2007 Study Plan for the Walhonding Watershed (Richland, Ashland, Wayne, Morrow Knox, Holmes and Coshocton Counties, OH)

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Introduction:
During the 2007 field season (June thru October) chemical, physical, and biological sampling will be conducted in the Walhonding watershed to assess and characterize water quality conditions. Sample locations were either stratified by drainage area or selected to ensure adequate representation of principal linear reaches. In addition, some sites were selected to support development of Total Maximum Daily Load (TMDL) models or because they are part of Ohio EPA's reference data set.

Four major municipal and two major industrial NPDES permitted entities exist in the study area (Table 1). Beyond assuring that sample locations were adequate to assess these potential influences, the survey was broadly structured to characterize possible effects from other pollution sources. These sources include minor permitted discharges, unsewered communities, agricultural or industrial activities, and oil, gas or mineral extraction.

A potential confounding factor in the watershed is the presence of numerous impoundments and stream modifications (Table 2). The Muskingum Watershed Conservancy District (MWCD) and the U.S. Army Corps of Engineers (US ACoE) operate several dams to manipulate stream flow and to provide recreation opportunities. The Clear Fork reservoir is Mansfield's drinking water source. Apple Valley Lake is central to a rural planned community development. Knox Lake is maintained by the Ohio Division of Wildlife to support sport fishing. Sample sites were adjusted in consideration of the different management objectives and the functional storage or outfall designs of the various dams.

Streams, locations, and types of sampling scheduled for the study area are listed in Table 3. Lab effort is detailed in Table 4.

Sampling Objectives:
- Evaluate all streams in the watershed which drain at least 8 mi^2 to determine the status of the aquatic community.
- Characterize any aquatic resource degradation and determine the extent it is attributable to particular sources.
- Assess physical habitat influences on stream biotic integrity.
- Determine recreational water quality status .

Background:
Ohio EPA previously evaluated portions of the 2007 Walhonding study area in 1998; *Biological and Water Quality Study of the Black Fork, Clear Fork, Rocky Fork and Jerome Fork of the Mohican River and Selected Tributaries*, in 1993; *Biological and Water Quality Study of the Rocky Fork Mohican River*, and in 1987; *Biological and Water Quality Study of the Kokosing River and five tributaries*. Two investigations specific to DERR sites were completed in 2004; *Biological and Water Quality Study of the Clear Fork Mohican River* (in the vicinity of United Technologies, a.k.a Hamilton Standard Controls) and in 2002; *Biological and Water Quality Study of the Rocky Fork Mohican River, Touby Run and Mansfield Foundry Wetland.*

These surveys characterized acute water quality issues in the Rocky and Black Forks emanating with Mansfield and Shelby's industrial heritage. These surveys also documented the need for wastewater treatment upgrades at the Mansfield, Shelby and Ashland WWTPs. The more recent investigations have revealed that habitat degradation and pollution associated with agricultural and surburban land uses are chronic sources of impairment. As the severity of industrial and wastewater pollutants has abated over time, the widespread magnitude of landscape oriented water quality problems has become more apparent.

Ohio EPA has little water quality information from the Lake Fork Assessment Unit. Neither the Mohican or Walhonding Large River Assessment Units have been assessed under our present interdisciplinary strategy. The portions of the 2007 study area that were previously assessed tended to be discharge

oriented reaches. Subsequently, many of the small streams in the 2007 survey have not been previously evaluated. Thus, this 2007 Walhonding watershed study is structured to assess a broad area and avoids undue focus on specific previously characterized concerns.

Water Column and Sediment Sampling

Chemical sampling locations within the study area are listed in Table 3. Conventional chemical/physical and bacteriological water quality samples will be collected five times at all locations (denoted by corresponding letters in Table 3). Additional bacteria sampling will occur in the vicinity of some campgrounds or canoe liveries (54 sites denoted by an upper case "B" in Table 3). The extra bacteria sampling will facilitate calculation of a geometric mean concentration within a thirty day interval to determine compliance with Ohio recreational use criteria (2 additional samples are anticipated at these locations). Water column metals analysis is only requested at 82 selected locations denoted by an upper case "C" in Table 3. These sites are generally background screening type locations or in the vicinity of plausible sources.

In support of a statewide study to assess nutrient assimilation, dissolved P, water column chlorophyll, and periphyton samples will be collected at ten sites: Walhonding River - RM 0.76 & RM 15.73; Kokosing River - RM 2.68, RM 20.89 & RM 32.56; Mohican River - RM 0.47; Negro Run – RM 1.04; Muddy Fork Mohican River - RM 4.30; Jerome Fork Mohican River - RM 12.08; and Pine Run - RM 5.71 (4 reference and 3 sentinel sites). The sampling protocol for determination of chlorophyll a concentrations requires that these samples be collected between late July and early September following a minimum of two weeks of stable, low-flow conditions. For a given sampling event (either water column chlorophyll or periphyton), one composite sample per site will be split among three filters for later analysis. The dissolved P and water column chlorophyll samples should be collected during the same sampling event. Nutrient sample sites are indicated by an ***N*** in the Location column in Table 3.

Organic water samples will be collected once at 35 locations specified in Table 3. Sediment metal and organic samples will be collected once at 36 sites (Table 3). These locations are generally on principal streams or located in the vicinity of plausible sources. Organic water column sampling in the Kokosing drainage will exclude VOC and BNA analysis as these parameters are extremely unlikely. Sediment sampling to assess total organic carbon and particle size should occur at all nutrient assessment locations.

Datasonde© sampling will be completed by the Modeling Unit. Two deployment runs utilizing 26 units are anticipated (52 locations). Mainstem reaches, sentinel and nutrient sites will be evaluated. The Modeling Unit will calibrate discharge correlated to stream height at sentinel sites (indicated by an ***S*** in the Location column in Table 3). These stations will be chemically sampled five times during which stream height will be recorded. Subsequently, loading calculations will be possible for these locations.

