Biological and Water Quality Study of Mill Creek 2021

Mill Creek downstream from SSO 700 (MC 104)

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Biological and Water Quality Study of Mill Creek 2021

Hamilton County, Ohio

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Glossary of Terms

Ambient Monitoring	Sampling and evaluation of receiving waters not necessarily associated with episodic perturbations.
Aquatic Assemblage	An association of interacting populations of organisms in a given waterbody, for example, the fish assemblage or the benthic macroinvertebrate assemblage.
Aquatic Community	An association of interacting assemblages in a given waterbody, the biotic component of an ecosystem.
Aquatic Life Use (ALU)	A beneficial use designation in which the waterbody provides suitable habitat for survival and reproduction of desirable fish, shellfish, and other aquatic organisms; classifications specified in State water quality standards relating to the level of protection afforded to the resident biological community by the custodial State agency.
Assemblage	Refers to all of the various species of a particular taxonomic grouping (e.g., fish, macroinvertebrates, algae, submergent aquatic plants, etc.) that exist in a particular habitat. Operationally this term is useful for defining biological assessment methods and their attendant assessment mechanisms, i.e., indices of biotic integrity (IBI), O/E models, or fuzzy set models.
Attainment Status	The state of condition of a waterbody as measured by chemical, physical, and biological indicators. Full attainment is the point at which measured indicators signify that a water quality standard has been met and that the designated use is both attained and protected. Non-attainment is when the designated use is not attained based on one or more of these indicators being below the required condition or state for that measure or parameter.
Attribute	A measurable part or process of a biological system.
Beneficial Uses	Desirable uses that acceptable water quality should support. Examples are drinking water supply, primary contact recreation (such as swimming), and aquatic life support.

Benthic Macroinvertebrates	Animals without backbones, living in or on the substrates, of a size large enough to be seen by the unaided eye, and which can be retained by a U.S. Standard No. 30 sieve (0.595 mm openings). Also referred to as benthos, infauna, or macrobenthos.
Best Management Practice	An engineered structure or management activity, or combination of these that eliminates or reduces an adverse environmental effect of a pollutant, pollution, or stressor effect.
Biological Assessment	An evaluation of the biological condition of a waterbody using surveys of the structure and function of a community of resident biota; also known as bioassessment. It also includes the interdisciplinary process of determining condition and relating that condition to chemical, physical, and biological factors that are measured along with the biological sampling.
Biological Criteria (Biocriteria)	Scientific meaning: quantified values representing the biological condition of a waterbody as measured by structure and function of the aquatic communities typically at reference condition; also known as biocriteria. Regulatory meaning: narrative descriptions or numerical values of the structure and function of aquatic communities in a waterbody necessary to protect a designated aquatic life use, implemented in, or through state water quality standards.
Biological Condition Gradient	A scientific model that describes the biological responses within an aquatic ecosystem to the increasing effects of stressors.
Biological Diversity	Refers to the variety and variability among living organisms and the ecological complexes in which they occur. Diversity can be defined as the number of different taxa and their relative frequencies. For biological diversity, these taxa are organized at many levels, ranging from complete ecosystems to the biochemical structures that are the molecular basis of heredity. Thus, the term encompasses different

	ecosystems, species, and genes; also known as biodiversity.
Biological Indicator	An organism, species, assemblage, or community characteristic of a particular habitat, or indicative of a particular set of environmental conditions; also known as a bioindicator.
Biological Integrity	The ability of an aquatic ecosystem to support and maintain a balanced, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats within a region (after Karr and Dudley 1981).
Biological Monitoring	The use of a biological entity (taxon, species, assemblage) as a detector and its response as a measure of response to determine environmental conditions. Ambient biological surveys and toxicity tests are common biological monitoring methods; also known as biomonitoring.
Biological Survey	The collection, processing, and analysis of a representative portion of the resident aquatic community to determine its structural and/or functional characteristics and hence its condition using standardized methods.
Clean Water Act (CWA)	An act passed by the U.S. Congress to control water pollution (formally referred to as the Federal Water Pollution Control Act of 1972). Public Law 92-500, as amended. 33 U.S.C. 1251 et seq.; referred to herein as the CWA.
CWA Section 303(d)	This section of the Act requires States, territories, and authorized Tribes to develop lists of impaired waters for which applicable water quality standards are not being met, even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that these jurisdictions establish priority rankings for waters on the lists and develop TMDLs for these waters. States, territories, and authorized Tribes are to submit their list of waters on April 1 in every even-numbered year.

CWA Section 305(b)	Biennial reporting required by the Act to describe the quality of the Nation's surface waters, to serve as an evaluation of progress made in maintaining and restoring water quality, and describe the extent of remaining problems.
Criteria	Limits on a particular pollutant or condition of a waterbody presumed to support or protect the designated use or uses of a waterbody. Criteria may be narrative or numeric and are commonly expressed as a chemical concentration, a physical parameter, or a biological assemblage endpoint.
DELT Anomalies	The percentage of Deformities, Erosions (e.g., fins, barbels), Lesions and Tumors on fish assemblages (DELT). An important fish assemblage attribute that is a commonly employed metric in fish IBIs.
Designated Uses	Those uses specified in state water quality standards for each waterbody or segment whether or not they are being attained.
Disturbance	Any activity of natural or human causes that alters the natural state of the environment and its attributes and which can occur at or across many spatial and temporal scales.
Ecological integrity	The summation of chemical, physical, and biological integrity capable of supporting and maintaining a balanced, integrated adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats in the region.
Ecoregion	A relatively homogeneous geographical area defined by a similarity of climate, landform, soil, potential natural vegetation, hydrology, or other ecologically relevant variables; ecoregions are portioned at increasing levels of spatial detail from level I to level IV.
Existing Use	A use that was actually attained in a waterbody on or after November 28, 1975, whether or not they are included in the state water quality standards (November 28, 1975 is the date on which U.S. EPA

	promulgated its first water quality standards regulation in 40CFR Part 131). Existing uses must be maintained and cannot be removed.
Index of Biotic Integrity (IBI)	An integrative expression of site condition across multiple metrics comprised of attributes of a biological assemblage. It refers to the index developed by Karr (1981) and explained by Karr et al. (1986). It has been used to express the condition of fish, macroinvertebrate, algal, and terrestrial assemblages throughout the U.S. and in each of five major continents.
MIwb	The Modified Index of Well-Being (MIwb) is based on fish assemblage measures including numbers, biomass, and two diversity indices (Shannon Index) based on numbers and biomass. The numbers and biomass metrics exclude highly tolerant species. It reflects the overall productivity and diversity of the fish assemblage and it frequently responds before the IBI to improvements in water quality and habitat.
Metric	A calculated term or enumeration representing an attribute of a biological assemblage, usually a structural aspect, that changes in a predictable manner with an increased effect of human disturbance.
Monitoring and Assessment	The entire process of collecting data from the aquatic environment using standardized methods and protocols, managing that data, analyzing that data to make assessments in support of multiple program objectives, and disseminating the assessments to stakeholders and the public.
Multimetric Index	An index that combines assemblage attributes, or metrics, into a single index value. Each metric is tested and calibrated to a scale and transformed into a unitless score prior to being aggregated into a multimetric index. Both the index and metrics are useful in assessing and diagnosing ecological condition.
Narrative Biocriteria	Written statements describing the narrative attributes of the structure and function of aquatic communities

	in a waterbody necessary to protect a designated aquatic life use.
Natural Condition	This includes the multiplicity of factors that determine the physical, chemical, or biological conditions that would exist in a waterbody in the absence of measurable impacts from human activity or influence.
Numeric Biocriteria	Specific quantitative and numeric measures of the structure and function of aquatic communities in a waterbody necessary to protect a designated aquatic life use.
Qualitative Habitat Evaluation Index	A qualitative habitat evaluation assessment tool that is applied to streams and rivers in Ohio and which is used to identify habitat variables that are important to attainment of the Ohio biological criteria.
Reference Condition	The condition that approximates natural, unimpacted to best attainable conditions (biological, chemical, physical, etc.) for a waterbody. Reference condition is best determined by collecting measurements at a number of sites in a similar waterbody class or region under minimally or least disturbed conditions (by human activity), if they exist. Since undisturbed or minimally disturbed conditions may be difficult or impossible to find in some states, least disturbed conditions, combined with historical information, models or other methods may be used to approximate reference condition as long as the departure from natural or ideal is comprehended. Reference condition is used as a benchmark to establish numeric biocriteria.
Reference Site	A site selected to represent an approximation of reference condition and by comparison to other sites being assessed. For the purpose of assessing the ecological condition of other sites, a reference site is a specific locality on a waterbody that is minimally or least disturbed and is representative of the expected ecological condition of other localities on the same waterbody or nearby waterbodies.

Regional Reference Condition	A description of the chemical, physical, or biological condition based on an aggregation of data from reference sites that are representative of a waterbody type in an ecoregion, subregion, bioregion, or major drainage unit.
Stressors	Physical, chemical, and biological factors that can adversely affect aquatic organisms. The effect of stressors is apparent in the biological responses.
Use Attainability Analysis (UAA)	A structured scientific assessment of the physical, chemical, biological or economic factors affecting attainment of the uses of waterbodies.
Use Classes	A broad capture of a designated use for general purposes such as recreation, water supply, and aquatic life.
Use Subclasses	A subcategorization of use classes into discrete and meaningful descriptions. For aquatic life this would include a hierarchy of warmwater and coldwater uses and additional stratification provided by different levels of warmwater uses and further stratification by waterbody types.
TALU Based Approach	This approach includes tiered aquatic life uses (TALU) based on numeric biological criteria and implementation via an adequate monitoring and assessment program that includes biological, chemical, and physical measures, parameters, indicators and a process for stressor identification.
Tiered Aquatic Life Uses (TALUs)	As defined: The structure of designated aquatic life uses that incorporates a hierarchy of use subclasses and stratification by natural divisions that pertain to geographical and waterbody class strata. TALUs are based on representative ecological attributes and these should be reflected in the narrative description of each TALU tier and be embodied in the measurements that extend to expressions of that narrative through numeric biocriteria and by extension to chemical and physical indictors and criteria.

	As used: TALUs are assigned to water bodies based on the protection and restoration of ecological potential. This means that the assignment of a TALU tier to a specific waterbody is done with regard to reasonable restoration or protection expectations and attainability. Hence knowledge of the current condition of a waterbody and an accompanying and adequate assessment of stressors affecting that waterbody are needed to make these assignments.
Total Maximum Daily Load (TMDL)	The maximum amount of a pollutant that a body of water can receive while still meeting water quality standards. Alternatively, a TMDL is an allocation of a water pollutant deemed acceptable to attain the designated use assigned to the receiving water.
Water Quality Standards (WQS)	A law or regulation that consists of the designated use or uses of a waterbody, the narrative or numerical water quality criteria (including biocriteria) that are necessary to protect the use or uses of that particular waterbody, and an antidegradation policy.
Water Quality Management	A collection of management programs relevant to water resource protection that includes problem identification, the need for and placement of best management practices, pollution abatement actions, and measuring the effectiveness of management actions.

List of Acronyms

ALU	Aquatic Life Use
BCG	Biological Condition Gradient
BNA	Base Neutral Acid Compound
CSO	Combined Sewer Overflow
CWA	Clean Water Act
DELT	Deformities, Erosions, Lesions, and Tumors (fish)
ECOS	Ohio EPA database framework used by MBI
EPA	Environmental Protection Agency
EPT	Ephemeroptera, Plecoptera, Trichoptera
HD (or H-D)	Hester Dendy artificial substrate sampler
HHEI	Headwater Habitat Evaluation Index
IBI	Index of Biotic Integrity for fish assemblages
ICI	Invertebrate Community Index
IPS	Integrated Prioritization System
LIMS	Laboratory Information Management System
M&A	Monitoring and Assessment
MBI	Midwest Biodiversity Institute
MIwb	Modified Index of Well-Being
MSDGC	Metropolitan Sewer District of Greater Cincinnati
NPDES	National Pollutant Discharge Elimination System
OAC	Ohio Administrative Code

OCDL	Ohio Credible Data Law
OEPA	Ohio Environmental Protection Agency
ORC	Ohio Revised Code
PAH	Polycyclic Aromatic Hydrocarbon
PHWH	Primary Headwater Habitat
PSO	Pump Station Overflow
PSP	Project Study Plan
QDC	Qualified Data Collector
QAPP	Quality Assurance Program Plan
QHEI	Qualitative Habitat Evaluation Index
RM	River mile per Ohio EPA RM Index
SOP	Standard Operating Procedure
SSO	Sanitary Sewer Overflow
TALU	Tiered Aquatic Life Use
TMDL	Total Maximum Daily Load
UAA	Use Attainability Analysis
VOC	Volatile Organic Compound
WLA	Waste Load Allocation
WQS	Water Quality Standards
WRF	Water Reclamation Facility
WWTP	Wastewater Treatment Plant

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 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. The latter is the case with this study in that Mill Creek represents a watershed of 170 square miles in drainage area with a mix of overlapping stressors and sources in a highly urbanized and legacy industrial landscape. The 2021 assessment is a follow-up to previous surveys of the Mill Creek performed by MBI in 2011, 2013, and 2016 and Ohio EPA in 1992 (Ohio EPA 1994) and 2014 (partial assessment).

Scope of the 2021 Mill Creek Biological and Water Quality Assessment

The scope of the 2021 Mill Creek biological and water quality assessment included the mainstem and parts of three tributaries compared to the full watershed scope of the 2011 survey (MBI 2012). In addition to supporting the instream monitoring requirement of the CSO NPDES permit the overall objectives remained the same:

1. Determine the extent to which biological assemblages are impaired (using Ohio EPA methods and criteria);
2. Determine the categorical stressors and sources that are associated with those impairments; and,
3. Add to the broader databases for the Mill Creek and MSDGC watersheds to track and understand changes through time that occur as the result of abatement actions or other factors.

The data presented herein were processed, evaluated, and synthesized as a biological and water quality assessment of aquatic life and recreational use support status. The assessment of the mainstem is directly comparable to that accomplished previously in 1992 and 2014 by Ohio EPA and 2011, 2013, and 2016 by MBI, such that trends in status can be examined, and causes and sources of impairment can be confirmed, appended, or removed. This study includes an assessment of chemical and physical stressors related to the biological assemblages. It is not the purpose of this study to identify specific remedial actions on a site specific or watershed basis. However, the data produced by this study contributes to the maintenance and use of the Integrated Prioritization System (IPS; MBI 2015) that was developed to determine and prioritize remedial projects for the MSDGC service area.

EXECUTIVE SUMMARY

Scope and Purpose

In 2010, MSDGC and MBI developed a four-year rotational watershed assessment approach that is documented in the *Watershed Monitoring and Bioassessment Plan for the MSD Greater Cincinnati Service Area, Hamilton County, Ohio; Technical Report MBI/5-11-3* (MBI 2011). Initiated in 2011, it has provided biological and water quality monitoring data that has assisted MSDGC in better understanding current water quality, trends through time, and considerations for its capital planning and implementation of Project Groundwork to further improve water quality. The 2021 bioassessment of Mill Creek is the second round of the follow-up sampling and analysis that is now being conducted primarily in support of the instream monitoring requirement of the CSO NPDES permit. The sampling and analysis in 2021 were performed by Level 3 Qualified Data Collectors and under a full biological, habitat, and chemical water quality Project Study Plan approved by Ohio EPA under the Ohio Credible Data Law and Regulations.

An intensive pollution survey design that employed a high density of sampling sites and biological, chemical, and physical indicators and parameters was followed. The principal objectives of biological assessments are to assess current conditions, verify existing aquatic life and recreational use designations, assign uses to unlisted streams and stream segments, make recommendations for any changes to use designations, report attainment status following the Ohio WQS and Ohio EPA practices, and determine associated causes and sources of impairment. The determination of associated causes and sources of impairments to aquatic life and recreational uses followed practices similar to those employed by Ohio EPA. As such, these determinations are usually categorical, but can include the identification of specific pollutants. The results of this study will be incorporated in an ongoing assessment of stressors and their root causes and sources throughout the MSDGC service area via the Integrated Prioritization System (IPS; MBI 2015). The IPS includes more detailed analyses of regional patterns in stressors by relating them to the chemical, physical, and biological data generated by the surveys to ancillary data available in GIS coverages.

Highlighted Findings

General Conditions in Mill Creek

The 2021 assessment of Mill Creek provided an opportunity to gauge the effectiveness of past and ongoing attempts to improve water quality and overall conditions by comparing the results to prior assessments. The 2011, 2013, and 2016 (fish/habitat only) by MBI and the 1992, 1997, and 2014 surveys by Ohio EPA provide the most consistent basis for comparisons in terms of spatial coverage and between indicators and parameters for the Mill Creek mainstem. Highlights of these comparisons include:

- The 2021 Mill Creek results show that the biological assemblages continue to recover incrementally. Most of the sites that were rated as poor or very poor in 1992 and fair to

marginally good in 2011, and fair to good in 2016 were further improved to fair, good, and in a few instances exceptional quality for macroinvertebrates in 2021;

- Of the 41 sites that were evaluated under the Warmwater Habitat (WWH) suite of uses and biocriteria, 12 were in full attainment of the applicable use tier (WWH-4; MWH–8), 18 in partial attainment (WWH-17; MWH-1), with the remaining 11 in non-attainment (WWH-7; MWH-4);
- Of the total of 44 sites that were evaluated, three (3) were classified as Primary Headwater Habitat (PHWH) class 2 (1 site) and 3B (2 sites) the latter being the highest quality PHWH classification. The uppermost sites in Cooper Creek were evaluated against the existing WWH use biocriteria, but some site could be classified PHWH Class 3B pending the outcome of planned restoration to provide improved habitat in the form of deeper pools;
- Of the partially attaining sites, the fish assemblage was the limiting determinant as the macroinvertebrate assemblage met the ICI biocriterion at all these sites;
- Based on the results of the continuous monitoring of D.O. and temperature, the over-riding influence of the concrete channel beginning at RM 6.9 and the downstream channelized reach of Mill Creek was evident. From this point downstream, diel D.O. swings were extremely wide, and temperatures were elevated above the average and maximum Ohio water quality criteria. The feasibility of restoration aside, the controlling factor is the highly modified habitat that exacerbates water quality effects;
- The longitudinal patterns in conductivity, total dissolved solids (TDS), chlorides, nitrate, and total phosphorus continue to clearly point to the Butler Co. Upper Mill Creek Water Reclamation Facility (WRF) as the principal source of elevated levels of these parameters in the East Fork and downstream into Mill Creek extending to the MWH reach at RM 6.9;
- Two (2) of the non-attaining sites were in Lick Run which failed to meet the WWH biocriteria being a newly daylighted channel that is not directly connected to Mill Creek and with a substrate covered in dense mats of filamentous algae. Lick Run is currently undesignated and no recommendation for an aquatic life or recreational use will be made at this time;
- The 2021 Mill Creek and East Fork Mill Creek results are a modest improvement over 2016 and are a distinct improvement over 2011 when 11 of 28 sites were in non-attainment and only four (4) in full attainment of the MWH use – no WWH sites fully attained in 2011. Full attainment was observed in nearly all of the MWH reach of lower Mill Creek;
- The improvements in the biological assemblages since 1992 are due mostly to reductions in chemical pollutant loadings resulting from the collection and treatment of wastewater and the clean-up of toxic materials handling adjacent to Mill Creek. In the 26 miles of the mainstem, full attainment increased from 0.1 mile in 1992 to 10.8 miles in 2016 and non-attainment declined from 24.4 miles in 1992 to 5.8 miles in 2016 and 5.1 miles in 2021. While reaches of partial and isolated sites in non-attainment remained in 2021, the results indicate continued incremental improvement since the 2011 and 2016 surveys;
- Recreational uses continued to exhibit widespread impairment based on *E. coli* results. Although *E. coli* values were reduced compared to 2011 and 2016, no site fully attained the Primary Contact Recreation (PCR) use criteria.

Aquatic Life Use Attainment Status

The key indicator of overall condition in terms of aquatic life is the status of the aquatic life use designations based on attainment of the Ohio biological criteria. The status of these uses is portrayed as full, partial, or non-attainment in Table 1. Additionally, of the 44 sites that were assessed in the 2021 Mill Creek assessment, 28 sites were evaluated against the Warmwater Habitat (WWH) use, 13 were evaluated against the Modified Warmwater Habitat (MWH) use, and three (3) via the PHWH classification scheme. There are no recommended use changes for any of the existing use designations as they were addressed in prior years of assessment. Out of 44 sites sampled in 2021, 12 were in full attainment, 18 in partial attainment, and 14 in non-attainment of WWH or MWH. Of the latter, two were in Lick Run and four were in the mainstem of Mill Creek. The partially attaining sites were all limited by the fish assemblage failing to meet the biocriteria for the IBI and/or the MIwb. Three (3) sites were each evaluated with the PHWH protocol with one as a PWHW Class 2 and the remaining two (2) as PHWH Class 3B. Seven (7) sites were sampled and assessed for aquatic life use in the Cooper Creek subwatershed in cooperation with the Hamilton Co. SWCD (Table 1). Of the sites sampled in 2021, two (2) were in full attainment of WWH, one (1) in partial attainment of WWH, and four (4) in the headwaters that were in non-attainment of the existing WWH use. The attainment of WWH at two (2) of the lower Cooper Creek sites was a marked improvement over prior results in 2011 which reflected non-attainment and a poor-quality fish assemblage (MBI 2012).

Recreational Use Status

Impairment of the Primary Contact Recreation (PCR) recreational use in Mill Creek was pervasive in 2021. The PCR 30-day geometric mean criterion for *E. coli* was exceeded at 36 of the 44 sites. The geometric mean is the primary criterion used to determine recreational use support for streams and rivers. The high minimum values greater than the geometric mean criterion observed in 2011 and 2016 illustrated the chronic nature of the impairment and underscored the high frequency of exceedances observed throughout Mill Creek. This continued in 2021, but very high maximum values resulted in average counts greatly exceeding the PCR 30-day geometric mean on a frequent basis (Table 2).

Causes and Sources of Non-attainment

The determination of causes and sources of aquatic life use impairment was accomplished by associating the occurrence of sampling results that exceeded various chemical and physical thresholds that are known to adversely affect aquatic organisms. These categorizations are in some cases categorical (e.g., habitat alterations) and may include multiple specific types of effects and mechanisms. Others are parameter specific (e.g., dissolved oxygen) since the data are collected at that level. Yet others are at the categorical level (e.g., nutrients, toxics) which may include multiple parameters. In addition, some parameters can be proxies for a wider range of specific causes. The causes and sources that are listed along with the biological impairments appear in the aquatic life use attainment status (Table 1). New in 2021 is the weighting of causes in accordance with the severity of exceedances of stressor thresholds developed by the IPS framework in 2015 (MBI 2015). This approach provides a way to

***Table 1**. Aquatic life use attainment status in the 2021 Mill Creek study area with associated causes of impairment listed for sites in partial and non-attainment and weighted by severity of threshold exceedances. Threat factors are listed for fully attaining sites. Existing and recommended uses are listed for mainstem reaches and tributaries. A glossary of causal terms is listed at the bottom of the table.*

Site ID	River Mile Fish/Macros	Drain-age Area (sq. mi.)	Aquatic Life Use	IBI	MIwb	ICI	Aq. Life Status	QHEI	Location	Very Poor	Poor	Fair	Threats
Mill Creek (WWH Exisiting)													
MC00	26.40/26.00	4.43	**WWH**	43	NA	44	**FULL**	69.0	dst. Liberty-Fairfield Rd.				TDS; BOD; Zinc(7.0);Chloride; Cond;
MC12	19.22/19.10	26.70	**WWH**	30*	6.20*	42	Partial	69.3	ust. Windisch Rd.	H. Urb (Cat); H. Urb (Buff);	Zinc(15.8);	Chloride; TDS; Org. Enrich., Min. D.O.	
MC10	18.86/18.70	27.00	**WWH**	28*	6.22*	44	Partial	70.5	Ust. Crescentville Rd.	H. Urb (Cat); H. Urb (Buff); QHEI Poor Attr.	Chloride; Zinc; TP; Max D.O.; Diel D.O.; TP	TDS; Cond; Min. D.O	
MC08	18.37/18.10	27.30	**WWH**	34*	6.57*	44	Partial	83.5	ust. 200 m of E.Fk Mill Creek	H. Urb (Cat); H. Urb (Buff);	Chloride; TDS; Zinc(12.0); Diel D.O.; TP	TKN; Cond; BOD; Max.&Min. D.O.	
MC101	17.96/1.30	42.20	**WWH**	31*	6.41*	40	Partial	65.0	RR trestel dst. East Fork Mill Creek	Chloride; TDS; Cond; TP	Nitrate; Zinc(34.6); TKN	Channel; QHEI Good Attr.	
MC06	16.73/16.60	50.50	**WWH**	22*	5.09*	40	**NON**	56.0	ust. E. Sharon Rd.	Chloride; TDS; TP; Cond; H.Urb(Cat); H.Urb(Buff); QHEI Poor Attr.	Nitrate; Zinc(27.4); QHEI Poor Attr.; TKN	QHEI; QHEI Ratio; Channel; TKN;	
MC04	15.41/14.80	61.30	**WWH**	24*	3.74*	40	**NON**	50.5	dst. Glendale Milford ExpWay	Chloride; TDS; Cond; H.Urb(Cat) H.Urb(Buff); TP	Zinc(30.6); QHEI Good& Poor Attr.; TKN; SSC	QHEI; Substr; Channel; TKN; Nitrate; QHEI Ratio; Org. Enrich.	
MC11	13.96/13.90	68.80	**WWH**	35*	7.06*	40	Partial	65.5	ust. Barrett Paving	Chloride; TDS; H. Urb (Cat); H. Urb (Buff); TP	Cond; Zinc(22.3); TP	TKN; Nitrate; BOD; Max. D.O.; Nitrate	
MC104	13.76/13.70	71.60	**WWH**	36^{ns}	6.57*	46	Partial	75.8	immediately dst. SSO 700 outfall	Chloride; TDS;	Cond; Zinc(28.6); Max. D.O.; TKN: TP	Nitrate; BOD; Nitrate	
MC02	13.27/13.10	72.30	**WWH**	31*	5.92*	46	Partial	55.5	dst. W. Columbia Rd./ Koening Park	Chloride; TDS; H. Urb (Cat); H. Urb (Buff);	Cond; Zinc(23.4); QHEI Good & Poor; TKN; TP	QHEI; Channel; Nitrate; Max. D.O.	
MC01	11.70/11.30	73.90	**WWH**	39^{ns}	7.19*	42	Partial	69.5	dst. E. Galbraith Rd.	Chloride; TDS; H. Urb (Cat); H. Urb (Buff);	Cond; Zinc(23.7); TKN; TP	Nitrate	
MC80	10.48/10.45	115.00	**WWH**	37^{ns}	7.09*	36	Partial	78.3	dst. Anthony Wayne Ave.	H. Urb (Cat); H. Urb (Buff);	Chloride; TDS; Zinc(19.5);	TKN; Cond.	
MC105	9.24/9.24	119.00	**WWH**	38^{ns}	7.84^{ns}	38	**FULL**	71.8	dst. Congress Run				Chloride; TDS; Cond; Zinc(13.5); TKN;
MC79	8.63/8.65	120.00	**WWH**	35*	8.09^{ns}	40	Partial	75.5	dst. Este Ave.	TDS; H. Urb (Cat); H. Urb (Buff);	Chloride; Cond; Zinc(20.7); TP	TKN; BOD	
MC77	7.47/7.45	126.00	**WWH**	40	6.88*	38	Partial	55.0	RR trestle Winton Place/ dst. Center Hill Ave.	TDS; H. Urb (Cat); H. Urb (Buff);	Chloride; Cond; Zinc(14.8); QHEI Good&Poor; QHEI Ratio	QHEI; QHEI Ratio; Channel; TKN	
Mill Creek (MWH Exisiting)													
MC09	6.80/6.80	128.00	**MWH**	30	3.84*	24	**NON**	28.5	dst. CSX RR Bridge	QHEI; Chloride; TDS; H. Urb (Cat); H. Urb (Buff);	QHEI; BOD; Cond; Zinc(13.7);	Substr; Channel; QHEI Good Attr.	
MC07	6.45/6.35	135.00	**MWH**	28	3.69*	16*	**NON**	38.5	Dst. Spring Grove Ave.	TDS; H. Urb (Cat); H. Urb (Buff); Min. & Max. D.O.	QHEI; Chloride; Cond; Zinc(11.8); Dile D.O.' TP	QHEI Good Attr.; Substr; Channel; BOD	
MC75	4.84/5.10	139.00	**MWH**	31	6.53	28	**FULL**	49.0	adj. Salway Park				TDS; H. Urb (Cat); H. Urb (Buff); Chloride; Cond; Zinc(16.2); QHEI; Substr; Channel;
MC74	4.21/4.30	141.00	**MWH**	38	6.98	28	**FULL**	62.0	ust. S. Ludlow Ave.				TDS; H. Urb (Cat); H. Urb (Buff); Chloride; Cond; Zinc(13.2); TKN;
MC73	3.45/3.50	144.00	**MWH**	34	6.34	44	**FULL**	58.5	ust. Mill Creek Rd.				TDS; H. Urb (Cat); H. Urb (Buff); Chloride; Cond; Zinc(17.5); Chloride; Cond; Zinc(17.5); QHEI; Channel; TKN;
MC72	3.15/3.10	154.00	**MWH**	36	7.26	36	**FULL**	58.5	dst. Mill Creek Rd.				Chloride; TDS; H. Urb (Cat); H. Urb (Buff);Cond; Zinc(13.1); QHEI; Channel;
MC05	2.50/2.50	156.00	**MWH**	34	6.69	36	**FULL**	53.0	dst. Hopple St.				TDS; H. Urb (Cat); H. Urb (Buff); Chloride; Cond; Zinc(13.8); QHEI; Channel; TKN;
MC03	1.69/1.70	163.00	**MWH**	34	9.27	20*	Partial	57.5	dst. Lick Run CSO	H. Urb (Cat); H. Urb (Buff);	Chloride; TDS; Cond; Zinc(23.1);	QHEI; Good Attr.; QHEI Ratio; Channel	
MC71	0.83/0.65	164.00	**MWH**	34	8.16		**FULL**	49.0	ust. Gest St.				H. Urb (Cat); H. Urb (Buff); Chloride; TDS; Cond; Zinc(22.1); QHEI; Substr; Channel;
MC70	0.50/0.30	164.00	**MWH**	30	7.72		**FULL**	50.0	dst. Gest St.				H. Urb (Cat); H. Urb (Buff); Zinc(15.5); QHEI; Substr; Channel; TDS;
MC69	0.21/0.10	164.00	**MWH**	28	6.47		**FULL**	50.5	RR trestle-Queensgate				H. Urb (Cat); H. Urb (Buff); Zinc(14.9); QHEI; Substr; Channel;

***Table 1**. continued.*

Site ID	River Mile Fish/Macros	Drain-age Area (sq. mi.)	Aquatic Life Use	IBI	MIwb	ICI	Aq. Life Status	QHEI	Location	Very Poor	Poor	Fair	Threats
West Fork Mill Creek (WWH Existing)													
MC45	0.20/0.20	36.50	**WWH**	26*	7.06*	30	**NON**	69.3	Elliot Ave.	H. Urb (Cat); H. Urb (Buff);	Zinc(14.5); TP	Min. D.O.	
East Fork Mill Creek (WWH Existing)													
MC18	1.14/1.20	9.27	**WWH**	33*	NA	42	Partial	71.5	ust. Butler Co. Upper Mill Creek WWTP	H. Urb (Cat); H. Urb (Buff);	Chloride; BOD; TDS; Zinc(5.0);	Channel; Cond; Min. D.O.; TP	
MC15	0.96/1.00	9.30	**WWH**	34*	NA	30	Partial	78.0	dst. Butler Co. Upper Mill Creek WWTP	Chloride; TDS; Nitrate; Cond; H. Urb (Cat); H. Urb (Buff); TP	Zinc(46.4); TKN	TKN; Organic Enrich.; Nitrate	
MC14	0.66/0.50	9.53	**WWH**	28*	NA	38	Partial	71.0	dst. Crescentville Rd.	Chloride; TDS; Nitrate; Cond; H. Urb (Cat); H. Urb (Buff);	Zinc(36.5); QHEI Poor Attr.	Channel; TKN; BOD; QHEI Good Attr.; Org. Enrich.	
MC16	0.39/0.05	9.59	**WWH**	28*	NA	36	Partial	60.5	dst. Fada Rd./ust. Confluence Mill Creek	Chloride; TDS; Nitrate; Cond; H. Urb (Cat); H. Urb (Buff); TP	Zinc(38.5); TKN	Channel; TKN; Org. Enrich.; Nitrate	
Cooper Creek (Rossmoyne Creek; WWH Existing)													
MC111	3.57/3.57	0.34	**WWH**	28*	NA	VP*	**NON**	48.5	Bechtold Park, approx 350-ft below origin	H. Urb (Cat); H. Urb (Buff); Hyd. Alt.	Chloride; Nitrate; Zinc(15.7);	QHEI; TKN; TDS; Cond;	
MC112	3.42/3.42	0.48	**WWH**	28*	NA	F*	**NON**	42.5	Approx 300-ft above Plainfield Road	Chloride;H. Urb (Cat);H. Urb (Buff);Hyd. Alt.	BOD; TDS; Zinc(32.7);	QHEI; Channel; TKN; Cond;	
MC113	2.84/2.84	1.10	**WWH**	30*	NA	VP*	**NON**	47.5	Below Wecklow Avenue	TKN;H. Urb (Cat); H. Urb (Buff); Hyd. Alt.	Chloride;TDS;Nitrate; Zinc(71.9)	QHEI; Channel; BOD; TAmm; Cond;	
MC32	2.59/2.55	1.80	**WWH**	30*	NA	VP*	**NON**	49.5	Approx 1,500-ft above RT 126 culvert	pH; H. Urb (Cat); H. Urb (Buff); Hyd. Alt.	Chloride; Zinc(11.2);	QHEI; Channel; TKN; TDS;	
MC28	2.13/2.20	2.60	**WWH**	32*	NA	MG	Partial	61.3	Approx 450-ft below RT 126 culvert	H. Urb (Cat); H. Urb (Buff); Hyd. Alt.	TDS; Zinc(13.3);	TKN; Chloride; Cond;	
MC118	1.58/1.58	3.99	**WWH**	46	NA	G	**FULL**	81.5	end of N. Kathwood Cir.				Chloride; Zinc(7.6);
MC119	0.44/0.46	5.43	**WWH**	46	NA	G	**FULL**	88.5	ust. Reading Rd.				Chloride; TDS; Zinc(11.2);
Unnamed Tributary to Cooper Creek (Rossmoyne Creek) @RM 2.80 (WWH Existing)													
MC114	0.55/0.55	0.49	**WWH**	12*	NA	VP*	**NON**	45.5	Between Langhorst Ct. and Jeffrey Ct.	H. Urb (Cat); H. Urb (Buff); Hyd. Alt.	BOD; Zinc(18.2)	QHEI;Good Attr.; Channel; TKN; Chloride;	
Kings Run (Undesignated; PHW3A Recommended)													
MC109	1.11/1.00	0.91	**PHW3A**					52.0	Along Wooden Shoe Hollow Ln.				Chloride; BOD; TDS; Zinc(8.0); QHEI; QHEI Ratio; Cond;
Unnamed Tributary to West Fork Creek @RM 1.24 (Undesignated; PHW3A Recommended)													
MC97	1.49/1.40	0.84	**PHW3A**					69.5	Kirby Rd.				H. Urb (Cat); Chloride; BOD; TDS; Zinc(9.2); Channel; Cond;
Lick Run (Undesignated; No Recommendation)													
MC108	1.70/1.70	0.19	**PHW2**						Glenway Woods				QHEI; Substr; Channel; TKN; BOD; TDS; Zinc(8.5);
MC106	0.98/0.98	3.45	**WWH**	16*		P	**NON**	45.0	Grotto Court	BOD	Chloride; TDS; Zinc(8.8); Good Attr.; QHEI Ratio	QHEI; Good & Poor Attr.; Channel;	
MC107	0.45/0.45	3.55	**WWH**	20*		P	**NON**	47.5	Queen City and Cora Ave.		Zinc(14.1);	QHEI; Good & Poor Attr.; QHEI Ratio; Chloride; BOD; TDS;	

Glossary of terms used in Table 1

Acronym	Description	Acronym	Description	Acronym	Description
H. Urban(Cat)	Urban land use HUC12	QHEI Ratio	Ratio of modified:good QHEI attributes	VSS	Volatile suspended solids
H. Urban (Buff)	Urban land use 30 m buffer	Cond.	Specific conductance (conductivity)	Conduct	Specific conductivity
Hyd. Alt.	Hydrological alteration	Org. Enrich.	Organic enrichment related to sewage	TKN	Total Kjeldahl nitrogen
QHEI	Qualitative Habitat Evaluation Index (QHEI)	PAH	Polycyclic aromatic hydrocarbons	TP	Total phosphorus
QHEI Poor Attr.	Number of modified QHEI attributes	TDS	Total dissolved solids	BOD	Biochemical oxygen demand
QHEI Good Attr.	Number of goodd QHEI attributes	DO	Dissolved oxygen	Max.	Maximum
Channel	Channel condition from QHEI	TSS	Total suspended solids		

***Table 2**. Recreational use attainment status at sites sampled in the 2021 Mill Creek study area. Minimum, mean, and maximum Escherichia coli bacteria counts are provided along with exceedances of the Ohio Primary Contact Recreation (PCR) 30-day geometric mean and statistical threshold value (STV) and the Secondary Contact (SC) maximum criterion.*

Site ID	River Mile	Drainage Area (sq. mi.)	Samples	Minimum	Geometric Mean	Maximum STV
Mill Creek						
MC00	26.4	4.43	4	173	487	866
MC12	19.22	26.7	5	72	595	7980
MC10	18.86	27	5	109	325	1046
MC08	18.37	27.3	5	81	396	1986
MC101	17.96	42.2	6	225	366	770
MC06	16.73	50.5	6	205	410	649
MC04	15.41	61.3	6	281	494	1300
MC11	13.96	68.8	6	185	344	687
MC104	13.76	71.6	6	99	841	111990
MC02	13.27	72.3	6	214	890	86640
MC01	11.7	73.9	6	236	478	1203
MC80	10.48	115	6	157	935	10430
MC105	9.24	119	6	99	468	1986
MC79	8.63	120	6	96	398	10140
MC77	7.47	126	6	99	346	1046
MC09	6.8	128	6	96	255	488
MC07	6.45	135	6	60	149	435
MC75	4.84	139	6	228	1409	26130
MC74	4.21	141	6	179	1164	29870
MC73	3.45	144	6	131	740	30760
MC72	3.15	154	6	172	610	1986
MC05	2.5	156	6	162	748	2420
MC03	1.69	163	6	162	919	22470
MC71	0.83	164	6	101	850	32550
MC70	0.5	164	6	16	334	54750
MC69	0.21	164	6	28	186	24890
East Fork Mill Creek						
MC18	1.14	9.27	5	27	359	1120
MC15	0.96	9.3	5	33	96	461
MC14	0.66	9.53	5	179	392	1553
MC16	0.39	9.59	5	272	663	2420

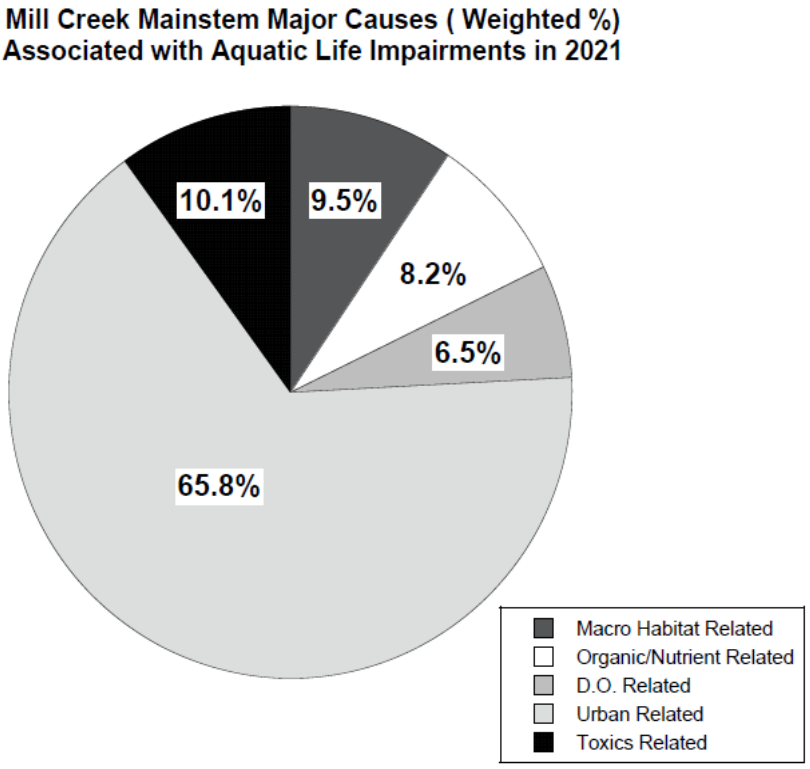
	Exceedance of Primary Contact Recreation 30 day geometric mean of 126 cfu/100 mL.
	Exceedance of Primary Contact Recreation Statisitical Threshold Value (STV) of 410 cfu/100 mL.
	Exceedance of Secondary Contact Recreation maximum of 1030 cfu/100 mL.

***Table 2**. continued*

Cooper Creek (Rossmoyne Creek)						
MC111 (MR-1)	3.57	0.34	4	866	1587	3090
MC112 (MR-2)	3.42	0.48	4	613	3962	68670
MC113 (MR-3)	2.84	1.1	4	687	1147	3150
MC32 (MR-5)	2.59	1.8	4	194	395	921
MC28 (MR-6)	2.13	2.6	4	70	389	1300
MC118	1.58	3.99	4	770	2235	12810
MC119	0.44	5.43	4	236	1880	13540
Unnamed Tributary to Cooper Creek (Rossmoyne Creek) @RM 2.80						
MC114 (MR-4b)	0.55	0.49	4	1414	2055	2980
Kings Run						
MC109	1.11	0.91	4	291	1260	6830
Unnamed Tributary to West Fork Creek @RM 1.24						
MC97	1.49	0.84	4	291	884	8840
Lick Run						
MC108	1.7	0.19	4	238	591	4100
MC106	0.98	3.45	4	96	322	5480
MC107	0.45	3.55	4	192	509	1553
	Exceedance of Primary Contact Recreation 30 day geometric mean of 126 cfu/100 mL.					
	Exceedance of Primary Contact Recreation Statisitical Threshold Value (STV) of 410 cfu/100 mL.					
	Exceedance of Secondary Contact Recreation maximum of 1030 cfu/100 mL.					

determine which causes are the most limiting and which are of a lesser magnitude of effect. For fully attaining sites, threat factors were listed also in accordance with the IPS framework derived from the susceptibility/threat factors for each fully attaining site.

Weighted and unweighted causes for the 2021 Mill Creek mainstem for partial and non-attaining sites are portrayed in Figure 1 by major subcategories. Urban land use and chemical related stressors (chlorides, TDS, conductivity) ranked first in both the weighted and unweighted rankings, with a higher proportion for weighted causes at 65.8% vs. 43.6% for unweighted. Macro habitat and organic enrichment/nutrient related causes ranked second and third at 20.3% and 19.2% unweighted dropping to 9.5% and 8.2% as weighted causes. Toxics (and toxicity) and D.O. ranked fourth and fifth, respectively at 9.3% and 7.6% unweighted and 10.1% and 6.5% weighted. The predominance of urban related causes is the likely result of land uses in that category remaining constant, urban chemical related indicators increasing, and many of the other causes declining along with the decline in impaired sites compared to prior years.



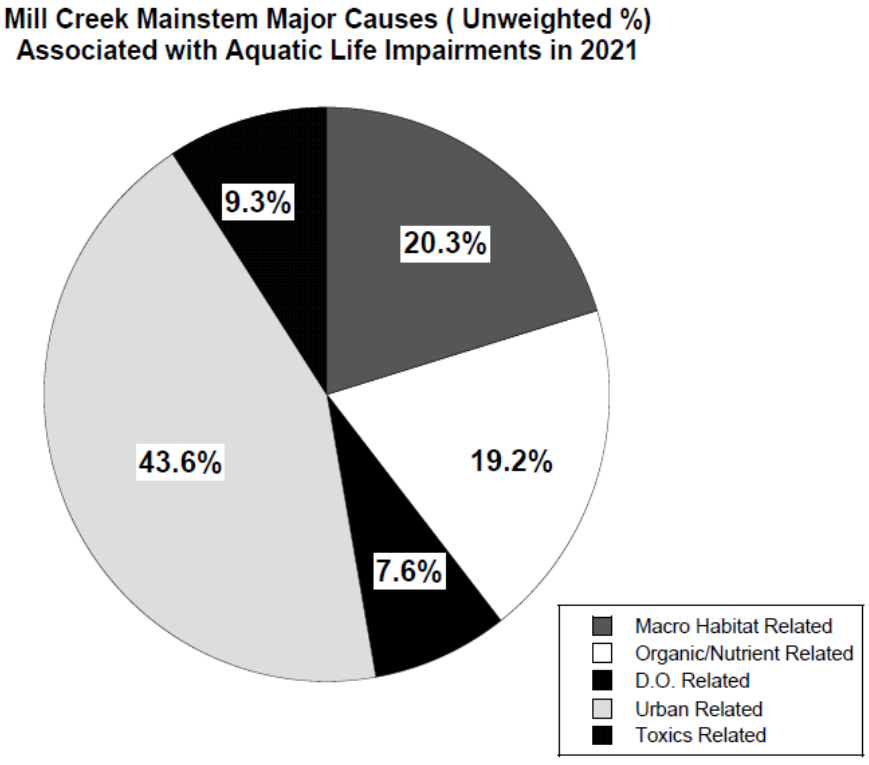


***Figure 1**. Weighted and unweighted causes associated with impairment of aquatic life in the Mill Creek mainstem study area in 2021. Major subcategories of causes are derived from the causes listed in Table 1.*

Trajectories in Key Indicators

Developing an understanding of the trajectory of the different indicators and parameters that are provided by a spatially adequate monitoring design provides important feedback to MSDGC, Ohio EPA, and stakeholders in the Mill Creek watershed. Given that Mill Creek has a complex mosaic of numerous watershed level and site-specific impacts, the complexity of being able to understand and then develop management responses to impairments is an immense challenge. The documentation of incremental improvements as opposed to as singular focus on the full restoration of impairments allows program effectiveness to receive credit short of full restoration. Furthermore, failing to recognize if waters are improving and are on a positive trajectory can lead to erroneous conclusions about the attainability of Clean Water Act (CWA) goals and the viability of restoration efforts. Simply put, a selective focus on individual and selected pollutants are insufficient in a complex setting like Mill Creek. It is for these reasons that being able to detect, measure, and express incremental improvements in key indicators is vital. The ability to show incremental progress not only provides confirmation that restoration efforts are working, but it also provides important feedback for those programs which must be adaptive in order to succeed. As such, the type of monitoring and assessment that was employed in this survey was designed to provide results that could be used to demonstrate the degree and direction of incremental change.

The results of the bioassessment, using the primary indices that comprise the Ohio biocriteria, were used to quantify the degree to which overall aquatic life conditions have improved through time up to and including the 2021 survey. The Area of Degradation (ADV) and Attainment (AAV) methodology (Yoder et al. 2005) was used to illustrate the degree of change between the Ohio EPA surveys of 1992, 1997, and 2014 and the 2011, 2013, 2016, and 2021 MBI surveys of the mainstem of Mill Creek. The ADV/AAV term is an expression of the degree to which one of the biological index values is either above or below the WWH biocriterion and the distance of the mainstem over which it occurs. As such it is a quantification of the "quantity" of biological attainment and impairment including the severity of degradation. When normalized to a standard distance (e.g., per mile) it can be an effective indicator of the degree of change which is taking place through time.

The change in ADV/AAV results for the fish Index of Biotic Integrity (IBI), the Modified Index of Well-Being (MIwb), and the macroinvertebrate Invertebrate Community Index (ICI) between 1992 and 2016 indicates a substantial and continuing improvement in biological condition (Figure 1). In 1992, the ADV was significantly larger than subsequent years and the AAV was zero for all three indices in 1992. In 2016, the AAV was positive for all three indices and the highest for the macroinvertebrate assemblage. In terms of the miles of attainment and non-attainment of the WWH and MWH designated uses in Mill Creek, full attainment was evident in portions of Mill Creek for the first time in 2016. While significant areas of degradation and non-attainment remain, these results indicate a significant incremental improvement in the Mill Creek mainstem which reflects the cumulative effects of pollution abatement efforts over the previous three decades. The 2021 results were comparable to 2016 with perhaps a slightly higher AAV for the fish indices (IBI and MIwb) and a virtual zero ADV for the ICI. The miles of

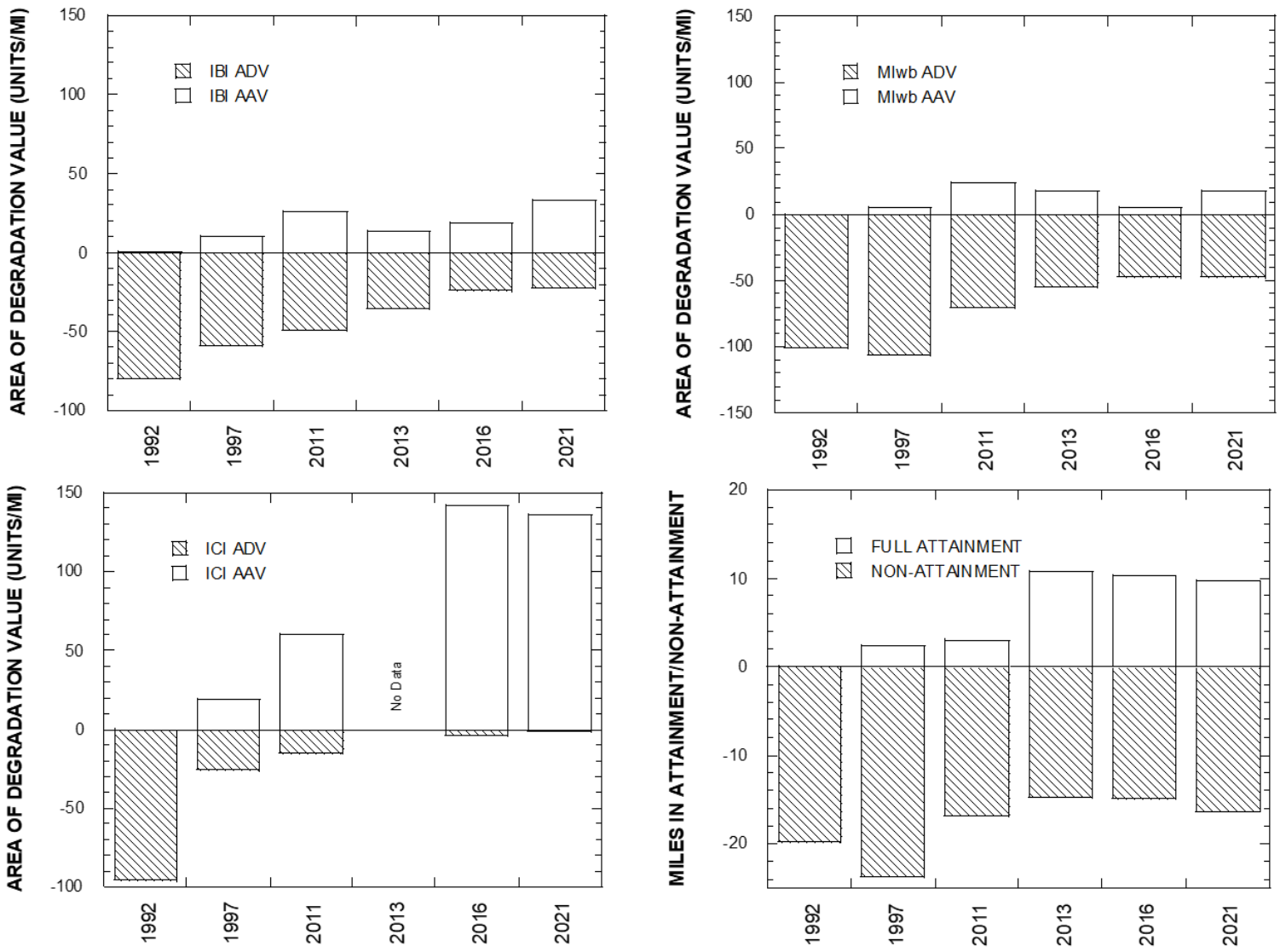


***Figure 2**. Area of Degradation (ADV) and Area of Attainment (AAV) values for the IBI (upper left), MIwb (upper right), and ICI (lower right) in the Mill Creek mainstem between 1992 and 2021. The miles of full and non-attainment between 1992 and 2021 are depicted in the lower right panel.*

attainment declined and non-attainment increased slightly. If anything, the 2021 results show a lessening of the rate of recovery and a leveling off of miles in attainment and non-attainment.

Realizing further improvements will require additional reductions in pollution impacts and "subsidizing" the natural features of the Mill Creek watershed such as increasing the quality of stream habitat, removing barriers to fish, and improving the flow regime. Restoration and abatement actions and their design will need to incorporate these important factors and understand their important role in the eventual attainment of aquatic life designated uses in Mill Creek.

CONCLUSIONS and RECOMMENDATIONS

Mill Creek Watershed Designated Use Attainment Status

A principal objective of the MSDGC service area watershed bioassessment plan was to evaluate the existing aquatic life and recreational use designations and to recommend new uses for undesignated or unverified streams and changes to existing uses determined as a result of the series of 2011-14 baseline watershed assessments. Ohio EPA last reviewed the aquatic life and recreational designations in the Mill Creek watershed in the early 1990s when they completed their baseline survey (Ohio EPA 1994) and other localized surveys since that time (Ohio EPA 2016). Now, Ohio EPA has either adopted, or is in the process of adopting, the use designation recommendations from the 2011-18 MSDGC surveys. As such, that objective has been or will be largely satisfied. As a result, the MSDGC instream monitoring has shifted to a more focused series of assessments to document status, trends, and causes/sources of impairments related to pollution control efforts by Project Groundwork and related wet weather source control efforts by MSDGC. The 2016 Mill Creek assessment represented the first attempt at this more focused approach, with the 2021 survey serving as a follow-up assessment.

Aquatic life use attainment status was determined by comparing the biological index values derived from the fish and macroinvertebrate assemblages to the biological criteria in the Ohio Water Quality Standards (WQS; OAC 3745-1). The results of this process for each site in the 2021 Mill Creek study area are presented herein. In addition, the causes and sources that were most associated with observed impairments were also identified. The status of existing recreational uses was likewise assessed by determining the attainability of the applicable recreational use. Ohio EPA recognizes two major subcategories of recreational uses, Primary Contact Recreation (PCR) and Secondary Contact Recreation (SCR).

Aquatic Life Use Recommendations

The aquatic life uses in the Ohio Water Quality Standards (WQS) that are applicable to the 2021 study area are the basis for the aquatic life use attainment status in Table 1. There are no recommendations for aquatic life use changes based on the 2021 results, but three new PHWH streams were identified (Table 1). The results of the 2011 Mill Creek watershed assessments (MBI 2012, 2017) were used to recommend numerous changes that were adopted by the Ohio EPA via use designation rulemakings in 2016 that became effective on January 2, 2017. Additional recommendations based on the 2016 bioassessment will eventually be covered under future rulemakings.

Aquatic Life Use Attainment Status

The status of aquatic life uses in the 2021 Mill Creek study area was determined based on the verified and recommended use designations discussed previously and in accordance with Ohio EPA methods and practices. In addition to listing the status of each site, the weighted proximate causes are also indicated for all impaired sites (Table 1). A map of the aquatic life attainment status is depicted in Figure 3.

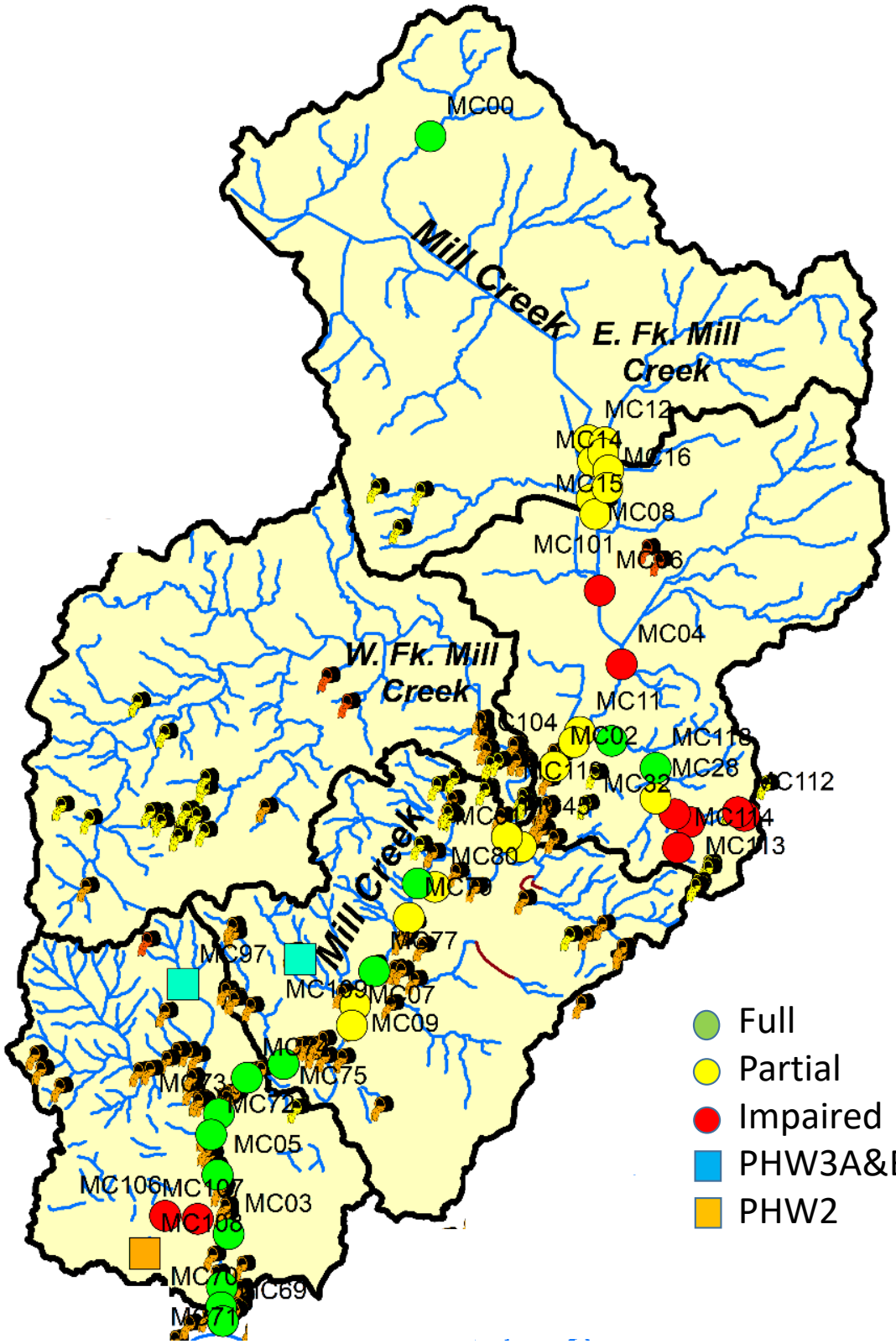


Figure 3*. Aquatic life use attainment status for the Warmwater Habitat suite of use tiers in the Mill Creek study area during 2021. Green circles – full attainment of aquatic life use tier; yellow – partial attainment; red – non-attainment. Site codes correspond to those described in Tables 1 and 2. Sites recommended for classification as Primary Headwater Habitat (PHWH) appear with their classification results. Blue squares – PHWH Class 3A or B; orange squares PHWH Class 2.*

Use attainment was expressed as full, partial, or non-attainment following Ohio EPA guidelines and practices. Of the 41 sites that were evaluated under the Warmwater Habitat suite of uses and biocriteria, 12 were in full attainment of the applicable use tier (WWH-4; MWH–8), 18 in partial attainment (WWH-17; MWH-1), and 11 were in non-attainment (WWH-7; MWH-4). Proximate causes were delineated for impaired sites (i.e., partial and non-attainment) and typified the urban setting being predominated by sedimentation, the effect of elevated nutrients, elevated urban parameters, habitat alterations, elevated PAH compounds, and occasional low D.O. values. The sources were mostly related to wet weather sources and hydromodification (Table 1).

Recreational Use Status

The status of recreational uses was based on the geometric mean of the *E. coli* results (Table 5) for the Primary Contact use and the maximum for the Secondary Contact use. Most of the sites in the 2021 study area are designated PCR with various Mill Creek tributaries as SCR. Impairment of recreation uses in the Mill Creek watershed was pervasive throughout all of the sampled subwatersheds. The Primary Contact 30-day (geometric mean) criterion was exceeded at 36 of 44 sites (Table 2). The geometric mean is the primary criterion used to determine recreational use support and the single sample maximum is typically only used to determine use support at public bathing beaches, but not for streams and rivers. Sites with minimum values greater than the geometric mean criterion underscored the high frequency of exceedances coded in yellow on Table 2. A map of the recreational attainment status is depicted in Figure 4.

Linking Impairments to Sources and Reductions in Pollution Required to Meet WQS

The IPS biological effect thresholds (MBI 2015) were used to assess all of the chemical parameters and habitat variables in addition to determining exceedances of water quality criteria. The IPS thresholds are portrayed as goals for each parameter that correspond to the attainment of the Ohio biological criteria for the tiered aquatic life uses (e.g., EWH, WWH, and MWH). The ambient results were color coded in accordance with the narrative benchmarks used in the IPS – exceptional (EWH), blue; good (WWH), green; fair (MWH), yellow; poor (LRW), orange; very poor (no use), red. The IPS thresholds for each parameter were listed alongside the ambient results to provide an assessment of where reductions in specific parameters and attributes are needed to resolve biological impairments. Exceedances of the IPS thresholds were extensive for chlorides, conductivity, TDS, sulfate, TKN, nitrate, total phosphorus, the Hydro QHEI, substrate, and channel condition. By contrast, exceedances of water quality criteria were sparse and limited to low D.O. and elevated temperature.

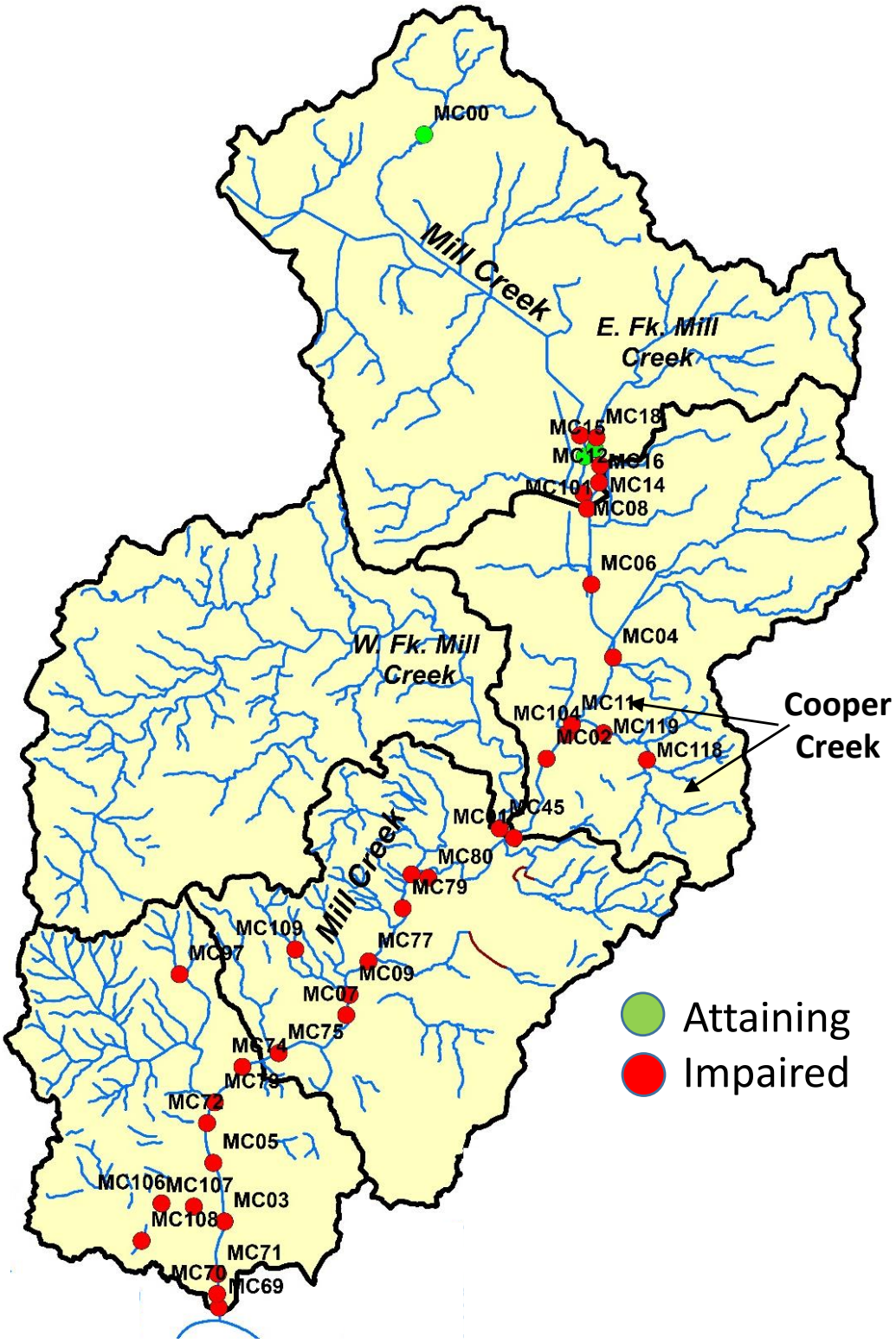


***Figure 4**. Map of recreational use attainment status for the Primary Contact Recreational use in the 2021 Mill Creek study area expressed as attainment (green) or non-attainment (red) based on E. coli values.*

BIOLOGICAL AND WATER QUALITY STUDY OF MILL CREEK 2021

Introduction

The 2021 Mill Creek biological and water quality assessment covered more than 60 CSOs and SSOs, one municipal WWTP, several industrial discharges, and numerous stormwater sources, providing the basis for documenting incremental changes against the previous 30 years of standardized monitoring of the Mill Creek mainstem and major tributaries by Ohio EPA and MSDGC. The spatial and temporal sampling design and the biological, chemical, and physical indicators and parameters that were collected at each sampling site are described in the *Watershed Monitoring and Bioassessment Plan for the MSD Greater Cincinnati Service Area, Hamilton County, Ohio; Technical Report MBI/5-11-3* (MBI 2011). Biological sampling methods for fish and macroinvertebrate assemblages and habitat assessment are supported by chemical and physical measures and ancillary information about pollution sources and other stressors for the overall biological assessment. The assessment employed a targeted-intensive pollution survey design which documents changes in a longitudinal manner as the effects of multiple pollution sources accumulate in a downstream direction.

