State of Ohio
Environmental Protection Agency

Division of Surface Water

Biological and Water Quality Assessment of the Muskingum River

Gould National Battery

Muskingum County, Ohio

December 11, 2009

Ted Strickland, Governor
Chris Korleski, Director

Biological and Water Quality Study

Muskingum River
(Gould National Battery Property)

2009

Muskingum County, Ohio
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EXECUTIVE SUMMARY

The biological and water quality conditions in a 1.2 mile impounded section of the Muskingum River in the Zanesville area was assessed by the Ohio EPA during 2009. Using standard Ohio EPA assessment protocols, the upper 0.4 miles of the Muskingum River were in full attainment of the Warmwater Habitat (WWH) aquatic life use, and the lower 0.6 miles were partially attaining the use (Table 1). Within the 1.2 mile study area, all three fish sampling sites were fully achieving warmwater biocriteria. Macroinvertebrates were collected from both near shore locations (to capture any impairment related to the release of pollutants from the Gould National Battery property) and mid channel (to incorporate better habitat and flow conditions). The macroinvertebrate communities from the near shore upstream and downstream sampling locations were very poor. The sampling location adjacent to Gould National Battery was evaluated as poor. Ohio EPA has identified some members of the macroinvertebrate community that are tolerant of toxic instream conditions. Toxic tolerant macroinvertebrates frequently become abundant and may predominate a community when toxic conditions are present. Toxic tolerant macroinvertebrates were not identified in any of the samples from the near shore sampling locations. The very poor and poor condition of the macroinvertebrate community from all three sampling locations was related to poor habitat conditions. The Gould National Battery property did not appear to have an impact on the macroinvertebrate community. The macroinvertebrate communities from the mid channel sites ranged in quality from marginally good at the upstream site to high fair at the adjacent and downstream sites. The adjacent and downstream sites had ICI scores lower than the upstream site but an examination of the individual metric scores revealed very slight differences in most of the macroinvertebrate community components. The assessment of the biological communities did not document impairment associated with the Gould National Battery property.

RECOMMENDATIONS

The aquatic life use designation of Warmwater Habitat has been confirmed in this study and previous Ohio EPA biological and water quality studies, and should be maintained. Physical habitat conditions, river pool depths, and recreational activity verified that the Primary Contact Recreation use is appropriate for the Muskingum River.

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Stream sampling: Mike Gray, David Altfater, Holly Tucker
Data support: Dennis Mishne
Report preparation and analysis: David Altfater, Mike Gray
Reviewers - Jeff DeShon, Marc Smith

INTRODUCTION

A 1.5 mile section of the Muskingum River was assessed during 2009, evaluating biological, sediment, and surface water resources. This study was undertaken to assess water resource conditions in the Muskingum River upstream, adjacent, and downstream from the Gould National Battery property. This water resource project is part of a Targeted Brownfield Assessment (TBA).

Specific objectives of the evaluation were to:

- Assess biological conditions in the Muskingum River by evaluating fish and macroinvertebrate communities,
- Evaluate surficial sediment and surface water chemical quality in the Muskingum River,
- Determine the aquatic life use attainment status of the Muskingum River with regard to the Warmwater Habitat (WWH) aquatic life use designation codified in the Ohio Water Quality Standards, and
- Perform the work to satisfy the requirements of VAP rule OAC 3745-300-09.

The Muskingum River is located in the Western Allegheny Plateau (WAP) ecoregion. The Muskingum River is currently assigned the Warmwater Habitat (WWH) aquatic life use designation for its entire length.

Aquatic life use attainment conditions are presented in Table 1, and sampling locations are detailed in Table 2 and graphically presented in Figure 1.

Table 1. Aquatic life use attainment status for sampling locations in the Muskingum River, Zanesville area, 2009. The Index of Biotic Integrity (IBI), Modified Index of Well-being (MIwb), and Invertebrate Community Index (ICI) scores are based on the performance of the biological community. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support a biological community. River sites are located in the Western Allegheny Plateau (WAP) ecoregion. In the Ohio Water Quality Standards, the Muskingum River is designated Warmwater Habitat (WWH). If biological impairment has occurred, the cause(s) and source(s) of the impairment are noted.

Sample Location River Mile	Aquatic Life Use Designation	Aquatic Life Attainment Status	IBI	MIwb	ICI	Stream [a] Habitat	Aquatic Life Use Impairment Cause/Source[b]
74.7	WWH	**FULL**	45	9.6	34[ns]	Fair	
74.2	WWH	**PARTIAL**	45	9.8	30*	Fair	Direct Habitat Alterations/ Impoundment
73.5	WWH	**PARTIAL**	42	9.7	26*	Fair	Direct Habitat Alterations/ Impoundment

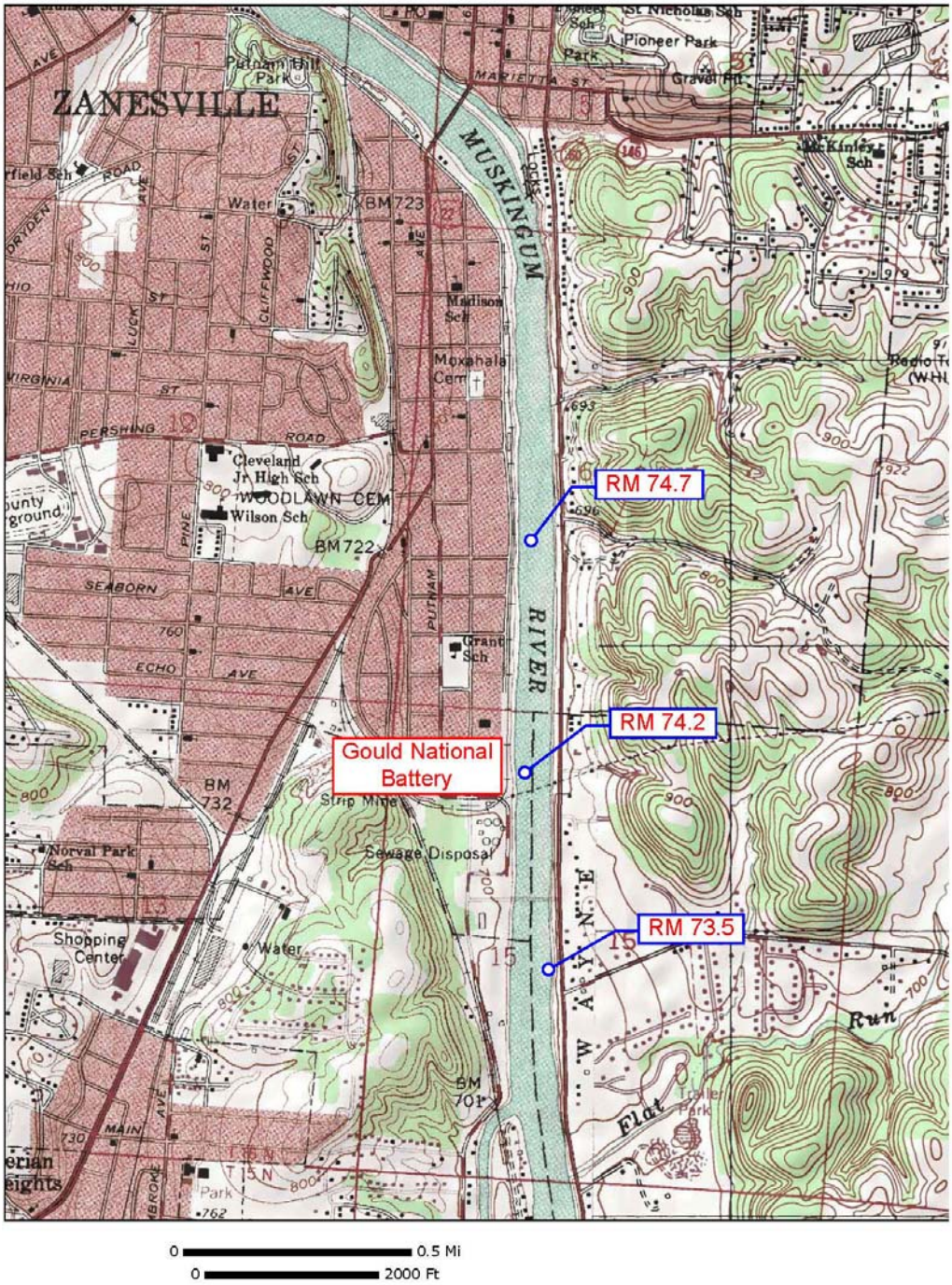
BIOCRITERIA		
INDEX - Site Type	WWH	EWH
IBI: Boat	40	48
MIwb: Boat	8.6	9.6
ICI	36	46

* Significant departure from ecoregion biocriterion; poor and very poor results are underlined.
ns Nonsignificant departure from biocriterion (≤4 IBI or ICI units, 0.5 MIwb units).
a Narrative habitat evaluations are based on QHEI scores as follows: Excellent =75-100, Good = 60-74, Fair = 45-59, Poor = 30-44 and Very Poor <30.

Table 2. Sampling locations in the Muskingum River, Zanesville area, 2009. Type of sampling included fish community (F), macroinvertebrate community (M), surface water (W), and sediment (S).

Stream/ River Mile	Type of Sampling	Latitude	Longitude	Landmark
74.7	F,M,W,S	39.9224	82.0027	Upstream Gould National Battery, downstream lock
74.2	F,M,W,S	39.9148	82.0027	Adjacent Gould National Battery
73.5	F,M,W,S	39.9047	82.0033	Downstream Gould National Battery/ Dst. SR 555

Figure 1. Sampling locations in the Muskingum River, Zanesville area, 2009.



