State of Ohio
Environmental Protection Agency

Division of Surface Water

Biological and Water Quality Study of the West Branch Nimishillen Creek

Stark County, Ohio

October 24, 2008

Ted Strickland, Governor
Chris Korleski, Director

Biological and Water Quality Study

West Branch Nimishillen Creek

2008

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SUMMARY

A total of 0.4 miles of the lower West Branch Nimishillen Creek were biologically assessed by the Ohio EPA during 2008. Based on the performance of the biological communities, the entire 0.4 miles were in partial attainment of the Warmwater Habitat aquatic life use (Table 1). Partial attainment at all three sampling locations was largely associated with extensive sedimentation of the river bottom and general water quality effects related to runoff (storm sewers) from a highly urbanized area. Additionally, elevated zinc levels in the sediment and water adjacent to and downstream from the Gregory Industries property may have contributed to the impaired macroinvertebrate community.

Biological communities have shown substantial improvement in the lower 0.5 miles of the West Branch Nimishillen Creek over the last 20 years.

RECOMMENDATIONS

The aquatic life use designations of Warmwater Habitat for the West Branch Nimishillen Creek have been confirmed in previous Ohio EPA biological and water quality studies. This study verified continued WWH performance for the lower 0.5 miles of the West Branch Nimishillen Creek.

Physical habitat conditions and pool depths verified that the Primary Contact Recreation use is appropriate for the West Branch Nimishillen Creek.

FOREWORD

What is a Biological and Water Quality Survey?

A biological and water quality survey, or "biosurvey," is an interdisciplinary monitoring effort coordinated on a waterbody specific or watershed scale. This effort may involve a relatively simple setting focusing on one or two small streams, one or two principal stressors, and a handful of sampling sites or a much more complex effort including entire drainage basins, multiple and overlapping stressors, and tens of sites. Each year Ohio EPA conducts biosurveys in 4-5 watersheds study areas with an aggregate total of 250-300 sampling sites.

The Ohio EPA employs biological, chemical, and physical monitoring and assessment techniques in biosurveys in order to meet three major objectives: 1) determine the extent to which use designations assigned in the Ohio Water Quality Standards (WQS) are either attained or not attained; 2) determine if use designations assigned to a given water body are appropriate and attainable; and 3) determine if any changes in key ambient biological, chemical, or physical indicators have taken place over time, particularly before and after the implementation of point source pollution controls or best management practices. The data gathered by a biosurvey is processed, evaluated, and synthesized in a biological and water quality report. Each biological and water quality study contains a summary of major findings and recommendations for revisions to WQS, future monitoring needs, or other actions which may be needed to resolve existing impairment of designated uses. While the principal focus of a biosurvey is on the status of aquatic life uses, the status of other uses such as recreation and water supply, as well as human health concerns, are also addressed.

The findings and conclusions of a biological and water quality study may factor into regulatory actions taken by Ohio EPA (*e.g.,* NPDES permits, Director's Orders, the Ohio Water Quality Standards [OAC 3745-1], Water Quality Permit Support Documents [WQPSDs]), and are eventually incorporated into State Water Quality Management Plans, the Ohio Nonpoint Source Assessment, and the biennial Integrated Water Quality Monitoring and Assessment Report (305[b] and 303[d]).

Hierarchy of Indicators

A carefully conceived ambient monitoring approach, using cost-effective indicators consisting of ecological, chemical, and toxicological measures, can ensure that all relevant pollution sources are judged objectively on the basis of environmental results. Ohio EPA relies on a tiered approach in attempting to link the results of administrative activities with true environmental measures. This integrated approach includes a hierarchical continuum from administrative to true environmental indicators (Figure 1). The six "levels" of indicators include: 1) actions taken by regulatory agencies (permitting, enforcement, grants); 2) responses by the regulated community (treatment works, pollution prevention); 3) changes in discharged quantities (pollutant loadings); 4) changes in ambient conditions (water quality, habitat); 5) changes in uptake and/or assimilation (tissue contamination, biomarkers, wasteload allocation); and, 6) changes in health, ecology, or other effects (ecological condition, pathogens). In this process the results of administrative activities (levels 1 and 2) can be linked to efforts to improve water quality (levels 3, 4, and 5) which should translate into the environmental "results" (level 6). Thus, the aggregate effect of billions of dollars spent on water pollution control since the early 1970s can now be determined with quantifiable measures of environmental condition. Superimposed on this hierarchy is the concept of stressor, exposure, and response indicators. *Stressor* indicators generally include activities which have the potential to degrade the aquatic environment such as pollutant discharges (permitted and unpermitted), land use effects, and habitat modifications. *Exposure* indicators are those which measure the effects of stressors and can include whole effluent toxicity tests, tissue residues, and biomarkers, each of which provides evidence of biological exposure to a stressor or bioaccumulative agent. *Response* indicators are generally composite measures of the cumulative effects of stress and exposure and include the more direct measures of community and population response that are represented here by the biological indices which comprise Ohio's biological criteria. Other response indicators could include target assemblages, *i.e.,* rare, threatened, endangered, special status, and

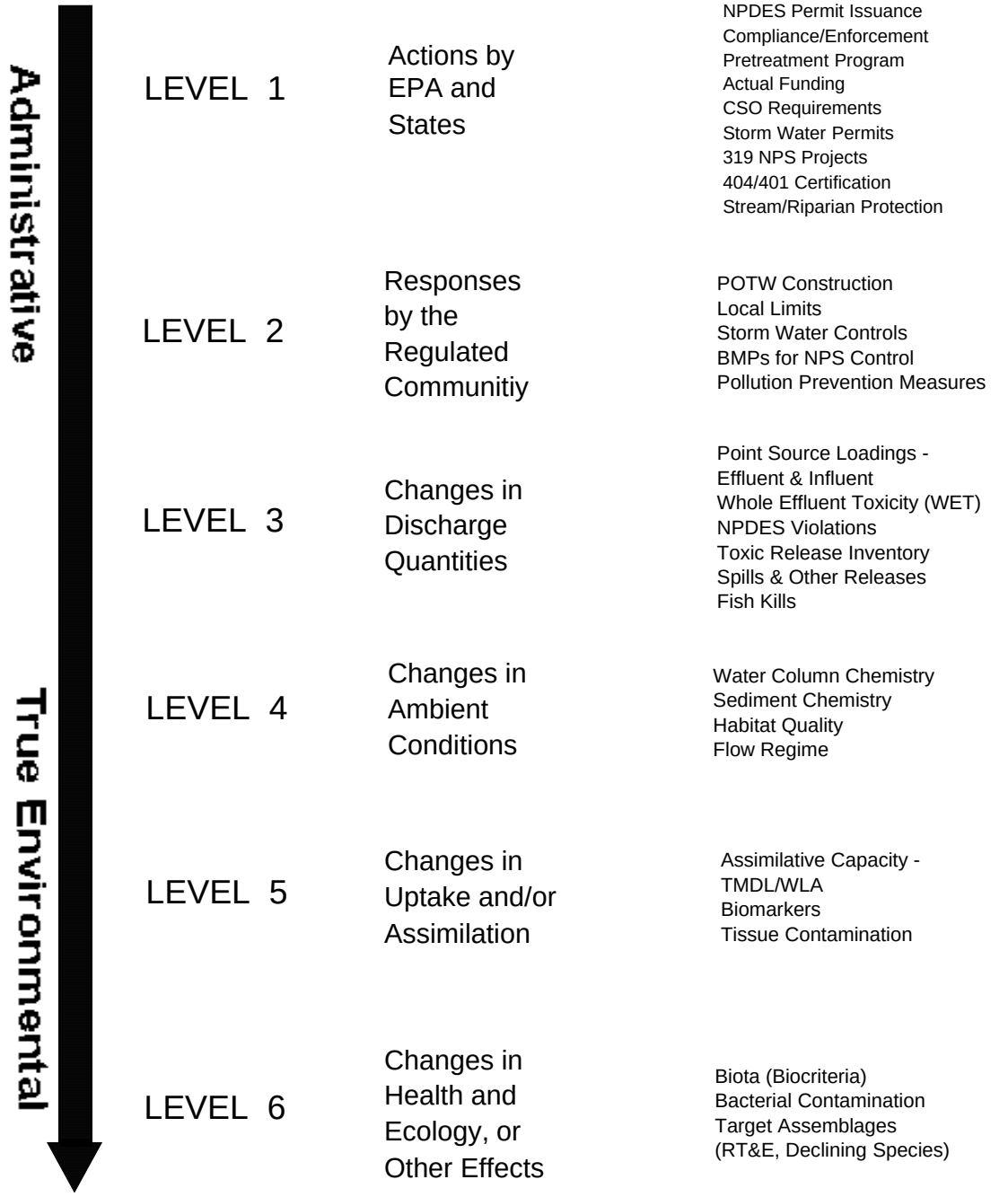

Figure 1. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by the U.S. EPA.