MSDGC intends to use the results and analysis of the monitoring and bioassessment program to accomplish the following:

1. Determine the status of service area rivers and streams in quantitative terms, i.e., not only if the waterbody is impaired but the spatial extent and severity of the impairment;
2. Determine the proximate stressors that contribute to the observed impairments for the purpose of targeting management actions at those stressors;
3. Evaluate the appropriateness of existing aquatic life and recreational use designations and make recommendations for any changes to those designations; and,
4. Continue the development of the Integrated Prioritization System (IPS; MBI 2015) for a variety of purposes. Among its many uses, the IPS will assist MSDGC in making decisions about how to prioritize and design pollution abatement projects and measure their effectiveness.

To meet these objectives, all data was generated by methods and implementation in conformance with the provisions of the Ohio Credible Data Law (ORC 6111.51). Under the regulations that govern the Credible Data program at Ohio EPA, data collection and analyses must be collected and performed under the direction of Level 3 Qualified Data Collectors (OAC 3745-4). MSDGC has used the data to evaluate the attainability of aquatic life and recreational uses and determine the status of their service area rivers and streams since 2011. As such, the sampling and analysis of the biological and physical condition conducted herein conforms to these provisions by the development and submittal of annual Level 3 Project Study Plans (PSP).

MSDGC Watershed Bioassessment Scope and Purpose

The MSDGC project study area consists of 11 subwatersheds and the Ohio River mainstem within Hamilton County and parts of adjoining counties. These watersheds are impacted by a variety of stressors including municipal and industrial point source discharges of wastewater, habitat modifications in the form of modified stream channels, run-of-river low head dams, riparian encroachment, channelization, and nonpoint source runoff from widely differing degrees of landscape modifications from rural to suburban to intensive urban development. The urban impact gradient is the strongest in Lower and Middle Mill Creek, lessening somewhat across the Little Miami and Great Miami River subwatersheds. Combined sewer overflows (CSOs) are the most numerous in Mill Creek and adjacent Little Miami River tributaries, and some have subsumed historical streams (Figure 5).

2021 Mill Creek Assessment Scope and Purpose

The 2021 Mill Creek assessment included the mainstem of Mill Creek, the lower E. Fork Mill Creek, and selected tributary locations that are part of the MSDGC service area watershed monitoring plan (MBI 2011). In addition to the baseline purposes of the MSDGC monitoring plan, specific assessment issues in Mill Creek include a high density of CSO and SSO outfalls, the extensively modified channel in lower Mill Creek, and pollution sources including direct discharges and runoff from industrial operations, urban stormwater, and permitted municipal point sources.

Cincinnati has the fifth highest volume of CSOs in the U.S. (MSDGC 2011a). As a result, water quality has been significantly impacted in the Mill Creek subwatershed. MSDGC is working to remediate these issues under a Consent Decree with the U.S. Dept. of Justice and U.S. EPA to reduce CSO volume by two (2) billion gallons by 2019. To resolve the public health and water quality issues, MSDGC has implemented Project Groundwork, a multi-year and multi-billion dollar initiative that includes hundreds of sewer improvements and stormwater control projects (MSDGC 2011b). The role of the watershed monitoring program is to support these initiatives by providing current information about baseline conditions, provide feedback about the effectiveness of new and past remediation efforts via trend assessment, and to assure that restoration resources are targeted to the actions and places that have the greatest return on investment. As such, the 2021 Mill Creek assessment is a continuation of that process.

The Mill Creek 2021 monitoring fulfills the MSDGC National Pollutant Discharge Elimination System (NPDES) CSO permit reporting requirements.

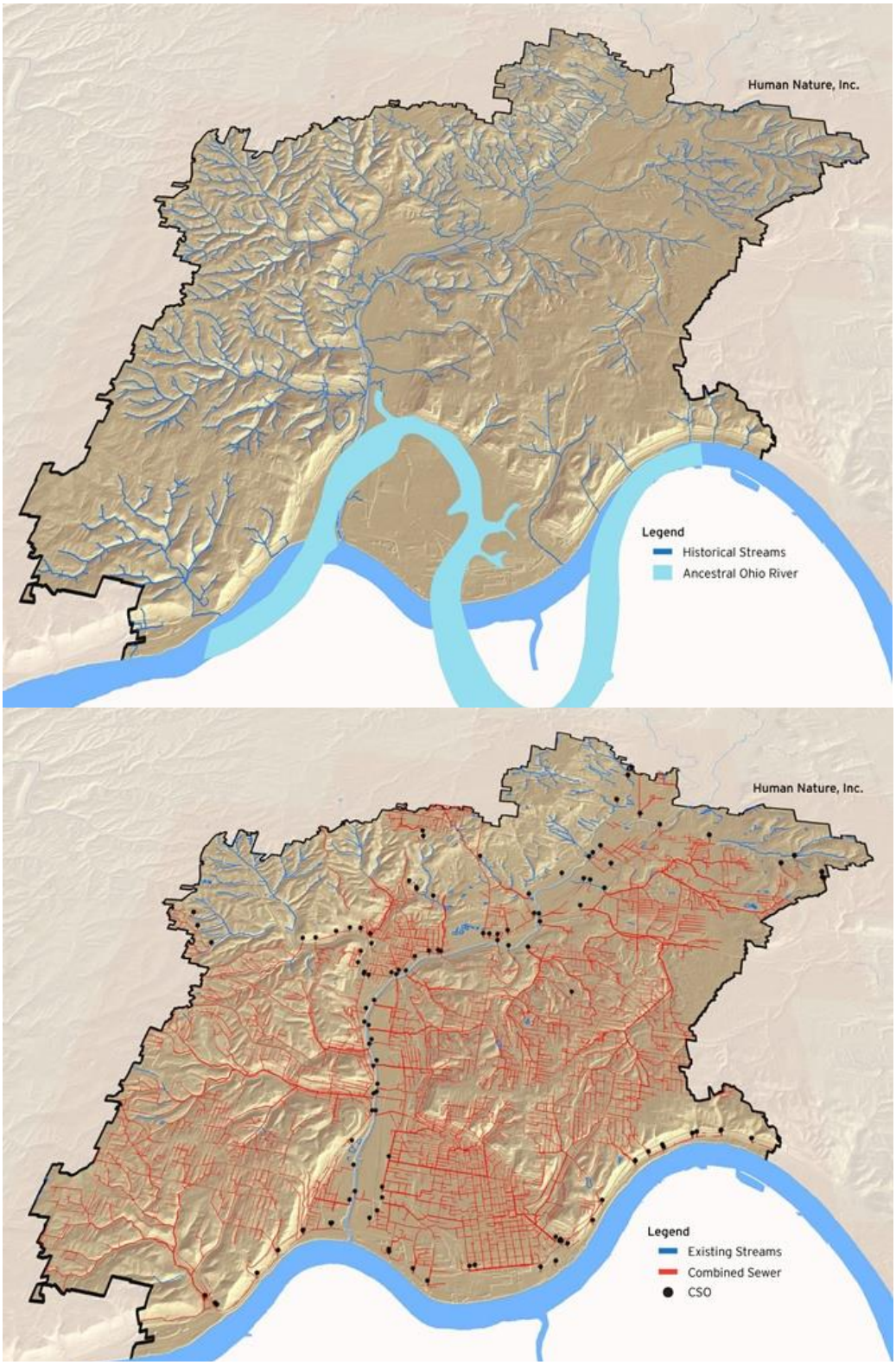


***Figure 5**. The historical occurrence of the Lower Mill Creek watershed (upper) and the current watershed (lower) showing the current MSDGC combined sewer system and the historical subjugation of natural streams (after MSDGC 2011b).*

METHODS

Monitoring Design

An intensive pollution survey design that employs a high density of sampling sites and biological, chemical, and physical indicators and parameters was followed in 2021. The principal objectives of the biological assessment are to report aquatic life and recreational use attainment status, following the Ohio WQS and Ohio EPA practices, and determine associated causes and sources of impairment. To accomplish this, sites were positioned upstream and downstream from major discharges, sources of potential releases and contamination, and major physical modifications to provide a "pollution profile" along the Mill Creek mainstem. The result was a design that included chemical, physical, and biological sampling at a total of 44 sites in Mill Creek and selected tributaries. Each site was assigned a unique site code as depicted in Table 3 and Figure 2. Six (6) new sites were added in 2021 to better assess selected tributaries and a restoration site in Mill Creek.

Biological and Water Quality Surveys

A biological and water quality survey, or "biosurvey," is an interdisciplinary monitoring effort coordinated on a water body-specific or watershed scale. Biological, chemical, and physical monitoring and assessment techniques are employed in biosurveys to meet three major objectives:

1. Determine the extent to which use designations assigned in the state Water Quality Standards (WQS) or equivalent policies or procedures are either attained or not attained;
2. Determine if use designations and/or goals set for or 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.

Measuring Incremental Changes

Incremental change is defined here to represent a measurable and technically defensible change in the condition of a water body within which it has been measured. Most commonly this is termed "incremental improvement" in which the condition of a water body that does not yet fully meet all applicable water quality standards (WQS) can be tracked as to the direction of any changes. The general principles of incremental change are defined as follows (after Yoder and Rankin 2008):

- ***measurement of incremental change*** can be accomplished in different ways, provided the measurement method is scientifically sound, appropriately used, and sufficiently sensitive enough to generate data from which signal can be discerned from noise;

***Table 3**. List of sampling locations in the 2021 Mill Creek study area with site code, stream name, proximity to CSO, SSO, WWTP, and industrial point sources, and the biological, habitat, and chemical parameters collected at each site.*

Site ID	Basin	Stream	Stream Name	Latitude	Longitude	RM	SubType	Location-Description	CSO/SSO/Other	Drain. Area	Fish	Macro-invert	Hab-itat	Data-Sonde	Field Chem	Demand	Nutrients	Metals	Organics	Supple-mental	Sediment Metals	Sediment Organics
Mill Creek Mainstem																						
MC00	23	001	Mill Creek	39.375000	-84.482000	26.40	OH EPA	Liberty-Fairfield Rd. (SE Butler Co.)	NA	4.43	D,E	HD	QHEI		6X	6X	6X	6X	3X	Bact (6X)	X	X
MC12	23	001	Mill Creek	39.312250	-84.434910	19.10	MSDGC	Dst. Ikea retention pond spillway	NA	26.5	D,E	HD	QHEI	X1	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC10	23	001	Mill Creek	39.299360	-84.434340	18.70	MSDGC	Dst. E. Crescentview Rd.	NA	27.0	D,E	HD	QHEI	X1	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC08	23	001	Mill Creek	39.291100	-84.435300	18.10	OH EPA	200 m ust. E. Fk. confluence	NA	32.4	D,E	HD	QHEI	X1	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC101	23	001	Mill Creek	39.288932	-84.434034	17.90	Modeling	R.R. trestle; dst. E. Fk. Mill Creek	NA	42.2	D	HD	QHEI	X1	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC06	23	001	Mill Creek	39.270000	-84.432200	16.60	OH EPA	Ust. E. Sharon Rd.	NA	50.0	D	HD	QHEI	X1	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC04	23	001	Mill Creek	39.254320	-84.425770	14.80	MSDGC	Glendale-Milford Express Way	Glendale WWTP (1PB00012) via Town Run	61.3	D	HD	QHEI	X1	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC11	23	001	Mill Creek	39.237387	-84.439116	13.90	MSDGC	Behind asphalt plant - Cavett Dr.	GE Avondale (1IN00006) via effluent ditch conveyance	68.8	D	HD	QHEI	X1	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC104	23	001	Mill Creek	39.234910	-84.440690	13.70	MBI New	Immediately dst. SSO 700 outfall	SSO 700 HRTF	71.0	D	HD	QHEI	X1	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC02	23	001	Mill Creek	39.229200	-84.446100	13.20	OH EPA	Dst. W. Columbia Rd.	CSO 513, 514*, 670, SSO 700	72.0	D	HD	QHEI	X1	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC01	23	001	Mill Creek	39.211980	-84.454650	11.30	MSDGC	Dst. E. Galbraith Rd.	CSO 508, 509, 510, 511*, 512; Pristine, Inc. (1IN90002)	73.9	D	HD	QHEI	X2	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC80	23	001	Mill Creek	39.201460	-84.471180	10.00	MSDGC	Dst. Anthony Wayne Ave. bridge	CSO 490, SSO 572 (via West Fork Mill Creek)	115	D	HD	QHEI	X2	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC105	23	001	Mill Creek	39.203116	-84.485989	9.20	MBI New	Bank stabilization ust. North Bend Rd. @Congress Run	CSO 490, SSO 572 (via West Fork Mill Creek)	120	D	HD	QHEI		6X	6X	6X	6X	3X	Bact (6X)	X	X
MC79	23	001	Mill Creek	39.195780	-84.489570	8.70	OH EPA	Ust. Este Ave. bridge	CSO 171, 488, 655	124	D	HD	QHEI	X2	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC77	23	001	Mill Creek	39.183280	-84.498550	7.45	MSDGC	R.R. Trestle Winton Place	SSO 1065, CSO 181, 653, 544 (via Bloody Run), CSO 037, CSO 039	130	D	HD	QHEI	X2	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC09	23	001	Mill Creek	39.177799	-84.506429	6.90	MSDGC	Dst. Smuckers outfall, river left looking upstream	J.M. Smucker-Crisco 001 (1IH00026); Procter & Gamble (1IN00075)	127	D	HD	QHEI	X2	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC07	23	001	Mill Creek	39.169252	-84.505762	6.35	MSDGC	At RR tressel; dst. Spring Grove Ave & Smuckers	CSO 483 (via Kings Run), 485, 486, 487 (via pipe @RM 6.45)	135	D	HD	QHEI		6X	6X	6X	6X	3X	Bact (6X)	X	X
MC75	23	001	Mill Creek	39.162200	-84.523300	5.10	OH EPA	Adj. Salway Park	CSO 025, 026*, 028, 030, 033, 480, 481, 482	136	P	HD	QHEI	X2	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC74	23	001	Mill Creek	39.157210	-84.537830	4.25	MSDGC	Ust. S. Ludlow Ave, bridge	CSO 022, 023, 024, 179*	141	P	HD	QHEI	X2	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC73	23	001	Mill Creek	39.148960	-84.546420	3.50	MSDGC	Ust. Mill Creek Rd.	CSO 017, 018, 019*, 021; 528, 529, 530 (via West Fork Creek)	154	P	HD	QHEI	X2	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC72	23	001	Mill Creek	39.144200	-84.547800	3.10	OH EPA	Dst. Mill Creek Rd.	CSO 015	155	P	HD	QHEI	X2	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC05	23	001	Mill Creek	39.135720	-84.546027	2.50	MSDGC	Dst. Hopple Street bridge	CSO 010, 011, 012, 013, 014	154	P	HD	QHEI	X2	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC03	23	001	Mill Creek	39.125235	-84.543167	1.70	MSDGC	Dst. Lick Run CSO (005)	CSO 005 (Lick Run), 006, 007, 008*, 009	163	P	HD	QHEI	X2	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC71	23	001	Mill Creek	39.110000	-84.544700	0.70	OH EPA	Ust. Gest Street bridge	CSO 152, 002, 003, 004, 666, SSO 1066	165	P		QHEI		6X	6X	6X	6X	3X	Bact (6X)	X	X
MC70	23	001	Mill Creek	39.104400	-84.545000	0.30	OH EPA	Dst. Mill Creek WWTP	CSO 428, 429; MSDGC Mill Creek WWTP 001 (1PM00001)	165	P		QHEI		6X	6X	6X	6X	3X	Bact (6X)	X	X
MC69	23	001	Mill Creek	39.100680	-84.543820	0.05	MSDGC	R.R. trestle - Queensgate	CSO 428, 429; MSDGC Mill Creek WWTP 001 (1PM00001)	166	P		QHEI		6X	6X	6X	6X	3X	Bact (6X)	X	X
West Fork Mill Creek																						
MC45	23	004	W. Fk. Mill Cr.	39.213300	-84.458900	0.20	OHEPA	Elliot Ave.	SSO 572, CSO 226	36.4	E	HD	QHEI	X2	6X	6X	6X	6X	3X	Bact (6X)	X	X
East Fork Mill Creek																						
MC18	23	006	E. Fk. Mill Cr.	39.304437	-84.430850	1.20	Geometric	Ust. Butler Co. Upper Mill Creek WWTP	NA	9.25	E	HD	QHEI	X1	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC15	23	006	E. Fk. Mill Cr.	39.301913	-84.431017	1.00	Geometric	Dst. Butler Co. Upper Mill Creek WWTP	Butler Co. Upper Mill Creek WRF (1PK00016)	9.29	E	HD	QHEI	X1	6X	6X	6X	6X	3X	Bact (6X)	X	X
MC14	23	006	E. Fk. Mill Cr.	39.298100	-84.429700	0.70	MSDGC	Crescentville Rd.	NA	9.53	E	HD	QHEI		6X	6X	6X	6X	3X	Bact (6X)	X	X
MC16	23	006	E. Fk. Mill Cr.	39.289700	-84.432800	0.10	OHEPA	Fada Drive	NA	9.66	E	HD	QHEI	X1	6X	6X	6X	6X	3X	Bact (6X)	X	X
Direct Mill Creek Tributaries																						
MC106	23	xxx	Lick Run	39.126363	-84.566801	0.98	MSDGC new	Grotto Court	MSDGC Project 28607052	3.45	E,F	QL	QHEI/HHEI		4X	4X	4X	2X	1X	Bact (4X)		
MC107	23	xxx	Lick Run	39.132371	-84.566801	0.45	MSDGC new	Queen City Cora Ave.	MSDGC Project 25203017	3.55	E,F	QL	QHEI/HHEI		4X	4X	4X	2X	1X	Bact (4X)		
MC108	23	xxx	Lick Run	39.118321	-84.566801	1.70	MSDGC new	Glenway Woods	MSDGC Project 28709041	0.31	E,F	QL	QHEI/HHEI		4X	4X	4X	2X	1X	Bact (4X)		
MC97	23	028	Kings Run	39.179340	-84.555620	1.49	MSDGC 2011	Kirby Rd.		0.84	E,F	QL	QHEI/HHEI		4X	4X	4X	2X	1X	Bact (4X)	X	X
MC109	23	028	U.T. West Fk. Cr.	39.184781	-84.520665	1.11	MSDGC new	Along Wooden Shoe Hollow Lane	MSDGC Project 32414093; CSO 217	0.91	E,F	QL	QHEI/HHEI		4X	4X	4X	2X	1X	Bact (4X)	X	X
MC111	23	009	Cooper Creek	39.219496	-84.391084	3.57	MSDGC 2011	Ust. Plainfield Rd.	MSDGC Project 48110025	0.34	E,F	QL	QHEI		4X	4X	4X	2X	1X	Bact (4X)	X	X
MC112	23	009	Cooper Creek	39.2194	-84.3912	3.42	HCSWD	Approx 300-ft above Plainfield Rd		0.48	E,F	QL	QHEI/HHEI		4X	4X	4X	2X	1X	Bact (4X)	X	X
MC113	23	009	Cooper Creek	39.2171	-84.4056	2.84	HCSWD	Below Wecklow Ave.		1.10	E,F	QL	QHEI/HHEI		4X	4X	4X	2X	1X	Bact (4X)	X	X
MC32	23	009	Cooper Creek	39.2189	-84.41	2.59	HCSWD	Approx 1,500-ft above RT 126 culvert		1.80	E,F	QL	QHEI/HHEI		4X	4X	4X	2X	1X	Bact (4X)	X	X
MC28	23	009	Cooper Creek	39.2225	-84.4157	2.13	HCSWD	Ust. Plainfield Rd.		2.60	E,F	QL	QHEI/HHEI		4X	4X	4X	2X	1X	Bact (4X)	X	X
MC118	23	009	Cooper Creek	39.2296	-84.4156	1.58	MSDGC new	end of N. Kathwood Cir.		3.99	E,F	QL	QHEI		4X	4X	4X	2X	1X	Bact (4X)	X	X
MC119	23	009	Cooper Creek	39.2358	-84.4287	0.44	MSDGC new	Ust. Reading Rd		5.43	E,F	QL	QHEI		4X	4X	4X	2X	1X	Bact (4X)	X	X
MC114	23		U.T. Cooper Creel	39.2111	-84.409	0.55	HCSWD	Between Langhorst Ct. and Jeffery Ct.		0.49	E,F	QL	QHEI/HHEI		4X	4X	4X	2X	1X	Bact (4X)	X	X
											44	41	44	24	44	44	44	44	44	44	41	41

* - CSO/SSO controlled per terms of the Consent Decree and WWIP.

new MSDGC site in 2021 - RIVCODE and RMI to be determined in consultation with Ohio EPA.

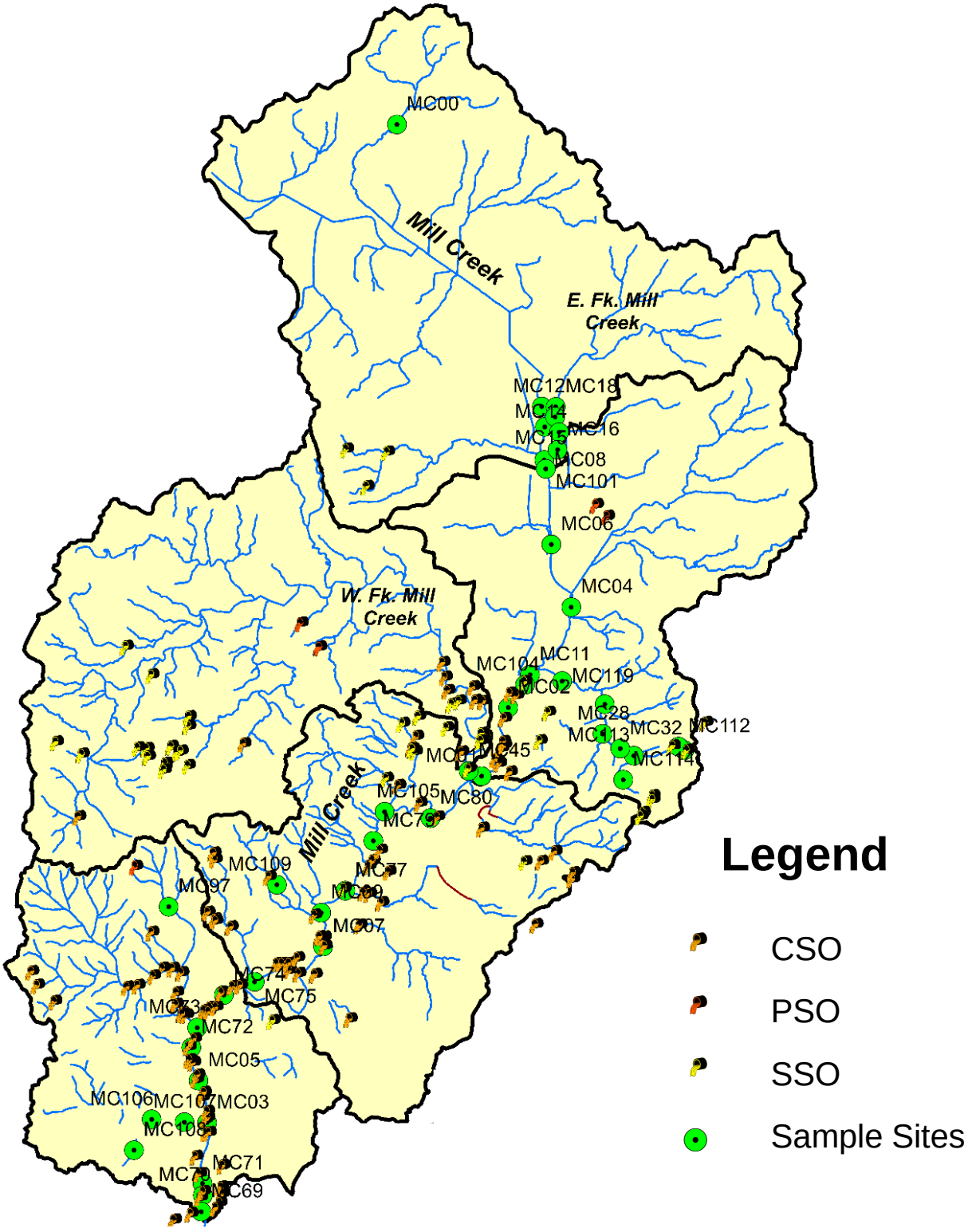


***Figure 6**. The 2021 Mill Creek study area showing sampling locations by site code (see Table 1) and the occurrence of CSO/SSO/PSO locations.*

- ***measurable parameters and indicators*** of incremental change include biological, chemical, and physical properties or attributes of an aquatic ecosystem that can be used to reliably indicate a change in condition; and,
- ***a positive change in condition*** means a measurable improvement that is related to a reduction in a specific pollutant load, a reduction in the number of impairment causes, a reduction in an accepted non-pollutant measure of degradation, or an increase in an accepted measure of waterbody condition relevant to designated use support.

This was accomplished for this study by comparing the results of prior, comparable assessments. In this case, there has been a series of bioassessments beginning in 1992 by Ohio EPA (1994) which serves as the baseline against which subsequent results were compared to assess incremental changes in key parameters and indicators. Subsequent to 1992, sufficient data is available from 1997 (Ohio EPA), 2011 (MBI), 2013 (MBI), 2014 (Ohio EPA) and 2016 (MBI) to inform the analyses. Historical chemical data from the early 1970s was also accessed and is part of the analysis of chemical parameter groups in the results section.

Biological Methods

All biological sampling methods are defined by the applicable protocols published by the Ohio EPA (1987a,b; 1989a,b; 2006, 2015 a,b). These meet the specifications of the Ohio WQS and are used to assess aquatic life and recreational use designations, to determine the extent and severity of impairments, and to document incremental changes that result from pollution abatement actions.

Fish Assemblage Methods

Methods for the collection of fish at wadeable sites was performed using a tow-barge or long-line pulsed D.C. electrofishing equipment based on a T&J 1736 DCV electrofishing unit described by Ohio EPA (1989a). A Wisconsin DNR battery powered backpack electrofishing unit was used as an alternative to the long line in the smallest streams and in accordance with the restrictions described by Ohio EPA (1989a). A three-person crew carried out the sampling protocol for each type of wading equipment. Sampling effort was indexed to lineal distance and ranged from 150- 200 meters in length. Non-wadeable sites were sampled with a raft-mounted pulsed D.C. electrofishing device. A Smith-Root 5.0 GPP unit was mounted on a 14’ Sea eagle raft with an electrode array in keeping with Ohio EPA (1989a) electrofishing design specifications. Sampling effort for this method was 500 meters. Sampling was conducted during a June 16-October 15 seasonal index period twice at all sites. A more detailed summary of the key aspects of each method appears in the *Watershed Monitoring and Bioassessment Plan for the MSD Greater Cincinnati Service Area, Hamilton County, Ohio; Technical Report MBI/5-11-3* (MBI 2011).

Macroinvertebrate Assemblage Methods

Macroinvertebrates were sampled using modified Hester-Dendy artificial substrate samplers (quantitative sample) and a qualitative dip net/hand pick method in accordance with Ohio EPA macroinvertebrate assessment procedures (Ohio EPA 1989a, 2015a). The artificial substrates were exposed for a colonization period of six weeks between July 12 and September 14 and placed to ensure adequate stream flow over the substrates, but in general samplers should be set where flow is 0.3 feet/second over the plates. A qualitative sample using a triangular frame dip net and hand picking was collected at the time of substrate retrieval. All samples were initially preserved in a 10% solution of formaldehyde. Substrates were then transferred to the laboratory, disassembled, sieved (standard no. 30 and 40), and transferred to 70% ethyl alcohol. Laboratory sample processing of both the quantitative and qualitative samples included an initial scan and pre-pick for large and rare taxa followed by subsampling procedures in accordance with Ohio EPA (1989a, 2015a). Identifications were performed to the lowest taxonomic resolution possible for the commonly encountered orders and families, which is genus/species for most organisms. From these results, the density of macroinvertebrates per square foot is determined as well as a taxonomic richness and an Invertebrate Community Index (ICI; Ohio EPA 1987b; DeShon 1995) score for the quantitative samples and a narrative assessment for the standalone qualitative samples. A more detailed summary of the key aspects of the methods appears in the *Watershed Monitoring and Bioassessment Plan for the MSD Greater Cincinnati Service Area, Hamilton County, Ohio; Technical Report MBI/5-11-3* (MBI 2011).

Area of Degradation and Attainment Values

The ADV (Yoder and Rankin 1995; Yoder et al. 2005) was originally developed to quantify the extent and severity of departures from a biocriterion within a defined river reach. For reaches that exceed a biocriterion, it is expressed as an Area of Attainment Value (AAV) that quantifies the extent to which minimum attainment criteria are surpassed. The ADV/AAV correspond to the area of the polygon formed by the longitudinal profile of IBI scores and the straight line boundary formed by a criterion, the ADV below and the AAV above. The computational formula (after Yoder et al. 2005) is:

$$ADV/AAV = \sum [(aIBIa + aIBIb) – (pIBIa + pIBIb)] * (RMa – RMb), \text{ for } a = 1 \text{ to } n, \text{ where;}$$

aIBIa = actual IBI at river mile a,
aIBIb = actual IBI at river mile b,
pIBIa = IBI biocriterion at river mile a,
pIBIb = IBI biocriterion at river mile b,
RMa = upstream most river mile,
RMb = downstream most river mile, and
n = number of samples.

The average of two contiguous sampling sites is assumed to integrate biological assemblage status for the distance between the points. The intensive pollution survey design typically positions sites in close enough proximity to sources of stress and along probable zones of

impact and recovery so that meaningful changes are adequately captured. We have observed biological assemblages as portrayed by their respective indices to change predictably in proximity to major sources and types of pollution in numerous instances (Ohio EPA1987a; Yoder and Rankin 1995; Yoder and Smith 1999; Yoder et al. 2005). Thus, the longitudinal connection of contiguous sampling points produces a reasonably accurate portrayal of the extent and severity of impairment in a specified river reach as reflected by the indices (Yoder and Rankin 1995). The total ADV/AAV for a specified river segment is normalized to ADV/AAV units/mile for making comparisons between years and rivers. The ADV is calculated as a negative (below the biocriterion) expression; the AAV is calculated as a positive (above the biocriterion) expression. Each depicts the extent and degree of impairment (ADV) and attainment (AAV) of a biological criterion, which provides a more quantitative depiction of quality than do pass/fail descriptions. It also allows the visualization of incremental changes in condition that may not alter the pass/fail status, but are nonetheless meaningful in terms of incremental change over space and time. In these analyses, the Warmwater Habitat (WWH) biocriterion for the fish and macroinvertebrate indices, which varies by use designation and ecoregion, was used as the threshold for calculating the ADV and AAV for the Mill Creek mainstem. The WWH use designation represents the minimum goal required by the Clean Water Act (CWA) for the protection and propagation of aquatic life, thus it was used as a standard benchmark for the ADV/AAV analyses.

Habitat Assessment

Physical habitat was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin 1989, 1995). Various attributes of the habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrates, amount and quality of instream cover, channel morphology, extent and quality of riparian vegetation, pool, run, and riffle development and quality, and gradient are some of the metrics used to determine the QHEI score which generally ranges from 20 to less than 100. The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have indicated that values greater than 60 are generally conducive to the existence of warmwater faunas whereas scores less than 45 generally cannot support a warmwater assemblage consistent with baseline Clean Water Act goal expectations (e.g., the WWH in the Ohio WQS).

Physical habitat was also evaluated at sites draining <2.5 mi.^{2} using the Headwater Habitat Evaluation Index (HHEI) developed by Ohio EPA (2020). The HHEI scores various attributes of the physical habitat that have been found to be statistically important determinants of biological community structure in primary headwater streams. Statistical analysis of a large number of physical habitat measurements showed that three QHEI habitat variables (channel substrate composition, bank full width, and maximum pool depth) are sufficient in

distinguishing the physical habitat of primary headwater streams using the HHEI. The characterization of the channel substrate includes a visual assessment of a 200-foot stream reach using a reasonably detailed evaluation of both the dominant types of substrate and the total number of substrate types. Bank full width is a morphological characteristic of streams that is determined by the energy dynamics related to flow and has been found to be a strong discriminator of the three classes of primary headwater streams in Ohio. The bank full width is the average of 3-4 separate bank full measurements along the stream reach. The maximum pool depth within the stream reach is important since it is a key indicator of whether the stream can support a WWH fish assemblage. Streams with pools less than 20 cm in depth during the low flow periods of the year are less likely to have WWH fish assemblages and thus more likely to have viable populations of lungless salamanders, which replace fish as the key vertebrate indicator in primary headwater streams.

Chemical/Physical Methods

Chemical/physical assessment for the MSDGC service area includes the collection and analysis of water samples for chemical/physical and bacterial analysis and sediment samples for determining sediment chemical quality. Methods for the collection of water column chemical/physical and bacterial samples followed the procedures of Ohio EPA (2019a,b) and MSDGC (2011c). Sediment chemical sampling followed that described by Ohio EPA (2019c). All laboratory analysis was performed and/or overseen by MSDGC.

Water Column Chemical Quality

Water column chemical quality was determined by the collection and analysis of grab water samples, instantaneous measurements recorded with a water quality meter, and continuous measurements recorded at 3–4-day intervals in the mainstem and larger tributary sites and at the reference sites.

Grab Sampling

Grab samples of water were collected with a stainless steel bucket from a location as close to the center point of the stream channel as possible by MBI and MSDGC sampling crews. Samples were collected from the upper 12-24 inches of the surface and then transferred to sample containers in accordance with MSDGC procedures (MSDGC 2011c). Sampling was conducted between mid-June and mid-October and under “normal” summer-fall low flows. Elevated flows following precipitation events were avoided and sampling was delayed until flows subsided. The frequency of sampling ranged from approximately weekly at mainstem sites and sites with multiple impacts to bi-weekly, four (4) times per season, two (2) times per season, and once at Primary Headwater sites. Water samples were collected provided there was sufficient water depth to collect a sample without disturbing the substrates. Instantaneous values for temperature (°C), conductivity (µS/cm2), pH (S.U.), and dissolved oxygen (D.O.; mg/l) were recorded with a YSI Model 664 meter at the time of grab sample collection.

Continuous Recordings

Continuous readings of temperature (°C), conductivity (µS/cm2), pH (S.U.), and dissolved oxygen (D.O.; mg/l) were recorded with a YSI 6920 V2 Sonde ("Datasonde") instrument at mainstem, major tributary, and reference site locations. The Datasondes were set as close as possible to the Thalweg (i.e., deepest part of the stream channel) in a PVC enclosure that ensured no contact with the stream bottom or other solid objects. The Datasondes were positioned vertically where depth allowed by driving steel fence posts into the bottom and positioning the PVC enclosure in an upright position. Where the depth was too shallow the PVC enclosure was secured in a horizontal position in an area of the stream channel with continuous flow. All Datasondes were secured against theft or vandalism as much as possible. Datasondes were deployed for a 3–4-day continuous interval during periods of maximum summer temperatures and normal summer flows. Readings were taken at 15-minute intervals. At the time of retrieval, data was downloaded to a YSI Model 650 Instrument with high memory capacity and then transferred to a PC for storage and later analysis.

Sediment Chemical Quality

Fine grain sediment samples were collected in the upper four (4) inches of bottom material at each sampling location using decontaminated stainless steel spoons and excavated using nitrile gloves. Decontamination of sediment sampling equipment followed the procedures outlined in the Ohio EPA sediment sampling guidance manual (Ohio EPA 2015c).

Sediment grab samples were homogenized in stainless steel pans (material for VOC analysis was not homogenized), transferred into glass jars with Teflon® lined lids, placed on ice (to maintain 4°C) in a cooler, and delivered to Metropolitan Sewer District of Greater Cincinnati, Division of Industrial Waste Lab. Sediment data is reported on a dry weight basis. Sediment samples were analyzed for total analyte list inorganics (metals), nutrients, volatile organic compounds, semivolatile organic compounds, PCBs, total petroleum hydrocarbons, and cyanide.

Determining Use Attainment Status

Use attainment status is a term which describes the degree to which environmental parameters or indicators are either above or below criteria specified by the Ohio Water Quality Standards (WQS; Ohio Administrative Code 3745-1). For the Mill Creek watershed assessment, two use designations are being evaluated: aquatic life and recreation in and on the water by humans. Hence, the process herein is referred to as the determination of aquatic life and recreational status for each sampling site. The process is applied to data collected by ambient assessments and applies to rivers and streams outside of discharge mixing zones.

Aquatic Life

Aquatic life use attainment status is determined by the Ohio EPA biological criteria (OAC 3745-1-07; Table 7-17). Numerical biological criteria are based on multimetric biological indices which include the Index of Biotic Integrity (IBI) and modified Index of Well-Being (MIwb), which

indicate the response of the fish assemblage, and the Invertebrate Community Index (ICI), which indicates the response of the macroinvertebrate assemblage. The IBI and ICI are multimetric indices patterned after an original IBI described by Karr (1981) and Fausch *et al.* (1984) and subsequently modified by Ohio EPA (1987b) for application to Ohio rivers and streams. The ICI was developed by Ohio EPA (1987b) and is further described by DeShon (1995). The MIwb is a measure of fish community abundance and diversity using numbers and weight information and is a modification of the original Index of Well-Being originally applied to fish community information (Gammon 1976; Gammon *et al.* 1981). Numerical biocriteria are stratified by ecoregion, use designation, and stream or river size. Three attainment status results are possible at each sampling location: full, partial, or non-attainment. Full attainment means that all of the indices meet the applicable biocriteria. Partial attainment means that one or more of the indices fails to meet the applicable biocriteria. Non-attainment means that none of the indices meet the applicable biocriteria or one of the organism groups reflects poor or very poor quality. An aquatic life use attainment table (see 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), the Qualitative Habitat Evaluation Index (QHEI), and comments and observations for each sampling location. The use attainment table is further organized by Ohio EPA Waterbody Assessment Unit so that the results can be used by Ohio EPA for assessment purposes.

Recreation

Water quality criteria for determining attainment of recreational uses are established in the Ohio Water Quality Standards (OAC 3745-1-07; Table 7-13) based upon the quantities of bacterial indicators *(Escherichia coli)* present in the water column. *Escherichia coli (E. coli)* bacteria are microscopic organisms that are normally present in the feces and intestinal tracts of humans and other warm-blooded animals. *E. coli* typically comprises approximately 97 percent of the organisms found in the fecal coliform bacteria of human feces (Dufour 1977). There is currently no simple way to differentiate between human and animal sources of coliform bacteria in surface waters, although methodologies for this type of analysis are being developed, including recent research supported by MSDGC. These microorganisms can enter water bodies where there is a direct discharge of human and animal wastes, or with runoff from soils where wastes have been deposited. Pathogenic (disease-causing) organisms are typically present in the environment in such small amounts that it is impractical to directly monitor each type of pathogen. Fecal indicator bacteria by themselves, including *E. coli*, are usually not pathogenic. However, some strains of *E. coli* can be pathogenic, capable of causing serious illness. Although not necessarily agents of disease, fecal indicator bacteria such as *E. coli* may signal the potential presence of pathogenic organisms that enter the environment via the same pathways. When *E. coli* are present in extremely high numbers in a water sample, it invariably means the water has received fecal matter from one or more sources.

The Ohio WQS for recreational uses were revised in early 2016 to reflect a more rigid adherence to any form of contact with surface waters as ensuing the same level of risk. This replaced the former framework that was stratified to account for the degree of contact with 3

levels of the Primary Contact Recreational (PCR) use as PCR-A, PCR-B, and PCR-C. Those subcategories are essentially merged into a single use. This action also obviated the recommendations made in the 2011-14 watershed assessments for assignment certain streams to one of the three former subcategories. The application of the Secondary Contact Recreational (SCR) use was also changed to a more restrictive interpretation of the potential for human contact with surface waters. Existing SCR designations remain but could potentially be reviewed and revised to PCR by Ohio EPA. Any new SCR recommendations would need to document that there is no human contact possible due to physical restrictions to access a surface water. As a result, the evaluation of the recreational uses in the 2016 Mill Creek study were done in accordance with the existing designations of PCR and SCR if applicable.

Streams in the Mill Creek watershed are designated as primary contact recreation (PCR) and/or secondary contact recreation (SCR) use in the Ohio WQS (OAC 3745-1- 30). Water bodies with a designated recreation use of PCR ". . . are suitable for one or more full-body contact recreation activities such as, but not limited to, wading, swimming, boating, water skiing, canoeing, kayaking, and scuba diving" (OAC 3745-1- 07(B)(4)(b)). Secondary Contact includes waters that ". . . result in minimal exposure potential to water borne pathogens because the waters are: rarely used for water based recreation such as, but not limited to, wading; situated in remote, sparsely populated areas; have restricted access points; and have insufficient depth to provide full body immersion, thereby greatly limiting the potential for water based recreation activities."

The *E. coli* criterion that applies to PCR is expressed as a 90-day geometric mean of ≤126 colony forming units (cfu)/100 ml with a Statistical Threshold Value of 410 cfu/100 ml[1]. The criterion that applies to SCR streams is ≤1,030 cfu/100 ml for both the 90-day geometric mean and the STV. The geometric mean is based on two or more samples and is used as the basis for determining the attainment status of the PCR use.

Determining Use Attainability

Use designation reviews and recommendations for revisions, whenever necessary, were a major product of the series of 2011-14 watershed assessments conducted throughout the MSDGC service area. Since the 2021 Mill Creek survey is a reassessment of a portion of the 2011 study area, we did not expect to have any use change recommendations. The details of the 2011-14 use recommendations are available in each watershed assessment report that can be found at: https://msdgc.org/programs/water_quality/index.html. Given the status of the 2011-16 data as Level 3 credible data it was eligible to be used by Ohio EPA to revise certain use designations. All the use recommendations made for the warmwater habitat suite of uses were either adopted or are in the process of being adopted by Ohio EPA into the Ohio WQS. None of the recreational use recommendations were accepted because of the subsequent revision to the recreational uses and criteria and how the uses are assigned to individual stream segments. None of the Primary Headwater Habitat (PHWH) use recommendations were adopted because

[1] These criteria shall not be exceeded in more than ten per cent of the samples taken during any ninety-day period.

Ohio EPA has not adopted PHWH as a use nor have they determined how to treat such segments. For the interim, MSDGC is assuming such streams will receive protections equivalent to WWH.

Determining Causal Associations

Using the results, conclusions, and recommendations of this report requires an understanding of the methodology used to determine biological status (i.e., unimpaired or impaired, narrative ratings of quality) and assign associated causes and sources of impairment utilizing the accompanying chemical/physical data and source information (e.g., point source loadings, land use). The identification of impairment in rivers and streams is straightforward—the numerical biological indices are the principal arbiter of aquatic life use attainment and impairment following the guidelines of Ohio EPA (1987). The rationale for using the biological results in the role as the principal arbiter within a weight of evidence framework has been extensively discussed elsewhere (Karr *et al.* 1986; Karr 1991; Ohio EPA 1987a,b; Yoder 1991; Yoder 1995).

Describing the causes and sources associated with observed biological 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 response signatures (Yoder and Rankin 1995; Yoder and DeShon 2003). Thus, the assignment of associated causes and sources of biological impairment in this report represents the association of impairments (based on response indicators) with stressor and exposure indicators using linkages to the bioassessment data based on previous experiences within the strata of analogous situations and impacts. For example, exceedances of established chemical thresholds such as chronic and acute water quality criteria or sediment effect thresholds are grounds for listing such categories of parameters to include individual pollutants if they co-occur with a biological impairment.

Biological effect thresholds derived in the *Integrated Prioritization System (IPS) Documentation and Atlas of Biological Stressor Relationships for Southwest Ohio* (Technical Report MBI/2015-12-15, MBI 2015) were also used to evaluate MSDGC service area data. These were used either as primary or supplemental screenings for the interpretation of biological impairments consistent with the WQS for the application of biological criteria in Ohio[2] and to assign the severity of a cause as very poor, poor, or fair. These were used to weight the causes with very poor =5, poor =3, and fair = 1. The IPS outputs were also used to list threat factors for all fully attaining sites.

Hierarchy of Water Indicators

A carefully conceived ambient monitoring approach, using cost-effective indicators comprised of ecological, chemical, and toxicological measures, can ensure that all pollution sources are judged objectively based on environmental results. A tiered approach that links the results of administrative actions with true environmental measures was employed in our analyses and within the limitations of the data that is currently available for certain sources. This integrated

[2] OAC 3745-1-07(A)(6)(a) for full attainment and (A)(6)(b) for non-attainment.

approach is outlined in Figure 4 and includes a hierarchical continuum from administrative to true environmental indicators. 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, assimilative capacity); 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

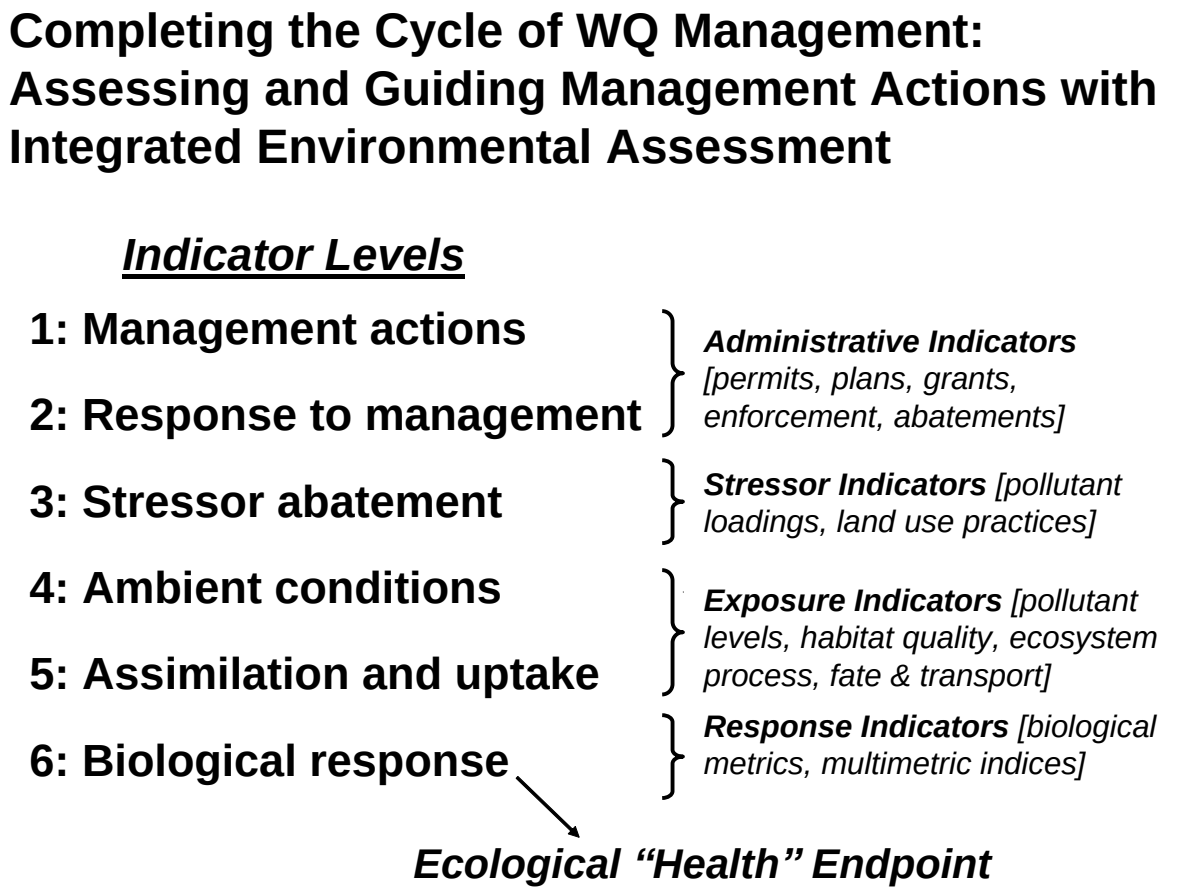


Figure 7*. Hierarchy of administrative and environmental indicators which can be used for water quality management activities such as monitoring and assessment, reporting, and the evaluation of overall program effectiveness. This is patterned after a model developed by U.S. EPA (1995a,b) and further enhanced by Karr and Yoder (2004).*

improve water quality (levels 3, 4, and 5) which should translate into the environmental "results" (level 6). An example is the aggregate effect of billions of dollars spent on water pollution control since the early 1970s that have been determined with quantifiable measures

of environmental condition (Yoder et al. 2005). 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 the Ohio EPA biological endpoints. Other response indicators can include target assemblages (*i.e.,* rare, threatened, endangered, special status, and declining species or bacterial levels that serve as surrogates for the recreational 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 (Yoder and Rankin 1998).

STUDY AREA DESCRIPTION

General Setting

The Mill Creek basin lies within the Interior Plateau Ecoregion of southwest Ohio and is bounded by the Great Miami River basin to the northwest, the Little Miami River basin to the east, and the Ohio River and direct tributary watersheds to the south and west. Mill Creek flows 28.1 miles from the headwaters in southeastern Butler County through central Hamilton County to a confluence with the Ohio River. The drainage area of Mill Creek is 166.2 square miles. Along its course, the stream has an average gradient of 11.9 feet per mile (Ohio DNR 1960). The total fall of Mill Creek from its headwaters in Butler County to the barrier dam near the mouth in Hamilton County is approximately 350 feet in elevation. The valley bottom in the upper reaches of the watershed is wide, averaging 1½ miles, and narrowing considerably in the downstream reaches, averaging only ½ mile through the City of Cincinnati. In the lower portion of the Mill Creek basin the valley walls are steep, rising 200-300 feet above the valley floor. Major tributaries include the East Fork Mill Creek, Sharon Creek, Beaver Creek, and the West Fork Mill of Creek. The tributaries are generally underlain by thinly inter-bedded layers of shales and limestone bedrock except in the lower reaches close to their confluences with Mill Creek. Most of Mill Creek flows atop a buried valley aquifer composed of highly permeable sands and gravel from glacial deposits and outwash. The upper portion of the Mill Creek watershed located in Butler County is mostly rural but is becoming increasingly suburban. The lower portion of Mill Creek is highly urbanized and is almost completely developed. This development consists of a mix of industrial, commercial, residential, transportation, and public properties.

Subecoregion Characteristics

Mill Creek lies within two different level III ecoregions, the Interior Plateau (IP) and the Eastern Corn Belt Plains (ECBP; Omernik 1987). Subsequent delineations of Level IV subregions provided more detail about the four components of ecoregions; surficial geology, soils, potential natural vegetation, and land use (Woods et al. 1995). The lower Mill Creek subwatershed and much of the West Fork of Mill Creek lie entirely within the Northern Bluegrass subregion (71d) of the Interior Plateau ecoregion. The remainder of the middle Mill Creek subwatershed lies within the Pre-Wisconsinan Drift Plains subregion (55d) of the Eastern Corn Belt Plains ecoregion. The southernmost portion of the upper Mill Creek watershed is within the Wisconsinan Drift Plains subregion (55d) and the northern portion, and the East Fork of Mill Creek lie within the Loamy High-lime Till Plains subregion (55b) of the ECBP ecoregion. The characteristics of each subregion appear in Table 4.

Description of Pollution Sources and Other Stressors

Pollution sources and general stressors are both numerous and overlapping in the Mill Creek watershed. These sources include permitted discharges of municipal and industrial process wastewater, discharges from combined and sanitary sewer overflows (CSO and SSO), releases from industrial facilities, urban runoff and its associated chemical pollution, hydrological

***Table 4**. Level IV subregions of the Mill Creek watershed and their key attributes (from Woods et al. 1995).*

Level IV Subregion	Physiography	Geology	Soils	Potential Natural Vegetation	Land Use/Land Cover
Loamy, High Lime Till Plains (55b)	Glaciated; level to rolling glacial till plain with low gradient streams; also end moraines and glacial outwash landforms.	Loamy, high lime, late-Wisconsinan glacial till and also glacial outwash and scattered loess overlie Paleozoic carbonates and shale.	Alfisols (Hapludalfs, Epiaqualfs, Endoaqualfs), Mollisols (Argiaquolls, Endoaquolls, Argiudolls), Entisols (Fluvaquents)	Mostly beech forest; also, oak-sugar maple forest, elm-ash swamp forest on poorly-drained valley bottoms and ground moraines.	Extensive corn, soybean, and livestock farming; also scattered beech-maple, pin oak-swamp, white oak woodlands. Urban-industrial activity in municipal areas.
Pre-Wisconsinan Drift Plains (55d)	Glaciated. Dissected glacial till plain with low to medium gradient streams.	Deeply leached, acidic pre-Wisconsinan clay-loam glacial till and thin loess overlie Paleozoic carbonates.	Alfisols (Fragiudalfs, Hapludalfs, Fragiaqualfs, Glossaqualfs), Entisols (Fluvaquents)	Mostly beech forest, elm-ash swamp forest; also oak-sugar maple forest.	Soybean, livestock, corn, general, and tobacco farming; where poorly-drained or rugged, pin oak-swamp, white oak flatwoods, and beech-maple woodlands.
Northern Bluegrass (71d)	Unglaciated and glaciated; dissected plains and hills with medium gradient, gravel bottom streams. Steep slopes, high relief near Ohio River.	Discontinuous loess and leached pre-Wisconsinan glacial till deposits. Ordovician limestone and shale.	Alfisols (Hapludalfs, Fragiudalfs), Mollisols (Hapludolls)	Mixed meso-phytic forest, mixed oak forest, oak-sugar maple forest; along Ohio River, bottomland hardwoods.	Mosaic of forest, agriculture, and urban-industrial activity near Cincinnati and elsewhere along Ohio River. Wooded where steep

alterations, and direct and indirect habitat alterations. These are described in the following discussions and major point sources, CSOs, and SSOs are included in Table 3.

Point Sources

There are approximately 20 point source discharges in the Mill Creek watershed that hold National Pollutant Discharge Elimination System (NPDES) permits. Together these sources discharge approximately 16 MGD of either treated sanitary wastewater, industrial process wastewater, or cooling water. The largest facility discharging treated sanitary wastewater in the watershed is the Butler Co. Upper Mill Creek Water Reclamation Facility. This plant discharges to the East Fork Mill Creek at RM 1.07. It currently discharges approximately 8 MGD and has been approved to expand its capacity to 16 MGD. Butler Co. is adding a denitrification process

to the treatment facility as part of the expansion to 16 MGD. The new expansion will also be constructed with an anoxic zone, which is specifically designed to effectively reduce nitrate-nitrogen and ammonia-nitrogen. The facility was also required to install nutrient removal by 2006. The General Electric Aircraft Engine facility in Evendale has the largest volume of cooling water and stormwater discharges in the Mill Creek watershed. It releases approximately 5.4 MGD of cooling and stormwater to Mill Creek via the GE tributary (RM 13.8).

Wet Weather Sources

The two major sources of wet weather-related pollution in Mill Creek emanate from combined sewer overflows (CSOs) and sanitary sewer overflows (SSOs). These occur because the volume of sanitary wastewater and stormwater entering the MSDGC sewer system during precipitation events (i.e., "wet weather") exceeds the capacity of the pipes and other equipment in the collection system. While CSOs and SSOs exist throughout much of Mill Creek, the highest concentration of outfalls and loadings occurs in Mill Creek below the SSO 700 outfall. Approximately one-third of MSDGC's sewers are combined sewers and the rest are sanitary sewers (MSDGC 2006).

Riparian and Stream Habitat

In response to extensive damage caused by major floods in 1937 and 1959, the Mill Creek Valley Conservancy District (MCVCD) was formed to act as the local liaison with the U.S. Army Corps of Engineers (U.S. ACE) for designing flood control measures. Beginning in 1981, a nearly 17-mile-long section of Mill Creek was channelized with further planned work being halted in 1991 due to a lack of funding. Further flooding occurred in 1998 and 2001. The U.S. ACE initiated a study in 1998 to complete the unfinished 1981 project, but this was never realized due to the failure to provide local cost sharing. A deep tunnel alternative was rejected due to the cost. In 2006, the City of Cincinnati acquired permanent conservation easements on all MVCD properties under the Mill Creek Greenway program.

The habitat modifications in the mainstem consist of traditional channelization accomplished by excavating and widening the natural channel to a trapezoidal shape. Shorter reaches of Mill Creek are encased in a concrete channel beginning approximately 1 km below Center Hill Rd. (RM 7.3) extending to 0.1 km above Clifton Ave. (RM 5.5). The remaining channelized segments are mix of unreinforced and reinforced banks with the latter consisting of concrete, rip rap, or revetments. The lower portions of some tributaries have also been encased in concrete channels. Encroachment of land uses on the riparian zone is commonplace and results in bank instability and the loss of tree cover. Some habitat improvements have been attempted and include the construction of artificial riffles in the mainstem and the removal of low head dams.

RESULTS and DISCUSSION

Chemical/Physical Water Quality

Chemical/physical water quality in the 2021 Mill Creek study area was characterized by grab sample data collected from the water column six (6) times at each site during base flows and within a June 16-October 15 seasonal index period. Continuous measurements were made with Datasondes over 3-4 consecutive day periods at selected mainstem sites in late July and early August. Sediment chemistry was determined from samples collected at all mainstem and selected tributaries in mid-October.

The results were evaluated by assessing exceedances of criteria in the Ohio WQS, by exceedances of regionally derived biological effect thresholds (MBI 2015) for parameters that lack formal criteria in the WQS, and by exceedances of probable and threshold effect levels for sediment chemistry (MacDonald et al. 2000). The chemical/physical results also serve as indicators of exposure and stress and in support of the biological data for assessing the attainment of aquatic life uses and assigning associated causes and sources for impairments. Bacteria data were collected by grab samples at all sites and were used primarily to determine the status of recreational uses in accordance with the Ohio WQS. Ohio EPA protocols for determining attainment of the applicable designated recreational use were followed.

Flow Regime

The flow regime in the Mill Creek mainstem during the period May 1 – October 31 is depicted in Figure 7 for the years 2011, 2013, 2016, and 2021 based on the gauge operated by the U.S. Geological Survey at Carthage (RM 10.0). These are recent years with bioassessment data in Mill Creek and each represents a slightly different periodicity of both high and low flows. What is consistent between years is a high degree of flashiness as depicted by flow spikes of 10-100 times the summer base flows, which is typical of an urban watershed. The lowest flows were generally at or above the median flow which is more than 6 times less than the 10^{th} percentile flow and less than two times higher than the 80th percentile flow. What are referred to herein as normal summer-fall flows are approximated by the statistical median (50^{th} percentile) flows that vary somewhat throughout this time period. All sampling was avoided during high flow events and was not resumed until normal base flows returned. Flows in 2021 consistently fluctuated with roughly 50% of them falling below the 10th percentile flow setting it apart from the other three years in Figure 7. Peak flows occurred in June and July 2021 following significant precipitation events.

Water Column Chemistry

Water quality was assessed by grab samples collected at all sampling locations six times during the summer-fall index period. Parameter groupings included field, demand, ionic strength, nutrients, heavy metals, and organic compounds. Continuous measurements over 3-4 consecutive day periods were made at all mainstem sites (excepting the downstream most sites influenced by the Ohio River) for D.O. (mg/l), pH (S.U.), conductivity (µS/cm), and temperature

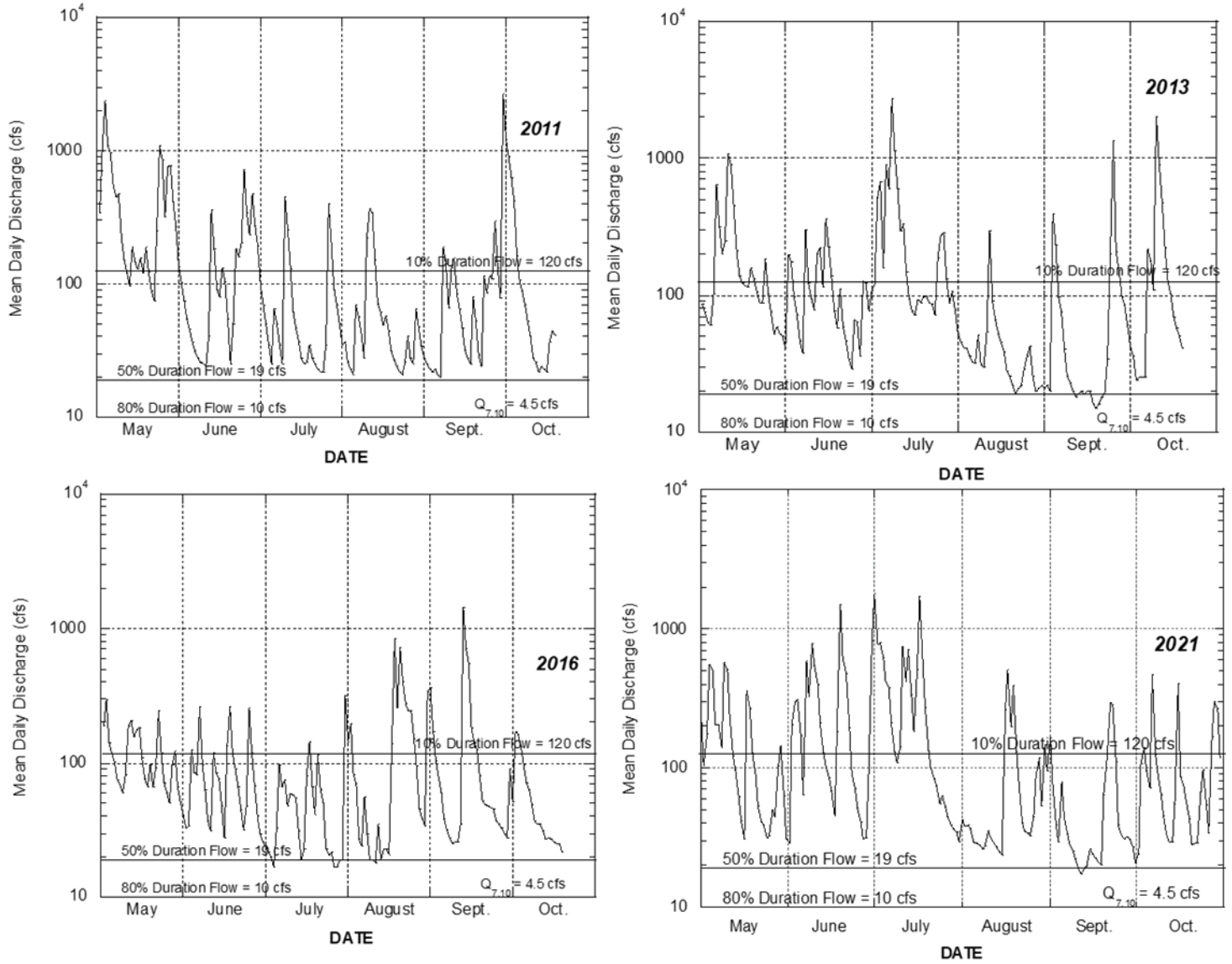


***Figure 8**. Flow measured at the USGS gauge at Carthage (RM 10.0) during May 1-October 31 during 2011, 2013, 2016, and 2021. The median, 80%, 10%, and $Q_{7,10}$ flows are indicated on each hydrograph.*

(°C) with YSI Datasonde continuous recorders during July 11-15 and July 20-22, 2021.

Water Quality Criteria Exceedances

Assessing exceedances of water quality criteria was done for parameters that have formal criteria codified in the Ohio WQS. For the 2021 Mill Creek survey this included criteria for the protection of aquatic life and for recreational uses.

Ohio WQS Aquatic Life Criteria Exceedances

Measured exceedances of aquatic life water quality criteria for in the Ohio WQS were few and limited to dissolved oxygen (D.O.) and temperature (Table 5). All except six (6) of the D.O. exceedances and all of the temperature exceedances were measured with the Datasondes and only at the sites at which they were deployed. The other D.O. exceedances were grab sample values below the 4.0 mg/l MWH minimum at two locations in the middle mainstem (RM 6.8 and 6.45), three sites in Cooper Creek, and the site in the unnamed tributary to Cooper Creek. Three samples in Cooper Creek had extremely low D.O. values that exceeded the MWH minimum of 3.0 mg/l. The single TKN exceedance was of the MMH maximum criterion of 0.51 in Lick Run (RM 1.7).

Exceedances of Biological Effect Thresholds

For parameters that do not have formal criteria codified in the Ohio WQS, biological effect thresholds were employed to determine the risks to attainment of aquatic life uses. The thresholds developed as part of the *Integrated Prioritization System (IPS) Documentation and Atlas of Biological Stressor Relationships for Southwest Ohio* (MBI 2015) were used to assess conventional, ionic strength, and nutrient parameters. These "IPS thresholds" are used in place of the Ohio EPA (1999) *Appendices to Association Between Nutrients and the Aquatic Biota of Ohio River and Streams* the thresholds from which were employed in a similar fashion in the 2011-16 MSDGC service area watershed assessments. The IPS thresholds are a more robust analysis of biological stressor thresholds, especially in light of the Ohio EPA (1999) dataset being rather sparse in the Interior Plateau ecoregion. The IPS thresholds also offer discrete goals that are directly linked to the codified biological criteria and their application in the determination of aquatic life use attainment and the response to a finding of attainment and findings of non-attainment[3]. The results for selected parameters are compared to the IPS threshold goals that align with the applicable aquatic life use and stream size category and color coded in keeping with the hierarchy of the Ohio tiered aquatic life uses. The results are also graphically depicted along the Mill Creek mainstem and compared to available results using the Ohio EPA 1992 results as a historical baseline.