METHODS

All chemical, physical, and biological field, 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 2006b), Biological Criteria for the Protection of Aquatic Life, Volumes II - III (Ohio Environmental Protection Agency 1987b, 1989a, 1989b, 2008a, 2008b), The Qualitative Habitat Evaluation Index (QHEI); Rationale, Methods, and Application (Rankin 1989), Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (Ohio EPA 2006a), and Ohio EPA Sediment Sampling Guide and Methodologies (Ohio EPA 2001).

Determining Use Attainment

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 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. 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 1) 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-attainment), the Qualitative Habitat Evaluation Index (QHEI), and a sampling location description. Biological results were compared to WWH biocriteria. The Muskingum River is currently listed as WWH in the Ohio Water Quality Standards.

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, 1995; Ohio EPA 2006a). 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 often typify habitat conditions which have the ability to support exceptional faunas.

Sediment and Surface Water Assessment

Fine grain sediment samples were collected multi-incrementally in the upper four inches of bottom material at each biological location using decontaminated stainless steel scoops. At each location, between 10 and 12 scoops of fine grained material over a 500 meter section of river were collected. Sediment incremental samples were mixed in stainless steel pans (VOC sample jars were filled prior to mixing), transferred into glass jars with teflon lined lids, placed on ice (to maintain 4^{o}C) in a cooler, and shipped to an Ohio EPA contract lab. Sediment data are reported on a dry weight basis. Decontamination of sediment sampling equipment followed the procedures outlined in the Ohio EPA sediment sampling guidance manual (Ohio EPA 2001). Surface water samples were collected directly into appropriate containers, preserved and delivered to an Ohio EPA contract lab. Surface water samples were collected once from each location from the upper 12 inches of water. Collected water was 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 2006b). 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), along with a comparison of metals results to Ohio Sediment Reference Values (Ohio EPA 2003).

Macroinvertebrate Community Assessment

Macroinvertebrates were collected from artificial substrates and from the natural habitats at the Muskingum River sites. 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). Since all three sampling locations were within a dam pool, two composite artificial substrate samples were used. One was placed in a wading accessible location near the shoreline in a manner consistent with OEPA historical sampling methods. The other was set on the bottom in mid-channel in water from 6-8 feet deep. 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 1989a, 2008b).

Fish Community Assessment

Fish were sampled twice at each Muskingum River site using pulsed DC boat electrofishing methods. Sampling occurred during the night to best reflect fish populations. Fish were processed in the field, and included identifying each individual to species, counting and weighing fish, 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 1989a, 2008b).

RESULTS

Surface Water

Chemical analyses were conducted on surface water samples collected on August 17, 2009 from three locations in the Muskingum River (Appendix Table 1). Surface water samples were analyzed for total analyte list inorganics (metals), PCBs, volatile organic compounds, and semivolatile organic compounds. No parameters were in exceedence of Ohio WQS criteria.

Concentrations of PCBs, volatile organics, and semivolatile organic compounds tested in river water at all three locations were reported as not detected. All metals concentrations were low, and were below applicable Ohio WQS aquatic life and human health criteria.

Nutrients, ammonia-N, dissolved oxygen and bacteriological parameters were not tested as part of this evaluation. Excluding the typical wastewater chemical parameters noted above, good chemical water quality was evident in all river samples.

Sediment

Surficial sediment samples were collected at three locations in the Muskingum River by the Ohio EPA on September 24, 2009. Sampling locations were co-located with biological sampling sites. Samples were analyzed for total analyte list inorganics (metals), volatile organic compounds, semivolatile organic compounds, PCBs, and total petroleum hydrocarbons. Specific chemical parameters tested and results are listed in Appendix Table 2. Sediment data were evaluated using Ohio Sediment Reference Values (Ohio EPA 2003), along with guidelines established in *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald *et.al*. 2000), and *Ecological Screening Levels (ESLs)* (USEPA 2003). The consensus-based sediment guidelines define two levels of ecotoxic effects. A *Threshold Effect Concentration* (TEC) is a level of sediment chemical quality below which harmful effects are unlikely to be observed. A *Probable Effect Concentration* (PEC) indicates a level above which harmful effects are likely to be observed. ESL values, considered protective benchmarks, were derived by USEPA, Region 5 using a variety of sources and methods.

Sediment samples were conservatively sampled by focusing on depositional areas of fine grain material (silts and clays). These areas typically are represented by higher contaminant levels, compared to coarse sands and gravels. Fine grained depositional areas were uncommon at all three sites.

Sediment results from RM 74.7 were below screening benchmarks for all parameters tested. Chemical parameters measured above ecological screening guidelines are presented in Table 3. Highest concentrations of two metals - lead and zinc - were noted at RM 74.2, an area adjacent to the Gound National Battery property. However, good biological integrity was documented at RM 74.2, as well as at RMs 74.7 and 73.5. The sparse deposits of fine grained material at each sampling site contributed to low exposure levels of sediment contaminants to biological communities.

Table 3. Chemical parameters measured above screening levels in sediment samples collected by Ohio EPA from surficial sediments in Muskingum River, September, 2009. Contamination levels were determined for parameters using Ohio Sediment Reference Values (SRVs), consensus-based sediment quality guidelines (MacDonald, et.al. 2000) and ecological screening levels (USEPA 2003). Shaded numbers indicate values above the following: SRVs (blue),Threshold Effect Concentration –TEC (yellow), Probable Effect Concentration – PEC (red) and Ecological Screening Levels (orange). Sampling locations are indicated by river mile (RM).

Parameter	RM 74.7	RM 74.2	RM 73.5
Arsenic (mg/kg)	5.6	11	10.7
Lead (mg/kg))	21.8	386	26.4
Nickel (mg/kg)	13.2	23	30.4
Zinc (mg/kg)	52.9	216	146

Stream Physical Habitat

Physical habitat was evaluated at each fish sampling location. Physical habitat was assessed using the Qualitative Habitat Evaluation Index (QHEI); scores are detailed in Table 4. All three sampling sites were within an impounded reach of river, where the habitat was 100 percent pool. Although the sampling sites were pooled habitat, detectable river flows of between 0.4 and 0.5 feet per second were recorded when the macroinvertebrate mid-channel samples were set and collected. All three Muskingum River impounded sites were rated as fair habitat quality.

Table 4. Qualitative Habitat Evaluation Index (QHEI) scores and physical attributes for fish sampling sites in Muskingum River, Zanesville area, 2009.

River Mile	QHEI	Habitat Rating	WWH Attributes: No Channelization or Recovered	Boulder/Cobble/Gravel Substrates	Silt Free Substrates	Good/Excellent Substrates	Moderate/High Sinuosity	Extensive/Moderate Cover	Fast Current/Eddies	Low-Normal Overall Embeddedness	Max. Depth >40 cm	Low-Normal Riffle Embeddedness	**Total WWH Attributes**	MWH Attributes – *High Influence*: Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/ No Cover	Max. Depth <40 cm (WD,HW sites)	**Total High Influence Attributes**	MWH Attributes – *Moderate Influence*: Recovering Channel	Heavy/Moderate Silt Cover	Sand Substrates (Boat)	Hardpan Substrate Origin	Fair/Poor Development	Low Sinuosity	Only 1-2 Cover Types	Intermittent & Poor Pools	No Fast Current	High/Mod. Overall Embeddedness	High/Mod. Riffle Embeddedness	No Riffle	**Total Moderate Influence Attributes**	**(MWH H.I.+1)/ (WWH+1) Ratio**	**(MWH M.I.+1)/ (WWH+1) Ratio**
Muskingum River Year: 2009																																	
74.7	**54.5**	Fair	■					■		■	■		4		◆		◆		2					●	●			●	●		●	5	0.60	1.60
74.2	**57.0**	Fair	■					■		■	■		4		◆		◆		2					●	●			●	●		●	5	0.60	1.60
73.5	**50.5**	Fair	■								■		2		◆		◆		2					●	●			●	●		●	5	1.00	2.67

Key QHEI Components

Fish Community

A total of 3,504 fish representing 34 species were collected from the Muskingum River in the Zanesville area between August and September, 2009. Relative numbers and species collected per location are presented in Appendix Table 3 and IBI metrics are presented in Appendix Table 4. Sampling locations were evaluated using Warmwater Habitat biocriteria. All three fish sampling locations evaluated during this study were achieving the applicable Warmwater Habitat fish biocriterion (Table 5). Fish communities were reflective of good to exceptional quality.

Table 5. Fish community summaries based on pulsed D.C. boat night electrofishing sampling conducted by Ohio EPA in the Muskingum River, Zanesville area, from August and September, 2009. Relative numbers are per 1.0 km. The applicable aquatic life use designation is WWH.

Stream River Mile	Sampling Method	Species (Mean)	Species (Total)	Relative Number	QHEI	Index of Biotic Integrity	Modified Index of Well-being	Narrative Evaluation
74.7	Boat	23.0	27	1135	54.5	45	9.6	Very Good/ Exceptional
74.2	Boat	25.0	27	1095	57.0	45	9.8	Very Good/ Exceptional
73.5	Boat	25.0	29	1274	50.5	42	9.7	Good/Exceptional

Ecoregion Biocriteria: Western Allegheny Plateau (WAP)		
INDEX - Site Type	WWH	EWH
IBI: Boat	40	48
MIwb: Boat	8.6	9.6

* Significant departure from ecoregion biocriterion; poor and very poor results are underlined.
ns Non-significant departure from ecoregion biocriterion (≤4 IBI units or 0.5 MIwb units).

