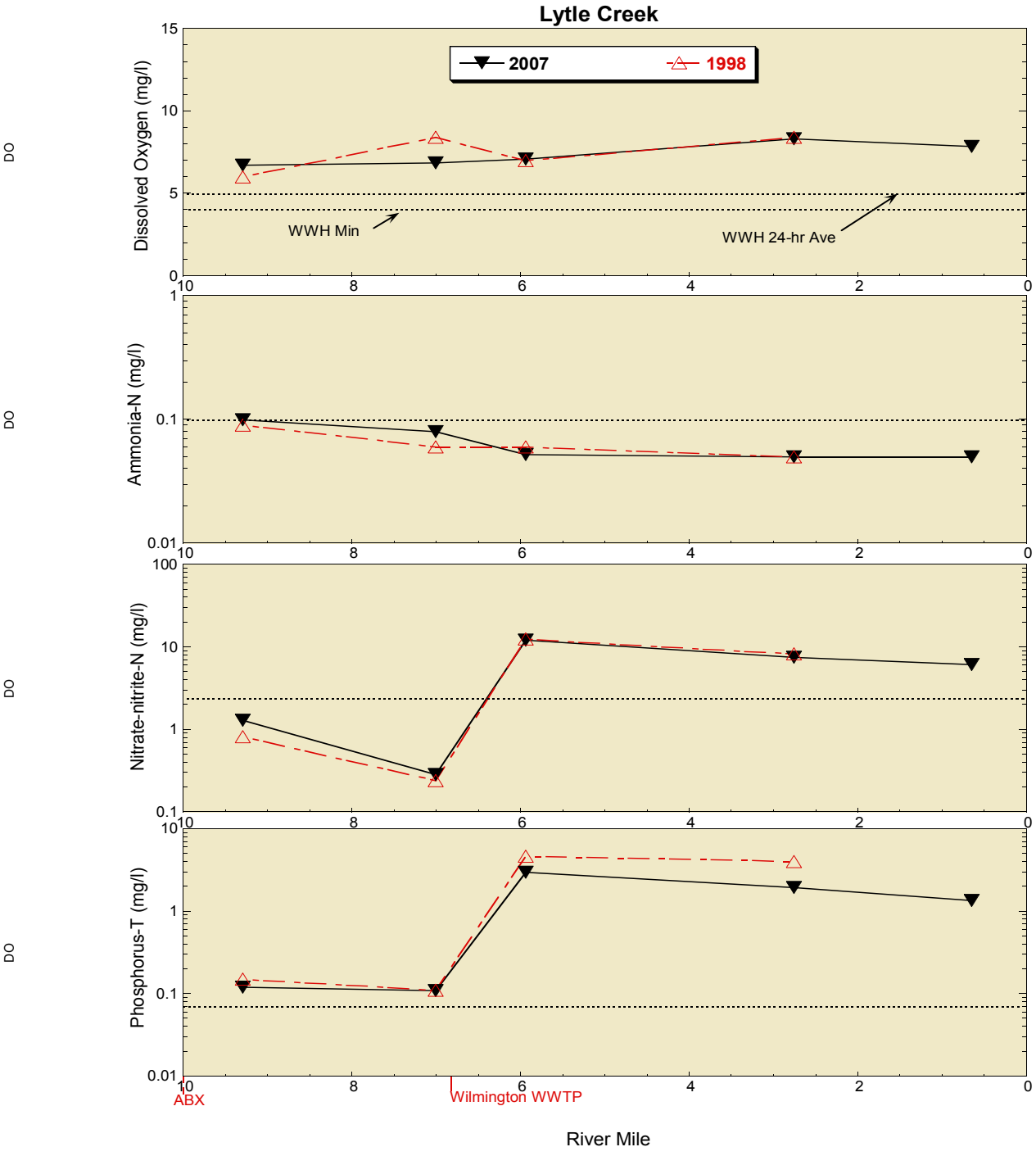

Figure 53. Longitudinal plots of median concentrations of dissolved oxygen, ammonia-Nitrogen, nitrate-nitrite-nitrogen, and total phosphorus in Lytle Creek (2007 and 1998). Water quality criteria are shown in the dissolved oxygen plot. Dashed horizontal lines in other plots represent applicable reference values from sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

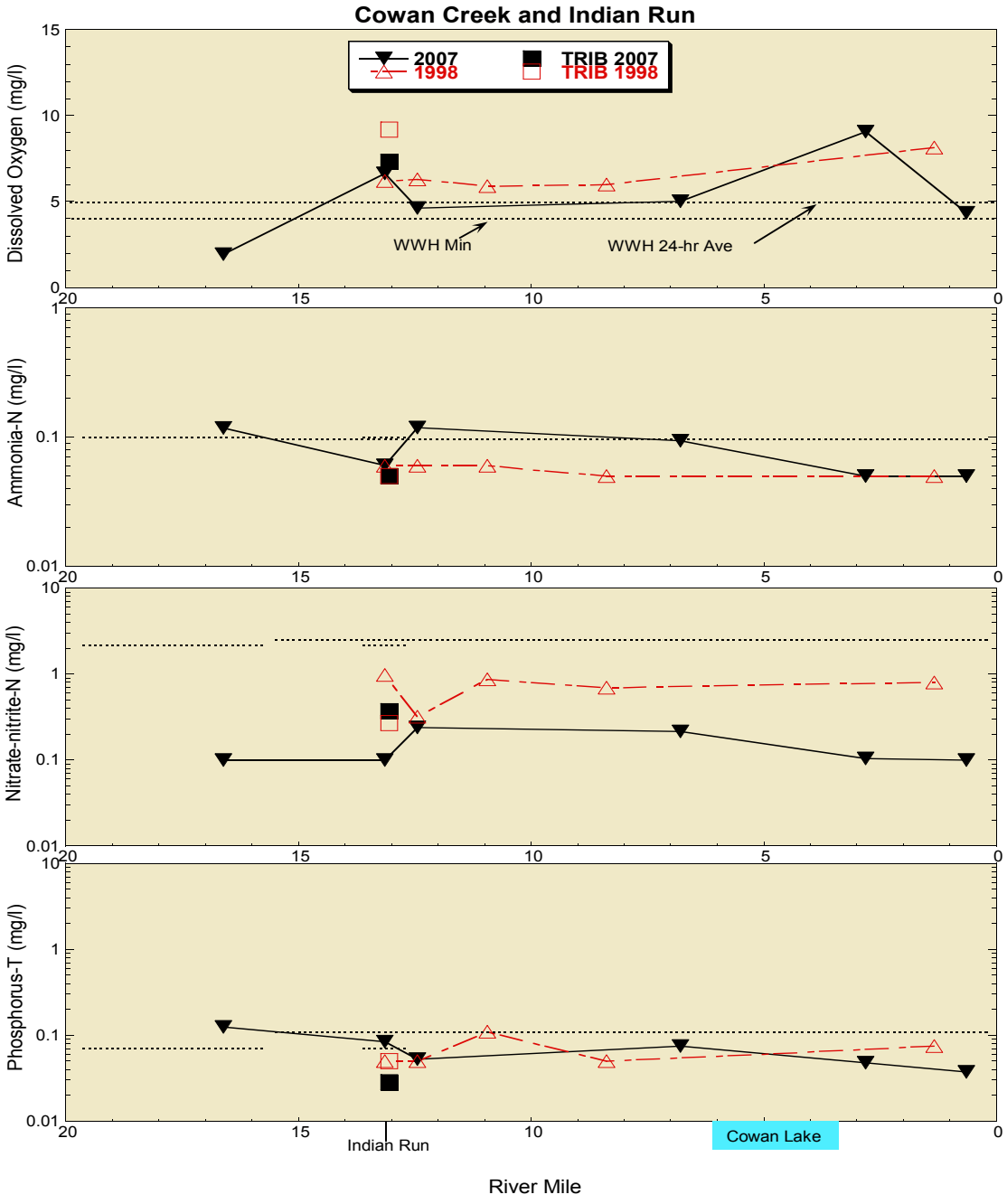

Figure 54. Longitudinal plots of median concentrations of dissolved oxygen, ammonia-Nitrogen, nitrate-nitrite-Nitrogen, and total phosphorus in Cowan Creek and in Indian Run near the mouth (2007 and 1998). Water quality criteria are shown in the dissolved oxygen plot. Dashed horizontal lines in other plots represent applicable reference values from sites of similar size in the Eastern Corn Belt Plains (ECBP) ecoregion.

Chemical Sediment Quality

Todd Fork

Todd Fork was sampled at three locations, RMs 19.5, 15.10 and at RM 0.14 (Table 26). None of the sediment metals sampled at all three locations were found to be over the Ohio and MacDonald sediment guidelines. No sediment organics were detected at any of the three sites. Sediment ammonia was over the Ontario sediment guideline at all three sites, decreasing in concentration downstream.

The uppermost sediment site on Todd Fork is at RM 19.5 at the SR 22 bridge. Sediment ammonia (1300 mg/kg) was well over the Ontario sediment guideline and the highest sediment ammonia levels recorded in the entire survey. Sediment sample was grey/black in color with a pudding consistency. The sample was composed of 45% fine grained material. Sediment phosphorus was 401 mg/kg.

The RM 19.5 site is 1.4 miles downstream from the Thousand Trails RV campground which has an older batch reactor treatment system that has routinely violated its ammonia limit. The rural nature of this part of the watershed also has the possibility of failing septic systems discharging to Todd Fork as well as agricultural influences. The Caesar Creek Flea Market documented 111NPDES violations for suspended solids, ammonia, and $CBOD_5$, from 2004 to 2007. Bypasses from the sand filter discharge 3.7 miles upstream into Little Creek, which empties into Todd Fork at RM 19.8.

The site at RM 15.10 was sampled upstream of the Spring Hill Bridge and downstream of the Clarksville WWTP. Sediment ammonia (650 mg/kg) was well over Ontario sediment guideline. Sediment samples consisted of dark fine sediment deposited over soft sand. This site had overall soft sandy substrate, very slow stream flow, and floating mats of green algae during the hotter part of the survey. No solids or sewage fungus were observed at the Clarksville WWTP outfall.