Nutrients were assessed using the draft Stream Nutrient Assessment Procedure (SNAP; Ohio EPA 2015b) which is a "combined criterion" consisting of the fish and macroinvertebrate biological criteria, the diel D.O. flux, benthic chlorophyll α, and total nitrate and phosphorus. Lastly, sediment chemical data was assessed using the threshold and probable effect levels of MacDonald et al. (2000).

[3] OAC 3745-1-07(A)(6)(a) describe the options for a finding of full attainment and (A)(6)(b) for a finding of non-attainment.

***Table 5**. Exceedances of water quality criteria for aquatic life based on grab sampling and continuous monitoring in the 2021 Mill Creek study area.*

Site ID	River Mile	Aquatic Life Use	Parameters (Values) Exceeding Ohio Aquatic Life Criteria[1]
Mill Creek – WWH Reach			
MC00	26.4	WWH	
MC12	19.22	WWH	
MC10	18.86	WWH	
MC08	18.37	WWH	Temperature (31.0°C)
MC101	17.96	WWH	
MC06	16.73	WWH	
MC04	15.41	WWH	
MC11	13.96	WWH	
MC104	13.76	WWH	
MC02	13.27	WWH	
MC01	11.7	WWH	
MC80	10.48	WWH	
MC105	9.24	WWH	
MC79	8.63	WWH	
MC77	7.47	WWH	
Mill Creek – MWH Reach			
MC09	6.9	MWH-C	D.O. (13.7)
MC07	6.35	MWH-C	D.O. (17.19); Temperature (30.5°C)
MC75	5.1	MWH-C	Temperature (30.8°C)
MC74	4.3	MWH-C	Temperature (32.2°C)
MC73	3.45	MWH-C	
MC72	3.1	MWH-C	Temperature (31.4°C)
MC05	2.5	MWH-C	Temperature (31.7°C)
MC03	1.7	MWH-C	
MC71	0.7	MWH-C	
MC70	0.3	MWH-C	
MC69	0.05	MWH-C	
East Fork Mill Creek			
MC18	1.2	WWH	
MC15	1	WWH	
MC14	0.7	WWH	

Site ID	River Mile	Aquatic Life Use	Parameters (Values) Exceeding Ohio Aquatic Life Criteria[1]
MC16	0.1	WWH	
Cooper Creek			
MC111	3.57	WWH	
MC112	3.42	WWH	D.O. (2.44)
MC113	2.84	WWH	D.O. (1.28)
MC32	2.59	WWH	
MC28	2.13	WWH	D.O. (2.54)
MC118	1.58	WWH	
MC119	0.44	WWH	
Unnamed Tributary to Cooper Creek @RM 2.80			
MC114	0.55	WWH	D.O. (1.49)
West Fork Mill Creek			
MC45	0.2	WWH	
King's Run			
MC109	1.11	PHW3A	
Unnamed Tributary to West Fork Creek @RM 1.24			
MC97	1.49	PHW3A	
Lick Run			
MC108	1.7	PHW2	
MC107	0.98	MWH-C	
MC106	0.45	MWH-C	

Conventional and Demand Parameters

This category includes D.O., temperature, pH, ammonia-N, and BOD_5. The D.O. results include both grab and continuous data. D.O. values from daytime grab samples, as expected, did not reveal any exceedances of the average or minimum criteria for either the WWH or MWH uses (Figure 9). Two averaged values that exceeded the maximum D.O., which is indicative of potentially excessive diel swings, occurred at two sites (RM 6.45 and 6.80) in 2021. High values were also observed further downstream in 2011 and all years had values >10 mg/l in the concrete channel reach.

Continuous D.O. data provided the most complete characterization of the D.O. regime in Mill Creek in 2021 (Figure 10, upper left). The results revealed multiple exceedances of the minimum D.O. criterion at single sites in Mill Creek. Excessively wide diel swings >10-20 mg/L

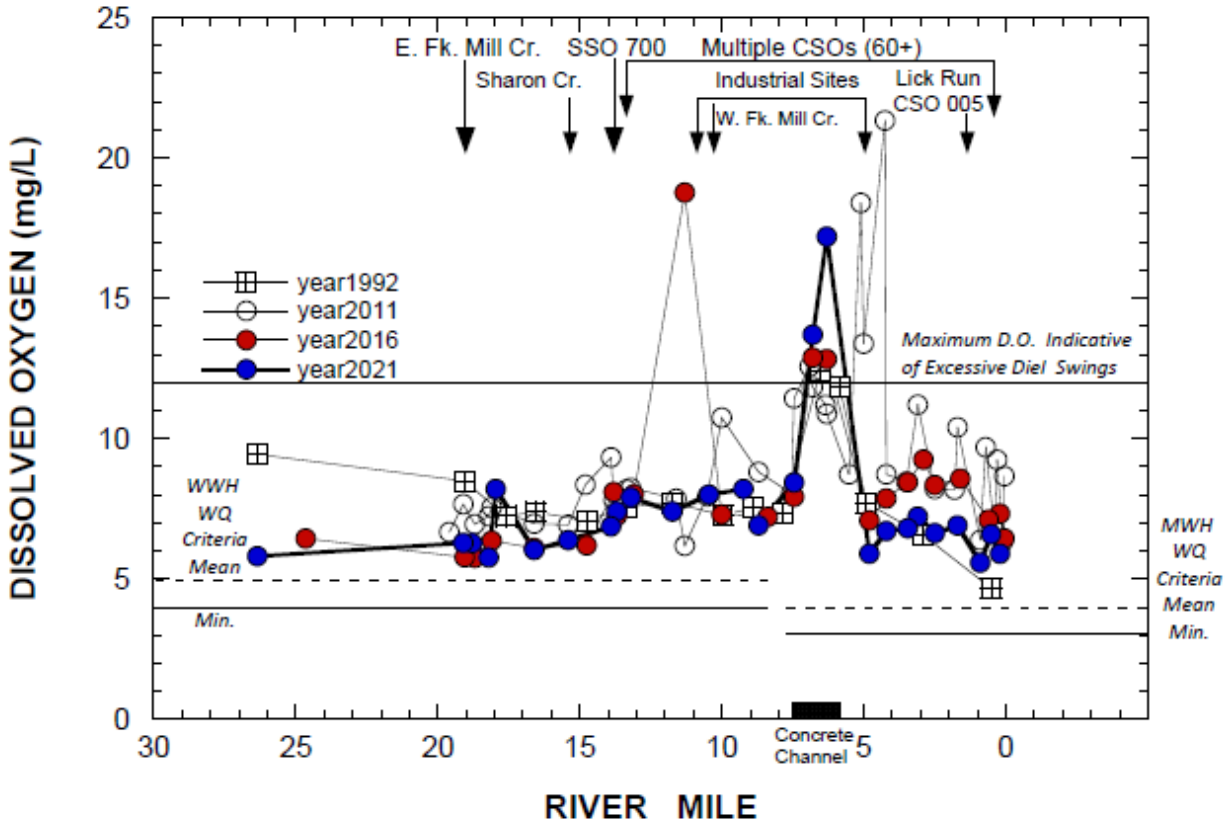
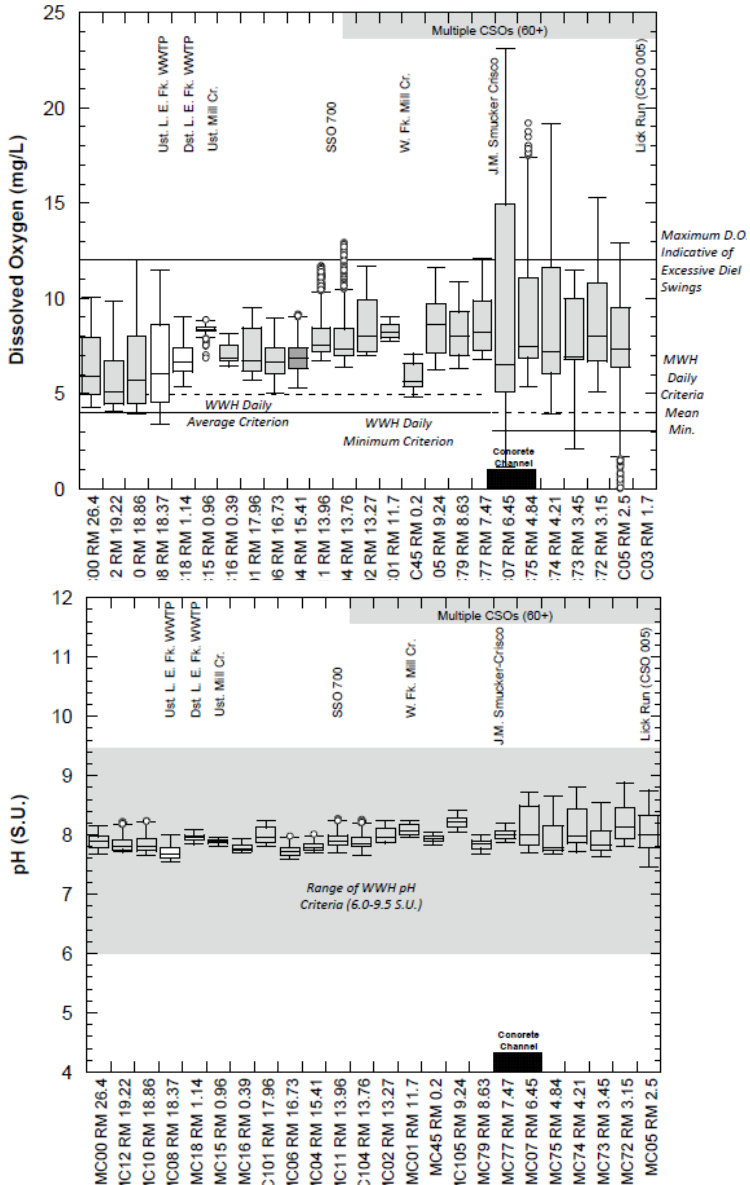


***Figure 9**. Mean dissolved oxygen (D.O.) at Mill Creek mainstem sites in 1992, 2011, 2016, and 2021. The average and minimum criteria for the WWH and MWH uses are shown as dashed and solid lines. The D.O. concentration that indicates excessive diel swings is depicted as a black solid line at 12.0 mg/L.*

were evident in the upper portion of the MWH reach being widest in the concrete channel part of that segment. This effect slowly subsided downstream but remained wider than in the WWH segment. These results clearly illustrate the role that the highly modified concrete channel habitat plays in exacerbating the effect of nutrients that is much less apparent in the comparatively better habitat in the upstream reaches.

Continuous temperature data revealed consistent exceedances of the maximum criterion applicable to the Mill Creek mainstem downstream from the concrete channel and a single site in the WWH reach upstream of the concrete channel in 2021 (Figure 12). The exceedances occurred at the same site where the excessive D.O. and pH swings started. This places the increased temperature in the shallow portion of the concrete channel that is also exposed to full sunlight, which contributes to the warming of Mill Creek temperatures in the MWH reach.

Continuous pH data revealed no exceedance of the maximum of 9.0 S.U. This parameter can also exhibit a diel swing related to increased algal activity spurred by excessive nutrients. Wide swings were observed in the MWH segment beginning in the concrete channel and continuing



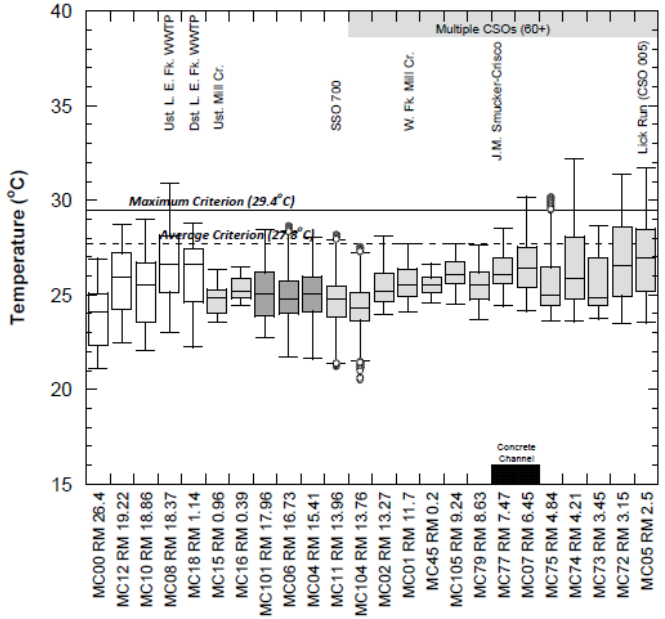


***Figure 10**. Box-and-whisker plot of continuous D.O. (upper left), temperature (upper right), and pH (lower left) from Datasonde continuous recorders at 24 sites in the mainstem of Mill Creek and the lower East Fork during July 11-15 and July 20-22, 2021. The WWH and MWH daily average and minimum criteria and IPS thresholds are indicated by dashed and solid lines. Major discharges and tributaries are indicated across the top.*

downstream (Figure 10; lower left). These results mirrored the diel D.O. data and both are the result of the modified habitat which is exacerbating the effect of nutrients.

5-day biochemical oxygen demand (BOD_5) values in 2021 were at or below the minimum detection level (MDL) at all mainstem sites, except for the most upstream site at RM 26.4 (MC00; Figure 11, upper). This is a consistent reduction in values observed in 1997, 2011, 2013, and 2016 and is a positive indication of decreased loadings of carbonaceous materials. All values were well below the IPS thresholds.

E. coli is included here as an indicator of organic enrichment from raw sewage and urban nonpoint source runoff in addition to its primary role as the indicator for recreational use impairment. As stated in the Recreational Use summary earlier, *E. coli* exceeding the PCR criteria were ubiquitous in the 2021 study area. However, levels that exceed the recreational criteria do not necessarily indicate significant inputs of raw sewage but could rather indicate non-human sources in urban stormwater. *E. coli* levels that far surpass the recreational criteria (>10,000 cfu/100 mL) increasingly indicate raw sewage. The mean values exceeded the STV criterion below the East Fork and approached the SCR criterion of 1030 cfu/100 mL downstream from SSO 700 (Figure 11, lower). Maximum values approaching and exceeding 100,000 cfu/100 mL, an indication of raw sewage inputs, occurred at the first two locations below SSO 700. Both mean and maximum values declined with distance downstream, but with some maximum exceeding the 10,000 cfu/100 mL value. Mean and maximum values increased downstream from the concrete channel exceeding the PCR STV criterion and the 10,000 cfu/100 mL value to the Ohio River backwater effect.

Ammonia-N is also included here as a conventional parameter as it has, along with BOD_5, been the target of point source controls of sewage treatment discharges and has shown historic declines in Ohio rivers and streams since the early 1990s. The 2021 results show ammonia-N below the MDL of 0.05 mg/l at all mainstem sites (Figure 12; upper left). These results, along with the 2011 and 2016 results, represent a significant and continued improvement compared to 1992 and 1997. The source of ammonia-N in those earlier years was the East Fork and presumably the Butler Co. Upper Mill Creek WRF prior to treatment upgrades. A second peak of ammonia-N occurred in 1992 beginning in the concrete channel which also received effluent from the former Procter and Gamble plant discharge. The reductions in ammonia-N are the result of improved wastewater treatment at point source discharges.

Nutrient Related Parameters

Total phosphorus in the Mill Creek mainstem declined markedly between the 1992 and 1997 surveys and the 2011 survey (Figure 12; upper right). Total P also decreased between 2016 and 2021 to levels less than one-third of the much higher levels in 1992 and 1997. The longitudinal pattern clearly points to the East Fork Mill Creek and the Butler Co. Upper Mill Creek WRF as the primary source of these values – it was independent of all other sources. The 2011 values were all less than the IPS biological effect threshold but exceeded it between the East Fork confluence downstream through the WWH segment. All 2021 values were well below the higher MWH IPS threshold during all years being close to the MDL in 2011 and 2016.

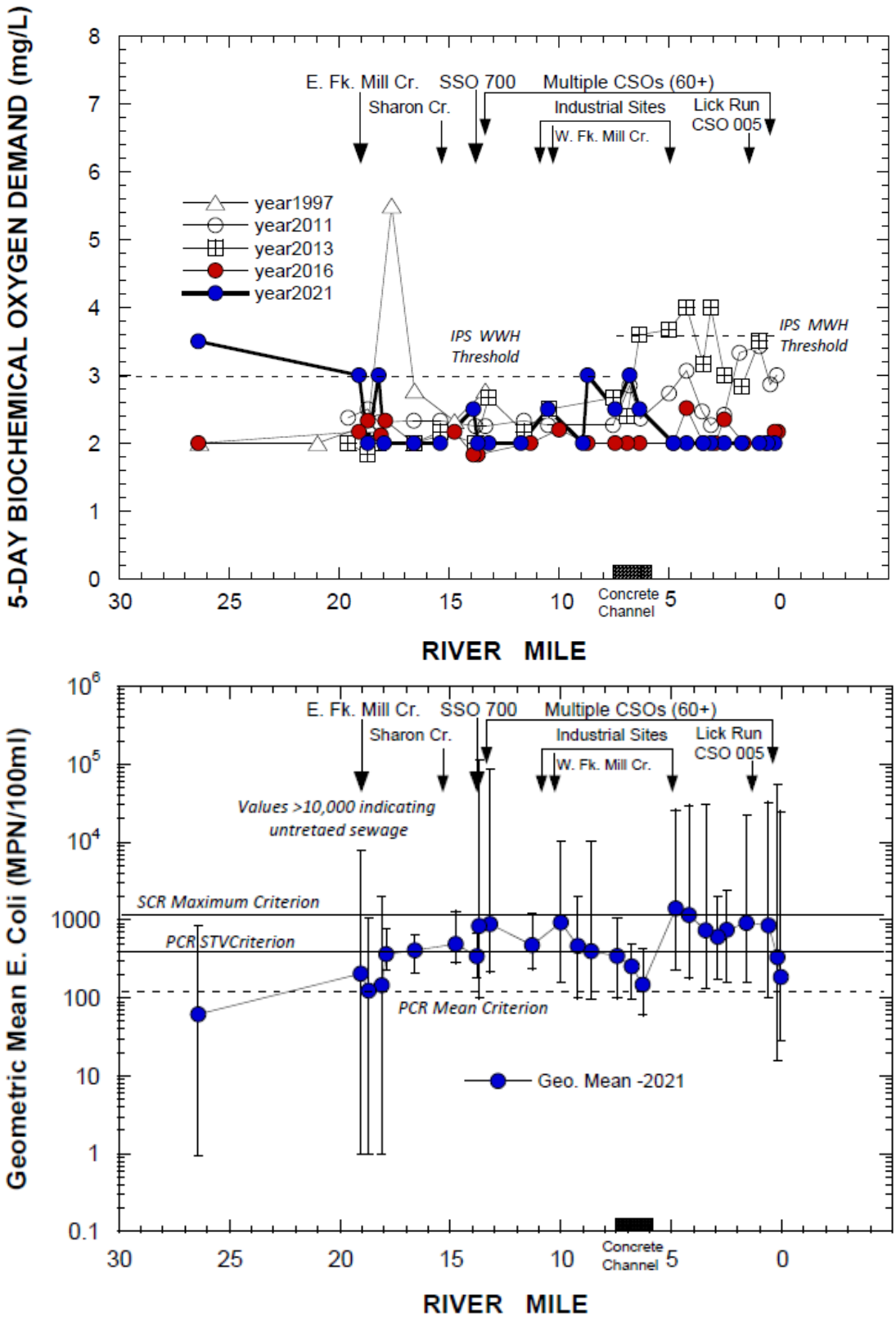


Figure 11. *Mean 5-day BOD in 1997, 2011, 2013, 2016, and 2021 (upper) and E. coli mean, maximum, and minimum values in 2021 at Mill Creek mainstem sites. The IPS biological effect thresholds for the WWH and MWH uses are shown as dashed lines for BOD and the PCR geometric mean, STV, and SCR criteria for E. coli are shown as dashed and solid lines.*

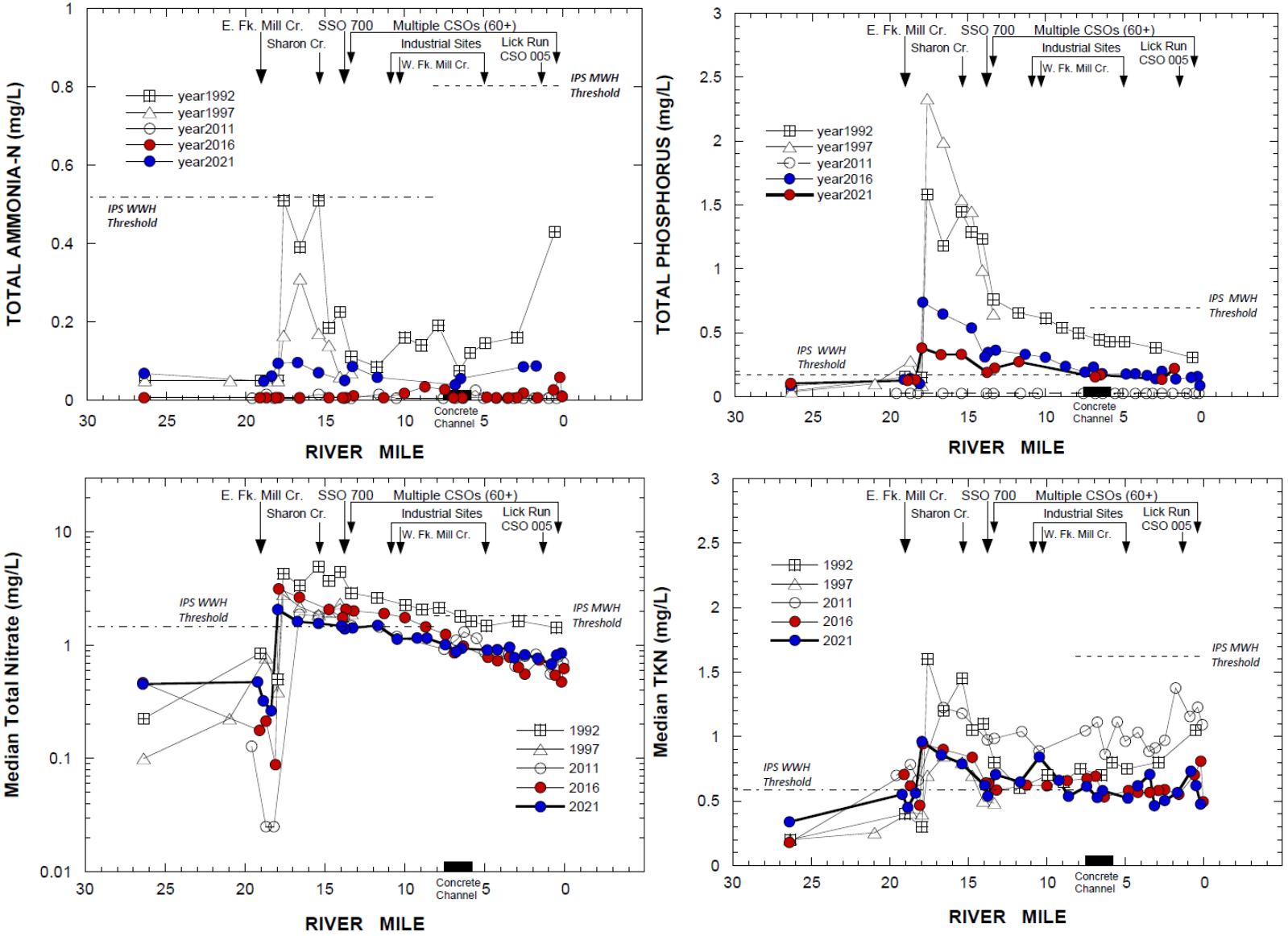


***Figure 12**. Median total ammonia-N (upper left), total phosphorus (upper right), total nitrate-N (lower right), and total Kjeldahl nitrogen (lower right) at Mill Creek mainstem sites in 1992, 1997, 2011, 2016, and 2021 based on grab samples. The WWH and MWH IPS thresholds are indicated by dashed and solid lines. Major discharges and tributaries are indicated across the top.*

The mean total nitrate-N exceeded the WWH IPS threshold in the Mill Creek mainstem between the East Fork confluence and RM 11.7 (MC 01; Figure 12, lower left). All except one site were in the fair range. The three sites below the Butler Co. Upper Mill Creek WRF in the East Fork were all very poor values. As with total P, the longitudinal pattern indicates the source of nitrate-N enrichment is the East Fork and the Butler Co. Upper Mill Creek WRF as the source. Mean nitrate-N values declined through the MWH segment to below the IPS threshold.

Mean TKN values exceeded the WWH IPS threshold in the WWH segment of Mill Creek beginning with the site immediately downstream from the East Fork, returning to good at the site immediately upstream from the East Fork, and sporadically exceeding the threshold downstream from the East Fork to the MWH segment (Figure 12, lower right). Similar to total P and nitrate, TKN was elevated above the WWH IPS threshold at all three sites in the East Fork below the Butler Co. Upper Mill Creek WRF with two fair and one poor value.

Nutrient Parameters/SNAP Assessment

The Stream Nutrient Assessment Procedure (SNAP) developed by Ohio EPA (2015b) was first used to assess the overall effects of nutrient enrichment in the Mill Creek mainstem (19 sites excluding the Ohio River influenced sites), the lower East Fork (4 sites), and the West Fork (1 site) in 2016. However, the SNAP analysis has been improved since that time, having been applied in other places, thus reducing direct comparisons between 2016 and 2021. The SNAP procedure requires continuous D.O. data for determining the diel D.O. flux (Figure 10) and benthic chlorophyll a biomass in addition to the primary nutrients total P and nitrate-N. BOD, TKN, and SSC are included as parameters that can be influenced by the effects of nutrient enrichment (Miltner 2018). As a result, the analysis was performed at 24 sites.

The IPS biological effect thresholds (MBI 2015) were used to assess all of the nutrient related and related conventional and demand parameters (Table 6). The IPS thresholds are portrayed as goals for each parameter that correspond to the attainment of the Ohio biological criteria for the tiered aquatic life uses (e.g., EWH, WWH, and MWH) and three states that depart from those criteria as fair, poor, and very poor. The ambient results were color coded in accordance with the IPS narrative benchmarks – exceptional (EWH), blue; good (WWH), green; fair (MWH), yellow; poor (LRW), orange; very poor (no use), red.

The SNAP method recognizes that the effects of nutrients on aquatic life are neither direct nor linear, but dependent on a number of factors such as low stream flow duration, stream habitat characteristics, shading, retention, aquatic life use (i.e., sensitivity to nutrient impacts) and the timing and delivery of nutrients to a stream or river. Table 6 summarizes the data used to identify sites that:

1) are attaining aquatic life uses and not threatened by nutrients,
2) are attaining aquatic life uses, but may be threatened by nutrients,
3) are impaired, but cause(s) other than nutrients are major limiting factors,
4) are impaired, with nutrients as one of multiple contributing causes, or
5) are impaired, with nutrient enrichment as a primary cause.

Two (2) sites (MC00 and MC105) in the WWH designated upstream reach of Mill Creek attained their respective aquatic life use biocriteria and were not threatened by nutrients. Six (6) sites were impaired, but by causes other than nutrients. The five (5) site downstream from the East Fork confluence were impaired with nutrients as a likely contributing cause with fair exceedances of IPS thresholds. Among the nutrient parameters mean total phosphorus exceeded the WWH IPS threshold at all except one site in the WWH reach downstream from

***Table 6**. Conventional, demand, and nutrient parameters in the 2021 Mill Creek study. Mean ambient values are color coded by their IPS ranges that correspond to tiered uses and narrative quality; blue – EWH (exceptional); green – WWH (good); yellow – MWH (fair); orange – LRW (poor); red – very poor quality. IPS threshold goals for each site are in the column to the right of each value.*

Site ID	Fish/Macro. River Mile	Drainage Area (sq. mi.)	Aq. Life Use	IBI	MIwb	ICI	ALUS Status	QHEI	Chlorophyll-a		BOD	Grab Dissolved Oxygen[a]				Continuous Dissolved Oxygen[a]				Total Kjeldahl Nitrogen (mg/L)	Susp. Sed. Conc. (mg/L)	Total Phos-phorus (mg/L)	Nitrate-N (mg/L)	Overall Assessment of Nutrient Effects
									Benthic (mg/m^2)	Sestonic (mg/m^3)	BOD (mg/L)	Min. (mg/L)	Mean (mg/L)	Max (mg/L)	Max. Swing	Min. (mg/L)	Mean (mg/L)	Max. (mg/L)	Max. Daily D.O. Swing					
Mill Creek (23-001) - 2021 - WWH Reach																								
MC00	26.40/26.00	4.4	WWH	43	NA	44	**Attaining**	69.0	28.40	3.20	3.00	5.03	5.96	6.99	1.96	4.25	6.43	10.07	5.59	0.41	12.7	0.111	0.49	Attaining and not threatened by nutrients
MC12	19.22/19.10	26.7	WWH	30*	6.2*	42	**Impaired**	69.3	34.10	4.81	2.67	5.60	6.41	7.53	1.93	4.10	5.73	9.83	5.67	0.56	14.0	0.174	0.50	Impaired, but cause(s) other than nutrients
MC10	18.86/18.70	27.0	WWH	28*	6.2*	44	**Impaired**	70.5	18.30	4.25	2.17	5.10	6.33	7.70	2.60	3.94	6.35	12.05	8.11	0.50	15.6	0.145	0.33	Impaired, with nutrients as a likely contributing cause
MC08	18.37/18.10	27.3	WWH	34*	6.6*	44	**Impaired**	83.5	49.50	4.29	2.50	3.40	5.40	8.11	4.71	3.38	6.61	11.49	7.55	0.64	17.4	0.145	0.30	Impaired, with nutrients as a likely contributing cause
MC101	17.96/17.96	42.2	WWH	31*	6.4*	40	**Impaired**	65.0	37.20	3.17	2.17	6.48	7.69	8.75	2.27	5.69	7.22	9.48	3.63	1.13	11.0	0.521	2.00	Impaired, with nutrients as a likely contributing cause
MC06	16.73/16.60	50.5	WWH	22*	5.1*	40	**Impaired**	56.0	27.60	1.79	2.00	5.10	6.66	9.04	3.94	5.02	6.74	8.97	3.84	0.94	13.0	0.420	1.79	Impaired, with nutrients as a likely contributing cause
MC04	15.41/15.10	61.3	WWH	24*	3.7*	40	**Impaired**	50.5	30.40	1.95	2.00	5.15	6.15	7.26	2.11	5.30	6.89	9.16	3.45	0.83	20.4	0.404	1.46	Impaired, with nutrients as a likely contributing cause
MC11	13.96/13.90	68.8	WWH	35*	7.2*	40	**Impaired**	65.5	94.50	3.99	2.67	5.10	7.05	9.14	4.04	6.73	7.98	11.70	4.85	0.74	8.1	0.358	1.49	Impaired, but cause(s) other than nutrients
MC104	13.76/13.70	71.6	WWH	36[ns]	6.7*	46	**Impaired**	75.8	54.90	2.66	2.50	5.48	7.29	9.00	3.52	6.36	7.95	12.93	6.36	1.05	11.7	0.362	1.43	Impaired, but cause(s) other than nutrients
MC02	13.27/13.10	72.3	WWH	31*	5.9*	46	**Impaired**	55.5	53.00	3.82	2.33	6.50	7.91	10.29	3.79	6.99	8.55	11.70	4.60	1.21	12.2	0.374	1.56	Impaired, but cause(s) other than nutrients
MC01	11.70/11.70	73.9	WWH	39[ns]	7.2*	42	**Impaired**	69.5	69.10	2.59	2.00	6.09	7.23	7.90	1.81	7.72	8.27	9.03	1.23	0.80	9.9	0.301	1.46	Impaired, but cause(s) other than nutrients
MC105	9.24/9.24	119.0	WWH	38[ns]	7.8[ns]	38	**Attaining**	71.8	48.10	4.34	2.33	5.30	7.84	9.18	3.88	6.24	8.60	11.61	5.18	0.69	18.6	0.222	1.10	Attaining and not threatened by nutrients
MC79	8.63/8.68	120.0	WWH	35*	8.1	40	**Impaired**	75.5	47.90	4.70	2.50	6.40	7.73	9.50	3.10	6.29	8.19	10.85	4.37	0.59	8.9	0.236	1.24	Impaired, but cause(s) other than nutrients
Mill Creek (23-001) - 2021 - MWH-C Reach																								
MC77	7.47/7.65	126.0	MWH-C	40	6.9	38	**Attaining**	55.0	37.30	4.61	2.50	4.89	8.08	9.95	5.06	6.79	8.69	12.07	5.15	0.68	7.3	0.200	1.01	Attaining, but may be threatened
MC07	6.45/6.35	135.0	MWH-C	28	3.7*	16*	**Impaired**	38.5	106.00	7.64	3.17	3.53	14.53	17.80	14.27	1.17	9.73	23.09	18.45	0.54	9.9	0.264	1.03	Impaired, with nutrients as a likely contributing cause
MC75	4.84/4.84	139.0	MWH-C	31	6.5	28	**Attaining**	49.0	36.10	6.13	2.00	3.96	6.56	10.50	6.54	5.38	8.98	19.20	13.82	0.56	12.9	0.289	0.90	Attaining, but may be threatened by nutrients
MC74	4.21/4.60	141.0	MWH-C	38	7.0	28	**Attaining**	62.0	70.10	6.58	2.17	4.08	6.61	9.14	5.06	3.95	9.01	19.17	14.74	0.66	12.5	0.286	0.87	Attaining, but may be threatened by nutrients
MC73	3.45/3.60	144.0	MWH-C	34	6.3	44	**Attaining**	58.5	60.00	5.65	2.17	5.64	7.06	9.80	4.16	2.12	8.02	11.47	9.35	0.68	12.2	0.208	0.93	Attaining, but may be threatened by nutrients
MC72	3.15/3.10	154.0	MWH-C	36	7.3	36	**Attaining**	58.5	57.90	4.43	2.50	4.80	7.81	10.85	6.05	5.09	8.89	15.28	9.88	0.56	7.6	0.160	0.80	Attaining, but may be threatened by nutrients
MC05	2.50/2.50	156.0	MWH-C	34	6.7	36	**Attaining**	53.0	46.20	8.46	2.83	5.30	6.60	7.90	2.60	0.03	7.65	12.91	10.18	0.59	10.5	0.170	0.83	Attaining, but may be threatened by nutrients
West Fork Mill Creek (23-004) - 2021																								
MC45	0.20/0.20	36.5	WWH	26*	7.0*	30	**Impaired**	69.3	20.10	1.67	2.20	4.15	6.23	7.85	3.70	4.85	5.91	7.09	1.80	0.56	8.4	0.154	0.57	Impaired, but cause(s) other than nutrients
East Fork Mill Creek (23-006) - 2021																								
MC18	1.14/2.00	9.3	WWH	33*	NA	42	**Impaired**	71.5	29.00	1.02	3.17	5.04	6.77	8.45	3.41	5.39	6.84	9.04	3.18	0.40	11.0	0.123	0.18	Impaired, but cause(s) other than nutrients
MC15	0.96/1.05	9.3	WWH	34*	NA	30	**Impaired**	78.0	49.00	1.97	2.17	7.96	8.48	9.09	1.13	6.87	8.38	8.87	1.73	1.18	6.1	0.854	2.27	Impaired, with nutrients as a likely contributing cause
MC16	0.39/0.10	9.6	WWH	28*	NA	36	**Impaired**	60.5	31.00	1.38	2.00	6.70	7.42	8.10	1.40	6.42	7.10	8.15	1.54	0.95	5.3	0.942	3.06	Impaired, with nutrients as a likely contributing cause
		Exceptional	≥50	≥8.9	≥46	**Attains WWH**	≥75				>6.0				>6.0			≤6.5	<0.75	<20	< 0.04	<0.44	Attaining and not threatened by nutrients
		Good	36-49	7.6-8.8	30-45	**Attains MWH**	60-74	≤182 mg/m^2	Acceptable	<2.25	5.0-5.9			≤6.5	5.0-5.9			>6.5	≥0.75	≥20	0.04-<0.08	0.44-1.10	Attaining, but may be threatened by nutrients
		Fair	28-35	5.8-7.5	20-29	**Impaired Fair**	46-59	182-320 mg/m^2	Enriched	<4.00	3.0-4.9			>6.5	3.0-4.9						0.08-0.131	>1.10-3.60	Impaired, but cause(s) other than nutrients
		Poor	18-27	3.4-5.7	13-19	**Impaired Poor**	30-45	>320 mg/m2	Over-Enriched	≥4.00	2.0-2.9			>10.0	2.0-2.9						>0.131-0.40	>3.60-<6.70	Impaired, with nutrients as a likely contributing cause
		Very Poor	≤17	<3.4	≤12	**Impaired V. Poor**	<30				< 2.0				< 2.0						≥0.40	>6.70	Impaired, with nutrient enrichment as the cause
		Source	OEPA	OEPA	OEPA		OEPA	SNAP	SNAP	SNAP	OEPA			SNAP	OEPA			SNAP	SNAP	SNAP	SNAP	SNAP	SNAP

the East Fork and all were fair values. No site upstream from the East Fork confluence exceeded the WWH IPS thresholds. The IPS threshold was exceeded at all three sites in the East Fork below the Butler Co. Upper Mill Creek WRF and all were poor values. Taken together, these results, in combination with the two lower most East Fork sites that were impaired with nutrients as a likely cause and with poor exceedances of IPS thresholds, point back to the Butler Co. Lower East Fork WRF as the source of enrichment. The upstream most site in the MWH designated reach (MC77) attained the MWH biocriteria and may be threatened by nutrients. The next site (MC07) at the upper end of the concrete channel was impaired with nutrients as a likely cause demonstrating the effect of the severe habitat modifications. The remaining sites in the MWH reach all attained, but threated by nutrients likely as a result of the marginal habitat and the concrete channel rapidly exporting enrichment effects downstream. All sites in the MWH reach of Mill Creek were well below the higher MWH IPS benchmark, and most below the WWH IPS benchmark. The single site on the West Fork was impaired by non-nutrient causes.

Mill Creek receives nutrients in runoff that originate from adjacent land uses (largely urban and suburban) as well as carbonaceous sources (CSOs and SSOs) that each contribute to the altered D.O. dynamics in the receiving streams. Benthic and sestonic chlorophyll concentrations were generally low to very low at most sites, as was BOD_5. The WWH designated reach of Mill Creek, other than the upstream most headwater site that was in full attainment of the WWH aquatic life use, had fish IBI and MIwb scores that that were impaired and in the fair range. However, three (3) sites were in the range of non-significant departure from the IBI biocriterion. Several sites with minimum D.O. values below 5 mg/L and two sites that had D.O. swings of >6.5 mg/L (MC10 and MC08) suggesting that nutrients may contribute to impairment, but were accompanied by urban stressors that are also influential. Total phosphorus concentrations were poor downstream of the Butler Co. Upper Mill Creek WRF and remained in the poor range in the remainder of that stream. The MWH designated reach of Mill Creek starts as a highly modified concrete lined channel with all except the concrete channel portion attaining the MWH modified use. This reach is predominated by species and taxa that are more tolerant of elevated nutrients and altered D.O. regimes. Nevertheless, the upper part of this reach at MC07 and MC09 had extremely wide D.O. swings of >10-20 mg/L and multiple sites with D.O. levels below 3 mg/L. This is the net result of the shallow concrete lined channel that exposes shallow depths to full sunlight and increases the retention time allowing algae to accumulate to higher levels than in adjacent reaches. Most sites in this reach attained the MWH use, but are considered threatened by nutrients because of the highly modified habitats among other sources of stress via stormwater and CSO discharges.

Mill Creek Tributary Conventional, Demand, and Nutrient Parameters

Table 7 includes the results of selected demand and nutrient related parameters in the 2021 Mill Creek study area including six (6) tributaries. The most comprehensively sampled tributary was Cooper Creek which was sampled by MBI in the lower subwatershed and the Hamilton Co. SWCD in the upper reached and tributaries. The five (5) upstream most sites in Cooper Creek subwatershed and the unnamed tributary (MC114) had low D.O. values that exceeded the 4 mg/L minimum with all except one sites being classified as PHWH3A or B, thus intermittent flows are the likely cause of the low D.O. values. IPS threshold exceedances were fair at some sites for total P and nitrate-N at MC111 and four TKN values between MC112 and MC28. All other results were within the good or exceptional ranges of each including very low sestonic chlorophyll a values. Among the remaining tributaries, the upstream site in Lick Run (MC 108) had very poor BOD, TKN, and sestonic chlorophyll a levels likely as a result of intermittent flows through this artificially constructed stream. Only two fair values for D.O. in Kings Run and total P in the unnamed tributary to West Fork Creek, otherwise all values were good or exceptional.

Urban Parameters

Urban parameters include ionic strength measures such as conductivity, total dissolved solids, total chlorides, and total sulfates and selected heavy metals such as copper, lead, and zinc. These parameters are either commonly detected and/or elevated above effect levels in urban areas. This is mostly the result of stormwater runoff but can also be indicative of industrial and municipal sources of pollution. The IPS biological effect thresholds (MBI 2015) were used to

***Table 7**. Mean values for selected demand and nutrient related parameters in the 2021 Mill Creek study area including the Mill Creek and East Fork mainstem and selected Mill Creek tributaries. ALU is the applicable aquatic life use and IPS are the IPS thresholds that apply to each site.*

Site ID	River Mile	ALU	Mean D.O. (mg/L)/IPS		Mean BOD_5 (mg/L)/IPS		Mean TKN (mg/L)/IPS		Mean Total Ammonia (mg/L)/IPS		Mean Nitrate (mg/L)/IPS		Mean Total Phosphorus (mg/L)/IPS		Benthic Chloro-phyll a (mg/m^2)	Sestonic Chloro-phyll a (µg/mL)
Mill Creek - WWH Reach																
MC00	26.4	WWH	5.81		3.5		0.34		0.07		0.454		0.10		28.4	1.57
MC12	19.22	WWH	6.28		3.0		0.55		0.05		0.475		0.16		34.1	2.94
MC10	18.86	WWH	6.27		2.0		0.45		0.05		0.322		0.13		18.3	3.34
MC08	18.37	WWH	5.76		3.0		0.56		0.06		0.264		0.13		49.5	2.67
MC101	17.96	WWH	8.20		2.0		0.96		0.09		2.065		0.38		37.2	2.67
MC06	16.73	WWH	6.03		2.0		0.86		0.10		1.620		0.33		27.6	1.04
MC04	15.41	WWH	6.38		2.0		0.79		0.07		1.560		0.33		30.4	1.84
MC11	13.96	WWH	6.87	**5.00**	2.5	**2.96**	0.62	**0.58**	0.06	**0.53**	1.480	**1.38**	0.25	**0.17**	94.5	1.47
MC104	13.76	WWH	7.40		2.0		0.54		0.06		1.395		0.21		54.9	2.67
MC02	13.27	WWH	7.90		2.0		0.71		0.09		1.420		0.22		53	3.47
MC01	11.7	WWH	7.40		2.0		0.65		0.06		1.499		0.27		69.1	2.07
MC80	10.48	WWH	8.00		2.5		0.84		0.08		1.135		0.24		-	5.73
MC105	9.24	WWH	8.20		2.0		0.66		0.06		1.160		0.18		48.1	2.14
MC79	8.63	WWH	6.91		3.0		0.54		0.09		1.155		0.18		47.9	4.74
MC77	7.47	WWH	8.43		2.5		0.61		0.08		1.012		0.16		37.3	4.54
Mill Creek - MWH Reach																
MC09	6.8	MWH	13.70		3.0		0.53		0.04		0.877		0.15		-	10.41
MC07	6.45	MWH	17.19		2.5		0.58		0.06		0.939		0.17		106	6.14
MC75	4.84	MWH	5.90		2.0		0.52		0.04		0.908		0.25		36.1	5.88
MC74	4.21	MWH	6.71		2.0		0.62		0.06		0.913		0.22		70.1	6.41
MC73	3.45	MWH	6.80		2.0		0.81		0.04		0.959		0.20		60	6.14
MC72	3.15	MWH	7.22	**4.00**	2.0	**3.35**	0.50	**1.63**	0.07	**0.83**	0.777	**1.70**	0.12	**0.70**	57.9	5.08
MC05	2.5	MWH	6.63		2.0		0.56		0.09		0.822		0.13		46.2	7.21
MC03	1.69	MWH	6.90		2.0		0.58		0.09		0.765		0.22		-	6.41
MC71	0.83	MWH	5.58		2.0		0.77		0.13		0.680		0.16		-	7.48
MC70	0.5	MWH	6.59		2.0		0.72		0.08		0.816		0.10		-	7.21
MC69	0.21	MWH	5.90		2.0		0.54		0.06		0.851		0.11		-	4.74
East Fork Mill Creek																
MC18	1.14	WWH	6.64		3.5		0.32		0.05		0.121		0.12		29	1.00
MC15	0.96	WWH	8.30	**5.00**	2.0	**2.96**	1.00	**0.58**	0.07	**0.53**	2.780	**1.38**	0.51	**0.17**	49	1.50
MC14	0.66	WWH	6.73		2.0		0.96		0.07		2.250		0.43		-	1.00
MC16	0.39	WWH	7.55		2.0		0.90		0.09		2.885		0.66		31	1.00
Cooper Creek (Rossmoyne Creek RM 14.05)																
MC111 (MR-1)	3.57	WWH	3.17		2.0		0.55		0.06		1.400		0.20		-	1.00
MC112 (MR-2)	3.42	WWH	2.44		2.0		0.87		0.05		0.634		0.16		-	1.00
MC113 (MR-3)	2.84	WWH	1.28		2.0		1.09		0.14		1.235		0.22		-	1.00
MC32 (MR-5)	2.59	WWH	3.29	**5.00**	2.0	**2.96**	0.60	**0.58**	0.02	**0.53**	0.194	**1.38**	0.12	**0.17**	-	1.00
MC28 (MR-6)	2.13	WWH	2.54		2.0		0.69		0.03		0.129		0.11		-	1.00
MC118	1.58	WWH	7.27		2.0		0.22		0.06		0.251		0.12		-	1.00
MC119	0.44	WWH	6.53		2.0		0.26		0.07		0.400		0.11		-	1.84
Unamed Tributary to Cooper Creek (Rossmoyne Creek RM 14.05) @2.80																
MC114 (MR-4b)	0.55	WWH	1.49	**5.00**	2.0	**2.96**	0.72	**0.58**	0.04	**0.53**	0.866	**1.38**	0.18	**0.17**	-	1.00
West Fork Mill Creek																
MC45	0.2	WWH	6.55	**5.00**	2.0	**2.96**	0.51	**0.58**	0.05	**0.53**	0.520	**1.38**	0.15	**0.17**	20.1	1.00
Kings Run																
MC109	1.11	PHW3A	4.75	**5.00**	2.5	**2.96**	0.20	**0.58**	0.06	**0.53**	0.412	**1.38**	0.17	**0.17**	-	1.00
Unnamed Tributary to West Fork Creek @RM 1.24																
MC97	1.49	PHW3A	7.05	**5.00**	2.5	**2.96**	0.34	**0.58**	0.06	**0.53**	0.766	**1.38**	0.24	**0.17**	-	1.00
Lick Run																
MC108	1.7	PHW2	8.13		8.0		1.72		0.05		0.043		0.43		-	93.60
MC106	0.98	MWH	8.20	**4.00**	4.5	**2.48**	0.41	**0.51**	0.03	**0.31**	0.397	**0.96**	0.16	**0.70**	-	2.19
MC107	0.45	MWH	9.80		2.5		0.36		0.09		0.035		0.12		-	1.57

assess all the urban parameters similar to the preceding analyses of nutrient and demand parameters (Table 8). None of these parameters exceeded any Ohio water quality criteria.

Conductivity was measured by grab sampling at all 2021 study area sites and as specific conductance by Datasonde continuous monitors deployed in the mainstem of Mill Creek and the lower East Fork (Figure 13). The longitudinal results show a sharp increase downstream of the East Fork and gradually declining downstream along the length of Mill Creek. The 2011, 2013, 2016, and 2021 results were each well in excess of both the WWH and MWH IPS thresholds at all locations except the lower two miles of Mill Creek. Unlike the reductions demonstrated for conventional, demand, and nutrient parameters, conductivity has increased markedly since 1992. The continuous data (Figure 13) reflect a clear pattern of values indicating the Butler Co. Upper Mill Creek WRF as the primary source of elevated conductivity in Mill Creek. This is the same conclusion reached in 2011 and 2016 showing no changes over the past

***Table 8**. Mean values for selected urban related parameters in the 2021 Mill Creek study area including the Mill Creek and East Fork mainstem and selected Mill Creek tributaries. ALU is the applicable aquatic life use and IPS are the IPS thresholds that apply to each site.*

Site ID	River Mile	ALU	Conductivity (µS/cm)	Ambient/IPS	TDS (mg/L)	Ambient/IPS	Total Chloride (mg/L)	Ambient/IPS	Total Sulfate (mg/L)	Ambient/IPS	Total Copper (µg/L)	Ambient/IPS	Total Lead (µg/L)	Ambient/IPS	Total Zinc (µg/L)	Ambient/IPS
Mill Creek - WWH Reach																
MC00	26.40	WWH	890	**703**	526	**364**	65.0	**53**	81	**119**	6.8		6.6		7.5	
MC12	19.22	WWH	710		400		75.0		38		5.4		13.0		16.3	
MC10	18.86	WWH	705		402		83.5		37		-		10.3		10.1	
MC08	18.37	WWH	730		434		83.0		36		-		10.4		9.8	
MC101	17.96	WWH	1300		758		140.0		225		3.7		9.7		36.4	
MC06	16.73	WWH	1300		764		155.0		210		6.8		10.7		27.2	
MC04	15.41	WWH	1300		746		145.0		200		6.9		12.5		25.0	
MC11	13.96	WWH	1150	**660**	662	**384**	135.0	**59**	165	**120**	6.8	**8.9**	10.8	**17.4**	21.5	**39.3**
MC104	13.76	WWH	1150		654		120.0		135		7.6		13.6		18.4	
MC02	13.27	WWH	1100		658		120.0		145		7.1		11.5		23.7	
MC01	11.70	WWH	1150		652		125.0		145		6.9		12.0		20.6	
MC80	10.48	WWH	970		508		100.0		120		5.8		4.4		20.5	
MC105	9.24	WWH	1000		586		115.0		135		4.0		6.6		15.5	
MC79	8.63	WWH	1100		626		115.0		135		6.8		11.1		20.6	
MC77	7.47	WWH	1100		618		120.0		125		6.8		9.5		16.9	
Mill Creek - MWH Reach																
MC09	6.80	MWH	1100		600		120.0		140		-		9.4		15.1	
MC07	6.45	MWH	1000		560		105.0		115		6.8		9.2		12.4	
MC75	4.84	MWH	1100		604		110.0		135		6.9		4.9		17.5	
MC74	4.21	MWH	1050		614		105.0		120		6.4		4.4		15.7	
MC73	3.45	MWH	1050		598		110.0		120		6.5		4.4		17.0	
MC72	3.15	MWH	1050	**814**	596	**428**	115.0	**75**	125	**120**	6.9	**10.4**	10.2	**26.8**	15.0	**50.8**
MC05	2.50	MWH	1050		576		115.0		125		6.9		8.5		15.7	
MC03	1.69	MWH	1000		566		110.0		120		6.6		4.4		19.0	
MC71	0.83	MWH	1000		512		120.0		130		6.8		8.0		21.9	
MC70	0.50	MWH	570		402		55.5		68		6.0		8.7		17.2	
MC69	0.21	MWH	430		270		32.5		58		5.9		10.2		16.0	
East Fork Mill Creek																
MC18	1.14	WWH	830		466		86.5		43		5.2		4.9		6.5	
MC15	0.96	WWH	1600	**660**	944	**384**	160.0	**59**	325	**120**	6.0	**8.9**	5.0	**17.4**	40.0	**39.3**
MC14	0.66	WWH	1450		846		150.0		285		5.2		4.4		35.5	
MC16	0.39	WWH	1400		846		140.0		270		5.3		4.5		36.0	
Cooper Creek (Rossmoyne Creek RM 14.05)																
MC111 (MR-1)	3.57	WWH	705		380		71.0		64		8.1		13.3		16.4	
MC112 (MR-2)	3.42	WWH	870		470		135.0		61		7.9		13.1		28.8	
MC113 (MR-3)	2.84	WWH	715		388		85.0		46		7.5		18.5		18.0	
MC32 (MR-5)	2.59	WWH	645	**660**	374	**384**	69.0	**59**	37	**120**	7.0	**8.9**	15.4	**17.4**	12.6	**39.3**
MC28 (MR-6)	2.13	WWH	730		420		65.0		49		7.0		20.4		13.4	
MC118	1.58	WWH	605		346		76.5		31		5.0		-		8.2	
MC119	0.44	WWH	615		358		71.5		35		6.1		-		11.2	
Unamed Tributary to Cooper Creek (Rossmoyne Creek RM 14.05) @2.80																
MC114 (MR-4b)	0.55	WWH	575	**660**	334	**384**	57.5	**59**	60	**120**	7.0	**8.9**	11.3	**17.4**	18.0	**39.3**
West Fork Mill Creek																
MC45	0.20	WWH	530	**660**	300	**384**	51.0	**59**	18	**120**	7.0	**8.9**	5.7	**17.4**	18.0	**39.3**
Kings Run																
MC109	1.11	PHW3A	840	**660**	518	**384**	80.0	**59**	90	**120**	-	**8.9**	9.2	**17.4**	8.0	**39.3**
Unnamed Tributary to West Fork Creek @RM 1.24																
MC97	1.49	PHW3A	800	**660**	474	**384**	89.5	**59**	60	**120**	-	**8.9**	9.2	**17.4**	9.2	**39.3**
Lick Run																
MC108	1.70	PHW2	900		530		72.0		90		-		12.8		8.5	
MC106	0.98	MWH	970	**660**	464	**384**	120.0	**59**	89	**120**	-	**8.9**	18.3	**17.4**	8.8	**39.3**
MC107	0.45	MWH	900		416		100.0		79		-		19.7		14.1	

10 years. This pattern has been observed in the continuous data since 2011 and with substantial exceedances of IPS threshold applicable to the Mill Creek and the East Fork.

Total chlorides showed a similar longitudinal and temporal pattern to conductivity (Figure 14) increasing sharply downstream from the East Fork, increasing in 2011, 2016, and 2021 over 1992 and 1997. The 2016 value at MC75 (RM 5.1) was the highest ever recorded (potentially indicative of an unknown source), but this was reduced in 2021. Increases in dissolved solids and chloride have been widely observed in urban watersheds over the past 15-20 years. Most is related to the buildup of deicing salt in the riparian zone and near-surface groundwater, but in Mill Creek a significant portion is discharged by point sources. In addition to conductivity and chloride, total dissolved solids were well in excess of the WWH and MWH IPS thresholds and not returning to those levels until RM 0.5 (Table 8). Sulfates exceeded the WWH IPS thresholds downstream from the East Fork, but persisted only through the WWH segment in Mill Creek.

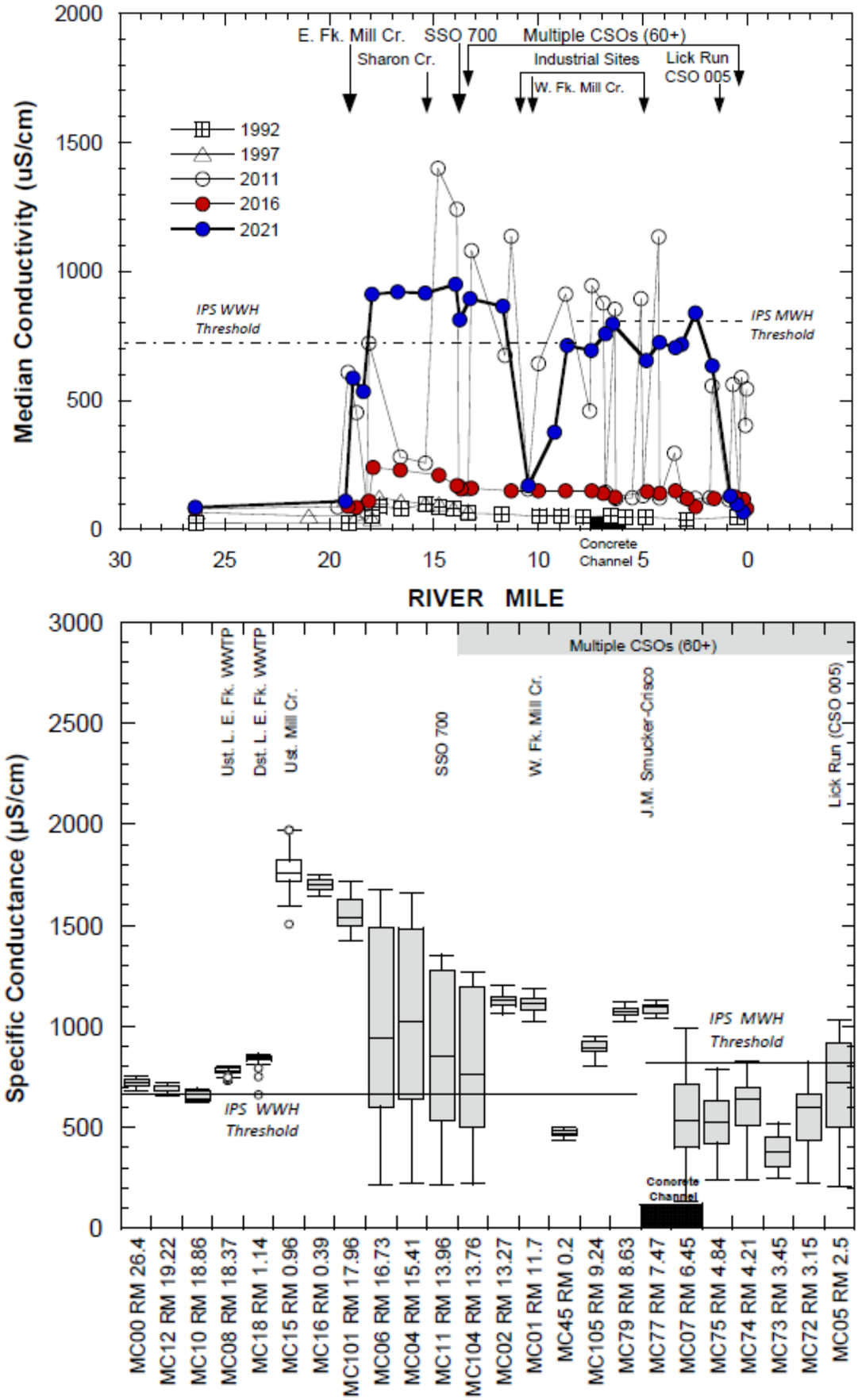


Figure 13*. Median conductivity at Mill Creek mainstem sites in 1992, 1997, 2011, 2016, and 2021 based on grab samples (upper). The IPS biological effect thresholds for the WWH and MWH uses are shown as dashed lines. Box-and-whisker plot of continuous specific conductance (lower) from Datasonde continuous recorders at 24 sites in the mainstem of Mill Creek and the lower East Fork during July 11-15 and July 20-22, 2021. The WWH and MWH IPS thresholds are indicated by dashed and solid lines. Major discharges and tributaries are indicated across the top.*

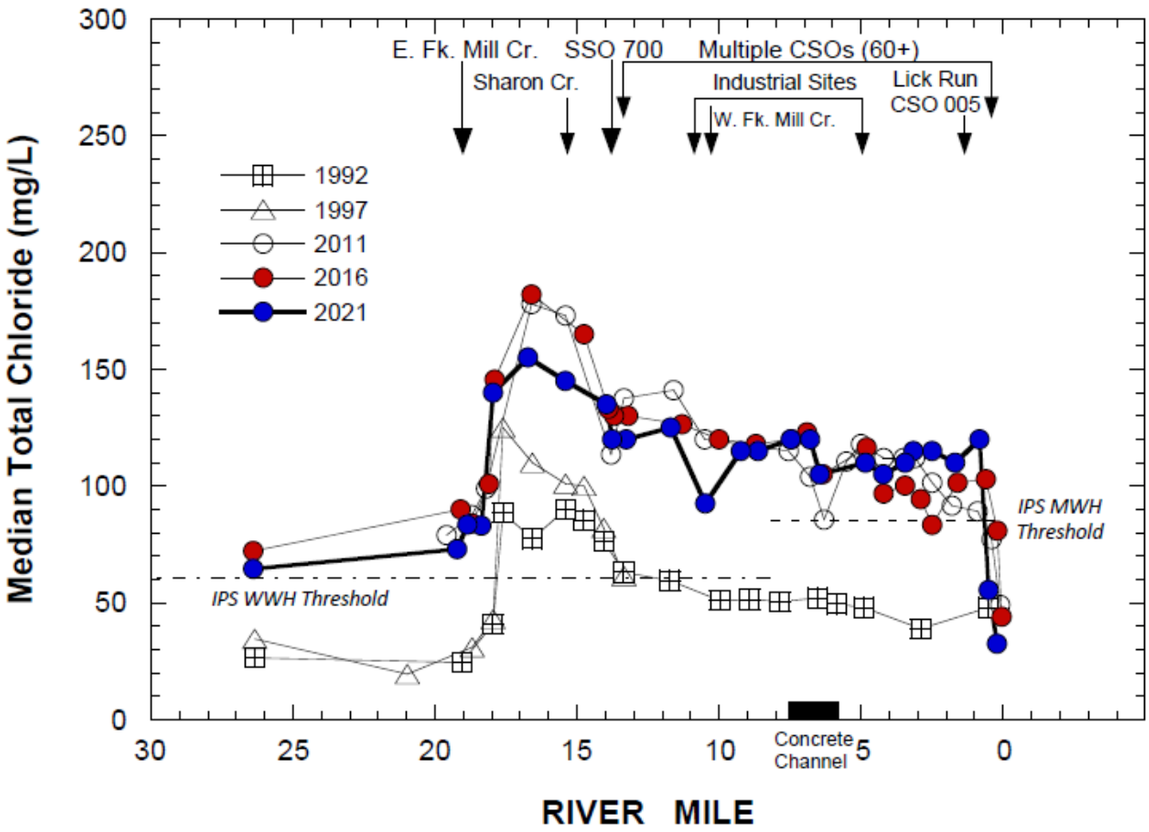


***Figure 14**. Median chloride at Mill Creek mainstem sites in 1992, 1997, 2011, 2016, and 2021 based on grab samples (upper). The IPS biological effect thresholds for the WWH and MWH uses are shown as dashed lines.*

In the Mill Creek tributaries there were eight (8) exceedances of very poor or poor thresholds for chloride, TDS, and conductivity with the exception of Lick Run that had six (6) such exceedances including two very poor chloride values in 2021 (Table 8). Cooper Creek had four such exceedances including a very poor chloride at MC112. There were 11 exceedances of the fair threshold for these same parameters in the Cooper Creek subwatershed. Of the heavy metals (copper, lead, and zinc) there were four exceedances of fair IPS thresholds, two values for lead in Cooper Creek and two in Lick Run that only slightly exceeded the WWH threshold and were well below equivalent values that would have exceed the Ohio water quality criteria.

Sediment Chemistry

Sediment samples were collected from 30 sites in the 2021 Mill Creek study area in October and analyzed for heavy metals and organic compounds. The results were screened with the MacDonald et al. (2000) consensus-based levels for potential adverse effects to aquatic life. MacDonald et al. (2000) described two values for sediment metal and organic compounds; a threshold effects concentration (TEC) and a probable effects concentration (PEC), the latter being the more conclusive threshold for the potential for adverse effects to aquatic life. Sediment chemistry has yet to be incorporated into the IPS, but developing those thresholds is an outstanding need for IPS development in the future.

Exceedances of heavy metals were documented for TECs only and among three metals including arsenic (one site only), copper, lead, and zinc (Table 9). All except two of the exceedances occurred in the mainstem between RM 13.27 (MC02) and the mouth at RM 0.05 (MC 69) and in Lick Run. Lead exceedances occurred at nine sites, copper at twelve sites, and zinc at a 15 sites. These are commonly detected metals in urban watersheds and are presumably from urban stormwater and CSOs.