Compliance sampling will occur at five Kokosing drainage municipal WWTPs. Sampling parameters and frequency will be determined by Central District personnel. This sampling is used to evaluate entity performance compared to its NPDES permit requirements.

Macroinvertebrate and Fish Assemblages

Quantitative macroinvertebrate sampling methods will be conducted at sites with drainage areas larger than 20 mi^2 and at all reference sites (70 locations). Qualitative macroinvertebrate sampling methods pass will be utilized at sites with smaller drainage areas (68 locations). Two fish sampling passes will be completed at larger drainage sites on principal streams (58 locations). One fish sampling pass will be conducted at sites with smaller drainage areas (8 mi^2, 16 mi^2 and selected 32 mi^2 sites - 80 locations). Habitat assessment will occur at all fish sampling locations. In Table 3, a capital M,F indicates where quantitative methods or two passes are requested while an m,f indicates where qualitative sampling or one pass is expected.

Collection of fish tissue samples is anticipated at 20 locations: Kokosing River - RM 2.68, RM 11.30, RM 16.14, RM 23.00, RM 29.70 & RM 40.48; North Branch Kokosing River - RM 0.02; Jerome Fork Mohican

Table 1. Major NPDES permitted entities in the 2007 Walhonding study area.

Facility	Typical Flow	Discharge to	RM	Note
Ashland WWTP	5 MGD	Lang Creek	0.34	I&I challenges
Mansfield WWTP	12.5 MGD	Rocky Fork	11.18	I&I challenges (severe) Lift station overflow
Mt. Vernon WWTP	5 MGD	Kokosing River	24.90	Industry loss
Shelby WWTP	2.5 MGD	Black Fork	50.07	I&I challenges
AK Steel	1 MGD	Rocky Fork	14.95	Contact cooling Boiler blow down
Dofasco	1 MGD	Tuby Run	0.66	Urban area

Table 2. Impoundments and associated modifications in the 2007 Walhonding study area.

Name	Stream	RM	Management	Purpose	Outlet structure	Impounds	Mi^2 /notes
Mohicanville Dam	Lake Fork	12.0	US ACoE/ MWCD	Flood control	3 7'x12' flow through gates	8800 acres when wet	271 mi^2
Jerome, Muddy & Lake Forks are extensively channelized upstream from the Mohicanville Dam							
Charles Mill Lake	Black Fork	18.5	US ACoE/ MWCD	Flood control	5 gates Hypolymnetic	1350 acres 7.2 miles	217 mi^2 Hypereutrophic
Clear Fork Reservoir	Clear Fork	30.5	Mansfield	Drinking H2O	Hypolymnetic	997 acres 4.5 miles	33.7 mi^2 Eutrophic
Bellville	Clear Fork	19.7	?	Ford ruin	?	NA	Hazard
Pleasant Hill Lake	Clear Fork	4.8	US ACoE/ MWCD	Flood control	Hypolymnetic	850 acres 5.2 miles	197 mi^2 Hypereutrophic
Brinkhaven Dam	Mohican River	11.7	ODNR	Mill ruin	Low head	~1.5 miles	988 mi^2 deteriorated
North Branch Kokosing Lake	North Branch Kokosing	9.5	US ACoE	Flood control	Unregulated 3.5'x6.75' spillway tunnel	160 acres 1.5 miles	45.4 mi^2
Fredericktown	North Branch Kokosing	7.1	?	Recreation	?	?	
Knox Lake	East Branch Kokosing	1.2	ODNR	Fishing	Hypolymnetic	469 acres 3.2 miles	31.4 mi^2
The Kokosing River is maintained within levees in Mt. Vernon							
Apple Valley Lake	Little Jelloway Creek	1.4	Apple Valley Association	Recreation	Hypolymnetic	511 acres 3.3 miles	18.5 mi^2 herbicides
Ax Factory Dam	Kokosing River	6.3	?	Mill ruin	Low head	NA	Hazard
Mohawk Dam	Walhonding River	17.3	US ACoE	Flood control	flow through gates	<40.6 miles when wet	1504 mi^2 sedimentation
Six Mile Dam	Walhonding River	8.8	?	Canal ruin	Low head	~1.1 miles	1574 mi^2
Coshocton	Walhonding River	1.0	?	Canal feeder	Low head	~0.5 miles	2256 mi^2

River – RM 5.65; Black Fork Mohican River RM 0.10, RM 1.50, RM 7.09 & RM 16.32; Rocky Fork Mohican River – RM 0.57, RM 3.72, RM 10.13 & RM 14.23; Clear Fork Mohican River – RM 0.20 & RM 4.03. Fish tissue from the North Branch Kokosing Lake and Apple Valley Lake will also be collected. Future tissue collection in the Mohican and Walhonding Rivers is anticipated in 2008.

Whole body fish tissue samples are requested from Rocky Fork Mohican River stations as deemed appropriate.

To support an Oklahoma State University – US Fish and Wildlife Service study conducted by Dr. Nick Lang, hornyhead chub fin clips will be collected. Two specimens per location are desired from different sub basins as available. A pectoral fin should be preserved in alcohol if fish is retained as a voucher. Otherwise, half of a caudal or dorsal fin can be preserved in alcohol if fish is photographed and released.

Quality Assurance / Sampling Methods

Ohio EPA Manuals

All biological, chemical, EPA laboratory, data processing, and data analysis methods and procedures adhere to those specified in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio Environmental Protection Agency 2006), Biological Criteria for the Protection of Aquatic Life, Volumes II - III (Ohio Environmental Protection Agency 1987, 1989a, 1989b), The Qualitative Habitat Evaluation Index (QHEI); Rationale, Methods, and Application (Rankin 1989) for habitat assessment, and Ohio EPA Sediment Sampling Guide and Methodologies (Ohio EPA 2001).