declining species or bacterial levels which serve as surrogates for the recreation uses. These indicators represent the essential technical elements for watershed-based management approaches. The key, however, is to use the different indicators *within* the roles which are most appropriate for each.

Describing the causes and sources associated with observed impairments revealed by the biological criteria and linking this with pollution sources involves an interpretation of multiple lines of evidence including water chemistry data, sediment data, habitat data, effluent data, biomonitoring results, land use data, and biological response signatures within the biological data itself. Thus the assignment of principal causes and sources of impairment represents the association of impairments (defined by response indicators) with stressor and exposure indicators. The principal reporting venue for this process on a watershed or subbasin scale is a biological and water quality report. These reports then provide the foundation for aggregated assessments such as the Integrated Water Quality Monitoring and Assessment Report (305[b] and 303[d]), the Ohio Nonpoint Source Assessment, and other technical bulletins.

Ohio Water Quality Standards: Designated Aquatic Life Use

The Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) consist of designated uses and chemical, physical, and biological criteria designed to represent measurable properties of the environment that are consistent with the goals specified by each use designation. Use designations consist of two broad groups, aquatic life and non-aquatic life uses. In applications of the Ohio WQS to the management of water resource issues in Ohio's rivers and streams, the aquatic life use criteria frequently result in the most stringent protection and restoration requirements, hence their emphasis in biological and water quality reports. Also, an emphasis on protecting for aquatic life generally results in water quality suitable for all uses. The five different aquatic life uses currently defined in the Ohio WQS are described as follows:

1) *Warmwater Habitat (WWH)* - this use designation defines the "typical" warmwater assemblage of aquatic organisms for Ohio rivers and streams; *this use represents the principal restoration target for the majority of water resource management efforts in Ohio.*

2) *Exceptional Warmwater Habitat (EWH)* - this use designation is reserved for waters which support "unusual and exceptional" assemblages of aquatic organisms which are characterized by a high diversity of species, particularly those which are highly intolerant and/or rare, threatened, endangered, or special status (*i.e.,* declining species); *this designation represents a protection goal for water resource management efforts dealing with Ohio's best water resources.*

3) *Coldwater Habitat (CWH)* - this use is intended for waters which support assemblages of cold water organisms and/or those which are stocked with salmonids with the intent of providing a put-and-take fishery on a year round basis which is further sanctioned by the Ohio DNR, Division of Wildlife; this use should not be confused with the Seasonal Salmonid Habitat (SSH) use which applies to the Lake Erie tributaries which support periodic "runs" of salmonids during the spring, summer, and/or fall.

4) *Modified Warmwater Habitat (MWH)* - this use applies to streams and rivers which have been subjected to extensive, maintained, and essentially permanent hydromodifications such that the biocriteria for the WWH use are not attainable *and where the activities have been sanctioned by state or federal law;* the representative aquatic assemblages are generally composed of species which are tolerant to low dissolved oxygen, silt, nutrient enrichment, and poor quality habitat.

5) *Limited Resource Water (LRW)* - this use applies to small streams (usually <3 mi^2 drainage area) and other water courses which have been irretrievably altered to the extent that no appreciable assemblage of aquatic life can be supported; such waterways generally include small streams in extensively urbanized areas, those which lie in watersheds with extensive drainage modifications, those which completely lack water on a recurring annual basis (*i.e.,* true ephemeral streams), or other irretrievably altered waterways.

Chemical, physical, and/or biological criteria are generally assigned to each use designation in accordance with the broad goals defined by each. As such the system of use designations employed in the Ohio WQS constitutes a "tiered" approach in that varying and graduated levels of protection are provided by each. This hierarchy is especially apparent for parameters such as dissolved oxygen, ammonia-nitrogen, temperature, and the biological criteria. For other parameters such as heavy metals,

the technology to construct an equally graduated set of criteria has been lacking, thus the same water quality criteria may apply to two or three different use designations.

Ohio Water Quality Standards: Non-Aquatic Life Uses

In addition to assessing the appropriateness and status of aquatic life uses, each biological and water quality survey also addresses non-aquatic life uses such as recreation, water supply, and human health concerns as appropriate. The recreation uses most applicable to rivers and streams are the Primary Contact Recreation (PCR) and Secondary Contact Recreation (SCR) uses. The criterion for designating the PCR use can be having a water depth of at least one meter over an area of at least 100 square feet or, lacking this, where frequent human contact is a reasonable expectation. If a water body does not meet either criterion, the SCR use applies. The attainment status of PCR and SCR is determined using bacterial indicators (*e.g.,* fecal coliform, *E. coli)* and the criteria for each are specified in the Ohio WQS.

Attainment of recreation uses are evaluated based on monitored bacteria levels. The Ohio Water Quality Standards state that all waters should be free from any public health nuisance associated with raw or poorly treated sewage (Administrative Code 3745-1-04, Part F). Additional criteria (Administrative Code 3745-1-07) apply to waters that are designated as suitable for full body contact such as swimming (PCR- primary contact recreation) or for partial body contact such as wading (SCR- secondary contact recreation). These standards were developed to protect human health, because even though fecal coliform bacteria are relatively harmless in most cases, their presence indicates that the water has been contaminated with fecal matter.

Water supply uses include Public Water Supply (PWS), Agricultural Water Supply (AWS), and Industrial Water Supply (IWS). Public Water Supplies are simply defined as segments within 500 yards of a potable water supply or food processing industry intake. The AWS and IWS use designations generally apply to all waters unless it can be clearly shown that they are not applicable. An example of this would be an urban area where livestock watering or pasturing does not take place, thus the AWS use would not apply. Chemical criteria are specified in the Ohio WQS for each use and attainment status is based primarily on chemical-specific indicators. Human health concerns are additionally addressed with fish tissue data, but any consumption advisories are issued by the Ohio Department of Health.

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INTRODUCTION

The lower 0.4 miles of the West Branch Nimishillen Creek were assessed during 2008, evaluating biological, sediment, and surface water resources. This study was undertaken to assess water resource conditions in the West Branch Nimishillen Creek upstream, adjacent, and downstream from the Gregory Industries property. The work performed in this study was designed to fulfill the requirements of VAP rule OAC 3745-300-09.

Specific objectives of the evaluation were to:

- Establish biological conditions in the West Branch Nimishillen Creek by evaluating fish and macroinvertebrate communities,
- Evaluate surficial sediment and surface water chemical quality in the lower West Branch Nimishillen Creek, and
- Determine the aquatic life use attainment status of the West Branch Nimishillen Creek with regard to the Warmwater Habitat (WWH)) aquatic life use designation codified in the Ohio Water Quality Standards.