Macroinvertebrate Community

The macroinvertebrate communities from the Muskingum River in the vicinity of the Gould National Battery facility were sampled in 2009 using quantitative (artificial substrate) and qualitative (natural substrate multi-habitat composite) sampling protocols. Results are summarized in Table 6. The ICI metrics with the associated scores and the raw data are attached as Appendix Tables 5 and 6. The Muskingum River was impounded at all three of the sampling locations. Placing artificial substrate samplers in near shore locations in large impounded rivers frequently result in low ICI scores. Low current velocities and sediment deposits along the shore combine to provide poor habitat for the establishment of macroinvertebrate communities. Artificial substrate samplers were placed in mid channel where current velocities and gravel/cobble bottom substrates provided adequate macroinvertebrate habitat. Artificial substrate samplers were also used at near shore sampling locations to capture any impairment related to the release of pollutants from the Gould National Battery property.

The macroinvertebrate communities from the near shore upstream (RM 74.7) and the downstream (RM 73.5) sampling locations were very poor. The adjacent sampling location (RM 74.2) was evaluated as poor. Ohio EPA has identified some members of the macroinvertebrate community that are tolerant of toxic instream conditions. Toxic tolerant macroinvertebrates frequently become abundant and may predominate a community when toxic conditions are present. Toxic tolerant macroinvertebrates were not identified in any of the samples from the near shore sampling locations. The very poor and poor condition of the macroinvertebrate community from all three sampling locations was related to poor habitat conditions. The Gould National Battery property did not appear to have an impact on the macroinvertebrate community.

The macroinvertebrate communities from the mid channel sites ranged in quality from marginally good (RM 74.7) to high fair at the RM 74.2 and 73.5 sites. The adjacent and downstream sites had ICI scores lower than the upstream site but an examination of the individual metric scores (Appendix Table 5) revealed very slight differences in most of the macroinvertebrate community components.

Table 6. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the Muskingum River, 2009.

Stream/ River Mile	Density Number/ft^2	Total Taxa	Quantitative Taxa	Qualitative Taxa	Qualitative EPT[a]	ICI	Evaluation
Muskingum River							
74.7A - Mid	1167	41	35	19	5	34^{ns}	Marginally Good
74.7B - Edge	4511	8	8	-	-	6*	Very Poor
74.2A - Mid	1219	40	34	21	8	30*	High Fair
74.2B - Edge	6222	14	14	-	-	12*	Poor
73.5A - Mid	1433	32	30	11	4	26*	High Fair
73.5B - Edge	3650	9	9	-	-	6*	Very Poor

Ecoregion Biocriteria: Western Allegheny Plateau (WAP)		
INDEX	WWH	EWH
ICI	36	46

[a] EPT=total Ephemeroptera (mayflies), Plecoptera (stoneflies), and Trichoptera (caddisflies) taxa richness, a measure of pollution sensitive organisms.
* Significant departure from ecoregion biocriterion; poor and very poor results are underlined.
[ns] Nonsignificant departure from biocriterion (≤4 ICI units).

REFERENCES

Karr, J. R. 1991. Biological integrity: A long-neglected aspect of water resource management. Ecological Applications 1(1): 66-84.

Karr, J.R., K.D. Fausch, P.L. Angermier, P.R. Yant, and I.J. Schlosser. 1986. Assessing biological integrity in running waters: a method and its rationale. Ill. Nat. Hist. Surv. Spec. Publ. 5. 28 pp.

MacDonald, D., C. Ingersoll, T. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch. Environ. Contam. Toxical.: Vol.39, 20-31.

Miner R. and D. Borton. 1991. Considerations in the development and implementation of biocriteria, Water Quality Standards for the 21st Century, U.S. EPA, Offc. Science and Technology, Washington, D.C., 115 pp.

Ohio Environmental Protection Agency. 2008a. 2008 updates to Biological Criteria for the Protection of Aquatic Life: Volume II and Volume II Addendum. Users manual for biological field assessment of Ohio surface waters. Div. of Surface Water, Ecol. Assess. Sect., Columbus, Ohio.

Ohio Environmental Protection Agency. 2008b. 2008 updates to Biological Criteria for the Protection of Aquatic Life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Div. of Surface Water, Ecol. Assess. Sect., Columbus, Ohio.

Ohio Environmental Protection Agency. 2006a. Methods for assessing habitat in flowing waters: Using the Qualitative Habitat Evaluation Index (QHEI). Ohio EPA Tech. Bull. EAS/2006-06-1. Div. of Surface Water, Ecol. Assess. Sect., Columbus, Ohio.

Ohio Environmental Protection Agency. 2006b. Ohio EPA manual of surveillance methods and quality assurance practices, updated edition. Division of Environmental Services, Columbus, Ohio.

Ohio Environmental Protection Agency. 2003. Ecological risk assessment guidance manual. Feb. 2003. Division of Emergency and Remedial Response, Columbus, Ohio.

Ohio Environmental Protection Agency. 2001. Sediment sampling guide and methodologies, 2nd edition. Nov. 2001. Division of Surface Water, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989a. Addendum to Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Ohio Environmental Protection Agency. 1989b. Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities. Div. Water Quality Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Ohio Environmental Protection Agency. 1987a. Biological criteria for the protection of aquatic life: Volume I. The role of biological data in water quality assessment. Div. Water Qual. Monit. & Assess., Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1987b. Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters. Div. Water Qual. Monit. & Assess., Surface Water Section, Columbus, Ohio.

Rankin, E. T. 1995. The use of habitat assessments in water resource management programs, pp. 181-208. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Rankin, E.T. 1989. The qualitative habitat evaluation index (QHEI): rationale, methods, and application. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Suter, G.W., II. 1993. A critique of ecosystem health concepts and indexes. Environmental Toxicology and Chemistry, 12: 1533-1539.

United States Environmental Protection Agency (2003). Region 5, final technical approach for developing ecological screening levels for RCRA Appendix IX constituents and other significant contaminants of ecological concern. August, 2003.

Yoder, C.O. 1995. Policy issues and management applications for biological criteria, pp. 327-344. in W. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Water Resource Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

Yoder, C. O. 1991**.** Answering some concerns about biological criteria based on experiences in Ohio, *in* G. H. Flock (ed.) Water quality standards for the 21st century. Proceedings of a National Conference, U. S. EPA, Office of Water, Washington, D.C.

Yoder, C.O. 1989. The development and use of biological criteria for Ohio surface waters. U.S. EPA, Criteria and Standards Div., Water Quality Stds. 21st Century, 1989: 139-146.

Yoder, C.O. and E.T. Rankin. 1995. The role of biological criteria in water quality monitoring, assessment, and regulation. Environmental Regulation in Ohio: How to Cope With the Regulatory Jungle. Inst. of Business Law, Santa Monica, CA. 54 pp.

APPENDICES – MUSKINGUM RIVER, 2009

Appendix Table 1. Results of chemical surface water sampling conducted by Ohio EPA in the Muskingum River, August 17, 2009.

Stream	**Muskingum River**	**Muskingum River**	**Muskingum River**	
River Mile	**74.7**	**74.2**	**73.5**	
Date Sampled	8/17/2009	8/17/2009	8/17/2009	
TAL Metals (ug/l)				
Mercury	<0.20	<0.20	<0.20	
Aluminum	120	126	190	
Antimony	<10.0	<10.0	<10.0	
Arsenic	20.2	13.5J	28.5	
Barium	52.6	53.6	58	
Beryllium	<5.00	<5.00	<5.00	
Cadmium	<10.0	<10.0	<10.0	
Calcium	59,600	61,600	62,400	
Chromium	<10.0	<10.0	<10.0	
Cobalt	1.00J	<3.00	2.54J	
Copper	3.93J	4.14J	5.21J	
Iron	193	215	324	
Lead	<10.0	<10.0	2.84J	
Magnesium	18,300	19,000	18,900	
Manganese	156	167	197	
Nickel	2.77J	3.81J	5.26J	
Potassium	5020	5170	5290	
Selenium	<20.0	<20.0	<20.0	
Silver	<10.0	<10.0	<10.0	
Sodium	40,500	41,900	43,400	
Thallium	<10.0	<10.0	<10.0	
Vanadium	4.12J	4.22J	5.15J	
Zinc	3.31J	5.23J	8.59J	
Volatile Organic Analytes (ug/l)				
Dichlorodifluoromethane	<1.00	<1.00	<1.00	
Chloromethane	<1.00	<1.00	<1.00	
Vinyl chloride	<2.00	<2.00	<2.00	
Bromomethane	<1.00	<1.00	<1.00	
Chloroethane	<1.00	<1.00	<1.00	
Trichlorofluoromethane	<2.00	<2.00	<2.00	
Acrolein	<10.0	<10.0	<10.0	
1,1-Dichloroethene	<1.00	<1.00	<1.00	
Acetone	<10.0	<10.0	<10.0	
Iodomethane	<1.00	<1.00	<1.00	
Carbon disulfide	<1.00	<1.00	<1.00	
Acetonitrile	<20.0	<20.0	<20.0	
Methylene chloride	<5.0	<5.0	<5.0	
Methyl tert-butyl ether	<2.00	<2.00	<2.00	
trans-1,2-Dichloroethene	<2.00	<2.00	<2.00	
Acrylonitrile	<10.0	<10.0	<10.0	
1,1-Dichloroethane	<1.00	<1.00	<1.00	
Vinyl acetate	<10.0	<10.0	<10.0	
cis-1,2-Dichloroethene	<1.00	<1.00	<1.00	
2-Butanone	<10.0	<10.0	<10.0	
Bromochloromethane	<1.00	<1.00	<1.00	

Appendix Table 1. Continued.