Quality Control Samples

Ten percent of the sediment, water, and bacteria samples will be submitted to the lab as field duplicates. One Datasonde© recorder site will have two instruments placed in the river as field duplicates.

Surface Water

Surface water grab samples will be collected from the upper 12 inches of river water using clean appropriate containers. Collected water will be preserved using appropriate methods, as outlined in Parts II and III of the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (Ohio EPA 2006) and delivered to the Ohio EPA lab for analysis. Datasonde© continuous recorders will be placed at select locations to evaluate diurnal measurements of dissolved oxygen, pH, temperature, and conductivity.

Bacteria

Water samples will be collected directly from the river using clean appropriate containers, cooled to 4°C, and transported to an Ohio EPA certified lab for analysis within 6 hours of sample collection. All samples will be analyzed for E. coli bacteria using U.S.EPA approved methods (STORET Parameter Code 31633). Samples may be processed in the field using standard incubation methods before delivery to the Ohio EPA lab.

Sediment

Fine grained multi-incremental sediment samples will be collected in the upper 4 inches of bottom material using either decontaminated stainless steel scoops or Ekman dredges. Collected sediment will be placed into glass jars with teflon lined lids, placed on ice (to maintain 4°C) and delivered to the Ohio EPA lab. Sampling and decontamination protocols will follow those listed in the Ohio EPA Sediment Sampling Guide and Methodologies, November, 2001.

Biological Community Assessment

Macroinvertebrates will be collected from artificial substrates and from the natural habitats. The artificial substrate collection provides quantitative data based on a sample from five modified Hester-Dendy (HD) multiple-plate samplers colonized for six weeks. When the HD's are retrieved a qualitative multihabitat composite sample will also be obtained. This sampling effort consists 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). Fish will be sampled once or twice at each sampling location with pulsed DC

current. Detailed biological sampling protocols are documented in the Ohio EPA manual Biological Criteria for the Protection of Aquatic Life, Volume III (1989).

Stream Habitat Evaluation

Physical habitat is evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989). Various attributes of the available habitat are scored based on their overall importance to the establishment of viable, diverse aquatic faunas. Evaluations of type and quality of substrate, amount of instream cover, channel morphology, extent of riparian canopy, pool and riffle development and quality, and stream gradient are among the metrics used to evaluate the characteristics of a stream segment, not just the characteristics of a single sampling site. As such, individual sites may have much 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 higher than 60 were generally conducive to the establishment of warmwater faunas while those which scored in excess of 75 typify conditions consistent with exceptional faunas.

Use Attainment

Attainment/non-attainment of aquatic life uses will be determined by using biological criteria codified in Ohio Administrative Code (OAC) 3745-1-07, Table 7-17. Numerical biological criteria are based on multimetric biological indices including the Index of Biotic Integrity (IBI) and modified Index of Well-Being (MIwb), indices measuring the response of the fish community, and the Invertebrate Community Index (ICI), which indicates the response of the macroinvertebrate community.

Performance expectations for the basic aquatic life uses (Warmwater Habitat [WWH], Exceptional Warmwater Habitat [EWH], and Modified Warmwater Habitat [MWH] were developed using the regional reference site approach (Hughes et al. 1986; Omernik 1988). This fits the practical definition of biological integrity as the biological performance of the natural habitats within a region (Karr and Dudley 1981). Attainment of an aquatic life use is FULL if all three indices (or those available) meet the applicable criteria, PARTIAL if at least one of the indices did not attain and performance did not fall below the fair category, and NON if all indices either fail to attain or any index indicates poor or very poor performance. The results will be compared to WWH biocriteria for the Western Allegheny Plateau ecoregion.

Recreational use attainment will be determined using E. coli bacteria. These organisms indicate the potential presence of pathogens in surface water resulting from the presence of untreated human or animal wastes, and are the basis for recreational use water quality criteria in Rule 3745-1-07 of the Ohio Administrative Code (OAC).

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Table 3. List of sampling locations in the 2007 Walhonding watershed study area. Sample type acronyms and number of sites follow:

RM	Sample Type	Location	Mi^2	Map	latitude	longitude
05040003 000 Walhonding Large River Assessment Unit						
	17-600-000	***Walhonding River***				
20.47	C,D,b,M,F	SR 715	1497	Warsaw	40.3529	-82.1201
15.73	C,S,D,b,M,F	US 36, Nellie (***R,N***)	1505	Warsaw	40.3414	-82.0647
8.81	C,S,D,b,M,F	Ust. Six Mile Dam	1574	Randle	40.3277	-81.9655
7.54	C,D,b,M,F	US 36, Ust. Killbuck Creek (***R***)	1576	Randle	40.3272	-81.9428
0.76	C,S,D,b,M,F	US 36, Coshocton (***R,N***)	2255	Randle	40.2839	-81.8706
05040003 010 Upper Kokosing River Assessment Unit (Ust. RM 29.66)						
54.69	C,b,m,f	Pulaskiville Rd.	8.3	Mount Gilead	40.5375	-82.7617
49.73	C,b,M,f	Chipps Rd. (***R***)	15.2	Shauck	40.5008	-82.7361
45.44	C,O,D,B,M,F	SR 314, Chesterville (***S***)	38.0	Chesterville	40.4747	-82.6839
40.48	T	TR 392, Lucerne Rd.	57.0	Chesterville	40.4610	-82.6284
39.27	C,b,M,F	TR 411, Vail Rd.	60.0	Fredricktown	40.4643	-82.6097
32.56	C,O,S,D,B,M,F	TR 401, Beckley Rd. (***N***)	79.9	Fredricktown	40.4385	-82.5373
29.70	T	From SR 13, Cassell Rd. Ust. North Br.	100	Fredricktown	40.4187	-82.5045
05040003 030 Middle Kokosing Assessment Unit (Ust. RM 11.38)						
28.61	C,O,S,D,B,M,F	TR 386, Banning Rd.-Tilden Ave., USGS gage (***R,S***)	202	Mt. Vernon	40.4056	-82.4997
25.30	C,B,M,F	Mt. Vernon Ave., Ust. WWTP (***R***)	251	Mt. Vernon	40.3833	-82.4692
24.90	Compliance	Mt. Vernon WWTP	262	Mt. Vernon	40.3788	-82.4665
24.30	C,S,D,B,M,F	Adj. TR 257, Glenn Rd., Dst. WWTP	272	Hunt	40.3717	-82.4625
23.00	T	Adj. TR 262, Lower Gambier Rd.	275	Mt. Vernon	40.3771	-82.4405
20.89	C,S,D,B,M,F	TR 259, Laymon Rd. (***R,N***)	280	Mt. Vernon	40.3761	-82.4036
18.05	C,D,B,M,F	SR 229, Newcastle Rd. (***R***)	313	Hunt	40.3619	-82.3931
17.76	Compliance	Gambier WWTP	314	Mt. Vernon	40.3658	-82.3844
16.14	T	CR 33, Zion Rd.	315	Danville	40.3754	-82.3687
11.55	C,D,B,M,F	CR 35, Pipesville Rd. (***R***)	379	Danville	40.4050	-82.3225
05040003 040 Lower Kokosing Assessment Unit						
	17-650-000	***Kokosing River***				
11.00	T	Adj. US 36, Dst. Jelloway Creek	453	Danville	40.4060	-82.3131
6.12	C,B,M,F	US 36, Coshocton Ave.	463	Danville	40.3839	-82.2547
2.68	C,O,S,D,B,M,F,T	TR 203, Riley Chapel Rd. (***R,N,S***)	478	Walhonding	40.3722	-82.2008
0.07	C,B,M,F	TR 423, MWCD Mohawk Area (***R***)	485	Walhonding	40.3606	-82.1614
05040003 010 Upper Kokosing River Assessment Unit						
	17-683-000	***South Branch Kokosing River***				
2.96	c,b,m,f	CR 23, Cardington Chesterville Rd.	8.4	Chesterville	40.4739	-82.7369
	17-682-000	***Mile Run***				
4.75	c,b,m,f	Driveway from CR 11, Sparta Rd.	9.0	Chesterville	40.4372	-82.6286
	17-681-000	***Granny Creek***				
4.29	c,b,m,f	TR 402, Granny Creek Rd.	9.1	Fredericktown	40.4272	-82.5919
05040003 020 North Branch Kokosing Assessment Unit						
	17-674-000	***North Branch Kokosing River***				
17.77	c,b,m,f	Drive from CR 22, Mt. Vernon Tiffin Rd.	8.0	Shauck	40.5569	-82.6808
14.00	c,b,m,f	TR 374, Levering Rd.	17.4	Bellville	40.5447	-82.6197
10.15	T	North Branch Kokosing Lake	43.0	Bellville	40.5095	-82.5829
9.15	c,b,M,F	TR 377, Overly Rd.	45.5	Bellville	40.5024	-82.5713
6.18	C,O,S,D,B,M,F	Mill St. (CR 14, Fredt'wn-Amity Rd.) (***R***)	84.0	Fredericktown	40.4889	-82.5422

Table 3. (continued)