Todd Fork enters the Little Miami River in the town of Morrow. Sediment was sampled upstream of the SR 22/3 bridge at RM 0.14. Sediment ammonia (170 mg/l) was over the Ontario sediment guideline. A thick growth of algae was present at this sampling event and during other times of the survey. The area generally possessed a sand and gravel substrate with a couple of pockets of fine grained sediment taken for the sample.

Lytle Creek

Lytle Creek, RM 9.30, is located adjacent to Townsend Field of Wilmington College and downstream from discharges from the Airborne Express Airpark. The site is influenced by large stormwater culverts draining urban areas. Sedimentation from flashy stream erosion resulted in soft substrate, allowing a sample of 33.5% fine grained material. No metals or nutrient parameters were above Ohio EPA, MacDonald or Ontario guidelines (Table 26). The sediment organic analysis detected 8 different polyaromatic hydrocarbons for a total PAH concentration of 6.88 mg/kg. This level of total PAH is over the MacDonald threshold effect concentration (adverse affects frequently occur). This group of PAH compounds are frequently associated with asphalt and coal tar sealing materials. Sediment organic analysis also detected Bis (2-Ethylhexyl) phthalate

(1.21 mg/kg) and pentachlorophenol (2.67 mg/kg). Neither compound has been evaluated in the guidelines. Bis (2Ethylhexyl) phthalate is a common plastizer used to soften plastics. Pentachlorophenol is used as a wood preservative.

The Wilmington WWTP and the stormwater retention pond from the Wilmington Sanitary Landfill discharge to Lytle Creek 0.9 and 0.6 miles respectively upstream of the sediment site at RM 5.95. Fine grained material comprised 59.6% of the sample material. Sediment metals were over the Ohio Sediment Reference Value (SRV) for copper (35.8 mg/kg) and zinc (166 mg/kg). Sediment lead (36.8 mg/kg) was over the MacDonald Threshold Effect Concentration but not over the Ohio SRV, indicating that lead at this level is not over background sediment metal concentration for this ecoregion. Sediment ammonia (200 mg/kg) was over the Ontario sediment guideline and phosphorus (1920 mg/kg) was just below the Ontario sediment guideline. The sediment organic analysis detected seven different polyaromatic hydrocarbons for a total PAH concentration of 9.30 mg/kg. The PAH pyrene was detected at 1.25 mg/kg, which was over the MacDonald Probable effect concentration (adverse effects usually or always occur). Sediment organic analysis detected the pesticide gamma-chlordane (9.1 µg/kg) over the MacDonald Probable Effect Concentration (PEC) (adverse effects frequently occur). Sediment organic analysis detected PCB-1254 at 0.260 mg/kg) over the MacDonald PEC.

Lytle Creek, RM 0.65, has a cobble and gravel substrate with ample riparian cover. Fine grained material composed 35.8% of the sample material and was taken from pockets along the banks of the creek in the slower moving section. Sediment manganese (1260 mg/kg) was over the Ohio Sediment Reference Value (SRV) and sediment arsenic (15.3 mg/kg) was over MacDonald Threshold Effect Concentration but not over the Ohio SRV, indicating that arsenic at this level is not over background sediment metal concentration for this ecoregion. Sediment ammonia (160 mg/kg) was over the Ontario sediment guideline. Sediment organic analysis detected PCB-1254 at 0.066 mg/kg over the MacDonald PEC. The PCB and ammonia are probably from upstream sources near Wilmington. The sediment manganese and arsenic could be from the outwash sand and gravel deposits that are mined in the area.

Cowan Creek

Cowan Creek RM 12.45 (WAU 06-04) is near Airborne Express Airpark downstream of Indian Run and 0.7 miles downstream of 47 acres of farm fields at McCoy/Jenkins Road, which are permitted to receive sewage sludge from the Wilmington WWTP. Sediment ammonia (240 mg/kg) was over the Ontario sediment guideline (Table 27). No other sediment metals or organic compounds were found to be over the Ohio or MacDonald sediment guidelines.

Cowan Creek RM 6.80 (WAU 06-05) was muck-laden with 72.6% fine grained material in the sample. No sediment metals, organics or nutrients were detected above the Ohio, MacDonald or Ontario sediment guidelines. Sediment ammonia (95 mg/kg) was detected just below the Ontario sediment guideline (100 mg/kg).

Cowan Creek RM 2.82 (WAU 06-05) is located just below the Cowan Lake spillway and bottom discharge. Sediment ammonia was detected at 430 mg/kg, which was over the Ontario sediment guideline of 100 mg/kg. No other sediment metals or organics were detected above the Ohio and MacDonald sediment guidelines. Lake bottom sediments are in a biochemical reducing atmosphere allowing bacteria to convert nitrogen compounds to ammonia.

Cowan Creek RM 0.65 (WAU 06-05) was sampled upstream of the Clarksville Road bridge. Cowan Creek had interstitial flow with cobble and sand near the bridge. During the summer, groundwater recharge kept the water clear and the dissolved oxygen low. About 1000 feet upstream, the substrate formed into deep pools that collected black and grey fine grained sediment (61.4%). Sediment ammonia was 190 mg/kg, over the Ontario sediment guideline. No other sediment metals or organics were detected above the Ohio and MacDonald sediment guidelines. The bottom sediment from Cowan Lake is suspected to have been carried downstream to this sampling location.

Indian Run

Indian Run near the mouth had no sediment metals, nutrients or organics detected above the Ohio, Ontario or MacDonald sediment guidelines (Table 27). Fine grained sediments were found at 35.8% of total sample.

Table 26. Concentrations (mg/kg unless otherwise noted) of metals and nutrients in sediment samples collected in Todd Fork and Lytle Creek during 2007. Parameter concentrations were evaluated based on Ohio EPA sediment metal reference sites (2003), MacDonald (2000) Sediment Quality Guidelines (SQG) and Persuad (1993). Values above guidelines are highlighted.

Parameter	Stream River Mile (Ecoregion)						***Reference***	
	Todd Fk 19.5 (ECBP)	Todd Fk 15.10 (ECBP)	Todd Fk 0.14 (IP)	Lytle Cr 9.30 (ECBP)	Lytle Cr 5.95 (ECBP)	Lytle Cr 0.65 (ECBP)		
							Ohio SRV ECBP / IP	**MacDonald** TEC -PEC
Al-T [O]	5550	5250	6230	4760	7680	6290	39000 / 28000	*
As-T [OM]	4.87	4.95	3.76	6.10	6.53	15.3 #	18 / 11	9.79-33
Ba-T [O]	59.0	56.9	54.4	36.2	95.4	212	240 / 170	*
Ca-T [O]	57400	52400	45000	39200	42300	36400	120000 / 94000	*
Cd-T [OM]	0.211	0.216	0.163	0.389	0.636	0.378	0.9 / 0.3	0.99-4.98
Cr-T [OM]	<17	<20	<16	<14	<23	<21	40 / 30	43.4-111
Cu-T [OM]	11.6	12.0	9.8	15.6	35.8 +#	19.2	34 / 25	31.6-149
Fe-T [O]	12000	12800	12900	13000	18600	20900	33000 / 31000	*
Hg-T [OM]	<0.043	<0.033	<0.038	0.029	0.070	<0.041	0.12	0.18-1.06
K-T [O]	<1100	<1340	<1050	<904	<1530	<1380	11000 / 5900	*
Mg-T [O]	11900	16600	8920	14900	16500	12300	35000 / 20000	*
Mn-T [O]	436	463	351	224	522	1260 +	780 / 1400	*
Na-T *	<2740	<3340	<2640	<2260	<3820	<3460	*	*
Ni-T [OM]	<22	<27 ?	<21	<18	<31 ?	<28 ?	42 / 33	22.7-48.6
Pb-T [OM]	9.66	11.0	13.7	12.9	36.8 #	19.4	47	35.8-128
Se-T [O]	<1.10	<1.34	<1.05	<0.90	<1.53	<1.38	2.3 / 1.6	*
Sr-T [O]	82	56	79	39	62	49	390 / *	*
Zn-T [OM]	48.4	60.9	57.6	105	166 +#	93.2	160 / 100	121-459
							Ohio	**Persuad**
NH_3-N [P]	1300 [L]	650 [L]	170 [L]	85	200 [L]	160 [L]	*	100
TOC(%) [P]	3.7	3.9	3.3	3.8	4.1	3.8	*	10.0%
pH (SU) *	7.5	7.3	7.3	7.3	7.4	7.3	*	*
P-T [P]	401	618	1640	632	1920	1040	*	2000
%FGM [O]	45.0	21.5↘	50.6	33.5	59.6	35.8	30.0%	*

↘ Below the goal of 30% Fine Grain Material in sample
%FGM Percent Fine Grain Material in sediment sample (<60 micron or >30 seconds settling time)
NA Compound not analyzed. * Not evaluated
[O] Evaluated by Ohio EPA (2003) [M] Evaluated by MacDonald (2000) [P] Evaluated by Persuad (1993)
? Detection limit is greater than guideline

Ohio Sediment Reference Values (SRV) Guidelines (2003)
+ above reference value for ecoregion

Ontario Sediment Guidelines (Persuad 1993)
L > Open Water Disposal Guidelines; equivalent to the Lowest Effect Level (LEL)-applicable to NH_3-N only.
▲ > severe effect level (disturbance in benthic community can be expected)

MacDonald (2000) Sediment Quality Guidelines (SQG)
**>** TEC (Threshold effect concentration) and ≤ PEC (Probable effect concentration)
Adverse effects frequently occur
■ > PEC (Probable effect concentration) -- Adverse effects usually or always occur

Table 27. Concentrations (mg/kg unless otherwise noted) of metals and nutrients in sediment samples collected in Cowan Creek and Indian Run during 2007. Parameter concentrations were evaluated based on Ohio EPA sediment metal reference sites (2003), MacDonald (2000) Sediment Quality Guidelines (SQG) and Persuad (1993). Values above guidelines are highlighted.