Stream	**Muskingum River**	**Muskingum River**	**Muskingum River**	
River Mile	**74.7**	**74.2**	**73.5**	
Date Sampled	8/17/2009	8/17/2009	8/17/2009	
Volatile Organic Analytes (ug/l)				
Tetrahydrofuran	<2.00	<2.00	<2.00	
Chloroform	<1.00	<1.00	<1.00	
1,1,1-Trichloroethane	<1.00	<1.00	<1.00	
Carbon tetrachloride	<1.00	<1.00	<1.00	
1,1-Dichloropropene	<1.00	<1.00	<1.00	
Benzene	<1.00	<1.00	<1.00	
1,2-Dichloroethane	<1.00	<1.00	<1.00	
Trichloroethene	<2.00	<2.00	<2.00	
1,2-Dichloropropane	<1.00	<1.00	<1.00	
Methyl Methacrylate	<20.0	<20.0	<20.0	
Dibromomethane	<1.00	<1.00	<1.00	
Bromodichloromethane	<1.00	<1.00	<1.00	
2-Chloroethyl vinyl ether	<10.0	<10.0	<10.0	
cis-1,3-Dichloropropene	<1.00	<1.00	<1.00	
4-Methyl-2-pentanone	<10.0	<10.0	<10.0	
Toluene	<2.00	<2.00	<2.00	
trans-1,3-Dichloropropene	<2.00	<2.00	<2.00	
1,1,2-Trichloroethane	<1.00	<1.00	<1.00	
Tetrachloroethene	<2.00	<2.00	<2.00	
1,3-Dichloropropane	<1.00	<1.00	<1.00	
2-Hexanone	<10.0	<10.0	<10.0	
Chlorodibromomethane	<1.00	<1.00	<1.00	
1,2-Dibromoethane	<1.00	<1.00	<1.00	
Chlorobenzene	<1.00	<1.00	<1.00	
Ethylbenzene	<1.00	<1.00	<1.00	
1,1,1,2-Tetrachloroethane	<1.00	<1.00	<1.00	
m-,p-Xylene	<2.00	<2.00	<2.00	
o-Xylene	<1.00	<1.00	<1.00	
Total xylenes	<3.00	<3.00	<3.00	
Styrene	<2.00	<2.00	<2.00	
Bromoform	<1.00	<1.00	<1.00	
Isopropylbenzene	<1.00	<1.00	<1.00	
trans-1,4-Dichloro-2-butene	<2.00	<2.00	<2.00	
1,1,2,2-Tetrachloroethane	<1.00	<1.00	<1.00	
Bromobenzene	<1.00	<1.00	<1.00	
n-Propylbenzene	<2.00	<2.00	<2.00	
1,2,3-Trichloropropane	<1.00	<1.00	<1.00	
2-Chlorotoluene	<1.00	<1.00	<1.00	
1,3,5-Trimethylbenzene	<1.00	<1.00	<1.00	
4-Chlorotoluene	<1.00	<1.00	<1.00	
tert-Butylbenzene	<2.00	<2.00	<2.00	
1,2,4-Trimethylbenzene	<1.00	<1.00	<1.00	
sec-Butylbenzene	<2.00	<2.00	<2.00	
4-Isopropyltoluene	<1.00	<1.00	<1.00	
1,3-Dichlorobenzene	<1.00	<1.00	<1.00	
1,4-Dichlorobenzene	<1.00	<1.00	<1.00	

Appendix Table 1. Continued.

Stream	**Muskingum River**	**Muskingum River**	**Muskingum River**	
River Mile	**74.7**	**74.2**	**73.5**	
Date Sampled	8/17/2009	8/17/2009	8/17/2009	
Volatile Organic Analytes (ug/l)				
n-Butylbenzene	<2.00	<2.00	<2.00	
1,2-Dichlorobenzene	<1.00	<1.00	<1.00	
1,2-Dibromo-3-chloropropane	<5.00	<5.00	<5.00	
1,2,4-Trichlorobenzene	<1.00	<1.00	<1.00	
Hexachlorobutadiene	<1.00	<1.00	<1.00	
Naphthalene	<10.0	<10.0	<10.0	
1,2,3-Trichlorobenzene	<1.00	<1.00	<1.00	
2,2-Dichloropropane	<1.00	<1.00	<1.00	
Semi-volatile Organic Analytes (ug/l)				
1,2,4,5-Tetrachlorobenzene	<10.0	<10.0	<10.0	
1,2,4-Trichlorobenzene	<10.0	<10.0	<10.0	
1,2-Dichlorobenzene	<10.0	<10.0	<10.0	
1,3-Dichlorobenzene	<10.0	<10.0	<10.0	
1,4-Dichlorobenzene	<10.0	<10.0	<10.0	
1,4-Dioxane	<10.0	<10.0	<10.0	
1-Chloronaphthalene	<10.0	<10.0	<10.0	
1-Naphthylamine	<10.0	<10.0	<10.0	
2,3,4,6-Tetrachlorophenol	<10.0	<10.0	<10.0	
2,4,5-Trichlorophenol	<10.0	<10.0	<10.0	
2,4,6-Trichlorophenol	<10.0	<10.0	<10.0	
2,4-Dichlorophenol	<10.0	<10.0	<10.0	
2,4-Dimethylphenol	<10.0	<10.0	<10.0	
2,4-Dinitrophenol	<25.0	<25.0	<25.0	
2,4-Dinitrotoluene	<10.0	<10.0	<10.0	
2,6-Dichlorophenol	<10.0	<10.0	<10.0	
2,6-Dinitrotoluene	<10.0	<10.0	<10.0	
2-Chloronaphthalene	<10.0	<10.0	<10.0	
2-Chlorophenol	<10.0	<10.0	<10.0	
2-Methylnaphthalene	<10.0	<10.0	<10.0	
2-Methylphenol	<10.0	<10.0	<10.0	
2-Naphthylamine	<10.0	<10.0	<10.0	
2-Nitroaniline	<10.0	<10.0	<10.0	
2-Nitrophenol	<10.0	<10.0	<10.0	
2-Picoline	<10.0	<10.0	<10.0	
3&4-Methylphenol	<10.0	<10.0	<10.0	
3,3'-Dichlorobenzidine	<10.0	<10.0	<10.0	
3-Methylcholanthrene	<10.0	<10.0	<10.0	
3-Nitroaniline	<10.0	<10.0	<10.0	
4,6-Dinitro-2-methylphenol	<25.0	<25.0	<25.0	
4-Aminobiphenyl	<10.0	<10.0	<10.0	
4-Bromophenyl-phenylether	<10.0	<10.0	<10.0	
4-Chloro-3-methylphenol	<10.0	<10.0	<10.0	
4-Chloroaniline	<10.0	<10.0	<10.0	
4-Chlorophenyl-phenyl ether	<10.0	<10.0	<10.0	
4-Nitroaniline	<10.0	<10.0	<10.0	
4-Nitrophenol	<10.0	<10.0	<10.0	
7,12-Dimethylbenz(a)anthracene	<10.0	<10.0	<10.0	
Acenaphthene	<10.0	<10.0	<10.0	
Acenaphthylene	<10.0	<10.0	<10.0	

Appendix Table 1. Continued.

Stream	**Muskingum River**	**Muskingum River**	**Muskingum River**	
River Mile	**74.7**	**74.2**	**73.5**	
Date Sampled	8/17/2009	8/17/2009	8/17/2009	
Semi-volatile Organic Analytes (ug/l)				
Acetophenone	<10.0	<10.0	<10.0	
Aniline	<10.0	<10.0	<10.0	
Anthracene	<10.0	<10.0	<10.0	
Azobenzene	<10.0	<10.0	<10.0	
Benz(a)anthracene	<10.0	<10.0	<10.0	
Benzidine	<10.0	<10.0	<10.0	
Benzo(a)pyrene	<10.0	<10.0	<10.0	
Benzo(b)fluoranthene	<10.0	<10.0	<10.0	
Benzo(g,h,i)perylene	<10.0	<10.0	<10.0	
Benzo(k)fluoranthene	<10.0	<10.0	<10.0	
Benzoic acid	<10.0	<10.0	<10.0	
Benzyl alcohol	<10.0	<10.0	<10.0	
bis(2-Chloroethoxy)methane	<10.0	<10.0	<10.0	
bis-(2-Chloroethyl) ether	<10.0	<10.0	<10.0	
bis(2-Chloroisopropyl) ether	<10.0	<10.0	<10.0	
bis(2-Ethylhexyl) phthalate	<10.0	<10.0	<10.0	
Butylbenzylphthalate	<10.0	<10.0	<10.0	
Chrysene	<10.0	<10.0	<10.0	
Di-N-butylphthalate	**<10.0**	**<10.0**	**<10.0**	
Di-n-octylphthalate	<10.0	<10.0	<10.0	
Dibenz(a,h)anthracene	<10.0	<10.0	<10.0	
Dibenz(a,j)acridine	<10.0	<10.0	<10.0	
Dibenzofuran	<10.0	<10.0	<10.0	
Diethylphthalate	<10.0	<10.0	<10.0	
Dimethylphthalate	<10.0	<10.0	<10.0	
Dimethylamine	<10.0	<10.0	<10.0	
Diphenylamine	<10.0	<10.0	<10.0	
Ethyl methanesulfonate	<10.0	<10.0	<10.0	
Fluoranthene	<10.0	<10.0	<10.0	
Fluorene	<10.0	<10.0	<10.0	
Hexachlorobenzene	<10.0	<10.0	<10.0	
Hexachlorobutadiene	<10.0	<10.0	<10.0	
Hexachlorocyclopentadiene	<10.0	<10.0	<10.0	
Hexachloroethane	<10.0	<10.0	<10.0	
Indeno(1,2,3-cd)pyrene	<10.0	<10.0	<10.0	
Isophorone	<10.0	<10.0	<10.0	
Methyl methanesulfonate	<10.0	<10.0	<10.0	
N-Nitroso-di-n-butylamine	<10.0	<10.0	<10.0	
N-Nitrosodi-n-propylamine	<10.0	<10.0	<10.0	
N-Nitrosodimethylamine	<10.0	<10.0	<10.0	
N-Nitrosodiphenylamine	<10.0	<10.0	<10.0	
N-Nitrospiperidine	<10.0	<10.0	<10.0	
Naphthalene	<10.0	<10.0	<10.0	
Nitrobenzene	<10.0	<10.0	<10.0	
p-dimethylamino Azobenzene	<10.0	<10.0	<10.0	
Pentachlorobenzene	<10.0	<10.0	<10.0	
Pentachloronitrobenzene	<10.0	<10.0	<10.0	
Pentachlorophenol	<10.0	<10.0	<10.0	

Appendix Table 1. Continued.