PAH compounds in excess of both TEC and PEC thresholds occurred at 30 sites in the Mill Creek study area beginning at RM 26.4 (MC 00) and extending to the mouth at RM 0.05 (MC 69; Table 10). This included 11 PAH compounds with PEC exceedances being commonplace for benzo(a)pyrene, benzo(ghi)perylene, chrysene, fluoranthene, phenanthrene, and pyrene. TEC exceedances occurred for benzo(b)fluoranthene, benzo(k)fluoranthene, and indeo(1,2,3-

***Table 9**. Metals in sediments in the 2021 Mill Creek study area. Yellow shaded values exceed the Threshold Effect Concentration (TEC) of MacDonald et al. (2000). No values exceeded the Probable Effect Concentration (PEC).*

Site ID	RM	Arsenic (mg/kg)	Cadmium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Magnesium (mg/kg)	Zinc (mg/kg)
Mill Creek							
MC00	26.4	5.2	BD	11.0	9.4	16000	41
MC12	19.22	8.1	BD	17.0	17.0	18000	82
MC10	18.86	12.0	BD	25.0	29.0	21000	120
MC08	18.37	3.4	BD	18.0	12.0	7500	110
MC101	17.96	4.3	BD	12.0	10.0	19000	72
MC06	16.73	5.4	BD	27.0	29.0	12000	150
MC04	15.41	5.1	BD	30.0	26.0	12000	120
MC11	13.96	3.6	BD	15.0	16.0	11000	78
MC104	13.76	4.9	BD	22.0	19.0	12000	100
MC02	13.27	6.4	BD	37.0	30.0	15000	170
MC01	11.7	7.2	BD	21.0	19.0	11000	80
MC80	10.48	6.5	BD	34.0	35.0	15000	140
MC105	9.24	5.1	BD	32.0	34.0	12000	140
MC79	8.63	6.2	BD	32.0	28.0	11000	140
MC77	7.47	7.6	BD	28.0	26.0	21000	130
MC09	6.8	5.0	BD	22.0	30.0	15000	110
MC07	6.45	4.0	BD	18.0	13.0	8700	60
MC75	4.84	8.1	BD	72.0	47.0	13000	210
MC74	4.21	7.0	0.36	62.0	43.0	14000	200
MC73	3.45	6.7	0.63	53.0	38.0	9800	170
MC72	3.15	5.4	BD	49.0	36.0	12000	170
MC05	2.5	5.9	0.31	49.0	51.0	19000	140
MC03	1.69	5.2	0.62	51.0	65.0	8400	170
East Fork Mill Creek							
MC18	1.14	3.0	BD	13.0	11.0	7100	54
MC15	0.96	3.5	BD	15.0	11.0	8300	60
MC14	0.66	2.0	BD	9.5	6.6	6800	46
MC16	0.39	1.1	BD	11.0	5.1	4300	56
West Fork Mill Creek							
MC45	0.2	5.7	BD	41.0	56.0	7300	140
Lick Run							
MC108	1.7	3.4	BD	43.0	80.0	7800	170
MC107	0.45	4.4	BD	26.0	45.0	10000	120

cd)pyrene. Similar exceedances were also documented at the mouth of the West Fork and in Lick Run that additionally included PEC exceedances for acenaphthene. All of the detected PAH compounds are in coal tar, gasoline exhaust, and are products of the incomplete combustion and several are known carcinogens. These are commonly found in elevated levels in urban areas with asphalt pavement and heavy automobile traffic and presumably enter streams via runoff from paved surfaces. The 2021 results showed detectable amounts of PAH compounds at all sites compared to six (6) sites that had no detections in 2016 including tow upstream sites in Mill Creek at MC00 and MC10, each of which had TEC exceedances in 2021. The PEC exceedances were comparable between 2016 and 2021.

Stream Habitat

The habitat assessment is based on the QHEI and its metrics, submetrics, and individual attributes. QHEI scores in 2021 were generally in line with those observed in prior surveys dating back to 1992 with some exceptions (Figure 15). QHEI scores were generally above the threshold for WWH attainability (60) for the mainstem downstream to MC77 immediately upstream from the concrete channel and the beginning of the MWH reach. The QHEI scores in the WWH reach exhibited some variability between years which is likely due to the sampling sites being in slightly different locations between years, but also because of the comparative

***Table 10**. PAH compounds in sediments in the 2021 Mill Creek study area. Yellow shaded values exceed the TEC and orange shaded values exceed the PEC values of MacDonald et al. (2000).*

Site ID	RM	1,4-Dichlorobenzene (mg/kg)	Acenaphthene (mg/kg)	Anthracene (mg/kg)	Benzo(a)anthracene (mg/kg)	Benzo(a)pyrene (mg/kg)	Benzo(b)fluoranthene (mg/kg)	Benzo(g,h,i)perylene (mg/kg)	Benzo(k)fluoranthene (mg/kg)	Chrysene (mg/kg)	Dibenzo(a,h)anthracene (mg/kg)	Fluoranthene (mg/kg)	Fluorene (mg/kg)	Indeno(1,2,3-cd)pyrene (mg/kg)	Phenanthrene (mg/kg)	Pyrene (mg/kg)
Mill Creek																
MC00	26.4	AA	AA	AA	0.29	0.29	0.41	AA	0.16	0.21	AA	0.65	AA	0.22	0.34	0.49
MC12	19.22	AA	AA	AA	0.52	0.50	0.77	0.36	0.34	0.43	AA	1.10	AA	0.43	0.38	0.84
MC10	18.86	AA	AA	AA	0.49	0.45	0.74	0.34	0.27	0.45	AA	1.30	AA	0.41	0.45	0.90
MC101	17.96	AA	AA	AA	2.50	2.30	3.60	1.90	1.30	2.30	AA	6.10	AA	2.30	AA	AA
MC06	16.73	AA	AA	AA	1.30	1.80	2.80	1.50	1.10	1.80	AA	4.10	AA	1.60	1.10	2.70
MC04	15.41	AA	AA	AA	1.70	2.20	3.80	1.90	1.20	2.60	AA	6.10	AA	2.30	2.20	3.90
MC11	13.96	AA	AA	AA	1.90	1.80	3.10	1.50	1.10	1.80	AA	5.10	AA	1.80	1.50	3.40
MC104	13.76	AA	AA	AA	1.90	2.30	4.00	AA	1.50	2.70	AA	6.20	AA	2.30	2.10	4.30
MC02	13.27	AA	AA	AA	1.80	1.90	3.40	1.90	1.30	2.20	AA	5.00	AA	2.30	1.50	3.50
MC01	11.7	AA	AA	AA	1.80	1.60	2.50	1.30	0.93	1.50	AA	4.70	AA	1.50	1.70	3.00
MC80	10.48	AA	AA	0.8	1.60	2.00	3.60	1.80	1.10	3.10	0.37	6.70	0.53	1.90	3.30	4.50
MC105	9.24	AA	AA	0.63	1.30	1.30	2.10	1.20	0.88	AA	AA	3.90	0.38	1.30	2.40	2.50
MC79	8.63	AA	AA	0.22	1.40	1.70	2.90	1.50	0.93	1.90	0.27	4.40	0.09	1.70	1.60	3.10
MC77	7.47	AA	0.67	0.86	2.20	2.10	3.20	1.60	0.97	2.00	AA	6.40	0.93	1.70	3.40	4.20
MC09	6.8	AA	AA	0.45	0.71	0.68	1.20	0.66	0.49	0.66	AA	2.10	AA	0.68	1.60	1.40
MC07	6.45	AA	AA	0.32	0.65	0.69	1.10	0.55	0.38	0.72	AA	2.10	AA	0.69	1.40	1.40
MC75	4.84	0.31	AA	0.54	1.30	1.20	2.10	1.10	0.76	1.40	AA	3.50	AA	1.20	AA	2.80
MC74	4.21	0.26	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA
MC73	3.45	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	1.40	AA	AA
MC72	3.15	0.12	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA
MC05	2.5	0.05	AA	0.29	1.20	1.30	2.50	1.30	0.79	1.90	0.26	4.80	AA	1.30	2.70	3.90
MC03	1.69	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA	AA
MC71	0.83	0.09	AA	AA	1.30	1.20	2.40	1.20	0.70	1.40	AA	3.10	AA	1.20	1.20	2.80
MC70	0.5	0.17	AA	AA	1.30	1.20	2.20	1.10	0.78	1.20	AA	2.80	AA	1.20	0.88	2.40
MC69	0.21	0.05	AA	AA	1.30	1.30	2.40	1.20	0.91	1.40	AA	2.90	AA	1.30	0.91	2.70
East Fork Mill Creek																
MC18	1.14	AA	AA	AA	0.30	0.35	0.39	AA	AA	AA	AA	0.55	AA	0.28	AA	0.41
MC15	0.96	AA	AA	AA	0.43	0.37	0.48	0.28	0.23	0.27	AA	0.80	AA	0.25	0.32	0.60
MC14	0.66	AA	AA	AA	0.39	0.43	0.59	AA	AA	AA	AA	0.66	AA	0.33	AA	0.46
West Fork Mill Creek																
MC45	0.2	AA	AA	AA	1.40	1.50	2.30	1.20	0.87	1.30	AA	3.50	AA	1.40	1.50	2.30
Lick Run																
MC108	1.7	AA	AA	AA	0.25	0.25	0.38	0.19	0.17	0.20	AA	0.52	AA	0.24	0.16	0.37
MC107	0.45	AA	0.19	0.55	1.10	1.10	1.50	0.83	0.58	1.20	0.17	2.70	0.40	0.89	2.30	2.50

instability of the channel in localized areas. In 2021 all QHEI scores excepting four locations were good and no score was less than 50. QHEI scores were consistently very poor in the concrete channel increasing to fair and borderline good scores in the MWH reach. There has been incremental improvement in portions of the MWH reach since its original designation in 1992 between MC74 and MC03 with one site >60 and others >50. However, the predominance of the high influence modified attributes would need to be addressed for upgrading portions of this reach to WWH to be a serious consideration.

The RM 7.50 site (MC77) was originally part of the MWH segment established by Ohio EPA in 1992 (Ohio EPA 1994) but was recommended for upgrading to WWH in 2011 (MBI 2012) because it was showing sufficient signs of recovery towards WWH potential. Presently the MWH segment begins at the upstream end of the concrete channel extending downstream approximately seven (7) miles to the mouth.

A QHEI matrix showing both good and poor habitat attributes (after Rankin 1995) was developed for each site in the Mill Creek study area (Table 11). Stream habitat in Mill Creek has been modified to varying extents throughout its length as evidenced by the presence of usually 4-7 moderate influence modified attributes at most sites. Both substrate and channel related modified attributes are evident in the QHEI matrix. All except 12 of 43 sites where QHEI was conducted had moderate to high silt covering of the harder substrates. The silt covering was also accompanied by moderate to extensive embeddedness at eight (8) of the 43 sites. Two of

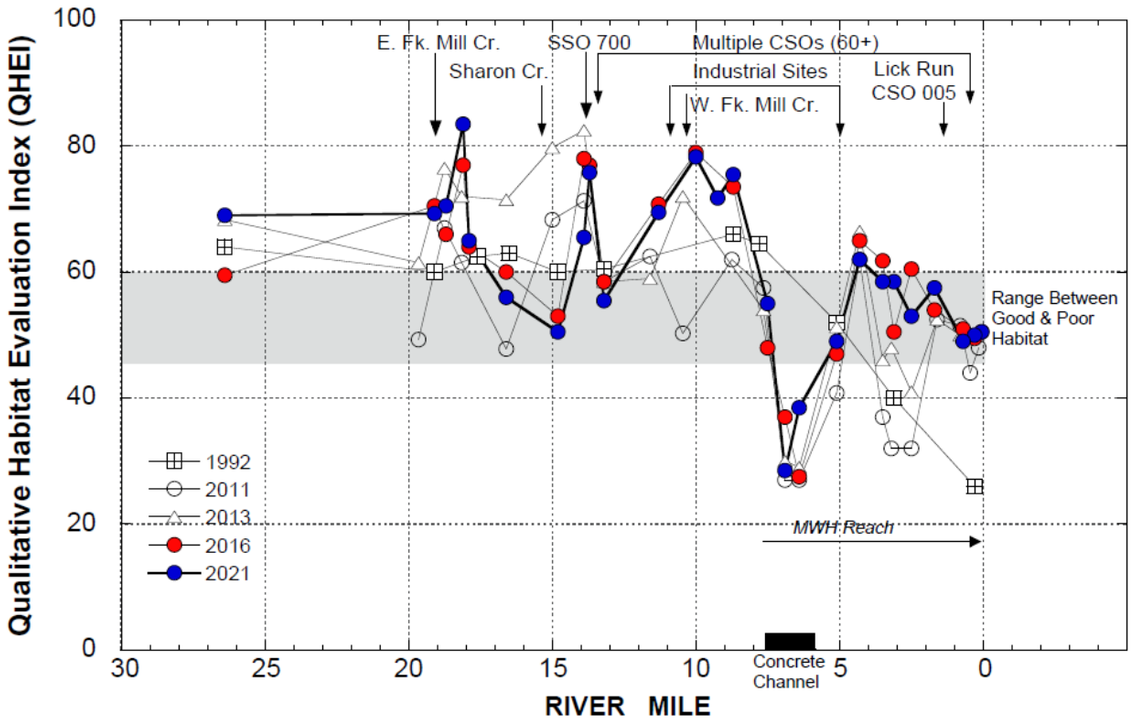


***Figure 15**. QHEI scores in the mainstem of Mill Creek in 1992, 2011, 2013, 2016, and 2021. The range between good and poor habitat is indicated by the shaded area ranging from 60 (good) to 45 (poor). The MWH reach and discharges and tributaries are indicated on the graphic.*

the sites without siltation or embeddedness were at MC09 and MC07 in the concrete channel where deposition of fine materials is deterred by the flushing of the concrete bottom by recurrent and flashy high flows. Channel modifications were evidenced by fair to poor development at 28 sites, including six (6) of the sites in the MWH reach. High influence modified attributes occurred in the MWH segment and especially so in the concrete channel.

The East Fork exhibited evidence of legacy modifications with high influence modified attributes recorded at 3 of 4 sites. An extensive restoration project was recently completed just upstream of the upstream most site at RM 1.2 (MC18) which had a QHEI score of 71.5, an increase of 14.5 points since 2016. The West Fork at RM 0.2 (MC45) exhibited good habitat with no high influence attributes and only 5 moderate influence modified attributes. Cooper Creek had borderline fair QHEI scores at the upstream most sites, but excellent QHEI scores at the two downstream sites. The upper sites were classified by this study as PHWH Class 3B and had both high and moderate influence modified QHEI attributes that related to shallow depths and flow intermittency. Rehabilitation steps are being taken by the Hamilton Co. SWCD to increase pool depths and riffle development using natural materials such as woody debris. Kings Run had a fair QHEI with two high influence modified attributes related to shallow depths and sparse cover. The unnamed tributary to West Fork Creek had good habitat quality. Lick Run exhibited attributes characteristic of an artificially constructed channel with three high and five moderate influence modified attributes and marginally fair QHEI scores. No recommendation for an aquatic life use was made at this time as Lick Run is disconnected from Mill Creek, is currently undesignated, and expectations over the long term are uncertain.

The IPS biological effect thresholds (MBI 2015) were used to assess the QHEI, the Hydro QHEI[4], and selected QHEI attributes the same way the water chemistry results were assessed (Table 12). The goals were derived from the biological stressor relationships developed to support IPS implementation (MBI 2015). This analysis of the QHEI results could be used to determine design criteria for habitat restoration where the QHEI and/or selected metrics are below the thresholds needed to meet the applicable aquatic life use. In the WWH reach of the Mill Creek the deficiencies included the Hydro QHEI at two (2) sites and channel condition at three (3)

[4] The Hydro QHEI is a subset of the QHEI metrics to include those representative of or influenced by flow.

Table 11. *Qualitative Habitat Evaluation Index (QHEI) scores showing good and modified habitat attributes and ratios at sites in the Mill Creek study area in 2021. Narrative ratings and color coding appear in the legend at bottom of table.*

			Good Habitat Attributes											High Influence Modified Attributes						Moderate Influence Modified Attributes															
Site ID	River Mile	QHEI	No Channelization	Boulder, Cobble, Gravel	Silt Free	Good-Excellent Development	Moderate-High Sinuosity	Moderate-Extensive Cover	Fast Flow w Eddies	Little to No Embeddedness	Max Depth > 40 cm	No Riffle Embeddedness	Good Habitat Attributes	Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse No Cover	Max Depths <40 cm	High Influence Poor Attributes	Recovering from Channelizatio	Mod-High Silt Cover	Sand Substrates (Boatable sites	Hardpan Origin	Fair- Poor Development	Low Sinuosity	< 2 Cover Types	Intermittent Flow or Pools <20	No Fast Current Types	Mod-Extensive Embeddedness	Mod-Extensive Riffle Embedde	No Riffle	Poor Habitat Attributes	Ratio of Modified (High) to Goo	Ratio of Modified (All) to Good
Mill Creek																																		
MC00^{HW}	26.40	69.00		■		■		■			■	■	5						0	●	●				●			●	●			5	0.00	1.00
MC12^{W}	19.22	69.30		■		■		■	■		■	■	6						0	●	●				●				●	●		5	0.00	0.83
MC10^{W}	18.86	65.75	■	■		■	■	■			■		6						0	●	●			●	●			●	●	●	●	8	0.00	1.33
MC08^{W}	18.37	83.50	■	■		■	■	■	■	■	■	■	9						0		●								●			2	0.00	0.22
MC101^{W}	17.96	65.00		■				■	■		■	■	5						0	●	●			●	●				●			5	0.00	1.00
MC06^{W}	16.73	56.00	■					■			■		3						0	●	●			●	●			●	●	●		7	0.00	2.33
MC04^{W}	15.41	50.50	■					■			■		3			●			1	●	●			●				●	●		●	6	0.33	2.33
MC11^{W}	13.96	65.50	■	■		■	■		■	■	■	■	8				●		1	●	●								●			3	0.13	0.50
MC104^{W}	13.76	75.80		■		■		■	■	■	■	■	7						0	●	●				●				●			4	0.00	0.57
MC02^{W}	13.27	55.50		■				■			■		3			●			1	●	●			●				●	●		●	6	0.33	2.33
MC01^{W}	11.70	69.50	■	■		■		■	■	■	■	■	8						0	●	●				●				●			4	0.00	0.50
MC80^{W}	10.48	78.30		■		■		■	■	■	■	■	7						0	●					●							2	0.00	0.29
MC105^{W}	9.24	71.80		■		■		■	■	■	■	■	7				●		1	●					●				●			3	0.14	0.57
MC79^{W}	8.63	75.50	■	■		■		■	■	■	■	■	8						0	●	●				●				●			4	0.00	0.50
MC77^{W}	7.47	55.00		■							■		2			●	●		2	●	●			●				●	●	●		6	1.00	4.00
MC09^{W}	6.80	28.50			■		■			■	■		4	●			●		2					●	●	●		●		●		5	0.50	1.75
MC07^{W}	6.45	38.50		■	■				■	■	■		5	●			●		2					●	●	●				●		4	0.40	1.20
MC75^{W}	4.84	49.00						■			■		2	●		●	●		3		●			●				●	●		●	5	1.50	4.00
MC74^{W}	4.21	62.00		■		■		■	■		■		5						0	●	●				●				●	●		5	0.00	1.00
MC73^{W}	3.45	58.50		■				■		■	■		4						0	●				●	●			●		●		5	0.00	1.25
MC72^{W}	3.15	58.50		■				■			■		3						0	●	●			●	●			●	●	●		7	0.00	2.33
MC05^{W}	2.50	53.00		■					■		■	■	4				●		1	●	●			●	●	●			●			6	0.25	1.75
MC03^{B}	1.69	57.50						■			■		2						0	●	●			●	●			●	●	●		7	0.00	3.50
MC71^{B}	0.83	49.00						■			■		2	●		●			2		●			●				●	●		●	5	1.00	3.50
MC70^{B}	0.50	50.00						■			■		2			●			1	●	●			●				●	●		●	6	0.50	3.50
MC69^{B}	0.21	50.50	■					■			■		3				●		1		●			●	●			●	●		●	6	0.33	2.33
QHEI Narrative	Excellent - B & W		≥75										9^{B};8^{W}						0														1	0.00	0.50
	Excellent - HW		≥70										8						0														2	0.00	0.50
	Good - B & W		60-74										6						0														4	0.50	1.00
	Good - HW		55-69										6						1														4	0.50	1.00
	Fair - B & W		45-59										2^{B};4^{W}						1														6	1.00	2.00
	Fair - HW		43-54										3						2														6	1.00	2.00
	Poor - B & W		30-44										2^{B};1^{W}						2														6^{B};7^{W}	2.00	4.00
	Poor - HW		30-42										2						3														6	2.00	4.00
	Very Poor		<30										1$^{B/W}$;0^{HW}						3$^{B/W}$;4^{HW}														7	>2.00	>6.00

Table 11. *continued .*

Site ID	River Mile	QHEI	Good Habitat Attributes											High Influence Modified Attributes						Moderate Influence Modified Attributes															Ratio of Modified (High) to Good	Ratio of Modified (All) to Good
			No Channelization	Boulder, Cobble, Gravel	Silt Free	Good-Excellent Development	Moderate-High Sinuosity	Moderate-Extensive Cover	Fast Flow w Eddies	Little to No Embeddedness	Max Depth > 40 cm	No Riffle Embeddedness	Good Habitat Attributes	Channelized or No Recovery	Silt/Muck Substrates	No Sinuosity	Sparse No Cover	Max Depths <40 cm	High Influence Poor Attributes	Recovering from Channelization	Mod-High Silt Cover	Sand Substrates (Boatable sites)	Hardpan Origin	Fair- Poor Development	Low Sinuosity	< 2 Cover Types	Intermittent Flow or Pools <20 cm	No Fast Current Types	Mod-Extensive Embeddedness	Mod-Extensive Riffle Embeddedness	No Riffle	Poor Habitat Attributes				
East Fork Mill Creek																																			
MC18^{HW}	1.14	**71.50**		■		■		■	■		■	■	6			●	●		2	●	●			●					●			4	0.33	1.00
MC15^{HW}	0.96	**78.00**		■		■		■	■	■	■	■	7						0	●	●				●				●			4	0.00	0.57
MC14^{HW}	0.66	**67.65**	■	■				■	■		■		5			●			1	●	●			●	●				●	●		6	0.20	1.20
MC16^{HW}	0.39	**60.50**				■		■	■	■	■		5	●		●	●		3		●			●					●	●		4	0.60	1.40
Cooper Creek (Rossmoyne Creek RM 14.05)																																			
MR-1^{HW}	3.57	**48.50**	■	■			■						3				●	●	2		●			●		●		●	●		●	6	0.67	2.67
MR-2^{HW}	3.42	**42.50**		■									1			●	●	●	3	●	●			●		●	●	●	●		●	8	3.00	11.00
MR-3^{HW}	2.84	**47.50**		■	■						■		3	●		●	●		3					●				●	●		●	4	1.00	2.33
MR-5^{HW}	2.59	**49.50**		■							■		2			●	●		2	●				●		●		●	●		●	6	1.00	4.00
MR-6^{HW}	2.13	**61.30**	■	■	■	■				■	■		6				●		1					●	●			●			●	4	0.17	0.83
MC118^{HW}	1.58	**81.50**	■	■		■	■	■	■	■	■	■	9						0														0	0.00	0.00
MC119^{HW}	0.44	**88.50**	■	■		■	■	■	■	■	■	■	9						0		●												1	0.00	0.11
Unnamed Tributary to (Rossmoyne Creek RM14.06) Cooper Creek @RM 2.80																																			
MR-4b^{HW}	0.55	**45.50**	■	■	■						■		4				●		1					●	●			●	●		●	5	0.25	1.50
West Fork Mill Creek																																			
MC45^{W}	0.20	**69.30**	■	■		■		■		■	■	■	7						0	●					●			●	●	●		5	0.00	0.71
Kings Run (RM)																																			
MC109^{HW}	1.11	**52.00**		■		■	■						3				●	●	2	●	●							●	●		●	5	0.67	2.33
Unnamed Tributary to West Fork Creek @RM1.24																																			
MC97^{HW}	1.49	**69.50**		■		■		■		■	■	■	6			●	●		2	●								●				2	0.33	0.67
Lick Run																																			
MC106^{HW}	0.98	**45.00**		■		■							2	●			●	●	3		●				●			●	●		●	5	1.50	4.00
MC107^{HW}	0.45	**47.50**		■		■	■						3	●			●	●	3		●					●		●	●		●	5	1.00	2.67
QHEI Narrative	Excellent - B & W	≥75											$9^{B};8^{W}$						0														1	0.00	0.50
	Excellent - HW	≥70											8						0														2	0.00	0.50
	Good - B & W	60-74											6						0														4	0.50	1.00
	Good - HW	55-69											6						1														4	0.50	1.00
	Fair - B & W	45-59											$2^{B};4^{W}$						1														6	1.00	2.00
	Fair - HW	43-54											3						2														6	1.00	2.00
	Poor - B & W	30-44											$2^{B};1^{W}$						2														$6^{B};7^{W}$	2.00	4.00
	Poor - HW	30-42											2						3														6	2.00	4.00
	Very Poor	<30											$1^{B/W};0^{HW}$						$3^{B/W};4^{HW}$														7	>2.00	>6.00

sites. In the MWH reach deficiencies were judged against the MWH use which is inherently modified thus only two sites in the concrete channel (RM 6.45/MC07 and RM6.80/MC09) revealed any deficiencies below MWH goals. The East Fork revealed deficiencies below the WWH IPS thresholds for channel condition (2 sites). Cooper Creek showed multiple deficiencies below the WWH IPS thresholds for the Hydro QHEI at 4 sites, along with deficiencies for current (4 sites), depth (3 sites), channel (3 sites), cover (4 sites), and riffle (4 sites) which is related to the altered hydrological characteristics of this highly urbanized watershed. Lick Run, a recently daylighted stream, had deficiencies below the MWH IPS thresholds for Hydro QHEI at two sites, current (2 sites), depth (2 sites), cover (2 sites), and riffle (2 sites) which is also related to its highly urbanized watershed.

Table 12. *QHEI and Hydro QHEI scores and selected attributes in the 2021 Mill Creek study area. Selected values are color coded by their IPS ranges that correspond to tiered uses and narrative quality; blue – EWH (exceptional); green – WWH (good); yellow – MWH (fair); orange – LRW (poor); red – very poor quality. IPS threshold goals for each site are in the column to the right of each value.*

Site ID	River Mile	Drainage Area (sq mi)	QHEI	Hydro-QHEI	Metric Scores								Gradient	
					Current	Depth	Substrate	Channel	Cover	Riparian	Pool	Riffle	ft/mi	Score
Mill Creek														
MC00	26.40	4.40	**69.00**	12	3	9	14.5	13.0	14.0	5.5	10.0	4.0	37.00	8
MC12	19.22	26.70	**69.25**	14	6	8	14.0	12.0	16.0	4.3	9.0	4.0	9.10	10
MC10	18.86	27.00	**70.50**	12	3	9	13.0	13.0	18.0	3.5	10.0	3.0	9.10	10
MC08	18.37	27.30	**83.50**	20	9	11	16.5	14.0	18.0	7.0	11.0	7.0	9.10	10
MC101	17.96	42.20	**65.00**	19	9	10	14.0	11.0	15.0	4.0	9.0	6.0	3.51	6
MC06	16.73	50.50	**56.00**	10	1	9	13.0	8.5	16.0	3.5	8.0	1.0	3.58	6
MC04	15.41	61.30	**50.50**	8	1	7	10.0	7.5	15.0	4.0	8.0	0.0	3.58	6
MC11	13.96	68.80	**65.50**	22	11	11	15.0	15.5	10.0	0.0	12.0	7.0	4.48	6
MC104	13.76	71.60	**75.75**	22	11	11	17.0	14.5	16.0	3.3	12.0	7.0	4.46	6
MC02	13.27	72.30	**55.50**	10	3	7	14.0	7.0	16.0	3.5	9.0	0.0	4.48	6
MC01	11.70	73.90	**69.50**	22	11	11	16.0	12.5	13.0	5.0	12.0	7.0	52.60	4
MC80	10.48	115.00	**78.25**	22	11	11	18.0	12.0	13.0	6.3	12.0	7.0	8.26	10
MC105	9.24	119.00	**71.75**	19	9	10	17.5	12.0	11.0	7.3	12.0	6.0	24.40	6
MC79	8.63	120.00	**75.50**	22	11	11	15.0	12.5	14.0	5.0	12.0	7.0	9.35	10
MC77	7.47	126.00	**55.00**	5	3	2	15.0	10.0	6.0	4.0	6.0	4.0	4.17	10
MC09	6.80	128.00	**28.50**	5	3	2	2.0	7.5	2.0	3.0	4.0	4.0	1.47	6
MC07	6.45	135.00	**38.50**	14	9	5	9.5	7.0	2.0	3.0	6.0	5.0	1.47	6
MC75	4.84	139.00	**49.00**	10	3	7	11.0	6.0	11.0	6.0	9.0	0.0	1.86	6
MC74	4.21	141.00	**62.00**	15	6	9	14.0	12.0	12.0	5.5	10.0	2.5	1.86	6
MC73	3.45	144.00	**58.50**	8	1	7	14.0	10.0	15.0	5.0	6.0	2.5	1.86	6
MC72	3.15	154.00	**58.50**	10	3	7	12.0	10.0	14.0	5.5	8.0	3.0	1.86	6
MC05	2.50	156.00	**53.00**	14	9	5	13.0	11.0	5.0	5.0	6.0	7.0	1.86	6
MC03	1.69	163.00	**57.50**	11	3	8	11.5	9.0	15.0	5.0	9.0	2.0	1.86	6
MC71	0.83	164.00	**49.00**	8	1	7	9.0	6.0	15.0	5.0	8.0	0.0	1.86	6
MC70	0.50	164.00	**50.00**	8	1	7	11.0	7.0	14.0	4.0	8.0	0.0	1.86	6
MC69	0.21	164.00	**50.50**	8	1	7	11.0	10.0	12.0	3.5	8.0	0.0	1.86	6
West Fork Mill Creek														
MC45	0.20	36.50	**69.25**	11	3	8	15.5	13.5	14.0	4.3	8.0	4.0	15.40	10
Wadeable Narrative Thresholds														
Excellent			**≥75**	≥11	≥6	≥8	≥16	≥16	≥15	≥6.5	≥10	≥5		10
Good			**60-74**	9-10	3-5	6-7	14-15	14-15	13-14	5-6	7-9	3-4		8-9
Fair			**45-59**	7-8	2	4-5	10-13	10-13	10-12	3-4	5-6	2		6-7
Poor			**30-44**	4-6	1	2-3	6-9	6-9	6-9	2	3-4	1		4-5
Very Poor			**<30**	≤3	<1	≤1	≤6	≤6	≤6	≤1	<3	0		<4
East Fork Mill Creek														
MC18	1.14	9.30	**71.50**	17	7	10	14.5	10.0	14.0	6.0	11.0	6.0	6.90	10
MC15	0.96	9.30	**78.00**	20	9	11	15.0	14.0	16.0	5.0	11.0	7.0	6.90	10
MC14	0.66	9.50	**71.00**	22	11	11	14.0	9.0	16.0	4.0	12.0	6.0	6.90	10
MC16	0.39	9.60	**60.50**	20	9	11	12.0	8.0	13.0	2.5	11.0	6.0	24.40	8
Cooper Creek (Rossmoyne Creek RM 14.05)														
MC111	3.57	0.30	**48.50**	1	1	0	16.0	13.0	5.0	6.5	4.0	0.0	52.00	4
MC112	3.42	0.50	**42.50**	-2	-2	0	16.5	9.0	5.0	6.0	2.0	0.0	52.00	4
MC113	2.84	1.10	**47.50**	4	-3	7	20.0	5.0	5.0	7.5	6.0	0.0	155.00	4
MC32	2.59	1.80	**49.50**	1	0	1	20.0	9.0	5.0	7.5	4.0	0.0	90.00	4
MC28	2.13	2.60	**61.25**	9	3	6	22.0	13.0	9.0	7.3	8.0	0.0	75.00	4
MC118	1.58	4.00	**81.50**	27	16	11	18.0	16.5	16.0	4.0	13.0	7.0	35.70	8
MC119	0.44	5.40	**88.50**	25	14	11	17.5	19.0	15.0	8.0	12.0	7.0	18.88	10
Unnamed Tributary to West Fork Creek @ RM 1.24														
MC97	1.49	0.80	**69.50**	12	3	9	19.0	11.5	13.0	7.0	10.0	5.0	166.70	4
Unnamed Tributary to Cooper Creek (Rossmoyne Creek RM 14.05)														
MC114	0.55	0.50	**45.50**	3	-3	6	17.5	9.0	6.0	5.0	4.0	0.0	86.00	4
Kings Run														
MC109	1.11	0.90	**52.00**	1	1	0	15.0	15.0	8.0	6.0	4.0	0.0	90.90	4
Lick Run														
MC106	0.98	3.50	**45.00**	1	1	0	15.0	11.0	6.0	5.0	4.0	0.0	83.30	4
MC107	0.45	3.60	**47.50**	1	1	0	14.5	12.0	4.0	5.0	4.0	0.0	13.16	8
Headwater Narrative Thresholds														
Excellent			**>70**	≥10	≥6	≥8	≥15	≥15	≥14	≥6.0	≥8	≥3.5		10
Good			**55-69**	8-9	3-5	6-7	13-14	13-14	12-13	4-5	6-7	3		8-9
Fair			**43-54**	6-7	2	4-5	10-12	10-12	9-11	3	4-5	2		6-7
Poor			**30-42**	3-5	1	2-3	6-9	6-9	6-9	2	2-3	1		4-5
Very Poor			**<30**	<3	<1	≤1	≤6	<6	<6	≤1	<2	0		<4

Biological Assemblages

Fish were sampled at 40 sites and macroinvertebrates at 33 sites in 2021 following standardized procedures specified by the 2011 Plan (MBI 2011) and consistent with Level 3 specifications and the Ohio WQS. Results for the IBI, MIwb, and %DELT anomalies were used to assess any changes in the fish assemblages and the ICI were used to assess changes in the macroinvertebrate assemblage. Such analyses offer the opportunity to determine not only the magnitude of any changes, but to determine the incremental changes that have taken place through time. It also provides a way to visualize the degree to which the biocriteria indices either exceed or fail to attain their respective biological criteria.

Fish Assemblage Results

Results for the two primary fish assemblage indices that comprise the Ohio biocriteria are depicted for 2021 and all years of previous results since 1992 (Figure 16). The prior sampling conducted by Ohio EPA in 1992 (Ohio EPA 1994) and MSD/MBI in 2011 (MBI 2012), 2013, and 2016 offers an opportunity to examine changes through time for the mainstem of Mill Creek.

The overall results show that increases in the quality of the fish assemblages have taken place along the length of the commonly assessed reaches of the mainstem over approximately 26 miles since 1992 (Figure 16). The increases in the IBI and MIwb between 1992 and 2016 were insufficient to attain the WWH biocriterion at most sites, but the narrative quality improved from consistently poor in 1992 to mostly fair in 2016. The IBI improved further in 2021 showing incremental increases below the WWH biocriterion, some to the nonsignificant departure range, and two sites meeting the WWH biocriterion (Figure 16). The increases observed in the MWH reach were sufficient to attain and exceed the IBI MWH biocriterion. The Ohio EPA results from the upper mainstem in 2014 were included in Figure 16 to illustrate the consistency with the 2011, 2013, 2016, and 2021 MBI results. The 2014 IBI at the upstream most site was in the very good range and was comparable to the 2021 result in terms of WWH attainment.

The MIwb showed comparatively little change between 1992 and 2016 in the WWH designated reach but increased in 2021 by attaining the WWH biocriterion at two sites in the WWH reach and nine sites in the MWH reach (Figure 16, lower). This is not necessarily a contradiction of the IBI results, but rather shows the usual recovery process where fish abundance and biomass can increase across tolerant and moderately tolerant species in the initial stages of recovery, whereas the IBI needs to have compositional changes among intermediate and sensitive species in order to attain the WWH IBI. The MIwb continued to show a marked increase from 1992 in the MWH designated reach which suggests a lessening of legacy toxic impacts along the formerly industrialized reach just upstream. DELT anomalies markedly declined between 1992 and 2016 suggesting diminished legacy toxic impacts but remained elevated above normal levels (Figure 17). The 2021 results were markedly lower than 2016, rates were below the range of normal to elevated incidence at all sites in 2021. This will continue to be a key indicator of lingering stress going forward.

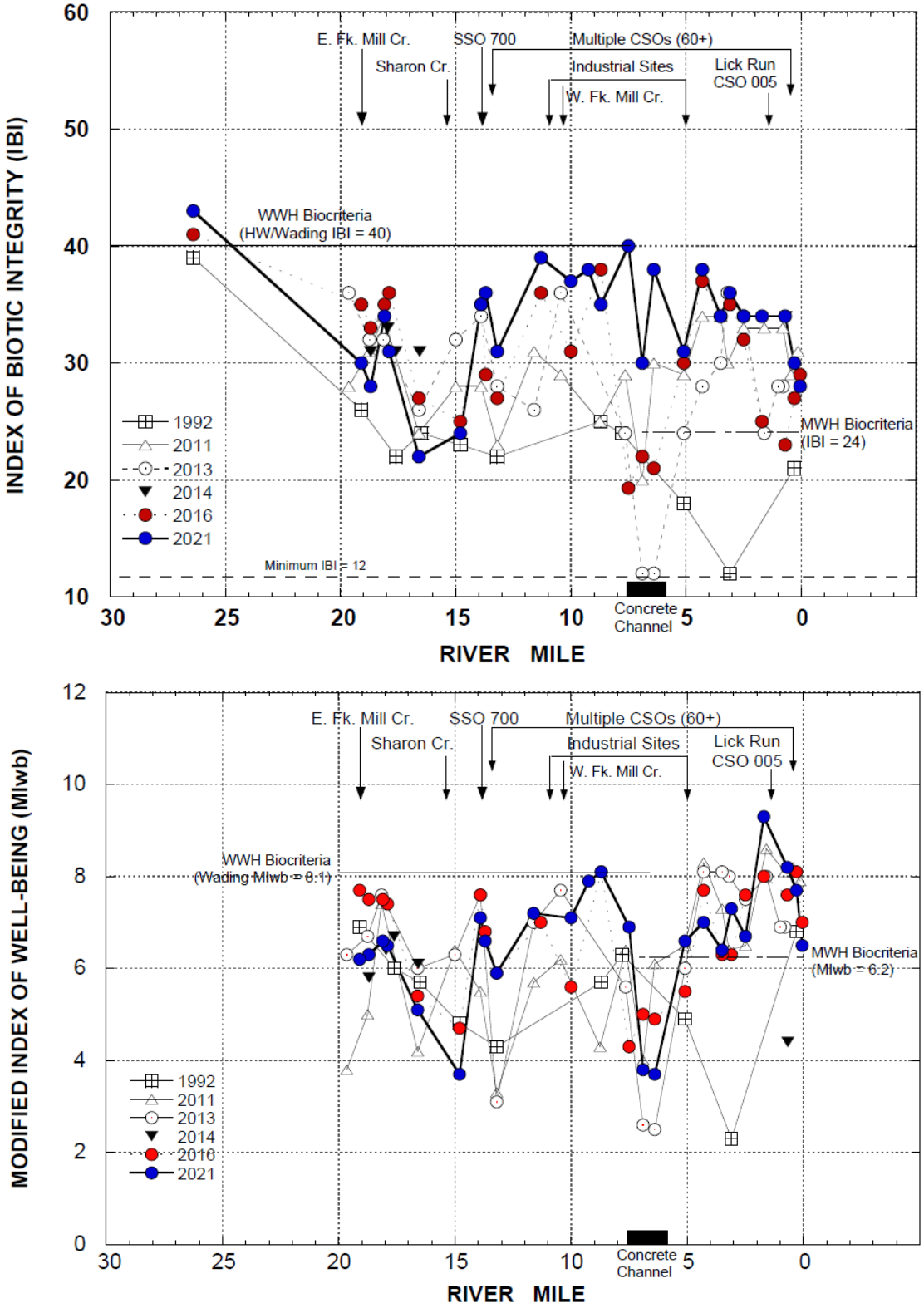


***Figure 16**. Index of biotic integrity (IBI) results for the Mill Creek mainstem (upper) and MIwb results (lower) in 1992, 2011, 2013, 2014, 2016, and 2021 (upper). The WWH and MWH biocriteria are depicted with major pollution sources and tributaries along the top of each graph.*

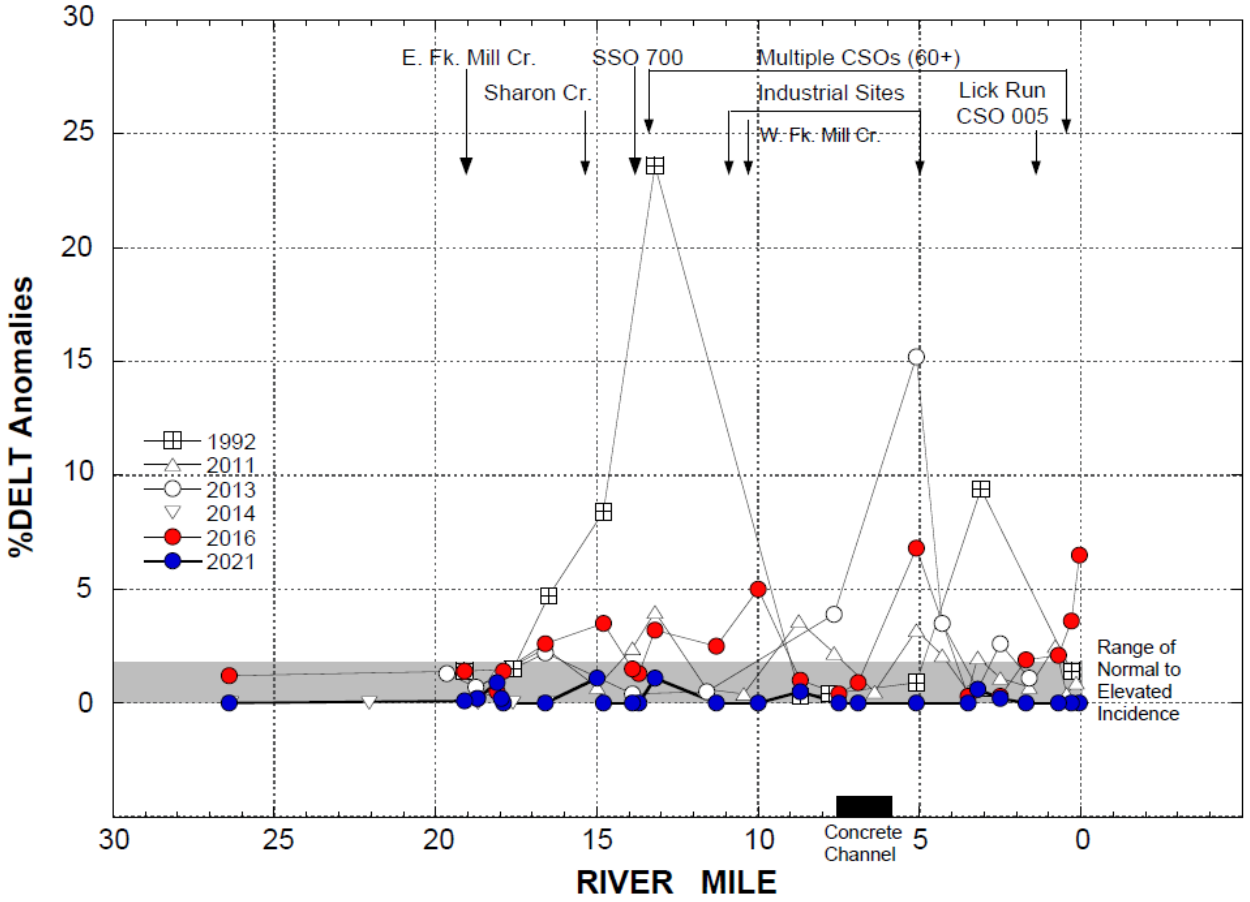


Figure 17*. The percentage of fish with DELT anomalies in the mainstem of Mill Creek during 1992, 2011, 2013, 2014, 2016, and 2021. The range of %DELT from normal to elevated incidence are depicted with major pollution sources and tributaries along the top of each graph.*

Key fish assemblage results are depicted in Table 13. Excepting four sites that had no fish collected, overall narrative fish assemblage condition ranged from very poor to good. Of the 40 sites with fish assemblage data 15 failed to attain the WWH IBI biocriteria threshold and another two (2) failed the MWH biocriterion which is 43% of all sites, which is down from 61% in 2016. No toxic tolerant signatures such as highly elevated DELT anomalies were evident in the 2021 results. The [proportion of tolerant species was high in the upper Mill Creek mainstem along with low proportions of simple lithophils in the lower mainstem. The tributaries had few or no sensitive species with high proportions of tolerant species at two Cooper Creek sites (MC112 and MC113) and the two Lick Run sites with fish. DELT anomalies were low and at or below background levels expected for this metric.

The composition of the fish assemblage was compared between 2016 and 2021 and for the WWH and MWH reaches (Tables 14 and 15). In the WWH reach Emerald Shiner, Striped Shiner, Rainbow Darter, and Greenside Darter increased in numbers from 2016 to 2021. Seven species not collected in 2016 were collected in 2021 and included Smallmouth Redhorse for the first

***Table 13**. Fish assemblage response indicators in the Mill Creek, the East Fork, and West Fork Mill Creek in 2021. The results for each indicator are color coded in accordance with the key at the bottom of the table.*

Site ID	River Mile	Drainage Area (sq. mi.)	IBI	Miwb	Native Species	%DELT	Sensitive Species	Simple Lithophils	%Tolerant
Mill Creek									
MC00	26.4	4.43	43	NA	11.5	0.00	1.0	33.38	27.72
MC12	19.22	26.7	30	6.20	14.0	0.12	2.5	10.23	67.82
MC10	18.86	27	28	6.22	12.0	0.19	1.5	8.34	65.70
MC08	18.37	27.3	34	6.57	11.0	0.85	1.0	5.54	42.67
MC101	17.96	42.2	31	6.41	13.5	0.15	2.0	10.03	71.73
MC06	16.73	50.5	22	5.09	8.0	0.00	2.0	2.25	77.53
MC04	15.41	61.3	24	3.74	4.0	1.14	1.0	1.12	66.29
MC11	13.96	68.8	35	7.06	16.0	0.00	2.5	14.65	55.33
MC104	13.76	71.6	36	6.57	13.5	0.00	3.0	22.72	40.33
MC02	13.27	72.3	31	5.92	11.5	1.06	1.5	16.16	73.31
MC01	11.7	73.9	39	7.19	21.0	0.00	5.5	13.92	41.62
MC80	10.48	115	37	7.09	16.0	0.00	7.0	36.78	33.42
MC105	9.24	119	38	7.84	19.5	0.00	7.0	11.89	24.83
MC79	8.63	120	35	8.09	16.5	0.50	6.0	24.30	29.22
MC77	7.47	126	40	6.88	16.5	0.00	5.0	14.94	11.70
MC09	6.8	128	30	3.84	7.0	0.00	2.0	2.56	1.54
MC07	6.45	135	28	3.69	3.0	0.00	1.0	0.00	0.00
MC75	4.84	139	31	6.53	10.0	0.00	1.5	0.67	28.28
MC74	4.21	141	38	6.98	14.5	0.00	6.0	5.75	17.00
MC73	3.45	144	34	6.34	14.5	0.00	3.5	3.17	18.64
MC72	3.15	154	36	7.26	14.5	0.56	4.5	0.80	12.59
MC05	2.5	156	34	6.69	11.0	0.16	4.0	0.97	0.28
MC03	1.69	163	34	9.27	16.0	0.00	1.0	0.00	7.19
MC71	0.83	164	34	8.16	16.0	0.00	1.0	0.00	10.34
MC70	0.5	164	30	7.72	11.0	0.00	1.0	2.50	5.00
MC69	0.21	164	28	6.47	8.0	0.00	2.0	3.23	12.91
West Fork Mill Creek									
MC45	0.2	36.5	26	7.06	14.0	0.00	3.0	21.57	72.55
East Fork Mill Creek									
MC18	1.14	9.27	33	NA	10.5	0.00	1.5	14.43	58.80
MC15	0.96	9.3	34	NA	11.5	0.00	2.5	17.56	67.35
MC14	0.66	9.53	28	NA	8.5	0.18	1.0	21.73	70.23
MC16	0.39	9.59	28	NA	8.5	0.00	1.5	17.91	75.12
Narrative Ranking Thresholds	**Excellent**		44-60	> 9.1	>25	0	>15	>30	≤15
	Good		38-43	8.0-9.0	>14	<1.3	11-15	>20-30	>15-30
	Fair		26-37	5.8-7.9	>10	<3.0	3-10	>10-20	>30-50
	Poor		19-25	4.0-5.7	>7	>10	1-2	>5-10	>50-70
	Very Poor		12-18	<4.0	≤7	>20	0	≤5	≥70

***Table 13** . continued.*

Site ID	River Mile	Drainage Area (sq. mi.)	IBI	Miwb	Native Species	%DELT	Sensitive Species	Simple Lithophils	%Tolerant
Coopers Creek (Rossmoyne Creek RM 14.05)									
MC111	3.57	0.34	28	NA	3.0	0.49	0.0	8.25	64.56
MC112	3.42	0.48	28	NA	3.0	0.22	0.0	16.18	76.40
MC113	2.84	1.1	30	NA	4.0	0.00	0.0	5.15	73.39
MC32	2.59	1.8	30	NA	4.0	0.00	0.0	6.68	41.43
MC28	2.13	2.6	32	NA	5.0	0.53	0.0	15.33	47.73
MC118	1.58	3.99	46	NA	11.0	0.00	1.0	23.16	28.95
MC119	0.44	5.43	46	NA	12.0	0.00	1.0	16.62	27.79
Unnamed Tributary to Cooper Creek (Rossmoyne Creek RM 14.05) @RM 2.80									
MC114	0.55	0.49	12	NA	1.0	0.00	0.0	0.00	NA
Kings Run									
MC109	1.11	0.91	12	NA	0.0	0.00	0.0	0.00	NA
Unnamed Tributary to West Fork Creek @RM 1.24									
MC97	1.49	0.84	12	NA	0.0	0.00	0.0	0.00	NA
Lick Run									
MC108	1.7	0.19	Dry						
MC106	0.98	3.45	16	NA	2.0	0.00	0.0	0.00	97.06
MC107	0.45	3.55	20	NA	2.0	0.00	0.0	0.00	80.65
Narrative Ranking Thresholds	**Excellent**		44-60	> 9.1	>25	0	>15	>30	≤15
	Good		38-43	8.0-9.0	>14	<1.3	11-15	>20-30	>15-30
	Fair		26-37	5.8-7.9	>10	<3.0	3-10	>10-20	>30-50
	Poor		19-25	4.0-5.7	>7	>10	1-2	>5-10	>50-70
	Very Poor		12-18	<4.0	≤7	>20	0	≤5	≥70

time. Other notable new species were Black Redhorse, River Carpsucker, Rosyface Shiner, and Silverjaw Minnow. Five species collected in 2016 were not collected in 2021, but each occurred in low numbers in 2016. Tolerant species such as Green Sunfish and Common Carp increased in abundance while intermediate and sensitive species slightly decreased or remained stable in numbers between 2016 and 2021. In the MWH reach species with significant increases in 2021 included Longear Sunfish (3.0 vs. 16.0), Rainbow Darter, and Sand Shiner. The 2021 assemblage included several large river species which presumably entered Mill Creek via the Ohio River as water quality conditions continue to improve.

Prior to the urbanization development of the Mill Creek watershed the fish fauna also included the highly intolerant Bigeye Chub, Rosyface Shiner, Brook Silverside, and Sand Darter and one record of Alligator Gar at the mouth of Mill Creek (Trautman 1981). Species of intermediate tolerance (e.g., Striped Shiner, Silverjaw Minnow, Sand Shiner, and Orangethroat Darter) have now been documented in Mill Creek as the heavily polluted conditions of the pre-1980s and 1990s have been abated. Sensitive fish species still occur in low numbers and restoring the assemblage to full WWH expectations will require dealing with non-pollutant stressors such as urban runoff and habitat.

***Table 14**. Fish species (excluding hybrids) collected in the WWH reach of the Mill Creek mainstem in 2021 showing catch-per-unit-effort (CPUE) and percent by numbers compared to 2016.*

Species (rank in 2016)	**2021**		**2016**	
	CPUE	**%numbers**	**CPUE**	**%numbers**
1. Green Sunfish (2)	159.1	32.63%	44.5	12.50%
2. Common Carp (13)	53.5	10.97%	6.4	1.81%
3. Bluegill Sunfish (4)	44.7	9.16%	37.4	10.47%
4. Emerald Shiner (33)	39.5	8.11%	0.1	0.03%
5. Central Stoneroller (1)	36.0	7.38%	75.9	21.30%
6. Northern Hog Sucker (6)	24.0	4.93%	22.0	6.18%
7. Bluntnose Minnow (7)	19.2	3.94%	18.7	5.24%
8. Largemouth Bass (9)	13.5	2.77%	12.2	3.43%
9. White Sucker (3)	12.7	2.61%	40.9	11.47%
10. Gizzard Shad (8)	10.8	2.21%	13.8	3.87%
11. Striped Shiner (17)	9.7	2.00%	3.2	0.89%
12. Orangethroat Darter (10)	9.4	1.92%	12.0	3.37%
13. Rainbow Darter (23)	7.4	1.52%	1.0	0.28%
14. Greenside Darter (31)	7.0	1.43%	0.2	0.05%
15. Spotfin Shiner (5)	6.4	1.31%	24.2	6.80%
16. Fantail Darter (24)	6.3	1.29%	0.7	0.20%
17. Johnny Darter (12)	5.4	1.11%	7.0	1.97%
18. Sand Shiner (11)	5.3	1.09%	11.3	3.17%
19. Longear Sunfish (19)	4.1	0.85%	1.6	0.46%
20. Pumpkinseed Sunfish (15)	3.3	0.67%	4.1	1.15%
21. Yellow Bullhead (14)	3.2	0.65%	5.9	1.66%
22. Channel Catfish (22)	2.0	0.41%	1.2	0.34%
23. Smallmouth Bass (21)	1.3	0.26%	1.4	0.39%
24. Black Crappie (25)	0.9	0.19%	0.5	0.15%
25. Western Mosquitofish (none)	0.6	0.12%	-	-
26. Spotted Bass (20)	0.6	0.12%	1.6	0.44%
27. Logperch (28)	0.4	0.09%	0.2	0.07%
28. River Carpsucker (none)	0.3	0.05%	-	-
29. Smallmouth Redhorse (none)	0.2	0.04%	-	-
30. Creek Chub (16)	0.2	0.04%	3.3	0.91%
31. Black Redhorse (none)	0.1	0.02%	-	-
32. Goldfish (27)	0.1	0.02%	0.3	0.08%
33. Rosyface Shiner (none)	0.1	0.02%	-	-
34. Silverjaw Minnow (none)	0.1	0.02%	-	-
35. Warmouth Sunfish (none)	0.1	0.02%	-	-
2016 species not collected in 2021: Golden Redhorse, Western Blacknose Dace, Flathead Catfish, Quillback Carpsucker, Suckermouth Minnow				

Table 15. *Fish species (excluding hybrids) collected in the MWH reach of the Mill Creek mainstem in 2021 showing catch-per-unit-effort (CPUE) and percent by numbers compared to 2016.*

Species (rank in 2016)	**2021**		**2016**	
	CPUE	**%numbers**	**CPUE**	**%numbers**
1. Emerald Shiner (1)	346.6	58.83%	282.8	42.57%
2. Gizzard Shad (2)	48.2	8.18%	91.4	13.76%
3. Green Sunfish (15)	38.9	6.60%	9.2	1.39%
4. Bluegill Sunfish (4)	19.8	3.36%	23.4	3.52%
5. Longear Sunfish (13)	16.0	2.71%	3.0	1.48%
6. Channel Catfish (3)	13.6	2.30%	75.2	11.32%
7. Sand Shiner (16)	12.3	2.08%	2.4	1.17%
8. Common Carp (9)	11.9	2.02%	12.3	1.85%
9. Rainbow Darter (none)	11.1	1.89%	-	-
10. Northern Hog Sucker (11)	7.9	1.35%	3.6	1.78%
11. Largemouth Bass (10)	7.2	1.22%	12.3	1.85%
12. Spotfin Shiner (8)	6.9	1.17%	4.3	2.14%
13. Smallmouth Buffalo (17)	5.4	0.91%	6.6	0.99%
14. Central Stoneroller (5)	4.9	0.82%	6.1	3.05%
15. Bluntnose Minnow (18)	4.7	0.80%	2.0	0.99%
16. River Carpsucker (6)	4.5	0.76%	15.0	2.25%
17. Freshwater Drum (14)	4.2	0.72%	2.9	1.43%
18. Channel Shiner (12)	3.8	0.65%	11.1	1.67%
19. Greenside Darter (none)	3.6	0.61%	-	-
20. Spotted Bass (20)	2.6	0.43%	3.3	0.49%
21. Smallmouth Redhorse (21)	1.3	0.22%	0.9	0.42%
22. Yellow Bullhead (30)	1.2	0.20%	0.2	0.12%
23. Smallmouth Bass (29)	1.2	0.20%	0.3	0.14%
24. Orangethroat Darter (none)	1.2	0.20%	-	-
25. Flathead Catfish (25)	1.0	0.17%	0.4	0.21%
26. Quillback Carpsucker (19)	0.9	0.15%	4.7	0.70%
27. Suckermouth Minnow (none)	0.9	0.15%	-	-
28. White Bass (24)	0.9	0.15%	1.7	0.26%
29. White Crappie (23)	0.6	0.11%	1.9	0.28%
30. Black Crappie (27)	0.6	0.11%	1.3	0.19%
31. Orangespotted Sunfish (none)	0.6	0.11%	-	-
32. Pumpkinseed Sunfish (22)	0.6	0.11%	0.9	0.42%
33. Logperch (33)	0.5	0.09%	0.6	0.09%
34. Longnose Gar (26)	0.4	0.07%	1.3	0.19%
35. Black Buffalo (none)	0.4	0.07%	-	-
2016 species not collected: none				

Macroinvertebrate Assemblage Results

Results for the primary macroinvertebrate assemblage indices that comprise the Ohio biocriteria are depicted for 2021 and all years of previous results since 1992 (Figure 18) and along a gradient of quality for selected macroinvertebrate assemblage attributes (Table 16). The prior sampling conducted by Ohio EPA in 1992 (Ohio EPA 1994) and MSD/MBI in 2011 (MBI 2012), 2014 (Ohio EPA), 2016, and 2021 offers an opportunity to examine changes through time for the mainstem of Mill Creek.

The overall results show that increases in the quality of the macroinvertebrate assemblages have taken place along the length of the commonly assessed reaches of the mainstem over approximately 26 miles since 1992 (Figure 18). The increases in the ICI between 1992 and 2011 were sufficient to attain the WWH ICI biocriterion at all sites, but the narrative quality improved from consistently poor in 1992 to mostly good and exceptional at selected sites in 2016 and 2021.

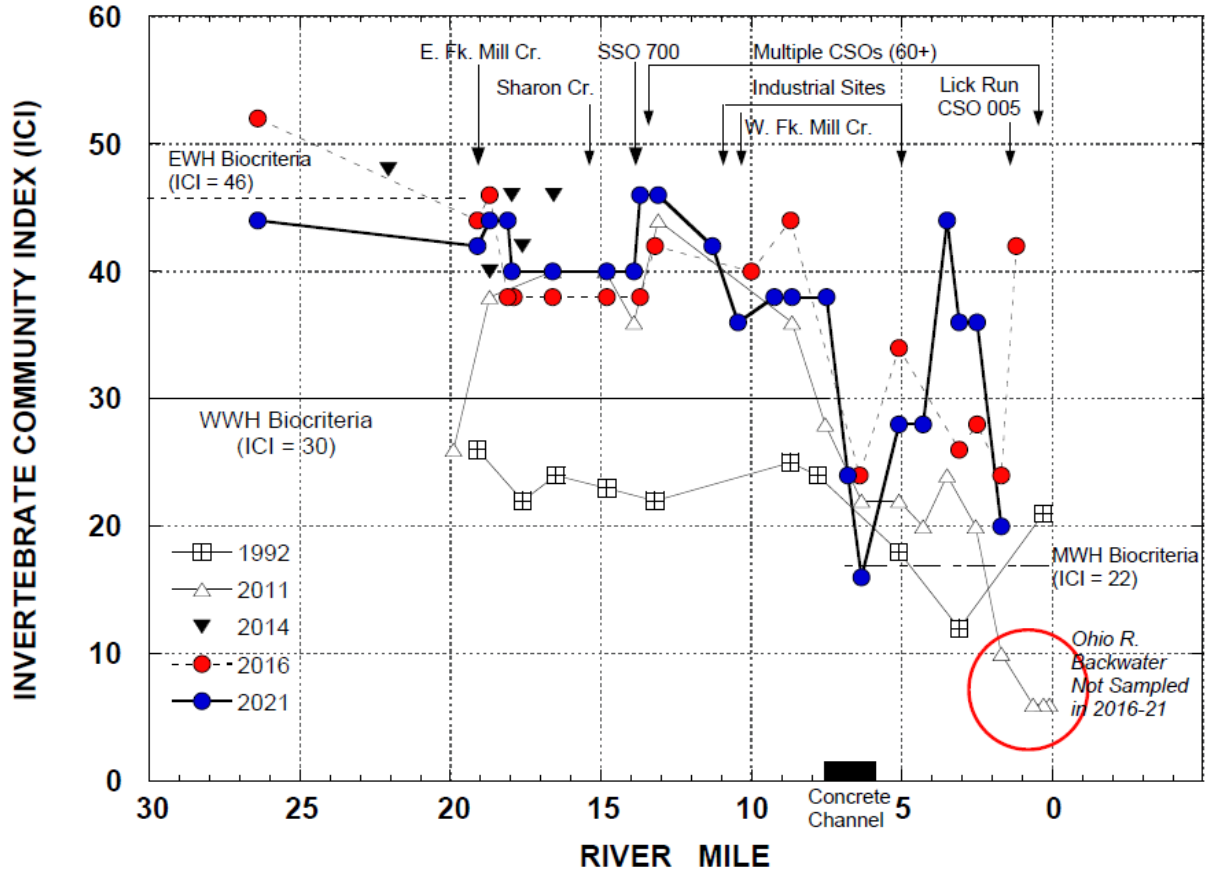


Figure 18*. Invertebrate Community Index (ICI) results for the Mill Creek mainstem in 1992, 2011, 2014, 2016, and 2021. The WWH and MWH biocriteria are depicted with major pollution sources and tributaries along the top of each graph.*

The ICI WWH biocriterion of 30 was met or surpassed at 23 of the 33 sites (70%) sampled in 2021 and included meeting the WWH criterion at all sites in the WWH designated reach (Table 16). Qualitative EPT taxa ranged from 8-13 in the WWH reach and 2-7 in the MWH reach.

***Table 16**. Macroinvertebrate assemblage response indicators in the Mill Creek, the East Fork, and West Fork Mill Creek in 2021. The results for each indicator are color coded in accordance with the key at the bottom of the table. ICI and qualitative metrics are on a quality scale consistent with a gradient from exceptional to very poor and not related to ICI calibration curves.*

Site ID	River Mile	Drainage Area (sq. mi.)	ICI	Narrative	Total Taxa	Sensitive Taxa	Percent Tolerant	Percent Mayflies	Qualitative EPT Taxa	%Toxic Tolerant Taxa	%Organic Enrichment Taxa
Mill Creek											
MC00	26.00	4.43	44		48	5	2.86	4.58	10	2.9	11.0
MC12	19.10	26.70	42		48	6	1.99	13.43	8	1.0	16.4
MC10	18.70	27.00	44		34	2	0.35	17.59	8	0.3	3.3
MC08	18.37	27.30	44		67	8	5.80	8.54	13	0.6	13.3
MC101	17.96	42.20	40		48	4	1.22	6.97	9	0.8	2.7
MC06	16.60	50.50	40		50	5	3.06	3.65	11	0.5	2.9
MC04	15.41	61.30	40		57	8	0.67	16.77	11	0.0	23.2
MC11	13.96	68.80	40		53	7	1.30	0.98	12	0.0	3.7
MC104	13.70	71.60	46		46	5	0.98	35.30	9	0.3	3.7
MC02	13.10	72.30	46		52	8	2.94	14.22	13	0.0	14.1
MC01	11.70	73.90	42		47	7	0.95	10.16	11	0.0	1.0
MC80	10.48	115.00	36		45	5	0.34	14.71	9	0.0	2.1
MC105	9.24	119.00	38		43	3	0.24	8.84	8	0.2	2.2
MC79	8.68	120.00	40		45	3	0.54	12.00	8	0.0	1.9
MC77	7.65	126.00	38		53	6	1.04	13.08	11	0.0	0.4
MC09	6.80	128.00	24		24	1	10.48	6.96	5	0.9	3.3
MC07	6.35	135.00	16		23	0	40.32	1.72	3	0.0	6.5
MC75	4.84	139.00	28		50	3	7.85	0.56	7	0.0	22.9
MC74	4.60	141.00	28		37	4	2.94	1.05	6	0.0	17.6
MC73	3.60	144.00	44		58	4	1.28	5.49	7	0.0	6.7
MC72	3.10	154.00	36		44	3	1.26	4.92	7	0.8	13.6
MC05	2.50	156.00	36		54	2	7.07	2.01	5	0.6	13.1
MC03	1.69	163.00	20		38	0	18.09	1.53	2	0.9	53.7
West Fork Mill Creek											
MC45	0.20	36.50	30		29	3	5.56	71.47	8	1.0	2.0
East Fork Mill Creek											
MC18	1.14	9.27	42		57	9	3.46	37.85	12	1.1	8.4
MC15	1.05	9.30	30		41	1	30.08	0.40	7	4.4	30.5
MC14	0.72	9.53	38		38	1	5.15	0.91	7	1.9	15.8
MC16	0.10	9.59	36		57	3	17.83	0.61	6	1.7	28.8
Cooper Creek (Rossmoyne Creek RM 14.05)											
MC111	3.57	0.34	NA	VP*	11	0			0		
MC112	3.42	0.48	NA	F*	17	2			4		
MC113	2.84	1.10	NA	VP*	7	0			0		
MC32	2.59	1.80	NA	VP*	5	0			0		
MC28	2.13	2.60	NA	MG	27	1			7		
MC118	1.58	3.99	NA	G	29	6			10		
MC119	0.46	5.43	NA	G	29	5			10		
Unnamed Tributary to Cooper Creek (Rossmoyne Creek RM 14.05) @RM 2.80											
MC114	0.55	0.49	NA	VP*	9	0			0		
Kings Run											
MC109	1.00	0.91	NA	PHW3A	36	3			10		
Unnamed Tributary to West Fork Creek @RM 1.24											
MC97	1.40	0.84	NA	PHW3A	31	3			9		
Lick Run											
MC108	1.70	0.19	NA	PHW2	23	0			1		
MC106	0.98	3.45	NA	P	22	1			1		
MC107	0.45	3.55	NA	P	23	0			3		
Narrative Categories	Excellent		≥ 42	E	> 60	>20	≤5	≥30	>20	0.0	<5
	Good		32-41	MG-G	>40-60	>15-20	>5-10	>20-30	>15-20	<5	<15
	Fair		23-31	F	>20-40	>10-15	>10-25	>10-20	>10-15	<20	≥15
	Poor		13-22	P	>10-20	2-10	>25-50	>5-10	2-10	≥35	≥35
	Very Poor		0-12	VP	<10	<2	≥50	≤5	<2	<60	>60

The narrative range of biological quality assignments for the assemblage attributes in Table 16 were taken from Yoder and Rankin (1995b) or DeShon (2003) or established by examining box and whisker plots of metrics vs. narrative ranges of the ICI/IBI, typically using the 25th percentile metric score at sites within these ICI/IBI ranges to set boundaries of metric narrative categories. These are not necessarily equivalent to metric scores of the IBI and ICI. The macroinvertebrate Qual. EPT and Sensitive Taxa narrative ranges were based on the narrative quality ranges in Ohio EPA (2015) Table 4 and Figures 4 and 5.