Parameter	Stream River Mile (Ecoregion)					***Reference***	
	Cowan Cr 12.45 (ECBP)	Cowan Cr 6.80 (ECBP)	Cowan Cr 2.82 (ECBP)	Cowan Cr 0.6 (ECBP)	Indian Run 0.2 (ECBP)		
						Ohio SRV ECBP / IP	**MacDonald** TEC -PEC
Al-T [O]	5160	8410	11900	9420	6800	39000 / 28000	*
As-T [OM]	4.52	7.13	5.82	6.42	5.17	18 / 11	9.79-33
Ba-T [O]	48.7	80.4	107	108	53.5	240 / 170	*
Ca-T [O]	21800	35900	94000	52200	20600	120000 / 94000	*
Cd-T [OM]	0.197	0.307	<0.231	<0.252	0.198	0.9 / 0.3	0.99-4.98
Cr-T [OM]	<13	13	<35	<38	<13	40 / 30	43.4-111
Cu-T [OM]	10.8	15.4	17.1	15.8	12.0	34 / 25	31.6-149
Fe-T [O]	11100	18300	24400	19000	13500	33000 / 31000	*
Hg-T [OM]	<0.034	<0.039	<0.074	<0.070	0.093	0.12	0.18-1.06
K-T [O]	<870	986	<2310	<2520	974	11000 / 5900	*
Mg-T [O]	8080	13100	15300	10100	8800	35000 / 20000	*
Mn-T [O]	254	602	593	454	222	780 / 1400	*
Na-T *	<2180	<2240	<5760	<6300	<2170	*	*
Ni-T [OM]	<17	18	<46 ?	<50 ?	<17	42 / 33	22.7-48.6
Pb-T [OM]	7.83	13.6	16.7	17.4	8.90	47	35.8-128
Se-T [O]	<0.87	<0.90	<2.31 ?	<2.52 ?	<0.87	2.3 / 1.6	*
Sr-T [O]	39	58	166	74	47	390 / *	*
Zn-T [OM]	40.6	70.4	83.3	67.7	51.0	160 / 100	121-459
						Ohio	**Persuad**
NH_3-N [P]	240 [L]	95	430 [L]	190 [L]	50	*	100
TOC(%) [P]	3.1	3.2	6.1	4.6	2.1	*	10.0%
pH (SU) *	7.5	7.1	7.2	NA	7.6	*	*
P-T [P]	438	672	1160	750	424	*	2000
%FGM [O]	29.6↘	72.6	54.5	61.4	37.7	30.0%	*

↘ Below the goal of 30% Fine Grain Material in sample
%FGM Percent Fine Grain Material in sediment sample (<60 micron or >30 seconds settling time)
NA Compound not analyzed. * Not evaluated
[O] Evaluated by Ohio EPA (2003) [M] Evaluated by MacDonald (2000) [P] Evaluated by Persuad (1993)
? Detection limit is greater than guideline

Ohio Sediment Reference Values (SRV) Guidelines (2003)
+ above reference value for ecoregion

Ontario Sediment Guidelines (Persuad 1993)
L > Open Water Disposal Guidelines; equivalent to the Lowest Effect Level (LEL)-applicable to NH_3-N only.
▲ > severe effect level (disturbance in benthic community can be expected)

MacDonald (2000) Sediment Quality Guidelines (SQG)
**>** TEC (Threshold effect concentration) and ≤ PEC (Probable effect concentration) Adverse effects frequently occur
■ > PEC (Probable effect concentration) -- Adverse effects usually or always occur

Stream Physical Habitat

The physical habitat of Todd Fork ranged from fair to excellent with an average QHEI of 69.6 (Table 28 and Figure 55). The natural flowing channel with assorted substrates provided adequate habitat for a diverse fish assemblage. The site at Starbuck Road (RM 32.72) scored within the fair range (QHEI=44.0) due to poor channel development, moderate silt and extensively embedded substrates which limited the amount of habitat available for riffle obligate species. As shown in Figure 55, the high intensity row crop agriculture upstream of Starbuck Road is likely contributing to the siltation and embedded substrates. The only other site to score within the fair range on Todd Fork was at State Route 22/3 (RM 0.14) which received a QHEI of 57.5. The interstitial nature of the stream in this location resulted in poor pool depth and the lower QHEI score. However, the QHEI score was well within reasonable expectation of supporting a WWH fish community, which it did. Maintaining the overall high quality habitat found throughout the Todd Fork watershed should be a high priority in order to sustain the now exceptional fish community present.

Figure 55. Land use surrounding Todd Fork at Starbuck Road, RM 32.72. Beige color indicates row crop agriculture, while green areas indicate forest.

Tributary streams within the Todd Fork subwatershed had an average QHEI of 63.4 and a range of values from 39.0 at Lick Run (RM 1.28) to 78.0 along Cowan Creek (RM 0.6). Lick Run was the only stream to score within the poor range in the Todd Fork subwatershed (Table 28). The low score was primarily related to the low flow conditions present. Riffles were absent during the sampling event, likely as a result of the intermittent nature of the stream, which diminished the habitat available to the fish community.

In addition to the poor habitat present at Lick Run, three tributary sites scored within the fair range on the QHEI. East Fork Todd Fork at RM 18.3 received a QHEI score of 42.5 and had four high influence MWH attributes (Table 28 and Appendix QHEI table). Control of silt loads entering this portion of the stream from the surrounding agricultural activities would likely improve habitat quality. Dutch Creek received a QHEI of 51.5 (fair) with three high influence MWH attributes. The habitat was negatively influenced by the lack of diverse instream cover and low sinuosity. Cowan Creek adjacent to Jenkins Road (RM 12.45) and First Creek at Volkerding Road (RM 3.83) received QHEI scores of 58.0 and 58.5, respectively. Though these sites scored within the fair range, the scores are high enough that in the absence of other stressors, the habitat should be sufficient to support WWH communities. However, nutrient enrichment from failing septic systems upstream

of First Creek RM 3.83 and siltation and nutrient enrichment from Airborne Express Airpark upstream of Cowan Creek RM 3.83 limited each stream's ability to support WWH fish communities. The remaining streams within the Todd Fork subwatershed had adequate habitat available to maintain diverse fish communities.

Table 28. Stream physical habitat (QHEI) summarized results for the Todd Fork subwatershed, 2007.

Stream and Location	River Mile	Drainage (mi^2)	QHEI	Comments
EXCELLENT				
Todd Fork @ SR 73	25.2	29.1	84.0	
Todd Fork @ SR 22, ust. Lytle Creek	19.5	56.0	74.5	
Todd Fork @ Roachester-Osceola Road	5.6	200.0	80.5	
Todd Fork @ Achterman Road	2.65	239.0	77.5	
Lytle Creek dst. Wilmington WWTP	5.95	9.3	77.0	
Lytle Creek @Clarksville Road	0.65	19.8	77.0	
Cowan Creek @ Clarksville Road	0.6	54.0	78.0	
Second Creek @ Gustin-Rider Road	6.55	13.2	77.0	
GOOD				
Todd Fork adj. Creek Rd. dst. Cowan Creek	17.1	135.0	70.5	
Todd Fork @ Spring Hill Rd. dst. Clarksville WWTP	15.1	142.0	69.0	
Todd Fork @ Gum Grove Road	12.2	192.0	72.5	
Todd Fork @ Middleboro Road	8.53	198.0	66.5	
Lytle Creek adj. Townsend Field	9.3	3.0	59.5	
Lytle Creek @ Nelson Road	7.01	8.1	66.5	
Lytle Creek @ Ogden Road	2.76	15.9	67.0	
Indian Run @ Jenkins Road, dst. ABX outfalls	0.2	4.1	57.0	
Cowan Creek @ School Road	16.62	15.1	65.0	Intermittent
Cowan Creek @ Jenkins Road	13.2	26.0	60.5	Intermittent
Cowan Creek @ Champlin Road	6.8	40.0	67.0	
Cowan Creek @ Old State Road	2.82	51.0	68.0	
East Fork Todd Fork @ Gibson Road	17.28	14.6	66.0	
East Fork Todd Fork @ US 68	11.46	27.9	64.0	
East Fork Todd Fork @ Reeder Road	7.12	35.0	68.0	
East Fork Todd Fork @ SR 132	1.6	37.3	73.0	

Stream and Location	River Mile	Drainage (mi^2)	QHEI	Comments
Second Creek @ Columbus Street	10.94	6.8	60.5	No riffle
Second Creek dst. Blanchester WWTP	9.45	11.0	56.5	
Second Creek @ Cozaddale Road, near Butlerville	1.53	19.0	65.5	
FAIR				
Todd Fork @ Starbuck Rd.	32.72	14.4	44.0	No riffle with poor channel development
Todd Fork @ SR 22/3	0.14	261.0	57.5	Poor to fair channel development with only two instream cover types.
First Creek @ Volkerding Rd.	3.83	13.8	58.5	Intermittent and no riffle
Dutch Creek @ Todd Fork Road	0.28	14.7	51.5	Instream cover nearly absent and poor to fair channel development
Cowan Creek adj. Jenkins Road, dst. Indian Run	12.45	32.0	58.0	Poor to fair channel development
East Fork Todd Fork @ Greene Road	18.29	7.8	42.5	No riffle with poor channel development and lack of instream cover.
POOR				
Lick Run @ SR 132	1.28	12.3	39.0	No riffle, intermittent.

General narrative ranges assigned to QHEI scores.

Narrative Rating		QHEI Range	
		Headwaters (≤20 sq mi)	Larger Streams
Excellent		≥70	≥75
Good		55 to 69	60 to 74
Fair		43 to 54	45 to 59
Poor		30 to 42	30 to 44
Very Poor		<30	<30

Fish Community

Fish Biocriteria Full Attainment

Todd Fork: 100%
Tributaries: 83%

The fish community of Todd Fork was sampled at 10 locations between Starbuck Road (RM 32.72) and State Route 22/3 (RM 0.14). The fish community fully met WWH expectations throughout the sampled reach with an average IBI of 50 and average MIwb of 9.9. In fact, the fish community of Todd Fork actually met EWH expectations at all but the most upstream site (RM 32.72) (Table 29 and Figure 56). However, 46.9% of the fish collected in Todd Fork were central stoneroller minnows. The central stoneroller minnow is an herbivorous species known for thriving in eutrophic streams with abundant algae. The percent of stoneroller minnow increased from 19.46% near US 22 (RM 19.5) to 61% downstream of Cowan Creek (RM 17.1). The dominance of the fish community by central stoneroller minnows reflects the enrichment of the stream due to nutrient contributions from Lytle Creek and Cowan Creek.