The West Branch Nimishillen Creek is located in the Erie Ontario Lake Plain (EOLP) ecoregion. The West Branch Nimishillen Creek is currently assigned the Warmwater Habitat (WWH) aquatic life use designation.

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

Table 1. Aquatic life use attainment status for sampling locations in the West Branch Nimishillen Creek, 2008. 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. Stream sites are located in the Erie Ontario Lake Plains (EOLP) ecoregion. In the Ohio Water Quality Standards, the West Branch Nimishillen Creek is designated Warmwater Habitat (WWH). If biological impairment has occurred, the cause(s) and source(s) of the impairment are noted.

Sample Site River Mile	Attainment Status	IBI	MIwb	ICI	QHEI	Location	Cause	Source
0.4	Partial	31*	6.3*	32^{ns}	56.5	15th Street	Sedimentation/ urban contaminants	Urban runoff
0.2	Partial	36^{ns}	6.4*	24*	60.0	Adjacent Gregory Industries	Sedimentation/ urban contaminants	Urban runoff/ seeps
0.1	Partial	35^{ns}	6.7*	28*	60.0	Market Street	Sedimentation/ urban contaminants	Urban runoff

Ecoregion Biocriteria: Erie Ontario Lake Plain (EOLP) (OAC 3745-1-07, Table 7-15)		
INDEX - Site Type	WWH	EWH
IBI: Wading	38	50
MIwb: Wading	7.9	9.4
ICI	34	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).

Table 2. Sampling locations in the West Branch Nimishillen Creek study area, 2008. 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
West Branch Nimishillen Creek				
0.4	F,M,W,S	40° 37' 38"	83° 10' 21"	15th Street
0.2	F,M,W,S	40° 36' 40"	83° 11' 00"	Adjacent Gregory Industries
0.1	F,M,W,S	40° 36' 02"	83° 10' 59"	Market Street

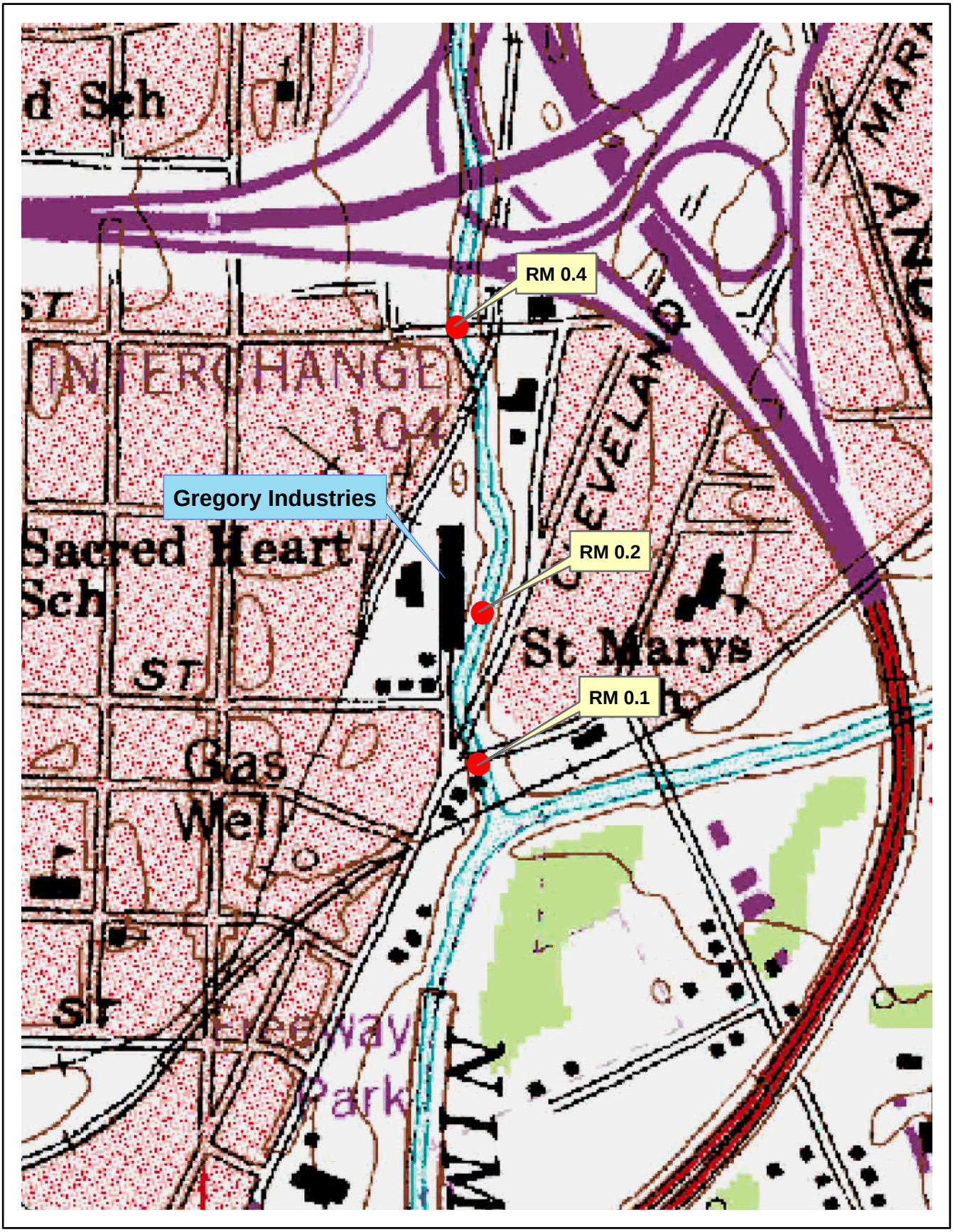

Figure 2. Map of West Branch Nimishillen Creek Sampling Locations, 2008

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 West Branch Nimishillen Creek is currently listed as a Warmwater Habitat stream 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 150 meter section of stream were collected. Sediment incremental samples were mixed in stainless steel pans, 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 twice 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) and USEPA Ecological Screening Levels (2003), 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 all three 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). 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 fish site using pulsed DC wading electrofishing methods. Fish were processed in the field, and included identifying each individual to species, counting, weighing, and recording any external abnormalities. Discussion of the fish community assessment methodology used in this report is contained in Biological Criteria for the Protection of Aquatic Life: Volume III, Standardized Biological Field Sampling and Laboratory Methods for Assessing Fish and Macroinvertebrate Communities (Ohio EPA 1989a, 2008b).

Field Instrument Calibration

Field instruments are calibrated using manufacturer recommended procedures along with procedures noted in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (2006b) and Biological Criteria for the Protection of Aquatic Life, Volume III (1989b). Laser rangefinders, used to measure sampling distance, were calibrated once at the Groveport Field Facility prior to summer field sampling activities. Fish weighing scales were checked against certified weights once per month during the field season.

Causal Associations

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

RESULTS

Surface Water Quality

Chemical analyses were conducted on surface water samples collected on June 17 and July 29, 2008 from three locations in the study area (Table 3, Appendix Table 1). Surface water samples were analyzed for total analyte list inorganics (metals) and PAH compounds. Parameters which were in exceedence of Ohio WQS criteria are reported in Table 3.

Concentrations of PAH compounds tested in stream waters were mostly reported as not detected. One fluoranthene measurement – at the upstream RM 0.4 site – exceeded the Aquatic Life Outside Mixing Zone Average water quality criterion. All of the other detected PAH compounds were below water quality criteria.

Excluding zinc, metals concentrations were generally very low, with most of the tested parameters less than lab detection limits. Although zinc concentrations were below water quality criteria, an elevated value (219 ug/l) was recorded during July at the most downstream location (RM 0.1). All of the metal parameters were below applicable Ohio WQS aquatic life and human health criteria.