RM	Sample Type	Location	Mi^2	Map	latitude	longitude
	17-674-000	***North Branch Kokosing River - cont'd.***				
5.55	Compliance	Fredricktown WWTP	85.0	Fredericktown	40.4806	-82.5417
0.02	C,O,S,D,B,M,F,T	SR 13, Cassell Rd. (***S***)	97.9	Fredericktown	40.4189	-82.5339
	17-674-001	***Trib. to N. Br. Kokosing R. (RM 9.99)***				
4.04	c,b,m,f	TR 178, Ruggles Rd.	8.4	Shauck	40.5128	-82.6439
	17-676-000	***East Branch Kokosing River***				
6.04	c,b,m,f	TR 288, Toms Rd.	9.9	Butler	40.5389	-82.4919
0.01	c,b,M,f	Ust. Confluence, Access is uncertain	31.8	Fredericktown	40.4881	-82.5394
	17-675-000	***Job Run***				
0.08	c,b,m,f	CR 6, Upper Fredericktown Rd.	8.5	Fredericktown	40.4331	-82.5061
		05040003 030 Middle Kokosing Assessment Unit				
	17-673-000	***Armstrong Run***				
1.06	c,b,m,f	TR 389, Lower Green Valley Rd.	8.3	Fredericktown	40.4100	-82.5122
	17-671-000	***Dry Creek***				
10.72	C,b,m,f	CR 25, Simmons Chruch Rd.	7.6	Centerburg	40.3453	-82.6292
9.22	C,b,m,f	TR 121, Tucker Rd.	16.0	Homer	40.3500	-82.6069
4.52	C,b,m,f	TR 127, Thayer Rd., Dst. landfill	25.1	Homer	40.3535	-82.5337
1.04	C,O,D,B,M,f	CR 83, Parrott St. (***S***)	33.7	Mt. Vernon	40.3784	-82.4966
	17-670-000	***Center Run***				
1.72	c,b,m,f	Beech St.	7.8	Mt. Vernon	40.4039	-82.4672
	17-650-005	***Delano Run***				
1.55	C,b,m,f	From Meadowbrook Dr.	7.1	Hunt	40.3576	-82.4792
	17-667-000	***Big Run***				
4.40	c,b,m,f	SR 586, Martinsburg Rd.	9.1	Hunt	40.3069	-82.3958
0.66	C,O,D,B,M,f	CR 54, Big Run Rd. (***S***)	29.2	Hunt	40.3481	-82.3833
	17-668-000	***Dudgeon Ditch/ Elliott Run***				
1.05	c,b,m,f	TR 415, Curtis Rd., Ust. RM 1.02 Trib.	8.0	Hunt	40.3094	-82.3756
	17-666-000	***Indianfield Run***				
2.62	c,b,m,f	SR 229, Newcastle Rd.	8.4	Martinsburg	40.3581	-82.3381
	17-662-000	***Schenck Creek***				
8.75	c,b,m,f	Driveway from TR 274, Proper Rd.	8.9	Mt. Vernon	40.4442	-82.4319
2.64	M,F	US 36, Coshocton Ave. (***R***)	37.3	Danville	40.4100	-82.3703
0.55	C,O,D,B	CR 34, Schenck Creek Rd. (***S***)	41.2	Danville	40.3930	-82.3471
	17-664-000	***Little Schenck Creek***				
4.45	c,b,m,f	CR 66, Fredricktown-Amity Rd.	8.2	Mt. Vernon	40.4942	-82.4181
0.15	c,b,m,f	CR 8, Gilchrist Rd.	16.3	Mt. Vernon	40.4403	-82.3817
		05040003 040 Lower Kokosing Assessment Unit				
	17-654-000	***Jelloway Creek***				
8.85	c,b,m,f	TR 325, Orange Hill Rd.	16.5	Jelloway	40.5017	-82.2933
4.26	c,b,M,f	CR 9, Danville-Howard Rd.	36.5	Danville	40.4472	-82.2956
0.08	C,O,S,D,B,M,F	US 36, Coshocton Ave. (***R,S***)	74.0	Danville	40.4066	-82.3208
	17-656-000	***East Branch Jelloway Creek***				
3.33	c,b,M,f	US 62, Millersburg Rd. (***R***)	4.5	Brinkhaven	40.4511	-82.2486
1.87	Compliance	Danville WWTP	6.1	Danville	40.4436	-82.2696
1.03	c,b,m,f	TR 348, Carey Lane	9.1	Danville	40.4392	-82.2800
	17-655-000	***Little Jelloway Creek***				
6.97	c,b,m,f	TR 318, Beaver Rd.	10.5	Danville	40.4757	-82.3465
1.63	T	Apple Valley Lake	18.5	Danville	40.4197	-82.3458

Table 3. (continued)

RM	Sample Type	Location	Mi^2	Map	latitude	longitude
	17-655-000	***Little Jelloway Creek - cont'd.***				
0.88	C,B,D,M,f	CR 94, Magers Rd. (***R***)	19.0	Danville	40.4156	-82.3347
0.25	Compliance	Little Jelloway WWTP	19.5	Danville	40.4136	-82.3263
	17-652-000	***Brush Run***				
0.91	c,b,m,f	CR 36, Rutledge Rd.	7.8	Walhonding	40.3683	-82.2425
		05040002 000 Mohican Large River Assessment Unit				
	17-700-000	***Mohican River***				
27.00	C,D,B,M,F	Adj. TR 3175	573	Greer	40.6029	-82.2481
22.54	C,D,B,M,F	TR 211, Dst. Lake Fork	937	Greer	40.6064	-82.1941
16.92	C,D,B,M,F	SR 514, Nashville Rd.	948	Greer	40.5222	-82.1958
11.66	C,D,B,M,F	Canal St., Dst. Brinkhaven dam	967	Brinkhaven	40.4674	-82.1962
6.53	C,D,B,M,F	TR 365, Ust. Flat Run, Cavallo Station	987	Brinkhaven	40.4127	-82.1786
0.47	C,O,S,D,B,M,F	SR 715, MWCD Mohawk Area (***S,N***)	998	Walhonding	40.3658	-82.1575
		05040002 030 Upper Clear Fork Assessment Unit (Ust. RM 21.45)				
35.67	C,b,m,f	CR 146, Marion Ave.	6.6	Blooming Grove	40.7433	-82.6392
29.57	C,D,B,M,F	CR 144, Lexington-Ontario Rd.	40.0	Mansfield South	40.6917	-82.5928
23.35	C,O,S,D,B,M,F	TR 348, Ritter Rd., Dst. I-71	63.0	Mansfield South	40.6403	-82.5494
		05040002 040 Lower Clear Fork Assessment Unit				
	17-750-000	***Clear Fork Mohican River***				
19.83	C,O,D,B,M,F	SR 13 (***S***)	114	Bellville	40.6231	-82.5114
16.17	C,B,M,F	TR 392, Cutnaw Rd.	131	Butler	40.5983	-82.4604
10.55	C,B,M,F	CR 350, Bunker Hill Rd.	160	Butler	40.6175	-82.3851
4.03	C,O,D,B,M,F,T	Forest Rd. (***S***)	199	Jelloway	40.6133	-82.3167
0.20	T	Adj. CR 23	217	Jelloway	40.6070	-82.2559
		05040002 030 Upper Clear Fork Assessment Unit				
	17-761-000	***Cedar Fork***				
8.25	c,b,m,f	CR 29, West Point Rd.	10.3	Blooming Grove	40.6378	-82.6683
5.61	c,b,m,f	TR 2, Wirick Rd.	17.2	Shauck	40.6242	-82.6253
3.25	c,b,M,f	SR 546	36.0	Bellville	40.6181	-82.5897
		05040002 040 Lower Clear Fork Assessment Unit				
	17-759-000	***Honey Creek***				
0.81	c,b,m,f	TR 404, Durbin Rd.	8.8	Butler	40.5958	-82.4906
	17-755-000	***Slater Run***				
0.82	c,b,m,f	SR 97, Cleveland St.	8.1	Butler	40.5864	-82.4189
	17-754-000	***Possum Run***				
4.57	c,b,m,f	CR 398, Rhinehart Rd.	7.8	Lucas	40.6353	-82.4600
0.35	c,b,m,f	SR 95	15.6	Lucas	40.6281	-82.3886
	17-753-000	***Switzer Creek***				
2.83	c,b,m,f	Drive from CR 303, Pleasant Valley Rd.	9.2	Lucas	40.5736	-82.4094
	17-751-000	***Pine Run***				
5.71	c,S,D,b,m,f	CR 3275, McGurdy Rd. (***N***)	7.8	Jelloway	40.5817	-82.3294
		05040002 010 Upper Black Fork Assessment Unit (Ust. RM 31.00)				
	17-730-000	***Black Fork Mohican River***				
57.72	C,b,m,f	Stivings Rd.	7.4	Crestline	40.8342	-82.6431
53.88	C,O,S,D,B,M,f	Shelby water intake from Park Ave.	21.5	Crestline	40.8677	-82.6614
51.32	C,O,S,D,B,M,F	CR 58, London West Rd.	30.8	Shelby	40.9083	-82.6567
43.18	C,O,S,D,B,M,F	CR 207, Ganges-Five Points Rd.	85.0	Shiloh	40.9092	-82.5631
36.60	C,D,B,M,F	SR 13, Upper Charles Mill Reservoir	108	Shiloh	40.8872	-82.5108

Table 3. (continued)

RM	Sample Type	Location	Mi^2	Map	latitude	longitude
05040002 020 Middle Black Fork Assessment Unit (Ust. RM 14.02)						
	17-730-000	***Black Fork Mohican River- cont'd.***				
29.67	C,O,D,B,M,F	TR 89, Charles Rd. (***S***)	166	Pavonia	40.8517	-82.4300
23.31	C,D,b,M,F	CR 92, Crider Rd., Dst. I-71	190	Pavonia	40.8002	-82.3873
18.30	C,O,D,B	Dst. Charles Mill Lake (***S***)	217	Perrysville	40.7381	-82.3633
17.81	M,F	Mifflin TR 1265	218	Perrysville	40.7333	-82.3669
16.32	T	SR 603	221	Perrysville	40.7207	-82.3731
14.65	C,S,D,B,M,F	SR 39	224	Perrysville	40.7047	-82.3544
05040002 080 Lower Black Fork Assessment Unit						
7.09	C,S,D,B,M,F,T	SR 39, Dst. Perrysville WWTP	316	Perrysville	40.6531	-82.3029
2.50	C,O,S,D,B,M,F	SR 39, Loudonville (***S***)	349	Loudonville	40.6356	-82.2389
1.50	T	CR 3175, Wally Rd.	352	Greer	40.6198	-82.2458
0.10	T	CR 3175, Wally Rd. Campground	356	Jelloway	40.6094	-82.2538
05040002 010 Upper Black Fork Assessment Unit						
	17-730-010	***Trib. to Black Fork (RM 54.46)***				
0.08	C,b,m,f	SR 61, S. Gamble St.	4.8	Crestline	40.8636	-82.6636
	17-730-005	***Tuby Run***				
0.01	C,O,S,b,m,f	Adj. Richland Central St.	4.5	Shelby	40.8797	-82.6594
	17-742-000	***Marsh Run***				
4.55	c,b,m,f	CR 58, London West Rd.	8.5	Shelby	40.9086	-82.7231
0.13	C,O,S,B,M,f	Shelby water intake from Bistline Rd.	20.0	Shelby	40.9165	-82.6565
	17-741-000	***Bear Run***				
0.48	c,b,m,f	CR 58, London West Rd.	8.6	Shelby	40.9086	-82.6381
	17-739-000	***Shipp Creek***				
0.95	c,b,m,f	SR 603	6.8	Shiloh	40.9286	-82.5347
	17-737-000	***Brubaker Creek***				
2.16	m,f	From TR 138, Brubaker Ck. Rd., Ust. Trib. Access is uncertain	8.2	Mansfield North	40.8583	-82.4869
0.30	c,b,M,f	TR 230, Eby Rd.	22.7	Pavonia	40.8736	-82.4864
	17-736-000	***Whetstone Creek***				
3.88	C,O,S,B,m,f	Driveway from CR 77, Olivesburg-Fitchville Rd., Dst. landfill	10.2	Olivesburg	40.9067	-82.4369
0.69	C,b,m,f	TR 86, Vantilburg Rd.	16.5	Pavonia	40.8692	-82.4292
05040002 020 Middle Black Fork Assessment Unit						
	17-730-014	***Trib. to Black Fork RM 25.16***				
1.68	c,b,m,f	SR 603	7.8	Pavonia	40.8239	-82.3964
	17-733-000	***Rocky Fork Mohican River***				
16.44	C,O,S,b,m,f	CR 215, Bowman Rd., Ust. Trib.'s	7.3	Mansfield North	40.8001	-82.5390
14.23	C,O,S,b,m,f,T	Longview Ave.	19.3	Mansfield North	40.7770	-82.5162
12.49	C,O,S,D,b,M,F	SR 39, Eastlawn Ave.	30.3	Pavonia	40.7578	-82.4981
10.13	C,O,S,D,B,M,F,T	SR 39, Dst. Mansfield WWTP	51.0	Lucas	40.7408	-82.4631
4.38	C,O,S,D,B,M,F	TR 355, Smart Rd. (south)	66.0	Lucas	40.7108	-82.4078
3.72	T	SR 39, Lucas	66.1	Lucas	40.7036	-82.4144
0.57	C,O,S,D,B,M,F,T	TR 431, Applegate Rd. (***S***)	77.0	Perrysville	40.7025	-82.3667
	17-734-000	***Touby Run***				
1.00	C,b,m,f	Bowman St.	9.2	Mansfield North	40.7664	-82.5231
	17-733-004	***Trib. to Rocky Fork (RM 10.70)***				
1.33	C,b,m,f	CR 300, Mansfield - Lucas Rd.	8.8	Lucas	40.7308	-82.4828

Table 3. (continued)

RM	Sample Type	Location	Mi^2	Map	latitude	longitude
05040002 080 Lower Black Fork Assessment Unit						
	17-732-000	***Honey Creek***				
5.19	c,b,m,f	CR 2175	7.8	Perrysville	40.7192	-82.2853
0.11	c,b,m,f	CR 775	17.3	Perrysville	40.6581	-82.2694
	17-731-000	***Big Run***				
0.19	c,b,m,f	CR 775	8.5	Loudonville	40.6556	-82.2484
05040002 070 Lake Fork Assessment Unit						
	17-710-000	***Lake Fork***				
14.05	C,B,M,F	SR 95	271	Loudonville	40.7233	-82.1547
7.33	C,B,M,F	SR 3	290	Loudonville	40.6647	-82.1512
0.95	C,O,S D,B,M,F	Washington TR 451(***S***)	345	Greer	40.6064	-82.1941
	17-712-000	***Odell Lake Outlet***				
3.04	c,b,m,f	SR 226	11.3	Shreve	40.6686	-82.0964
0.59	c,b,M,F	SR 179	31.6	Shreve	40.6569	-82.1350
	17-713-000	***Crab Run***				
2.15	c,b,m,f	Washington TR 473	8.0	Shreve	40.6281	-82.1228
	17-711-000	***Plum Run***				
0.13	c,b,m,f	CR 22	7.4	Loudonville	40.6475	-82.1758
05040002 050 Jerome Fork Assessment Unit						
	17-718-000	***Jerome Fork***				
12.98	C,O,S,D,B,M,F	US 42 (***R***)	38.6	Ashland North	40.8842	-82.2844
12.08	C,O,S,D,B,M,F	CR 1302, Dst. Ashland WWTP (***N***)	73.4	Ashland North	40.8754	-82.2715
7.90	C,D,B,M,F	TR 1600	114	Jeromesville	40.8279	-82.2239
5.65	T	CR 30A, Main St., Jeromesville	120	Jeromesville	40.8024	-82.2003
2.56	C,O,S,D,B,M,F	CR 175 (***S***)	147	Jeromesville	40.7764	-82.1567
	17-729-000	***Leidigh Mill Creek***				
1.91	c,b,m,f	Driveway from SR 511	8.6	Ashland North	40.9239	-82.3178
	17-728-000	***Orange Creek***				
6.32	c,b,m,f	CR 620	9.2	Ashland North	40.9742	-82.2558
4.85	c,b,m,f	SR 58	15.9	Ashland North	40.9556	-82.2583
	17-725-000	***Lang Creek***				
5.26	c,b,m,f	TR 1006 from US 250	7.7	Ashland North	40.9164	-82.3431
3.15	C,b,M,f	TR 1104 (***R***)	17.3	Ashland North	40.9017	-82.3128
	17-726-000	***Jamison Creek***				
0.30	C,b,m,f	CR 1302, Dst. Town Run	13.2	Ashland South	40.8719	-82.2819
	17-724-000	***Katotawa Creek***				
3.49	c,b,m,f	TR 1275	9.1	Polk	40.8878	-82.2294
	17-723-000	***Newell Run***				
1.00	c,b,m,f	TR 655	8.4	Ashland South	40.8344	-82.2508
	17-720-000	***Oldtown Run***				
4.31	c,b,m,f	CR 1802	7.6	Jeromesville	40.7975	-82.2411
	17-721-000	***Quaker Springs Run***				
1.97	c,b,m,f	CR 2000	7.6	Jeromesville	40.7719	-82.2197
05040002 060 Muddy Fork Assessment Unit						
	17-714-000	***Muddy Fork Mohican River***				
25.50	C,O,S,B	Cinamon Lake WTP	1.5	Polk	40.9865	-82.1772
23.29	C,b,m,f	Jackson TR 101	9.3	Polk	40.9811	-82.1486
18.37	C,b,M,f	Congress TR 247, Fleming Rd. (***R***)	18.5	West Salem	40.9506	-82.1189

Table 3. (continued)

RM	Sample Type	Location	Mi^2	Map	latitude	longitude
	17-714-000	***Muddy Fork Mohican River - cont'd.***				
13.43	C,b,M,F	CR 1100, Martin Rd. (***R***)	39.0	Polk	40.8914	-82.1403
8.20	C,B,M,F	Perry TR 1550, Hiner Rd.	66.6	Jeromesville	40.8362	-82.1376
4.30	C,O,S,D,B,M,F	Plain TR 16, Funk Rd. (***S,N***)	75.0	New Pittsburg	40.7938	-82.1175
	17-716-000	***Redhaw Creek***				
2.54	c,b,m,f	Jackson TR 133	8.0	Polk	40.9075	-82.1567
	17-714-001	***Kiser Ditch***				
0.38	c,b,m,f	SR 95	19.4	New Pittsburg	40.7547	-82.1131
		05040002 080 Lower Black Fork Assessment Unit				
	17-702-000	***Negro Run***				
1.04	c,S,D,b,m,f	Driveway from US 62, Dst. Trib. (***N***)	8.5	Brinkhaven	40.4625	-82.1792

Sample type acronyms and number of sites:

C - Conventional water chemistry with metals, 5 passes - 82 sites (410 samples)
c - conventional water chemistry no metals, 5 passes - 56 sites (280 samples)
O - Organic water chemistry, 1 pass - 35 sites (35 samples).
S - Sediment inorganic, organic and metal concentrations, 1 pass - 36 sites (36 samples).
B - Bacteriological analysis, 7 passes - 54 sites (378 samples)
b - bacteriological analysis, 5 passes - 84 sites (420 samples)
D - Datasonde (areas of algal activity may require units with stirrers) 1 pass - 52 sites
M - macroinvertebrates, quantitative, 70 sites (70 samples).
m - macroinvertebrates, qualitative, 68 sites (68 samples).
F - fish, 2 pass, 58 sites (116 samples).
f - fish, 1 pass, 80 sites (80 samples).
T- Fish tissue, human consumption risk analysis (20 sites).
Compliance - Sampling will determine entity NPDES permit compliance (5 sites).

(***R***) Reference site: Data from these locations was used to derive ecoregional biological expectations. Generally, a robust sampling effort is conducted at these sites to support future calibration needs (20 sites).
(***N***) Nutrient site: Ohio EPA is evaluating data from these locations toward developing nutrient concentration water quality criteria in correlation with aquatic life use performance. Dissolved P, water column chlorophyll, and periphyton will be assessed at these sites (10 sites).
(***S***) Sentinel site: Location where modeling unit will calibrate flow with stage height. Water level will be measured on each chemistry sample pass (18 sites).

Table 4. Ohio EPA chemistry lab sampling effort for the 2007 Walhonding watershed study area (See attached mock lab report forms) Tabulations do not include 5 compliance locations.

Type of sample	# DES Parameters	# Sites	# Passes	Total #
Water Chemistry				
Conventional (Inorganic Samples)				
Demand	4	138	5	2760
oil & grease	1 (compliance sites)	5	-	-
Nutrients	9	138	5	6210
dissolved P	1	10	1	10
Bacteria	1	78 / 54	5 / 7	768
Metals / Low Level	18	82	5	7380
mercury	1	82	2 / 3	164-246
Organic Scan				
Volatiles (VOC)	1 (59 compounds)	25	1	25
Cyanazine / Herbicides	2 (13 compounds)	35	1	70
Semivolatiles (BNA)	1 (54 compounds)	25	1	25
PCBs, Pesticides	4 (27 compounds)	35	1	140
Carbamates	1 (10 compounds)	35	1	35
Glyphosate	1 (1 compound)	35	1	35
Sediment Chemistry				
Conventional (Inorganic Samples)				
Demand	3	36	1	108
Nutrients	2	36	1	72
Metals / Low Level	17	36	1	612
mercury	1	36	1	36
Organic Scan				
Volatiles (VOC)	1 (64 compounds)	36	1	36
Semivolatiles (BNA)	1 (86 compounds)	36	1	36
PCBs, Pesticides	4 (31 compounds)	36	1	144
Chlorophyll A				
Fluorometer test	1	10	1	10

Table 5. Ohio EPA test methods for the 2007 Walhonding watershed study area.

Parameters	Water column field test method	Water column lab test method	Sediment lab test method
Percent Solids			SM 2540G
BOD, 5-Day	USEPA 405.1, SM 5210B		
Conductivity	Hanna HI9811 meter	USEPA 120.1	
Particle Size			OEPA 160.1
pH	Hanna HI9811 meter		
Solids, Dissolved (TDS)		USEPA 160.1	
Solids, Suspended (TSS)		USEPA 160.2	
Total Organic Carbon (TOC)			OEPA 335.2
Acidity, Total CaCO3		USEPA 305.1	
Alkalinity, Total CaCO3		USEPA 310.1	
Chloride, Cl		USEPA 325.1	
COD		USEPA 410.4	
Nitrite		USEPA 354.1	
Ammonia		USEPA 350.1	SM 4500 -NH3 B&E
Nitrate+Nitrite		USEPA 353.1	
Phosphorus, Dissolved		USEPA 365.4	
Sulfate		USEPA 375.4	
TKN (Total Kjeldahl Nitrogen)		USEPA 351.2	
Phosphorus, Total		USEPA 365.4	USEPA 365.4
E.coli		USEPA 1103.1/ 640.1	
Total Coliform		SM 9222 B	
ICP 1 (Al,Ba,Ca,Cr,Cu,Fe, Mg, Mn, Na, Ni, K, Sr, Zn, Hardness)		USEPA 200.7	
ICP 3 (Al,Ba,Ca,Cr,Cu,Fe,Mg,Mn,Na,Ni,K,Sr,Zn,Pb)			USEPA 200.7
GFAA/SIMA 1 (As,Cd,Pb,Se)	USEPA 200.9, SM 3113B		
GFAA/SIMA 2 (As, Cd, Se)		USEPA 200.9, SM 3113B	
Mercury, Total		USEPA 245.1,7470A	USEPA 7471A
Chlorophyll A		USEPA 445	
Dissolved Oxygen	YSI 55 meter		
Temperature	YSI 55 meter		
VOCs		USEPA 624	USEPA 8260B
Cyanazine (Bladex)		USEPA 525.2	
Herbicides (Atrazine, etc.)		USEPA 525.2	
BNA Organics (SVOCs)		USEPA 625	USEPA 8270C
Pesticides/ PCBs/ Chlordane		USEPA 608	USEPA 8081A, 8082
Carbamates (Sevin)		USEPA 531.1	
Glyphosate (Roundup)		USEPA 547	

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