Stream	**Muskingum River**	**Muskingum River**	**Muskingum River**	
River Mile	**74.7**	**74.2**	**73.5**	
Date Sampled	8/17/2009	8/17/2009	8/17/2009	
Semi-volatile Organic Analytes (ug/l)				
Phenacetin	<10.0	<10.0	<10.0	
Phenanthrene	<10.0	<10.0	<10.0	
Phenol	<10.0	<10.0	<10.0	
Pronamide	<10.0	<10.0	<10.0	
Pyrene	<10.0	<10.0	<10.0	
Pyridine	<10.0	<10.0	<10.0	
Total Cresol	<10.0	<10.0	<10.0	
PCBs (ug/l)				
Aroclor 1016	<0.5	<0.5	<0.5	
Aroclor 1221	<0.5	<0.5	<0.5	
Aroclor 1232	<0.5	<0.5	<0.5	
Aroclor 1242	<0.5	<0.5	<0.5	
Aroclor 1248	<0.5	<0.5	<0.5	
Aroclor 1254	<0.5	<0.5	<0.5	
Aroclor 1260	<0.5	<0.5	<0.5	
Aroclor 1262	<0.5	<0.5	<0.5	
Aroclor 1268	<0.5	<0.5	<0.5	

J - The analyte was positively identified, but the quantitation was below the reporting limit.

Appendix Table 2. Results of sediment sampling conducted by Ohio EPA in the Muskingum River, September 24, 2009.

Stream	**Muskingum River**	**Muskingum River**	**Muskingum River**	
River Mile	**74.7**	**74.2**	**73.5**	
Date Sampled	9/24/2009	9/24/2009	9/24/2009	
TAL Metals (mg/kg)				
Mercury	<0.18	<0.18	<0.18	
Aluminum	2620	8700	10900	
Antimony	5.09	8.09	12.9	
Arsenic	5.6	11	10.7	
Barium	27.6	132.0	109	
Beryllium	<1.25	0.530J	0.78J	
Cadmium	<0.50	0.78	0.53	
Calcium	4300	17600	12000	
Chromium	8.56	17.3	24.7	
Cobalt	5.05	8.07	12.6	
Copper	7.01	19.6	19.8	
Iron	9120	23100	31500	
Lead	21.8	386	26.4	
Magnesium	1720	3710	2770	
Manganese	410	891	1700	
Nickel	13.2	23	30.4	
Potassium	339	940	971	
Selenium	<1.00	<1.00	<1.00	
Silver	<0.50	<0.50	<0.50	
Sodium	59.9	117	111	
Thallium	<0.50	<0.50	<0.50	
Vanadium	8.56	20.9	20.8	
Zinc	52.9	216	146	
Volatile Organic Analytes (ug/kg)				
Dichlorodifluoromethane	<5.00	<5.00	<5.00	
Chloromethane	<5.00	<5.00	<5.00	
Vinyl chloride	<5.00	<5.00	<5.00	
Bromomethane	<5.00	<5.00	<5.00	
Chloroethane	<5.00	<5.00	<5.00	
Acrolein	<10.0	<10.0	<10.0	
Trichlorofluoromethane	<5.00	<5.00	<5.00	
1,1-Dichloroethene	<5.00	<5.00	<5.00	
Acetone	<5.00	<5.00	<5.00	
Iodomethane	<5.00	<5.00	<5.00	
Carbon disulfide	<5.00	<5.00	<5.00	
Methylene chloride	13.9B	13.7B	16.0B	
Methyl tert-butyl ether	<10.0	<10.0	25.8	
trans-1,2-Dichloroethene	<5.0	<5.0	<5.0	
Acrylonitrile	<25.0	<25.0	<25.0	
1,1-Dichloroethane	<5.0	<5.0	<5.0	
Vinyl acetate	<5.0	<5.0	<5.0	
2,2-Dichloropropane	<5.0	<5.0	<5.0	
cis-1,2-Dichloroethene	<5.0	<5.0	<5.0	

Appendix Table 2. Continued.

Stream	**Muskingum River**	**Muskingum River**	**Muskingum River**	
River Mile	**74.7**	**74.2**	**73.5**	
Date Sampled	9/24/2009	9/24/2009	9/24/2009	
Volatile Organic Analytes (ug/kg)				
2-Butanone	<5.0	<5.0	<5.0	
Bromochloromethane	<5.0	<5.0	<5.0	
Chloroform	<5.0	<5.0	<5.0	
1,1,1-Trichloroethane	<5.0	<5.0	<5.0	
Carbon tetrachloride	<5.0	<5.0	<5.0	
1,1-Dichloropropene	<5.0	<5.0	<5.0	
Benzene	<5.0	<5.0	<5.0	
1,2-Dichloroethane	<5.0	<5.0	<5.0	
Trichloroethene	<5.0	<5.0	<5.0	
1,2-Dichloropropane	<5.0	<5.0	<5.0	
Dibromomethane	<5.0	<5.0	<5.0	
Bromodichloromethane	<5.0	<5.0	<5.0	
2-Chloroethyl vinyl ether	<5.0	<5.0	<5.0	
cis-1,3-Dichloropropene	<5.0	<5.0	<5.0	
4-Methyl-2-pentanone	<5.0	<5.0	<5.0	
Toluene	<5.0	<5.0	<5.0	
trans-1,3-Dichloropropene	<5.0	<5.0	<5.0	
1,1,2-Trichloroethane	<5.0	<5.0	<5.0	
Tetrachloroethene	<5.0	<5.0	<5.0	
1,3-Dichloropropane	<5.0	<5.0	<5.0	
2-Hexanone	<5.0	<5.0	<5.0	
Chlorodibromomethane	<5.0	<5.0	<5.0	
1,2-Dibromoethane	<5.0	<5.0	<5.0	
Chlorobenzene	<5.0	<5.0	<5.0	
Ethylbenzene	<5.0	<5.0	<5.0	
1,1,1,2-Tetrachloroethane	<5.0	<5.0	<5.0	
m-,p-Xylene	<10.0	<10.0	<10.0	
o-Xylene	<5.0	<5.0	<5.0	
Styrene	<5.0	<5.0	<5.0	
Bromoform	<5.0	<5.0	<5.0	
Isopropylbenzene	<5.0	<5.0	<5.0	
trans-1,4-Dichloro-2-butene	<5.0	<5.0	<5.0	
Bromobenzene	<5.0	<5.0	<5.0	
1,1,2,2-Tetrachloroethane	<5.0	<5.0	<5.0	
n-Propylbenzene	<5.0	<5.0	<5.0	
1,2,3-Trichloropropane	<5.0	<5.0	<5.0	
2-Chlorotoluene	<5.0	<5.0	<5.0	
1,3,5-Trimethylbenzene	<5.0	<5.0	<5.0	
4-Chlorotoluene	<5.0	<5.0	<5.0	
tert-Butylbenzene	<5.0	<5.0	<5.0	
1,2,4-Trimethylbenzene	<5.0	<5.0	<5.0	
sec-Butylbenzene	<5.0	<5.0	<5.0	
4-Isopropyltoluene	<5.0	<5.0	<5.0	
1,3-Dichlorobenzene	<5.0	<5.0	<5.0	
1,4-Dichlorobenzene	<5.0	<5.0	<5.0	
n-Butylbenzene	<5.0	<5.0	<5.0	

Appendix Table 2. Continued.