Table 3. Exceedences of Ohio Water Quality Standards criteria (OAC3745-1) for chemical/physical parameters measured in the West Branch Nimishillen Creek study area, 2008.

River Mile	Parameter (value – ug/l)
RM 0.4	Fluoranthene (0.974)
RM 0.2	None
RM 0.1	None

[a] Exceedence of the aquatic life Outside Mixing Zone Average water quality criterion.

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

Sediment Quality

Surficial sediment samples were collected at three locations in the West Branch Nimishillen Creek by the Ohio EPA on June 17, 2008. Sampling locations were co-located with biological sampling sites. Samples were analyzed for total analyte list inorganics (metals) and PAH compounds. Specific chemical parameters tested and results are listed in Appendix Table 2. Sediment data were evaluated using guidelines established in *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald *et.al*. 2000), USEPA Ecological Screening Levels (2003), and *Ohio Specific Sediment Reference Values (SRVs)* for metals (Ohio EPA 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.

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. All West Branch Nimishillen Creek sediment sampling occurred in areas along the stream bank, which were represented by sparse deposits of fine grained material. These nearbank areas comprised only a small fraction of the bottom substrates of the West Branch Nimishillen Creek. Stream substrates were predominated by gravel, sand, and artificial material.

Chemical parameters measured above ecological screening guidelines are presented in Table 4. All three locations had chemical compounds above ecological screening levels. Of particular note were the elevated levels of PAH compounds at all three sampling locations. Analysis of metal parameters revealed high zinc concentrations in sediment adjacent to the Gregory Industries property.

The elevated sediment PAH and zinc conditions did not directly correlate with co-located biological sampling results. The sparse deposits of fine grained material at each sampling site contributed to low exposure levels of sediment contaminants to biological communities.

Table 4. Chemical parameters measured above screening levels in sediment samples collected by Ohio EPA from surficial sediments in the West Branch Nimishillen Creek, June, 2008. Contamination levels were determined for parameters using consensus-based sediment quality guidelines (MacDonald, et.al. 2000), and ecological screening levels (USEPA 2003). Sediment reference values are listed in the Ohio EPA Ecological Risk Assessment Guidance (2003). Shaded numbers indicate values above the following: Threshold Effect Concentration -TEC (yellow), Probable Effect Concentration – PEC (red), Ecological Screening Level (green), and Sediment Reference Value (orange). Sampling locations are indicated by river mile (RM).

Parameter	RM 0.4	RM 0.2	RM 0.1
Total PAHs (ug/kg)	20,700	23,106	52,645
Anthracene (ug/kg)	515	408	1130
Benz(a)anthracene (ug/kg)	1380	1590	3970
Benzo(a)pyrene (ug/kg)	1170	1410	3300
Benzo(g,h,i)perylene (ug/kg)	953	1170	2430
Benzo(k)fluoranthene (ug/kg)	1140	1410	3350
Chrysene (ug/kg)	1680	2020	4670
Dibenz(a,h)anthracene (ug/kg)	248	417	954
Fluoranthene (ug/kg)	4890	5450	11,800
Fluorene (ug/kg)	237	146	433
Indeno(1,2,3-cd)pyrene (ug/kg)	818	1030	2370
2-Methylnaphthalene (ug/kg)	<71.3	98.4 J	112 J
Acenaphthylene (ug/kg)	<71.3	69.5 J	353
Acenaphthene (ug/kg)	169	110 J	308
Phenanthrene (ug/kg)	3020	2610	6300
Pyrene (ug/kg)	3240	3480	7840
Cadmium (mg/kg)	0.709	0.683	0.967
Chromium (mg/kg)	45.8	28.5	36.6
Copper (mg/kg)	24.3	25.2	46.6
Lead (mg/kg)	44.0	42.4	69.7
Selenium (mg/kg)	2.14	29.2	9.15
Silver (mg/kg)	0.473 J	0.503 J	0.616 J
Zinc (mg/kg)	105	1390	286

J - The analyte was positively identified; the associated numerical value is an approximate concentration of the analyte in the sample.

Stream Physical Habitat

Physical habitat was evaluated in the West Branch Nimishillen Creek at each fish sampling location. Physical habitat was assessed using the Qualitative Habitat Evaluation Index (QHEI); scores are detailed in Table 5.

Substrates were predominated by gravel and artificial material (riprap, bricks, broken concrete) at the two most downstream sites (RMs 0.2 and 0.1), and gravel and sand at the upstream site. The upstream site had been channel modified in the past, probably related to the extensive bridge and road development in the area. The sampling zones were represented by extensive riffle/run areas and several moderately deep pools. Floodplain encroachment was obvious along the lower 0.2 miles of the West Branch Nimishillen Creek, as evidenced by extensive artificial fill material along both banks of the stream. QHEI scores ranged between 56.5 and 60.0 and were indicative of marginally good stream habitat, and adequate for supporting a WWH biological community.

Table 5. Qualitative Habitat Evaluation Index (QHEI) scores and physical attributes for fish sampling sites on the West Branch Nimishillen Creek, 2008.

			WWH Attributes											**MWH Attributes**																										
														High Influence						*Moderate Influence*																				
Key QHEI Components			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**	Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse/ No Cover	Max. Depth <40 cm (WD,HW sites)	**Total High Influence Attributes**	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**
River Mile	QHEI	Gradient (ft/mile)																																					
West Branch Nimishillen Cr. Year: 2008																																							
0.4	**56.5**	6.62		■		■					■		3				◆		1	●	●			●	●			●	●	●		7	0.50	2.25
0.2	**60.0**	6.62	■	■		■		■	■		■		6				◆		1		●				●				●	●		4	0.29	0.86
0.1	**60.0**	6.62	■	■		■	■	■	■		■		7				◆		1		●				●				●	●		4	0.25	0.75

Fish Community

A total of 1,777 fish representing 23 species were collected from the West Branch Nimishillen Creek between June and July, 2008. 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.

The most upstream fish sampling site (RM 0.4) was represented by modified channel conditions. The IBI and MIwb scores, 31 and 6.3, respectively, were within the fair range of environmental quality (Table 6). Fish sampling results were not achieving the WWH biocriteria. The adjacent and downstream sampling sites (RMs 0.2 and 0.1) were comparable in results, with some improvement in biological integrity from the upstream site. Both sites were partially achieving the WWH biocriteria, with IBI scores meeting and MIwb scores below criteria levels.

One rainbow trout was collected in the West Branch Nimishillen Creek near the mouth. Banded darters, a pollution sensitive species, were collected in low numbers at all three sampling sites.

There has been improvement in the fish communities at RM 0.1 over the last 22 years. Average IBI and MIwb results from the 1980s (IBI=19, MIwb=2.7) and 1990s (IBI=24, MIwb=5.1) were substantially below results from 2008 (IBI=35, MIwb=6.7).

Table 6. Fish community summaries based on pulsed D.C. electrofishing sampling conducted by Ohio EPA in West Branch Nimishillen Creek from June and July, 2008. Relative numbers and weight are per 0.3 km for wading sites. The applicable aquatic life use designation is WWH.

River Mile	Sampling Method	Species (Mean)	Species (Total)	Relative Number	Relative Weight (kg)	QHEI	Modified Index of Well-Being	Index of Biotic Integrity	Narrative Evaluation
0.4	Wading	12.5	15	401	6.0	56.5	6.3*	31*	Fair
0.2	Wading	14.0	18	637	5.9	60.0	6.4*	36^{ns}	Fair/Marginally Good
0.1	Wading	12.0	15	739	12.9	60.0	6.7*	35^{ns}	Fair/Marginally Good

Ecoregion Biocriteria: Erie Ontario Lake Plain (EOLP)		
INDEX - Site Type	WWH	EWH
IBI: Wading	38	50
MIwb: Wading	7.9	9.4

* Significant departure from ecoregion biocriterion; poor and very poor results are underlined.