Eight tributary streams accounting for 24 sites within the Todd Fork subwatershed were sampled during 2007 (Table 29 and Figure 56). Four of these streams met the applicable WWH biocriterion for fish (Dutch Creek, Indian Run, East Fork Todd Fork, and Lick Run). The remaining four streams each had one site which did not meet the applicable biocriterion for fish. The fish communities of Lytle Creek along Townsend Field (RM 9.3) and Cowan Creek along Jenkins Road (RM 12.45) reflected siltation and nutrient enrichment from the Airborne Express Airpark with an IBI of 26 at the former and an IBI of 38 and MIwb of 7.2 at the latter. Nutrient enrichment from agricultural activities influenced the fish community of Second Creek at Columbus Street (RM 10.94), resulting in an IBI of 32 while the fish community of First Creek was impacted by an unknown source with an IBI of 30.

Table 29. Fish community status for stations sampled in the Todd Fork subwatershed based on data collected July-October 2007. The Index of Biotic Integrity (IBI) and Modified Index of well being (MIwb) are scores based on the performance of the fish community. The Fish Narrative score (Exceptional, Very Good, etc.) is based upon the corresponding IBI and MIwb relative to the drainage area, ecoregion, and the assigned ALU. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biotic community

Location	River Mile	Drain (mi^2)^	Species (Total)	Relative Number	Rel. Wt (Kg)	IBI	MIwb[a]	QHEI
Exceptional								
Todd Fork @ SR 73	25.2	29.1w	35	4,916.4	63.6	50	10.1	84.0
Todd Fork @ SR 22, ust. Lytle Creek	19.5	56.0w	25	1268.3	32.6	55	9.5	74.5
Todd Fork @ Spring Hill Rd. dst. Clarksville WWTP	15.1	142.0w	34	2,204.0	51.8	56	10.0	69.0
Todd Fork @ Gum Grove Road	12.2	192.0w	34	4,070.3	110.7	54	10.6	72.5
Todd Fork @ Middleboro Road	8.53	198.0[w]	35	1,882.5	48.5	51	10.1	66.5
Todd Fork @ Roachester-Osceola Road	5.6	200.0[w]	32	6,743.25	93.4	52	10.1	80.5
Todd Fork @ Achterman Road	2.65	239.0[w]	31	3,630.0	40.5	51	10.2	77.5

Location	River Mile	Drain (mi²)^	Species (Total)	Relative Number	Rel. Wt (Kg)	IBI	MIwb[a]	QHEI
Dutch Creek @ Todd Fork Road	0.28	14.7[H]	22	1,964.0	N/A	54	N/A	51.5
Lytle Creek @ Ogden Road	2.76	15.9[H]	19	1,618.5	N/A	56	N/A	67.0
Lytle Creek @Clarksville Road	0.65	19.8[H]	26	3,961.5	N/A	55	N/A	77.0
East Fork Todd Fork @ Greene Road	18.29	7.8[H]	20	3,888.0	N/A	50	N/A	42.5
East Fork Todd Fork @ Gibson Road	17.28	14.6[H]	22	1,856.0	N/A	52	N/A	66.0
East Fork Todd Fork @ SR 132	1.6	37.3[W]	30	1,438.5	31.2	54	9.6	73.0
Very Good								
Todd Fork adj. Creek Rd. dst. Cowan Creek	17.1	135.0[W]	28	3,690.0	64.5	48	9.3	70.5
Todd Fork @ SR 22/3	0.14	261.0[W]	24	7,625.3	42.0	50	9.2	57.5
Lytle Creek dst. Wilmington WWTP	5.95	9.3[H]	17	3,960.0	N/A	48	N/A	77.0
Cowan Creek @ School Road	16.62	15.1[H]	21	2,556.0	N/A	46	N/A	65.0
Cowan Creek @ Champlin Road	6.8	40.0[W]	33	749.3	64.3	47	9.3	67.0
Cowan Creek @ Old State Road	2.82	51.0[W]	28	753.0	47.3	49	9.2	68.0
Cowan Creek @ Clarksville Road	0.6	54.0[W]	33	898.6	31.8	52	9.2	78.0
East Fork Todd Fork @ Reeder Road	7.12	35.0[W]	26	3,258.0	89.9	49	10.0	68.0
Good								
Indian Run @ Jenkins Road, dst. ABX outfalls	0.2	4.1[H]	13	1,276.0	N/A	42	N/A	57.0
East Fork Todd Fork @ US 68	11.46	27.9[W]	28	5,119.5	40.8	50	8.7	64.0
Lick Run @ SR 132	1.28	12.3[H]	10	7,094.0	N/A	42	N/A	39.0
Second Creek @ Cozaddale Road, near Butlerville	1.53	19.0[H]	13	4,042.0	N/A	42	N/A	65.5
Marginally Good								
Todd Fork @ Starbuck Rd.	32.72	14.4[H]	16	2,184.0	N/A	36	N/A	44.0
Lytle Creek @ Nelson Road	7.01	8.1[H]	17	2,168.0	N/A	38	N/A	66.5
Cowan Creek @ Jenkins Road	13.2	26.0[W]	22	1,502.5	15.9	43	7.9	60.5
Second Creek dst. Blanchester WWTP	9.45	11.0[H]	12	1,964.0	N/A	36	N/A	56.5
Second Creek @ Gustin-Rider Road	6.55	13.2[H]	11	1,118.0	N/A	38	N/A	77.0
Fair								
Cowan Creek adj. Jenkins Road, dst. Indian Run	12.45	32.0[W]	21	873.0	10.9	38	7.2	58.0
Second Creek @ Columbus Street	10.94	6.8[H]	12	854.0	N/A	32	N/A	60.5
First Creek @ Volkerding Rd.	3.83	13.8[H]	7	210.0	N/A	30	N/A	58.5
Poor								
Lytle Creek adj. Townsend Field	9.3	3.0[H]	6	1,196.0	N/A	26	N/A	59.5

a - MIwb is not applicable to headwater streams with drainage areas $\leq$ 20 mi^2.

^ - Letters in superscript refer to the fish site type and associated biocriteria as indicated in the table below. B = boat; W = wading; and H = headwater.

Biological Criteria

	Eastern Corn Belt Plains			Interior Plateau			
Index – Site Type	**EWH**	**WWH**	**MWH**	**EWH**	**WWH**	**MWH**	**LRW**
IBI – Headwaters	50	40	24	50	40	24	18
IBI – Wading	50	40	24	50	40	24	18
IBI – Boat	48	42	24	48	38	24	16
MIwb – Wading	9.4	8.3	6.2	9.4	8.1	6.2	4.5
MIwb – Boat	9.6	8.5	5.8	9.6	8.7	5.8	5.0

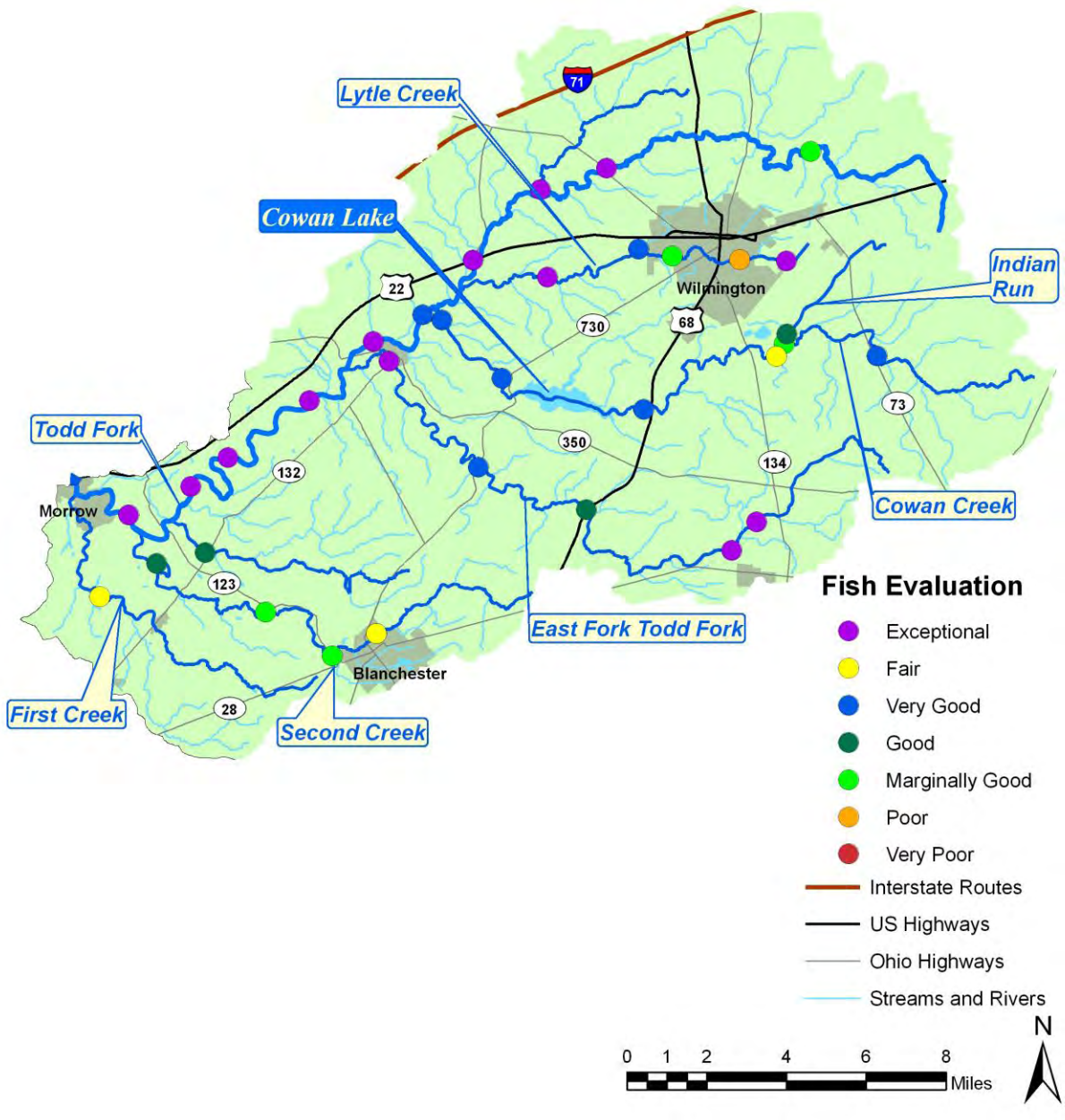

Figure 56. Narrative fish community scores from the Todd Fork subwatershed, 2007.