Stream	**Muskingum River**	**Muskingum River**	**Muskingum River**	
River Mile	**74.7**	**74.2**	**73.5**	
Date Sampled	9/24/2009	9/24/2009	9/24/2009	
Volatile Organic Analytes (ug/kg)				
1,2-Dichlorobenzene	<5.0	<5.0	<5.0	
1,2-Dibromo-3-chloropropane	<5.0	<5.0	<5.0	
1,2,4-Trichlorobenzene	<5.0	<5.0	<5.0	
Hexachlorobutadiene	<5.0	<5.0	<5.0	
Naphthalene	<5.0	<5.0	<5.0	
1,2,3-Trichlorobenzene	<5.0	<5.0	<5.0	
Xylenes, Total	<15.0	<15.0	<15.0	
Ethyl Methacrylate	<5.0	<5.0	<5.0	
Hexane	<5.0	<5.0	<5.0	
Semi-volatile Organic Analytes (ug/kg)				
1,2,4,5-Tetrachlorobenzene	<250	<250	<250	
1,2,4-Trichlorobenzene	<250	<250	<250	
1,2-Dichlorobenzene	<250	<250	<250	
1,3-Dichlorobenzene	<250	<250	<250	
1,4-Dichlorobenzene	<250	<250	<250	
1-Chloronaphthalene	<250	<250	<250	
1-Naphthylamine	<250	<250	<250	
2,3,4,6-Tetrachlorophenol	<250	<250	<250	
2,4,5-Trichlorophenol	<250	<250	<250	
2,4,6-Trichlorophenol	<250	<250	<250	
2,4-Dichlorophenol	<250	<250	<250	
2,4-Dimethylphenol	<250	<250	<250	
2,4-Dinitrophenol	<250	<250	<250	
2,4-Dinitrotoluene	<250	<250	<250	
2,6-Dichlorophenol	<250	<250	<250	
2,6-Dinitrotoluene	<250	<250	<250	
2-Chloronaphthalene	<250	<250	<250	
2-Chlorophenol	<250	<250	<250	
2-Methylnaphthalene	<250	<250	<250	
2-Methylphenol	<250	<250	<250	
2-Naphthylamine	<250	<250	<250	
2-Nitroaniline	<250	<250	<250	
2-Nitrophenol	<250	<250	<250	
2-Picoline	<250	<250	<250	
3&4-Methylphenol	<250	<250	<250	
3,3'-Dichlorobenzidine	<250	<250	<250	
3-Methylcholanthrene	<250	<250	<250	
3-Nitroaniline	<250	<250	<250	
4,6-Dinitro-2-methylphenol	<250	<250	<250	
4-Aminobiphenyl	<250	<250	<250	
4-Bromophenyl-phenylether	<250	<250	<250	
4-Chloro-3-methylphenol	<250	<250	<250	
4-Chloroaniline	<250	<250	<250	
4-Chlorophenyl-phenyl ether	<250	<250	<250	

Appendix Table 2. Continued.

Stream	**Muskingum River**	**Muskingum River**	**Muskingum River**	
River Mile	**74.7**	**74.2**	**73.5**	
Date Sampled	9/24/2009	9/24/2009	9/24/2009	
Semi-volatile Organic Analytes (ug/kg)				
4-Nitroaniline	<250	<250	<250	
4-Nitrophenol	<250	<250	<250	
7,12-Dimethylbenz(a)anthracene	<250	<250	<250	
Acenaphthene	<250	<250	<250	
Acenaphthylene	<250	<250	<250	
Acetophenone	<250	<250	<250	
Aniline	<250	<250	<250	
Anthracene	<250	<250	<250	
Azobenzene	<250	<250	<250	
Benz(a)anthracene	<250	<250	<250	
Benzidine	<250	<250	<250	
Benzo(a)pyrene	<250	<250	<250	
Benzo(b)fluoranthene	68.7J	119J	110J	
Benzo(g,h,i)perylene	<250	<250	<250	
Benzo(k)fluoranthene	<250	<250	<250	
Benzoic acid	<250	<250	<250	
Benzyl alcohol	<250	<250	<250	
bis(2-Chloroethoxy)methane	<250	<250	<250	
bis-(2-Chloroethyl) ether	<250	<250	<250	
bis(2-Chloroisopropyl) ether	<250	<250	<250	
bis(2-Ethylhexyl) phthalate	<250	<250	<250	
Butylbenzylphthalate	<250	<250	<250	
Chrysene	<250	<250	<250	
Di-N-butylphthalate	164J	446	<250	
Di-n-octylphthalate	<250	<250	<250	
Dibenz(a,h)anthracene	<250	<250	<250	
Dibenz(a,j)acridine	<250	<250	<250	
Dibenzofuran	<250	<250	<250	
Diethylphthalate	<250	<250	<250	
Dimethylphthalate	<250	<250	<250	
Dimethylamine	<250	<250	<250	
Diphenylamine	<250	<250	<250	
Ethyl methanesulfonate	<250	<250	<250	
Fluoranthene	144J	174J	188J	
Fluorene	<250	<250	<250	
Hexachlorobenzene	<250	<250	<250	
Hexachlorobutadiene	<250	<250	<250	
Hexachlorocyclopentadiene	<250	<250	<250	
Hexachloroethane	<250	<250	<250	
Indeno(1,2,3-cd)pyrene	<250	<250	<250	
Isophorone	<250	<250	<250	
Methyl methanesulfonate	<250	<250	<250	
N-Nitroso-di-n-butylamine	<250	<250	<250	
N-Nitrosodi-n-propylamine	<250	<250	<250	
N-Nitrosodimethylamine	<250	<250	<250	

Appendix Table 2. Continued.

Stream	**Muskingum River**	**Muskingum River**	**Muskingum River**	
River Mile	**74.7**	**74.2**	**73.5**	
Date Sampled	9/24/2009	9/24/2009	9/24/2009	
Semi-volatile Organic Analytes (ug/kg)				
N-Nitrosodiphenylamine	<250	<250	<250	
N-Nitrospiperidine	<250	<250	<250	
Naphthalene	<250	<250	<250	
Nitrobenzene	<250	<250	<250	
p-dimethylamino Azobenzene	<250	<250	<250	
Pentachlorobenzene	<250	<250	<250	
Pentachloronitrobenzene	<250	<250	<250	
Pentachlorophenol	<250	<250	<250	
Phenacetin	<250	<250	<250	
Phenanthrene	<250	<250	<250	
Phenol	<250	<250	<250	
Pronamide	<250	<250	<250	
Pyrene	<250	<250	<250	
Pyridine	<250	<250	<250	
PCBs (ug/kg)				
Aroclor 1016	<20.0	<20.0	<20.0	
Aroclor 1221	<20.0	<20.0	<20.0	
Aroclor 1232	<20.0	<20.0	<20.0	
Aroclor 1242	<20.0	<20.0	<20.0	
Aroclor 1248	<20.0	<20.0	<20.0	
Aroclor 1254	<20.0	<20.0	<20.0	
Aroclor 1260	<20.0	50.2	<20.0	
Other Parameters				
Diesel Range Organics (C10-C28) - mg/kg	15.5	27.3	19.2	
Gasoline Range Organics - mg/kg	<0.10	<0.10	<0.10	

B - Analyte detected in the associated Method Blank.

J - The analyte was positively identified, but the quantitation was below the reporting limit.

Appendix Table 3. Fish sampling results for the Muskingum River, Zanesville area, 2009.

River Code: **17-001**	Stream: **Muskingum River**	Sample Date: **2009**
River Mile: **74.70**	Location: upst. Gould National Battery	Date Range: 08/17/2009
Time Fished: 4874 sec	Drainage: 6852.0 sq mi	Thru: 09/24/2009
Dist Fished: 1.00 km	Basin: Muskingum River No of Passes: 2	Sampler Type: N

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
Gizzard Shad		O	M		175	175.00	15.42	3.74	3.65	21.36
Smallmouth Buffalo	C	I	M		16	16.00	1.41	36.15	35.29	2,259.31
Silver Redhorse	R	I	S	M	20	20.00	1.76	3.92	3.82	195.90
Golden Redhorse	R	I	S	M	20	20.00	1.76	4.32	4.22	215.95
River Redhorse [S]	R	I	S	I	1	1.00	0.09	0.37	0.36	370.00
Smallmouth Redhorse	R	I	S	M	3	3.00	0.26	0.42	0.41	140.00
Common Carp	G	O	M	T	13	13.00	1.15	30.08	29.36	2,313.46
Emerald Shiner	N	I	M		374	374.00	32.95	0.83	0.81	2.21
Striped Shiner	N	I	S		2	2.00	0.18	0.01	0.01	3.00
Spotfin Shiner	N	I	M		72	72.00	6.34	0.14	0.14	1.96
Sand Shiner	N	I	M	M	27	27.00	2.38	0.04	0.04	1.33
Mimic Shiner	N	I	M	I	106	106.00	9.34	0.13	0.13	1.25
Ghost Shiner	N	I	M		71	71.00	6.26	0.08	0.08	1.17
Bullhead Minnow	N	O	C		21	21.00	1.85	0.06	0.06	3.06
Bluntnose Minnow	N	O	C	T	9	9.00	0.79	0.03	0.03	3.33
Channel Catfish	F		C		17	17.00	1.50	5.02	4.90	295.12
Flathead Catfish	F	P	C		3	3.00	0.26	2.11	2.06	702.00
Brook Silverside		I	M	M	1	1.00	0.09	0.00	0.00	1.00
White Bass	F	P	M		6	6.00	0.53	0.17	0.17	29.00
White Crappie	S	I	C		2	2.00	0.18	0.18	0.17	88.00
Black Crappie	S	I	C		1	1.00	0.09	0.20	0.20	202.00
Rock Bass	S	C	C		3	3.00	0.26	0.10	0.10	34.00
Smallmouth Bass	F	C	C	M	12	12.00	1.06	1.01	0.99	84.25
Spotted Bass	F	C	C		135	135.00	11.89	10.72	10.47	79.42
Largemouth Bass	F	C	C		1	1.00	0.09	0.02	0.02	19.00
Bluegill Sunfish	S	I	C	P	9	9.00	0.79	0.55	0.54	61.22
Orangespotted Sunfish	S	I	C		14	14.00	1.23	0.15	0.14	10.36
Sauger X Walleye	E	P			1	1.00	0.09	1.90	1.85	1,900.00
	Mile Total				1,135	1,135.00		102.43		
	Number of Species				27					
	Number of Hybrids				1					