Macroinvertebrate Community

The macroinvertebrate communities at three West Branch Nimishillen Creek sites were sampled in 2008 using qualitative (multi-habitat composite) and quantitative (artificial substrate) sampling protocols. Results are summarized in Table 7. The ICI metrics with the associated scores, and the raw data are attached as Appendix Tables 5 and 6.

The macroinvertebrate sampling results from the site upstream from Gregory Industries (RM 0.4) indicated a non-significant departure from attainment of the WWH biocriterion, with an ICI score of 32. The sites adjacent to and downstream from Gregory Industries (RM 0.2 and 0.1) had fair macroinvertebrate communities with ICI scores of 24 and 28, respectively. Compared to the upstream site, the density of mayfly and caddisfly taxa was much lower at RMs 0.2 and 0.1. The density of mayflies and caddisflies at the upstream site was 147/ft^2 while the adjacent and downstream sites were 6/ft^2 and 35/ft^2, respectively. The relative abundance of toxic tolerant midges (Chironomidae) at the adjacent and downstream sites may indicate a localized impact. The percentage of midges that Ohio EPA has identified as tolerant to toxic conditions was two percent in the upstream quantitative sample. In the adjacent and downstream samples, 8 and 13 percent of the midges were tolerant to toxic conditions.

Macroinvertebrate communities have improved compared to a prior survey. In 1985, the macroinvertebrate community was evaluated as poor at RM 0.1 with an ICI score of 12.

Table 7. Summary of macroinvertebrate data collected from artificial substrates (quantitative sampling) and natural substrates (qualitative sampling) in the West Branch Nimishillen Creek, 2008.

Stream/ River Mile	Density Number/ft^2	Total Taxa	Quantitative Taxa	Qualitative Taxa	Qualitative EPT[a]	ICI	Evaluation
0.4	1212	47	40	26	5	32^{ns}	Marginally Good
0.2	306	48	42	20	5	24*	Fair
0.1	504	48	40	30	6	28*	Fair

Ecoregion Biocriteria: Erie Ontario Lake Plain (EOLP) (Ohio Administrative Code 3745-1-07, Table 7-15)		
INDEX	WWH	EWH
ICI	34	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 ($\leq$4 ICI units).

NOTICE TO USERS

Ohio EPA incorporated biological criteria into the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1) regulations in February 1990 (effective May 1990). These criteria consist of numeric values for the Index of Biotic Integrity (IBI) and Modified Index of Well-Being (MIwb), both of which are based on fish assemblage data, and the Invertebrate Community Index (ICI), which is based on macroinvertebrate assemblage data. Criteria for each index are specified for each of Ohio's five ecoregions (as described by Omernik 1987), and are further organized by organism group, index, site type, and aquatic life use designation. These criteria, along with the existing chemical and whole effluent toxicity evaluation methods and criteria, figure prominently in the monitoring and assessment of Ohio's surface water resources.

The following documents support the use of biological criteria by outlining the rationale for using biological information, the methods by which the biocriteria were derived and calculated, the field methods by which sampling must be conducted, and the process for evaluating results:

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.

Ohio Environmental Protection Agency. 1989b. 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. 1989c. 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. 1990. The use of biological criteria in the Ohio EPA surface water monitoring and assessment program. Div. Water Qual. Plan. & Assess., Ecol. Assess. Sect., Columbus, Ohio.

Ohio Environmental Protection Agency. 2008a. 2006 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. 2006 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.

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

In addition to the preceding guidance documents, the following publications by the Ohio EPA should also be consulted as they present supplemental information and analyses used by the Ohio EPA to implement the biological criteria.

DeShon, J.D. 1995. Development and application of the invertebrate community index (ICI), pp. 217-243. in W.S. Davis and T. Simon (eds.). Biological Assessment and Criteria: Tools for Risk-based Planning and Decision Making. Lewis Publishers, Boca Raton, FL.

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.

Yoder, C.O. and E.T. Rankin. 1995. Biological criteria program development and implementation in Ohio, pp. 109-144. 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. and E.T. Rankin. 1995. Biological response signatures and the area of degradation value: new tools for interpreting multimetric data, pp. 263-286. 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. 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. 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.

Yoder, C.O. and M.A. Smith. 1999. Using fish assemblages in a State biological assessment and criteria program: essential concepts and considerations, pp. 17-63. in T. Simon (ed.). Assessing the Sustainability and Biological Integrity of Water Resources Using Fish Communities. CRC Press, Boca Raton, FL.

These documents and this report may be obtained by writing to:

Ohio EPA, Division of Surface Water
Ecological Assessment Section
4675 Homer Ohio Lane
Groveport, Ohio 43125
(614) 836-8786

or

www.epa.state.oh.us/dsw/formspubs.html

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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.

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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.

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APPENDICES – WEST BRANCH NIMISHILLEN CREEK, 2008

Appendix Table 1. Results for surficial sediment samples collected by the Ohio EPA from the West Branch Nimishillen Creek, June and July, 2008.

Sampling Location River Mile Date Sampled	15th Street **RM 0.4** 6/17/2008	Adjacent Gregory **RM 0.2** 6/17/2008	Market Street **RM 0.1** 6/17/2008
TAL Metals (ug/l)			
ALUMINUM	608	252	389
ANTIMONY	0.375 J	0.354 J	0525 J
ARSENIC	5 U	5 U	5 U
BARIUM	76.4	70.5	68.9
BERYLLIUM	0.5 U	0.5 U	0.5 U
CADMIUM	2.5 U	2.5 U	2.5 U
CALCIUM	99,600	107,000	103,000
CHROMIUM	2.5 U	2.5 U	2.5 U
COBALT	2.5 U	2.5 U	2.5 U
COPPER	5 U	5 U	5 U
IRON	1,990	927	1,210
LEAD	2.5 U	2.5 U	2.5 U
MAGNESIUM	20,400	22,900	21,700
MANGANESE	275	216	232
MERCURY	0.1 U	0.1 U	0.1 U
NICKEL	5 U	5 U	5 U
POTASSIUM	2970	2980	2860
SELENIUM	10 U	5 U	5 U
SILVER	5 U	5 U	5 U
SODIUM	85,200	82,100	77,600
THALLIUM	0.0813 J	0.0820 J	0.0825 J
VANADIUM	5 U	5 U	5 U
ZINC	17.7	31.3	19.6 J
PAH Compounds (ug/l)			
Naphthalene	0.104 U	0.102 U	0.106 U
Acenaphthylene	0.104 U	0.102 U	0.106 U
Acenaphthene	0.104 U	0.102 U	0.106 U
Fluorene	0.104 U	0.102 U	0.106 U
Phenanthrene	0.349	0.102 U	0.106 U
Anthracene	0.104 U	0.102 U	0.106 U
Fluoranthene	0.974	0.279	0.296
Pyrene	0.639	0.173	0.168 J
Benzo(a)anthracene	0.28	0.102 U	0.106 U
Chrysene	0.421	0.108	0.127 J
Benzo(b)fluoranthene	0.303	0.104	0.106 U
Benzo(k)fluoranthene	0.303	0.102 U	0.106 U
Benzo(a)pyrene	0.279	0.102 U	0.106 U
Indeno(1,2,3-cd)pyrene	0.211	0.102 U	0.106 U
Dibenzo(a,h)anthracene	0.104 U	0.102 U	0.106 U
Benzo(g,h,i)perylene	0.236	0.102 U	0.106 U
1-Methylnaphthalene	0.104 U	0.102 U	0.106 U
2-Methylnaphthalene	0.104 U	0.102 U	0.106 U

Appendix Table 1. Continued.