Fish Community Trends, 1998-2008

The fish community of Todd Fork was extensively sampled in 1998 and 2007 (Figure 57). The headwaters of Todd Fork, from State Route 73 (RM 25.2) to Starbuck Road (RM 32.72) were sampled for the first time in 2007 and met WWH expectations. The Ohio EPA report based on 1998 sampling indicated that the fish community of Todd Fork had the potential to meet EWH biocriterion if nonpoint controls were implemented to address sedimentation issues (Ohio EPA, 2000). In 2007, the fish community performed within EWH expectations at all sites except for RM 32.72.

Fish community scores for Indian Run have improved over time. The IBI at RM 0.2 improved from 28 in 1998 to 42 in 2007. The propylene glycol spill reported at the Airborne Express Airpark in February 1998 probably contributed to the lower IBI score noted in 1998. Over time, the fish community was typical of smaller streams, with pioneering fish comprising significant portions of the population (93% in 1996, 83% in 1998, and 48% in 2007). While the decline in pioneering species dominance over time may indicate a slightly more stable community, 76% of the fish present were considered pollution tolerant in 2007. In addition, a fish kill was reported on May 7, 2008 in Cowan Creek. According to ODNR, a white, oily film was noted over the water in Cowan Creek and traced upstream to Indian Run. The source was identified as a stormwater outlet from the Airborne Express Airpark, and over 550 dead fish were counted (ODNR, 2008). At this time, it is unknown if the fish community has recovered from the spill or the extent of the impact to the aquatic community. Future surveys should include sampling in the area to determine if recovery has occurred.

The fish community of Cowan Creek upstream of Indian Run has generally improved over time, and received an IBI of 46 at RM 16.6 in 2007 (Figure 58). However, stormwater from Airborne Express Airpark via Indian Run continued to negatively influence the fish community (IBI=38 and MIwb=7.1 at RM 12.45). The fish community improved to an IBI of 47 and a MIwb of 9.4 at RM 6.8, indicating that aquatic life had recovered after the CSX train derailment spill of sodium hydroxide in 2001. However, as previously mentioned, a fish kill was reported in Indian Run and Cowan Creek on May 7, 2008. Discharge from the Airborne Express Airpark was identified as the source, and over 550 fish were killed. Stormwater from the Airborne Express Airpark should be better managed in order to prevent future impacts to the fish community of Cowan Creek.

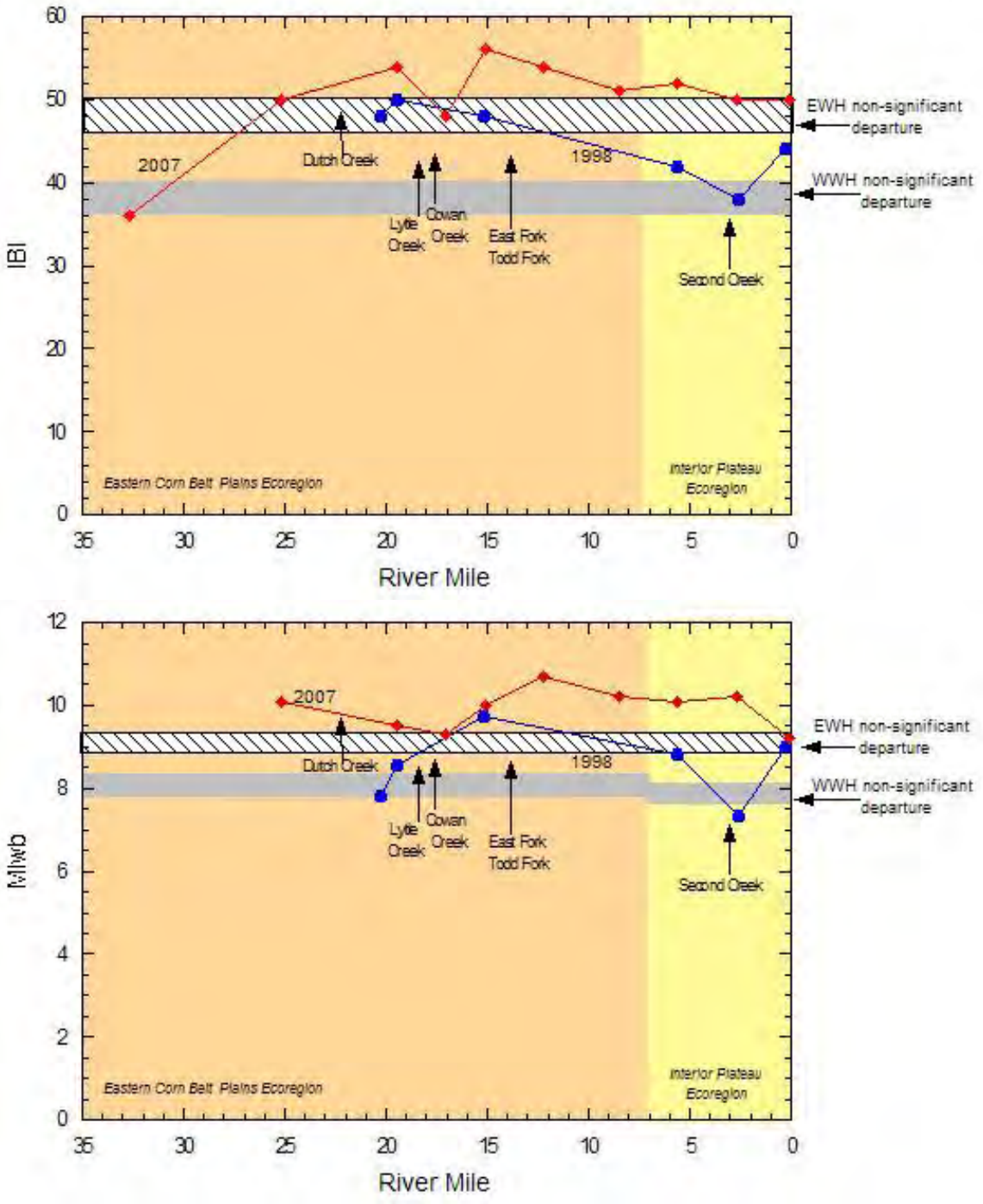

Figure 57. IBI and MIwb scores versus River Mile for Todd Fork from 1998 and 2007. MIwb is not calculated for sites <20mi^2, hence there are no MIwb values upstream of RM 25.2.

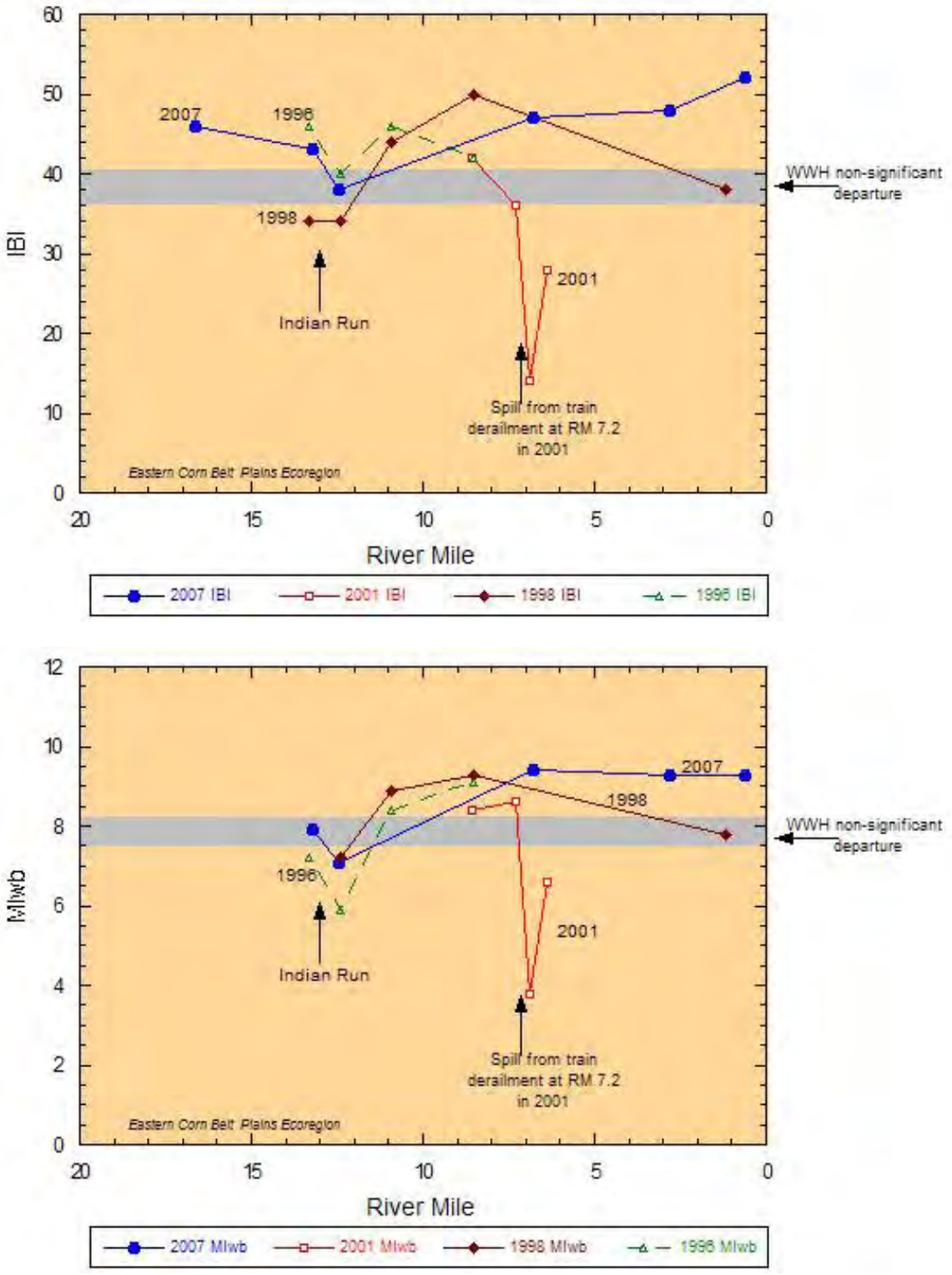

Figure 58. IBI and MIwb scores for Cowan Creek from 1996, 1998, 2001 and 2007.

Figure 59 shows how the fish community within the headwaters of Lytle Creek has continued to be impacted by stormwater from the Airborne Express Airpark (IBI=26 at RM 9.3 in 2007). Further downstream, the fish community improved to an IBI of 38 just upstream from the Wilmington WWTP (RM 7.01), though tolerant fish still comprised 76% of the fish community and reflected the far-reaching effects of the airport stormwater. Downstream from the Wilmington WWTP, the fish community improved to an IBI of 48, up 16 points since 1998. Pollution-sensitive species increased from only 2 species at RM 7.0 to 6 species at RM 5.9, reflecting the improved water quality as a result of improvements in the Wilmington sewer system. The improvements continued throughout the remaining length of Lytle Creek. Actions to address the stormwater from the Airborne Express Airpark should be undertaken in the future to improve the overall water quality of Lytle Creek.

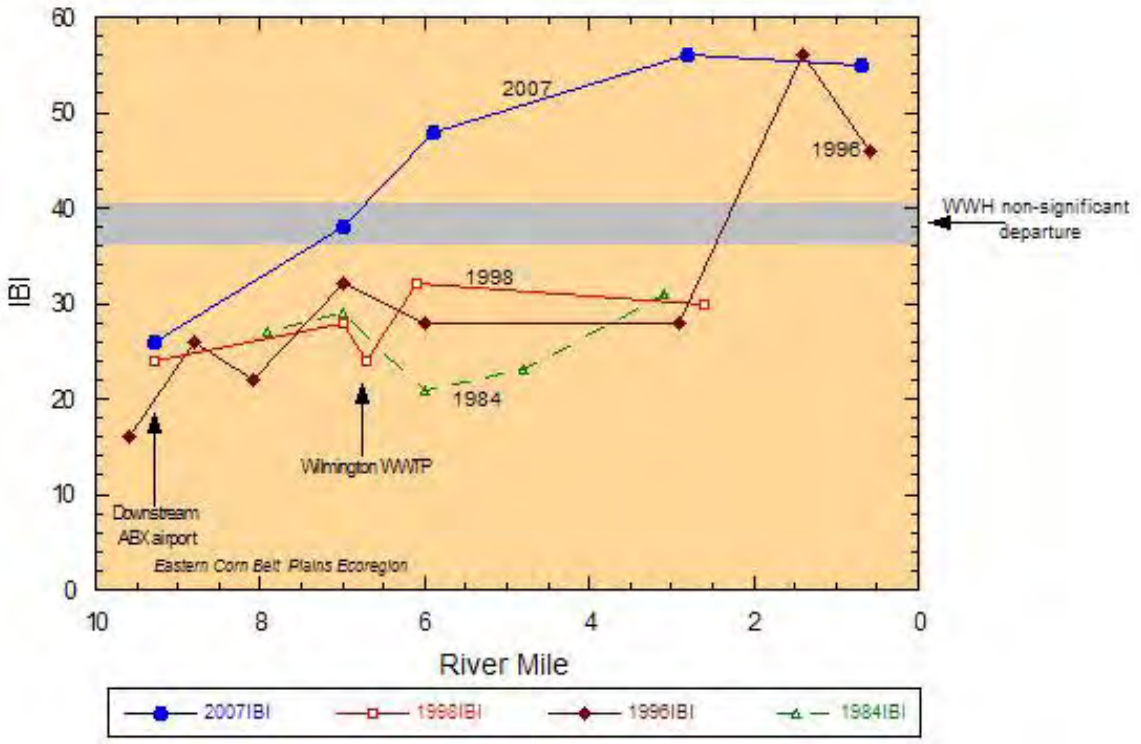

Figure 59. Fish community IBI scores for Lytle Creek from 1984, 1996, 1998, and 2007.

Macroinvertebrate Community

Macroinvertebrate Criteria Full Attainment

Todd Fork: 100%
Tributaries: 56%

Ten streams accounting for 36 sites were sampled for macroinvertebrates in the Todd Fork subwatershed in 2007 (Table 30, Figure 60). Of these, 21 sites on seven streams were attaining WWH criteria, with scores ranging from exceptional to marginally good. Of note was the performance of the macroinvertebrate community of the Todd Fork mainstem, where six of ten sites that were at least within non-significant departure of EWH criteria. No other stream in the subwatershed had higher resource quality. Overall, there were 160 total taxa collected from the Todd Fork mainstem, including the intolerant mayflies *Plauditis dubius/virilis* and *Leucrocuta sp.*, and the caddisflies *Protoptila sp.* and *Triaenodes perna*. The remaining sites that met applicable WWH criteria included Dutch Creek at RM 0.28, East Fork Todd Fork headwaters at RMs 18.29 and 17.28, Lick Run at RM 1.28, Second Creek at RMs 6.55 and 1.53, Lytle Creek at RM 0.65, Cowan Creek at RMs 13.2, 6.6, and 2.82, and First Creek at RM 3.83.

Fourteen sites did not achieve applicable WWH biocriteria. These sites were distributed among six tributary streams and had evaluations ranging from fair to poor. Fair communities at Cowan Creek RMs 16.62 and 0.6 and East Fork Todd Fork RMs 11.46, 7.2, and 1.6 were the result of interstitial or otherwise reduced stream flow. A site on Whitacre's Run (RM 1.15) in Blanchester received a narrative of very poor. A small pool located behind a dam on Old Broadway Road was the only reach of stream that contained water, as the rest of the stream was intermittent. The macroinvertebrate community, comprised almost entirely of tolerant taxa, was reflective of these conditions. The remaining eight impaired sites were influenced primarily by stormwater or wastewater discharges.

Eutrophication due to a combination of stormwater and wastewater discharges had the greatest impact on macroinvertebrate communities in Lytle Creek. Degraded communities were found downstream from the Airborne Express Airpark stormwater outfall 002 at RM 9.3 and showed no sign of recovery until RM 2.76, where communities improved slightly from low fair to fair. Wastewater discharge from the Wilmington WWTP at RM 6.83 further impeded recovery at RMs 5.95 and 2.76, due to nutrient over-enrichment. By RM 0.65, recovery appeared nearly complete with a marginally good ICI of 32 and the presence of high quality taxa such as the mayfly *Leucrocuta sp.* and an abundance of the net-spinning caddisfly *Chimarra obscura*. Neither taxon was found at any other sampling station on Lytle Creek.

Both Cowan Creek and Indian Run were also affected by stormwater from the airpark. Nutrient over-enrichment due to channelization probably had the greatest impact on macroinvertebrate communities in Indian Run; however, an even further decline in the macroinvertebrate community was documented at RM 0.2, which is downstream from outfall 032 of the Airborne Express Airpark. Total taxa declined from 41 at RM 0.7 to 29 at RM 0.2, and only one EPT taxon was collected at RM 0.2, compared to five at RM

0.7. This in turn translated to a decline from low fair to poor quality downstream from the outfall. Further, Indian Run appeared to be impacting water quality immediately downstream from its confluence with Cowan Creek. Upstream from Indian Run, a marginally good community was collected at RM 13.2 under interstitial flow conditions. However, downstream from Indian Run, where flow was visible with intact riffles, only a low fair community was found. Siltation from eroding banks likely contributed to the near absence of net-spinning caddisflies from the riffle, but the overall abundance of flatworms and leeches was indicative of organic enrichment via Indian Run.

The remaining waterbody that had impaired macroinvertebrate communities was Second Creek. A low fair community with six EPT and three sensitive taxa was collected at the most upstream site at RM 10.94. This reach was downstream from farm land and appeared to be affected by runoff from agricultural activities. Both phosphorus and ammonia exceeded background values on numerous sampling events, corroborating the impairment to the benthic community. Slight improvement was noted at the next site downstream at RM 9.45, with a fair community that included six EPT and seven sensitive taxa. However, an abundance of flatworms and red midges, accompanied by the strong odor of sewage, indicated that organic enrichment was depressing community performance. The Blanchester WWTP discharges upstream from RM 9.45 and has a history of wet weather bypasses and sanitary sewer overflows. In addition, a pipe discharging raw sewage into Second Creek was discovered just upstream from Blanchester's outfall. Currently, the Village of Blanchester is under Findings and Orders to address both the collection system failures and the illicit raw sewage discharges into Second Creek. Benthic community quality recovered downstream at the next two sites, culminating with a good community consisting of 14 EPT and 11 sensitive taxa at RM 1.53.

Table 30. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the Todd Fork study area, July to September, 2007 and 2008.

Location	River Mile[Δ]	Map #	Drainage Area (mi^2)	Total Taxa	Qual EPT	Total Sen.*	Total Tol.*	Substrate Density[a]	ICI[b]	Observations[c]
Exceptional										
Todd Fork	12.2	31	192.0	77	15	33	10	Moderate	46	Philopotamid/hydropsychid caddisflies (F,MI), baetid/heptageniid mayflies (F,MI), *Elimia sp.* (MI) snails, and waterpenny beetles (MI) predominant.
Very Good										
Todd Fork	17.1	29	135.0	78	14	30	8	Moderate	44	Slow current over artificial substrates (< 0.3 f/s). Philopotamid and hydropsychid caddisflies (F,MI) and heptageniid mayflies (F-I) predominant.
Todd Fork	8.53	32	198.0	60	13	30	4	Moderate	42	Philopotamid (MI) and hydropsychid caddisflies (F,MI), heptageniid mayflies (F,MI) predominant.
Todd Fork	5.6	33	200.0	66	14	31	5	Low	44	Riffle beetles (F,MI), Asian clams (MI), heptageniid mayflies (F-I), *Petrophila sp*. moths (MI) predominant.
Todd Fork	2.65	34	239.0	45	19	22	4	Moderate	--	Heptageniid mayflies (F-I), riffle beetles (F), and *Petrophila sp.* moths (MI) predominant.
Todd Fork	0.14	35	261.0	59	16	25	9	Low	42	Slow current over HDs (< 0.3 f/s). High water temp. day of sampling (31°C) w/algal mats collecting in margins. Hydropsychid caddisflies (F,MI), baetid (F,I) and heptageniid (F-I) mayflies predominant.
Good										
Todd Fork	32.72	26	14.4	47	10	12	7	Moderate	n/a	Helicopsyche borealis caddisfly (MI), riffle beetles (F), Caenis sp. mayfly (F), water mites (F) predominant. *Lampsilis radiata luteola* (fat mucket) mussels common.
Todd Fork	25.2	27	28.0	60	13	24	7	Low	32	Non-detectable current over artificial substrates; nearly interstitial. Asian clams (MI), riffle beetles (F,MI), Caenis sp. mayflies (F), heptageniid mayflies (F,MI) predominant.
Todd Fork	19.5	28	56.0	61	16	21	9	Low	34	Slow current over artificial substrates (< 0.3 f/s); nearly interstitial. Philopotamid caddisflies (MI), riffle beetles (F,MI) and heptageniid mayflies (F,MI) predominant.
Todd Fork	15.1	30	142.0	67	13	29	7	Moderate	40	Philopotamid (MI) and hydropsychid (F,MI) caddisflies, Caenis sp. mayflies (F) predominant.
Dutch Creek	0.28	7	14.7	53	14	17	5	Moderate	n/a	Hydropsychid (F,MI) and philopotamid (MI) caddisflies, heptageniid mayflies (F,MI) predominant.
East Fork Todd Fork	18.29	8	7.8	50	12	14	5	Moderate	n/a	Hydropsychid caddisflies (F), riffle beetles (F), *Caenis sp.* mayflies (F), crayfish (F), midges 9(T-MI) predominant.
Lick Run	1.28	16	12.3	41	12	15	2	Moderate	n/a	Bedrock stream. Hydropsychid (F,MI) and philopotamid (MI) caddisflies, Caenis sp.(F) and heptageniid mayflies (F) predominant.

Location	River Mile[Δ]	Map #	Drainage Area (mi^2)	Total Taxa	Qual EPT	Total Sen.*	Total Tol.*	Substrate Density[a]	ICI[b]	Observations[c]
Second Creek	1.53	25	19.0	38	14	11	5	Moderate	n/a	Hydropsychid caddisflies (F,MI), baetid mayflies (F) predominant.
Marginally Good										
Lytle Creek	0.65	21	19.8	39	9	12	2	Moderate	32	Philopotamid caddisflies (MI), midges (F,MI), heptageniids (F,I), *Caenis sp.* mayflies (F) predominant.
Cowan Creek	13.2	2	26.0	52	6	10	8	Moderate	--	Interstitial flow. Water boatmen (F), beetles (T-MI), snails (T-MI) predominant.
Cowan Creek	6.6	4	41.0	45	9	12	5	Low	--	Hydropsychid (F) and philopotamid (MI) caddisflies, riffle beetles (F,MI), water boatmen (F) predominant.
Cowan Creek	2.82	5	51.0	41	9	11	9	Moderate	--	Downstream Cowan Lake. Philopotamid caddisflies (MI), midges (T-MI), flatworms (F) predominant.
East Fork Todd Fork	17.28	9	14.6	45	8	10	7	Moderate	n/a	Nearly interstitial. Hydropsychid (F) and philopotamid (MI) caddisflies, *Caenis sp.* mayflies (F) predominant.
Second Creek	6.55	24	13.2	32	9	8	6	Moderate	n/a	Hydropsychid (F) and philopotamid (MI) caddisflies, Caenis sp. mayflies (F), midges ((F,MI), waterpenny beetles (MI) predominant.
First Creek	3.83	13	13.8	30	7	10	5	Moderate	n/a	Waterpenny bettles (MI), heptageniid mayflies (F), midges (F,MI) crayfish (F) predominant.
Fair										
Lytle Creek	2.76	20	15.9	38	7	7	9	Moderate	n/a	Hydropsychid caddisflies (F,MI), midges (T-MI) predominant.
Cowan Creek	16.62	1	15.1	40	6	7	5	Very low	n/a	Near interstitial flow. Hydropsychid (F) caddisflies, riffle beetles (F), heptageniid mayflies (F) predominant.
Cowan Creek	0.6	6	54.0	24	6	6	5	Low	--	Long stretches of dry stream bed with few pools. Heptageniid and *Caenis sp*. mayflies (F), midges (MT-MI), scuds (MT-F) predominant.
East Fork Todd Fork	11.46	10	27.9	40	9	8	6	Moderate	--	Interstitial flow. Water boatmen (F), *Caenis sp*. mayflies (F), midges (T-MI) predominant.
East Fork Todd Fork	7.2	11	35.0	31	6	8	5	Low	--	Interstitial flow. Flatworms (F), *Caenis sp*. (F) and heptageniid (F) mayflies predominant.
East Fork Todd Fork	1.6	12	37.3	30	7	9	5	Low	--	Interstitial flow. Midges (F,MI), oligochaetes (T)< beetles (MT-MI) predominant.
Second Creek	9.45	23	11.0	30	6	7	5	Low	n/a	Organic debris and septic odor noted. Flatworms (F), riffle beetles (F), red midges (F) predominant.
Low Fair										

Location	River Mile[Δ]	Map #	Drainage Area (mi^2)	Total Taxa	Qual EPT	Total Sen.*	Total Tol.*	Substrate Density[a]	ICI[b]	Observations[c]
Lytle Creek	9.3	17	3.0	39	4	7	8	Moderate	n/a	Downstream ABX storm sewers. Blackflies (F), midges (T-MI), oligochaetes (T) predominant.
Lytle Creek	7.01	18	8.1	43	4	3	10	Moderate	n/a	Oligochaetes (T), hydropsychid caddisflies (F), midges (MT-MI), physid snails (T) predominant.
Lytle Creek	5.95	19	9.3	26	4	3	8	Moderate	n/a	Excessive algae and foam noted. Monotonous community with hydropsychid caddisflies (F,MI), baetid mayflies, (F), midges (F,MI), oligochaetes (T), and hydroptilid mayflies (F) predominant.
Cowan Creek	12.45	3	32.0	44	6	7	10	Low	--	Flatworms (F), midges (F,MI), water mites (F), alderflies (F) predominant.
Indian Run	0.7	14	4.1	41	5	0	17	Moderate	n/a	Channelized; full of algae. Blackflies (F), midges (VT-F), water mites (F), *Caenis sp*. mayflies (F) predominant.
Second Creek	10.94	22	6.8	27	6	3	8	Moderate	n/a	Heptageniid mayflies (F), riffle beetles (F), midges (F,MI), snails (T-F) predominant.
Poor										
Indian Run	0.2	15		29	1	1	11	Moderate	n/a	Downstream ABX/DHL storm sewers. Midges (T-MI), Dytiscid beetle larvae (T,F) predominant.
Very Poor										
Whitacre's Run	1.15	36	1.5	17	0	0	10	Low	n/a	One pool in impounded area sampled; rest of stream dry. Leeches (T-F), snails (T) predominant.

Δ – The river mile indicated on this table may differ slightly from the river mile listed in the Appendix. The river miles in the Appendix are the Absolute Location Points (ALPs) and are indicative of the *actual* river mile where the data was collected and are thereby linked to the Point of Record (POR) river miles indicated in this and other tables throughout the main body of this document.
- Each macroinvertebrate sampling location corresponds to a color-coded, numbered point on a map of the watershed following this table.
***** - Sen = Sensitive taxa and are those listed on the Ohio EPA macroinvertebrate taxa list as being either Moderately Intolerant (MI) or Intolerant (I). Tol = Tolerant taxa and are those taxa listed on the Ohio EPA macroinvertebrate taxa list as being Moderately Tolerant (MT), Tolerant (T), or Very Tolerant (VT).
a – Observed relative density of the benthos on natural substrates. Please refer to Appendix table A-16 for relative densities on artificial substrates (where available).
b – Invertebrate Community Index. ICI not available for sampling locations with drainage area <20mi^2 (excluding reference sites), and are indicated by n/a. Dashed lines (--) indicate sites where quantitative data were not available due to vandalism, dessication, or some other disturbance of Hester Dendy artificial substrates (HDs).
c – Predominant taxa are those observed on natural substrates. Please refer to Appendix table A-18 for predominant taxa on artificial substrates. Tolerance categories for taxa groups are parenthetically expressed: VT = Very Tolerant, T = Tolerant, MT = Moderately Tolerant, F = Facultative, MI = Moderately Intolerant, I = Intolerant.

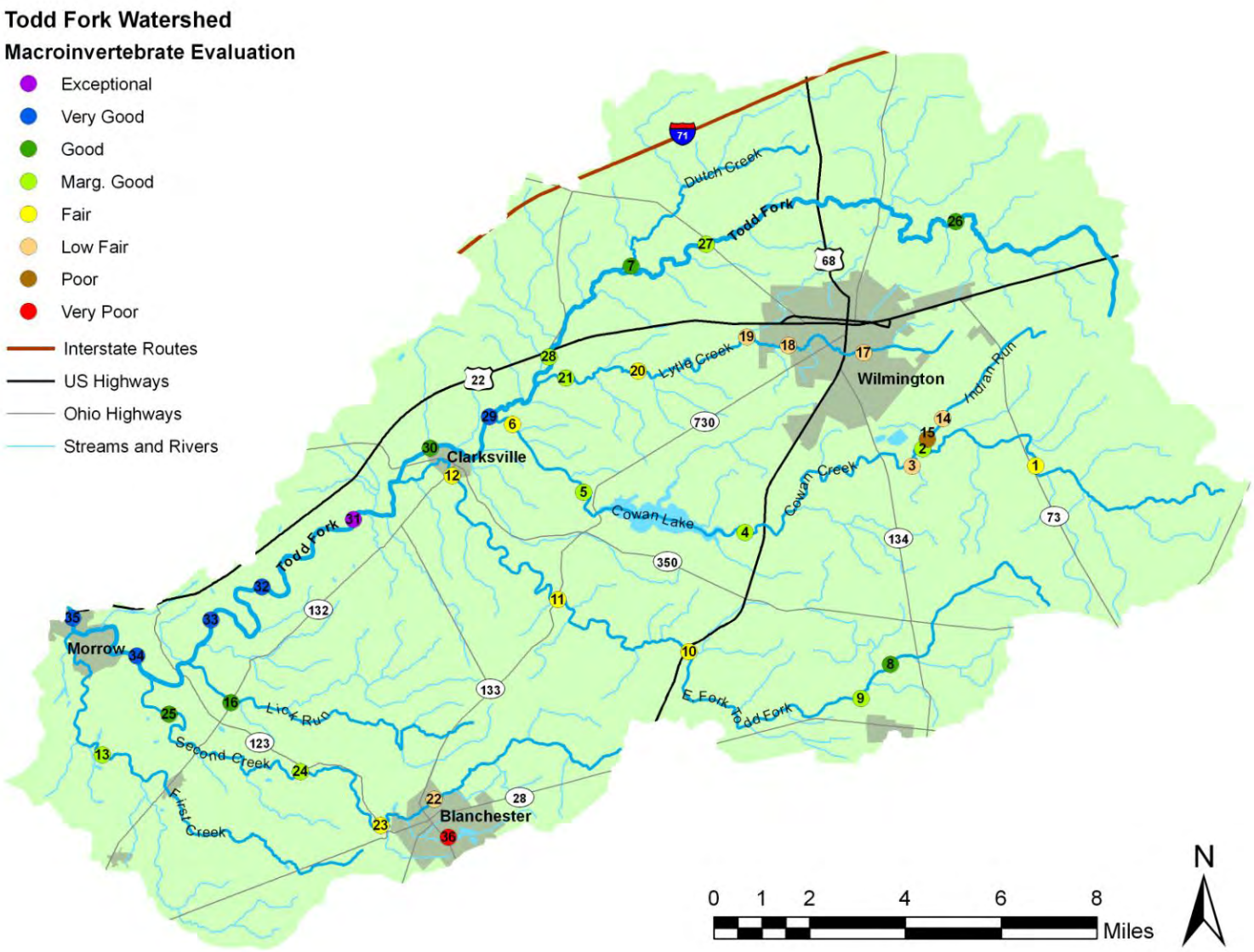

Figure 60. Todd Fork and tributaries, showing the location and performance of macroinvertebrate communities across the watershed. Each point is labeled with a number that corresponds to a sampling location as indicated in the preceding macroinvertebrate summary table.

Macroinvertebrate trends 1998-2008

Historical data are available for Todd Fork, Cowan Creek, Indian Run and Lytle Creek from 1998 to 2008. Trend assessment for data collected prior to 1998 can be found in the 2000 technical support document by Ohio EPA entitled "Biological and Water Quality Study of the Little Miami River Basin including Caesar Creek and Massie Creek".

The macroinvertebrate sampling effort on Todd Fork in 2007 was conducted at ten locations, which was double the effort of 1998. Ohio EPA had not sampled the Todd Fork headwaters above RM 19.5 until 2007, when sites at RMs 25.2 and 32.72 were assessed. Therefore, historical comparisons are limited to the reach downstream of RM 19.5. A comparison of qualitative EPT and sensitive taxa (as ICI data are not available at most 1998 sites), as displayed in Figure 61 shows a slight overall decline in both categories, with notable declines in sensitive taxa at RMs 15.1 and 0.14. This may be indicative of the lower flows encountered in 2007, and likely not a symptom of true imbalance of the benthos. However, ICIs and descriptive evaluations were comparable between 1998 and 2007, with all sites meeting applicable WWH criteria with the majority in the very good range.

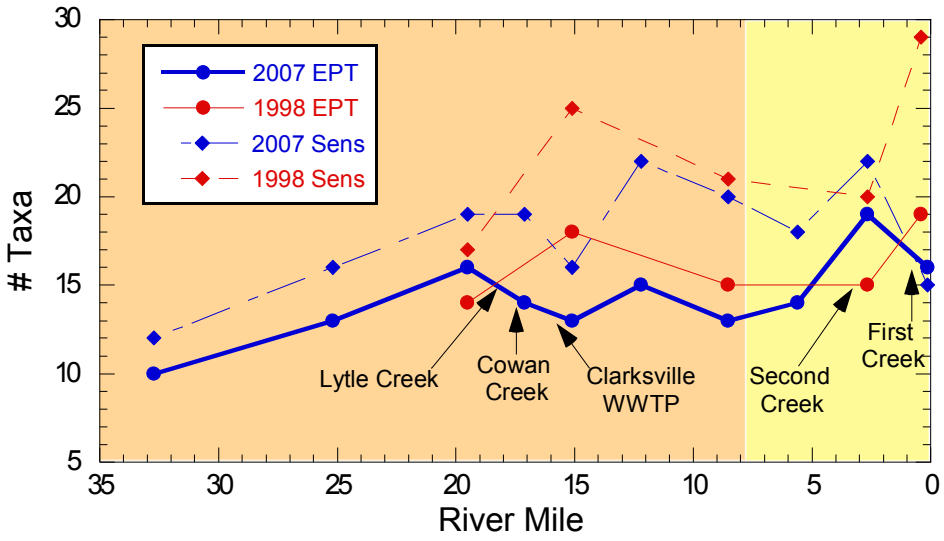

Figure 61. Longitudinal comparison of Todd Fork qualitative EPT and sensitive taxa in 1998 and 2007. ICI scores could not be plotted and compared due to their limited availability in 1998.

Lytle Creek has not experienced significant overall change in macroinvertebrate community performance. From the headwaters at RM 9.3 downstream to RM 2.76, benthic performance has remained steadfast with only fair range scores, as stormwater discharge from the Airborne Express Airpark and wastewater discharge from the Wilmington WWTP continue to contribute to impairment. However, a new site added in 2007 at RM 0.65 has demonstrated that the lowermost reach of Lytle Creek has recovered from upstream sources with increased EPT and sensitive taxa (Figure 62) and a marginally good ICI of 32.

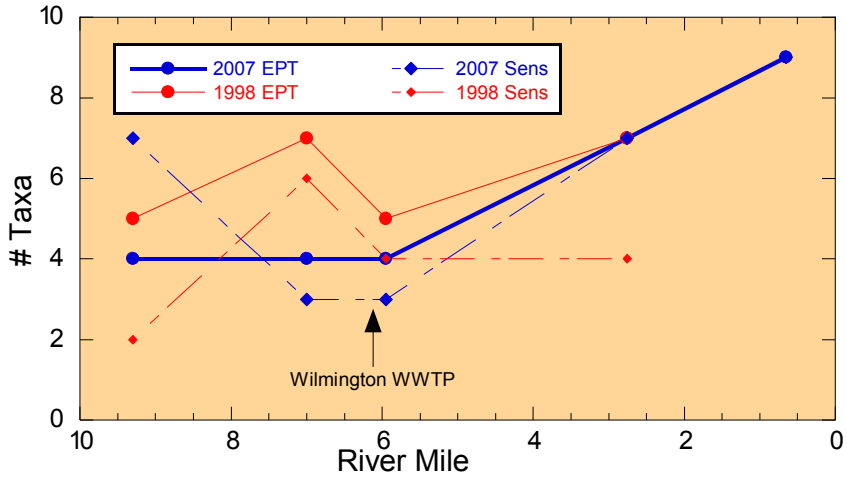

Figure 62. Longitudinal comparison of Lytle Creek qualitative EPT and sensitive taxa in 1998 and 2007.

In contrast to Todd Fork and Lytle Creek, whose scores have remained similar between 1998 and 2007, Cowan Creek and Indian Run experienced changes in community performance. None of the six sites sampled on Cowan Creek in 2007 were evaluated higher than marginally good in 2007; in 1998, four of five sites were in the good to very good range. Most noteworthy among these changes was the decline in performance at RM 12.45. In 1998, this site received a good-range score and included 14 EPT taxa, 12 sensitive taxa, and a sensitive-to-tolerant taxa ratio of 2.00. In 2007, the score declined into the low fair range with only 6 EPT taxa, 7 sensitive taxa, and a sensitive-to-tolerant taxa ratio of 0.70. Additionally, the riffle at this site was predominated by flatworms and midges in 2007, while hydropsychid caddisflies were predominant in 1998. The overall lower quality of the benthos in Cowan Creek is primarily related to a greater number of sites being interstitial or intermittent in 2007. The change at RM 12.45, however, is likely a reflection of further decline to the quality of Indian Run since 1998.

Indian Run enters Cowan Creek at RM 13.06, and receives stormwater from the Airborne Express Airpark via outfall 032 to a tributary at RM 0.6. Historically, Indian Run has not met WWH criteria for macroinvertebrates due to nutrient enrichment related to channelization and lack of riparian cover. Sampling conducted in 2008 at RM 0.2 indicated a poor community that included one EPT and one sensitive taxon. This was a decline from the fair community collected in 1998 that included five EPT and two sensitive taxa. While neither community meets WWH criteria, a categorical decline from fair to poor is indicative of further disturbance to the benthic community. A fish kill in Cowan Creek in 2008 was traced to bacteriological decomposition of glycol compounds at Airborne Express Airpark stormwater outfall 032. It should be further investigated as to whether this incident is either episodic or chronic, and appropriate adjustments to the

treatment of the airport stormwater made accordingly. It is likely that such poor quality stormwater is impacting the benthos in both Indian Run and in Cowan Creek.

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