River Code: **17-001**	Stream: **Muskingum River**	Sample Date: **2009**
River Mile: **74.20**	Location: adjacent to Gould National Battery	Date Range: 08/18/2009
Time Fished: 4967 sec	Drainage: 6852.0 sq mi	Thru: 09/24/2009
Dist Fished: 1.00 km	Basin: Muskingum River No of Passes: 2	Sampler Type: N

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
Gizzard Shad		O	M		153	153.00	13.97	2.40	1.77	15.66
Smallmouth Buffalo	C	I	M		16	16.00	1.46	44.25	32.62	2,765.63
Highfin Carpsucker	C	O	M		2	2.00	0.18	1.45	1.07	725.00
Silver Redhorse	R	I	S	M	28	28.00	2.56	12.77	9.41	455.90
Golden Redhorse	R	I	S	M	31	31.00	2.83	9.60	7.08	309.71
Smallmouth Redhorse	R	I	S	M	2	2.00	0.18	0.11	0.08	53.50
Common Carp	G	O	M	T	21	21.00	1.92	43.04	31.73	2,049.71
Emerald Shiner	N	I	M		332	332.00	30.32	0.73	0.54	2.20
Spotfin Shiner	N	I	M		71	71.00	6.48	0.17	0.13	2.41
Sand Shiner	N	I	M	M	30	30.00	2.74	0.04	0.03	1.20
Mimic Shiner	N	I	M	I	150	150.00	13.70	0.18	0.13	1.17
Ghost Shiner	N	I	M		17	17.00	1.55	0.02	0.02	1.35
Bullhead Minnow	N	O	C		24	24.00	2.19	0.08	0.06	3.44
Bluntnose Minnow	N	O	C	T	14	14.00	1.28	0.04	0.03	3.00
Channel Catfish	F		C		25	25.00	2.28	3.83	2.82	153.12
Flathead Catfish	F	P	C		3	3.00	0.27	0.94	0.70	314.67
White Bass	F	P	M		2	2.00	0.18	0.16	0.12	82.00
White Crappie	S	I	C		3	3.00	0.27	0.37	0.27	121.67
Rock Bass	S	C	C		4	4.00	0.37	0.17	0.13	43.50
Smallmouth Bass	F	C	C	M	8	8.00	0.73	1.11	0.82	139.13
Spotted Bass	F	C	C		122	122.00	11.14	7.48	5.51	61.29
Largemouth Bass	F	C	C		2	2.00	0.18	0.03	0.02	12.50
Bluegill Sunfish	S	I	C	P	10	10.00	0.91	0.99	0.73	99.40
Orangespotted Sunfish	S	I	C		17	17.00	1.55	0.30	0.22	17.82
Yellow Perch			M		1	1.00	0.09	0.07	0.05	71.00
Logperch	D	I	S	M	1	1.00	0.09	0.01	0.00	5.00
Freshwater Drum			M	P	6	6.00	0.55	5.30	3.91	883.33
	Mile Total				1,095	1,095.00		135.64		
	Number of Species				27					
	Number of Hybrids				0					

River Code: **17-001**	Stream: **Muskingum River**	Sample Date: **2009**
River Mile: **73.50**	Location: dst. Gould National Battery , upst. Moxahala	Date Range: 08/18/2009
Time Fished: 4296 sec	Drainage: 6853.0 sq mi	Thru: 09/25/2009
Dist Fished: 1.00 km	Basin: Muskingum River No of Passes: 2	Sampler Type: N

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
Longnose Gar		P	M		1	1.00	0.08	0.08	0.06	80.00
Gizzard Shad		O	M		156	156.00	12.24	2.66	1.87	17.05
Smallmouth Buffalo	C	I	M		23	23.00	1.81	56.25	39.64	2,445.81
Highfin Carpsucker	C	O	M		1	1.00	0.08	0.90	0.63	900.00
Silver Redhorse	R	I	S	M	22	22.00	1.73	2.94	2.07	133.50
Golden Redhorse	R	I	S	M	34	34.00	2.67	14.91	10.50	438.44
Smallmouth Redhorse	R	I	S	M	1	1.00	0.08	0.39	0.27	385.00
Common Carp	G	O	M	T	19	19.00	1.49	43.78	30.85	2,304.17
Emerald Shiner	N	I	M		432	432.00	33.91	1.05	0.74	2.42
Spotfin Shiner	N	I	M		67	67.00	5.26	0.18	0.13	2.66
Sand Shiner	N	I	M	M	20	20.00	1.57	0.02	0.02	1.10
Mimic Shiner	N	I	M	I	52	52.00	4.08	0.08	0.05	1.50
Ghost Shiner	N	I	M		32	32.00	2.51	0.03	0.02	0.91
Bullhead Minnow	N	O	C		67	67.00	5.26	0.22	0.15	3.24
Bluntnose Minnow	N	O	C	T	46	46.00	3.61	0.16	0.12	3.56
Channel Catfish	F		C		28	28.00	2.20	2.55	1.80	91.00
Flathead Catfish	F	P	C		2	2.00	0.16	1.15	0.81	577.00
Brook Silverside		I	M	M	4	4.00	0.31	0.01	0.01	2.75
White Bass	F	P	M		15	15.00	1.18	0.33	0.24	22.27
Rock Bass	S	C	C		11	11.00	0.86	0.69	0.48	62.36
Smallmouth Bass	F	C	C	M	6	6.00	0.47	0.23	0.16	38.00
Spotted Bass	F	C	C		201	201.00	15.78	10.58	7.46	52.64
Largemouth Bass	F	C	C		1	1.00	0.08	0.02	0.01	20.00
Green Sunfish	S	I	C	T	2	2.00	0.16	0.06	0.04	31.00
Bluegill Sunfish	S	I	C	P	2	2.00	0.16	0.25	0.17	122.50
Orangespotted Sunfish	S	I	C		22	22.00	1.73	0.30	0.21	13.45
Pumpkinseed Sunfish	S	I	C	P	1	1.00	0.08	0.06	0.04	62.00
Logperch	D	I	S	M	3	3.00	0.24	0.04	0.03	13.00
Freshwater Drum			M	P	3	3.00	0.24	2.01	1.42	670.67
	Mile Total				1,274	1,274.00		141.91		
	Number of Species				29					
	Number of Hybrids				0					

Appendix Table 4. Index of Biotic Integrity (IBI) metrics and scores for sampling locations in the Muskingum River, Zanesville area, 2009.

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Number of: Sunfish species	Number of: Sucker species	Number of: Intolerant species	Percent of Individuals: Rnd-bodied suckers	Percent of Individuals: Simple Lithophils	Percent of Individuals: Tolerant fishes	Percent of Individuals: Omni-vores	Percent of Individuals: Top carnivores	Percent of Individuals: Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(1.0 km)	IBI	Modified Iwb
Muskingum River - (17-001)																	
Year: 2009																	
74.70	N	08/17/2009	6852	22(5)	4(5)	4(3)	1(1)	4(1)	4(1)	2(5)	13(5)	16(5)	70(5)	0.3(5)	1184(5)	46	9.9
74.70	N	09/24/2009	6852	22(5)	3(3)	5(3)	2(3)	4(1)	4(1)	2(5)	27(3)	12(5)	59(5)	0.2(5)	1042(5)	44	9.2
74.20	N	08/18/2009	6852	24(5)	4(5)	5(3)	1(1)	6(1)	6(1)	4(5)	16(5)	11(5)	72(5)	0.0(5)	1094(5)	46	10.0
74.20	N	09/24/2009	6852	24(5)	4(5)	5(3)	1(1)	5(1)	5(1)	2(5)	24(3)	15(5)	57(5)	0.2(5)	1026(5)	44	9.6
73.50	N	08/18/2009	6853	25(5)	4(5)	4(3)	1(1)	3(1)	4(1)	9(5)	25(3)	21(5)	52(3)	0.0(5)	1048(5)	42	9.9
73.50	N	09/25/2009	6853	23(5)	3(3)	4(3)	1(1)	5(1)	6(1)	2(5)	21(3)	17(5)	60(5)	0.0(5)	1366(5)	42	9.6

♦ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample

Appendix Table 5. Invertebrate Community Index (ICI) metrics and scores for sampling locations in the Muskingum River, Zanesville area, 2009.

River Mile	Drainage Area (sq mi)	Number of				Percent:					Qual. EPT	Eco-region	ICI
		Total Taxa	Mayfly Taxa	Caddisfly Taxa	Dipteran Taxa	Mayflies	Caddis-flies	Tany-tarsini	Other Dipt/NI	Tolerant Organisms			
Muskingum River (17-001)													
Year: 2009													
74.70 A	6852	35(6)	5(4)	10(6)	8(6)	7.1(4)	15.1(2)	3.5(2)	73.5(0)	3.7(2)	5(2)	4	34
74.70 B	6852	8(0)	1(0)	1(0)	2(2)	0.0(2)	0.7(0)	0.0(0)	99.3(0)	5.0(0)	5(2)	4	6
74.20 A	6852	34(6)	6(4)	11(6)	7(6)	2.5(2)	15.0(2)	1.5(2)	80.8(0)	3.8(0)	8(2)	4	30
74.20 B	6852	14(2)	1(0)	1(0)	4(4)	0.0(2)	3.0(0)	0.0(0)	96.9(0)	3.6(2)	8(2)	4	12
73.50 A	6853	30(4)	6(4)	9(6)	5(4)	1.8(2)	13.6(2)	0.7(2)	83.7(0)	3.6(2)	4(0)	4	26
73.50 B	6853	9(0)	0(0)	2(2)	3(2)	0.0(0)	6.2(2)	0.0(0)	93.8(0)	7.5(0)	4(0)	4	6

Appendix Table 6. Macroinvertebrate sampling results for the Muskingum River, Zanesville area, 2009.