Sampling Location River Mile Date Sampled	15th Street **RM 0.4** 7/29/2008	Adjacent Gregory **RM 0.2** 7/29/2008	Market Street **RM 0.1** 7/29/2008
TAL Metals (ug/l)			
ALUMINUM	46.4	34.1	44.1
ANTIMONY	<4.0	<4.0	<4.0
ARSENIC	<15.0	<15.0	<15.0
BARIUM	81.1	75.7	72.2
BERYLLIUM	<5.0	<5.0	<5.0
CADMIUM	<10.0	<10.0	<10.0
CALCIUM	129,000	136,000	138,000
CHROMIUM	<10.0	<10.0	<10.0
COBALT	<3.0	<3.0	<3.0
COPPER	<10.0	<10.0	<10.0
IRON	422	388	380
LEAD	2.53 J	<10.0	<10.0
MAGNESIUM	27,200	29,200	30,200
MANGANESE	204	215	229
MERCURY	<0.50	<0.50	<0.50
NICKEL	<10.0	<10.0	<10.0
POTASSIUM	3760	3970	3770
SELENIUM	<5.0	<5.0	<5.0
SILVER	<10.0	<10.0	<10.0
SODIUM	96,800	92,200	89,400
THALLIUM	NA	NA	NA
VANADIUM	<10.0	<10.0	<10.0
ZINC	9.27 J	8.33 J	219
PAH Compounds (ug/l)			
Naphthalene	<1.00	<1.00	<1.00
Acenaphthylene	<1.00	<1.00	<1.00
Acenaphthene	<1.00	<1.00	<1.00
Fluorene	<1.00	<1.00	<1.00
Phenanthrene	<1.00	<1.00	<1.00
Anthracene	<0.100	<0.100	<0.100
Fluoranthene	<1.00	<1.00	<1.00
Pyrene	<1.00	<1.00	<1.00
Benzo(a)anthracene	<0.100	<0.100	<0.100
Chrysene	<0.500	<0.500	<0.500
Benzo(b)fluoranthene	<0.100	<0.100	<0.100
Benzo(k)fluoranthene	<0.100	<0.100	<0.100
Benzo(a)pyrene	<0.100	<0.100	<0.100
Indeno(1,2,3-cd)pyrene	<0.100	<0.100	<0.100
Dibenzo(a,h)anthracene	<0.100	<0.100	<0.100
Benzo(g,h,i)perylene	<0.100	<0.100	<0.100
1-Methylnaphthalene	NA	NA	NA
2-Methylnaphthalene	<1.00	<1.00	<1.00
Dibenzofuran	<10.0	<10.0	<10.0

J - The analyte was positively identified; the associated numerical value is an approximate concentration of the analyte in the sample.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

Appendix Table 2. Results for surficial sediment samples collected by the Ohio EPA from the West Branch Nimishillen Creek, 2008.

Sampling Location	15th Street	Adjacent Gregory	Market Street	**Sediment Screening Benchmarks**		
River Mile	**RM 0.4**	**RM 0.2**	**RM 0.1**	Sediment	MacDonald	
Date Sampled	6/17/2008	6/17/2008	6/17/2008	Reference	2000	USEPA
Percent Solids	76.1	72.3	60.9	Values	TEC	EDQLs
TAL Metals (mg/kg)						
ALUMINUM	2200	2730	3380	29,000		
ANTIMONY	0.326 U	0.346 U	0.399 U	1.3		
ARSENIC	7.32	8.31	9.0	25	9.79	9.79
BARIUM	31.8	25.0	46.2	190		
BERYLLIUM	0.263 J	0.283 J	0.329 J	0.8		
CADMIUM	0.709	0.683	0.967	0.79	0.99	0.99
CALCIUM	15,500	3290	15,900	21,000		
CHROMIUM	45.8	28.5	36.6	29	43.4	43.4
COBALT	2.43	1.24	3.09	12		50
COPPER	24.3	25.2	46.6	32	31.6	31.6
IRON	17,800	22,600	16,200	41,000		
LEAD	44.0	42.4	69.7	47	35.8	35.8
MAGNESIUM	3250	1280	3120	7100		
MANGANESE	614	193	273	1500		
MERCURY	0.0150 J	0.0594 J	0.0677 J	0.12	0.18	0.174
NICKEL	13.4	11.9	17.3	33	22.7	22.7
POTASSIUM	185	175	325	6800		
SELENIUM	2.14	29.2	9.15	1.7		
SILVER	0.473 J	0.503 J	0.616 J	0.43		0.5
SODIUM	90.4	98.8	117			
THALLIUM	0.0782 J	0.110 J	0.136 J	4.7		
VANADIUM	7.26	7.51	9.81	40		
ZINC	105	1390	286	160	121	121
PAH Compounds (ug/kg)						
Naphthalene	71.3 U	86 J	125 J		176	176
Acenaphthylene	71.3 U	69.5 J	353			5.87
Acenaphthene	169	110 J	308			6.71
Fluorene	237	146	433		77.4	77.4
Phenanthrene	3020	2610	6300		204	204
Anthracene	515	408	1130		57.2	57.2
Fluoranthene	4890	5450	11,800		423	423
Pyrene	3240	3480	7840		195	195
Benzo(a)anthracene	1380	1590	3970		108	108
Chrysene	1680	2020	4670		166	166
Benzo(b)fluoranthene	1240	1530	3200			10,400
Benzo(k)fluoranthene	1140	1410	3350			240
Benzo(a)pyrene	1170	1410	3300		150	150
Indeno(1,2,3-cd)pyrene	818	1030	2370			200
Dibenzo(a,h)anthracene	248	417	954		33	33
Benzo(g,h,i)perylene	953	1170	2430			170
1-Methylnaphthalene	71.3 U	72.4 J	91.6 U			
2-Methylnaphthalene	71.3 U	98.4 J	112 J			20.2

J - The analyte was positively identified; the associated numerical value is an approximate concentration of the analyte in the sample.

U - The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

Appendix Table 3. Ohio EPA fish results from the West Branch Nimishillen Creek, 2008.

River Code: **17-464**	Stream: **West Branch Nimishillen Creek**	Sample Date: **2008**
River Mile: **0.40**	Location: 15th St.	Date Range: 06/17/2008
Time Fished: 2921 sec	Drainage: 46.3 sq mi	Thru: 07/29/2008
Dist Fished: 0.30 km	Basin: Muskingum River No of Passes: 2	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
Northern Hog Sucker	R	I	S	M	3	3.00	0.75	1.04	17.51	348.00
White Sucker	W	O	S	T	29	29.00	7.23	1.03	17.33	35.62
Common Carp	G	O	M	T	1	1.00	0.25	1.60	26.84	1,600.00
Western Blacknose Dace	N	G	S	T	91	91.00	22.69	0.34	5.64	3.70
Creek Chub	N	G	N	T	25	25.00	6.23	0.35	5.90	14.08
Sand Shiner	N	I	M	M	2	2.00	0.50	0.01	0.13	4.00
Silverjaw Minnow	N	I	M		1	1.00	0.25	0.00	0.07	4.00
Bluntnose Minnow	N	O	C	T	43	43.00	10.72	0.16	2.65	3.67
Central Stoneroller	N	H	N		1	1.00	0.25	0.00	0.07	4.00
Green Sunfish	S	I	C	T	7	7.00	1.75	0.15	2.57	21.86
Bluegill Sunfish	S	I	C	P	3	3.00	0.75	0.03	0.54	10.67
Johnny Darter	D	I	C		2	2.00	0.50	0.01	0.08	2.50
Greenside Darter	D	I	S	M	5	5.00	1.25	0.02	0.27	3.20
Banded Darter	D	I	S	I	3	3.00	0.75	0.01	0.13	2.67
Mottled Sculpin		I	C		185	185.00	46.13	1.21	20.27	6.53
	Mile Total				401	401.00		5.96		
	Number of Species				15					
	Number of Hybrids				0					

River Code: **17-464**	Stream: **West Branch Nimishillen Creek**	Sample Date: **2008**
River Mile: **0.20**	Location: adj. Gregory Galvanizing	Date Range: 06/17/2008
Time Fished: 3921 sec	Drainage: 46.5 sq mi	Thru: 07/29/2008
Dist Fished: 0.30 km	Basin: Muskingum River No of Passes: 2	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
Northern Hog Sucker	R	I	S	M	4	4.00	0.63	1.20	20.48	300.00
White Sucker	W	O	S	T	6	6.00	0.94	0.09	1.55	15.17
Western Blacknose Dace	N	G	S	T	35	35.00	5.49	0.19	3.16	5.28
Creek Chub	N	G	N	T	39	39.00	6.12	0.58	9.94	14.93
Sand Shiner	N	I	M	M	1	1.00	0.16	0.00	0.07	4.00
Fathead Minnow	N	O	C	T	1	1.00	0.16	0.00	0.05	3.00
Bluntnose Minnow	N	O	C	T	19	19.00	2.98	0.12	2.12	6.53
Central Stoneroller	N	H	N		1	1.00	0.16	0.01	0.14	8.00
Yellow Bullhead		I	C	T	10	10.00	1.57	0.39	6.67	39.10
Largemouth Bass	F	C	C		2	2.00	0.31	0.01	0.17	5.00
Green Sunfish	S	I	C	T	14	14.00	2.20	0.18	3.14	13.14
Bluegill Sunfish	S	I	C	P	2	2.00	0.31	0.05	0.79	23.00
Pumpkinseed Sunfish	S	I	C	P	1	1.00	0.16	0.02	0.39	23.00
Logperch	D	I	S	M	1	1.00	0.16	0.04	0.68	40.00
Johnny Darter	D	I	C		1	1.00	0.16	0.00	0.05	3.00
Greenside Darter	D	I	S	M	18	18.00	2.83	0.15	2.53	8.22
Banded Darter	D	I	S	I	4	4.00	0.63	0.01	0.15	2.25
Mottled Sculpin		I	C		478	478.00	75.04	2.81	47.92	5.87
	Mile Total				637	637.00		5.86		
	Number of Species				18					
	Number of Hybrids				0					

River Code: **17-464**	Stream: **West Branch Nimishillen Creek**	Sample Date: **2008**
River Mile: **0.10**	Location: Market St.	Date Range: 06/17/2008
Time Fished: 5216 sec	Drainage: 46.5 sq mi	Thru: 07/29/2008
Dist Fished: 0.30 km	Basin: Muskingum River No of Passes: 2	Sampler Type: E

Species Name / ODNR status	IBI Grp	Feed Guild	Breed Guild	Tol	# of Fish	Relative Number	% by Number	Relative Weight	% by Weight	Ave(gm) Weight
Rainbow Trout	E		N		1	1.00	0.14	0.21	1.64	212.00
Northern Hog Sucker	R	I	S	M	12	12.00	1.62	3.21	24.75	267.08
White Sucker	W	O	S	T	46	46.00	6.22	2.80	21.59	60.78
Common Carp	G	O	M	T	2	2.00	0.27	2.77	21.41	1,386.00
Western Blacknose Dace	N	G	S	T	27	27.00	3.65	0.17	1.31	6.26
Creek Chub	N	G	N	T	20	20.00	2.71	0.24	1.85	12.00
Bluntnose Minnow	N	O	C	T	7	7.00	0.95	0.06	0.42	7.86
Yellow Bullhead		I	C	T	7	7.00	0.95	0.18	1.41	26.14
Rock Bass	S	C	C		1	1.00	0.14	0.01	0.07	9.00
Largemouth Bass	F	C	C		1	1.00	0.14	0.13	0.97	126.00
Green Sunfish	S	I	C	T	4	4.00	0.54	0.10	0.78	25.25
Greenside Darter	D	I	S	M	30	30.00	4.06	0.20	1.52	6.57
Banded Darter	D	I	S	I	2	2.00	0.27	0.01	0.06	4.00
Rainbow Darter	D	I	S	M	1	1.00	0.14	0.00	0.03	4.00
Mottled Sculpin		I	C		578	578.00	78.21	2.87	22.18	4.97
Mile Total					739	739.00		12.95		
Number of Species					15					
Number of Hybrids					0					

Appendix Table 4. Index of Biotic Integrity (IBI and Modified Index of Well-being (MIwb) metrics and scores for the West Branch Nimishillen Creek, 2008.

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Sunfish species	Sucker species	Intolerant species	Darter species	Percent of Individuals: Simple Lithophils	Tolerant fishes	Omni-vores	Top carnivores	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)	IBI	Modified Iwb
W Br Nimishillen Cr. - (17464)																	
Year: 2008																	
0.40	E	06/17/2008	46	11(3)	2(3)	2(3)	1(1)	2(1)	29(3)	42(3)	12(5)	0.0(1)	61(5)	0.6(3)	190(1)	32	6.4
0.40	E	07/29/2008	46	13(3)	1(1)	2(3)	1(1)	3(3)	35(3)	54(1)	23(3)	0.0(1)	47(3)	0.0(5)	220(3)	30	6.2
0.20	E	06/17/2008	46	13(3)	3(3)	1(1)	1(1)	2(1)	13(1)	22(5)	4(5)	0.0(1)	80(5)	0.0(5)	422(3)	34	6.0
0.20	E	07/29/2008	46	15(3)	2(3)	2(3)	1(1)	4(3)	9(1)	18(5)	4(5)	0.5(1)	86(5)	0.0(5)	604(3)	38	6.8
0.10	E	06/17/2008	46	11(3)	2(3)	2(3)	0(1)	1(1)	18(1)	17(5)	9(5)	0.5(1)	85(5)	0.3(3)	618(3)	34	6.8
0.10	E	07/29/2008	46	10(3)	1(1)	2(3)	1(1)	3(3)	14(1)	13(5)	5(5)	0.0(1)	87(5)	0.0(5)	634(3)	36	6.5

na - Qualitative data, Modified Iwb not applicable.

♦ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample

● - One or more species excluded from IBI calculation.

Appendix Table 5. Invertebrate Community Index (ICI) metrics and scores for sites sampled in the West Branch Nimishillen Creek, 2008.

River Mile	Drainage Area (sq mi)	Number of: Total Taxa	Mayfly Taxa	Caddisfly Taxa	Dipteran Taxa	Percent: Mayflies	Caddis-flies	Tany-tarsini	Other Dipt/NI	Tolerant Organisms	Qual. EPT	Eco-region	ICI
West Branch Nimishillen Creek (17-464)													
Year: 2008													
0.40	46.3	40(6)	3(2)	5(6)	20(6)	1.4(2)	10.7(4)	20.6(4)	66.1(0)	22.0(0)	5(2)	3	32
0.20	46.5	42(6)	0(0)	5(6)	28(6)	0.0(0)	1.9(2)	4.6(2)	93.2(0)	48.3(0)	5(2)	3	24
0.10	46.5	40(6)	2(0)	4(6)	24(6)	1.1(2)	5.8(4)	8.9(2)	83.8(0)	33.0(0)	6(2)	3	28

Appendix Table 6. Ohio EPA macroinvertebrate results from the West Branch Nimishillen Creek, 2008.

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Site: West Branch Nimishillen Creek
15th St.

Collection Date: 07/29/2008 River Code: 17-464 RM: 0.40

Taxa Code	Taxa	Quant/Qual
01801	*Turbellaria*	51 +
03600	*Oligochaeta*	706 +
04664	*Helobdella stagnalis*	1
04901	*Erpobdellidae*	3 +
05800	*Caecidotea sp*	19 +
06700	*Crangonyx sp*	16
06810	*Gammarus fasciatus*	133 +
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	+
08601	*Hydrachnidia*	48 +
11120	*Baetis flavistriga*	20
11130	*Baetis intercalaris*	65 +
13400	*Stenacron sp*	+
17200	*Caenis sp*	1
44501	*Corixidae*	+
52200	*Cheumatopsyche sp*	385 +
52430	*Ceratopsyche morosa group*	147 +
52530	*Hydropsyche depravata group*	12 +
53800	*Hydroptila sp*	102
59410	*Nectopsyche diarina*	2
68700	*Dubiraphia sp*	1
68901	*Macronychus glabratus*	35
69400	*Stenelmis sp*	35 +
74100	*Simulium sp*	+
77500	*Conchapelopia sp*	147
77750	*Hayesomyia senata or Thienemannimyia norena*	37
80410	*Cricotopus (C.) sp*	403 +
80420	*Cricotopus (C.) bicinctus*	37 +
80430	*Cricotopus (C.) tremulus group*	293
81825	*Rheocricotopus (Psilocricotopus) robacki*	403
82220	*Tvetenia discoloripes group*	330 +
82730	*Chironomus (C.) decorus group*	73 +
82800	*Cladopelma sp*	+
83003	*Dicrotendipes fumidus*	37 +
83040	*Dicrotendipes neomodestus*	220
83820	*Microtendipes "caelum" (sensu Simpson & Bode, 1980)*	37
83840	*Microtendipes pedellus group*	37
84300	*Phaenopsectra obediens group*	+
84450	*Polypedilum (Uresipedilum) flavum*	367 +
84470	*Polypedilum (P.) illinoense*	37 +
84540	*Polypedilum (Tripodura) scalaenum group*	73
85500	*Paratanytarsus sp*	330
85625	*Rheotanytarsus sp*	330
85800	*Tanytarsus sp*	147
85821	*Tanytarsus glabrescens group sp 7*	440
87540	*Hemerodromia sp*	17
96900	*Ferrissia sp*	482 +
97601	*Corbicula fluminea*	+

No. Quantitative Taxa: 40 Total Taxa: 47
No. Qualitative Taxa: 26 ICI: **32**
Number of Organisms: 6059 Qual EPT: 5

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Site: West Branch Nimishillen Creek
adj. Gregory Galvanizing

Collection Date: 07/29/2008 River Code: 17-464 RM: 0.20

Taxa Code	Taxa	Quant/Qual
01801	*Turbellaria*	10 +
03600	*Oligochaeta*	593 +
04664	*Helobdella stagnalis*	1
04901	*Erpobdellidae*	9
05800	*Caecidotea sp*	39 +
06810	*Gammarus fasciatus*	35 +
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	+
08601	*Hydrachnidia*	+
11120	*Baetis flavistriga*	+
11130	*Baetis intercalaris*	+
52200	*Cheumatopsyche sp*	23 +
52430	*Ceratopsyche morosa group*	1 +
52530	*Hydropsyche depravata group*	1 +
53501	*Hydroptilidae*	2
59410	*Nectopsyche diarina*	2
68901	*Macronychus glabratus*	3
69400	*Stenelmis sp*	2 +
71900	*Tipula sp*	1
74100	*Simulium sp*	+
77500	*Conchapelopia sp*	50
77750	*Hayesomyia senata or Thienemannimyia norena*	10
77800	*Helopelopia sp*	10
78401	*Natarsia species A (sensu Roback, 1978)*	10
80420	*Cricotopus (C.) bicinctus*	20 +
80430	*Cricotopus (C.) tremulus group*	30 +
80510	*Cricotopus (Isocladius) sylvestris group*	10
81650	*Parametriocnemus sp*	10
81825	*Rheocricotopus (Psilocricotopus) robacki*	30 +
82220	*Tvetenia discoloripes group*	10 +
82730	*Chironomus (C.) decorus group*	80
82820	*Cryptochironomus sp*	70 +
83002	*Dicrotendipes modestus*	20
83003	*Dicrotendipes fumidus*	10
83040	*Dicrotendipes neomodestus*	50
83300	*Glyptotendipes (G.) sp*	10
83840	*Microtendipes pedellus group*	10
84210	*Paratendipes albimanus or P. duplicatus*	20
84300	*Phaenopsectra obediens group*	100
84450	*Polypedilum (Uresipedilum) flavum*	30
84460	*Polypedilum (P.) fallax group*	20
84470	*Polypedilum (P.) illinoense*	10 +
84540	*Polypedilum (Tripodura) scalaenum group*	100
84790	*Tribelos fuscicorne*	10
85500	*Paratanytarsus sp*	50
85625	*Rheotanytarsus sp*	+
85800	*Tanytarsus sp*	20
87540	*Hemerodromia sp*	1
96900	*Ferrissia sp*	5

No. Quantitative Taxa: 42 Total Taxa: 48
No. Qualitative Taxa: 20 ICI: **24**
Number of Organisms: 1528 Qual EPT: 5

Ohio EPA/DSW Ecological Assessment Section
Macroinvertebrate Collection

Site: West Branch Nimishillen Creek
Market St.

Collection Date: 07/29/2008 River Code: 17-464 RM: 0.10

Taxa Code	Taxa	Quant/Qual
01200	*Cordylophora lacustris*	1
01801	*Turbellaria*	10 +
03360	*Plumatella sp*	+
03600	*Oligochaeta*	554 +
04901	*Erpobdellidae*	3 +
05800	*Caecidotea sp*	45 +
06810	*Gammarus fasciatus*	52 +
08260	*Orconectes (Crokerinus) sanbornii sanbornii*	+
08601	*Hydrachnidia*	16 +
11120	*Baetis flavistriga*	15 +
11130	*Baetis intercalaris*	13 +
52200	*Cheumatopsyche sp*	83 +
52430	*Ceratopsyche morosa group*	40 +
52530	*Hydropsyche depravata group*	7 +
53800	*Hydroptila sp*	15 +
68901	*Macronychus glabratus*	4
69400	*Stenelmis sp*	9 +
71900	*Tipula sp*	1 +
74100	*Simulium sp*	1 +
77500	*Conchapelopia sp*	52
77750	*Hayesomyia senata or Thienemannimyia norena*	17
77800	*Helopelopia sp*	+
78450	*Nilotanypus fimbriatus*	34
80310	*Cardiocladius obscurus*	17 +
80410	*Cricotopus (C.) sp*	17
80420	*Cricotopus (C.) bicinctus*	121 +
80430	*Cricotopus (C.) tremulus group*	172
80440	*Cricotopus (C.) trifascia*	+
80510	*Cricotopus (Isocladius) sylvestris group*	52
81825	*Rheocricotopus (Psilocricotopus) robacki*	310
82141	*Thienemanniella xena*	56
82220	*Tvetenia discoloripes group*	155 +
82730	*Chironomus (C.) decorus group*	+
82820	*Cryptochironomus sp*	+
83040	*Dicrotendipes neomodestus*	17
84300	*Phaenopsectra obediens group*	17
84450	*Polypedilum (Uresipedilum) flavum*	155 +
84460	*Polypedilum (P.) fallax group*	34
84470	*Polypedilum (P.) illinoense*	52 +
84540	*Polypedilum (Tripodura) scalaenum group*	121 +
84750	*Stictochironomus sp*	+
85500	*Paratanytarsus sp*	17
85625	*Rheotanytarsus sp*	103
85800	*Tanytarsus sp*	34
85821	*Tanytarsus glabrescens group sp 7*	69 +
87540	*Hemerodromia sp*	8
96900	*Ferrissia sp*	19
97601	*Corbicula fluminea*	+

No. Quantitative Taxa: 40 Total Taxa: 48
No. Qualitative Taxa: 30 ICI: **28**
Number of Organisms: 2518 Qual EPT: 6