The macroinvertebrate ICI showed the most consistency among the biological assemblage results in 2021 attaining the WWH biocriterion in the entirety of the WWH and MWH reaches (Figure 18; Table 16). In 2011 the ICI was in non-attainment in the Ohio R. backwater affected section of the mainstem due primarily to the altered habitat and lack of flow over the artificial substrate samplers. These sites were not sampled in 2016 or 2021 given the difficulties of interpreting and the relevancy of the ICI results.

Sensitive taxa were present at all except three sites mostly ranging from 2-8 taxa in the WWH reach with 8 taxa at three sites in the middle reaches. There were 2-4 sensitive taxa in the MWH reach. The East Fork had 6-12 Qualitative EPT taxa and 3-7 sensitive taxa. Three sites on Coopers Creek had no qualitative EPT taxa and only one sensitive taxa, a reflection of the current limiting habitat and water quality conditions. The 2021 results all represent an overall improvement over the 2016 and all prior year results.

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APPENDIX A

Mill Creek 2021 Raw Chemical Data

(Contact Chris Hall, MSDGC at Chris.Hall@cincinnati-oh.gov for Excel files)

APPENDIX B

Mill Creek 2021 Fish Assemblage Data

B-1: Index of Biotic Integrity (IBI) Metrics and Scores, Modified Index of Well-Being (MIwb) Scores

B-2: Fish Species Grand (all sites combined)

B-3: Fish Species by Sampling Event

Appendix Table B-1. Boatable IBI scores and metrics for the Mill Creek study area sampled in 2021 by MBI.

Site ID	River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Sunfish species	Sucker species	Intolerant species	Percent of Individuals: Rnd-bodied suckers	Simple Lithophils	Tolerant fishes	Omni-vores	Top carnivores	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(1.0 km)		IBI	Modified Iwb	Source
Mill Creek - (23001)																				
Year: 2021																				
	1.69	P	08/14/2021	163	16(3)	4(5)	3(3)	0(1)	0(1)	0(1)	7(5)	53(1)	14(5)	22(1)	0.0(5)	258(3)		34	9.3	MBI
	0.83	P	08/14/2021	164	16(3)	6(5)	3(3)	0(1)	0(1)	0(1)	10(5)	38(1)	10(5)	47(3)	0.0(5)	104(1)	*	34	8.2	MBI
	0.50	P	08/14/2021	166	11(3)	2(3)	3(3)	0(1)	0(1)	3(1)	5(5)	40(1)	10(3)	48(3)	0.0(5)	90(1)	*	30	7.7	MBI
	0.21	P	08/14/2021	164	8(1)	3(3)	2(1)	0(1)	3(1)	3(1)	13(5)	29(1)	29(5)	42(3)	0.0(5)	77(1)	*	28	6.5	MBI

♦ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample

Appendix Table B-1. Wadeable IBI scores and metrics for sites sampled in the Mill Creek study area in 2021.

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
Mill Creek - (23001)																		
Year: 2021																		
19.22	D	07/08/2021	26.7	13(3)	2(3)	2(3)	0(1)	2(3)	11(1)	62(1)	27(3)	13.5(5)	51(3)	0.0(5)	138(1)		32	6.0
19.22	D	09/13/2021	26.7	15(3)	2(3)	1(1)	0(1)	3(3)	9(1)	73(1)	49(1)	5.7(5)	41(3)	0.2(5)	162(1)		28	6.4
18.86	D	09/14/2021	27.0	13(3)	3(3)	2(3)	0(1)	0(1)	10(1)	69(1)	45(1)	5.3(5)	47(3)	0.4(3)	123(1)		26	6.8
18.86	D	07/07/2021	27.0	11(3)	3(3)	2(3)	0(1)	0(1)	7(1)	63(1)	38(1)	5.6(5)	54(5)	0.0(5)	71(1)	*	30	5.7
18.37	D	07/07/2021	27.3	12(3)	4(5)	2(3)	0(1)	1(1)	9(1)	45(3)	19(5)	4.0(3)	72(5)	1.7(1)	146(1)		32	6.7
18.37	D	09/13/2021	27.3	10(3)	3(3)	2(3)	0(1)	0(1)	2(1)	40(3)	13(5)	6.8(5)	76(5)	0.0(5)	132(1)		36	6.5
17.96	D	07/07/2021	26.9	12(3)	2(3)	2(3)	0(1)	2(3)	11(1)	68(1)	19(3)	1.8(3)	75(5)	0.0(5)	108(1)		32	6.2
17.96	D	09/13/2021	26.9	15(3)	3(3)	2(3)	0(1)	3(3)	9(1)	75(1)	21(3)	0.3(1)	76(5)	0.3(5)	122(1)		30	6.7
16.73	D	08/09/2021	50.5	8(1)	2(3)	1(1)	0(1)	2(1)	2(1)	78(1)	35(1)	0.6(1)	63(5)	0.0(5)	60(1)		22	5.1
15.41	D	08/09/2021	61.3	4(1)	3(3)	1(1)	0(1)	0(1)	1(1)	66(1)	6(5)	0.0(1)	91(5)	1.1(3)	60(1)	*	24	3.7
13.96	D	08/11/2021	68.8	16(3)	4(5)	2(3)	0(1)	4(3)	17(1)	49(1)	12(5)	0.3(1)	65(5)	0.0(5)	276(3)		36	7.2
13.96	D	09/14/2021	68.8	16(3)	4(5)	2(3)	0(1)	3(3)	12(1)	62(1)	16(5)	0.8(1)	63(5)	0.0(5)	149(1)		34	6.9
13.76	D	09/14/2021	71.6	16(3)	2(3)	2(3)	0(1)	4(3)	18(1)	47(1)	10(5)	1.8(3)	64(5)	0.0(5)	227(3)		36	7.1
13.76	D	07/09/2021	71.6	11(3)	1(1)	2(3)	0(1)	3(3)	28(3)	34(3)	2(5)	3.0(3)	74(5)	0.0(5)	132(1)	*	36	6.0
13.27	D	08/11/2021	72.3	12(3)	3(3)	2(3)	0(1)	3(3)	15(1)	72(1)	14(5)	1.9(3)	82(5)	0.0(5)	90(1)		34	6.3
13.27	D	09/15/2021	72.3	11(3)	3(3)	2(3)	0(1)	1(1)	17(1)	75(1)	13(5)	2.1(3)	79(5)	2.1(1)	54(1)		28	5.5
11.70	D	08/11/2021	73.9	22(5)	4(5)	3(3)	0(1)	4(3)	10(1)	46(1)	23(3)	0.8(1)	67(5)	0.0(5)	210(3)		36	7.1
11.70	D	09/15/2021	73.9	20(3)	4(5)	4(5)	0(1)	4(3)	18(3)	38(3)	32(3)	1.6(3)	59(5)	0.0(5)	233(3)		42	7.3
10.48	E	08/12/2021	115.0	16(3)	3(3)	1(1)	0(1)	6(5)	32(3)	41(1)	0(5)	1.0(1)	89(5)	0.0(5)	124(1)		34	6.7

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 B-1. Wadeable IBI scores and metrics for sites sampled in the Mill Creek study area in 2021.

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
10.48	E	09/15/2021	115.0	16(3)	3(3)	2(1)	1(1)	5(3)	41(5)	26(3)	4(5)	5.9(5)	88(5)	0.0(5)	126(1)	*	40	7.5
9.24	D	08/12/2021	119.0	21(3)	3(3)	2(1)	0(1)	6(5)	14(1)	26(3)	13(5)	2.0(3)	76(5)	0.0(5)	380(3)		38	8.1
9.24	D	09/15/2021	119.0	18(3)	4(5)	1(1)	1(1)	3(3)	10(1)	23(3)	4(5)	1.7(3)	86(5)	0.0(5)	467(3)		38	7.6
8.63	E	08/13/2021	120.0	17(3)	4(5)	2(1)	0(1)	2(1)	34(3)	30(3)	9(5)	4.0(3)	83(5)	1.0(3)	142(1)		34	8.0
8.63	E	09/15/2021	120.0	16(3)	4(5)	2(1)	0(1)	2(1)	15(1)	29(3)	14(5)	4.0(3)	82(5)	0.0(5)	248(3)		36	8.2
7.47	D	08/13/2021	126.0	17(3)	2(3)	2(1)	0(1)	4(3)	8(1)	4(5)	4(5)	0.1(1)	92(5)	0.0(5)	1083(5)		38	7.1
7.47	D	09/16/2021	126.0	16(3)	2(3)	3(3)	0(1)	3(3)	22(3)	19(5)	1(5)	1.2(3)	97(5)	0.0(5)	399(3)		42	6.6
6.80	D	08/12/2021	127.0	7(1)	0(1)	2(1)	0(1)	0(1)	3(1)	2(5)	2(5)	0.0(1)	95(5)	0.0(5)	288(3)		30	3.8
6.45	D	08/12/2021	135.0	3(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(5)	0(5)	0.0(1)	100(5)	0.0(5)	162(1)	*	28	3.7
4.84	D	08/13/2021	139.0	10(1)	4(5)	1(1)	0(1)	1(1)	1(1)	40(1)	20(3)	1.3(3)	75(5)	0.0(5)	68(1)	*	28	5.8
4.84	D	09/17/2021	139.0	10(1)	4(5)	2(1)	0(1)	0(1)	0(1)	17(5)	28(3)	8.0(5)	62(5)	0.0(5)	189(1)		34	7.3
4.21	D	08/13/2021	141.0	12(3)	3(3)	1(1)	0(1)	2(1)	4(1)	15(5)	10(5)	1.6(3)	87(5)	0.0(5)	395(3)		36	5.4
4.21	D	09/17/2021	141.0	17(3)	3(3)	3(3)	0(1)	3(3)	7(1)	19(5)	12(5)	2.6(3)	84(5)	0.0(5)	599(3)		40	8.5
3.45	D	08/12/2021	139.0	13(3)	3(3)	3(3)	0(1)	0(1)	5(1)	30(3)	10(5)	0.7(1)	89(5)	0.0(5)	158(1)		32	6.2
3.45	D	09/16/2021	139.0	16(3)	4(5)	1(1)	0(1)	0(1)	2(1)	8(5)	19(3)	2.6(3)	77(5)	0.0(5)	590(3)		36	6.5
3.15	D	08/12/2021	154.0	12(3)	3(3)	1(1)	0(1)	0(1)	1(1)	17(5)	18(5)	7.8(5)	73(5)	0.9(3)	143(1)	*	34	7.1
3.15	D	09/16/2021	154.0	17(3)	4(5)	1(1)	1(1)	1(1)	1(1)	8(5)	18(5)	1.7(3)	78(5)	0.2(5)	569(3)		38	7.5
2.50	D	08/11/2021	154.0	10(1)	1(1)	2(1)	0(1)	1(1)	1(1)	0(5)	4(5)	0.3(1)	70(5)	0.3(5)	480(3)		30	6.9
2.50	D	09/16/2021	154.0	12(3)	2(3)	3(3)	2(1)	0(1)	1(1)	1(5)	8(5)	0.4(1)	85(5)	0.0(5)	798(5)		38	6.5

West Fork Mill Creek - (23004)

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 B-1. Wadeable IBI scores and metrics for sites sampled in the Mill Creek study area in 2021.

River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Number of: Sunfish species	Number of: Sucker species	Number of: Intolerant species	Number of: Darter species	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	Percent of Individuals: DELT anomalies	Rel.No. minus tolerants /(0.3km)	IBI	Modified Iwb
Year: 2021																	
0.20	E	08/12/2021	36.4	14(3)	2(3)	2(3)	0(1)	3(3)	22(3)	73(1)	62(1)	0.0(1)	26(1)	0.0(5)	196(1)	26	7.1

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 B-1. Headwater IBI scores and metrics for sites sampled in the Mill Creek study area in 2021.

Site ID	River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Minnow species	Headwater species	Sensitive species	Darter & Sculpin species	Simple Lithophils	Percent of Individuals: Tolerant fishes	Omni-vores	Pioneering fishes	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)	IBI
(23-001) - Mill Creek																	
Year: 2021																	
MC00	26.40	E	07/09/2021	4.1	11(3)	3(3)	0(1)	1(1)	3(5)	4(3)	32(5)	16(3)	45(3)	60(5)	0.0(5)	228(3)	40
MC00	26.40	E	09/16/2021	4.1	12(5)	3(3)	0(1)	1(1)	3(5)	4(3)	23(5)	12(5)	31(3)	78(5)	0.0(5)	428(5)	46
(23-006) - East Fork Mill Creek																	
Year: 2021																	
MC18	1.14	E	07/08/2021	9.3	9(3)	1(1)	0(1)	1(1)	3(3)	3(3)	43(3)	4(5)	51(3)	84(5)	0.0(5)	252(3)	36
MC18	1.14	E	09/13/2021	9.3	12(3)	2(1)	1(1)	2(1)	4(5)	5(3)	74(1)	41(1)	36(3)	55(5)	0.0(5)	98(1)	30
MC15	0.96	D	07/08/2021	9.3	10(3)	2(1)	0(1)	2(1)	2(3)	4(3)	58(1)	15(5)	47(3)	78(5)	0.0(5)	228(3)	34
MC15	0.96	D	09/13/2021	9.3	13(3)	5(3)	0(1)	3(3)	3(3)	5(3)	77(1)	27(3)	55(3)	64(5)	0.0(5)	174(1)	34
MC14	0.66	E	07/08/2021	9.5	11(3)	2(1)	0(1)	1(1)	2(3)	4(3)	70(1)	19(3)	52(3)	79(5)	0.4(5)	166(1)	30
MC14	0.66	E	09/14/2021	9.5	6(1)	1(1)	0(1)	1(1)	0(1)	3(3)	71(1)	21(3)	48(3)	79(5)	0.0(5)	86(1)	26
MC16	0.39	E	07/07/2021	9.6	10(3)	2(1)	0(1)	2(1)	2(3)	4(3)	79(1)	15(5)	63(1)	81(5)	0.0(5)	53(1)	30
MC16	0.39	E	09/13/2021	9.6	7(1)	0(1)	0(1)	1(1)	1(1)	3(3)	71(1)	10(5)	63(1)	88(5)	0.0(5)	42(1) *	26
(23-009) - (Rossmoyne Creek RM 14.05) Cooper Creek																	
Year: 2021																	
MR-1	3.57	F	09/17/2021	0.3	3(1)	3(3)	1(1)	0(1)	0(1)	1(3)	65(1)	0(5)	56(1)	0(1)	0.5(5)	129(5)	28
MR-2	3.42	F	09/17/2021	0.4	3(1)	3(3)	1(1)	0(1)	0(1)	1(3)	76(1)	0(5)	60(1)	0(1)	0.2(5)	210(5)	28
MR-3	2.84	F	09/17/2021	0.0	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0(0)	0.0(0)	0(0) * *	0
MR-3	2.84	F	10/01/2021	1.1	4(3)	4(5)	1(1)	0(1)	0(1)	1(1)	73(1)	1(5)	68(1)	0(1)	0.0(5)	124(5)	30
MR-5	2.59	F	10/01/2021	1.8	4(1)	4(3)	1(1)	0(1)	0(1)	1(1)	41(3)	0(5)	35(3)	0(1)	0.0(5)	526(5)	30
MR-6	2.13	F	09/24/2021	2.6	5(3)	3(3)	1(1)	0(1)	1(1)	3(3)	48(3)	1(5)	35(3)	1(1)	0.5(3)	784(5)	32
MC118	1.58	F	08/16/2021	4.0	11(3)	5(3)	2(3)	1(1)	4(5)	5(5)	29(5)	5(5)	29(5)	28(3)	0.0(5)	270(3)	46

♦ - 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 B-1. Headwater IBI scores and metrics for sites sampled in the Mill Creek study area in 2021.

Site ID	River Mile	Type	Date	Drainage area (sq mi)	Number of: Total species	Minnow species	Headwater species	Sensitive species	Darter & Sculpin species	Simple Lithophils	Percent of Individuals: Tolerant fishes	Omni-vores	Pioneering fishes	Insect-ivores	DELT anomalies	Rel.No. minus tolerants /(0.3km)	IBI
MC119	0.44	F	08/16/2021	5.4	12(3)	5(3)	2(3)	1(1)	4(5)	5(5)	28(5)	7(5)	22(5)	20(3)	0.0(5)	478(3)	46
(23-028) - Trib to West Fork Creek @ RM 1.24																	
Year: 2021																	
MC97	1.49	F	08/16/2021	0.8	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0.0(1)	0(1) * *	12
MC109	1.11	F	08/16/2021	0.9	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0.0(1)	0(1) * *	12
(23-046) - Unnamed Tributary to (Rossmoyne Creek RM14.06) Cooper Creek																	
Year: 2021																	
MR-4b	0.55	F	09/17/2021	0.7	1(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0.0(1)	0(1) * *	12
(23-068) - Lick Run																	
Year: 2021																	
MC108	1.70	F	08/16/2021	0.2	1(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0(1)	0.0(1)	0(1) * *	12
MC106	0.98	F	07/09/2021	3.5	2(1)	1(1)	0(1)	0(1)	0(1)	0(1)	97(1)	85(1)	94(1)	15(1)	0.0(5)	2(1) *	16
MC107	0.45	F	07/09/2021	3.6	2(1)	1(1)	0(1)	0(1)	0(1)	0(1)	81(1)	48(1)	81(1)	52(5)	0.0(5)	12(1) *	20

♦ - IBI is low end adjusted.

* - < 200 Total individuals in sample

** - < 50 Total individuals in sample

● - One or more species excluded from IBI calculation.

Appendix B-2: Midwest Biodiversity Institute
Fish Species List - Grand Totals

Rivers: *Mill Creek; West Fork Mill Creek (Mill Cr. RM 11.57); East Fork Mill Creek; (Rossmoyne Creek (RM 14.05)) Cooper Creek; Trib to West Fork Creet at RM 1.24; Unnamed Trib to (Rossmoyne Creek) Cooper Creek*

Years: 2021

Number of Samples: 66 Data Sources: 74; 99 Data Types: D; E; F; P

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
10-004	LONGNOSE GAR	P		M		3	0.2	0.02	191	0.68	810.0
20-003	GIZZARD SHAD	O		M		502	39.7	3.33	2148	7.62	54.1
40-002	BIGMOUTH BUFFALO	I		M	C	1	0.0	0.01	57	0.67	2400.0
40-003	BLACK BUFFALO	I		M	C	3	0.2	0.02	402	1.43	1700.0
40-004	SMALLMOUTH BUFFALO	I		M	C	42	3.3	0.28	1674	5.94	504.7
40-005	QUILLBACK CARPSUCKER	O		M	C	7	0.6	0.05	270	0.96	488.5
40-006	RIVER CARPSUCKER	O		M	C	38	3.0	0.25	1114	3.96	371.3
40-009	BLACK REDHORSE	I	I	S	R	1	0.0	0.01	33	0.39	1400.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	417	10.0	2.77	1300	15.19	129.9
40-016	WHITE SUCKER	O	T	S	W	367	8.8	2.44	310	3.62	35.2
40-023	SMALLMOUTH REDHORSE	I	M	S	R	12	1.0	0.08	88	0.31	93.3
43-001	COMMON CARP	O	T	M	G	908	71.7	6.03	5124	18.18	71.4
43-002	GOLDFISH	O	T	M	G	2	0.1	0.01	14	0.17	300.0
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	273	6.6	1.81	11	0.13	1.6
43-013	CREEK CHUB	G	T	N	N	1052	25.3	6.98	138	1.62	5.4
43-015	SUCKERMOUTH MINNOW	I		S	N	7	0.2	0.05	1	0.02	9.2
43-020	EMERALD SHINER	I		M	N	3170	250.4	21.05	143	0.51	0.5
43-022	ROSYFACE SHINER	I	I	S	N	1	0.0	0.01	0	0.00	2.0
43-025	STRIPED SHINER	I		S	N	159	3.8	1.06	64	0.76	16.9
43-027	RIVER SHINER	I		S	N	1	0.0	0.01	0	0.00	1.0
43-032	SPOTFIN SHINER	I		M	N	132	3.2	0.88	16	0.19	5.1
43-034	SAND SHINER	I	M	M	N	161	3.9	1.07	9	0.11	2.4
43-039	SILVERJAW MINNOW	I		M	N	1	0.0	0.01	0	0.00	5.0
43-042	FATHEAD MINNOW	O	T	C	N	46	1.1	0.31	0	0.00	0.1
43-043	BLUNTNOSE MINNOW	O	T	C	N	445	10.7	2.95	34	0.41	3.2
43-044	CENTRAL STONEROLLER	H		N	N	1680	40.3	11.15	160	1.88	3.9
43-063	CHANNEL SHINER	I	I	M	N	30	0.7	0.20	1	0.02	1.8
43-142	Spotfin x Scarlet Shiner	I				1	0.0	0.01	0	0.00	2.0
47-002	CHANNEL CATFISH			C	F	129	10.2	0.86	2045	7.26	200.7
47-004	YELLOW BULLHEAD	I	T	C		68	1.6	0.45	117	1.37	71.9
47-007	FLATHEAD CATFISH	P		C	F	8	0.6	0.05	227	0.81	360.6
47-008	STONECAT MADTOM	I	I	C		3	0.1	0.02	0	0.01	10.0
57-001	WESTERN MOSQUITOFISH	I		N	E	14	0.3	0.09	0	0.00	1.2
74-001	WHITE BASS	P		M	F	7	0.6	0.05	103	0.37	187.1
74-002	STRIPED BASS	P		M	E	2	0.2	0.01	268	0.95	1700.0
74-005	Striped X White Bass				E	20	0.5	0.13	138	1.62	289.5
77-001	WHITE CRAPPIE	I		C	S	5	0.4	0.03	48	0.17	124.0
77-002	BLACK CRAPPIE	I		C	S	16	1.3	0.11	66	0.24	52.5
77-004	SMALLMOUTH BASS	C	M	C	F	24	0.6	0.16	61	0.72	107.0

Appendix B-2: Midwest Biodiversity Institute
Fish Species List - Grand Totals

Rivers: *Mill Creek; West Fork Mill Creek (Mill Cr. RM 11.57); East Fork Mill Creek; (Rossmoyne Creek (RM 14.05)) Cooper Creek; Trib to West Fork Creet at RM 1.24; Unnamed Trib to (Rossmoyne Creek) Cooper Creek*

Years: 2021

Number of Samples: 66 Data Sources: 74; 99 Data Types: D; E; F; P

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
77-005	SPOTTED BASS	C		C	F	28	2.2	0.19	188	0.67	85.0
77-006	LARGEMOUTH BASS	C		C	F	238	18.8	1.58	933	3.31	49.6
77-007	WARMOUTH SUNFISH	C		C	S	1	0.0	0.01	0	0.01	30.0
77-008	GREEN SUNFISH	I	T	C	S	2929	231.4	19.45	2509	8.90	10.8
77-009	BLUEGILL SUNFISH	I	P	C	S	948	74.9	6.29	1075	3.82	14.3
77-010	ORANGESPOTTED SUNFISH	I		C	S	6	0.5	0.04	5	0.02	10.8
77-011	LONGEAR SUNFISH	I	M	C	S	223	17.6	1.48	433	1.54	24.6
77-012	REDEAR SUNFISH	I		C	E	1	0.1	0.01	2	0.01	30.0
77-013	PUMPKINSEED SUNFISH	I	P	C	S	43	1.0	0.29	11	0.13	11.0
77-015	GREEN SF X BLUEGILL SF					66	5.2	0.44	136	0.48	26.2
77-016	GREEN SF X PUMPKINSEED					4	0.1	0.03	5	0.06	52.5
77-021	GREEN SF X LONGEAR SF					1	0.0	0.01	0	0.01	40.0
80-001	SAUGER	P		S	F	1	0.1	0.01	55	0.20	700.0
80-011	LOGPERCH	I	M	S	D	10	0.2	0.07	5	0.06	21.5
80-014	JOHNNY DARTER	I		C	D	101	2.4	0.67	4	0.05	1.7
80-015	GREENSIDE DARTER	I	M	S	D	110	2.6	0.73	18	0.22	7.0
80-022	RAINBOW DARTER	I	M	S	D	202	4.9	1.34	11	0.14	2.3
80-023	ORANGETHROAT DARTER	I		S	D	212	5.1	1.41	5	0.06	0.9
80-024	FANTAIL DARTER	I		C	D	145	3.5	0.96	4	0.05	1.2
85-001	FRESHWATER DRUM		P	M		34	2.7	0.23	556	1.98	207.3
99-997	Dry Site					0	0.0	0.00	0	0.00	*****.*
99-999	NO FISH					0	0.0	0.00	0	0.00	*****.*

No Species: 61 **Nat. Species:** 51 **Hybrids:** 4 **Total Counted:** 15061 **Total Rel. Wt. :** 22359

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC00 River: 23-001 Mill Creek RM: 26.40 Date: 07/09/2021

Time Fished: 1204 Distance: 0.150 Drainge (sq mi): 4.4 Depth: 0

Location: Dst. Liberty-Fairfiled Rd. Lat: 39.37520 Long: -84.48260

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-016	WHITE SUCKER	O	T	S	W	17	34.0	10.12	0	0.00	0.0
43-001	COMMON CARP	O	T	M	G	6	12.0	3.57	0	0.00	0.0
43-025	STRIPED SHINER	I		S	N	7	14.0	4.17	0	0.00	0.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	4	8.0	2.38	0	0.00	0.0
43-044	CENTRAL STONEROLLER	H		N	N	28	56.0	16.67	0	0.00	0.0
47-004	YELLOW BULLHEAD	I	T	C		2	4.0	1.19	0	0.00	0.0
77-006	LARGEMOUTH BASS	C		C	F	12	24.0	7.14	0	0.00	0.0
77-008	GREEN SUNFISH	I	T	C	S	25	50.0	14.88	0	0.00	0.0
77-009	BLUEGILL SUNFISH	I	P	C	S	14	28.0	8.33	0	0.00	0.0
80-014	JOHNNY DARTER	I		C	D	10	20.0	5.95	0	0.00	0.0
80-022	RAINBOW DARTER	I	M	S	D	6	12.0	3.57	0	0.00	0.0
80-023	ORANGETHROAT DARTER	I		S	D	37	74.0	22.02	0	0.00	0.0

No Species: 12 **Nat. Species:** 11 **Hybrids:** 0 **Total Counted:** 168 **Total Rel. Wt. :** 0

IBI: 40.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC00 River: 23-001 Mill Creek RM: 26.40 Date: 09/16/2021

Time Fished: 1020 Distance: 0.150 Drainge (sq mi): 4.4 Depth: 0

Location: Dst. Liberty-Fairfiled Rd. Lat: 39.37520 Long: -84.48260

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		4	8.0	1.43	300	1.60	37.5
40-016	WHITE SUCKER	O	T	S	W	12	24.0	4.30	3520	18.74	146.6
43-001	COMMON CARP	O	T	M	G	17	34.0	6.09	5520	29.39	162.3
43-025	STRIPED SHINER	I		S	N	7	14.0	2.51	460	2.45	32.8
43-043	BLUNTNOSE MINNOW	O	T	C	N	1	2.0	0.36	10	0.05	5.0
43-044	CENTRAL STONEROLLER	H		N	N	16	32.0	5.73	320	1.70	10.0
47-004	YELLOW BULLHEAD	I	T	C		3	6.0	1.08	60	0.32	10.0
77-006	LARGEMOUTH BASS	C		C	F	12	24.0	4.30	3120	16.61	130.0
77-008	GREEN SUNFISH	I	T	C	S	32	64.0	11.47	1520	8.09	23.7
77-009	BLUEGILL SUNFISH	I	P	C	S	110	220.0	39.43	3840	20.45	17.4
80-014	JOHNNY DARTER	I		C	D	9	18.0	3.23	20	0.11	1.1
80-022	RAINBOW DARTER	I	M	S	D	11	22.0	3.94	30	0.16	1.3
80-023	ORANGETHROAT DARTER	I		S	D	45	90.0	16.13	60	0.32	0.6

No Species: 13 **Nat. Species:** 12 **Hybrids:** 0 **Total Counted:** 279 **Total Rel. Wt. :** 18780

IBI: 46.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC12 River: 23-001 Mill Creek RM: 19.22 Date: 07/08/2021

Time Fished: 1516 Distance: 0.200 Drainge (sq mi): 26.7 Depth: 0

Location: ust. Windisch Rd. Lat: 39.30520 Long: -84.43570

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	2	3.0	0.82	255	6.81	85.0
40-016	WHITE SUCKER	O	T	S	W	10	15.0	4.10	240	6.41	16.0
43-001	COMMON CARP	O	T	M	G	53	79.5	21.72	352	9.41	4.4
43-025	STRIPED SHINER	I		S	N	9	13.5	3.69	180	4.80	13.3
43-032	SPOTFIN SHINER	I		M	N	3	4.5	1.23	30	0.80	6.6
43-034	SAND SHINER	I	M	M	N	2	3.0	0.82	9	0.24	3.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	4	6.0	1.64	22	0.60	3.7
43-044	CENTRAL STONEROLLER	H		N	N	16	24.0	6.56	30	0.80	1.2
47-004	YELLOW BULLHEAD	I	T	C		1	1.5	0.41	15	0.40	10.0
77-006	LARGEMOUTH BASS	C		C	F	33	49.5	13.52	105	2.80	2.1
77-008	GREEN SUNFISH	I	T	C	S	84	126.0	34.43	1890	50.44	15.0
77-009	BLUEGILL SUNFISH	I	P	C	S	18	27.0	7.38	450	12.01	16.6
77-015	GREEN SF X BLUEGILL SF					3	4.5	1.23	150	4.00	33.3
80-022	RAINBOW DARTER	I	M	S	D	2	3.0	0.82	6	0.16	2.0
80-023	ORANGETHROAT DARTER	I		S	D	4	6.0	1.64	12	0.32	2.0

No Species: 14 **Nat. Species:** 13 **Hybrids:** 1 **Total Counted:** 244 **Total Rel. Wt. :** 3747

IBI: 32.0 **MIwb:** 6.0

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC12 River: 23-001 Mill Creek RM: 19.22 Date: 09/13/2021

Time Fished: 1356 Distance: 0.200 Drainge (sq mi): 26.7 Depth: 0

Location: ust. Windisch Rd. Lat: 39.30520 Long: -84.43570

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		1	1.5	0.25	60	0.69	40.0
40-016	WHITE SUCKER	O	T	S	W	15	22.5	3.70	375	4.30	16.6
43-001	COMMON CARP	O	T	M	G	171	256.5	42.22	3300	37.87	12.8
43-013	CREEK CHUB	G	T	N	N	1	1.5	0.25	15	0.17	10.0
43-025	STRIPED SHINER	I		S	N	19	28.5	4.69	735	8.43	25.7
43-032	SPOTFIN SHINER	I		M	N	2	3.0	0.49	30	0.34	10.0
43-034	SAND SHINER	I	M	M	N	5	7.5	1.23	30	0.34	4.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	10	15.0	2.47	45	0.52	3.0
43-044	CENTRAL STONEROLLER	H		N	N	13	19.5	3.21	75	0.86	3.8
47-004	YELLOW BULLHEAD	I	T	C		4	6.0	0.99	270	3.10	45.0
57-001	WESTERN MOSQUITOFISH	I		N	E	2	3.0	0.49	12	0.14	4.0
77-006	LARGEMOUTH BASS	C		C	F	23	34.5	5.68	285	3.27	8.2
77-008	GREEN SUNFISH	I	T	C	S	96	144.0	23.70	2250	25.82	15.6
77-009	BLUEGILL SUNFISH	I	P	C	S	31	46.5	7.65	990	11.36	21.2
77-015	GREEN SF X BLUEGILL SF					6	9.0	1.48	225	2.58	25.0
80-014	JOHNNY DARTER	I		C	D	2	3.0	0.49	7	0.09	2.5
80-022	RAINBOW DARTER	I	M	S	D	1	1.5	0.25	3	0.03	2.0
80-023	ORANGETHROAT DARTER	I		S	D	3	4.5	0.74	7	0.09	1.6

No Species: 17 **Nat. Species:** 15 **Hybrids:** 1 **Total Counted:** 405 **Total Rel. Wt. :** 8715

IBI: 28.0 **MIwb:** 6.4

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC10 River: 23-001 Mill Creek RM: 18.86 Date: 07/07/2021

Time Fished: 1657 Distance: 0.200 Drainge (sq mi): 27.0 Depth: 0

Location: ust. Crescentville Rd. Lat: 39.30030 Long: -84.43430

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	1	1.5	0.79	330	2.97	220.0
40-016	WHITE SUCKER	O	T	S	W	5	7.5	3.97	915	8.25	122.0
43-001	COMMON CARP	O	T	M	G	25	37.5	19.84	6930	62.47	184.8
43-025	STRIPED SHINER	I		S	N	3	4.5	2.38	210	1.89	46.6
43-032	SPOTFIN SHINER	I		M	N	3	4.5	2.38	15	0.14	3.3
43-043	BLUNTNOSE MINNOW	O	T	C	N	18	27.0	14.29	90	0.81	3.3
43-044	CENTRAL STONEROLLER	H		N	N	1	1.5	0.79	1	0.01	1.0
47-004	YELLOW BULLHEAD	I	T	C		3	4.5	2.38	390	3.52	86.6
77-006	LARGEMOUTH BASS	C		C	F	7	10.5	5.56	480	4.33	45.7
77-008	GREEN SUNFISH	I	T	C	S	28	42.0	22.22	765	6.90	18.2
77-009	BLUEGILL SUNFISH	I	P	C	S	29	43.5	23.02	915	8.25	21.0
77-010	ORANGESPOTTED SUNFISH	I		C	S	1	1.5	0.79	7	0.07	5.0
77-015	GREEN SF X BLUEGILL SF					2	3.0	1.59	45	0.41	15.0

No Species: 12 **Nat. Species:** 11 **Hybrids:** 1 **Total Counted:** 126 **Total Rel. Wt. :** 11094

IBI: 30.0 **MIwb:** 5.7

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC10 River: 23-001 Mill Creek RM: 18.86 Date: 09/14/2021

Time Fished: 1054 Distance: 0.200 Drainge (sq mi): 27.0 Depth: 0

Location: ust. Crescentville Rd. Lat: 39.30030 Long: -84.43430

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		3	4.5	1.15	240	2.12	53.3
40-015	NORTHERN HOG SUCKER	I	M	S	R	1	1.5	0.38	165	1.46	110.0
40-016	WHITE SUCKER	O	T	S	W	19	28.5	7.25	3135	27.76	110.0
43-001	COMMON CARP	O	T	M	G	77	115.5	29.39	1560	13.81	13.5
43-025	STRIPED SHINER	I		S	N	5	7.5	1.91	120	1.06	16.0
43-032	SPOTFIN SHINER	I		M	N	11	16.5	4.20	75	0.66	4.5
43-034	SAND SHINER	I	M	M	N	2	3.0	0.76	15	0.13	5.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	18	27.0	6.87	105	0.93	3.8
47-002	CHANNEL CATFISH			C	F	1	1.5	0.38	75	0.66	50.0
47-004	YELLOW BULLHEAD	I	T	C		2	3.0	0.76	120	1.06	40.0
77-002	BLACK CRAPPIE	I		C	S	1	1.5	0.38	30	0.27	20.0
77-006	LARGEMOUTH BASS	C		C	F	14	21.0	5.34	2400	21.25	114.2
77-008	GREEN SUNFISH	I	T	C	S	64	96.0	24.43	1680	14.87	17.5
77-009	BLUEGILL SUNFISH	I	P	C	S	38	57.0	14.50	1215	10.76	21.3
77-015	GREEN SF X BLUEGILL SF					6	9.0	2.29	360	3.19	40.0

No Species: 14 **Nat. Species:** 13 **Hybrids:** 1 **Total Counted:** 262 **Total Rel. Wt. :** 11295

IBI: 26.0 **MIwb:** 6.8

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC08 River: 23-001 Mill Creek RM: 18.37 Date: 07/07/2021

Time Fished: 1915 Distance: 0.200 Drainge (sq mi): 27.3 Depth: 0

Location: ust. 200 m of E.Fk Mill Creek Lat: 39.39300 Long: -84.43530

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		4	6.0	2.26	1560	19.85	260.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	4	6.0	2.26	795	10.12	132.5
40-016	WHITE SUCKER	O	T	S	W	4	6.0	2.26	1365	17.37	227.5
43-025	STRIPED SHINER	I		S	N	8	12.0	4.52	150	1.91	12.5
43-043	BLUNTNOSE MINNOW	O	T	C	N	25	37.5	14.12	99	1.26	2.6
43-044	CENTRAL STONEROLLER	H		N	N	5	7.5	2.82	10	0.13	1.4
77-002	BLACK CRAPPIE	I		C	S	1	1.5	0.56	37	0.48	25.0
77-006	LARGEMOUTH BASS	C		C	F	7	10.5	3.95	21	0.27	2.0
77-008	GREEN SUNFISH	I	T	C	S	51	76.5	28.81	1725	21.95	22.5
77-009	BLUEGILL SUNFISH	I	P	C	S	61	91.5	34.46	1800	22.91	19.6
77-013	PUMPKINSEED SUNFISH	I	P	C	S	1	1.5	0.56	22	0.29	15.0
77-015	GREEN SF X BLUEGILL SF					5	7.5	2.82	270	3.44	36.0
80-014	JOHNNY DARTER	I		C	D	1	1.5	0.56	1	0.02	1.0

No Species: 12 **Nat. Species:** 12 **Hybrids:** 1 **Total Counted:** 177 **Total Rel. Wt. :** 7857

IBI: 32.0 **MIwb:** 6.7

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC08 River: 23-001 Mill Creek RM: 18.37 Date: 09/13/2021

Time Fished: 1580 Distance: 0.200 Drainge (sq mi): 27.3 Depth: 0

Location: ust. 200 m of E.Fk Mill Creek Lat: 39.39300 Long: -84.43530

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		15	22.5	10.20	4335	46.41	192.6
40-015	NORTHERN HOG SUCKER	I	M	S	R	1	1.5	0.68	195	2.09	130.0
40-016	WHITE SUCKER	O	T	S	W	2	3.0	1.36	465	4.98	155.0
43-001	COMMON CARP	O	T	M	G	2	3.0	1.36	165	1.77	55.0
43-032	SPOTFIN SHINER	I		M	N	1	1.5	0.68	7	0.08	5.0
47-002	CHANNEL CATFISH			C	F	2	3.0	1.36	105	1.12	35.0
47-004	YELLOW BULLHEAD	I	T	C		1	1.5	0.68	195	2.09	130.0
57-001	WESTERN MOSQUITOFISH	I		N	E	1	1.5	0.68	3	0.03	2.0
77-002	BLACK CRAPPIE	I		C	S	3	4.5	2.04	165	1.77	36.6
77-006	LARGEMOUTH BASS	C		C	F	10	15.0	6.80	405	4.34	27.0
77-008	GREEN SUNFISH	I	T	C	S	54	81.0	36.73	1305	13.97	16.1
77-009	BLUEGILL SUNFISH	I	P	C	S	50	75.0	34.01	1635	17.50	21.8
77-015	GREEN SF X BLUEGILL SF					5	7.5	3.40	360	3.85	48.0

No Species: 12 **Nat. Species:** 10 **Hybrids:** 1 **Total Counted:** 147 **Total Rel. Wt. :** 9340

IBI: 36.0 **MIwb:** 6.5

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC101 River: 23-001 Mill Creek RM: 17.96 Date: 07/07/2021

Time Fished: 1557 Distance: 0.200 Drainge (sq mi): 42.2 Depth: 0

Location: RR trestel dst. East Fork Mill Creek Lat: 39.28810 Long: -84.43360

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	15	22.5	6.67	4950	53.70	220.0
40-016	WHITE SUCKER	O	T	S	W	3	4.5	1.33	720	7.81	160.0
43-001	COMMON CARP	O	T	M	G	38	57.0	16.89	315	3.42	5.5
43-025	STRIPED SHINER	I		S	N	3	4.5	1.33	90	0.98	20.0
43-032	SPOTFIN SHINER	I		M	N	2	3.0	0.89	22	0.24	7.5
43-043	BLUNTNOSE MINNOW	O	T	C	N	1	1.5	0.44	4	0.05	3.0
43-044	CENTRAL STONEROLLER	H		N	N	8	12.0	3.56	45	0.49	3.7
47-004	YELLOW BULLHEAD	I	T	C		1	1.5	0.44	30	0.33	20.0
57-001	WESTERN MOSQUITOFISH	I		N	E	2	3.0	0.89	6	0.07	2.0
77-006	LARGEMOUTH BASS	C		C	F	4	6.0	1.78	129	1.40	21.5
77-008	GREEN SUNFISH	I	T	C	S	110	165.0	48.89	2190	23.76	13.2
77-009	BLUEGILL SUNFISH	I	P	C	S	32	48.0	14.22	600	6.51	12.5
77-015	GREEN SF X BLUEGILL SF					2	3.0	0.89	105	1.14	35.0
80-023	ORANGETHROAT DARTER	I		S	D	3	4.5	1.33	9	0.10	2.0
80-024	FANTAIL DARTER	I		C	D	1	1.5	0.44	1	0.02	1.0

No Species: 14 **Nat. Species:** 12 **Hybrids:** 1 **Total Counted:** 225 **Total Rel. Wt. :** 9217

IBI: 32.0 **MIwb:** 6.2

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC101 River: 23-001 Mill Creek RM: 17.96 Date: 09/13/2021

Time Fished: 1411 Distance: 0.200 Drainge (sq mi): 42.2 Depth: 0

Location: RR trestel dst. East Fork Mill Creek Lat: 39.28810 Long: -84.43360

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	19	28.5	5.76	4275	28.00	150.0
40-016	WHITE SUCKER	O	T	S	W	6	9.0	1.82	1020	6.68	113.3
43-001	COMMON CARP	O	T	M	G	53	79.5	16.06	5100	33.40	64.1
43-025	STRIPED SHINER	I		S	N	2	3.0	0.61	195	1.28	65.0
43-032	SPOTFIN SHINER	I		M	N	2	3.0	0.61	60	0.39	20.0
43-034	SAND SHINER	I	M	M	N	9	13.5	2.73	75	0.49	5.5
43-043	BLUNTNOSE MINNOW	O	T	C	N	9	13.5	2.73	75	0.49	5.5
43-044	CENTRAL STONEROLLER	H		N	N	9	13.5	2.73	75	0.49	5.5
47-004	YELLOW BULLHEAD	I	T	C		4	6.0	1.21	450	2.95	75.0
77-002	BLACK CRAPPIE	I		C	S	1	1.5	0.30	150	0.98	100.0
77-006	LARGEMOUTH BASS	C		C	F	1	1.5	0.30	45	0.29	30.0
77-008	GREEN SUNFISH	I	T	C	S	177	265.5	53.64	2730	17.88	10.2
77-009	BLUEGILL SUNFISH	I	P	C	S	32	48.0	9.70	945	6.19	19.6
80-014	JOHNNY DARTER	I		C	D	2	3.0	0.61	30	0.20	10.0
80-022	RAINBOW DARTER	I	M	S	D	1	1.5	0.30	15	0.10	10.0
80-023	ORANGETHROAT DARTER	I		S	D	3	4.5	0.91	30	0.20	6.6

No Species: 16 **Nat. Species:** 15 **Hybrids:** 0 **Total Counted:** 330 **Total Rel. Wt. :** 15270

IBI: 30.0 **MIwb:** 6.7

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC06 River: 23-001 Mill Creek RM: 16.73 Date: 08/09/2021

Time Fished: 1751 Distance: 0.200 Drainge (sq mi): 50.5 Depth: 0

Location: ust. E. Sharon Rd. Lat: 39.27050 Long: -84.43230

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		4	6.0	2.25	1350	5.91	225.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	3	4.5	1.69	1170	5.12	260.0
43-001	COMMON CARP	O	T	M	G	58	87.0	32.58	15375	67.32	176.7
47-002	CHANNEL CATFISH			C	F	1	1.5	0.56	2100	9.20	1400.0
77-006	LARGEMOUTH BASS	C		C	F	1	1.5	0.56	15	0.07	10.0
77-008	GREEN SUNFISH	I	T	C	S	80	120.0	44.94	2025	8.87	16.8
77-009	BLUEGILL SUNFISH	I	P	C	S	27	40.5	15.17	510	2.23	12.5
77-015	GREEN SF X BLUEGILL SF					1	1.5	0.56	150	0.66	100.0
77-016	GREEN SF X PUMPKINSEED					1	1.5	0.56	120	0.53	80.0
80-014	JOHNNY DARTER	I		C	D	1	1.5	0.56	15	0.07	10.0
80-022	RAINBOW DARTER	I	M	S	D	1	1.5	0.56	7	0.03	5.0

No Species: 9 **Nat. Species:** 8 **Hybrids:** 2 **Total Counted:** 178 **Total Rel. Wt. :** 22837

IBI: 22.0 **MIwb:** 5.1

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC04 River: 23-001 Mill Creek RM: 15.41 Date: 08/09/2021

Time Fished: 1816 Distance: 0.150 Drainge (sq mi): 61.3 Depth: 0

Location: dst. Glendale Milford ExpWay Lat: 39.25350 Long: -84.42580

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	1	2.0	1.12	240	1.11	120.0
43-001	COMMON CARP	O	T	M	G	5	10.0	5.62	18400	85.42	1840.0
77-008	GREEN SUNFISH	I	T	C	S	54	108.0	60.67	1300	6.04	12.0
77-009	BLUEGILL SUNFISH	I	P	C	S	23	46.0	25.84	1060	4.92	23.0
77-013	PUMPKINSEED SUNFISH	I	P	C	S	3	6.0	3.37	240	1.11	40.0
77-015	GREEN SF X BLUEGILL SF					2	4.0	2.25	200	0.93	50.0
77-016	GREEN SF X PUMPKINSEED					1	2.0	1.12	100	0.46	50.0

No Species: 5 **Nat. Species:** 4 **Hybrids:** 2 **Total Counted:** 89 **Total Rel. Wt. :** 21540

IBI: 24.0 **MIwb:** 3.7

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC11 River: 23-001 Mill Creek RM: 13.96 Date: 08/11/2021

Time Fished: 1650 Distance: 0.200 Drainge (sq mi): 68.8 Depth: 0

Location: ust. Barrett Paving Lat: 39.23790 Long: -84.43820

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	26	39.0	7.20	10890	39.07	279.2
40-016	WHITE SUCKER	O	T	S	W	9	13.5	2.49	225	0.81	16.6
43-001	COMMON CARP	O	T	M	G	12	18.0	3.32	11340	40.69	630.0
43-025	STRIPED SHINER	I		S	N	24	36.0	6.65	600	2.15	16.6
43-032	SPOTFIN SHINER	I		M	N	5	7.5	1.39	60	0.22	8.0
43-034	SAND SHINER	I	M	M	N	1	1.5	0.28	15	0.05	10.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	24	36.0	6.65	240	0.86	6.6
43-044	CENTRAL STONEROLLER	H		N	N	73	109.5	20.22	1650	5.92	15.0
77-002	BLACK CRAPPIE	I		C	S	2	3.0	0.55	15	0.05	5.0
77-006	LARGEMOUTH BASS	C		C	F	1	1.5	0.28	15	0.05	10.0
77-008	GREEN SUNFISH	I	T	C	S	132	198.0	36.57	2400	8.61	12.1
77-009	BLUEGILL SUNFISH	I	P	C	S	10	15.0	2.77	180	0.65	12.0
77-013	PUMPKINSEED SUNFISH	I	P	C	S	1	1.5	0.28	15	0.05	10.0
77-015	GREEN SF X BLUEGILL SF					9	13.5	2.49	120	0.43	8.8
80-014	JOHNNY DARTER	I		C	D	4	6.0	1.11	15	0.05	2.5
80-022	RAINBOW DARTER	I	M	S	D	1	1.5	0.28	7	0.03	5.0
80-023	ORANGETHROAT DARTER	I		S	D	1	1.5	0.28	7	0.03	5.0
80-024	FANTAIL DARTER	I		C	D	26	39.0	7.20	75	0.27	1.9

No Species: 17 **Nat. Species:** 16 **Hybrids:** 1 **Total Counted:** 361 **Total Rel. Wt. :** 27870

IBI: 36.0 **MIwb:** 7.2

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC11 River: 23-001 Mill Creek RM: 13.96 Date: 09/14/2021

Time Fished: 1264 Distance: 0.200 Drainge (sq mi): 68.8 Depth: 0

Location: ust. Barrett Paving Lat: 39.23790 Long: -84.43820

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	16	24.0	6.20	4995	43.12	208.1
40-016	WHITE SUCKER	O	T	S	W	8	12.0	3.10	225	1.94	18.7
43-001	COMMON CARP	O	T	M	G	3	4.5	1.16	120	1.04	26.6
43-025	STRIPED SHINER	I		S	N	7	10.5	2.71	195	1.68	18.5
43-032	SPOTFIN SHINER	I		M	N	1	1.5	0.39	30	0.26	20.0
43-034	SAND SHINER	I	M	M	N	1	1.5	0.39	9	0.08	6.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	29	43.5	11.24	225	1.94	5.1
43-044	CENTRAL STONEROLLER	H		N	N	48	72.0	18.60	960	8.29	13.3
47-002	CHANNEL CATFISH			C	F	2	3.0	0.78	2550	22.01	850.0
77-002	BLACK CRAPPIE	I		C	S	1	1.5	0.39	22	0.19	15.0
77-006	LARGEMOUTH BASS	C		C	F	2	3.0	0.78	60	0.52	20.0
77-008	GREEN SUNFISH	I	T	C	S	119	178.5	46.12	1980	17.09	11.0
77-009	BLUEGILL SUNFISH	I	P	C	S	2	3.0	0.78	30	0.26	10.0
77-013	PUMPKINSEED SUNFISH	I	P	C	S	1	1.5	0.39	30	0.26	20.0
77-015	GREEN SF X BLUEGILL SF					4	6.0	1.55	120	1.04	20.0
80-014	JOHNNY DARTER	I		C	D	5	7.5	1.94	7	0.06	1.0
80-023	ORANGETHROAT DARTER	I		S	D	1	1.5	0.39	3	0.03	2.0
80-024	FANTAIL DARTER	I		C	D	8	12.0	3.10	22	0.19	1.8

No Species: 17 **Nat. Species:** 16 **Hybrids:** 1 **Total Counted:** 258 **Total Rel. Wt. :** 11584

IBI: 34.0 **MIwb:** 6.9

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC104 River: 23-001 Mill Creek RM: 13.76 Date: 07/09/2021

Time Fished: 1715 Distance: 0.200 Drainge (sq mi): 71.6 Depth: 0

Location: immediately dst. SSO 700 outfall Lat: 39.23550 Long: -84.43990

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	31	46.5	23.31	9180	86.04	197.4
40-016	WHITE SUCKER	O	T	S	W	2	3.0	1.50	304	2.85	101.5
43-001	COMMON CARP	O	T	M	G	1	1.5	0.75	0	0.00	0.0
43-032	SPOTFIN SHINER	I		M	N	2	3.0	1.50	9	0.08	3.0
43-034	SAND SHINER	I	M	M	N	6	9.0	4.51	15	0.14	1.6
43-044	CENTRAL STONEROLLER	H		N	N	28	42.0	21.05	75	0.70	1.7
47-004	YELLOW BULLHEAD	I	T	C		1	1.5	0.75	450	4.22	300.0
57-001	WESTERN MOSQUITOFISH	I		N	E	1	1.5	0.75	3	0.03	2.0
77-006	LARGEMOUTH BASS	C		C	F	4	6.0	3.01	15	0.14	2.5
77-008	GREEN SUNFISH	I	T	C	S	41	61.5	30.83	585	5.48	9.5
80-014	JOHNNY DARTER	I		C	D	2	3.0	1.50	6	0.06	2.0
80-023	ORANGETHROAT DARTER	I		S	D	4	6.0	3.01	12	0.11	2.0
80-024	FANTAIL DARTER	I		C	D	10	15.0	7.52	15	0.14	1.0

No Species: 13 **Nat. Species:** 11 **Hybrids:** 0 **Total Counted:** 133 **Total Rel. Wt. :** 10669

IBI: 36.0 **MIwb:** 6.0

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC104 River: 23-001 Mill Creek RM: 13.76 Date: 09/14/2021

Time Fished: 1707 Distance: 0.200 Drainge (sq mi): 71.6 Depth: 0

Location: immediately dst. SSO 700 outfall Lat: 39.23550 Long: -84.43990

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	22	33.0	7.75	6705	31.37	203.1
40-016	WHITE SUCKER	O	T	S	W	7	10.5	2.46	315	1.47	30.0
43-001	COMMON CARP	O	T	M	G	5	7.5	1.76	10740	50.25	1432.0
43-013	CREEK CHUB	G	T	N	N	1	1.5	0.35	15	0.07	10.0
43-025	STRIPED SHINER	I		S	N	12	18.0	4.23	300	1.40	16.6
43-032	SPOTFIN SHINER	I		M	N	6	9.0	2.11	75	0.35	8.3
43-034	SAND SHINER	I	M	M	N	9	13.5	3.17	45	0.21	3.3
43-043	BLUNTNOSE MINNOW	O	T	C	N	16	24.0	5.63	135	0.63	5.6
43-044	CENTRAL STONEROLLER	H		N	N	65	97.5	22.89	930	4.35	9.5
47-004	YELLOW BULLHEAD	I	T	C		2	3.0	0.70	435	2.04	145.0
77-006	LARGEMOUTH BASS	C		C	F	5	7.5	1.76	90	0.42	12.0
77-008	GREEN SUNFISH	I	T	C	S	102	153.0	35.92	1395	6.53	9.1
77-013	PUMPKINSEED SUNFISH	I	P	C	S	1	1.5	0.35	15	0.07	10.0
77-015	GREEN SF X BLUEGILL SF					1	1.5	0.35	22	0.11	15.0
77-016	GREEN SF X PUMPKINSEED					1	1.5	0.35	105	0.49	70.0
80-015	GREENSIDE DARTER	I	M	S	D	1	1.5	0.35	7	0.04	5.0
80-022	RAINBOW DARTER	I	M	S	D	7	10.5	2.46	7	0.04	0.7
80-023	ORANGETHROAT DARTER	I		S	D	1	1.5	0.35	4	0.02	3.0
80-024	FANTAIL DARTER	I		C	D	20	30.0	7.04	30	0.14	1.0

No Species: 17 **Nat. Species:** 16 **Hybrids:** 2 **Total Counted:** 284 **Total Rel. Wt. :** 21372

IBI: 36.0 **MIwb:** 7.1

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC02 River: 23-001 Mill Creek RM: 13.27 Date: 08/11/2021

Time Fished: 1890 Distance: 0.200 Drainge (sq mi): 72.3 Depth: 0

Location: dst. W. Columbia Rd./ Koening Park Lat: 39.22990 Long: -84.44580

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	12	18.0	5.61	3900	12.18	216.6
40-016	WHITE SUCKER	O	T	S	W	19	28.5	8.88	1650	5.15	57.8
43-001	COMMON CARP	O	T	M	G	9	13.5	4.21	18165	56.73	1345.5
43-002	GOLDFISH	O	T	M	G	1	1.5	0.47	900	2.81	600.0
43-034	SAND SHINER	I	M	M	N	3	4.5	1.40	22	0.07	5.0
47-002	CHANNEL CATFISH			C	F	3	4.5	1.40	4575	14.29	1016.6
47-004	YELLOW BULLHEAD	I	T	C		2	3.0	0.93	195	0.61	65.0
77-006	LARGEMOUTH BASS	C		C	F	4	6.0	1.87	75	0.23	12.5
77-008	GREEN SUNFISH	I	T	C	S	123	184.5	57.48	2025	6.32	10.9
77-009	BLUEGILL SUNFISH	I	P	C	S	8	12.0	3.74	210	0.66	17.5
77-013	PUMPKINSEED SUNFISH	I	P	C	S	12	18.0	5.61	105	0.33	5.8
77-015	GREEN SF X BLUEGILL SF					3	4.5	1.40	150	0.47	33.3
80-014	JOHNNY DARTER	I		C	D	12	18.0	5.61	30	0.09	1.6
80-023	ORANGETHROAT DARTER	I		S	D	2	3.0	0.93	15	0.05	5.0
80-024	FANTAIL DARTER	I		C	D	1	1.5	0.47	3	0.01	2.0

No Species: 14 **Nat. Species:** 12 **Hybrids:** 1 **Total Counted:** 214 **Total Rel. Wt. :** 32020

IBI: 34.0 **MIwb:** 6.3

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC02 River: 23-001 Mill Creek RM: 13.27 Date: 09/15/2021

Time Fished: 1510 Distance: 0.200 Drainge (sq mi): 72.3 Depth: 0

Location: dst. W. Columbia Rd./ Koening Park Lat: 39.22990 Long: -84.44580

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	17	25.5	11.97	5655	17.72	221.7
40-016	WHITE SUCKER	O	T	S	W	6	9.0	4.23	2310	7.24	256.6
43-001	COMMON CARP	O	T	M	G	11	16.5	7.75	19350	60.65	1172.7
43-043	BLUNTNOSE MINNOW	O	T	C	N	2	3.0	1.41	7	0.02	2.5
43-044	CENTRAL STONEROLLER	H		N	N	3	4.5	2.11	45	0.14	10.0
47-002	CHANNEL CATFISH			C	F	3	4.5	2.11	3015	9.45	670.0
47-004	YELLOW BULLHEAD	I	T	C		1	1.5	0.70	45	0.14	30.0
57-001	WESTERN MOSQUITOFISH	I		N	E	1	1.5	0.70	1	0.00	1.0
77-002	BLACK CRAPPIE	I		C	S	1	1.5	0.70	135	0.42	90.0
77-006	LARGEMOUTH BASS	C		C	F	3	4.5	2.11	75	0.24	16.6
77-008	GREEN SUNFISH	I	T	C	S	86	129.0	60.56	1200	3.76	9.3
77-013	PUMPKINSEED SUNFISH	I	P	C	S	5	7.5	3.52	30	0.09	4.0
77-015	GREEN SF X BLUEGILL SF					1	1.5	0.70	15	0.05	10.0
77-016	GREEN SF X PUMPKINSEED					1	1.5	0.70	15	0.05	10.0
80-023	ORANGETHROAT DARTER	I		S	D	1	1.5	0.70	7	0.02	5.0

No Species: 13 **Nat. Species:** 11 **Hybrids:** 2 **Total Counted:** 142 **Total Rel. Wt. :** 31906

IBI: 28.0 **MIwb:** 5.5

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC01 River: 23-001 Mill Creek RM: 11.70 Date: 08/11/2021

Time Fished: 1884 Distance: 0.200 Drainge (sq mi): 73.9 Depth: 0

Location: dst. E. Galbraith Rd. Lat: 39.21140 Long: -84.45560

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		17	25.5	6.59	1920	5.66	75.2
40-006	RIVER CARPSUCKER	O		M	C	1	1.5	0.39	1800	5.31	1200.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	8	12.0	3.10	2400	7.08	200.0
40-016	WHITE SUCKER	O	T	S	W	1	1.5	0.39	75	0.22	50.0
43-001	COMMON CARP	O	T	M	G	39	58.5	15.12	18750	55.31	320.5
43-020	EMERALD SHINER	I		M	N	38	57.0	14.73	75	0.22	1.3
43-025	STRIPED SHINER	I		S	N	1	1.5	0.39	15	0.04	10.0
43-032	SPOTFIN SHINER	I		M	N	8	12.0	3.10	90	0.27	7.5
43-034	SAND SHINER	I	M	M	N	1	1.5	0.39	15	0.04	10.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	1	1.5	0.39	15	0.04	10.0
43-044	CENTRAL STONEROLLER	H		N	N	22	33.0	8.53	420	1.24	12.7
47-002	CHANNEL CATFISH			C	F	2	3.0	0.78	3000	8.85	1000.0
47-004	YELLOW BULLHEAD	I	T	C		1	1.5	0.39	120	0.35	80.0
77-006	LARGEMOUTH BASS	C		C	F	2	3.0	0.78	30	0.09	10.0
77-008	GREEN SUNFISH	I	T	C	S	76	114.0	29.46	1425	4.20	12.5
77-009	BLUEGILL SUNFISH	I	P	C	S	12	18.0	4.65	315	0.93	17.5
77-011	LONGEAR SUNFISH	I	M	C	S	5	7.5	1.94	195	0.58	26.0
77-013	PUMPKINSEED SUNFISH	I	P	C	S	6	9.0	2.33	90	0.27	10.0
80-015	GREENSIDE DARTER	I	M	S	D	8	12.0	3.10	105	0.31	8.7
80-022	RAINBOW DARTER	I	M	S	D	6	9.0	2.33	30	0.09	3.3
80-023	ORANGETHROAT DARTER	I		S	D	1	1.5	0.39	7	0.02	5.0
80-024	FANTAIL DARTER	I		C	D	1	1.5	0.39	7	0.02	5.0
85-001	FRESHWATER DRUM		P	M		1	1.5	0.39	3000	8.85	2000.0

No Species: 23 **Nat. Species:** 22 **Hybrids:** 0 **Total Counted:** 258 **Total Rel. Wt. :** 33900

IBI: 36.0 **MIwb:** 7.1

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC01 River: 23-001 Mill Creek RM: 11.70 Date: 09/15/2021

Time Fished: 1714 Distance: 0.200 Drainge (sq mi): 73.9 Depth: 0

Location: dst. E. Galbraith Rd. Lat: 39.21140 Long: -84.45560

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		41	61.5	16.53	5025	15.30	81.7
40-006	RIVER CARPSUCKER	O		M	C	1	1.5	0.40	1500	4.57	1000.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	33	49.5	13.31	8025	24.44	162.1
40-016	WHITE SUCKER	O	T	S	W	2	3.0	0.81	75	0.23	25.0
40-023	SMALLMOUTH REDHORSE	I	M	S	R	1	1.5	0.40	210	0.64	140.0
43-001	COMMON CARP	O	T	M	G	32	48.0	12.90	14025	42.71	292.1
43-020	EMERALD SHINER	I		M	N	26	39.0	10.48	75	0.23	1.9
43-025	STRIPED SHINER	I		S	N	3	4.5	1.21	105	0.32	23.3
43-032	SPOTFIN SHINER	I		M	N	3	4.5	1.21	30	0.09	6.6
43-043	BLUNTNOSE MINNOW	O	T	C	N	3	4.5	1.21	15	0.05	3.3
43-044	CENTRAL STONEROLLER	H		N	N	19	28.5	7.66	120	0.37	4.2
47-004	YELLOW BULLHEAD	I	T	C		4	6.0	1.61	765	2.33	127.5
77-006	LARGEMOUTH BASS	C		C	F	4	6.0	1.61	765	2.33	127.5
77-008	GREEN SUNFISH	I	T	C	S	52	78.0	20.97	1560	4.75	20.0
77-009	BLUEGILL SUNFISH	I	P	C	S	4	6.0	1.61	150	0.46	25.0
77-011	LONGEAR SUNFISH	I	M	C	S	6	9.0	2.42	165	0.50	18.3
77-013	PUMPKINSEED SUNFISH	I	P	C	S	7	10.5	2.82	120	0.37	11.4
80-011	LOGPERCH	I	M	S	D	1	1.5	0.40	45	0.14	30.0
80-015	GREENSIDE DARTER	I	M	S	D	3	4.5	1.21	45	0.14	10.0
80-022	RAINBOW DARTER	I	M	S	D	2	3.0	0.81	15	0.05	5.0
80-024	FANTAIL DARTER	I		C	D	1	1.5	0.40	3	0.01	2.0

No Species: 21 **Nat. Species:** 20 **Hybrids:** 0 **Total Counted:** 248 **Total Rel. Wt. :** 32838

IBI: 42.0 **MIwb:** 7.3

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC80 River: 23-001 Mill Creek RM: 10.48 Date: 08/12/2021

Time Fished: 2342 Distance: 0.150 Drainge (sq mi): 115.0 Depth: 0

Location: dst. Anthony Wayne Ave. Lat: 39.20210 Long: -84.48130

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	17	34.0	16.19	6740	63.77	198.2
43-020	EMERALD SHINER	I		M	N	3	6.0	2.86	20	0.19	3.3
43-032	SPOTFIN SHINER	I		M	N	1	2.0	0.95	20	0.19	10.0
43-034	SAND SHINER	I	M	M	N	1	2.0	0.95	20	0.19	10.0
43-044	CENTRAL STONEROLLER	H		N	N	6	12.0	5.71	120	1.14	10.0
47-002	CHANNEL CATFISH			C	F	3	6.0	2.86	1040	9.84	173.3
77-004	SMALLMOUTH BASS	C	M	C	F	1	2.0	0.95	80	0.76	40.0
77-008	GREEN SUNFISH	I	T	C	S	43	86.0	40.95	1600	15.14	18.6
77-009	BLUEGILL SUNFISH	I	P	C	S	4	8.0	3.81	360	3.41	45.0
77-011	LONGEAR SUNFISH	I	M	C	S	5	10.0	4.76	160	1.51	16.0
77-015	GREEN SF X BLUEGILL SF					2	4.0	1.90	80	0.76	20.0
80-011	LOGPERCH	I	M	S	D	2	4.0	1.90	100	0.95	25.0
80-014	JOHNNY DARTER	I		C	D	1	2.0	0.95	10	0.09	5.0
80-015	GREENSIDE DARTER	I	M	S	D	10	20.0	9.52	160	1.51	8.0
80-022	RAINBOW DARTER	I	M	S	D	4	8.0	3.81	40	0.38	5.0
80-023	ORANGETHROAT DARTER	I		S	D	1	2.0	0.95	10	0.09	5.0
80-024	FANTAIL DARTER	I		C	D	1	2.0	0.95	10	0.09	5.0

No Species: 16 **Nat. Species:** 16 **Hybrids:** 1 **Total Counted:** 105 **Total Rel. Wt. :** 10570

IBI: 34.0 **MIwb:** 6.7

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC80 River: 23-001 Mill Creek RM: 10.48 Date: 09/15/2021

Time Fished: 1250 Distance: 0.150 Drainge (sq mi): 115.0 Depth: 0

Location: dst. Anthony Wayne Ave. Lat: 39.20210 Long: -84.48130

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		3	6.0	3.53	700	4.86	116.6
40-009	BLACK REDHORSE	I	I	S	R	1	2.0	1.18	2800	19.46	1400.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	16	32.0	18.82	7400	51.42	231.2
43-020	EMERALD SHINER	I		M	N	11	22.0	12.94	40	0.28	1.8
43-032	SPOTFIN SHINER	I		M	N	1	2.0	1.18	20	0.14	10.0
43-044	CENTRAL STONEROLLER	H		N	N	1	2.0	1.18	100	0.69	50.0
77-004	SMALLMOUTH BASS	C	M	C	F	2	4.0	2.35	1060	7.37	265.0
77-005	SPOTTED BASS	C		C	F	3	6.0	3.53	420	2.92	70.0
77-008	GREEN SUNFISH	I	T	C	S	22	44.0	25.88	1220	8.48	27.7
77-009	BLUEGILL SUNFISH	I	P	C	S	1	2.0	1.18	200	1.39	100.0
77-011	LONGEAR SUNFISH	I	M	C	S	1	2.0	1.18	60	0.42	30.0
77-015	GREEN SF X BLUEGILL SF					1	2.0	1.18	120	0.83	60.0
80-011	LOGPERCH	I	M	S	D	2	4.0	2.35	100	0.69	25.0
80-014	JOHNNY DARTER	I		C	D	2	4.0	2.35	10	0.07	2.5
80-015	GREENSIDE DARTER	I	M	S	D	6	12.0	7.06	60	0.42	5.0
80-022	RAINBOW DARTER	I	M	S	D	10	20.0	11.76	70	0.49	3.5
80-024	FANTAIL DARTER	I		C	D	2	4.0	2.35	10	0.07	2.5

No Species: 16 **Nat. Species:** 16 **Hybrids:** 1 **Total Counted:** 85 **Total Rel. Wt. :** 14390

IBI: 40.0 **MIwb:** 7.5

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC105 River: 23-001 Mill Creek RM: 9.24 Date: 08/12/2021

Time Fished: 1565 Distance: 0.200 Drainge (sq mi): 119.0 Depth: 0

Location: dst. Congress Run Lat: 39.20290 Long: -84.48640

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		5	7.5	1.45	495	12.18	66.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	7	10.5	2.03	300	7.38	28.5
40-016	WHITE SUCKER	O	T	S	W	1	1.5	0.29	15	0.37	10.0
43-020	EMERALD SHINER	I		M	N	130	195.0	37.79	315	7.75	1.6
43-025	STRIPED SHINER	I		S	N	3	4.5	0.87	34	0.85	7.6
43-032	SPOTFIN SHINER	I		M	N	9	13.5	2.62	75	1.85	5.5
43-034	SAND SHINER	I	M	M	N	15	22.5	4.36	58	1.44	2.6
43-043	BLUNTNOSE MINNOW	O	T	C	N	40	60.0	11.63	210	5.17	3.5
43-044	CENTRAL STONEROLLER	H		N	N	28	42.0	8.14	345	8.49	8.2
43-142	Spotfin x Scarlet Shiner	I				1	1.5	0.29	3	0.07	2.0
47-004	YELLOW BULLHEAD	I	T	C		1	1.5	0.29	75	1.85	50.0
77-004	SMALLMOUTH BASS	C	M	C	F	3	4.5	0.87	450	11.07	100.0
77-006	LARGEMOUTH BASS	C		C	F	4	6.0	1.16	345	8.49	57.5
77-008	GREEN SUNFISH	I	T	C	S	49	73.5	14.24	930	22.88	12.6
77-009	BLUEGILL SUNFISH	I	P	C	S	2	3.0	0.58	15	0.37	5.0
77-011	LONGEAR SUNFISH	I	M	C	S	1	1.5	0.29	45	1.11	30.0
80-011	LOGPERCH	I	M	S	D	1	1.5	0.29	30	0.74	20.0
80-014	JOHNNY DARTER	I		C	D	7	10.5	2.03	15	0.37	1.4
80-015	GREENSIDE DARTER	I	M	S	D	21	31.5	6.10	210	5.17	6.6
80-022	RAINBOW DARTER	I	M	S	D	12	18.0	3.49	75	1.85	4.1
80-023	ORANGETHROAT DARTER	I		S	D	2	3.0	0.58	15	0.37	5.0
80-024	FANTAIL DARTER	I		C	D	2	3.0	0.58	9	0.22	3.0

No Species: 21 **Nat. Species:** 21 **Hybrids:** 0 **Total Counted:** 344 **Total Rel. Wt. :** 4065

IBI: 38.0 **MIwb:** 8.1

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC105 River: 23-001 Mill Creek RM: 9.24 Date: 09/15/2021

Time Fished: 1565 Distance: 0.200 Drainge (sq mi): 119.0 Depth: 0

Location: dst. Congress Run Lat: 39.20290 Long: -84.48640

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	3	4.5	0.74	1350	13.88	300.0
43-020	EMERALD SHINER	I		M	N	208	312.0	51.36	480	4.94	1.5
43-022	ROSYFACE SHINER	I	I	S	N	1	1.5	0.25	3	0.03	2.0
43-032	SPOTFIN SHINER	I		M	N	7	10.5	1.73	75	0.77	7.1
43-034	SAND SHINER	I	M	M	N	6	9.0	1.48	30	0.31	3.3
43-039	SILVERJAW MINNOW	I		M	N	1	1.5	0.25	7	0.08	5.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	17	25.5	4.20	75	0.77	2.9
43-044	CENTRAL STONEROLLER	H		N	N	28	42.0	6.91	465	4.78	11.0
47-002	CHANNEL CATFISH			C	F	4	6.0	0.99	4830	49.68	805.0
77-004	SMALLMOUTH BASS	C	M	C	F	4	6.0	0.99	675	6.94	112.5
77-006	LARGEMOUTH BASS	C		C	F	3	4.5	0.74	510	5.25	113.3
77-008	GREEN SUNFISH	I	T	C	S	77	115.5	19.01	825	8.49	7.1
77-009	BLUEGILL SUNFISH	I	P	C	S	1	1.5	0.25	15	0.15	10.0
77-011	LONGEAR SUNFISH	I	M	C	S	1	1.5	0.25	37	0.39	25.0
77-013	PUMPKINSEED SUNFISH	I	P	C	S	1	1.5	0.25	15	0.15	10.0
77-015	GREEN SF X BLUEGILL SF					1	1.5	0.25	30	0.31	20.0
80-014	JOHNNY DARTER	I		C	D	5	7.5	1.23	15	0.15	2.0
80-015	GREENSIDE DARTER	I	M	S	D	18	27.0	4.44	180	1.85	6.6
80-022	RAINBOW DARTER	I	M	S	D	19	28.5	4.69	105	1.08	3.6

No Species: 18 **Nat. Species:** 18 **Hybrids:** 1 **Total Counted:** 405 **Total Rel. Wt. :** 9723

IBI: 38.0 **MIwb:** 7.6

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC79 River: 23-001 Mill Creek RM: 8.63 Date: 08/13/2021

Time Fished: 1879 Distance: 0.150 Drainge (sq mi): 120.0 Depth: 0

Location: dst. Este Ave. Lat: 39.19500 Long: -84.48900

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		6	12.0	5.94	1280	4.66	106.6
40-015	NORTHERN HOG SUCKER	I	M	S	R	24	48.0	23.76	9550	34.74	198.9
40-023	SMALLMOUTH REDHORSE	I	M	S	R	1	2.0	0.99	280	1.02	140.0
43-001	COMMON CARP	O	T	M	G	2	4.0	1.98	8000	29.10	2000.0
43-020	EMERALD SHINER	I		M	N	2	4.0	1.98	20	0.07	5.0
43-032	SPOTFIN SHINER	I		M	N	3	6.0	2.97	100	0.36	16.6
43-043	BLUNTNOSE MINNOW	O	T	C	N	1	2.0	0.99	10	0.04	5.0
43-044	CENTRAL STONEROLLER	H		N	N	1	2.0	0.99	20	0.07	10.0
47-002	CHANNEL CATFISH			C	F	2	4.0	1.98	3600	13.10	900.0
47-004	YELLOW BULLHEAD	I	T	C		3	6.0	2.97	760	2.76	126.6
77-004	SMALLMOUTH BASS	C	M	C	F	2	4.0	1.98	900	3.27	225.0
77-005	SPOTTED BASS	C		C	F	1	2.0	0.99	240	0.87	120.0
77-007	WARMOUTH SUNFISH	C		C	S	1	2.0	0.99	60	0.22	30.0
77-008	GREEN SUNFISH	I	T	C	S	24	48.0	23.76	1120	4.07	23.3
77-009	BLUEGILL SUNFISH	I	P	C	S	7	14.0	6.93	460	1.67	32.8
77-011	LONGEAR SUNFISH	I	M	C	S	11	22.0	10.89	830	3.02	37.7
77-015	GREEN SF X BLUEGILL SF					1	2.0	0.99	60	0.22	30.0
80-015	GREENSIDE DARTER	I	M	S	D	8	16.0	7.92	140	0.51	8.7
80-022	RAINBOW DARTER	I	M	S	D	1	2.0	0.99	60	0.22	30.0

No Species: 18 **Nat. Species:** 17 **Hybrids:** 1 **Total Counted:** 101 **Total Rel. Wt. :** 27490

IBI: 34.0 **MIwb:** 8.0

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC79 River: 23-001 Mill Creek RM: 8.63 Date: 09/15/2021

Time Fished: 2043 Distance: 0.150 Drainge (sq mi): 120.0 Depth: 0

Location: dst. Este Ave. Lat: 39.19500 Long: -84.48900

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		22	44.0	12.64	5600	22.19	127.2
40-006	RIVER CARPSUCKER	O		M	C	1	2.0	0.57	2200	8.72	1100.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	18	36.0	10.34	7400	29.33	205.5
43-001	COMMON CARP	O	T	M	G	2	4.0	1.15	4800	19.02	1200.0
43-020	EMERALD SHINER	I		M	N	41	82.0	23.56	120	0.48	1.4
43-032	SPOTFIN SHINER	I		M	N	4	8.0	2.30	40	0.16	5.0
43-034	SAND SHINER	I	M	M	N	1	2.0	0.57	4	0.02	2.0
47-004	YELLOW BULLHEAD	I	T	C		1	2.0	0.57	100	0.40	50.0
77-002	BLACK CRAPPIE	I		C	S	1	2.0	0.57	60	0.24	30.0
77-004	SMALLMOUTH BASS	C	M	C	F	3	6.0	1.72	760	3.01	126.6
77-005	SPOTTED BASS	C		C	F	3	6.0	1.72	680	2.69	113.3
77-006	LARGEMOUTH BASS	C		C	F	1	2.0	0.57	40	0.16	20.0
77-008	GREEN SUNFISH	I	T	C	S	47	94.0	27.01	1840	7.29	19.5
77-009	BLUEGILL SUNFISH	I	P	C	S	3	6.0	1.72	200	0.79	33.3
77-011	LONGEAR SUNFISH	I	M	C	S	18	36.0	10.34	1340	5.31	37.2
80-015	GREENSIDE DARTER	I	M	S	D	6	12.0	3.45	40	0.16	3.3
80-022	RAINBOW DARTER	I	M	S	D	2	4.0	1.15	8	0.03	2.0

No Species: 17 **Nat. Species:** 16 **Hybrids:** 0 **Total Counted:** 174 **Total Rel. Wt. :** 25232

IBI: 36.0 **MIwb:** 8.2

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC77 River: 23-001 Mill Creek RM: 7.47 Date: 08/13/2021

Time Fished: 1783 Distance: 0.200 Drainge (sq mi): 126.0 Depth: 0

Location: RR trestle Winton Place/ dst. Center Hill Ave. Lat: 39.18260 Long: -84.49930

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		30	45.0	3.98	2220	46.24	49.3
40-015	NORTHERN HOG SUCKER	I	M	S	R	7	10.5	0.93	120	2.50	11.4
40-016	WHITE SUCKER	O	T	S	W	1	1.5	0.13	30	0.62	20.0
43-015	SUCKERMOUTH MINNOW	I		S	N	1	1.5	0.13	30	0.62	20.0
43-020	EMERALD SHINER	I		M	N	560	840.0	74.27	675	14.06	0.8
43-032	SPOTFIN SHINER	I		M	N	33	49.5	4.38	120	2.50	2.4
43-034	SAND SHINER	I	M	M	N	11	16.5	1.46	60	1.25	3.6
43-043	BLUNTNOSE MINNOW	O	T	C	N	1	1.5	0.13	15	0.31	10.0
43-044	CENTRAL STONEROLLER	H		N	N	22	33.0	2.92	495	10.31	15.0
47-002	CHANNEL CATFISH			C	F	2	3.0	0.27	9	0.19	3.0
77-006	LARGEMOUTH BASS	C		C	F	1	1.5	0.13	15	0.31	10.0
77-008	GREEN SUNFISH	I	T	C	S	30	45.0	3.98	615	12.81	13.6
77-013	PUMPKINSEED SUNFISH	I	P	C	S	3	4.5	0.40	60	1.25	13.3
77-015	GREEN SF X BLUEGILL SF					1	1.5	0.13	37	0.78	25.0
80-014	JOHNNY DARTER	I		C	D	2	3.0	0.27	15	0.31	5.0
80-015	GREENSIDE DARTER	I	M	S	D	5	7.5	0.66	75	1.56	10.0
80-022	RAINBOW DARTER	I	M	S	D	35	52.5	4.64	135	2.81	2.5
80-023	ORANGETHROAT DARTER	I		S	D	9	13.5	1.19	75	1.56	5.5

No Species: 17 **Nat. Species:** 17 **Hybrids:** 1 **Total Counted:** 754 **Total Rel. Wt. :** 4801

IBI: 38.0 **MIwb:** 7.1

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC77 River: 23-001 Mill Creek RM: 7.47 Date: 09/16/2021

Time Fished: 1444 Distance: 0.200 Drainge (sq mi): 126.0 Depth: 0

Location: RR trestle Winton Place/ dst. Center Hill Ave. Lat: 39.18260 Long: -84.49930

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		2	3.0	0.61	165	3.05	55.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	12	18.0	3.65	3150	58.25	175.0
40-016	WHITE SUCKER	O	T	S	W	1	1.5	0.30	30	0.55	20.0
40-023	SMALLMOUTH REDHORSE	I	M	S	R	1	1.5	0.30	180	3.33	120.0
43-013	CREEK CHUB	G	T	N	N	2	3.0	0.61	30	0.55	10.0
43-015	SUCKERMOUTH MINNOW	I		S	N	3	4.5	0.91	45	0.83	10.0
43-020	EMERALD SHINER	I		M	N	180	270.0	54.71	270	4.99	1.0
43-032	SPOTFIN SHINER	I		M	N	2	3.0	0.61	6	0.11	2.0
43-034	SAND SHINER	I	M	M	N	1	1.5	0.30	3	0.06	2.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	1	1.5	0.30	4	0.08	3.0
77-004	SMALLMOUTH BASS	C	M	C	F	4	6.0	1.22	450	8.32	75.0
77-008	GREEN SUNFISH	I	T	C	S	59	88.5	17.93	870	16.09	9.8
77-009	BLUEGILL SUNFISH	I	P	C	S	1	1.5	0.30	7	0.14	5.0
77-015	GREEN SF X BLUEGILL SF					1	1.5	0.30	15	0.28	10.0
80-015	GREENSIDE DARTER	I	M	S	D	8	12.0	2.43	37	0.69	3.1
80-022	RAINBOW DARTER	I	M	S	D	48	72.0	14.59	135	2.50	1.8
80-024	FANTAIL DARTER	I		C	D	3	4.5	0.91	9	0.17	2.0

No Species: 16 **Nat. Species:** 16 **Hybrids:** 1 **Total Counted:** 329 **Total Rel. Wt. :** 5407

IBI: 42.0 **MIwb:** 6.6

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC09 River: 23-001 Mill Creek RM: 6.80 Date: 08/12/2021

Time Fished: 1093 Distance: 0.200 Drainge (sq mi): 128.0 Depth: 0

Location: dst. CSX RR bridge Lat: 39.17480 Long: -84.50500

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	2	3.0	1.03	534	8.68	178.0
40-016	WHITE SUCKER	O	T	S	W	1	1.5	0.51	7	0.12	5.0
43-001	COMMON CARP	O	T	M	G	2	3.0	1.03	5250	85.30	1750.0
43-015	SUCKERMOUTH MINNOW	I		S	N	2	3.0	1.03	15	0.24	5.0
43-020	EMERALD SHINER	I		M	N	180	270.0	92.31	180	2.92	0.6
43-034	SAND SHINER	I	M	M	N	1	1.5	0.51	3	0.05	2.0
43-044	CENTRAL STONEROLLER	H		N	N	5	7.5	2.56	75	1.22	10.0
47-002	CHANNEL CATFISH			C	F	2	3.0	1.03	90	1.46	30.0

No Species: 8 **Nat. Species:** 7 **Hybrids:** 0 **Total Counted:** 195 **Total Rel. Wt. :** 6154

IBI: 30.0 **MIwb:** 3.8

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC07 River: 23-001 Mill Creek RM: 6.45 Date: 08/12/2021

Time Fished: 839 Distance: 0.200 Drainge (sq mi): 135.0 Depth: 0

Location: dst. Spring Grove Ave. Lat: 39.17010 Long: -84.50600

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
43-020	EMERALD SHINER	I		M	N	90	135.0	83.33	180	73.17	1.3
43-032	SPOTFIN SHINER	I		M	N	1	1.5	0.93	6	2.44	4.0
43-034	SAND SHINER	I	M	M	N	17	25.5	15.74	60	24.39	2.3

No Species: 3 **Nat. Species:** 3 **Hybrids:** 0 **Total Counted:** 108 **Total Rel. Wt. :** 246

IBI: 28.0 **MIwb:** 3.7

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC75 River: 23-001 Mill Creek RM: 4.84 Date: 08/13/2021

Time Fished: 2060 Distance: 0.200 Drainge (sq mi): 139.0 Depth: 0

Location: adj. Salway Park Lat: 39.16120 Long: -84.52630

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		2	3.0	2.67	390	1.72	130.0
40-005	QUILLBACK CARPSUCKER	O		M	C	2	3.0	2.67	2700	11.87	900.0
43-001	COMMON CARP	O	T	M	G	11	16.5	14.67	16500	72.56	1000.0
47-002	CHANNEL CATFISH			C	F	1	1.5	1.33	60	0.26	40.0
47-004	YELLOW BULLHEAD	I	T	C		1	1.5	1.33	345	1.52	230.0
47-007	FLATHEAD CATFISH	P		C	F	1	1.5	1.33	270	1.19	180.0
77-001	WHITE CRAPPIE	I		C	S	2	3.0	2.67	270	1.19	90.0
77-008	GREEN SUNFISH	I	T	C	S	18	27.0	24.00	525	2.31	19.4
77-009	BLUEGILL SUNFISH	I	P	C	S	22	33.0	29.33	1125	4.95	34.0
77-011	LONGEAR SUNFISH	I	M	C	S	12	18.0	16.00	450	1.98	25.0
77-015	GREEN SF X BLUEGILL SF					2	3.0	2.67	60	0.26	20.0
80-011	LOGPERCH	I	M	S	D	1	1.5	1.33	45	0.20	30.0

No Species: 11 **Nat. Species:** 10 **Hybrids:** 1 **Total Counted:** 75 **Total Rel. Wt. :** 22740

IBI: 28.0 **MIwb:** 5.8

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC75 River: 23-001 Mill Creek RM: 4.84 Date: 09/17/2021

Time Fished: 1892 Distance: 0.200 Drainge (sq mi): 139.0 Depth: 0

Location: adj. Salway Park Lat: 39.16120 Long: -84.52630

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		30	45.0	19.87	3525	12.53	78.3
40-005	QUILLBACK CARPSUCKER	O		M	C	3	4.5	1.99	5265	18.72	1170.0
40-006	RIVER CARPSUCKER	O		M	C	2	3.0	1.32	3315	11.79	1105.0
43-001	COMMON CARP	O	T	M	G	7	10.5	4.64	11325	40.27	1078.5
47-004	YELLOW BULLHEAD	I	T	C		3	4.5	1.99	270	0.96	60.0
47-007	FLATHEAD CATFISH	P		C	F	1	1.5	0.66	315	1.12	210.0
77-002	BLACK CRAPPIE	I		C	S	4	6.0	2.65	450	1.60	75.0
77-006	LARGEMOUTH BASS	C		C	F	11	16.5	7.28	1125	4.00	68.1
77-008	GREEN SUNFISH	I	T	C	S	15	22.5	9.93	300	1.07	13.3
77-009	BLUEGILL SUNFISH	I	P	C	S	41	61.5	27.15	1350	4.80	21.9
77-011	LONGEAR SUNFISH	I	M	C	S	30	45.0	19.87	780	2.77	17.3
77-015	GREEN SF X BLUEGILL SF					4	6.0	2.65	105	0.37	17.5

No Species: 11 **Nat. Species:** 10 **Hybrids:** 1 **Total Counted:** 151 **Total Rel. Wt. :** 28125

IBI: 34.0 **MIwb:** 7.3

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC74 River: 23-001 Mill Creek RM: 4.21 Date: 08/13/2021

Time Fished: 2045 Distance: 0.200 Drainge (sq mi): 141.0 Depth: 0

Location: ust. S. Ludlow Ave. Lat: 39.15800 Long: -84.53720

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		15	22.5	4.87	1200	5.61	53.3
40-015	NORTHERN HOG SUCKER	I	M	S	R	6	9.0	1.95	300	1.40	33.3
43-001	COMMON CARP	O	T	M	G	17	25.5	5.52	16875	78.87	661.7
43-020	EMERALD SHINER	I		M	N	200	300.0	64.94	105	0.49	0.3
43-032	SPOTFIN SHINER	I		M	N	5	7.5	1.62	15	0.07	2.0
43-034	SAND SHINER	I	M	M	N	4	6.0	1.30	6	0.03	1.0
47-002	CHANNEL CATFISH			C	F	2	3.0	0.65	150	0.70	50.0
77-001	WHITE CRAPPIE	I		C	S	1	1.5	0.32	180	0.84	120.0
77-006	LARGEMOUTH BASS	C		C	F	5	7.5	1.62	780	3.65	104.0
77-008	GREEN SUNFISH	I	T	C	S	28	42.0	9.09	900	4.21	21.4
77-011	LONGEAR SUNFISH	I	M	C	S	18	27.0	5.84	780	3.65	28.8
80-011	LOGPERCH	I	M	S	D	1	1.5	0.32	30	0.14	20.0
80-015	GREENSIDE DARTER	I	M	S	D	6	9.0	1.95	75	0.35	8.3

No Species: 13 **Nat. Species:** 12 **Hybrids:** 0 **Total Counted:** 308 **Total Rel. Wt. :** 21396

IBI: 36.0 **MIwb:** 5.4

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC74 River: 23-001 Mill Creek RM: 4.21 Date: 09/17/2021

Time Fished: 1726 Distance: 0.200 Drainge (sq mi): 141.0 Depth: 0

Location: ust. S. Ludlow Ave. Lat: 39.15800 Long: -84.53720

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-004	SMALLMOUTH BUFFALO	I		M	C	2	3.0	0.40	6000	21.63	2000.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	18	27.0	3.64	6000	21.63	222.2
40-023	SMALLMOUTH REDHORSE	I	M	S	R	1	1.5	0.20	900	3.24	600.0
43-001	COMMON CARP	O	T	M	G	24	36.0	4.85	3150	11.35	87.5
43-020	EMERALD SHINER	I		M	N	250	375.0	50.51	225	0.81	0.6
43-025	STRIPED SHINER	I		S	N	3	4.5	0.61	22	0.08	5.0
43-032	SPOTFIN SHINER	I		M	N	8	12.0	1.62	37	0.14	3.1
43-034	SAND SHINER	I	M	M	N	40	60.0	8.08	45	0.16	0.7
43-043	BLUNTNOSE MINNOW	O	T	C	N	35	52.5	7.07	105	0.38	2.0
47-002	CHANNEL CATFISH			C	F	2	3.0	0.40	4875	17.57	1625.0
47-004	YELLOW BULLHEAD	I	T	C		3	4.5	0.61	240	0.87	53.3
74-005	Striped X White Bass				E	7	10.5	1.41	1875	6.76	178.5
77-006	LARGEMOUTH BASS	C		C	F	13	19.5	2.63	1800	6.49	92.3
77-008	GREEN SUNFISH	I	T	C	S	34	51.0	6.87	1140	4.11	22.3
77-009	BLUEGILL SUNFISH	I	P	C	S	20	30.0	4.04	465	1.68	15.5
77-011	LONGEAR SUNFISH	I	M	C	S	21	31.5	4.24	720	2.60	22.8
80-011	LOGPERCH	I	M	S	D	2	3.0	0.40	22	0.08	7.5
80-015	GREENSIDE DARTER	I	M	S	D	8	12.0	1.62	105	0.38	8.7
80-022	RAINBOW DARTER	I	M	S	D	4	6.0	0.81	15	0.05	2.5

No Species: 18 **Nat. Species:** 17 **Hybrids:** 1 **Total Counted:** 495 **Total Rel. Wt. :** 27742

IBI: 40.0 **MIwb:** 8.5

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC73 River: 23-001 Mill Creek RM: 3.45 Date: 08/12/2021

Time Fished: 1310 Distance: 0.200 Drainge (sq mi): 144.0 Depth: 0

Location: ust. Mill Creek Rd. Lat: 39.14970 Long: -84.54550

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		1	1.5	0.67	120	0.29	80.0
40-002	BIGMOUTH BUFFALO	I		M	C	1	1.5	0.67	3600	8.67	2400.0
40-004	SMALLMOUTH BUFFALO	I		M	C	2	3.0	1.34	5100	12.29	1700.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	6	9.0	4.03	2100	5.06	233.3
43-001	COMMON CARP	O	T	M	G	14	21.0	9.40	28800	69.40	1371.4
43-020	EMERALD SHINER	I		M	N	66	99.0	44.30	75	0.18	0.7
43-027	RIVER SHINER	I		S	N	1	1.5	0.67	1	0.00	1.0
43-034	SAND SHINER	I	M	M	N	1	1.5	0.67	1	0.00	1.0
47-004	YELLOW BULLHEAD	I	T	C		1	1.5	0.67	270	0.65	180.0
77-005	SPOTTED BASS	C		C	F	1	1.5	0.67	315	0.76	210.0
77-008	GREEN SUNFISH	I	T	C	S	29	43.5	19.46	435	1.05	10.0
77-009	BLUEGILL SUNFISH	I	P	C	S	20	30.0	13.42	435	1.05	14.5
77-011	LONGEAR SUNFISH	I	M	C	S	5	7.5	3.36	195	0.47	26.0
85-001	FRESHWATER DRUM		P	M		1	1.5	0.67	52	0.13	35.0

No Species: 14 **Nat. Species:** 13 **Hybrids:** 0 **Total Counted:** 149 **Total Rel. Wt. :** 41500

IBI: 32.0 **MIwb:** 6.2

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC73 River: 23-001 Mill Creek RM: 3.45 Date: 09/16/2021

Time Fished: 1306 Distance: 0.200 Drainge (sq mi): 144.0 Depth: 0

Location: ust. Mill Creek Rd. Lat: 39.14970 Long: -84.54550

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		73	109.5	17.14	1275	3.32	11.6
40-015	NORTHERN HOG SUCKER	I	M	S	R	7	10.5	1.64	2400	6.25	228.5
43-001	COMMON CARP	O	T	M	G	9	13.5	2.11	26100	67.97	1933.3
43-020	EMERALD SHINER	I		M	N	277	415.5	65.02	195	0.51	0.4
43-032	SPOTFIN SHINER	I		M	N	1	1.5	0.23	7	0.02	5.0
43-034	SAND SHINER	I	M	M	N	6	9.0	1.41	7	0.02	0.8
47-002	CHANNEL CATFISH			C	F	1	1.5	0.23	15	0.04	10.0
47-004	YELLOW BULLHEAD	I	T	C		1	1.5	0.23	90	0.23	60.0
47-007	FLATHEAD CATFISH	P		C	F	1	1.5	0.23	30	0.08	20.0
74-005	Striped X White Bass				E	1	1.5	0.23	150	0.39	100.0
77-004	SMALLMOUTH BASS	C	M	C	F	1	1.5	0.23	30	0.08	20.0
77-005	SPOTTED BASS	C		C	F	6	9.0	1.41	1305	3.40	145.0
77-006	LARGEMOUTH BASS	C		C	F	3	4.5	0.70	90	0.23	20.0
77-008	GREEN SUNFISH	I	T	C	S	23	34.5	5.40	255	0.66	7.3
77-009	BLUEGILL SUNFISH	I	P	C	S	5	7.5	1.17	45	0.12	6.0
77-011	LONGEAR SUNFISH	I	M	C	S	6	9.0	1.41	165	0.43	18.3
77-013	PUMPKINSEED SUNFISH	I	P	C	S	1	1.5	0.23	15	0.04	10.0
85-001	FRESHWATER DRUM		P	M		4	6.0	0.94	6225	16.21	1037.5

No Species: 17 **Nat. Species:** 16 **Hybrids:** 1 **Total Counted:** 426 **Total Rel. Wt. :** 38400

IBI: 36.0 **MIwb:** 6.5

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC72 River: 23-001 Mill Creek RM: 3.15 Date: 08/12/2021

Time Fished: 1015 Distance: 0.200 Drainge (sq mi): 154.0 Depth: 0

Location: dst. Mill Creek Rd. Lat: 39.14490 Long: -84.54780

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		21	31.5	18.26	2475	41.94	78.5
40-015	NORTHERN HOG SUCKER	I	M	S	R	1	1.5	0.87	510	8.64	340.0
43-020	EMERALD SHINER	I		M	N	30	45.0	26.09	150	2.54	3.3
43-034	SAND SHINER	I	M	M	N	1	1.5	0.87	3	0.05	2.0
47-002	CHANNEL CATFISH			C	F	1	1.5	0.87	3	0.05	2.0
47-007	FLATHEAD CATFISH	P		C	F	1	1.5	0.87	142	2.41	95.0
77-004	SMALLMOUTH BASS	C	M	C	F	1	1.5	0.87	105	1.78	70.0
77-005	SPOTTED BASS	C		C	F	4	6.0	3.48	555	9.41	92.5
77-006	LARGEMOUTH BASS	C		C	F	3	4.5	2.61	270	4.58	60.0
77-008	GREEN SUNFISH	I	T	C	S	20	30.0	17.39	285	4.83	9.5
77-009	BLUEGILL SUNFISH	I	P	C	S	20	30.0	17.39	1050	17.79	35.0
77-011	LONGEAR SUNFISH	I	M	C	S	12	18.0	10.43	352	5.97	19.5

No Species: 12 **Nat. Species:** 12 **Hybrids:** 0 **Total Counted:** 115 **Total Rel. Wt. :** 5901

IBI: 34.0 **MIwb:** 7.1

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC72 River: 23-001 Mill Creek RM: 3.15 Date: 09/16/2021

Time Fished: 1514 Distance: 0.200 Drainge (sq mi): 154.0 Depth: 0

Location: dst. Mill Creek Rd. Lat: 39.14490 Long: -84.54780

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		72	108.0	17.52	1845	36.62	17.0
40-023	SMALLMOUTH REDHORSE	I	M	S	R	2	3.0	0.49	30	0.60	10.0
43-015	SUCKERMOUTH MINNOW	I		S	N	1	1.5	0.24	7	0.15	5.0
43-020	EMERALD SHINER	I		M	N	226	339.0	54.99	345	6.85	1.0
43-032	SPOTFIN SHINER	I		M	N	4	6.0	0.97	15	0.30	2.5
43-034	SAND SHINER	I	M	M	N	14	21.0	3.41	30	0.60	1.4
43-044	CENTRAL STONEROLLER	H		N	N	10	15.0	2.43	90	1.79	6.0
43-063	CHANNEL SHINER	I	I	M	N	21	31.5	5.11	60	1.19	1.9
47-002	CHANNEL CATFISH			C	F	2	3.0	0.49	390	7.74	130.0
47-007	FLATHEAD CATFISH	P		C	F	1	1.5	0.24	225	4.47	150.0
77-004	SMALLMOUTH BASS	C	M	C	F	1	1.5	0.24	90	1.79	60.0
77-006	LARGEMOUTH BASS	C		C	F	5	7.5	1.22	1110	22.03	148.0
77-008	GREEN SUNFISH	I	T	C	S	32	48.0	7.79	465	9.23	9.6
77-009	BLUEGILL SUNFISH	I	P	C	S	14	21.0	3.41	150	2.98	7.1
77-011	LONGEAR SUNFISH	I	M	C	S	4	6.0	0.97	165	3.27	27.5
77-013	PUMPKINSEED SUNFISH	I	P	C	S	1	1.5	0.24	15	0.30	10.0
80-014	JOHNNY DARTER	I		C	D	1	1.5	0.24	6	0.12	4.0

No Species: 17 **Nat. Species:** 17 **Hybrids:** 0 **Total Counted:** 411 **Total Rel. Wt. :** 5038

IBI: 38.0 **MIwb:** 7.5

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC05 River: 23-001 Mill Creek RM: 2.50 Date: 08/11/2021

Time Fished: 1817 Distance: 0.200 Drainge (sq mi): 156.0 Depth: 0

Location: dst. Hopple St. Lat: 39.13560 Long: -84.54590

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
10-004	LONGNOSE GAR	P		M		1	1.5	0.31	1950	3.96	1300.0
20-003	GIZZARD SHAD	O		M		14	21.0	4.38	1140	2.31	54.2
40-004	SMALLMOUTH BUFFALO	I		M	C	12	18.0	3.75	38250	77.62	2125.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	1	1.5	0.31	22	0.05	15.0
43-020	EMERALD SHINER	I		M	N	209	313.5	65.31	210	0.43	0.6
43-044	CENTRAL STONEROLLER	H		N	N	1	1.5	0.31	15	0.03	10.0
47-002	CHANNEL CATFISH			C	F	61	91.5	19.06	7200	14.61	78.6
74-005	Striped X White Bass				E	1	1.5	0.31	210	0.43	140.0
77-009	BLUEGILL SUNFISH	I	P	C	S	1	1.5	0.31	60	0.12	40.0
80-015	GREENSIDE DARTER	I	M	S	D	1	1.5	0.31	1	0.00	1.0
85-001	FRESHWATER DRUM		P	M		18	27.0	5.63	217	0.44	8.0

No Species: 10 **Nat. Species:** 10 **Hybrids:** 1 **Total Counted:** 320 **Total Rel. Wt. :** 49276

IBI: 30.0 **MIwb:** 6.9

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC05 River: 23-001 Mill Creek RM: 2.50 Date: 09/16/2021

Time Fished: 1640 Distance: 0.200 Drainge (sq mi): 156.0 Depth: 0

Location: dst. Hopple St. Lat: 39.13560 Long: -84.54590

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		41	61.5	7.66	3750	18.29	60.9
40-004	SMALLMOUTH BUFFALO	I		M	C	1	1.5	0.19	3900	19.03	2600.0
40-015	NORTHERN HOG SUCKER	I	M	S	R	2	3.0	0.37	750	3.66	250.0
40-023	SMALLMOUTH REDHORSE	I	M	S	R	5	7.5	0.93	120	0.59	16.0
43-020	EMERALD SHINER	I		M	N	432	648.0	80.75	412	2.01	0.6
43-063	CHANNEL SHINER	I	I	M	N	9	13.5	1.68	22	0.11	1.6
47-002	CHANNEL CATFISH			C	F	20	30.0	3.74	2115	10.32	70.5
47-008	STONECAT MADTOM	I	I	C		3	4.5	0.56	45	0.22	10.0
74-005	Striped X White Bass				E	11	16.5	2.06	9195	44.86	557.2
77-004	SMALLMOUTH BASS	C	M	C	F	2	3.0	0.37	60	0.29	20.0
77-008	GREEN SUNFISH	I	T	C	S	3	4.5	0.56	7	0.04	1.6
77-011	LONGEAR SUNFISH	I	M	C	S	2	3.0	0.37	45	0.22	15.0
85-001	FRESHWATER DRUM		P	M		4	6.0	0.75	75	0.37	12.5

No Species: 12 **Nat. Species:** 12 **Hybrids:** 1 **Total Counted:** 535 **Total Rel. Wt. :** 20497

IBI: 38.0 **MIwb:** 6.5

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC03 River: 23-001 Mill Creek RM: 1.69 Date: 08/14/2021

Time Fished: 1855 Distance: 0.500 Drainge (sq mi): 163.0 Depth: 0

Location: dst. Lick Run CSO Lat: 39.12190 Long: -84.54260

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
10-004	LONGNOSE GAR	P		M		1	2.0	0.72	2200	1.82	1100.0
20-003	GIZZARD SHAD	O		M		51	102.0	36.69	9260	7.67	90.7
40-004	SMALLMOUTH BUFFALO	I		M	C	6	12.0	4.32	26000	21.54	2166.6
40-005	QUILLBACK CARPSUCKER	O		M	C	2	4.0	1.44	840	0.70	210.0
40-006	RIVER CARPSUCKER	O		M	C	12	24.0	8.63	26000	21.54	1083.3
43-001	COMMON CARP	O	T	M	G	8	16.0	5.76	15600	12.92	975.0
43-020	EMERALD SHINER	I		M	N	5	10.0	3.60	20	0.02	2.0
47-002	CHANNEL CATFISH			C	F	9	18.0	6.47	24200	20.05	1344.4
47-007	FLATHEAD CATFISH	P		C	F	1	2.0	0.72	560	0.46	280.0
74-001	WHITE BASS	P		M	F	6	12.0	4.32	1420	1.18	118.3
74-002	STRIPED BASS	P		M	E	1	2.0	0.72	6200	5.14	3100.0
77-005	SPOTTED BASS	C		C	F	6	12.0	4.32	300	0.25	25.0
77-006	LARGEMOUTH BASS	C		C	F	5	10.0	3.60	5340	4.42	534.0
77-008	GREEN SUNFISH	I	T	C	S	2	4.0	1.44	120	0.10	30.0
77-009	BLUEGILL SUNFISH	I	P	C	S	6	12.0	4.32	480	0.40	40.0
77-010	ORANGESPOTTED SUNFISH	I		C	S	2	4.0	1.44	40	0.03	10.0
77-011	LONGEAR SUNFISH	I	M	C	S	9	18.0	6.47	460	0.38	25.5
77-015	GREEN SF X BLUEGILL SF					1	2.0	0.72	20	0.02	10.0
85-001	FRESHWATER DRUM		P	M		6	12.0	4.32	1640	1.36	136.6

No Species: 18 **Nat. Species:** 16 **Hybrids:** 1 **Total Counted:** 139 **Total Rel. Wt. :** 120700

IBI: 34.0 **MIwb:** 9.3

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC71 River: 23-001 Mill Creek RM: 0.83 Date: 08/14/2021

Time Fished: 2141 Distance: 0.500 Drainge (sq mi): 164.0 Depth: 0

Location: ust. Gest St. Lat: 39.10970 Long: -84.54460

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
10-004	LONGNOSE GAR	P		M		1	2.0	1.72	60	0.12	30.0
20-003	GIZZARD SHAD	O		M		8	16.0	13.79	1200	2.31	75.0
40-003	BLACK BUFFALO	I		M	C	1	2.0	1.72	4600	8.86	2300.0
40-004	SMALLMOUTH BUFFALO	I		M	C	3	6.0	5.17	8600	16.57	1433.3
40-006	RIVER CARPSUCKER	O		M	C	14	28.0	24.14	28400	54.72	1014.2
43-020	EMERALD SHINER	I		M	N	6	12.0	10.34	60	0.12	5.0
47-002	CHANNEL CATFISH			C	F	2	4.0	3.45	5800	11.18	1450.0
47-007	FLATHEAD CATFISH	P		C	F	1	2.0	1.72	700	1.35	350.0
74-002	STRIPED BASS	P		M	E	1	2.0	1.72	600	1.16	300.0
77-001	WHITE CRAPPIE	I		C	S	2	4.0	3.45	640	1.23	160.0
77-002	BLACK CRAPPIE	I		C	S	1	2.0	1.72	280	0.54	140.0
77-005	SPOTTED BASS	C		C	F	1	2.0	1.72	400	0.77	200.0
77-006	LARGEMOUTH BASS	C		C	F	2	4.0	3.45	60	0.12	15.0
77-008	GREEN SUNFISH	I	T	C	S	6	12.0	10.34	100	0.19	8.3
77-009	BLUEGILL SUNFISH	I	P	C	S	4	8.0	6.90	160	0.31	20.0
77-010	ORANGESPOTTED SUNFISH	I		C	S	3	6.0	5.17	80	0.15	13.3
77-011	LONGEAR SUNFISH	I	M	C	S	1	2.0	1.72	40	0.08	20.0
77-015	GREEN SF X BLUEGILL SF					1	2.0	1.72	120	0.23	60.0

No Species: 17 **Nat. Species:** 16 **Hybrids:** 1 **Total Counted:** 58 **Total Rel. Wt. :** 51900

IBI: 34.0 **MIwb:** 8.2

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC70 River: 23-001 Mill Creek RM: 0.50 Date: 08/14/2021

Time Fished: 1541 Distance: 0.420 Drainge (sq mi): 164.0 Depth: 0

Location: dst. Gest St. Lat: 39.10500 Long: -84.54480

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		9	21.4	22.50	1261	1.20	58.8
40-003	BLACK BUFFALO	I		M	C	2	4.8	5.00	14286	13.60	3000.0
40-004	SMALLMOUTH BUFFALO	I		M	C	14	33.3	35.00	64548	61.43	1936.4
40-006	RIVER CARPSUCKER	O		M	C	7	16.7	17.50	14762	14.05	885.7
47-002	CHANNEL CATFISH			C	F	1	2.4	2.50	2142	2.04	900.0
47-007	FLATHEAD CATFISH	P		C	F	1	2.4	2.50	3809	3.63	1600.0
74-001	WHITE BASS	P		M	F	1	2.4	2.50	1428	1.36	600.0
77-006	LARGEMOUTH BASS	C		C	F	1	2.4	2.50	952	0.91	400.0
77-008	GREEN SUNFISH	I	T	C	S	2	4.8	5.00	142	0.14	30.0
77-011	LONGEAR SUNFISH	I	M	C	S	1	2.4	2.50	71	0.07	30.0
80-001	SAUGER	P		S	F	1	2.4	2.50	1666	1.59	700.0

No Species: 11 **Nat. Species:** 11 **Hybrids:** 0 **Total Counted:** 40 **Total Rel. Wt. :** 105073

IBI: 30.0 **MIwb:** 7.7

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC69 River: 23-001 Mill Creek RM: 0.21 Date: 08/14/2021

Time Fished: 1140 Distance: 0.350 Drainge (sq mi): 164.0 Depth: 0

Location: RR trestle-Queensgate Lat: 39.10180 Long: -84.54430

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
20-003	GIZZARD SHAD	O		M		8	22.9	25.81	1142	6.72	50.0
40-004	SMALLMOUTH BUFFALO	I		M	C	2	5.7	6.45	7142	42.02	1250.0
40-023	SMALLMOUTH REDHORSE	I	M	S	R	1	2.9	3.23	57	0.34	20.0
43-001	COMMON CARP	O	T	M	G	1	2.9	3.23	7713	45.38	2700.0
77-005	SPOTTED BASS	C		C	F	2	5.7	6.45	114	0.67	20.0
77-006	LARGEMOUTH BASS	C		C	F	7	20.0	22.58	228	1.34	11.4
77-008	GREEN SUNFISH	I	T	C	S	3	8.6	9.68	171	1.01	20.0
77-009	BLUEGILL SUNFISH	I	P	C	S	2	5.7	6.45	57	0.34	10.0
77-011	LONGEAR SUNFISH	I	M	C	S	4	11.4	12.90	285	1.68	25.0
77-012	REDEAR SUNFISH	I		C	E	1	2.9	3.23	85	0.50	30.0

No Species: 10 **Nat. Species:** 8 **Hybrids:** 0 **Total Counted:** 31 **Total Rel. Wt. :** 16999

IBI: 28.0 **MIwb:** 6.5

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC45 River: 23-004 West Fork Mill Creek (Mill Cr. RM 11.57) RM: 0.20 Date: 08/12/2021

Time Fished: 1614 Distance: 0.150 Drainge (sq mi): 36.5 Depth: 0

Location: Elliot Ave. Lat: 39.21360 Long: -84.45990

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	9	18.0	2.52	1500	16.09	83.3
40-016	WHITE SUCKER	O	T	S	W	57	114.0	15.97	2500	26.82	21.9
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	2	4.0	0.56	40	0.43	10.0
43-013	CREEK CHUB	G	T	N	N	31	62.0	8.68	780	8.37	12.5
43-025	STRIPED SHINER	I		S	N	8	16.0	2.24	300	3.22	18.7
43-032	SPOTFIN SHINER	I		M	N	2	4.0	0.56	80	0.86	20.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	164	328.0	45.94	860	9.23	2.6
43-044	CENTRAL STONEROLLER	H		N	N	9	18.0	2.52	120	1.29	6.6
47-004	YELLOW BULLHEAD	I	T	C		3	6.0	0.84	380	4.08	63.3
77-008	GREEN SUNFISH	I	T	C	S	2	4.0	0.56	100	1.07	25.0
77-011	LONGEAR SUNFISH	I	M	C	S	50	100.0	14.01	2400	25.75	24.0
77-021	GREEN SF X LONGEAR SF					1	2.0	0.28	80	0.86	40.0
80-014	JOHNNY DARTER	I		C	D	8	16.0	2.24	60	0.64	3.7
80-015	GREENSIDE DARTER	I	M	S	D	1	2.0	0.28	20	0.21	10.0
80-024	FANTAIL DARTER	I		C	D	10	20.0	2.80	100	1.07	5.0

No Species: 14 **Nat. Species:** 14 **Hybrids:** 1 **Total Counted:** 357 **Total Rel. Wt. :** 9320

IBI: 26.0 **MIwb:** 7.1

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC18 River: 23-006 East Fork Mill Creek RM: 1.14 Date: 07/08/2021

Time Fished: 1604 Distance: 0.150 Drainge (sq mi): 9.2 Depth: 0

Location: ust. Butler Co. Upper Mill Creek WWTP Lat: 39.30470 Long: -84.43080

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-016	WHITE SUCKER	O	T	S	W	9	18.0	4.05	0	0.00	0.0
43-044	CENTRAL STONEROLLER	H		N	N	18	36.0	8.11	0	0.00	0.0
47-004	YELLOW BULLHEAD	I	T	C		2	4.0	0.90	0	0.00	0.0
77-006	LARGEMOUTH BASS	C		C	F	9	18.0	4.05	0	0.00	0.0
77-008	GREEN SUNFISH	I	T	C	S	85	170.0	38.29	0	0.00	0.0
77-009	BLUEGILL SUNFISH	I	P	C	S	67	134.0	30.18	0	0.00	0.0
80-014	JOHNNY DARTER	I		C	D	6	12.0	2.70	0	0.00	0.0
80-022	RAINBOW DARTER	I	M	S	D	4	8.0	1.80	0	0.00	0.0
80-023	ORANGETHROAT DARTER	I		S	D	22	44.0	9.91	0	0.00	0.0

No Species: 9 **Nat. Species:** 9 **Hybrids:** 0 **Total Counted:** 222 **Total Rel. Wt. :** 0

IBI: 36.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC18 River: 23-006 East Fork Mill Creek RM: 1.14 Date: 09/13/2021

Time Fished: 826 Distance: 0.150 Drainge (sq mi): 9.2 Depth: 0

Location: ust. Butler Co. Upper Mill Creek WWTP Lat: 39.30470 Long: -84.43080

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	2	4.0	1.05	80	1.72	20.0
40-016	WHITE SUCKER	O	T	S	W	12	24.0	6.28	340	7.33	14.1
43-001	COMMON CARP	O	T	M	G	67	134.0	35.08	2300	49.57	17.1
43-025	STRIPED SHINER	I		S	N	7	14.0	3.66	320	6.90	22.8
43-044	CENTRAL STONEROLLER	H		N	N	1	2.0	0.52	20	0.43	10.0
47-004	YELLOW BULLHEAD	I	T	C		3	6.0	1.57	240	5.17	40.0
77-006	LARGEMOUTH BASS	C		C	F	6	12.0	3.14	360	7.76	30.0
77-008	GREEN SUNFISH	I	T	C	S	60	120.0	31.41	640	13.79	5.3
77-009	BLUEGILL SUNFISH	I	P	C	S	22	44.0	11.52	300	6.47	6.8
80-014	JOHNNY DARTER	I		C	D	6	12.0	3.14	20	0.43	1.6
80-022	RAINBOW DARTER	I	M	S	D	2	4.0	1.05	8	0.17	2.0
80-023	ORANGETHROAT DARTER	I		S	D	2	4.0	1.05	8	0.17	2.0
80-024	FANTAIL DARTER	I		C	D	1	2.0	0.52	4	0.09	2.0

No Species: 13 **Nat. Species:** 12 **Hybrids:** 0 **Total Counted:** 191 **Total Rel. Wt. :** 4640

IBI: 30.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC15 River: 23-006 East Fork Mill Creek RM: 0.96 Date: 07/08/2021

Time Fished: 1936 Distance: 0.150 Drainge (sq mi): 9.3 Depth: 0

Location: dst. Butler Co. Upper Mill Creek WWTP Lat: 39.30210 Long: -84.43130

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	4	8.0	1.48	0	0.00	0.0
40-016	WHITE SUCKER	O	T	S	W	33	66.0	12.22	0	0.00	0.0
43-001	COMMON CARP	O	T	M	G	8	16.0	2.96	0	0.00	0.0
43-032	SPOTFIN SHINER	I		M	N	2	4.0	0.74	0	0.00	0.0
43-044	CENTRAL STONEROLLER	H		N	N	17	34.0	6.30	0	0.00	0.0
47-004	YELLOW BULLHEAD	I	T	C		4	8.0	1.48	0	0.00	0.0
77-006	LARGEMOUTH BASS	C		C	F	1	2.0	0.37	0	0.00	0.0
77-008	GREEN SUNFISH	I	T	C	S	111	222.0	41.11	0	0.00	0.0
77-009	BLUEGILL SUNFISH	I	P	C	S	63	126.0	23.33	0	0.00	0.0
80-022	RAINBOW DARTER	I	M	S	D	10	20.0	3.70	0	0.00	0.0
80-023	ORANGETHROAT DARTER	I		S	D	17	34.0	6.30	0	0.00	0.0

No Species: 11 **Nat. Species:** 10 **Hybrids:** 0 **Total Counted:** 270 **Total Rel. Wt. :** 0

IBI: 34.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC15 River: 23-006 East Fork Mill Creek RM: 0.96 Date: 09/13/2021

Time Fished: 1169 Distance: 0.150 Drainge (sq mi): 9.3 Depth: 0

Location: dst. Butler Co. Upper Mill Creek WWTP Lat: 39.30210 Long: -84.43130

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	6	12.0	1.59	2400	5.47	200.0
40-016	WHITE SUCKER	O	T	S	W	19	38.0	5.04	1160	2.65	30.5
43-001	COMMON CARP	O	T	M	G	83	166.0	22.02	34900	79.59	210.2
43-013	CREEK CHUB	G	T	N	N	1	2.0	0.27	40	0.09	20.0
43-025	STRIPED SHINER	I		S	N	1	2.0	0.27	20	0.05	10.0
43-034	SAND SHINER	I	M	M	N	3	6.0	0.80	40	0.09	6.6
43-043	BLUNTNOSE MINNOW	O	T	C	N	1	2.0	0.27	40	0.09	20.0
43-044	CENTRAL STONEROLLER	H		N	N	31	62.0	8.22	580	1.32	9.3
47-004	YELLOW BULLHEAD	I	T	C		2	4.0	0.53	860	1.96	215.0
77-008	GREEN SUNFISH	I	T	C	S	184	368.0	48.81	3380	7.71	9.1
77-009	BLUEGILL SUNFISH	I	P	C	S	24	48.0	6.37	380	0.87	7.9
80-014	JOHNNY DARTER	I		C	D	5	10.0	1.33	20	0.05	2.0
80-022	RAINBOW DARTER	I	M	S	D	2	4.0	0.53	8	0.02	2.0
80-023	ORANGETHROAT DARTER	I		S	D	15	30.0	3.98	20	0.05	0.6

No Species: 14 **Nat. Species:** 13 **Hybrids:** 0 **Total Counted:** 377 **Total Rel. Wt. :** 43848

IBI: 34.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC14 River: 23-006 East Fork Mill Creek RM: 0.66 Date: 07/08/2021

Time Fished: 2008 Distance: 0.150 Drainge (sq mi): 9.5 Depth: 0

Location: dst. Crescentville Rd. Lat: 39.29820 Long: -84.42970

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	17	34.0	6.20	0	0.00	0.0
40-016	WHITE SUCKER	O	T	S	W	41	82.0	14.96	0	0.00	0.0
43-001	COMMON CARP	O	T	M	G	11	22.0	4.01	0	0.00	0.0
43-025	STRIPED SHINER	I		S	N	4	8.0	1.46	0	0.00	0.0
43-044	CENTRAL STONEROLLER	H		N	N	1	2.0	0.36	0	0.00	0.0
47-004	YELLOW BULLHEAD	I	T	C		3	6.0	1.09	0	0.00	0.0
77-005	SPOTTED BASS	C		C	F	1	2.0	0.36	0	0.00	0.0
77-006	LARGEMOUTH BASS	C		C	F	3	6.0	1.09	0	0.00	0.0
77-008	GREEN SUNFISH	I	T	C	S	136	272.0	49.64	0	0.00	0.0
77-009	BLUEGILL SUNFISH	I	P	C	S	51	102.0	18.61	0	0.00	0.0
80-014	JOHNNY DARTER	I		C	D	3	6.0	1.09	0	0.00	0.0
80-023	ORANGETHROAT DARTER	I		S	D	3	6.0	1.09	0	0.00	0.0

No Species: 12 **Nat. Species:** 11 **Hybrids:** 0 **Total Counted:** 274 **Total Rel. Wt. :** 0

IBI: 30.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC14 River: 23-006 East Fork Mill Creek RM: 0.66 Date: 09/14/2021

Time Fished: 1129 Distance: 0.150 Drainge (sq mi): 9.5 Depth: 0

Location: dst. Crescentville Rd. Lat: 39.29820 Long: -84.42970

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	9	18.0	6.12	4000	35.34	222.2
40-016	WHITE SUCKER	O	T	S	W	13	26.0	8.84	3540	31.27	136.1
43-001	COMMON CARP	O	T	M	G	18	36.0	12.24	900	7.95	25.0
43-025	STRIPED SHINER	I		S	N	7	14.0	4.76	400	3.53	28.5
47-004	YELLOW BULLHEAD	I	T	C		2	4.0	1.36	320	2.83	80.0
77-008	GREEN SUNFISH	I	T	C	S	71	142.0	48.30	1560	13.78	10.9
77-009	BLUEGILL SUNFISH	I	P	C	S	27	54.0	18.37	600	5.30	11.1

No Species: 7 **Nat. Species:** 6 **Hybrids:** 0 **Total Counted:** 147 **Total Rel. Wt. :** 11320

IBI: 26.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC16 River: 23-006 East Fork Mill Creek RM: 0.39 Date: 07/07/2021

Time Fished: 1027 Distance: 0.120 Drainge (sq mi): 9.5 Depth: 0

Location: dst. Fada Rd/ ust. confluence Mill Creek Lat: 39.29420 Long: -84.43000

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	4	10.0	4.00	0	0.00	0.0
40-016	WHITE SUCKER	O	T	S	W	11	27.5	11.00	0	0.00	0.0
43-001	COMMON CARP	O	T	M	G	4	10.0	4.00	0	0.00	0.0
43-025	STRIPED SHINER	I		S	N	2	5.0	2.00	0	0.00	0.0
43-044	CENTRAL STONEROLLER	H		N	N	1	2.5	1.00	0	0.00	0.0
47-004	YELLOW BULLHEAD	I	T	C		2	5.0	2.00	0	0.00	0.0
77-006	LARGEMOUTH BASS	C		C	F	2	5.0	2.00	0	0.00	0.0
77-008	GREEN SUNFISH	I	T	C	S	62	155.0	62.00	0	0.00	0.0
77-009	BLUEGILL SUNFISH	I	P	C	S	9	22.5	9.00	0	0.00	0.0
77-015	GREEN SF X BLUEGILL SF					1	2.5	1.00	0	0.00	0.0
80-014	JOHNNY DARTER	I		C	D	1	2.5	1.00	0	0.00	0.0
80-022	RAINBOW DARTER	I	M	S	D	1	2.5	1.00	0	0.00	0.0

No Species: 11 **Nat. Species:** 10 **Hybrids:** 1 **Total Counted:** 100 **Total Rel. Wt. :** 0

IBI: 30.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC16 River: 23-006 East Fork Mill Creek RM: 0.39 Date: 09/13/2021

Time Fished: 1120 Distance: 0.150 Drainge (sq mi): 9.5 Depth: 0

Location: dst. Fada Rd/ ust. confluence Mill Creek Lat: 39.29420 Long: -84.43000

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-015	NORTHERN HOG SUCKER	I	M	S	R	7	14.0	9.59	2600	10.86	185.7
40-016	WHITE SUCKER	O	T	S	W	4	8.0	5.48	640	2.67	80.0
43-001	COMMON CARP	O	T	M	G	3	6.0	4.11	18000	75.16	3000.0
47-004	YELLOW BULLHEAD	I	T	C		1	2.0	1.37	700	2.92	350.0
77-006	LARGEMOUTH BASS	C		C	F	2	4.0	2.74	560	2.34	140.0
77-008	GREEN SUNFISH	I	T	C	S	44	88.0	60.27	1120	4.68	12.7
77-009	BLUEGILL SUNFISH	I	P	C	S	10	20.0	13.70	320	1.34	16.0
80-023	ORANGETHROAT DARTER	I		S	D	2	4.0	2.74	10	0.04	2.5

No Species: 8 **Nat. Species:** 7 **Hybrids:** 0 **Total Counted:** 73 **Total Rel. Wt. :** 23950

IBI: 26.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MR-1 River: 23-009 (Rossmoyne Creek (RM 14.05)) Cooper Creek RM: 3.57 Date: 09/17/2021

Time Fished:	Distance:	Drainge (sq mi):	Depth:
1183	0.170	0.3	0

Location:	Lat:	Long:
20m dst Bechtold sewer outlet, Bechtold Park	39.21850	-84.38930

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	17	30.0	8.25	44	4.41	1.4
43-013	CREEK CHUB	G	T	N	N	116	204.7	56.31	831	83.07	4.0
43-044	CENTRAL STONEROLLER	H		N	N	73	128.9	35.44	125	12.52	0.9

No Species: 3 **Nat. Species:** 3 **Hybrids:** 0 **Total Counted:** 206 **Total Rel. Wt. :** 1000

IBI: 28.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MR-2 River: 23-009 (Rossmoyne Creek (RM 14.05)) Cooper Creek RM: 3.42 Date: 09/17/2021

Time Fished: 1710 Distance: 0.150 Drainge (sq mi): 0.4 Depth: 0

Location: 20m ust Plainfield Rd., Bechtold Park Lat: 39.21940 Long: -84.39120

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	72	144.0	16.18	222	7.62	1.5
43-013	CREEK CHUB	G	T	N	N	268	536.0	60.22	2390	82.07	4.4
43-044	CENTRAL STONEROLLER	H		N	N	105	210.0	23.60	300	10.30	1.4

No Species: 3 **Nat. Species:** 3 **Hybrids:** 0 **Total Counted:** 445 **Total Rel. Wt. :** 2912

IBI: 28.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MR-3 River: 23-009 (Rossmoyne Creek (RM 14.05)) Cooper Creek RM: 2.84 Date: 10/01/2021

Time Fished:	Distance:	Drainge (sq mi):	Depth:
1357	0.150	1.1	0

Location:	Lat:	Long:
50m dst. Wicklow Ave.	39.21710	-84.40560

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	12	24.0	5.15	50	3.09	2.0
43-013	CREEK CHUB	G	T	N	N	157	314.0	67.38	1404	86.77	4.4
43-042	FATHEAD MINNOW	O	T	C	N	2	4.0	0.86	10	0.62	2.5
43-044	CENTRAL STONEROLLER	H		N	N	62	124.0	26.61	154	9.52	1.2

No Species: 4 **Nat. Species:** 4 **Hybrids:** 0 **Total Counted:** 233 **Total Rel. Wt. :** 1618

IBI: 30.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MR-5 River: 23-009 (Rossmoyne Creek (RM 14.05)) Cooper Creek RM: 2.59 Date: 10/01/2021

Time Fished:	Distance:	Drainge (sq mi):	Depth:
497	0.150	1.8	0

Location:	Lat:	Long:
30m ust Arborcrest Ct.	39.21890	-84.41000

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	30	60.0	6.68	150	5.43	2.5
43-013	CREEK CHUB	G	T	N	N	155	310.0	34.52	1420	51.45	4.5
43-042	FATHEAD MINNOW	O	T	C	N	1	2.0	0.22	2	0.07	1.0
43-044	CENTRAL STONEROLLER	H		N	N	263	526.0	58.57	1188	43.04	2.2

No Species: 4 **Nat. Species:** 4 **Hybrids:** 0 **Total Counted:** 449 **Total Rel. Wt. :** 2760

IBI: 30.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MR-6 River: 23-009 (Rossmoyne Creek (RM 14.05)) Cooper Creek RM: 2.13 Date: 09/24/2021

Time Fished: 3230 Distance: 0.150 Drainge (sq mi): 2.6 Depth: 0

Location: 200m dst Ronald Reagan Hwy 126 Lat: 39.22250 Long: -84.41570

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-016	WHITE SUCKER	O	T	S	W	5	10.0	0.67	472	5.99	47.2
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	101	202.0	13.47	412	5.23	2.0
43-013	CREEK CHUB	G	T	N	N	252	504.0	33.60	4504	57.17	8.9
43-044	CENTRAL STONEROLLER	H		N	N	383	766.0	51.07	2452	31.12	3.2
80-023	ORANGETHROAT DARTER	I		S	D	9	18.0	1.20	38	0.48	2.1

No Species: 5 **Nat. Species:** 5 **Hybrids:** 0 **Total Counted:** 750 **Total Rel. Wt. :** 7878

IBI: 32.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC118 River: 23-009 (Rossmoyne Creek (RM 14.05)) Cooper Creek RM: 1.58 Date: 08/16/2021

Time Fished:	Distance:	Drainge (sq mi):	Depth:
1191	0.150	3.9	0

Location:	Lat:	Long:
end of N. Kathwood Cir.	39.22960	-84.41560

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-016	WHITE SUCKER	O	T	S	W	7	14.0	3.68	0	0.00	0.0
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	12	24.0	6.32	0	0.00	0.0
43-013	CREEK CHUB	G	T	N	N	31	62.0	16.32	0	0.00	0.0
43-025	STRIPED SHINER	I		S	N	3	6.0	1.58	0	0.00	0.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	3	6.0	1.58	0	0.00	0.0
43-044	CENTRAL STONEROLLER	H		N	N	83	166.0	43.68	0	0.00	0.0
77-008	GREEN SUNFISH	I	T	C	S	2	4.0	1.05	0	0.00	0.0
80-014	JOHNNY DARTER	I		C	D	2	4.0	1.05	0	0.00	0.0
80-022	RAINBOW DARTER	I	M	S	D	5	10.0	2.63	0	0.00	0.0
80-023	ORANGETHROAT DARTER	I		S	D	17	34.0	8.95	0	0.00	0.0
80-024	FANTAIL DARTER	I		C	D	25	50.0	13.16	0	0.00	0.0

No Species: 11 **Nat. Species:** 11 **Hybrids:** 0 **Total Counted:** 190 **Total Rel. Wt. :** 0

IBI: 46.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC119 River: 23-009 (Rossmoyne Creek (RM 14.05)) Cooper Creek RM: 0.44 Date: 08/16/2021

Time Fished: 1072 Distance: 0.150 Drainge (sq mi): 5.4 Depth: 0

Location: ust. Reading Rd. Lat: 39.23580 Long: -84.42870

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
40-016	WHITE SUCKER	O	T	S	W	5	10.0	1.51	0	0.00	0.0
43-011	WESTERN BLACKNOSE DACE	G	T	S	N	27	54.0	8.16	0	0.00	0.0
43-013	CREEK CHUB	G	T	N	N	37	74.0	11.18	0	0.00	0.0
43-025	STRIPED SHINER	I		S	N	11	22.0	3.32	0	0.00	0.0
43-043	BLUNTNOSE MINNOW	O	T	C	N	17	34.0	5.14	0	0.00	0.0
43-044	CENTRAL STONEROLLER	H		N	N	177	354.0	53.47	0	0.00	0.0
77-006	LARGEMOUTH BASS	C		C	F	2	4.0	0.60	0	0.00	0.0
77-008	GREEN SUNFISH	I	T	C	S	6	12.0	1.81	0	0.00	0.0
80-014	JOHNNY DARTER	I		C	D	4	8.0	1.21	0	0.00	0.0
80-022	RAINBOW DARTER	I	M	S	D	5	10.0	1.51	0	0.00	0.0
80-023	ORANGETHROAT DARTER	I		S	D	7	14.0	2.11	0	0.00	0.0
80-024	FANTAIL DARTER	I		C	D	33	66.0	9.97	0	0.00	0.0

No Species: 12 **Nat. Species:** 12 **Hybrids:** 0 **Total Counted:** 331 **Total Rel. Wt. :** 0

IBI: 46.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC97 River: 23-028 Trib to West Fork Creet at RM 1.24 RM: 1.49 Date: 08/16/2021

Time Fished: 740 Distance: 0.150 Drainge (sq mi): 0.8 Depth: 0

Location: Kirby Rd. Lat: 39.17960 Long: -84.55610

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
99-999	NO FISH					0	0.0	***.**	0	0.00	*****.*

No Species: 0 **Nat. Species:** 1 **Hybrids:** 0 **Total Counted:** 0 **Total Rel. Wt. :** 0

IBI: 12.0 **Mlwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC109 River: 23-028 Trib to West Fork Creet at RM 1.24 RM: 1.11 Date: 08/16/2021

Time Fished: 480 Distance: 0.150 Drainge (sq mi): 0.9 Depth: 0

Location: Along Wooden Shoe Hollow Ln. Lat: 39.18540 Long: -84.52130

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
99-999	NO FISH					0	0.0	***.**	0	0.00	*****.*

No Species: 0 **Nat. Species:** 1 **Hybrids:** 0 **Total Counted:** 0 **Total Rel. Wt. :** 0

IBI: 12.0 **Mlwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MR-4b River: 23-046 Unnamed Trib to (Rossmoyne Creek) RM: 0.55 Date: 09/17/2021

Cooper Creek

Time Fished: 663 Distance: 0.150 Drainge (sq mi): 0.4 Depth: 0

Location: Hamilton Co. SWCD Lat: 39.21110 Long: -84.40900

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
99-997	Dry Site					0	0.0	***.**	0	0.00	*****.*

No Species: 1 **Nat. Species:** 1 **Hybrids:** 0 **Total Counted:** 0 **Total Rel. Wt. :** 0

IBI: 12.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC108 River: 23-068 Lick Run (Trib to Mill Creek @ RM 1.70 RM: 1.70 Date: 08/16/2021

Time Fished: 0 Distance: 0.150 Drainge (sq mi): 0.1 Depth: 0

Location: Glenway Woods Lat: 39.11740 Long: -84.56750

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
99-997	Dry Site					0	0.0	***.**	0	0.00	*****.*

No Species: 1 **Nat. Species:** 1 **Hybrids:** 0 **Total Counted:** 0 **Total Rel. Wt. :** 0

IBI: 12.0 **Mlwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC106 River: 23-068 Lick Run (Trib to Mill Creek @ RM 1.70 RM: 0.98 Date: 07/09/2021

Time Fished: 806 Distance: 0.150 Drainge (sq mi): 3.4 Depth: 0

Location: Grotto Court Lat: 39.12610 Long: -84.56150

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
43-002	GOLDFISH	O	T	M	G	1	2.0	2.94	0	0.00	0.0
43-042	FATHEAD MINNOW	O	T	C	N	28	56.0	82.35	0	0.00	0.0
57-001	WESTERN MOSQUITOFISH	I		N	E	1	2.0	2.94	0	0.00	0.0
77-008	GREEN SUNFISH	I	T	C	S	4	8.0	11.76	0	0.00	0.0

No Species: 4 **Nat. Species:** 2 **Hybrids:** 0 **Total Counted:** 34 **Total Rel. Wt. :** 0

IBI: 16.0 **MIwb:** N/A

Appendix Table B-3. Midwest Biodiversity Institute
Fish Species List

Site ID: MC107 River: 23-068 Lick Run (Trib to Mill Creek @ RM 1.70 RM: 0.45 Date: 07/09/2021

Time Fished: 1292 Distance: 0.150 Drainge (sq mi): 3.5 Depth: 0

Location: Queen City and Cora Ave. Lat: 39.12540 Long: -84.55180

Species Code:	Species Name:	Feed Guild	Toler-ance	Breed Guild	IBI Group	No. Fish	Rel. No.	% by No.	Rel. Wt.	% by Wt.	Av. Wt.
43-042	FATHEAD MINNOW	O	T	C	N	15	30.0	48.39	0	0.00	0.0
57-001	WESTERN MOSQUITOFISH	I		N	E	6	12.0	19.35	0	0.00	0.0
77-008	GREEN SUNFISH	I	T	C	S	10	20.0	32.26	0	0.00	0.0

No Species: 3 **Nat. Species:** 2 **Hybrids:** 0 **Total Counted:** 31 **Total Rel. Wt. :** 0

IBI: 20.0 **MIwb:** N/A

APPENDIX C

Mill Creek 2021 Macroinvertebrate Assemblage Data

C-1: Invertebrate Community Index (ICI) Metrics and Scores

C-2: Macroinvertebrate Taxa by Site and Sample

Appendix Table C-1. ICI metrics and values in the Mill Creek watershed study area during 2021.

Site_ID	River Mile	Drainage Area (sq mi)	Number of Total Taxa	Number of Mayfly Taxa	Number of Caddisfly Taxa	Number of Dipteran Taxa	Percent: Mayflies	Percent: Caddis-flies	Percent: Tany-tarsini	Percent: Other Dipt/NI	Percent: Tolerant Organisms	Percent: Qual. EPT	ICI or Narrative
Mill Creek (23-001)													
Year: 2021													
MC00	26.00	4.4	34(4)	2(0)	4(6)	20(6)	4.6(2)	1.6(6)	40.1(6)	51.2(2)	2.9(6)	10(6)	44
MC12	19.10	26.5	34(4)	3(2)	5(6)	16(4)	13.4(4)	29.4(6)	9.3(2)	44.4(4)	2.0(6)	8(4)	42
MC10	18.70	27.0	26(4)	5(4)	5(6)	9(2)	17.6(4)	45.9(6)	10.4(2)	25.0(6)	0.3(6)	8(4)	44
MC08	18.37	27.3	41(6)	4(2)	5(6)	21(6)	8.5(2)	18.6(6)	11.8(2)	59.2(2)	5.8(6)	13(6)	44
MC08	18.10	32.4	41(6)	4(2)	5(6)	21(6)	8.5(2)	18.6(6)	11.8(2)	59.2(2)	5.8(6)	13(6)	44
MC101	17.96	26.9	30(4)	2(0)	5(6)	12(2)	7.0(2)	54.0(6)	15.3(4)	22.9(6)	1.2(6)	9(4)	40
MC06	16.60	50.5	31(4)	3(2)	6(6)	11(2)	3.7(2)	67.6(6)	6.7(2)	21.2(6)	3.1(6)	11(4)	40
MC04	15.41	61.3	31(4)	3(2)	6(6)	11(2)	16.8(4)	45.9(6)	0.9(2)	35.1(4)	0.7(6)	11(4)	40
MC04	15.10	62.5	31(4)	3(2)	6(6)	11(2)	16.8(4)	45.9(6)	0.9(2)	35.1(4)	0.7(6)	11(4)	40
MC11	13.96	68.8	27(4)	3(2)	7(6)	10(2)	1.0(2)	74.8(6)	1.7(2)	22.3(6)	1.3(6)	12(4)	40
MC11	13.90	68.8	27(4)	3(2)	7(6)	10(2)	1.0(2)	74.8(6)	1.7(2)	22.3(6)	1.3(6)	12(4)	40
MC104	13.70	71.6	37(4)	6(4)	5(6)	19(4)	35.3(6)	36.8(6)	7.6(2)	20.2(6)	1.0(6)	9(2)	46
MC02	13.10	72.2	39(6)	5(2)	5(6)	21(6)	14.2(2)	21.2(6)	16.3(4)	44.2(4)	2.9(6)	13(4)	46
MC01	11.70	73.9	28(4)	6(4)	6(6)	13(2)	10.2(2)	61.8(6)	6.1(2)	21.9(6)	0.9(6)	11(4)	42
MC80	10.50	118.0	24(2)	3(2)	5(6)	9(2)	14.7(2)	66.5(6)	2.2(2)	16.6(6)	0.3(6)	9(2)	36
MC80	10.48	115.0	24(2)	3(2)	5(6)	9(2)	14.7(2)	66.5(6)	2.2(2)	16.6(6)	0.3(6)	9(2)	36
MC105	9.24	119.0	26(4)	5(2)	5(6)	10(2)	8.8(2)	66.8(6)	2.9(2)	21.3(6)	0.2(6)	8(2)	38
MC79	8.68	120.0	31(4)	5(2)	5(6)	13(4)	12.0(2)	65.1(6)	2.2(2)	20.4(6)	0.5(6)	8(2)	40
MC77	7.65	126.0	26(4)	4(2)	4(4)	11(2)	13.1(2)	63.0(6)	3.5(2)	20.3(6)	1.0(6)	11(4)	38
MC09	6.80	127.0	18(2)	1(0)	3(4)	10(2)	7.0(2)	31.1(6)	6.4(2)	51.9(2)	10.5(2)	5(2)	24
MC07	6.35	135.0	21(2)	3(2)	3(4)	10(2)	1.7(2)	8.9(2)	4.7(2)	84.3(0)	40.3(0)	3(0)	16
MC75	4.84	139.0	34(4)	3(2)	3(4)	17(4)	0.6(2)	9.5(4)	16.9(2)	71.9(0)	7.9(4)	7(2)	28
MC74	4.60	141.0	27(4)	2(0)	4(4)	14(4)	1.0(2)	10.8(4)	9.4(2)	78.5(0)	2.9(6)	6(2)	28
MC73	3.60	144.0	40(6)	6(4)	5(6)	19(6)	5.5(2)	50.9(6)	11.2(2)	32.3(4)	1.3(6)	7(2)	44
MC72	3.10	155.0	35(4)	3(2)	6(6)	17(4)	4.9(2)	48.2(6)	2.1(2)	44.4(2)	1.3(6)	7(2)	36
MC05	2.50	154.0	42(6)	5(2)	5(6)	21(6)	2.0(2)	42.2(6)	9.1(2)	46.1(2)	7.1(4)	5(0)	36
MC03	1.69	163.0	33(4)	3(2)	3(4)	17(4)	1.5(2)	8.8(2)	5.6(2)	83.1(0)	18.1(0)	2(0)	20
West Fork Mill Creek (23-004)													
Year: 2021													
MC45	0.20	36.4	15(2)	2(0)	1(2)	9(2)	71.5(6)	2.3(2)	4.5(2)	21.7(6)	5.6(6)	8(2)	30
East Fork Mill Creek (23-006)													
Year: 2021													
MC18	2.00	8.1	29(4)	3(2)	2(4)	17(4)	37.8(6)	4.2(6)	9.0(2)	47.1(2)	3.5(6)	12(6)	42

Narrative Codes, VP - Very Poor, P - Poor, F - Fair, MG - Marginally Good, G - Good, E - Excellent, PHW3A - Spring Water Type A, PHW2 - Small Drainage Warm Water Stream

Appendix Table C-1. ICI metrics and values in the Mill Creek watershed study area during 2021.

Site_ID	River Mile	Drainage Area (sq mi)	Number of				Percent:						ICI or Narrative
			Total Taxa	Mayfly Taxa	Caddisfly Taxa	Dipteran Taxa	Mayflies	Caddis-flies	Tany-tarsini	Other Dipt/NI	Tolerant Organisms	Qual. EPT	
MC18	1.14	9.4	29(4)	3(2)	2(4)	17(4)	37.8(6)	4.2(6)	9.0(2)	47.1(2)	3.5(6)	12(6)	42
MC15	1.05	9.3	28(4)	1(0)	5(6)	14(4)	0.4(2)	5.2(6)	9.2(4)	84.4(0)	30.1(0)	7(4)	30
MC14	0.72	9.5	24(2)	3(2)	5(6)	10(2)	0.9(2)	25.5(6)	20.5(6)	52.2(2)	5.2(6)	7(4)	38
MC16	0.10	9.4	34(4)	2(0)	5(6)	19(4)	0.6(2)	17.9(6)	33.6(6)	47.8(2)	17.8(4)	6(2)	36
Coopers Creek (Rossmoyne Creek RM 14.05) (23-009)													
Year: 2021													
MC111	3.57	0.3										0	VP
MC112	3.42	0.4										4	F
MC113	2.84	1.1										0	VP
MC32	2.59	1.8										0	VP
MC28	2.13	2.6										7	MG
MC118	1.58	4.0										10	G
MC119	0.46	5.4										10	G
Trib to West Fork Creek @ RM 1.24 (23-028)													
Year: 2021													
MC97	1.40	0.8										9	
Unamed Trib to Cooper Creek at RM 2.80 (23-046)													
Year: 2021													
MC114	0.55	0.7										0	VP
Kings Run (23-065)													
Year: 2021													
MC109	1.00	0.9										10	
Lick Run (23-068)													
Year: 2021													
MC108	1.70	0.2										1	
MC106	0.98	3.5										1	P
MC107	0.45	3.6										3	P

Narrative Codes, VP - Very Poor, P - Poor, F - Fair, MG - Marginally Good, G - Good, E - Excellent, PHW3A - Spring Water Type A, PHW2 - Small Drainage Warm Water Stream

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/07/2021* RM: **26.00**

Site ID: **MC00** Location: *dst. Libery-Fairfield Rd.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		F	6	+
02000	Nematoda			4	
03600	Oligochaeta		T		+
04664	Helobdella stagnalis		T	1	+
05900	Lirceus sp		MT	8	+
06700	Crangonyx sp		MT	1	+
11120	Baetis flavistriga		F		+
11130	Baetis intercalaris		F		+
13521	Stenonema femoratum		F	36	+
17200	Caenis sp		F	20	+
21200	Calopteryx sp		F	6	+
22001	Coenagrionidae		T		+
22300	Argia sp		F	21	+
50301	Chimarra aterrima		MI		+
50315	Chimarra obscura		MI		+
51050	Cernotina sp		MI		+
51600	Polycentropus sp		MI	1	
52200	Cheumatopsyche sp		F	1	+
52430	Ceratopsyche morosa group		MI		+
52530	Hydropsyche depravata group		F	1	+
53800	Hydroptila sp		F	16	
68075	Psephenus herricki		MI		+
68601	Ancyronyx variegata		F		+
69400	Stenelmis sp		F		+
71900	Tipula sp		F		+
77120	Ablabesmyia mallochi		F	12	
77500	Conchapelopia sp		F	58	
77800	Helopelopia sp		F	12	
78450	Nilotanypus fimbriatus		F	24	
80370	Corynoneura lobata		F	20	
80410	Cricotopus (C.) sp		F	12	
81650	Parametriocnemus sp	X	F	12	
83040	Dicrotendipes neomodestus		F	105	
83840	Microtendipes pedellus group		F	12	
83900	Nilothauma sp		F	12	
84210	Paratendipes albimanus or P. duplicatus		F	117	+
84300	Phaenopsectra obediens group		F	117	+
84450	Polypedilum (Uresipedilum) flavum		F	23	+
84460	Polypedilum (P.) fallax group		F	23	
84470	Polypedilum (P.) illinoense		T	12	
84480	Polypedilum (P.) laetum group		MI	12	
84540	Polypedilum (Tripodura) scalaenum group		F	23	
85500	Paratanytarsus sp		F	140	
85625	Rheotanytarsus sp		F	70	+
85821	Tanytarsus glabrescens group sp 7		F	281	
95100	Physella sp		T		+
96801	Ancylidae		F	4	
97601	Corbicula fluminea		F		+

No. Quantitative Taxa:	34	Total Taxa;	48
No. Qualitative Taxa:	28	ICI:	44
Number of Organisms:	1223	Qual EPT:	10

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/07/2021* RM: **19.10**

Site ID: **MC12** Location: *ust. Windisch Rd.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		**F**	132	+
03000	Ectoprocta		**F**	2	+
03451	Urnatella gracilis		**MI**	1	
03600	Oligochaeta		**T**	13	+
04664	Helobdella stagnalis		**T**		+
04964	Erpobdella microstoma		**MT**		+
08250	Orconectes (Procericambarus) rusticus		**F**	1	+
11130	Baetis intercalaris		**F**	148	+
11670	Procloeon viridoculare		**MI**		+
13521	Stenonema femoratum		**F**	12	+
17200	Caenis sp		**F**	22	+
21200	Calopteryx sp		**F**		+
21300	Hetaerina sp		**F**	1	
22001	Coenagrionidae		**T**		+
22300	Argia sp		**F**	30	+
50315	Chimarra obscura		**MI**	1	+
51206	Cyrnellus fraternus		**F**	15	
52200	Cheumatopsyche sp		**F**	363	+
52430	Ceratopsyche morosa group		**MI**	13	+
52530	Hydropsyche depravata group		**F**	6	+
59970	Petrophila sp		**MI**		+
68075	Psephenus herricki		**MI**		+
69400	Stenelmis sp		**F**	14	+
74100	Simulium sp		**F**		+
77120	Ablabesmyia mallochi		**F**		+
77130	Ablabesmyia rhamphe group		**MT**	14	
77500	Conchapelopia sp		**F**	35	
77750	Hayesomyia senata or Thienemannimyia norena		**F**	70	+
77800	Helopelopia sp		**F**	14	
78450	Nilotanypus fimbriatus		**F**	25	
82820	Cryptochironomus sp		**F**		+
83300	Glyptotendipes (G.) sp		**MT**	35	
84100	Paracladopelma sp				+
84155	Paralauterborniella nigrohalteralis		**F**	7	
84210	Paratendipes albimanus or P. duplicatus		**F**		+
84300	Phaenopsectra obediens group		**F**	14	
84450	Polypedilum (Uresipedilum) flavum		**F**	161	+
84460	Polypedilum (P.) fallax group		**F**	7	
84470	Polypedilum (P.) illinoense		**T**	7	+
84540	Polypedilum (Tripodura) scalaenum group		**F**	42	+
85230	Cladotanytarsus mancus group		**F**		+
85265	Cladotanytarsus vanderwulpi group sp 5		**MI**		+
85625	Rheotanytarsus sp		**F**	77	
85821	Tanytarsus glabrescens group sp 7		**F**	35	+
85840	Tanytarsus sepp		**F**	14	
87540	Hemerodromia sp		**F**	12	
96801	Ancylidae		**F**	11	
97601	Corbicula fluminea		**F**	1	

No. Quantitative Taxa:	34	Total Taxa;	48
No. Qualitative Taxa:	32	ICI:	42
Number of Organisms:	1355	Qual EPT:	8

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/07/2021* RM: **18.70**

Site ID: **MC10** Location: *Ust. Crescentville Rd.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.		Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		**F**	84	+						
03000	Ectoprocta		**F**	1							
03600	Oligochaeta		**T**		+						
04660	Helobdella sp		**MT**		+						
08200	Orconectes sp		**F**		+						
11120	Baetis flavistriga		**F**	4	+						
11130	Baetis intercalaris		**F**	734	+						
12200	Isonychia sp		**MI**	4							
13521	Stenonema femoratum		**F**	19	+						
17200	Caenis sp		**F**	1	+						
22001	Coenagrionidae		**T**		+						
22300	Argia sp		**F**	3	+						
50315	Chimarra obscura		**MI**	17	+						
51206	Cyrnellus fraternus		**F**	33							
52200	Cheumatopsyche sp		**F**	1099	+						
52430	Ceratopsyche morosa group		**MI**	42	+						
52530	Hydropsyche depravata group		**F**	799	+						
68708	Dubiraphia vittata group		**F**	1							
68901	Macronychus glabratus		**F**	16							
69400	Stenelmis sp		**F**	25	+						
77750	Hayesomyia senata or Thienemannimyia norena		**F**	87							
78450	Nilotanypus fimbriatus		**F**	15							
78655	Procladius (Holotanypus) sp		**MT**		+						
81240	Nanocladius (N.) distinctus		**MT**	15							
82820	Cryptochironomus sp		**F**		+						
83300	Glyptotendipes (G.) sp		**MT**	44							
84450	Polypedilum (Uresipedilum) flavum		**F**	815	+						
84540	Polypedilum (Tripodura) scalaenum group		**F**	15	+						
85625	Rheotanytarsus sp		**F**	393	+						
85800	Tanytarsus sp		**F**	58							
87540	Hemerodromia sp		**F**	8							
95100	Physella sp		**T**		+						
95501	Planorbidae		**MT**		+						
97601	Corbicula fluminea		**F**	1	+						

No. Quantitative Taxa:	26	Total Taxa;	34
No. Qualitative Taxa:	23	ICI:	44
Number of Organisms:	4333	Qual EPT:	8

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/13/2021* RM: **18.10**

Site ID: **MC08** Location: *ust. E. Branch Mill Creek confluence* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt.	Ql.
00401	Spongillidae		F		+
01320	Hydra sp		F	98	
01801	Turbellaria		F	100	+
03040	Fredericella sp		F	2	
03360	Plumatella sp		F	5	+
03451	Urnatella gracilis		MI	8	
03600	Oligochaeta		T	104	+
04601	Glossiphoniidae		MT		+
04666	Helobdella papillata		MT		+
04930	Erpobdella sp		MT		+
06201	Hyalella azteca		F		+
11120	Baetis flavistriga		F	22	+
11130	Baetis intercalaris		F	235	+
11600	Paracloeodes fleeki		MI		+
11620	Paracloeodes minutus		MI		+
11670	Procloeon viridoculare		MI		+
13521	Stenonema femoratum		F	34	+
16700	Tricorythodes sp		MI		+
17200	Caenis sp		F	67	+
21200	Calopteryx sp		F		+
22300	Argia sp		F	66	+
43300	Ranatra sp		F		+
49200	Climacia sp		F		+
50315	Chimarra obscura		MI		+
51206	Cyrnellus fraternus		F	62	+
52200	Cheumatopsyche sp		F	543	+
52430	Ceratopsyche morosa group		MI	1	
52530	Hydropsyche depravata group		F	54	+
53800	Hydroptila sp		F	121	+
59970	Petrophila sp		MI	10	+
68025	Ectopria sp		F		+
68075	Psephenus herricki		MI		+
69400	Stenelmis sp		F		+
77120	Ablabesmyia mallochi		F		+
77500	Conchapelopia sp		F	49	
77740	Hayesomyia senata		F	247	+
77800	Helopelopia sp		F	99	
78140	Labrundinia pilosella		F	48	
78450	Nilotanypus fimbriatus		F	24	
78655	Procladius (Holotanypus) sp		MT		+
78750	Rheopelopia paramaculipennis		MI	25	
80360	Corynoneura floridaensis		MI	8	+
80370	Corynoneura lobata		F	8	
80420	Cricotopus (C.) bicinctus		T	25	+
81231	Nanocladius (N.) crassicornus or N. (N.) "rectinervis"		F	25	
81825	Rheocricotopus (Psilocricotopus) robacki		F	25	
82101	Thienemanniella taurocapita		MI	8	
82730	Chironomus (C.) decorus group		T		+
82820	Cryptochironomus sp		F		+
82824	Cryptochironomus ponderosus		F		+
83003	Dicrotendipes fumidus		F		+
83040	Dicrotendipes neomodestus		F	178	+
83300	Glyptotendipes (G.) sp		MT	74	+
84450	Polypedilum (Uresipedilum) flavum		F	1088	+
84470	Polypedilum (P.) illinoense		T	25	+
84540	Polypedilum (Tripodura) scalaenum group		F	99	+
85230	Cladotanytarsus mancus group		F		+
85500	Paratanytarsus sp		F	25	
85625	Rheotanytarsus sp		F	222	+
85800	Tanytarsus sp		F		+
85818	Tanytarsus glabrescens group sp 4		F	25	
85821	Tanytarsus glabrescens group sp 7		F	222	+
85840	Tanytarsus sepp		F		+
87540	Hemerodromia sp		F		+
95100	Physella sp		T	1	+
96900	Ferrissia sp		F	88	
97601	Corbicula fluminea		F	23	+

No. Quantitative Taxa:	41	Total Taxa;	67
No. Qualitative Taxa:	51	ICI:	44
Number of Organisms:	4193	Qual EPT:	13

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/14/2021* RM: **17.96**

Site ID: **MC101** Location: *RR trestel dst. East Fork Mill Creek* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		**F**	68	+
03000	Ectoprocta		**F**	1	+
03600	Oligochaeta		**T**	24	
04962	Erpobdella fervida		**MT**		+
06201	Hyalella azteca		**F**		+
08250	Orconectes (Procericambarus) rusticus		**F**		+
08601	Hydrachnidia		**F**	9	
11120	Baetis flavistriga		**F**	1	
11130	Baetis intercalaris		**F**	434	+
13521	Stenonema femoratum		**F**		+
17200	Caenis sp		**F**		+
21200	Calopteryx sp		**F**	1	
21300	Hetaerina sp		**F**	9	
22001	Coenagrionidae		**T**		+
22300	Argia sp		**F**	1	+
50315	Chimarra obscura		**MI**		+
51206	Cyrnellus fraternus		**F**	1	+
52200	Cheumatopsyche sp		**F**	1924	+
52430	Ceratopsyche morosa group		**MI**	1	+
52530	Hydropsyche depravata group		**F**	1420	+
53800	Hydroptila sp		**F**	27	+
59970	Petrophila sp		**MI**	9	+
68075	Psephenus herricki		**MI**		+
68708	Dubiraphia vittata group		**F**		+
69400	Stenelmis sp		**F**		+
77750	Hayesomyia senata or Thienemannimyia norena		**F**	133	+
78450	Nilotanypus fimbriatus		**F**	16	
80420	Cricotopus (C.) bicinctus		**T**		+
81240	Nanocladius (N.) distinctus		**MT**	26	
82730	Chironomus (C.) decorus group		**T**		+
82820	Cryptochironomus sp		**F**		+
82822	Cryptochironomus eminentia		**F**		+
83040	Dicrotendipes neomodestus		**F**	26	+
83300	Glyptotendipes (G.) sp		**MT**	53	
84450	Polypedilum (Uresipedilum) flavum		**F**	1009	+
84470	Polypedilum (P.) illinoense		**T**	26	
84540	Polypedilum (Tripodura) scalaenum group		**F**		+
84700	Stenochironomus sp		**F**		+
84790	Tribelos fuscicorne		**F**		+
84960	Pseudochironomus sp		**F**	26	
85230	Cladotanytarsus mancus group		**F**		+
85500	Paratanytarsus sp		**F**	26	
85625	Rheotanytarsus sp		**F**	796	+
85800	Tanytarsus sp		**F**	80	+
85821	Tanytarsus glabrescens group sp 7		**F**	53	+
87540	Hemerodromia sp		**F**	9	
96801	Ancylidae		**F**	32	
97601	Corbicula fluminea		**F**	1	+

No. Quantitative Taxa:	30	Total Taxa;	48
No. Qualitative Taxa:	35	ICI:	40
Number of Organisms:	6242	Qual EPT:	9

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/07/2021* RM: **16.60**

Site ID: **MC06** Location: *ust. E. Sharon Rd.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt.	Ql.
01801	Turbellaria		F	4	+
02000	Nematoda				+
03600	Oligochaeta		T	144	+
04664	Helobdella stagnalis		T	9	+
04901	Erpobdellidae		MT	17	+
06201	Hyalella azteca		F		+
08601	Hydrachnidia		F	32	+
11120	Baetis flavistriga		F		+
11130	Baetis intercalaris		F	194	+
11620	Paracloeodes minutus		MI		+
12200	Isonychia sp		MI	3	
13521	Stenonema femoratum		F		+
16700	Tricorythodes sp		MI		+
17200	Caenis sp		F	8	+
21200	Calopteryx sp		F		+
22001	Coenagrionidae		T		+
22300	Argia sp		F	2	+
50301	Chimarra aterrima		MI	1	+
50315	Chimarra obscura		MI	10	+
52200	Cheumatopsyche sp		F	2955	+
52430	Ceratopsyche morosa group		MI	98	
52530	Hydropsyche depravata group		F	716	+
53800	Hydroptila sp		F	17	+
59970	Petrophila sp		MI	2	+
63300	Hydroporini		T		+
68901	Macronychus glabratus		F	9	
69400	Stenelmis sp		F	36	+
77120	Ablabesmyia mallochi		F		+
77500	Conchapelopia sp		F	14	
77750	Hayesomyia senata or Thienemannimyia norena		F	390	+
79085	Telopelopia okoboji		MI	14	
80370	Corynoneura lobata		F		+
80420	Cricotopus (C.) bicinctus		T		+
81825	Rheocricotopus (Psilocricotopus) robacki		F	14	
82822	Cryptochironomus eminentia		F		+
82824	Cryptochironomus ponderosus		F		+
83040	Dicrotendipes neomodestus		F	14	+
84450	Polypedilum (Uresipedilum) flavum		F	376	+
84470	Polypedilum (P.) illinoense		T	28	+
84540	Polypedilum (Tripodura) scalaenum group		F		+
84790	Tribelos fuscicorne		F		+
84960	Pseudochironomus sp		F	14	
85625	Rheotanytarsus sp		F	320	+
85800	Tanytarsus sp		F		+
85821	Tanytarsus glabrescens group sp 7		F	56	
85840	Tanytarsus sepp		F		+
87540	Hemerodromia sp		F	32	
95100	Physella sp		T		+
96801	Ancylidae		F	64	+
97601	Corbicula fluminea		F	24	+

No. Quantitative Taxa:	31	Total Taxa;	50
No. Qualitative Taxa:	41	ICI:	40
Number of Organisms:	5617	Qual EPT:	11

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/07/2021* RM: **15.10**

Site ID: **MC04** Location: *dst. Glendale Milford ExpWay behind 5/3 Bank* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
00401	Spongillidae		F	+
01801	Turbellaria		F	764 +
03000	Ectoprocta		F	+
03600	Oligochaeta		T	8 +
04901	Erpobdellidae		MT	+
05900	Lirceus sp		MT	2 +
06201	Hyalella azteca		F	+
08601	Hydrachnidia		F	24 +
11020	Acerpenna pygmaea		MI	2
11120	Baetis flavistriga		F	2 +
11130	Baetis intercalaris		F	596 +
11670	Procloeon viridoculare		MI	+
13521	Stenonema femoratum		F	+
17200	Caenis sp		F	+
21200	Calopteryx sp		F	+
21300	Hetaerina sp		F	1
22001	Coenagrionidae		T	+
22300	Argia sp		F	16 +
50301	Chimarra aterrima		MI	1 +
50315	Chimarra obscura		MI	21 +
52200	Cheumatopsyche sp		F	660 +
52430	Ceratopsyche morosa group		MI	495 +
52530	Hydropsyche depravata group		F	426 +
53800	Hydroptila sp		F	39 +
59970	Petrophila sp		MI	+
65800	Berosus sp		MT	+
68075	Psephenus herricki		MI	+
68201	Scirtidae		F	+
68708	Dubiraphia vittata group		F	1 +
69400	Stenelmis sp		F	30 +
74100	Simulium sp		F	18 +
77120	Ablabesmyia mallochi		F	+
77130	Ablabesmyia rhamphe group		MT	+
77750	Hayesomyia senata or Thienemannimyia norena		F	27 +
77800	Helopelopia sp		F	18 +
78450	Nilotanypus fimbriatus		F	5
78655	Procladius (Holotanypus) sp		MT	+
80310	Cardiocladius obscurus		MI	+
81825	Rheocricotopus (Psilocricotopus) robacki		F	5
82730	Chironomus (C.) decorus group		T	+
82820	Cryptochironomus sp		F	+
82824	Cryptochironomus ponderosus		F	+
83040	Dicrotendipes neomodestus		F	5 +
84100	Paracladopelma sp			+
84210	Paratendipes albimanus or P. duplicatus		F	+
84450	Polypedilum (Uresipedilum) flavum		F	281 +
84470	Polypedilum (P.) illinoense		T	+
84540	Polypedilum (Tripodura) scalaenum group		F	36 +
84888	Xenochironomus xenolabis		F	+
85625	Rheotanytarsus sp		F	9
85800	Tanytarsus sp		F	5 +
85821	Tanytarsus glabrescens group sp 7		F	18
85840	Tanytarsus sepp		F	+
93900	Elimia sp		MI	38 +
96900	Ferrissia sp		F	16 +
97601	Corbicula fluminea		F	+
98001	Pisidiidae			8

No. Quantitative Taxa:	31	Total Taxa;	57
No. Qualitative Taxa:	50	ICI:	40
Number of Organisms:	3577	Qual EPT:	11

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/07/2021* RM: **13.90**

Site ID: **MC11** Location: *ust. Barrett Paving* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		F	52	+
03600	Oligochaeta		T	8	+
05900	Lirceus sp		MT		+
06201	Hyalella azteca		F		+
08601	Hydrachnidia		F	8	+
11120	Baetis flavistriga		F		+
11130	Baetis intercalaris		F		+
11200	Callibaetis sp		MT		+
11670	Procloeon viridoculare		MI		+
12200	Isonychia sp		MI	1	
13521	Stenonema femoratum		F	1	+
17200	Caenis sp		F	16	+
21200	Calopteryx sp		F		+
21300	Hetaerina sp		F		+
22001	Coenagrionidae		T		+
22300	Argia sp		F		+
50301	Chimarra aterrima		MI		+
50315	Chimarra obscura		MI	12	+
51001	Polycentropodidae			5	
52200	Cheumatopsyche sp		F	815	+
52430	Ceratopsyche morosa group		MI	455	+
52530	Hydropsyche depravata group		F	52	+
53800	Hydroptila sp		F	36	+
54160	Ochrotrichia sp		MI	2	
59970	Petrophila sp		MI		+
68075	Psephenus herricki		MI		+
68601	Ancyronyx variegata		F	2	
69400	Stenelmis sp		F	2	+
71900	Tipula sp		F	1	
74100	Simulium sp		F		+
77120	Ablabesmyia mallochi		F		+
77130	Ablabesmyia rhamphe group		MT		+
77500	Conchapelopia sp		F	20	
77750	Hayesomyia senata or Thienemannimyia norena		F	87	
77800	Helopelopia sp		F		+
78655	Procladius (Holotanypus) sp		MT		+
80310	Cardiocladius obscurus		MI		+
82100	Thienemanniella sp			4	
82730	Chironomus (C.) decorus group		T		+
82820	Cryptochironomus sp		F		+
82824	Cryptochironomus ponderosus		F		+
83040	Dicrotendipes neomodestus		F		+
84100	Paracladopelma sp				+
84210	Paratendipes albimanus or P. duplicatus		F	4	+
84450	Polypedilum (Uresipedilum) flavum		F	201	+
84470	Polypedilum (P.) illinoense		T		+
84540	Polypedilum (Tripodura) scalaenum group		F	8	+
85625	Rheotanytarsus sp		F	12	
85800	Tanytarsus sp		F	4	+
85821	Tanytarsus glabrescens group sp 7		F	16	
85840	Tanytarsus sepp		F		+
96900	Ferrissia sp		F	16	+
97601	Corbicula fluminea		F	2	+

No. Quantitative Taxa:	27	Total Taxa;	53
No. Qualitative Taxa:	43	ICI:	40
Number of Organisms:	1842	Qual EPT:	12

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/10/2021* RM: **13.70**

Site ID: **MC104** Location: *immediately dst. SSO 700 outfall* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		**F**	52	+
03600	Oligochaeta		**T**	1	+
04685	Placobdella ornata		**MT**		+
04901	Erpobdellidae		**MT**		+
06201	Hyalella azteca		**F**		+
08601	Hydrachnidia		**F**		+
11120	Baetis flavistriga		**F**	2	
11130	Baetis intercalaris		**F**	1042	+
11670	Procloeon viridoculare		**MI**	1	+
12200	Isonychia sp		**MI**	1	
13521	Stenonema femoratum		**F**	34	+
17200	Caenis sp		**F**	4	+
21200	Calopteryx sp		**F**	1	
22001	Coenagrionidae		**T**		+
22300	Argia sp		**F**		+
50315	Chimarra obscura		**MI**	16	+
52200	Cheumatopsyche sp		**F**	694	+
52430	Ceratopsyche morosa group		**MI**	220	+
52530	Hydropsyche depravata group		**F**	4	+
53800	Hydroptila sp		**F**	195	+
59970	Petrophila sp		**MI**		+
65800	Berosus sp		**MT**	1	
69400	Stenelmis sp		**F**	2	
77500	Conchapelopia sp		**F**	10	
77750	Hayesomyia senata or Thienemannimyia norena		**F**	254	+
78450	Nilotanypus fimbriatus		**F**	51	
80420	Cricotopus (C.) bicinctus		**T**		+
80430	Cricotopus (C.) tremulus group		**MT**		+
81825	Rheocricotopus (Psilocricotopus) robacki		**F**	10	
82820	Cryptochironomus sp		**F**	20	+
83000	Dicrotendipes sp		**F**	10	
83040	Dicrotendipes neomodestus		**F**	10	+
83820	Microtendipes "caelum" (sensu Simpson & Bode, 1980)		**MI**	10	
84210	Paratendipes albimanus or P. duplicatus		**F**	31	
84300	Phaenopsectra obediens group		**F**	20	
84450	Polypedilum (Uresipedilum) flavum		**F**	41	+
84460	Polypedilum (P.) fallax group		**F**	10	+
84520	Polypedilum (Tripodura) halterale group		**MT**	10	
84540	Polypedilum (Tripodura) scalaenum group		**F**	51	+
84700	Stenochironomus sp		**F**	10	
85615	Rheotanytarsus pellucidus		**MI**	10	+
85625	Rheotanytarsus sp		**F**	142	+
85800	Tanytarsus sp		**F**	10	
85821	Tanytarsus glabrescens group sp 7		**F**	71	
96900	Ferrissia sp		**F**	19	+
98600	Sphaerium sp		**F**	1	

No. Quantitative Taxa:	37	Total Taxa;	46
No. Qualitative Taxa:	29	ICI:	46
Number of Organisms:	3071	Qual EPT:	9

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/10/2021* RM: **13.10**

Site ID: **MC02** Location: *dst. W. Columbia Rd./ Koening Park* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		**F**	1	+
01900	Nemertea		**F**	4	
03600	Oligochaeta		**T**	8	+
04666	Helobdella papillata		**MT**		+
04685	Placobdella ornata		**MT**		+
04901	Erpobdellidae		**MT**		+
06201	Hyalella azteca		**F**		+
11120	Baetis flavistriga		**F**	13	+
11130	Baetis intercalaris		**F**	101	+
12200	Isonychia sp		**MI**		+
13521	Stenonema femoratum		**F**	35	+
16700	Tricorythodes sp		**MI**	1	+
17200	Caenis sp		**F**	29	+
21200	Calopteryx sp		**F**	8	+
22300	Argia sp		**F**	43	+
50301	Chimarra aterrima		**MI**		+
50315	Chimarra obscura		**MI**	1	+
52200	Cheumatopsyche sp		**F**	205	+
52430	Ceratopsyche morosa group		**MI**	36	+
52530	Hydropsyche depravata group		**F**	2	+
53800	Hydroptila sp		**F**	23	+
59407	Nectopsyche candida		**MI**		+
59970	Petrophila sp		**MI**		+
68075	Psephenus herricki		**MI**		+
68601	Ancyronyx variegata		**F**	1	
69400	Stenelmis sp		**F**		+
71900	Tipula sp		**F**	1	
77120	Ablabesmyia mallochi		**F**	7	
77500	Conchapelopia sp		**F**	7	
77750	Hayesomyia senata or Thienemannimyia norena		**F**	125	+
77800	Helopelopia sp		**F**	44	+
78140	Labrundinia pilosella		**F**	15	
78450	Nilotanypus fimbriatus		**F**	7	
78750	Rheopelopia paramaculipennis		**MI**	22	
81231	Nanocladius (N.) crassicornus or N. (N.) "rectinervis"		**F**	7	
81825	Rheocricotopus (Psilocricotopus) robacki		**F**	15	
82730	Chironomus (C.) decorus group		**T**	7	+
82820	Cryptochironomus sp		**F**	15	+
82822	Cryptochironomus eminentia		**F**		+
83040	Dicrotendipes neomodestus		**F**	103	
84155	Paralauterborniella nigrohalteralis		**F**		+
84210	Paratendipes albimanus or P. duplicatus		**F**		+
84300	Phaenopsectra obediens group		**F**	15	
84450	Polypedilum (Uresipedilum) flavum		**F**	44	+
84540	Polypedilum (Tripodura) scalaenum group		**F**	59	+
84790	Tribelos fuscicorne		**F**	15	
85500	Paratanytarsus sp		**F**	7	
85625	Rheotanytarsus sp		**F**	51	+
85821	Tanytarsus glabrescens group sp 7		**F**	103	
85840	Tanytarsus sepp		**F**	44	
96900	Ferrissia sp		**F**	22	+
97601	Corbicula fluminea		**F**	13	

No. Quantitative Taxa:	39	Total Taxa;	52
No. Qualitative Taxa:	35	ICI:	46
Number of Organisms:	1259	Qual EPT:	13

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/15/2021* RM: **11.70**

Site ID: **MC01** Location: *dst. E. Galbraith Rd.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		**F**	37	+
03000	Ectoprocta		**F**		+
03600	Oligochaeta		**T**		+
04661	Helobdella elongata		**MT**		+
06201	Hyalella azteca		**F**		+
08601	Hydrachnidia		**F**	48	+
11120	Baetis flavistriga		**F**	10	+
11130	Baetis intercalaris		**F**	522	+
11670	Procloeon viridoculare		**MI**		+
13000	Leucrocuta sp		**MI**		+
13500	Maccaffertium sp		**MI**	1	
13521	Stenonema femoratum		**F**	2	+
16700	Tricorythodes sp		**MI**	5	
17200	Caenis sp		**F**	19	+
22300	Argia sp		**F**		+
50315	Chimarra obscura		**MI**	1	+
51206	Cyrnellus fraternus		**F**	17	
52200	Cheumatopsyche sp		**F**	1932	+
52430	Ceratopsyche morosa group		**MI**	1298	+
52530	Hydropsyche depravata group		**F**	30	+
53800	Hydroptila sp		**F**	121	+
59970	Petrophila sp		**MI**		+
68025	Ectopria sp		**F**		+
68075	Psephenus herricki		**MI**		+
69400	Stenelmis sp		**F**		+
77120	Ablabesmyia mallochi		**F**		+
77750	Hayesomyia senata or Thienemannimyia norena		**F**	177	+
78100	Labrundinia sp		**F**	18	+
78450	Nilotanypus fimbriatus		**F**	96	
80410	Cricotopus (C.) sp		**F**	53	
80420	Cricotopus (C.) bicinctus		**T**	35	+
80430	Cricotopus (C.) tremulus group		**MT**	18	
81825	Rheocricotopus (Psilocricotopus) robacki		**F**	18	
82730	Chironomus (C.) decorus group		**T**		+
82820	Cryptochironomus sp		**F**		+
83040	Dicrotendipes neomodestus		**F**	18	+
84450	Polypedilum (Uresipedilum) flavum		**F**	638	+
84540	Polypedilum (Tripodura) scalaenum group		**F**		+
85500	Paratanytarsus sp		**F**		+
85625	Rheotanytarsus sp		**F**	160	+
85800	Tanytarsus sp		**F**	18	+
85821	Tanytarsus glabrescens group sp 7		**F**	160	
87540	Hemerodromia sp		**F**	32	
89700	Limnophora sp		**F**		+
93900	Elimia sp		**MI**		+
96900	Ferrissia sp		**F**	17	+
97601	Corbicula fluminea		**F**		+

No. Quantitative Taxa:	28	Total Taxa;	47
No. Qualitative Taxa:	38	ICI:	42
Number of Organisms:	5501	Qual EPT:	11

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/07/2021* RM: **10.50**

Site ID: **MC80** Location: *dst. Anthony Wayne Ave.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.		Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		F	116	+	87540	Hemerodromia sp		F	2	
02600	Nematomorpha		F		+	93900	Elimia sp		MI		+
03000	Ectoprocta		F		+	96900	Ferrissia sp		F	5	+
03600	Oligochaeta		T	16	+	97601	Corbicula fluminea		F	21	+
06201	Hyalella azteca		F		+	98600	Sphaerium sp		F		+
08250	Orconectes (Procericambarus) rusticus		F		+						
08601	Hydrachnidia		F	80	+						
11120	Baetis flavistriga		F		+						
11130	Baetis intercalaris		F	913	+						
11670	Procloeon viridoculare		MI		+						
12200	Isonychia sp		MI	1							
13521	Stenonema femoratum		F	8	+						
22300	Argia sp		F		+						
49200	Climacia sp		F		+						
50315	Chimarra obscura		MI	1	+						
52200	Cheumatopsyche sp		F	2893	+						
52430	Ceratopsyche morosa group		MI	1052	+						
52530	Hydropsyche depravata group		F	196	+						
53800	Hydroptila sp		F	25	+						
59970	Petrophila sp		MI	4	+						
69400	Stenelmis sp		F	1	+						
71900	Tipula sp		F		+						
74100	Simulium sp		F	1	+						
77120	Ablabesmyia mallochi		F		+						
77500	Conchapelopia sp		F		+						
77750	Hayesomyia senata or Thienemannimyia norena		F	118							
78450	Nilotanypus fimbriatus		F	16							
81231	Nanocladius (N.) crassicornus or N. (N.) "rectinervis"		F	9							
81240	Nanocladius (N.) distinctus		MT		+						
82220	Tvetenia discoloripes group		MI	9							
82820	Cryptochironomus sp		F		+						
84450	Polypedilum (Uresipedilum) flavum		F	647	+						
84470	Polypedilum (P.) illinoense		T		+						
84540	Polypedilum (Tripodura) scalaenum group		F		+						
84888	Xenochironomus xenolabis		F		+						
85500	Paratanytarsus sp		F		+						
85625	Rheotanytarsus sp		F	118							
85800	Tanytarsus sp		F		+						
85821	Tanytarsus glabrescens group sp 7		F	18							
85840	Tanytarsus sepp		F		+						

No. Quantitative Taxa:	24	Total Taxa;	45
No. Qualitative Taxa:	37	ICI:	36
Number of Organisms:	6270	Qual EPT:	9

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/10/2021* RM: **9.24**

Site ID: **MC105** Location: *dst. Congress Run* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	84 +
03000	Ectoprocta		**F**	1
03600	Oligochaeta		**T**	+
06201	Hyalella azteca		**F**	1 +
08250	Orconectes (Procericambarus) rusticus		**F**	+
08601	Hydrachnidia		**F**	+
11120	Baetis flavistriga		**F**	10 +
11130	Baetis intercalaris		**F**	497 +
12200	Isonychia sp		**MI**	1
13521	Stenonema femoratum		**F**	7 +
16700	Tricorythodes sp		**MI**	1
17200	Caenis sp		**F**	+
22300	Argia sp		**F**	2 +
23600	Aeshna sp		**MT**	+
50315	Chimarra obscura		**MI**	+
52200	Cheumatopsyche sp		**F**	3102 +
52430	Ceratopsyche morosa group		**MI**	707 +
52530	Hydropsyche depravata group		**F**	47
53800	Hydroptila sp		**F**	26 +
54160	Ochrotrichia sp		**MI**	20
68075	Psephenus herricki		**MI**	+
68130	Helichus sp		**F**	+
68901	Macronychus glabratus		**F**	1
69400	Stenelmis sp		**F**	+
74100	Simulium sp		**F**	+
77120	Ablabesmyia mallochi		**F**	+
77130	Ablabesmyia rhamphe group		**MT**	+
77750	Hayesomyia senata or Thienemannimyia norena		**F**	75 +
78655	Procladius (Holotanypus) sp		**MT**	+
81240	Nanocladius (N.) distinctus		**MT**	11
82730	Chironomus (C.) decorus group		**T**	+
83040	Dicrotendipes neomodestus		**F**	21 +
83300	Glyptotendipes (G.) sp		**MT**	11
84210	Paratendipes albimanus or P. duplicatus		**F**	+
84450	Polypedilum (Uresipedilum) flavum		**F**	1017 +
84540	Polypedilum (Tripodura) scalaenum group		**F**	11 +
84700	Stenochironomus sp		**F**	11
85625	Rheotanytarsus sp		**F**	96 +
85800	Tanytarsus sp		**F**	+
85821	Tanytarsus glabrescens group sp 7		**F**	75
87540	Hemerodromia sp		**F**	1
96900	Ferrissia sp		**F**	3
97601	Corbicula fluminea		**F**	+

No. Quantitative Taxa:	26	Total Taxa;	43
No. Qualitative Taxa:	31	ICI:	38
Number of Organisms:	5839	Qual EPT:	8

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/19/2021* RM: **8.68**

Site ID: **MC79** Location: *dst. Este Ave.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
00401	Spongillidae		F		+
01801	Turbellaria		F	73	+
03040	Fredericella sp		F		+
03600	Oligochaeta		T		+
04615	Actinobdella inequiannulata		MT		+
04960	Erpobdella sp (= Mooreobdella)		MT		+
06201	Hyalella azteca		F		+
08601	Hydrachnidia		F	40	
11120	Baetis flavistriga		F	20	+
11130	Baetis intercalaris		F	548	+
12200	Isonychia sp		MI	1	
13521	Stenonema femoratum		F	6	+
13561	Maccaffertium pulchellum		MI	1	
21300	Hetaerina sp		F	9	
22001	Coenagrionidae		T		+
22300	Argia sp		F	2	+
51206	Cyrnellus fraternus		F	2	+
52200	Cheumatopsyche sp		F	2569	+
52430	Ceratopsyche morosa group		MI	374	+
52530	Hydropsyche depravata group		F	73	+
53800	Hydroptila sp		F	109	+
59970	Petrophila sp		MI	1	+
69400	Stenelmis sp		F	1	+
77120	Ablabesmyia mallochi		F		+
77500	Conchapelopia sp		F	11	
77750	Hayesomyia senata or Thienemannimyia norena		F	72	
78450	Nilotanypus fimbriatus		F	64	
78750	Rheopelopia paramaculipennis		MI	31	
80310	Cardiocladius obscurus		MI		+
80370	Corynoneura lobata		F	8	
80410	Cricotopus (C.) sp		F	9	
80420	Cricotopus (C.) bicinctus		T	9	
81630	Parakiefferiella sp		F	9	
82730	Chironomus (C.) decorus group		T		+
83040	Dicrotendipes neomodestus		F		+
84300	Phaenopsectra obediens group		F		+
84450	Polypedilum (Uresipedilum) flavum		F	619	+
84540	Polypedilum (Tripodura) scalaenum group		F	17	
85625	Rheotanytarsus sp		F	87	+
85821	Tanytarsus glabrescens group sp 7		F	17	
85840	Tanytarsus sepp		F		+
87501	Empididae		F	1	
96900	Ferrissia sp		F	17	+
97601	Corbicula fluminea		F	1	+
98600	Sphaerium sp		F		+

No. Quantitative Taxa:	31	Total Taxa;	45
No. Qualitative Taxa:	30	ICI:	40
Number of Organisms:	4801	Qual EPT:	8

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/15/2021* RM: **7.65**

Site ID: **MC77** Location: *RR trestle Winton Place/ dst. Center Hill Ave.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		F	31
03000	Ectoprocta		F	+
03040	Fredericella sp		F	+
03360	Plumatella sp		F	1 +
03600	Oligochaeta		T	+
04615	Actinobdella inequiannulata		MT	+
04687	Placobdella parasitica		MT	+
04960	Erpobdella sp (= Mooreobdella)		MT	+
06201	Hyalella azteca		F	+
08601	Hydrachnidia		F	136
11120	Baetis flavistriga		F	5 +
11130	Baetis intercalaris		F	944 +
11620	Paracloeodes minutus		MI	+
12200	Isonychia sp		MI	1
13521	Stenonema femoratum		F	+
16700	Tricorythodes sp		MI	2
17200	Caenis sp		F	+
21300	Hetaerina sp		F	2 +
22300	Argia sp		F	+
50315	Chimarra obscura		MI	+
51206	Cyrnellus fraternus		F	+
51300	Neureclipsis sp		MI	+
52200	Cheumatopsyche sp		F	3982 +
52430	Ceratopsyche morosa group		MI	442 +
52530	Hydropsyche depravata group		F	4
53800	Hydroptila sp		F	158 +
59970	Petrophila sp		MI	4 +
68075	Psephenus herricki		MI	+
68601	Ancyronyx variegata		F	1
69400	Stenelmis sp		F	+
77120	Ablabesmyia mallochi		F	+
77130	Ablabesmyia rhamphe group		MT	+
77500	Conchapelopia sp		F	18
77750	Hayesomyia senata or Thienemannimyia norena		F	18 +
78450	Nilotanypus fimbriatus		F	56
78750	Rheopelopia paramaculipennis		MI	74
80370	Corynoneura lobata		F	16
80410	Cricotopus (C.) sp		F	37 +
80420	Cricotopus (C.) bicinctus		T	55 +
82820	Cryptochironomus sp		F	+
83040	Dicrotendipes neomodestus		F	+
84300	Phaenopsectra obediens group		F	+
84450	Polypedilum (Uresipedilum) flavum		F	975 +
84700	Stenochironomus sp		F	37 +
85625	Rheotanytarsus sp		F	129
85800	Tanytarsus sp		F	+
85821	Tanytarsus glabrescens group sp 7		F	129 +
85840	Tanytarsus sepp		F	+
89716	Limnophora discreta		MT	+
95100	Physella sp		T	+
96900	Ferrissia sp		F	21 +
97601	Corbicula fluminea		F	+
98600	Sphaerium sp		F	+

No. Quantitative Taxa:	26	Total Taxa;	53
No. Qualitative Taxa:	42	ICI:	38
Number of Organisms:	7278	Qual EPT:	11

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/10/2021* RM: **6.80**

Site ID: **MC09** Location: *dst. CSX RR Bridge* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		**F**	54	+
03000	Ectoprocta		**F**	1	
03600	Oligochaeta		**T**	64	
06201	Hyalella azteca		**F**		+
11130	Baetis intercalaris		**F**	339	+
17200	Caenis sp		**F**		+
21300	Hetaerina sp		**F**		+
52200	Cheumatopsyche sp		**F**	1466	+
52430	Ceratopsyche morosa group		**MI**	47	
53800	Hydroptila sp		**F**	1	+
59407	Nectopsyche candida		**MI**		+
69400	Stenelmis sp		**F**	180	+
71900	Tipula sp		**F**		+
77750	Hayesomyia senata or Thienemannimyia norena		**F**	719	
78200	Larsia sp		**MT**		+
80420	Cricotopus (C.) bicinctus		**T**	405	+
81240	Nanocladius (N.) distinctus		**MT**	42	+
82820	Cryptochironomus sp		**F**	42	
84450	Polypedilum (Uresipedilum) flavum		**F**	1102	+
84540	Polypedilum (Tripodura) scalaenum group		**F**	42	
84960	Pseudochironomus sp		**F**	42	+
85625	Rheotanytarsus sp		**F**	270	
85821	Tanytarsus glabrescens group sp 7		**F**	42	
87501	Empididae		**F**	16	

No. Quantitative Taxa:	18	Total Taxa;	24
No. Qualitative Taxa:	15	ICI:	24
Number of Organisms:	4874	Qual EPT:	5

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/10/2021* RM: **6.35**

Site ID: **MC07** Location: *Dst. Spring Grove Ave./ RR bridge* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.		Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	87	+					
03600	Oligochaeta		**T**	160						
06201	Hyalella azteca		**F**	1	+					
11130	Baetis intercalaris		**F**	70	+					
12200	Isonychia sp		**MI**	1						
17200	Caenis sp		**F**	16						
52200	Cheumatopsyche sp		**F**	446	+					
52430	Ceratopsyche morosa group		**MI**	1						
53800	Hydroptila sp		**F**	4	+					
69400	Stenelmis sp		**F**	19	+					
74100	Simulium sp		**F**		+					
74501	Ceratopogonidae		**T**		+					
77130	Ablabesmyia rhamphe group		**MT**	40						
77750	Hayesomyia senata or Thienemannimyia norena		**F**	840						
80410	Cricotopus (C.) sp		**F**	40						
80420	Cricotopus (C.) bicinctus		**T**	1881	+					
80430	Cricotopus (C.) tremulus group		**MT**	40						
83040	Dicrotendipes neomodestus		**F**	80						
84300	Phaenopsectra obediens group		**F**	40						
84450	Polypedilum (Uresipedilum) flavum		**F**	1040						
85625	Rheotanytarsus sp		**F**	160						
85821	Tanytarsus glabrescens group sp 7		**F**	80						
97601	Corbicula fluminea		**F**	16	+					

No. Quantitative Taxa:	21	Total Taxa;	23
No. Qualitative Taxa:	10	ICI:	16
Number of Organisms:	5062	Qual EPT:	3

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/14/2021* RM: **4.84**

Site ID: **MC75** Location: *adj. Salway Park* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		F	49 +
01900	Nemertea		F	+
03040	Fredericella sp		F	1 +
03360	Plumatella sp		F	1 +
03600	Oligochaeta		T	43 +
04661	Helobdella elongata		MT	+
06201	Hyalella azteca		F	36 +
11130	Baetis intercalaris		F	+
13400	Stenacron sp		F	+
13521	Stenonema femoratum		F	2 +
16700	Tricorythodes sp		MI	2 +
17200	Caenis sp		F	9
22300	Argia sp		F	15 +
27307	Epitheca (Epicordulia) princeps		MT	+
44501	Corixidae		F	+
51206	Cyrnellus fraternus		F	12 +
52200	Cheumatopsyche sp		F	122 +
53800	Hydroptila sp		F	86 +
59970	Petrophila sp		MI	3
68075	Psephenus herricki		MI	+
69400	Stenelmis sp		F	9 +
71900	Tipula sp		F	1
72700	Anopheles sp		F	+
74501	Ceratopogonidae		T	8
77120	Ablabesmyia mallochi		F	23 +
77500	Conchapelopia sp		F	23
77750	Hayesomyia senata or Thienemannimyia norena		F	370 +
78655	Procladius (Holotanypus) sp		MT	+
78750	Rheopelopia paramaculipennis		MI	162 +
80420	Cricotopus (C.) bicinctus		T	139 +
82820	Cryptochironomus sp		F	+
82824	Cryptochironomus ponderosus		F	+
82826				+
83040	Dicrotendipes neomodestus		F	208 +
83050	Dicrotendipes lucifer		MT	69 +
83300	Glyptotendipes (G.) sp		MT	+
84450	Polypedilum (Uresipedilum) flavum		F	254
84520	Polypedilum (Tripodura) halterale group		MT	+
84540	Polypedilum (Tripodura) scalaenum group		F	162 +
84700	Stenochironomus sp		F	+
84790	Tribelos fuscicorne		F	46
84960	Pseudochironomus sp		F	23 +
85625	Rheotanytarsus sp		F	69 +
85800	Tanytarsus sp		F	23
85821	Tanytarsus glabrescens group sp 7		F	231
85840	Tanytarsus sepp		F	69
95100	Physella sp		T	+
96120	Menetus (Micromenetus) dilatatus		MT	8 +
97601	Corbicula fluminea		F	29 +
98600	Sphaerium sp		F	11

No. Quantitative Taxa:	34	Total Taxa;	50
No. Qualitative Taxa:	39	ICI:	28
Number of Organisms:	2318	Qual EPT:	7

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/17/2021* RM: **4.60**

Site ID: **MC74** Location: *ust. S. Ludlow Ave.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.		Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		F	407	+					
03000	Ectoprocta		F	1						
03600	Oligochaeta		T	49	+					
04901	Erpobdellidae		MT	43						
06201	Hyalella azteca		F		+					
11130	Baetis intercalaris		F	35	+					
11600	Paracloeodes fleeki		MI		+					
13521	Stenonema femoratum		F		+					
16700	Tricorythodes sp		MI	2						
22001	Coenagrionidae		T		+					
22300	Argia sp		F	1	+					
50315	Chimarra obscura		MI	1						
52200	Cheumatopsyche sp		F	226	+					
52430	Ceratopsyche morosa group		MI	3	+					
53800	Hydroptila sp		F	152	+					
59970	Petrophila sp		MI		+					
69400	Stenelmis sp		F	8	+					
77120	Ablabesmyia mallochi		F	28	+					
77750	Hayesomyia senata or Thienemannimyia norena		F	166	+					
78450	Nilotanypus fimbriatus		F	16						
80410	Cricotopus (C.) sp		F	637	+					
80420	Cricotopus (C.) bicinctus		T	55	+					
80430	Cricotopus (C.) tremulus group		MT	111	+					
82730	Chironomus (C.) decorus group		T		+					
82820	Cryptochironomus sp		F	28	+					
83040	Dicrotendipes neomodestus		F	166	+					
84300	Phaenopsectra obediens group		F		+					
84450	Polypedilum (Uresipedilum) flavum		F	914						
84540	Polypedilum (Tripodura) scalaenum group		F		+					
84790	Tribelos fuscicorne		F	28						
84960	Pseudochironomus sp		F	111	+					
85625	Rheotanytarsus sp		F	166						
85800	Tanytarsus sp		F	28	+					
85821	Tanytarsus glabrescens group sp 7		F	139	+					
93900	Elimia sp		MI		+					
96900	Ferrissia sp		F		+					
97601	Corbicula fluminea		F	18	+					

No. Quantitative Taxa:	27	Total Taxa;	37
No. Qualitative Taxa:	29	ICI:	28
Number of Organisms:	3539	Qual EPT:	6

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/17/2021* RM: **3.60**

Site ID: **MC73** Location: *ust. Mill Creek Rd.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
00401	Spongillidae		F	+
01320	Hydra sp		F	8
01801	Turbellaria		F	96 +
01900	Nemertea		F	+
03360	Plumatella sp		F	5 +
03451	Urnatella gracilis		MI	1
03600	Oligochaeta		T	45
04615	Actinobdella inequiannulata		MT	+
06201	Hyalella azteca		F	+
11120	Baetis flavistriga		F	2
11130	Baetis intercalaris		F	253 +
11620	Paracloeodes minutus		MI	+
13521	Stenonema femoratum		F	9
13561	Maccaffertium pulchellum		MI	8
13570	Maccaffertium terminatum		MI	1
16700	Tricorythodes sp		MI	11
17200	Caenis sp		F	+
21200	Calopteryx sp		F	+
21300	Hetaerina sp		F	+
22001	Coenagrionidae		T	+
22300	Argia sp		F	1 +
27400	Neurocordulia sp		F	1
50315	Chimarra obscura		MI	19 +
51206	Cyrnellus fraternus		F	1
52200	Cheumatopsyche sp		F	2441 +
52430	Ceratopsyche morosa group		MI	103 +
53800	Hydroptila sp		F	70 +
59970	Petrophila sp		MI	3
69400	Stenelmis sp		F	1 +
77120	Ablabesmyia mallochi		F	+
77130	Ablabesmyia rhamphe group		MT	+
77750	Hayesomyia senata or Thienemannimyia norena		F	145
78655	Procladius (Holotanypus) sp		MT	+
78750	Rheopelopia paramaculipennis		MI	41 +
80360	Corynoneura floridaensis		MI	16
80410	Cricotopus (C.) sp		F	41 +
80430	Cricotopus (C.) tremulus group		MT	103
81231	Nanocladius (N.) crassicornus or N. (N.) "rectinervis"		F	41
82730	Chironomus (C.) decorus group		T	21 +
83040	Dicrotendipes neomodestus		F	62
83050	Dicrotendipes lucifer		MT	41
83300	Glyptotendipes (G.) sp		MT	41
83900	Nilothauma sp		F	21
84300	Phaenopsectra obediens group		F	21 +
84450	Polypedilum (Uresipedilum) flavum		F	805 +
84520	Polypedilum (Tripodura) halterale group		MT	+
84540	Polypedilum (Tripodura) scalaenum group		F	41 +
84700	Stenochironomus sp		F	+
84960	Pseudochironomus sp		F	21 +
85615	Rheotanytarsus pellucidus		MI	41
85625	Rheotanytarsus sp		F	454 +
85821	Tanytarsus glabrescens group sp 7		F	83
87501	Empididae		F	+
87540	Hemerodromia sp		F	55
87601	Dolichopodidae		MT	+
95100	Physella sp		T	+
97601	Corbicula fluminea		F	1 +
98600	Sphaerium sp		F	+

No. Quantitative Taxa:	40	Total Taxa;	58
No. Qualitative Taxa:	36	ICI:	44
Number of Organisms:	5174	Qual EPT:	7

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/17/2021* RM: **3.10**

Site ID: **MC72** Location: *dst. Mill Creek Rd.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		F	818	+
03000	Ectoprocta		F	1	
03600	Oligochaeta		T		+
04901	Erpobdellidae		MT	1	+
06201	Hyalella azteca		F		+
08250	Orconectes (Procericambarus) rusticus		F		+
11118	Plauditus dubius		MI		+
11130	Baetis intercalaris		F	394	+
13000	Leucrocuta sp		MI	1	
13521	Stenonema femoratum		F		+
16700	Tricorythodes sp		MI	4	+
21200	Calopteryx sp		F	1	
22300	Argia sp		F	22	+
50315	Chimarra obscura		MI	68	
51300	Neureclipsis sp		MI	1	
52200	Cheumatopsyche sp		F	3704	+
52430	Ceratopsyche morosa group		MI	117	+
52530	Hydropsyche depravata group		F	3	
53800	Hydroptila sp		F	17	+
68075	Psephenus herricki		MI	1	
69400	Stenelmis sp		F	3	+
74100	Simulium sp		F	115	+
77500	Conchapelopia sp		F	103	
77750	Hayesomyia senata or Thienemannimyia norena		F	376	
78450	Nilotanypus fimbriatus		F	34	
78750	Rheopelopia paramaculipennis		MI	137	
79100	Thienemannimyia group		F	34	
80420	Cricotopus (C.) bicinctus		T	34	+
81231	Nanocladius (N.) crassicornus or N. (N.) "rectinervis"		F	68	
81240	Nanocladius (N.) distinctus		MT	68	
81650	Parametriocnemus sp	X	F	34	
82730	Chironomus (C.) decorus group		T		+
82822	Cryptochironomus eminentia		F		+
83040	Dicrotendipes neomodestus		F	103	
83050	Dicrotendipes lucifer		MT	68	
83300	Glyptotendipes (G.) sp		MT		+
84450	Polypedilum (Uresipedilum) flavum		F	1574	
84540	Polypedilum (Tripodura) scalaenum group		F		+
84960	Pseudochironomus sp		F	34	+
85625	Rheotanytarsus sp		F	137	
85821	Tanytarsus glabrescens group sp 7		F	34	+
87540	Hemerodromia sp		F	1	
97601	Corbicula fluminea		F	1	+
98600	Sphaerium sp		F	2	

No. Quantitative Taxa:	35	Total Taxa;	44
No. Qualitative Taxa:	23	ICI:	36
Number of Organisms:	8113	Qual EPT:	7

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/17/2021* RM: **2.50**

Site ID: **MC05** Location: *dst. Hopple St.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		F	165	+
03360	Plumatella sp		F	2	+
03451	Urnatella gracilis		MI	1	
03600	Oligochaeta		T	64	+
05900	Lirceus sp		MT	2	
06201	Hyalella azteca		F	16	+
11120	Baetis flavistriga		F	1	
11130	Baetis intercalaris		F	114	+
13521	Stenonema femoratum		F	4	
16700	Tricorythodes sp		MI	17	
17200	Caenis sp		F	1	
21300	Hetaerina sp		F		+
22001	Coenagrionidae		T		+
22300	Argia sp		F	20	+
26700	Macromia sp		MI	1	+
50315	Chimarra obscura		MI	17	+
51206	Cyrnellus fraternus		F	1	
52200	Cheumatopsyche sp		F	2532	+
52430	Ceratopsyche morosa group		MI	1	
52530	Hydropsyche depravata group		F		+
53800	Hydroptila sp		F	325	+
59970	Petrophila sp		MI	18	
68130	Helichus sp		F		+
69400	Stenelmis sp		F		+
74100	Simulium sp		F		+
77500	Conchapelopia sp		F	414	
77750	Hayesomyia senata or Thienemannimyia norena		F	414	
78350	Meropelopia sp	X	F	41	
78650	Procladius sp		MT		+
78750	Rheopelopia paramaculipennis		MI	124	
80310	Cardiocladius obscurus		MI	41	
80420	Cricotopus (C.) bicinctus		T	166	+
80430	Cricotopus (C.) tremulus group		MT	124	
81231	Nanocladius (N.) crassicornus or N. (N.) "rectinervis"		F	83	
82730	Chironomus (C.) decorus group		T		+
82820	Cryptochironomus sp		F		+
83040	Dicrotendipes neomodestus		F	207	+
83050	Dicrotendipes lucifer		MT	207	+
83300	Glyptotendipes (G.) sp		MT	41	
84040	Parachironomus frequens		F	83	
84300	Phaenopsectra obediens group		F	41	
84450	Polypedilum (Uresipedilum) flavum		F	354	+
84470	Polypedilum (P.) illinoense		T	41	+
84540	Polypedilum (Tripodura) scalaenum group		F		+
84700	Stenochironomus sp		F	41	
84960	Pseudochironomus sp		F	207	
85625	Rheotanytarsus sp		F	332	
85800	Tanytarsus sp		F	83	
85814	Tanytarsus glabrescens group		F	207	
87540	Hemerodromia sp		F	2	
95100	Physella sp		T	211	+
96120	Menetus (Micromenetus) dilatatus		MT	48	
97601	Corbicula fluminea		F		+
98600	Sphaerium sp		F		+

No. Quantitative Taxa:	42	Total Taxa;	54
No. Qualitative Taxa:	28	ICI:	36
Number of Organisms:	6814	Qual EPT:	5

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-001** River: ***Mill Creek*** Coll. Date: *09/17/2021* RM: **1.69**

Site ID: **MC03** Location: *dst. Lick Run CSO* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.		Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		F	67	+					
03360	Plumatella sp		F	1	+					
03600	Oligochaeta		T	258	+					
04601	Glossiphoniidae		MT		+					
04901	Erpobdellidae		MT	1						
06201	Hyalella azteca		F	3	+					
13500	Maccaffertium sp		MI	1						
13521	Stenonema femoratum		F	12	+					
17200	Caenis sp		F	18						
22001	Coenagrionidae		T		+					
22300	Argia sp		F	3	+					
28500	Libellula sp		MT		+					
42700	Belostoma sp		T		+					
51206	Cyrnellus fraternus		F	19						
52200	Cheumatopsyche sp		F	125	+					
53800	Hydroptila sp		F	35						
68708	Dubiraphia vittata group		F	1						
69400	Stenelmis sp		F	16						
77120	Ablabesmyia mallochi		F	131						
77500	Conchapelopia sp		F	113						
77750	Hayesomyia senata or Thienemannimyia norena		F	150						
80420	Cricotopus (C.) bicinctus		T	19						
81231	Nanocladius (N.) crassicornus or N. (N.) "rectinervis"		F	19						
82730	Chironomus (C.) decorus group		T	19	+					
83040	Dicrotendipes neomodestus		F	375	+					
83050	Dicrotendipes lucifer		MT	244						
83300	Glyptotendipes (G.) sp		MT	56						
84450	Polypedilum (Uresipedilum) flavum		F	75						
84470	Polypedilum (P.) illinoense		T	19						
84540	Polypedilum (Tripodura) scalaenum group		F	19	+					
84700	Stenochironomus sp		F	19						
84960	Pseudochironomus sp		F	38						
85625	Rheotanytarsus sp		F	19						
85800	Tanytarsus sp		F	19						
85821	Tanytarsus glabrescens group sp 7		F	75						
95100	Physella sp		T	52	+					
96801	Ancylidae		F	8						
97601	Corbicula fluminea		F		+					

No. Quantitative Taxa:	33	Total Taxa;	38
No. Qualitative Taxa:	16	ICI:	20
Number of Organisms:	2029	Qual EPT:	2

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-004** River: ***West Fork Mill Creek*** Coll. Date: *09/07/2021* RM: **0.20**

Site ID: **MC45** Location: *Elliot Ave.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.		Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	8	+					
03600	Oligochaeta		**T**		+					
04685	Placobdella ornata		**MT**		+					
06201	Hyalella azteca		**F**	1						
08200	Orconectes sp		**F**		+					
11120	Baetis flavistriga		**F**		+					
11130	Baetis intercalaris		**F**	227	+					
13400	Stenacron sp		**F**		+					
13521	Stenonema femoratum		**F**	56	+					
17200	Caenis sp		**F**		+					
22300	Argia sp		**F**		+					
50315	Chimarra obscura		**MI**		+					
52200	Cheumatopsyche sp		**F**	9	+					
52430	Ceratopsyche morosa group		**MI**		+					
68075	Psephenus herricki		**MI**		+					
69400	Stenelmis sp		**F**		+					
74100	Simulium sp		**F**		+					
77500	Conchapelopia sp		**F**	4						
77750	Hayesomyia senata or Thienemannimyia norena		**F**	5						
78450	Nilotanypus fimbriatus		**F**	3						
81825	Rheocricotopus (Psilocricotopus) robacki		**F**	1						
82141	Thienemanniella xena		**F**	2						
84210	Paratendipes albimanus or P. duplicatus		**F**		+					
84450	Polypedilum (Uresipedilum) flavum		**F**	40						
84470	Polypedilum (P.) illinoense		**T**	4	+					
85625	Rheotanytarsus sp		**F**	9						
85800	Tanytarsus sp		**F**	9						
96900	Ferrissia sp		**F**	18	+					
97601	Corbicula fluminea		**F**		+					

No. Quantitative Taxa:	15	Total Taxa;	29
No. Qualitative Taxa:	20	ICI:	30
Number of Organisms:	396	Qual EPT:	8

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-006** River: ***East Fork Mill Creek*** Coll. Date: *09/14/2021* RM: **2.00**

Site ID: **MC18** Location: *'ust. Butler Co. Upper Mill Creek WWTP/Ust. Allen Rd.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		F	5 +
01900	Nemertea		F	+
03600	Oligochaeta		T	24 +
04964	Erpobdella microstoma		MT	+
05900	Lirceus sp		MT	2 +
06904	Synurella dentata		MT	+
08250	Orconectes (Procericambarus) rusticus		F	1 +
11130	Baetis intercalaris		F	36 +
11670	Procloeon viridoculare		MI	+
13521	Stenonema femoratum		F	269 +
17200	Caenis sp		F	78 +
21200	Calopteryx sp		F	+
22001	Coenagrionidae		T	+
22300	Argia sp		F	4 +
50301	Chimarra aterrima		MI	+
50315	Chimarra obscura		MI	+
52200	Cheumatopsyche sp		F	24 +
52430	Ceratopsyche morosa group		MI	19 +
52530	Hydropsyche depravata group		F	+
53501	Hydroptilidae		F	+
58505	Helicopsyche borealis		MI	+
59720	Triaenodes ignitus		MI	+
60900	Peltodytes sp		MT	+
63900	Laccophilus sp		T	+
68025	Ectopria sp		F	+
68075	Psephenus herricki		MI	+
68708	Dubiraphia vittata group		F	+
69400	Stenelmis sp		F	14 +
72700	Anopheles sp		F	+
77120	Ablabesmyia mallochi		F	+
77750	Hayesomyia senata or Thienemannimyia norena		F	11
77800	Helopelopia sp		F	+
78140	Labrundinia pilosella		F	22
78450	Nilotanypus fimbriatus		F	4
80370	Corynoneura lobata		F	112
81231	Nanocladius (N.) crassicornus or N. (N.) "rectinervis"		F	11
82141	Thienemanniella xena		F	+
83003	Dicrotendipes fumidus		F	+
83040	Dicrotendipes neomodestus		F	39 +
83820	Microtendipes "caelum" (sensu Simpson & Bode, 1980)		MI	+
83840	Microtendipes pedellus group		F	23
84210	Paratendipes albimanus or P. duplicatus		F	152 +
84300	Phaenopsectra obediens group		F	11
84450	Polypedilum (Uresipedilum) flavum		F	28 +
84460	Polypedilum (P.) fallax group		F	11
84520	Polypedilum (Tripodura) halterale group		MT	+
84540	Polypedilum (Tripodura) scalaenum group		F	17
85230	Cladotanytarsus mancus group		F	11 +
85501	Paratanytarsus longistilus	X	MI	6 +
85625	Rheotanytarsus sp		F	51 +
85800	Tanytarsus sp		F	+
85818	Tanytarsus glabrescens group sp 4		F	+
85821	Tanytarsus glabrescens group sp 7		F	17
85840	Tanytarsus sepp		F	6 +
95100	Physella sp		T	+
97601	Corbicula fluminea		F	+
98200	Pisidium sp		MT	4

No. Quantitative Taxa:	29	Total Taxa;	57
No. Qualitative Taxa:	46	ICI:	42
Number of Organisms:	1012	Qual EPT:	12

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-006** River: ***East Fork Mill Creek*** Coll. Date: *09/14/2021* RM: **1.05**

Site ID: **MC15** Location: *dst. Butler Co. Upper Mill Creek WWTP* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01418	Craspedacusta sowerbyi		F	33	
01801	Turbellaria		F	207	+
01900	Nemertea		F	480	+
03000	Ectoprocta		F	1	
03600	Oligochaeta		T	2528	
04964	Erpobdella microstoma		MT		+
06201	Hyalella azteca		F	2070	+
07701	Cambaridae			1	
11130	Baetis intercalaris		F		+
13521	Stenonema femoratum		F		+
17200	Caenis sp		F	41	+
21200	Calopteryx sp		F		+
22001	Coenagrionidae		T		+
22300	Argia sp		F	70	+
51206	Cyrnellus fraternus		F	104	+
52200	Cheumatopsyche sp		F	180	
52430	Ceratopsyche morosa group		MI	40	
52530	Hydropsyche depravata group		F	205	+
53800	Hydroptila sp		F	1	+
59300	Mystacides sp		MI		+
65800	Berosus sp		MT		+
69400	Stenelmis sp		F		+
77500	Conchapelopia sp		F	41	
77740	Hayesomyia senata		F	327	
77800	Helopelopia sp		F	123	
80420	Cricotopus (C.) bicinctus		T	82	+
81240	Nanocladius (N.) distinctus		MT	286	+
82730	Chironomus (C.) decorus group		T		+
83040	Dicrotendipes neomodestus		F	204	+
83158	Endochironomus nigricans		MT		+
83300	Glyptotendipes (G.) sp		MT	164	+
84210	Paratendipes albimanus or P. duplicatus		F	41	
84450	Polypedilum (Uresipedilum) flavum		F	1636	+
84470	Polypedilum (P.) illinoense		T	164	+
84540	Polypedilum (Tripodura) scalaenum group		F		+
84700	Stenochironomus sp		F		+
84960	Pseudochironomus sp		F	41	
85625	Rheotanytarsus sp		F	900	+
85821	Tanytarsus glabrescens group sp 7		F	41	+
87540	Hemerodromia sp		F	163	
97601	Corbicula fluminea		F		+

No. Quantitative Taxa:	28	Total Taxa;	41
No. Qualitative Taxa:	29	ICI:	30
Number of Organisms:	10174	Qual EPT:	7

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-006** River: ***East Fork Mill Creek*** Coll. Date: *09/14/2021* RM: **0.72**

Site ID: **MC14** Location: *dst. Crescentville Rd.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		**F**	35	+
03600	Oligochaeta		**T**	192	
05900	Lirceus sp		**MT**		+
06201	Hyalella azteca		**F**		+
07800	Cambarus sp				+
08601	Hydrachnidia		**F**		+
11130	Baetis intercalaris		**F**	16	+
12200	Isonychia sp		**MI**		+
13521	Stenonema femoratum		**F**	20	+
17200	Caenis sp		**F**	32	+
21200	Calopteryx sp		**F**		+
22001	Coenagrionidae		**T**		+
22300	Argia sp		**F**	70	+
51206	Cyrnellus fraternus		**F**	233	+
52200	Cheumatopsyche sp		**F**	1217	+
52430	Ceratopsyche morosa group		**MI**	55	
52530	Hydropsyche depravata group		**F**	410	+
53501	Hydroptilidae		**F**	4	
68708	Dubiraphia vittata group		**F**	1	+
69400	Stenelmis sp		**F**		+
77750	Hayesomyia senata or Thienemannimyia norena		**F**	144	
78702	Psectrotanypus dyari		**VT**		+
80420	Cricotopus (C.) bicinctus		**T**	48	+
81200	Nanocladius sp		**F**	48	
82730	Chironomus (C.) decorus group		**T**		+
82824	Cryptochironomus ponderosus		**F**		+
83040	Dicrotendipes neomodestus		**F**	528	+
83300	Glyptotendipes (G.) sp		**MT**	432	+
84450	Polypedilum (Uresipedilum) flavum		**F**	2306	+
84470	Polypedilum (P.) illinoense		**T**	144	
85625	Rheotanytarsus sp		**F**	1441	+
85821	Tanytarsus glabrescens group sp 7		**F**	96	+
85840	Tanytarsus sepp		**F**		+
87540	Hemerodromia sp		**F**	37	
95100	Physella sp		**T**	3	+
96801	Ancylidae		**F**	1	
97601	Corbicula fluminea		**F**		+
98001	Pisidiidae				+

No. Quantitative Taxa:	24	Total Taxa;	38
No. Qualitative Taxa:	30	ICI:	38
Number of Organisms:	7513	Qual EPT:	7

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-006** River: ***East Fork Mill Creek*** Coll. Date: *09/13/2021* RM: **0.10**

Site ID: **MC16** Location: *dst. Fada Rd./ust. Confluence Mill Creek* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	
01801	Turbellaria		F	53	+
01900	Nemertea		F	40	+
03600	Oligochaeta		T	832	
04915	Erpobdella parva				+
06201	Hyalella azteca		F	5	
08601	Hydrachnidia		F	32	
11130	Baetis intercalaris		F		+
11670	Procloeon viridoculare		MI		+
13521	Stenonema femoratum		F	2	+
17200	Caenis sp		F	33	
21200	Calopteryx sp		F		+
22001	Coenagrionidae		T	1	+
22300	Argia sp		F	6	+
51206	Cyrnellus fraternus		F	132	
52200	Cheumatopsyche sp		F	616	+
52430	Ceratopsyche morosa group		MI	20	
52530	Hydropsyche depravata group		F	115	+
53800	Hydroptila sp		F	144	+
60900	Peltodytes sp		MT		+
64050	Liodessus sp		MT		+
65800	Berosus sp		MT		+
68075	Psephenus herricki		MI		+
69400	Stenelmis sp		F		+
77120	Ablabesmyia mallochi		F		+
77750	Hayesomyia senata or Thienemannimyia norena		F	129	+
77800	Helopelopia sp		F		+
78450	Nilotanypus fimbriatus		F	21	
78655	Procladius (Holotanypus) sp		MT		+
78750	Rheopelopia paramaculipennis		MI		+
80360	Corynoneura floridaensis		MI	8	
80420	Cricotopus (C.) bicinctus		T	96	+
81231	Nanocladius (N.) crassicornus or N. (N.) "rectinervis"		F	32	
81240	Nanocladius (N.) distinctus		MT	64	
81825	Rheocricotopus (Psilocricotopus) robacki		F		+
82121	Thienemanniella lobapodema		F	29	
82141	Thienemanniella xena		F		+
82730	Chironomus (C.) decorus group		T		+
82824	Cryptochironomus ponderosus		F		+
83040	Dicrotendipes neomodestus		F	643	+
83050	Dicrotendipes lucifer		MT	32	
83300	Glyptotendipes (G.) sp		MT	96	
84450	Polypedilum (Uresipedilum) flavum		F	546	+
84470	Polypedilum (P.) illinoense		T	32	
84540	Polypedilum (Tripodura) scalaenum group		F		+
84700	Stenochironomus sp		F		+
84960	Pseudochironomus sp		F		+
84960	Pseudochironomus sp		F	32	
85230	Cladotanytarsus mancus group		F		+
85500	Paratanytarsus sp		F	32	
85625	Rheotanytarsus sp		F	1189	+
85800	Tanytarsus sp		F	64	
85821	Tanytarsus glabrescens group sp 7		F	611	
85840	Tanytarsus sepp		F	32	
87540	Hemerodromia sp		F	24	
94400	Fossaria sp		MT		+
95100	Physella sp		T		+
97601	Corbicula fluminea		F	1	+

No. Quantitative Taxa:	34	Total Taxa;	57
No. Qualitative Taxa:	37	ICI:	36
Number of Organisms:	5744	Qual EPT:	6

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-009** River: ***Coopers Creek (Rossmoyne Creek RM 14.05)*** Coll. Date: *09/17/2021* RM: **3.57**

Site ID: **MC111** Location: *Bechtold Park, approx 350-ft below origin* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	+
03600	Oligochaeta		**T**	+
21200	Calopteryx sp		**F**	+
72700	Anopheles sp		**F**	+
72900	Culex sp		**T**	+
77500	Conchapelopia sp		**F**	+
78200	Larsia sp		**MT**	+
78401	Natarsia species A (sensu Roback, 1978)		**T**	+
82730	Chironomus (C.) decorus group		**T**	+
84210	Paratendipes albimanus or P. duplicatus		**F**	+
95100	Physella sp		**T**	+

No. Quantitative Taxa:	0	Total Taxa;	11
No. Qualitative Taxa:	11	ICI:	
Number of Organisms:	0	Qual EPT:	0

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-009** River: ***Coopers Creek (Rossmoyne Creek RM 14.05)*** Coll. Date: *09/13/2021* RM: **3.42**

Site ID: **MC112** Location: *Approx 300-ft above Plainfield Road* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	+
03600	Oligochaeta		**T**	+
04660	Helobdella sp		**MT**	+
04666	Helobdella papillata		**MT**	+
07800	Cambarus sp			+
11120	Baetis flavistriga		**F**	+
21001	Calopterygidae		**F**	+
50301	Chimarra aterrima		**MI**	+
50315	Chimarra obscura		**MI**	+
52200	Cheumatopsyche sp		**F**	+
71900	Tipula sp		**F**	+
77750	Hayesomyia senata or Thienemannimyia norena		**F**	+
84300	Phaenopsectra obediens group		**F**	+
84302	Phaenopsectra punctipes		**F**	+
84450	Polypedilum (Uresipedilum) flavum		**F**	+
95100	Physella sp		**T**	+
96900	Ferrissia sp		**F**	+

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.

No. Quantitative Taxa:	0	Total Taxa;	17
No. Qualitative Taxa:	17	ICI:	
Number of Organisms:	0	Qual EPT:	4

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-009** River: ***Coopers Creek (Rossmoyne Creek RM 14.05)*** Coll. Date: *09/26/2021* RM: **2.84**

Site ID: **MC113** Location: *Below Wecklow Avenue* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	+
03600	Oligochaeta		**T**	+
07820	Cambarus (Cambarus) sp A		**MT**	+
72700	Anopheles sp		**F**	+
72900	Culex sp		**T**	+
84210	Paratendipes albimanus or P. duplicatus		**F**	+
96120	Menetus (Micromenetus) dilatatus		**MT**	+

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.

No. Quantitative Taxa:	0	Total Taxa;	7
No. Qualitative Taxa:	7	ICI:	
Number of Organisms:	0	Qual EPT:	0

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-009** River: ***Coopers Creek (Rossmoyne Creek RM 14.05)*** Coll. Date: *09/07/2021* RM: **2.59**

Site ID: **MC32** Location: *Approx 1,500-ft above RT 126 culvert* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.	Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	+					
03600	Oligochaeta		**T**	+					
06800	Gammarus sp		**F**	+					
69400	Stenelmis sp		**F**	+					
83040	Dicrotendipes neomodestus		**F**	+					

No. Quantitative Taxa:	0	Total Taxa;	5
No. Qualitative Taxa:	5	ICI:	
Number of Organisms:	0	Qual EPT:	0

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-009** River: ***Coopers Creek (Rossmoyne Creek RM 14.05)*** Coll. Date: *08/24/2021* RM: **2.13**

Site ID: **MC28** Location: *Approx 450-ft below RT 126 culvert* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	+
03600	Oligochaeta		**T**	+
06501	Gammaridae			+
07800	Cambarus sp			+
08250	Orconectes (Procericambarus) rusticus		**F**	+
08601	Hydrachnidia		**F**	+
11120	Baetis flavistriga		**F**	+
11130	Baetis intercalaris		**F**	+
13521	Stenonema femoratum		**F**	+
17200	Caenis sp		**F**	+
21200	Calopteryx sp		**F**	+
50301	Chimarra aterrima		**MI**	+
52200	Cheumatopsyche sp		**F**	+
52530	Hydropsyche depravata group		**F**	+
69400	Stenelmis sp		**F**	+
71900	Tipula sp		**F**	+
74100	Simulium sp		**F**	+
77750	Hayesomyia senata or Thienemannimyia norena		**F**	+
77800	Helopelopia sp		**F**	+
78655	Procladius (Holotanypus) sp		**MT**	+
80410	Cricotopus (C.) sp		**F**	+
81825	Rheocricotopus (Psilocricotopus) robacki		**F**	+
82820	Cryptochironomus sp		**F**	+
84210	Paratendipes albimanus or P. duplicatus		**F**	+
84300	Phaenopsectra obediens group		**F**	+
84450	Polypedilum (Uresipedilum) flavum		**F**	+
84540	Polypedilum (Tripodura) scalaenum group		**F**	+

No. Quantitative Taxa:	0	Total Taxa;	27
No. Qualitative Taxa:	27	ICI:	MG
Number of Organisms:	0	Qual EPT:	7

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-009** River: ***Coopers Creek (Rossmoyne Creek RM 14.05)*** Coll. Date: *09/27/2021* RM: **1.58**

Site ID: **MC118** Location: *end of N. Kathwood Cir.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	+
03600	Oligochaeta		**T**	+
04901	Erpobdellidae		**MT**	+
05900	Lirceus sp		**MT**	+
08200	Orconectes sp		**F**	+
11120	Baetis flavistriga		**F**	+
11130	Baetis intercalaris		**F**	+
13521	Stenonema femoratum		**F**	+
17200	Caenis sp		**F**	+
21200	Calopteryx sp		**F**	+
22300	Argia sp		**F**	+
50301	Chimarra aterrima		**MI**	+
50315	Chimarra obscura		**MI**	+
51050	Cernotina sp		**MI**	+
52200	Cheumatopsyche sp		**F**	+
52530	Hydropsyche depravata group		**F**	+
53501	Hydroptilidae		**F**	+
59970	Petrophila sp		**MI**	+
68075	Psephenus herricki		**MI**	+
71900	Tipula sp		**F**	+
74100	Simulium sp		**F**	+
77120	Ablabesmyia mallochi		**F**	+
81650	Parametriocnemus sp	**X**	**F**	+
82730	Chironomus (C.) decorus group		**T**	+
82820	Cryptochironomus sp		**F**	+
83040	Dicrotendipes neomodestus		**F**	+
83820	Microtendipes "caelum" (sensu Simpson & Bode, 1980)		**MI**	+
84210	Paratendipes albimanus or P. duplicatus		**F**	+
84300	Phaenopsectra obediens group		**F**	+

No. Quantitative Taxa:	0	Total Taxa;	29
No. Qualitative Taxa:	29	ICI:	G
Number of Organisms:	0	Qual EPT:	10

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-009** River: ***Coopers Creek (Rossmoyne Creek RM 14.05)*** Coll. Date: *09/27/2021* RM: **0.46**

Site ID: **MC119** Location: *ust. Reading Rd.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	+
03600	Oligochaeta		**T**	+
05900	Lirceus sp		**MT**	+
08250	Orconectes (Procericambarus) rusticus		**F**	+
11120	Baetis flavistriga		**F**	+
11130	Baetis intercalaris		**F**	+
13521	Stenonema femoratum		**F**	+
17200	Caenis sp		**F**	+
21200	Calopteryx sp		**F**	+
22001	Coenagrionidae		**T**	+
22300	Argia sp		**F**	+
50301	Chimarra aterrima		**MI**	+
50315	Chimarra obscura		**MI**	+
52200	Cheumatopsyche sp		**F**	+
52430	Ceratopsyche morosa group		**MI**	+
52530	Hydropsyche depravata group		**F**	+
53501	Hydroptilidae		**F**	+
59970	Petrophila sp		**MI**	+
68075	Psephenus herricki		**MI**	+
68130	Helichus sp		**F**	+
69400	Stenelmis sp		**F**	+
71900	Tipula sp		**F**	+
74100	Simulium sp		**F**	+
77120	Ablabesmyia mallochi		**F**	+
77800	Helopelopia sp		**F**	+
83840	Microtendipes pedellus group		**F**	+
84210	Paratendipes albimanus or P. duplicatus		**F**	+
84300	Phaenopsectra obediens group		**F**	+
85800	Tanytarsus sp		**F**	+

No. Quantitative Taxa:	0	Total Taxa;	29
No. Qualitative Taxa:	29	ICI:	G
Number of Organisms:	0	Qual EPT:	10

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-028** River: ***Trib to West Fork Creek @ RM 1.24*** Coll. Date: *09/03/2021* RM: **1.40**

Site ID: **MC97** Location: *Kirby Rd.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
03600	Oligochaeta		**T**	+
04680	Placobdella sp		**MT**	+
05900	Lirceus sp		**MT**	+
07800	Cambarus sp			+
11120	Baetis flavistriga		**F**	+
11130	Baetis intercalaris		**F**	+
13521	Stenonema femoratum		**F**	+
21200	Calopteryx sp		**F**	+
45300	Sigara sp		**MT**	+
50301	Chimarra aterrima		**MI**	+
51050	Cernotina sp		**MI**	+
52200	Cheumatopsyche sp		**F**	+
52315	Diplectrona modesta	**X**	**F**	+
52530	Hydropsyche depravata group		**F**	+
53800	Hydroptila sp		**F**	+
68025	Ectopria sp		**F**	+
68075	Psephenus herricki		**MI**	+
69400	Stenelmis sp		**F**	+
72501	Culicidae		**MT**	+
74100	Simulium sp		**F**	+
77500	Conchapelopia sp		**F**	+
77750	Hayesomyia senata or Thienemannimyia norena		**F**	+
77800	Helopelopia sp		**F**	+
79720	Diamesa sp	**X**	**F**	+
82730	Chironomus (C.) decorus group		**T**	+
83840	Microtendipes pedellus group		**F**	+
84210	Paratendipes albimanus or P. duplicatus		**F**	+
84450	Polypedilum (Uresipedilum) flavum		**F**	+
84750	Stictochironomus sp		**F**	+
85625	Rheotanytarsus sp		**F**	+
85840	Tanytarsus sepp		**F**	+

No. Quantitative Taxa:	0	Total Taxa;	31
No. Qualitative Taxa:	31	ICI:	
Number of Organisms:	0	Qual EPT:	9

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-046** River: ***Unamed Trib to Cooper Creek (Rossmoyne Creek*** Coll. Date: *08/27/2021* RM: **0.55**

Site ID: **MC114** Location: *Between Langhorst Ct. and Jeffrey Ct.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	+
03600	Oligochaeta		**T**	+
04985	Barbronia weberi		**MT**	+
72900	Culex sp		**T**	+
79400	Zavrelimyia sp	**X**	**F**	+
82710	Chironomus (C.) sp		**MT**	+
84470	Polypedilum (P.) illinoense		**T**	+
95100	Physella sp		**T**	+
96120	Menetus (Micromenetus) dilatatus		**MT**	+

No. Quantitative Taxa:	0	Total Taxa;	9
No. Qualitative Taxa:	9	ICI:	
Number of Organisms:	0	Qual EPT:	0

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-065** River: ***Kings Run*** Coll. Date: *09/03/2021* RM: **1.00**

Site ID: **MC109** Location: *Along Wooden Shoe Hollow Ln.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
03600	Oligochaeta		**T**	+
04901	Erpobdellidae		**MT**	+
05900	Lirceus sp		**MT**	+
07800	Cambarus sp			+
11120	Baetis flavistriga		**F**	+
11130	Baetis intercalaris		**F**	+
11200	Callibaetis sp		**MT**	+
13521	Stenonema femoratum		**F**	+
17200	Caenis sp		**F**	+
21300	Hetaerina sp		**F**	+
22001	Coenagrionidae		**T**	+
23700	Anax sp		**MT**	+
28500	Libellula sp		**MT**	+
28705	Pachydiplax longipennis		**T**	+
28810	Pantala flavescens		**VT**	+
45300	Sigara sp		**MT**	+
45900	Notonecta sp		**T**	+
50315	Chimarra obscura		**MI**	+
51050	Cernotina sp		**MI**	+
52200	Cheumatopsyche sp		**F**	+
52530	Hydropsyche depravata group		**F**	+
53501	Hydroptilidae		**F**	+
63900	Laccophilus sp		**T**	+
65800	Berosus sp		**MT**	+
67800	Tropisternus sp		**T**	+
68075	Psephenus herricki		**MI**	+
74100	Simulium sp		**F**	+
77120	Ablabesmyia mallochi		**F**	+
77500	Conchapelopia sp		**F**	+
77750	Hayesomyia senata or Thienemannimyia norena		**F**	+
77800	Helopelopia sp		**F**	+
78655	Procladius (Holotanypus) sp		**MT**	+
83040	Dicrotendipes neomodestus		**F**	+
84210	Paratendipes albimanus or P. duplicatus		**F**	+
85800	Tanytarsus sp		**F**	+
95100	Physella sp		**T**	+

No. Quantitative Taxa:	0	Total Taxa;	36
No. Qualitative Taxa:	36	ICI:	
Number of Organisms:	0	Qual EPT:	10

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-068** River: ***Lick Run*** Coll. Date: *09/03/2021* RM: **1.70**

Site ID: **MC108** Location: *Glenway Woods* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	+
03600	Oligochaeta		**T**	+
05900	Lirceus sp		**MT**	+
06700	Crangonyx sp		**MT**	+
11200	Callibaetis sp		**MT**	+
22300	Argia sp		**F**	+
28500	Libellula sp		**MT**	+
45300	Sigara sp		**MT**	+
60900	Peltodytes sp		**MT**	+
63300	Hydroporini		**T**	+
63900	Laccophilus sp		**T**	+
65501	Hydrophilidae		**F**	+
66500	Enochrus sp		**MT**	+
67700	Paracymus sp		**MT**	+
67800	Tropisternus sp		**T**	+
72700	Anopheles sp		**F**	+
78200	Larsia sp		**MT**	+
78655	Procladius (Holotanypus) sp		**MT**	+
78702	Psectrotanypus dyari		**VT**	+
84210	Paratendipes albimanus or P. duplicatus		**F**	+
87400	Stratiomys sp		**MT**	+
95100	Physella sp		**T**	+
98200	Pisidium sp		**MT**	+

No. Quantitative Taxa:	0	Total Taxa;	23
No. Qualitative Taxa:	23	ICI:	
Number of Organisms:	0	Qual EPT:	1

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-068** River: ***Lick Run*** Coll. Date: *08/26/2021* RM: **0.98**

Site ID: **MC106** Location: *Grotto Court* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
01801	Turbellaria		**F**	+
03600	Oligochaeta		**T**	+
04664	Helobdella stagnalis		**T**	+
04901	Erpobdellidae		**MT**	+
22001	Coenagrionidae		**T**	+
23700	Anax sp		**MT**	+
28500	Libellula sp		**MT**	+
28705	Pachydiplax longipennis		**T**	+
53800	Hydroptila sp		**F**	+
60900	Peltodytes sp		**MT**	+
65800	Berosus sp		**MT**	+
67800	Tropisternus sp		**T**	+
72150	Pericoma sp		**MT**	+
77500	Conchapelopia sp		**F**	+
77750	Hayesomyia senata or Thienemannimyia norena		**F**	+
78655	Procladius (Holotanypus) sp		**MT**	+
80420	Cricotopus (C.) bicinctus		**T**	+
81690	Paratrichocladius sp		**MI**	+
82730	Chironomus (C.) decorus group		**T**	+
84960	Pseudochironomus sp		**F**	+
87400	Stratiomys sp		**MT**	+
95100	Physella sp		**T**	+

No. Quantitative Taxa:	0	Total Taxa;	22
No. Qualitative Taxa:	22	ICI:	P
Number of Organisms:	0	Qual EPT:	1

Appendix Table C-2. Macroinvertebrate taxa list for sites from the Mill Creek study area in 2021.

River Code: **23-068** River: ***Lick Run*** Coll. Date: *08/26/2021* RM: **0.45**

Site ID: **MC107** Location: *Queen City and Cora Ave.* Sample:

Taxa Code	Taxa	CWH Taxa	Tol.	Qt./Ql.
03600	Oligochaeta		**T**	+
04901	Erpobdellidae		**MT**	+
11200	Callibaetis sp		**MT**	+
13521	Stenonema femoratum		**F**	+
17200	Caenis sp		**F**	+
22001	Coenagrionidae		**T**	+
28500	Libellula sp		**MT**	+
28810	Pantala flavescens		**VT**	+
60900	Peltodytes sp		**MT**	+
66500	Enochrus sp		**MT**	+
68901	Macronychus glabratus		**F**	+
74501	Ceratopogonidae		**T**	+
77120	Ablabesmyia mallochi		**F**	+
77355	Clinotanypus pinguis		**MT**	+
78655	Procladius (Holotanypus) sp		**MT**	+
80420	Cricotopus (C.) bicinctus		**T**	+
80510	Cricotopus (Isocladius) sylvestris group		**T**	+
83040	Dicrotendipes neomodestus		**F**	+
84540	Polypedilum (Tripodura) scalaenum group		**F**	+
84960	Pseudochironomus sp		**F**	+
85821	Tanytarsus glabrescens group sp 7		**F**	+
94800	Stagnicola sp		**T**	+
95100	Physella sp		**T**	+

No. Quantitative Taxa:	0	Total Taxa;	23
No. Qualitative Taxa:	23	ICI:	P
Number of Organisms:	0	Qual EPT:	3

APPENDIX D

D-1: Mill Creek 2021 QHEI Metrics and Scores

Appendix D-1. QHEI metric scores for sites in the Mill Creek study area in 2021.

River Mile	QHEI	QHEI Metrics: Substrate	Cover	Channel	Riparian	Pool	Riffle	Gradient / Score	Narrative
23-001	*Mill Creek*								
	Year: **2021**								
26.40	**69.00**	14.5	14.0	13.0	5.5	10.0	4.0	37.00 - (8)	**Good**
19.22	**69.25**	14.0	16.0	12.0	4.2	9.0	4.0	9.10 - (10)	**Good**
18.86	**70.50**	13.0	18.0	13.0	3.5	10.0	3.0	9.10 - (10)	**Good**
18.86	**61.00**	13.0	12.0	11.5	4.5	10.0	0.0	9.10 - (10)	**Good**
18.37	**83.50**	16.5	18.0	14.0	7.0	11.0	7.0	9.10 - (10)	**Excellent**
17.96	**65.00**	14.0	15.0	11.0	4.0	9.0	6.0	3.51 - (6)	**Good**
16.73	**56.00**	13.0	16.0	8.5	3.5	8.0	1.0	3.58 - (6)	**Fair**
15.41	**50.50**	10.0	15.0	7.5	4.0	8.0	0.0	3.58 - (6)	**Fair**
13.96	**65.50**	15.0	10.0	15.5	0.0	12.0	7.0	4.48 - (6)	**Good**
13.76	**75.75**	17.0	16.0	14.5	3.2	12.0	7.0	4.46 - (6)	**Excellent**
13.27	**55.50**	14.0	16.0	7.0	3.5	9.0	0.0	4.48 - (6)	**Fair**
11.70	**69.50**	16.0	13.0	12.5	5.0	12.0	7.0	52.60 - (4)	**Good**
10.48	**78.25**	18.0	13.0	12.0	6.2	12.0	7.0	8.26 - (10)	**Excellent**
9.24	**71.75**	17.5	11.0	12.0	7.2	12.0	6.0	24.40 - (6)	**Good**
8.63	**75.50**	15.0	14.0	12.5	5.0	12.0	7.0	9.35 - (10)	**Excellent**
7.47	**55.00**	15.0	6.0	10.0	4.0	6.0	4.0	4.17 - (10)	**Fair**
6.80	**28.50**	2.0	2.0	7.5	3.0	4.0	4.0	1.47 - (6)	**Very Poor**
6.45	**38.50**	9.5	2.0	7.0	3.0	6.0	5.0	1.47 - (6)	**Poor**
4.84	**49.00**	11.0	11.0	6.0	6.0	9.0	0.0	1.86 - (6)	**Fair**
4.21	**62.00**	14.0	12.0	12.0	5.5	10.0	2.5	1.86 - (6)	**Good**
3.45	**58.50**	14.0	15.0	10.0	5.0	6.0	2.5	1.86 - (6)	**Fair**
3.15	**58.50**	12.0	14.0	10.0	5.5	8.0	3.0	1.86 - (6)	**Fair**
2.50	**53.00**	13.0	5.0	11.0	5.0	6.0	7.0	1.86 - (6)	**Fair**
1.69	**57.50**	11.5	15.0	9.0	5.0	9.0	2.0	1.86 - (6)	**Fair**
0.83	**49.00**	9.0	15.0	6.0	5.0	8.0	0.0	1.86 - (6)	**Fair**
0.50	**50.00**	11.0	14.0	7.0	4.0	8.0	0.0	1.86 - (6)	**Fair**
0.21	**50.50**	11.0	12.0	10.0	3.5	8.0	0.0	1.86 - (6)	**Fair**
23-004	*West Fork Mill Creek*								
	Year: **2021**								
0.20	**69.25**	15.5	14.0	13.5	4.2	8.0	4.0	15.40 - (10)	**Good**
23-006	*East Fork Mill Creek*								
	Year: **2021**								
1.14	**71.50**	14.5	14.0	10.0	6.0	11.0	6.0	6.90 - (10)	**Excellent**
0.96	**78.00**	15.0	16.0	14.0	5.0	11.0	7.0	6.90 - (10)	**Excellent**
0.66	**71.00**	14.0	16.0	9.0	4.0	12.0	6.0	6.90 - (10)	**Excellent**
0.66	**64.25**	11.0	14.0	12.0	3.7	11.0	2.5	6.90 - (10)	**Good**

Appendix D-1. QHEI metric scores for sites in the Mill Creek study area in 2021.

River Mile	QHEI	QHEI Metrics							Narrative
		Substrate	Cover	Channel	Riparian	Pool	Riffle	Gradient / Score	
0.39	**60.50**	12.0	13.0	8.0	2.5	11.0	6.0	24.40 - (8)	**Good**
23-009	*(Rossmoyne Creek RM 14.05) Cooper Creek*								
	Year: **2021**								
3.57	**48.50**	16.0	5.0	13.0	6.5	4.0	0.0	52.00 - (4)	**Fair**
3.42	**42.50**	16.5	5.0	9.0	6.0	2.0	0.0	52.00 - (4)	**Poor**
2.84	**47.50**	20.0	5.0	5.0	7.5	6.0	0.0	155.0 - (4)	**Fair**
2.59	**49.50**	20.0	5.0	9.0	7.5	4.0	0.0	90.00 - (4)	**Fair**
2.13	**61.25**	22.0	9.0	13.0	7.2	8.0	0.0	75.00 - (4)	**Good**
1.58	**81.50**	18.0	16.0	16.5	4.0	13.0	7.0	35.70 - (8)	**Excellent**
0.44	**88.50**	17.5	15.0	19.0	8.0	12.0	7.0	18.88 - (10)	**Excellent**
23-028	*Trib to West Fork Creek @ RM 1.24*								
	Year: **2021**								
1.49	**69.50**	19.0	13.0	11.5	7.0	10.0	5.0	166.7 - (4)	**Good**
1.11	**52.00**	15.0	8.0	15.0	6.0	4.0	0.0	90.90 - (4)	**Fair**
23-046	*Unnamed Tributary to (Rossmoyne Creek RM14.06) Cooper Creek*								
	Year: **2021**								
0.55	**45.50**	17.5	6.0	9.0	5.0	4.0	0.0	86.00 - (4)	**Fair**
23-068	*Lick Run*								
	Year: **2021**								
0.98	**45.00**	15.0	6.0	11.0	5.0	4.0	0.0	83.30 - (4)	**Fair**
0.45	**47.50**	14.5	4.0	12.0	5.0	4.0	0.0	13.16 - (8)	**Fair**

APPENDIX E

E-1: Mill Creek 2021 HHEI Metrics and Scores

Appendix E1. Primary Headwater Aquatic Life Use information for the small Mill Creek tributaries during 2021.

Site ID	RM	Year	River	Location:
MC111	**3.57**	**2021**	(23009) (Rossmoyne Creek RM 14.05) Cooper Creek	20m dst Bechtold sewer outlet, Bechtold Park

HHEI Info: HHEI Score: ***84.0*** Substrate: **29.0** Pool: **30.0** Bankfull **25.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: ***48.5*** Substrate: **16.0** Pool: **4.0** Max Z.: **20-40 cm** Channel **13.0** Flow: ***Flowing***

Drainage Size: **0.34** Riffle: **0.0** Ripar: **6.5** Cover: **5.0** PHW Class:**PHW3B**

FISH Info: IBI Score: **28.0** Species: **3.0** Sensitive Sp.: **0.0** % Pioneer: **56.3** Headwater Sp. **1.00**

MACRO Info: ICI Score: QUAL EPT: **0** Coldwater Taxa.: **0** Intols: Sens. **0** Toler: V. Tol.

Salamanders:**X** Adults: **6** Larvae: **4** *Eurycea bislineata* Alternate Site ID:**MR-1**

MC112	**3.42**	**2021**	(23009) (Rossmoyne Creek RM 14.05) Cooper Creek	20m ust Plainfield Rd., Bechtold Park

HHEI Info: HHEI Score: ***90.0*** Substrate: **30.0** Pool: **30.0** Bankfull **30.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: ***42.5*** Substrate: **16.5** Pool: **2.0** Max Z.: **20-40 cm** Channel **9.0** Flow: ***Interst.***

Drainage Size: **0.48** Riffle: **0.0** Ripar: **6.0** Cover: **5.0** PHW Class:**PHW3B**

FISH Info: IBI Score: **28.0** Species: **3.0** Sensitive Sp.: **0.0** % Pioneer: **60.2** Headwater Sp. **1.00**

MACRO Info: ICI Score: QUAL EPT: **4** Coldwater Taxa.: **0** Intols: Sens. **2** Toler: V. Tol.

Salamanders:**X** Adults: **1** Larvae: **4** *Eurycea bislineata* Alternate Site ID:**MR-2**

MC113	**2.84**	**2021**	(23009) (Rossmoyne Creek RM 14.05) Cooper Creek	50m dst. Wicklow Ave.

HHEI Info: HHEI Score: ***85.0*** Substrate: **35.0** Pool: **20.0** Bankfull **30.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: ***47.5*** Substrate: **20.0** Pool: **6.0** Max Z.: **> 100 cm** Channel **5.0** Flow: ***Interst.***

Drainage Size: **1.10** Riffle: **0.0** Ripar: **7.5** Cover: **5.0** PHW Class:**PHW3B**

FISH Info: IBI Score: **30.0** Species: **4.0** Sensitive Sp.: **0.0** % Pioneer: **68.2** Headwater Sp. **1.00**

MACRO Info: ICI Score: QUAL EPT: **0** Coldwater Taxa.: **0** Intols: Sens. **0** Toler: V. Tol.

Salamanders:**X** Adults: Larvae: **1** *Eurycea bislineata* Alternate Site ID:**MR-3**

MC32	**2.59**	**2021**	(23009) (Rossmoyne Creek RM 14.05) Cooper Creek	30m ust Arborcrest Ct.

HHEI Info: HHEI Score: ***86.0*** Substrate: **36.0** Pool: **20.0** Bankfull **30.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: ***49.5*** Substrate: **20.0** Pool: **4.0** Max Z.: **40-70 cm** Channel **9.0** Flow: ***Flowing***

Drainage Size: **1.80** Riffle: **0.0** Ripar: **7.5** Cover: **5.0** PHW Class:**PHW3B**

FISH Info: IBI Score: **30.0** Species: **4.0** Sensitive Sp.: **0.0** % Pioneer: **34.7** Headwater Sp. **1.00**

MACRO Info: ICI Score: QUAL EPT: **0** Coldwater Taxa.: **0** Intols: Sens. **0** Toler: V. Tol.

Salamanders:**X** Adults: **1** Larvae: **6** *Eurycea bislineata* Alternate Site ID:**MR-5**

Appendix E1. Primary Headwater Aquatic Life Use information for the small Mill Creek tributaries during 2021.

Site ID	RM	Year	River	Location:
MC28	**2.13**	**2021**	(23009) (Rossmoyne Creek RM 14.05) Cooper Creek	200m dst Ronald Reagan Hwy 126

HHEI Info: HHEI Score: ***86.0*** Substrate: **36.0** Pool: **20.0** Bankfull **30.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: ***61.2*** Substrate: **22.0** Pool: **8.0** Max Z.: **70-100 cm** Channel **13.0** Flow: ***Flowing***

Drainage Size: **2.60** Riffle: **0.0** Ripar: **7.2** Cover: **9.0** PHW Class:**WWH**

FISH Info: IBI Score: **32.0** Species: **5.0** Sensitive Sp.: **0.0** % Pioneer: **34.8** Headwater Sp. **1.00**

MACRO Info: ICI Score: QUAL EPT: **7** Coldwater Taxa.: **0** Intols: Sens. **1** Toler: V. Tol.

Salamanders:**X** Adults: Larvae: **2** *Eurycea bislineata* Alternate Site ID:**MR-6**

MC118	**1.58**	**2021**	(23009) (Rossmoyne Creek RM 14.05) Cooper Creek	end of N. Kathwood Cir.

HHEI Info: HHEI Score: ***77.0*** Substrate: **27.0** Pool: **20.0** Bankfull **30.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: ***81.5*** Substrate: **18.0** Pool: **13.0** Max Z.: **> 100 cm** Channel **16.5** Flow: ***Flowing***

Drainage Size: **3.99** Riffle: **7.0** Ripar: **4.0** Cover: **16.0** PHW Class:**WWH**

FISH Info: IBI Score: **46.0** Species: **11.0** Sensitive Sp.: **1.0** % Pioneer: **29.0** Headwater Sp. **2.00**

MACRO Info: ICI Score: QUAL EPT: **10** Coldwater Taxa.: **1** Intols: Sens. **6** Toler: V. Tol.

Salamanders:**X** Adults: Larvae: **4** *Eurycea bislineata* Alternate Site ID:

MC119	**0.46**	**2021**	(23009) (Rossmoyne Creek RM 14.05) Cooper Creek	ust. Reading Rd.

HHEI Info: HHEI Score: ***89.0*** Substrate: **29.0** Pool: **30.0** Bankfull **30.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: Substrate: Pool: Max Z.: Channel Flow:

Drainage Size: **5.43** Riffle: Ripar: Cover: PHW Class:**WWH**

FISH Info: IBI Score: **46.0** Species: **12.0** Sensitive Sp.: **1.0** % Pioneer: **21.5** Headwater Sp. **2.00**

MACRO Info: ICI Score: QUAL EPT: **10** Coldwater Taxa.: **0** Intols: Sens. **5** Toler: V. Tol.

Salamanders:**X** Adults: Larvae: **5** *Eurycea bislineata* Alternate Site ID:

MC97	**1.40**	**2021**	(23028) Trib to West Fork Creek @ RM 1.24	Kirby Rd.

HHEI Info: HHEI Score: ***96.0*** Substrate: **36.0** Pool: **30.0** Bankfull **30.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: Substrate: Pool: Max Z.: Channel Flow:

Drainage Size: **0.84** Riffle: Ripar: Cover: PHW Class:**PHW3B**

FISH Info: IBI Score: **12.0** Species: **0.0** Sensitive Sp.: **0.0** % Pioneer: **0.00** Headwater Sp. **0.00**

MACRO Info: ICI Score: QUAL EPT: **9** Coldwater Taxa.: **2** Intols: Sens. **3** Toler: V. Tol.

Salamanders:**X** Adults: **1** Larvae: **7** *Eurycea bislineata* Alternate Site ID:

Appendix E1. Primary Headwater Aquatic Life Use information for the small Mill Creek tributaries during 2021.

Site ID	RM	Year	River	Location:
MC114	**0.55**	**2021**	(23046) Unnamed Tributary to (Rossmoyne Creek RM	Hamilton Co. SWCD

HHEI Info: HHEI Score: ***72.0*** Substrate: **27.0** Pool: **20.0** Bankfull **25.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: ***45.5*** Substrate: **17.5** Pool: **4.0** Max Z.: **70-100 cm** Channel **9.0** Flow: ***Interst.***

Drainage Size: **0.49** Riffle: **0.0** Ripar: **5.0** Cover: **6.0** PHW Class:**PHW3B**

FISH Info: IBI Score: **12.0** Species: **1.0** Sensitive Sp.: **0.0** % Pioneer: **0.00** Headwater Sp. **0.00**

MACRO Info: ICI Score: QUAL EPT: **0** Coldwater Taxa.: **1** Intols: Sens. **0** Toler: V. Tol.

Salamanders:**X** Adults: Larvae: **3** *Eurycea bislineata* Alternate Site ID:**MR-4b**

MC109	**1.00**	**2021**	(23065) King's Run	Along Wooden Shoe Hollow Ln.

HHEI Info: HHEI Score: ***90.0*** Substrate: **35.0** Pool: **30.0** Bankfull **25.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: Substrate: Pool: Max Z.: Channel Flow:

Drainage Size: **0.93** Riffle: Ripar: Cover: PHW Class:**PHW3B**

FISH Info: IBI Score: **12.0** Species: **0.0** Sensitive Sp.: **0.0** % Pioneer: **0.00** Headwater Sp. **0.00**

MACRO Info: ICI Score: QUAL EPT: **10** Coldwater Taxa.: **0** Intols: Sens. **3** Toler: **1** V. Tol. **1.0**

Salamanders:**X** Adults: **4** Larvae: *Eurycea bislineata* Alternate Site ID:

MC108	**1.70**	**2021**	(23068) Lick Run	Glenway Woods

HHEI Info: HHEI Score: ***70.0*** Substrate: **20.0** Pool: **30.0** Bankfull **20.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: Substrate: Pool: Max Z.: Channel Flow:

Drainage Size: **0.19** Riffle: Ripar: Cover: PHW Class:**PHW2**

FISH Info: IBI Score: **12.0** Species: **1.0** Sensitive Sp.: **0.0** % Pioneer: **0.00** Headwater Sp. **0.00**

MACRO Info: ICI Score: QUAL EPT: **1** Coldwater Taxa.: **0** Intols: Sens. **0** Toler: **1** V. Tol. **1.0**

Salamanders: Adults: Larvae: Alternate Site ID:

MC106	**0.98**	**2021**	(23068) Lick Run	Grotto Court

HHEI Info: HHEI Score: ***66.0*** Substrate: **21.0** Pool: **20.0** Bankfull **25.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: ***45.0*** Substrate: **15.0** Pool: **4.0** Max Z.: **20-40 cm** Channel **11.0** Flow: ***Flowing***

Drainage Size: **3.45** Riffle: **0.0** Ripar: **5.0** Cover: **6.0** PHW Class:**MWH**

FISH Info: IBI Score: **16.0** Species: **4.0** Sensitive Sp.: **0.0** % Pioneer: **94.1** Headwater Sp. **0.00**

MACRO Info: ICI Score: QUAL EPT: **1** Coldwater Taxa.: **0** Intols: Sens. **1** Toler: V. Tol.

Salamanders: Adults: Larvae: Alternate Site ID:

Appendix E1. Primary Headwater Aquatic Life Use information for the small Mill Creek tributaries during 2021.

Site ID	RM	Year	River	Location:
MC107	**0.45**	**2021**	(23068) Lick Run	Queen City and Cora Ave.

HHEI Info:	HHEI Score:	***74.0***	Substrate:	**19.0**	Pool:	**30.0**	Bankfull	**25.0**	Channel:	***Recent***	Flow:	***Ephem.***
QHEI Info:	QHEI Score:	***47.5***	Substrate:	**14.5**	Pool:	**4.0**	Max Z.:	**20-40 cm**	Channel	**12.0**	Flow:	***Flowing***
Drainage Size:	**3.55**		Riffle:	**0.0**	Ripar:	**5.0**	Cover:	**4.0**	PHW Class:	**MWH**		
FISH Info:	IBI Score:	**20.0**	Species:	**3.0**	Sensitive Sp.:	**0.0**	% Pioneer:	**80.7**	Headwater Sp.	**0.00**		
MACRO Info:	ICI Score:		QUAL EPT:	**3**	Coldwater Taxa.:	**0**	Intols:		Sens.	**0**	Toler:	**1**	V. Tol.	**1.0**
Salamanders:	Adults:		Larvae:						Alternate Site ID:			

Appendix E1. Primary Headwater Aquatic Life Use information for the small Mill Creek tributaries during 2021.

Site ID	RM	Year	River	Location:
MC111	**3.57**	**2021**	(23009) (Rossmoyne Creek RM 14.05) Cooper Creek	20m dst Bechtold sewer outlet, Bechtold Park

HHEI Info: HHEI Score: ***84.0*** Substrate: **29.0** Pool: **30.0** Bankfull **25.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: ***48.5*** Substrate: **16.0** Pool: **4.0** Max Z.: **20-40 cm** Channel **13.0** Flow: ***Flowing***

Drainage Size: **0.34** Riffle: **0.0** Ripar: **6.5** Cover: **5.0** PHW Class:**PHW3B**

FISH Info: IBI Score: **28.0** Species: **3.0** Sensitive Sp.: **0.0** % Pioneer: **56.3** Headwater Sp. **1.00**

MACRO Info: ICI Score: QUAL EPT: **0** Coldwater Taxa.: **0** Intols: Sens. **0** Toler: V. Tol.

Salamanders:**X** Adults: **6** Larvae: **4** *Eurycea bislineata* Alternate Site ID:**MR-1**

MC112	**3.42**	**2021**	(23009) (Rossmoyne Creek RM 14.05) Cooper Creek	20m ust Plainfield Rd., Bechtold Park

HHEI Info: HHEI Score: ***90.0*** Substrate: **30.0** Pool: **30.0** Bankfull **30.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: ***42.5*** Substrate: **16.5** Pool: **2.0** Max Z.: **20-40 cm** Channel **9.0** Flow: ***Interst.***

Drainage Size: **0.48** Riffle: **0.0** Ripar: **6.0** Cover: **5.0** PHW Class:**PHW3B**

FISH Info: IBI Score: **28.0** Species: **3.0** Sensitive Sp.: **0.0** % Pioneer: **60.2** Headwater Sp. **1.00**

MACRO Info: ICI Score: QUAL EPT: **4** Coldwater Taxa.: **0** Intols: Sens. **2** Toler: V. Tol.

Salamanders:**X** Adults: **1** Larvae: **4** *Eurycea bislineata* Alternate Site ID:**MR-2**

MC113	**2.84**	**2021**	(23009) (Rossmoyne Creek RM 14.05) Cooper Creek	50m dst. Wicklow Ave.

HHEI Info: HHEI Score: ***85.0*** Substrate: **35.0** Pool: **20.0** Bankfull **30.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: ***47.5*** Substrate: **20.0** Pool: **6.0** Max Z.: **> 100 cm** Channel **5.0** Flow: ***Interst.***

Drainage Size: **1.10** Riffle: **0.0** Ripar: **7.5** Cover: **5.0** PHW Class:**PHW3B**

FISH Info: IBI Score: **30.0** Species: **4.0** Sensitive Sp.: **0.0** % Pioneer: **68.2** Headwater Sp. **1.00**

MACRO Info: ICI Score: QUAL EPT: **0** Coldwater Taxa.: **0** Intols: Sens. **0** Toler: V. Tol.

Salamanders:**X** Adults: Larvae: **1** *Eurycea bislineata* Alternate Site ID:**MR-3**

MC32	**2.59**	**2021**	(23009) (Rossmoyne Creek RM 14.05) Cooper Creek	30m ust Arborcrest Ct.

HHEI Info: HHEI Score: ***86.0*** Substrate: **36.0** Pool: **20.0** Bankfull **30.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: ***49.5*** Substrate: **20.0** Pool: **4.0** Max Z.: **40-70 cm** Channel **9.0** Flow: ***Flowing***

Drainage Size: **1.80** Riffle: **0.0** Ripar: **7.5** Cover: **5.0** PHW Class:**PHW3B**

FISH Info: IBI Score: **30.0** Species: **4.0** Sensitive Sp.: **0.0** % Pioneer: **34.7** Headwater Sp. **1.00**

MACRO Info: ICI Score: QUAL EPT: **0** Coldwater Taxa.: **0** Intols: Sens. **0** Toler: V. Tol.

Salamanders:**X** Adults: **1** Larvae: **6** *Eurycea bislineata* Alternate Site ID:**MR-5**

Appendix E1. Primary Headwater Aquatic Life Use information for the small Mill Creek tributaries during 2021.

Site ID	RM	Year	River	Location:
MC28	**2.13**	**2021**	(23009) (Rossmoyne Creek RM 14.05) Cooper Creek	200m dst Ronald Reagan Hwy 126

HHEI Info: HHEI Score: ***86.0*** Substrate: **36.0** Pool: **20.0** Bankfull **30.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: ***61.2*** Substrate: **22.0** Pool: **8.0** Max Z.: **70-100 cm** Channel **13.0** Flow: ***Flowing***

Drainage Size: **2.60** Riffle: **0.0** Ripar: **7.2** Cover: **9.0** PHW Class:**WWH**

FISH Info: IBI Score: **32.0** Species: **5.0** Sensitive Sp.: **0.0** % Pioneer: **34.8** Headwater Sp. **1.00**

MACRO Info: ICI Score: QUAL EPT: **7** Coldwater Taxa.: **0** Intols: Sens. **1** Toler: V. Tol.

Salamanders:**X** Adults: Larvae: **2** *Eurycea bislineata* Alternate Site ID:**MR-6**

MC118	**1.58**	**2021**	(23009) (Rossmoyne Creek RM 14.05) Cooper Creek	end of N. Kathwood Cir.

HHEI Info: HHEI Score: ***77.0*** Substrate: **27.0** Pool: **20.0** Bankfull **30.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: ***81.5*** Substrate: **18.0** Pool: **13.0** Max Z.: **> 100 cm** Channel **16.5** Flow: ***Flowing***

Drainage Size: **3.99** Riffle: **7.0** Ripar: **4.0** Cover: **16.0** PHW Class:**WWH**

FISH Info: IBI Score: **46.0** Species: **11.0** Sensitive Sp.: **1.0** % Pioneer: **29.0** Headwater Sp. **2.00**

MACRO Info: ICI Score: QUAL EPT: **10** Coldwater Taxa.: **1** Intols: Sens. **6** Toler: V. Tol.

Salamanders:**X** Adults: Larvae: **4** *Eurycea bislineata* Alternate Site ID:

MC119	**0.46**	**2021**	(23009) (Rossmoyne Creek RM 14.05) Cooper Creek	ust. Reading Rd.

HHEI Info: HHEI Score: ***89.0*** Substrate: **29.0** Pool: **30.0** Bankfull **30.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: Substrate: Pool: Max Z.: Channel Flow:

Drainage Size: **5.43** Riffle: Ripar: Cover: PHW Class:**WWH**

FISH Info: IBI Score: **46.0** Species: **12.0** Sensitive Sp.: **1.0** % Pioneer: **21.5** Headwater Sp. **2.00**

MACRO Info: ICI Score: QUAL EPT: **10** Coldwater Taxa.: **0** Intols: Sens. **5** Toler: V. Tol.

Salamanders:**X** Adults: Larvae: **5** *Eurycea bislineata* Alternate Site ID:

MC97	**1.40**	**2021**	(23028) Trib to West Fork Creek @ RM 1.24	Kirby Rd.

HHEI Info: HHEI Score: ***96.0*** Substrate: **36.0** Pool: **30.0** Bankfull **30.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: Substrate: Pool: Max Z.: Channel Flow:

Drainage Size: **0.84** Riffle: Ripar: Cover: PHW Class:**PHW3B**

FISH Info: IBI Score: **12.0** Species: **0.0** Sensitive Sp.: **0.0** % Pioneer: **0.00** Headwater Sp. **0.00**

MACRO Info: ICI Score: QUAL EPT: **9** Coldwater Taxa.: **2** Intols: Sens. **3** Toler: V. Tol.

Salamanders:**X** Adults: **1** Larvae: **7** *Eurycea bislineata* Alternate Site ID:

Appendix E1. Primary Headwater Aquatic Life Use information for the small Mill Creek tributaries during 2021.

Site ID	RM	Year	River	Location:
MC114	**0.55**	**2021**	(23046) Unnamed Tributary to (Rossmoyne Creek RM	Hamilton Co. SWCD

HHEI Info: HHEI Score: ***72.0*** Substrate: **27.0** Pool: **20.0** Bankfull **25.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: ***45.5*** Substrate: **17.5** Pool: **4.0** Max Z.: **70-100 cm** Channel **9.0** Flow: ***Interst.***

Drainage Size: **0.49** Riffle: **0.0** Ripar: **5.0** Cover: **6.0** PHW Class:**PHW3B**

FISH Info: IBI Score: **12.0** Species: **1.0** Sensitive Sp.: **0.0** % Pioneer: **0.00** Headwater Sp. **0.00**

MACRO Info: ICI Score: QUAL EPT: **0** Coldwater Taxa.: **1** Intols: Sens. **0** Toler: V. Tol.

Salamanders:**X** Adults: Larvae: **3** *Eurycea bislineata* Alternate Site ID:**MR-4b**

MC109	**1.00**	**2021**	(23065) King's Run	Along Wooden Shoe Hollow Ln.

HHEI Info: HHEI Score: ***90.0*** Substrate: **35.0** Pool: **30.0** Bankfull **25.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: Substrate: Pool: Max Z.: Channel Flow:

Drainage Size: **0.93** Riffle: Ripar: Cover: PHW Class:**PHW3B**

FISH Info: IBI Score: **12.0** Species: **0.0** Sensitive Sp.: **0.0** % Pioneer: **0.00** Headwater Sp. **0.00**

MACRO Info: ICI Score: QUAL EPT: **10** Coldwater Taxa.: **0** Intols: Sens. **3** Toler: **1** V. Tol. **1.0**

Salamanders:**X** Adults: **4** Larvae: *Eurycea bislineata* Alternate Site ID:

MC108	**1.70**	**2021**	(23068) Lick Run	Glenway Woods

HHEI Info: HHEI Score: ***70.0*** Substrate: **20.0** Pool: **30.0** Bankfull **20.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: Substrate: Pool: Max Z.: Channel Flow:

Drainage Size: **0.19** Riffle: Ripar: Cover: PHW Class:**PHW2**

FISH Info: IBI Score: **12.0** Species: **1.0** Sensitive Sp.: **0.0** % Pioneer: **0.00** Headwater Sp. **0.00**

MACRO Info: ICI Score: QUAL EPT: **1** Coldwater Taxa.: **0** Intols: Sens. **0** Toler: **1** V. Tol. **1.0**

Salamanders: Adults: Larvae: Alternate Site ID:

MC106	**0.98**	**2021**	(23068) Lick Run	Grotto Court

HHEI Info: HHEI Score: ***66.0*** Substrate: **21.0** Pool: **20.0** Bankfull **25.0** Channel: ***Recent*** Flow: ***Ephem.***

QHEI Info: QHEI Score: ***45.0*** Substrate: **15.0** Pool: **4.0** Max Z.: **20-40 cm** Channel **11.0** Flow: ***Flowing***

Drainage Size: **3.45** Riffle: **0.0** Ripar: **5.0** Cover: **6.0** PHW Class:**MWH**

FISH Info: IBI Score: **16.0** Species: **4.0** Sensitive Sp.: **0.0** % Pioneer: **94.1** Headwater Sp. **0.00**

MACRO Info: ICI Score: QUAL EPT: **1** Coldwater Taxa.: **0** Intols: Sens. **1** Toler: V. Tol.

Salamanders: Adults: Larvae: Alternate Site ID:

Appendix E1. Primary Headwater Aquatic Life Use information for the small Mill Creek tributaries during 2021.

Site ID	RM	Year	River	Location:
MC107	**0.45**	**2021**	(23068) Lick Run	Queen City and Cora Ave.

HHEI Info:	HHEI Score:	***74.0***	Substrate:	**19.0**	Pool:	**30.0**	Bankfull	**25.0**	Channel:	***Recent***	Flow:	***Ephem.***
QHEI Info:	QHEI Score:	***47.5***	Substrate:	**14.5**	Pool:	**4.0**	Max Z.:	**20-40 cm**	Channel	**12.0**	Flow:	***Flowing***
Drainage Size:	**3.55**		Riffle:	**0.0**	Ripar:	**5.0**	Cover:	**4.0**	PHW Class:	**MWH**		
FISH Info:	IBI Score:	**20.0**	Species:	**3.0**	Sensitive Sp.:	**0.0**	% Pioneer:	**80.7**	Headwater Sp.	**0.00**		
MACRO Info:	ICI Score:		QUAL EPT:	**3**	Coldwater Taxa.:	**0**	Intols:		Sens.	**0**	Toler:	**1**	V. Tol.	**1.0**
Salamanders:	Adults:		Larvae:						Alternate Site ID:			