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Site: Muskingum River

Collection Date: 09/29/2009 River Code: 17-001 RM: 74.70 A upst. Gould National Battery

Taxa Code	Taxa	Quant/Qual	
01200	*Cordylophora lacustris*	1	
01320	*Hydra sp*	32	
01801	*Turbellaria*	97	+
03073	*Lophopodella carteri*	1	
03121	*Paludicella articulata*	1	
03221	*Pectinatella magnifica*		+
03360	*Plumatella sp*	19	+
03600	*Oligochaeta*	136	+
05800	*Caecidotea sp*		+
06810	*Gammarus fasciatus*	5	+
13400	*Stenacron sp*	1	+
13561	*Maccaffertium pulchellum*	109	+
13570	*Maccaffertium terminatum*	78	
16700	*Tricorythodes sp*	177	
17200	*Caenis sp*	47	
22300	*Argia sp*		+
24900	*Gomphus sp*		+
51206	*Cyrnellus fraternus*	505	
51300	*Neureclipsis sp*	65	
51600	*Polycentropus sp*	23	+
52200	*Cheumatopsyche sp*	200	+
52510	*Hydropsyche aerata*	40	+
52520	*Hydropsyche bidens*	1	
52560	*Hydropsyche orris*	3	
52570	*Hydropsyche simulans*	30	
52620	*Macrostemum zebratum*	9	
52801	*Potamyia flava*	7	
68601	*Ancyronyx variegata*		+
68901	*Macronychus glabratus*	13	+
69400	*Stenelmis sp*	32	+
77100	*Ablabesmyia sp*		+
77750	*Hayesomyia senata or Thienemannimyia norena*	570	
79085	*Telopelopia okoboji*	41	
80420	*Cricotopus (C.) bicinctus*	41	
83002	*Dicrotendipes modestus*	41	
83300	*Glyptotendipes (G.) sp*	3256	+
85625	*Rheotanytarsus sp*	163	
85800	*Tanytarsus sp*	41	
87540	*Hemerodromia sp*	8	
93900	*Elimia sp*	1	+
95100	*Physella sp*	41	

Taxa Code	Taxa	Quant/Qual

No. Quantitative Taxa: 35 Total Taxa: 41

No. Qualitative Taxa: 19 ICI: **34**

Number of Organisms: 5835 Qual EPT: 5

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Site: Muskingum River

Collection Date: 09/29/2009 River Code: 17-001 RM: 74.70 B upst. Gould National Battery

Taxa Code	Taxa	Quant/Qual
01801	*Turbellaria*	516
03360	*Plumatella sp*	1
03600	*Oligochaeta*	1121
06810	*Gammarus fasciatus*	148
16700	*Tricorythodes sp*	2
51206	*Cyrnellus fraternus*	157
83000	*Dicrotendipes sp*	182
83300	*Glyptotendipes (G.) sp*	20426
99998	*NO QUALITATIVE SAMPLE COLLECTED*	+

Taxa Code	Taxa	Quant/Qual

No. Quantitative Taxa: 8 Total Taxa: 9

No. Qualitative Taxa: 1 ICI: **6**

Number of Organisms: 22553 Qual EPT:

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Site: Muskingum River

Collection Date: 09/29/2009 River Code: 17-001 RM: 74.20 A adjacent to Gould National Battery

Taxa Code	Taxa	Quant/Qual	
01200	*Cordylophora lacustris*	1	
01320	*Hydra sp*	8	
01801	*Turbellaria*	2	+
03121	*Paludicella articulata*	1	
03360	*Plumatella sp*	8	+
03600	*Oligochaeta*	232	+
05800	*Caecidotea sp*		+
06810	*Gammarus fasciatus*	26	+
11130	*Baetis intercalaris*	1	
13000	*Leucrocuta sp*		+
13400	*Stenacron sp*		+
13510	*Maccaffertium exiguum*	1	
13561	*Maccaffertium pulchellum*	9	+
13570	*Maccaffertium terminatum*	6	+
16700	*Tricorythodes sp*	93	+
17200	*Caenis sp*	44	
22300	*Argia sp*	2	+
51206	*Cyrnellus fraternus*	757	+
51300	*Neureclipsis sp*	1	
51600	*Polycentropus sp*	8	
52200	*Cheumatopsyche sp*	84	+
52430	*Ceratopsyche morosa group*	2	
52510	*Hydropsyche aerata*	21	+
52560	*Hydropsyche orris*	10	
52570	*Hydropsyche simulans*	22	
52620	*Macrostemum zebratum*	4	
52801	*Potamyia flava*	3	
53501	*Hydroptilidae*	1	
68601	*Ancyronyx variegata*	1	+
68901	*Macronychus glabratus*	10	+
77750	*Hayesomyia senata or Thienemannimyia norena*	224	
81231	*Nanocladius (N.) crassicornus or N. (N.) "rectinervis"*	134	
83002	*Dicrotendipes modestus*	45	
83300	*Glyptotendipes (G.) sp*	4211	+
85625	*Rheotanytarsus sp*	45	
85800	*Tanytarsus sp*	45	+
87540	*Hemerodromia sp*	32	
93900	*Elimia sp*		+
95100	*Physella sp*		+
96900	*Ferrissia sp*		+

Taxa Code	Taxa	Quant/Qual

No. Quantitative Taxa: 34 Total Taxa: 40

No. Qualitative Taxa: 21 ICI: **30**

Number of Organisms: 6094 Qual EPT: 8

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Site: Muskingum River

Collection Date: 09/29/2009 River Code: 17-001 RM: 74.20 B adjacent to Gould National Battery

Taxa Code	Taxa	Quant/Qual
01801	*Turbellaria*	69
03360	*Plumatella sp*	1
03600	*Oligochaeta*	1120
06810	*Gammarus fasciatus*	39
16700	*Tricorythodes sp*	1
22300	*Argia sp*	21
51206	*Cyrnellus fraternus*	926
68901	*Macronychus glabratus*	2
77130	*Ablabesmyia rhamphe group*	321
81231	*Nanocladius (N.) crassicornus or N. (N.) "rectinervis"*	321
83002	*Dicrotendipes modestus*	964
83300	*Glyptotendipes (G.) sp*	27321
95100	*Physella sp*	1
96900	*Ferrissia sp*	1
99998	*NO QUALITATIVE SAMPLE COLLECTED*	+

Taxa Code	Taxa	Quant/Qual

No. Quantitative Taxa: 14 Total Taxa: 15

No. Qualitative Taxa: 1 ICI: **12**

Number of Organisms: 31108 Qual EPT:

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Site: Muskingum River

Collection Date: 09/29/2009 River Code: 17-001 RM: 73.50 A dst. Gould National Battery , upst. Moxahala Cr.

Taxa Code	Taxa	Quant/Qual		Taxa Code	Taxa	Quant/Qual
01320	*Hydra sp*	9				
01801	*Turbellaria*		+			
03073	*Lophopodella carteri*	1				
03221	*Pectinatella magnifica*	1				
03360	*Plumatella sp*	7	+			
03451	*Urnatella gracilis*	1				
03600	*Oligochaeta*	256				
06810	*Gammarus fasciatus*	2	+			
11130	*Baetis intercalaris*	17				
13400	*Stenacron sp*	1				
13561	*Maccaffertium pulchellum*	34				
13570	*Maccaffertium terminatum*	29	+			
16700	*Tricorythodes sp*	31				
17200	*Caenis sp*	16				
22300	*Argia sp*		+			
51206	*Cyrnellus fraternus*	717	+			
51300	*Neureclipsis sp*	18				
51600	*Polycentropus sp*	9				
52200	*Cheumatopsyche sp*	119	+			
52510	*Hydropsyche aerata*	15	+			
52560	*Hydropsyche orris*	40				
52570	*Hydropsyche simulans*	49				
52620	*Macrostemum zebratum*	3				
52801	*Potamyia flava*	1				
68901	*Macronychus glabratus*	17				
77750	*Hayesomyia senata or Thienemannimyia norena*	981	+			
83002	*Dicrotendipes modestus*	245				
83300	*Glyptotendipes (G.) sp*	4461	+			
85625	*Rheotanytarsus sp*	49	+			
87540	*Hemerodromia sp*	32				
93900	*Elimia sp*	1				
97601	*Corbicula fluminea*	1				

No. Quantitative Taxa: 30 Total Taxa: 32

No. Qualitative Taxa: 11 ICI: **26**

Number of Organisms: 7163 Qual EPT: 4

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Site: Muskingum River

Collection Date: 09/29/2009 River Code: 17-001 RM: 73.50 B dst. Gould National Battery , upst. Moxahala Cr.

Taxa Code	Taxa	Quant/Qual
01801	*Turbellaria*	133
03221	*Pectinatella magnifica*	12
03600	*Oligochaeta*	1376
06810	*Gammarus fasciatus*	3
51206	*Cyrnellus fraternus*	1139
51600	*Polycentropus sp*	1
77001	*Tanypodinae*	151
83002	*Dicrotendipes modestus*	1059
83300	*Glyptotendipes (G.) sp*	14374
99998	*NO QUALITATIVE SAMPLE COLLECTED*	+

Taxa Code	Taxa	Quant/Qual

No. Quantitative Taxa: 9 Total Taxa: 10

No. Qualitative Taxa: 1 ICI: **6**

Number of Organisms: 18248 Qual EPT: