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A Total Maximum Daily Load Report for the Maria Creek Watershed

Final TMDL Report

August 19, 2021

Prepared for: U.S. Environmental Protection Agency Region 5

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Executive Summary

The Maria Creek watershed (HUC 0512011118) is located in southwestern Indiana and drains an area of approximately 97 square miles. The watershed originates in southern Sullivan County and then flows south into Knox County where it ultimately empties into the Wabash River north of Vincennes. Land use throughout the watershed is predominantly agriculture with forested areas being the second most abundant land use type.

The Clean Water Act (CWA) and U.S. Environmental Protection Agency (U.S. EPA) regulations require that states develop Total Maximum Daily Loads (TMDLs) for waters on the Section 303(d) List of Impaired Waters. A TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards. TMDLs are composed of the sum of individual wasteload allocations (WLAs) for regulated sources and load allocations (LAs) for sources that are not directly regulated. In addition, the TMDL must include a margin of safety (MOS), either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this is defined by the equation:

$$\text{TMDL} = \sum \text{WLAs} + \sum \text{LAs} + \text{MOS}$$

This TMDL has been developed to address *E. coli* and biotic communities in the Maria Creek watershed, in accordance with the TMDL Program Priority Framework. Parameters chosen for TMDL development include *E. coli* and total suspended solids (TSS). These parameters will be referred to cumulatively in this report as "pollutants."

The Maria Creek watershed TMDL was prioritized to be completed at this time based on local interest in addressing water quality, IDEM interest in conducting baseline water quality monitoring for local planning, and a competitive Section 319 application from the local partners to develop a watershed management plan in conjunction with the IDEM sampling and TMDL development for streams impaired for *E. coli* and biotic communities.

After the Indiana Department of Environmental Management (IDEM) identifies a waterbody as having impairment and places the waterbody on Indiana's Section 303(d) List of Impaired Waters, IDEM implements a sampling plan to determine the extent and the magnitude of the impairment. The next task is to reassess each waterbody using new sampling data and to examine the watershed as a whole. The reassessment data help IDEM identify the area of concern for TMDL development. As a result of the reassessment of the Maria Creek watershed, the pollutants and the impaired segments for which TMDLs were developed differ from those appearing on the 2020 Section 303(d) List because sampling performed by IDEM in 2019 and 2020 generated new water quality data that were not available at the time the 2020 Section 303(d) List was developed.

Sampling data were collected at 18 sampling sites from November 2019 to October 2020 by IDEM for the TMDL analysis. The data indicate that 16 of the sample sites violated one or more of the Indiana water quality standards (327 IAC 2).

Potential sources of biotic impairment and *E. coli* in the watershed include both regulated point sources and nonpoint sources. Point sources such as a public water supply (PWS) facility, wastewater treatment plants (WWTPs), surface and underground coal mining operations, and stormwater permitted construction activities are regulated through the National Pollutant Discharge Elimination System (NPDES). Nonpoint sources such as agricultural run-off, stream bank erosion, unregulated urban stormwater, wildlife, confined feeding operations (CFOs), pasture animals with access to streams, and faulty and failing septic systems are also potential sources.

Determining the specific reasons for high *E. coli* counts in any given waterbody is challenging. There are many potential sources, and *E. coli* counts are inherently variable. There is only one permitted confined feeding operation (CFO) within the Maria Creek watershed. However, several small unregulated animal feeding operations were observed throughout the watershed. It is therefore possible that these small unregulated operations that allow livestock to have direct access to streams are contributing to the elevated *E. coli* levels. However, with the highest amount of land being agricultural use throughout all of the subwatersheds, land application of manure could be a primary source of high *E. coli* levels. The second highest land use for all subwatersheds was forested, which indicates that wildlife excrement could be a contributing source as well. Additionally, being a very rural watershed, other factors such as failing septic systems or illegal straight pipes could be affecting subwatersheds that also tend to experience lower flows, and thus have less dilution. Specific sources of *E. coli* to each impaired waterbody should be further evaluated during follow-up implementation activities.

Various subwatersheds in the Maria Creek watershed have impaired biotic communities (IBC). Biological communities include fish and aquatic invertebrates, such as insects. These in-stream organisms are indicators of the cumulative effects of activities that affect water quality conditions over time. An IBC listing on Indiana's 303(d) List suggests that one or more of the aquatic biological communities is unhealthy as determined by IDEM's monitoring data. IBC is not a source of impairment but a symptom of other sources. To address these impairments in the Maria Creek watershed, high TSS has been identified as the pollutant for TMDL development. Results of watershed modeling indicate run-off from cropland and stream bank erosion contribute the greatest sediment loads throughout Maria Creek.

An important step in the TMDL process is the allocation of the allowable loads to individual point sources, as well as sources that are not directly regulated. The Maria Creek watershed TMDL includes these allocations, which are presented for each of the 12-digit hydrologic unit code (HUC) subwatersheds containing impairments.

There are seven NPDES permitted facilities located in the Maria Creek watershed. These facilities include a public water supply (PWS), wastewater treatment plants (WWTPs), and coal mining operations. Of these facilities, three have been found to be in violation of their permit limits for TSS. Although these NPDES facilities have been found to be in violation of their permit limits, the majority of the time effluent from permitted facilities meets water quality standards and/or targets.

There are several types of documented and suspected nonpoint sources located in the Maria Creek watershed, including unregulated livestock operations with direct access to streams, agricultural row crop land use, straight pipes, leaking or failing septic systems, wildlife, and erosion. Of these, agricultural row crop land use, livestock operations, and erosion are found most often in subwatersheds with elevated levels of *E. coli* and TSS. Although Indiana does not have a permitting program for nonpoint sources, many nonpoint sources are addressed through voluntary programs intended to reduce pollutant loads, minimize flow, and improve water quality.

This TMDL report identifies which locations could most benefit from focus on implementation activities. These areas throughout the Maria Creek watershed are referred to as critical conditions. It also provides recommendations on the types of implementation activities, including best management practices (BMPs), that key implementation partners in the Maria Creek watershed can consider to achieve the pollutant load reductions calculated for each subwatershed. Table 1 presents potential critical areas which can be used to recommend BMPs identified as having a high likely degree of effectiveness to achieve the *E. coli* and TSS load reductions allocated to sources in each subwatershed. The critical condition for each TMDL is identified as the flow condition requiring the largest percent reduction based on a 90th percentile concentration of observed water quality data in each subwatershed and flow regime combination. A more detailed explanation of critical conditions can be found in Section 5.2.

Table 1: Critical Conditions for TMDL Parameters

Parameter	Subwatershed (HUC)	Critical Condition (Reduction Needed)				
		High	Moist	Mid-Range	Dry	Low
E. coli (MPN/100mL)	Cotton Branch (051201111804)	99%	59%	79%	76%	7%
	Tilley Ditch (051201111802)	99%	74%	93%	93%	84%
	Marsh Creek (051201111803)	99%	75%	88%	87%	45%
	Headwaters Maria Creek (051201111801)	89%	--	85%	88%	72%
Total Suspended Solids (mg/L)	Cotton Branch (051201111804)	95%	0%	0%	0%	0%
	Marsh Creek (051201111803)	91%	0%	0%	0%	0%
	Headwaters Maria Creek (051201111801)	92%	0%	0%	0%	0%

Note: -- represents no data collected in the flow regime

Public participation is an important and required component of the TMDL development process. The following public meetings and public comment periods have been held to further develop this project:

- A kickoff public meeting was held in Sullivan, IN on December 10, 2019 to introduce the project and solicit public input. IDEM explained the TMDL process and presented initial information regarding the Maria Creek watershed. Questions were answered from the public, and information was solicited from stakeholders in the area.
- On October 14, 2020, IDEM worked with the Sullivan County Soil and Water Conservation District (SWCD) to host a water monitoring demonstration. The event was at the Emison Mill County Park adjacent to Maria Creek in Bruceville, IN. IDEM staff were on site to explain and/or

give demonstrations on their process for collecting water chemistry, fish (through electrofishing techniques), and macroinvertebrates. Results were discussed for the 2019 and 2020 IDEM sampling of the watershed. The details of the partnership between the Sullivan County SWCD and IDEM were presented as well.

- On February 24, 2021, a notice was posted to the Indiana Register to inform stakeholders of new impairments discovered during the 2019 and 2020 watershed characterization study in the Maria Creek watershed. The notice outlined the findings of the study and listed proposed additions/deletions to the 2022 303(d) List of Impaired Waters. Public comments were solicited through May 25, 2021. IDEM received no comments regarding the notice.
- A virtual draft TMDL public meeting was held for the Maria Creek TMDL project on July 8, 2021. The findings of the TMDL were presented at the meeting, and the public had the opportunity to ask questions and provide information to be included in the final TMDL report. A public comment period was from July 12, 2021 to August 12, 2021. IDEM received no comments regarding the notice.

1.0 INTRODUCTION

This section of the Total Maximum Daily Load (TMDL) provides an overview of the Maria Creek watershed location and the regulatory requirements that have led to the development of this TMDL to address impairments in the Maria Creek watershed.

The Maria Creek watershed TMDL was prioritized to be completed at this time based on local interest from the Sullivan County Soil and Water Conservation District (SWCD) in addressing water quality, IDEM interest in conducting baseline water quality monitoring for local planning, and a competitive Section 319 application from the local partners to develop a watershed management plan in conjunction with the IDEM sampling and TMDL development for streams impaired by *E. coli* and biological communities.

The Maria Creek watershed (HUC 0512011118), shown in Figure 1, is located in southwestern Indiana and drains a total of 97 square miles. The Maria Creek watershed originates in southern Sullivan County and then flows south into Knox County where it ultimately empties into the Wabash River north of Vincennes. Land use throughout the watershed is predominantly agriculture with forested areas being the second most abundant land use type. There are no public water supply intakes in the Maria Creek watershed.

The Clean Water Act (CWA) and U.S. Environmental Protection Agency (U.S. EPA) regulations require that states develop TMDLs for waters on the Section 303(d) List of Impaired Waters. U.S. EPA defines a TMDL as the sum of the individual wasteload allocations (WLA) for point sources and load allocations (LA) for nonpoint sources, and a margin of safety (MOS) that addressed the uncertainty in the analysis.

The overall goals and objectives of the TMDL study for the Maria Creek watershed are to:

- Assess the water quality of the impaired waterbodies and identify key issues associated with the impairments and potential pollutant sources.
- Determine current loads of pollutants to the impaired waterbodies.
- Use the best available science and available data to determine the total maximum daily load the waterbodies can receive while fully supporting the designated use(s) that are impaired.
- If current loads exceed the maximum allowable loads, determine the load reduction that is needed.
- Inform and involve the public throughout the project to ensure that key concerns are addressed and the best available information is used.
- Identify critical flow conditions that watershed stakeholders can use to identify critical areas.
- Recommend activities for purposes of TMDL implementation.
- Submit a final TMDL report to the U.S. EPA for review and approval.

Watershed stakeholders and partners can use the final approved TMDL report to craft a watershed management plan (WMP) that meets both U.S. EPA's nine minimum elements under the CWA Section 319 Nonpoint Source Program, as well as the additional requirements under IDEM's WMP Checklist.

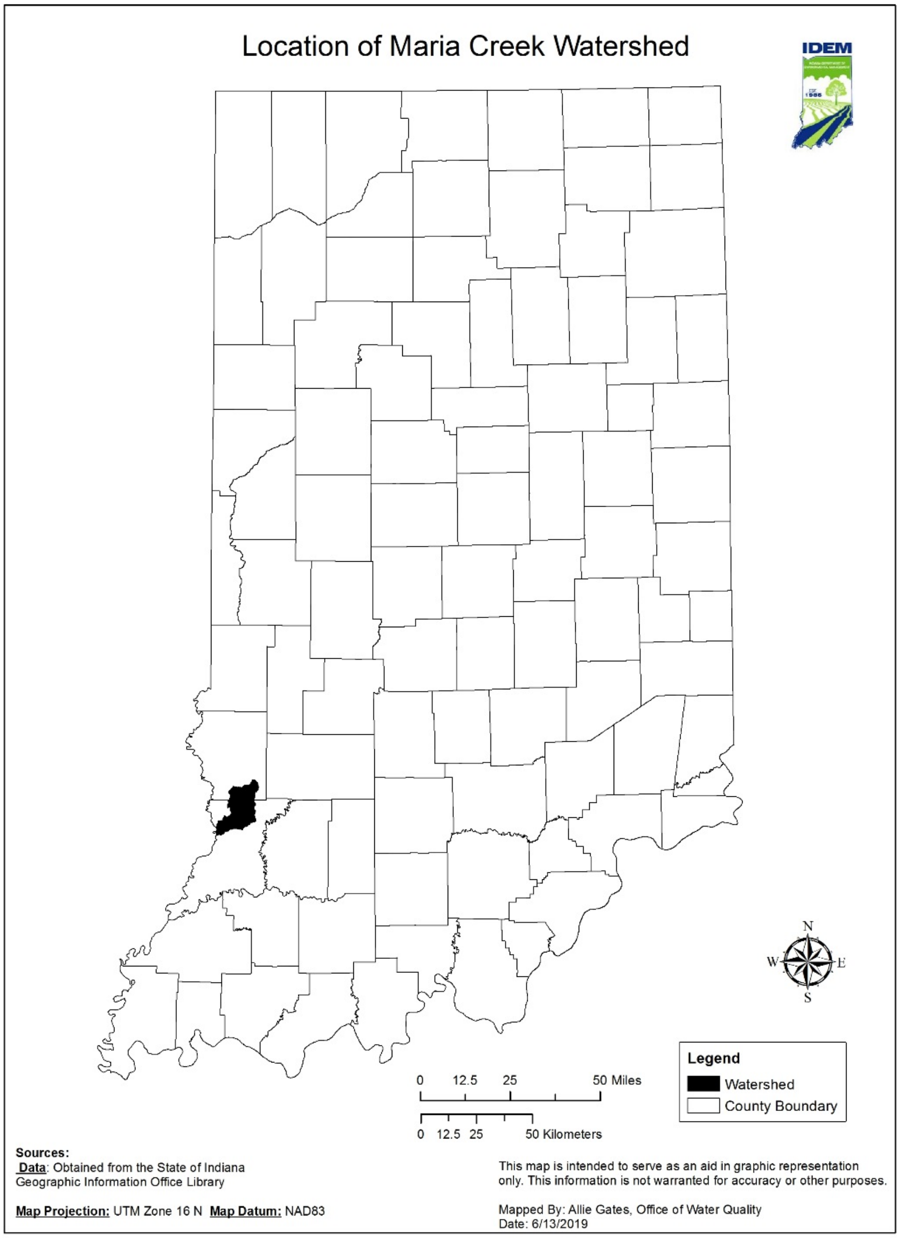

Figure 1: Location of Maria Creek Watershed

1.1 Water Quality Standards

Under the CWA, every state must adopt water quality standards to protect, maintain, and improve the quality of the nation's surface waters. These standards represent a level of water quality that will support the CWA's goal of "swimmable/fishable" waters. Water quality standards consist of three different components:

- **Designated uses** reflect how the water can potentially be used by humans and how well it supports a biological community. Examples of designated uses include aquatic life support, drinking water supply, and full body contact recreation. Every waterbody in Indiana has a designated use or uses; however, not all uses apply to all waters. The Maria Creek watershed TMDLs focus on protecting the designated aquatic life support and full body contact recreational uses of the waterbodies.
- Criteria express the condition of the water that is necessary to support the designated uses. **Numeric criteria** represent the concentration of a pollutant that can be in the water and still protect the designated use of the waterbody. **Narrative criteria** are the general water quality criteria ("free froms…") that apply to all surface waters. Numeric criteria for *E. coli* and narrative criteria for Impaired Biotic Communities (IBC) were used as the basis of the Maria Creek watershed TMDLs.
- **Antidegradation** policies provide protection of existing uses and extra protection for high-quality or unique waters.

The water quality standards in Indiana pertaining to *E. coli* and IBC ("the impairments") are described below.

1.1.1 *E. coli*

E. coli is an indicator of the possible presence of pathogenic organisms (e.g., enterococcal *E. coli*, viruses, and protozoa) which may cause human illness. The direct monitoring of these pathogens is difficult; therefore, *E. coli* is used as an indicator of potential fecal contamination. *E. coli* is a sub-group of fecal coliform, the presence of *E. coli* in a water sample indicates recent fecal contamination is likely. Concentrations are typically reported as the count of organisms in 100 milliliters of water (count/100 mL) or most probable number (MPN/100 mL) and may vary at a particular site depending on the baseline *E. coli* level already in the river, inputs from other sources, dilution due to precipitation events, and die-off or multiplication of the organism within the river water and sediments.

The numeric *E. coli* criteria associated with protecting the recreational use are described below.

> *"The criteria in this subsection are to be used to evaluate waters for full body contact recreational uses, to establish wastewater treatment requirements, and to establish effluent limits during the recreational season, which is defined as the months of April through October, inclusive. E. coli bacteria, shall not exceed one hundred twenty-five (125) per one hundred (100) milliliters as a geometric mean based on not less than five (5) samples equally spaced over a thirty (30) day period nor exceed two hundred thirty-five (235) per one hundred (100) milliliters in any one (1) sample in a thirty (30) day period. . . However, a single sample shall be used for making beach notification and*

closure decisions." [Source: Indiana Administrative Code Title 327 Water Pollution Control Board. Article 2. Section 1-6(a).]

1.1.2 Biological Communities

The water quality regulatory definition of a "well-balanced aquatic community" is *"an aquatic community which is diverse in species composition, contains several different trophic levels, and is not composed mainly of strictly pollution tolerant species"* [327 IAC 2-1-9(49)].

Impaired biotic communities (IBC) is not a source of impairment but a symptom of other sources. To address these impairments in the Maria Creek watershed, TSS has been identified as a pollutant for TMDL development. IDEM has not yet adopted numeric water quality criteria for total suspended solids (TSS). The relevant narrative criteria that apply to the TMDLs presented in this report state the following:

> *"All surface waters at all times and at all places, including waters within the mixing zone, shall meet the minimum conditions of being free from substances, materials, floating debris, oil, or scum attributable to municipal, industrial, agricultural, and other land use practices, or other discharges that do any of the following:" [327 IAC 2-1-6. Sec. 6. (a)(1)]…*
>
> *(a)re in concentrations or combinations that will cause or contribute to the growth of aquatic plants or algae to such degree as to create a nuisance, be unsightly, or otherwise impair the designated uses." [327 IAC 2-1-6. Sec. 6. (a) (1)(D)]*
>
> *(a)re in amounts sufficient to be acutely toxic to, or to otherwise severely injure or kill, aquatic life, other animals, plants, or humans." [327 IAC 2-1-6. Sec. 6. (a) (1)(E)]*

In addition, the narrative biological criterion [327 IAC 2-1-3(2)] states the following:

> *"All waters, except those designated as limited use, will be capable of supporting a well-balanced, warm water aquatic community."*

Biological assessments for streams are based on the sampling and evaluation of either the fish communities, the benthic aquatic macroinvertebrate communities, or both. Indices of Biotic Integrity (IBI) for fish and macroinvertebrate (mIBI) assessment scores, or both, were calculated and compared to regionally calibrated models. In evaluating fish communities, streams rating as "poor" or worse are classified as non-supporting for aquatic life uses. For benthic aquatic macroinvertebrate communities, individual sites are compared to a statewide calibration at the lowest practical level of identification for Indiana. All sites at or above background for the calibration are considered to be supporting aquatic life uses. Those sites rated as moderately or severely impaired in the calibration are considered to be non-supporting. Waters with identified impairments to one or more biological communities are considered not supporting aquatic life use. The biological thresholds Indiana uses to make use attainment decisions are shown in Table 2 to provide greater context for understanding the range of biological conditions that is considered either fully supporting or impaired.

IDEM's aquatic life use assessments are never based solely on habitat evaluations. However, habitat evaluations are used as supporting information in conjunction with biological data to determine aquatic life use support. Such evaluations, which take into consideration a variety of habitat characteristics as well as stream size, help IDEM to determine the extent to which habitat conditions may be influencing the ability of biological communities to thrive. If habitat is determined to be driving a biological community impairment (IBC) and no other pollutants that might be contributing to the impairment have been identified, the IBC may not be considered for inclusion on IDEM's 303(d) List of Impaired Waters (Category 5). In such cases, the waterbody is instead placed in Category 4C for the biological impairment.

Table 2: Maria Creek Watershed Aquatic Life Use Support Criteria for Biological Communities

Biotic Index Score and Associated Assessment Decision	Integrity Class	Corresponding Integrity Class Score	Attributes
Fish community Index of Biotic Integrity (IBI) Scores (Range of possible scores is 0-60)			
Fully Supporting IBI ≥ 36 Indicates Full Support	Excellent	53-60	Comparable to "least impacted" conditions, exceptional assemblage of species
	Good	45-52	Decreased species richness (intolerant species in particular), sensitive species present
	Fair	36-44	Intolerant and sensitive species absent, skewed trophic structure
Not Supporting IBI < 36 Indicates Impairment	Poor	23-35	Many expected species absent or rare, tolerant species dominant
	Very Poor	12-22	At least one species present, tolerant species dominant
	No Organisms	0	No fish captured during sampling.
Benthic aquatic macroinvertebrate community Index of Biotic Integrity (mIBI) Scores Multihabitat MHAB methods (Range of possible scores is 0-60)			
Fully Supporting mIBI ≥ 36 Indicates Full Support	Excellent	53-60	Comparable to "least impacted" conditions, exceptional assemblage of species
	Good	45-52	Decreased species richness (intolerant species in particular), sensitive species present
	Fair	36-44	Intolerant and sensitive species absent, skewed trophic structure
Not Supporting mIBI < 36 Indicates Impairment	Poor	23-35	Many expected species absent or rare, tolerant species dominant
	Very Poor	12-22	At least one species present, tolerant species dominant
	No Organisms	0	No macroinvertebrates captured during sampling.

1.2 Water Quality Targets

Target values are needed for the development of TMDLs because of the need to calculate allowable daily loads. For parameters that have numeric criteria, such as *E. coli*, the target equals the numeric criteria. For parameters that do not have numeric criteria, target values must be identified from some other source. The target values used to develop the Maria Creek watershed TMDL are presented below.

1.2.1 *E. coli* TMDLs

The target value used for the Maria Creek watershed TMDL was based on the 235 counts/100 mL single sample maximum component of the water quality standard (i.e., daily loading capacities were calculated by multiplying flows by 235 counts/100 mL). The U.S. EPA report, "An Approach for Using Load Duration Curves in the Development of TMDLs" describes how the monthly geometric mean (125 counts/100mL) is likely to be met when the single sample maximum value (235 counts/100mL) is used to develop the loading capacity (U.S. EPA, 2007). The process calculates the daily maximum bacteria value that is possible to observe and still attain the monthly geometric mean. If the single sample maximum is set as a never-to-be surpassed value then it becomes the maximum value that can be observed, and all other bacteria values would have to be less than the maximum.

1.2.2 IBC TMDLs

The following section describes the TMDL target value used for TSS when developing IBC TMDLs.

Total Suspended Solids (TSS)

Although Indiana has not yet adopted numeric water quality criteria for TSS, IDEM has identified a target value based on IDEM's NPDES permitting process. A target of 30.0 mg/L for TSS has been identified as a permit limit for NPDES facilities. A target value of 30.0 mg/L TSS was therefore used as the TSS TMDL target value to ensure consistency with IDEM's NPDES permitting process. IDEM has determined that meeting the TSS target will result in achieving the narrative biological criterion by improving water quality and promoting a well-balanced aquatic community.

Various subwatersheds in the Maria Creek watershed have IBC impairments. Biological communities include fish and aquatic invertebrates, such as insects. These in-stream organisms are indicators of the cumulative effects of activities that affect water quality conditions over time. An IBC listing on Indiana's 303(d) List of Impaired Waters means IDEM's monitoring data shows one or both of the aquatic communities are not as healthy as they should be. IBC is not a source of impairment but a symptom of other sources. To address these impairments in the Maria Creek watershed, TSS has been identified as a pollutant for TMDL development.

Table 3 reiterates the TMDL target values presented in this section. These are the target values IDEM uses to assess water quality data collected in the Maria Creek watershed.

Table 3: Target Values Used for Development of the Maria Creek Watershed TMDLs

Parameter	Target Value
Total Suspended Solids	No value should exceed 30.0 mg/L
E. coli	No value should exceed 235 counts/100 mL (single sample maximum)

1.3 Listing Information

1.3.1 Understanding Subwatersheds and Assessment Units

This section presents information concerning IDEM's segmentation process as it applies to the Maria Creek watershed. IDEM identifies the Maria Creek watershed and its tributaries using a watershed numbering system developed by the United States Geological Survey (USGS), Natural Resource Conservation Service (NRCS), and the U.S. Water Resources Council referred to as hydrologic unit codes (HUCs). HUCs are a way of identifying watersheds in a nested arrangement from largest (i.e., those with shorter HUCs) to smallest (i.e., those with longer HUCs) (IDEM, 2010). Figure 2 shows the 12-digit HUCs located in the Maria Creek watershed.

Within each 12-digit HUC subwatershed, IDEM has identified several AUIDs which represent individual stream segments. Through the process of segmenting subwatersheds into AUIDs, IDEM identifies streams reaches and stream networks that are representative for the purposes of assessment. In practice, this process leads to grouping tributary streams into smaller catchment basins of similar hydrology, land use, and other characteristics such that all tributaries within the catchment basin can be expected to have similar potential water quality impacts. Catchment basins, as defined by the aforementioned factors, are typically very small, which significantly reduces the variability in the water quality expected from one stream or stream reach to another. Given this, all tributaries within a catchment basin are assigned a single AUID. Grouping tributary systems into smaller catchment basins also allows for better characterization of the larger watershed and more localized recommendations for implementation activities. Variability within the larger watershed will be accounted for by the differing AUIDs assigned to the different catchment basins.

Table 4 contains the AUIDs in the subwatersheds of the Maria Creek watershed, and Table 9 contains the associated drainage areas. Subsequent sections of the TMDL report organize information by subwatershed (if applicable) and AUID.

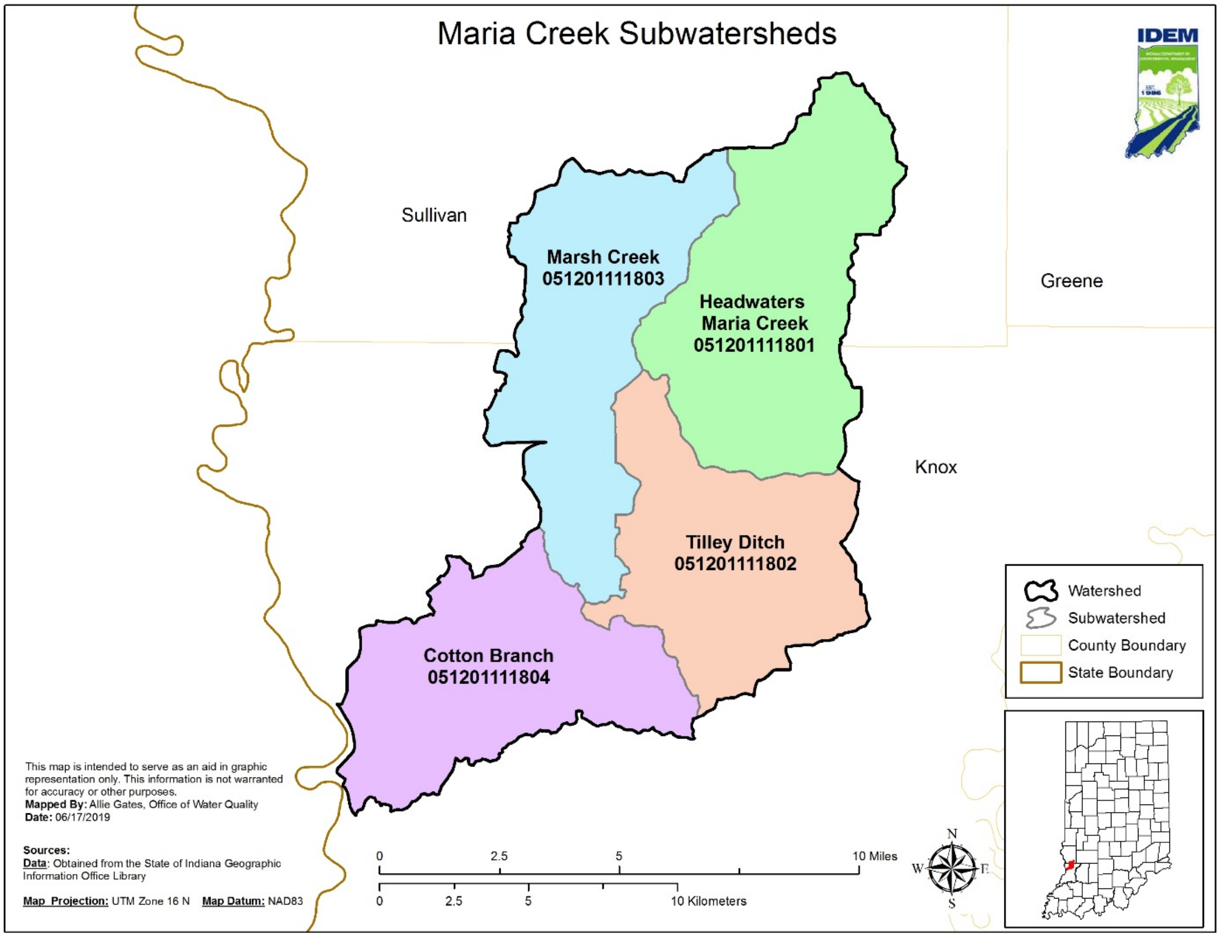

Figure 2: Subwatersheds (12-Digit HUCs) in the Maria Creek Watershed

1.3.2 Understanding 303(d) Listing Information

There are a number of existing impairments in the Maria Creek watershed from the 2020 303(d) List of Impaired Waters. The listings and causes of impairment have been adjusted as a result of reassessment data collected at 18 sampling locations in the watershed. Within the Maria Creek watershed a total of 20 assessment unit IDs (AUIDs) will be cited as impaired for *E. coli*, 5 AUIDs cited as impaired for dissolved oxygen, and 8 AUIDs cited as impaired for biotic communities on Indiana's 2022 303(d) List of Impaired Waters. These impaired segments account for approximately 122 miles. Table 4 presents listing information for the Maria Creek watershed, including a comparison of the updated listings with the 2020 listings and associated causes of impairments addressed by the TMDLs. The reassessment data used in updating the listings for the Maria Creek watershed are available in Appendix D.

Table 4: Section 303(d) List Information for the Maria Creek Watershed for 2020 and 2022

Subwatershed	Current AUID	Length (mi)	2020 Section 303(d) Listed Impairment	Updated Impairments to be Listed 2022 303(d)
Cotton Branch 051201111804	INB11I4_03	5.57		*E. coli*
	INB11I4_T1008	0.59		
	INB11P1117_00	0.13		
	INB11I4_T1007	7.01		
	INB11I4_T1005	3.82		*E. coli*
	INB11I4_T1004	4.05		*E. coli, IBC*
	INB11I4_02	3.19		*E. coli, IBC*
	INB11I4_T1003	2.42		
	INB11I4_T1002	1.62		
	INB11I4_T1001	5.74		*E. coli*
	INB11I4_T1009	1.69		
Tilley Ditch 051201111802	INB11I2_01	8.11	*E. coli*	*E. coli*
	INB11I2_T1004	12.51		
	INB11I2_T1002	5.40		*E. coli, DO*
	INB11I2_T1001	6.70		*E. coli*
Marsh Creek 051201111803	INB11I3_05	4.79		*E. coli, IBC*
	INB11I3_04	7.24		*E. coli, IBC*
	INB11I3_03	8.62		*E. coli*
	INB11I3_T1003	4.02		
	INB11I3_T1002	2.79		*E. coli*
	INB11I3_T1001	2.36		
	INB11I3_02	8.73		*E. coli, IBC, DO*
Headwaters Maria Creek 051201111801	INB11I1_T1005	8.08	*E. coli*	*E. coli, IBC, DO*
	INB11I1_01	17.50	*E. coli, IBC*	*E. coli*
	INB11I1_T1004	6.31	*E. coli*	*E. coli, IBC, DO*
	INB11I1_01A	1.15	*E. coli*	*E. coli*
	INB11I1_T1003	3.33	*E. coli*	*E. coli*
	INB11I1_T1001	5.14	*E. coli, IBC, DO*	*E. coli, IBC, DO*
	INB11I1_T1002	5.37	*E. coli*	*E. coli*

Understanding Table 4:

- Column 1: Subwatershed. Shows the name of the subwatershed at the 12-digit HUC scale. The subwatershed found in this column is the appropriate scale for what the IDEM's WMP Checklist defines as a subwatershed for the purposes of watershed management planning.
- Column 2: Current AUID. Identifies the AUID given to waterbodies within the subwatershed for purposes of the 2022 Section 303(d) listing assessment process.
- Column 3: Length (mi). Provides the length in miles of the associated AUID.
- Column 4: 2020 Section 303(d) Listed Impairment. Identifies the cause of impairment associated with the 2020 Section 303(d) listing.

- Column 5: Updated Impairments to be Listed 2022 303(d). Provides the updated causes of impairment if new data and information are available.

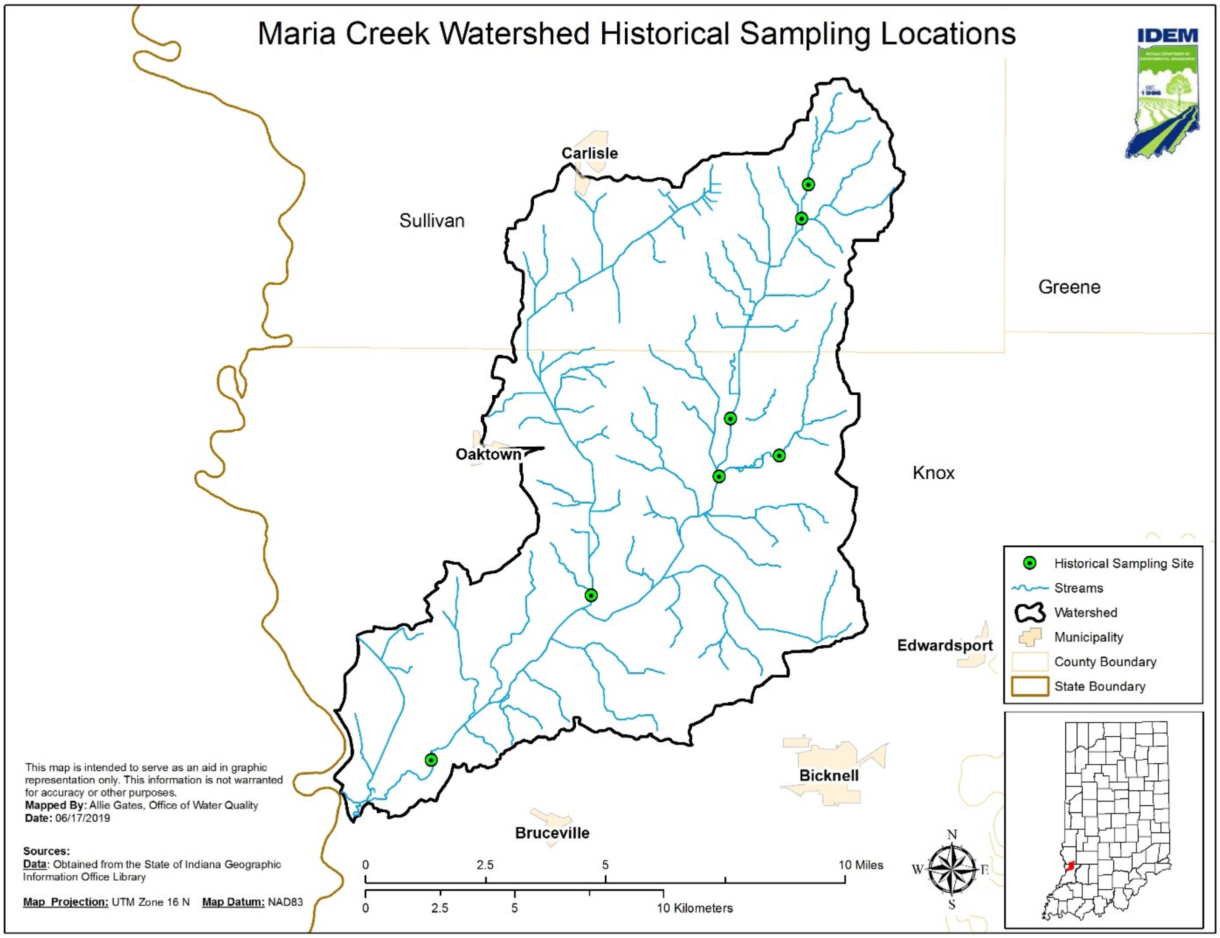

Figure 3: Location of Historical Sampling Sites in the Maria Creek Watershed

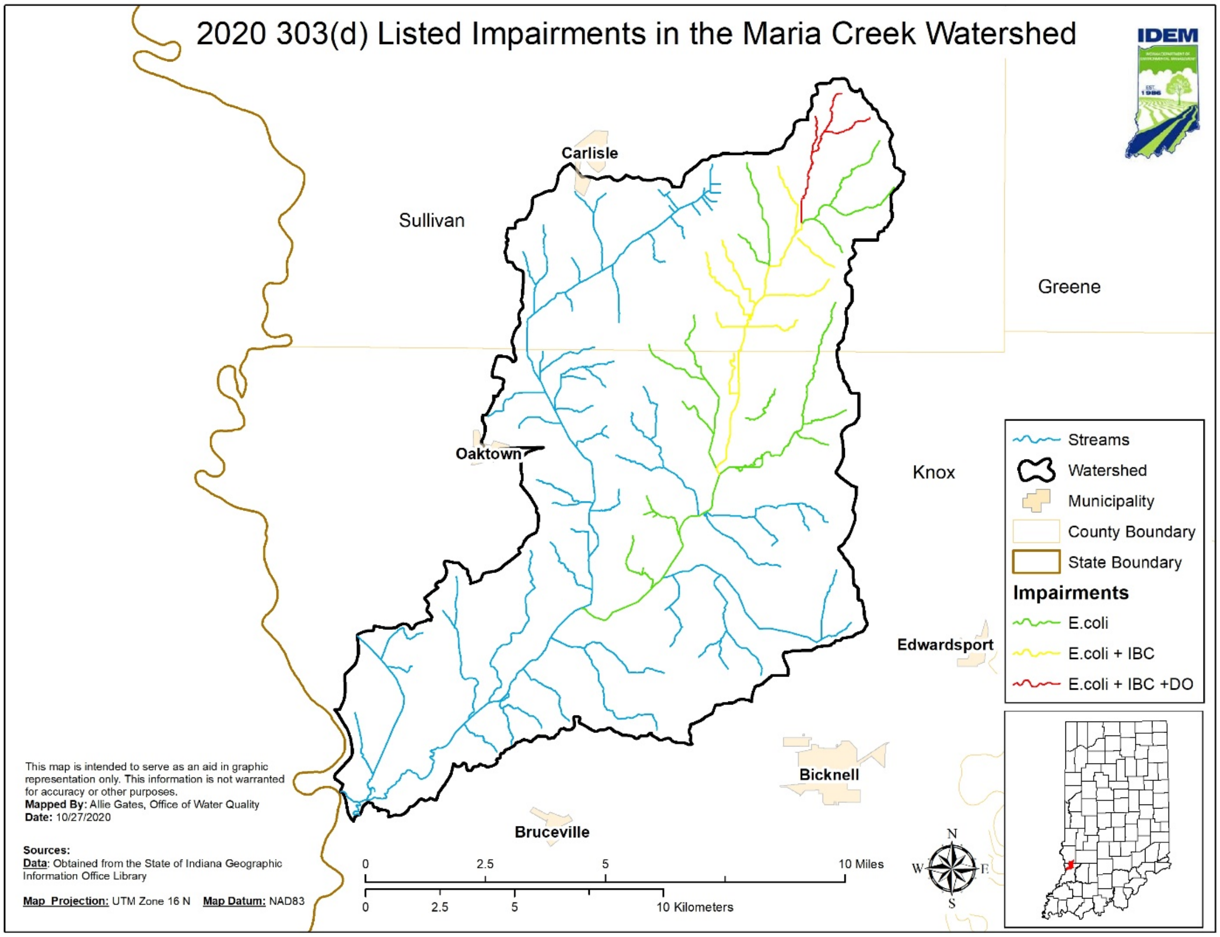

Figure 4: Streams Listed on the 2020 Section 303(d) List in the Maria Creek Watershed

1.4 Water Quality Data

This section of the TMDL report contains a brief characterization of the Maria Creek watershed water quality information that was collected in development of this TMDL. Understanding the natural and human factors affecting the watershed will assist in selecting and tailoring appropriate and feasible implementation activities to achieve water quality standards.

1.4.1 Water Quality Data

Data collected by IDEM from November 2019 through October 2020 were used for the TMDL analysis. Seventeen sites were sampled for pathogens, water chemistry, and biological data and one site was sampled for biological data only in the Maria Creek watershed. Table 5 and Figure 5 show the sampling site locations and information. Table 6 summarizes the pathogen data, and Table 7 summarizes the water chemistry data within the Maria Creek watershed in addition to the maximum concentrations at all impaired stations along with the reduction needed to meet the TMDL.

The percent reductions were calculated as follows:

$$\% \text{ Reduction} = \frac{(\text{Observed Concentration} - \text{Target Value or WQS})}{\text{Observed Concentration}} \text{ x } 100$$

Appendix A shows the individual sample results and summaries of all the water quality data for all 18 monitoring stations.

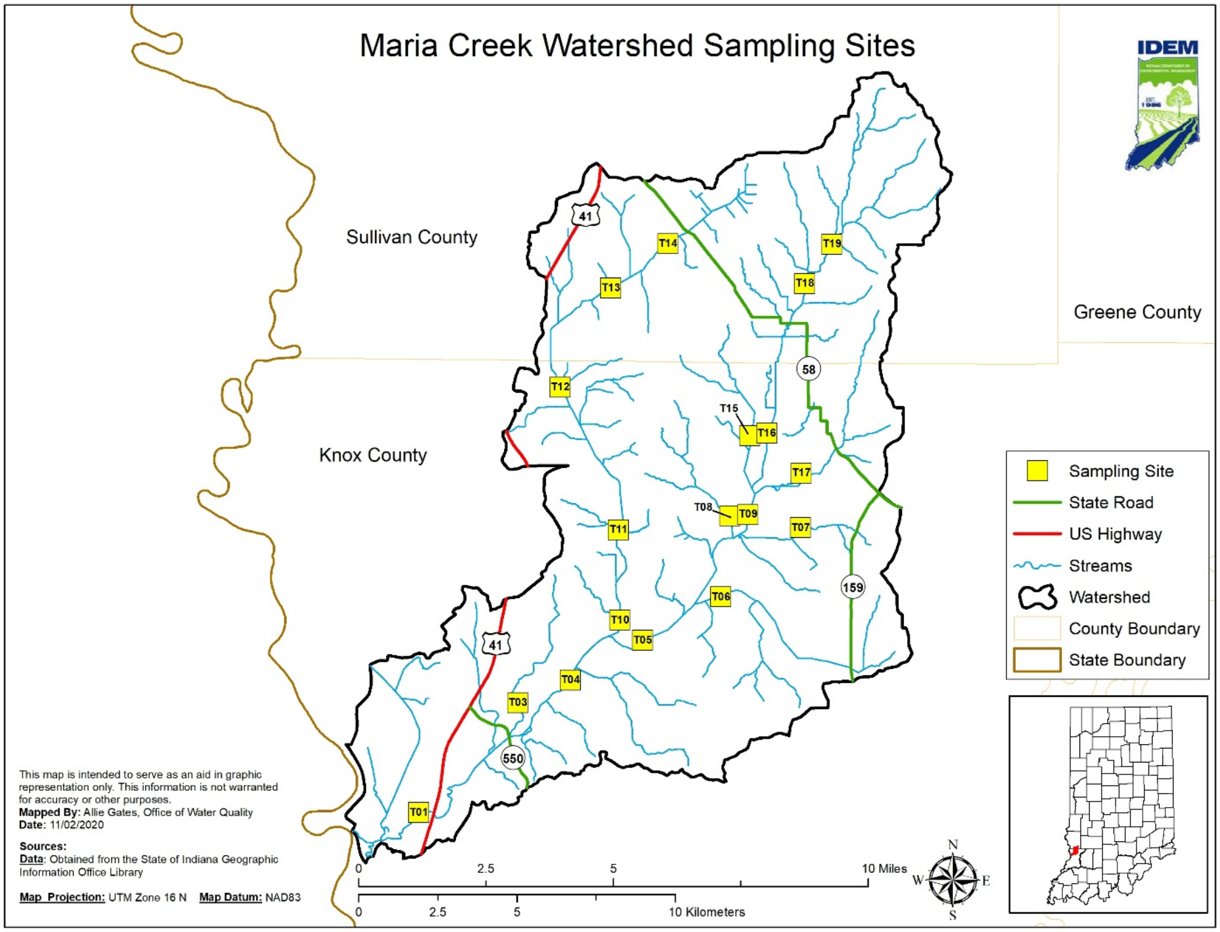

Figure 5: 2019 – 2020 Sampling Locations for the Maria Creek TMDL Watershed Characterization

Table 5: Maria Creek Sampling Site Information

Site #	EPA Site ID	IDEM Station ID	Stream Name	Road Name	AUID
T01	20T-001	WBU-18-0004	Maria Creek	N Old 41	INB11I4_03
T03	20T-003	WBU-18-0006	Cotton Branch	E Springtown Rd	INB11I4_T1004
T04	20T-004	WBU-18-0007	Maria Creek	N Perry Rd	INB11I4_02
T05	20T-005	WBU-18-0008	Maria Creek	N Risley Rd	INB11I2_01
T06	20T-006	WBU-18-0009	Tilley Ditch	E Pepmeir Rd	INB11I2_T1004
T07	20T-007	WBU-18-0010	Tributary of Maria Creek	CR 700 E (Lane Rd)	INB11I2_T1001
T08	20T-008	WBU-18-0011	Tributary of Maria Creek	CR 900 N (E Lower Freelandville Rd)	INB11I2_T1002
T09	20T-009	WBU-18-0013	Maria Creek	CR 900 N (E Lower Freelandville Rd)	INB11I2_01
T10	20T-010	WBU190-0001	Marsh Creek	CR 500 NE (E Springtown Rd)	INB11I3_05
T11	20T-011	WBU-18-0012	Marsh Creek	E Hunley Rd	INB11I3_04
T12	20T-012	WBU-18-0015	Marsh Creek	E Moody Rd	INB11I3_03
T13	20T-013	WBU-18-0016	Marsh Creek	CR 50 E	INB11I3_03
T14	20T-014	WBU-18-0017	Marsh Creek	CR 5 SE	INB11I3_02
T15	20T-015	WBU-18-0014	Tributary of Maria Creek	Freelandville Rd	INB11I1_T1004
T16	20T-016	WBU190-0002	Maria Creek	CR 1050 N (Freelandville Rd)	INB11I1_01
T17	20T-017	WBU-18-0018	Tributary of Maria Creek	CR 700 E (Lane Rd)	INB11I1_T1005
T18	20T-018	WBU-18-0019	Maria Creek	CR 1050 S	INB11I1_01
T19	20T-019	WBU-18-0020	Maria Creek	CR 975 S	INB11I1_01

Understanding Table 5:

- Column 1: Site #. Lists the site number that corresponds to the site location in Figure 5.
- Column 2: EPA Site ID. Provides the U.S. EPA assigned site number.
- Column 3: IDEM Station ID. Provides the IDEM assigned site number.
- Column 4: Stream Name. Identifies the stream name that the site is located on.
- Column 5: Road Name. Identifies the road name that the site is located on.
- Column 6: AUID. Identifies the AUID given to waterbodies within the 12-digit HUC subwatershed for purposes of the 2022 Section 303(d) listing assessment process.

1.4.2 *E. coli* Data

Table 6: Summary of Pathogen Data in the Maria Creek Watershed

Subwatershed	Site #	IDEM Station ID	AUID	Period of Record	Total Number of Samples	Percent of Samples Exceeding *E. coli* WQS (#/100 mL)		Geomean (#/100 mL)	*E. coli* Percent Reduction Based on Geomean (125/100mL)	Single Sample Maximum (SSM) (#/100 mL)	*E. coli* Percent Reduction Based on SSM (#/100 mL)
						125	235				
Cotton Branch	T01	WBU-18-0004	INB11I4_03	6/16/20-10/14/20	8	75	50	482.71	74.1	9,870	97.6
	T03	WBU-18-0006	INB11I4_T1004	6/16/20-10/14/20	8	100	87.5	887.3	86.0	11,780	98.0
	T04	WBU-18-0007	INB11I4_02	6/16/20-10/14/20	8	37.5	12.5	306.63	59.2	64,880	99.6
Tilley Ditch	T05	WBU-18-0008	INB11I2_01	6/16/20-10/14/20	8	87.5	62.5	734.99	83.0	36,540	99.4
	T06	WBU-18-0009	INB11I2_T1004	6/15/20-10/13/20	8	50	25	98.57	0	435.2	46.0
	T07	WBU-18-0010	INB11I2_T1001	6/15/20-8/4/20	6	100	100	1,710.68	92.7	>2,419.6	90.3
	T08	WBU-18-0011	INB11I2_T1002	6/15/20-10/13/20	8	100	87.5	1,237.53	89.9	>2,419.6	90.3
	T09	WBU-18-0013	INB11I2_01	6/15/20-10/13/20	8	37.5	37.5	166.32	24.8	1,046.2	77.5
Marsh Creek	T10	WBU190-0001	INB11I3_05	6/16/20-10/14/20	8	75	50	425.09	70.6	5,810	96.0
	T11	WBU-18-0012	INB11I3_04	6/16/20-10/14/20	8	75	75	499.26	75.0	12,230	98.1
	T12	WBU-18-0015	INB11I3_03	6/16/20-10/14/20	8	100	75	2,200.89	94.3	48,840	99.5
	T13	WBU-18-0016	INB11I3_03	6/16/20-10/14/20	8	87.5	50	439.81	71.6	24,810	99.1
	T14	WBU-18-0017	INB11I3_02	6/16/20-8/5/20	6	100	66.67	1,209.73	89.7	36,540	99.4
Headwaters Maria Creek	T15	WBU-18-0014	INB11I1_T1004	6/15/20-8/4/20	6	50	50	165.58	24.5	>2,419.6	90.3

Subwatershed	Site #	IDEM Station ID	AUID	Period of Record	Total Number of Samples	Percent of Samples Exceeding *E. coli* WQS (#/100 mL)		Geomean (#/100 mL)	*E. coli* Percent Reduction Based on Geomean (125/100mL)	Single Sample Maximum (SSM) (#/100 mL)	*E. coli* Percent Reduction Based on SSM (#/100 mL)
						125	**235**				
	T16	WBU190-0002	INB11I1_01	6/15/20-10/13/20	8	62.5	25	283.88	56.0	686.7	65.8
	T17	WBU-18-0018	INB11I1_T1005	6/15/20-10/13/20	8	100	100	727.95	82.8	1,553.1	84.9
	T18	WBU-18-0019	INB11I1_01	6/15/20-10/13/20	8	87.5	75	359.17	65.2	579.4	59.4

Understanding Table 6: Pathogen data for the Maria Creek watershed indicated the following:

- Reductions of 99 percent or greater are needed to meet the TMDL target values for *E. coli* in Cotton Branch.
- Reductions of 99 percent or greater are needed to meet the TMDL target values for *E. coli* in Tilley Ditch.
- Reductions of 99 percent or greater are needed to meet the TMDL target values for *E. coli* in Marsh Creek.
- Reductions of 90 percent or greater are needed to meet the TMDL target values for *E. coli* in Headwaters Maria Creek.

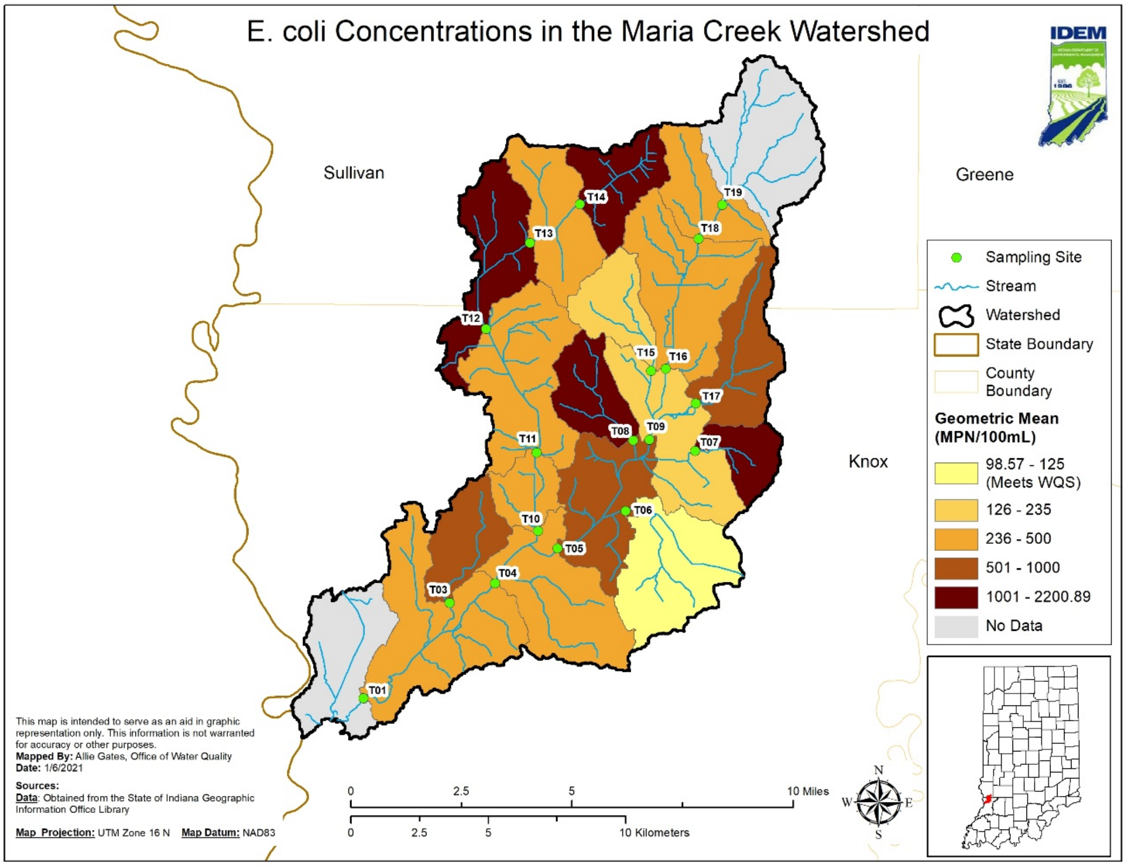

Figure 6: *E.coli* concentrations based on 5-week geometric mean (MPN/100 mL) and sampling site drainage areas for 2019 and 2020. Values over 125 MPN/100 mL are not meeting the water quality standard for *E.coli*.

1.4.3 Water Chemistry Data

Table 7: Summary of Chemistry Data in Maria Creek Watershed for Total Suspended Solids

Subwatershed	Site #	IDEM Station ID	AUID	Total Suspended Solids Single Sample Maximum (mg/L)	Total Suspended Solids Percent Reduction
Cotton Branch	T01	WBU-18-0004	INB11I4_03	690	95.7
	T03	WBU-18-0006	INB11I4_T1004	13	0
	T04	WBU-18-0007	INB11I4_02	480	93.8
Tilley Ditch	T05	WBU-18-0008	INB11I2_01	420	92.9
	T06	WBU-18-0009	INB11I2_T1004	13	0
	T07	WBU-18-0010	INB11I2_T1001	14	0
	T08	WBU-18-0011	INB11I2_T1002	44	31.8
	T09	WBU-18-0013	INB11I2_01	370	91.9
Marsh Creek	T10	WBU190-0001	INB11I3_05	370	91.9
	T11	WBU-18-0012	INB11I3_04	6.5	0
	T12	WBU-18-0015	INB11I3_03	14	0
	T13	WBU-18-0016	INB11I3_03	11	0
	T14	WBU-18-0017	INB11I3_02	23	0
Headwaters Maria Creek	T15	WBU-18-0014	INB11I1_T1004	13	0
	T16	WBU190-0002	INB11I1_01	400	92.5
	T17	WBU-18-0018	INB11I1_T1005	24	0
	T18	WBU-18-0019	INB11I1_01	12	0

*Understanding Table 7**:** Water chemistry data for the Maria Creek watershed indicated the following:*

- Reductions of 96 percent or greater are needed to meet the TMDL target values for TSS in Cotton Branch.
- Reductions of 93 percent or greater are needed to meet the TMDL target values for TSS in Tilley Ditch.
- Reductions of 92 percent or greater are needed to meet the TMDL target values for TSS in Marsh Creek.
- Reductions of 93 percent or greater are needed to meet the TMDL target values for TSS in Headwaters Maria Creek.

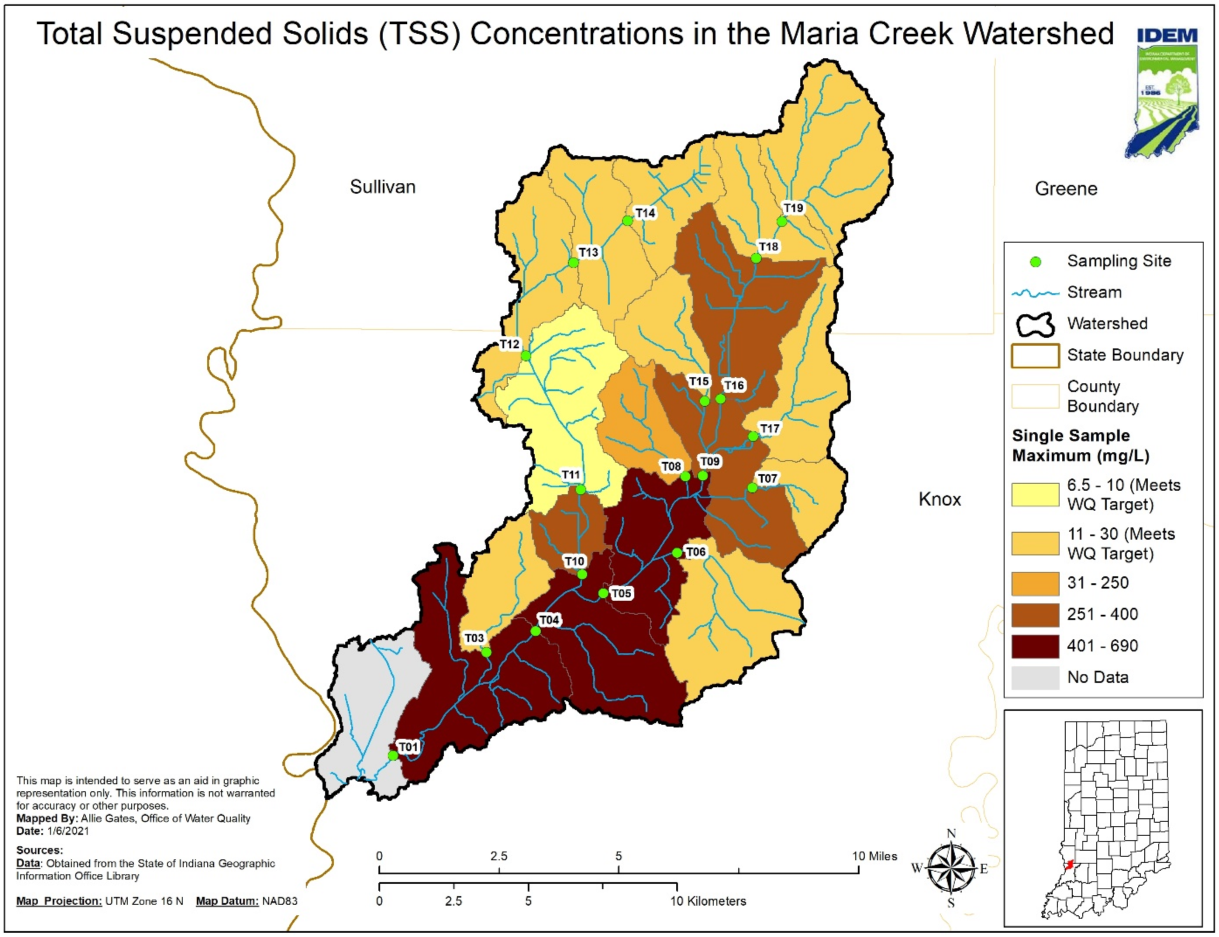

Figure 7: Total suspended solids concentrations based on single sample maximum concentration (mg/L) and sampling site drainage areas for 2019-2020. Values over 30 mg/L are not meeting the water quality target value for TSS.

1.4.4 Biological Data

Sampling performed by IDEM in June, July, and August 2020 documented widespread biological impairments in the Maria Creek watershed as summarized in Table 8. Fish community sampling took place at 18 sample sites in the Maria Creek watershed. Sampling data indicate that the overall biological integrity of the Maria Creek watershed was fair. Sampling resulted in 7 of the 18 sites failing established criteria for aquatic life support for fish and/or macroinvertebrates.

Through the TMDL efforts, IDEM has identified TSS as a potential reason for the widespread impairments. TSS can reduce plants available for consumption by inhibiting growth of submerged aquatic plants, lower dissolved oxygen levels by reducing light penetration which impairs algal growth, impair the ability of fish to see and catch food, increase stream temperature, clog fish gills which may decrease disease resistance, slow growth rates, and prevent the development of eggs and larvae. Attaining the TSS target value shown in Table 3 will address the causes of IBC impairments.

Table 8: Impaired Biotic Community Stream Segments in the Maria Creek Watershed Identified During June/July 2020 Sampling

Subwatershed	Stream Name	Site #	IDEM Station ID	Score	Integrity Class	QHEI	Score	Integrity Class	QHEI
				mIBI	mIBI	mIBI	IBI	IBI	IBI
Cotton Branch	Maria Creek	T01	WBU-18-0004	38	Fair	55	48	Good	66
	Cotton Branch	T03	WBU-18-0006	34	Poor	63	42	Fair	65
	Maria Creek	T04	WBU-18-0007	48	Good	28	16	Very Poor	30
Tilley Ditch	Maria Creek	T05	WBU-18-0008	42	Fair	30	42	Fair	32
	Tilley Ditch	T06	WBU-18-0009	36	Fair	42	42	Fair	38
	Tributary of Maria Creek	T07	WBU-18-0010	36	Fair	29	40	Fair	46
	Tributary of Maria Creek	T08	WBU-18-0011	38	Fair	34	44	Fair	33
	Maria Creek	T09	WBU-18-0013	36	Fair	33	46	Good	43
Marsh Creek	Marsh Creek	T10	WBU190-0001	44	Fair	35	20	Very Poor	38
	Marsh Creek	T11	WBU-18-0012	42	Fair	43	20	Very Poor	45
	Marsh Creek	T12	WBU-18-0015	46	Fair	25	44	Fair	37
	Marsh Creek	T13	WBU-18-0016	40	Fair	37	42	Fair	50
	Marsh Creek	T14	WBU-18-0017	-	-	-	20	Very Poor	33
Headwaters Maria Creek	Tributary of Maria Creek	T15	WBU-18-0014	32	Poor	24	20	Very Poor	37
	Maria Creek	T16	WBU190-0002	48	Good	38	34	Poor	52
	Tributary of Maria Creek	T17	WBU-18-0018	42	Fair	44	34	Poor	41
	Maria Creek	T18	WBU-18-0019	40	Fair	45	40	Fair	45
	Maria Creek	T19	WBU-18-0020	42	Fair	64	48	Good	58

Notes: IBI = Index of Biotic Integrity for fish community, mIBI = Index of Biotic Integrity for macroinvertebrate community, QHEI = Qualitative Habitat Evaluation Index. Scores were calculated using IDEM's Procedures for Completing the Qualitative Habitat Evaluation Index Technical Standard Operating Procedure (IDEM, 2019).

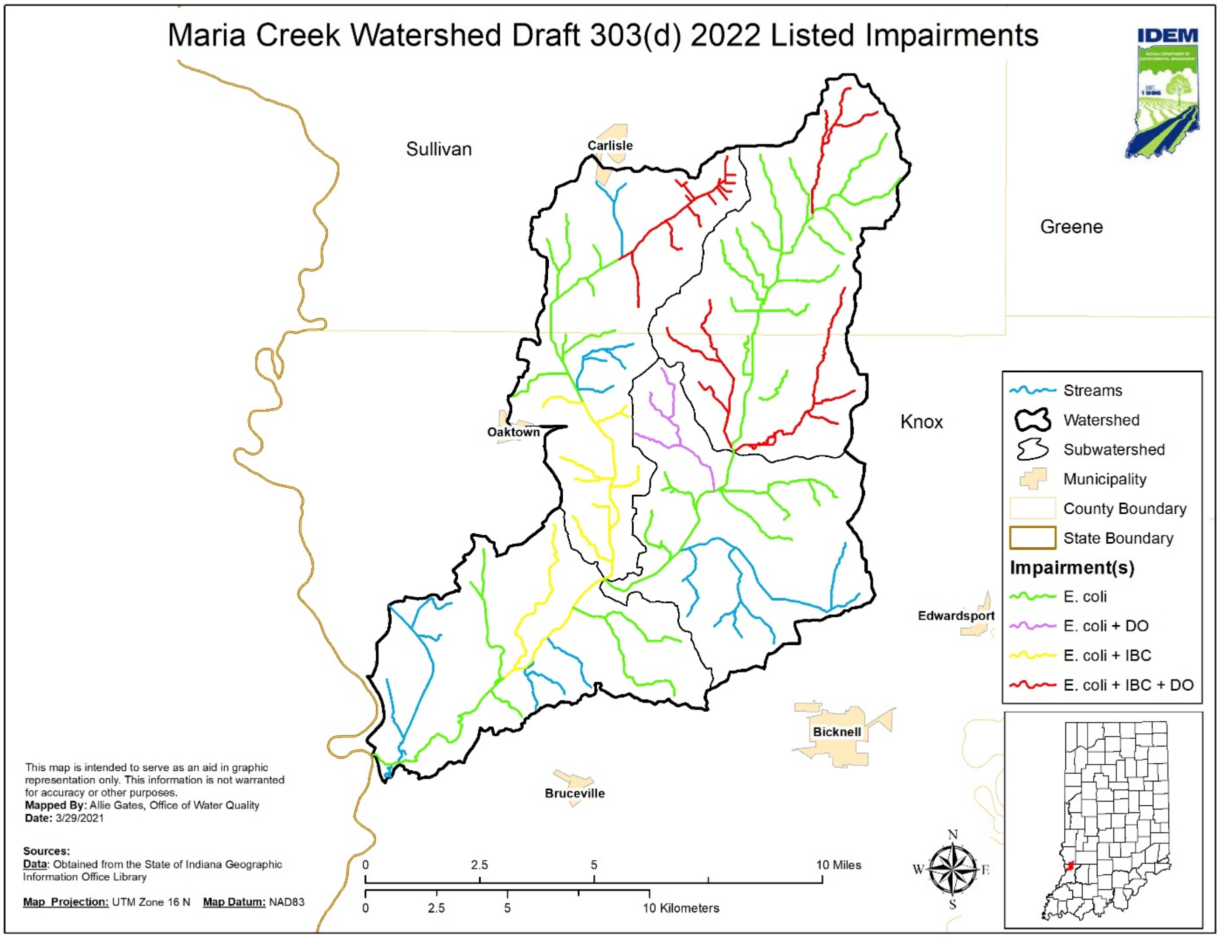

Figure 8: Streams to be listed on the Draft 2022 Section 303(d) List of Impaired Waters in the Maria Creek Watershed

2.0 DESCRIPTION OF THE WATERSHED AND SOURCE ASSESSMENT

This section of the TMDL report contains a brief characterization of the Maria Creek watershed to provide a better understanding of the historic and current conditions of the watershed that affect water quality and contribute to the impairments. Understanding the natural and human factors affecting the watershed will assist in selecting and tailoring appropriate and feasible implementation activities to achieve water quality standards.

As discussed in Section 1.3, the Maria Creek watershed contains four 12-digit HUC subwatersheds. Examining subwatersheds enables a closer examination of key factors that affect water quality. The subwatersheds include:

- Cotton Branch (051201111804)
- Tilley Ditch (051201111802)
- Marsh Creek (051201111803)
- Headwaters Maria Creek (051201111801)

The following table contains the names of the four subwatersheds of the Maria Creek watershed and their associated drainage area.

Table 9: Maria Creek Subwatershed Drainage Areas

Subwatershed	12-digit HUC	Area Within Watershed (sq. miles)	Percent of Watershed Area	Drainage Area (sq miles)	Percent of Total Drainage Area
Cotton Branch	0512021111804	23.22	24.05%	96.55	100.00%
Tilley Ditch	051201111802	22.17	22.96%	49.51	51.28%
Marsh Creek	051201111803	23.82	24.67%	23.82	24.67%
Headwaters Maria Creek	051201111801	27.34	28.32%	27.34	28.32%

Understanding Table 9: Land area helps IDEM to define the pollutant load reductions needed for each AU in each 12-digit HUC subwatershed that comprises the Maria Creek watershed. Information in each column is as follows:

- Column 1: Subwatershed. Lists the name of the subwatersheds.
- Column 2: 12-digit HUC. Identifies the subwatershed's 12-digit HUC.
- Column 3: Area Within Watershed. Provides the area of each subwatershed within the overall watershed in square miles.
- Column 4: Percent of Watershed Area. Indicates the percent of land area of each subwatershed, providing a relative understanding of the portions of each subwatershed compared to the overall Maria Creek watershed.
- Column 5: Drainage Area. Quantifies the area the specific subwatershed drains in square miles.

- Column 6: Percent of Total Drainage Area. Indicates the percent of the total drainage area, providing a relative understanding of the portion of the subwatershed in the overall Maria Creek watershed.

IDEM bases load calculations on the drainage area for each of the 12-digit HUC subwatersheds. The information contained in this table is the foundation for the technical calculations found in Section 3.0. This table will help watershed stakeholders look at the smaller subwatersheds within the Maria Creek watershed and understand the smaller areas contributing to the impaired waterbody, helping to quantify the geographic scale that influences source characterization and areas for implementation.

The term “point source” refers to any discernible, confined and discrete conveyance, such as a pipe, ditch, channel, tunnel or conduit, by which pollutants are transported to a waterbody. It also includes vessels or other floating craft from which pollutants are or may be discharged. By law, the term “point source” also includes: confined feeding operations (which are places where animals are confined and fed); and illicitly connected “straight pipe” discharges of household waste. Permitted point sources are regulated through the National Pollutant Discharge Elimination System (NPDES).

Nonpoint sources include all other categories not classified as point sources. In urban areas, nonpoint sources can include leaking or faulty septic systems, run-off from lawn fertilizer applications, pet waste and other sources. In rural areas, nonpoint sources can include run-off from cropland, pastures, and animal feeding operations and inputs from streambank erosion, leaking, failing or straight-piped septic systems, and wildlife.

2.1 Land Use

Land use patterns provide important clues to the potential sources of impairments in a watershed. Land use information for the Maria Creek watershed is available from the National Agricultural Statistics Service (NASS) cropland data layer. These data categorize the land use for each 30 meters by 30 meters parcel of land in the watershed based on satellite imagery from circa 2018. Figure 9 displays the spatial distribution of the land uses and the data are summarized in Table 10. Additionally, Table 11 displays the breakdown of land uses within each of the four subwatersheds.

Land use in the Maria Creek watershed is primarily agriculture, comprising 73 percent of the Maria Creek watershed. Corn and soybean crops are not typically associated with high *E. coli* loads, unless they have been fertilized with manure. Approximately 14 percent of the land is forest. Pasture/hay represents 5 percent of the watershed and could indicate the presence of animal feedlots which can be significant sources of *E. coli,* TSS, and/or nutrients. The remaining land categories represent less than 10 percent of the total land area.

The Maria Creek watershed has a diverse network of streams. Tributaries include Beaver Ditch, Cotton Branch, Tilley Ditch, and Marsh Creek among others. There are few urban areas within the watershed. The Town of Carlisle extends into the northern portion of the watershed, and the Town of Oaktown exists at the western extent of the watershed. In addition, Freelandville, an unincorporated community, is located at the eastern extent of the watershed. Forested areas are primarily limited to the southwestern portion of the watershed surrounding Maria Creek. Water generally flows in a southwesterly direction to

Maria Creek where it eventually departs the Maria Creek watershed and discharges into the Wabash River.

Many threatened and endangered species call this watershed home. Various fish species, such as the Greater Redhorse (*Moxostoma valenciennesi*), Western Sand Darter (*Ammocrypta clara*), and Gilt Darter (*Percina evides*) can be found in Sullivan and Knox counties and are dependent upon the health of the aquatic system (IDNR, 2020). Additional information on state endangered, threatened and rare species can be found on the DNR website (https://www.in.gov/dnr/nature-preserves/heritage-data-center/endangered-plant-and-species/county/).

Table 10: Land Use of the Maria Creek Watershed

Land Use	Watershed		
	Area		Percent
	Acres	Square Miles	
Agricultural Land	45,097.67	70.47	72.9
Developed Land	3,893.02	6.08	6.3
Forested Land	8,883.56	13.88	14.4
Hay/Pasture	3,248.30	5.08	5.2
Open Water	645.17	1.01	1.0
Shrub/Scrub	2.89	<1	<1
Wetlands	64.49	0.10	0.1
Total	61,835.11	96.62	100%

Understanding Table 10: The predominant land use types in the Maria Creek watershed can indicate potential sources of E. coli and TSS loadings. Different types of land uses are characterized by different types of hydrology. For example, developed lands are characterized by impervious surfaces that increase the potential of stormwater events during high flow periods delivering E. coli and TSS to downstream streams and rivers. Forested land and wetlands allow water to infiltrate slowly, thus reducing the risks of polluted water to running off into waterbodies. In addition to differences in hydrology, land use types are associated with different types of activities that could contribute pollutants to the watershed. Understanding types of land uses will help identify the type of implementation approaches that watershed stakeholders can use to achieve E. coli and TSS load reductions.

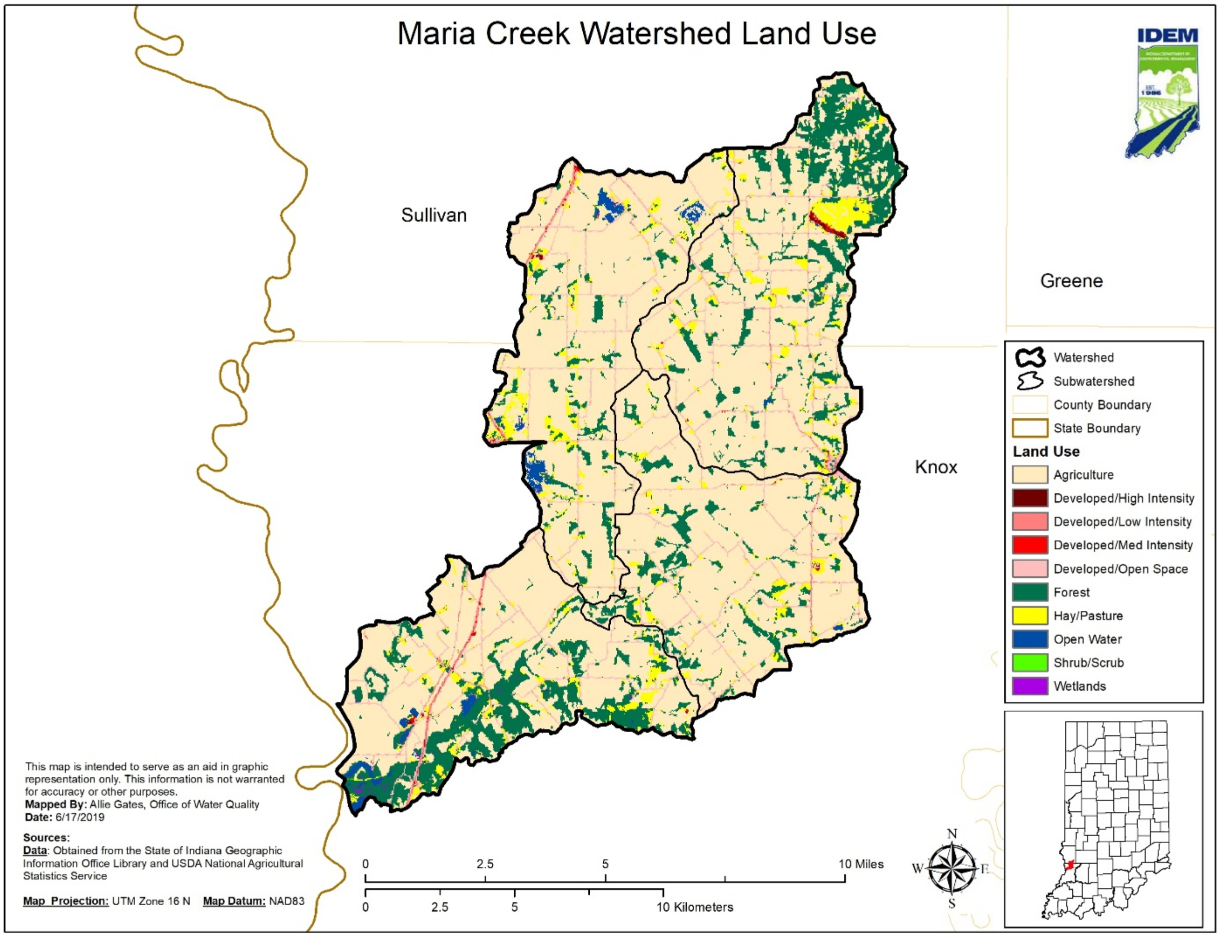

Figure 9: Land Use in the Maria Creek Watershed

Table 11: Land Use in the Maria Creek Subwatersheds

Subwatershed	Area	Land Use							Total
		Agriculture	Developed	Forest	Hay/ Pasture	Open Water	Shrub/ Scrub	Wetlands	
Cotton Branch (051201111804)	Acres	9,560	1,047	3,251	761	248	1	42	14,911
	Sq. Mi.	14.94	1.64	5.08	1.19	0.39	0.00	0.07	23.30
	Percent	64%	7%	22%	5%	2%	0%	0%	100%
Tilley Ditch (051201111802)	Acres	11,473	800	1,365	540	14	0	2	14,194
	Sq. Mi.	17.93	1.25	2.13	0.84	0.02	0.00	0.00	22.18
	Percent	81%	6%	10%	4%	0%	0%	0%	100%
Marsh Creek (051201111803)	Acres	12,113	942	944	897	352	1	9	15,258
	Sq. Mi.	18.93	1.47	1.47	1.40	0.55	0.00	0.01	23.84
	Percent	79%	6%	6%	6%	2%	0%	0%	100%
Headwaters Maria Creek (051201111801)	Acres	11,999	1,097	3,327	1,053	32	0	10	17,519
	Sq. Mi.	18.75	1.71	5.20	1.64	0.05	0.00	0.02	27.37
	Percent	68%	6%	19%	6%	0%	0%	0%	100%

2.1.1 Cropland

Croplands can be a source of *E. coli* and sediments. Accumulation of *E. coli* on cropland occurs from fertilization with manure fertilizers, wildlife excreta, irrigation water, and application of waste products from municipal and industrial wastewater treatment facilities. Data available from the National Agricultural Statistic Service (NASS) were downloaded to estimate crop acreage in the subwatersheds. The 2018 NASS statistics were used in the analysis as shown in Table 12 and displayed in Figure 10 (USDA, 2018).

Table 12: Major Cash Crop Acreage in the Maria Creek Watershed

Subwatershed	Crop	Total Acreage	% of Subwatershed Cash Crop Acreage
Cotton Branch (051201111804)	Corn	3,364	35%
	Winter Wheat/Soybeans (Double Crop)	605	6%
	Soybeans	5,373	57%
	Watermelons	130	2%
	Total	9,472	100%
Tilley Ditch (051201111802)	Corn	5,663	49%
	Winter Wheat/Soybeans (Double Crop)	1	<1%
	Soybeans	5,790	51%
	Watermelons	17	<1%
	Total	11,471	100%
Marsh Creek (051201111803)	Corn	5,723	48%
	Winter Wheat/Soybeans (Double Crop)	125	1%
	Soybeans	6,162	51%
	Watermelons	50	<1%
	Total	12,060	100%
Headwaters Maria Creek (051201111801)	Corn	5,398	45%
	Winter Wheat/Soybeans (Double Crop)	29	<1%
	Soybeans	6,556	55%
	Watermelons	4	<1%
	Total	11,987	100%

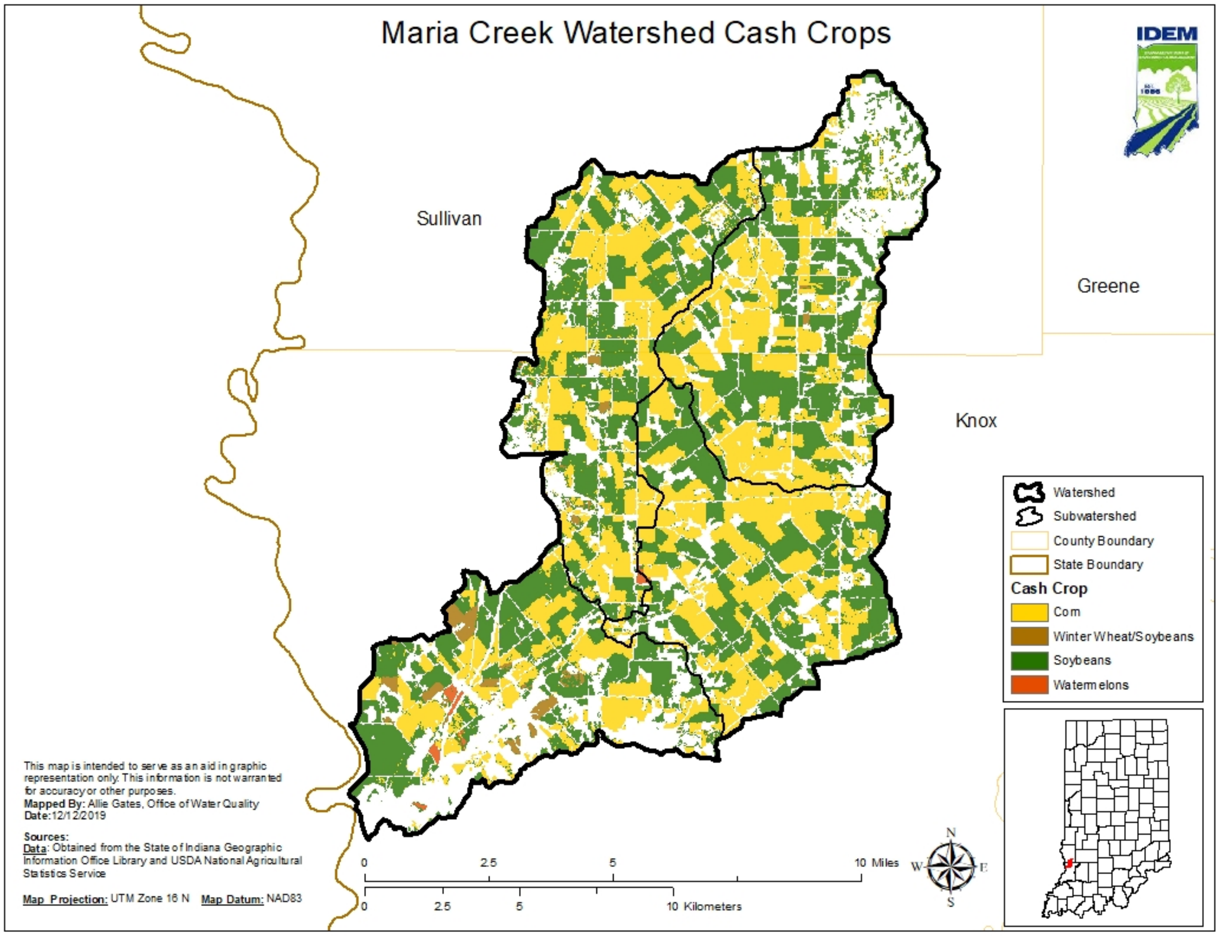

Figure 10: Cash Crop Acreage in the Maria Creek Watershed

2.1.2 Hay/Pastureland

Run-off from pastures and livestock operations can be potential agricultural sources of *E. coli* and sediments. For example, animals grazing in pasturelands deposit manure directly upon the land surface and, even though a pasture may be relatively large and animal densities low, the manure will often be concentrated near the feeding and watering areas in the field. These areas can quickly become barren of plant cover, increasing the possibility of erosion and contaminated run-off during a storm event.

Livestock are a potential source of *E. coli* and TSS to streams, particularly when direct access is not restricted and/or where feeding structures are located adjacent to riparian areas. Watershed specific data are not available for livestock populations. The amount of hay/pasture land across the landscape can be used to as an indicator for potential areas of higher densities from livestock. Information on permitted livestock facilities within the Maria Creek watershed are presented in Figure 11 and Table 13.

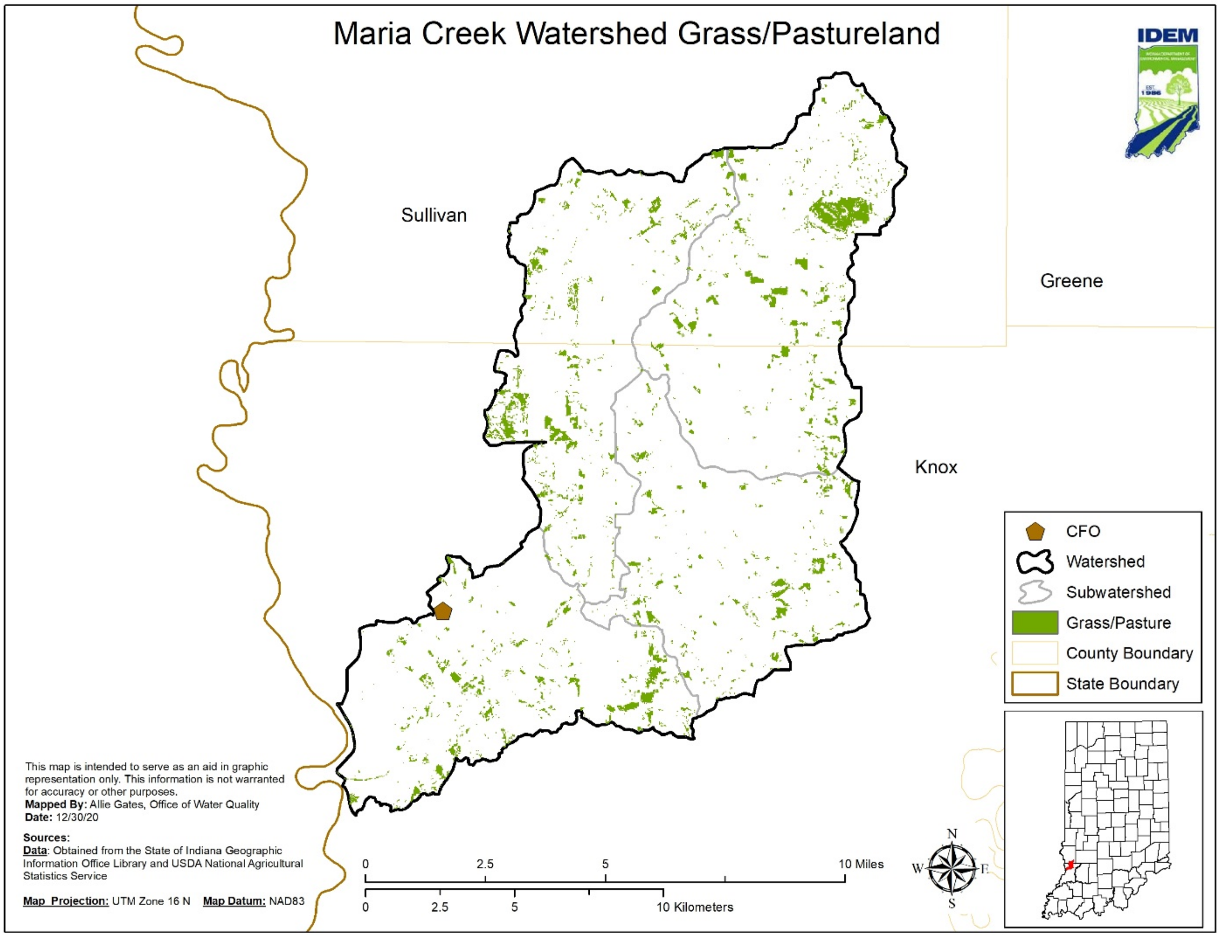

Figure 11: Grassland and Pastureland in the Maria Creek Watershed with CFO Locations

2.1.3 Confined Feeding Operations (CFOs) and Animal Feeding Operations (AFOs)

A CFO is an agricultural operation where animals are kept and raised in confined situations. It is a lot or facility (other than an aquatic animal production facility) where the following conditions are met:

- Animals have been, are, or will be stabled or confined and fed or maintained for a total of 45 days or more in any 12-month period.
- Crops, vegetation, forage growth, or post-harvest residues are not sustained in the normal growing season over 50 percent of the lot or facility.
- The number of animals present meets the requirements for the state permitting action.

Feeding operations that are not classified as concentrated animal feeding operations (CAFOs) are known as confined feeding operations (CFOs) in Indiana. There are currently no CAFOs in the Maria Creek watershed. Non-CAFO animal feeding operations identified as CFOs by IDEM are considered nonpoint sources by U.S. EPA. Indiana's CFOs have state issued permits and are therefore categorized as nonpoint sources for the purposes of this TMDL. CFO permits are "no discharge" permits. Therefore, it is prohibited for these facilities to discharge to any water of the State.

The CFO regulations (327 IAC 19, 327 IAC 15-16) require that operations “not cause or contribute to an impairment of surface waters of the state.” IDEM regulates these confined feeding operations under IC 13-18-10, the Confined Feeding Control Law. The rules at 327 IAC 19, which implement the statute regulating confined feeding operations, were effective on July 1, 2012. The rule at 327 IAC 15-16, which regulates CAFOs and incorporates by reference the federal NPDES CAFO regulations, became effective on July 1, 2012. It should be noted that there are currently no facilities in Indiana that have an NPDES permit under 15-16.

The animals raised in CFOs produce manure that is stored in pits, lagoons, tanks, and other storage devices. The manure can then be applied to area fields as fertilizer. CFO owners can either apply manure to land they own or market and sell manure to other landowners per regulations outline in 327 IAC 19-14. When stored and applied properly, this beneficial re-use of manure provides a natural source for crop nutrition. It also lessens the need for fuel and other natural resources that are used in the production of fertilizer.

However, CFOs can also be a potential source of *E. coli* due to the following:

- Improper application of manure can contaminate surface or groundwater.
- Manure over application or improper application can adversely impact soil productivity.

There are several AFOs and one permitted CFO in the Maria Creek watershed, as shown below in Table 13 and in Figure 11. Manure used for land application in the Maria Creek watershed may also originate from AFOs and CFOs in adjacent watersheds.

Table 13**:** CFOs in the Maria Creek Watershed

Subwatershed	Farm ID	Operation Name	County	Animal Type and Permitted Number
Cotton Branch	6164	Grant & Dawn Earley Farms	Knox	Turkeys: 36,000

2.2 Topography and Geology

Topographic and geologic features of a watershed play a role in defining a watershed’s drainage pattern. Figure 12 below displays the topography of the watershed. Information concerning the topography and geology within the Maria Creek watershed is available from the Indiana Geologic and Water Survey (IGWS). The Maria Creek watershed originates in Sullivan County and travels southwest through Knox County, eventually discharging into the Wabash River. The Maria Creek watershed is located in the Southern Hills and Lowlands physiographic region which is characterized by knolls and ridges with gorges and ridges to the south. It is unique in Indiana by not having been covered by glacial till.

The entire bedrock surface of Indiana consists of sedimentary rocks. The major kinds of sedimentary rock in Indiana include limestone, dolomite, shale, sandstone, and siltstone. The northern two-thirds of Indiana are composed of glacial deposits containing groundwater. These glacial aquifers exist where sand and gravel bodies are present within clay-rich glacial till (sediment deposited by ice) or in alluvial, coastal, and glacial outwash deposits. Groundwater availability is much different in the southern unglaciated part of Indiana. There are few unconsolidated deposits above the bedrock surface, and the voids in bedrock (other than karst dissolution features) are seldom sufficiently interconnected to yield useful amounts of groundwater. Reservoirs in the state, such as Monroe Lake and Patoka Lake, are used for water supply in lieu of water wells in southern Indiana. The IGWS website contains information about the geology of Indiana (http://igws.indiana.edu/Groundwater/).

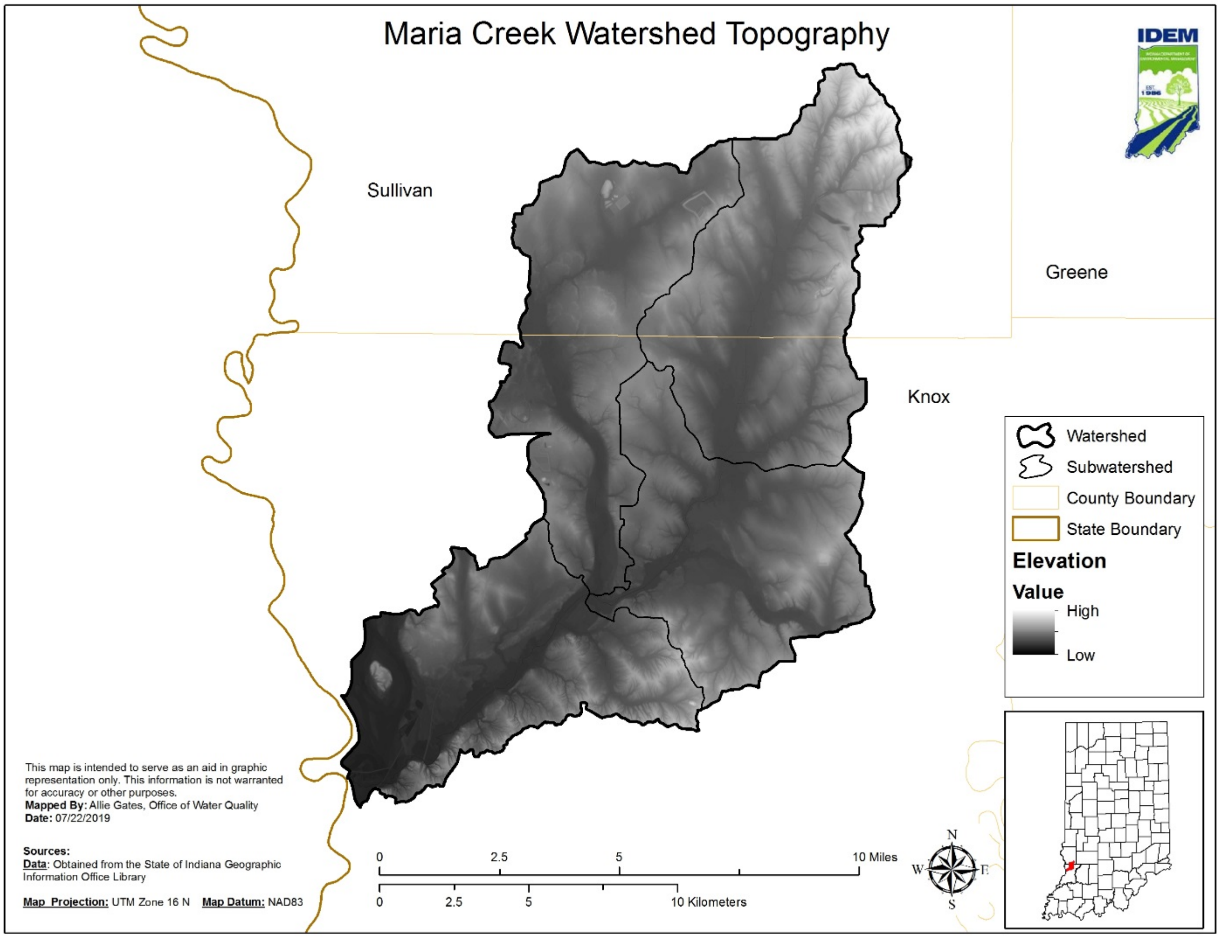

Figure 12: Topography of the Maria Creek Watershed. Digital Elevation Data (DEM) was taken from the State of Indiana's Geographic Information Office (GIO).

2.2.1 Karst Geology

Karst regions are characterized by the presence of limestone or other soluble rocks, where drainage has been largely diverted into subsurface routes. The topography of such areas is dominated by sinkholes, sinking streams, large springs, and caves. No karst features are currently mapped within the Maria Creek watershed. While the State of Indiana has performed dye-tracing studies in southern Indiana, none have been performed within the Maria Creek watershed (Flemming et al., 1995).

The Indiana Karst Conservancy is a 501(c)(3) non-profit organization dedicated to the preservation and conservation of Indiana's unique karst features. Unfortunately, many karst features are subject to incompatible or damaging uses. Most are on private land, occasionally with owners unware of their significance or apathetic to their preservation. The IKC provides protection and awareness of karst features and the unique habitat they provide. For more information regarding the IKC, visit their website at http://www.ikc.caves.org/.

2.3 Soils

There are different soil characteristics that can affect the health of the watershed. Some of these characteristics include soil drainage, septic tank suitability, soil saturation, and soil erodibility.

2.3.1 Soil Drainage

The hydrologic soil group classification is a means for categorizing soils by similar infiltration and run-off characteristics during periods of prolonged wetting. The NRCS has defined four hydrologic groups for soils, described in Table 14 (USDA, 2009). Data for the Maria Creek watershed were obtained from the USDA Soil Survey Geographic (SSURGO) database. Downloaded data were summarized based on the major hydrologic group in the surface layers of the map unit and are displayed below in Figure 13 and Table 15.

The majority of the watershed is covered by category D soils (56%) followed by category B soils (18%), category A soils (17%), and category C soils (9%). Category D soils have a high run-off potential when thoroughly wet, which indicates that flooding in this watershed is likely and could transport pollutants across the landscape.

Of the soils identified as category D, 63% are specified as dual hydrologic group B/D, and 33% are specified as dual hydrologic group C/D. Dual hydrologic groups are identified for certain wet soils that can be adequately drained. The first letter applies to the drained condition, and the second letter applies to the undrained, natural condition. Due to the watershed scale of this report, soils with dual hydrologic groups are classified as category D. However, a site-specific study should consider whether the site has been drained when soils with a dual hydrologic group are present.

Table 14: Hydrologic Soil Groups

Hydrologic Soils Group	Description
A	Soils with high infiltrations rates. Usually deep, well drained sands or gravels. Little run-off.
B	Soils with moderate infiltration rates. Usually moderately deep, moderately well drained soils.
C	Soils with slow infiltration rates. Soils with finer textures and slow water movement.
D	Soils with very slow infiltration rates. Soils with high clay content and poor drainage. High amounts of run-off.

Understanding Table 14: Typically, clay soils that are poorly drained have lower infiltration rates, while well-drained sandy soils have the greatest infiltration rates. Soil infiltration rates can affect pollutant loading within a watershed. During high flows, areas with low soil infiltration capacity can flood and therefore discharge high pollutant loads to nearby waterways. In contrast, soils with high infiltration rates can slow the movement of pollutants to streams.

Table 15: Hydrologic Soil Groups in the Maria Creek Subwatersheds

Subwatershed	Hydrologic Soil Group			
	A	B	C	D
Cotton Branch	38.2%	23.8%	1.8%	36.3%
Tilley Ditch	12.0%	21.4%	5.7%	60.9%
Marsh Creek	21.0%	8.6%	7.1%	63.3%
Headwaters Maria Creek	1.1%	16.0%	15.5%	67.5%

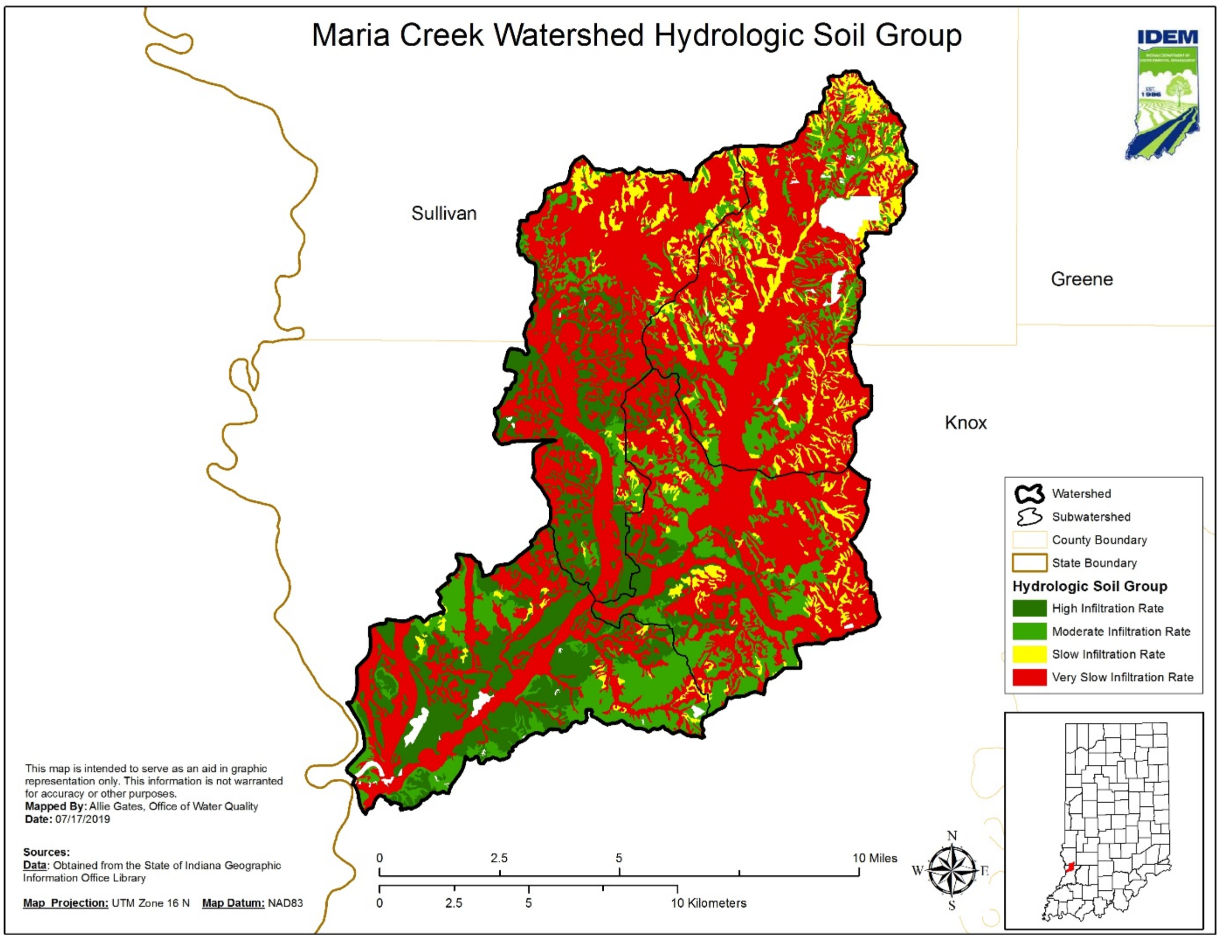

Figure 13: Hydrologic Soil Groups in the Maria Creek Watershed

2.3.2 Septic Tank Absorption Field Suitability

Septic systems require soil characteristics and geology that allow gradual seepage of wastewater into the surrounding soils. Seasonal high water tables, shallow compact till, and coarse soils present limitations for septic systems. Heavy clay soils require larger (and therefore more expensive) absorption fields; while sandier, well-drained soils are often suitable for smaller, more affordable gravity-flow trench systems. Hydrologic soil group A and B soils have good infiltration rates and have less risk for failing septic systems due to this factor. Group C and D soils have slow infiltration rates with finer textures and slow water movement. Figure 13 illustrates the hydrologic soil groups for the Maria Creek subwatersheds.

While system design can often overcome these limitations (i.e., perimeter drains, mound systems or pressure distribution), sometimes the soil characteristics prove to be unsuitable for any type of traditional septic system. Common soil type limitations which contribute to septic system failure are seasonal water tables, compact glacial till, bedrock, coarse sand and gravel outwash, and fragipan. When these septic systems fail hydraulically (surface breakouts) or hydrogeological (inadequate soil filtration), there can be adverse effects to surface waters due to *E. coli* and nutrients (Horsley and Witten, 1996). Refer to Section 2.6.1 for additional information regarding septic systems within the Maria Creek watershed.

Figure 14 shows ratings that indicate the extent to which the soils are suitable for septic systems within the Maria Creek watershed. Only that part of the soil between depths of 24 and 60 inches is evaluated for septic system suitability. The ratings are based on the soil properties that affect absorption of the effluent, construction, maintenance of the system, and public health.

Soils labeled "very limited" indicate that the soil has at least one feature that is unfavorable for septic systems. Approximately 85 percent of the Maria Creek watershed is considered "very limited" in terms of soil suitability for septic systems. These limitations generally cannot be overcome without major soil reclamation or expensive installation designs. Less than one percent of the soils within the Maria Creek watershed are "not rated," meaning these soils have not been assigned a rating class because it is not industry standard to install a septic system in these geographic locations. Approximately 15 percent of the soils in the Maria Creek watershed are designated "somewhat limited," meaning that the soil type is suitable for septic systems.

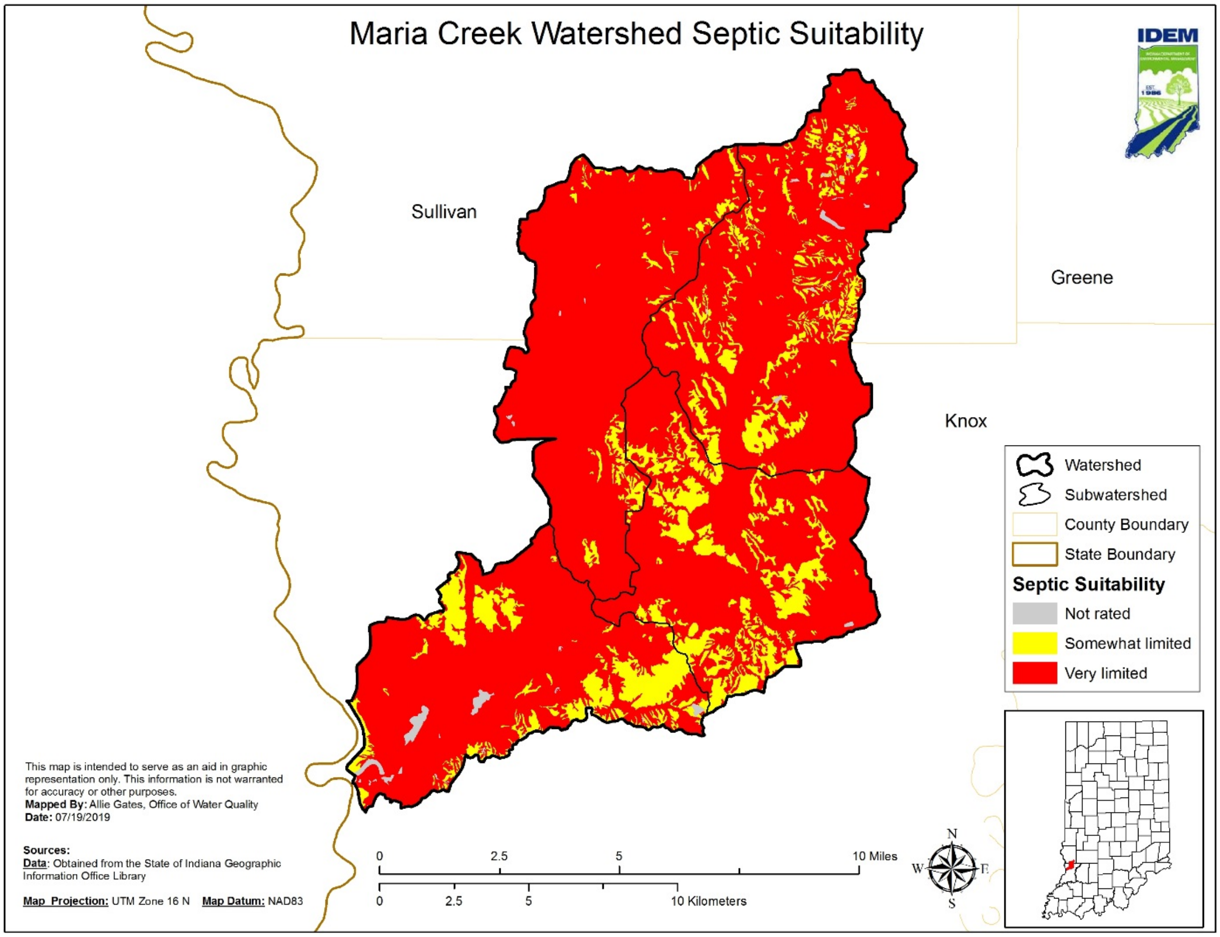

Figure 14: Suitability of Soils for Septic Systems in the Maria Creek Watershed

2.3.3 Soil Saturation and Wetlands

Soils that remain saturated or inundated with water for a sufficient length of time become hydric through a series of chemical, physical, and biological processes. Once a soil takes on hydric characteristics, it retains those characteristics even after the soil is drained. Hydric soils have been identified in the Maria Creek watershed and are important in consideration of wetland restoration activities. Approximately 48,286 acres or 78 percent of the Maria Creek watershed area contains soils that are hydric or have hydric inclusions. Table 16 includes a list of each map unit within the Maria Creek watershed with a hydric rating greater than 0. Hydric ratings indicate the percentage of the map unit that meets the criteria for hydric soils. For example, map units with a hydric rating of 6 or less likely have small areas of hydric soils, and map units with a hydric rating of 95 or more have more significant coverage of hydric soils. Figure 15 displays the hydric ratings for each map unit within the Maria Creek watershed. The Marsh Creek subwatershed appears to have the most significant hydric soil coverage in the watershed. However, a large majority of the soils in the watershed have been drained for either agricultural production or urban development and would no longer support a wetland. The location of remaining hydric soils can be used to consider possible locations of wetland creation or enhancement. There are many components in addition to soil type that must be considered before moving forward with wetland design and creation.

Table 16: Hydric Ratings for Map Units with Hydric Soils in the Maria Creek Watershed

Subwatershed	Map Symbol	Map Unit Name	Hydric Rating	Map Unit Acreage
Cotton Branch	AdB	Ade loamy fine sand, 2 to 6 percent slopes	3	28
	AnD	Alvin fine sandy loam, 12 to 18 percent slopes	3	549
	AnB	Alvin fine sandy loam, 12 to 18 percent slopes	3	2,016
	AnC	Alvin fine sandy loam, 6 to 12 percent slopes	3	837
	Ar	Armiesburg silty clay loam, rarely flooded	3	172
	Ay	Ayrshire fine sandy loam	3	768
	Bd	Birds silt loam, rarely flooded	100	117
	BlD	Bloomfield loamy fine sand, 12 to 18 percent slopes	3	87
	BlB	Bloomfield loamy fine sand, 2 to 10 percent slopes	3	1,323
	ChC	Chelsea loamy fine sand, 4 to 10 percent slopes	3	75
	ClF	Chetwynd loam, 25 to 50 percent slopes	3	9
	EkA	Elkinsville silt loam, 0 to 2 percent slopes	3	10
	ElA	Elston sandy loam, 0 to 3 percent slopes	3	279
	Hb	Haymond silt loam, rarely flooded	3	5
	Hc	Haymond variant loamy sand, frequently flooded	2	5
	HeA	Henshaw silt loam, 0 to 2 percent slopes	3	16
	IvA	Iva silt loam, 0 to 2 percent slopes	5	5
	Kn	Kings silty clay	100	233
	Lo	Lomax loam, rarely flooded	2	70
	Ly	Lyles fine sandy loam	100	611
	No	Nolin silty clay loam, rarely flooded	2	57
	Pb	Patton silt loam	100	191
	Po	Petrolia silty clay loam, frequently flooded	100	835
	Ra	Ragsdale silt loam	100	388
	ReA	Reesville silt loam, 0 to 2 percent slopes	5	50
	Sc	Selma clay loam	100	362
	Sa	Selma loam	100	390
	SdA	Stockland sandy loam, 0 to 2 percent slopes	3	194
	Vn	Vincennes loam	100	182
	Wa	Wakeland silt loam, 0 to 2 percent slopes, frequently flooded	5	1,070

Subwatershed	Map Symbol	Map Unit Name	Hydric Rating	Map Unit Acreage
	Zp	Zipp silty clay, 0 to 2 percent slopes	95	134
	Zt	Zipp silty clay, frequently flooded	100	108
			Total Acreage:	**11,175**
Tilley Ditch	AnD	Alvin fine sandy loam, 12 to 18 percent slopes	**3**	101
	AnB	Alvin fine sandy loam, 2 to 6 percent slopes	3	1,272
	AnC	Alvin fine sandy loam, 6 to 12 percent slopes	3	391
	Ay	Ayrshire fine sandy loam	3	1,095
	Bd	Birds silt loam, rarely flooded	100	331
	BlD	Bloomfield loamy fine sand, 12 to 18 percent slopes	3	34
	BlB	Bloomfield loamy fine sand, 2 to 10 percent slopes	3	334
	ChC	Chelsea loamy fine sand, 4 to 10 percent slopes	3	10
	EkA	Elkinsville silt loam, 0 to 2 percent slopes	3	193
	HeA	Henshaw silt loam, 0 to 2 percent slopes	3	104
	IvA	Iva silt loam, 0 to 2 percent slopes	5	331
	Kn	Kings silty clay	100	46
	Ly	Lyles fine sandy loam	100	560
	Pb	Patton silt loam	100	1,083
	Ra	Ragsdale silt loam	100	1,174
	ReA	Reesville silt loam, 0 to 2 percent slopes	5	1,687
	Vn	Vincennes loam	100	64
	Wa	Wakeland silt loam, 0 to 2 percent slopes, frequently flooded	5	2,464
	Zp	Zipp silty clay, 0 to 2 percent slopes	95	279
			Total Acreage:	**11,552**
Marsh Creek	AnD	Alvin fine sandy loam, 12 to 18 percent slopes	3	249
	AnB	Alvin fine sandy loam, 2 to 6 percent slopes	3	1,693
	AnC	Alvin fine sandy loam, 6 to 12 percent slopes	3	430
	Ay	Ayrshire fine sandy loam	3	1,996
	AsA	Ayrshire fine sandy loam, 0 to 2 percent slopes	3	852
	AsB	Ayrshire fine sandy loam, 2 to 4 percent slopes	3	137
	AyA	Ayrshire loam, 0 to 2 percent slopes	3	37
	BlD	Bloomfield loamy fine sand, 12 to 18 percent slopes	3	22

Subwatershed	Map Symbol	Map Unit Name	Hydric Rating	Map Unit Acreage
	BlB	Bloomfield loamy fine sand, 2 to 10 percent slopes	3	775
	Kn	Kings silty clay	100	121
	Ly	Lyles fine sandy loam	100	1,498
	Ly	Lyles loam	100	657
	Pb	Patton silt loam	100	7
	Pc	Patton silty clay loam	100	508
	PrD2	Princeton fine sandy loam, 12 to 18 percent slopes, eroded	3	3
	PrB2	Princeton fine sandy loam, 2 to 6 percent slopes, eroded	3	445
	PrC2	Princeton fine sandy loam, 6 to 12 percent slopes, eroded	3	63
	Ra	Ragsdale silt loam	100	2,017
	ReA	Reesville silt loam, 0 to 2 percent slopes	5	2,157
	ReB2	Reesville silt loam, 2 to 5 percent slopes, eroded	5	283
	Rm	Rensselaer loam	100	314
	Sa	Selma loam	100	185
	Vo	Vincennes clay loam, gravelly substratum	100	3
	Vn	Vincennes loam	100	18
	Wa	Wakeland silt loam, 0 to 2 percent slopes, frequently flooded	5	621
	Zp	Zipp silty clay, 0 to 2 percent slopes	95	42
			Total Acreage:	**15,134**
Headwaters Maria Creek	AnB	Alvin fine sandy loam, 2 to 6 percent slopes	**3**	132
	AnC	Alvin fine sandy loam, 6 to 12 percent slopes	3	63
	Ay	Ayrshire fine sandy loam	3	689
	AsA	Ayrshire fine sandy loam, 0 to 2 percent slopes	3	97
	AsB	Ayrshire fine sandy loam, 2 to 4 percent slopes	3	8
	Bd	Birds silt loam, rarely flooded	100	210
	BlD	Bloomfield loamy fine sand, 12 to 18 percent slopes	3	3
	BlB	Bloomfield loamy fine sand, 2 to 10 percent slopes	3	13
	EkA	Elkinsville silt loam, 0 to 2 percent slopes	3	2
	Ha	Haymond silt loam, frequently flooded	6	8
	IvA	Iva silt loam, 0 to 2 percent slopes	5	1,213
	IvB2	Iva silt loam, 2 to 4 percent slopes, eroded	3	315

Subwatershed	Map Symbol	Map Unit Name	Hydric Rating	Map Unit Acreage
	Ly	Lyles fine sandy loam	100	115
	Ly	Lyles loam	100	16
	Pb	Patton silt loam	100	645
	PrB2	Princeton fine sandy loam, 2 to 6 percent slopes, eroded	3	26
	PrC2	Princeton fine sandy loam, 6 to 12 percent slopes, eroded	3	16
	Ra	Ragsdale silt loam	100	823
	ReA	Reesville silt loam, 0 to 2 percent slopes	5	2,531
	ReB2	Reesville silt loam, 2 to 5 percent slopes, eroded	5	342
	Rm	Rensselaer loam	100	40
	Sn	Stendal silt loam	3	76
	VgA	Vigo silt loam, 0 to 2 percent slopes	3	120
	VgB2	Vigo silt loam, 2 to 4 percent slopes, eroded	3	14
	Wa	Wakeland silt loam, 0 to 2 percent slopes, frequently flooded	5	2,586
	Zp	Zipp silty clay, 0 to 2 percent slopes	95	322
			Total Acreage:	**10,425**

Understanding Table 16: Areas with the most acreage of hydric soils might contain opportunities for wetland restoration activities that could help address water quality impairments. The hydric rating indicates the percentage of the map unit with hydric soils. Map units with a hydric rating of 100 have 100% hydric soils.

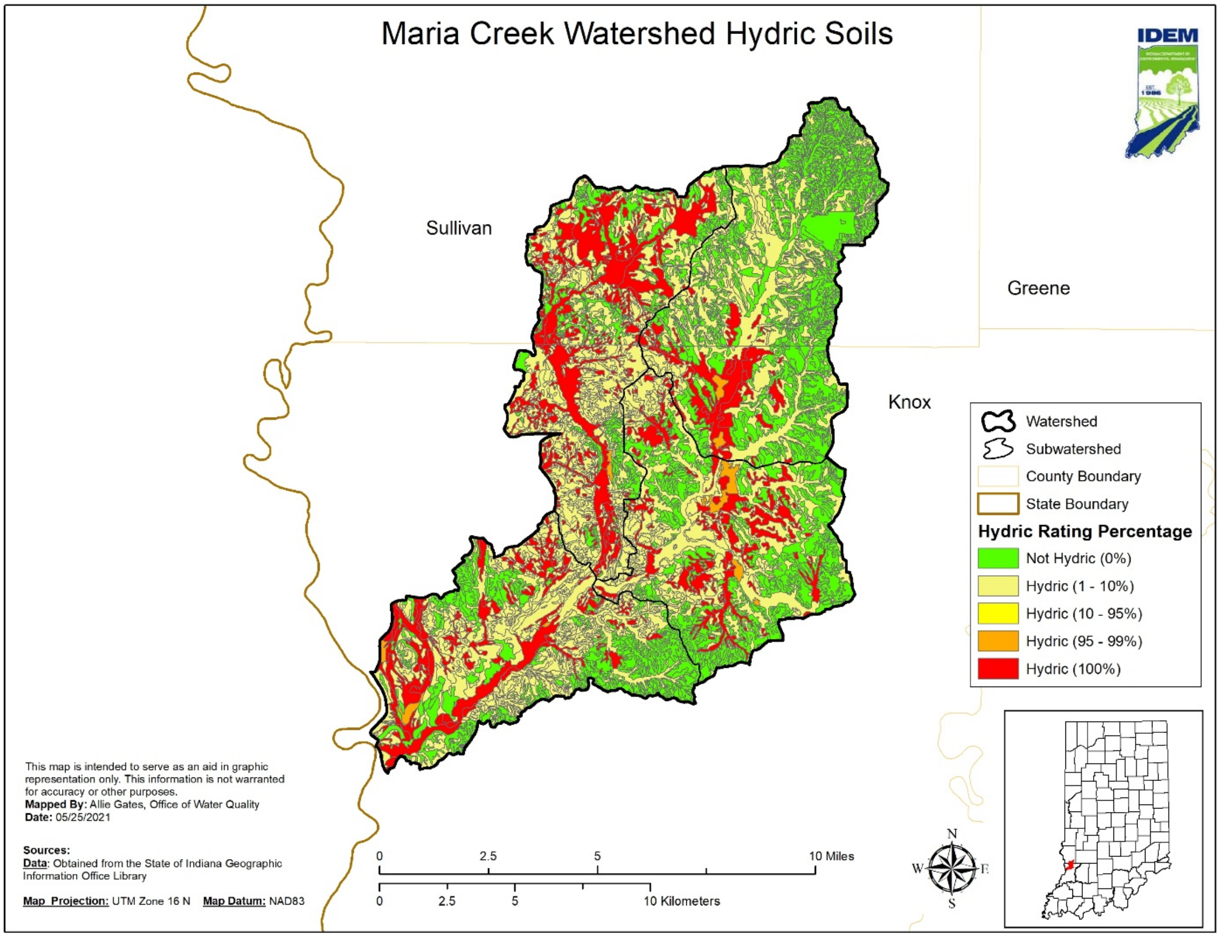

Figure 15: Hydric Ratings by Map Unit in the Maria Creek Watershed (Data on hydric soils by county available from NRCS at https://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/survey/)

Nationally, since the late 1600s roughly 50 percent of the wetlands in the lower 48 states have been lost. Indiana has lost a large number of its wetlands, approximating over 80 percent (USGS, 1999). In the 1800s and 1900s millions of acres of wetlands were drained or converted into farms, cities, and roads. In the early 1700s, wetlands covered 25 percent of the total area of Indiana. That number has been greatly reduced. By the late 1980s, over 4.7 million acres of wetlands had been lost. Before the conversion of wetlands, there were over 5.6 million acres of wetlands in the state, wetlands such as bogs, fens, wet prairies, dune and swales, cypress swamps, marshes, and swamps. Wetlands now cover less than 4 percent of Indiana. (http://www.in.gov/idem/wetlands/importance-of-wetlands/)

Wetlands are home to wildlife. More than one-third (1/3) of America's threatened and endangered species live only in wetlands, which means they need them to survive. Over 200 species of birds rely on wetlands for feeding, nesting, foraging, and roosting. Wetlands provide areas for recreation, education, and aesthetics. More than 98 million people hunt, fish, birdwatch, or photograph wildlife. Americans spend $59.5 billion annually on these activities.

Wetland plants and soils naturally store and filter nutrients and sediments. Calm wetland waters, with their flat surface and flow characteristics, allow these materials to settle out of the water column, where plants in the wetland take up certain nutrients from the water. As a result, our lakes, rivers and streams are cleaner and our drinking water is safer. Constructed wetlands can even be used to clean wastewater, when properly designed. Wetlands also recharge our underground aquifers. Over 70 percent of Indiana residents rely on groundwater for part or all of their drinking water needs.

Wetlands protect our homes from floods. Like sponges, wetlands soak up and slowly release floodwaters. This lowers flood heights and slows the flow of water down rivers and streams. Wetlands also control erosion. Shorelines along rivers, lakes, and streams are protected by wetlands, which hold soil in place, absorb the energy of waves, and buffer strong currents.

Wetland areas act to buffer wide variations in flow conditions that result from storm events. They also allow water to infiltrate slowly thus reducing the risks of contaminated water run-off into waterbodies. Agencies such as the USGS and U.S. Fish and Wildlife Service (USFWS) estimate that Indiana has lost approximately 85 percent of the state's original wetlands. Currently, the Maria Creek watershed contains approximately 1,964 acres of wetlands or 3.18 percent of the total surface area. Additional information on wetlands can be found on the IDEM website http://www.in.gov/idem/wetlands/.

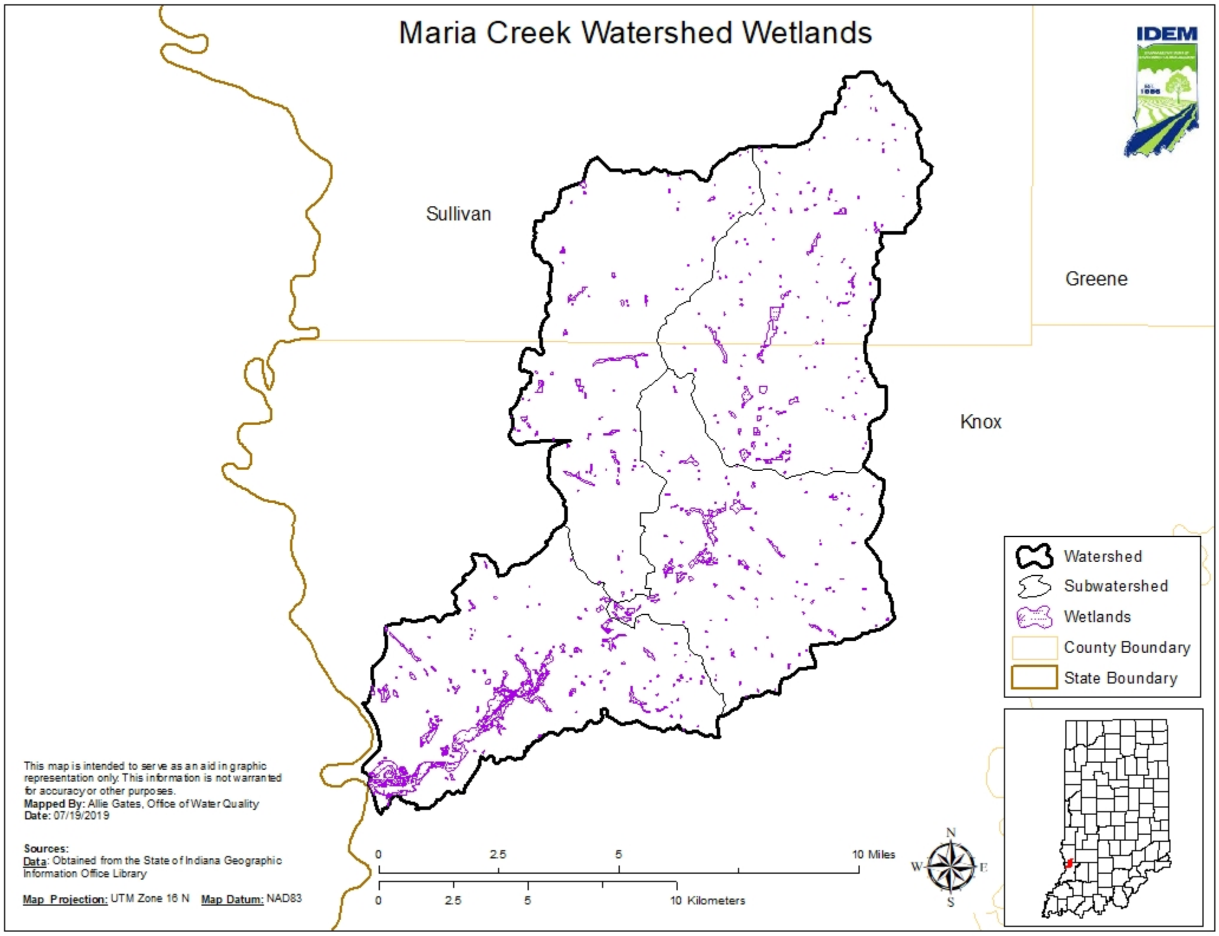

Figure 16: Location of Wetlands in the Maria Creek Watershed

The USFWS has the responsibility for mapping wetlands in the United States. Those map products are currently held in the Fish and Wildlife Service Wetland Database (sometimes referred to as the National Wetlands Inventory or NWI). Figure 16 shows estimated locations of wetlands as defined by the USFWS's NWI. Wetland data for Indiana is available from the U.S. Fish and Wildlife Service's NWI at https://www.fws.gov/wetlands/data/Mapper.html. The NWI was not intended to produce maps that show exact wetland boundaries comparable to boundaries derived from ground soil surveys, and boundaries are generalized in most cases. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis. Therefore, the estimate of the current extent of wetlands in the Maria Creek watershed from the NWI may not agree with those listed in Section 2.1, which are based upon the National Agricultural Statistic Service. For more information on the wetland classification codes visit http://www.fws.gov/wetlands/Data/Wetland-Codes.html. The USFWS uses data standards to increase the quality and compatibility of its data.

Changes to the natural drainage patterns of a watershed are referred to as hydromodifications. Historically, drain tiles have been used throughout Indiana to drain marsh or wetlands and make it either habitable or tillable for agricultural purposes. While tile drainage is understood to be pervasive – estimated at thousands of miles in Indiana – it is extremely challenging to quantify on a watershed basis because these tiles were established by varying authorities including County Courts, County Commissioners, or County Drainage Boards (See: http://indianacountysurveyors.org/directory.html)

In addition to tile drainage, regulated drains are another form of hydromodification. A regulated drain is a drain which was established through either a Circuit Court or Commissioners Court of the County prior to January 1, 1966 or by the County Drainage Board since that time. Regulated drains can be an open ditch, a tile drain, or a combination of both. The County Drainage Board can construct, maintain, reconstruct or vacate a regulated drain.

2.3.4 Soil Erodibility

Although erosion is a natural process within stream ecosystems, excessive erosion negatively impacts the health of watersheds. Erosion increases sedimentation of the streambeds, which impacts the quality of habitat for fish and other organisms. Erosion also impacts water quality as it increases nutrients and decreases water clarity. As water flows over land and enters the stream as run-off, it carries pollutants and other nutrients that are attached to the sediment. Sediment suspended in the water blocks light needed by plants for photosynthesis and clogs respiratory surfaces of aquatic organisms.

The NRCS maintains a list of highly erodible lands (HEL) units for each county based upon the potential of soil units to erode from the land (https://efotg.sc.egov.usda.gov/references/public/NE/HEL_Intro.pdf). HELs are especially susceptible to the erosional forces of wind and water. Wind erosion is common in flat areas where vegetation is sparse or where soil is loose, dry, and finely granulated. Wind erosion damages land and natural vegetation by removing productive top soil from one place and depositing it in another. The classification for HELs is based upon an erodibility index for a soil, which is determined by dividing the potential average annual rate of erosion by the soil unit's soil loss tolerance (T) value, which is the maximum annual rate of erosion that could occur without causing a decline in long-term productivity. The soil types and acreages in the Maria Creek watershed are listed in Table 17. HELs and potential HELs in the Maria Creek watershed are mapped in Figure 17.

A total of 43,505 acres or 71 percent of the Maria Creek watershed is considered highly erodible or potentially highly erodible. Rainfall surrounding the Maria Creek watershed is moderately heavy with an annual average of 49.2 inches. This rainfall and climate data specific to the watershed is available from the Midwestern Regional Climate Center (http://mrcc.isws.illinois.edu/CLIMATE/). Heavy rainfall increases flow rates within streams as the volume and velocity of water moving through the stream channels increases. Velocity of water also increases as streambank steepness increases.

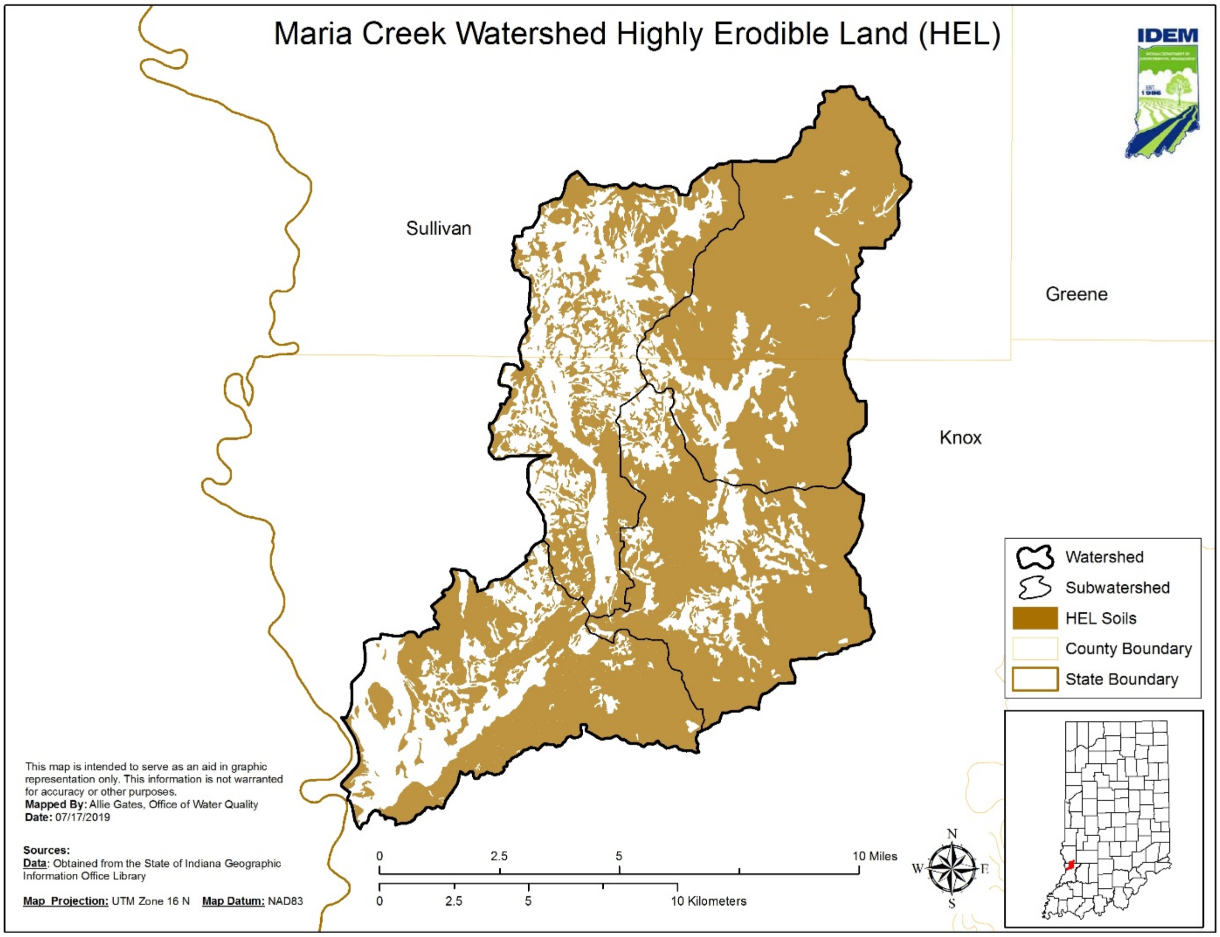

Figure 17: Location of Highly Erodible Lands (HEL) in the Maria Creek Watershed

Table 17: HEL/Potential HEL Total Acres in the Maria Creek Watershed

Map Symbol	HEL/Potential HEL Soil Types	Acres
AfB2	Alford silt loam, 2 to 5 percent slopes, eroded	600
AfB3	Alford silt loam, 2 to 5 percent slopes, severely eroded	473
AfC2	Alford silt loam, 5 to 10 percent slopes, eroded	93
AfC3	Alford silt loam, 5 to 10 percent slopes, severely eroded	484
AfD2	Alford silt loam, 10 to 18 percent slopes, eroded	35
AfD3	Alford silt loam, 10 to 18 percent slopes, severely eroded	57
AfE	Alford silt loam, 18 to 35 percent slopes	2
AlA	Ava silt loam, 0 to 2 percent slopes	62
AlB2	Ava silt loam, 2 to 6 percent slopes, eroded	2283
AlB3	Ava silt loam, 2 to 6 percent slopes, severely eroded	102
AlC2	Alford silt loam, 5 to 10 percent slopes, eroded	909
AlD3	Alford silt loam, 10 to 18 percent slopes, severely eroded	286
AnB	Alvin fine sandy loam, 2 to 6 percent slopes	4144
AnC	Alvin fine sandy loam, 6 to 12 percent slopes	1465
AnD	Alvin fine sandy loam, 12 to 18 percent slopes	801
Ar	Armiesburg silty clay loam, rarely flooded	172
AsB	Ayrshire fine sandy loam, 2 to 4 percent slopes	142
AyA	Ayrshire loam, 0 to 2 percent slopes	37
Bd	Birds silt loam, rarely flooded	659
BlB	Bloomfield loamy fine sand, 2 to 6 percent slopes	2468
BlC	Bloomfield loamy fine sand, 6 to 12 percent slopes	239
BlD	Bloomfield loamy fine sand, 12 to 18 percent slopes	161
BlF	Bloomfield loamy fine sand, 18 to 40 percent slopes	5
ChC	Chelsea loamy fine sand, 4 to 10 percent slopes	75
ClF	Chetwynd loam, 25 to 50 percent slopes	9
CnB2	Cincinnati silt loam, Wabash Lowland, 2 to 6 percent slopes, eroded	169
CnC2	Cincinnati silt loam, Wabash Lowland, 6 to 12 percent slopes, eroded	91
CnC3	Cincinnati silt loam, Wabash Lowland, 6 to 12 percent slopes, severely eroded	453
CnD2	Cincinnati silt loam, 12 to 18 percent slopes, eroded	258
CnD3	Cincinnati silt loam, 12 to 18 percent slopes, severely eroded	221
Cu	Cuba silt loam	175
EkA	Elkinsville silt loam, 0 to 2 percent slopes	195
FaB	Fairpoint parachannery silt loam, 0 to 8 percent slopes	39
Ha	Haymond silt loam, frequently flooded	8
Hb	Haymond silt loam, rarely flooded	5
HeA	Henshaw silt loam, 0 to 2 percent slopes	119
HkE	Hickory silt loam, 18 to 25 percent slopes	239
HkF	Hickory silt loam, 25 to 35 percent slopes	402
HkF3	Hickory silt loam, 18 to 35 percent slopes, severely eroded	76
HoA	Hosmer silt loam, 0 to 2 percent slopes	420
HoB2	Hosmer silt loam, 2 to 5 percent slopes, eroded	2062
HoC3	Hosmer silt loam, 5 to 10 percent slopes, severely eroded	970
HoD3	Hosmer silt loam, 10 to 18 percent slopes, severely eroded	301

Map Symbol	HEL/Potential HEL Soil Types	Acres
IoA	Iona silt loam, 0 to 2 percent slopes	987
IoB2	Iona silt loam, 2 to 6 percent slopes, eroded	1673
IoB3	Iona silt loam, 2 to 6 percent slopes, severely eroded	155
IvA	Iva silt loam, 0 to 2 percent slopes	1539
IvB2	Iva silt loam, 2 to 4 percent slopes, eroded	315
Lo	Lomax loam, rarely flooded	70
MaD2	Markland silt loam, 12 to 18 percent slopes, eroded	3
MuB2	Muren silt loam, 2 to 6 percent slopes, eroded	1069
No	Nolin silty clay loam, rarely flooded	57
PaC3	Parke silt loam, 6 to 12 percent slopes, severely eroded	3
PaD3	Parke silt loam, 12 to 18 percent slopes, severely eroded	2
PrB2	Princeton fine sandy loam, 2 to 6 percent slopes, eroded	456
PrC2	Princeton fine sandy loam, 6 to 12 percent slopes, eroded	63
PrD2	Princeton fine sandy loam, 12 to 18 percent slopes, eroded	3
ReA	Reesville silt loam, 0 to 2 percent slopes	4866
ReB2	Reesville silt loam, 2 to 5 percent slopes, eroded	534
St	Strip mines	547
SyB2	Sylvan silt loam, 2 to 6 percent slopes, eroded	3195
SyC3	Sylvan silt loam, 6 to 12 percent slopes, severely eroded	729
SyD3	Sylvan silt loam, 12 to 18 percent slopes, severely eroded	114
SyF	Sylvan silt loam, 25 to 40 percent slopes	511
VgA	Vigo silt loam, 0 to 2 percent slopes	120
VgB2	Vigo silt loam, 2 to 4 percent slopes, eroded	14
Wa	Wakeland silt loam, 0 to 2 percent slopes, frequently flooded	4228
Ww	Wilbur silt loam	286
	Total	**43,505**

Understanding Table 17 and Figure 17: Areas with the most acreage of HEL might contribute to water quality impairments associated with excessive erosion, including IBC/TSS, and might contain opportunities for restoration to decrease erosion.

The Indiana State Department of Agriculture (ISDA) tracks trends in conservation and cropland through annual county tillage transects. Data collected through the county tillage transect (https://secure.in.gov/isda/divisions/soil-conservation/cover-crop-and-tillage-transect-data/) can help determine adoption of conservation practices and estimate the average annual soil loss from Indiana's agricultural lands. The latest figures for the counties in the Maria Creek watershed are shown in Table 18. Tillage practices captured in ISDA's tillage transect include living cover and no till practices. According to ISDA, living cover includes living cover crops and cereal grains planted into cash crops using direct seeding or broadcast methods, and no till is any direct seeding system including site preparation, with minimal soil disturbance (ISDA, 2019).

Table 18: Tillage Transect Data for 2019 by County in the Maria Creek Watershed

County	Tillage Practice 2019			
	Living Cover		No Till	
	Corn	Soybean	Corn	Soybean
Sullivan	4,150 acres 7%	4,109 acres 5%	16,227 acres 28%	37,734 acres 44%
Knox	21,896 acres 22%	38,599 acres 35%	49,825 acres 47%	46,347 acres 37%

Understanding Table 18: According to the table, in Knox County no till is predominant for corn, and living cover is predominant for soybeans. In Sullivan County, no till is predominant for soybeans, and living cover is predominant for corn. Overall, living cover is utilized at a greater percentage in Knox County, but the percentage of no till is similar for both Knox and Sullivan counties.

2.3.5 Streambank Erosion

Streambank erosion is potentially a significant source of pollutants in the Maria Creek watershed. Streambank erosion is a natural process but can be accelerated due to a variety of human activities. Vegetation located adjacent to streams flowing through crop or pasture fields is often removed to promote drainage or provide access to water for cattle. The loss of vegetation makes the streambanks more susceptible to erosion due to the loss of plant roots. Extensive areas of agricultural tiles promote much quicker delivery of rainfall into streams than would occur without subsurface drainage, which could potentially contribute to streambank erosion, due to high velocities and shear stress. The creation of impervious surfaces (e.g., streets, rooftops, driveways, parking lots) can also lead to rapid run-off of rainfall and higher stream velocities that might cause streambank erosion.

2.4 Wildlife and Classified Lands

2.4.1 Wildlife

The Indiana Department of Natural Resources (IDNR) is the primary entity responsible for monitoring wildlife populations and habitats throughout Indiana. Wildlife such as deer, waterfowl, raccoon, beaver, etc. can be sources of *E. coli*. The animal habitat and proximity to surface waters are important factors that determine if animal waste can be transported to surface waters. Waterfowl and riparian mammals deposit waste directly into streams while other riparian species deposit waste in the floodplain, which can be transported to surface waters by runoff from precipitation events. Animal waste deposited in upland areas can also be transported to streams and rivers; however, due to the distance from uplands to surface streams, only larger precipitation events can sustain sufficient amounts of runoff to transport upland animal waste to surface waters.

Little information exist surrounding feces depositional patterns of wildlife and a direct inventory of wildlife populations is generally not available. However, based on the *Bacteria Source Load Calculator* developed by the Center for TMDL and Watershed Studies, bacteria production by animal type is estimated as well as their preferred habitat. Higher concentrations of wildlife in the habitats described in Table 19 could contribute *E. coli* to the watershed, particularly during high flow conditions or flooding events.

Table 19: Bacteria Source Load by Species

Wildlife Type	*E. coli* Production Rate (cfu/day – animal)	Habitat
Deer	1.86×10^8	Entire Watershed
Raccoon	2.65×10^7	Low density on forests in rural areas; high density on forest near a permanent water source or near cropland
Muskrat	1.33×10^7	Near ditch, medium sized stream, pond or lake edge
Goose	4.25×10^8	Near main streams and impoundments
Duck	1.27×10^9	Near main streams and impoundments
Beaver	2.00×10^5	Near streams and impoundments in forest and pastures

2.4.2 Classified Lands

Managed lands shown in Table 20 include natural and recreation areas which are owned or managed by the IDNR, federal agencies, local agencies, non-profit organizations, and conservation easements. Classified lands are public or private lands containing areas supporting growth of native or planted trees, native or planted grasses, wetlands, or other acceptable types of cover that have been set aside for managed production of timber, wildlife habitat and watershed protection. Natural areas provide ideal habitat for wildlife. Some of the more common wildlife often found in natural areas include white-tailed deer, raccoon, muskrat, fowl and beaver. While wildlife is known to contribute *E.coli* to the surface waters, natural areas provide economic, ecological and social benefits and should be preserved and protected. Management practices such as reducing impervious surfaces, native vegetation plantings, wetland creation and riparian buffers will help in reducing stormwater run-off transporting pollutants to the streams. Table 20 and Figure 18 show the managed lands within the Maria Creek watershed. Table 21 and Figure 18 show the classified lands within Maria Creek watershed.

Table 20: Managed Lands within the Maria Creek Watershed

Managed Lands	Manager	Area (acres)
Yocum Woods	DNR Fish and Wildlife	61

Table 21: Classified Lands within the Maria Creek Watershed

Classified Lands	
Subwatershed	**Area (acres)**
Cotton Branch	787
Tilley Ditch	30
Marsh Creek	24
Headwaters Maria Creek	187
Total	1,028

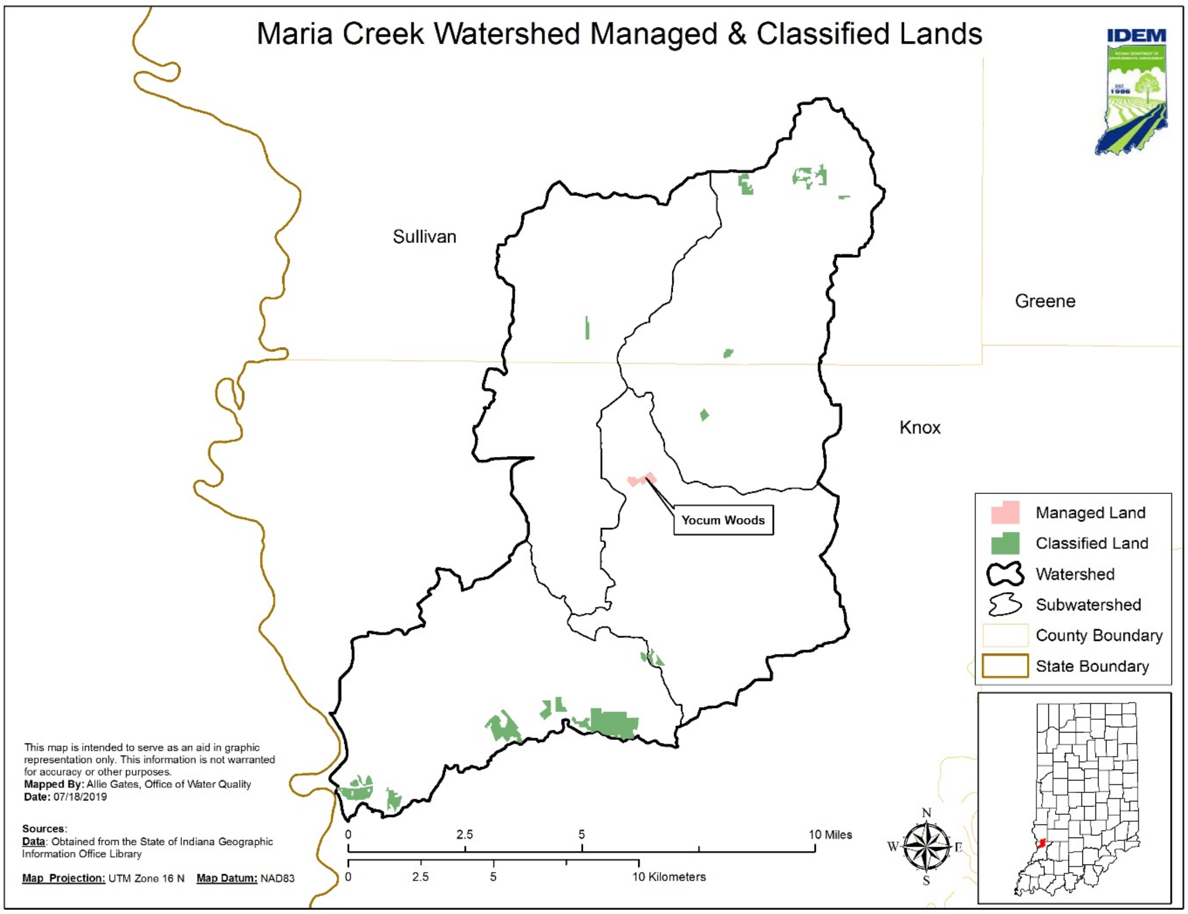

Figure 18: Managed and Classified Lands within the Maria Creek Watershed

2.5 Climate and Precipitation

Climate varies in Indiana depending on latitude, topography, soil types, and lakes. Information on Indiana's climate is available through sources including the Midwestern Regional Climate Center (http://mrcc.illinois.edu/CLIMATE/).

Climate data from Station USC00129113 located in Vincennes, IN were used for climate analysis of the Maria Creek watershed. Monthly data from 1982 - 2019 were available at the time of analysis. In general, the climate of the region is continental with hot, humid summers and cold winters. From 2009 to 2019, the average winter temperature in Vincennes was 35.7°F and the average summer temperature was 74.8°F. The average growing season (consecutive days with low temperatures greater than or equal to 32 degrees) is 202 days.

Examination of precipitation patterns is also a key component of watershed characterization because of the impact of run-off on water quality. From 2009 to 2019, the annual average precipitation in Vincennes at Station USC00129113 was approximately 49.2 inches, including approximately 11.1 inches on average of total annual snowfall.

Rainfall intensity and timing affect watershed response to precipitation. This information is important in evaluating the effects of stormwater on the Maria Creek watershed. Using data from USC00129113 during 2009 to 2019, 82 percent of the measurable precipitation events were low intensity (i.e., less than 0.2 inches), while 4 percent of the measurable precipitation events were greater than one inch.

According to the "Impacts of Climate Change for the State of Indiana" report developed by the Purdue Climate Change Research Center, Indiana will face a number of potential impacts if greenhouse gas concentrations continue to increase. The occurrence and duration of extreme hot events is likely to increase in Indiana while the occurrence of extreme cold events is likely to decrease (Diffenbaugh et al., 2005). Indiana could experience a significant reduction in extreme cold temperatures leading to warmer winters (Diffenbaugh et al., 2005). Total annual average precipitation is likely to increase, but there may be a shift in when the precipitation occurs. Winter and spring precipitation are projected to increase by 21 and 30 percent, respectively, by the end of the century, but summer precipitation may decline by 9 percent. Warmer and wetter winters may result in higher streamflow and increased flooding frequency. Total run-off is also projected to increase annually by between 25 and 38 percent by the end of the century with the largest percent increase in total run-off occurring in the winter and spring (Purdue Climate Change Research Center, 2008).

Understanding when precipitation events occur helps in the linkage analysis in Section 4.0, which correlates flow conditions to pollutant concentrations and loads. Data indicates that the wet weather season in the Maria Creek watershed occurs between the months of April and June.

2.6 Human Population

Counties with land located in the Maria Creek watershed include Sullivan and Knox. Major government units with jurisdiction at least partially within the Maria Creek watershed include Carlisle and Oaktown. U.S. Census data for each county during the past three decades are provided in Table 22 (U.S. Census Bureau, 2012).

Table 22: Population Data for Counties in Maria Creek Watershed

County	1990	2000	2010
Sullivan	18,993	21,751	21,475
Knox	39,884	39,256	38,440
Total	58,887	61,007	59,915

Understanding Table 22: Water quality is linked to population growth because a growing population often leads to more development, translating into more houses, roads, and infrastructure to support more people. The table provides information that shows how population has changed in each of the counties located in the Maria Creek watershed over time. In addition, understanding population trends can help watershed stakeholders to anticipate where pressures might increase in the future and where actions within the watershed could help prevent further water quality degradation.

Estimates of population within Maria Creek watershed are based on 2010 US Census data and the percentage of census blocks in urban and rural areas (Table 23). Based on this analysis, the estimated population of the watershed is 2,083 with approximately 91 percent of the population classified as rural residents and 9 percent classified as urban residents. Figure 19 below indicates population density within the Maria Creek watershed.

Table 23: Estimated Population in the Maria Creek Watershed

County	2010 Population	Total Estimated Watershed Urban Population	Total Estimated Watershed Rural Population	Total Estimated Watershed Population	Percent of Total Watershed Population
Sullivan	21,475	29	1,747	1776	85.3%
Knox	38,440	152	155	307	14.7%
Total	***59,915***	**181**	**1,902**	**2,083**	**100.0%**

Understanding Table 23: Understanding where the greatest population is concentrated within the Maria Creek watershed will help watershed stakeholders understand where different types of water quality pressures might currently exist. In general, watersheds with large urban populations are more likely to have problems associated with lots of impervious surfaces, poor riparian habitat, flashy stormwater flows, and large wastewater inputs. Alternatively, watersheds with mostly a non-urban population are more likely to suffer problems from failing septic systems, agricultural run-off, and other types of poor riparian habitat (e.g., channelized streams). Comparing the information in Table 22 with the information in Table 23 can provide an understanding of how population might change in the Maria Creek watershed and which counties are experiencing the most growth and shifts in urban and non-urban population. Population change can serve as an indicator for changes in land uses. For example, growing populations might mean more development, resulting in increased impervious surfaces and more infrastructures (e.g., sanitary sewer and storm sewer). Declining population in areas of the Maria Creek watershed might signify communities with under-utilized infrastructure and indicate opportunities to "rightsize" existing infrastructure and promote changes to land use that would benefit water quality (e.g., green infrastructure).

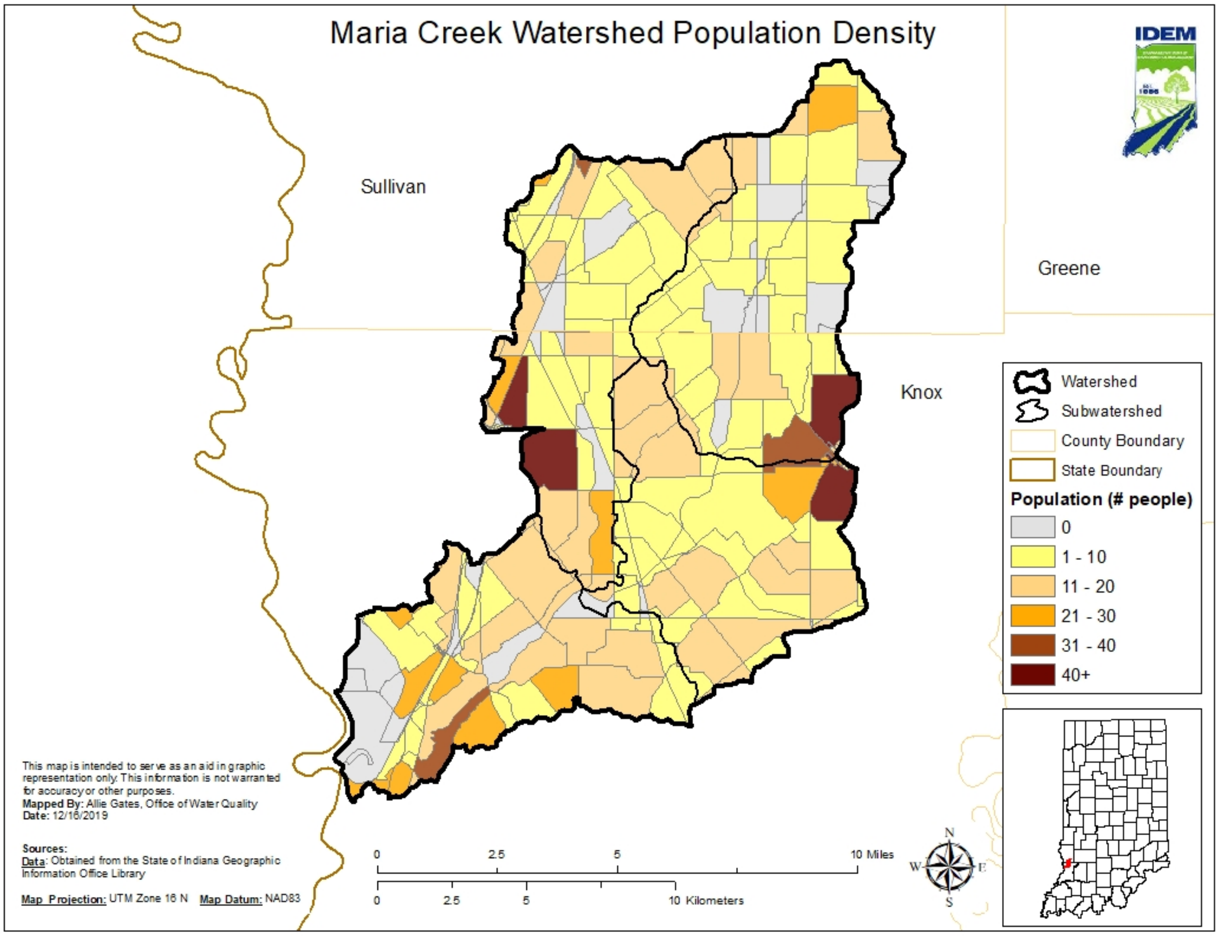

Figure 19: Population Density in the Maria Creek Watershed

2.6.1 Onsite Sewage Disposal Systems

Onsite sewage disposal systems (i.e., septic systems) are underground wastewater treatment structures most commonly used in rural areas without centralized sewer systems. According to the U.S. EPA's SepticSmart Homeowners program, one in five U.S. homes has a septic system (U.S EPA, 2018). Local health departments regulate onsite residential sewage disposal systems via designated authority from the Indiana Department of Health (IDOH) (410 IAC 6-8.3). More than 800,000 onsite sewage disposal systems are currently used in Indiana. Local health departments issue more than 15,000 permits per year for new systems and about 6,000 permits for repairs (IDOH, 2020).

Septic systems typically consist of a septic tank to settle out and digest sewage solids followed by a system of perforated piping to distribute the treated wastewater for absorption into the soil, also known as the drainfield. The septic tank holds the wastewater to allow for separation of solids, fats, oil, and grease. The septic tank also contains microorganisms that aid in breaking down sludge and removing some contaminants from the wastewater. The drainfield allows for further removal of remaining contaminants through soil filtration.

Regular maintenance of septic systems, such as frequent inspections and pumping of the septic tank, is important to ensure the system is functioning safely and effectively. Septic systems that are properly designed and maintained should not serve as a source of contamination to surface waters. However, a septic system may fail if it is not properly installed or maintained or if it is installed in an unsuitable soil type as discussed in Section 2.3.2. A septic system that is not functioning properly may inadvertently contaminate groundwater and surface water due to elevated levels of nutrients and bacteria that can be found in untreated or inadequately treated household wastewater. A septic system is considered failing when the system exhibits one or more of the following:

1. The system refuses to accept sewage at the rate of design application thereby interfering with the normal use of plumbing fixtures.

2. Effluent discharge exceeds the absorptive capacity of the soil, resulting in ponding, seepage, or other discharge of the effluent to the ground surface or to surface waters.

3. Effluent is discharged from the system causing contamination of a potable water supply, groundwater, or surface water.

The general sewage disposal requirements (410 IAC 6-8.3-52) in the residential onsite sewage systems rule state that:

- No person shall throw, run, drain, seep, or otherwise dispose into any of the surface waters or groundwaters of this state, or cause, permit, or suffer to be thrown, run, drained, allowed to seep, or otherwise disposed into such waters, any organic or inorganic matter from a dwelling or residential onsite sewage system that would cause or contribute to a health hazard or water pollution.
- The: (1) design; (2) construction; (3) installation; (4) location; (5) maintenance; and (6) operation; of residential onsite sewage systems shall comply with the provisions of this rule.

The violations and permit denial and revocation section (410 IAC 6-8.3-55) of the residential onsite sewage system rule states that:

- Should a residential onsite sewage system fail, the failure shall be corrected by the owner within the time limit set by the health officer.
- If any component of a residential onsite sewage system is found to be: (1) defective; (2) malfunctioning; or (3) in need of service; the health officer may require the repair, replacement, or service of that component. The repair, replacement, or service shall be conducted within the time limit set by the health officer.
- Any person found to be violating this rule may be served by the health officer with a written order stating the nature of the violation and providing a time limit for satisfactory correction thereof.

A comprehensive database of septic systems within the Maria Creek watershed is not available; therefore, the rural population of each subwatershed was calculated to obtain a general representation of the number of systems. The U.S. Census provides the total number of people within a county as well as the total urban and rural population of the county. Subwatershed population is estimated by using the census block population found within each area. It is assumed that the numbers of septic systems in the subwatersheds are directly proportional to rural household density. An additional estimate of septic systems can be made using the 1990 US Census, as that is the last census that inventoried how household wastewater is disposed. The rural households in the Maria Creek subwatersheds are shown in Table 24, along with a calculated density (total rural households divided by total area). The rural household density can be used to compare the different subwatersheds within the Maria Creek watershed (U.S. Census Bureau, 2012).

Table 24: Rural and Urban Household Density in the Maria Creek Subwatersheds

Subwatershed	County	Area of County in Subwatershed (mi2)	County Households in Subwatershed	Urban Households	Rural Households	Urban Household Density (Houses/mi2)	Rural Household Density (Houses/mi2)
Cotton Branch	Knox	23.22	218	0	218	0.0	9.4
	Total	23.22	218	0	218		
Tilley Ditch	Knox	22.17	206	0	206	0.0	9.3
	Total	22.17	206	0	206		
Marsh Creek	Sullivan	12.75	76	29	47	7.6	3.7
	Knox	11.07	192	152	40		
	Total	23.82	268	181	87		
Headwaters Maria Creek	Sullivan	17.49	70	0	70	0.0	8.2
	Knox	9.85	155	0	155		
	Total	27.34	225	0	225		

A report by the Indiana Advisory Commission on Intergovernmental Relations (ACIR) surveyed county health department officials statewide from 2016 to 2017. Of the 444 unsewered communities reported statewide, the study was able to identify 192 of those communities where at least 25 percent of the individual wastewater treatment systems were failing. Unsewered communities were defined as "contiguous geographical areas containing at least 25 homes and/or businesses that are not served by sewers" (Palmer et. al, 2019). Table 25 reports unsewered communities by counties relevant to the Maria Creek watershed.

Table 25: Unsewered Residences/Businesses Reported by County in 2016-2017

County	Unsewered Communities	Residences	Businesses
Sullivan	8	530	14
Knox	7	497	13

2.6.2 Urban Stormwater

In areas not regulated under the NPDES construction stormwater, industrial stormwater, or MS4 programs, as discussed in Section 2.8.3, stormwater run-off from developed areas is not regulated under a permit and is therefore a nonpoint source. Run-off from urban areas can carry a variety of pollutants originating from a variety of sources. Potential sources of *E. coli* in urban stormwater include pet waste, urban wildlife waste, homeless encampments, leaking sanitary sewers exfiltrating to storm drains, combined and sanitary sewer overflows, failing septic systems and more (Clary et al., 2014). Depending on the amount of developed, impervious land in a watershed, urban nonpoint source inputs can result in localized or widespread water quality degradation. The percent and distribution of developed land in the Maria Creek watershed is discussed in Section 2.1. However, inputs from urban sources are difficult to quantify. Estimates can be made of residential areas that may be a source of pollutants of concern. These estimates provide insight into the potential of urban nonpoint sources as important sources of TSS and *E. coli* in the Maria Creek watershed.

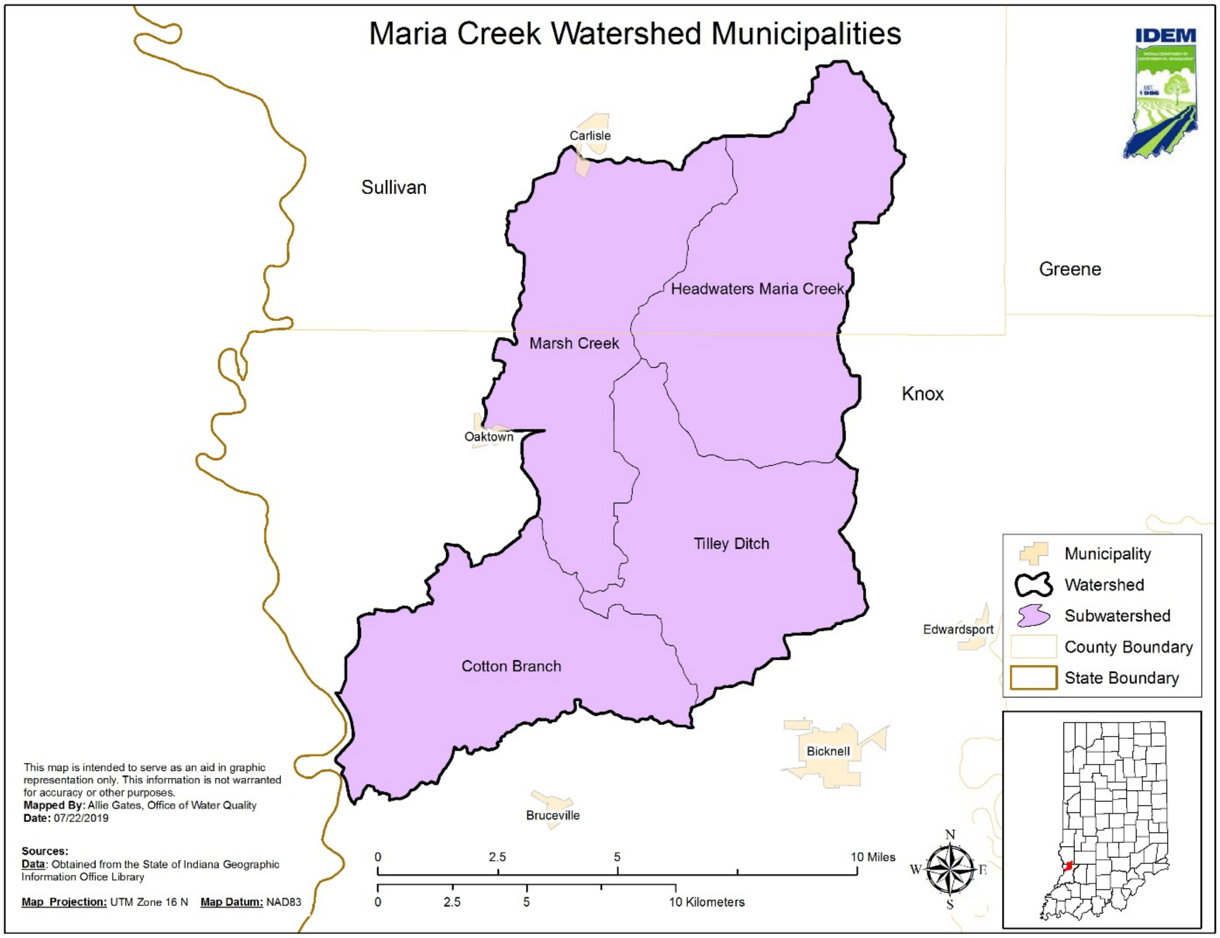

Figure 20: Municipalities in the Maria Creek Watershed

2.8 Point Sources

This section summarizes the potential point sources of *E. coli* and TSS in the Maria Creek watershed, as regulated through the National Pollutant Discharge Elimination System (NPDES) Program. As authorized by the CWA, the NPDES permit program controls water pollution by regulating facilities that discharge pollutants into waters of the United States. Point sources with NPDES permits within the Maria Creek watershed include municipal wastewater treatment plants (WWTPs), a public water supply, surface and underground coal mining operations, and construction sites. A summary of the potential point sources of *E. coli* and TSS in the Maria Creek watershed, including an overview of the facilities and wasteload allocations (WLAs), is provided in Appendix G.

2.8.1 Municipal Wastewater Treatment Plants (WWTPs)

Municipal Wastewater Treatment Plants (WWTPs) that discharge wastewater through a point source to a surface water of the state are required to obtain a municipal NPDES wastewater permit. Some of the functions of a WWTP include sewage treatment and industrial waste treatment. Municipal wastewater facilities are required to disinfect their effluent for *E. coli* during the recreational season (April 1 to October 31) in accordance with 327 IAC 5-10-6. WWTPs are critical for maintaining public sanitation and a healthy environment. However, WWTPs may discharge wastewater with elevated concentrations of pollutants into streams. Municipal wastewater permits include effluent limitations that are derived using water quality criteria developed to protect all designated and existing uses of the receiving water body and/or any more stringent technology-based limitations. There are three active WWTPs that discharge wastewater within the Maria Creek watershed (Table 26 and Figure 21).

The Freelandville Regional Sewer District operates a minor municipal WWTP (IN0064513). The WWTP is a Class I, 0.088 MGD bio-mechanical treatment facility consisting of Sequencing Batch Reactors with associated appurtenances including a mechanical cleaned bar screen, main lift station, blowers and diffusers for aeration and sludge digestion, decanters, ultraviolet light disinfection, influent and effluent flow metering aerobic sludge digestion, sludge dewatering equipment, and step aeration. The system is comprised of 100 percent separate sanitary sewers by design with no overflow or bypass points. The facility has one outfall (Outfall 001) that discharges to an unnamed tributary of Maria Creek. The receiving water has a seven day, ten year low flow ($Q_{7,10}$) of 0.0 cubic feet per second at the outfall location.

North Knox School Corporation operates a minor semi-public WWTP at North Knox High School (IN0041084). The WWTP is a Class I, 0.022 MGD extended aeration treatment facility consisting of an influent bar screen, a surge tank, an aeration tank, a secondary clarifier, rapid sand filters, chlorination and dechlorination facilities and an effluent flow meter. Final sludge is hauled off-site for disposal. The system is comprised of 100 percent separate sanitary sewers by design with no overflow or bypass points. The facility has one outfall (Outfall 001) that discharges into Tilley Ditch. The receiving water has a seven day, ten year low flow ($Q_{7,10}$) of 0.0 cubic feet per second at the outfall location.

North Knox School Corporation also operates a minor semi-public WWTP at North Knox Intermediate School (IN0041092). The WWTP is a Class I, 0.005 MGD extended aeration treatment facility consisting of an influent surge tank, an aeration tank, a settling tank, rapid sand filters, chlorination/dechlorination and an effluent flow meter. The system is comprised of 100 percent separate sanitary sewers by design with no overflow or bypass points. The facility has one outfall (Outfall 001) that discharges into an unnamed tributary of Maria Creek. The receiving water has a seven day, ten year low flow ($Q_{7,10}$) of 0.0 cubic feet per second at the outfall location.

Effluent from these facilities are potential point sources of *E. coli* and TSS. As discussed in Section 1.2, the TMDL target value for TSS is 30.0 mg/L or interpreted from current permit limits. The TMDL target value for *E. coli* is the 235 counts/100 mL single sample maximum component of the water quality standard. These target values can be used to establish potential permit limits. Flows used to calculate pollutant loads from each treatment plant are estimated based on current flow data from data monitoring reports (DMR) or design flows from the facility permits when actual flow data is not available. Pollutant concentrations used to calculate wasteloads from each treatment plant are based on known technological limitations of the facilities.

The facilities' permit effluent limits for *E. coli* and TSS are used to determine wasteload allocations for each treatment plant. The effluent limit for TSS is set at the NPDES permit limit of 12 mg/L monthly average for the Freelandville Regional Sewer District. The effluent limit for TSS is set at the NPDES permit limit of 30 mg/L winter monthly average for the North Knox High School WWTP and North Knox Intermediate School WWTP. The effluent limit for *E. coli* is set at the 235 counts/100 mL single sample maximum component of the water quality standard for all three facilities. Average design flow was determined from information reported by the facility during the permitting process. Compliance with current NPDES permit limits for each facility is consistent with the assumptions used to determine WLAs in the TMDL for protection of applicable water quality standards.

Table 26: Municipal Wastewater Treatment Plant Facilities Discharging within the Maria Creek Watershed

Subwatershed	Facility Name	Permit Number	AUID	Receiving Stream	Average Design Flow (MGD)
Tilley Ditch	Freelandville Regional Sewer District	IN0064513	INB11I2_T1001	Tributary of Maria Creek	0.088
Tilley Ditch	North Knox High School WWTP	IN0041084	INB11I2_T1004	Tilley Ditch	0.022
Cotton Branch	North Knox Intermediate School WWTP	IN0041092	INB11I4_02	Tributary of Maria Creek	0.005

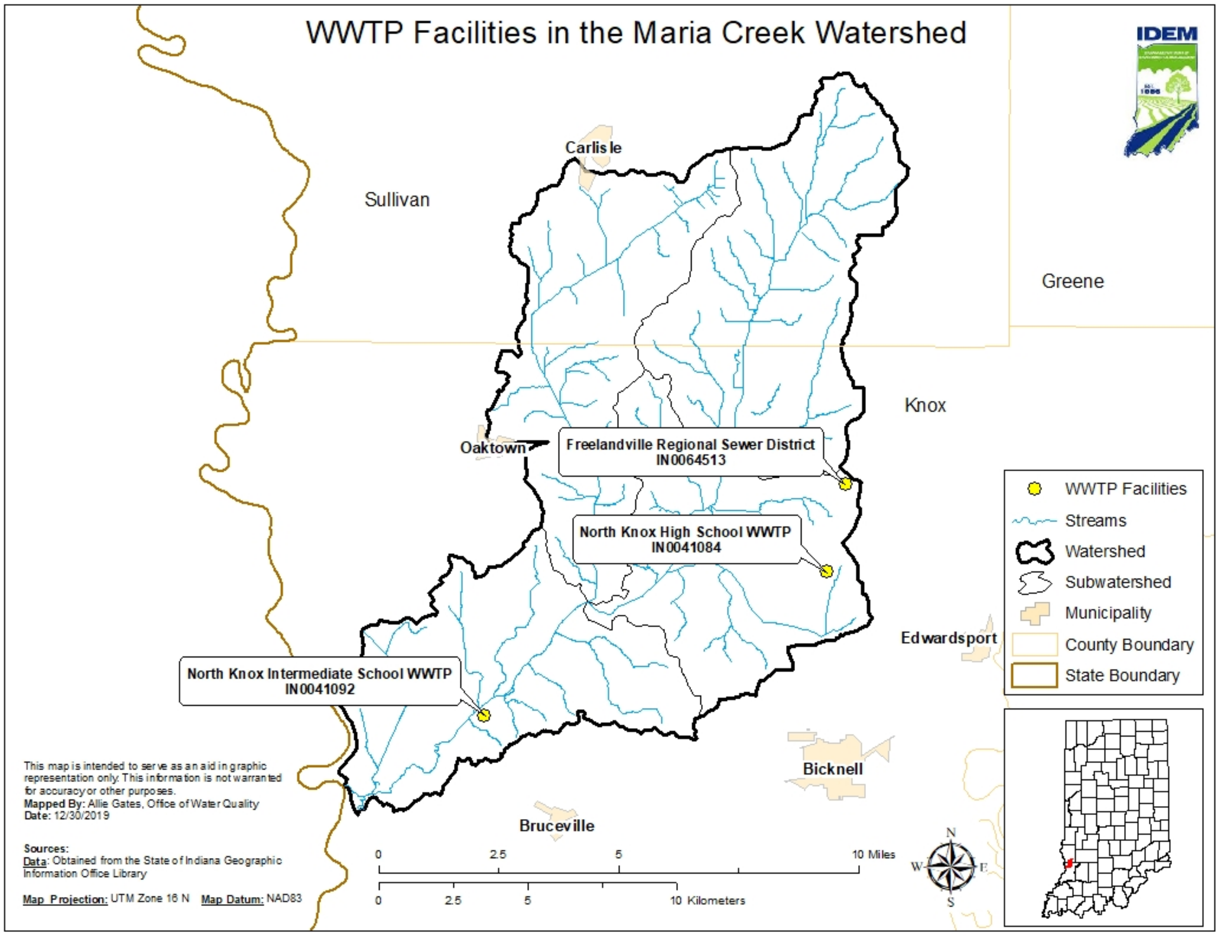

Figure 21: Municipal Wastewater Treatment Plant Facilities Discharging within the Maria Creek Watershed

Permit Compliance

Table 27: Summary of Municipal Wastewater Treatment Plant Permit Compliance in the Maria Creek Watershed for the Five-Year Period of 2016-2020.

Subwatershed	Facility Name	NPDES Permit Number	Stream	Inspections for the Last Five Years	Water Quality Violations for the Last Five Years					
					Outfall	Month	Year	Parameter	Type	Exceedance
Tilley Ditch	Freelandville Regional Sewer District WWTP	IN0064513	Tributary of Maria Creek	Inspected by IDEM: 11/7/2017: Violations Observed 1/29/2018: Violations Observed 11/1/2018 Violations Observed 2/24/2020: Violations Observed	001 001	Jan. April	2019 2019	DO E. coli	Daily Avg. Min. Mo. Geomean	-13% 50%
Tilley Ditch	North Knox High School WWTP	IN0041084	Tributary of Tilley Ditch	Inspected by IDEM: 1/13/2016: Violations Observed 11/3/2016: Violations Observed 10/31/2017: Violations Observed 11/8/2018: Violations Observed 3/11/2020: Violations Observed	001 001 001 001 001 001	April May April Aug. Aug. April	2016 2016 2017 2018 2018 2019	*E. coli* *E. coli* *E. coli* NH3-N (lbs/d) NH3-N (lbs/d) *E. coli*	Daily Max. Mo. Geomean Mo. Geomean Max. Wk. Avg. Mo. Avg. Mo. Geomean	930% 34% 3% 240% 35% 13%
Cotton Branch	North Knox Intermediate School WWTP	IN0041092	Tributary of Maria Creek	Inspected by IDEM: 1/13/2016: Violations Observed 11/3/2016: Violations Observed 10/31/2017: Potential Problems 11/8/2018: Potential Problems 3/11/2020: Violations Observed	001 001 001 001 001 001 001 001 001 001 001 001 001 001	March March March March April April April April Dec. May May May April April	2016 2016 2016 2016 2016 2016 2016 2016 2019 2016 2016 2016 2017 2019	NH3-N (lbs/d) NH3-N (lbs/d) NH3-N (mg/L) NH3-N (mg/L) NH3-N (lbs/d) NH3-N (lbs/d) NH3-N (mg/L) NH3-N (mg/L) NH3-N (mg/L) *E. coli* *E. coli* TR Chlorine *E. coli* *E. coli*	Mo. Avg. Max. Wk. Avg. Mo. Avg. Max. Wk. Avg. Mo. Avg. Max. Wk. Avg. Mo. Avg. Max. Wk. Avg. Max. Wk. Avg. Mo. Geomean Daily Max. Daily Min. Mo. Geomean Mo. Geomean	3757% 7260% 1739% 2963% 200% 180% 7% 28% 2% 60% 26% -92% 8% 14%

2.8.2 Industrial Wastewater

Industrial facilities that discharge wastewater through a point source to a surface water of the state are required to obtain an industrial NPDES wastewater permit. Industrial facilities typically generate wastewater through the production of a product. Wastewater discharges from these industrial sources may contain pollutants at levels that could affect the quality of receiving waters. Industrial wastewater permits include effluent limitations that are derived using water quality criteria developed to protect all designated and existing uses of the receiving water body and/or any more stringent technology-based limitations.

An industrial facility may be required to obtain an individual or a general industrial wastewater permit, depending on the activities that occur at the facility. An individual permit includes effluent limitations and operating requirements that are tailored to the specific activities of the facility. A general permit is a "one size fits all" type of activity-specific permit. General permit requirements were originally contained in Indiana Administrative Code (IAC) and set by Indiana's Environmental Rules Board through its formal rulemaking process. Unlike individual permits, general permits apply universally to all entities required to operate in accordance with the rule. However, IDEM is currently in the process of changing its approach to general permits from permit-by-rule to administrative general permits. There are four industrial facilities with industrial wastewater permits within the Maria Creek watershed.

Public Water Supply

Wastewater discharges from Freelandville Water Association are regulated by an individual industrial wastewater permit (IN0059480) (Table 28 and Figure 22). Freelandville Water Association has two outfalls (Outfalls 001 and 002) which discharge into an unnamed tributary that flows north into Tilley Ditch. At the point of discharge, the unnamed tributary has a $Q_{7,10}$ low flow value of 0.0 cfs. Groundwater is the source of the permitted facility's drinking water supply. The wastewater discharged at Outfalls 001 and 002 consists of filter backwash. The backwash is treated in sedimentation basins prior to discharging. The facility has an average discharge of approximately 0.022 MGD.

Effluent from this facility is potentially a point source of TSS. As discussed in Section 1.2, the TMDL target value for TSS is 30.0 mg/l or interpreted from current permit limits. This target value can be used to establish potential permit limits. Flows used to calculate sediment loads from this facility are estimated based on current flow data from data monitoring reports (DMR) or design flow from the facility permit when actual flow data is not available. Sediment concentrations used to calculate sediment loads from the public water supply are based on known technological limitations of the facility.

The facility's permit effluent limit for TSS is set at the NPDES per limit of 40 mg/L daily maximum. Average design flow was determined from information reported by the facility during the permitting process. Discharges from this facility are not believed to be significant contributions of TSS in the watershed. Compliance with the current NPDES permit limit is consistent with the assumptions used to determine WLAs in the TMDL for protection of applicable water quality standards.

Table 28: Public Water Supply Facilities Discharging within Maria Creek Watershed

Subwatershed	Facility Name	Permit Number	AUID	Receiving Stream	Average Design Flow (MGD)
Tilley Ditch	Freelandville Water Association	IN0059480	INB11I2_T1004	Tributary of Tilley Ditch	0.022

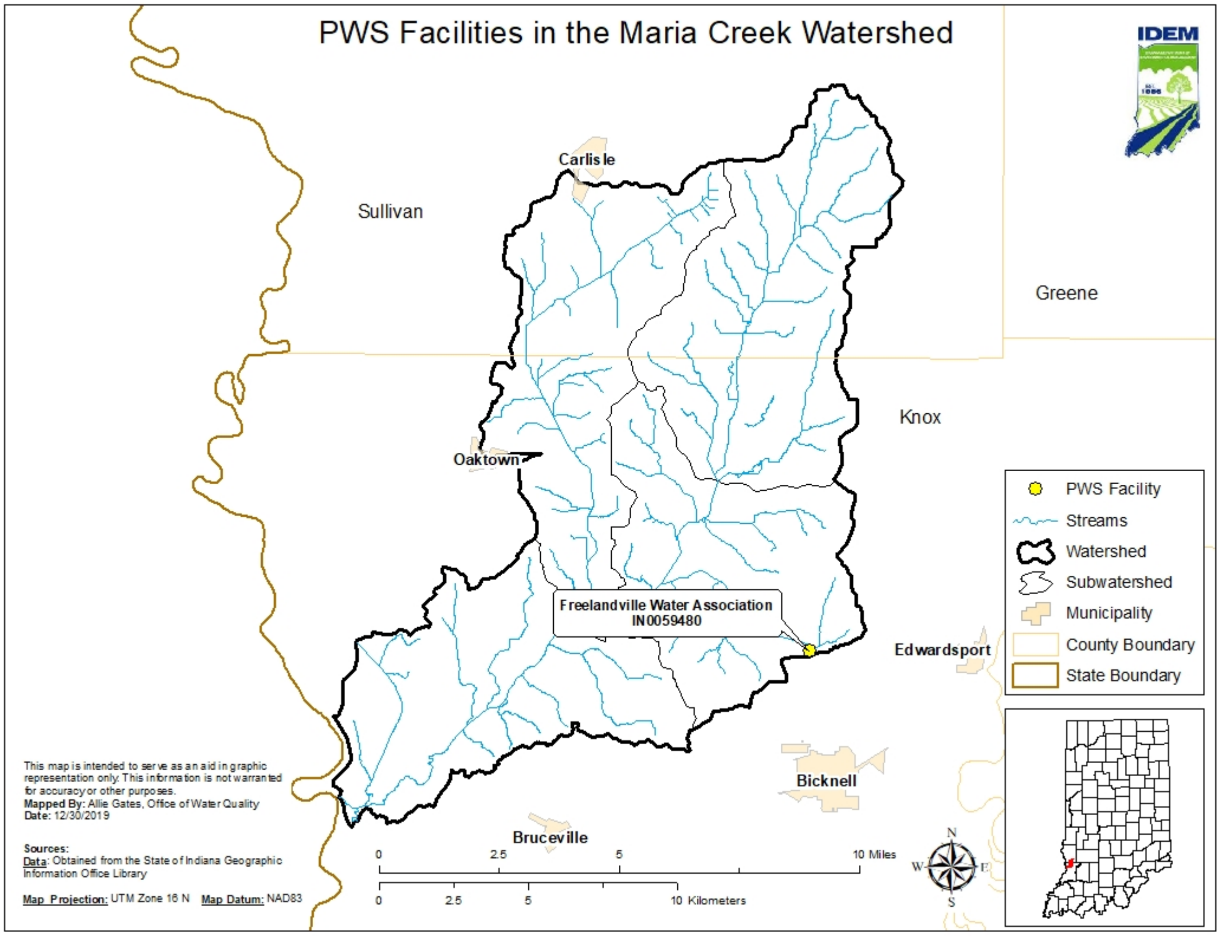

Figure 22: Public Water Supply Facilities Discharging within the Maria Creek Watershed

Coal Mining

Discharges from facilities engaged in mining of coal, coal processing, and reclamation activities may be regulated through a NPDES General Permit under 327 IAC 15-7 or through an individual NPDES permit. The purpose of the coal mining general permit rule is to regulate wastewater discharges from surface mining, underground mining, and reclamation projects which utilize sedimentation basin treatment for pit dewatering and surface run-off and to require best management practices for stormwater run-off to protect the public health, existing water uses, and aquatic biota. The coal mining general permit rule provides a standard set of conditions for discharges attributed to typical coal mining operations. An individual NPDES permit for discharges associated with coal mining operations may have similar conditions as the general permit rule but will also include more stringent or facility specific permit requirements as warranted.

There are two surface mining operations located within the Maria Creek watershed, Bear Run Mine (ING040239) and Freelandville Mine (ING040030) (Table 30 and Figure 23). Discharges from Bear Run Mine and Freelandville Mine are regulated by the coal mining general permit rule. Bear Run Mine currently has one active outfall (Outfall 068) that discharges within the Maria Creek watershed. Freelandville Mine currently has no permitted outfalls that discharge within the Maria Creek watershed. Therefore, Freelandville Mine will not receive a WLA for purposes of this TMDL report.

Bear Run Mine is operated by Peabody Midwest Mining LLC. The discharge at Outfall 068 consists of stormwater run-off that has potentially been contaminated by contact with overburden, coal product, coal byproduct, coal waste, or other mining operations and treated through detention within a sedimentation pond. Two stream segments located within the northeastern portion of the Headwaters of Maria Creek subwatershed have been impacted by the Bear Run Mine surface mining activity. The stream segments include Maria Creek (INB11I1_T1001) and a tributary of Maria Creek (INB11I1_T1002). These stream impacts are permitted through the U.S. Army Corps of Engineers (LRL-2022-1117-GJD) and IDEM (2011-487-77-DDC-A). Mitigation of these streams is required after mining activities are completed in the area. Available plans indicate these stream segments will likely be mitigated onsite in a similar location as the original stream channels. Maria Creek (INB11I1_T1001) was previously identified as impaired for *E. coli*, biological communities, and DO. These impairments will remain on the 2022 303(d) List of Impaired Waters. *E. coli* and TSS WLAs developed for this TMDL will be applicable to this stream segment, and any stream segments impaired for *E. coli* or biological communities impacted in the future, after stream mitigation is complete.

There are two underground mining facilities located within the Maria Creek watershed, Carlisle Mine (ING040199, IN0062791) and Oaktown Mine (ING040222, IN0064629) (Table 29, Table 30, and Figure 23). Discharges from Carlisle Mine and Oaktown Mine are regulated by either the coal mining general permit rule or an individual NPDES permit. Carlisle Mine has three outfalls (Outfalls 003, 005, and 202) that discharge within the Maria Creek watershed. Oaktown Mine has four outfalls (Outfalls 001, 002, 005, and 006) that discharge within the Maria Creek watershed.

Carlisle Mine is operated by Sunrise Coal LLC. The discharge at Outfalls 003 and 202 are regulated by the coal mining general permit rule (ING040199). The discharge consists of stormwater run-off that has potentially been contaminated by contact with mine surface facilities, topsoil and subsoil stockpiles, and a coal fine refuse disposal facility and treated through detention within a sedimentation pond. The discharge at Outfall 005 is regulated by an individual NPDES permit (IN0062791) and consists of comingled water from underground mining operations and stormwater run-off that is augmented with well water prior to entering the receiving water. Water from the underground mine is pumped to the surface and treated in a sedimentation pond along with the stormwater. Suspended solids settle in the pond and oil and grease are treated with adsorptive floating booms if necessary. Chemical addition for pH adjustment may also be used. Chemicals used to treat pH may include hydrated lime, calcium oxide, sodium hydroxide, soda ash, aluminum sulfate, or sodium permanganate. When there is a discharge from the sedimentation pond, water from a freshwater supply well is added to dilute the chloride and sulfate content prior to entering the receiving water. The receiving water has a seven day, ten year low flow ($Q_{7,10}$) of 0.0 cubic feet per second.

Oaktown Mine is also operated by Sunrise Coal LLC. The discharge at Outfalls 002, 005, and 006 are regulated by the coal mining general permit rule (ING040222). The discharge consists of stormwater run-off that has potentially been contaminated by contact with vegetated and gravel areas near ventilation fans, topsoil and subsoil stockpiles, the laydown yard, the rail loadout facility, and clean coal stockpiles and treated through detention within a sedimentation pond. The discharge at Outfall 001 was covered under general permit ING040222 until it was transferred to a new individual NPDES permit (IN0064629) effective July 1, 2018. Outfall 001 consists of comingled water from underground mining operations, coal processing wastewater, and stormwater run-off. Water from the underground mine is pumped to the surface into a sedimentation pond. Water is then pumped from the sediment pond into a slurry impoundment on-site. Sodium hydroxide is added to the water for treatment of iron and pH. This water is then allowed to settle out pollutants in the slurry impoundment. Impoundment seepage and surface run-off is directed back into the sediment pond, where additional treatment with sodium hydroxide is used. This closed loop system allows the sediment pond to be kept below discharge levels unless an extreme precipitation event occurs. Outfall 001 has three discharge scenarios: dry weather (001D), wet weather discharge caused by precipitation or snowmelt event that is less than or equal to the 10 year, 24-hour precipitation event (001A), and wet weather discharge caused by precipitation or snowmelt event that is greater than the 10 year, 24-hour precipitation event (001B). The receiving water has a seven day, ten year low flow ($Q_{7,10}$) of 0.0 cubic feet per second at the outfall location.

Discharges from the Bear Run Mine surface mine and Carlisle and Oaktown mine underground mine outfalls regulated through the general permit rule are believed to be primarily related to precipitation events. An estimated design flow is not available for these facilities. Therefore, the WLAs for the outfalls regulated through the general permit rule were calculated by using an estimate of the surface impacts associated with each surface mine operation or underground mine outfall to determine run-off flow volumes, and existing permit limits were used to calculate allowable loadings. Surface impacts were estimated by delineating the disturbed surface area associated with each surface mine operation or underground mine outfall using the most recent aerial imagery available in ArcGIS and calculating the acreage of each area. These permits have varying discharge limits based on dry and wet weather discharge flow rates. For wet weather discharges, dilution rates are assumed, and limits for TSS are suspended. WLAs for coal mining facilities regulated through the general permit rule are based on the NPDES permit limit of 70 mg/L daily maximum for TSS and are implemented through compliance with their NPDES permit.

Design flow estimates for discharges from underground mine outfalls regulated through individual NPDES permits were estimated based on the unique characteristics of each outfall and how each outfall is utilized by the facility. Carlisle Mine has one outfall (Outfall 005) regulated through an individual NPDES permit. An analysis of the past two years of flow data available from Discharge Monitoring Reports (DMRs) was completed to gain a better understanding of typical discharge from this outfall. Data over the past two years indicated flow was significantly influenced by precipitation events. The flow regime for each discharge event was determined, and the average discharge for each flow regime was calculated. The average discharge for each flow regime was used as the estimated design flow to calculate the WLA for each flow regime. DMRs were also reviewed to determine typical TSS concentrations for discharge events from the past two years. It was determined that TSS concentrations were typically less than 35 mg/L. Therefore, the WLA for the Carlisle Mine, Outfall 005 was calculated using the NPDES permit limit of 35 mg/L monthly average as it is more representative of existing load conditions.

Oaktown Mine has one outfall (Outfall 001) regulated through an individual NPDES permit. An analysis of the past two years of flow data available from DMRs was completed to gain an understanding of typical discharge from this outfall. Data over the past two years indicated that this outfall does not regularly discharge, and when the outfall does discharge it typically occurs during precipitation events. Due to the irregularity of the discharges from this outfall, the estimated design flow of 0.5 MGD as reported in the facility's permit was used as the estimated design flow to calculate the WLA. DMRs were also reviewed to determine typical TSS concentrations for discharge events from the past two years. It was determined that TSS concentrations were typically less than 35 mg/L. Therefore, the WLA for the Oaktown Mine, Outfall 001 was calculated using the NPDES permit limit of 35 mg/L monthly average as it is more representative of existing load conditions.

The WLA for each coal mining operation outfall will be achieved through compliance with the facility's NPDES general permit coverage or individual permit. The WLAs were estimated based upon consideration of TSS contributions from current operating conditions and current permit limits of each facility. IDEM's analyses of current operating conditions and flow and water quality discharge data from individual facilities indicate that WLAs in Table 36, Table 38, and Table 39 can be achieved through compliance with each facility's existing NPDES general permit coverage (under 327 IAC 15-7) or individual permit. Therefore, IDEM believes that existing general and individual permit limits are suitable to attain the WLAs described in Table 36, Table 38, and Table 39. This TMDL does not preclude new or modified mining activities that employ the 70 mg/L daily maximum and 35 mg/L monthly average for TSS under the general permit rule. New or modified discharges under individual permits will be addressed through the NPDES permit process and must follow the assumptions set forth in the TMDL.

Table 29: Coal Mining Facilities with Individual Permits Discharging within the Maria Creek Watershed

Facility Name	Permit Number	Subwatershed	Outfall ID	AUID	Receiving Stream	Flow Regime	Estimated Design Flow (MGD)
Sunrise Coal Carlisle Mine	IN0062791	Marsh Creek	005	INB11I3_T1001	Tributary of Marsh Creek	High	1.77
						Moist	0.88
						Mid	0.88
						Dry	0.66
						Low	0.47
Sunrise Coal Oaktown Mine	IN0064629	Marsh Creek	001	INB11I3_04	Marsh Creek	All	0.5

Table 30: Coal Mining Facilities with General Permits Discharging within the Maria Creek Watershed

Facility Name	Permit Number	Subwatershed	Outfall ID	AUID	Receiving Stream	Estimated Surface Impacts in Subwatershed (Acres)
Sunrise Coal Carlisle Mine	ING040199	Marsh Creek	003, 202	INB11I3_02	Marsh Creek	283
Sunrise Coal Oaktown Mine	ING040222	Marsh Creek	002, 005	INB11I3_04	Marsh Creek	122
		Cotton Branch	006	INB11I4_T1001	Tributary of Maria Creek	20
Peabody Midwest Bear Run Mine	ING040239	Headwaters Maria Creek	068	INB11I1_T1002	Tributary of Maria Creek	2,123

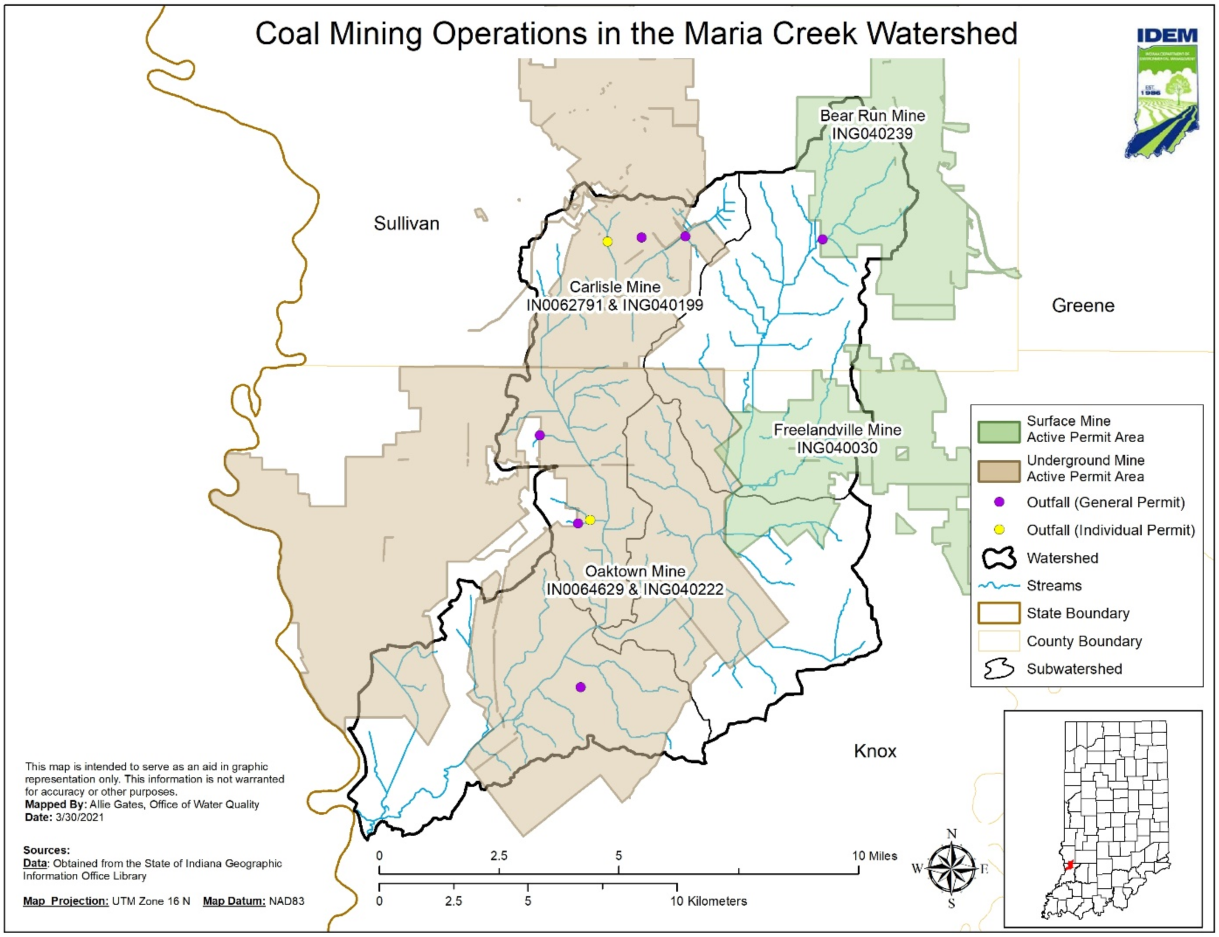

Figure 23: Coal Mining Facilities located within the Maria Creek Watershed

Permit Compliance

Table 31: Summary of Industrial Wastewater Permit Compliance in the Maria Creek Watershed for the Five-Year Period of 2016-2020.

Subwatershed	Facility Name	NPDES Permit Number	Stream	Inspections for the Last Five Years	Water Quality Violations for the Last Five Years					
					Outfall	Month	Year	Parameter	Type	Exceedance
Tilley Ditch	Freelandville Water Association	IN0059480	Tributary of Tilley Ditch	Inspected by IDEM: 11/17/2016: Violations Observed 7/6/2017: Violations Observed 11/1/2018: Potential Problems 6/22/2020: Potential Problems	002	Jan.	2016	TR Iron	Mo. Avg.	23%
					002	Jan.	2016	TSS	Mo. Avg.	133%
					002	Jan.	2016	TSS	Daily Max.	16%
					002	Feb.	2016	TSS	Mo. Avg.	248%
					002	Feb.	2016	TSS	Daily Max.	74%
					002	May	2016	TR Iron	Mo. Avg.	42%
					002	June	2016	TR Iron	Daily Max.	38%
					002	June	2016	TR Iron	Mo. Avg.	214%
					002	July	2016	TR Iron	Daily Max.	264%
					002	July	2016	TR Iron	Mo. Avg.	729%
					002	July	2016	TSS	Daily Max.	29%
					002	July	2016	TSS	Mo. Avg.	158%
					002	Aug.	2016	TR Iron	Daily Max.	46%
					002	Aug.	2016	TR Iron	Mo. Avg.	233%
					002	Dec.	2016	TR Iron	Mo. Avg.	122%
					002	March	2017	TR Iron	Mo. Avg.	56%
					002	Jan	2020	TR Iron	Mo. Avg.	28%
					002	March	2020	TR Iron	Mo. Avg.	53%
					002	March	2020	TR Iron	Daily Max.	21%
					002	April	2020	TR Iron	Mo. Avg.	4%
Marsh Creek	Sunrise Coal LLC – Carlisle Mine	ING040199	Tributary of Marsh Creek	Inspected monthly by IDNR	003	Feb.	2017	Total Mn	Daily Avg.	9%
					003	March	2017	Total Mn	Daily Avg.	10%
					003	April	2019	Total Iron	Daily Avg.	36%
					003	April	2019	Total Iron	Daily Max.	12%
					003	March	2020	Total Iron	Daily Avg.	7%
	Sunrise Coal LLC – Carlisle Mine	IN0062791	Tributary of Marsh Creek	Inspected by IDEM: 3/28/2017: Violations Observed 9/19/2017: Violations Observed 11/29/2018: Satisfactory 7/14/20: Satisfactory Inspected monthly by IDNR	005	Aug.	2016	Sulfate	Mo. Avg.	9%
					005	Aug.	2016	pH	Daily Min.	-21%
					005	Aug.	2016	TR Iron	Daily Max.	7%
					005	Aug.	2016	TR Iron	Mo Avg.	114%
					005	May	2017	Sulfate	Mo. Avg.	37%

Subwatershed	Facility Name	NPDES Permit Number	Stream	Inspections for the Last Five Years	Water Quality Violations for the Last Five Years					
					Outfall	Month	Year	Parameter	Type	Exceedance
	Sunrise Coal LLC – Oaktown Mine	ING040222	Tributary of Marsh Creek	Inspected monthly by IDNR	001	Aug.	2016	pH	Daily Min.	-49%
	Sunrise Coal LLC – Oaktown Mine	IN0064629	Tributary of Marsh Creek	Inspected by IDEM: 12/12/2018: Violations Observed 9/10/2019: Violations Observed Inspected monthly by IDNR	001B	Sep.	2018	pH	Daily Min.	-35%
					001B	Sep.	2018	TR Iron	Mo. Avg.	5233%
					001B	Sep.	2018	TR Iron	Daily Max.	3022%
					001B	Sep.	2018	TR Nickel	Mo. Avg.	402%
					001B	Sep.	2018	TR Nickel	Daily Max.	109%
					001B	Sep.	2018	TR Zinc	Mo. Avg.	718%
					001B	Sep.	2018	TR Zinc	Daily Max.	382%
					001B	Sep.	2018	TR Copper	Mo. Avg.	522%
					001B	Sep.	2018	TR Copper	Daily Max.	265%
					001A	Feb.	2019	TR Iron	Mo. Avg.	2025%
					001A	Feb.	2019	TR Iron	Daily Max.	1215%
					001A	Feb.	2019	TR Zinc	Mo. Avg.	167%
					001A	Feb.	2019	TR Zinc	Daily Max.	64%
					001A	Feb.	2019	TR Nickel	Mo. Avg.	92%
					001D	Feb.	2019	TR Iron	Mo. Avg.	1558%
					001D	Feb.	2019	TR Iron	Daily Max.	871%
					001D	Feb.	2019	TR Nickel	Mo. Avg.	7%
					001D	Feb.	2019	TSS	Mo. Avg.	13%
					001D	Feb.	2019	TR Zinc	Mo. Avg.	27%
					001A	April	2019	Total Sulfate	Mo. Avg.	8%
					001A	April	2019	TR Iron	Mo. Avg.	667%
					001A	April	2019	TR Iron	Daily Max.	349%
					001A	April	2019	TR Nickel	Mo. Avg.	18%
					001A	April	2019	TR Zinc	Mo. Avg.	9%
Headwaters Maria Creek	Peabody Midwest Mining LLC – Bear Run Mine	ING040239	Tributary of Maria Creek	Inspected monthly by IDNR	068	May	2017	Total Iron	Daily Avg.	12%
					068	May	2017	Total Iron	Daily Max.	38%
					068	May	2017	TSS	Daily Avg.	166%
					068	May	2017	TSS	Daily Max.	266%
					068	April	2018	TSS	Daily Avg.	80%
					068	April	2018	TSS	Daily Max.	14%
					068	April	2020	TSS	Daily Avg.	6%

2.8.3 Regulated Stormwater

Activities that discharge stormwater are typically regulated through NPDES stormwater general permits. The stormwater general permit requirements were originally contained in IAC and set by Indiana's Environmental Rules Board through its formal rulemaking process. General permits apply universally to all entities required to operate in accordance with the rule. However, IDEM is currently in the process of changing its approach to general permits from permit-by-rule to administrative general permits. The construction stormwater, municipal separate storm sewer system (MS4), and industrial stormwater administrative general permits are currently being developed.

Construction Stormwater

Stormwater run-off associated with construction activity is currently regulated under 327 IAC 15-5, which is commonly referred to as "Rule 5" or the construction stormwater general permit. The construction stormwater general permit is a performance-based regulation designed to reduce pollutants that are associated with construction and/or land disturbing activities. In Indiana, most construction projects are administered through the general permit. The requirements of the permit apply to all persons who are involved in construction activity (which includes clearing, grading, excavation and other land disturbing activities) that results in the disturbance of one (1) acre or more of total land area. If the land disturbing activity results in the disturbance of less than one (1) acre of total land area but is part of a larger common plan of development or sale, the project is still subject to stormwater permitting.

The construction stormwater general permit requires the development and implementation of a construction plan that includes a stormwater pollution prevention plan (SWPPP). The SWPPP outlines how erosion and sedimentation will be controlled on the project site to minimize the discharge of sediment off-site or to a water of the state. The SWPPP addresses other pollutants that may be associated with construction activity. This can include disposal of building materials, management of fueling operations, etc. The SWPPP should also address pollutants that will be associated with the post-construction land use. It is the responsibility of the project site owner to implement the SWPPP. In addition, it is critical that the site is monitored during the construction process and in-field modifications are made to address the discharge of sediment and other pollutants from the project site. This may require modification of the SWPPP and field changes on the project site, as necessary, to prevent pollutants, including sediment, from leaving the project site.

If an adverse environmental impact from a project site is evident, IDEM may require the site to obtain an individual construction stormwater permit. An individual construction stormwater permit is typically required only if IDEM determines the discharge will significantly lower water quality. If an individual construction stormwater permit is required, notice will be given to the project site owner. An individual construction stormwater permit is a written document developed specifically for the project site.

The average annual land disturbance associated with construction sites permitted under 327 IAC 15-5 are reported in Table 32. The estimated land disturbance was calculated for each subwatershed using data from permitted construction sites for the past five years.

Table 32: Average Annual Land Disturbance from Permitted Construction Activity in the Maria Creek Subwatersheds from 2016-2020

Subwatershed	Estimated Annual Land Disturbance (Acres)
Cotton Branch	3.33
Tilley Ditch	1.55
Marsh Creek	2.35
Headwaters Maria Creek	7.88

Industrial Stormwater

Stormwater run-off associated with industrial activity is currently regulated under 327 IAC 15-6, which is commonly referred to as “Rule 6” or the industrial stormwater general permit. Compliance with the industrial stormwater general permit is required for facilities where activities of the industrial operation are exposed to stormwater and run-off is discharged though a point source to a waters of the state. The general permit applies to specific categories of industrial activities that must obtain permit coverage. Determination of applicable industrial activities is based on a facility’s Standard Industrial Classification (SIC) Code(s) or facility activities included in the listed narrative descriptions within 327 IAC 15-6. There are currently no facilities with industrial stormwater general permit coverage located in the Maria Creek watershed.

Municipal Separate Storm Sewer Systems

Stormwater run-off from certain types of urbanized areas are currently regulated under 327 IAC 15-13, which is commonly referred to as “Rule 13” or the municipal separate storm sewer system (MS4) general permit. MS4s are defined as a conveyance or system of conveyances owned by a state, city, town, or other public entity that discharges to waters of the state and is designed or used for collecting or conveying stormwater. Regulated conveyance systems include roads with drains, municipal streets, catch basins, curbs, gutters, storm drains, piping, channels, ditches, tunnels, and conduits. It does not include combined sewer overflows and publicly owned treatment works. Municipalities with a population served by a MS4 of 100,000 or more are regulated as a Phase I MS4 entity. Municipalities with a population served by a MS4 of 7,000 or more are regulated as a Phase II MS4 entity. There are currently no MS4 entities in the Maria Creek watershed.

2.9 Summary

The information presented in Section 2.0 helps to provide a better comprehensive understanding of the conditions and characteristics in the Maria Creek watershed that, when coupled with the potential sources of pollution, affect both water quality and water quantity. In summary, the predominant land uses in the Maria Creek watershed of agriculture and forestry serve as indicators as to the type of sources that are likely to contribute to water quality impairments in the Maria Creek watershed. Human population in the Maria Creek watershed indicates where more infrastructure related pressures on water quality might exist. The sections on topography and geology, as well as soils, provide information on the natural features that affect hydrology in the Maria Creek watershed. These features interact with land use activities and human population to create pressures on both water quality and quantity in the Maria Creek watershed. Lastly, the section on climate and precipitation provides information on water quantity and the factors that influence flow, which ultimately affects the influence of stormwater on the watershed. Collectively, this information plays an important role in understanding the sources that contribute to water quality impairment during TMDL development and crafting the linkage analysis that connects the observed water quality impairment to what has caused that impairment.

3.0 TECHNICAL APPROACH

Previous sections of the report have provided a description of the Maria Creek watershed and summarized the applicable water quality standards, water quality data, and identified the potential sources of *E. coli* and TSS for assessment units in each subwatershed. This section presents IDEM's technical approach for using water quality sampling data and flow data for each subwatershed to estimate the current allowable loads of *E. coli* and TSS in each subwatershed. This section focuses on describing the methodology and is helpful in understanding subsequent sections of the TMDL report.

3.1 Load Duration Curves

To determine allowable loads for the TMDL, IDEM uses a load duration curve approach. This approach helps to characterize water quality problems across flow conditions and provide a visual display that assists in determining whether loadings originate from point or nonpoint sources. Load duration curves present the frequency and magnitude of water quality violations in relation to the allowable loads, communicating the magnitude of the needed load reductions.

Developing a load duration curve is a multi-step process. To calculate the allowable loadings of a pollutant at different flow regimes, the load duration curve approach involves multiplying each flow by the TMDL target value or water quality standard and an appropriate conversion factor. The steps are as follows:

- A flow duration curve for the stream is developed by generating a flow frequency table and plotting the observed flows in order from highest (left portion of curve) to lowest (right portion of curve).
- The flow curve is translated into a load duration (or TMDL) curve. To accomplish this, each flow value is multiplied by the TMDL target value or water quality standard with the appropriate conversion factor, and the resulting points are graphed. Conversion factors are used to convert the units of the target (e.g., #/100 mL for *E. coli*) to loads (e.g., MPN/day for *E. coli*) with the following factors used for this TMDL:
- *E. coli*: Flow (cfs) x TMDL Concentration Target (#/100mL) x Conversion Factor (24,465,758.4) = Load (MPN/day)
- TSS: Flow (cfs) x TMDL Concentration Target (mg/L) x Conversion Factor (5.39) = Load (lb/day)
- To estimate existing loads, each water quality sample is converted to a load by multiplying the water quality sample concentration by the average daily flow on the day the sample was collected and the appropriate conversion factor. Then, the existing individual loads are plotted on the TMDL graph with the curve.
- Points plotting above the curve represent violations of the applicable water quality standard or exceedances of the applicable target and the daily allowable load. Those points plotting below the curve represent compliance with standards and the daily allowable load.

- The area beneath the load duration curve is interpreted as the loading capacity of the stream. The difference between this area and the area representing the current loading conditions above the curve is the load that must be reduced to meet water quality standards.

The load duration curve approach can consider seasonal variation in TMDL development as required by the CWA and U.S. EPA's implementing regulations. Because the load duration curve approach establishes loads based on a representative flow regime, it inherently considers seasonal variations and critical conditions attributed to flow conditions.

The stream flows displayed on water quality or load duration curves may be grouped into various flow regimes to aid with interpretation of the load duration curves. The flow regimes are typically divided into the following five "hydrologic zones" (U.S. EPA, 2007):

- High Flows: Flows in this represent flooding or near flooding stages of a stream. These flows are exceeded 0 – 10 percent of the time.
- Moist Zone: Flows in this range are related to wet weather conditions. These flows are exceeded 10 – 40 percent of the time.
- Mid-Range Zone: Flows in this range represent median stream flow conditions. These flows are exceeded 40 – 60 percent of the time.
- Dry Zone: Flows in this range are related to dry weather flows. These flows are exceeded 60 -90 percent of the time.
- Low Flows: Flows in this range are seen in drought-like conditions. These flows are exceeded 90 -100 percent of the time.

The load duration curve approach helps to identify the sources contributing to the impairment and to roughly differentiate between sources. Exceedances of the load duration curve at higher flows (0-40 percent ranges) are indicative of wet weather sources (e.g., nonpoint sources, regulated stormwater discharges). Exceedances of the load duration curve at lower flows (60 to 100 percent range) are indicative of point source sources (e.g., wastewater treatment facilities, livestock in the stream). Table 33 summarizes the general relationship between the five hydrologic zones and potentially contributing source areas (the table is not specific to any individual pollutant). For example, the table indicates that impacts from wastewater treatment plants are usually most pronounced during dry and low flow zones because there is less water in the stream to dilute their loads. In contrast, impacts from channel bank erosion is most pronounced during high flow zones because these are the periods during which stream velocities are high enough to cause erosion to occur.

Table 33: Relationship between Load Duration Curve Zones and Contributing Sources

Contributing Source Area	Duration Curve Zone				
	High	Moist	Mid-Range	Dry	Low
Livestock direct access to streams				M	H
Wildlife direct access to streams				M	H
Pasture Management	H	H	M		
On-site wastewater systems/Unsewered Areas	M	M-H	H	H	H
Riparian Buffer areas		H	H	M	
Abandoned mines	H	H	H	H	H
Stormwater: Impervious		H	H	H	
Stormwater: Upland	H	H	M		
Field drainage: Natural condition	H	M			
Field drainage: Tile system	H	H	M-H	L-M	
Bank erosion	H	M			

Note: Potential relative importance of source area to contribute loads under given hydrologic condition (H: High; M: Medium; L: Low)

3.2 Stream Flow Estimates

Daily stream flows are necessary to implement the load duration curve approach. Load duration assessment locations in the Maria Creek watershed were chosen based on the location of the impaired stream segments and the availability of water quality samples to estimate existing loads.

The USGS does not operate any stream flow gaging stations in the Maria Creek watershed. Since there are no continuous flow data for the Maria Creek watershed, flow data were estimated for the Maria Creek watershed using flow data from a neighboring “surrogate” watershed. This is a standard practice when developing TMDLs for ungaged watersheds and is appropriate when the two watersheds are located close to one another and have similar land use and soil characteristics.

The USGS gage for Busseron Creek near Carlisle, IN (03342500) is located in Sullivan County approximately seven miles upstream of the confluence of Busseron Creek and the Wabash River. This gage was used for the development of the *E. coli* and TSS load duration curve analysis for the Maria Creek watershed TMDL. Gage 03342500 drains approximately 228 square miles in the Busseron Creek (HUC 10: 0512011115) watershed as shown in Figure 24.

Table 34: USGS Site Assignment for Development of Load Duration Curve

Gage Location	Gage ID	Period of Record Used in Analysis
Busseron Creek near Carlisle, IN	03342500	2011 - 2020

Since the load duration approach requires a stream flow time series for each site included in the analysis, stream flows were extrapolated from USGS gage 03342500 for each assessment location by using a multiplier based upon the ratio of the upstream drainage area for a given location to the drainage area of the Maria Creek watershed.

Flows were estimated using the following equation:

$$Q_{ungaged} = \frac{A_{ungaged}}{A_{gaged}} \times Q_{gaged}$$

Where,

$Q_{ungaged}$:	Flow at the ungaged location
Q_{gaged}:	Flow at surrogate USGS gage station
$A_{ungaged}$:	Drainage area of the ungaged location
A_{gaged}:	Drainage area of the gaged location

In this procedure, the drainage area of each of the load duration stations was divided by the drainage area of the surrogate USGS gage. The flows for each of the stations were then calculated by multiplying the flows at the surrogate gage by the drainage area ratios. Additional flows were added to certain locations to account for municipal wastewater treatment plants that discharge upstream and are not directly reflected in the load duration curve method.

Table 35: Load Duration Curve Key Flow Percentile Estimates

Subwatershed	Drainage Area (sq. miles)	Flow Duration Exceedance Interval Flows (cfs)				
		High (5%)	Moist (25%)	Mid-Range (50%)	Dry (75%)	Low (95%)
Cotton Branch	96.56	563	124	48	16	6
Tilley Ditch	49.51	287	63	24	8	2
Marsh Creek	23.83	141	32	13	5	3
Headwaters Maria Creek	27.34	158	35	13	4	1

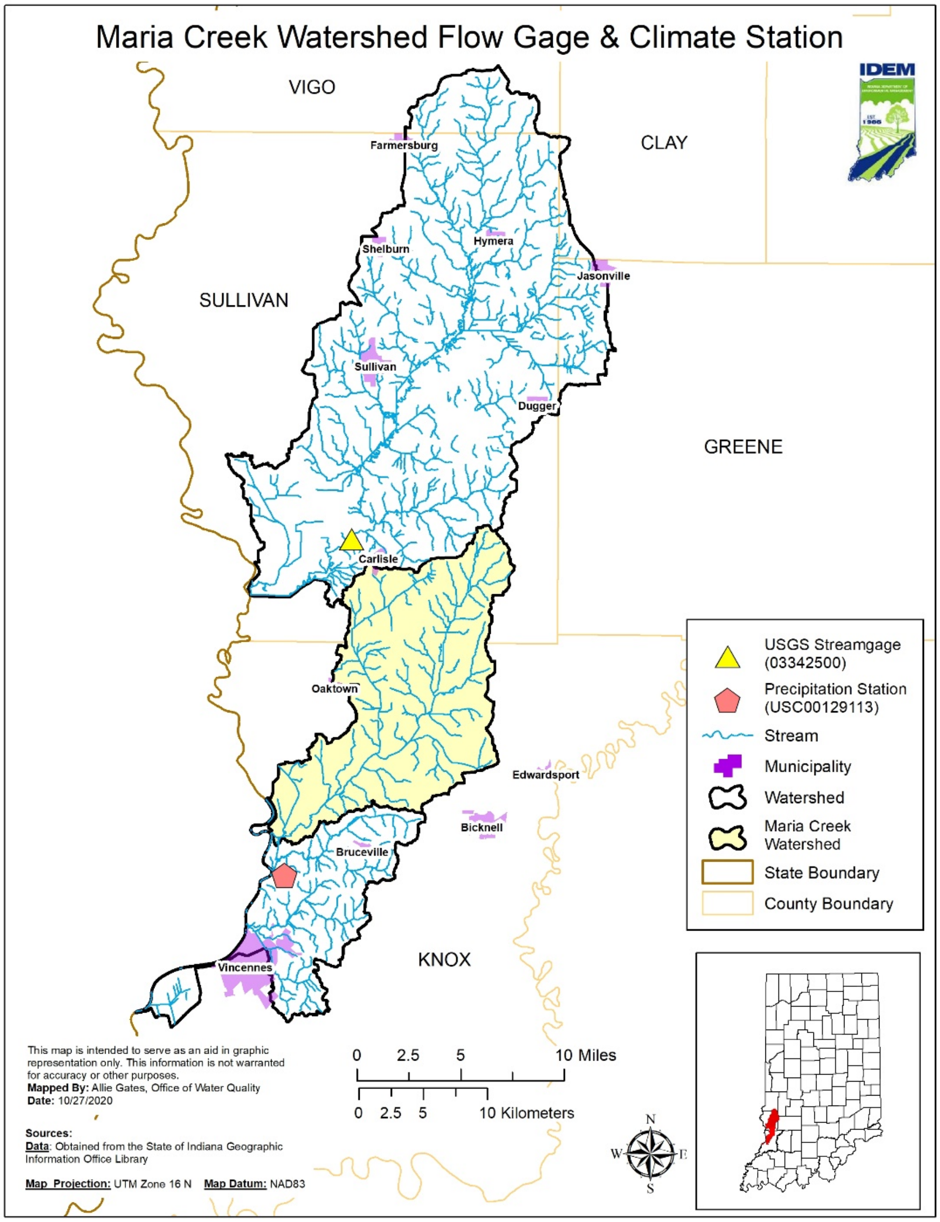

Figure 24: Location of Surrogate Flow Gage in Carlisle, Indiana

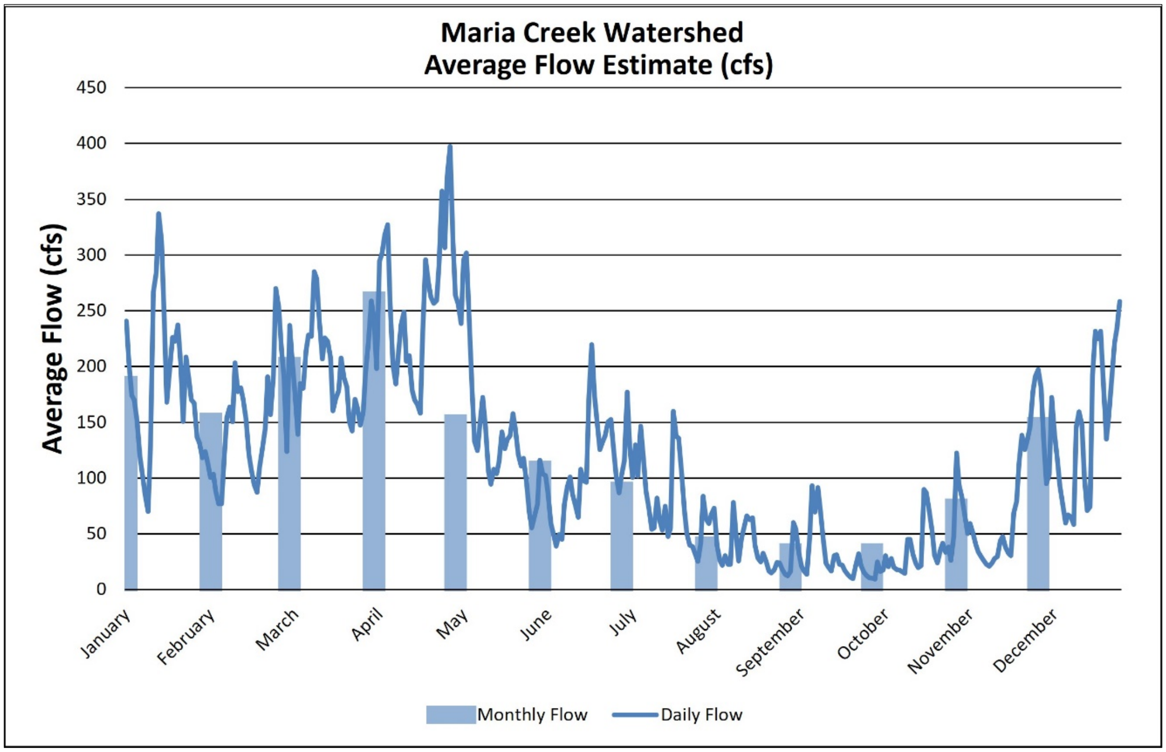

Figure 25: Average Daily Flow Estimate for the Maria Creek Watershed for data from 2011-2020

3.3 Margin of Safety (MOS)

Section 303(d) of the Clean Water Act and U.S. EPA regulations at 40 CFR 130.7 require that "TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numeric water quality standards with seasonal variations and a MOS which takes into account any lack of knowledge concerning the relationship between limitations and water quality." U.S. EPA guidance explains that the MOS may be implicit (i.e., incorporated into the TMDL through conservative assumptions in the analysis) or explicit (i.e., expressed in the TMDL as loadings set aside for the MOS). This TMDL uses both an implicit and explicit MOS. An implicit MOS was used by applying a couple of conservative assumptions. A moderate explicit MOS has been applied by reserving ten percent of the allowable load. Ten percent was considered an appropriate MOS based on the following considerations:

- The use of the load duration curve approach minimizes a great deal of uncertainty associated with the development of TMDLs because the calculation of the loading capacity is simply a function of flow multiplied by the target value. Most of the uncertainty is therefore associated with the estimated flows in each assessed segment which were based on extrapolating flows from the nearest USGS gage.
- An additional implicit MOS for *E. coli* is included because the load duration analysis does not address die-off of pathogens.
- An additional implicit MOS for pollutants is realized in that when in compliance NPDES permitted sources are seldom discharging at their allowable limits.

3.4 Future Growth Calculations

Population trends indicate that this watershed has seen a slight increase in population but has generally been stagnant over the past two decades (Table 22). Uncertainty regarding future populations and land use changes in the Maria Creek watershed have led IDEM to allocate 5% of the loading capacity to address increased bacteria loads from future contributors. Mining activity continues to play an important role in land use activities and disturbance in the Maria Creek watershed. Mining operations are not static in the landscape and may move outfall locations as activities are conducted. Additionally, new sources of mining activities can change based on new technology for extracting coal and/or economic feasibility. As such, IDEM has chosen to allocate 10% of the loading capacity to address increased sediment loads from future contributors.

4.0 LINKAGE ANALYSIS

A linkage analysis connects the observed water quality impairment to what has caused that impairment. An essential component of developing a TMDL is establishing a relationship between the source loadings and the resulting water quality. Potential point and nonpoint sources are inventoried in Section 2.0, and water quality data within the Maria Creek watershed are discussed in Section 1.4. The purpose of this section is to evaluate which of the various potential sources is most likely to be contributing to the observed water quality impairments.

Load duration curves were created for each subwatershed in the Maria Creek watershed that were sampled by IDEM in 2019 and 2020. The load duration curve method considers how stream flow conditions relate to a variety of pollutant loadings and their sources (point and nonpoint). Load duration curves illustrate water quality standard and target value violations during all flow ranges that occurred during the sampling events. Section 3.0 summarizes the load duration curve approach.

To further investigate sources, water quality precipitation graphs have been created. Elevated levels of pollutants during rain events indicate contributions of pollutants due to run-off. The precipitation data was taken from a weather station in Carlisle, IN and managed by the Midwestern Regional Climate Center. Additionally, sediment loading by sources in the watershed were estimated using the Generalized Watershed Loading Function Enhanced (GWLF-E) watershed model. Results of the model indicate which land uses are contributing the greatest annual loading across the watershed and are discussed in Section 4.3

A linkage analysis for each subwatershed is included in this section. The analysis includes a summary of the subwatershed, including information regarding sampling sites, land use, NPDES facilities, CFOs, and soil characteristics. A summary table of each subwatershed is also provided that includes the load allocations (LAs), wasteload allocations (WLAs), and margin of safety (MOS) values for pollutants of concern. Evaluating the load duration curves and precipitation graphs with consideration of these watershed characteristics allows for identification of potential point and nonpoint sources that are contributing to elevated concentrations of pollutants. Pollutants of concern for the Maria Creek watershed identified by sampling data include *E. coli* and TSS.

4.1 Pollutants of Concern

4.1.1 *E. coli*

Establishing a linkage analysis for *E. coli* is challenging because there are so many potential sources, and *E. coli* counts have a high degree of variability. While it is difficult to perform a site-specific assessment of the causes of high *E. coli* for each location in a watershed, it is reasonable to expect that general patterns and trends can be used to provide some perspective on the most significant sources. Additional information is outlined in Section 1.1.

E. coli sources typically associated with high flow and moist conditions include failing onsite wastewater systems, urban stormwater/CSOs, run-off from agricultural areas, and bacterial re-suspension from the streambed. *E. coli* sources typically associated with low flow conditions include a large number of homes on failing or illicitly connected septic systems that would provide a constant source. Elevated *E. coli* levels at low flow could also result from inadequate disinfection at wastewater treatment plants or animals with direct access to streams.

4.1.2 Total Suspended Solids (TSS)

Developing a linkage analysis to address the connection between siltation and its effect on aquatic life use often involves an evaluation of multiple factors. The interaction between erosion processes and hydrology is an important part of the assessment, with land use, riparian areas, and channel conditions being key considerations. Each can play a potential role in both creating and solving sediment problems. The sediment issues can occur when external inputs (e.g., sediment, run-off volume) to the stream become excessive, or when stream characteristics are altered so that it can no longer assimilate the loads, or a combination of both occur. Additional information is outlined in Section 1.1.

Sheet erosion is the detachment of soil particles by raindrop impact and their removal by water flowing overland as a sheet instead of in channels or rills. Rill erosion refers to the development of small, ephemeral concentrated flow paths, which function as both sediment source and sediment delivery systems for erosion on hillslopes. Sheet and rill erosion occurs more frequently in areas that lack or have sparse vegetation.

Bank and channel erosion refers to the wearing away of the banks of a stream or river. High rates of bank and channel erosion can often be associated with water flow and sediment dynamics being out of balance. This may result from land use activities that either alter flow regimes, adversely affect the floodplain and streamside riparian areas, or a combination of both. Hydrology is a major driver for both sheet/rill and stream channel erosion. Bank and channel erosion are made worse when streams are straightened or channelized because channelization shortens overall stream lengths and results in increased velocities, bed and bank erosion, and sedimentation. Modified stream channels often have little habitat structure and variability necessary for diverse and abundant aquatic species. Channelization also disconnects streams from floodplain and riparian areas that are often converted to developed or agricultural lands.

Since monitoring began, TSS in the Maria Creek watershed has sporadically exceeded the target. TSS primarily exceeded the target value in the winter months, although data is lacking for the spring months. High loads in the winter may be related to a lack of vegetative cover on agricultural fields adjacent to streams, leading to increased likelihood of soil erosion during precipitation events. Agricultural fields that have been tilled for the winter have an even greater potential for soil erosion. Further analysis pairing the TSS concentrations with flow conditions reveals elevated TSS concentrations during high flows and generally lower concentrations during mid-range and lower flow conditions. Elevated TSS concentrations during high flows are consistent with significant loads coming from stream bank and gully erosion.

In addition to TSS, siltation within a stream may be analyzed by taking a closer look into the Qualitative Habitat Evaluation Index (QHEI) scores assigned to each sampling location. Habitat assessments were completed at each sampling site after both fish community and macroinvertebrate community sample collections using a slightly modified version of the Ohio Environmental Protection Agency (OHEPA) QHEI (OHEPA, 2006). The QHEI allows for a quantitative assessment of physical characteristics of the sampled stream. Each sampling site was assigned a QHEI score in relation to the habitat quality for both fish and macroinvertebrate communities. Completed QHEI forms for the Maria Creek watershed are available in Appendix C.

The overall QHEI score is composed of a total of six metric scores. The six individual metrics include substrate, instream cover, channel morphology, bank erosion/riparian zone, pool/glide and riffle/run quality, and gradient. Of these metrics, the substrate metric is the most indicative of excessive siltation within a stream, while the bank erosion/riparian zone metric provides an explanation for excessive amounts of observed siltation. The substrate and bank erosion/riparian zone metric scores were analyzed for each sampling location throughout the watershed to determine if excessive siltation is linked to poor fish community IBI scores and macroinvertebrate community mIBI scores. Additional information regarding IBI and mIBI scores is available in Section 1.1.2.

Substrate and bank erosion/riparian zone metric scores were totaled and plotted against both fish community IBI scores and macroinvertebrate community mIBI scores (Figure 26 and Figure 27). Lower values for the substrate and bank erosion/riparian zone metrics indicate greater observed siltation within the stream and/or lower riparian and flood plain quality. Lower IBI and mIBI scores indicate fewer individuals and/or low species diversity was observed within a stream. The R^2 value for the fish community analysis was approximately 0.85, and the R^2 value for the macroinvertebrate community was approximately 0.88. These values indicate a strong positive correlation between excessive siltation and low IBI and mIBI scores. This analysis provides additional evidence that excessive siltation within a stream is linked to impaired biotic communities throughout the Maria Creek watershed in addition to elevated TSS monitoring data.

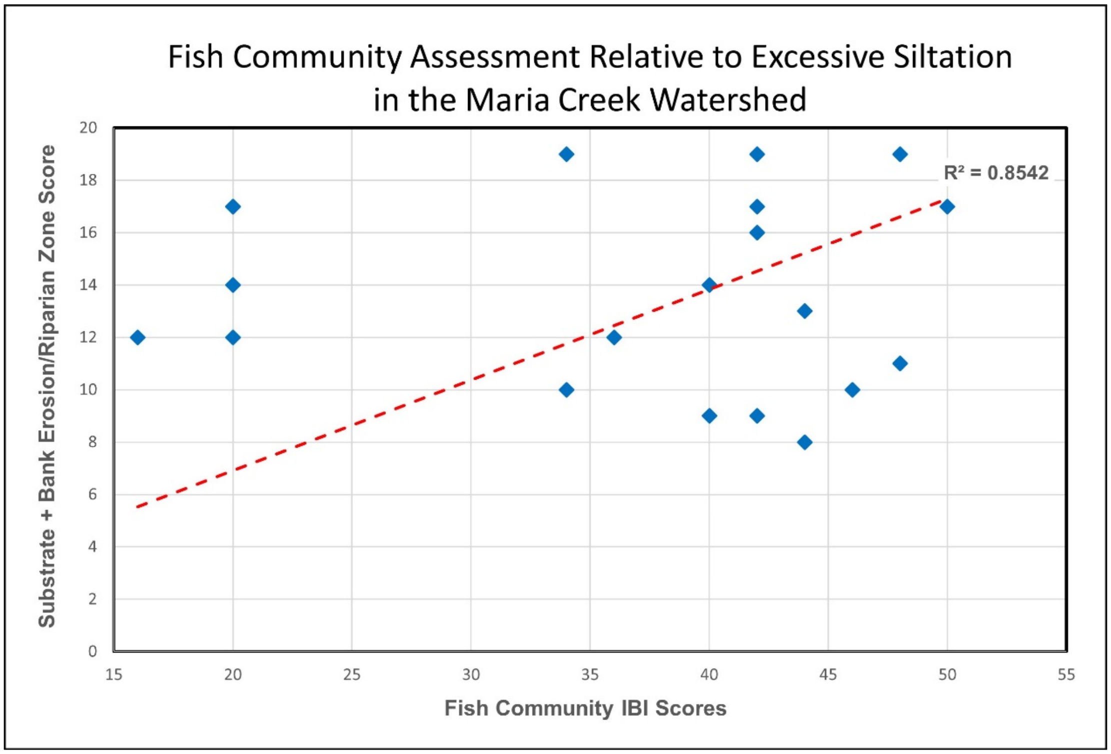

Figure 26: Substrate + Bank Erosion/Riparian Zone Score in Relation to Fish Community IBI Scores in the Maria Creek Watershed

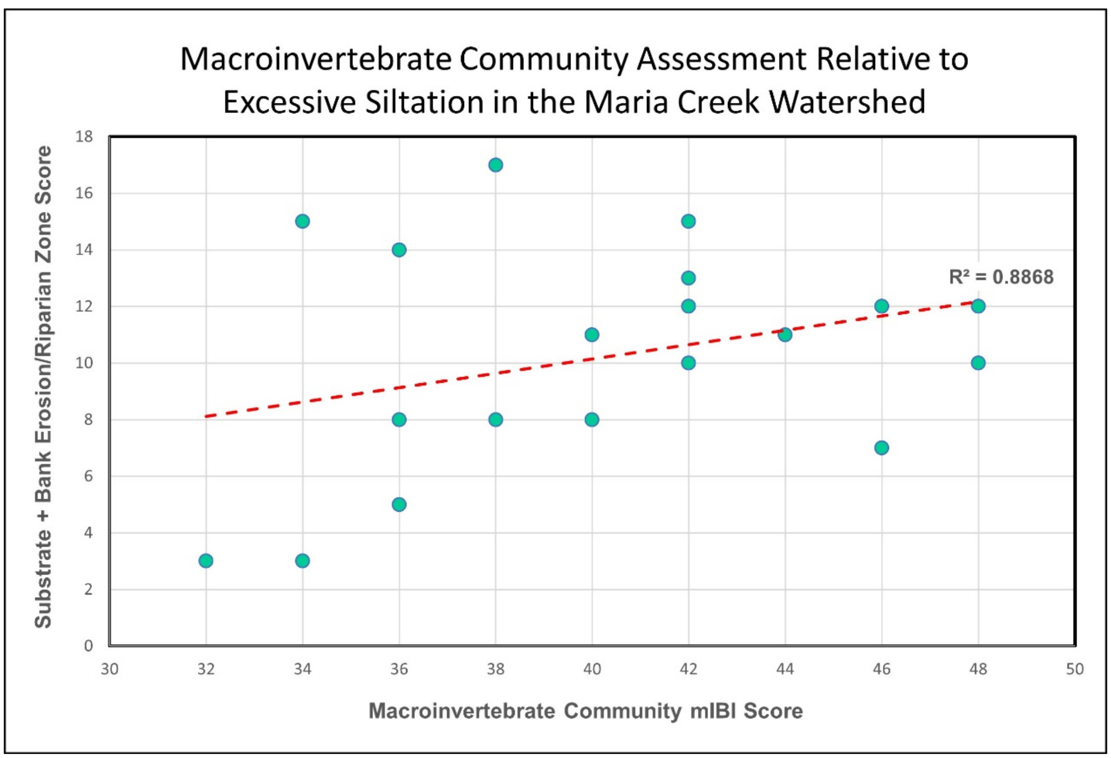

Figure 27: Substrate + Bank Erosion/Riparian Zone Score in Relation to Macroinvertebrate Community mIBI Scores in the Maria Creek Watershed

4.2 Linkage Analysis by Subwatershed

The following sections discuss the load duration curves, precipitation graphs, water quality duration graphs, and linkage of sources to the water quality exceedances for each subwatershed. Load duration curves, precipitation graphs, and water quality duration graphs were created for each subwatershed.

4.2.1 Cotton Branch

The Cotton Branch subwatershed drains approximately 96.56 square miles. This subwatershed is the southern extent of the Maria Creek watershed. Surface water generally flows southwest and drains out of the subwatershed and into the Wabash River north of Vincennes, IN. The land use is primarily agriculture (64 percent) followed by forested land (22 percent) and developed land (7 percent). There are two NPDES permitted dischargers located within the subwatershed. North Knox Intermediate School WWTP (IN0041092) discharges at Outfall 001 into a tributary of Maria Creek. Sunrise Coal Oaktown Mine (ING040222) is an underground mining operation that discharges into a tributary of Maria Creek at Outfall 006. The majority of the subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, this subwatershed is rated as somewhat limited or very limited. Maintenance and inspections of septic systems in the area are important to ensure proper function and capacity. The landscape in the area is relatively flat leading to its intense conversion to agricultural production and use. In many areas of the subwatershed there are little to no remaining riparian buffers left along its banks due to agricultural practices. Despite its flat nature, the subwatershed does contain significant amounts of highly erodible soil types. These soil types can be susceptible to sheet, rill, and isolated gully erosion and can contribute to sediment loss from agricultural lands, as well as lands from the high gradient slopes.

Many of the waterways in this subwatershed are identified as having hydric soil types in their riparian zones. These areas could be potential areas for wetland restoration or high functioning two stage ditch implementation. With a land use of 5 percent pasture land a heavy presence of pasture animals is not expected. There is one permitted CFO in the subwatershed.

There are three monitoring sites located in this subwatershed. Sites T01 and T04 are located on the main stem of Maria Creek, and site T03 is located on Cotton Branch (Figure 28). In 2019 and 2020, this subwatershed was sampled a total of 41 times between the three sites. All three sites failed the *E. coli* geometric mean (geomean) water quality standard of 125 MPN/100 mL. The *E. coli* geomean for site T01 was 482.71 MPN with 4/8 samples in exceedance of the single sample max. Site T03 had a geomean of 887.3 MPN with 7/8 samples in exceedance of the single sample max. Site T04 had a geomean of 306.63 MPN with 1/8 samples in exceedance of the single sample max. The *E. coli* water quality samples from sites T01, T03, and T04 used to calculate the geomean were taken on the same day approximately one hour apart for five consecutive weeks.

The fish community IBI score for site T01 was 48 (good) and the QHEI was 66 (good). The macroinvertebrate community mIBI score was 38 (fair) and the QHEI was 55 (good). The fish community IBI score for site T03 was 42 (fair) and the QHEI was 65 (good). The macroinvertebrate community mIBI score was 34 (poor) and the QHEI was 63 (good). The fish community IBI score for site T04 was 16 (very poor) and the QHEI was 30 (poor). The macroinvertebrate community mIBI score was 48 (good) and the QHEI was 28 (poor). Based on assessments of this data, two stream segments within the subwatershed were determined to be impaired for biological communities.

Evaluation of TSS monitoring data and QHEI substrate and bank erosion/riparian zone metric scores indicate a linkage between siltation and biological communities impairments in the Cotton Branch subwatershed. TSS concentrations ranged from 2.7 mg/L to 690 mg/L across 21 sampling events within the subwatershed and exceeded the target value of 30 mg/L four times. Heavy siltation was observed at one sampling site with silt as a predominant substrate and a very narrow riparian width. Heavy/severe erosion was noted at an additional sampling site. The floodplain quality was documented as open pasture/row crop at 66% of sampling sites. Given that the target value for TSS was sporadically violated and excessive siltation or indicators of siltation were documented throughout the subwatershed, high TSS is believed to be a primary linkage to the biological communities impairments. Therefore, a TMDL for TSS was developed for this subwatershed to address the biological communities impairments.

There are approximately 36 miles of streams in the subwatershed. Based on IDEM data collected in 2019 and 2020, there will be 22 stream miles impaired for *E. coli* and seven miles impaired for biological communities. These stream reaches will be listed on the 2022 303(d) List of Impaired Waters. Therefore, *E. coli* TMDLs were developed to address all *E. coli* impairments, and TSS TMDLs were developed to address all impaired biotic communities. The load duration curves for the Cotton Branch subwatershed are shown in Figure 29 and Figure 31. Table 36 provides a summary of the Cotton Branch subwatershed, including listed stream reaches by AUID, drainage area, sampling sites, land use, NPDES facilities, CFOs, as well as LA, WLAs, and MOS values for *E. coli* and TSS.

Precipitation graphs (Figure 30 and Figure 32) and water quality duration graphs (Appendix F) were created to further analyze potential sources. Elevated levels of pollutants during rain events indicate streams are susceptible to high loads of *E. coli* and TSS from run-off. However, precipitation graphs illustrate that streams are also occasionally in violation of water quality standards/targets even during drier conditions. This indicates point sources may also be contributing pollutants in addition to nonpoint sources. The water quality duration graphs indicate the majority of sources of *E.coli* and TSS in this watershed are nonpoint sources. Nonpoint sources may include small animal operations, wildlife, pasture animals with direct access to streams, land application of animal waste, straight pipes, streambank erosion, agricultural practices, and leaking and failing septic systems. See Section 6.1 and Table 44 for information pertaining to potentially suitable BMP selection for the Maria Creek watershed.

Table 36: Summary of Cotton Branch Subwatershed Characteristics

Cotton Branch (051201111804)					
Drainage Area	96.56 square miles				
Surface Area	23.22 square miles				
Site # [IDEM Station ID]	T01 [WBU-18-0004], T03 [WBU-18-0006], T04 [WBU-18-0007]				
Listed Segments	INB11I4_03; INB11I4_T1004; INB11I4_T1005; INB11I4_02; INB11I4_T1001				
Listed Impairments [TMDL(s)]	*E. coli* [*E. coli*], Impaired Biotic Communities [TSS]				
Land Use	Agricultural Land: 64% Forested Land: 22% Developed Land: 7% Hay/Pasture: 5% Open Water: 2% Shrub/Scrub: <1% Wetlands: <1%				
NPDES Facilities	North Knox Intermediate School WWTP (IN0041092); Sunrise Coal Oaktown Mine (ING040222) – Outfall 006				
CAFOs	NA				
CFOs	Grant & Dawn Earley Farms (Farm ID: 6164)				
TMDL *E. Coli Allocations* (MPN/day)					
Allocation Category Duration Interval (%)	**High Flows 5%**	**Moist Conditions 25%**	**Mid-Range Flows 50%**	**Dry Conditions 75%**	**Low Flows 95%**
LA	6.57E+11	1.43E+11	5.38E+10	1.68E+10	5.15E+09
WLA (Total)	4.45E+07	4.45E+07	4.45E+07	4.45E+07	4.45E+07
MOS (10%)	7.73E+10	1.69E+10	6.33E+09	1.98E+09	6.11E+08
Future Growth (5%)	3.87E+10	8.43E+09	3.16E+09	9.89E+08	3.06E+08
Upstream Drainage Input (Tilley Ditch, Marsh Creek)	**2.46E+12**	**5.46E+11**	**2.13E+11**	**7.38E+10**	**2.90E+10**
TMDL = LA+WLA+MOS	**3.24E+12**	**7.15E+11**	**2.76E+11**	**9.36E+10**	**3.51E+10**
WLA (Individual)					
North Knox Intermediate School WWTP (IN0041092)	4.45E+07	4.45E+07	4.45E+07	4.45E+07	4.45E+07
TMDL Total Suspended Solids Allocations (lbs/day)					
Allocation Category Duration Interval (%)	**High Flows 5%**	**Moist Conditions 25%**	**Mid-Range Flows 50%**	**Dry Conditions 75%**	**Low Flows 95%**
LA	17,327.61	3,780.37	1,417.80	442.23	135.77
WLA (Total)	74.40	17.21	6.92	3.02	1.80
MOS (10%)	2,175.25	474.70	178.09	55.66	17.20
Future Growth (10%)	2,175.25	474.70	178.09	55.66	17.20

Upstream Drainage Input (Tilley Ditch, Marsh Creek)	**69,302.22**	**15,367.77**	**5,999.45**	**2,077.35**	**815.04**
TMDL = LA+WLA+MOS	**91,054.73**	**20,114.75**	**7,780.35**	**2,633.92**	**987.00**
WLA (Individual)					
North Knox Intermediate School WWTP (IN0041092)	1.25	1.25	1.25	1.25	1.25
Oaktown Mine (ING040222)	69.26	15.11	5.67	1.77	0.55
Construction Stormwater	3.88	0.85	0.00	0.00	0.00

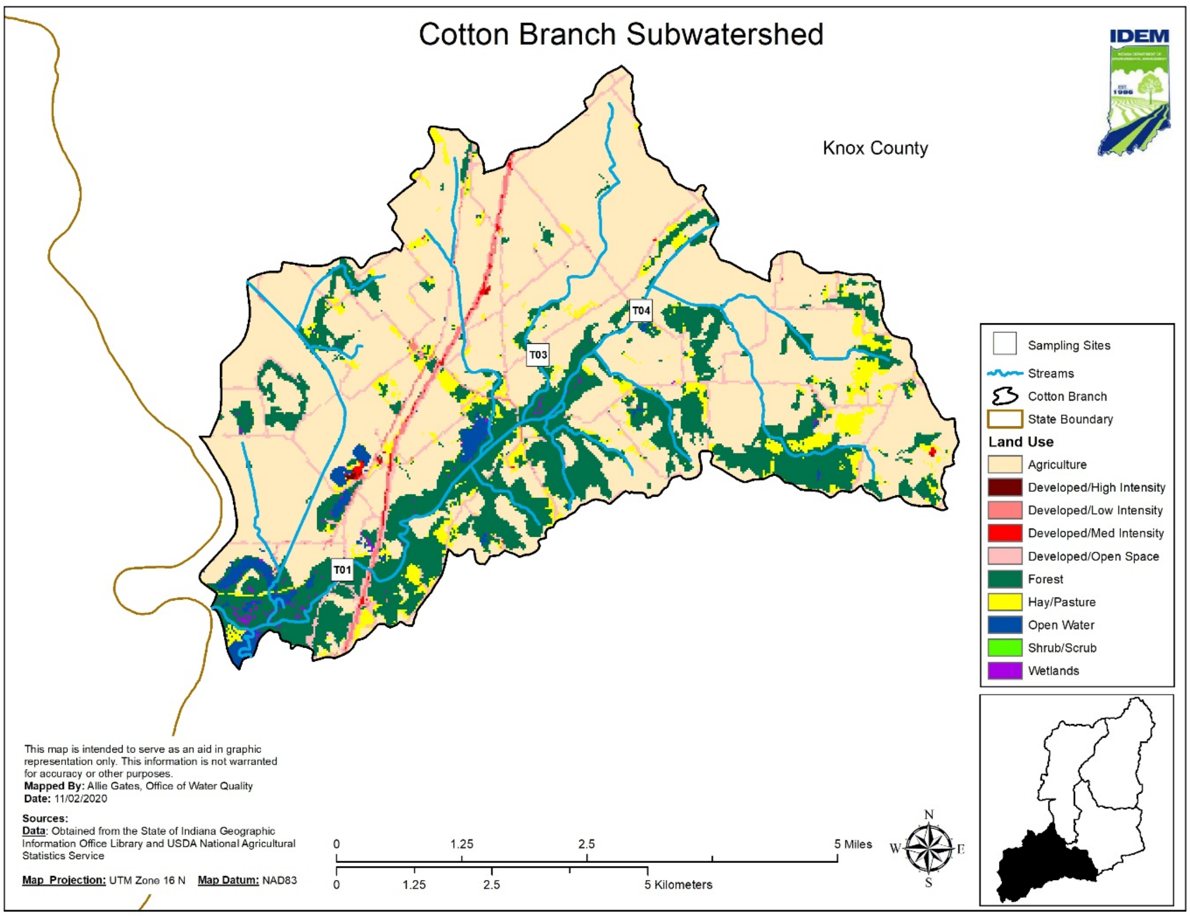

Figure 28: Sampling Sites in the Cotton Branch Subwatershed

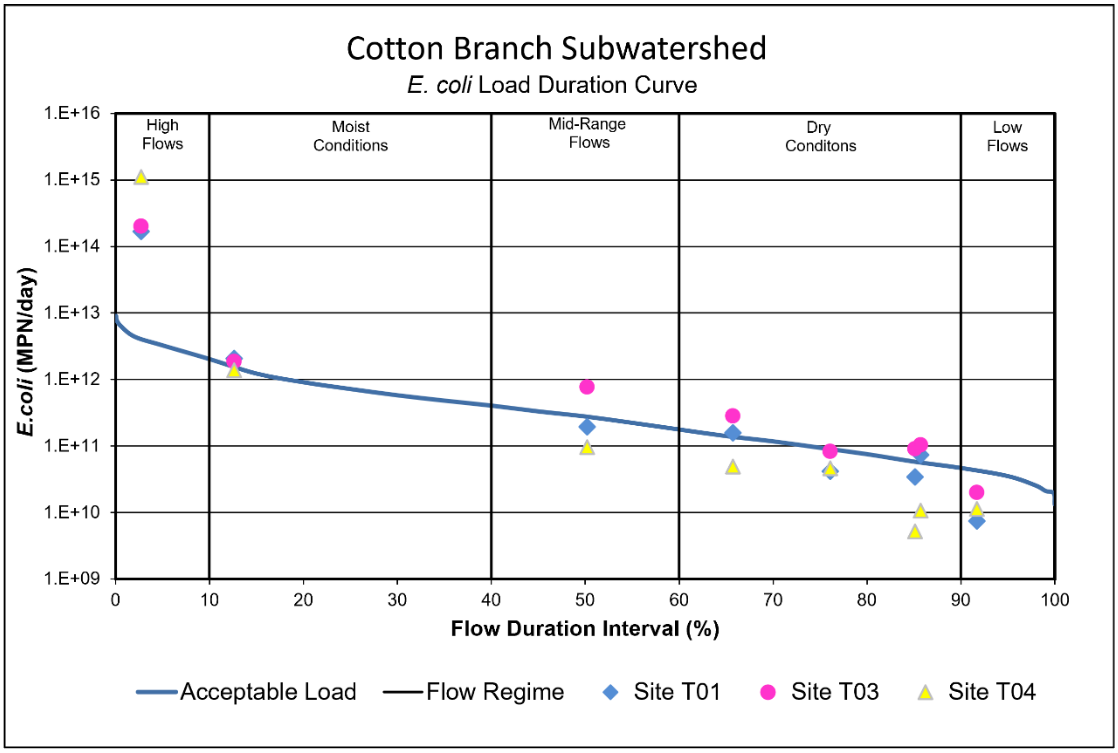

Figure 29: *E. coli* Load Duration Curve for Cotton Branch Subwatershed

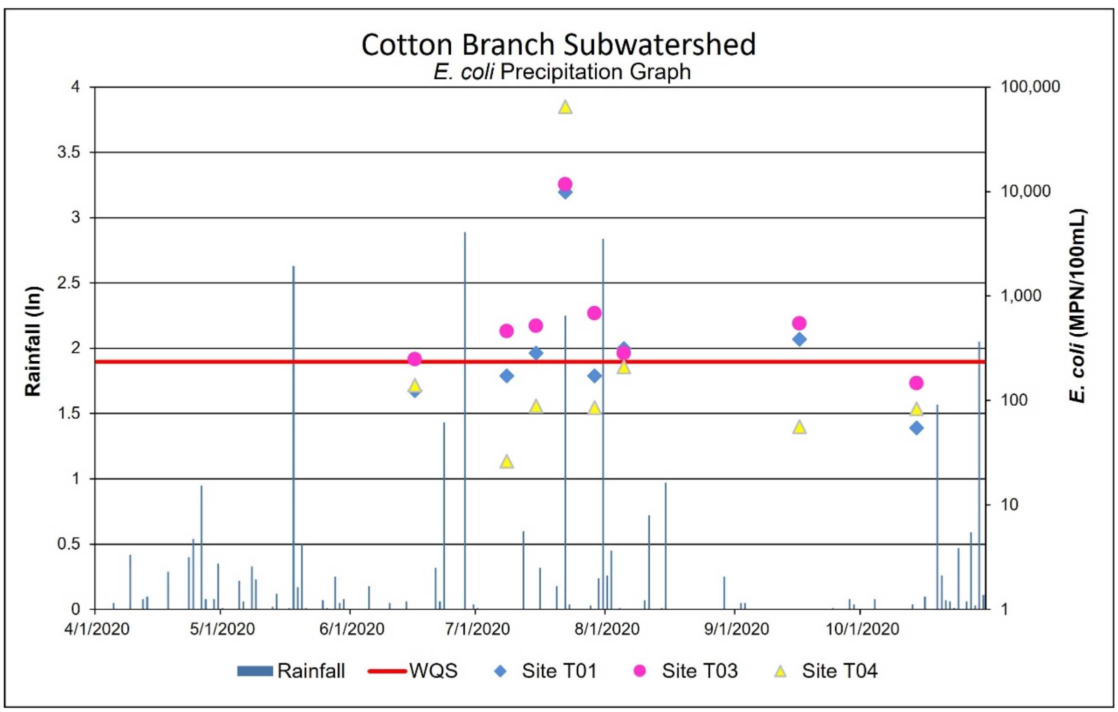

Figure 30: Graph of Precipitation and *E. coli* Data for Cotton Branch Subwatershed

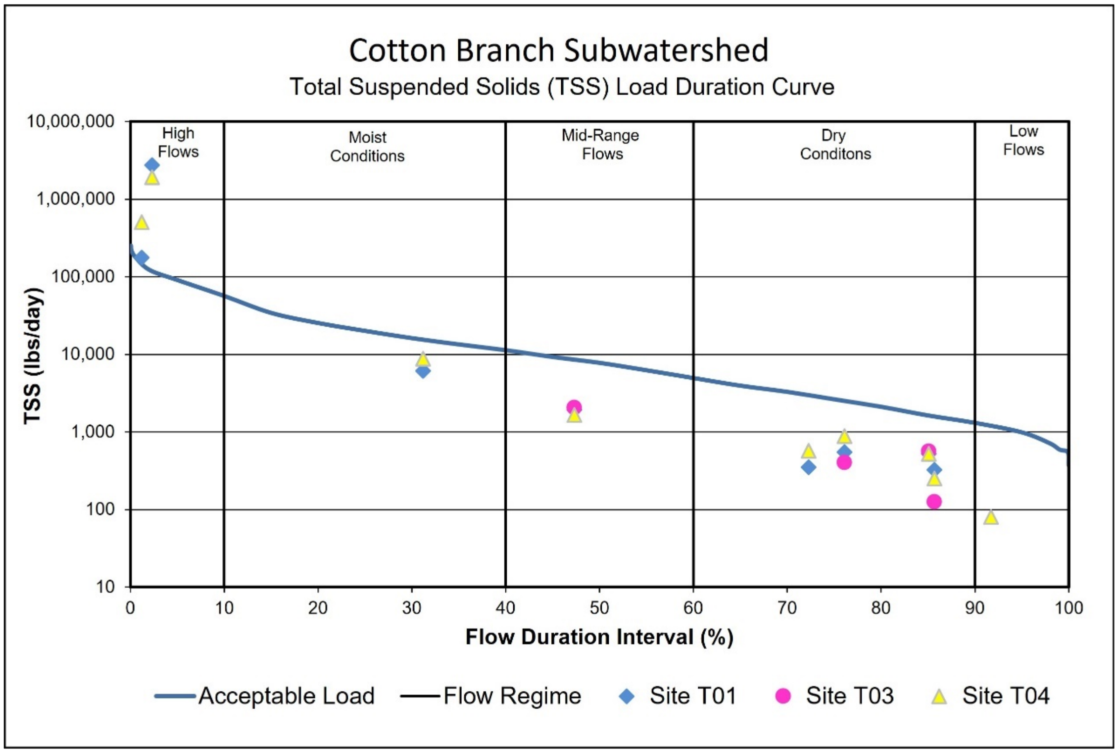

Figure 31: Total Suspended Solids (TSS) Load Duration Curve for Cotton Branch Subwatershed

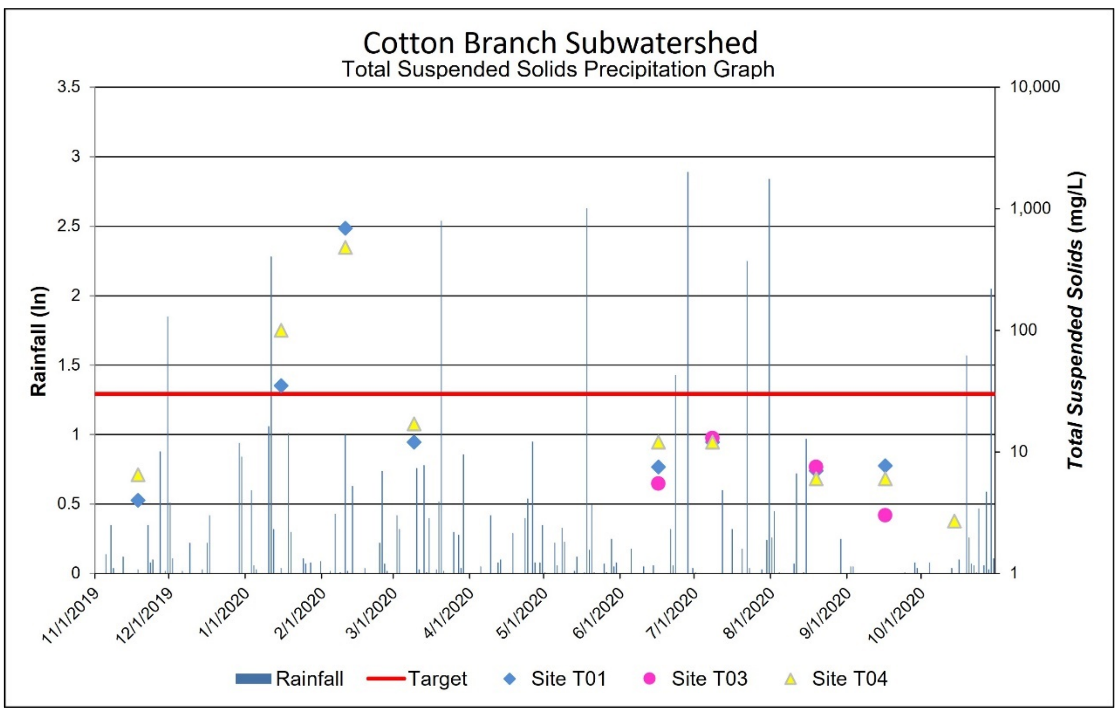

Figure 32: Graph of Precipitation and Total Suspended Solids (TSS) Data for Cotton Branch Subwatershed

4.2.2 Tilley Ditch

The Tilley Ditch subwatershed drains approximately 49.51 square miles with an actual land area of approximately 22.17 square miles. Surface water generally flows southwest and drains into the main stem of Maria Creek and into the Cotton Branch subwatershed. The land use is primarily agriculture (81 percent) followed by forested land (10 percent) and developed land (6 percent). There are three NPDES permitted facilities in the subwatershed. Freelandville Regional Sewer District WWTP (IN0064513) discharges at Outfall 001 into a tributary of Maria Creek. North Knox High School WWTP (IN0041084) discharges at Outfall 001 into Tilley Ditch. Freelandville Water Association (IN0059480) discharges at Outfalls 001 and 002 into Tilley Ditch. The majority of the subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, this subwatershed is primarily rated as somewhat limited or very limited. Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. The landscape in the area is relatively flat leading to its intense conversion to agricultural production and use. In many areas of the subwatershed, there are little to no remaining riparian buffers left along its banks due to agricultural practices. Despite its flat nature the subwatershed does contain significant amounts of highly erodible soil types. These soil types can be susceptible to sheet, rill, and isolated gully erosion and can contribute to sediment loss from agricultural lands, as well as lands from the high gradient slopes.

Many of the waterways in this subwatershed are identified as having hydric soil types in their riparian zones. These areas could be potential areas for wetland restoration or high functioning two stage ditch implementation. With a land use of 4 percent pasture land a heavy presence of pasture animals is not expected. There are no permitted CFOs in the watershed.

There are five monitoring sites located in this subwatershed. Sites T05 and T09 are located on the main stem of Maria Creek. Site T06 is located on Tilley Ditch. Sites T07 and T08 are located on tributaries of Maria Creek (Figure 33). In 2019 and 2020 this subwatershed was sampled a total of 61 times between the five sites. Four sites failed the *E. coli* geometric mean (geomean) water quality standard of 125 MPN/100 mL. The *E. coli* geomean for site T05 was 734.99 MPN with 5/8 samples in exceedance of the single sample max. Site T06 had a geomean of 98.57 MPN with 2/8 samples in exceedance of the single sample max. Site T07 had a geomean of 1,710.68 MPN with 6/6 samples in exceedance of the single sample max. Site T08 had a geomean of 1,237.53 MPN with 7/8 samples in exceedance of the single sample max. Site T09 had a geomean of 166.32 MPN with 3/8 samples in exceedance of the single sample max. The *E. coli* water quality samples from sites T05, T06, T07, T08, and T09 used to calculate the geomean were taken on the same day approximately one hour apart for five consecutive weeks.

Dissolved oxygen (DO) was found to be below the water quality standard of 4.0 mg/L on two occasions at site T08. Given the characteristics of the stream segment and minimal precipitation throughout the summer sampling season, it is believed that low physical flows in the system are likely contributing to the low DO levels found in the stream.

The fish community IBI score for site T05 was 42 (fair) and the QHEI was 32 (poor). The macroinvertebrate community mIBI score was 42 (fair) and the QHEI was 30 (poor). The fish community IBI score for site T06 was 42 (fair) and the QHEI was 38 (poor). The macroinvertebrate community mIBI score was 36 (fair) and the QHEI was 42 (poor). The fish community IBI score for site T07 was 40 (fair) and the QHEI was 46 (poor). The macroinvertebrate community mIBI score was 36 (fair) and the QHEI was 29 (poor). The fish community IBI score for site T08 was 44 (fair) and the QHEI was 33 (poor). The macroinvertebrate community mIBI score was 38 (fair) and the QHEI was 34 (poor). The fish community IBI score for site T09 was 46 (good) and the QHEI was 43 (poor). The macroinvertebrate community mIBI score was 36 (fair) and the QHEI was 33 (poor). Based on assessments of this data, no stream segments within the subwatershed were determined to be impaired for biological communities.

There are approximately 33 miles of streams in the subwatershed. Based on IDEM data collected in 2019 and 2020, there will be 20 stream miles impaired for *E. coli* and five miles impaired for dissolved oxygen. These stream reaches will be listed on the 2022 303(d) List of Impaired Waters. Therefore, *E. coli* TMDLs were developed to address all *E. coli* impairments. Since there was no apparent pollutant linkage for the DO impairment, a TMDL was not developed to address this issue. It is likely linked to the low flow conditions in the stream. The load duration curve for the Tilley Ditch subwatershed is shown in Figure 34. Table 37 provides a summary of the Tilley Ditch subwatershed, including listed stream reaches by AUID, drainage area, sampling sites, land use, NPDES facilities, as well as LA, WLAs, and MOS values for *E. coli*.

A precipitation graph (Figure 35) and water quality duration graph (Appendix F) were created to further analyze potential sources. Elevated levels of *E. coli* during rain events indicate streams are susceptible to high loads of *E. coli* from run-off. However, the precipitation graph illustrates that streams are also consistently in violation of the water quality standard even during drier conditions. This indicates point sources may also be contributing pollutants in addition to nonpoint sources. There are two WWTPs that discharge within the subwatershed. These facilities have had occasional permit violations due to *E. coli* (Table 27). The water quality duration graph indicates the most significant *E. coli* exceedances occurred during high flows, but exceedances occurred across all flow regimes. Contributors of *E. coli* in this subwatershed may be both point and nonpoint sources. Nonpoint sources may include small animal operations, wildlife, pasture animals with direct access to streams, land application of animal waste, straight pipes, and leaking and failing septic systems. See Section 6.1 and Table 44 for information pertaining to potentially suitable BMP selection for the Maria Creek watershed.

Table 37: Summary of Tilley Ditch Subwatershed Characteristics

Tilley Ditch (051201111802)					
Drainage Area	49.51 square miles				
Surface Area	22.17 square miles				
Site # [IDEM Station ID]	T05 [WBU-18-0008], T06 [WBU-18-0009], T07 [WBU-18-0010], T08 [WBU-18-0011], T09 [WBU-18-0013]				
Listed Segments	INB11I2_01; INB11I2_T1001; INB11I2_T1002				
Listed Impairments [TMDL(s)]	*E. coli* [*E. coli*], Dissolved Oxygen [N/A]				
Land Use	Agricultural Land: 81% Forested Land: 10% Developed Land: 6% Hay/Pasture: 4% Open Water: <1% Shrub/Scrub: <1% Wetlands: <1%				
NPDES Facilities	Freelandville Regional Sewer District (IN0064513); North Knox High School WWTP (IN0041084); Freelandville Water Association (IN0059480)				
CAFOs	NA				
CFOs	NA				
TMDL *E. Coli Allocations* (MPN/day)					
Allocation Category Duration Interval (%)	**High Flows 5%**	**Moist Conditions 25%**	**Mid-Range Flows 50%**	**Dry Conditions 75%**	**Low Flows 95%**
LA	6.27E+11	1.37E+11	5.13E+10	1.60E+10	4.94E+09
WLA (Total)	9.78E+08	9.78E+08	9.78E+08	9.78E+08	9.78E+08
MOS (10%)	7.39E+10	1.62E+10	6.16E+09	2.00E+09	6.97E+08
Future Growth (5%)	3.70E+10	8.11E+09	3.08E+09	1.00E+09	3.48E+08
Upstream Drainage Input (Headwaters Maria Creek)	**9.10E+11**	**1.99E+11**	**7.45E+10**	**2.32E+10**	**7.14E+09**
TMDL = LA+WLA+MOS	**1.65E+12**	**3.61E+11**	**1.36E+11**	**4.32E+10**	**1.41E+10**
WLA (Individual)					
Freelandville Regional Sewer District (IN0064513)	7.83E+08	7.83E+08	7.83E+08	7.83E+08	7.83E+08
North Knox High School WWTP (IN0041084)	1.96E+08	1.96E+08	1.96E+08	1.96E+08	1.96E+08

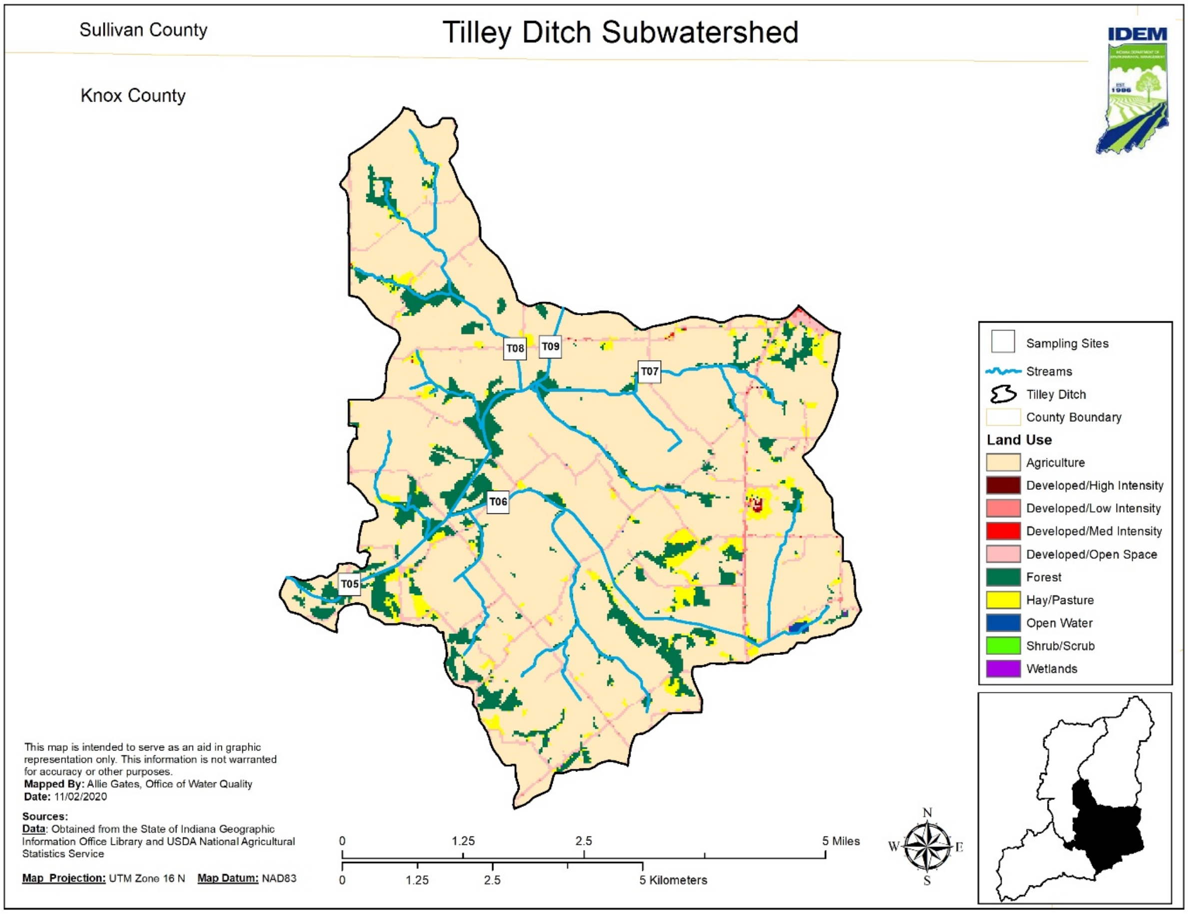

Figure 33: Sampling Sites in the Tilley Ditch Subwatershed

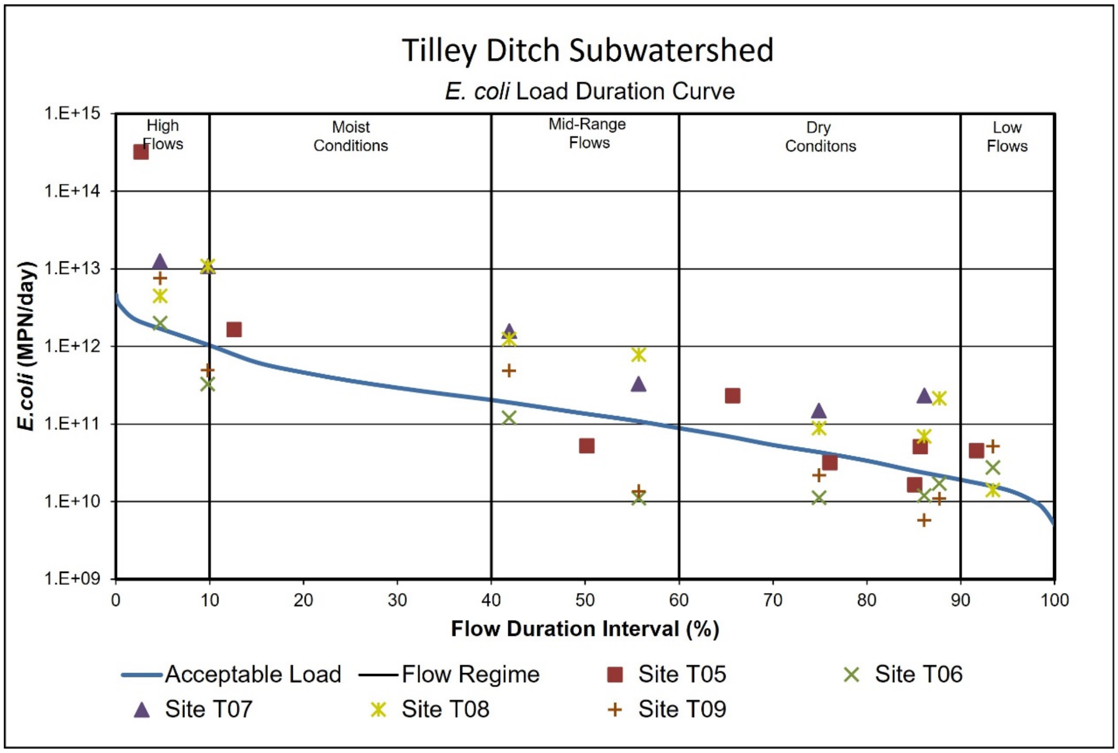

Figure 34: *E. coli* Load Duration Curve for Tilley Ditch Subwatershed

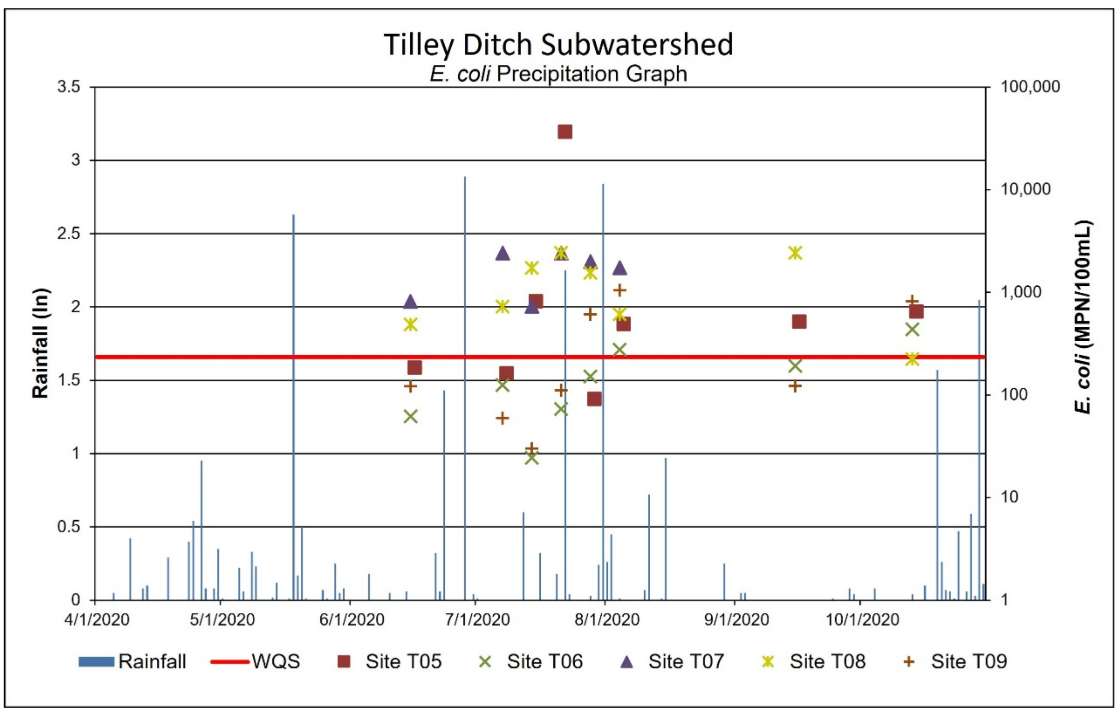

Figure 35: Graph of Precipitation and *E. coli* Data in Tilley Ditch Subwatershed

4.2.3 Marsh Creek

The Marsh Creek subwatershed drains approximately 23.83 square miles. Surface water generally flows south and drains into the main stem of Maria Creek and into the Cotton Branch subwatershed. The land use is primarily agriculture (79 percent) followed by forested (6 percent), developed (6 percent), and hay and pasture land (6 percent). There are two NPDES permitted facilities located within the subwatershed. Sunrise Coal Oaktown Mine discharges into Marsh Creek at three outfalls. Discharges at Outfall 001 are regulated by an individual NPDES permit (IN0064629), and discharges at Outfalls 005 and 002 are regulated by the coal mining general permit (ING040222). Sunrise Coal Carlisle Mine also discharges into Marsh Creek at three outfalls. Discharges at Outfall 005 are regulated by an individual NPDES permit (IN0062791), and discharges at Outfalls 002 and 003 are regulated by the coal mining general permit (ING040199). The majority of the subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, this subwatershed is primarily rated as very limited. Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. The landscape in the area is relatively flat leading to its intense conversion to agricultural production and use. In many areas of the subwatershed there are little to no remaining riparian buffers left along its banks due to agricultural practices. Despite its flat nature the subwatershed does contain some highly erodible soil types. These soil types can be susceptible to sheet, rill, and isolated gully erosion, and can contribute to sediment loss from agricultural lands, as well as lands from the high gradient slopes.

Many of the waterways in this subwatershed are identified as having hydric soil types in their riparian zones. These areas could be potential areas for wetland restoration or high functioning two stage ditch implementation. With a land use of 6 percent pasture land, a heavy presence of pasture animals is not expected. There are no permitted CFOs in the watershed.

There are five monitoring sites located in this subwatershed. The sites include T10, T11, T12, T13, and T14. The sites are all located on the main stem of Marsh Creek (Figure 36). In 2019 and 2020 this subwatershed was sampled a total of 56 times between the five sites. All five sites failed the *E. coli* geometric mean (geomean) water quality standard of 125 MPN/100 mL. The *E. coli* geomean for site T10 was 425.09 MPN with 4/8 samples in exceedance of the single sample max. Site T11 had a geomean of 499.26 MPN with 6/8 samples in exceedance of the single sample max. Site T12 had a geomean of 2,200.89 MPN with 6/8 samples in exceedance of the single sample max. Site T13 had a geomean of 439.81 MPN with 4/8 samples in exceedance of the single sample max. Site T14 had a geomean of 1,209.73 MPN with 4/6 samples in exceedance of the single sample max. The *E. coli* water quality samples from sites T10, T11, T12, T13, and T14 used to calculate the geomean were taken on the same day approximately one hour apart for five consecutive weeks.

Dissolved oxygen (DO) was found to be below the water quality standard of 4.0 mg/L on two occasions at site T14. Given the characteristics of the stream segment and minimal precipitation throughout the summer sampling season, it is believed that low physical flows in the system are likely contributing to the low DO levels found in the stream.

The fish community IBI score for site T10 was 20 (very poor) and the QHEI was 38 (poor). The macroinvertebrate community mIBI score was 44 (fair) and the QHEI was 35 (poor). The fish community IBI score for site T11 was 20 (very poor) and the QHEI was 45 (poor). The macroinvertebrate community mIBI score was 42 (fair) and the QHEI was 43 (poor). The fish community IBI score for site T12 was 44 (fair) and the QHEI was 37 (poor). The macroinvertebrate community mIBI score was 46 (good) and the QHEI was 25 (poor). The fish community IBI score for site T13 was 42 (fair) and the QHEI was 50 (poor). The macroinvertebrate community mIBI score was 40 (fair) and the QHEI was 37 (poor). The fish community IBI score for site T14 was 20 (very poor) and the QHEI was 33 (poor). Macroinvertebrate communities were not sampled at site T14 because the stream was dry. Based on assessments of this data, three stream segments within the subwatershed were determined to be impaired for biological communities.

Evaluation of TSS monitoring data and QHEI substrate and bank erosion/riparian zone metric scores indicate a linkage between siltation and biological communities impairments in the Marsh Creek subwatershed. TSS concentrations ranged from 1.7 mg/L to 370 mg/L across 27 sampling events within the subwatershed and exceeded the target value of 30 mg/L once. Heavy siltation and excessive embeddedness were observed at one sampling site. Three sampling sites had silt as a predominant substrate, and three sampling sites had a very narrow riparian width. Heavy/severe erosion was noted at an additional sampling site. The floodplain quality was documented as open pasture/row crop at 100% of sampling sites. Given that the target value for TSS was sporadically violated and excessive siltation or indicators of siltation were documented throughout the subwatershed, high TSS is believed to be a primary linkage to the biological communities impairments. Therefore, a TMDL for TSS was developed for this subwatershed to address the biological communities impairments.

There are approximately 39 miles of streams in the subwatershed. Based on IDEM data collected in 2019 and 2020, there will be 32 stream miles impaired for *E. coli*, 21 miles impaired for biological communities, and nine miles impaired for dissolved oxygen. These stream reaches will be listed on the 2022 303(d) List of Impaired Waters. Therefore, *E. coli* TMDLs were developed to address all *E. coli* impairments, and TSS TMDLs were developed to address all impaired biotic communities. Since there was no apparent pollutant linkage for the DO impairment, a TMDL was not developed to address this issue. It is likely linked to the low flow conditions in the stream. The load duration curves for the Marsh Creek subwatershed are shown in Figure 37 and Figure 39. Table 38 provides a summary of the Marsh Creek subwatershed, including listed stream reaches by AUID, drainage area, sampling sites, land use, NPDES facilities, as well as LA, WLAs, and MOS values for *E. coli* and TSS.

Precipitation graphs (Figure 38 and Figure 40) and water quality duration graphs (Appendix F) were created to further analyze potential sources. Elevated levels of pollutants during rain events indicate streams are susceptible to high loads of *E. coli* and TSS from run-off. However, the precipitation and water quality duration graphs illustrate that streams are also consistently in violation of the *E. coli* water quality standard even during drier conditions. However, no permitted facilities that discharge *E. coli* are located within the subwatershed. Therefore, the majority of sources of *E. coli* and TSS in this subwatershed are likely nonpoint sources. Nonpoint sources may include small animal operations, wildlife, pasture animals with direct access to streams, land application of animal waste, straight pipes, streambank erosion, agricultural practices, and leaking and failing septic systems. See Section 6.1 and Table 44 for information pertaining to potentially suitable BMP selection for the Maria Creek watershed.

Table 38: Summary of Marsh Creek Subwatershed Characteristics

Marsh Creek (051201111803)					
Drainage Area	23.83 square miles				
Surface Area	23.83 square miles				
Site # [IDEM Station ID]	T10 [WBU190-0001], T11 [WBU-18-0012], T12 [WBU-18-0015], T13 [WBU-18-0016], T14 [WBU-18-0017]				
Listed Segments	INB11I3_05; INB11I3_04; INB11I3_03; INB11I3_T1002; INB11I3_02				
Listed Impairments [TMDL(s)]	*E. coli* [*E. coli*], Impaired Biotic Communities [TSS], Dissolved Oxygen [N/A]				
Land Use	Agricultural Land: 79% Forested Land: 6% Developed Land: 6% Hay/Pasture: 6% Open Water: 2% Shrub/Scrub: <1% Wetlands: <1%				
NPDES Facilities	Sunrise Coal Oaktown Mine (ING040222) – Outfalls 002 & 005; Sunrise Coal Oaktown Mine (IN0064629) – Outfall 001; Sunrise Coal Carlisle Mine (ING040199) – Outfalls 202 & 003; Sunrise Coal Carlisle Mine (IN0062791) – Outfall 005				
CAFOs	NA				
CFOs	NA				
TMDL *E. Coli* Allocations (MPN/day)					
Allocation Category Duration Interval (%)	**High Flows 5%**	**Moist Conditions 25%**	**Mid-Range Flows 50%**	**Dry Conditions 75%**	**Low Flows 95%**
LA	6.91E+11	1.58E+11	6.56E+10	2.60E+10	1.26E+10
WLA (Total)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MOS (10%)	8.13E+10	1.85E+10	7.72E+09	3.06E+09	1.49E+09
Future Growth (5%)	4.07E+10	9.27E+09	3.86E+09	1.53E+09	7.43E+08
TMDL = LA+WLA+MOS	**8.13E+11**	**1.85E+11**	**7.72E+10**	**3.06E+10**	**1.49E+10**
TMDL Total Suspended Solids Allocations (lbs/day)					
Allocation Category Duration Interval (%)	**High Flows 5%**	**Moist Conditions 25%**	**Mid-Range Flows 50%**	**Dry Conditions 75%**	**Low Flows 95%**
LA	16,226.75	3,445.45	1,199.69	296.07	25.19
WLA (Total)	2,085.94	727.21	537.77	392.13	309.20
MOS (10%)	2,289.09	521.58	217.18	86.03	41.80
Future Growth (10%)	2,289.09	521.58	217.18	86.03	41.80
TMDL = LA+WLA+MOS	**22,890.87**	**5,215.82**	**2,171.82**	**860.26**	**418.00**
WLA (Individual)					
Oaktown Mine (IN0064629)	146.01	146.01	146.01	146.01	146.01
Oaktown Mine (ING040222)	428.57	97.65	40.66	16.11	7.83

Carlisle Mine (IN0062791)	516.88	256.98	256.98	192.74	137.25
Carlisle Mine (ING040199)	991.98	226.03	94.12	37.28	18.11
Construction Stormwater	2.50	0.53	0.00	0.00	0.00

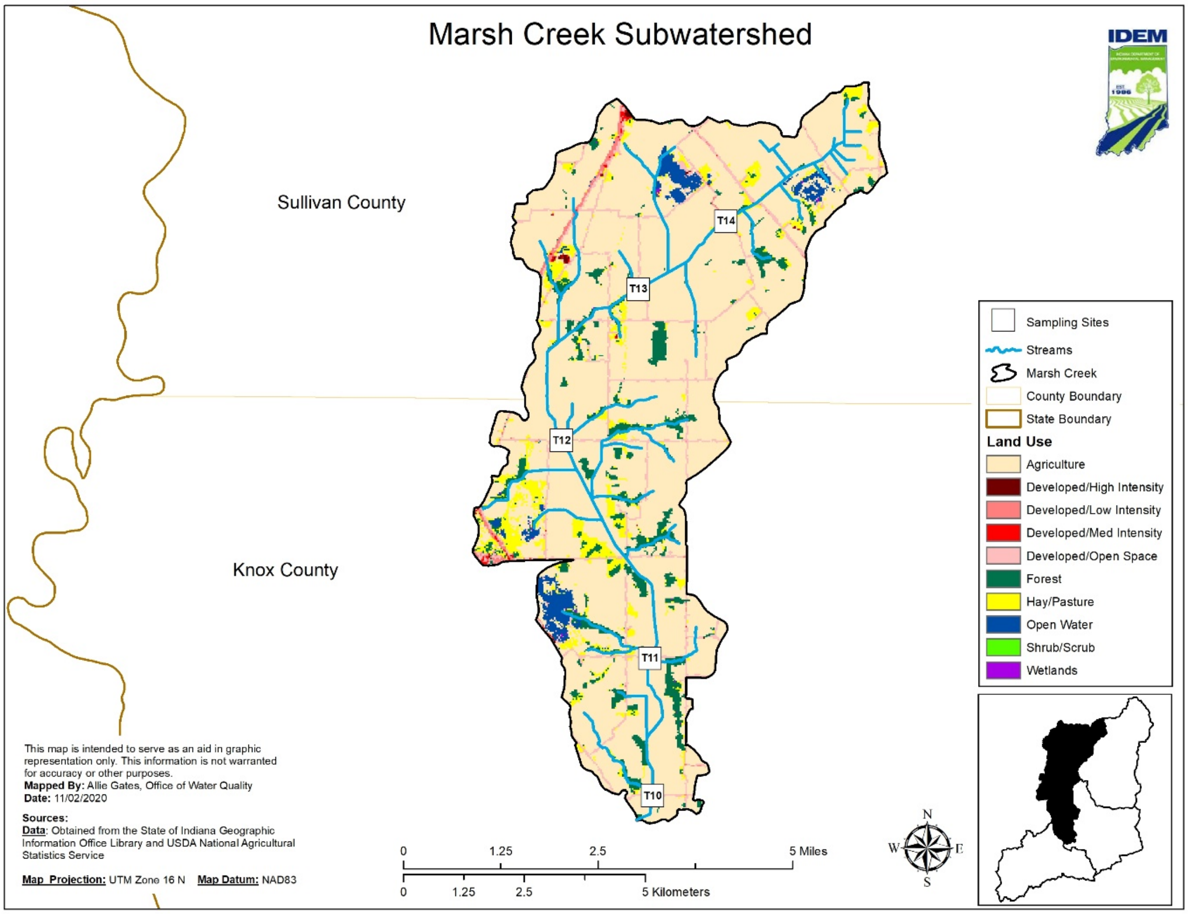

Figure 36: Sampling Sites in the Marsh Creek Subwatershed

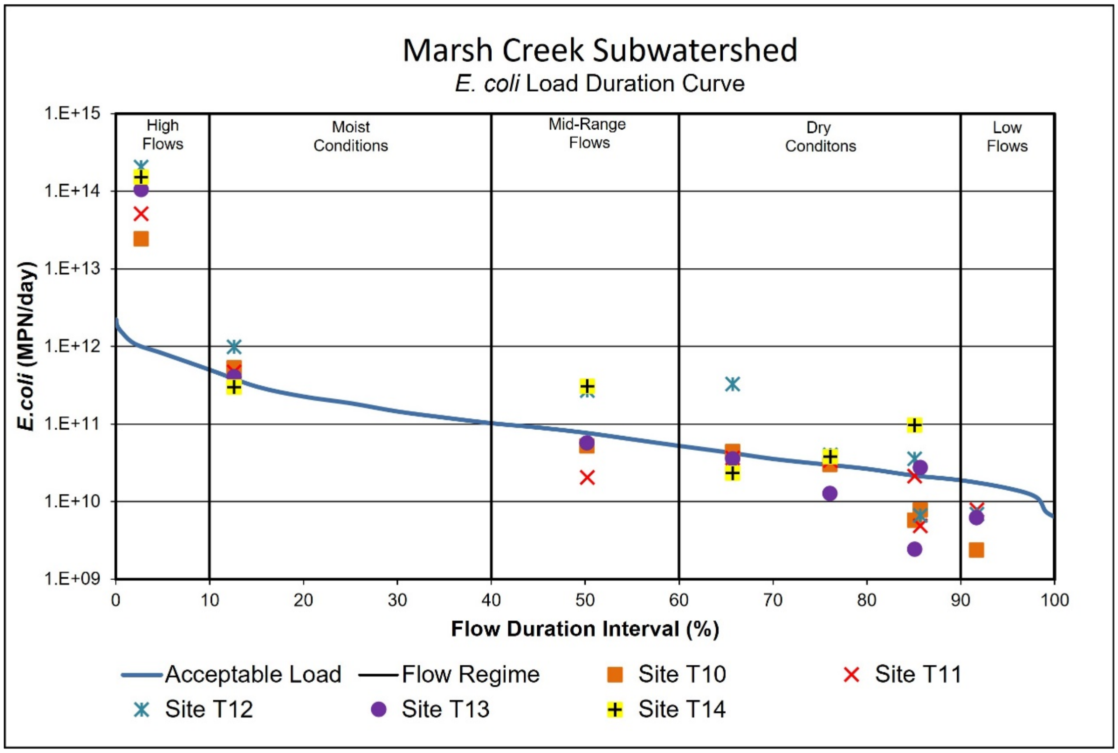

Figure 37: *E. coli* Load Duration Curve for Marsh Creek Subwatershed

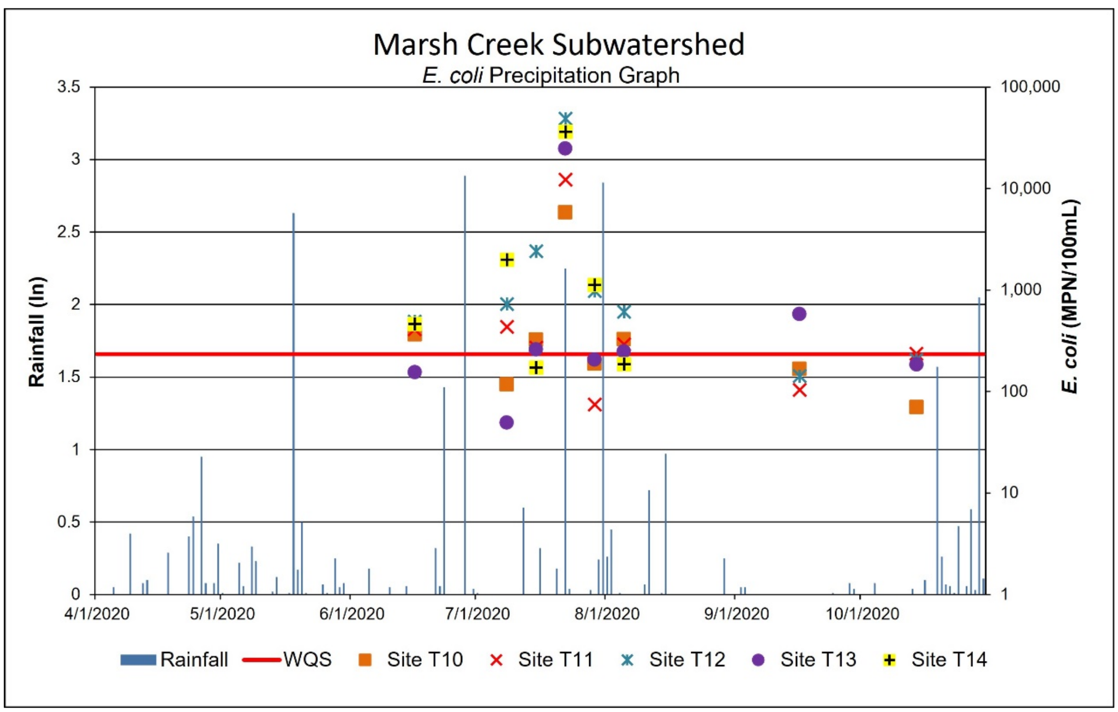

Figure 38: Graph of Precipitation and *E.coli* Data at Marsh Creek Subwatershed

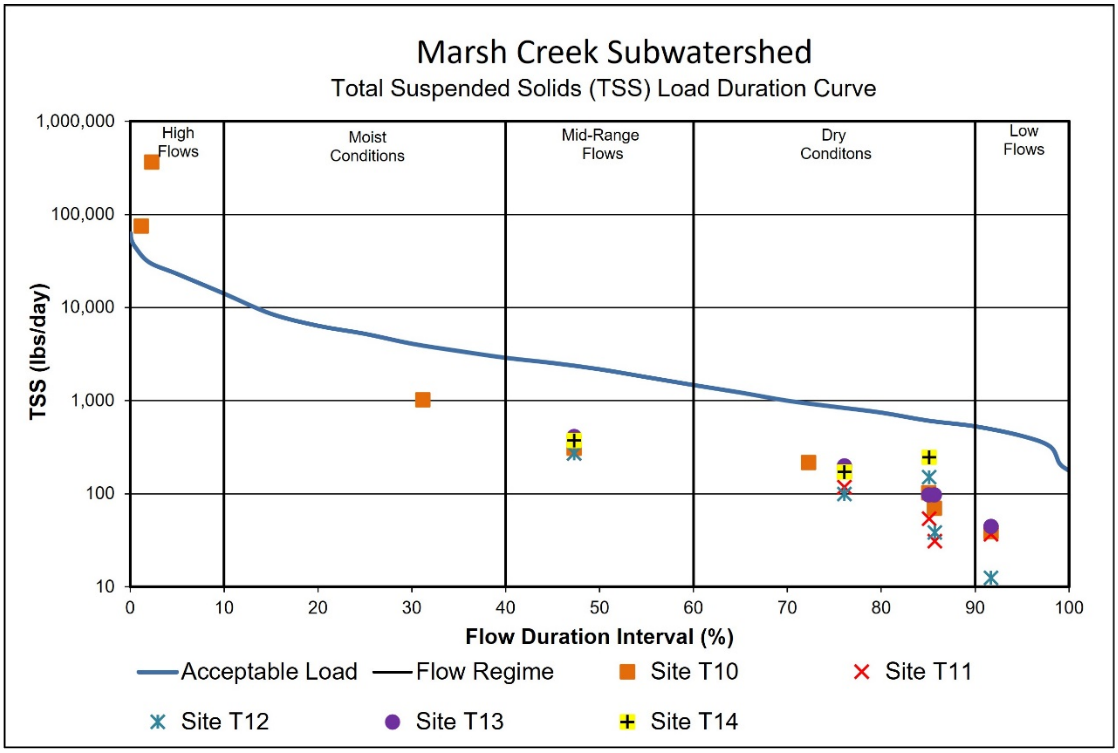

Figure 39: Total Suspended Solids (TSS) Load Duration Curve for Marsh Creek Subwatershed

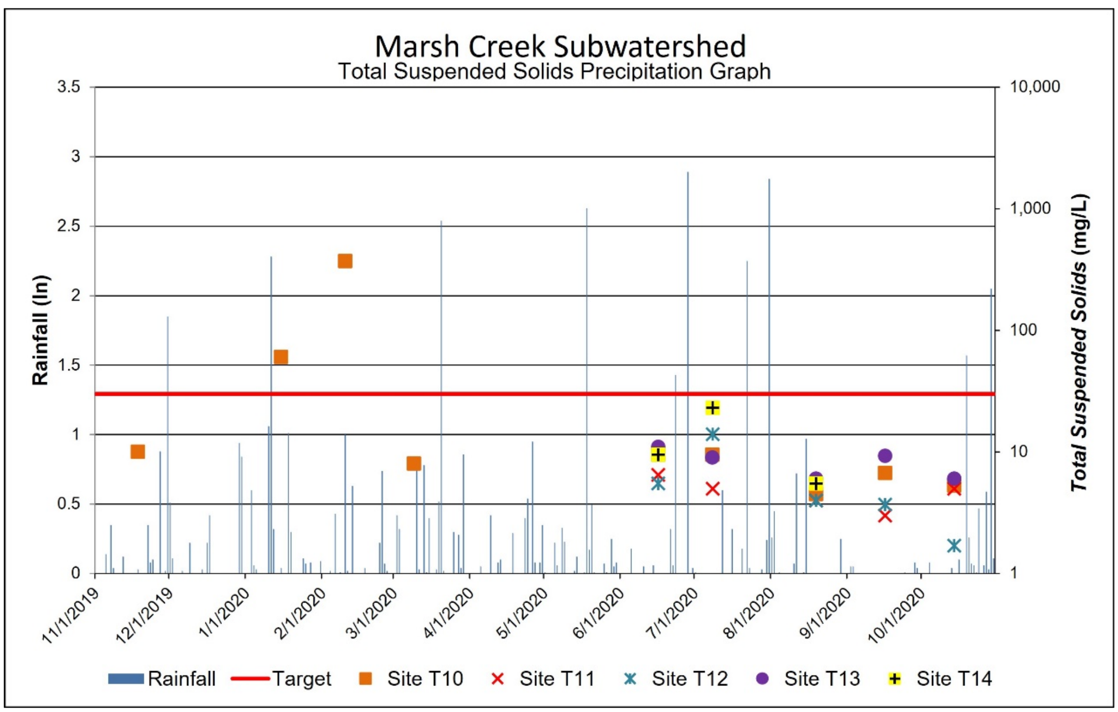

Figure 40: Graph of Precipitation and Total Suspended Solids (TSS) Data at Marsh Creek Subwatershed

4.2.4 Headwaters Maria Creek

The Headwaters Maria Creek subwatershed drains approximately 27.34 square miles. This subwatershed is the northern extent of the Maria Creek watershed and contains the headwaters of Maria Creek. Surface water generally flows southwest and drains into the main stem of Maria Creek and into the Tilley Ditch subwatershed. The land use is primarily agriculture (68 percent) followed by forested land (19 percent) and hay and pasture (6 percent) and developed land (6 percent). There is one NPDES permitted facility located within the subwatershed. Peabody Midwest Bear Run Mine (ING040239) is a surface mining operation that discharges into tributaries of Maria Creek at Outfall 068. Discharges from Bear Run Mine are regulated by the coal mining general permit. The majority of the subwatershed is rural indicating homes pump to on-site septic systems. Based on the septic suitability of the soil, this subwatershed is primarily rated as very limited. Maintenance and inspections of septic systems in the area is important to ensure proper function and capacity. The landscape in the area is relatively flat leading to its intense conversion to agricultural production and use. In many areas of the subwatershed there are little to no remaining riparian buffers left along its banks due to agricultural practices. Despite its flat nature the subwatershed does contain significant amounts of highly erodible soil types. These soil types can be susceptible to sheet, rill, and isolated gully erosion, and can contribute to sediment loss from agricultural lands, as well as lands from the high gradient slopes.

Many of the waterways in this subwatershed are identified as having hydric soil types in their riparian zones. These areas could be potential areas for wetland restoration or high functioning two stage ditch implementation. With a land use of 6 percent pasture land, a heavy presence of pasture animals is not expected. There are no permitted CFOs in the watershed.

There are five monitoring sites located in this subwatershed. Sites T16, T18, and T9 are located on the main stem of Maria Creek. Sites T15 and T17 are located on tributaries of Maria Creek (Figure 41). In 2019 and 2020 this subwatershed was sampled a total of 49 times between the five sites. Four sites failed the *E. coli* geometric mean (geomean) water quality standard of 125 MPN/100 mL. The *E. coli* geomean for site T15 was 165.58 MPN with 3/6 samples in exceedance of the single sample max. Site T16 had a geomean of 283.88 MPN with 2/8 samples in exceedance of the single sample max. Site T17 had a geomean of 727.95 MPN with 8/8 samples in exceedance of the single sample max. Site T18 had a geomean of 359.17 MPN with 6/8 samples in exceedance of the single sample max. The *E. coli* water quality samples from sites T15, T16, T17, and T18 used to calculate the geomean were taken on the same day approximately one hour apart for five consecutive weeks.

Dissolved oxygen (DO) was found to be below the water quality standard of 4.0 mg/L on three occasions at site T15 and on three occasions at site T17. Given the characteristics of the stream segments and minimal precipitation throughout the summer sampling season, it is believed that low physical flows in the system are likely contributing to the low DO levels found in the streams.

The fish community IBI score for site T15 was 20 (very poor) and the QHEI was 37 (poor). The macroinvertebrate community mIBI score was 32 (poor) and the QHEI was 24 (poor). The fish community IBI score for site T16 was 34 (poor) and the QHEI was 52 (good). The macroinvertebrate community mIBI score was 48 (good) and the QHEI was 38 (poor). The fish community IBI score for site T17 was 34 (poor) and the QHEI was 41 (poor). The macroinvertebrate community mIBI score was 42 (fair) and the QHEI was 44 (poor). The fish community IBI score for site T18 was 40 (fair) and the QHEI was 45 (poor). The macroinvertebrate community mIBI score was 40 (fair) and the QHEI was 45 (poor). The fish community IBI score for site T19 was 48 (good) and the QHEI was 58 (good). The macroinvertebrate community mIBI score was 42 (fair) and the QHEI was 64 (good). Based on assessments of this data, three stream segments within the subwatershed were determined to be impaired for biological communities.

Evaluation of TSS monitoring data and QHEI substrate and bank erosion/riparian zone metric scores indicate a linkage between siltation and biological communities impairments in the Headwaters Maria Creek subwatershed. TSS concentrations ranged from 2 mg/L to 400 mg/L across 23 sampling events within the subwatershed and exceeded the target value of 30 mg/L three times. Heavy siltation and excessive embeddedness were observed at two sampling sites. Three sampling sites had silt as a predominant substrate, and three sampling sites had a very narrow riparian width. Heavy/severe erosion was noted at two sampling sites. The floodplain quality was documented as open pasture/row crop at 100% of sampling sites. Given that the target value for TSS was sporadically violated and excessive siltation or indicators of siltation were documented throughout the subwatershed, high TSS is believed to be a primary linkage to the biological communities impairments. Therefore, a TMDL for TSS was developed for this subwatershed to address the biological communities impairments.

There are approximately 47 miles of streams in the subwatershed. Based on IDEM data collected in 2019 and 2020, there will be 47 stream miles impaired for *E. coli*, 20 miles impaired for biological communities, and 20 miles impaired for dissolved oxygen. These stream reaches will be listed on the 2022 303(d) List of Impaired Waters. Therefore, *E. coli* TMDLs were developed to address all *E. coli* impairments, and TSS TMDLs were developed to address all impaired biotic communities. Since there was no apparent pollutant linkage for the DO impairments, a TMDL was not developed to address these issues. They are likely linked to the low flow conditions in the streams. The load duration curves for the Headwaters Maria Creek subwatershed are shown in Figure 42 and Figure 44. Table 39 provides a summary of the Headwaters Maria Creek subwatershed, including listed stream reaches by AUID, drainage area, sampling sites, land use, NPDES facilities, as well as LA, WLAs, and MOS values for *E. coli* and TSS.

Two stream segments located within the northeastern portion of the Headwaters of Maria Creek subwatershed have been impacted by the Bear Run Mine surface mining activity. The stream segments include Maria Creek (INB11I1_T1001) and a tributary of Maria Creek (INB11I1_T1002). These stream impacts are permitted through the U.S. Army Corps of Engineers (LRL-2022-1117-GJD) and IDEM (2011-487-77-DDC-A). Mitigation of these streams is required after mining activities are completed in the area. Available plans indicate these stream segments will likely be mitigated onsite in a similar location as the original stream channels. Maria Creek (INB11I1_T1001) was previously identified as impaired for *E. coli*, biological communities, and DO. These impairments will remain on the 2022 303(d) List of Impaired Waters. *E. coli* and TSS WLAs developed for this TMDL will be applicable to this stream segment, and any stream segments impaired for *E. coli* or biological communities impacted in the future, after stream mitigation is complete.

Precipitation graphs (Figure 43 and Figure 45) and water quality duration graphs (Appendix F) were created to further analyze potential sources. Elevated levels of pollutants during rain events indicate streams are susceptible to high loads of *E. coli* and TSS from run-off. However, the precipitation and water quality duration graphs illustrate that streams are also consistently in violation of the *E. coli* water quality standard even during drier conditions. However, no permitted facilities that discharge *E. coli* are located within the subwatershed. Therefore, the majority of sources of *E. coli* and TSS in this subwatershed are likely nonpoint sources. Nonpoint sources may include small animal operations, wildlife, pasture animals with direct access to streams, land application of animal waste, straight pipes, streambank erosion, agricultural practices, and leaking and failing septic systems. See Section 6.1 and Table 44 for information pertaining to potentially suitable BMP selection for the Maria Creek watershed.

Table 39: Summary of Headwaters Maria Creek Subwatershed Characteristics

Headwaters Maria Creek (051201111801)					
Drainage Area	27.34 square miles				
Surface Area	27.34 square miles				
Site # [IDEM Station ID]	T15 [WBU-18-0014], T16 [WBU190-0002], T17 [WBU-18-0018], T18 [WBU-18-0019], T19 [WBU-18-0020]				
Listed Segments	INB11I1_T1004; INB11I1_01; INB11I1_T1005; INB11I1_T1001; INB11I1_01A; INB11I1_T1003; INB11I1_T1002				
Listed Impairments [TMDL(s)]	*E. coli* [*E. coli*], Impaired Biotic Communities [TSS], Dissolved Oxygen [N/A]				
Land Use	Agricultural Land: 68% Forested Land: 19% Developed Land: 6% Hay/Pasture: 6% Open Water: <1% Shrub/Scrub: <1% Wetlands: <1%				
NPDES Facilities	Peabody Midwest Bear Run Mine (ING040239) – Outfalls 056, 057, 058, 059, 060, 068				
CAFOs	NA				
CFOs	NA				
TMDL *E. Coli* Allocations (MPN/day)					
Allocation Category Duration Interval (%)	**High Flows 5%**	**Moist Conditions 25%**	**Mid-Range Flows 50%**	**Dry Conditions 75%**	**Low Flows 95%**
LA	7.74E+11	1.69E+11	6.33E+10	1.98E+10	6.07E+09
WLA (Total)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
MOS (10%)	9.10E+10	1.99E+10	7.45E+09	2.32E+09	7.14E+08
Future Growth (5%)	4.55E+10	9.93E+09	3.72E+09	1.16E+09	3.57E+08
TMDL = LA+WLA+MOS	**9.10E+11**	**1.99E+11**	**7.45E+10**	**2.32E+10**	**7.14E+09**
TMDL Total Suspended Solids Allocations (lbs/day)					
Allocation Category Duration Interval (%)	**High Flows 5%**	**Moist Conditions 25%**	**Mid-Range Flows 50%**	**Dry Conditions 75%**	**Low Flows 95%**
LA	13,232.81	2,887.16	1,083.17	337.99	103.90
WLA (Total)	7,255.71	1,583.06	593.16	185.09	56.90

MOS (10%)	2,561.06	558.78	209.54	65.38	20.10
Future Growth (10%)	2,561.06	558.78	209.54	65.38	20.10
TMDL = LA+WLA+MOS	**25,610.65**	**5,587.78**	**2,095.42**	**653.85**	**201.00**
WLA (Individual)					
Bear Run Mine (ING040239)	7,249.75	1,581.76	593.16	185.09	56.90
Construction Stormwater	5.96	1.30	0.00	0.00	0.00

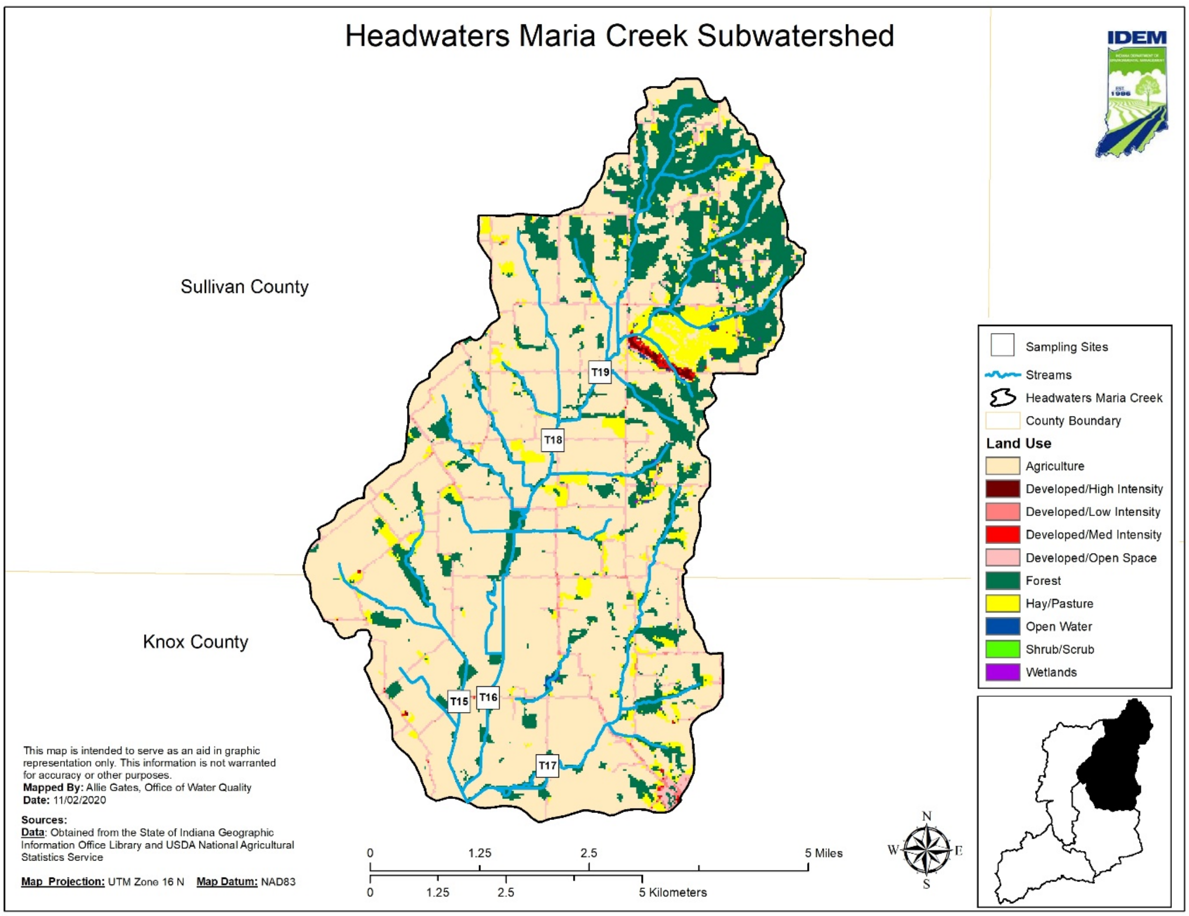

Figure 41: Sampling Sites in the Headwaters Maria Creek Subwatershed

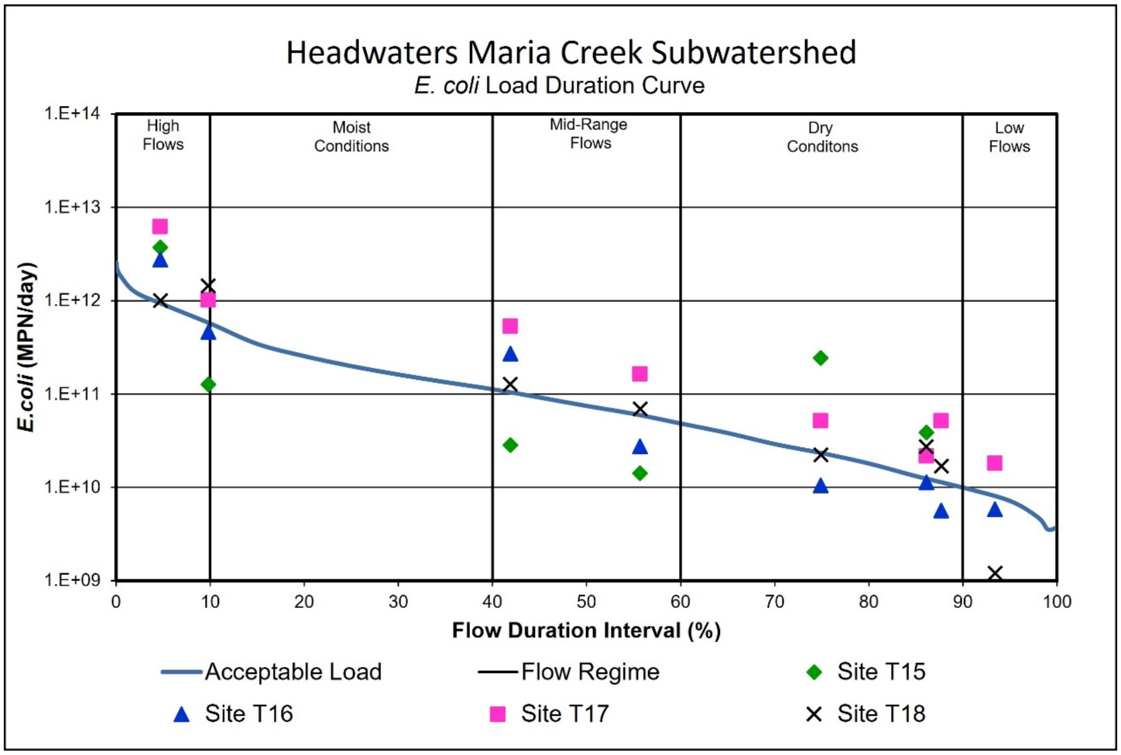

Figure 42: *E. coli* Load Duration Curve for Headwaters Maria Creek Subwatershed

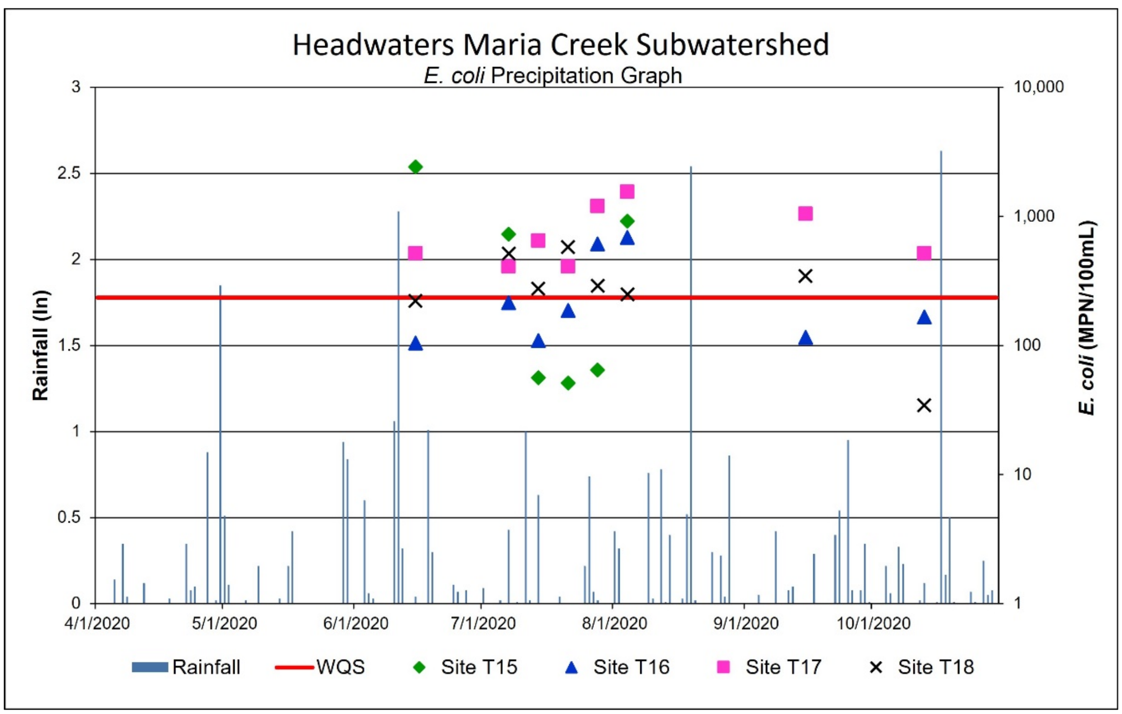

Figure 43: Graph of Precipitation and *E. coli* Data at Headwaters Maria Creek Subwatershed

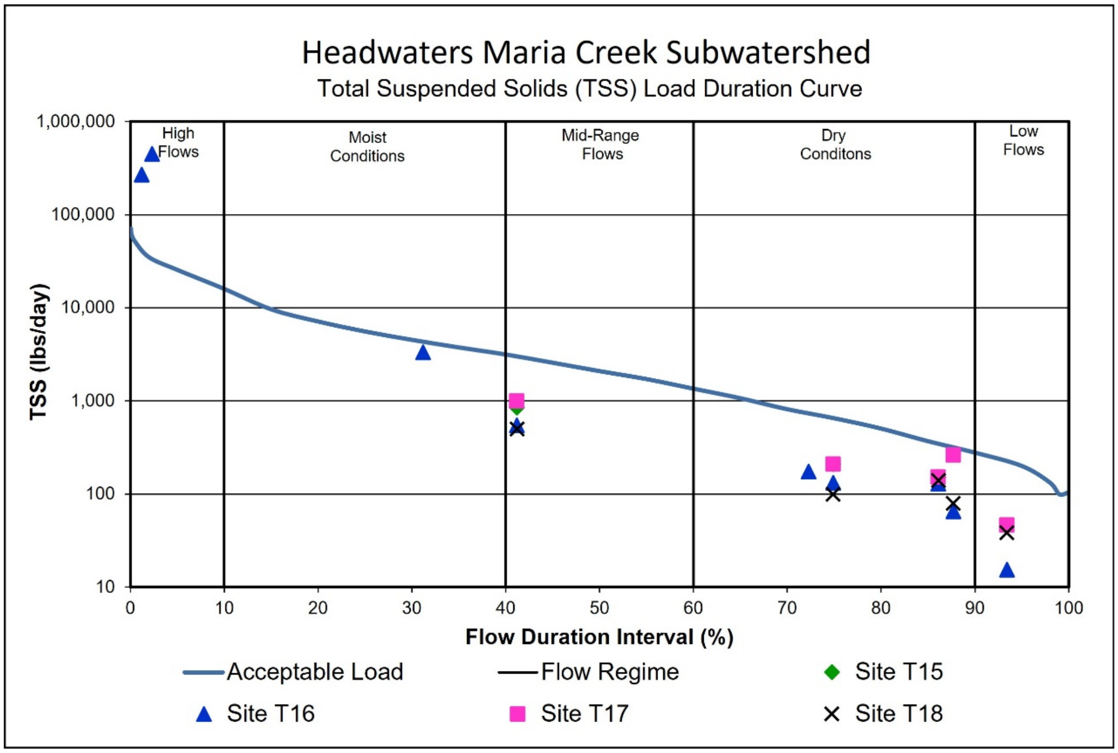

Figure 44: Total Suspended Solids (TSS) Load Duration Curve for Headwaters Maria Creek Subwatershed

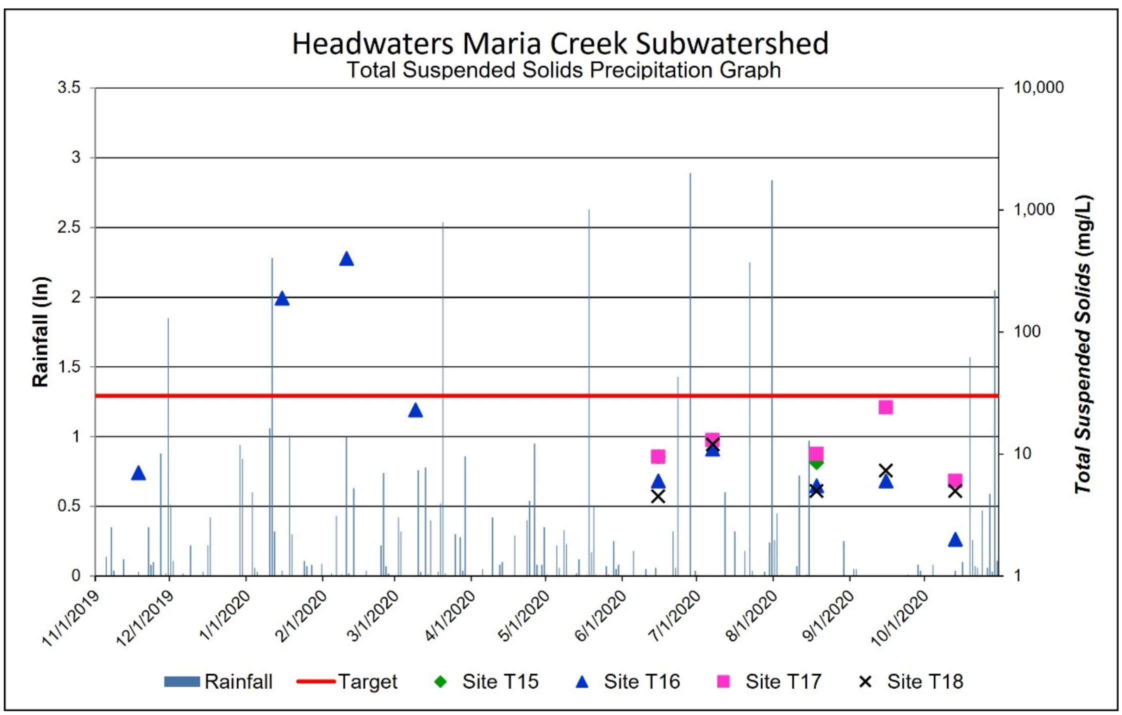

Figure 45: Graph of Precipitation and Total Suspended Solids (TSS) Data at Headwaters Maria Creek Subwatershed

4.3 Sediment Source Modeling Analysis for the Maria Creek Watershed

The Generalized Watershed Loading Function Enhanced (GWLF-E) model was utilized to further identify primary sources of sediment for each subwatershed in the Maria Creek watershed. The GWLF-E (MapShed) model utilizes the GWLF model which is an aggregate distributed/lumped parameter watershed model that provides the ability to simulate runoff, sediment, and nutrient (nitrogen (N) and phosphorus (P)) loads from a watershed given variable-size source areas (e.g., agricultural, forested, and developed land). The model requires input data related to land use, rainfall, runoff, evapotranspiration, soil water capacity, erosion, crop management, and point sources in order to provide estimated loadings of pollutants. Input data were collected from Model My Watershed, MapShed, the Midwestern Regional Climate Center, the Indiana Geographic Information Office, the USDA Web Soil Survey, and the USDA National Agricultural Statistics Service Center. Additional overview information regarding the GWLF-E model can be found in Appendix H.

The GWLF-E model analysis results indicate that cropland and stream banks contribute the greatest sediment loadings throughout the Maria Creek watershed (Table 40 and Figure 46). Cropland contributes the overwhelming majority of annual sediment comprising approximately 90% of the overall loading. Overall, the Headwaters of Maria Creek subwatershed is contributing the greatest annual load on average to the Maria Creek watershed while Marsh Creek is contributing the least amount of loading. Although similar in land uses, Headwaters of Maria Creek contributes nearly twice the annual loading to the Maria Creek watershed as Marsh Creek. This may be due to the unique soil characteristics between the two subwatersheds. Soil erodibility and length-slope factors are both on average lower in Marsh Creek for cropland land uses compared to Headwaters of Maria Creek. Additionally, Marsh Creek has a greater unsaturated soil water holding capacity compared to Headwaters of Maria Creek. Sediment loads from mining operations are captured in “disturbed” land uses. However, additional contributions from mining activities may be captured within other land uses due to the nature of activities and classifications from the original land use layer. Source contributions of sediment should be considered when selecting best management practices (BMPs), which will result in the greatest load reductions overall. Results from the GWLF-E model analysis were calculated for informational purposes on sediment sources only and do not take place of the total maximum daily loads or reductions established within this document for the Maria Creek watershed. Additional information regarding the GWLF-E model analysis for the Maria Creek watershed can be found in Appendix H.

Table 40: Average Annual Sediment Loads (in tons) by Source for the Maria Creek Subwatersheds

Source		Marsh Creek	Tilley Ditch	Headwaters Maria Creek	Cotton Branch	Maria Creek Watershed
Rural	Cropland	11,230.4	18,093.2	21,107.0	15,308.0	**65,738.4**
	Stream Bank	657.2	1,255.0	858.5	2,370.4	**5,141.1**
	Hay/Pasture	238.4	269.2	480.6	332.0	**1,320.1**
	Forest	22.0	58.6	152.5	127.1	**360.2**
	Wetland	1.3	0.5	1.8	0.8	**4.4**
	Turfgrass	0.0	0.0	0.0	0.7	**0.7**
Urban	Disturbed	25.0	4.3	127.1	1.2	**157.6**
	Low Density Mixed Urban	16.5	14.6	16.0	17.3	**64.4**
	Medium Density Mixed Urban	2.9	1.0	1.0	3.7	**8.6**
	High Density Mixed Urban	1.4	0.5	1.6	0.5	**4.0**
Total (tons)		**12,195**	**19,697**	**22,746**	**18,162**	**72,799**

Understanding Table 40: The GWLF-E model analysis indicates that cropland contributes the greatest amount of sediment to the Maria Creek watershed. Results from the GWLF-E model analysis were calculated for informational purposes on sediment sources only and do not take place of the total maximum daily loads or reductions established within this document for the Maria Creek watershed.

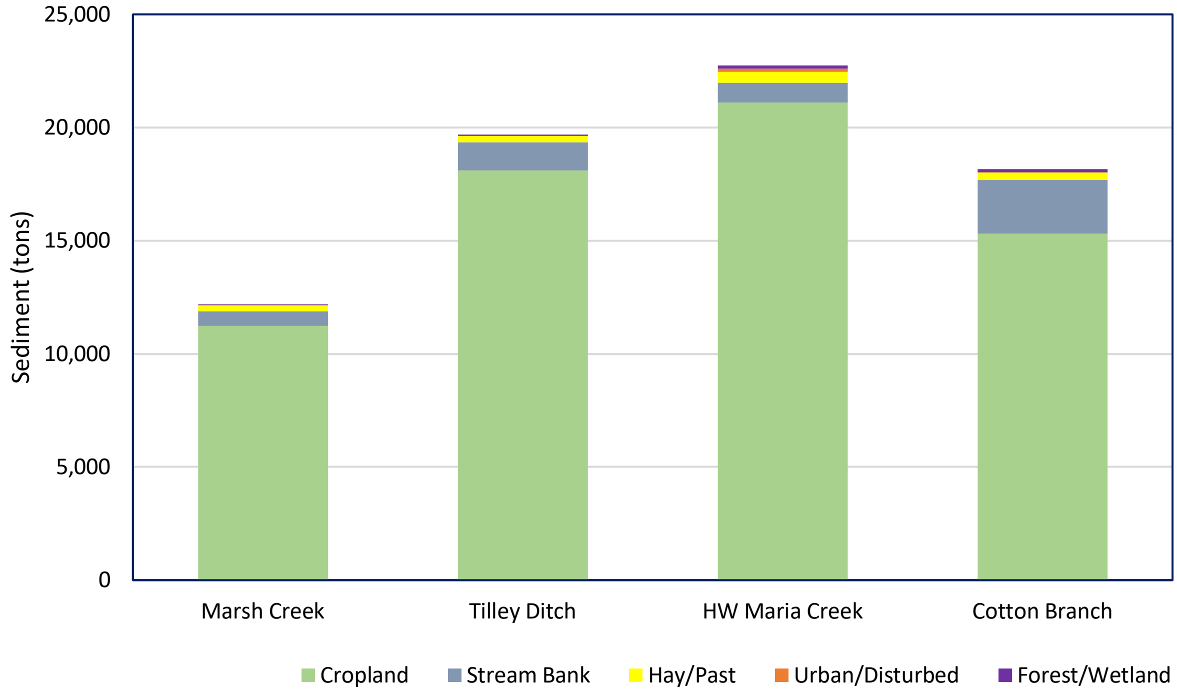

Figure 46: Average Annual Sediment Loading from Sources in the Maria Creek Subwatersheds

5.0 ALLOCATIONS

A TMDL is the total amount of a pollutant that can be assimilated by the receiving water while still achieving water quality standards. TMDLs are composed of the sum of individual WLAs for regulated sources and LAs for sources not directly regulated by a permit. In addition, the TMDL must include a MOS, either implicitly or explicitly, that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. Conceptually, this is defined by the equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

5.1 Individual Wasteload Allocations

This section presents the allowable pollutant loads and associated allocations for each of the subwatersheds and associated assessment units in the Maria Creek watershed. Allocations were calculated for each 12-digit HUC (subwatershed). WLAs are typically calculated based on the design flow or estimated flow of the facility and the TMDL target or applicable permit limit. Three municipal WWTPs and one public water supply were calculated following this method. However, coal mining operations with individual NPDES permits located within the Maria Creek watershed required additional consideration for WLA calculations.

There are two underground mining facilities located within the watershed with individual NPDES permits, Carlisle Mine (IN0062791) and Oaktown Mine (IN0064629). Design flow estimates for discharges from underground mine outfalls regulated through individual NPDES permits were estimated based on the unique characteristics of each outfall and how each outfall is utilized by the facility. Carlisle Mine has one outfall (Outfall 005) regulated through an individual NPDES permit. An analysis of the past two years of flow data available from Discharge Monitoring Reports (DMRs) was completed to gain a better understanding of typical discharge from this outfall. Data over the past two years indicated flow was significantly influenced by precipitation events. The flow regime for each discharge event was determined, and the average discharge for each flow regime was calculated. The average discharge for each flow regime was used as the estimated design flow to calculate the WLA for each flow regime. DMRs were also reviewed to determine typical TSS concentrations for discharge events from the past two years. It was determined that TSS concentrations were typically less than 35 mg/L. Therefore, the WLA for the Carlisle Mine, Outfall 005 was calculated using the NPDES permit limit of 35 mg/L monthly average as it is more representative of existing load conditions.

Oaktown Mine has one outfall (Outfall 001) regulated through an individual NPDES permit. An analysis of the past two years of flow data available from DMRs was completed to gain an understanding of typical discharge from this outfall. Data over the past two years indicated that this outfall does not regularly discharge, and when the outfall does discharge it typically occurs during precipitation events. Due to the irregularity of the discharges from this outfall, the estimated design flow of 0.5 MGD as reported in the facility's permit was used as the estimated design flow to calculate the WLA. DMRs were also reviewed to determine typical TSS concentrations for discharge events from the past two years. It was determined that TSS concentrations were typically less than 35 mg/L. Therefore, the WLA for the Oaktown Mine, Outfall 001 was calculated using the NPDES permit limit of 35 mg/L monthly average as it is more representative of existing load conditions.

Table 41: Individual WLAs for NPDES Individual Permit Municipal and Industrial Facilities in the Maria Creek Watershed

<table>
<tr><th>Subwatershed</th><th>Facility Name</th><th>Permit Number</th><th>AUID</th><th>Receiving Stream</th><th>Flow Regime</th><th>Estimated Design Flow (MGD)</th><th>E. coli WLA (MPN/day)</th><th>NPDES Permit E. coli Limit</th><th>TSS WLA (lbs/day)</th><th>NPDES Permit TSS Limit</th></tr>
<tr><td>Tilley Ditch</td><td>Freelandville Regional Sewer District</td><td>IN0064513</td><td>INB11I2_T1001</td><td>Tributary of Maria Creek</td><td>All</td><td>0.088</td><td>7.83E+08</td><td>235 MPN/100 mL Daily Max.</td><td>8.8*</td><td>12 mg/L* Monthly Avg.</td></tr>
<tr><td>Tilley Ditch</td><td>North Knox High School WWTP</td><td>IN0041084</td><td>INB11I2_T1004</td><td>Tilley Ditch</td><td>All</td><td>0.022</td><td>1.96E+08</td><td>235 MPN/100 mL Daily Max.</td><td>5.5*</td><td>30 mg/L* Monthly Avg.</td></tr>
<tr><td>Cotton Branch</td><td>North Knox Intermediate School WWTP</td><td>IN0041092</td><td>INB11I4_02</td><td>Tributary of Maria Creek</td><td>All</td><td>0.005</td><td>4.45E+07</td><td>235 MPN/100 mL Daily Max.</td><td>1.25</td><td>30 mg/L Monthly Avg.</td></tr>
<tr><td>Tilley Ditch</td><td>Freelandville Water Association</td><td>IN0059480</td><td>INB11I2_T1004</td><td>Tributary of Tilley Ditch</td><td>All</td><td>0.022</td><td>NA</td><td>NA</td><td>NA</td><td>40 mg/L* Daily Max.</td></tr>
<tr><td rowspan="5">Marsh Creek</td><td rowspan="5">Sunrise Coal Carlisle Mine</td><td rowspan="5">IN0062791</td><td rowspan="5">INB11I3_T1001</td><td rowspan="5">Tributary of Marsh Creek</td><td>High</td><td>1.77</td><td rowspan="5">NA</td><td rowspan="5">NA</td><td>516.88</td><td rowspan="5">35 mg/L Monthly Avg.</td></tr>
<tr><td>Moist</td><td>0.88</td><td>256.98</td></tr>
<tr><td>Mid</td><td>0.88</td><td>256.98</td></tr>
<tr><td>Dry</td><td>0.66</td><td>192.74</td></tr>
<tr><td>Low</td><td>0.47</td><td>137.25</td></tr>
<tr><td>Marsh Creek</td><td>Sunrise Coal Oaktown Mine</td><td>IN0064629</td><td>INB11I3_04</td><td>Marsh Creek</td><td>All</td><td>0.5</td><td>NA</td><td>NA</td><td>146.01</td><td>35 mg/L Monthly Avg.</td></tr>
</table>

Understanding Table 41: The WLA for each NPDES permitted facility will be achieved through compliance with the facility's NPDES individual permit.

**A TSS TMDL was not developed for the Tilley Ditch subwatershed. The WLAs and TSS limits are referenced from current permit limits for reporting purposes only.*

5.1.1 Approach for Calculating General Permit Wasteload Allocations

A number of permittees in the Maria Creek watershed are regulated through general rather than individual permits. An individual permit is site-specific and is developed to address discharges from a specific facility. A general permit is used to cover a category of similar discharges, rather than a specific site. IDEM may issue a general permit when there are several sources or activities involved in similar operations that may be adequately regulated with a standard set of conditions. Calculating WLAs for facilities with individual permits is straightforward; all of the necessary information regarding allowable flows and effluent limits is contained within the permit. Calculating WLAs for facilities with general permits is more difficult because only limited information is available on historical flow and pollutant concentrations.

For example, several outfalls associated with surface and underground mining operations in the watershed are regulated through general permits for treating run-off; discharge is believed to be primarily related to precipitation events rather than a "design" flow as is available for WWTPs. WLAs were therefore calculated by using an estimate of the surface impacts associated with each surface mine operation or underground mine outfall to determine run-off flow volumes, and existing permit limits were used to calculate allowable loadings. Surface impacts were estimated by delineating the disturbed surface area associated with each surface mine operation or underground mine outfall using the most recent aerial imagery available in ArcGIS and calculating the acreage of each area. To determine the WLA, the estimated surface impact acreage was divided by the total subwatershed acreage and multiplied by the corresponding flow values for the subwatershed to determine flow from the facility. Flow based WLAs were then calculated by multiplying the flow values by the target concentration of 70 mg/L daily maximum.

Table 42: Individual WLAs for NPDES General Permit Coal Mining Facilities in the Maria Creek Watershed

<table>
<tr><th>Subwatershed</th><th>Facility Name</th><th>Permit Number</th><th>AUID</th><th>Receiving Stream</th><th>Estimated Surface Impacts (Acres)</th><th>High Flow Regime TSS WLA (lbs/day)</th><th>Low Flow Regime TSS WLA (lbs/day)</th><th>NPDES Permit TSS Limit</th></tr>
<tr><td>Marsh Creek</td><td>Sunrise Coal Carlisle Mine</td><td>ING040199</td><td>INB11I3_02</td><td>Marsh Creek</td><td>283</td><td>991.98</td><td>18.11</td><td>70 mg/L daily max</td></tr>
<tr><td>Marsh Creek</td><td rowspan="2">Sunrise Coal Oaktown Mine</td><td rowspan="2">ING040222</td><td>INB11I3_04</td><td>Marsh Creek</td><td>122</td><td>428.57</td><td>7.83</td><td>70 mg/L daily max</td></tr>
<tr><td>Cotton Branch</td><td>INB11I4_T1001</td><td>Tributary of Maria Creek</td><td>20</td><td>69.26</td><td>0.55</td><td>70 mg/L daily max</td></tr>
<tr><td>Headwaters Maria Creek</td><td>Peabody Midwest Bear Run Mine</td><td>ING040239</td><td>INB11I1_T1002</td><td>Tributary of Maria Creek</td><td>2,123</td><td>7,249.75</td><td>56.90</td><td>70 mg/L daily max</td></tr>
</table>

Understanding Table 42: The WLA for each NPDES permitted facility will be achieved through compliance with the facility's NPDES general permit coverage.

Stormwater run-off associated with construction activity is currently regulated under 327 IAC 15-5, which is commonly referred to as "Rule 5" or the construction stormwater general permit. The WLA for sites regulated under the construction stormwater general permit was determined based on the average annual land disturbance associated with total overall acreage for all sites in the subwatershed. The average annual land disturbance was calculated for each subwatershed using data from permitted constructions sites for the past five years.

5.2 Critical Conditions

The CWA requires that TMDLs take into account critical conditions for stream flow, loading, and water quality parameters as part of the analysis of loading capacity. The load duration curve approach helps to identify the sources contributing to the impairment and to roughly differentiate between sources.

Exceedances of the load duration curve at higher flows (0-40 percent ranges) are indicative of wet weather sources (e.g., nonpoint sources, regulated stormwater discharges). Exceedances of the load duration curve at lower flows (60 to 100 percent range) are indicative of point sources (e.g., wastewater treatment facilities, livestock in the stream). Table 43 summarizes the general relationship between the five hydrologic zones and potentially contributing source areas (the table is not specific to any individual pollutant). Existing loading is calculated as the 90th percentile of measured pollutant concentrations under each hydrologic condition class multiplied by the flow at the middle of the flow exceedance percentile.

For example, in calculating the existing loading under dry conditions (flow exceedance percentile = 60-90 percent), the 75th percentile exceedance flow is multiplied by the 90th percentile of pollutant concentrations measured under 60-90th percentile flows. Through the load duration curve approach, it has been determined that load reductions for *E. coli* and TSS are needed for specific flow conditions. The critical conditions (the periods when the greatest reductions are required) vary by location and are summarized in Table 44. After existing loading and percent reductions are calculated under each hydrologic condition class, the critical condition for each TMDL is identified as the flow condition requiring the largest percent reduction. For example, impacts from point sources are usually most pronounced during dry and low flow zones because there is less water in the stream to dilute their loads. In contrast, impacts from channel bank erosion is most pronounced during high flow zones because these are the periods during which stream velocities are high enough to cause erosion to occur. The table indicates that critical conditions for pollutants for most locations occur during the dry to high regimes, and therefore implementation of controls should be targeted for these conditions.

Table 43: Relationship between Load Duration Curve Zones and Contributing Sources

Contributing Source Area	Duration Curve Zone				
	High (0%-10%)	Moist (10%-40%)	Mid-Range (40%-60%)	Dry (60%-90%)	Low (90%-100%)
Wastewater treatment plants (point source)			L	M	H
Livestock direct access to streams			L	M	H
Wildlife direct access to streams			L	M	H
Pasture management	H	H	M		
On-site wastewater systems/Unsewered areas	L	M	H	H	H
Riparian buffer areas	H	H	M	M	
Stormwater: Impervious	H	H	H		
Stormwater: Upland	H	H	M		
Field drainage: Natural condition	H	M			
Field drainage: Tile system	H	H	M	L	
Bank erosion	H	M	L		

Note: Potential relative importance of source area to contribute loads under given hydrologic condition (H: High; M: Medium; L: Low) (Modified from An Approach for Using Load Duration Curves in the Development of TMDLs (U.S. EPA, 2007)

Table 44: Critical Conditions for TMDL Parameters

Parameter	Subwatershed (HUC)	Critical Condition				
		High	Moist	Mid-Range	Dry	Low
E. coli (counts/mL)	Cotton Branch (051201111804)	99%	59%	79%	76%	7%
	Tilley Ditch (051201111802)	99%	74%	93%	93%	84%
	Marsh Creek (051201111803)	99%	75%	88%	87%	45%
	Headwaters Maria Creek (051201111801)	89%	--	85%	88%	72%
Total Suspended Solids (mg/L)	Cotton Branch (051201111804)	95%	0%	0%	0%	0%
	Marsh Creek (051201111803)	91%	0%	0%	0%	0%
	Headwaters Maria Creek (051201111801)	92%	0%	0%	0%	0%

Note: -- represents no data collected in the flow regime

Table 43 and Table 44 provide the foundation necessary to identify subwatersheds that are in need of the most significant pollutant reductions to achieve water quality standards in the Maria Creek watershed. Using these two tables, along with the linkage analysis in Section 4.0, watershed organizations will gain a better understanding of which subwatersheds require the most pollutant load reductions. This can assist in future efforts to identify critical areas in the Maria Creek watershed for implementation. The tables above focus on the information and data collected and analyzed through the TMDL development process for percent reduction purposes, whereas critical areas take into account other factors for consideration (e.g., political, social, economic) to help determine implementation feasibility that will affect progress toward pollutant load reductions and, ultimately, attainment of water quality standards. This information can be key to watershed organizations in the process of identifying and selecting critical areas and implementation activities for the purposes of watershed management plan development. IDEM recommends that watershed organizations take the percent reductions into consideration when selecting critical areas for purposes of watershed management planning. By also taking into account different flow regimes, watershed groups will be able to prioritize practices that give them the most efficient load reductions for each critical area that is chosen.

6.0 REASONABLE ASSURANCES/IMPLEMENTATION

This section of the Maria Creek watershed TMDL focuses on implementation activities that have the potential to achieve the WLAs and LAs presented in previous sections. The focus of this section is to identify and select the most appropriate structural and non-structural best management practices (BMPs) and control technologies to reduce *E. coli* and TSS loads from sources throughout the Maria Creek watershed, particularly in the critical areas identified in Section 5.2. This section also addresses the programs that are available to facilitate implementation of structural and non-structural BMPs to achieve the allocations, as well as current ongoing activities in the Maria Creek watershed at the local level that will play a key role in successful TMDL implementation.

To select appropriate BMPs and control technologies, it is important to review the relevant sources in the Maria Creek watershed.

Point Sources:

- Municipal Wastewater Treatment Plants
- Public Water Supply
- Surface and underground coal mining facilities
- Illicitly connected straight pipe systems

Nonpoint Sources:

- Cropland
- Stream bank erosion
- CFOs and AFOs
- Pastures and livestock operations
- Onsite wastewater treatment systems
- Wildlife
- Urban nonpoint source run-off

6.1 Implementation Activity Options for Sources in the Maria Creek Watershed

Keeping the list of significant sources in the Maria Creek watershed in mind, it is possible to review the types of BMPs that are most appropriate for the pollutants and the source type. Table 45 provides a list of implementation activities that are potentially suitable for the Maria Creek watershed based on the pollutants and the types of sources. The implementation activities are a combination of structural and non-structural BMPs to achieve the assigned WLAs and LAs. IDEM recognizes that actions taken in any individual subwatershed may depend on a number of factors (including socioeconomic, political, and ecological factors). The recommendations in Table 45 are not intended to be prescriptive. Any number or combination of implementation activities might contribute to water quality improvement, whether applied at sites where the actual impairment was noted or other locations where sources contribute indirectly to the water quality impairment.

Table 45: List of Potentially Suitable BMPs for the Maria Creek Watershed

Implementation Activities	Pollutant			Point Sources			Nonpoint Sources						
	Bacteria	Nutrients	Sediment	WWTPs and Industrial Facilities	CAFOs	Illicitly Connected " Straight Pipe" Systems	Cropland	Pastures and Livestock Operations	CFOs	Streambank Erosion	Onsite Wastewater Treatment Systems	Wildlife/Domestic Pets	Urban NPS Run-off
Inspection and maintenance	X	X	X	X	X						X		
Outreach and education and training	X	X	X	X	X	X	X	X	X	X	X	X	
System replacement	X	X				X					X		
Conservation tillage/residue management	X	X	X				X						
Cover crops	X	X	X				X			X			
Filter strips	X	X	X		X		X	X	X	X			
Grassed waterways	X		X		X		X		X	X			
Riparian forested/herbaceous buffers	X	X	X		X		X	X	X	X		X	
Manure handling, storage, treatment, and disposal	X	X			X				X				
Alternative watering systems	X		X		X			X	X	X			
Stream fencing (animal exclusion)	X	X	X		X			X		X			
Prescribed grazing	X	X	X					X		X			
Conservation easements	X	X	X										
Two-stage ditches		X	X										
Rain barrel		X	X										
Rain garden		X	X										
Porous pavement		X	X										
Stormwater planning and management	X	X	X	X						X	X	X	
Comprehensive Nutrient Management Plan	X	X					X		X				
Constructed Wetland	X	X	X	X		X	X					X	
Critical Area Planting			X					X		X			
Drainage Water Management		X					X						
Nutrient Management Plan		X					X			X			
Land Reconstruction of Mined Land			X							X			
Sediment Basin		X	X										
Pasture and Hay Planting	X	X	X				X	X	X	X		X	
Streambank and Shoreline Protection			X				X	X	X	X		X	
Conservation Crop Rotation		X	X				X	X	X				
Field Border	X	X					X	X	X			X	

Implementation Activities	Pollutant			Point Sources			Nonpoint Sources						
	Bacteria	Nutrients	Sediment	WWTPs and Industrial Facilities	CAFOs	Illicitly Connected " Straight Pipe" Systems	Cropland	Pastures and Livestock Operations	CFOs	Streambank Erosion	Onsite Wastewater Treatment Systems	Wildlife/Domestic Pets	Urban NPS Run-off
Conservation Crop Rotation	X	X	X				X			X			

The information provided in Section 5.2 assisted in the development of Table 45, which provides a more refined suite of recommended implementation activities targeted to the critical flow conditions. Watershed stakeholders can use the implementation activities identified in Table 45 for each critical flow condition and select activities that are most feasible in the Maria Creek watershed. This table can also help watershed stakeholders to identify implementation activities for critical areas that they select through the watershed management planning process.

6.2 Implementation Goals and Indicators

For each pollutant in the Maria Creek watershed, IDEM has identified broad goal statements and indicators. This information is to help watershed stakeholders determine how to track implementation progress over time and also provides the information necessary to complete a watershed management plan.

***E. coli* Goal Statement:** The waterbodies (or streams) in the Maria Creek watershed should meet the 235 colonies/100 mL daily max TMDL target value.

***E. coli* Indicator:** Water quality monitoring by IDEM will serve as the environmental indicator to determine progress toward the *E. coli* target value.

Total Suspended Solids Goal Statement: The waterbodies (or streams) in the Maria Creek watershed should meet the 30 mg/L TMDL total suspended solids target value.

Total Suspended Solids Indicator: Water quality monitoring by IDEM will serve as the environmental indicator to determine progress toward the total suspended solids target value.

6.3 Summary of Programs

There are a number of federal, state, and local programs that either require or can assist with the implementation activities recommended for the Maria Creek watershed. A description of these programs is provided in this section. The following section discusses how some of these programs relate to the various sources in the Maria Creek watershed.

6.3.1 Federal Programs

Clean Water Act Section 319(h) Grants

Section 319 of the federal Clean Water Act contains provisions for the control of nonpoint source pollution. The Section 319 program provides for various voluntary projects throughout the state to prevent water pollution and also provides for assessment and management plans related to waterbodies in Indiana impacted by NPS pollution. The Watershed Planning and Restoration Section within the Watershed Assessment and Planning Branch of the IDEM Office of Water Quality administers the Section 319 program for the NPS-related projects.

U.S. EPA offers Clean Water Act Section 319(h) grant monies to the state on an annual basis. These grants must be used to fund projects that address nonpoint source pollution issues. Some projects which the Office of Water Quality has funded with this money in the past include developing and implementing Watershed Management Plans (WMPs), BMP demonstrations, data management, educational programs, modeling, stream restoration, and riparian buffer establishment. Projects are usually two to three years in length. Section 319(h) grants are intended to be used for project start-up, not as a continuous funding source. Units of government, nonprofit groups, and universities in the state that have expertise in nonpoint source pollution problems are invited to submit Section 319(h) proposals to the Office of Water Quality.

Clean Water Action Section 205(j) Grants

Section 205(j) provides for planning activities relating to the improvement of water quality from nonpoint and point sources by making funding available to municipal and county governments, regional planning commissions, and other public organizations. For-profit entities, non-profit organizations, private associations, universities, and individuals are not eligible for funding through Section 205(j). The CWA states that the grants are to be used for water quality management and planning, including, but not limited to:

- Identifying most cost effective and locally acceptable facility and nonpoint source measures to meet and maintain water quality standards;
- Developing an implementation plan to obtain state and local financial and regulatory commitments to implement measures developed under those plans;
- Determining the nature, extent, and cause of water quality problems in various areas of the state.

The Section 205(j) program provides for projects that gather and map information on nonpoint and point source water pollution, develop recommendations for increasing the involvement of environmental and civic organizations in watershed planning and implementation activities, and develop watershed management plans.

HUD Community Development Block Grant Program (CDBG)

The Community Development Block Grant Program (CDBG) is authorized under Title I of the Housing and Community Development (HCD) Act of 1974, as amended. The main objective of the CDBG program is to develop viable communities by helping to provide decent housing and suitable living environments and expanding economic opportunities principally for persons of low- and moderate-income. The U.S. Department of Housing and Urban Development (HUD) provides federal CDBG funds directly to Indiana annually, through the Office of Community and Rural Affairs (OCRA), which then provides funding to small, incorporated cities and towns with populations less than 50,000 and to non-urban counties.

CDBG regulations define eligible activities and the National Objectives that each activity must meet. OCRA is responsible for ensuring projects that receive funding in Indiana are in accordance with the National Objectives and eligible activities.

OCRA is required to develop a Consolidated Plan that describes needs, resources, priorities, and proposed activities to be undertaken. Indiana's Consolidated Plan includes four goals for prioritizing fund allocations. These goals include: expand and preserve affordable housing opportunities throughout the housing continuum, reduce homelessness and increase housing stability for special needs populations, promote livable communities and community revitalization through addressing unmet community development needs, and promote activities that enhance local economic development efforts. OCRA has funded a variety of projects, including sanitary sewer and water systems.

USDA Conservation Stewardship Program (CSP)

The Conservation Stewardship Program (CSP) helps landowners build on their existing conservation efforts while strengthening their operation. Whether they are looking to improve grazing conditions, increase crop yields, or develop wildlife habitat, NRCS can custom design a CSP plan to help them meet those goals. NRCS can help landowners schedule timely planting of cover crops, develop a grazing plan that will improve the forage base, implement no-till to reduce erosion or manage forested areas in a way that benefits wildlife habitat. If landowners are already taking steps to improve the condition of the land, chances are CSP can help them find new ways to meet their goals.

USDA Conservation Reserve Program (CRP)

NRCS provides technical assistance to landowners interested in participating in the Conservation Reserve Program (CRP) administered by the USDA Farm Service Agency. The Conservation Reserve Program reduces soil erosion, protects the nation's ability to produce food and fiber, reduces sedimentation in streams and lakes, improves water quality, establishes wildlife habitat, and enhances forest and wetland resources. It encourages farmers to convert highly erodible cropland or other environmentally sensitive acreage to vegetative cover, such as tame or native grasses, wildlife plantings, trees, filter strips, or riparian buffers. Farmers receive an annual rental payment for the term of the multi-year contract. Cost-share funding is provided to establish the vegetative cover practices.

USDA Conservation Reserve Enhancement Program (CREP)

NRCS provides technical assistance to landowners interested in participating in the Conservation Reserve Program administered by the USDA Farm Service Agency. The Conservation Reserve Enhancement Program (CREP), an offshoot of CRP, targets high-priority conservation concerns identified by a state and federal funds are supplemented with non-federal funds to address those concerns. In exchange for removing environmentally sensitive land from production and establishing permanent resource conserving plant species, farmers and ranchers are paid an annual rental rate along with other federal and state incentives as applicable per each CREP agreement. Participation is voluntary, and the contract period is typically 10–15 years.

USDA Environmental Quality Incentives Program (EQIP)

The Environmental Quality Incentives Program provides technical, educational, and financial assistance to eligible farmers and ranchers to address soil, water, and related natural resource concerns on their lands in an environmentally beneficial and cost effective manner. The program provides assistance to farmers and ranchers in complying with federal, state, and tribal environmental laws, and encourages environmental enhancement. The program is funded through the Commodity Credit Corporation. The purposes of the program are achieved through the implementation of a conservation plan, which includes structural, vegetative, and land management practices on eligible land. Five to ten year contracts are made with eligible producers. Cost-share payments may be made to implement one or more eligible structural or vegetative practices, such as animal waste management facilities, terraces, filter strips, tree planting, and permanent wildlife habitat. Incentive payments can be made to implement one or more land management practices, such as nutrient management, pest management, and grazing land management. Fifty percent of the funding available for the program is targeted at natural resource concerns relating to livestock production. The program is carried out primarily in priority areas that may be watersheds, regions, or multi-state areas, and for significant statewide natural resource concerns that are outside of geographic priority areas.

USDA Farmable Wetlands Program

NRCS provides technical assistance to landowners interested in participating in the Conservation Reserve Program administered by the USDA Farm Service Agency. The Farmable Wetlands Program (FWP) is designed to restore previously farmed wetlands and wetland buffer to improve both vegetation and water flow. FWP is a voluntary program to restore up to one million acres of farmable wetlands and associated buffers. Participants must agree to restore the wetlands, establish plant cover, and to not use enrolled land for commercial purposes. Plant cover may include plants that are partially submerged or specific types of trees. By restoring farmable wetlands, FWP improves groundwater quality, helps trap and break down pollutants, prevents soil erosion, reduces downstream flood damage, and provides habitat for water birds and other wildlife. Wetlands can also be used to treat sewage and are found to be as effective as “high tech” methods. The Farm Service Agency runs the program through the Conservation Reserve Program (CRP) with assistance from other government agencies and local conservation groups.

USDA Conservation Technical Assistance (CTA)

The purpose of the CTA program is to assist land users, communities, units of state and local government, and other Federal agencies in planning and implementing conservation systems. The purpose of the conservation systems is to reduce erosion, improve soil and water quality, improve and conserve wetlands, enhance fish and wildlife habitat, improve air quality, improve pasture and range condition, reduce upstream flooding, and improve woodlands.

One objective of the program is to assist individual land users, communities, conservation districts, and other units of state and local government and federal agencies to meet their goals for resource stewardship and assist individuals in complying with state and local requirements. NRCS assistance to individuals is provided through conservation districts in accordance with the Memorandum of Understanding signed by the Secretary of Agriculture, the Governor of the State, and the conservation district. Assistance is provided to land users voluntarily applying conservation practices and to those who must comply with local or state laws and regulations.

Another objective is to provide assistance to agricultural producers to comply with the highly erodible land (HEL) and wetland (Swampbuster) provisions of the 1985 Food Security Act, as amended by the Food, Agriculture, Conservation and Trade Act of 1990 (16 U.S.C. 3801 et. seq.), the Federal Agriculture Improvement and Reform Act of 1996, and wetlands requirements of Section 404 of the Clean Water Act. NRCS makes HEL and wetland determinations and helps land users develop and implement conservation plans to comply with the law. The program also provides technical assistance to participants in USDA cost-share and conservation incentive programs.

NRCS collects, analyzes, interprets, displays, and disseminates information about the condition and trends of the Nation's soil and other natural resources so that people can make good decisions about resource use and about public policies for resource conservation. They also develop effective science based technologies for natural resource assessment, management, and conservation.

USDA Section 504 Home Repair Program

USDA Rural Development administers the Section 504 Home Repair Program, or Single Family Housing Repair Loans and Grants. The Section 504 Home Repair Program provides loans to very low-income homeowners to repair, improve, or modernize their home and provides grants to elderly very low-income homeowners to remove health and safety hazards. The purpose of this program is to help families stay in their own home and keep their home in good repair. Applicants must live in a rural area below 50 percent of the area median income. Grant applicants must be age 62 or older and unable to repay a repair loan. Loans may be used to repair, improve, or modernize homes or to remove health and safety hazards. Grants must be used to remove health and safety hazards. For example, repairing a failed septic system may be an applicable health and safety hazard. The maximum loan amount is $20,000, and the maximum grant amount is $7,500.

USDA Watershed Surveys and Planning

The Watershed and Flood Prevention Act, P.L. 83-566, August 4, 1954, (16 U.S.C. 1001-1008) authorized this program. Prior to fiscal year 1996, small watershed planning activities and the cooperative river basin surveys and investigations authorized by Section 6 of the Act were operated as separate programs. The 1996 appropriations act combined the activities into a single program entitled the Watershed Surveys and Planning program. Activities under both programs are continuing under this authority.

The purpose of the program is to assist federal, state, and local agencies and tribal governments to protect watersheds from damage caused by erosion, floodwater, and sediment and to conserve and develop water and land resources. Resource concerns addressed by the program include water quality, opportunities for water conservation, wetland and water storage capacity, agricultural drought problems, rural development, municipal and industrial water needs, upstream flood damages, and water needs for fish, wildlife, and forest-based industries.

Types of surveys and plans include watershed plans, river basin surveys and studies, flood hazard analyses, and floodplain management assistance. The focus of these plans is to identify solutions that use land treatment and non-structural measures to solve resource problems.

USDA Agricultural Conservation Easement Program (ACEP)

The Agricultural Conservation Easement Program (ACEP) provides financial and technical assistance to help conserve agricultural lands and wetlands and their related benefits. Under the Agricultural Land Easements component, NRCS helps American Indian tribes, state and local governments and nongovernmental organizations protect working agricultural lands and limit non-agricultural uses of the land. Under the Wetlands Reserve Easements component, NRCS helps to restore, protect, and enhance enrolled wetlands.

Agricultural Land Easements protect the long-term viability of the nation's food supply by preventing conversion of productive working lands to non-agricultural uses. Land protected by agricultural land easements provides additional public benefits, including environmental quality, historic preservation, wildlife habitat, and protection of open space.

Wetland Reserve Easements provide habitat for fish and wildlife, including threatened and endangered species, improve water quality by filtering sediments and chemicals, reduce flooding, recharge groundwater, protect biological diversity, and provide opportunities for educational, scientific, and limited recreational activities.

NRCS provides financial assistance to eligible partners for purchasing Agricultural Land Easements that protect the agricultural use and conservation values of eligible land. In the case of working farms, the program helps farmers and ranchers keep their land in agriculture. The program also protects grazing uses and related conservation values by conserving grassland, including rangeland, pastureland and shrubland. Eligible partners include American Indian tribes, state and local governments and non-governmental organizations that have farmland, rangeland, or grassland protection programs.

Under the Agricultural Land component, NRCS may contribute up to 50 percent of the fair market value of the agricultural land easement. Where NRCS determines that grasslands of special environmental significance will be protected, NRCS may contribute up to 75 percent of the fair market value of the agricultural land easement.

USDA Regional Conservation Partnership Program (RCPP)

The Regional Conservation Partnership Program (RCPP) encourages partners to join in efforts with producers to increase the restoration and sustainable use of soil, water, wildlife, and related natural resources on regional or watershed scales. Through the program, NRCS and its partners help producers install and maintain conservation activities in selected project areas. Partners leverage RCPP funding in project areas and report on the benefits achieved.

USDA Healthy Forests Reserve Program (HFRP)

The Healthy Forests Reserve Program (HFRP) helps landowners restore, enhance, and protect forestland resources on private lands through easements and financial assistance. HRFP aids the recovery of endangered and threatened species under the Endangered Species Act, improves plant and animal biodiversity, and enhances carbon sequestration.

HFRP provides landowners with 10-year restoration agreements and 30-year or permanent easements for specific conservation actions. For acreage owned by an Indian tribe, there is an additional enrollment option of a 30-year contract. Some landowners may avoid regulatory restrictions under the Endangered Species Act by restoring or improving habitat on their land for a specified period of time.

USDA Voluntary Public Access and Habitat Incentive Program (VPA-HIP)

The Voluntary Public Access and Habitat Incentive Program (VPA-HIP) is a competitive grants program that helps state and tribal governments increase public access to private lands for wildlife-dependent recreation, such as hunting, fishing, nature watching, or hiking.

State and tribal governments may submit proposals for VPA-HIP block grants from NRCS. These governments provide the funds to participating private landowners to initiate new or expand existing public access programs that enhance public access to areas previously unavailable for wildlife-dependent recreation. Nothing in VPA-HIP preempts liability laws that may apply to activities on any property related to grants made in this program.

U.S. Army Corps of Engineers

Section 404 of the Clean Water Act establishes a program to regulate the discharge of dredged or fill material into Waters of the United States, including wetlands. Dredge and fill activities are controlled by a permit process administered by the U.S. Army Corps of Engineers and overseen by the U.S. Environmental Protection Agency. In addition, when a project is planned in Indiana that will impact a wetland, stream, river, lake, or other Water of the U.S., the Indiana Department of Environmental Management (IDEM) must also issue a Section 401 Water Quality Certification. A Section 401 WQC is a required component of a federal permit and must be issued before a federal permit or license can be granted. Depending on the extent of impact, mitigation may be required to offset the impacts. Stream and wetland mitigation is usually conducted onsite or offsite within the same 8-digit HUC watershed.

Coal mining often results in wetland and stream impacts that require permits from the U.S. Army Corps of Engineers and IDEM due to the significant land disturbing activities associated with operations. There are three coal mining operations that discharge within the Maria Creek watershed, as discussed in Section 2.8.2. Two stream segments located within the northeastern portion of the Headwaters of Maria Creek subwatershed have been impacted by the Bear Run Mine surface mining activity. The stream segments include Maria Creek (INB11I1_T1001) and a tributary of Maria Creek (INB11I1_T1002). These stream impacts are permitted through the U.S. Army Corps of Engineers (LRL-2022-1117-GJD) and IDEM (2011-487-77-DDC-A). Available plans indicate these stream segments will likely be mitigated onsite in a similar location as the original stream channels. Mining operations take several years to complete, so mitigation is often phased over the course of several years. Additional stream and wetland impacts within the watershed are likely as coal mining operations move and expand. As stream and wetland mitigation is planned and constructed, there is a potential for partnerships between the local community, coal mining facilities, and regulatory agencies for mitigation of streams and wetlands to improve water quality and address impairments in the Maria Creek watershed.

6.3.2 State Programs

IDEM Point Source Control Program

Point source pollution is regulated by several IDEM Office of Water Quality branches, including the Wastewater Compliance Branch, the Wastewater Permitting Branch, and the Surface Water, Operations, and Enforcement Branch. The Wastewater Permitting Branch issues NPDES and construction permits to sources that discharge wastewater to streams, lakes, and other waterbodies, including municipal wastewater treatment plants and industrial wastewater dischargers. The Stormwater Program, which is managed under the Surface Water, Operations, and Enforcement Branch, issues NPDES permits for stormwater discharges associated with industrial activities, active construction that results in a land disturbance of an acre or more, and municipal separate storm sewer systems (MS4). NPDES permits are issued in accordance with the Clean Water Act, federal laws, and state laws and regulations. The purpose of the NPDES permit is to control the point source discharge of pollutants into the waters of the state such that the quality of the water of the state is maintained in accordance with applicable water quality standards. The Wastewater Compliance Branch and Stormwater Program conduct inspections of facilities and projects with NPDES permits and review and evaluate compliance data to ensure permittees abide by the requirements of their permit. Control of discharges from point sources consistent with WLAs are implemented through the respective NPDES program.

IDEM Nonpoint Source Control Program

The state's Nonpoint Source Program, administered by the IDEM Office of Water Quality's Watershed Planning and Restoration Section, focuses on the assessment and prevention of nonpoint source water pollution. The program also provides for education and outreach to improve the way land is managed. Through the use of federal funding for the installation of BMPs, the development of watershed management plans, and the implementation of watershed restoration pollution prevention activities, the program reaches out to citizens so that land is managed in such a way that less pollution is generated.

Nonpoint source projects funded through the Office of Water Quality are a combination of local, regional, and statewide efforts sponsored by various public and not-for-profit organizations. The emphasis of these projects has been on the local, voluntary implementation of nonpoint source water pollution controls. The Watershed Planning and Restoration Section administers the Section 319 funding for nonpoint source-related projects, as well as Section 205(j) grants.

To award 319 grants, Watershed Planning and Restoration Section staff review proposals for minimum 319(h) eligibility criteria and rank each proposal. In their review, members consider such factors as: technical soundness; likelihood of achieving water quality results; strength of local partnerships; and competence/reliability of contracting agency. They then convene to discuss individual project merits and pool all rankings to arrive at final rankings for the projects. All proposals that rank above the funding target are included in the annual grant application to U.S. EPA, with U.S. EPA reserving the right to make final changes to the list. Actual funding depends on approval from U.S. EPA and yearly congressional appropriations.

Section 205(j) projects are administered through grant agreements that define the tasks, schedule, and budget for the project. IDEM project managers work closely with the project sponsors to help ensure that the project runs smoothly and the tasks of the grant agreement are fulfilled. Site visits are conducted at least quarterly to touch base on the project, provide guidance and technical assistance as needed, and to work with the grantee on any issues that arise to ensure a successful project closeout.

IDEM Hoosier Riverwatch Program

Hoosier Riverwatch (HRW) is a statewide volunteer stream water quality monitoring program administered by the IDEM Office of Water Quality, Watershed Assessment and Planning Branch. The mission of HRW is to involve the citizens of Indiana in becoming active stewards of Indiana's water resources and to increase public awareness of water quality issues and concerns. HRW accomplishes this through watershed education, hands-on training of volunteers, water monitoring, and clean-up activities. HRW collaborates with agencies and volunteers to educate local communities about the relationship between land use and water quality and to provide water quality information to citizens and governmental agencies working to protect Indiana's rivers and streams.

ISDA Division of Soil Conservation

The Indiana State Department of Agriculture (ISDA) Division of Soil Conservation's mission is to ensure the protection, wise use, and enhancement of Indiana's soil and water resources. The Division's employees are part of Indiana's Conservation Partnership, which includes the 92 soil and water conservation districts (SWCDs), the USDA Natural Resources Conservation Service, and the Purdue University Cooperative Extension Service. Working together, the partnership provides technical, educational, and financial assistance to citizens to solve erosion and sediment-related problems occurring on the land or impacting public waters.

ISDA Clean Water Indiana (CWI) Program

The ISDA Division of Soil Conservation administers the Clean Water Indiana (CWI) program under the direction of the State Soil Conservation Board. The CWI program provides financial assistance to landowners and conservation groups to support the implementation of conservation practices which will reduce nonpoint sources of water pollution through education, technical assistance, training, and cost sharing programs. The program is responsible for providing local matching funds, as well as competitive grants for sediment and nutrient reduction projects through Indiana's SWCDs.

ISDA INfield Advantage (INFA) Program

The ISDA Division of Soil Conservation administers Infield Advantage (INFA). INFA is a collaborative opportunity for farmers to collect and understand personalized, on-farm data to optimize their management practices. Participating farmers use precision agricultural tools and technologies, such as aerial imagery and the corn stalk nitrate test, to conduct research on their own farms to determine nitrogen use efficiency in each field that they enroll. Peer to peer group discussions, local aggregated results, and collected data allow participants to make more informed decisions and implement personalized best management practices. INFA is available to farmers as a resource and a conduit to diverse on-farm research, innovative ideas, and technologies. INFA collaborates with local, regional, and national partners to help Indiana farmers improve their bottom line, adopt new management practices, protect natural resources, and benefit their surrounding communities.

IDNR Lake and River Enhancement (LARE) Program

The Lake and River Enhancement program is part of the Aquatic Habitat Unit of the Fisheries Section in the Indiana Department of Natural Resources (IDNR), Division of Fish and Wildlife. The goal of the LARE program is to protect and enhance aquatic habitat for fish and wildlife and to ensure the continued viability of Indiana's publicly accessible lakes and streams for multiple uses, including recreational opportunities. This is accomplished through measures that reduce nonpoint source sediment and nutrient pollution of surface waters to a level that meets or surpasses state water quality standards. The LARE program provides technical and financial assistance to local entities for qualifying projects that improve and maintain water quality in public access lakes, rivers, and streams.

IFA State Revolving Fund (SRF) Loan Program

The SRF is a fixed rate, 20-year loan administered by the Indiana Finance Authority (IFA). The SRF provides low-interest loans to Indiana communities for projects that improve wastewater and drinking water infrastructure. The program's mission is to provide eligible entities with the lowest interest rates possible on the financing of such projects while protecting public health and the environment. SRF also funds nonpoint source projects that are tied to a wastewater loan. Any project where there is an existing pollution abatement need is eligible for SRF funding.

6.3.3 Local Programs

Programs taking place at the local level are key to successful TMDL implementation. Partners such as Sullivan and Knox SWCDs are instrumental to bringing grant funding into the Maria Creek watershed to support local protection and restoration projects. This section provides a brief summary of the local programs taking place in the Maria Creek watershed that will help to reduce pollutant loads, as well as provide ancillary benefits to the Maria Creek watershed.

Sullivan County has begun outreach events to garner interest for watershed management planning and implementation in the Maria Creek and adjacent No Business Creek watersheds. The Maria – No Business Creek (MNBC) Watershed Project kick-off meetings were held on April 7th, 2021 in Vincennes, Indiana and on April 14th, 2021 in Sullivan, Indiana. An email list with over 120 contacts has already been collected for the MNBC Watershed Project, and local cross-program coordination with partner agencies has been initiated.

Additional monitoring will likely take place in the Maria Creek watershed as a result of the MNBC Watershed Project. Local groups frequently conduct monitoring in watersheds with watershed management plans to engage the public through Hoosier Riverwatch volunteer monitoring events and through more formal monitoring efforts to determine if implementation activities have been successful in reducing nonpoint source pollutant loads. After best management practices are implemented by local groups, IDEM may also conduct performance monitoring at specific sites in the watershed through the Targeted Monitoring Program. Data collected through performance monitoring is compared to water quality standards and targets, as discussed in Section 1.0, to determine if previously impaired waterbodies can be delisted from the Section 303(d) List of Impaired Waters.

Sullivan and Knox counties are both active in obtaining funding and implementing projects in their respective watersheds to improve water quality. Both counties conduct an annual tillage/cover crop transect and have been involved in voluntary nutrient analysis programs, such as INField Advantage (INFA). Knox County led a multi-county Reclaimed Mined Lands Regional Conservation Partnership Program (RCPP) through NRCS. Knox County also conducts county-wide water quality assessments. Both counties have had many contribution agreements with NRCS to provide technical and administration assistance for Farm Bill conservation programs. In addition, there are also active and upcoming 319 grants in nearby watersheds located in both counties that will be beneficial for cross-promotion and public awareness with the MNBC Watershed Project.

Sullivan County
Sullivan County has received the following funding to improve water quality and conservation in 2018:

- Local: $36,577
- Clean Water Indiana: $10,000
- Lake and River Enhancement Program: $67,000
- Wildlife Habitat Cost-Share Program: $1,520
- Conservation Reserve Program & Conservation Reserve Enhancement Program: $499,511
- Conservation Stewardship Program: $13,226
- Environmental Quality Incentives Program: $445,271
- Wetland Reserve Program: $3,498

Total: $1,076,603

Knox County
Knox County has received the following funding to improve water quality and conservation in 2018:

- Local: $324,589
- Clean Water Indiana: $62,500
- Conservation Reserve Program & Conservation Reserve Enhancement Program: $1,077,758
- Agricultural Conservation Easement Program: $901,865
- Conservation Stewardship Program: $82,581
- Environmental Quality Incentives Program: $591,303
- Wetland Reserve Program: $65,197

Total: $3,105,793

6.4 Implementation Programs by Source

Section 6.3 Summary of Programs identified a number of federal, state, and local programs that can support implementation of the recommended management or restoration activities for the Maria Creek watershed. Table 46 and the following sections identify which programs are relevant to the various sources in the Maria Creek watershed.

Table 46: Summary of Programs Relevant to Sources in the Maria Creek Watershed

Source	IDEM NPDES program	Local agencies/programs	CWA 319(h) Grants	CWA 205(j) Grants	ISDA Division of Soil Conservation (INFA & CWI)	IDNR Division of Fish and Wildlife (LARE)	IFA State Revolving Fund (SRF) Loan Program)	HUD Community Development Block Grant Program (CDBG)	USDA Conservation Stewardship Program (CSP)	USDA Conservation Reserve Program (CRP)	USDA Conservation Reserve Enhancement Program (CREP)	USDA Conservation Technical Assistance (CTA)	USDA Environmental Quality Incentives Program (EQUIP)	USDA Farmable Wetlands Program	USDA Agricultural Conservation Easement Program (ACEP)	USDA Regional Conservation Partnership Program (RCPP)	USDA Healthy Forests Reserve Program (HFRP)	USDA Voluntary Public Access and Habitat Incentive Program (VPA-HIP)	USDA Watershed Surveys and Planning	USDA Section 504 Program
Municipal & Industrial Wastewater	X			X			X													
Regulated Stormwater	X			X			X													
Illicitly Connected “Straight Pipe” Systems	X	X		X				X												
Cropland		X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	
Pastures and Livestock Operations		X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	
CFOs	X			X		X														
Streambank Erosion		X	X	X	X	X						X	X	X	X	X		X	X	
Onsite Wastewater Treatment Systems		X		X			X	X												X
In-stream Habitat	X	X	X																	

6.4.1 Point Source Programs

Municipal Wastewater Treatment Plants (WWTPs)

Municipal Wastewater Treatment Plants (WWTPs) that discharge wastewater through a point source to a surface water of the state are required to obtain a municipal NPDES wastewater permit. Municipal wastewater permits include effluent limitations that are derived using water quality criteria developed to protect all designated and existing uses of the receiving waterbody and/or any more stringent technology-based limitations. The NPDES program provides IDEM the authority to ensure that recommended effluent limits are applied to the appropriate permit holders within the watershed.

Industrial Wastewater

Industrial facilities that discharge wastewater through a point source to a surface water of the state are required to obtain an industrial NPDES wastewater permit. Industrial wastewater permits include effluent limitations that are derived using water quality criteria developed to protect all designated and existing uses of the receiving waterbody and/or any more stringent technology-based limitations. The NPDES program provides IDEM the authority to ensure that recommended effluent limits are applied to the appropriate permit holders within the watershed.

Construction Stormwater

Stormwater run-off associated with construction activity is currently regulated under 327 IAC 15-5, which is commonly referred to as "Rule 5" or the construction stormwater general permit. The construction stormwater general permit requires the development and implementation of a construction plan that includes a stormwater pollution prevention plan (SWPPP). The SWPPP outlines how erosion and sedimentation will be controlled on the project site to minimize the discharge of sediment off-site or to a water of the state. The primary pollutant of concern from active construction sites is sediment, or TSS. TSS TMDLs were developed to address impaired biotic communities in the Cotton Branch, Marsh Creek, and Headwaters Maria Creek subwatersheds. Identification of impaired waters with TMDLs, specifically those with TSS TMDLs, in the SWPPP is recommended to ensure adequate stormwater control measures are implemented to minimize discharges of sediment to impaired waters. It is assumed that permitted construction sites that are in compliance with the construction stormwater general permit meet the requirements of the TMDL. However, in order to ensure sediment-laden stormwater discharges from construction sites to impaired waters with TMDLs are minimized, implementation of additional measures may be considered, such as:

- Identify any waterbodies within the project site that have a U.S. EPA approved or established TMDL, including the name of the TMDL and pollutant(s) for which there is a TMDL.
- Increase self-monitoring in locations on the project site that discharge to impaired waters with TSS TMDLs.
- Improve construction sequencing to limit the amount of exposed soil at any given time as much as possible throughout the project.

- Increase frequency of stabilization of areas that are void of vegetative cover. When an area is left idle for seven days initiate stabilization. Stabilization includes permanent stabilization with structured armor, permanent seed mixes, or temporary seed mixes.
- Place signage or easily identifiable barriers, such as orange safety fencing, near impaired waters to alert construction crews of the sensitive resource.
- Increase the maintenance schedule of measures installed adjacent to impaired waters with TSS TMDLs to promote effective sediment removal.

Industrial Stormwater

Stormwater run-off associated with industrial activity is currently regulated under 327 IAC 15-6, which is commonly referred to as "Rule 6" or the industrial stormwater general permit. Facilities may also be required to obtain an individual stormwater permit as discussed in Section 2.8.3. There are currently no facilities in the Maria Creek watershed that have coverage under the industrial stormwater general permit or an individual stormwater permit.

Municipal Separate Storm Sewer Systems (MS4)

Stormwater run-off from certain types of urbanized areas are currently regulated under 327 IAC 15-13, which is commonly referred to as "Rule 13" or the municipal separate storm sewer system (MS4) general permit. There are currently no MS4s in the Maria Creek watershed that have coverage under IDEM's MS4 general permit.

CAFOs

CAFOs are point sources regulated through the NPDES Program. Indiana regulations for CAFOs can be found in 327 IAC 15-15 and federal regulations for all CAFOs can be found in 40 CFR Parts 9, 122, and 412. The Effluent Limitations Guidelines and New Source Performance Standards for CAFOs require, in general, zero discharge from these areas and require proper design, construction, operation, and maintenance of the structures to contain all manure, litter, and process wastewater including the run-off and direct precipitation from a 25-year, 24-hour rainfall event. The NPDES general permit also requires that water quality standards shall not be exceeded in the event of an overflow from production areas. There are currently no CAFOs in the Maria Creek watershed.

Illegal straight pipes

Local health departments are responsible for locating and eliminating illicit discharges and illegal connections to the sewer system.

6.4.2 Nonpoint Sources Programs

Cropland

Nonpoint source pollution from cropland areas is typically reduced through the voluntary implementation of BMPs by private landowners. Programs available to support implementation of cropland BMPs, whether through cost-share or technical assistance and education, include:

- Clean Water Act Section 319(h) Grants
- Clean Water Act Section 205(j) Grants
- Indiana State Department of Agriculture Division of Soil Conservation/SWCDs (CWI & INFA)
- Indiana Department of Natural Resources Division of Fish and Wildlife (LARE)
- USDA Conservation Stewardship Program (CSP)
- USDA Conservation Reserve Program (CRP)
- USDA Conservation Reserve Enhancement Program (CREP)
- USDA Conservation Technical Assistance (CTA)
- USDA Environmental Quality Incentives Program (EQIP)
- USDA Farmable Wetlands Program
- USDA Agricultural Conservation Easement Program (ACEP)
- USDA Regional Conservation Partnership Program (RCPP)
- USDA Healthy Forests Reserve Program (HFRP)
- USDA Voluntary Public Access and Habitat Incentive Program (VPA-HIP)
- USDA Watershed Surveys and Planning

Pastures and livestock operations

Nonpoint source pollution from pasture and livestock areas is typically reduced through the voluntary implementation of BMPs by private landowners. Programs available to support implementation of pasture and grazing BMPs, whether through cost-share or technical assistance and education, include:

- Clean Water Act Section 319(h) Grants
- Clean Water Act Section 205(j) Grants
- Indiana State Department of Agriculture Division of Soil Conservation/SWCDs (CWI & INFA)
- Indiana Department of Natural Resources Division of Fish and Wildlife (LARE)
- USDA Conservation Stewardship Program (CSP)
- USDA Conservation Reserve Program (CRP)
- USDA Conservation Reserve Enhancement Program (CREP)
- USDA Conservation Technical Assistance (CTA)
- USDA Environmental Quality Incentives Program (EQIP)
- USDA Farmable Wetlands Program
- USDA Agricultural Conservation Easement Program (ACEP)

- USDA Regional Conservation Partnership Program (RCPP)
- USDA Healthy Forests Reserve Program (HFRP)
- USDA Voluntary Public Access and Habitat Incentive Program (VPA-HIP)
- USDA Watershed Surveys and Planning

CFOs

While CAFOs are regulated by federal law, CFOs are not. However, Indiana has CFO regulations 327 IAC 16, 327 IAC 15 that require that operations manage manure, litter, and process wastewater in a manner that "does not cause or contribute to an impairment of surface waters of the state." IDEM regulates CFOs under IC 13-18-10, the Confined Feeding Control Law. The rules at 327 IAC 16, which implement the statute regulating CFOs, were effective on March 10, 2002. IDEM's Office of Land Quality administers the regulatory program, which includes permitting, compliance monitoring, and enforcement activities.

Streambank erosion

Streambank erosion can be the result of changes in the physical structure of the immediate bank from activities such as removal of riparian vegetation or frequent use by livestock, or it can be the result of increased flow volumes and velocities resulting from increased surface run-off throughout the upstream watershed. Therefore, streambank erosion might be addressed through BMPs and restoration targeted to the specific stream reach, and further degradation could be addressed through the use of BMPs implemented to address stormwater issues throughout the watershed. Programs available to support implementation of BMPs to address streambank erosion, whether through cost-share or technical assistance and education, include:

- Clean Water Act Section 319(h) Grants
- Clean Water Act Section 205(j) Grants
- Indiana State Department of Agriculture Division of Soil Conservation/SWCDs (CWI & INFA)
- Indiana Department of Natural Resources Division of Fish and Wildlife (LARE)
- USDA Conservation Technical Assistance (CTA)
- USDA Environmental Quality Incentives Program (EQIP)
- USDA Farmable Wetlands Program
- USDA Agricultural Conservation Easement Program (ACEP)
- USDA Regional Conservation Partnership Program (RCPP)
- USDA Voluntary Public Access and Habitat Incentive Program (VPA-HIP)
- USDA Watershed Surveys and Planning
- Mitigation Funds

Onsite Wastewater Treatment Systems

Local health departments and the Indiana Department of Health (IDOH) regulate septic systems through local ordinances and the Onsite Sewage Disposal Program (410 IAC 6-8.3). Regulations include constraints on the location and design of current septic systems in an effort to prevent system failures. The onsite sewage system rule also prohibits failing systems, requiring that no system will contaminate groundwater, and no system will discharge untreated effluent to the surface. Programs available to address issues related to failing onsite wastewater treatment systems within a community include:

- Clean Water Act Section 205(j) Grants
- IFA State Revolving Fund Loan Program
- HUD Community Development Block Grant Program (CDBG)
- USDA Section 504 Program

Wildlife/Domestic Pets

Addressing pollutant contributions from wildlife and domestic pets is typically done at the local level through education and outreach efforts. For wildlife, educational programs focus on proper maintenance of riparian areas and discouraging the public from feeding wildlife. For domestic pets, education programs focus on responsible pet waste maintenance (e.g., scoop the poop campaigns) coupled with local ordinances.

6.5 Potential Implementation Partners and Technical Assistance Resources

Agencies and organizations at the federal, state, and local levels will play a critical role in implementation to achieve the WLAs and LAs assigned under this TMDL. Table 47 identifies key potential implementation partners and the type of technical assistance they can provide to watershed stakeholders. IDEM has also compiled a matrix of public and private grants and other funding resources available to fund watershed implementation activities. The matrix is available on IDEM's website at https://www.in.gov/idem/nps/funding/non-idem-funding/funding-matrix/.

Table 47: Potential Implementation Partners in the Maria Creek Watershed

Potential Implementation Partner	Funding Source
Federal	
USDA	Conservation Stewardship Program
USDA	Conservation Reserve Program
USDA	Conservation Reserve Enhancement Program
USDA	Conservation Technical Assistance (technical assistance only)
USDA	Environmental Quality Incentives Program
USDA	Farmable Wetlands Program
USDA	Agricultural Conservation Easement Program

Potential Implementation Partner	Funding Source
USDA	Regional Conservation Partnership Program
USDA	Healthy Forests Reserve Program
USDA	Voluntary Public Access and Habitat Incentive Program
USDA	Watershed Surveys and Planning
USDA	Section 504 Home Repair Program
HUD	Community Development Block Grant Program
State	
ISDA	Division of Soil Conservation – Clean Water Indiana Program
ISDA	Division of Soil Conservation – INfield Advantage Program
IDNR	Division of Fish and Wildlife - Lake and River Enhancement program
IDEM	Clean Water Act Section 319(h) Grants
IDEM	Clean Water Act Section 205(j) Grants
Local	
Soil and Water Conservation Districts	Local funds
County Health Departments	

In addition, several tools are available to assist local watershed stakeholders with the estimation of pollutant load reductions from the implementation of various BMPs within the Maria Creek watershed in order to optimize BMP selection. These tools include L-THIA LID, STEPL, the Region 5 Model, and the Indiana *E. coli* Calculator.

The Long-Term Hydrologic Impact Assessment (L-THIA) model is an online tool developed by Purdue University that estimates run-off, recharge, and pollutant loads for land use configurations based on precipitation data, soils, and land use data for an area. The L-THIA LID model is an enhancement to the original model, which can be used to simulate run-off and pollutant loads associated with low impact development (LID) practices at lot to watershed scales. The model can be used as a screening tool to evaluate the benefits of implementation of LID practices. LID practices included in the model include, but are not limited to, grass swales, rain barrel/cisterns, rain gardens, and porous pavement. The L-THIA LID tool is available online at https://engineering.purdue.edu/mapserve/LTHIA7/lthianew/lidIntro.php.

The Spreadsheet Tool for Estimating Pollutant Loads (STEPL) employs simple algorithms to calculate nutrient and sediment loads from different land uses and the load reductions that would result from the implementation of various BMPs. STEPL provides a user-friendly Visual Basic (VB) interface to create a customized spreadsheet-based model in Microsoft Excel. It computes watershed surface run-off, nutrient loads, and sediment delivery based on land use distribution and management practices. The sediment and pollutant load reductions that result from the implementation of BMPs are computed using known BMP efficiencies. The STEPL package can be downloaded at https://www.epa.gov/nps/spreadsheet-tool-estimating-pollutant-loads-stepl. Purdue University has also developed a web-based version of STEPL available at https://engineering.purdue.edu/mapserve/ldc/STEPL/?.

The Region 5 Model is a Microsoft Excel workbook that provides a gross estimate of sediment and nutrient load reductions from the implementation of agricultural and urban BMPs. The model was developed by the U.S. EPA Region 5 and the Michigan Department of Environmental Quality. It does not estimate pollutant load reductions for dissolved constituents. The algorithms for non-urban BMPs are based on the Michigan Department of Environmental Quality’s "Pollutants controlled: Calculation and documentation for Section 319 watersheds training manual". The algorithms for urban BMPs are based on the data and calculations developed by Illinois EPA. The Region 5 Model download and training materials can be found at https://www.epa.gov/nps/region-5-model-estimating-pollutant-load-reductions.

The Indiana *E. coli* Calculator (IEC) is a spreadsheet tool that estimates the *E. coli* contribution from multiple sources and calculates load reductions of BMP installations. The portions of the spreadsheet that calculate *E. coli* contributions are heavily based upon the U.S. EPA’s Bacteria Indicator Tool (BIT). The BIT estimates the monthly accumulation rate of fecal coliform bacteria on four land uses (cropland, forest, built-up, and pastureland). The tool also estimates the direct input of fecal coliform bacteria to streams from grazing agricultural animals and failing septic systems. The IEC converts the fecal coliform values of the BIT to *E. coli* through a conversion equation based on Ohio water quality sampling results. The IEC is available in a condensed version as well as an expanded version. The IEC spreadsheets and user guide can be found at https://www.in.gov/idem/nps/watershed-toolkit/planning/.

7.0 PUBLIC PARTICIPATION

Public participation is an important and required component of the TMDL development process. The following public meetings were held in the watershed to discuss this project:

- A kickoff public meeting was held in Sullivan, IN on December 10, 2019 to introduce the project and solicit public input. IDEM explained the TMDL process and presented initial information regarding the Maria Creek watershed. Questions were answered from the public, and information was solicited from stakeholders in the area.
- On October 14, 2020, IDEM worked with the Sullivan County Soil and Water Conservation District (SWCD) to host a water monitoring demonstration. The event was at the Emison Mill County Park adjacent to Maria Creek in Bruceville, IN. IDEM staff were on site to explain and/or give demonstrations on their process for collecting water chemistry, fish (through electrofishing techniques), and macroinvertebrates. Results were discussed for the 2019 and 2020 IDEM sampling of the watershed. The details of the partnership between the Sullivan County SWCD and IDEM were presented as well.
- On February 24, 2021, a notice was posted to the Indiana Register to inform stakeholders of new impairments discovered during the 2019 and 2020 watershed characterization study in the Maria Creek watershed. The notice outlined the findings of the study and listed proposed additions/deletions to the 2022 303(d) List of Impaired Waters. Public comments were solicited through May 25, 2021. IDEM received no comments regarding the notice.
- A virtual draft TMDL public meeting was held for the Maria Creek TMDL project on July 8, 2021. The findings of the TMDL were presented at the meeting, and the public had the opportunity to ask questions and provide information to be included in the final TMDL report. A public comment period was from July 12, 2021 to August 12, 2021. IDEM received no comments regarding the notice.

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APPENDIX A. WATER QUALITY DATA FOR THE MARIA CREEK WATERSHED TMDL

Subwatershed	AUID	Stream	IDEM Station ID	Site #	Location	Date	% Saturation	Alkalinity (mg/L)	Calcium (mg/L)	Chloride (mg/L)	Coliforms (Total)	DO (mg/L)	E. coli	Hardness (mg/L)	Magnesium (mg/L)	Ammonia Nitrogen (mg/L)	Nitrogen, Nitrate+Nitrite (mg/L)	pH (SU)	Total Phosphorus (mg/L)	Total Suspended Solids (mg/L)	Total Solids (mg/L)	Total Dissolved Solids (mg/L)	Specific Conductance (mg/L)	Sulfate (mg/L)	Temperature (°C)	TKN (mg/L)	TOC (mg/L)	Turbidity (NTU)	2020 303(d) Listing	Draft 2022 303(d) Listing Decision	Potential Sources
Cotton Branch	INB11I4_03	Maria Creek	WBU-18-0004	T01	N Old 41	11/18/2019	89.7	590	80	38		11.31		300	25	<0.2	2.9	7.98	0.073	4	490	470	734	92	5.3	0.48	2.7	6.44		E. coli	E.coli: Upstream source
						1/15/2020	85.4	150	54	17		10.36		210	18	0.17	3.7	7.77	0.16	35	320	260	450	34	7	0.58	2.7	55.9			
						2/10/2020	89.3	56	25	6.2		11.23		100	9.4	0.11	0.98	7.71	0.095	690	780	190	186	21	5.6	1.3	6	507			
						3/9/2020	94.8	190	67	27		10.93		270	24	<0.2	4.1	7.77	0.083	12	350	330	599	65	9.1	0.56	2	10.9			
						6/16/2020	95.6	210	75	40	>2419.6	8.37	124.6	280	23			7.87		7.5	540	490	722	98	21.6			7.33			
						6/22/2020	166.9					13.44						8.24					797		26.4			5.49			
						7/8/2020	87.3	190	49	26	>2419.6	6.76	172.5	200	20		1.2	7.93	0.077	12	420		620	77	28.5	0.46	3	10.3			
						7/14/2020	74.5					6.19						7.77					680		24.6			11.8			
						7/15/2020	78.9				>2419.6	6.43	285.1					7.67					710		25.7			7.95			
						7/22/2020	69.4				241960	5.95	9870					7.71					304		23.1			861			
						7/29/2020	91.2				>2419.6	7.28	172.5					7.85					378		26.8			23			
						8/5/2020	84.6				>2419.6	7.66	313					7.55					461		20.1			26.7			
						8/19/2020	86.8	190	68	22		7.54		270	24	0.25	1.2	7.82	0.099	7	400	310	595	86	22.3	<0.4	2.9	6.55			
						9/16/2020	89.7	210	130	30	>2419.6	8.38	387.3	430	25	0.16	1.8	7.84	0.049	7.7	770	680	1009	300	18.5	0.47	2.1	8.28			
						10/14/2020	77.3		68		1553.1	7.91	54.6	270	23			7.88					547		14.3			4.52			
	INB11I4_T1008 INB11P1117_00 INB11I4_T1007																														
	INB11I4_T1005																													E. coli	E. coli: Confined animal feeding operations (Non-Point Source)
	INB11I4_T1004	Cotton Branch	WBU-18-0006	T03	E Springtown Road	6/16/2020	91.5	230	75	16	>2419.6	8.67	248.1	290	24	0.29	4.7	7.96	0.038	5.5	440	420	568	31	17.9	0.71	1.2	5.47		E. coli, IBC	E. coli: Confined animal feeding operations (Non-Point Source)
						7/8/2020	88.1					7.87						8.04					558		20.8			5.27			IBC: Source unknown
						7/8/2020	89	240	65	13	>2419.6	7.87	461.1	250	22		5.3	7.92	0.07	13	420		557	27	21.4	0.5	1.4	9.64			
						7/14/2020	88.9					8.2						7.95					570		19.2			7.06			
						7/15/2020	88.4				>2419.6	8.18	517.2					7.91					550		19			5.62			
						7/22/2020	75.4				>241960	6.56	11780					7.3					207		22.2			136			
						7/29/2020	89.4				>2419.6	7.75	686.7					7.91					562		22.3			7.05			
						8/5/2020	89.1				>2419.6	8.56	285.1					7.78					580		17.2			4.98			
						8/19/2020	88	230	78	12		8.27		300	25	0.13	5	7.98	0.063	7.5	450	300	554	28	18.3	<0.4	1.4	5.58			
						9/16/2020	90.3	240	73	13	>2419.6	8.93	547.5	270	22	<0.2	5.8	7.99	<0.05	3	390	290	550	28	15.9	0.37	1.1	3.86			
						10/14/2020	72.5		78		>2419.6	7.63	147	300	24			7.85					558		12.9			2.71			
	INB11I4_02	Maria Creek	WBU-18-0007	T04	N Perry Road	11/18/2019	96.7	210	79	45		11.98		300	25	<0.2	3	7.96	0.065	6.5	540	490	792	120	6.1	0.41	2.2	6.85		E. coli, IBC	E. coli: Upstream source
						1/15/2020	89.9	160	57	19		10.69		230	20	0.49	4.2	7.9	0.18	100	350	270	481	40	7.9	<0.4	2.3	83.9			IBC: Source unknown
						2/10/2020	90.1	64	22	7		11.41		88	8.2	<0.2	1.2	7.66	0.57	480	590	230	205	27	5.3	1.7	5.9	376			
						3/9/2020	96.8	190	66	30		11.18		260	23	<0.2	4.3	7.8	0.09	17	350	340	607	74	8.9	0.51	2	12.9			
						6/16/2020	135.1	200	74	49	>2419.6	11.53	139.6	280	22	0.17	2.7	8.1	0.055	12	590	550	759	120	23.1	0.62	2.2	6.77			
						6/22/2020	173.6					14.62						8.25					638		23.9			5.41			
						7/8/2020	174.7	200	61	32	>2419.6	13.36	26.2	240	21		1.6	8.26	0.075	12	470		630	97	29.3	0.65	2.7	9.45			
						7/14/2020	213.6					15.88						8.42					816		30.8			16			
						7/15/2020	142.8				>2419.6	11.79	88.9					8.1					757		24.9			7.11			
						7/22/2020	72.6				>241960	6.26	64880					7.78					199		22.8			1000			
						7/29/2020	201.3				>2419.6	14.84	85.5					8.35					698		31.3			7.65			
						8/5/2020	87.8				>2419.6	8.01	209.8					7.53					527		19.8			31.1			
						8/19/2020	141.8	170	72	29		12.35		270	21	0.1	1.6	8.1	0.074	6	500	400	650	130	22.1	<0.4	2.5	5.84			
						9/16/2020	120.4	190	67	24	>2419.6	11.33	56.3	250	21	<0.2	2.2	7.93	0.09	6	490	390	486	110	18.2	0.35	2	7.59			
						10/14/2020	119.5	210	68	13	>2419.6	12.38	83.3	260	21	<0.2	1.8	8.15	0.067	2.7	320	310	536	45	13.7	0.5	1.8	5.71			
	INB11I4_T1003 INB11I4_T1002 INB11J1_T1007																														
	INB11I4_T1001																													E. coli	E. coli: Livestock (grazing or feeding operations) E. coli: Upstream source
Tilley Ditch	INB11I2_01	Maria Creek	WBU-18-0008	T05	N Risley Road	11/18/2019	85.3	230	72	23		10.75		290	26	0.21	2.4	7.84	0.079	8.5	440	430	648	74	5.3	0.47	2.9	19.3	E. coli	E. coli	E. coli: Livestock (grazing or feeding operations)
						1/15/2020	90.4	140	50	18		10.84		200	19	0.14	4.5	7.79	0.14	100	350	240	448	34	7.7	0.77	2.5	108			E. coli: Upstream source
						2/10/2020	90.7	55	19	28		11.53		77	7.3	<0.2	1	7.39	0.52	420	580	230	212	31	5.2	1.4	5.8	368			
						3/9/2020	95.5	180	59	23		11.06		240	23	<0.2	4.1	7.75	0.088	13	300	340	545	53	8.9	0.6	2.2	16.8			
						6/16/2020	96.4	200	61	20	>2419.6	8.5	184.2	240	22	0.2	3.1	7.92	0.096	25	520	450	592	68	21.7	0.82	2.4	24.7			
						6/22/2020	104.5					9.01						7.94					556		22.7			7.72			
						7/8/2020	79.3	220	60	17	>2419.6	6.06	161.6	250	23		1.4	7.83	0.075	32	490		662	92	29.3	0.53	2.8	32			
						7/15/2020	74.08					6.11						7.74					840		25			35.6			
						7/15/2020	81.8				>2419.6	6.63	816.4					7.86					819		26			34.3			
						7/22/2020	76.7				>241960	6.62	36540					7.85					203		22.8			1000			
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

APPENDIX B. FISH AND MACROINVERTEBRATE COMMUNITY ASSESSMENT REPORTS

Indiana Department of Environmental Management
Fish Community Assessments

Site Information

SubBasin: Middle Wabash-Busseron **14 digit HUC:** 05120111190040 **LSite:** WBU-18-0004
Site: Maria Creek **Location:** N Old 41 **County:** Knox
Latitude: 38.773466 **Longitude:** -87.472764 **IASNat Region:** 8 **Topo:** H-49 **Segment:** 52
Ecoregion: Interior River Lowland **Drainage Area (sq.miles):** 90.629 **Gradient (ft/mile):** 3.217

Sample Information

SampleNumber: AB42669 **EventID:** 20T001 **Sample MediumCollected:** Fish Community + Water
SampleDate: 07/07/2020 **SurveyCrewChief:** RAC **SampleTime:** 12:31:00 PM **HydroLabNumber:** P5
WaterFlowType: Run **WaterAppearance:** Murky **SkyConditions:** 2 - Scattered **AirTemperature:** 6 - > 86
WindDirection: 27 - West (270 degrees) **WindStrength:** 1 - Light
DissolvedO2 (mg/l): 6.39 **pH:** 7.84 **WaterTemp(°C):** 27.8 **SpecificConductivity (µS/cm):** 630 **Turbidity (NTU):** 8.08
SpecialNotes:

ElectrofishingEquipment: Canoe **Voltage:** 200 **Avg.StreamWidth(m):** 13 **DistanceFished (m):** 195
SecondsFished: 1448 **WaterDepthAvg (m):** .4 **WaterDepthMax (m):** 2 **TimeAtSite:** 03:00
BridgeInReach: ☐ **ReachRepresentative:** ☑ **WhyReachNotRepresentative:**
SpecialComments: w/MLES

Habitat Information

TotalScore (max100): 66 **SubstrateScore (max20):** 10 **InstreamCover Score (max20):** 13 **ChannelMorphologyScore (max20):** 15
RiparianZoneBankErosion Score(max10): 9 **Pool/GlideQualityScore(max12):** 10 **Riffle/RunQualityScore(max8):** 3
GradientScore (max10): 6 **%Pool:** 35 **%Riffle:** 15 **%Run:** 50 **%Glide:** 0 **CanopyCover PctOpen:** 30%-<55%
SubjectiveRating: **AestheticRating:** **NOTES:** "NEW RECORD"

Fish Community Index of Biotic Integrity (IBI) Information

Calibration Used:

	Actual Observation	Metric Score
SpeciesCount:	24	5
SunfishSpeciesCount:	5	5
MinnowSpeciesCount:	8	5
SuckerSpeciesCount:	0	1
SensitiveSpeciesCount:	5	5

	Actual Observation	Metric Score
%TolerantIndividuals:	12.93	5
%OmnivoreIndividuals:	18.37	3
%InsectivoreIndividuals:	74.15	5
%CarnivoreIndividuals:	6.8	1
Total # of Individuals (CPUE):	147	3
%SimpleLithophilicInd.:	29.25	5
%Ind.withDELT:	0	5

Metrics are dependent on Ecoregion and Drainage Area.
Metrics can score a 0, 1, 3, or 5 depending on calibration.

Total IBI Score (min 0, max 60)	48

SampleNumber: AB42669 **EventID:** 20T001 **LSite:** WBU-18-0004 **County:** Knox

StreamName: Maria Creek **LocationDescription:** N Old 41

Common Name	Individual Fish Count	Deformities	Eroded Fins	Lesions	Tumors	Multiple Anomalies
Bluegill	2					
Bluntnose Minnow	9					
Bullhead Minnow	1					
Channel Catfish	5					
Creek Chub	1					
Dusky Darter	15					
Emerald Shiner	7					
Gizzard Shad	3					
Green Sunfish	1					
Johnny Darter	3					
Longear Sunfish	11					
Mississippi Silvery Minnow	15					
Mud Darter	10					
Orangespotted Sunfish	1					
Pirate Perch	2					
Redear Sunfish	1					
Sand Shiner	13					
Slough Darter	11					
Smallmouth Bass	1					
Spotfin Shiner	24					
Spotted Bass	3					
Spotted Gar	1					
Suckermouth Minnow	6					
Western Mosquitofish	1					

Indiana Department of Environmental Management
Fish Community Assessments

Site Information

SubBasin: Middle Wabash-Busseron **14 digit HUC:** 05120111190040 **LSite:** WBU-18-0006
Site: Cotton Branch **Location:** E Springtown Road **County:** Knox
Latitude: 38.804843 **Longitude:** -87.436835 **IASNat Region:** 7A **Topo:** H-49 **Segment:** 52
Ecoregion: Interior River Lowland **Drainage Area (sq.miles):** 3.133 **Gradient (ft/mile):** 9.645

Sample Information

SampleNumber: AB42670 **EventID:** 20T003 **Sample MediumCollected:** Fish Community + Water
SampleDate: 07/08/2020 **SurveyCrewChief:** RAC **SampleTime:** 11:40:00 AM **HydroLabNumber:** P5
WaterFlowType: Run **WaterAppearance:** Clear **SkyConditions:** 2 - Scattered **AirTemperature:** 6 - > 86
WindDirection: 27 - West (270 degrees) **WindStrength:** 2 - Mod./Light
DissolvedO2 (mg/l): 7.87 **pH:** 8.04 **WaterTemp(°C):** 20.8 **SpecificConductivity (µS/cm):** 558 **Turbidity (NTU):** 5.27
SpecialNotes:

ElectrofishingEquipment: Backpack **Voltage:** 200 **Avg.StreamWidth(m):** 3 **DistanceFished (m):** 50
SecondsFished: 199 **WaterDepthAvg (m):** .3 **WaterDepthMax (m):** 1.1 **TimeAtSite:** 01:00
BridgeInReach: ☐ **ReachRepresentative:** ☑ **WhyReachNotRepresentative:**
SpecialComments:

Habitat Information

TotalScore (max100): 65 **SubstrateScore (max20):** 10 **InstreamCover Score (max20):** 13 **ChannelMorphologyScore (max20):** 14
RiparianZoneBankErosion Score(max10): 9 **Pool/GlideQualityScore(max12):** 11 **Riffle/RunQualityScore(max8):** 2
GradientScore (max10): 6 **%Pool:** 50 **%Riffle:** 10 **%Run:** 40 **%Glide:** **CanopyCover PctOpen:** 10%-<30%
SubjectiveRating: **AestheticRating:** **NOTES:** "NEW RECORD"

Fish Community Index of Biotic Integrity (IBI) Information

Calibration Used: Interior River Lowland

	Actual Observation	Metric Score
SpeciesCount:	11	5
SunfishSpeciesCount:	2	3
MinnowSpeciesCount:	6	5
SuckerSpeciesCount:	1	1
SensitiveSpeciesCount:	2	5

	Actual Observation	Metric Score
%TolerantIndividuals:	45.95	3
%OmnivoreIndividuals:	10.81	5
%InsectivoreIndividuals:	54.05	5
%PioneerIndividuals:	54.05	3
Total # of Individuals (CPUE):	37	1
%SimpleLithophilicInd.:	5.41	1
%Ind.withDELT:	0	5

Metrics are dependent on Ecoregion and Drainage Area.
Metrics can score a 0, 1, 3, or 5 depending on calibration.

Total IBI Score (min 0, max 60)	42

SampleNumber: AB42670 **EventID:** 20T003 **LSite:** WBU-18-0006 **County:** Knox

StreamName: Cotton Branch **LocationDescription:** E Springtown Road

Common Name	Individual Fish Count	Deformities	Eroded Fins	Lesions	Tumors	Multiple Anomalies
Bluntnose Minnow	2					
Creek Chub	13					
Green Sunfish	1					
Johnny Darter	2					
Longear Sunfish	5					
Mississippi Silvery Minnow	1					
Sand Shiner	1					
Silverjaw Minnow	2					
Slough Darter	4					
Spotfin Shiner	5					
White Sucker	1					

Indiana Department of Environmental Management
Fish Community Assessments

Site Information

SubBasin: Middle Wabash-Busseron **14 digit HUC:** 05120111190040 **LSite:** WBU-18-0007

Site: Maria Creek **Location:** N Perry Road **County:** Knox

Latitude: 38.811320 **Longitude:** -87.417867 **IASNat Region:** 7A **Topo:** H-49 **Segment:** 52

Ecoregion: Interior River Lowland **Drainage Area (sq.miles):** 78.969 **Gradient (ft/mile):** 1.971

Sample Information

SampleNumber: AB42671 **EventID:** 20T004 **Sample MediumCollected:** Fish Community + Water

SampleDate: 06/22/2020 **SurveyCrewChief:** KJC **SampleTime:** 01:36:00 PM **HydroLabNumber:** P8

WaterFlowType: Glide **WaterAppearance:** Clear **SkyConditions:** 2 - Scattered **AirTemperature:** 6 - > 86

WindDirection: 27 - West (270 degrees) **WindStrength:** 0 - Calm

DissolvedO2 (mg/l): 13.44 **pH:** 8.24 **WaterTemp(°C):** 26.4 **SpecificConductivity (µS/cm):** 797 **Turbidity (NTU):** 5.49

SpecialNotes:

ElectrofishingEquipment: Canoe **Voltage:** 185 **Avg.StreamWidth(m):** 11 **DistanceFished (m):** 165

SecondsFished: 538 **WaterDepthAvg (m):** .3 **WaterDepthMax (m):** .6 **TimeAtSite:** 02:00

BridgeInReach: ☐ **ReachRepresentative:** ☑ **WhyReachNotRepresentative:**

SpecialComments: MLES in canoe

Habitat Information

TotalScore (max100): 30 **SubstrateScore (max20):** 9 **InstreamCover Score (max20):** 4 **ChannelMorphologyScore (max20):** 6

RiparianZoneBankErosion Score(max10): 3 **Pool/GlideQualityScore(max12):** 4 **Riffle/RunQualityScore(max8):** 0

GradientScore (max10): 4 **%Pool:** 0 **%Riffle:** 0 **%Run:** 0 **%Glide:** 100 **CanopyCover PctOpen:** 55%-<85%

SubjectiveRating: **AestheticRating:** **NOTES:** "NEW RECORD"

Fish Community Index of Biotic Integrity (IBI) Information

Calibration Used: Interior River Lowland

	Actual Observation	Metric Score
SpeciesCount:	12	3
SunfishSpeciesCount:	2	3
MinnowSpeciesCount:	3	1
SuckerSpeciesCount:	0	1
SensitiveSpeciesCount:	2	1

	Actual Observation	Metric Score
%TolerantIndividuals:	19.05	1
%OmnivoreIndividuals:	4.76	1
%InsectivoreIndividuals:	78.57	1
%CarnivoreIndividuals:	16.67	1
Total # of Individuals (CPUE):	42	1
%SimpleLithophilicInd.:	0	1
%Ind.withDELT:	0	1

Metrics are dependent on Ecoregion and Drainage Area.
Metrics can score a 0, 1, 3, or 5 depending on calibration.

Total IBI Score (min 0, max 60)	16

SampleNumber: AB42671 **EventID:** 20T004 **LSite:** WBU-18-0007 **County:** Knox

StreamName: Maria Creek **LocationDescription:** N Perry Road

Common Name	Individual Fish Count	Deformities	Eroded Fins	Lesions	Tumors	Multiple Anomalies
Blackstripe Topminnow	2					
Bluegill	2					
Bluntnose Minnow	2					
Channel Catfish	5					
Longear Sunfish	20					
Mud Darter	1					
Sand Shiner	1					
Spotfin Shiner	3					
Spotted Bass	1					
Spotted Gar	1					
Western Mosquitofish	3					
Yellow Bullhead	1					

Indiana Department of Environmental Management
Fish Community Assessments

Site Information

SubBasin: Middle Wabash-Busseron **14 digit HUC:** 05120111190020 **LSite:** WBU-18-0008
Site: Maria Creek **Location:** N Risley Road **County:** Knox
Latitude: 38.822774 **Longitude:** -87.391656 **IASNat Region:** 7A **Topo:** H-49 **Segment:** 52
Ecoregion: Interior River Lowland **Drainage Area (sq.miles):** 49.206 **Gradient (ft/mile):** 1.971

Sample Information

SampleNumber: AB42672 **EventID:** 20T005 **Sample MediumCollected:** Fish Community + Water
SampleDate: 08/18/2020 **SurveyCrewChief:** KRW **SampleTime:** 10:30:00 AM **HydroLabNumber:** P5
WaterFlowType: Run **WaterAppearance:** Murky **SkyConditions:** 3 - Partly **AirTemperature:** 5 - 76-85
WindDirection: 27 - West (270 degrees) **WindStrength:** 1 - Light
DissolvedO2 (mg/l): 5.86 **pH:** 7.72 **WaterTemp(°C):** 23.6 **SpecificConductivity (µS/cm):** 548 **Turbidity (NTU):** 43.9
SpecialNotes: Site always very turbid.

ElectrofishingEquipment: Canoe **Voltage:** 265 **Avg.StreamWidth(m):** 11 **DistanceFished (m):** 165
SecondsFished: 950 **WaterDepthAvg (m):** .7 **WaterDepthMax (m):** 1 **TimeAtSite:** 02:00
BridgeInReach: ☐ **ReachRepresentative:** ☑ **WhyReachNotRepresentative:**
SpecialComments: w/MLES

Habitat Information

TotalScore (max100): 32 **SubstrateScore (max20):** 6 **InstreamCover Score (max20):** 6 **ChannelMorphologyScore (max20):** 7
RiparianZoneBankErosion Score(max10): 3 **Pool/GlideQualityScore(max12):** 6 **Riffle/RunQualityScore(max8):** 0
GradientScore (max10): 4 **%Pool:** 40 **%Riffle:** 0 **%Run:** 60 **%Glide:** 0 **CanopyCover PctOpen:** 55%-<85%
SubjectiveRating: **AestheticRating:** **NOTES:** "NEW RECORD"

Fish Community Index of Biotic Integrity (IBI) Information

Calibration Used: Interior River Lowland

	Actual Observation	Metric Score
SpeciesCount:	**21**	**5**
SunfishSpeciesCount:	**3**	**3**
MinnowSpeciesCount:	**5**	**3**
SuckerSpeciesCount:	**4**	**5**
SensitiveSpeciesCount:	**6**	**5**

	Actual Observation	Metric Score
%TolerantIndividuals:	**21.62**	**5**
%OmnivoreIndividuals:	**15.14**	**3**
%InsectivoreIndividuals:	**80.54**	**5**
%CarnivoreIndividuals:	**4.32**	**1**
Total # of Individuals (CPUE):	**185**	**3**
%SimpleLithophilicInd.:	**1.62**	**1**
%Ind.withDELT:	**1.08**	**3**

Metrics are dependent on Ecoregion and Drainage Area.
Metrics can score a 0, 1, 3, or 5 depending on calibration.

Total IBI Score (min 0, max 60)	42

SampleNumber: AB42672 **EventID:** 20T005 **LSite:** WBU-18-0008 **County:** Knox

StreamName: Maria Creek **LocationDescription:** N Risley Road

Common Name	Individual Fish Count	Deformities	Eroded Fins	Lesions	Tumors	Multiple Anomalies
Blackstripe Topminnow	2					
Bluegill	22					
Bluntnose Minnow	19					
Brook Silverside	4					
Common Carp	2					
Emerald Shiner	28					
Gizzard Shad	5					
Golden Redhorse	1		1			
Green Sunfish	8					
Greenside Darter	1					
Johnny Darter	1					
Longear Sunfish	49					
Longnose Gar	1					
Quillback	1	1				
River Carpsucker	1					
Sand Shiner	2					
Shortnose Gar	3					
Silver Redhorse	2					
Spotfin Shiner	28					
Spotted Bass	4					
Western Mosquitofish	1					

Indiana Department of Environmental Management
Fish Community Assessments

Site Information

SubBasin: Middle Wabash-Busseron **14 digit HUC:** 05120111190020 **LSite:** WBU-18-0009

Site: Tilley Ditch **Location:** E Pepmeir Road **County:** Knox

Latitude: 38.835159 **Longitude:** -87.363200 **IASNat Region:** 7B **Topo:** H-50 **Segment:** 52

Ecoregion: Interior River Lowland **Drainage Area (sq.miles):** 9.299 **Gradient (ft/mile):** 4.379

Sample Information

SampleNumber: AB42673 **EventID:** 20T006 **Sample MediumCollected:** Fish Community + Water

SampleDate: 07/08/2020 **SurveyCrewChief:** RAC **SampleTime:** 09:50:00 AM **HydroLabNumber:** P5

WaterFlowType: Pool **WaterAppearance:** Clear **SkyConditions:** 1 - Clear **AirTemperature:** 6 - > 86

WindDirection: 27 - West (270 degrees) **WindStrength:** 0 - Calm

DissolvedO2 (mg/l): 8.22 **pH:** 7.75 **WaterTemp(°C):** 22.1 **SpecificConductivity (µS/cm):** 558 **Turbidity (NTU):** 6.43

SpecialNotes:

ElectrofishingEquipment: Backpack **Voltage:** 200 **Avg.StreamWidth(m):** 3 **DistanceFished (m):** 50

SecondsFished: 397 **WaterDepthAvg (m):** .4 **WaterDepthMax (m):** .7 **TimeAtSite:** 01:30

BridgeInReach: ☐ **ReachRepresentative:** ☑ **WhyReachNotRepresentative:**

SpecialComments:

Habitat Information

TotalScore (max100): 38 **SubstrateScore (max20):** 12 **InstreamCover Score (max20):** 8 **ChannelMorphologyScore (max20):** 8

RiparianZoneBankErosion Score(max10): 5 **Pool/GlideQualityScore(max12):** 5 **Riffle/RunQualityScore(max8):** 0

GradientScore (max10): 0 **%Pool:** 40 **%Riffle:** **%Run:** 60 **%Glide:** **CanopyCover PctOpen:** >85%-Open

SubjectiveRating: **AestheticRating:** **NOTES:** "NEW RECORD"

Fish Community Index of Biotic Integrity (IBI) Information

Calibration Used: Interior River Lowland

	Actual Observation	Metric Score
SpeciesCount:	14	5
SunfishSpeciesCount:	2	3
MinnowSpeciesCount:	5	5
SuckerSpeciesCount:	1	1
SensitiveSpeciesCount:	2	5

	Actual Observation	Metric Score
%TolerantIndividuals:	36.21	3
%OmnivoreIndividuals:	39.66	1
%InsectivoreIndividuals:	55.17	5
%PioneerIndividuals:	39.66	3
Total # of Individuals (CPUE):	58	1
%SimpleLithophilicInd.:	20.69	5
%Ind.withDELT:	0	5

Metrics are dependent on Ecoregion and Drainage Area.
Metrics can score a 0, 1, 3, or 5 depending on calibration.

Total IBI Score (min 0, max 60)	42

SampleNumber: AB42673 **EventID:** 20T006 **LSite:** WBU-18-0009 **County:** Knox

StreamName: Tilley Ditch **LocationDescription:** E Pepmeir Road

Common Name	Individual Fish Count	Deformities	Eroded Fins	Lesions	Tumors	Multiple Anomalies
Blackstripe Topminnow	2					
Bluntnose Minnow	11					
Central Stoneroller	3					
Emerald Shiner	1					
Green Sunfish	2					
Greenside Darter	2					
Johnny Darter	7					
Longear Sunfish	11					
Mississippi Silvery Minnow	7					
Pirate Perch	2					
Spotfin Shiner	1					
Tadpole Madtom	1					
White Sucker	5					
Yellow Bullhead	3					

Indiana Department of Environmental Management
Fish Community Assessments

Site Information

SubBasin: Middle Wabash-Busseron **14 digit HUC:** 05120111190020 **LSite:** WBU-18-0010
Site: Tributary of Maria Creek **Location:** County Road 700 E, Lane Road **County:** Knox
Latitude: 38.854910 **Longitude:** -87.334256 **IASNat Region:** 7B **Topo:** H-50 **Segment:** 52
Ecoregion: Interior River Lowland **Drainage Area (sq.miles):** 2.623 **Gradient (ft/mile):** 9.923

Sample Information

SampleNumber: AB42674 **EventID:** 20T007 **Sample MediumCollected:** Fish Community + Water
SampleDate: 06/22/2020 **SurveyCrewChief:** KJC **SampleTime:** 10:54:00 AM **HydroLabNumber:** P8
WaterFlowType: Glide **WaterAppearance:** Clear **SkyConditions:** 2 - Scattered **AirTemperature:** 6 - > 86
WindDirection: 27 - West (270 degrees) **WindStrength:** 2 - Mod./Light
DissolvedO2 (mg/l): 14.62 **pH:** 8.25 **WaterTemp(°C):** 23.9 **SpecificConductivity (µS/cm):** 638 **Turbidity (NTU):** 5.41
SpecialNotes:

ElectrofishingEquipment: Backpack **Voltage:** 150 **Avg.StreamWidth(m):** 3 **DistanceFished (m):** 50
SecondsFished: 298 **WaterDepthAvg (m):** .2 **WaterDepthMax (m):** .5 **TimeAtSite:** 01:00
BridgeInReach: ☐ **ReachRepresentative:** ☑ **WhyReachNotRepresentative:**
SpecialComments:

Habitat Information

TotalScore (max100): 46 **SubstrateScore (max20):** 11 **InstreamCover Score (max20):** 8 **ChannelMorphologyScore (max20):** 10
RiparianZoneBankErosion Score(max10): 3 **Pool/GlideQualityScore(max12):** 6 **Riffle/RunQualityScore(max8):** 2
GradientScore (max10): 6 **%Pool:** 10 **%Riffle:** 10 **%Run:** 10 **%Glide:** 70 **CanopyCover PctOpen:** 55%-<85%
SubjectiveRating: **AestheticRating:** **NOTES:** "NEW RECORD"

Fish Community Index of Biotic Integrity (IBI) Information

Calibration Used: Interior River Lowland

	Actual Observation	Metric Score
SpeciesCount:	13	5
SunfishSpeciesCount:	3	3
MinnowSpeciesCount:	7	5
SuckerSpeciesCount:	0	1
SensitiveSpeciesCount:	1	5

	Actual Observation	Metric Score
%TolerantIndividuals:	43.4	3
%OmnivoreIndividuals:	28.77	3
%InsectivoreIndividuals:	27.83	3
%PioneerIndividuals:	78.3	1
Total # of Individuals (CPUE):	212	5
%SimpleLithophilicInd.:	3.77	1
%Ind.withDELT:	0	5

Metrics are dependent on Ecoregion and Drainage Area.
Metrics can score a 0, 1, 3, or 5 depending on calibration.

Total IBI Score (min 0, max 60)	40

SampleNumber: AB42674 **EventID:** 20T007 **LSite:** WBU-18-0010 **County:** Knox

StreamName: Tributary of Maria Creek **LocationDescription:** County Road 700 E, Lane Road

Common Name	Individual Fish Count	Deformities	Eroded Fins	Lesions	Tumors	Multiple Anomalies
Blackstripe Topminnow	16					
Bluegill	1					
Bluntnose Minnow	59					
Central Stoneroller	66					
Creek Chub	26					
Green Sunfish	2					
Johnny Darter	5					
Longear Sunfish	13					
Mississippi Silvery Minnow	2					
Redfin Shiner	3					
Silverjaw Minnow	8					
Suckermouth Minnow	6					
Yellow Bullhead	5					

Indiana Department of Environmental Management
Fish Community Assessments

Site Information

SubBasin:	Middle Wabash-Busseron	**14 digit HUC:**	05120111190020	**LSite:**	WBU-18-0011
Site:	Tributary of Maria Creek	**Location:**	County Road 900 N, E Lower Freelandville Road	**County:**	Knox
Latitude:	38.858259	**Longitude:**	-87.360084	**IASNat Region:**	7B
Topo:	H-50	**Segment:**	52		
Ecoregion:	Interior River Lowland	**Drainage Area (sq.miles):**	3.055	**Gradient (ft/mile):**	12.542

Sample Information

SampleNumber: AB42675 **EventID:** 20T008 **Sample MediumCollected:** Fish Community + Water

SampleDate: 06/22/2020 **SurveyCrewChief:** KJC **SampleTime:** 12:01:00 PM **HydroLabNumber:** P8

WaterFlowType: Pool **WaterAppearance:** Clear **SkyConditions:** 2 - Scattered **AirTemperature:** 6 - > 86

WindDirection: 27 - West (270 degrees) **WindStrength:** 2 - Mod./Light

DissolvedO2 (mg/l): 9.01 **pH:** 7.94 **WaterTemp(°C):** 22.7 **SpecificConductivity (µS/cm):** 556 **Turbidity (NTU):** 7.72

SpecialNotes:

ElectrofishingEquipment: Backpack **Voltage:** 150 **Avg.StreamWidth(m):** 3 **DistanceFished (m):** 50

SecondsFished: 318 **WaterDepthAvg (m):** .25 **WaterDepthMax (m):** .5 **TimeAtSite:** 01:00

BridgeInReach: ☐ **ReachRepresentative:** ☑ **WhyReachNotRepresentative:**

SpecialComments:

Habitat Information

TotalScore (max100): 33 **SubstrateScore (max20):** 6 **InstreamCover Score (max20):** 5 **ChannelMorphologyScore (max20):** 8

RiparianZoneBankErosion Score(max10): 2 **Pool/GlideQualityScore(max12):** 4 **Riffle/RunQualityScore(max8):** 0

GradientScore (max10): 8 **%Pool:** 0 **%Riffle:** 0 **%Run:** 0 **%Glide:** 100 **CanopyCover PctOpen:** >85%-Open

SubjectiveRating: **AestheticRating:** **NOTES:** "NEW RECORD"

Fish Community Index of Biotic Integrity (IBI) Information

Calibration Used: Interior River Lowland

	Actual Observation	Metric Score
SpeciesCount:	10	5
SunfishSpeciesCount:	2	3
MinnowSpeciesCount:	5	5
SuckerSpeciesCount:	1	1
SensitiveSpeciesCount:	1	5

	Actual Observation	Metric Score
%TolerantIndividuals:	21.51	5
%OmnivoreIndividuals:	45.16	1
%InsectivoreIndividuals:	39.78	3
%PioneerIndividuals:	20.43	5
Total # of Individuals (CPUE):	93	1
%SimpleLithophilicInd.:	39.78	5
%Ind.withDELT:	0	5

Metrics are dependent on Ecoregion and Drainage Area.
Metrics can score a 0, 1, 3, or 5 depending on calibration.

Total IBI Score (min 0, max 60)	44

SampleNumber: AB42675 **EventID:** 20T008 **LSite:** WBU-18-0011 **County:** Knox

StreamName: Tributary of Maria Creek **LocationDescription:** County Road 900 N, E Lower Freelandville Road

Common Name	Individual Fish Count	Deformities	Eroded Fins	Lesions	Tumors	Multiple Anomalies
Bluegill	1					
Bluntnose Minnow	5					
Central Stoneroller	13					
Creek Chub	1					
Longear Sunfish	29					
Mississippi Silvery Minnow	28					
Pirate Perch	1					
Spotfin Shiner	1					
White Sucker	9					
Yellow Bullhead	5					

Indiana Department of Environmental Management
Fish Community Assessments

Site Information

SubBasin: Middle Wabash-Busseron **14 digit HUC:** 05120111190020 **LSite:** WBU-18-0013
Site: Maria Creek **Location:** County Road 900 N **County:** Knox
Latitude: 38.858568 **Longitude:** -87.353384 **IASNat Region:** 7B **Topo:** H-50 **Segment:** 52
Ecoregion: Interior River Lowland **Drainage Area (sq.miles):** 30.791 **Gradient (ft/mile):** 3.885

Sample Information

SampleNumber: AB42676 **EventID:** 20T009 **Sample MediumCollected:** Fish Community + Water
SampleDate: 06/23/2020 **SurveyCrewChief:** KRW **SampleTime:** 11:34:00 AM **HydroLabNumber:** P5
WaterFlowType: Pool **WaterAppearance:** Clear **SkyConditions:** 3 - Partly **AirTemperature:** 5 - 76-85
WindDirection: 27 - West (270 degrees) **WindStrength:** 1 - Light
DissolvedO2 (mg/l): 9.98 **pH:** 8.23 **WaterTemp(°C):** 23.9 **SpecificConductivity (µS/cm):** 714 **Turbidity (NTU):** 10.4
SpecialNotes:

ElectrofishingEquipment: Canoe **Voltage:** 230 **Avg.StreamWidth(m):** 5 **DistanceFished (m):** 75
SecondsFished: 1000 **WaterDepthAvg (m):** .5 **WaterDepthMax (m):** 1.2 **TimeAtSite:** 03:00
BridgeInReach: ☐ **ReachRepresentative:** ☑ **WhyReachNotRepresentative:**
SpecialComments: w/MLES

Habitat Information

TotalScore (max100): 43 **SubstrateScore (max20):** 7 **InstreamCover Score (max20):** 10 **ChannelMorphologyScore (max20):** 9
RiparianZoneBankErosion Score(max10): 3 **Pool/GlideQualityScore(max12):** 8 **Riffle/RunQualityScore(max8):** 0
GradientScore (max10): 6 **%Pool:** 20 **%Riffle:** 0 **%Run:** 80 **%Glide:** 0 **CanopyCover PctOpen:** >85%-Open
SubjectiveRating: **AestheticRating:** **NOTES:** "NEW RECORD"

Fish Community Index of Biotic Integrity (IBI) Information

Calibration Used:

	Actual Observation	Metric Score
SpeciesCount:	**23**	**5**
SunfishSpeciesCount:	**4**	**5**
MinnowSpeciesCount:	**4**	**3**
SuckerSpeciesCount:	**5**	**5**
SensitiveSpeciesCount:	**4**	**5**

	Actual Observation	Metric Score
%TolerantIndividuals:	**28.17**	**3**
%OmnivoreIndividuals:	**18.78**	**3**
%InsectivoreIndividuals:	**77**	**5**
%CarnivoreIndividuals:	**2.82**	**1**
Total # of Individuals (CPUE):	**213**	**5**
%SimpleLithophilicInd.:	**7.04**	**1**
%Ind.withDELT:	**0**	**5**

Metrics are dependent on Ecoregion and Drainage Area.
Metrics can score a 0, 1, 3, or 5 depending on calibration.

Total IBI Score (min 0, max 60)	46

SampleNumber: AB42676 **EventID:** 20T009 **LSite:** WBU-18-0013 **County:** Knox

StreamName: Maria Creek **LocationDescription:** County Road 900 N

Common Name	Individual Fish Count	Deformities	Eroded Fins	Lesions	Tumors	Multiple Anomalies
Bigmouth Buffalo	1					
Blackstripe Topminnow	6					
Bluegill	23					
Bluntnose Minnow	32					
Central Stoneroller	3					
Channel Catfish	2					
Emerald Shiner	2					
Freshwater Drum	1					
Gizzard Shad	1					
Green Sunfish	15					
Greenside Darter	1					
Johnny Darter	9					
Logperch	1					
Longear Sunfish	64					
Shorthead Redhorse	1					
Smallmouth Buffalo	1					
Spotfin Shiner	31					
Spotted Bass	3					
Spotted Sucker	6					
Tadpole Madtom	1					
Warmouth	1					
Western Mosquitofish	1					
White Sucker	7					

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Fish Community Assessments

Site Information

SubBasin: Middle Wabash-Busseron **14 digit HUC:** 05120111190030 **LSite:** WBU190-0001
Site: Marsh Creek **Location:** E Springtown Road **County:** Knox
Latitude: 38.828463 **Longitude:** -87.399871 **IASNat Region:** 7A **Topo:** H-49 **Segment:** 52
Ecoregion: Interior River Lowland **Drainage Area (sq.miles):** 23.57 **Gradient (ft/mile):** 2.96

Sample Information

SampleNumber: AB42677 **EventID:** 20T010 **Sample MediumCollected:** Fish Community + Water
SampleDate: 06/22/2020 **SurveyCrewChief:** KAG **SampleTime:** 11:00:00 AM **HydroLabNumber:** P6
WaterFlowType: Glide **WaterAppearance:** Clear **SkyConditions:** 2 - Scattered **AirTemperature:** 5 - 76-85
WindDirection: 9 - East (90 degrees) **WindStrength:** 1 - Light
DissolvedO2 (mg/l): 10.01 **pH:** 8.06 **WaterTemp(°C):** 22.6 **SpecificConductivity (µS/cm):** 1055 **Turbidity (NTU):** 4.33
SpecialNotes:

ElectrofishingEquipment: Backpack **Voltage:** 210 **Avg.StreamWidth(m):** 5 **DistanceFished (m):** 75
SecondsFished: 510 **WaterDepthAvg (m):** .2 **WaterDepthMax (m):** .5 **TimeAtSite:** 00:45
BridgeInReach: ☐ **ReachRepresentative:** ☑ **WhyReachNotRepresentative:**
SpecialComments: High Conductivity

Habitat Information

TotalScore (max100): 38 **SubstrateScore (max20):** 14 **InstreamCover Score (max20):** 7 **ChannelMorphologyScore (max20):** 5
RiparianZoneBankErosion Score(max10): 3 **Pool/GlideQualityScore(max12):** 5 **Riffle/RunQualityScore(max8):** 0
GradientScore (max10): 4 **%Pool:** 20 **%Riffle:** 0 **%Run:** 0 **%Glide:** 80 **CanopyCover PctOpen:** >85%-Open
SubjectiveRating: **AestheticRating:** **NOTES:** "NEW RECORD"

Fish Community Index of Biotic Integrity (IBI) Information

Calibration Used: Interior River Lowland

	Actual Observation	Metric Score
SpeciesCount:	10	3
SunfishSpeciesCount:	2	3
MinnowSpeciesCount:	5	3
SuckerSpeciesCount:	0	1
SensitiveSpeciesCount:	3	3

	Actual Observation	Metric Score
%TolerantIndividuals:	29.03	1
%OmnivoreIndividuals:	29.03	1
%InsectivoreIndividuals:	61.29	1
%CarnivoreIndividuals:	0	1
Total # of Individuals (CPUE):	31	1
%SimpleLithophilicInd.:	9.68	1
%Ind.withDELT:	0	1

Metrics are dependent on Ecoregion and Drainage Area.
Metrics can score a 0, 1, 3, or 5 depending on calibration.

Total IBI Score (min 0, max 60)	20

SampleNumber: AB42677 **EventID:** 20T010 **LSite:** WBU190-0001 **County:** Knox

StreamName: Marsh Creek **LocationDescription:** E Springtown Road

Common Name	Individual Fish Count	Deformities	Eroded Fins	Lesions	Tumors	Multiple Anomalies
Blackstripe Topminnow	1					
Bluntnose Minnow	7					
Central Stoneroller	3					
Dusky Darter	1					
Green Sunfish	1					
Longear Sunfish	5					
Mississippi Silvery Minnow	2					
Sand Shiner	1					
Spotfin Shiner	9					
Yellow Bullhead	1					

Indiana Department of Environmental Management
Fish Community Assessments

Site Information

SubBasin: Middle Wabash-Busseron **14 digit HUC:** 05120111190030 **LSite:** WBU-18-0012
Site: Marsh Creek **Location:** E Hunley Road **County:** Knox
Latitude: 38.854119 **Longitude:** -87.400627 **IASNat Region:** 7A **Topo:** H-49 **Segment:** 52
Ecoregion: Interior River Lowland **Drainage Area (sq.miles):** 20.805 **Gradient (ft/mile):** 3.392

Sample Information

SampleNumber: AB42678 **EventID:** 20T011 **Sample MediumCollected:** Fish Community + Water
SampleDate: 06/22/2020 **SurveyCrewChief:** KAG **SampleTime:** 12:20:00 PM **HydroLabNumber:** P6
WaterFlowType: Glide **WaterAppearance:** Clear **SkyConditions:** 2 - Scattered **AirTemperature:** 5 - 76-85
WindDirection: 9 - East (90 degrees) **WindStrength:** 3 - Moderate
DissolvedO2 (mg/l): 11.1 **pH:** 8.15 **WaterTemp(°C):** 26.3 **SpecificConductivity (µS/cm):** 1148 **Turbidity (NTU):** 4.26
SpecialNotes:

ElectrofishingEquipment: Backpack **Voltage:** 200 **Avg.StreamWidth(m):** 4 **DistanceFished (m):** 60
SecondsFished: 448 **WaterDepthAvg (m):** .2 **WaterDepthMax (m):** .25 **TimeAtSite:** 01:00
BridgeInReach: ☐ **ReachRepresentative:** ☑ **WhyReachNotRepresentative:**
SpecialComments: High Conductivity

Habitat Information

TotalScore (max100): 45 **SubstrateScore (max20):** 14 **InstreamCover Score (max20):** 10 **ChannelMorphologyScore (max20):** 9
RiparianZoneBankErosion Score(max10): 3 **Pool/GlideQualityScore(max12):** 3 **Riffle/RunQualityScore(max8):** 0
GradientScore (max10): 6 **%Pool:** 20 **%Riffle:** 0 **%Run:** 0 **%Glide:** 80 **CanopyCover PctOpen:** >85%-Open
SubjectiveRating: **AestheticRating:** **NOTES:** "NEW RECORD"

Fish Community Index of Biotic Integrity (IBI) Information

Calibration Used: Interior River Lowland

	Actual Observation	Metric Score
SpeciesCount:	**10**	**3**
SunfishSpeciesCount:	**2**	**3**
MinnowSpeciesCount:	**3**	**3**
SuckerSpeciesCount:	**0**	**1**
SensitiveSpeciesCount:	**2**	**3**

	Actual Observation	Metric Score
%TolerantIndividuals:	**26.19**	**1**
%OmnivoreIndividuals:	**19.05**	**1**
%InsectivoreIndividuals:	**78.57**	**1**
%CarnivoreIndividuals:	**2.38**	**1**
Total # of Individuals (CPUE):	**42**	**1**
%SimpleLithophilicInd.:	**0**	**1**
%Ind.withDELT:	**2.38**	**1**

Metrics are dependent on Ecoregion and Drainage Area.
Metrics can score a 0, 1, 3, or 5 depending on calibration.

Total IBI Score (min 0, max 60)	20

SampleNumber: AB42678 **EventID:** 20T011 **LSite:** WBU-18-0012 **County:** Knox

StreamName: Marsh Creek **LocationDescription:** E Hunley Road

Common Name	Individual Fish Count	Deformities	Eroded Fins	Lesions	Tumors	Multiple Anomalies
Blackstripe Topminnow	6					
Bluegill	3					
Bluntnose Minnow	8					
Channel Catfish	1					
Greenside Darter	2					
Johnny Darter	2					
Longear Sunfish	15					
Silverjaw Minnow	1					
Spotfin Shiner	2					
Yellow Bullhead	2			1		

Indiana Department of Environmental Management
Fish Community Assessments

Site Information

SubBasin: Middle Wabash-Busseron **14 digit HUC:** 05120111190030 **LSite:** WBU-18-0015
Site: Marsh Creek **Location:** E Moody Road **County:** Knox
Latitude: 38.894577 **Longitude:** -87.422060 **IASNat Region:** 7A **Topo:** H-26 **Segment:** 52
Ecoregion: Interior River Lowland **Drainage Area (sq.miles):** 12.234 **Gradient (ft/mile):** 2.932

Sample Information

SampleNumber: AB42679 **EventID:** 20T012 **Sample MediumCollected:** Fish Community + Water
SampleDate: 06/23/2020 **SurveyCrewChief:** KAG **SampleTime:** 12:10:00 PM **HydroLabNumber:** P6
WaterFlowType: Glide **WaterAppearance:** Clear **SkyConditions:** 3 - Partly **AirTemperature:** 4 - 61-75
WindDirection: 0 - North (0 degrees) **WindStrength:** 3 - Moderate
DissolvedO2 (mg/l): 9.45 **pH:** 7.98 **WaterTemp(°C):** 24 **SpecificConductivity (µS/cm):** 1240 **Turbidity (NTU):** 6.09
SpecialNotes:

ElectrofishingEquipment: Backpack **Voltage:** 200 **Avg.StreamWidth(m):** 6 **DistanceFished (m):** 90
SecondsFished: 478 **WaterDepthAvg (m):** .1 **WaterDepthMax (m):** .5 **TimeAtSite:** 01:00
BridgeInReach: ☐ **ReachRepresentative:** ☑ **WhyReachNotRepresentative:**
SpecialComments:

Habitat Information

TotalScore (max100): 37 **SubstrateScore (max20):** 9 **InstreamCover Score (max20):** 8 **ChannelMorphologyScore (max20):** 8
RiparianZoneBankErosion Score(max10): 4 **Pool/GlideQualityScore(max12):** 4 **Riffle/RunQualityScore(max8):** 0
GradientScore (max10): 4 **%Pool:** 20 **%Riffle:** 0 **%Run:** 0 **%Glide:** 80 **CanopyCover PctOpen:** >85%-Open
SubjectiveRating: **AestheticRating:** **NOTES:** "NEW RECORD"

Fish Community Index of Biotic Integrity (IBI) Information

Calibration Used: Interior River Lowland

	Actual Observation	Metric Score
SpeciesCount:	**11**	**5**
SunfishSpeciesCount:	**4**	**5**
MinnowSpeciesCount:	**3**	**3**
SuckerSpeciesCount:	**0**	**1**
SensitiveSpeciesCount:	**2**	**3**

	Actual Observation	Metric Score
%TolerantIndividuals:	**20.69**	**5**
%OmnivoreIndividuals:	**8.62**	**5**
%InsectivoreIndividuals:	**86.21**	**5**
%PioneerIndividuals:	**13.79**	**5**
Total # of Individuals (CPUE):	**58**	**1**
%SimpleLithophilicInd.:	**1.72**	**1**
%Ind.withDELT:	**0**	**5**

Metrics are dependent on Ecoregion and Drainage Area.
Metrics can score a 0, 1, 3, or 5 depending on calibration.

Total IBI Score (min 0, max 60)	44

SampleNumber: AB42679 **EventID:** 20T012 **LSite:** WBU-18-0015 **County:** Knox

StreamName: Marsh Creek **LocationDescription:** E Moody Road

Common Name	Individual Fish Count	Deformities	Eroded Fins	Lesions	Tumors	Multiple Anomalies
Blackstripe Topminnow	2					
Bluegill	11					
Bluntnose Minnow	4					
Green Sunfish	4					
Longear Sunfish	29					
Mississippi Silvery Minnow	1					
Orangespotted Sunfish	1					
Sand Shiner	1					
Shortnose Gar	3					
Western Mosquitofish	1					
Yellow Bullhead	1					

Indiana Department of Environmental Management
Fish Community Assessments

Site Information

SubBasin: Middle Wabash-Busseron **14 digit HUC:** 05120111190030 **LSite:** WBU-18-0016
Site: Marsh Creek **Location:** S County Road 50 E **County:** Sullivan
Latitude: 38.922848 **Longitude:** -87.403759 **IASNat Region:** 7A **Topo:** H-26 **Segment:** 52
Ecoregion: Interior River Lowland **Drainage Area (sq.miles):** 8.376 **Gradient (ft/mile):** 5.502

Sample Information

SampleNumber: AB42680 **EventID:** 20T013 **Sample MediumCollected:** Fish Community + Water
SampleDate: 06/23/2020 **SurveyCrewChief:** KAG **SampleTime:** 11:00:00 AM **HydroLabNumber:** P6
WaterFlowType: Glide **WaterAppearance:** Clear **SkyConditions:** 3 - Partly **AirTemperature:** 4 - 61-75
WindDirection: 0 - North (0 degrees) **WindStrength:** 3 - Moderate
DissolvedO2 (mg/l): 9.07 **pH:** 7.87 **WaterTemp(°C):** 22.8 **SpecificConductivity (µS/cm):** 1686 **Turbidity (NTU):** 4.34
SpecialNotes:

ElectrofishingEquipment: Backpack **Voltage:** 200 **Avg.StreamWidth(m):** 4 **DistanceFished (m):** 60
SecondsFished: 528 **WaterDepthAvg (m):** .2 **WaterDepthMax (m):** .5 **TimeAtSite:** 00:45
BridgeInReach: ☐ **ReachRepresentative:** ☑ **WhyReachNotRepresentative:**
SpecialComments:

Habitat Information

TotalScore (max100): 50 **SubstrateScore (max20):** 11 **InstreamCover Score (max20):** 13 **ChannelMorphologyScore (max20):** 10
RiparianZoneBankErosion Score(max10): 5 **Pool/GlideQualityScore(max12):** 5 **Riffle/RunQualityScore(max8):** 0
GradientScore (max10): 6 **%Pool:** 10 **%Riffle:** 0 **%Run:** 0 **%Glide:** 90 **CanopyCover PctOpen:** 55%-<85%
SubjectiveRating: **AestheticRating:** **NOTES:** "NEW RECORD"

Fish Community Index of Biotic Integrity (IBI) Information

Calibration Used: Interior River Lowland

	Actual Observation	Metric Score
SpeciesCount:	11	5
SunfishSpeciesCount:	3	3
MinnowSpeciesCount:	5	5
SuckerSpeciesCount:	0	1
SensitiveSpeciesCount:	2	5

	Actual Observation	Metric Score
%TolerantIndividuals:	43.75	3
%OmnivoreIndividuals:	14.06	5
%InsectivoreIndividuals:	82.81	5
%PioneerIndividuals:	37.5	3
Total # of Individuals (CPUE):	64	1
%SimpleLithophilicInd.:	7.81	1
%Ind.withDELT:	0	5

Metrics are dependent on Ecoregion and Drainage Area.
Metrics can score a 0, 1, 3, or 5 depending on calibration.

Total IBI Score (min 0, max 60)	42

SampleNumber: AB42680 **EventID:** 20T013 **LSite:** WBU-18-0016 **County:** Sullivan

StreamName: Marsh Creek **LocationDescription:** S County Road 50 E

Common Name	Individual Fish Count	Deformities	Eroded Fins	Lesions	Tumors	Multiple Anomalies
Blackstripe Topminnow	2					
Bluegill	1					
Bluntnose Minnow	4					
Creek Chub	1					
Green Sunfish	19					
Longear Sunfish	25					
Mississippi Silvery Minnow	5					
Redfin Pickerel	1					
Sand Shiner	1					
Spotfin Shiner	1					
Yellow Bullhead	4					

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Fish Community Assessments

Site Information

SubBasin:	Middle Wabash-Busseron	**14 digit HUC:**	05120111190030	**LSite:**	WBU-18-0017		
Site:	Marsh Creek	**Location:**	S County Road 5 SE	**County:**	Sullivan		
Latitude:	38.935544	**Longitude:**	-87.382966	**IASNat Region:**	7A	**Topo:**	H-26
Segment:	52						
Ecoregion:	Interior River Lowland	**Drainage Area (sq.miles):**	3.624	**Gradient (ft/mile):**	7.445		

Sample Information

SampleNumber: AB42681 **EventID:** 20T014 **Sample MediumCollected:** Fish Community + Water

SampleDate: 06/23/2020 **SurveyCrewChief:** KAG **SampleTime:** 10:05:00 AM **HydroLabNumber:** P6

WaterFlowType: Glide **WaterAppearance:** Brown **SkyConditions:** 4 - Cloudy **AirTemperature:** 4 - 61-75

WindDirection: 0 - North (0 degrees) **WindStrength:** 3 - Moderate

DissolvedO2 (mg/l): 6.48 **pH:** 7.38 **WaterTemp(°C):** 20.6 **SpecificConductivity (µS/cm):** 478.5 **Turbidity (NTU):** 8.34

SpecialNotes:

ElectrofishingEquipment: Backpack **Voltage:** 220 **Avg.StreamWidth(m):** 2 **DistanceFished (m):** 50

SecondsFished: 326 **WaterDepthAvg (m):** .1 **WaterDepthMax (m):** .15 **TimeAtSite:** 00:45

BridgeInReach: ☐ **ReachRepresentative:** ☑ **WhyReachNotRepresentative:**

SpecialComments:

Habitat Information

TotalScore (max100): 33 **SubstrateScore (max20):** 7 **InstreamCover Score (max20):** 7 **ChannelMorphologyScore (max20):** 8

RiparianZoneBankErosion Score(max10): 5 **Pool/GlideQualityScore(max12):** 0 **Riffle/RunQualityScore(max8):** 0

GradientScore (max10): 6 **%Pool:** 20 **%Riffle:** 0 **%Run:** 0 **%Glide:** 80 **CanopyCover PctOpen:** <10%-Closed

SubjectiveRating: **AestheticRating:** **NOTES:** "NEW RECORD"

Fish Community Index of Biotic Integrity (IBI) Information

Calibration Used: Interior River Lowland

	Actual Observation	Metric Score
SpeciesCount:	7	5
SunfishSpeciesCount:	1	1
MinnowSpeciesCount:	4	5
SuckerSpeciesCount:	0	1
SensitiveSpeciesCount:	0	1

	Actual Observation	Metric Score
%TolerantIndividuals:	55.56	1
%OmnivoreIndividuals:	16.67	1
%InsectivoreIndividuals:	50	1
%PioneerIndividuals:	72.22	1
Total # of Individuals (CPUE):	18	1
%SimpleLithophilicInd.:	0	1
%Ind.withDELT:	0	1

Metrics are dependent on Ecoregion and Drainage Area.
Metrics can score a 0, 1, 3, or 5 depending on calibration.

Total IBI Score (min 0, max 60)	20

SampleNumber: AB42681 **EventID:** 20T014 **LSite:** WBU-18-0017 **County:** Sullivan

StreamName: Marsh Creek **LocationDescription:** S County Road 5 SE

Common Name	Individual Fish Count	Deformities	Eroded Fins	Lesions	Tumors	Multiple Anomalies
Blackstripe Topminnow	2					
Bluntnose Minnow	3					
Creek Chub	6					
Green Sunfish	1					
Johnny Darter	2					
Silverjaw Minnow	1					
Spotfin Shiner	3					

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Site Information

SubBasin: Middle Wabash-Busseron **14 digit HUC:** 05120111190010 **LSite:** WBU-18-0014
Site: Tributary of Maria Creek **Location:** Freelandville Road **County:** Knox
Latitude: 38.881029 **Longitude:** -87.352830 **IASNat Region:** 7B **Topo:** H-27 **Segment:** 52
Ecoregion: Interior River Lowland **Drainage Area (sq.miles):** 2.96 **Gradient (ft/mile):** 7.362

Sample Information

SampleNumber: AB42682 **EventID:** 20T015 **Sample MediumCollected:** Fish Community + Water
SampleDate: 06/22/2020 **SurveyCrewChief:** KAG **SampleTime:** 01:35:00 PM **HydroLabNumber:** P6
WaterFlowType: Glide **WaterAppearance:** Murky **SkyConditions:** 3 - Partly **AirTemperature:** 5 - 76-85
WindDirection: 9 - East (90 degrees) **WindStrength:** 2 - Mod./Light
DissolvedO2 (mg/l): 11.82 **pH:** 8.2 **WaterTemp(°C):** 25 **SpecificConductivity (µS/cm):** 481.1 **Turbidity (NTU):** 5.67
SpecialNotes:

ElectrofishingEquipment: Backpack **Voltage:** 225 **Avg.StreamWidth(m):** 2 **DistanceFished (m):** 50
SecondsFished: 495 **WaterDepthAvg (m):** .2 **WaterDepthMax (m):** .3 **TimeAtSite:** 01:00
BridgeInReach: ☐ **ReachRepresentative:** ☑ **WhyReachNotRepresentative:**
SpecialComments:

Habitat Information

TotalScore (max100): 37 **SubstrateScore (max20):** 10 **InstreamCover Score (max20):** 5 **ChannelMorphologyScore (max20):** 8
RiparianZoneBankErosion Score(max10): 4 **Pool/GlideQualityScore(max12):** 4 **Riffle/RunQualityScore(max8):** 0
GradientScore (max10): 6 **%Pool:** 10 **%Riffle:** 0 **%Run:** 0 **%Glide:** 90 **CanopyCover PctOpen:** >85%-Open
SubjectiveRating: **AestheticRating:** **NOTES:** "NEW RECORD"

Fish Community Index of Biotic Integrity (IBI) Information

Calibration Used: Interior River Lowland

	Actual Observation	Metric Score
SpeciesCount:	**8**	**5**
SunfishSpeciesCount:	**1**	**1**
MinnowSpeciesCount:	**4**	**5**
SuckerSpeciesCount:	**1**	**1**
SensitiveSpeciesCount:	**0**	**1**

	Actual Observation	Metric Score
%TolerantIndividuals:	**63.16**	**1**
%OmnivoreIndividuals:	**31.58**	**1**
%InsectivoreIndividuals:	**21.05**	**1**
%PioneerIndividuals:	**57.89**	**1**
Total # of Individuals (CPUE):	**19**	**1**
%SimpleLithophilicInd.:	**21.05**	**1**
%Ind.withDELT:	**0**	**1**

Metrics are dependent on Ecoregion and Drainage Area.
Metrics can score a 0, 1, 3, or 5 depending on calibration.

Total IBI Score (min 0, max 60)	20

SampleNumber: AB42682 **EventID:** 20T015 **LSite:** WBU-18-0014 **County:** Knox

StreamName: Tributary of Maria Creek **LocationDescription:** Freelandville Road

Common Name	Individual Fish Count	Deformities	Eroded Fins	Lesions	Tumors	Multiple Anomalies
Blackstripe Topminnow	1					
Bluegill	1					
Bluntnose Minnow	2					
Central Stoneroller	2					
Creek Chub	7					
Mississippi Silvery Minnow	1					
Pirate Perch	2					
White Sucker	3					

Indiana Department of Environmental Management
Fish Community Assessments

Site Information

SubBasin: Middle Wabash-Busseron **14 digit HUC:** 05120111190010 **LSite:** WBU190-0002
Site: Maria Creek **Location:** CR 1050 N/Freelandville Road **County:** Knox
Latitude: 38.881727 **Longitude:** -87.346680 **IASNat Region:** 7B **Topo:** H-27 **Segment:** 52
Ecoregion: Interior River Lowland **Drainage Area (sq.miles):** 17.468 **Gradient (ft/mile):** 5.282

Sample Information

SampleNumber: AB42683 **EventID:** 20T016 **Sample MediumCollected:** Fish Community + Water
SampleDate: 06/22/2020 **SurveyCrewChief:** KAG **SampleTime:** 02:50:00 PM **HydroLabNumber:** P6
WaterFlowType: Glide **WaterAppearance:** Clear **SkyConditions:** 1 - Clear **AirTemperature:** 6 - > 86
WindDirection: 9 - East (90 degrees) **WindStrength:** 2 - Mod./Light
DissolvedO2 (mg/l): 17.14 **pH:** 8.69 **WaterTemp(°C):** 28.1 **SpecificConductivity (µS/cm):** 761 **Turbidity (NTU):** 8.12
SpecialNotes:

ElectrofishingEquipment: Backpack **Voltage:** 210 **Avg.StreamWidth(m):** 4 **DistanceFished (m):** 60
SecondsFished: 495 **WaterDepthAvg (m):** .2 **WaterDepthMax (m):** .25 **TimeAtSite:** 00:45
BridgeInReach: ☐ **ReachRepresentative:** ☑ **WhyReachNotRepresentative:**
SpecialComments:

Habitat Information

TotalScore (max100): 52 **SubstrateScore (max20):** 14 **InstreamCover Score (max20):** 14 **ChannelMorphologyScore (max20):** 9
RiparianZoneBankErosion Score(max10): 5 **Pool/GlideQualityScore(max12):** 4 **Riffle/RunQualityScore(max8):** 0
GradientScore (max10): 6 **%Pool:** 10 **%Riffle:** 0 **%Run:** 90 **%Glide:** 0 **CanopyCover PctOpen:** >85%-Open
SubjectiveRating: **AestheticRating:** **NOTES:** "NEW RECORD"

Fish Community Index of Biotic Integrity (IBI) Information

Calibration Used: Interior River Lowland

	Actual Observation	Metric Score
SpeciesCount:	8	3
SunfishSpeciesCount:	3	3
MinnowSpeciesCount:	3	3
SuckerSpeciesCount:	0	1
SensitiveSpeciesCount:	2	3

	Actual Observation	Metric Score
%TolerantIndividuals:	38.46	3
%OmnivoreIndividuals:	2.56	5
%InsectivoreIndividuals:	97.44	5
%PioneerIndividuals:	15.38	5
Total # of Individuals (CPUE):	39	1
%SimpleLithophilicInd.:	0	1
%Ind.withDELT:	5.13	1

Metrics are dependent on Ecoregion and Drainage Area.
Metrics can score a 0, 1, 3, or 5 depending on calibration.

Total IBI Score (min 0, max 60)	34

SampleNumber: AB42683 **EventID:** 20T016 **LSite:** WBU190-0002 **County:** Knox

StreamName: Maria Creek **LocationDescription:** CR 1050 N/Freelandville Road

Common Name	Individual Fish Count	Deformities	Eroded Fins	Lesions	Tumors	Multiple Anomalies
Blackstripe Topminnow	4					
Bluegill	5					
Bluntnose Minnow	1					
Green Sunfish	5					
Longear Sunfish	12					
Sand Shiner	1					
Spotfin Shiner	2					
Yellow Bullhead	9	1	1			

Indiana Department of Environmental Management
Fish Community Assessments

Site Information

SubBasin: Middle Wabash-Busseron **14 digit HUC:** 05120111190010 **LSite:** WBU-18-0018
Site: Tributary of Maria Creek **Location:** County Road 700 E, Lane Road **County:** Knox
Latitude: 38.870452 **Longitude:** -87.334043 **IASNat Region:** 7B **Topo:** H-50 **Segment:** 52
Ecoregion: Interior River Lowland **Drainage Area (sq.miles):** 4.37 **Gradient (ft/mile):** 6.761

Sample Information

SampleNumber: AB42684 **EventID:** 20T017 **Sample MediumCollected:** Fish Community + Water
SampleDate: 06/22/2020 **SurveyCrewChief:** KRW **SampleTime:** 02:24:00 PM **HydroLabNumber:** P5
WaterFlowType: Run **WaterAppearance:** Clear **SkyConditions:** 2 - Scattered **AirTemperature:** 6 - > 86
WindDirection: 27 - West (270 degrees) **WindStrength:** 1 - Light
DissolvedO2 (mg/l): 14.6 **pH:** 8.54 **WaterTemp(°C):** 27.9 **SpecificConductivity (µS/cm):** 506 **Turbidity (NTU):** 5.46
SpecialNotes:

ElectrofishingEquipment: Backpack **Voltage:** 200 **Avg.StreamWidth(m):** 5 **DistanceFished (m):** 75
SecondsFished: 373 **WaterDepthAvg (m):** .3 **WaterDepthMax (m):** .5 **TimeAtSite:** 01:00
BridgeInReach: ☐ **ReachRepresentative:** ☑ **WhyReachNotRepresentative:**
SpecialComments:

Habitat Information

TotalScore (max100): 41 **SubstrateScore (max20):** 6 **InstreamCover Score (max20):** 8 **ChannelMorphologyScore (max20):** 11
RiparianZoneBankErosion Score(max10): 4 **Pool/GlideQualityScore(max12):** 4 **Riffle/RunQualityScore(max8):** 2
GradientScore (max10): 6 **%Pool:** 10 **%Riffle:** 20 **%Run:** 70 **%Glide:** 0 **CanopyCover PctOpen:** 10%-<30%
SubjectiveRating: **AestheticRating:** **NOTES:** "NEW RECORD"

Fish Community Index of Biotic Integrity (IBI) Information

Calibration Used: Interior River Lowland

	Actual Observation	Metric Score
SpeciesCount:	14	5
SunfishSpeciesCount:	2	3
MinnowSpeciesCount:	8	5
SuckerSpeciesCount:	0	1
SensitiveSpeciesCount:	2	5

	Actual Observation	Metric Score
%TolerantIndividuals:	52.54	1
%OmnivoreIndividuals:	40.11	1
%InsectivoreIndividuals:	25.99	3
%PioneerIndividuals:	81.36	1
Total # of Individuals (CPUE):	177	3
%SimpleLithophilicInd.:	3.95	1
%Ind.withDELT:	0	5

Metrics are dependent on Ecoregion and Drainage Area.
Metrics can score a 0, 1, 3, or 5 depending on calibration.

Total IBI Score (min 0, max 60)	34

SampleNumber: AB42684 **EventID:** 20T017 **LSite:** WBU-18-0018 **County:** Knox

StreamName: Tributary of Maria Creek **LocationDescription:** County Road 700 E, Lane Road

Common Name	Individual Fish Count	Deformities	Eroded Fins	Lesions	Tumors	Multiple Anomalies
Blackstripe Topminnow	5					
Bluntnose Minnow	64					
Central Stoneroller	39					
Creek Chub	21					
Green Sunfish	4					
Johnny Darter	1					
Longear Sunfish	7					
Mississippi Silvery Minnow	7					
Pirate Perch	1					
Redfin Shiner	1					
Sand Shiner	7					
Silverjaw Minnow	15					
Spotfin Shiner	1					
Yellow Bullhead	4					

Indiana Department of Environmental Management
Fish Community Assessments

Site Information

SubBasin: Middle Wabash-Busseron **14 digit HUC:** 05120111190010 **LSite:** WBU-18-0019
Site: Maria Creek **Location:** E County Road 1050 S **County:** Sullivan
Latitude: 38.924364 **Longitude:** -87.333119 **IASNat Region:** 7B **Topo:** H-27 **Segment:** 52
Ecoregion: Interior River Lowland **Drainage Area (sq.miles):** 10.192 **Gradient (ft/mile):** 8.775

Sample Information

SampleNumber: AB42685 **EventID:** 20T018 **Sample MediumCollected:** Fish Community + Water
SampleDate: 06/22/2020 **SurveyCrewChief:** KRW **SampleTime:** 12:11:00 PM **HydroLabNumber:** P5
WaterFlowType: Run **WaterAppearance:** Clear **SkyConditions:** 1 - Clear **AirTemperature:** 5 - 76-85
WindDirection: 27 - West (270 degrees) **WindStrength:** 1 - Light
DissolvedO2 (mg/l): 8.89 **pH:** 8.22 **WaterTemp(°C):** 24.3 **SpecificConductivity (µS/cm):** 968 **Turbidity (NTU):** 10.1
SpecialNotes:

ElectrofishingEquipment: Backpack **Voltage:** 200 **Avg.StreamWidth(m):** 5 **DistanceFished (m):** 75
SecondsFished: 460 **WaterDepthAvg (m):** .3 **WaterDepthMax (m):** .7 **TimeAtSite:** 01:15
BridgeInReach: ☐ **ReachRepresentative:** ☑ **WhyReachNotRepresentative:**
SpecialComments: 250 volts for sunfish/pool

Habitat Information

TotalScore (max100): 45 **SubstrateScore (max20):** 6 **InstreamCover Score (max20):** 10 **ChannelMorphologyScore (max20):** 11
RiparianZoneBankErosion Score(max10): 3 **Pool/GlideQualityScore(max12):** 3 **Riffle/RunQualityScore(max8):** 2
GradientScore (max10): 10 **%Pool:** 15 **%Riffle:** 25 **%Run:** 60 **%Glide:** **CanopyCover PctOpen:** <10%-Closed
SubjectiveRating: **AestheticRating:** **NOTES:** "NEW RECORD"

Fish Community Index of Biotic Integrity (IBI) Information

Calibration Used: Interior River Lowland

	Actual Observation	Metric Score
SpeciesCount:	**15**	**5**
SunfishSpeciesCount:	**3**	**3**
MinnowSpeciesCount:	**8**	**5**
SuckerSpeciesCount:	**0**	**1**
SensitiveSpeciesCount:	**2**	**3**

	Actual Observation	Metric Score
%TolerantIndividuals:	**31.71**	**3**
%OmnivoreIndividuals:	**21.95**	**3**
%InsectivoreIndividuals:	**42.28**	**3**
%PioneerIndividuals:	**61.79**	**3**
Total # of Individuals (CPUE):	**123**	**3**
%SimpleLithophilicInd.:	**17.89**	**3**
%Ind.withDELT:	**0**	**5**

Metrics are dependent on Ecoregion and Drainage Area.
Metrics can score a 0, 1, 3, or 5 depending on calibration.

Total IBI Score (min 0, max 60)	40

SampleNumber: AB42685 **EventID:** 20T018 **LSite:** WBU-18-0019 **County:** Sullivan

StreamName: Maria Creek **LocationDescription:** E County Road 1050 S

Common Name	Individual Fish Count	Deformities	Eroded Fins	Lesions	Tumors	Multiple Anomalies
Blackstripe Topminnow	2					
Bluegill	1					
Bluntnose Minnow	8					
Central Stoneroller	19					
Creek Chub	25					
Green Sunfish	4					
Johnny Darter	13					
Longear Sunfish	16					
Mississippi Silvery Minnow	19					
Sand Shiner	1					
Silverjaw Minnow	7					
Slough Darter	2					
Spotfin Shiner	1					
Suckermouth Minnow	3					
Yellow Bullhead	2					

Indiana Department of Environmental Management
Fish Community Assessments

Site Information

SubBasin: Middle Wabash-Busseron		**14 digit HUC:** 05120111190010		**LSite:** WBU-18-0020	
Site: Maria Creek	**Location:** E County Road 975 S				**County:** Sullivan
Latitude: 38.935575	**Longitude:** -87.323211	**IASNat Region:** 7B		**Topo:** H-27	**Segment:** 52
Ecoregion: Interior River Lowland		**Drainage Area (sq.miles):** 7.331			**Gradient (ft/mile):** 7.687

Sample Information

SampleNumber: AB42686 **EventID:** 20T019 **Sample MediumCollected:** Fish Community + Water

SampleDate: 06/22/2020 **SurveyCrewChief:** KRW **SampleTime:** 10:42:00 AM **HydroLabNumber:** P5

WaterFlowType: Run **WaterAppearance:** Clear **SkyConditions:** 1 - Clear **AirTemperature:** 5 - 76-85

WindDirection: 27 - West (270 degrees) **WindStrength:** 1 - Light

DissolvedO2 (mg/l): 7.12 **pH:** 8.02 **WaterTemp(°C):** 24.6 **SpecificConductivity (µS/cm):** 997 **Turbidity (NTU):** 11.5

SpecialNotes:

ElectrofishingEquipment: Backpack **Voltage:** 200 **Avg.StreamWidth(m):** 4 **DistanceFished (m):** 60

SecondsFished: 493 **WaterDepthAvg (m):** .4 **WaterDepthMax (m):** 1 **TimeAtSite:** 01:00

BridgeInReach: ☐ **ReachRepresentative:** ☑ **WhyReachNotRepresentative:**

SpecialComments: 250 volts for deeper pools

Habitat Information

TotalScore (max100): 58 **SubstrateScore (max20):** 6 **InstreamCover Score (max20):** 15 **ChannelMorphologyScore (max20):** 17

RiparianZoneBankErosion Score(max10): 5 **Pool/GlideQualityScore(max12):** 7 **Riffle/RunQualityScore(max8):** 2

GradientScore (max10): 6 **%Pool:** 70 **%Riffle:** 10 **%Run:** 20 **%Glide:** 0 **CanopyCover PctOpen:** 10%-<30%

SubjectiveRating: **AestheticRating:** **NOTES:** "NEW RECORD"

Fish Community Index of Biotic Integrity (IBI) Information

Calibration Used: Interior River Lowland

	Actual Observation	Metric Score
SpeciesCount:	15	5
SunfishSpeciesCount:	3	3
MinnowSpeciesCount:	7	5
SuckerSpeciesCount:	1	1
SensitiveSpeciesCount:	2	5

	Actual Observation	Metric Score
%TolerantIndividuals:	26.42	3
%OmnivoreIndividuals:	14.15	5
%InsectivoreIndividuals:	68.87	5
%PioneerIndividuals:	29.25	5
Total # of Individuals (CPUE):	106	3
%SimpleLithophilicInd.:	11.32	3
%Ind.withDELT:	0.94	5

Metrics are dependent on Ecoregion and Drainage Area.
Metrics can score a 0, 1, 3, or 5 depending on calibration.

Total IBI Score (min 0, max 60)	48

SampleNumber: AB42686 **EventID:** 20T019 **LSite:** WBU-18-0020 **County:** Sullivan

StreamName: Maria Creek **LocationDescription:** E County Road 975 S

Common Name	Individual Fish Count	Deformities	Eroded Fins	Lesions	Tumors	Multiple Anomalies
Blackstripe Topminnow	4					
Bluegill	9					
Bluntnose Minnow	5					
Central Stoneroller	6					
Creek Chub	8					
Green Sunfish	2					
Johnny Darter	6					
Largemouth Bass	4	1				
Longear Sunfish	39					
Sand Shiner	1					
Silverjaw Minnow	4					
Spotfin Shiner	3					
Suckermouth Minnow	2					
White Sucker	10					
Yellow Bullhead	3					

Indiana Department of Environmental Management
Fish Community Assessments

Site Information

SubBasin:	Middle Wabash-Busseron	**14 digit HUC:**	05120111190010	**LSite:**	WBU-18-0019
Site:	Maria Creek	**Location:**	E County Road 1050 S	**County:**	Sullivan
Latitude:	38.924364	**Longitude:**	-87.333119	**IASNat Region:**	7B
Topo:	H-27	**Segment:**	52		
Ecoregion:	Interior River Lowland	**Drainage Area (sq.miles):**	10.192	**Gradient (ft/mile):**	8.775

Sample Information

SampleNumber: AB43431 **EventID:** 20T018.5 **Sample MediumCollected:** Fish Community + Water

SampleDate: 08/18/2020 **SurveyCrewChief:** KRW **SampleTime:** 01:14:00 PM **HydroLabNumber:** P5

WaterFlowType: Run **WaterAppearance:** Clear **SkyConditions:** 4 - Cloudy **AirTemperature:** 5 - 76-85

WindDirection: 27 - West (270 degrees) **WindStrength:** 1 - Light

DissolvedO2 (mg/l): 8.45 **pH:** 8.09 **WaterTemp(°C):** 23.6 **SpecificConductivity (µS/cm):** 735 **Turbidity (NTU):** 12.9

SpecialNotes:

ElectrofishingEquipment: Backpack **Voltage:** 200 **Avg.StreamWidth(m):** 5 **DistanceFished (m):** 75

SecondsFished: 561 **WaterDepthAvg (m):** .3 **WaterDepthMax (m):** .5 **TimeAtSite:** 01:00

BridgeInReach: ☐ **ReachRepresentative:** ☑ **WhyReachNotRepresentative:**

SpecialComments:

Habitat Information

TotalScore (max100): 46 **SubstrateScore (max20):** 10 **InstreamCover Score (max20):** 8 **ChannelMorphologyScore (max20):** 9

RiparianZoneBankErosion Score(max10): 2 **Pool/GlideQualityScore(max12):** 6 **Riffle/RunQualityScore(max8):** 1

GradientScore (max10): 10 **%Pool:** 50 **%Riffle:** 10 **%Run:** 30 **%Glide:** 10 **CanopyCover PctOpen:** 55%-<85%

SubjectiveRating: **AestheticRating:** **NOTES:** "NEW RECORD"

Fish Community Index of Biotic Integrity (IBI) Information

Calibration Used: Interior River Lowland

	Actual Observation	Metric Score
SpeciesCount:	14	5
SunfishSpeciesCount:	3	3
MinnowSpeciesCount:	7	5
SuckerSpeciesCount:	0	1
SensitiveSpeciesCount:	1	1

	Actual Observation	Metric Score
%TolerantIndividuals:	34.85	3
%OmnivoreIndividuals:	6.06	5
%InsectivoreIndividuals:	46.97	3
%PioneerIndividuals:	77.27	1
Total # of Individuals (CPUE):	132	3
%SimpleLithophilicInd.:	4.55	1
%Ind.withDELT:	0	5

Metrics are dependent on Ecoregion and Drainage Area.
Metrics can score a 0, 1, 3, or 5 depending on calibration.

Total IBI Score (min 0, max 60)	36

SampleNumber: AB43431 **EventID:** 20T018.5 **LSite:** WBU-18-0019 **County:** Sullivan

StreamName: Maria Creek **LocationDescription:** E County Road 1050 S

Common Name	Individual Fish Count	Deformities	Eroded Fins	Lesions	Tumors	Multiple Anomalies
Blackstripe Topminnow	3					
Bluegill	4					
Bluntnose Minnow	4					
Central Stoneroller	26					
Creek Chub	36					
Green Sunfish	2					
Johnny Darter	25					
Longear Sunfish	8					
Mississippi Silvery Minnow	4					
Silverjaw Minnow	9					
Slough Darter	3					
Spotfin Shiner	2					
Suckermouth Minnow	2					
Yellow Bullhead	4					

Indiana Department of Environmental Management
Fish Community Assessments

Site Information

SubBasin: Middle Wabash-Busseron **14 digit HUC:** 05120111190020 **LSite:** WBU-18-0009
Site: Tilley Ditch **Location:** E Pepmeir Road **County:** Knox
Latitude: 38.835159 **Longitude:** -87.363200 **IASNat Region:** 7B **Topo:** H-50 **Segment:** 52
Ecoregion: Interior River Lowland **Drainage Area (sq.miles):** 9.299 **Gradient (ft/mile):** 4.379

Sample Information

SampleNumber: AB43849 **EventID:** 20T006.5 **Sample MediumCollected:** Fish Community + Water
SampleDate: 08/20/2020 **SurveyCrewChief:** KRW **SampleTime:** 09:55:00 AM **HydroLabNumber:** P5
WaterFlowType: Run **WaterAppearance:** Clear **SkyConditions:** 1 - Clear **AirTemperature:** 4 - 61-75
WindDirection: 27 - West (270 degrees) **WindStrength:** 1 - Light
DissolvedO2 (mg/l): 7.39 **pH:** 7.6 **WaterTemp(°C):** 16.7 **SpecificConductivity (µS/cm):** 531 **Turbidity (NTU):** 7.64
SpecialNotes:

ElectrofishingEquipment: Backpack **Voltage:** 200 **Avg.StreamWidth(m):** 3 **DistanceFished (m):** 50
SecondsFished: 336 **WaterDepthAvg (m):** .4 **WaterDepthMax (m):** .6 **TimeAtSite:** 01:00
BridgeInReach: ☐ **ReachRepresentative:** ☑ **WhyReachNotRepresentative:**
SpecialComments: MLES backpack

Habitat Information

TotalScore (max100): 51 **SubstrateScore (max20):** 12 **InstreamCover Score (max20):** 10 **ChannelMorphologyScore (max20):** 10
RiparianZoneBankErosion Score(max10): 5 **Pool/GlideQualityScore(max12):** 5 **Riffle/RunQualityScore(max8):** 3
GradientScore (max10): 6 **%Pool:** 10 **%Riffle:** 5 **%Run:** 85 **%Glide:** **CanopyCover PctOpen:** >85%-Open
SubjectiveRating: **AestheticRating:** **NOTES:** "NEW RECORD"

Fish Community Index of Biotic Integrity (IBI) Information

Calibration Used: Interior River Lowland

	Actual Observation	Metric Score
SpeciesCount:	**17**	**5**
SunfishSpeciesCount:	**1**	**1**
MinnowSpeciesCount:	**9**	**5**
SuckerSpeciesCount:	**0**	**1**
SensitiveSpeciesCount:	**3**	**5**

	Actual Observation	Metric Score
%TolerantIndividuals:	**10.04**	**5**
%OmnivoreIndividuals:	**28.03**	**3**
%InsectivoreIndividuals:	**66.53**	**5**
%PioneerIndividuals:	**19.67**	**5**
Total # of Individuals (CPUE):	**239**	**5**
%SimpleLithophilicInd.:	**24.69**	**5**
%Ind.withDELT:	**0**	**5**

Metrics are dependent on Ecoregion and Drainage Area.
Metrics can score a 0, 1, 3, or 5 depending on calibration.

Total IBI Score (min 0, max 60)	50

SampleNumber: AB43849 **EventID:** 20T006.5 **LSite:** WBU-18-0009 **County:** Knox

StreamName: Tilley Ditch **LocationDescription:** E Pepmeir Road

Common Name	Individual Fish Count	Deformities	Eroded Fins	Lesions	Tumors	Multiple Anomalies
Blackstripe Topminnow	4					
Bluntnose Minnow	14					
Brook Silverside	13					
Central Stoneroller	9					
Creek Chub	4					
Emerald Shiner	16					
Johnny Darter	13					
Longear Sunfish	75					
Mississippi Silvery Minnow	53					
Pirate Perch	2					
Sand Shiner	8					
Silverjaw Minnow	7					
Slough Darter	3					
Spotfin Shiner	4					
Suckermouth Minnow	6					
Western Mosquitofish	2					
Yellow Bullhead	6					

OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Site Name	EPA ID	Macro Sample Type	Sample #	Macro Event #	Sample Date	County
WBU190-0001	20T-010	MHAB	AB42967	200714704	7/14/20	Knox

Stream Name	Location	HUC 12	HUCTO14
Marsh Creek	E Springtown Road	051201111803	05120111190030

Northing	Easting	Ecoregion	Gradient	Drainage Area	QHEI Score
4297817.29	465290.89	72	2.96	23.57	35

TAXON	COUNT	NOTES	HBI Tolerance
1220 (PLATYHELMINTHES)	2		
1233 (ERPOBDELLIDAE)	1		
1090 (Physa)	10		8
1210 (BIVALVIA)	8	1 crushed while moving to vial	
2156 (Corbicula fluminea)	10		6
1083 (ACARI)	1		4
9031 (Lirceus)	1		8
1251 (ISOTOMIDAE)	1		
1253 (SMINTHURIDAE)	1		
3048 (Stenacron)	1		3
1012 (BAETIDAE)	6	damaged	4
7010 (Acerpenna macdunnoughi)	1	S20-029.4	1
3079 (Paracloeodes minutus)	8	S20-029.3	
9347 (Procloeon viridoculare)	1	S20-29.2	
9361 (Caenis dimunata grp.)	19		
3109 (Isonychia)	1		2
3175 (Tricorythodes)	1		3
3245 (Boyeria vinosa)	1		4
3116 (Progomphus obscurus)	3	immature (<6 mm)	
3052 (Erpetogomphus designatus)	1	!	
3397 (Macromia)	3		2
7027 (Hetaerina americana)	13		
3542 (Ischnura posita)	1		
3546 (Enallagma)	6	no gills	9
3549 (Enallagma divagans)	9		
3568 (Argia)	3	no gills; early instar	5
7201 (Trichocorixa calva)	2	adults (1M adn 1F)	4
7122 (Microvelia)	2	1 nymph w/ wingpads and 1 adult w/ wings	
3600 (Peltodytes duodecimpunctatus)	1	adult	
3604 (Peltodytes sexmaculatus)	1	adult	
3846 (Berosus)	1	larva	7
3851 (Berosus peregrinus)	4	adults	6
3872 (Tropisternus)	3	larvae	
3877 (Tropisternus glaber)	2	adults	

Type	Value	Metric Score
Total Taxa:	71	5
Total No. Individuals:	326	5
EPT Taxa:	14	5
% Orthocladiinae + Tanytarsini of Chironomidae:	50	1
% Non-insects excluding Astacidae:	10.12	5
Diptera Taxa:	29	5
% Intolerant (0-3):	3.99	1
% Tolerant (8-10):	6.13	5
% Predators FFG 1:	19.33	3
% Shredders + Scrapers FFG 1:	6.13	1
% Collector-Filterers FFG 1:	11.66	3
% Sprawlers:	6.13	5
mIBI Metric Score:		**44**

Supplemental Metrics

HBI	4.97
Shannon-Weaver Index	3.67
Shannon Equitability	0.86
% Dominant 3 Taxon	23.62
% Chironomidae	46.01

OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

TAXON	COUNT	NOTES	HBI Tolerance
7307 (Stenelmis)	3	larvae	5
9266 (Stenelmis grossa)	18	adults (19M and 9F); Slide S20-029.1	
1160 (TRICHOPTERA)	2	early instar	
3432 (Cheumatopsyche)	3		3
3473 (Hydropsyche alvata)	2		
3000 (Hydroptila)	1	largest ind. had case	3
8922 (Nectopsyche candida)	10	small vial had ind. broken in half	
8923 (Nectopsyche diarina)	1		3
7843 (Dasyhelea)	1		
9370 (Ceratopogon grp.)	2		8
7984 (Procladius)	11		7
7926 (Tanypodinae (Subfamily))	2		
8083 (Chironomini (Tribe))	7		
8227 (Tanytarsini (Tribe))	3		
9248 (Ablabesmyia (Ablabesmyia) mallochi grp.)	1		
9261 (Thienemannimyia grp.)	3		
8006 (Orthocladiinae (Subfamily)	1		
8067 (Rheocricotopus robacki)	2		4
8086 (Chironomus)	1		8
8099 (Cryptochironomus)	2		5
8104 (Cryptotendipes)	3		4
8112 (Dicrotendipes)	14		6
9165 (Saetheria tylus)	17		4
8228 (Cladotanytarsus)	38		4
8235 (Paratanytarsus)	1		4
9093 (Stempellinella)	1		3
8241 (Tanytarsus)	20		4
9260 (Cricotopus (Cricotopus) /Orthocladius (Orthocladius)	3		
9235 (Polypedilum (Tripodura))	1		
9277 (Polypedilum (Tripodura) scalaenum grp)	2		
9278 (Polypedilum (Tripodura) halterale-simulans grp)	5		
9241 (Polypedilum (Polypedilum) illinoense grp.)	6		
9344 (Cricotopus (Cricotopus) bicinctus)	4		
9346 (Cricotopus (Cricotopus) tremulus grp)	2		
1192 (STRATIOMYIDAE)	1	immature; stratiomys?	
8274 (Stratiomys)	1		
8397 (Hemerodromia)	2		

Residuals

OWQ/WAPB Macroinvertebrate Community Assessment
MHAB Report

Identifier	Date	Count	%PSE
JMB	9/9/2020	8	97.55

OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Site Name	EPA ID	Macro Sample Type	Sample #	Macro Event #	Sample Date	County
WBU-18-0012	20T-011	MHAB	AB42976	200715702	7/15/20	Knox

Stream Name	Location	HUC 12	HUCTO14
Marsh Creek	E Hunley Road	051201111803	05120111190030

Northing	Easting	Ecoregion	Gradient	Drainage Area	QHEI Score
4300664.61	465237.78	72	3.392	20.805	43

TAXON	COUNT	NOTES	HBI Tolerance
1084 (TURBELLARIA)	1		4
1517 (Pristina leidyi)	1		8
1565 (Aeolosoma)	1		8
1234 (GLOSSIPHONIIDAE)	1	Placobdella?	
1233 (ERPOBDELLIDAE)	3		
1091 (Lymnaea)	1		6
1090 (Physa)	15		8
2156 (Corbicula fluminea)	1		6
2181 (Sphaerium)	1		6
8997 (Orconectes propinquus)	1	Form II male	4
1254 (ENTOMOBRYIDAE)	2	small/beat up	
1012 (BAETIDAE)	1	no palps? or abdomen	4
7011 (Acerpenna pygmaea)	1		2
9366 (Baetis intercalaris complex)	2	one without abdomen except first 3 segments, pattern intact	3
3079 (Paracloeodes minutus)	8		
3081 (Callibaetis)	1	gills in microvial	6
9347 (Procloeon viridoculare)	1	J20-001.3	
9361 (Caenis dimunata grp.)	14		
9362 (Caenis hilaris grp.)	1		
3228 (Anax junius)	1		
3282 (Plathemis lydia)	3		8
7025 (ZYGOPTERA)	2	very small	
7027 (Hetaerina americana)	18	some w/out gills but still lacking lateral spine on 8th seg.	
3540 (Ischnura)	1	imm.	9
7031 (Ischnura verticalis)	1		
3542 (Ischnura posita)	2		
3546 (Enallagma)	9	no gills / undeveloped,	9
3549 (Enallagma divagans)	8		
3551 (Enallagma exsulans)	3		
3568 (Argia)	5	small banded femur	5
9095 (Argia fumipennis)	3		
7207 (Belostoma)	3	imm.	
7122 (Microvelia)	1	imm.	
7139 (Merragata brunnea)	1		

Type	Value	Metric Score
Total Taxa:	66	5
Total No. Individuals:	210	3
EPT Taxa:	14	5
% Orthocladiinae + Tanytarsini of Chironomidae:	42.55	3
% Non-insects excluding Astacidae:	11.9	5
Diptera Taxa:	11	3
% Intolerant (0-3):	8.57	1
% Tolerant (8-10):	14.76	3
% Predators FFG 1:	36.19	5
% Shredders + Scrapers FFG 1:	11.9	3
% Collector-Filterers FFG 1:	13.81	3
% Sprawlers:	3.33	3
mIBI Metric Score:		**42**

Supplemental Metrics

HBI	5.63
Shannon-Weaver Index	3.69
Shannon Equitability	0.88
% Dominant 3 Taxon	23.33
% Chironomidae	22.38

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TAXON	COUNT	NOTES	HBI Tolerance
3599 (Peltodytes dunavani)	1		
3601 (Peltodytes lengi)	1		
3970 (Hydrocanthus iricolor)	1		
3846 (Berosus)	3	3L	7
3863 (Paracymus)	1	based on Florida Coleoptera character (claws)	
3872 (Tropisternus)	3	3L	
3877 (Tropisternus glaber)	1		
9217 (Enochrus pygmaeus)	3	3A	
3910 (Helochares maculicollis)	1		
1096 (SCIRTIDAE)	3	3L	5
7309 (Stenelmis crenata)	2	1m 1f? J20-001.2	5
9266 (Stenelmis grossa)	2	1m 1f? J20-001.1	
7295 (Ancyronyx variegatus)	1		4
7321 (Macronychus glabratus)	1	1A	3
3793 (Chauliodes rastricornis)	1		
3432 (Cheumatopsyche)	10		3
3473 (Hydropsyche alvata)	1		
1054 (HYDROPTILIDAE)	3	1 pupa, 2 imm.	4
1060 (LEPTOCERIDAE)	1	pupa	4
8926 (Oecetis)	1	tiny	3
8924 (Nectopsyche exquisita)	3	?	3
9370 (Ceratopogon grp.)	1		8
7984 (Procladius)	7		7
7926 (Tanypodinae (Subfamily))	1	pupa, no thoracic horn	
9261 (Thienemannimyia grp.)	1		
8112 (Dicrotendipes)	6	modestus? some neomodestus?	6
8221 (Pseudochironomus)	1		5
8228 (Cladotanytarsus)	4	2 pupae	4
8241 (Tanytarsus)	16		4
9277 (Polypedilum (Tripodura) scalaenum grp)	1		
9238 (Polypedilum (Uresipedilum) flavum)	4		
9241 (Polypedilum (Polypedilum) illinoense grp.)	6	1 pupa w/ last larval skin	

Residuals

Identifier	Date	Count	%PSE
MSG	8/31/2020	1	99.53

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OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Site Name	EPA ID	Macro Sample Type	Sample #	Macro Event #	Sample Date	County
WBU-18-0013	20T-009	MHAB	AB42968	200713803	7/13/20	Knox

Stream Name	Location	HUC 12	HUCTO14
Maria Creek	County Road 900 N	051201111802	05120111190020

Northing	Easting	Ecoregion	Gradient	Drainage Area	QHEI Score
4301141.36	469338.96	72	3.885	30.791	33

TAXON	COUNT	NOTES	HBI Tolerance
1084 (TURBELLARIA)	1		4
1233 (ERPOBDELLIDAE)	6		
1090 (Physa)	1		8
1210 (BIVALVIA)	2	>1 mm	
2156 (Corbicula fluminea)	2		6
1083 (ACARI)	4		4
9031 (Lirceus)	1		8
3081 (Callibaetis)	2	gills double G20-017.2	6
9361 (Caenis dimunata grp.)	4	one specimen with triad of dots less conspicuous	
1026 (COENAGRIONIDAE)	7		9
3540 (Ischnura)	3		9
7031 (Ischnura verticalis)	3		
3542 (Ischnura posita)	3		
3546 (Enallagma)	16	no gills or poorly developed pigment	9
3549 (Enallagma divagans)	37		
3557 (Enallagma civile)	1		
3560 (Enallagma basidens)	1		
1041 (CORIXIDAE)	3	nymph	5
7202 (Trichocorixa kanza)	1	1 adult female	4
1039 (BELOSTOMATIDAE)	1	nymph imm.	
7117 (Trepobates)	1	imm.	
7105 (Gerris marginatus)	1	adult male	
3600 (Peltodytes duodecimpunctatus)	1	1 adult	
3606 (Peltodytes litoralis)	1	1 adult, hind legs yellow	
3789 (Liodessus flavicollis)	1	1 adult	6
3854 (Berosus aculeatus)	1	1 adult female	
3959 (Helichus lithophilus)	1	1A	
9266 (Stenelmis grossa)	4	4 adults	
7296 (Dubiraphia)	1	1 larva	5
7300 (Dubiraphia vittata)	1	1 adult male, penis ~ 250 um, G20-017.4	
3899 (Helophorus)	1	1 adult G20-017.1	5
1073 (CHIRONOMIDAE(all other))	1		6

Type	Value	Metric Score
Total Taxa:	43	5
Total No. Individuals:	141	3
EPT Taxa:	2	1
% Orthocladiinae + Tanytarsini of Chironomidae:	25	3
% Non-insects excluding Astacidae:	12.06	5
Diptera Taxa:	12	3
% Intolerant (0-3):	0	1
% Tolerant (8-10):	19.86	3
% Predators FFG 1:	56.74	5
% Shredders + Scrapers FFG 1:	1.42	1
% Collector-Filterers FFG 1:	3.55	5
% Sprawlers:	2.13	1
mIBI Metric Score:		**36**

Supplemental Metrics

HBI	6.83
Shannon-Weaver Index	3.07
Shannon Equitability	0.82
% Dominant 3 Taxon	42.55
% Chironomidae	19.86

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TAXON	COUNT	NOTES	HBI Tolerance
7943 (Ablabesmyia)	1		5
7984 (Procladius)	2		7
8083 (Chironomini (Tribe))	2		
9248 (Ablabesmyia (Ablabesmyia) mallochi grp.)	1		
8104 (Cryptotendipes)	1		4
8112 (Dicrotendipes)	4		6
8228 (Cladotanytarsus)	3		4
8235 (Paratanytarsus)	2		4
8241 (Tanytarsus)	2		4
9278 (Polypedilum (Tripodura) halterale-simulans grp)	6		
9241 (Polypedilum (Polypedilum) illinoense grp.)	3		

Residuals

Identifier	Date	Count	%PSE
SEZ	8/11/2020	1	99.29

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OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Site Name	EPA ID	Macro Sample Type	Sample #	Macro Event #	Sample Date	County
WBU-18-0007	20T-004	MHAB	AB42961	200714703	7/14/20	Knox

Stream Name	Location	HUC 12	HUCTO14
Maria Creek	N Perry Road	051201111804	05120111190040

Northing	Easting	Ecoregion	Gradient	Drainage Area	QHEI Score
4295921.95	463720.13	72	1.971	78.969	28

TAXON	COUNT	NOTES	HBI Tolerance
1260 (NEMATODA)	2		6
1515 (Pristina aequiseta)	2		8
1517 (Pristina leidyi)	3		8
1561 (Nais communis/variabilis complex)	24	or pardalis?	
1553 (Tubificidae with pectinate chetae and hair chetae)	1	? or Pristinella sima?	
1555 (Tubificidae with bifid chetae and hair)	1		
1556 (NAIDIDAE w/bifid chetae + hair chetae)	3		
1565 (Aeolosoma)	1	?	8
1090 (Physa)	5		8
3048 (Stenacron)	2	interpunctatum colors	3
1012 (BAETIDAE)	1	callibaetis based on patterns/mouthparts	4
9129 (Acerpenna)	1	beat up, ID based on no villopore, labial palps	4
9366 (Baetis intercalaris complex)	4	J20-010.3	3
3079 (Paracloeodes minutus)	3		
3083 (Callibaetis floridanus)	4		
9347 (Procloeon viridoculare)	2	based on sternal patterns J20-010.2	
9361 (Caenis dimunata grp.)	11		
3175 (Tricorythodes)	7	one mangled	3
1020 (LIBELLULIDAE)	1	imm.	9
3397 (Macromia)	1	pacifica?	2
3542 (Ischnura posita)	1		
3549 (Enallagma divagans)	1		
3568 (Argia)	1	imm. no gills	5
1041 (CORIXIDAE)	64	imm.	5
7201 (Trichocorixa calva)	24	12f , 12m, some kanza?	4
7202 (Trichocorixa kanza)	4	all male	4
7203 (Trichocorixa sexcincta)	1	? female	4
7183 (Palmacorixa)	1	1 female	5
3600 (Peltodytes	1		

Type	Value	Metric Score
Total Taxa:	71	5
Total No. Individuals:	455	5
EPT Taxa:	13	5
% Orthocladiinae + Tanytarsini of Chironomidae:	14.17	5
% Non-insects excluding Astacidae:	9.23	5
Diptera Taxa:	30	5
% Intolerant (0-3):	4.84	1
% Tolerant (8-10):	7.91	5
% Predators FFG 1:	32.09	3
% Shredders + Scrapers FFG 1:	5.93	1
% Collector-Filterers FFG 1:	10.11	3
% Sprawlers:	10.55	5
mIBI Metric Score:		**48**

Supplemental Metrics

HBI	5.49
Shannon-Weaver Index	3.3
Shannon Equitability	0.77
% Dominant 3 Taxon	37.58
% Chironomidae	52.75

OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

TAXON	COUNT	NOTES	HBI Tolerance
duodecimpunctatus)			
3828 (Dineutus)	1	larva	4
3851 (Berosus peregrinus)	8		6
3872 (Tropisternus)	1	larva	
3879 (Enochrus)	2	larvae	
3884 (Enochrus ochraceus)	1	has some features of sublongus but that doesn't occur in Indiana	
1096 (SCIRTIDAE)	4	4L	5
7307 (Stenelmis)	1	larva	5
9266 (Stenelmis grossa)	6	5 males, 1 female J20 -010.1	
3432 (Cheumatopsyche)	2		3
9154 (Hydropsyche venularis)	2	?	3
3000 (Hydroptila)	3		3
8923 (Nectopsyche diarina)	1		3
7452 (Tipula)	1	Yamatotipula	7
7830 (Atrichopogon)	1		5
7843 (Dasyhelea)	1	Dasyhelea?	
1073 (CHIRONOMIDAE(all other))	1	unclear maybe P. halterale grp or orthoclad?	6
7984 (Procladius)	32		7
9153 (Tribelos)	1	fuscicorne?	5
8083 (Chironomini (Tribe))	9	1 pupae	
8227 (Tanytarsini (Tribe))	1	pupa, no abdomen, tanytarsus?	
9248 (Ablabesmyia (Ablabesmyia) mallochi grp.)	4		
9261 (Thienemannimyia grp.)	2		
8006 (Orthocladiinae (Subfamily)	1	O. dorenus?	
8086 (Chironomus)	24		8
8099 (Cryptochironomus)	13		5
8112 (Dicrotendipes)	75	4 pupae most modestus/neomodestus?	6
8126 (Glyptotendipes)	20		6
8179 (Polypedilum)	1	1 pupa? 1probably halterale grp, antennae obscured	
9165 (Saetheria tylus)	4		4
8206 (Stenochironomus)	1		4
8221 (Pseudochironomus)	1		5
8228 (Cladotanytarsus)	7	1 pupa?	4
8235 (Paratanytarsus)	1		4
8241 (Tanytarsus)	20	6 pupae	4
9260 (Cricotopus (Cricotopus) /Orthocladius (Orthocladius)	1	O. dorenus?	

OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

TAXON	COUNT	NOTES	HBI Tolerance
9277 (Polypedilum (Tripodura) scalaenum grp)	2		
9278 (Polypedilum (Tripodura) halterale-simulans grp)	6		
9238 (Polypedilum (Uresipedilum) flavum)	5		
9241 (Polypedilum (Polypedilum) illinoense grp.)	5		
9346 (Cricotopus (Cricotopus) tremulus grp)	3		
8274 (Stratiomys)	1		
8320 (Chrysops)	2		5

Residuals

Identifier	Date	Count	%PSE
MSG	9/1/2020	3	99.34

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OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Site Name	EPA ID	Macro Sample Type	Sample #	Macro Event #	Sample Date	County
WBU-18-0014	20T-015	MHAB	AB42966	200714804	7/14/20	Knox

Stream Name	Location	HUC 12	HUCTO14
Tributary of Maria Creek	Freelandville Road	051201111801	05120111190010

Northing	Easting	Ecoregion	Gradient	Drainage Area	QHEI Score
4303633.71	469396.62	72	7.362	2.96	24

TAXON	COUNT	NOTES	HBI Tolerance
1260 (NEMATODA)	1		6
1552 (Tubificidae with bifid chetae and no hair chetae)	4		
1234 (GLOSSIPHONIIDAE)	1		
1233 (ERPOBDELLIDAE)	4		
1090 (Physa)	40		8
1083 (ACARI)	1		4
1251 (ISOTOMIDAE)	1		
3048 (Stenacron)	1		3
3081 (Callibaetis)	2		6
9361 (Caenis dimunata grp.)	9	white globular stuff covering many specimens, fungi?	
3228 (Anax junius)	1	female nymph	
1026 (COENAGRIONIDAE)	3	small instars with under developed eye + gill pigmentation	9
3540 (Ischnura)	3	gills missing	9
7031 (Ischnura verticalis)	5		
3542 (Ischnura posita)	7		
1041 (CORIXIDAE)	2	nymphs	5
7201 (Trichocorixa calva)	3	1 male + 2 females	4
7105 (Gerris marginatus)	1	1 male	
3850 (Berosus pantherinus)	1	10 elytral spots	
3872 (Tropisternus)	1	larva	
3884 (Enochrus ochraceus)	1	male see slide G20-073	
1193 (CULICIDAE)	1		8
9369 (Bezzia grp.)	1		7
7984 (Procladius)	1		7
7926 (Tanypodinae (Subfamily))	1		
8227 (Tanytarsini (Tribe))	1		
8086 (Chironomus)	6		8
8112 (Dicrotendipes)	9		6
8123 (Endochironomus)	2		6
8235 (Paratanytarsus)	3		4
8241 (Tanytarsus)	1		4
9204 (Phaenopsectra/Tribelos)	1		
9241 (Polypedilum (Polypedilum) illinoense grp.)	1		

Type	Value	Metric Score
Total Taxa:	33	3
Total No. Individuals:	120	1
EPT Taxa:	3	3
% Orthocladiinae + Tanytarsini of Chironomidae:	19.23	5
% Non-insects excluding Astacidae:	42.5	1
Diptera Taxa:	12	3
% Intolerant (0-3):	0.83	1
% Tolerant (8-10):	44.17	1
% Predators FFG 1:	25	3
% Shredders + Scrapers FFG 1:	35.83	5
% Collector-Filterers FFG 1:	2.5	5
% Sprawlers:	0.83	1
mIBI Metric Score:		**32**

Supplemental Metrics

HBI	7.16
Shannon-Weaver Index	2.72
Shannon Equitability	0.78
% Dominant 3 Taxon	48.33
% Chironomidae	21.67

OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Residuals

Identifier	Date	Count	%PSE

OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Site Name	EPA ID	Macro Sample Type	Sample #	Macro Event #	Sample Date	County
WBU-18-0009	20T-006	MHAB	AB42962	200713801	7/13/20	Knox

Stream Name	Location	HUC 12	HUCTO14
Tilley Ditch	E Pepmeir Road	051201111802	05120111190020

Northing	Easting	Ecoregion	Gradient	Drainage Area	QHEI Score
4298547.08	468476.93	72	4.379	9.299	42

TAXON	COUNT	NOTES	HBI Tolerance
1498 (Nais)	2		8
1552 (Tubificidae with bifid chetae and no hair chetae)	2		
1087 (Ferrissia)	2	I accidently crushed shell of one	6
1090 (Physa)	17	some very small were crushed when picked up	8
1210 (BIVALVIA)	1	tiny	
2156 (Corbicula fluminea)	9		6
9031 (Lirceus)	1		8
9001 (Orconectes immunis)	8	females, form II males, or small instars	
1251 (ISOTOMIDAE)	2		
3048 (Stenacron)	2		3
1012 (BAETIDAE)	1	see slide G20-001.1+.2	4
3081 (Callibaetis)	4		6
3183 (Caenis)	4	possibly C. hillaris grp. triad of dots not apparent	3
9361 (Caenis dimunata grp.)	55		
3248 (Basiaeschna janata)	1		6
7025 (ZYGOPTERA)	1		
1026 (COENAGRIONIDAE)	77	very small instars, eye pattern poorly developed, or damaged	9
3540 (Ischnura)	8	no gills or gills poorly pigmented	9
7031 (Ischnura verticalis)	2		
3542 (Ischnura posita)	6		
3546 (Enallagma)	23	no gills or poorly developed	9
3549 (Enallagma divagans)	13		
3568 (Argia)	3	no gills	5
3569 (Argia apicalis)	1		
9095 (Argia fumipennis)	2		
1041 (CORIXIDAE)	4	nymphs	5
7208 (Belostoma flumineum)	1		4

Type	Value	Metric Score
Total Taxa:	61	5
Total No. Individuals:	465	5
EPT Taxa:	6	3
% Orthocladiinae + Tanytarsini of Chironomidae:	31.18	3
% Non-insects excluding Astacidae:	7.31	5
Diptera Taxa:	26	5
% Intolerant (0-3):	2.37	1
% Tolerant (8-10):	27.53	1
% Predators FFG 1:	16.34	1
% Shredders + Scrapers FFG 1:	6.02	1
% Collector-Filterers FFG 1:	8.17	5
% Sprawlers:	1.94	1
mIBI Metric Score:		**36**

Supplemental Metrics

HBI	6.66
Shannon-Weaver Index	3.04
Shannon Equitability	0.74
% Dominant 3 Taxon	48.17
% Chironomidae	40

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OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

TAXON	COUNT	NOTES	HBI Tolerance
7107 (Limnoporus canaliculatus)	1		
7145 (Mesovelia mulsanti)	1		
3600 (Peltodytes duodecimpunctatus)	5	some without sublateral elytral blotch	
3851 (Berosus peregrinus)	1		6
9266 (Stenelmis grossa)	3	2 females + 1 male; see slide G20-001.4	
7296 (Dubiraphia)	3	3 larvae	5
7300 (Dubiraphia vittata)	7	4 males + 3 females; G20-001.3 ~240 um	
3000 (Hydroptila)	4	2 withoug cases, may have lost one when spilled the vial	3
1073 (CHIRONOMIDAE(all other))	1		6
7964 (Labrundinia pilosella)	1		3
7984 (Procladius)	4		7
8083 (Chironomini (Tribe))	2		
8227 (Tanytarsini (Tribe))	1		
9248 (Ablabesmyia (Ablabesmyia) mallochi grp.)	2		
9261 (Thienemannimyia grp.)	1		
8006 (Orthocladiinae (Subfamily)	2		
8099 (Cryptochironomus)	4		5
8104 (Cryptotendipes)	2		4
8112 (Dicrotendipes)	92		6
8162 (Paracladopelma)	1		7
8166 (Paralauterborniella nigrohalterale)	1		
8179 (Polypedilum)	1		
8206 (Stenochironomus)	1		4
8228 (Cladotanytarsus)	9		4
8235 (Paratanytarsus)	13		4
8241 (Tanytarsus)	27		4
9260 (Cricotopus (Cricotopus) /Orthocladius (Orthocladius)	2		
9277 (Polypedilum (Tripodura) scalaenum grp)	2		
9278 (Polypedilum (Tripodura) halterale-simulans grp)	5		
9241 (Polypedilum (Polypedilum) illinoense grp.)	8		
9344 (Cricotopus (Cricotopus) bicinctus)	1		
9346 (Cricotopus (Cricotopus) tremulus grp)	3		
8355 (Tabanus)	1		5
1074 (EMPIDIDAE)	1		6

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OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Residuals

Identifier	Date	Count	%PSE
RAC	8/6/2020	6	98.71

OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Site Name	EPA ID	Macro Sample Type	Sample #	Macro Event #	Sample Date	County
WBU190-0002	20T-016	MHAB	AB42965	200714802	7/14/20	Knox

Stream Name	Location	HUC 12	HUCTO14
Maria Creek	CR 1050 N/Freelandville Road	051201111801	05120111190010

Northing	Easting	Ecoregion	Gradient	Drainage Area	QHEI Score
4303709.05	469930.39	72	5.282	17.468	38

TAXON	COUNT	NOTES	HBI Tolerance
1552 (Tubificidae with bifid chetae and no hair chetae)	1		
1090 (Physa)	7		8
1094 (Corbicula)	4		
9019 (Cambarus)	1	1F	2
8996 (Orconectes)	1	1F	4
3048 (Stenacron)	2	R20-045.2, L&R maxilla & mandible	3
3081 (Callibaetis)	1	R20-045.3 labium &proleg, R20-045.4 mandible	6
1013 (CAENIDAE)	3	imm.	7
9361 (Caenis dimunata grp.)	15		
3397 (Macromia)	1		2
7027 (Hetaerina americana)	1		
1026 (COENAGRIONIDAE)	1	imm.	9
3540 (Ischnura)	1	no gills	9
3542 (Ischnura posita)	1		
3546 (Enallagma)	2		9
3549 (Enallagma divagans)	35		
3560 (Enallagma basidens)	1		
3568 (Argia)	1	imm.	5
9095 (Argia fumipennis)	1		
3572 (Argia tibialis)	1		
7207 (Belostoma)	1	imm.	
7216 (Ranatra)	1	imm.	
7111 (Rheumatobates)	5	imm.	
7107 (Limnoporus canaliculatus)	1	1M	
7122 (Microvelia)	3	imm.	
3600 (Peltodytes duodecimpunctatus)	1		
3606 (Peltodytes litoralis)	1		
3851 (Berosus peregrinus)	8		6
9266 (Stenelmis grossa)	5	R20-045.1 genitalia & protarsus	
1057 (HYDROPSYCHIDAE)	1	imm.	4
3432 (Cheumatopsyche)	1		3
9154 (Hydropsyche venularis)	1		3
8818 (Oxyethira)	1		5
7964 (Labrundinia pilosella)	1		3
7984 (Procladius)	7		7

Type	Value	Metric Score
Total Taxa:	45	5
Total No. Individuals:	148	3
EPT Taxa:	8	5
% Orthocladiinae + Tanytarsini of Chironomidae:	11.11	5
% Non-insects excluding Astacidae:	8.11	5
Diptera Taxa:	12	3
% Intolerant (0-3):	4.73	1
% Tolerant (8-10):	7.43	5
% Predators FFG 1:	43.92	5
% Shredders + Scrapers FFG 1:	11.49	3
% Collector-Filterers FFG 1:	4.73	5
% Sprawlers:	4.73	3
mIBI Metric Score:		**48**

Supplemental Metrics

HBI	5.93
Shannon-Weaver Index	3.09
Shannon Equitability	0.81
% Dominant 3 Taxon	39.86
% Chironomidae	24.32

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TAXON	COUNT	NOTES	HBI Tolerance
7926 (Tanypodinae (Subfamily))	2		
8083 (Chironomini (Tribe))	9	1P	
9248 (Ablabesmyia (Ablabesmyia) mallochi grp.)	2		
8104 (Cryptotendipes)	1		4
8112 (Dicrotendipes)	8		6
8221 (Pseudochironomus)	1		5
8235 (Paratanytarsus)	3		4
8241 (Tanytarsus)	1		4
9278 (Polypedilum (Tripodura) halterale-simulans grp)	1		
8560 (SCIOMYZIDAE)	1		

Residuals

Identifier	Date	Count	%PSE

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OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Site Name	EPA ID	Macro Sample Type	Sample #	Macro Event #	Sample Date	County
WBU-18-0018	20T-017	MHAB	AB42964	200714801	7/14/20	Knox

Stream Name	Location	HUC 12	HUCTO14
Tributary of Maria Creek	County Road 700 E, Lane Road	051201111801	05120111190010

Northing	Easting	Ecoregion	Gradient	Drainage Area	QHEI Score
4302453.83	471021.92	72	6.761	4.37	44

TAXON	COUNT	NOTES	HBI Tolerance
1552 (Tubificidae with bifid chetae and no hair chetae)	1		
1204 (GASTROPODA)	2	tiny, ~ 1 mm long	7
1090 (Physa)	9		8
1083 (ACARI)	1		4
8996 (Orconectes)	1	female	4
1251 (ISOTOMIDAE)	2		
1012 (BAETIDAE)	1	no gills, possibly Calibaetis	4
9347 (Procloeon viridoculare)	3		
9361 (Caenis dimunata grp.)	4		
1026 (COENAGRIONIDAE)	2	tiny instars/ eye pigment poorly developed	9
3542 (Ischnura posita)	1		
3546 (Enallagma)	3	gills missing or poorly developed	9
3549 (Enallagma divagans)	28		
3568 (Argia)	1	gills missing	5
9095 (Argia fumipennis)	6		
1060 (LEPTOCERIDAE)	2	possibly Oecetus? tiny instars, ~ 1 mm long each	4
1073 (CHIRONOMIDAE(all other))	1		6
7964 (Labrundinia pilosella)	1		3
7984 (Procladius)	11		7
7926 (Tanypodinae (Subfamily))	2		
8083 (Chironomini (Tribe))	1		
8227 (Tanytarsini (Tribe))	3		
9246 (Ablabesmyia (Ablabesmyia))	2		
9248 (Ablabesmyia (Ablabesmyia) mallochi grp.)	6		
8086 (Chironomus)	11		8
8099 (Cryptochironomus)	8		5
8104 (Cryptotendipes)	8		4
8112 (Dicrotendipes)	38		6
9166 (Paracladopelma nereis)	1		
9335 (Paratendipes albimanus grp)	1		
8211 (Stictochironomus)	1		4

Type	Value	Metric Score
Total Taxa:	38	3
Total No. Individuals:	253	3
EPT Taxa:	4	5
% Orthocladiinae + Tanytarsini of Chironomidae:	44.62	3
% Non-insects excluding Astacidae:	5.14	5
Diptera Taxa:	22	5
% Intolerant (0-3):	0.4	1
% Tolerant (8-10):	9.88	5
% Predators FFG 1:	24.11	3
% Shredders + Scrapers FFG 1:	5.14	1
% Collector-Filterers FFG 1:	17.39	3
% Sprawlers:	7.51	5
mIBI Metric Score:		**42**

Supplemental Metrics

HBI	5.28
Shannon-Weaver Index	2.9
Shannon Equitability	0.8
% Dominant 3 Taxon	42.29
% Chironomidae	73.52

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TAXON	COUNT	NOTES	HBI Tolerance
8228 (Cladotanytarsus)	29		4
8235 (Paratanytarsus)	10		4
8241 (Tanytarsus)	40		4
9260 (Cricotopus (Cricotopus) /Orthocladius (Orthocladius)	1		
9277 (Polypedilum (Tripodura) scalaenum grp)	6		
9278 (Polypedilum (Tripodura) halterale-simulans grp)	4		
9241 (Polypedilum (Polypedilum) illinoense grp.)	1		

Residuals

Identifier	Date	Count	%PSE
SEZ	8/11/2020	15	94.07

OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Site Name	EPA ID	Macro Sample Type	Sample #	Macro Event #	Sample Date	County
WBU-18-0011	20T-008	MHAB	AB42969	200713804	7/13/20	Knox

Stream Name	Location	HUC 12	HUCTO14
Tributary of Maria Creek	County Road 900 N, E Lower Freelandville Road	051201111802	05120111190020

Northing	Easting	Ecoregion	Gradient	Drainage Area	QHEI Score
4301109.34	468757.52	72	12.542	3.055	34

TAXON	COUNT	NOTES	HBI Tolerance
1552 (Tubificidae with bifid chetae and no hair chetae)	1		
1090 (Physa)	6		8
9036 (Caecidotea)	1		8
8996 (Orconectes)	3		4
1251 (ISOTOMIDAE)	1		
3081 (Callibaetis)	8	one without gills but similar color pattern	6
9361 (Caenis dimunata grp.)	11	including one tiny instar (without conspicuous triad of dots)	
1026 (COENAGRIONIDAE)	7	tiny instars or eye pigment underdeveloped	9
3540 (Ischnura)	1	gills missing	9
7031 (Ischnura verticalis)	8		
3546 (Enallagma)	3	gill pigment poorly developed	9
3549 (Enallagma divagans)	4		
3560 (Enallagma basidens)	1		
3568 (Argia)	2	lateral gills missing	5
9095 (Argia fumipennis)	2		
7105 (Gerris marginatus)	2	1 male + 1 female	
7122 (Microvelia)	3	3 adults with wings	
7128 (Microvelia hinei)	4	4 apterous adults	
3600 (Peltodytes duodecimpunctatus)	1		
7296 (Dubiraphia)	1	male	5
9369 (Bezzia grp.)	1		7
7929 (Clinotanypus pinguis)	1		8
7964 (Labrundinia pilosella)	1		3
7984 (Procladius)	9		7
8086 (Chironomus)	1		8
8104 (Cryptotendipes)	5		4
8112 (Dicrotendipes)	14		6
8179 (Polypedilum)	2		
8235 (Paratanytarsus)	8		4

Type	Value	Metric Score
Total Taxa:	34	3
Total No. Individuals:	128	1
EPT Taxa:	2	3
% Orthocladiinae + Tanytarsini of Chironomidae:	19.64	5
% Non-insects excluding Astacidae:	6.25	5
Diptera Taxa:	13	3
% Intolerant (0-3):	0.78	1
% Tolerant (8-10):	15.63	3
% Predators FFG 1:	32.03	3
% Shredders + Scrapers FFG 1:	6.25	1
% Collector-Filterers FFG 1:	0	5
% Sprawlers:	7.03	5
mIBI Metric Score:		**38**

Supplemental Metrics

HBI	6.32
Shannon-Weaver Index	3.17
Shannon Equitability	0.9
% Dominant 3 Taxon	26.56
% Chironomidae	43.75

OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

TAXON	COUNT	NOTES	HBI Tolerance
9278 (Polypedilum (Tripodura) halterale-simulans grp)	8		
9241 (Polypedilum (Polypedilum) illinoense grp.)	4		
9344 (Cricotopus (Cricotopus) bicinctus)	1		
9346 (Cricotopus (Cricotopus) tremulus grp)	2		
9376 (Brachycera (Cyclorrhapha))	1	pupa in larval skin	

Residuals

Identifier	Date	Count	%PSE

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OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Site Name	EPA ID	Macro Sample Type	Sample #	Macro Event #	Sample Date	County
WBU-18-0016	20T-013	MHAB	AB42974	200715801	7/15/20	Sullivan

Stream Name	Location	HUC 12	HUCTO14
Marsh Creek	S County Road 50 E	051201111803	05120111190030

Northing	Easting	Ecoregion	Gradient	Drainage Area	QHEI Score
4308292.57	464999.74	72	5.502	8.376	37

TAXON	COUNT	NOTES	HBI Tolerance
1552 (Tubificidae with bifid chetae and no hair chetae)	1		
1555 (Tubificidae with bifid chetae and hair)	1		
1090 (Physa)	1		8
2156 (Corbicula fluminea)	4		6
8996 (Orconectes)	1	small female	4
1251 (ISOTOMIDAE)	1		
1012 (BAETIDAE)	1	no gills	4
3066 (Baetis intercalaris)	3		3
3081 (Callibaetis)	1		6
9361 (Caenis dimunata grp.)	21		
3397 (Macromia)	1		2
7027 (Hetaerina americana)	5		
1026 (COENAGRIONIDAE)	6	tiny instars	9
3542 (Ischnura posita)	5		
3546 (Enallagma)	7	gills missing or pigment poorly developed	9
3549 (Enallagma divagans)	17		
3560 (Enallagma basidens)	1		
9095 (Argia fumipennis)	4		
7105 (Gerris marginatus)	1	female	
3809 (Gyrinus)	2	larvae	4
3851 (Berosus peregrinus)	1	adult female	6
1096 (SCIRTIDAE)	3	larvae	5
9266 (Stenelmis grossa)	3	2 females + 1 male slide G20-066.2	
7296 (Dubiraphia)	1	larva	5
7300 (Dubiraphia vittata)	3	2 females + 1 male, penis ~ 275 um Slide G20-066.1	
3799 (Corydalus cornutus)	1	tiny instar	2
1057 (HYDROPSYCHIDAE)	3	tiny instars	4
3432 (Cheumatopsyche)	5		3
3473 (Hydropsyche alvata)	1		
8980 (Hydropsyche betteni grp)	3		
3000 (Hydroptila)	2		3
8922 (Nectopsyche candida)	2	or maybe N. exquisita	
7984 (Procladius)	3		7

Type	Value	Metric Score
Total Taxa:	55	5
Total No. Individuals:	179	3
EPT Taxa:	10	5
% Orthocladiinae + Tanytarsini of Chironomidae:	48.44	1
% Non-insects excluding Astacidae:	3.91	5
Diptera Taxa:	23	5
% Intolerant (0-3):	6.7	1
% Tolerant (8-10):	7.82	5
% Predators FFG 1:	29.05	3
% Shredders + Scrapers FFG 1:	4.47	1
% Collector-Filterers FFG 1:	11.73	3
% Sprawlers:	4.47	3
mIBI Metric Score:		**40**

Supplemental Metrics

HBI	5.17
Shannon-Weaver Index	3.56
Shannon Equitability	0.9
% Dominant 3 Taxon	27.93
% Chironomidae	35.75

OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

TAXON	COUNT	NOTES	HBI Tolerance
7926 (Tanypodinae (Subfamily))	1	1 pupa	
8082 (Chironominae (Subfamily))	1	1 pupa	
8083 (Chironomini (Tribe))	1		
9261 (Thienemannimyia grp.)	1		
8006 (Orthocladiinae (Subfamily)	1		
8099 (Cryptochironomus)	3		5
8112 (Dicrotendipes)	8		6
8179 (Polypedilum)	1		
9165 (Saetheria tylus)	2		4
8211 (Stictochironomus)	1		4
8228 (Cladotanytarsus)	4		4
8235 (Paratanytarsus)	12		4
8241 (Tanytarsus)	9		4
9260 (Cricotopus (Cricotopus) /Orthocladius (Orthocladius)	1		
9277 (Polypedilum (Tripodura) scalaenum grp)	4		
9278 (Polypedilum (Tripodura) halterale-simulans grp)	4		
9241 (Polypedilum (Polypedilum) illinoense grp.)	1		
9344 (Cricotopus (Cricotopus) bicinctus)	2		
8397 (Hemerodromia)	2		
1082 (MUSCIDAE)	1	1 larva	6

Residuals

Identifier	Date	Count	%PSE

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OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Site Name	EPA ID	Macro Sample Type	Sample #	Macro Event #	Sample Date	County
WBU-18-0015	20T-012	MHAB	AB42975	200715703	7/15/20	Knox

Stream Name	Location	HUC 12	HUCTO14
Marsh Creek	E Moody Road	051201111803	05120111190030

Northing	Easting	Ecoregion	Gradient	Drainage Area	QHEI Score
4305162.56	463398.79	72	2.932	12.234	25

TAXON	COUNT	NOTES	HBI Tolerance
1552 (Tubificidae with bifid chetae and no hair chetae)	6		
1556 (NAIDIDAE w/bifid chetae + hair chetae)	1		
1233 (ERPOBDELLIDAE)	1		
1091 (Lymnaea)	1		6
1090 (Physa)	5		8
1210 (BIVALVIA)	13		
2156 (Corbicula fluminea)	3	1 lost while placing in vial	6
1110 (EPHEMEROPTERA)	1	damaged - only head (Caenis?)	
1012 (BAETIDAE)	5	damaged	4
9361 (Caenis dimunata grp.)	37		
7031 (Ischnura verticalis)	1		
3542 (Ischnura posita)	2		
3546 (Enallagma)	3	no gills, likely E. divagans	9
3549 (Enallagma divagans)	3		
1041 (CORIXIDAE)	43	nymphs	5
7201 (Trichocorixa calva)	62	adults (24 males, 38 females)	4
7202 (Trichocorixa kanza)	6	adults (3 males, 3 females)	4
7111 (Rheumatobates)	6	1 winged female, 5 nymphs	
3600 (Peltodytes duodecimpunctatus)	4	adults (2F, 1M, 1?); males with genitalia in small vial	
3604 (Peltodytes sexmaculatus)	1	adult	
3606 (Peltodytes litoralis)	2	adults	
3851 (Berosus peregrinus)	1	adult	6
7300 (Dubiraphia vittata)	3	S20-018 (PL = 255 um); adults (2M and 1F)	
9370 (Ceratopogon grp.)	1		8
7974 (Pentaneura inconspicua)	1		5
7984 (Procladius)	21		7
8083 (Chironomini (Tribe))	2		
9248 (Ablabesmyia (Ablabesmyia) mallochi grp.)	1		
9261 (Thienemannimyia grp.)	1		

Type	Value	Metric Score
Total Taxa:	41	5
Total No. Individuals:	298	5
EPT Taxa:	3	1
% Orthocladiinae + Tanytarsini of Chironomidae:	25.29	3
% Non-insects excluding Astacidae:	10.07	5
Diptera Taxa:	18	5
% Intolerant (0-3):	0	1
% Tolerant (8-10):	3.36	5
% Predators FFG 1:	51.68	5
% Shredders + Scrapers FFG 1:	2.35	1
% Collector-Filterers FFG 1:	5.03	5
% Sprawlers:	8.39	5
mIBI Metric Score:		**46**

Supplemental Metrics

HBI	5.02
Shannon-Weaver Index	2.84
Shannon Equitability	0.76
% Dominant 3 Taxon	47.65
% Chironomidae	29.19

OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

TAXON	COUNT	NOTES	HBI Tolerance
8086 (Chironomus)	1		8
8099 (Cryptochironomus)	4		5
8104 (Cryptotendipes)	4		4
8112 (Dicrotendipes)	22		6
8221 (Pseudochironomus)	1		5
8228 (Cladotanytarsus)	8		4
8235 (Paratanytarsus)	1		4
9221 (Stempellina)	1		
8241 (Tanytarsus)	12		4
9235 (Polypedilum (Tripodura))	1		
9278 (Polypedilum (Tripodura) halterale-simulans grp)	3		
9241 (Polypedilum (Polypedilum) illinoense grp.)	3		

Residuals

Identifier	Date	Count	%PSE
SEZ	9/1/2020	7	97.65

OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Site Name	EPA ID	Macro Sample Type	Sample #	Macro Event #	Sample Date	County
WBU-18-0014	20T-015	MHAB	AB42981	200714805	7/14/20	Knox

Stream Name	Location	HUC 12	HUCTO14
Tributary of Maria Creek	Freelandville Road	051201111801	05120111190010

Northing	Easting	Ecoregion	Gradient	Drainage Area	QHEI Score
4303633.71	469396.62	72	7.362	2.96	23

TAXON	COUNT	NOTES	HBI Tolerance
1552 (Tubificidae with bifid chetae and no hair chetae)	2		
1234 (GLOSSIPHONIIDAE)	1		
1233 (ERPOBDELLIDAE)	4		
1090 (Physa)	26		8
9031 (Lirceus)	1		8
1012 (BAETIDAE)	2	gills missing	4
3081 (Callibaetis)	1		6
9347 (Procloeon viridoculare)	1		
9361 (Caenis dimunata grp.)	30		
1026 (COENAGRIONIDAE)	2	eye pigmentation poorly developed	9
3540 (Ischnura)	4	gills missing or poorly developed	9
3542 (Ischnura posita)	8		
1041 (CORIXIDAE)	1	nymph	5
7201 (Trichocorixa calva)	3	females	4
3851 (Berosus peregrinus)	1	adult	6
3863 (Paracymus)	1		
3872 (Tropisternus)	1	larva	
9217 (Enochrus pygmaeus)	2	1 male + 1 female	
7984 (Procladius)	1		7
9248 (Ablabesmyia (Ablabesmyia) mallochi grp.)	2		
9261 (Thienemannimyia grp.)	2		
8112 (Dicrotendipes)	9		6
8179 (Polypedilum)	1		
8228 (Cladotanytarsus)	4		4
8235 (Paratanytarsus)	3		4
8241 (Tanytarsus)	1		4
9278 (Polypedilum (Tripodura) halterale-simulans grp)	2		
9241 (Polypedilum (Polypedilum) illinoense grp.)	4		

Type	Value	Metric Score
Total Taxa:	28	3
Total No. Individuals:	120	1
EPT Taxa:	4	5
% Orthocladiinae + Tanytarsini of Chironomidae:	27.59	3
% Non-insects excluding Astacidae:	28.33	3
Diptera Taxa:	10	3
% Intolerant (0-3):	0	1
% Tolerant (8-10):	27.5	1
% Predators FFG 1:	18.33	3
% Shredders + Scrapers FFG 1:	23.33	5
% Collector-Filterers FFG 1:	0.83	5
% Sprawlers:	0.83	1
mIBI Metric Score:		**34**

Supplemental Metrics

HBI	6.78
Shannon-Weaver Index	2.61
Shannon Equitability	0.78
% Dominant 3 Taxon	54.17
% Chironomidae	24.17

Residuals

Identifier	Date	Count	%PSE

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OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Site Name	EPA ID	Macro Sample Type	Sample #	Macro Event #	Sample Date	County
WBU-18-0020	20T-019	MHAB	AB42963	200715803	7/15/20	Sullivan

Stream Name	Location	HUC 12	HUCTO14
Maria Creek	E County Road 975 S	051201111801	05120111190010

Northing	Easting	Ecoregion	Gradient	Drainage Area	QHEI Score
4309677.15	471987.13	72	7.687	7.331	64

TAXON	COUNT	NOTES	HBI Tolerance
1552 (Tubificidae with bifid chetae and no hair chetae)	1		
2156 (Corbicula fluminea)	3		6
1083 (ACARI)	1		4
8996 (Orconectes)	4	females + form II males	4
1012 (BAETIDAE)	3	damaged instars	4
7011 (Acerpenna pygmaea)	16		2
3066 (Baetis intercalaris)	5		3
9361 (Caenis dimunata grp.)	23		
1120 (ANISOPTERA)	1	tiny instar ~ 1.5 mm long	
3397 (Macromia)	2		2
1026 (COENAGRIONIDAE)	6	tiny instars with poorly developed eye pigment	9
3542 (Ischnura posita)	1		
3546 (Enallagma)	1	gills missing	9
3549 (Enallagma divagans)	9		
3571 (Argia sedula)	6	or A. fumipennis?	
7111 (Rheumatobates)	1	nymph	
7117 (Trepobates)	2	female	
7120 (Trepobates pictus)	1	1 male + 1 female	
7307 (Stenelmis)	7	larvae	5
9266 (Stenelmis grossa)	20	adults, 9 females + 11 males, slides G20-061.2 +.3	
7296 (Dubiraphia)	13	adults 7 females + 6 males, G20-061.1 penis ~270 um	5
7321 (Macronychus glabratus)	1	adult	3
3432 (Cheumatopsyche)	18		3
8980 (Hydropsyche betteni grp)	1		
1054 (HYDROPTILIDAE)	1	dorsoventrally compressed with cylindrical case	4
8945 (Triaenodes nox)	2		
7943 (Ablabesmyia)	1		5
7984 (Procladius)	1		7
7926 (Tanypodinae (Subfamily))	1	1 pupa	

Type	Value	Metric Score
Total Taxa:	47	5
Total No. Individuals:	195	3
EPT Taxa:	8	5
% Orthocladiinae + Tanytarsini of Chironomidae:	42.22	3
% Non-insects excluding Astacidae:	2.56	5
Diptera Taxa:	21	5
% Intolerant (0-3):	21.54	3
% Tolerant (8-10):	3.59	5
% Predators FFG 1:	15.38	1
% Shredders + Scrapers FFG 1:	4.62	1
% Collector-Filterers FFG 1:	15.9	3
% Sprawlers:	3.08	3
mIBI Metric Score:		**42**

Supplemental Metrics

HBI	4.22
Shannon-Weaver Index	3.27
Shannon Equitability	0.85
% Dominant 3 Taxon	31.28
% Chironomidae	23.08

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TAXON	COUNT	NOTES	HBI Tolerance
8082 (Chironominae (Subfamily))	1	1 pupa	
8083 (Chironomini (Tribe))	1		
8227 (Tanytarsini (Tribe))	1		
9248 (Ablabesmyia (Ablabesmyia) mallochi grp.)	1		
8023 (Cricotopus bicinctus)	1		7
9284 (Tribelos jucundus)	1		
8099 (Cryptochironomus)	4		5
8104 (Cryptotendipes)	3		4
8112 (Dicrotendipes)	5		6
8206 (Stenochironomus)	1		4
8221 (Pseudochironomus)	1		5
8228 (Cladotanytarsus)	4		4
8235 (Paratanytarsus)	4		4
8241 (Tanytarsus)	9		4
9278 (Polypedilum (Tripodura) halterale-simulans grp)	2		
9238 (Polypedilum (Uresipedilum) flavum)	1		
9241 (Polypedilum (Polypedilum) illinoense grp.)	2		
1078 (TABANIDAE)	1		6

Residuals

Identifier	Date	Count	%PSE

OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Site Name	EPA ID	Macro Sample Type	Sample #	Macro Event #	Sample Date	County
WBU-18-0019	20T-018	MHAB	AB42972	200715802	7/15/20	Sullivan

Stream Name	Location	HUC 12	HUCTO14
Maria Creek	E County Road 1050 S	051201111801	05120111190010

Northing	Easting	Ecoregion	Gradient	Drainage Area	QHEI Score
4308436.12	471123.9	72	8.775	10.192	45

TAXON	COUNT	NOTES	HBI Tolerance
1552 (Tubificidae with bifid chetae and no hair chetae)	1		
1087 (Ferrissia)	1		6
1090 (Physa)	8		8
1210 (BIVALVIA)	2	tiny	
2156 (Corbicula fluminea)	24		6
1083 (ACARI)	3		4
8996 (Orconectes)	13	Females + Form II males	4
7011 (Acerpenna pygmaea)	5		2
3065 (Baetis)	3		3
9366 (Baetis intercalaris complex)	6	G20-020.1	3
9347 (Procloeon viridoculare)	2		
9361 (Caenis dimunata grp.)	33		
3116 (Progomphus obscurus)	2		
3397 (Macromia)	6		2
3448 (Somatochlora)	1		1
7025 (ZYGOPTERA)	3		
7026 (Calopteryx maculata)	2		
1026 (COENAGRIONIDAE)	67	tiny instars or eye pigment underdeveloped	9
7031 (Ischnura verticalis)	1		
3546 (Enallagma)	11	lateral gills missing or underdeveloped	9
3549 (Enallagma divagans)	22		
3568 (Argia)	2	gills missing or underdeveloped	5
3569 (Argia apicalis)	1		
3571 (Argia sedula)	14		
7111 (Rheumatobates)	1	nymph, tiny instar	
7122 (Microvelia)	2	nymphs	
3600 (Peltodytes duodecimpunctatus)	2		
7307 (Stenelmis)	4	larvae	5
9266 (Stenelmis grossa)	21	adults; 10 males + 11 females; see slides G20-020.3+.4	
7296 (Dubiraphia)	3	larvae	5
7300 (Dubiraphia vittata)	4	adults, 2 females	

Type	Value	Metric Score
Total Taxa:	56	5
Total No. Individuals:	432	5
EPT Taxa:	8	5
% Orthocladiinae + Tanytarsini of Chironomidae:	67.52	1
% Non-insects excluding Astacidae:	9.03	5
Diptera Taxa:	21	5
% Intolerant (0-3):	5.79	1
% Tolerant (8-10):	19.91	3
% Predators FFG 1:	18.75	3
% Shredders + Scrapers FFG 1:	3.01	1
% Collector-Filterers FFG 1:	18.98	3
% Sprawlers:	3.7	3
mIBI Metric Score:		**40**

Supplemental Metrics

HBI	5.73
Shannon-Weaver Index	3.2
Shannon Equitability	0.79
% Dominant 3 Taxon	35.19
% Chironomidae	36.34

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TAXON	COUNT	NOTES	HBI Tolerance
		+ 2 males; G20-020.2 ~260 um	
7321 (Macronychus glabratus)	1	adult	3
1160 (TRICHOPTERA)	1	probably very small Hydropsychid instar without gills	
8937 (Triaenodes)	1	tiny instar	
8926 (Oecetis)	1	tiny instar	3
9369 (Bezzia grp.)	1		7
1073 (CHIRONOMIDAE(all other))	1		6
7984 (Procladius)	13		7
9153 (Tribelos)	1		5
8082 (Chironominae (Subfamily))	1		
8083 (Chironomini (Tribe))	3		
8227 (Tanytarsini (Tribe))	3		
9248 (Ablabesmyia (Ablabesmyia) mallochi grp.)	2		
9284 (Tribelos jucundus)	2		
8074 (Thienemanniella)	1		4
8099 (Cryptochironomus)	1		5
8104 (Cryptotendipes)	3		4
8112 (Dicrotendipes)	17		6
8167 (Paratendipes)	1		6
9165 (Saetheria tylus)	3		4
8228 (Cladotanytarsus)	27		4
8235 (Paratanytarsus)	21		4
8238 (Rheotanytarsus)	2		3
8241 (Tanytarsus)	52		4
9278 (Polypedilum (Tripodura) halterale-simulans grp)	1		
9241 (Polypedilum (Polypedilum) illinoense grp.)	2		

Residuals

Identifier	Date	Count	%PSE
SEZ	8/11/2020	6	98.61

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OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Site Name	EPA ID	Macro Sample Type	Sample #	Macro Event #	Sample Date	County
WBU-18-0010	20T-007	MHAB	AB42970	200713802	7/13/20	Knox

Stream Name	Location	HUC 12	HUCTO14
Tributary of Maria Creek	County Road 700 E, Lane Road	051201111802	05120111190020

Northing	Easting	Ecoregion	Gradient	Drainage Area	QHEI Score
4300729.19	470997.09	72	9.923	2.623	29

TAXON	COUNT	NOTES	HBI Tolerance
1233 (ERPOBDELLIDAE)	5		
1204 (GASTROPODA)	2	tiny, with crushed shells	7
1090 (Physa)	9		8
1083 (ACARI)	4	some with strange abdominal constriction, Arreneus?	4
9001 (Orconectes immunis)	2	form II male	
1251 (ISOTOMIDAE)	1		
3245 (Boyeria vinosa)	1		4
3305 (Erythemis simplicicollis)	8	tiny instars	
1026 (COENAGRIONIDAE)	2	small instars with underdeveloped eye pigment	9
3540 (Ischnura)	4	gills missing or poorly developed	9
7031 (Ischnura verticalis)	6		
3542 (Ischnura posita)	2		
3568 (Argia)	1	gills missing	5
9095 (Argia fumipennis)	3		
7201 (Trichocorixa calva)	2	2 females	4
7230 (Neoplea striola)	1		
7207 (Belostoma)	1	nymph	
7208 (Belostoma flumineum)	1	male with eggs	4
3600 (Peltodytes duodecimpunctatus)	2		
3846 (Berosus)	1	larva	7
3872 (Tropisternus)	1	larva	
9216 (Tropisternus lateralis)	1	adult	
3879 (Enochrus)	1	larva	
9217 (Enochrus pygmaeus)	2	adults, 1 male + 1 female	
7300 (Dubiraphia vittata)	1	male, G20-049, penis ~255 um	
7321 (Macronychus glabratus)	1	adult	3
3899 (Helophorus)	1	adult	5
1077 (CERATOPOGONIDAE)	1		6
9369 (Bezzia grp.)	10		7
9370 (Ceratopogon grp.)	5		8
1073 (CHIRONOMIDAE(all other))	2		6

Type	Value	Metric Score
Total Taxa:	40	3
Total No. Individuals:	108	1
EPT Taxa:	0	1
% Orthocladiinae + Tanytarsini of Chironomidae:	15.38	5
% Non-insects excluding Astacidae:	18.52	3
Diptera Taxa:	13	3
% Intolerant (0-3):	0.93	1
% Tolerant (8-10):	18.52	3
% Predators FFG 1:	50.93	5
% Shredders + Scrapers FFG 1:	11.11	3
% Collector-Filterers FFG 1:	2.78	5
% Sprawlers:	4.63	3
mIBI Metric Score:		**36**

Supplemental Metrics

HBI	6.25
Shannon-Weaver Index	3.3
Shannon Equitability	0.89
% Dominant 3 Taxon	29.63
% Chironomidae	24.07

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TAXON	COUNT	NOTES	HBI Tolerance
7965 (Larsia)	2		4
7984 (Procladius)	2		7
8227 (Tanytarsini (Tribe))	1		
8112 (Dicrotendipes)	1		6
8221 (Pseudochironomus)	13		5
8228 (Cladotanytarsus)	2		4
8235 (Paratanytarsus)	1		4
9277 (Polypedilum (Tripodura) scalaenum grp)	1		
9278 (Polypedilum (Tripodura) halterale-simulans grp)	1		

Residuals

Identifier	Date	Count	%PSE
SEZ	8/11/2020	0	100

OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Site Name	EPA ID	Macro Sample Type	Sample #	Macro Event #	Sample Date	County
WBU-18-0006	20T-003	MHAB	AB42978	200714702	7/14/20	Knox

Stream Name	Location	HUC 12	HUCTO14
Cotton Branch	E Springtown Road	051201111804	05120111190040

Northing	Easting	Ecoregion	Gradient	Drainage Area	QHEI Score
4295210.91	462069.86	72	9.645	3.133	63

TAXON	COUNT	NOTES	HBI Tolerance
1091 (Lymnaea)	2	2 different species? is one a hydroboid w/out operculum?	6
1090 (Physa)	1		8
9031 (Lirceus)	9		8
8996 (Orconectes)	1	f	4
1017 (HEPTAGENIIDAE)	1	Stenacron or Stenonema?	4
7011 (Acerpenna pygmaea)	1		2
7025 (ZYGOPTERA)	1	Coenagrionidae?	
3551 (Enallagma exsulans)	1		
9095 (Argia fumipennis)	1		
1041 (CORIXIDAE)	1	nymph, big swimming hairs on back legs	5
3809 (Gyrinus)	1	1L	4
1096 (SCIRTIDAE)	4	4L	5
7321 (Macronychus glabratus)	1	1A	3
7732 (Anopheles)	3		
7984 (Procladius)	3		7
9153 (Tribelos)	2	fuscicorne?	5
9248 (Ablabesmyia (Ablabesmyia) mallochi grp.)	1		
8006 (Orthocladiinae (Subfamily)	1	3 median teeth, imm. smittia?	
8011 (Brillia flavifrons)	1		
8086 (Chironomus)	6		8
8112 (Dicrotendipes)	1		6
9335 (Paratendipes albimanus grp)	1		
9353 (Phaenopsectra punctipes grp)	1	Ph. flavipes?	
8228 (Cladotanytarsus)	1		4
8241 (Tanytarsus)	1		4
9277 (Polypedilum (Tripodura) scalaenum grp)	1		
9241 (Polypedilum (Polypedilum) illinoense grp.)	8		

Type	Value	Metric Score
Total Taxa:	27	3
Total No. Individuals:	56	1
EPT Taxa:	2	3
% Orthocladiinae + Tanytarsini of Chironomidae:	14.29	5
% Non-insects excluding Astacidae:	21.43	3
Diptera Taxa:	14	5
% Intolerant (0-3):	3.57	1
% Tolerant (8-10):	28.57	1
% Predators FFG 1:	12.5	1
% Shredders + Scrapers FFG 1:	14.29	3
% Collector-Filterers FFG 1:	7.14	5
% Sprawlers:	5.36	3
mIBI Metric Score:		**34**

Supplemental Metrics

HBI	6.31
Shannon-Weaver Index	2.92
Shannon Equitability	0.89
% Dominant 3 Taxon	41.07
% Chironomidae	50

Residuals

Identifier	Date	Count	%PSE

SEZ	9/1/2020	0	100

OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Site Name	EPA ID	Macro Sample Type	Sample #	Macro Event #	Sample Date	County
WBU190-0002	20T-016	MHAB	AB42982	200714803	7/14/20	Knox

Stream Name	Location	HUC 12	HUCTO14
Maria Creek	CR 1050 N/Freelandville Road	051201111801	05120111190010

Northing	Easting	Ecoregion	Gradient	Drainage Area	QHEI Score
4303709.05	469930.39	72	5.282	17.468	38

TAXON	COUNT	NOTES	HBI Tolerance
1090 (Physa)	4	2 imm.	8
1094 (Corbicula)	2		
1083 (ACARI)	1		4
8996 (Orconectes)	1	1F	4
3081 (Callibaetis)	3	Slide R20-007.1 & R20-007.2 labial palp and mandible	6
9347 (Procloeon viridoculare)	1	Slide R20-007.3 labial palp & mandible	
3183 (Caenis)	5	imm.	3
9361 (Caenis dimunata grp.)	13		
9362 (Caenis hilaris grp.)	1		
3397 (Macromia)	3		2
1026 (COENAGRIONIDAE)	1	imm.	9
3540 (Ischnura)	1	no gills	9
3546 (Enallagma)	5		9
3549 (Enallagma divagans)	18		
3551 (Enallagma exsulans)	1		
3560 (Enallagma basidens)	1		
3568 (Argia)	2	imm.	5
3569 (Argia apicalis)	1		
1041 (CORIXIDAE)	1		5
1038 (GERRIDAE)	1	imm.	
7107 (Limnoporus canaliculatus)	2		
7122 (Microvelia)	4		
7145 (Mesovelia mulsanti)	1		
3600 (Peltodytes duodecimpunctatus)	2		
3601 (Peltodytes lengi)	2	2A	
3604 (Peltodytes sexmaculatus)	5	5A	
3846 (Berosus)	1	1L	7
3851 (Berosus peregrinus)	6	6A	6
1096 (SCIRTIDAE)	3	3L	5
7307 (Stenelmis)	3	1AF, 2L	5
7300 (Dubiraphia vittata)	3	1M 2F, R20-007.4 250um	
9369 (Bezzia grp.)	3		7
7964 (Labrundinia pilosella)	1		3
7984 (Procladius)	10		7
8083 (Chironomini (Tribe))	2	1P	
9248 (Ablabesmyia	5		

Type	Value	Metric Score
Total Taxa:	46	5
Total No. Individuals:	159	3
EPT Taxa:	5	3
% Orthocladiinae + Tanytarsini of Chironomidae:	24.14	3
% Non-insects excluding Astacidae:	4.4	5
Diptera Taxa:	15	5
% Intolerant (0-3):	5.66	1
% Tolerant (8-10):	6.92	5
% Predators FFG 1:	34.59	3
% Shredders + Scrapers FFG 1:	10.69	3
% Collector-Filterers FFG 1:	4.4	5
% Sprawlers:	7.55	5
mIBI Metric Score:		**46**

Supplemental Metrics

HBI	5.68
Shannon-Weaver Index	3.35
Shannon Equitability	0.87
% Dominant 3 Taxon	32.7
% Chironomidae	36.48

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OWQ/WAPB Macroinvertebrate Community Assessment
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TAXON	COUNT	NOTES	HBI Tolerance
(Ablabesmyia) mallochi grp.)			
8017 (Corynoneura)	1		4
8023 (Cricotopus bicinctus)	1		7
8099 (Cryptochironomus)	1		5
8112 (Dicrotendipes)	21		6
8206 (Stenochironomus)	1		4
8221 (Pseudochironomus)	1		5
8228 (Cladotanytarsus)	2		4
8235 (Paratanytarsus)	5		4
8241 (Tanytarsus)	5		4
9278 (Polypedilum (Tripodura) halterale-simulans grp)	2		

Residuals

Identifier	Date	Count	%PSE
MSG	12/1/2020	5	96.86

OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Site Name	EPA ID	Macro Sample Type	Sample #	Macro Event #	Sample Date	County
WBU-18-0008	20T-005	MHAB	AB42977	200715701	7/15/20	Knox

Stream Name	Location	HUC 12	HUCTO14
Maria Creek	N Risley Road	051201111802	05120111190020

Northing	Easting	Ecoregion	Gradient	Drainage Area	QHEI Score
4297182.92	466001.32	72	1.971	49.206	30

TAXON	COUNT	NOTES	HBI Tolerance
1090 (Physa)	1		8
1083 (ACARI)	1		4
1012 (BAETIDAE)	1	damaged	4
9361 (Caenis dimunata grp.)	8		
1120 (ANISOPTERA)	1	early instar; Corduliidae or Libellulidae	
3540 (Ischnura)	1	no gills	9
3546 (Enallagma)	7	no gills	9
3549 (Enallagma divagans)	3		
3560 (Enallagma basidens)	2		
1041 (CORIXIDAE)	64	wingless/nymphs	5
7201 (Trichocorixa calva)	27	adults (12M and 15F)	4
7202 (Trichocorixa kanza)	17	adults (8M and 9F)	4
7230 (Neoplea striola)	1		
7122 (Microvelia)	2	nymph	
3600 (Peltodytes duodecimpunctatus)	1	adults (1F)	
3601 (Peltodytes lengi)	2	adults (2F)	
3604 (Peltodytes sexmaculatus)	1	adult (1F)	
3606 (Peltodytes litoralis)	1	adult	
3851 (Berosus peregrinus)	4		6
1096 (SCIRTIDAE)	2	larvae	5
7300 (Dubiraphia vittata)	2	adults (1M and 1F); S20-004.1 (PL = 250 um)	
3000 (Hydroptila)	2	1 not final instar, but with 3 posterior gills	3
7830 (Atrichopogon)	1		5
9370 (Ceratopogon grp.)	4		8
7984 (Procladius)	23		7
8083 (Chironomini (Tribe))	1		
9248 (Ablabesmyia (Ablabesmyia) mallochi grp.)	3		
8086 (Chironomus)	2		8
8099 (Cryptochironomus)	2		5
8112 (Dicrotendipes)	1		6
8228 (Cladotanytarsus)	9		4
8235 (Paratanytarsus)	1		4
8241 (Tanytarsus)	16		4

Type	Value	Metric Score
Total Taxa:	37	3
Total No. Individuals:	218	3
EPT Taxa:	3	1
% Orthocladiinae + Tanytarsini of Chironomidae:	44.07	3
% Non-insects excluding Astacidae:	0.92	5
Diptera Taxa:	15	5
% Intolerant (0-3):	0.92	1
% Tolerant (8-10):	6.88	5
% Predators FFG 1:	70.18	5
% Shredders + Scrapers FFG 1:	4.13	1
% Collector-Filterers FFG 1:	7.8	5
% Sprawlers:	12.39	5
mIBI Metric Score:		**42**

Supplemental Metrics

HBI	5.15
Shannon-Weaver Index	2.64
Shannon Equitability	0.73
% Dominant 3 Taxon	52.29
% Chironomidae	27.06

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TAXON	COUNT	NOTES	HBI Tolerance
9278 (Polypedilum (Tripodura) halterale-simulans grp)	1		
9294 (Myxosargus)	1	early instar	
8301 (Odontomyia)	1	cool!	
8274 (Stratiomys)	1		

Residuals

Identifier	Date	Count	%PSE
MSG	8/14/2020	0	100

OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

Site Name	EPA ID	Macro Sample Type	Sample #	Macro Event #	Sample Date	County
WBU-18-0004	20T-001	MHAB	AB42979	200714701	7/14/20	Knox

Stream Name	Location	HUC 12	HUCTO14
Maria Creek	N Old 41	051201111804	05120111190040

Northing	Easting	Ecoregion	Gradient	Drainage Area	QHEI Score
4291744.55	458932.16	72	3.217	90.629	55

TAXON	COUNT	NOTES	HBI Tolerance
1090 (Physa)	2		8
2156 (Corbicula fluminea)	1		6
1017 (HEPTAGENIIDAE)	1	missing abdomen and all legs	4
3048 (Stenacron)	1		3
9366 (Baetis intercalaris complex)	3	Slide S20-011.3	3
9361 (Caenis dimunata grp.)	1		
3175 (Tricorythodes)	3		3
3397 (Macromia)	1		2
1026 (COENAGRIONIDAE)	1	immature - 5 segment atennae	9
3568 (Argia)	3	missing gills, immature	5
1041 (CORIXIDAE)	6	nymphs	5
7201 (Trichocorixa calva)	27	21 males and 6 females (adults)	4
7202 (Trichocorixa kanza)	6	4 males and 2 females (adults)	4
7116 (Metrobates hesperius)	5		
3874 (Tropisternus mixtus)	1	adult	
1096 (SCIRTIDAE)	1	larva	5
7307 (Stenelmis)	1	larva	5
9266 (Stenelmis grossa)	8	adults (3F and 5M); Slide S20-011.1	
7295 (Ancyronyx variegatus)	2	adults	4
7321 (Macronychus glabratus)	1	adult female	3
3799 (Corydalus cornutus)	1		2
3432 (Cheumatopsyche)	11		3
3473 (Hydropsyche alvata)	12		
3000 (Hydroptila)	1		3
8837 (Neureclipsis crepuscularis)	1	S20-011.2	
7984 (Procladius)	1		7
9250 (Ablabesmyia (Ablabesmyia) rhamphae grp.)	1		
9261 (Thienemannimyia grp.)	2		
8099 (Cryptochironomus)	1		5
8126 (Glyptotendipes)	2		6
8184 (Polypedilum fallax)	1		
9165 (Saetheria tylus)	1		4
8206 (Stenochironomus)	1		4

Type	Value	Metric Score
Total Taxa:	39	3
Total No. Individuals:	162	3
EPT Taxa:	9	3
% Orthocladiinae + Tanytarsini of Chironomidae:	9.84	5
% Non-insects excluding Astacidae:	1.85	5
Diptera Taxa:	14	5
% Intolerant (0-3):	14.2	1
% Tolerant (8-10):	1.85	5
% Predators FFG 1:	31.48	3
% Shredders + Scrapers FFG 1:	4.32	1
% Collector-Filterers FFG 1:	11.73	3
% Sprawlers:	1.23	1
mIBI Metric Score:		**38**

Supplemental Metrics

HBI	4.11
Shannon-Weaver Index	2.87
Shannon Equitability	0.78
% Dominant 3 Taxon	47.53
% Chironomidae	37.65

A82

OWQ/WAPB Macroinvertebrate Community Assessment MHAB Report

TAXON	COUNT	NOTES	HBI Tolerance
8235 (Paratanytarsus)	1		4
8238 (Rheotanytarsus)	1		3
8241 (Tanytarsus)	4		4
9278 (Polypedilum (Tripodura) halterale-simulans grp)	2		
9238 (Polypedilum (Uresipedilum) flavum)	5		
9241 (Polypedilum (Polypedilum) illinoense grp.)	38		

Residuals

Identifier	Date	Count	%PSE
MSG	8/31/2020	1	99.38

APPENDIX C. FISH AND MACROINVERTEBRATE COMMUNITY QUALITATIVE HABITAT EVALUATION INDEX

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42679	Fish	20T012	Marsh Creek	E Moody Road

Surveyor	Sample Date	County	Macro Sample Type
KAG	6/23/20	Knox	N/A

◇ Habitat Complete

QHEI Score: 37

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or* 2 & *average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)			
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)		x	
◇ ◇ Cobble (8)				◇ ◇ Muck (2)			
◇ ◇ Gravel (7)				◇ ◈ Silt (2)		x	x
◈ ◇ Sand (6)		x	x	◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ◇ Limestone (1)
- ◈ Tills (1)
- ◇ Wetlands (0)
- ◇ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◇ Heavy (-2)
- ◇ Moderate (-1)
- ◈ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◇ Moderate (-1)
- ◈ Normal (0)
- ◇ None (1)

Substrate 9 *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- 1 Undercut banks (1)
- 1 Overhanging vegetation (1)
- 1 Shallows (in slow water) (1)
- 0 Rootmats (1)
- 0 Pools > 70cm (2)
- 0 Rootwads (1)
- 0 Boulders (1)
- 0 Oxbows, Backwaters (1)
- 1 Aquatic macrophytes (1)
- 1 Logs and woody debris (1)

AMOUNT

Check ONE (*or* 2 & *average*)
- ◇ Extensive >75% (11)
- ◇ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover 8 *Maximum 20*

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY
- ◇ High (4)
- ◇ Moderate (3)
- ◈ Low (2)
- ◇ None (1)

DEVELOPMENT
- ◇ Excellent (7)
- ◇ Good (5)
- ◈ Fair (3)
- ◈ Poor (1)

CHANNELIZATION
- ◇ None (6)
- ◇ Recovered (4)
- ◈ Recovering (3)
- ◇ Recent or no recovery (1)

STABILITY
- ◇ High (3)
- ◇ Moderate (2)
- ◈ Low (1)

Channel 8 *Maximum 20*

COMMENTS

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION

L R
- ◇ ◇ None or little (3)
- ◈ ◈ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH

L R
- ◇ ◇ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◇ Narrow 5-10m (2)
- ◈ ◈ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY

L R
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)

L R
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

Riparian 4 *Maximum 10*

COMMENTS

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◇ 0.7-<1m (4)
- ◈ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or* 2 & *average*)
- ◇ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◇ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◇ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current 4 *Maximum 12*

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

◈ No Riffle (metric=0)

Check **ONE** (*ONLY!*)

RIFFLE DEPTH
- ◇ Best Areas >10cm (2)
- ◇ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◇ Maximum <50cm (1)

Check ONE (*or* 2 & *average*)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◇ Extensive (-1)

Riffle/Run 0 *Maximum 8*

COMMENTS

6-GRADIENT

(2.932 ft/mi)

DRAINAGE AREA

(12.234 mi²)

- ◈ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 20 % GLIDE: 80

% RUN: 0 % RIFFLE: 0

Gradient 4 *Maximum 10*

A85

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY

- >85% - Open
- 55%-<85%
- 30%-<55%
- 10%-<30%
- <10% - Closed

Canopy Upstream Reading

Right

98 Middle

Left

B-AESTHETICS

- Nuisance algae
- Invasive macrophytes
- Excess turbidity
- Discoloration
- Foam/Scum
- Oil sheen
- Trash/Litter
- Nuisance odor
- Sludge deposits
- CSOs/SSOs/Outfalls

C-MAINTENANCE

- Public
- Private
- Active
- Historic
- Young – Succession
- Old - Succession
- Spray
- Leveed – One sided
- Leveed – Both Banks
- Moving – Bedload
- Stable - Bedload
- Armoured
- Slumps
- Islands
- Scoured
- Relocated
- Cutoffs
- Impounded
- Desiccated
- Flood Control
- Drainage
- Snag Removed
- Snag Modified

D-ISSUES

- WWTP
- NPDES
- CSO
- Hardened
- Urban
- Dirt & Grime
- Contaminated
- Landfill
- Industry
- Construction BMPs
- Sediment BMPs
- Logging
- Irrigation
- Cooling
- Bank Erosion
- Surface Erosion
- H2O table
- False bank
- Manure
- Lagoon
- Wash H2O
- Tile
- Natural Flow
- Acid Mine
- Wetlands
- Stagnant Flow
- Quarry Mine
- Golf
- Home
- Park
- Data Paucity
- Lawn
- Agriculture
- Livestock
- Atmosphere Deposition

Stream Drawing

A86

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42682	Fish	20T015	Tributary of Maria Creek	Freelandville Road

Surveyor	Sample Date	County	Macro Sample Type
CPB	6/22/20	Knox	N/A

◈ Habitat Complete

QHEI Score: 37

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

BEST TYPES

	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)			
◇ ◇ Boulders (9)			
◇ ◇ Cobble (8)		x	
◇ ◇ Gravel (7)			
◈ ◇ Sand (6)		x	
◇ ◇ Bedrock (5)			

OTHER TYPES

	TOTAL	POOL	RIFFLE
◈ ◇ Hardpan (4)		x	
◇ ◇ Detritus (3)			
◇ ◇ Muck (2)		x	
◇ ◇ Silt (2)			
◇ ◇ Artificial (0)			

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES:
◇ 4 or more (2)
◈ 3 or less (0)

Check ONE (*or* 2 & *average*)

ORIGIN
◇ Limestone (1)
◈ Tills (1)
◇ Wetlands (0)
◇ Hardpan (0)
◇ Sandstone (0)
◇ Rip/Rap (0)
◇ Lacustrine (0)
◇ Shale (-1)
◇ Coal fines (-2)

QUALITY
SILT
◈ Heavy (-2)
◈ Moderate (-1)
◇ Normal (0)
◇ Free (1)
EMBEDDEDNESS
◇ Extensive (-2)
◇ Moderate (-1)
◈ Normal (0)
◇ None (1)

Substrate Maximum 20: **10**

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

0 Undercut banks (1)
2 Overhanging vegetation (1)
1 Shallows (in slow water) (1)
0 Rootmats (1)
0 Pools > 70cm (2)
0 Rootwads (1)
0 Boulders (1)
0 Oxbows, Backwaters (1)
0 Aquatic macrophytes (1)
0 Logs and woody debris (1)

AMOUNT
Check ONE (*or* 2 & *average*)
◇ Extensive >75% (11)
◇ Moderate 25-75% (7)
◈ Sparse 5-<25% (3)
◇ Nearly absent <5% (1)

COMMENTS

Cover Maximum 20: **5**

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY
◇ High (4)
◇ Moderate (3)
◈ Low (2)
◇ None (1)

DEVELOPMENT
◇ Excellent (7)
◇ Good (5)
◇ Fair (3)
◈ Poor (1)

CHANNELIZATION
◇ None (6)
◇ Recovered (4)
◈ Recovering (3)
◇ Recent or no recovery (1)

STABILITY
◇ High (3)
◈ Moderate (2)
◈ Low (1)

COMMENTS

Channel Maximum 20: **8**

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION
L R
◈ ◈ None or little (3)
◇ ◇ Moderate (2)
◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH
L R
◇ ◇ Wide >50m (4)
◇ ◇ Moderate 10-50m (3)
◇ ◇ Narrow 5-10m (2)
◈ ◈ Very narrow <5m (1)
◇ ◇ None (0)

FLOOD PLAIN QUALITY
L R
◇ ◇ Forest, Swamp (3)
◇ ◇ Shrub or Old field (2)
◇ ◇ Residential, Park, New field (1)
◇ ◇ Fenced pasture (1)
◈ ◈ Open Pasture/Rowcrop (0)

L R
◇ ◇ Conservation Tillage (1)
◇ ◇ Urban or Industrial (0)
◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian Maximum 10: **4**

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH
Check **ONE** (*ONLY!*)
◇ >1m (6)
◇ 0.7-<1m (4)
◇ 0.4-<0.7m (2)
◈ 0.2-<0.4m (1)
◇ <0.2m (0) (metric=0)

CHANNEL WIDTH
Check ONE (*or* 2 & *average*)
◈ Pool width > riffle width (2)
◇ Pool width = riffle width (1)
◇ Pool width < riffle width (0)

CURRENT VELOCITY
Check ALL that apply
◇ Torrential (-1)
◇ Very Fast (1)
◇ Fast (1)
◇ Moderate (1)
◈ Slow (1)
◇ Interstitial (-1)
◇ Intermittent (-2)
◇ Eddies (1)
Indicate for reach – pools and riffles.

RECREATION POTENTIAL
◇ *Primary Contact*
◇ *Secondary Contact*
(circle one and comment on back)

COMMENTS

Pool/Current Maximum 12: **4**

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

◈ No Riffle (metric=0)

RIFFLE DEPTH
◇ Best Areas >10cm (2)
◇ Best Areas 5-10cm (1)
◇ Best Areas <5cm (metric=0)

Check **ONE** (*ONLY!*)

RUN DEPTH
◇ Maximum >50cm (2)
◇ Maximum <50cm (1)

Check ONE (*or* 2 & *average*)

RIFFLE/RUN SUBSTRATE
◇ Stable (e.g. cobble, boulder) (2)
◇ Mod. Stable (e.g. large gravel) (1)
◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
◇ None (2)
◇ Low (1)
◇ Moderate (0)
◇ Extensive (-1)

Riffle/Run Maximum 8: **0**

COMMENTS

6-GRADIENT

(7.362 ft/mi)
DRAINAGE AREA
(2.96 mi²)

◇ Very low – Low (2-4)
◈ Moderate (6-10)
◇ High – Very high (10-6)

% POOL: 10 **% GLIDE:** 90
% RUN: 0 **% RIFFLE:** 0

Gradient Maximum 10: **6**

A87

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY

- ◇ >85% - Open
- ◇ 55%-<85%
- ◇ 30%-<55%
- ◇ 10%-<30%
- ◇ <10% - Closed

Canopy Upstream Reading

Right

90 Middle

Left

B-AESTHETICS

- ◇ Nuisance algae
- ◇ Invasive macrophytes
- ◇ Excess turbidity
- ◇ Discoloration
- ◇ Foam/Scum
- ◇ Oil sheen
- ◇ Trash/Litter
- ◇ Nuisance odor
- ◇ Sludge deposits
- ◇ CSOs/SSOs/Outfalls

C-MAINTENANCE

◇ Public	◇ Private
◇ Active	◇ Historic
◇ Young – Succession	
◇ Old - Succession	
◇ Spray	
◇ Leveed – One sided	
◇ Leveed – Both Banks	
◇ Moving – Bedload	
◇ Stable - Bedload	
◇ Armoured	◇ Slumps
◇ Islands	◇ Scoured
◇ Relocated	◇ Cutoffs
◇ Impounded	◇ Desiccated
◇ Flood Control	◇ Drainage
◇ Snag Removed	
◇ Snag Modified	

D-ISSUES

◇ WWTP	◇ NPDES	◇ CSO
◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ Contaminated	◇ Landfill	◇ Industry
◇ Construction BMPs	◇ Sediment BMPs	
◇ Logging	◇ Irrigation	◇ Cooling
◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
◇ False bank	◇ Manure	◇ Lagoon
◇ Wash H2O	◇ Tile	◇ Natural Flow
◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
◇ Quarry Mine	◇ Golf	◇ Home
◇ Park	◇ Data Paucity	◇ Lawn
◇ Agriculture	◇ Livestock	
◇ Atmosphere Deposition		

Stream Drawing

IDEM OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42683	Fish	20T016	Maria Creek	CR 1050 N/Freelandville Road

Surveyor	Sample Date	County	Macro Sample Type
KAG	6/22/20	Knox	N/A

◈ Habitat Complete

QHEI Score: 52

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or 2 & average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)		x	x
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)		x	
◇ ◇ Cobble (8)		x		◇ ◇ Muck (2)			
◇ ◈ Gravel (7)		x	x	◇ ◇ Silt (2)			
◈ ◇ Sand (6)		x	x	◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
◇ Limestone (1)
◈ Tills (1)
◇ Wetlands (0)
◇ Hardpan (0)
◇ Sandstone (0)
◇ Rip/Rap (0)
◇ Lacustrine (0)
◇ Shale (-1)
◇ Coal fines (-2)

QUALITY
SILT
◇ Heavy (-2)
◇ Moderate (-1)
◈ Normal (0)
◇ Free (1)
EMBEDDEDNESS
◇ Extensive (-2)
◇ Moderate (-1)
◈ Normal (0)
◇ None (1)

Substrate **14** *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

1 Undercut banks (1)
1 Overhanging vegetation (1)
1 Shallows (in slow water) (1)
0 Rootmats (1)
0 Pools > 70cm (2)
0 Rootwads (1)
1 Boulders (1)
1 Oxbows, Backwaters (1)
2 Aquatic macrophytes (1)
1 Logs and woody debris (1)

AMOUNT
Check ONE (*or 2 & average*)
◇ Extensive >75% (11)
◈ Moderate 25-75% (7)
◇ Sparse 5-<25% (3)
◇ Nearly absent <5% (1)

COMMENTS

Cover **14** *Maximum 20*

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or 2 & average*)

SINUOSITY
◇ High (4)
◇ Moderate (3)
◈ Low (2)
◇ None (1)

DEVELOPMENT
◇ Excellent (7)
◇ Good (5)
◈ Fair (3)
◇ Poor (1)

CHANNELIZATION
◇ None (6)
◇ Recovered (4)
◈ Recovering (3)
◇ Recent or no recovery (1)

STABILITY
◇ High (3)
◇ Moderate (2)
◈ Low (1)

COMMENTS

Channel **9** *Maximum 20*

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
◇ ◇ None or little (3)
◈ ◈ Moderate (2)
◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
◇ ◇ Wide >50m (4)
◈ ◇ Moderate 10-50m (3)
◇ ◈ Narrow 5-10m (2)
◇ ◇ Very narrow <5m (1)
◇ ◇ None (0)

FLOOD PLAIN QUALITY (L R)
◇ ◇ Forest, Swamp (3)
◇ ◇ Shrub or Old field (2)
◇ ◇ Residential, Park, New field (1)
◇ ◇ Fenced pasture (1)
◈ ◈ Open Pasture/Rowcrop (0)
◇ ◇ Conservation Tillage (1)
◇ ◇ Urban or Industrial (0)
◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian **5** *Maximum 10*

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH
Check **ONE** (*ONLY!*)
◇ >1m (6)
◇ 0.7-<1m (4)
◇ 0.4-<0.7m (2)
◈ 0.2-<0.4m (1)
◇ <0.2m (0) (metric=0)

CHANNEL WIDTH
Check ONE (*or 2 & average*)
◇ Pool width > riffle width (2)
◈ Pool width = riffle width (1)
◇ Pool width < riffle width (0)

CURRENT VELOCITY
Check ALL that apply
◇ Torrential (-1)
◇ Very Fast (1)
◇ Fast (1)
◈ Moderate (1)
◈ Slow (1)
◇ Interstitial (-1)
◇ Intermittent (-2)
◇ Eddies (1)
Indicate for reach – pools and riffles.

RECREATION POTENTIAL
◇ *Primary Contact*
◇ *Secondary Contact*
(circle one and comment on back)

COMMENTS

Pool/Current **4** *Maximum 12*

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ◈ No Riffle (metric=0)

Check **ONE** (*ONLY!*) — Check ONE (*or 2 & average*)

RIFFLE DEPTH
◇ Best Areas >10cm (2)
◇ Best Areas 5-10cm (1)
◇ Best Areas <5cm (metric=0)

RUN DEPTH
◇ Maximum >50cm (2)
◇ Maximum <50cm (1)

RIFFLE/RUN SUBSTRATE
◇ Stable (e.g. cobble, boulder) (2)
◇ Mod. Stable (e.g. large gravel) (1)
◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
◇ None (2)
◇ Low (1)
◇ Moderate (0)
◇ Extensive (-1)

COMMENTS

Riffle/Run **0** *Maximum 8*

6-GRADIENT

(5.282 ft/mi)
DRAINAGE AREA
(17.468 mi^2)

◈ Very low – Low (2-4)
◈ Moderate (6-10)
◇ High – Very high (10-6)

% POOL: 10 % GLIDE: 0
% RUN: 90 % RIFFLE: 0

Gradient **6** *Maximum 10*

A89

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY

- >85% - Open
- 55%-<85%
- 30%-<55%
- 10%-<30%
- <10% - Closed

Canopy Upstream Reading

Right

99 Middle

Left

B-AESTHETICS

- Nuisance algae
- Invasive macrophytes
- Excess turbidity
- Discoloration
- Foam/Scum
- Oil sheen
- Trash/Litter
- Nuisance odor
- Sludge deposits
- CSOs/SSOs/Outfalls

C-MAINTENANCE

Public	Private
Active	Historic
Young – Succession	
Old - Succession	
Spray	
Leveed – One sided	
Leveed – Both Banks	
Moving – Bedload	
Stable - Bedload	
Armoured	Slumps
Islands	Scoured
Relocated	Cutoffs
Impounded	Desiccated
Flood Control	Drainage
Snag Removed	
Snag Modified	

D-ISSUES

WWTP	NPDES	CSO
Hardened	Urban	Dirt & Grime
Contaminated	Landfill	Industry
Construction BMPs	Sediment BMPs	
Logging	Irrigation	Cooling
Bank Erosion	Surface Erosion	H2O table
False bank	Manure	Lagoon
Wash H2O	Tile	Natural Flow
Acid Mine	Wetlands	Stagnant Flow
Quarry Mine	Golf	Home
Park	Data Paucity	Lawn
Agriculture	Livestock	
Atmosphere Deposition		

Stream Drawing

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42681	Fish	20T014	Marsh Creek	S County Road 5 SE

Surveyor	Sample Date	County	Macro Sample Type
KAG	6/23/20	Sullivan	N/A

◇ Habitat Complete

QHEI Score: 33

1-SUBSTRATE

Check *ONLY* Two substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or 2 & average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)			
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)			
◇ ◇ Cobble (8)				◈ ◇ Muck (2)		x	x
◇ ◇ Gravel (7)				◇ ◇ Silt (2)		x	x
◇ ◈ Sand (6)			x	◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ◇ Limestone (1)
- ◈ Tills (1)
- ◇ Wetlands (0)
- ◇ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◈ Heavy (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ None (1)

Substrate 7 *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

0	Undercut banks (1)	0	Pools > 70cm (2)	0	Oxbows, Backwaters (1)
1	Overhanging vegetation (1)	0	Rootwads (1)	0	Aquatic macrophytes (1)
1	Shallows (in slow water) (1)	0	Boulders (1)	1	Logs and woody debris (1)
1	Rootmats (1)				

AMOUNT

Check ONE (*or 2 & average*)
- ◇ Extensive >75% (11)
- ◇ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover Maximum 20 7

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or 2 & average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◇ High (4)	◇ Excellent (7)	◇ None (6)	◇ High (3)
◇ Moderate (3)	◇ Good (5)	◇ Recovered (4)	◇ Moderate (2)
◈ Low (2)	◈ Fair (3)	◈ Recovering (3)	◈ Low (1)
◇ None (1)	◈ Poor (1)	◇ Recent or no recovery (1)	

COMMENTS

Channel Maximum 20 8

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION

L R
- ◇ ◇ None or little (3)
- ◈ ◈ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH

L R
- ◇ ◇ Wide >50m (4)
- ◇ ◈ Moderate 10-50m (3)
- ◈ ◇ Narrow 5-10m (2)
- ◇ ◇ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY

L R
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◇ Open Pasture/Rowcrop (0)

L R
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian Maximum 10 5

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◇ 0.7-<1m (4)
- ◇ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or 2 & average*)
- ◇ Pool width > riffle width (2)
- ◇ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◇ Moderate (1)
- ◇ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ ***Primary Contact***
- ◇ ***Secondary Contact***

(circle one and comment on back)

COMMENTS

Pool/Current Maximum 12 0

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

◈ No Riffle (metric=0)

Check **ONE** (*ONLY!*)

RIFFLE DEPTH
- ◇ Best Areas >10cm (2)
- ◇ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◇ Maximum <50cm (1)

Check ONE (*or 2 & average*)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◇ Extensive (-1)

Riffle/Run Maximum 8 0

COMMENTS

6-GRADIENT

(7.445 ft/mi)

DRAINAGE AREA

(3.624 mi²)

- ◈ Very low – Low (2-4)
- ◈ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 20 **% GLIDE:** 80

% RUN: 0 **% RIFFLE:** 0

Gradient Maximum 10 6

A91

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY

- >85% - Open
- 55%-<85%
- 30%-<55%
- 10%-<30%
- <10% - Closed

Canopy Upstream Reading

Right

0 Middle

Left

B-AESTHETICS

- Nuisance algae
- Invasive macrophytes
- Excess turbidity
- Discoloration
- Foam/Scum
- Oil sheen
- Trash/Litter
- Nuisance odor
- Sludge deposits
- CSOs/SSOs/Outfalls

C-MAINTENANCE

Public	Private
Active	Historic
Young – Succession	
Old - Succession	
Spray	
Leveed – One sided	
Leveed – Both Banks	
Moving – Bedload	
Stable - Bedload	
Armoured	Slumps
Islands	Scoured
Relocated	Cutoffs
Impounded	Desiccated
Flood Control	Drainage
Snag Removed	
Snag Modified	

D-ISSUES

WWTP	NPDES	CSO
Hardened	Urban	Dirt & Grime
Contaminated	Landfill	Industry
Construction BMPs	Sediment BMPs	
Logging	Irrigation	Cooling
Bank Erosion	Surface Erosion	H2O table
False bank	Manure	Lagoon
Wash H2O	Tile	Natural Flow
Acid Mine	Wetlands	Stagnant Flow
Quarry Mine	Golf	Home
Park	Data Paucity	Lawn
Agriculture	Livestock	
Atmosphere Deposition		

Stream Drawing

IDEM OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42678	Fish	20T011	Marsh Creek	E Hunley Road

Surveyor	Sample Date	County	Macro Sample Type
KAG	6/22/20	Knox	N/A

◈ Habitat Complete

QHEI Score: 45

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or 2 & average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)		x	
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)		x	
◇ ◇ Cobble (8)				◇ ◇ Muck (2)			
◈ ◇ Gravel (7)		x	x	◇ ◇ Silt (2)			
◇ ◈ Sand (6)		x	x	◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

ORIGIN
- ◇ Limestone (1)
- ◈ Tills (1)
- ◇ Wetlands (0)
- ◇ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◇ Heavy (-2)
- ◇ Moderate (-1)
- ◈ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◇ Moderate (-1)
- ◈ Normal (0)
- ◇ None (1)

Substrate 14 *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

1	Undercut banks (1)	0	Pools > 70cm (2)
1	Overhanging vegetation (1)	0	Rootwads (1)
1	Shallows (in slow water) (1)	0	Boulders (1)
1	Rootmats (1)		

0	Oxbows, Backwaters (1)
1	Aquatic macrophytes (1)
0	Logs and woody debris (1)

AMOUNT

Check ONE (*or 2 & average*)
- ◇ Extensive >75% (11)
- ◈ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover Maximum 20 10

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or 2 & average*)

SINUOSITY
- ◇ High (4)
- ◇ Moderate (3)
- ◈ Low (2)
- ◇ None (1)

DEVELOPMENT
- ◇ Excellent (7)
- ◇ Good (5)
- ◈ Fair (3)
- ◇ Poor (1)

CHANNELIZATION
- ◇ None (6)
- ◇ Recovered (4)
- ◈ Recovering (3)
- ◇ Recent or no recovery (1)

STABILITY
- ◇ High (3)
- ◇ Moderate (2)
- ◈ Low (1)

COMMENTS

Channel Maximum 20 9

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION

L R
- ◇ ◇ None or little (3)
- ◈ ◈ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH

L R
- ◇ ◇ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◇ Narrow 5-10m (2)
- ◈ ◈ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY

L R
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)

L R
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian Maximum 10 3

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◇ 0.7-<1m (4)
- ◇ 0.4-<0.7m (2)
- ◈ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or 2 & average*)
- ◇ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◇ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ ***Primary Contact***
- ◇ ***Secondary Contact***

(circle one and comment on back)

COMMENTS

Pool/Current Maximum 12 3

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ◈ **No Riffle (metric=0)**

Check **ONE** (*ONLY!*)

RIFFLE DEPTH
- ◇ Best Areas >10cm (2)
- ◇ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◇ Maximum <50cm (1)

Check ONE (*or 2 & average*)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◇ Extensive (-1)

Riffle/Run Maximum 8 0

COMMENTS

6-GRADIENT

(3.392 ft/mi)

DRAINAGE AREA

(20.805 mi²)

- ◇ Very low – Low (2-4)
- ◈ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 20 **% GLIDE:** 80

% RUN: 0 **% RIFFLE:** 0

Gradient Maximum A93*10* 6

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY

- ◇ >85% - Open
- ◇ 55%-<85%
- ◇ 30%-<55%
- ◇ 10%-<30%
- ◇ <10% - Closed

Canopy Upstream Reading

Right

100 Middle

Left

B-AESTHETICS

- ◇ Nuisance algae
- ◇ Invasive macrophytes
- ◇ Excess turbidity
- ◇ Discoloration
- ◇ Foam/Scum
- ◇ Oil sheen
- ◇ Trash/Litter
- ◇ Nuisance odor
- ◇ Sludge deposits
- ◇ CSOs/SSOs/Outfalls

C-MAINTENANCE

- ◇ Public ◇ Private
- ◇ Active ◇ Historic
- ◇ Young – Succession
- ◇ Old - Succession
- ◇ Spray
- ◇ Leveed – One sided
- ◇ Leveed – Both Banks
- ◇ Moving – Bedload
- ◇ Stable - Bedload
- ◇ Armoured ◇ Slumps
- ◇ Islands ◇ Scoured
- ◇ Relocated ◇ Cutoffs
- ◇ Impounded ◇ Desiccated
- ◇ Flood Control ◇ Drainage
- ◇ Snag Removed
- ◇ Snag Modified

D-ISSUES

- ◇ WWTP ◇ NPDES ◇ CSO
- ◇ Hardened ◇ Urban ◇ Dirt & Grime
- ◇ Contaminated ◇ Landfill ◇ Industry
- ◇ Construction BMPs ◇ Sediment BMPs
- ◇ Logging ◇ Irrigation ◇ Cooling
- ◇ Bank Erosion ◇ Surface Erosion ◇ H2O table
- ◇ False bank ◇ Manure ◇ Lagoon
- ◇ Wash H2O ◇ Tile ◇ Natural Flow
- ◇ Acid Mine ◇ Wetlands ◇ Stagnant Flow
- ◇ Quarry Mine ◇ Golf ◇ Home
- ◇ Park ◇ Data Paucity ◇ Lawn
- ◇ Agriculture ◇ Livestock
- ◇ Atmosphere Deposition

Stream Drawing

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42677	Fish	20T010	Marsh Creek	E Springtown Road

Surveyor	Sample Date	County	Macro Sample Type
KAG	6/22/20	Knox	N/A

◈ Habitat Complete

QHEI Score: 38

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or 2 & average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)			
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)			
◇ ◇ Cobble (8)				◇ ◇ Muck (2)		x	x
◇ ◈ Gravel (7)		x	x	◇ ◇ Silt (2)			
◈ ◇ Sand (6)		x	x	◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ◇ Limestone (1)
- ◈ Tills (1)
- ◇ Wetlands (0)
- ◇ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◇ Heavy (-2)
- ◇ Moderate (-1)
- ◈ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◇ Moderate (-1)
- ◈ Normal (0)
- ◇ None (1)

Substrate 14 — *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

1	**Undercut banks (1)**	0	**Pools > 70cm (2)**	0	**Oxbows, Backwaters (1)**
1	**Overhanging vegetation (1)**	0	**Rootwads (1)**	0	**Aquatic macrophytes (1)**
1	**Shallows (in slow water) (1)**	0	**Boulders (1)**	1	**Logs and woody debris (1)**
0	**Rootmats (1)**				

AMOUNT

Check ONE (*or 2 & average*)
- ◇ Extensive >75% (11)
- ◇ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

Cover 7 — *Maximum 20*

COMMENTS

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or 2 & average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◇ High (4)	◇ Excellent (7)	◇ None (6)	◇ High (3)
◇ Moderate (3)	◇ Good (5)	◇ Recovered (4)	◇ Moderate (2)
◇ Low (2)	◈ Fair (3)	◇ Recovering (3)	◈ Low (1)
◈ None (1)	◈ Poor (1)	◈ Recent or no recovery (1)	

Channel 5 — *Maximum 20*

COMMENTS

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ◇ ◇ None or little (3)
- ◈ ◈ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◇ ◇ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◇ Narrow 5-10m (2)
- ◈ ◈ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY (L R)
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

Riparian 3 — *Maximum 10*

COMMENTS

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH
Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◇ 0.7-<1m (4)
- ◈ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH
Check ONE (*or 2 & average*)
- ◇ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY
Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◈ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◇ *Secondary Contact*

(circle one and comment on back)

Pool/Current 5 — *Maximum 12*

COMMENTS

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ◈ No Riffle (metric=0)

Check **ONE** (*ONLY!*) — Check ONE (*or 2 & average*)

RIFFLE DEPTH
- ◇ Best Areas >10cm (2)
- ◇ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◇ Maximum <50cm (1)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◇ Extensive (-1)

Riffle/Run 0 — *Maximum 8*

COMMENTS

6-GRADIENT

(2.96 ft/mi)

DRAINAGE AREA

(23.57 mi²)

- ◈ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 20 **% GLIDE:** 80

% RUN: 0 **% RIFFLE:** 0

Gradient 4 — *Maximum 10*

A95

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◇ >85% - Open	◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◇ 55%-<85%	◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ 30%-<55%	◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
		◇ Old - Succession				
◇ 10%-<30%	◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◇ <10% - Closed	◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
	◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
	◇ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading		◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
		◇ Stable - Bedload				
Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
	◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
	◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
100 Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
		◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
		◇ Snag Removed		◇ Atmosphere Deposition		
		◇ Snag Modified				
Left						

Stream Drawing

A96

IDEM OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42680	Fish	20T013	Marsh Creek	S County Road 50 E

Surveyor	Sample Date	County	Macro Sample Type	
KAG	6/23/20	Sullivan	N/A	◇ Habitat Complete

QHEI Score: 50

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◈ Hardpan (4)		x	x
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)			
◇ ◇ Cobble (8)				◇ ◇ Muck (2)		x	x
◇ ◇ Gravel (7)		x	x	◇ ◇ Silt (2)		x	x
◈ ◇ Sand (6)		x	x	◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

Check ONE (*or* 2 & *average*)

ORIGIN
- ◇ Limestone (1)
- ◈ Tills (1)
- ◇ Wetlands (0)
- ◇ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◇ Heavy (-2)
- ◇ Moderate (-1)
- ◈ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◇ Moderate (-1)
- ◈ Normal (0)
- ◇ None (1)

Substrate 11 *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

1 Undercut banks (1)	0 Pools > 70cm (2)	0 Oxbows, Backwaters (1)	
1 Overhanging vegetation (1)	0 Rootwads (1)	1 Aquatic macrophytes (1)	
1 Shallows (in slow water) (1)	0 Boulders (1)	1 Logs and woody debris (1)	
1 Rootmats (1)			

AMOUNT

Check ONE (*or* 2 & *average*)
- ◇ Extensive >75% (11)
- ◈ Moderate 25-75% (7)
- ◇ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover Maximum 20 13

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◇ High (4)	◇ Excellent (7)	◇ None (6)	◇ High (3)
◇ Moderate (3)	◈ Good (5)	◇ Recovered (4)	◇ Moderate (2)
◈ Low (2)	◈ Fair (3)	◈ Recovering (3)	◈ Low (1)
◇ None (1)	◇ Poor (1)	◇ Recent or no recovery (1)	

COMMENTS

Channel Maximum 20 10

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION

L R
- ◇ ◇ None or little (3)
- ◈ ◈ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH

L R
- ◈ ◇ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◇ Narrow 5-10m (2)
- ◇ ◈ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY

L R
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)

L R
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian Maximum 10 5

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◇ 0.7-<1m (4)
- ◈ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or* 2 & *average*)
- ◇ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◈ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◇ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current Maximum 12 5

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ◈ No Riffle (metric=0)

Check **ONE** (*ONLY!*)

RIFFLE DEPTH
- ◇ Best Areas >10cm (2)
- ◇ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◇ Maximum <50cm (1)

Check ONE (*or* 2 & *average*)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◇ Extensive (-1)

Riffle/Run Maximum 8 0

COMMENTS

6-GRADIENT

(5.502 ft/mi)

DRAINAGE AREA

(8.376 mi²)

- ◇ Very low – Low (2-4)
- ◈ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 10 **% GLIDE:** 90

% RUN: 0 **% RIFFLE:** 0

Gradient Maximum 10 6

A97

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◇ >85% - Open	◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◈ 55%-<85%	◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ 30%-<55%	◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
		◇ Old - Succession				
◇ 10%-<30%	◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◇ <10% - Closed	◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
	◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
	◇ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading		◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
		◇ Stable - Bedload				
Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
	◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
	◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
58 Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
		◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
		◇ Snag Removed		◇ Atmosphere Deposition		
		◇ Snag Modified				
Left						

Stream Drawing

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42685	Fish	20T018	Maria Creek	E County Road 1050 S

Surveyor	Sample Date	County	Macro Sample Type		QHEI Score:
CWY	6/22/20	Sullivan	N/A	◈ Habitat Complete	45

1-SUBSTRATE

Check ***ONLY*** **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or* 2 & *average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)			x
◇ ◇ Boulders (9)			x	◇ ◇ Detritus (3)			
◇ ◇ Cobble (8)				◇ ◇ Muck (2)			
◇ ◇ Gravel (7)			x	◈ ◇ Silt (2)		x	
◇ ◈ Sand (6)		x	x	◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES:
◇ 4 or more (2)
◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
◇ Limestone (1)
◇ Tills (1)
◇ Wetlands (0)
◈ Hardpan (0)
◇ Sandstone (0)
◇ Rip/Rap (0)
◇ Lacustrine (0)
◇ Shale (-1)
◇ Coal fines (-2)

QUALITY
SILT
◇ Heavy (-2)
◈ Moderate (-1)
◇ Normal (0)
◇ Free (1)
EMBEDDEDNESS
◇ Extensive (-2)
◈ Moderate (-1)
◇ Normal (0)
◇ None (1)

Substrate 6
Maximum 20

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

0	Undercut banks (1)	0	Pools > 70cm (2)	1	Oxbows, Backwaters (1)
1	Overhanging vegetation (1)	0	Rootwads (1)	1	Aquatic macrophytes (1)
2	Shallows (in slow water) (1)	1	Boulders (1)	2	Logs and woody debris (1)
2	Rootmats (1)				

AMOUNT
Check ONE (*or* 2 & *average*)
◇ Extensive >75% (11)
◇ Moderate 25-75% (7)
◈ Sparse 5-<25% (3)
◇ Nearly absent <5% (1)

COMMENTS

Cover Maximum 20 10

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY
◇ High (4)
◈ Moderate (3)
◇ Low (2)
◇ None (1)

DEVELOPMENT
◇ Excellent (7)
◇ Good (5)
◈ Fair (3)
◇ Poor (1)

CHANNELIZATION
◇ None (6)
◇ Recovered (4)
◈ Recovering (3)
◇ Recent or no recovery (1)

STABILITY
◇ High (3)
◈ Moderate (2)
◇ Low (1)

COMMENTS

Channel Maximum 20 11

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION
L R
◇ ◇ None or little (3)
◇ ◈ Moderate (2)
◈ ◇ Heavy/Severe (1)

RIPARIAN WIDTH
L R
◇ ◇ Wide >50m (4)
◇ ◇ Moderate 10-50m (3)
◇ ◇ Narrow 5-10m (2)
◈ ◈ Very narrow <5m (1)
◇ ◇ None (0)

FLOOD PLAIN QUALITY
L R
◇ ◇ Forest, Swamp (3)
◇ ◇ Shrub or Old field (2)
◇ ◇ Residential, Park, New field (1)
◇ ◇ Fenced pasture (1)
◈ ◈ Open Pasture/Rowcrop (0)

L R
◇ ◇ Conservation Tillage (1)
◇ ◇ Urban or Industrial (0)
◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian Maximum 10 3

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH
Check **ONE** (*ONLY!*)
◇ >1m (6)
◇ 0.7-<1m (4)
◇ 0.4-<0.7m (2)
◈ 0.2-<0.4m (1)
◇ <0.2m (0) (metric=0)

CHANNEL WIDTH
Check ONE (*or* 2 & *average*)
◇ Pool width > riffle width (2)
◈ Pool width = riffle width (1)
◇ Pool width < riffle width (0)

CURRENT VELOCITY
Check ALL that apply
◇ Torrential (-1)
◇ Very Fast (1)
◇ Fast (1)
◈ Moderate (1)
◇ Slow (1)
◇ Interstitial (-1)
◇ Intermittent (-2)
◇ Eddies (1)
Indicate for reach – pools and riffles.

RECREATION POTENTIAL
◇ *Primary Contact*
◇ *Secondary Contact*
(circle one and comment on back)

COMMENTS

Pool/Current Maximum 12 3

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

◇ No Riffle (metric=0)

RIFFLE DEPTH
Check **ONE** (*ONLY!*)
◇ Best Areas >10cm (2)
◈ Best Areas 5-10cm (1)
◇ Best Areas <5cm (metric=0)

RUN DEPTH
◇ Maximum >50cm (2)
◈ Maximum <50cm (1)

Check ONE (*or* 2 & *average*)

RIFFLE/RUN SUBSTRATE
◇ Stable (e.g. cobble, boulder) (2)
◇ Mod. Stable (e.g. large gravel) (1)
◈ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
◇ None (2)
◇ Low (1)
◈ Moderate (0)
◇ Extensive (-1)

COMMENTS

Riffle/Run Maximum 8 2

6-GRADIENT

(8.775 ft/mi)
DRAINAGE AREA
(10.192 mi^2)

◇ Very low – Low (2-4)
◈ Moderate (6-10)
◇ High – Very high (10-6)

% POOL: 15 **% GLIDE:** #$
% RUN: 60 **% RIFFLE:** 25

Gradient Maximum A99*10* 10

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY

- >85% - Open
- 55%-<85%
- 30%-<55%
- 10%-<30%
- <10% - Closed

Canopy Upstream Reading

Right

7 Middle

Left

B-AESTHETICS

- Nuisance algae
- Invasive macrophytes
- Excess turbidity
- Discoloration
- Foam/Scum
- Oil sheen
- Trash/Litter
- Nuisance odor
- Sludge deposits
- CSOs/SSOs/Outfalls

C-MAINTENANCE

- Public
- Private
- Active
- Historic
- Young – Succession
- Old - Succession
- Spray
- Leveed – One sided
- Leveed – Both Banks
- Moving – Bedload
- Stable - Bedload
- Armoured
- Slumps
- Islands
- Scoured
- Relocated
- Cutoffs
- Impounded
- Desiccated
- Flood Control
- Drainage
- Snag Removed
- Snag Modified

D-ISSUES

- WWTP
- NPDES
- CSO
- Hardened
- Urban
- Dirt & Grime
- Contaminated
- Landfill
- Industry
- Construction BMPs
- Sediment BMPs
- Logging
- Irrigation
- Cooling
- Bank Erosion
- Surface Erosion
- H2O table
- False bank
- Manure
- Lagoon
- Wash H2O
- Tile
- Natural Flow
- Acid Mine
- Wetlands
- Stagnant Flow
- Quarry Mine
- Golf
- Home
- Park
- Data Paucity
- Lawn
- Agriculture
- Livestock
- Atmosphere Deposition

Stream Drawing

A100

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42673	Fish	20T006	Tilley Ditch	E Pepmeir Road

Surveyor	Sample Date	County	Macro Sample Type
RAC	7/8/20	Knox	N/A

◊ Habitat Complete

QHEI Score: 38

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or* 2 & *average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◊ ◊ Bldrs/Slabs (10)				◊ ◊ Hardpan (4)		x	
◊ ◊ Boulders (9)				◊ ◊ Detritus (3)			
◊ ◊ Cobble (8)				◊ ◊ Muck (2)			
◊ ◊ Gravel (7)			x	◊ ◊ Silt (2)		x	
◈ ◈ Sand (6)		x	x	◊ ◊ Artificial (0)		x	
◊ ◊ Bedrock (5)							

NUMBER OF BEST TYPES: ◊ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ◊ Limestone (1)
- ◊ Tills (1)
- ◊ Wetlands (0)
- ◈ Hardpan (0)
- ◊ Sandstone (0)
- ◊ Rip/Rap (0)
- ◊ Lacustrine (0)
- ◊ Shale (-1)
- ◊ Coal fines (-2)

QUALITY

SILT
- ◊ Heavy (-2)
- ◊ Moderate (-1)
- ◈ Normal (0)
- ◊ Free (1)

EMBEDDEDNESS
- ◊ Extensive (-2)
- ◊ Moderate (-1)
- ◈ Normal (0)
- ◊ None (1)

Substrate 12 *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

1	Undercut banks (1)	1	Pools > 70cm (2)	0	Oxbows, Backwaters (1)
2	Overhanging vegetation (1)	0	Rootwads (1)	0	Aquatic macrophytes (1)
0	Shallows (in slow water) (1)	0	Boulders (1)	1	Logs and woody debris (1)
0	Rootmats (1)				

AMOUNT

Check ONE (*or* 2 & *average*)
- ◊ Extensive >75% (11)
- ◊ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◊ Nearly absent <5% (1)

COMMENTS

Cover *Maximum 20* 8

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◊ High (4)	◊ Excellent (7)	◊ None (6)	◊ High (3)
◊ Moderate (3)	◊ Good (5)	◈ Recovered (4)	◈ Moderate (2)
◈ Low (2)	◊ Fair (3)	◊ Recovering (3)	◈ Low (1)
◈ None (1)	◈ Poor (1)	◊ Recent or no recovery (1)	

COMMENTS

Channel *Maximum 20* 8

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ◈ ◈ None or little (3)
- ◈ ◈ Moderate (2)
- ◊ ◊ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◊ ◊ Wide >50m (4)
- ◊ ◈ Moderate 10-50m (3)
- ◈ ◊ Narrow 5-10m (2)
- ◊ ◊ Very narrow <5m (1)
- ◊ ◊ None (0)

FLOOD PLAIN QUALITY (L R)
- ◊ ◊ Forest, Swamp (3)
- ◊ ◊ Shrub or Old field (2)
- ◊ ◊ Residential, Park, New field (1)
- ◊ ◊ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)
- ◊ ◊ Conservation Tillage (1)
- ◊ ◊ Urban or Industrial (0)
- ◊ ◊ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian *Maximum 10* 5

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◊ >1m (6)
- ◊ 0.7-<1m (4)
- ◈ 0.4-<0.7m (2)
- ◊ 0.2-<0.4m (1)
- ◊ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or* 2 & *average*)
- ◊ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◊ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◊ Torrential (-1)
- ◊ Very Fast (1)
- ◊ Fast (1)
- ◈ Moderate (1)
- ◈ Slow (1)
- ◊ Interstitial (-1)
- ◊ Intermittent (-2)
- ◊ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◊ *Primary Contact*
- ◊ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current *Maximum 12* 5

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ◈ No Riffle (metric=0)

Check **ONE** (*ONLY!*) | Check ONE (*or* 2 & *average*)

RIFFLE DEPTH
- ◊ Best Areas >10cm (2)
- ◊ Best Areas 5-10cm (1)
- ◊ Best Areas <5cm(metric=0)

RUN DEPTH
- ◊ Maximum >50cm (2)
- ◊ Maximum <50cm (1)

RIFFLE/RUN SUBSTRATE
- ◊ Stable (e.g. cobble, boulder) (2)
- ◊ Mod. Stable (e.g. large gravel) (1)
- ◊ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◊ None (2)
- ◊ Low (1)
- ◊ Moderate (0)
- ◊ Extensive (-1)

COMMENTS

Riffle/Run *Maximum 8* 0

6-GRADIENT

(0 ft/mi)

DRAINAGE AREA

(0 mi^2)

- ◊ Very low – Low (2-4)
- ◊ Moderate (6-10)
- ◊ High – Very high (10-6)

% POOL: 40 % GLIDE: #$

% RUN: 60 % RIFFLE: #$

Gradient *Maximum* A101*10* 0

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◇ >85% - Open	◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◇ 55%-<85%	◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ 30%-<55%	◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
		◇ Old - Succession				
◇ 10%-<30%	◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◇ <10% - Closed	◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
	◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
	◇ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading		◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
		◇ Stable - Bedload				
Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
	◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
	◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
90 Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
		◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
		◇ Snag Removed		◇ Atmosphere Deposition		
		◇ Snag Modified				
Left						

Stream Drawing

A102

IDEM OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB43849	Fish	20T006.5	Tilley Ditch	E Pepmeir Road

Surveyor	Sample Date	County	Macro Sample Type		QHEI Score:
KRW	8/20/20	Knox	N/A	◇ Habitat Complete	51

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or* 2 & *average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)		x	
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)			
◇ ◇ Cobble (8)				◇ ◇ Muck (2)			
◇ ◇ Gravel (7)			x	◇ ◇ Silt (2)		x	x
◈ ◈ Sand (6)		x	x	◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ◇ Limestone (1)
- ◇ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◇ Heavy (-2)
- ◇ Moderate (-1)
- ◈ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◇ Moderate (-1)
- ◈ Normal (0)
- ◇ None (1)

Substrate 12 *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

1	Undercut banks (1)	0	Pools > 70cm (2)	0	Oxbows, Backwaters (1)
1	Overhanging vegetation (1)	0	Rootwads (1)	0	Aquatic macrophytes (1)
1	Shallows (in slow water) (1)	0	Boulders (1)	1	Logs and woody debris (1)
1	Rootmats (1)				

AMOUNT

Check ONE (*or* 2 & *average*)
- ◇ Extensive >75% (11)
- ◈ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover Maximum 20 10

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◇ High (4)	◇ Excellent (7)	◇ None (6)	◇ High (3)
◇ Moderate (3)	◈ Good (5)	◇ Recovered (4)	◇ Moderate (2)
◈ Low (2)	◈ Fair (3)	◈ Recovering (3)	◈ Low (1)
◇ None (1)	◇ Poor (1)	◇ Recent or no recovery (1)	

COMMENTS

Channel Maximum 20 10

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION

L R
- ◈ ◈ None or little (3)
- ◇ ◇ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH

L R
- ◇ ◇ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◈ ◈ Narrow 5-10m (2)
- ◇ ◇ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY

L R
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)

L R
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian Maximum 10 5

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◇ 0.7-<1m (4)
- ◈ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or* 2 & *average*)
- ◇ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◈ Slow (1)
- ◇ Very Fast (1)
- ◇ Interstitial (-1)
- ◇ Fast (1)
- ◇ Intermittent (-2)
- ◈ Moderate (1)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◇ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current Maximum 12 5

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

◇ No Riffle (metric=0)

Check **ONE** (*ONLY!*)

RIFFLE DEPTH
- ◇ Best Areas >10cm (2)
- ◈ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◈ Maximum <50cm (1)

Check ONE (*or* 2 & *average*)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◈ Mod. Stable (e.g. large gravel) (1)
- ◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◈ Moderate (0)
- ◇ Extensive (-1)

Riffle/Run Maximum 8 3

COMMENTS

6-GRADIENT

(4.379 ft/mi)

DRAINAGE AREA

(9.299 mi²)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 10 % GLIDE: #$

% RUN: 85 % RIFFLE: 5

Gradient Maximum A103*10* 6

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◇ >85% - Open	◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◇ 55%-<85%	◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ 30%-<55%	◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
		◇ Old - Succession				
◇ 10%-<30%	◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◇ <10% - Closed	◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
	◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
	◇ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading		◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
		◇ Stable - Bedload				
Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
	◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
	◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
92 Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
		◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
		◇ Snag Removed		◇ Atmosphere Deposition		
		◇ Snag Modified				
Left						

Stream Drawing

A104

IDEM OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB43431	Fish	20T018.5	Maria Creek	E County Road 1050 S

Surveyor	Sample Date	County	Macro Sample Type
TAF	8/18/20	Sullivan	N/A

◇ Habitat Complete

QHEI Score: 46

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or 2 & average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)		x	
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)			
◇ ◇ Cobble (8)				◇ ◇ Muck (2)		x	x
◇ ◇ Gravel (7)		x	x	◇ ◇ Silt (2)		x	x
◈ ◈ Sand (6)		x	x	◇ ◇ Artificial (0)		x	
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ◇ Limestone (1)
- ◇ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◇ Heavy (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ None (1)

Substrate 10 — *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

1	Undercut banks (1)	0	Pools > 70cm (2)
1	Overhanging vegetation (1)	0	Rootwads (1)
1	Shallows (in slow water) (1)	0	Boulders (1)
1	Rootmats (1)		

0	Oxbows, Backwaters (1)
0	Aquatic macrophytes (1)
1	Logs and woody debris (1)

AMOUNT

Check ONE (*or 2 & average*)
- ◇ Extensive >75% (11)
- ◇ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover 8 — *Maximum 20*

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or 2 & average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◇ High (4)	◇ Excellent (7)	◇ None (6)	◇ High (3)
◇ Moderate (3)	◇ Good (5)	◇ Recovered (4)	◇ Moderate (2)
◈ Low (2)	◈ Fair (3)	◈ Recovering (3)	◈ Low (1)
◇ None (1)	◇ Poor (1)	◇ Recent or no recovery (1)	

COMMENTS

Channel 9 — *Maximum 20*

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ◇ ◇ None or little (3)
- ◇ ◈ Moderate (2)
- ◈ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◇ ◇ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◇ Narrow 5-10m (2)
- ◇ ◇ Very narrow <5m (1)
- ◈ ◈ None (0)

FLOOD PLAIN QUALITY (L R)
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian 2 — *Maximum 10*

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◇ 0.7-<1m (4)
- ◈ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or 2 & average*)
- ◈ Pool width > riffle width (2)
- ◇ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◈ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◈ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current 6 — *Maximum 12*

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ◇ No Riffle (metric=0)

RIFFLE DEPTH — Check **ONE** (*ONLY!*)
- ◇ Best Areas >10cm (2)
- ◈ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◈ Maximum <50cm (1)

RIFFLE/RUN SUBSTRATE — Check ONE (*or 2 & average*)
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◈ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◈ Extensive (-1)

Riffle/Run 1 — *Maximum 8*

COMMENTS

6-GRADIENT

(8.775 ft/mi)

DRAINAGE AREA

(10.192 mi²)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 50 % GLIDE: 10

% RUN: 30 % RIFFLE: 10

Gradient 10 — *Maximum 10*

A105

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◇ >85% - Open	◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◈ 55%-<85%	◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ 30%-<55%	◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
		◇ Old - Succession				
◇ 10%-<30%	◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◇ <10% - Closed	◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
	◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
	◇ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading		◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
		◇ Stable - Bedload				
Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
	◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
	◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
68 Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
		◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
		◇ Snag Removed		◇ Atmosphere Deposition		
		◇ Snag Modified				
Left						

Stream Drawing

A106

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42670	Fish	20T003	Cotton Branch	E Springtown Road

Surveyor	Sample Date	County	Macro Sample Type	
CWY	7/8/20	Knox	N/A	◇ Habitat Complete

QHEI Score: 65

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or* 2 & *average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)			x
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)			
◇ ◇ Cobble (8)				◇ ◇ Muck (2)		x	
◇ ◇ Gravel (7)				◇ ◇ Silt (2)		x	
◈ ◈ Sand (6)		x	x	◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

ORIGIN
- ◇ Limestone (1)
- ◇ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◇ Heavy (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ None (1)

Substrate 10 — *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

1	Undercut banks (1)	2	Pools > 70cm (2)	0	Oxbows, Backwaters (1)
2	Overhanging vegetation (1)	1	Rootwads (1)	0	Aquatic macrophytes (1)
1	Shallows (in slow water) (1)	0	Boulders (1)	3	Logs and woody debris (1)
1	Rootmats (1)				

AMOUNT

Check ONE (*or* 2 & *average*)
- ◇ Extensive >75% (11)
- ◈ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover 13 — *Maximum 20*

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◇ High (4)	◇ Excellent (7)	◈ None (6)	◇ High (3)
◈ Moderate (3)	◈ Good (5)	◇ Recovered (4)	◇ Moderate (2)
◇ Low (2)	◈ Fair (3)	◇ Recovering (3)	◈ Low (1)
◇ None (1)	◇ Poor (1)	◇ Recent or no recovery (1)	

COMMENTS

Channel 14 — *Maximum 20*

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ◇ ◇ None or little (3)
- ◇ ◈ Moderate (2)
- ◈ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◈ ◈ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◇ Narrow 5-10m (2)
- ◇ ◇ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY (L R)
- ◈ ◈ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◇ ◇ Open Pasture/Rowcrop (0)
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian 9 — *Maximum 10*

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◈ >1m (6)
- ◇ 0.7-<1m (4)
- ◇ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or* 2 & *average*)
- ◈ Pool width > riffle width (2)
- ◇ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◈ Fast (1)
- ◈ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◇ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current 11 — *Maximum 12*

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ◇ No Riffle (metric=0)

RIFFLE DEPTH — Check **ONE** (*ONLY!*)
- ◇ Best Areas >10cm (2)
- ◈ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◈ Maximum <50cm (1)

RIFFLE/RUN SUBSTRATE — Check ONE (*or* 2 & *average*)
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◈ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◈ Moderate (0)
- ◇ Extensive (-1)

COMMENTS

Riffle/Run 2 — *Maximum 8*

6-GRADIENT

(9.645 ft/mi)

DRAINAGE AREA

(3.133 mi²)

- ◇ Very low – Low (2-4)
- ◈ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 50 **% GLIDE:** #$

% RUN: 40 **% RIFFLE:** 10

Gradient 6 — *Maximum 10*

A107

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◇ >85% - Open	◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◇ 55%-<85%	◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ 30%-<55%	◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
		◇ Old - Succession				
◈ 10%-<30%	◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◇ <10% - Closed	◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
	◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
	◈ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading		◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
		◇ Stable - Bedload				
Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
	◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
	◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
11 Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
		◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
		◇ Snag Removed		◇ Atmosphere Deposition		
		◇ Snag Modified				
Left						

Stream Drawing

A108

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42669	Fish	20T001	Maria Creek	N Old 41

Surveyor	Sample Date	County	Macro Sample Type
CWY	7/7/20	Knox	N/A

◈ Habitat Complete

QHEI Score: 66

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or* 2 & *average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)		x	
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)			
◇ ◇ Cobble (8)				◇ ◇ Muck (2)		x	
◇ ◇ Gravel (7)				◇ ◇ Silt (2)		x	
◈ ◈ Sand (6)		x	x	◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ◇ Limestone (1)
- ◇ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◇ Heavy (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ None (1)

Substrate **10** *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- 1 Undercut banks (1)
- 0 Overhanging vegetation (1)
- 1 Shallows (in slow water) (1)
- 1 Rootmats (1)
- 3 Pools > 70cm (2)
- 1 Rootwads (1)
- 0 Boulders (1)
- 1 Oxbows, Backwaters (1)
- 0 Aquatic macrophytes (1)
- 3 Logs and woody debris (1)

AMOUNT

Check ONE (*or* 2 & *average*)
- ◇ Extensive >75% (11)
- ◈ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover Maximum 20 **13**

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY
- ◈ High (4)
- ◇ Moderate (3)
- ◇ Low (2)
- ◇ None (1)

DEVELOPMENT
- ◇ Excellent (7)
- ◈ Good (5)
- ◈ Fair (3)
- ◇ Poor (1)

CHANNELIZATION
- ◈ None (6)
- ◇ Recovered (4)
- ◇ Recovering (3)
- ◇ Recent or no recovery (1)

STABILITY
- ◇ High (3)
- ◇ Moderate (2)
- ◈ Low (1)

COMMENTS

Channel Maximum 20 **15**

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ◇ ◇ None or little (3)
- ◈ ◈ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◈ ◈ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◇ Narrow 5-10m (2)
- ◇ ◇ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY (L R)
- ◈ ◈ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◇ ◇ Open Pasture/Rowcrop (0)
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian Maximum 10 **9**

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◈ >1m (6)
- ◇ 0.7-<1m (4)
- ◇ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or* 2 & *average*)
- ◈ Pool width > riffle width (2)
- ◇ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◈ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◇ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current Maximum 12 **10**

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

◇ No Riffle (metric=0)

RIFFLE DEPTH — Check **ONE** (*ONLY!*)
- ◈ Best Areas >10cm (2)
- ◇ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm(metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◈ Maximum <50cm (1)

RIFFLE/RUN SUBSTRATE — Check ONE (*or* 2 & *average*)
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◈ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◈ Moderate (0)
- ◇ Extensive (-1)

COMMENTS

Riffle/Run Maximum 8 **3**

6-GRADIENT

(3.217 ft/mi)

DRAINAGE AREA

(90.629 mi^2)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 35 **% GLIDE:** 0

% RUN: 50 **% RIFFLE:** 15

Gradient Maximum 10 **6**

A109

Circle some &
COMMENT

A-CANOPY

- ◇ >85% - Open
- ◇ 55%-<85%
- ◈ 30%-<55%
- ◇ 10%-<30%
- ◇ <10% - Closed

Canopy Upstream Reading

49 Right

51 Middle

32 Left

B-AESTHETICS

- ◇ Nuisance algae
- ◇ Invasive macrophytes
- ◇ Excess turbidity
- ◇ Discoloration
- ◇ Foam/Scum
- ◇ Oil sheen
- ◇ Trash/Litter
- ◇ Nuisance odor
- ◇ Sludge deposits
- ◇ CSOs/SSOs/Outfalls

C-MAINTENANCE

◇ Public	◇ Private
◇ Active	◇ Historic
◇ Young – Succession	
◇ Old - Succession	
◇ Spray	
◇ Leveed – One sided	
◇ Leveed – Both Banks	
◇ Moving – Bedload	
◇ Stable - Bedload	
◇ Armoured	◇ Slumps
◇ Islands	◇ Scoured
◇ Relocated	◇ Cutoffs
◇ Impounded	◇ Desiccated
◇ Flood Control	◇ Drainage
◇ Snag Removed	
◇ Snag Modified	

D-ISSUES

◇ WWTP	◇ NPDES	◇ CSO
◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ Contaminated	◇ Landfill	◇ Industry
◇ Construction BMPs	◇ Sediment BMPs	
◇ Logging	◇ Irrigation	◇ Cooling
◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
◇ False bank	◇ Manure	◇ Lagoon
◇ Wash H2O	◇ Tile	◇ Natural Flow
◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
◇ Quarry Mine	◇ Golf	◇ Home
◇ Park	◇ Data Paucity	◇ Lawn
◇ Agriculture	◇ Livestock	
◇ Atmosphere Deposition		

Stream Drawing

A110

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42686	Fish	20T019	Maria Creek	E County Road 975 S

Surveyor	Sample Date	County	Macro Sample Type
CWY	6/22/20	Sullivan	N/A

◇ Habitat Complete

QHEI Score: 58

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or 2 & average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)			x
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)			
◇ ◇ Cobble (8)				◇ ◇ Muck (2)			
◇ ◇ Gravel (7)			x	◈ ◇ Silt (2)		x	
◇ ◈ Sand (6)		x	x	◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ◇ Limestone (1)
- ◇ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◇ Heavy (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ None (1)

Substrate **6** *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

1	Undercut banks (1)	3	Pools > 70cm (2)
0	Overhanging vegetation (1)	2	Rootwads (1)
2	Shallows (in slow water) (1)	0	Boulders (1)
1	Rootmats (1)		

0	Oxbows, Backwaters (1)
1	Aquatic macrophytes (1)
1	Logs and woody debris (1)

AMOUNT

Check ONE (*or 2 & average*)
- ◇ Extensive >75% (11)
- ◈ Moderate 25-75% (7)
- ◇ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover **15** *Maximum 20*

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◈ High (4)	◇ Excellent (7)	◈ None (6)	◇ High (3)
◇ Moderate (3)	◈ Good (5)	◇ Recovered (4)	◈ Moderate (2)
◇ Low (2)	◇ Fair (3)	◇ Recovering (3)	◇ Low (1)
◇ None (1)	◇ Poor (1)	◇ Recent or no recovery (1)	

COMMENTS

Channel **17** *Maximum 20*

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ◇ ◇ None or little (3)
- ◈ ◈ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◇ ◇ Wide >50m (4)
- ◈ ◇ Moderate 10-50m (3)
- ◇ ◈ Narrow 5-10m (2)
- ◇ ◇ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY (L R)
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian **5** *Maximum 10*

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◈ 0.7-<1m (4)
- ◇ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or 2 & average*)
- ◈ Pool width > riffle width (2)
- ◇ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◈ Moderate (1)
- ◇ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◇ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current **7** *Maximum 12*

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

◇ No Riffle (metric=0)

Check **ONE** (*ONLY!*)

RIFFLE DEPTH
- ◇ Best Areas >10cm (2)
- ◈ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◈ Maximum <50cm (1)

Check ONE (*or 2 & average*)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◈ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◈ Moderate (0)
- ◇ Extensive (-1)

COMMENTS

Riffle/Run **2** *Maximum 8*

6-GRADIENT

(7.687 ft/mi)

DRAINAGE AREA (7.331 mi²)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 70 **% GLIDE:** 0

% RUN: 20 **% RIFFLE:** 10

Gradient **6** *Maximum 10*

A111

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◇ >85% - Open	◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◇ 55%-<85%	◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ 30%-<55%	◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
		◇ Old - Succession				
◈ 10%-<30%	◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◇ <10% - Closed	◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
	◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
	◈ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading		◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
		◇ Stable - Bedload				
Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
	◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
	◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
29 Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
		◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
		◇ Snag Removed		◇ Atmosphere Deposition		
		◇ Snag Modified				
Left						

Stream Drawing

A112

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42674	Fish	20T007	Tributary of Maria Creek	County Road 700 E, Lane Road

Surveyor	Sample Date	County	Macro Sample Type
KJC	6/22/20	Knox	N/A

◇ Habitat Complete

QHEI Score: 46

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or 2 & average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)			
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)			
◇ ◇ Cobble (8)				◇ ◇ Muck (2)		x	
◇ ◈ Gravel (7)		x	x	◇ ◇ Silt (2)		x	
◈ ◇ Sand (6)		x	x	◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ◇ Limestone (1)
- ◈ Tills (1)
- ◇ Wetlands (0)
- ◇ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◈ Heavy (-2)
- ◇ Moderate (-1)
- ◇ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◈ Extensive (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ None (1)

Substrate Maximum 20: **11**

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

0	Undercut banks (1)	0	Pools > 70cm (2)	0	Oxbows, Backwaters (1)
2	Overhanging vegetation (1)	0	Rootwads (1)	1	Aquatic macrophytes (1)
1	Shallows (in slow water) (1)	0	Boulders (1)	0	Logs and woody debris (1)
0	Rootmats (1)				

AMOUNT

Check ONE (*or 2 & average*)
- ◇ Extensive >75% (11)
- ◈ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover Maximum 20: **8**

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or 2 & average*)

SINUOSITY
- ◇ High (4)
- ◇ Moderate (3)
- ◈ Low (2)
- ◈ None (1)

DEVELOPMENT
- ◇ Excellent (7)
- ◇ Good (5)
- ◈ Fair (3)
- ◈ Poor (1)

CHANNELIZATION
- ◇ None (6)
- ◈ Recovered (4)
- ◇ Recovering (3)
- ◇ Recent or no recovery (1)

STABILITY
- ◇ High (3)
- ◈ Moderate (2)
- ◇ Low (1)

COMMENTS

Channel Maximum 20: **10**

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ◇ ◇ None or little (3)
- ◈ ◈ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◇ ◇ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◇ Narrow 5-10m (2)
- ◈ ◈ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY (L R)
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian Maximum 10: **3**

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◇ 0.7-<1m (4)
- ◈ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or 2 & average*)
- ◈ Pool width > riffle width (2)
- ◇ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◈ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◈ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current Maximum 12: **6**

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

◇ No Riffle (metric=0)

RIFFLE DEPTH

Check **ONE** (*ONLY!*)
- ◇ Best Areas >10cm (2)
- ◈ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◈ Maximum <50cm (1)

Check ONE (*or 2 & average*)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◈ Mod. Stable (e.g. large gravel) (1)
- ◈ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◈ Extensive (-1)

COMMENTS

Riffle/Run Maximum 8: **2**

6-GRADIENT

(9.923 ft/mi)

DRAINAGE AREA

(2.623 mi^2)

- ◇ Very low – Low (2-4)
- ◈ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 10 **% GLIDE:** 70

% RUN: 10 **% RIFFLE:** 10

Gradient Maximum 10: **6**

A113

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◇ >85% - Open	◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◈ 55%-<85%	◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ 30%-<55%	◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
		◇ Old - Succession				
◇ 10%-<30%	◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◇ <10% - Closed	◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
	◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
	◇ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading		◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
		◇ Stable - Bedload				
Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
	◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
	◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
80 Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
		◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
		◇ Snag Removed		◇ Atmosphere Deposition		
		◇ Snag Modified				
Left						

Stream Drawing

A114

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42676	Fish	20T009	Maria Creek	County Road 900 N

Surveyor	Sample Date	County	Macro Sample Type	
KRW	6/23/20	Knox	N/A	◈ Habitat Complete

QHEI Score: 43

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or 2 & average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◈ ◈ Hardpan (4)		x	x
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)			
◇ ◇ Cobble (8)				◇ ◇ Muck (2)			
◇ ◇ Gravel (7)			x	◇ ◇ Silt (2)		x	x
◇ ◇ Sand (6)			x	◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

ORIGIN
- ◇ Limestone (1)
- ◇ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◇ Heavy (-2)
- ◈ Moderate (-1)
- ◈ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ None (1)

Substrate 7 — *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

1	Undercut banks (1)	1	Pools > 70cm (2)	0	Oxbows, Backwaters (1)
1	Overhanging vegetation (1)	0	Rootwads (1)	0	Aquatic macrophytes (1)
1	Shallows (in slow water) (1)	0	Boulders (1)	1	Logs and woody debris (1)
1	Rootmats (1)				

AMOUNT

Check ONE (*or 2 & average*)
- ◇ Extensive >75% (11)
- ◇ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

Cover 10 — *Maximum 20*

COMMENTS

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or 2 & average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◇ High (4)	◇ Excellent (7)	◇ None (6)	◇ High (3)
◇ Moderate (3)	◇ Good (5)	◇ Recovered (4)	◈ Moderate (2)
◇ Low (2)	◈ Fair (3)	◈ Recovering (3)	◈ Low (1)
◈ None (1)	◇ Poor (1)	◇ Recent or no recovery (1)	

Channel 9 — *Maximum 20*

COMMENTS

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ◇ ◇ None or little (3)
- ◈ ◈ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◇ ◇ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◇ Narrow 5-10m (2)
- ◈ ◈ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY (L R)
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

Riparian 3 — *Maximum 10*

COMMENTS

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◈ >1m (6)
- ◇ 0.7-<1m (4)
- ◇ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or 2 & average*)
- ◇ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◈ Slow (1)
- ◇ Very Fast (1)
- ◇ Interstitial (-1)
- ◇ Fast (1)
- ◇ Intermittent (-2)
- ◇ Moderate (1)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◇ *Secondary Contact*

(circle one and comment on back)

Pool/Current 8 — *Maximum 12*

COMMENTS

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ◈ No Riffle (metric=0)

RIFFLE DEPTH

Check **ONE** (*ONLY!*)
- ◇ Best Areas >10cm (2)
- ◇ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◇ Maximum <50cm (1)

Check ONE (*or 2 & average*)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◇ Extensive (-1)

Riffle/Run 0 — *Maximum 8*

COMMENTS

6-GRADIENT

(3.885 ft/mi)

DRAINAGE AREA (30.791 mi²)

- ◇ Very low – Low (2-4)
- ◈ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 20 % GLIDE: 0

% RUN: 80 % RIFFLE: 0

Gradient 6 — *Maximum 10*

A115

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◈ >85% - Open	◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◇ 55%-<85%	◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ 30%-<55%	◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
		◇ Old - Succession				
◇ 10%-<30%	◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◇ <10% - Closed	◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
	◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
	◇ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading		◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
		◇ Stable - Bedload				
Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
	◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
	◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
91 Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
		◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
		◇ Snag Removed		◇ Atmosphere Deposition		
		◇ Snag Modified				
Left						

Stream Drawing

A116

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42671	Fish	20T004	Maria Creek	N Perry Road

Surveyor	Sample Date	County	Macro Sample Type
KJC	6/22/20	Knox	N/A

◇ Habitat Complete

QHEI Score: 30

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or* 2 & *average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)			
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)			
◇ ◇ Cobble (8)				◇ ◇ Muck (2)			
◇ ◇ Gravel (7)			x	◇ ◇ Silt (2)		x	
◈ ◈ Sand (6)		x	x	◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ◇ Limestone (1)
- ◈ Tills (1)
- ◇ Wetlands (0)
- ◇ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◈ Heavy (-2)
- ◇ Moderate (-1)
- ◇ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◈ Extensive (-2)
- ◇ Moderate (-1)
- ◇ Normal (0)
- ◇ None (1)

Substrate 9 *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- 1 Undercut banks (1)
- 1 Overhanging vegetation (1)
- 1 Shallows (in slow water) (1)
- 0 Rootmats (1)
- 0 Pools > 70cm (2)
- 0 Rootwads (1)
- 0 Boulders (1)
- 0 Oxbows, Backwaters (1)
- 0 Aquatic macrophytes (1)
- 0 Logs and woody debris (1)

AMOUNT

Check ONE (*or* 2 & *average*)
- ◇ Extensive >75% (11)
- ◇ Moderate 25-75% (7)
- ◇ Sparse 5-<25% (3)
- ◈ Nearly absent <5% (1)

COMMENTS

Cover Maximum 20 4

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY
- ◇ High (4)
- ◇ Moderate (3)
- ◇ Low (2)
- ◈ None (1)

DEVELOPMENT
- ◇ Excellent (7)
- ◇ Good (5)
- ◇ Fair (3)
- ◈ Poor (1)

CHANNELIZATION
- ◇ None (6)
- ◇ Recovered (4)
- ◈ Recovering (3)
- ◇ Recent or no recovery (1)

STABILITY
- ◇ High (3)
- ◇ Moderate (2)
- ◈ Low (1)

COMMENTS

Channel Maximum 20 6

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ◇ ◇ None or little (3)
- ◈ ◈ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◇ ◇ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◈ Narrow 5-10m (2)
- ◇ ◇ Very narrow <5m (1)
- ◈ ◇ None (0)

FLOOD PLAIN QUALITY (L R)
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian Maximum 10 3

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◇ 0.7-<1m (4)
- ◈ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or* 2 & *average*)
- ◇ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◇ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◇ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current Maximum 12 4

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

◈ No Riffle (metric=0)

Check **ONE** (*ONLY!*)

RIFFLE DEPTH
- ◇ Best Areas >10cm (2)
- ◇ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◇ Maximum <50cm (1)

Check ONE (*or* 2 & *average*)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◇ Extensive (-1)

Riffle/Run Maximum 8 0

COMMENTS

6-GRADIENT

(1.971 ft/mi)

DRAINAGE AREA

(78.969 mi²)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 0 % GLIDE: 100

% RUN: 0 % RIFFLE: 0

Gradient Maximum 10 4

A117

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	**B-AESTHETICS**	**C-MAINTENANCE**		**D-ISSUES**		
◇ **>85% - Open**	◇ **Nuisance algae**	◇ **Public**	◇ **Private**	◇ **WWTP**	◇ **NPDES**	◇ **CSO**
◈ **55%-<85%**	◇ **Invasive macrophytes**	◇ **Active**	◇ **Historic**	◇ **Hardened**	◇ **Urban**	◇ **Dirt & Grime**
◇ **30%-<55%**	◇ **Excess turbidity**	◇ **Young – Succession**		◇ **Contaminated**	◇ **Landfill**	◇ **Industry**
		◇ **Old - Succession**				
◇ **10%-<30%**	◇ **Discoloration**	◇ **Spray**		◇ **Construction BMPs**	◇ **Sediment BMPs**	
◇ **<10% - Closed**	◇ **Foam/Scum**			◇ **Logging**	◇ **Irrigation**	◇ **Cooling**
	◇ **Oil sheen**	◇ **Leveed – One sided**		◇ **Bank Erosion**	◇ **Surface Erosion**	◇ **H2O table**
	◇ **Trash/Litter**	◇ **Leveed – Both Banks**				
Canopy Upstream Reading		◇ **Moving – Bedload**		◇ **False bank**	◇ **Manure**	◇ **Lagoon**
		◇ **Stable - Bedload**				
58 Right	◇ **Nuisance odor**	◇ **Armoured**	◇ **Slumps**	◇ **Wash H2O**	◇ **Tile**	◇ **Natural Flow**
	◇ **Sludge deposits**	◇ **Islands**	◇ **Scoured**	◇ **Acid Mine**	◇ **Wetlands**	◇ **Stagnant Flow**
	◇ **CSOs/SSOs/Outfalls**	◇ **Relocated**	◇ **Cutoffs**	◇ **Quarry Mine**	◇ **Golf**	◇ **Home**
78 Middle		◇ **Impounded**	◇ **Desiccated**	◇ **Park**	◇ **Data Paucity**	◇ **Lawn**
		◇ **Flood Control**	◇ **Drainage**	◇ **Agriculture**	◇ **Livestock**	
		◇ **Snag Removed**		◇ **Atmosphere Deposition**		
		◇ **Snag Modified**				
55 Left						

Stream Drawing

A118

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42675	Fish	20T008	Tributary of Maria Creek	County Road 900 N, E Lower Freelandville Road

Surveyor	Sample Date	County	Macro Sample Type
KJC	6/22/20	Knox	N/A

◇ Habitat Complete

QHEI Score: 33

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or* 2 & *average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◈ ◈ Hardpan (4)		x	x
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)			
◇ ◇ Cobble (8)				◇ ◇ Muck (2)			
◇ ◇ Gravel (7)				◇ ◇ Silt (2)		x	x
◇ ◇ Sand (6)				◇ ◇ Artificial (0)		x	
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ◇ Limestone (1)
- ◇ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◇ Heavy (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ None (1)

Substrate **6** *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

1	Undercut banks (1)	0	Pools > 70cm (2)	0	Oxbows, Backwaters (1)
1	Overhanging vegetation (1)	0	Rootwads (1)	0	Aquatic macrophytes (1)
0	Shallows (in slow water) (1)	0	Boulders (1)	0	Logs and woody debris (1)
0	Rootmats (1)				

AMOUNT

Check ONE (*or* 2 & *average*)
- ◇ Extensive >75% (11)
- ◇ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover *Maximum 20* **5**

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◇ High (4)	◇ Excellent (7)	◇ None (6)	◇ High (3)
◇ Moderate (3)	◇ Good (5)	◇ Recovered (4)	◈ Moderate (2)
◈ Low (2)	◇ Fair (3)	◈ Recovering (3)	◇ Low (1)
◇ None (1)	◈ Poor (1)	◇ Recent or no recovery (1)	

COMMENTS

Channel *Maximum 20* **8**

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ◇ ◇ None or little (3)
- ◈ ◈ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◇ ◇ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◇ Narrow 5-10m (2)
- ◇ ◇ Very narrow <5m (1)
- ◈ ◈ None (0)

FLOOD PLAIN QUALITY (L R)
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian *Maximum 10* **2**

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◇ 0.7-<1m (4)
- ◈ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or* 2 & *average*)
- ◇ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◇ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◇ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current *Maximum 12* **4**

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

◈ No Riffle (metric=0)

Check ONE (*ONLY!*)

RIFFLE DEPTH
- ◇ Best Areas >10cm (2)
- ◇ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◇ Maximum <50cm (1)

Check ONE (*or* 2 & *average*)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◇ Extensive (-1)

COMMENTS

Riffle/Run *Maximum 8* **0**

6-GRADIENT

(12.542 ft/mi)

DRAINAGE AREA

(3.055 mi²)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 0 **% GLIDE: 100**

% RUN: 0 **% RIFFLE: 0**

Gradient *Maximum 10* **8**

A119

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY		B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◇ >85% - Open		◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◇ 55%-<85%		◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ 30%-<55%		◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
			◇ Old - Succession				
◇ 10%-<30%		◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◇ <10% - Closed		◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
		◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
		◇ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading			◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
			◇ Stable - Bedload				
	Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
		◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
		◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
97	Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
			◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
			◇ Snag Removed		◇ Atmosphere Deposition		
			◇ Snag Modified				
	Left						

Stream Drawing

A120

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42684	Fish	20T017	Tributary of Maria Creek	County Road 700 E, Lane Road

Surveyor	Sample Date	County	Macro Sample Type
CWY	6/22/20	Knox	N/A

◇ Habitat Complete

QHEI Score: 41

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or 2 & average*)

BEST TYPES

	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)			
◇ ◇ Boulders (9)			
◇ ◇ Cobble (8)			
◇ ◇ Gravel (7)			x
◇ ◈ Sand (6)		x	x
◇ ◇ Bedrock (5)			

OTHER TYPES

	TOTAL	POOL	RIFFLE
◇ ◇ Hardpan (4)		x	x
◇ ◇ Detritus (3)			
◇ ◇ Muck (2)			
◈ ◇ Silt (2)		x	
◇ ◇ Artificial (0)			

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES:
◇ 4 or more (2)
◈ 3 or less (0)

ORIGIN
◇ Limestone (1)
◇ Tills (1)
◇ Wetlands (0)
◈ Hardpan (0)
◇ Sandstone (0)
◇ Rip/Rap (0)
◇ Lacustrine (0)
◇ Shale (-1)
◇ Coal fines (-2)

QUALITY
SILT
◇ Heavy (-2)
◈ Moderate (-1)
◇ Normal (0)
◇ Free (1)
EMBEDDEDNESS
◇ Extensive (-2)
◈ Moderate (-1)
◇ Normal (0)
◇ None (1)

Substrate 6 *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

2 Undercut banks (1)
1 Overhanging vegetation (1)
2 Shallows (in slow water) (1)
3 Rootmats (1)
0 Pools > 70cm (2)
0 Rootwads (1)
0 Boulders (1)
0 Oxbows, Backwaters (1)
0 Aquatic macrophytes (1)
1 Logs and woody debris (1)

AMOUNT
Check ONE (*or 2 & average*)
◇ Extensive >75% (11)
◇ Moderate 25-75% (7)
◈ Sparse 5-<25% (3)
◇ Nearly absent <5% (1)

COMMENTS

Cover 8 *Maximum 20*

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or 2 & average*)

SINUOSITY
◇ High (4)
◈ Moderate (3)
◇ Low (2)
◇ None (1)

DEVELOPMENT
◇ Excellent (7)
◇ Good (5)
◈ Fair (3)
◇ Poor (1)

CHANNELIZATION
◇ None (6)
◇ Recovered (4)
◈ Recovering (3)
◇ Recent or no recovery (1)

STABILITY
◇ High (3)
◈ Moderate (2)
◇ Low (1)

COMMENTS

Channel 11 *Maximum 20*

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION
L R
◇ ◇ None or little (3)
◈ ◈ Moderate (2)
◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH
L R
◇ ◇ Wide >50m (4)
◇ ◇ Moderate 10-50m (3)
◈ ◇ Narrow 5-10m (2)
◇ ◈ Very narrow <5m (1)
◇ ◇ None (0)

FLOOD PLAIN QUALITY
L R
◇ ◇ Forest, Swamp (3)
◇ ◇ Shrub or Old field (2)
◇ ◇ Residential, Park, New field (1)
◇ ◇ Fenced pasture (1)
◈ ◈ Open Pasture/Rowcrop (0)
◇ ◇ Conservation Tillage (1)
◇ ◇ Urban or Industrial (0)
◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian 4 *Maximum 10*

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH
Check **ONE** (*ONLY!*)
◇ >1m (6)
◇ 0.7-<1m (4)
◈ 0.4-<0.7m (2)
◇ 0.2-<0.4m (1)
◇ <0.2m (0) (metric=0)

CHANNEL WIDTH
Check ONE (*or 2 & average*)
◇ Pool width > riffle width (2)
◈ Pool width = riffle width (1)
◇ Pool width < riffle width (0)

CURRENT VELOCITY
Check ALL that apply
◇ Torrential (-1)
◇ Very Fast (1)
◇ Fast (1)
◇ Moderate (1)
◈ Slow (1)
◇ Interstitial (-1)
◇ Intermittent (-2)
◇ Eddies (1)
Indicate for reach – pools and riffles.

RECREATION POTENTIAL
◇ *Primary Contact*
◇ *Secondary Contact*
(circle one and comment on back)

COMMENTS

Pool/Current 4 *Maximum 12*

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

◇ No Riffle (metric=0)

RIFFLE DEPTH
Check **ONE** (*ONLY!*)
◇ Best Areas >10cm (2)
◈ Best Areas 5-10cm (1)
◇ Best Areas <5cm (metric=0)

RUN DEPTH
◇ Maximum >50cm (2)
◈ Maximum <50cm (1)

RIFFLE/RUN SUBSTRATE
Check ONE (*or 2 & average*)
◇ Stable (e.g. cobble, boulder) (2)
◇ Mod. Stable (e.g. large gravel) (1)
◈ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
◇ None (2)
◇ Low (1)
◈ Moderate (0)
◇ Extensive (-1)

COMMENTS

Riffle/Run 2 *Maximum 8*

6-GRADIENT

(6.761 ft/mi)
DRAINAGE AREA
(4.37 mi^2)

◇ Very low – Low (2-4)
◇ Moderate (6-10)
◇ High – Very high (10-6)

% POOL: 10
% GLIDE: 0
% RUN: 70
% RIFFLE: 20

Gradient 6 *Maximum 10*

A121

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◇ >85% - Open	◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◇ 55%-<85%	◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ 30%-<55%	◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
		◇ Old - Succession				
◈ 10%-<30%	◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◇ <10% - Closed	◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
	◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
	◇ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading		◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
		◇ Stable - Bedload				
Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
	◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
	◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
12 Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
		◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
		◇ Snag Removed		◇ Atmosphere Deposition		
		◇ Snag Modified				
Left						

Stream Drawing

A122

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42672	Fish	20T005	Maria Creek	N Risley Road

Surveyor	Sample Date	County	Macro Sample Type
KRW	8/18/20	Knox	N/A

◇ Habitat Complete

QHEI Score: 32

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or 2 & average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◈ Hardpan (4)		x	x
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)			
◇ ◇ Cobble (8)				◇ ◇ Muck (2)		x	
◇ ◇ Gravel (7)		x	x	◇ ◇ Silt (2)			
◈ ◇ Sand (6)		x	x	◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ◇ Limestone (1)
- ◇ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◈ Heavy (-2)
- ◇ Moderate (-1)
- ◇ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◈ Extensive (-2)
- ◇ Moderate (-1)
- ◇ Normal (0)
- ◇ None (1)

Substrate 6 *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

1 Undercut banks (1)	1 Pools > 70cm (2)	0 Oxbows, Backwaters (1)
0 Overhanging vegetation (1)	0 Rootwads (1)	0 Aquatic macrophytes (1)
1 Shallows (in slow water) (1)	0 Boulders (1)	0 Logs and woody debris (1)
0 Rootmats (1)		

AMOUNT

Check ONE (*or 2 & average*)
- ◇ Extensive >75% (11)
- ◇ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◈ Nearly absent <5% (1)

COMMENTS

Cover Maximum 20 6

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or 2 & average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◇ High (4)	◇ Excellent (7)	◇ None (6)	◇ High (3)
◇ Moderate (3)	◇ Good (5)	◇ Recovered (4)	◈ Moderate (2)
◇ Low (2)	◇ Fair (3)	◈ Recovering (3)	◈ Low (1)
◈ None (1)	◈ Poor (1)	◇ Recent or no recovery (1)	

COMMENTS

Channel Maximum 20 7

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION

L R
- ◇ ◇ None or little (3)
- ◇ ◇ Moderate (2)
- ◈ ◈ Heavy/Severe (1)

RIPARIAN WIDTH

L R
- ◇ ◇ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◈ ◈ Narrow 5-10m (2)
- ◇ ◇ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY

L R
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)

L R
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian Maximum 10 3

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◈ 0.7-<1m (4)
- ◇ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or 2 & average*)
- ◇ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◇ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◇ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current Maximum 12 6

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

◈ No Riffle (metric=0)

Check **ONE** (*ONLY!*)

RIFFLE DEPTH
- ◇ Best Areas >10cm (2)
- ◇ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◇ Maximum <50cm (1)

Check ONE (*or 2 & average*)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◇ Extensive (-1)

COMMENTS

Riffle/Run Maximum 8 0

6-GRADIENT

(1.971 ft/mi)

DRAINAGE AREA

(49.206 mi²)

- ◈ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 40 % GLIDE: 0

% RUN: 60 % RIFFLE: 0

Gradient Maximum 10 4

A123

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◇ >85% - Open	◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◈ 55%-<85%	◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ 30%-<55%	◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
		◇ Old - Succession				
◇ 10%-<30%	◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◇ <10% - Closed	◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
	◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
	◇ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading		◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
		◇ Stable - Bedload				
59 Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
	◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
	◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
80 Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
		◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
		◇ Snag Removed		◇ Atmosphere Deposition		
		◇ Snag Modified				
77 Left						

Stream Drawing

A124

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42965	Macro	200714802	Maria Creek	CR 1050 N/Freelandville Road

Surveyor	Sample Date	County	Macro Sample Type
RAC	7/14/20	Knox	MHAB

◇ Habitat Complete

QHEI Score: 38

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

BEST TYPES

	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)			
◇ ◇ Boulders (9)			
◇ ◇ Cobble (8)			
◇ ◇ Gravel (7)		x	x
◈ ◇ Sand (6)		x	x
◇ ◇ Bedrock (5)			

OTHER TYPES

	TOTAL	POOL	RIFFLE
◇ ◇ Hardpan (4)			
◇ ◇ Detritus (3)		x	
◇ ◇ Muck (2)			
◇ ◈ Silt (2)		x	x
◇ ◇ Artificial (0)		x	x

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

Check ONE (*or* 2 & *average*)

ORIGIN
- ◇ Limestone (1)
- ◈ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◇ Heavy (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ None (1)

Substrate 7 — *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

	Undercut banks (1)			Pools > 70cm (2)			Oxbows, Backwaters (1)
	2	Overhanging vegetation (1)		Rootwads (1)		2	Aquatic macrophytes (1)
	2	Shallows (in slow water) (1)		Boulders (1)			Logs and woody debris (1)
	1	Rootmats (1)					

AMOUNT

Check ONE (*or* 2 & *average*)
- ◇ Extensive >75% (11)
- ◇ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS macrophytes coated in filamentous algae

Cover 7 — *Maximum 20*

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY
- ◇ High (4)
- ◇ Moderate (3)
- ◈ Low (2)
- ◇ None (1)

DEVELOPMENT
- ◇ Excellent (7)
- ◇ Good (5)
- ◇ Fair (3)
- ◈ Poor (1)

CHANNELIZATION
- ◇ None (6)
- ◈ Recovered (4)
- ◇ Recovering (3)
- ◇ Recent or no recovery (1)

STABILITY
- ◇ High (3)
- ◈ Moderate (2)
- ◇ Low (1)

Channel 9 — *Maximum 20*

COMMENTS

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ◈ ◈ None or little (3)
- ◇ ◇ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◇ ◇ Wide >50m (4)
- ◇ ◈ Moderate 10-50m (3)
- ◈ ◇ Narrow 5-10m (2)
- ◈ ◇ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY (L R)
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

Riparian 5 — *Maximum 10*

COMMENTS

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◇ 0.7-<1m (4)
- ◈ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or* 2 & *average*)
- ◇ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◇ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◇ *Secondary Contact*

(circle one and comment on back)

Pool/Current 4 — *Maximum 12*

COMMENTS

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ◈ No Riffle (metric=0)

RIFFLE DEPTH

Check **ONE** (*ONLY!*)
- ◇ Best Areas >10cm (2)
- ◇ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◇ Maximum <50cm (1)

Check ONE (*or* 2 & *average*)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◇ Extensive (-1)

Riffle/Run 0 — *Maximum 8*

COMMENTS

6-GRADIENT

(5.282 ft/mi)

DRAINAGE AREA

(17.468 mi^2)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 20 **% GLIDE:** 40

% RUN: 40 **% RIFFLE:** #$

Gradient 6 — *Maximum 10*

A125

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
>85% - Open	Nuisance algae	Public	Private	WWTP	NPDES	CSO
55%-<85%	Invasive macrophytes	Active	Historic	Hardened	Urban	Dirt & Grime
30%-<55%	Excess turbidity	Young – Succession		Contaminated	Landfill	Industry
		Old - Succession				
10%-<30%	Discoloration	Spray		Construction BMPs	Sediment BMPs	
<10% - Closed	Foam/Scum			Logging	Irrigation	Cooling
	Oil sheen	Leveed – One sided		Bank Erosion	Surface Erosion	H2O table
	Trash/Litter	Leveed – Both Banks				
Canopy Upstream Reading		Moving – Bedload		False bank	Manure	Lagoon
		Stable - Bedload				
Right	Nuisance odor	Armoured	Slumps	Wash H2O	Tile	Natural Flow
	Sludge deposits	Islands	Scoured	Acid Mine	Wetlands	Stagnant Flow
	CSOs/SSOs/Outfalls	Relocated	Cutoffs	Quarry Mine	Golf	Home
97 Middle		Impounded	Desiccated	Park	Data Paucity	Lawn
		Flood Control	Drainage	Agriculture	Livestock	
		Snag Removed		Atmosphere Deposition		
		Snag Modified				
Left						

Stream Drawing

A126

IDEM OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42974	Macro	200715801	Marsh Creek	S County Road 50 E

Surveyor	Sample Date	County	Macro Sample Type
RAC	7/15/20	Sullivan	MHAB

◈ Habitat Complete

QHEI Score: 37

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or* 2 & *average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE	ORIGIN	QUALITY
◇ ◇ Bldrs/Slabs (10)				◈ ◇ Hardpan (4)		x	x	◇ Limestone (1)	SILT ◇ Heavy (-2)
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)		x	x	◇ Tills (1)	◈ Moderate (-1)
◇ ◇ Cobble (8)				◇ ◇ Muck (2)		x		◈ Wetlands (0)	◇ Normal (0)
◇ ◇ Gravel (7)			x	◇ ◈ Silt (2)		x	x	◈ Hardpan (0)	◇ Free (1)
◇ ◇ Sand (6)			x	◇ ◇ Artificial (0)				◇ Sandstone (0)	EMBEDDEDNESS ◇ Extensive (-2)
◇ ◇ Bedrock (5)								◇ Rip/Rap (0)	◈ Moderate (-1)
								◇ Lacustrine (0)	◇ Normal (0)
								◇ Shale (-1)	◇ None (1)
								◇ Coal fines (-2)	

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

Substrate 4 *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

		Undercut banks (1)			Pools > 70cm (2)		Oxbows, Backwaters (1)
	2	Overhanging vegetation (1)			Rootwads (1)		Aquatic macrophytes (1)
		Shallows (in slow water) (1)			Boulders (1)	1	Logs and woody debris (1)
	1	Rootmats (1)					

AMOUNT

Check ONE (*or* 2 & *average*)

- ◇ Extensive >75% (11)
- ◇ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover Maximum 20 6

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◇ High (4)	◇ Excellent (7)	◇ None (6)	◇ High (3)
◇ Moderate (3)	◇ Good (5)	◈ Recovered (4)	◈ Moderate (2)
◈ Low (2)	◇ Fair (3)	◇ Recovering (3)	◇ Low (1)
◇ None (1)	◈ Poor (1)	◇ Recent or no recovery (1)	

COMMENTS

Channel Maximum 20 9

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or* 2 *per bank & average*)

River right looking downstream

EROSION (L R)	RIPARIAN WIDTH (L R)	FLOOD PLAIN QUALITY (L R)	FLOOD PLAIN QUALITY (L R)
◈ ◈ None or little (3)	◇ ◇ Wide >50m (4)	◇ ◇ Forest, Swamp (3)	◇ ◇ Conservation Tillage (1)
◇ ◇ Moderate (2)	◇ ◇ Moderate 10-50m (3)	◇ ◇ Shrub or Old field (2)	◇ ◇ Urban or Industrial (0)
◇ ◇ Heavy/Severe (1)	◈ ◇ Narrow 5-10m (2)	◇ ◇ Residential, Park, New field (1)	◇ ◇ Mining, construction (0)
	◇ ◇ Very narrow <5m (1)	◇ ◇ Fenced pasture (1)	
	◇ ◈ None (0)	◈ ◈ Open Pasture/Rowcrop (0)	

Indicate predominant land use(s) past 100m riparian.

COMMENTS more moderate erosion downstream of reach

Riparian Maximum 10 4

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH Check **ONE** (*ONLY!*)	CHANNEL WIDTH Check ONE (*or* 2 & *average*)	CURRENT VELOCITY Check ALL that apply	
◇ >1m (6)	◇ Pool width > riffle width (2)	◇ Torrential (-1)	◈ Slow (1)
◇ 0.7-<1m (4)	◈ Pool width = riffle width (1)	◇ Very Fast (1)	◇ Interstitial (-1)
◈ 0.4-<0.7m (2)	◇ Pool width < riffle width (0)	◇ Fast (1)	◇ Intermittent (-2)
◇ 0.2-<0.4m (1)		◇ Moderate (1)	◇ Eddies (1)
◇ <0.2m (0) (metric=0)			

Indicate for reach – pools and riffles.

RECREATION POTENTIAL

◇ *Primary Contact*

◇ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current Maximum 12 4

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

◇ No Riffle (metric=0)

Check **ONE** (*ONLY!*) — Check ONE (*or* 2 & *average*)

RIFFLE DEPTH	RUN DEPTH	RIFFLE/RUN SUBSTRATE	RIFFLE/RUN EMBEDDEDNESS
◇ Best Areas >10cm (2)	◇ Maximum >50cm (2)	◇ Stable (e.g. cobble, boulder) (2)	◇ None (2)
◈ Best Areas 5-10cm (1)	◈ Maximum <50cm (1)	◈ Mod. Stable (e.g. large gravel) (1)	◈ Low (1)
◇ Best Areas <5cm (metric=0)		◈ Unstable (e.g. sand, fine gravel) (0)	◇ Moderate (0)
			◇ Extensive (-1)

Riffle/Run Maximum 8 4

COMMENTS riffle was sampled 27 m downstream of reach

6-GRADIENT

(5.502 ft/mi)

DRAINAGE AREA (8.376 mi²)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 30 **% GLIDE:** 30

% RUN: 40 **% RIFFLE:** #$

Gradient Maximum 10 6

A127

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
>85% - Open	Nuisance algae	Public	Private	WWTP	NPDES	CSO
55%-<85%	Invasive macrophytes	Active	Historic	Hardened	Urban	Dirt & Grime
30%-<55%	Excess turbidity	Young – Succession		Contaminated	Landfill	Industry
		Old - Succession				
10%-<30%	Discoloration	Spray		Construction BMPs	Sediment BMPs	
<10% - Closed	Foam/Scum			Logging	Irrigation	Cooling
	Oil sheen	Leveed – One sided		Bank Erosion	Surface Erosion	H2O table
	Trash/Litter	Leveed – Both Banks				
Canopy Upstream Reading		Moving – Bedload		False bank	Manure	Lagoon
		Stable - Bedload				
Right	Nuisance odor	Armoured	Slumps	Wash H2O	Tile	Natural Flow
	Sludge deposits	Islands	Scoured	Acid Mine	Wetlands	Stagnant Flow
	CSOs/SSOs/Outfalls	Relocated	Cutoffs	Quarry Mine	Golf	Home
65 Middle		Impounded	Desiccated	Park	Data Paucity	Lawn
		Flood Control	Drainage	Agriculture	Livestock	
		Snag Removed		Atmosphere Deposition		
		Snag Modified				
Left						

Stream Drawing

A128

IDEM OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42961	Macro	200714703	Maria Creek	N Perry Road

Surveyor	Sample Date	County	Macro Sample Type		QHEI Score:
PDM	7/14/20	Knox	MHAB	◈ Habitat Complete	28

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or* 2 & *average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE	ORIGIN	QUALITY
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)				◇ Limestone (1)	SILT ◈ Heavy (-2)
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)		X	X	◈ Tills (1)	◈ Moderate (-1)
◇ ◇ Cobble (8)				◇ ◇ Muck (2)				◇ Wetlands (0)	◇ Normal (0)
◇ ◇ Gravel (7)		X	X	◇ ◈ Silt (2)		X	X	◈ Hardpan (0)	◇ Free (1)
◈ ◇ Sand (6)		X	X	◇ ◇ Artificial (0)				◇ Sandstone (0)	EMBEDDEDNESS ◇ Extensive (-2)
◇ ◇ Bedrock (5)								◇ Rip/Rap (0)	◈ Moderate (-1)
								◇ Lacustrine (0)	◇ Normal (0)
								◇ Shale (-1)	◇ None (1)
								◇ Coal fines (-2)	

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

Substrate 6 *Maximum 20*

COMMENTS Substrate origin ?, seems like glacial tills from map, or from dunes/glacial outwash/ river floodplain deposits

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

						AMOUNT
0	Undercut banks (1)	0	Pools > 70cm (2)	0	Oxbows, Backwaters (1)	Check ONE (*or* 2 & *average*) ◇ Extensive >75% (11)
0	Overhanging vegetation (1)	0	Rootwads (1)	0	Aquatic macrophytes (1)	◇ Moderate 25-75% (7)
2	Shallows (in slow water) (1)	0	Boulders (1)	1	Logs and woody debris (1)	◇ Sparse 5-<25% (3)
0	Rootmats (1)					◈ Nearly absent <5% (1)

COMMENTS

Cover Maximum 20 3

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◇ High (4)	◇ Excellent (7)	◇ None (6)	◇ High (3)
◇ Moderate (3)	◇ Good (5)	◇ Recovered (4)	◇ Moderate (2)
◇ Low (2)	◇ Fair (3)	◈ Recovering (3)	◈ Low (1)
◈ None (1)	◈ Poor (1)	◇ Recent or no recovery (1)	

COMMENTS

Channel Maximum 20 6

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)	RIPARIAN WIDTH (L R)	FLOOD PLAIN QUALITY (L R)	(L R)
◈ ◈ None or little (3)	◇ ◇ Wide >50m (4)	◇ ◇ Forest, Swamp (3)	◇ ◇ Conservation Tillage (1)
◈ ◈ Moderate (2)	◇ ◇ Moderate 10-50m (3)	◇ ◇ Shrub or Old field (2)	◇ ◇ Urban or Industrial (0)
◇ ◇ Heavy/Severe (1)	◇ ◇ Narrow 5-10m (2)	◇ ◇ Residential, Park, New field (1)	◇ ◇ Mining, construction (0)
	◈ ◈ Very narrow <5m (1)	◇ ◇ Fenced pasture (1)	*Indicate predominant land use(s) past 100m riparian.*
	◇ ◇ None (0)	◈ ◈ Open Pasture/Rowcrop (0)	

COMMENTS

Riparian Maximum 10 4

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH	CHANNEL WIDTH	CURRENT VELOCITY	
Check **ONE** (*ONLY!*)	Check ONE (*or* 2 & *average*)	Check ALL that apply	
◇ >1m (6)	◇ Pool width > riffle width (2)	◇ Torrential (-1)	◈ Slow (1)
◇ 0.7-<1m (4)	◈ Pool width = riffle width (1)	◇ Very Fast (1)	◇ Interstitial (-1)
◈ 0.4-<0.7m (2)	◇ Pool width < riffle width (0)	◇ Fast (1)	◇ Intermittent (-2)
◇ 0.2-<0.4m (1)		◈ Moderate (1)	◇ Eddies (1)
◇ <0.2m (0) (metric=0)		Indicate for reach – pools and riffles.	

RECREATION POTENTIAL
◇ *Primary Contact*
◇ *Secondary Contact*
(circle one and comment on back)

COMMENTS

Pool/Current Maximum 12 5

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ◈ No Riffle (metric=0)

RIFFLE DEPTH	RUN DEPTH	RIFFLE/RUN SUBSTRATE	RIFFLE/RUN EMBEDDEDNESS
Check **ONE** (*ONLY!*)		Check ONE (*or* 2 & *average*)	
◇ Best Areas >10cm (2)	◇ Maximum >50cm (2)	◇ Stable (e.g. cobble, boulder) (2)	◇ None (2)
◇ Best Areas 5-10cm (1)	◇ Maximum <50cm (1)	◇ Mod. Stable (e.g. large gravel) (1)	◇ Low (1)
◇ Best Areas <5cm (metric=0)		◇ Unstable (e.g. sand, fine gravel) (0)	◇ Moderate (0)
			◇ Extensive (-1)

COMMENTS

Riffle/Run Maximum 8 0

6-GRADIENT

(1.971 ft/mi)
DRAINAGE AREA
(78.969 mi²)

◇ Very low – Low (2-4)
◇ Moderate (6-10)
◇ High – Very high (10-6)

% POOL: 10 **% GLIDE:** 70
% RUN: 20 **% RIFFLE:** #$

Gradient Maximum A129*10* 4

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY

- >85% - Open
- 55%-<85%
- 30%-<55%
- 10%-<30%
- <10% - Closed

Canopy Upstream Reading

Right

99 Middle

Left

B-AESTHETICS

- Nuisance algae
- Invasive macrophytes
- Excess turbidity
- Discoloration
- Foam/Scum
- Oil sheen
- Trash/Litter
- Nuisance odor
- Sludge deposits
- CSOs/SSOs/Outfalls

C-MAINTENANCE

Public	Private
Active	Historic
Young – Succession	
Old - Succession	
Spray	
Leveed – One sided	
Leveed – Both Banks	
Moving – Bedload	
Stable - Bedload	
Armoured	Slumps
Islands	Scoured
Relocated	Cutoffs
Impounded	Desiccated
Flood Control	Drainage
Snag Removed	
Snag Modified	

D-ISSUES

WWTP	NPDES	CSO
Hardened	Urban	Dirt & Grime
Contaminated	Landfill	Industry
Construction BMPs	Sediment BMPs	
Logging	Irrigation	Cooling
Bank Erosion	Surface Erosion	H2O table
False bank	Manure	Lagoon
Wash H2O	Tile	Natural Flow
Acid Mine	Wetlands	Stagnant Flow
Quarry Mine	Golf	Home
Park	Data Paucity	Lawn
Agriculture	Livestock	
Atmosphere Deposition		

Stream Drawing

A130

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42981	Macro	200714805	Tributary of Maria Creek	Freelandville Road

Surveyor	Sample Date	County	Macro Sample Type
MSG	7/14/20	Knox	MHAB

◇ Habitat Complete

QHEI Score: 23

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or* 2 & *average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)		x	
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)		x	
◇ ◇ Cobble (8)				◇ ◈ Muck (2)		x	x
◇ ◇ Gravel (7)				◈ ◇ Silt (2)		x	x
◇ ◇ Sand (6)		x		◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ◇ Limestone (1)
- ◇ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◈ Heavy (-2)
- ◇ Moderate (-1)
- ◇ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◈ Extensive (-2)
- ◇ Moderate (-1)
- ◇ Normal (0)
- ◇ None (1)

Substrate **0** *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

	Undercut banks (1)		Pools > 70cm (2)		Oxbows, Backwaters (1)
2	Overhanging vegetation (1)		Rootwads (1)		Aquatic macrophytes (1)
	Shallows (in slow water) (1)		Boulders (1)	1	Logs and woody debris (1)
1	Rootmats (1)				

AMOUNT

Check ONE (*or* 2 & *average*)
- ◇ Extensive >75% (11)
- ◇ Moderate 25-75% (7)
- ◇ Sparse 5-<25% (3)
- ◈ Nearly absent <5% (1)

COMMENTS

Cover Maximum 20 **4**

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◇ High (4)	◇ Excellent (7)	◇ None (6)	◇ High (3)
◇ Moderate (3)	◇ Good (5)	◈ Recovered (4)	◇ Moderate (2)
◇ Low (2)	◇ Fair (3)	◇ Recovering (3)	◈ Low (1)
◈ None (1)	◈ Poor (1)	◇ Recent or no recovery (1)	

COMMENTS

Channel Maximum 20 **7**

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or* 2 *per bank & average*)

River right looking downstream

EROSION (L R)
- ◈ ◈ None or little (3)
- ◈ ◈ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◇ ◇ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◇ Narrow 5-10m (2)
- ◇ ◇ Very narrow <5m (1)
- ◈ ◈ None (0)

FLOOD PLAIN QUALITY (L R)
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian Maximum 10 **3**

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH
Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◇ 0.7-<1m (4)
- ◇ 0.4-<0.7m (2)
- ◈ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH
Check ONE (*or* 2 & *average*)
- ◇ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY
Check ALL that apply
- ◇ Torrential (-1)
- ◈ Slow (1)
- ◇ Very Fast (1)
- ◇ Interstitial (-1)
- ◇ Fast (1)
- ◇ Intermittent (-2)
- ◇ Moderate (1)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◈ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current Maximum 12 **3**

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ◈ No Riffle (metric=0)

Check **ONE** (*ONLY!*) Check ONE (*or* 2 & *average*)

RIFFLE DEPTH
- ◇ Best Areas >10cm (2)
- ◇ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◇ Maximum <50cm (1)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◇ Extensive (-1)

Riffle/Run Maximum 8 **0**

COMMENTS

6-GRADIENT

(7.362 ft/mi)

DRAINAGE AREA

(2.96 mi^2)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 30 **% GLIDE:** 70

% RUN: #$ **% RIFFLE:** #$

Gradient Maximum 10 **6**

A131

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◇ >85% - Open	◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◇ 55%-<85%	◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ 30%-<55%	◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
		◇ Old - Succession				
◇ 10%-<30%	◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◇ <10% - Closed	◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
	◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
	◇ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading		◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
		◇ Stable - Bedload				
Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
	◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
	◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
100 Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
		◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
		◇ Snag Removed		◇ Atmosphere Deposition		
		◇ Snag Modified				
Left						

Stream Drawing

A132

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42967	Macro	200714704	Marsh Creek	E Springtown Road

Surveyor	Sample Date	County	Macro Sample Type	
PDM	7/14/20	Knox	MHAB	◇ Habitat Complete

QHEI Score: 35

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or* 2 & *average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)			
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)			
◇ ◇ Cobble (8)				◇ ◇ Muck (2)			
◇ ◇ Gravel (7)		X	X	◇ ◈ Silt (2)		X	X
◈ ◇ Sand (6)		X	X	◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ◇ Limestone (1)
- ◇ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◇ Heavy (-2)
- ◈ Moderate (-1)
- ◈ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ None (1)

Substrate 7 *Maximum 20*

COMMENTS ?

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

1	Undercut banks (1)	0	Pools > 70cm (2)	0	Oxbows, Backwaters (1)
1	Overhanging vegetation (1)	0	Rootwads (1)	2	Aquatic macrophytes (1)
2	Shallows (in slow water) (1)	0	Boulders (1)	0	Logs and woody debris (1)
0	Rootmats (1)				

AMOUNT

Check ONE (*or* 2 & *average*)
- ◇ Extensive >75% (11)
- ◈ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover 9 *Maximum 20*

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◇ High (4)	◇ Excellent (7)	◇ None (6)	◇ High (3)
◇ Moderate (3)	◇ Good (5)	◇ Recovered (4)	◇ Moderate (2)
◇ Low (2)	◈ Fair (3)	◈ Recovering (3)	◈ Low (1)
◈ None (1)	◈ Poor (1)	◇ Recent or no recovery (1)	

COMMENTS

Channel 7 *Maximum 20*

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ◈ ◈ None or little (3)
- ◇ ◇ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◇ ◇ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◇ Narrow 5-10m (2)
- ◈ ◈ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY (L R)
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian 4 *Maximum 10*

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◇ 0.7-<1m (4)
- ◇ 0.4-<0.7m (2)
- ◈ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or* 2 & *average*)
- ◇ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◈ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◇ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current 4 *Maximum 12*

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

◈ No Riffle (metric=0)

Check **ONE** (*ONLY!*) Check ONE (*or* 2 & *average*)

RIFFLE DEPTH
- ◇ Best Areas >10cm (2)
- ◇ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◇ Maximum <50cm (1)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◇ Extensive (-1)

COMMENTS

Riffle/Run 0 *Maximum 8*

6-GRADIENT

(2.96 ft/mi)

DRAINAGE AREA (23.57 mi²)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 10 % GLIDE: 30

% RUN: 60 % RIFFLE: #$

Gradient 4 *Maximum 10*

A133

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◈ >85% - Open	◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◇ 55%-<85%	◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ 30%-<55%	◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
		◇ Old - Succession				
◇ 10%-<30%	◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◇ <10% - Closed	◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
	◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
	◇ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading		◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
		◇ Stable - Bedload				
Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
	◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
	◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
98 Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
		◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
		◇ Snag Removed		◇ Atmosphere Deposition		
		◇ Snag Modified				
Left						

Stream Drawing

A134

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42978	Macro	200714702	Cotton Branch	E Springtown Road

Surveyor	Sample Date	County	Macro Sample Type
JMB	7/14/20	Knox	MHAB

◇ Habitat Complete

QHEI Score: 63

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

BEST TYPES

	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)			
◇ ◇ Boulders (9)			
◇ ◇ Cobble (8)			
◇ ◇ Gravel (7)			X
◈ ◇ Sand (6)		X	X
◇ ◇ Bedrock (5)			

OTHER TYPES

	TOTAL	POOL	RIFFLE
◇ ◈ Hardpan (4)		X	X
◇ ◇ Detritus (3)		X	X
◇ ◇ Muck (2)			
◇ ◇ Silt (2)		X	X
◇ ◇ Artificial (0)			

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

Check ONE (*or* 2 & *average*)

ORIGIN
- ◇ Limestone (1)
- ◇ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◇ Heavy (-2)
- ◇ Moderate (-1)
- ◈ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◇ Moderate (-1)
- ◈ Normal (0)
- ◇ None (1)

Substrate **10** *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

Score	Cover type	Score	Cover type	Score	Cover type
2	Undercut banks (1)	3	Pools > 70cm (2)	0	Oxbows, Backwaters (1)
0	Overhanging vegetation (1)	1	Rootwads (1)	0	Aquatic macrophytes (1)
3	Shallows (in slow water) (1)	0	Boulders (1)	2	Logs and woody debris (1)
1	Rootmats (1)				

AMOUNT

Check ONE (*or* 2 & *average*)
- ◇ Extensive >75% (11)
- ◈ Moderate 25-75% (7)
- ◇ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover *Maximum 20* **14**

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY
- ◇ High (4)
- ◈ Moderate (3)
- ◇ Low (2)
- ◇ None (1)

DEVELOPMENT
- ◇ Excellent (7)
- ◈ Good (5)
- ◈ Fair (3)
- ◇ Poor (1)

CHANNELIZATION
- ◈ None (6)
- ◇ Recovered (4)
- ◇ Recovering (3)
- ◇ Recent or no recovery (1)

STABILITY
- ◇ High (3)
- ◈ Moderate (2)
- ◇ Low (1)

COMMENTS

Channel *Maximum 20* **15**

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION

L R
- ◇ ◇ None or little (3)
- ◈ ◇ Moderate (2)
- ◈ ◈ Heavy/Severe (1)

RIPARIAN WIDTH

L R
- ◈ ◈ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◇ Narrow 5-10m (2)
- ◇ ◇ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY

L R
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)

L R
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian *Maximum 10* **5**

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◈ >1m (6)
- ◇ 0.7-<1m (4)
- ◇ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or* 2 & *average*)
- ◈ Pool width > riffle width (2)
- ◇ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◈ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◇ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current *Maximum 12* **10**

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

◇ No Riffle (metric=0)

Check **ONE** (*ONLY!*)

RIFFLE DEPTH
- ◇ Best Areas >10cm (2)
- ◈ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm(metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◈ Maximum <50cm (1)

Check ONE (*or* 2 & *average*)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◈ Mod. Stable (e.g. large gravel) (1)
- ◈ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◈ Moderate (0)
- ◇ Extensive (-1)

COMMENTS

Riffle/Run *Maximum 8* **3**

6-GRADIENT

(9.645 ft/mi)

DRAINAGE AREA

(3.133 mi²)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 30 **% GLIDE: #$**

% RUN: 60 **% RIFFLE: 10**

Gradient *Maximum 10* **6**

A135

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◇ >85% - Open	◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◇ 55%-<85%	◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ 30%-<55%	◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
		◇ Old - Succession				
◇ 10%-<30%	◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◈ <10% - Closed	◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
	◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
	◇ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading		◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
		◇ Stable - Bedload				
Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
	◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
	◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
0 Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
		◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
		◇ Snag Removed		◇ Atmosphere Deposition		
		◇ Snag Modified				
Left						

Stream Drawing

A136

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42977	Macro	200715701	Maria Creek	N Risley Road

Surveyor	Sample Date	County	Macro Sample Type	
PDM	7/15/20	Knox	MHAB	◇ Habitat Complete

QHEI Score: 30

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◈ Hardpan (4)		X	
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)		X	
◇ ◇ Cobble (8)				◇ ◇ Muck (2)			
◇ ◇ Gravel (7)				◈ ◇ Silt (2)		X	
◇ ◇ Sand (6)		X		◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

Check ONE (*or* 2 & *average*)

ORIGIN
- ◇ Limestone (1)
- ◇ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◈ Heavy (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◇ Moderate (-1)
- ◈ Normal (0)
- ◇ None (1)

Substrate 5 — *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

1	**Undercut banks (1)**	1	**Pools > 70cm (2)**	0	**Oxbows, Backwaters (1)**
0	**Overhanging vegetation (1)**	0	**Rootwads (1)**	0	**Aquatic macrophytes (1)**
0	**Shallows (in slow water) (1)**	0	**Boulders (1)**	0	**Logs and woody debris (1)**
0	**Rootmats (1)**				

AMOUNT

Check ONE (*or* 2 & *average*)
- ◇ Extensive >75% (11)
- ◇ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◈ Nearly absent <5% (1)

COMMENTS

Cover *Maximum 20* 5

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◇ High (4)	◇ Excellent (7)	◇ None (6)	◇ High (3)
◇ Moderate (3)	◇ Good (5)	◇ Recovered (4)	◇ Moderate (2)
◇ Low (2)	◇ Fair (3)	◈ Recovering (3)	◈ Low (1)
◈ None (1)	◈ Poor (1)	◈ Recent or no recovery (1)	

COMMENTS

Channel *Maximum 20* 5

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION

L R
- ◈ ◈ None or little (3)
- ◈ ◇ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH

L R
- ◇ ◇ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◇ Narrow 5-10m (2)
- ◈ ◈ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY

L R
- ◈ ◈ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)

L R
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian *Maximum 10* 5

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◈ 0.7-<1m (4)
- ◇ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or* 2 & *average*)
- ◇ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◇ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ ***Primary Contact***
- ◇ ***Secondary Contact***

(circle one and comment on back)

COMMENTS

Pool/Current *Maximum 12* 6

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ◈ **No Riffle (metric=0)**

RIFFLE DEPTH

Check **ONE** (*ONLY!*)
- ◇ Best Areas >10cm (2)
- ◇ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◇ Maximum <50cm (1)

Check ONE (*or* 2 & *average*)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◇ Extensive (-1)

COMMENTS

Riffle/Run *Maximum 8* 0

6-GRADIENT

(1.971 ft/mi)

DRAINAGE AREA

(49.206 mi^2)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 100 **% GLIDE:** #$

% RUN: #$ **% RIFFLE:** #$

Gradient *Maximum 10* 4

A137

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◇ >85% - Open	◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◈ 55%-<85%	◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ 30%-<55%	◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
		◇ Old - Succession				
◇ 10%-<30%	◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◇ <10% - Closed	◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
	◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
	◇ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading		◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
		◇ Stable - Bedload				
Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
	◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
	◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
82 Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
		◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
		◇ Snag Removed		◇ Atmosphere Deposition		
		◇ Snag Modified				
Left						

Stream Drawing

A138

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42982	Macro	200714803	Maria Creek	CR 1050 N/Freelandville Road

Surveyor	Sample Date	County	Macro Sample Type	
RAC	7/14/20	Knox	MHAB	◇ Habitat Complete

QHEI Score: 38

1-SUBSTRATE

Check *ONLY* Two substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or* 2 & *average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◈ Hardpan (4)			x
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)		x	x
◇ ◇ Cobble (8)				◇ ◇ Muck (2)			
◇ ◇ Gravel (7)		x	x	◇ ◇ Silt (2)		x	x
◈ ◇ Sand (6)		x	x	◇ ◇ Artificial (0)		x	x
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ◇ Limestone (1)
- ◈ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◇ Heavy (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ None (1)

Substrate 9 — *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

	Cover type		Cover type		Cover type
	Undercut banks (1)		Pools > 70cm (2)		Oxbows, Backwaters (1)
2	Overhanging vegetation (1)		Rootwads (1)	2	Aquatic macrophytes (1)
2	Shallows (in slow water) (1)		Boulders (1)		Logs and woody debris (1)
1	Rootmats (1)				

AMOUNT

Check ONE (*or* 2 & *average*)
- ◇ Extensive >75% (11)
- ◇ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover 7 — *Maximum 20*

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◇ High (4)	◇ Excellent (7)	◇ None (6)	◇ High (3)
◇ Moderate (3)	◇ Good (5)	◈ Recovered (4)	◈ Moderate (2)
◈ Low (2)	◇ Fair (3)	◇ Recovering (3)	◈ Low (1)
◇ None (1)	◈ Poor (1)	◇ Recent or no recovery (1)	

COMMENTS

Channel 9 — *Maximum 20*

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ◇ ◇ None or little (3)
- ◇ ◈ Moderate (2)
- ◈ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◇ ◇ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◈ Narrow 5-10m (2)
- ◇ ◇ Very narrow <5m (1)
- ◈ ◇ None (0)

FLOOD PLAIN QUALITY (L R)
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian 3 — *Maximum 10*

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◇ 0.7-<1m (4)
- ◈ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or* 2 & *average*)
- ◇ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◈ Slow (1)
- ◇ Very Fast (1)
- ◇ Interstitial (-1)
- ◇ Fast (1)
- ◇ Intermittent (-2)
- ◇ Moderate (1)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◇ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current 4 — *Maximum 12*

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ◈ No Riffle (metric=0)

RIFFLE DEPTH — Check **ONE** (*ONLY!*)
- ◇ Best Areas >10cm (2)
- ◇ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◇ Maximum <50cm (1)

RIFFLE/RUN SUBSTRATE — Check ONE (*or* 2 & *average*)
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◇ Extensive (-1)

COMMENTS

Riffle/Run 0 — *Maximum 8*

6-GRADIENT

(5.282 ft/mi)

DRAINAGE AREA (17.468 mi^2)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 20 % GLIDE: 40

% RUN: 40 % RIFFLE: #$

Gradient 6 — *Maximum 10*

A139

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY

- ◇ >85% - Open
- ◇ 55%-<85%
- ◇ 30%-<55%
- ◇ 10%-<30%
- ◇ <10% - Closed

Canopy Upstream Reading

Right

100 Middle

Left

B-AESTHETICS

- ◇ Nuisance algae
- ◇ Invasive macrophytes
- ◇ Excess turbidity
- ◇ Discoloration
- ◇ Foam/Scum
- ◇ Oil sheen
- ◇ Trash/Litter
- ◇ Nuisance odor
- ◇ Sludge deposits
- ◇ CSOs/SSOs/Outfalls

C-MAINTENANCE

◇ Public	◇ Private
◇ Active	◇ Historic
◇ Young – Succession	
◇ Old - Succession	
◇ Spray	
◇ Leveed – One sided	
◇ Leveed – Both Banks	
◇ Moving – Bedload	
◇ Stable - Bedload	
◇ Armoured	◇ Slumps
◇ Islands	◇ Scoured
◇ Relocated	◇ Cutoffs
◇ Impounded	◇ Desiccated
◇ Flood Control	◇ Drainage
◇ Snag Removed	
◇ Snag Modified	

D-ISSUES

◇ WWTP	◇ NPDES	◇ CSO
◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ Contaminated	◇ Landfill	◇ Industry
◇ Construction BMPs	◇ Sediment BMPs	
◇ Logging	◇ Irrigation	◇ Cooling
◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
◇ False bank	◇ Manure	◇ Lagoon
◇ Wash H2O	◇ Tile	◇ Natural Flow
◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
◇ Quarry Mine	◇ Golf	◇ Home
◇ Park	◇ Data Paucity	◇ Lawn
◇ Agriculture	◇ Livestock	
◇ Atmosphere Deposition		

Stream Drawing

A140

IDEM OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42964	Macro	200714801	Tributary of Maria Creek	County Road 700 E, Lane Road

Surveyor	Sample Date	County	Macro Sample Type
MSG	7/14/20	Knox	MHAB

◇ Habitat Complete

QHEI Score: 44

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◈ ◇ Hardpan (4)		x	x
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)		x	
◇ ◇ Cobble (8)				◇ ◇ Muck (2)		x	
◇ ◇ Gravel (7)		x	x	◇ ◇ Silt (2)		x	
◇ ◈ Sand (6)		x	x	◇ ◇ Artificial (0)		x	
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

Check ONE (*or* 2 & *average*)

ORIGIN
- ◇ Limestone (1)
- ◇ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◇ Heavy (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ None (1)

Substrate 8 — *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

1	Undercut banks (1)		Pools > 70cm (2)		Oxbows, Backwaters (1)
1	Overhanging vegetation (1)		Rootwads (1)		Aquatic macrophytes (1)
2	Shallows (in slow water) (1)		Boulders (1)	1	Logs and woody debris (1)
2	Rootmats (1)				

AMOUNT

Check ONE (*or* 2 & *average*)
- ◇ Extensive >75% (11)
- ◈ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover Maximum 20 — 10

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◇ High (4)	◇ Excellent (7)	◇ None (6)	◇ High (3)
◈ Moderate (3)	◇ Good (5)	◈ Recovered (4)	◈ Moderate (2)
◈ Low (2)	◈ Fair (3)	◇ Recovering (3)	◈ Low (1)
◇ None (1)	◇ Poor (1)	◇ Recent or no recovery (1)	

COMMENTS

Channel Maximum 20 — 11

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ◈ ◈ None or little (3)
- ◇ ◇ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◇ ◇ Wide >50m (4)
- ◇ ◈ Moderate 10-50m (3)
- ◇ ◇ Narrow 5-10m (2)
- ◈ ◇ Very narrow <5m (1)
- ◈ ◇ None (0)

FLOOD PLAIN QUALITY (L R)
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian Maximum 10 — 5

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◇ 0.7-<1m (4)
- ◈ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or* 2 & *average*)
- ◇ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◇ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◈ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current Maximum 12 — 4

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ◈ No Riffle (metric=0)

RIFFLE DEPTH (Check **ONE** (*ONLY!*))
- ◇ Best Areas >10cm (2)
- ◇ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◇ Maximum <50cm (1)

RIFFLE/RUN SUBSTRATE (Check ONE (*or* 2 & *average*))
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◇ Extensive (-1)

COMMENTS

Riffle/Run Maximum 8 — 0

6-GRADIENT

(6.761 ft/mi)

DRAINAGE AREA (4.37 mi^2)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 60 % GLIDE: 30

% RUN: 10 % RIFFLE: #$

Gradient Maximum A141*10* — 6

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◇ >85% - Open	◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◇ 55%-<85%	◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ 30%-<55%	◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
		◇ Old - Succession				
◈ 10%-<30%	◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◇ <10% - Closed	◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
	◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
	◇ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading		◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
		◇ Stable - Bedload				
Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
	◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
	◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
17 Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
		◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
		◇ Snag Removed		◇ Atmosphere Deposition		
		◇ Snag Modified				
Left						

Stream Drawing

A142

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42979	Macro	200714701	Maria Creek	N Old 41

Surveyor	Sample Date	County	Macro Sample Type	
PDM	7/14/20	Knox	MHAB	◈ Habitat Complete

QHEI Score: 55

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or 2 & average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)			
◇ ◇ Boulders (9)				◇ ◈ Detritus (3)		X	X
◇ ◇ Cobble (8)				◇ ◇ Muck (2)			
◇ ◇ Gravel (7)			X	◇ ◇ Silt (2)		X	X
◈ ◇ Sand (6)		X	X	◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ **4 or more (2)** ◈ **3 or less (0)**

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ◇ Limestone (1)
- ◇ Tills (1)
- ◇ Wetlands (0)
- ◇ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◈ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◇ Heavy (-2)
- ◇ Moderate (-1)
- ◈ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◇ Moderate (-1)
- ◈ Normal (0)
- ◇ None (1)

Substrate 8 *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

0	Undercut banks (1)	2	Pools > 70cm (2)	0	Oxbows, Backwaters (1)
0	Overhanging vegetation (1)	1	Rootwads (1)	0	Aquatic macrophytes (1)
2	Shallows (in slow water) (1)	0	Boulders (1)	2	Logs and woody debris (1)
1	Rootmats (1)				

AMOUNT

Check ONE (*or 2 & average*)
- ◇ Extensive >75% (11)
- ◈ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover Maximum 20 11

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or 2 & average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◇ High (4)	◇ Excellent (7)	◈ None (6)	◇ High (3)
◇ Moderate (3)	◇ Good (5)	◇ Recovered (4)	◇ Moderate (2)
◈ Low (2)	◈ Fair (3)	◇ Recovering (3)	◈ Low (1)
◇ None (1)	◇ Poor (1)	◇ Recent or no recovery (1)	

COMMENTS

Channel Maximum 20 12

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ◈ ◇ None or little (3)
- ◈ ◈ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◈ ◈ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◇ Narrow 5-10m (2)
- ◇ ◇ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY (L R)
- ◈ ◈ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◇ ◇ Open Pasture/Rowcrop (0)
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian Maximum 10 9

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◈ >1m (6)
- ◇ 0.7-<1m (4)
- ◇ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or 2 & average*)
- ◇ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◈ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◇ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current Maximum 12 9

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ◈ **No Riffle (metric=0)**

Check **ONE** (*ONLY!*) — Check ONE (*or 2 & average*)

RIFFLE DEPTH
- ◇ Best Areas >10cm (2)
- ◇ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◇ Maximum <50cm (1)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◇ Extensive (-1)

COMMENTS

Riffle/Run Maximum 8 0

6-GRADIENT

(3.217 ft/mi)

DRAINAGE AREA

(90.629 mi^2)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 50 **% GLIDE:** #$

% RUN: 50 **% RIFFLE:** #$

Gradient Maximum 10 6

A143

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◇ >85% - Open	◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◇ 55%-<85%	◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◈ 30%-<55%	◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
		◇ Old - Succession				
◇ 10%-<30%	◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◇ <10% - Closed	◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
	◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
	◇ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading		◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
		◇ Stable - Bedload				
Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
	◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
	◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
45 Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
		◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
		◇ Snag Removed		◇ Atmosphere Deposition		
		◇ Snag Modified				
Left						

Stream Drawing

A144

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42976	Macro	200715702	Marsh Creek	E Hunley Road

Surveyor	Sample Date	County	Macro Sample Type
JMB	7/15/20	Knox	MHAB

◇ Habitat Complete

QHEI Score: 43

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or* 2 & *average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)			X
◇ ◇ Boulders (9)				◇ ◈ Detritus (3)		X	
◇ ◇ Cobble (8)			X	◇ ◇ Muck (2)			
◇ ◇ Gravel (7)			X	◇ ◇ Silt (2)		X	X
◈ ◇ Sand (6)		X	X	◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ◇ Limestone (1)
- ◇ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◇ Heavy (-2)
- ◇ Moderate (-1)
- ◈ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◇ Moderate (-1)
- ◈ Normal (0)
- ◇ None (1)

Substrate Maximum 20: **9**

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

0	Undercut banks (1)	0	Pools > 70cm (2)	0	Oxbows, Backwaters (1)
3	Overhanging vegetation (1)	0	Rootwads (1)	1	Aquatic macrophytes (1)
2	Shallows (in slow water) (1)	0	Boulders (1)	0	Logs and woody debris (1)
1	Rootmats (1)				

AMOUNT

Check ONE (*or* 2 & *average*)
- ◇ Extensive >75% (11)
- ◇ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover Maximum 20: **7**

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY
- ◇ High (4)
- ◇ Moderate (3)
- ◈ Low (2)
- ◇ None (1)

DEVELOPMENT
- ◇ Excellent (7)
- ◇ Good (5)
- ◈ Fair (3)
- ◇ Poor (1)

CHANNELIZATION
- ◇ None (6)
- ◇ Recovered (4)
- ◈ Recovering (3)
- ◇ Recent or no recovery (1)

STABILITY
- ◇ High (3)
- ◈ Moderate (2)
- ◈ Low (1)

COMMENTS

Channel Maximum 20: **10**

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ◇ ◇ None or little (3)
- ◈ ◈ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◇ ◇ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◇ Narrow 5-10m (2)
- ◈ ◈ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY (L R)
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian Maximum 10: **3**

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◇ 0.7-<1m (4)
- ◈ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or* 2 & *average*)
- ◇ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◈ Slow (1)
- ◇ Very Fast (1)
- ◇ Interstitial (-1)
- ◇ Fast (1)
- ◇ Intermittent (-2)
- ◈ Moderate (1)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◇ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current Maximum 12: **5**

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

◇ No Riffle (metric=0)

Check **ONE** (*ONLY!*)

RIFFLE DEPTH
- ◇ Best Areas >10cm (2)
- ◈ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◈ Maximum <50cm (1)

Check ONE (*or* 2 & *average*)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◈ Mod. Stable (e.g. large gravel) (1)
- ◈ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◈ Low (1)
- ◈ Moderate (0)
- ◇ Extensive (-1)

COMMENTS

Riffle/Run Maximum 8: **3**

6-GRADIENT

(3.392 ft/mi)

DRAINAGE AREA

(20.805 mi²)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 25 % GLIDE: 20

% RUN: 50 % RIFFLE: 5

Gradient Maximum 10: **6**

A145

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY

- ◈ >85% - Open
- ◇ 55%-<85%
- ◇ 30%-<55%
- ◇ 10%-<30%
- ◇ <10% - Closed

Canopy Upstream Reading

Right

97 Middle

Left

B-AESTHETICS

- ◇ Nuisance algae
- ◇ Invasive macrophytes
- ◇ Excess turbidity
- ◇ Discoloration
- ◇ Foam/Scum
- ◇ Oil sheen
- ◇ Trash/Litter
- ◇ Nuisance odor
- ◇ Sludge deposits
- ◇ CSOs/SSOs/Outfalls

C-MAINTENANCE

◇ Public	◇ Private
◇ Active	◇ Historic
◇ Young – Succession	
◇ Old - Succession	
◇ Spray	
◇ Leveed – One sided	
◇ Leveed – Both Banks	
◇ Moving – Bedload	
◇ Stable - Bedload	
◇ Armoured	◇ Slumps
◇ Islands	◇ Scoured
◇ Relocated	◇ Cutoffs
◇ Impounded	◇ Desiccated
◇ Flood Control	◇ Drainage
◇ Snag Removed	
◇ Snag Modified	

D-ISSUES

◇ WWTP	◇ NPDES	◇ CSO
◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ Contaminated	◇ Landfill	◇ Industry
◇ Construction BMPs	◇ Sediment BMPs	
◇ Logging	◇ Irrigation	◇ Cooling
◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
◇ False bank	◇ Manure	◇ Lagoon
◇ Wash H2O	◇ Tile	◇ Natural Flow
◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
◇ Quarry Mine	◇ Golf	◇ Home
◇ Park	◇ Data Paucity	◇ Lawn
◇ Agriculture	◇ Livestock	
◇ Atmosphere Deposition		

Stream Drawing

A146

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42969	Macro	200713804	Tributary of Maria Creek	County Road 900 N, E Lower Freelandville Road

Surveyor	Sample Date	County	Macro Sample Type
RAC	7/13/20	Knox	MHAB

◇ Habitat Complete

QHEI Score: 34

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or* 2 & *average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◈ ◇ Hardpan (4)		x	x
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)		x	x
◇ ◇ Cobble (8)				◇ ◇ Muck (2)			
◇ ◇ Gravel (7)				◇ ◈ Silt (2)		x	x
◇ ◇ Sand (6)				◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

ORIGIN
- ◇ Limestone (1)
- ◈ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◇ Heavy (-2)
- ◈ Moderate (-1)
- ◇ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◈ Extensive (-2)
- ◇ Moderate (-1)
- ◇ Normal (0)
- ◇ None (1)

Substrate 4 — *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

		Undercut banks (1)		Pools > 70cm (2)			Oxbows, Backwaters (1)
	2	Overhanging vegetation (1)		Rootwads (1)			Aquatic macrophytes (1)
		Shallows (in slow water) (1)		Boulders (1)			Logs and woody debris (1)
		Rootmats (1)					

AMOUNT

Check ONE (*or* 2 & *average*)
- ◇ Extensive >75% (11)
- ◇ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover 4 — *Maximum 20*

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY
- ◇ High (4)
- ◈ Moderate (3)
- ◇ Low (2)
- ◇ None (1)

DEVELOPMENT
- ◇ Excellent (7)
- ◇ Good (5)
- ◇ Fair (3)
- ◈ Poor (1)

CHANNELIZATION
- ◇ None (6)
- ◈ Recovered (4)
- ◇ Recovering (3)
- ◇ Recent or no recovery (1)

STABILITY
- ◇ High (3)
- ◈ Moderate (2)
- ◇ Low (1)

Channel 10 — *Maximum 20*

COMMENTS

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ◈ ◈ None or little (3)
- ◇ ◇ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◇ ◇ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◇ Narrow 5-10m (2)
- ◈ ◈ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY (L R)
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

Riparian 4 — *Maximum 10*

COMMENTS

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◇ 0.7-<1m (4)
- ◈ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or* 2 & *average*)
- ◇ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◇ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◇ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current 4 — *Maximum 12*

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

◈ No Riffle (metric=0)

Check **ONE** (*ONLY!*)

RIFFLE DEPTH
- ◇ Best Areas >10cm (2)
- ◇ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◇ Maximum <50cm (1)

Check ONE (*or* 2 & *average*)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◇ Extensive (-1)

Riffle/Run 0 — *Maximum 8*

COMMENTS

6-GRADIENT

(12.542 ft/mi)

DRAINAGE AREA

(3.055 mi²)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 20 **% GLIDE:** 70

% RUN: 10 **% RIFFLE:** #$

Gradient 8 — *Maximum 10*

A147

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT overhanging veg throughout and only real cover. lots of hardpan throughout

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◇ >85% - Open	◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◇ 55%-<85%	◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ 30%-<55%	◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
		◇ Old - Succession				
◇ 10%-<30%	◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◇ <10% - Closed	◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
	◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
	◇ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading		◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
		◇ Stable - Bedload				
Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
	◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
	◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
100 Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
		◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
		◇ Snag Removed		◇ Atmosphere Deposition		
		◇ Snag Modified				
Left						

Stream Drawing

A148

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42975	Macro	200715703	Marsh Creek	E Moody Road

Surveyor	Sample Date	County	Macro Sample Type	
PDM	7/15/20	Knox	MHAB	◇ Habitat Complete

QHEI Score: 25

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or* 2 & *average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE	ORIGIN	QUALITY
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)				◇ Limestone (1)	SILT ◈ Heavy (-2)
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)				◇ Tills (1)	◈ Moderate (-1)
◇ ◇ Cobble (8)				◇ ◇ Muck (2)				◇ Wetlands (0)	◇ Normal (0)
◇ ◇ Gravel (7)				◇ ◈ Silt (2)		X	X	◈ Hardpan (0)	◇ Free (1)
◈ ◇ Sand (6)		X	X	◇ ◇ Artificial (0)				◇ Sandstone (0)	EMBEDDEDNESS ◈ Extensive (-2)
◇ ◇ Bedrock (5)								◇ Rip/Rap (0)	◈ Moderate (-1)
								◇ Lacustrine (0)	◇ Normal (0)
								◇ Shale (-1)	◇ None (1)
								◇ Coal fines (-2)	

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

Substrate **5** *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

0	**Undercut banks (1)**	0	**Pools > 70cm (2)**	0	**Oxbows, Backwaters (1)**
1	**Overhanging vegetation (1)**	0	**Rootwads (1)**	0	**Aquatic macrophytes (1)**
1	**Shallows (in slow water) (1)**	0	**Boulders (1)**	0	**Logs and woody debris (1)**
0	**Rootmats (1)**				

AMOUNT

Check ONE (*or* 2 & *average*)
- ◇ **Extensive >75% (11)**
- ◇ **Moderate 25-75% (7)**
- ◇ **Sparse 5-<25% (3)**
- ◈ **Nearly absent <5% (1)**

COMMENTS

Cover Maximum 20 **3**

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◇ High (4)	◇ Excellent (7)	◇ None (6)	◇ High (3)
◇ Moderate (3)	◇ Good (5)	◇ Recovered (4)	◇ Moderate (2)
◈ Low (2)	◈ Fair (3)	◈ Recovering (3)	◈ Low (1)
◈ None (1)	◈ Poor (1)	◈ Recent or no recovery (1)	

COMMENTS

Channel Maximum 20 **7**

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION L R	RIPARIAN WIDTH L R	FLOOD PLAIN QUALITY L R	
◇ ◇ None or little (3)	◇ ◇ Wide >50m (4)	◇ ◇ Forest, Swamp (3)	◇ ◇ Conservation Tillage (1)
◇ ◇ Moderate (2)	◇ ◇ Moderate 10-50m (3)	◇ ◇ Shrub or Old field (2)	◇ ◇ Urban or Industrial (0)
◈ ◈ Heavy/Severe (1)	◇ ◇ Narrow 5-10m (2)	◇ ◇ Residential, Park, New field (1)	◇ ◇ Mining, construction (0)
	◈ ◈ Very narrow <5m (1)	◇ ◇ Fenced pasture (1)	
	◇ ◇ None (0)	◈ ◈ Open Pasture/Rowcrop (0)	

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian Maximum 10 **2**

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH Check ONE (*ONLY!*)	CHANNEL WIDTH Check ONE (*or* 2 & *average*)	CURRENT VELOCITY Check ALL that apply	
◇ >1m (6)	◇ Pool width > riffle width (2)	◇ Torrential (-1)	◈ Slow (1)
◇ 0.7-<1m (4)	◈ Pool width = riffle width (1)	◇ Very Fast (1)	◇ Interstitial (-1)
◇ 0.4-<0.7m (2)	◇ Pool width < riffle width (0)	◇ Fast (1)	◇ Intermittent (-2)
◈ 0.2-<0.4m (1)		◈ Moderate (1)	◇ Eddies (1)
◇ <0.2m (0) (metric=0)			

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ ***Primary Contact***
- ◇ ***Secondary Contact***

(circle one and comment on back)

COMMENTS

Pool/Current Maximum 12 **4**

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ◈ **No Riffle (metric=0)**

RIFFLE DEPTH Check ONE (*ONLY!*)	RUN DEPTH	RIFFLE/RUN SUBSTRATE Check ONE (*or* 2 & *average*)	RIFFLE/RUN EMBEDDEDNESS
◇ Best Areas >10cm (2)	◇ Maximum >50cm (2)	◇ Stable (e.g. cobble, boulder) (2)	◇ None (2)
◇ Best Areas 5-10cm (1)	◇ Maximum <50cm (1)	◇ Mod. Stable (e.g. large gravel) (1)	◇ Low (1)
◇ Best Areas <5cm (metric=0)		◇ Unstable (e.g. sand, fine gravel) (0)	◇ Moderate (0)
			◇ Extensive (-1)

COMMENTS

Riffle/Run Maximum 8 **0**

6-GRADIENT

(2.932 ft/mi)

DRAINAGE AREA (12.234 mi^2)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 10 **% GLIDE:** 30

% RUN: 60 **% RIFFLE:** #$

Gradient Maximum 10 **4**

A149

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY

- >85% - Open
- 55%-<85%
- 30%-<55%
- 10%-<30%
- <10% - Closed

Canopy Upstream Reading

Right

98 Middle

Left

B-AESTHETICS

- Nuisance algae
- Invasive macrophytes
- Excess turbidity
- Discoloration
- Foam/Scum
- Oil sheen
- Trash/Litter
- Nuisance odor
- Sludge deposits
- CSOs/SSOs/Outfalls

C-MAINTENANCE

- Public
- Private
- Active
- Historic
- Young – Succession
- Old - Succession
- Spray
- Leveed – One sided
- Leveed – Both Banks
- Moving – Bedload
- Stable - Bedload
- Armoured
- Slumps
- Islands
- Scoured
- Relocated
- Cutoffs
- Impounded
- Desiccated
- Flood Control
- Drainage
- Snag Removed
- Snag Modified

D-ISSUES

- WWTP
- NPDES
- CSO
- Hardened
- Urban
- Dirt & Grime
- Contaminated
- Landfill
- Industry
- Construction BMPs
- Sediment BMPs
- Logging
- Irrigation
- Cooling
- Bank Erosion
- Surface Erosion
- H2O table
- False bank
- Manure
- Lagoon
- Wash H2O
- Tile
- Natural Flow
- Acid Mine
- Wetlands
- Stagnant Flow
- Quarry Mine
- Golf
- Home
- Park
- Data Paucity
- Lawn
- Agriculture
- Livestock
- Atmosphere Deposition

Stream Drawing

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42968	Macro	200713803	Maria Creek	County Road 900 N

Surveyor	Sample Date	County	Macro Sample Type	
MSG	7/13/20	Knox	MHAB	Habitat Complete

QHEI Score: 33

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

BEST TYPES

	TOTAL	POOL	RIFFLE
Bldrs/Slabs (10)			
Boulders (9)			
Cobble (8)			
Gravel (7)			x
Sand (6)		x	x
Bedrock (5)			

OTHER TYPES

	TOTAL	POOL	RIFFLE
Hardpan (4)			x
Detritus (3)			
Muck (2)		x	
Silt (2)		x	
Artificial (0)			

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES:
- 4 or more (2)
- 3 or less (0)

Check ONE (*or* 2 & *average*)

ORIGIN
- Limestone (1)
- Tills (1)
- Wetlands (0)
- Hardpan (0)
- Sandstone (0)
- Rip/Rap (0)
- Lacustrine (0)
- Shale (-1)
- Coal fines (-2)

QUALITY

SILT
- Heavy (-2)
- Moderate (-1)
- Normal (0)
- Free (1)

EMBEDDEDNESS
- Extensive (-2)
- Moderate (-1)
- Normal (0)
- None (1)

Substrate 2 — *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- 0 Undercut banks (1)
- 2 Overhanging vegetation (1)
- 0 Shallows (in slow water) (1)
- 0 Rootmats (1)
- 1 Pools > 70cm (2)
- 0 Rootwads (1)
- 0 Boulders (1)
- 0 Oxbows, Backwaters (1)
- 0 Aquatic macrophytes (1)
- 1 Logs and woody debris (1)

AMOUNT

Check ONE (*or* 2 & *average*)
- Extensive >75% (11)
- Moderate 25-75% (7)
- Sparse 5-<25% (3)
- Nearly absent <5% (1)

COMMENTS

Cover *Maximum 20* 7

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY
- High (4)
- Moderate (3)
- Low (2)
- None (1)

DEVELOPMENT
- Excellent (7)
- Good (5)
- Fair (3)
- Poor (1)

CHANNELIZATION
- None (6)
- Recovered (4)
- Recovering (3)
- Recent or no recovery (1)

STABILITY
- High (3)
- Moderate (2)
- Low (1)

COMMENTS

Channel *Maximum 20* 7

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- None or little (3)
- Moderate (2)
- Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- Wide >50m (4)
- Moderate 10-50m (3)
- Narrow 5-10m (2)
- Very narrow <5m (1)
- None (0)

FLOOD PLAIN QUALITY (L R)
- Forest, Swamp (3)
- Shrub or Old field (2)
- Residential, Park, New field (1)
- Fenced pasture (1)
- Open Pasture/Rowcrop (0)
- Conservation Tillage (1)
- Urban or Industrial (0)
- Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian *Maximum 10* 3

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- >1m (6)
- 0.7-<1m (4)
- 0.4-<0.7m (2)
- 0.2-<0.4m (1)
- <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or* 2 & *average*)
- Pool width > riffle width (2)
- Pool width = riffle width (1)
- Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- Torrential (-1)
- Very Fast (1)
- Fast (1)
- Moderate (1)
- Slow (1)
- Interstitial (-1)
- Intermittent (-2)
- Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- *Primary Contact*
- *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current *Maximum 12* 8

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

No Riffle (metric=0)

Check **ONE** (*ONLY!*)

RIFFLE DEPTH
- Best Areas >10cm (2)
- Best Areas 5-10cm (1)
- Best Areas <5cm (metric=0)

RUN DEPTH
- Maximum >50cm (2)
- Maximum <50cm (1)

Check ONE (*or* 2 & *average*)

RIFFLE/RUN SUBSTRATE
- Stable (e.g. cobble, boulder) (2)
- Mod. Stable (e.g. large gravel) (1)
- Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- None (2)
- Low (1)
- Moderate (0)
- Extensive (-1)

COMMENTS

Riffle/Run *Maximum 8* 0

6-GRADIENT

(3.885 ft/mi)

DRAINAGE AREA

(30.791 mi²)

- Very low – Low (2-4)
- Moderate (6-10)
- High – Very high (10-6)

% POOL: 20 % GLIDE: 60

% RUN: 20 % RIFFLE: #$

Gradient *Maximum 10* 6

A151

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◈ **>85% - Open**	◇ **Nuisance algae**	◇ **Public**	◇ **Private**	◇ **WWTP**	◇ **NPDES**	◇ **CSO**
◇ **55%-<85%**	◇ **Invasive macrophytes**	◇ **Active**	◇ **Historic**	◇ **Hardened**	◇ **Urban**	◇ **Dirt & Grime**
◇ **30%-<55%**	◇ **Excess turbidity**	◇ **Young – Succession**		◇ **Contaminated**	◇ **Landfill**	◇ **Industry**
		◇ **Old - Succession**				
◇ **10%-<30%**	◇ **Discoloration**	◇ **Spray**		◇ **Construction BMPs**	◇ **Sediment BMPs**	
◇ **<10% - Closed**	◇ **Foam/Scum**			◇ **Logging**	◇ **Irrigation**	◇ **Cooling**
	◇ **Oil sheen**	◇ **Leveed – One sided**		◇ **Bank Erosion**	◇ **Surface Erosion**	◇ **H2O table**
	◇ **Trash/Litter**	◇ **Leveed – Both Banks**				
Canopy Upstream Reading		◇ **Moving – Bedload**		◇ **False bank**	◇ **Manure**	◇ **Lagoon**
		◇ **Stable - Bedload**				
Right	◇ **Nuisance odor**	◇ **Armoured**	◇ **Slumps**	◇ **Wash H2O**	◇ **Tile**	◇ **Natural Flow**
	◇ **Sludge deposits**	◇ **Islands**	◇ **Scoured**	◇ **Acid Mine**	◇ **Wetlands**	◇ **Stagnant Flow**
	◇ **CSOs/SSOs/Outfalls**	◇ **Relocated**	◇ **Cutoffs**	◇ **Quarry Mine**	◇ **Golf**	◇ **Home**
89 Middle		◇ **Impounded**	◇ **Desiccated**	◇ **Park**	◇ **Data Paucity**	◇ **Lawn**
		◇ **Flood Control**	◇ **Drainage**	◇ **Agriculture**	◇ **Livestock**	
		◇ **Snag Removed**		◇ **Atmosphere Deposition**		
		◇ **Snag Modified**				
Left						

Stream Drawing

A152

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42963	Macro	200715803	Maria Creek	E County Road 975 S

Surveyor	Sample Date	County	Macro Sample Type
RAC	7/15/20	Sullivan	MHAB

◇ Habitat Complete

QHEI Score: 64

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or* 2 & *average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◈ Hardpan (4)		X	X
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)		X	X
◇ ◇ Cobble (8)				◇ ◇ Muck (2)			
◈ ◇ Gravel (7)			X	◇ ◇ Silt (2)		X	X
◇ ◇ Sand (6)		X	X	◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ◇ Limestone (1)
- ◇ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◇ Heavy (-2)
- ◈ Moderate (-1)
- ◈ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◇ Extensive (-2)
- ◈ Moderate (-1)
- ◈ Normal (0)
- ◇ None (1)

Substrate 10 *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

1	Undercut banks (1)	2	Pools > 70cm (2)		Oxbows, Backwaters (1)
2	Overhanging vegetation (1)	1	Rootwads (1)		Aquatic macrophytes (1)
1	Shallows (in slow water) (1)		Boulders (1)	1	Logs and woody debris (1)
3	Rootmats (1)				

AMOUNT

Check ONE (*or* 2 & *average*)
- ◇ Extensive >75% (11)
- ◈ Moderate 25-75% (7)
- ◇ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

Cover 15 *Maximum 20*

COMMENTS

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◈ High (4)	◇ Excellent (7)	◈ None (6)	◇ High (3)
◇ Moderate (3)	◈ Good (5)	◇ Recovered (4)	◈ Moderate (2)
◇ Low (2)	◇ Fair (3)	◇ Recovering (3)	◇ Low (1)
◇ None (1)	◇ Poor (1)	◇ Recent or no recovery (1)	

Channel 17 *Maximum 20*

COMMENTS

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ◈ ◈ None or little (3)
- ◇ ◇ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◇ ◇ Wide >50m (4)
- ◇ ◈ Moderate 10-50m (3)
- ◈ ◈ Narrow 5-10m (2)
- ◈ ◇ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY (L R)
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

Riparian 5 *Maximum 10*

COMMENTS erosion more severe downstream of reach

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH
Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◈ 0.7-<1m (4)
- ◇ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH
Check ONE (*or* 2 & *average*)
- ◈ Pool width > riffle width (2)
- ◇ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY
Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◈ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◈ *Secondary Contact*

(circle one and comment on back)

Pool/Current 8 *Maximum 12*

COMMENTS

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ◇ No Riffle (metric=0)

RIFFLE DEPTH
Check **ONE** (*ONLY!*)
- ◇ Best Areas >10cm (2)
- ◈ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◈ Maximum <50cm (1)

Check ONE (*or* 2 & *average*)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◈ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◈ Low (1)
- ◇ Moderate (0)
- ◇ Extensive (-1)

Riffle/Run 3 *Maximum 8*

COMMENTS

6-GRADIENT

(7.687 ft/mi)
DRAINAGE AREA
(7.331 mi^2)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 40 % GLIDE: #$
% RUN: 40 % RIFFLE: 20

Gradient 6 *Maximum 10*

A153

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY

◇ >85% - Open
◇ 55%-<85%
◈ 30%-<55%
◇ 10%-<30%
◇ <10% - Closed

Canopy Upstream Reading

	Right
37	Middle
	Left

B-AESTHETICS

◇ Nuisance algae
◇ Invasive macrophytes
◇ Excess turbidity
◇ Discoloration
◇ Foam/Scum
◇ Oil sheen
◇ Trash/Litter
◇ Nuisance odor
◇ Sludge deposits
◇ CSOs/SSOs/Outfalls

C-MAINTENANCE

◇ Public	◇ Private
◇ Active	◇ Historic
◇ Young – Succession	
◇ Old - Succession	
◇ Spray	
◇ Leveed – One sided	
◇ Leveed – Both Banks	
◇ Moving – Bedload	
◇ Stable - Bedload	
◇ Armoured	◇ Slumps
◇ Islands	◇ Scoured
◇ Relocated	◇ Cutoffs
◇ Impounded	◇ Desiccated
◇ Flood Control	◇ Drainage
◇ Snag Removed	
◇ Snag Modified	

D-ISSUES

◇ WWTP	◇ NPDES	◇ CSO
◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ Contaminated	◇ Landfill	◇ Industry
◇ Construction BMPs	◇ Sediment BMPs	
◇ Logging	◇ Irrigation	◇ Cooling
◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
◇ False bank	◇ Manure	◇ Lagoon
◇ Wash H2O	◇ Tile	◇ Natural Flow
◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
◇ Quarry Mine	◇ Golf	◇ Home
◇ Park	◇ Data Paucity	◇ Lawn
◇ Agriculture	◇ Livestock	
◇ Atmosphere Deposition		

Stream Drawing

A154

IDEM OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42972	Macro	200715802	Maria Creek	E County Road 1050 S

Surveyor	Sample Date	County	Macro Sample Type		QHEI Score:
MSG	7/15/20	Sullivan	MHAB	◈ Habitat Complete	45

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or* 2 & *average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE	ORIGIN	QUALITY
◇ ◇ Bldrs/Slabs (10)				◈ ◇ Hardpan (4)		X		◇ Limestone (1)	SILT ◇ Heavy (-2)
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)		X		◇ Tills (1)	◈ Moderate (-1)
◇ ◇ Cobble (8)			X	◇ ◇ Muck (2)		X		◇ Wetlands (0)	◇ Normal (0)
◇ ◇ Gravel (7)		X	X	◇ ◇ Silt (2)		X	X	◈ Hardpan (0)	◇ Free (1)
◇ ◈ Sand (6)		X	X	◇ ◇ Artificial (0)				◇ Sandstone (0)	EMBEDDEDNESS ◇ Extensive (-2)
◇ ◇ Bedrock (5)								◇ Rip/Rap (0)	◈ Moderate (-1)
								◇ Lacustrine (0)	◇ Normal (0)
								◇ Shale (-1)	◇ None (1)
								◇ Coal fines (-2)	

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

Substrate *Maximum 20*: 8

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

0	**Undercut banks (1)**	0	**Pools > 70cm (2)**	0	**Oxbows, Backwaters (1)**
1	**Overhanging vegetation (1)**	0	**Rootwads (1)**	0	**Aquatic macrophytes (1)**
1	**Shallows (in slow water) (1)**	0	**Boulders (1)**	0	**Logs and woody debris (1)**
2	**Rootmats (1)**				

AMOUNT

Check ONE (*or* 2 & *average*)

- ◇ Extensive >75% (11)
- ◇ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover *Maximum 20*: 6

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◇ High (4)	◇ Excellent (7)	◇ None (6)	◇ High (3)
◇ Moderate (3)	◇ Good (5)	◈ Recovered (4)	◇ Moderate (2)
◈ Low (2)	◈ Fair (3)	◇ Recovering (3)	◈ Low (1)
◇ None (1)	◈ Poor (1)	◇ Recent or no recovery (1)	

COMMENTS

Channel *Maximum 20*: 9

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)	RIPARIAN WIDTH (L R)	FLOOD PLAIN QUALITY (L R)	
◇ ◇ None or little (3)	◇ ◇ Wide >50m (4)	◇ ◇ Forest, Swamp (3)	◇ ◇ Conservation Tillage (1)
◇ ◈ Moderate (2)	◇ ◇ Moderate 10-50m (3)	◇ ◇ Shrub or Old field (2)	◇ ◇ Urban or Industrial (0)
◈ ◇ Heavy/Severe (1)	◈ ◈ Narrow 5-10m (2)	◇ ◇ Residential, Park, New field (1)	◇ ◇ Mining, construction (0)
	◈ ◈ Very narrow <5m (1)	◇ ◇ Fenced pasture (1)	
	◇ ◇ None (0)	◈ ◈ Open Pasture/Rowcrop (0)	

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian *Maximum 10*: 3

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH Check **ONE** (*ONLY!*)	CHANNEL WIDTH Check ONE (*or* 2 & *average*)	CURRENT VELOCITY Check ALL that apply	
◇ >1m (6)	◈ Pool width > riffle width (2)	◇ Torrential (-1)	◈ Slow (1)
◇ 0.7-<1m (4)	◇ Pool width = riffle width (1)	◇ Very Fast (1)	◇ Interstitial (-1)
◈ 0.4-<0.7m (2)	◇ Pool width < riffle width (0)	◇ Fast (1)	◇ Intermittent (-2)
◇ 0.2-<0.4m (1)		◈ Moderate (1)	◇ Eddies (1)
◇ <0.2m (0) (metric=0)			

Indicate for reach – pools and riffles.

RECREATION POTENTIAL

- ◇ *Primary Contact*
- ◈ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current *Maximum 12*: 6

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: ◇ No Riffle (metric=0)

Check **ONE** (*ONLY!*) — Check ONE (*or* 2 & *average*)

RIFFLE DEPTH	RUN DEPTH	RIFFLE/RUN SUBSTRATE	RIFFLE/RUN EMBEDDEDNESS
◇ Best Areas >10cm (2)	◇ Maximum >50cm (2)	◇ Stable (e.g. cobble, boulder) (2)	◇ None (2)
◈ Best Areas 5-10cm (1)	◈ Maximum <50cm (1)	◇ Mod. Stable (e.g. large gravel) (1)	◈ Low (1)
◇ Best Areas <5cm (metric=0)		◈ Unstable (e.g. sand, fine gravel) (0)	◈ Moderate (0)
			◇ Extensive (-1)

COMMENTS

Riffle/Run *Maximum 8*: 3

6-GRADIENT

(8.775 ft/mi)

DRAINAGE AREA

(10.192 mi²)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 50 **% GLIDE:** 0

% RUN: 40 **% RIFFLE:** 10

Gradient *Maximum 10*: 10

A155

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY

- ◇ >85% - Open
- ◇ 55%-<85%
- ◈ 30%-<55%
- ◇ 10%-<30%
- ◇ <10% - Closed

Canopy Upstream Reading

Right

36 Middle

Left

B-AESTHETICS

- ◇ Nuisance algae
- ◇ Invasive macrophytes
- ◇ Excess turbidity
- ◇ Discoloration
- ◇ Foam/Scum
- ◇ Oil sheen
- ◇ Trash/Litter
- ◇ Nuisance odor
- ◇ Sludge deposits
- ◇ CSOs/SSOs/Outfalls

C-MAINTENANCE

- ◇ Public
- ◇ Private
- ◇ Active
- ◇ Historic
- ◇ Young – Succession
- ◇ Old - Succession
- ◇ Spray
- ◇ Leveed – One sided
- ◇ Leveed – Both Banks
- ◇ Moving – Bedload
- ◇ Stable - Bedload
- ◇ Armoured
- ◇ Slumps
- ◇ Islands
- ◇ Scoured
- ◇ Relocated
- ◇ Cutoffs
- ◇ Impounded
- ◇ Desiccated
- ◇ Flood Control
- ◇ Drainage
- ◇ Snag Removed
- ◇ Snag Modified

D-ISSUES

- ◇ WWTP
- ◇ NPDES
- ◇ CSO
- ◇ Hardened
- ◇ Urban
- ◇ Dirt & Grime
- ◇ Contaminated
- ◇ Landfill
- ◇ Industry
- ◇ Construction BMPs
- ◇ Sediment BMPs
- ◇ Logging
- ◇ Irrigation
- ◇ Cooling
- ◇ Bank Erosion
- ◇ Surface Erosion
- ◇ H2O table
- ◇ False bank
- ◇ Manure
- ◇ Lagoon
- ◇ Wash H2O
- ◇ Tile
- ◇ Natural Flow
- ◇ Acid Mine
- ◇ Wetlands
- ◇ Stagnant Flow
- ◇ Quarry Mine
- ◇ Golf
- ◇ Home
- ◇ Park
- ◇ Data Paucity
- ◇ Lawn
- ◇ Agriculture
- ◇ Livestock
- ◇ Atmosphere Deposition

Stream Drawing

IDEM OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42966	Macro	200714804	Tributary of Maria Creek	Freelandville Road

Surveyor	Sample Date	County	Macro Sample Type
MSG	7/14/20	Knox	MHAB

◈ Habitat Complete

QHEI Score: 24

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or 2 & average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)		x	
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)		x	
◇ ◇ Cobble (8)				◇ ◈ Muck (2)		x	x
◇ ◇ Gravel (7)				◈ ◇ Silt (2)		x	x
◇ ◇ Sand (6)		x		◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ◇ Limestone (1)
- ◇ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◈ Heavy (-2)
- ◇ Moderate (-1)
- ◇ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◈ Extensive (-2)
- ◇ Moderate (-1)
- ◇ Normal (0)
- ◇ None (1)

Substrate 0 *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

		Undercut banks (1)			Pools > 70cm (2)		Oxbows, Backwaters (1)
	3	Overhanging vegetation (1)			Rootwads (1)		Aquatic macrophytes (1)
		Shallows (in slow water) (1)			Boulders (1)	1	Logs and woody debris (1)
	1	Rootmats (1)					

AMOUNT

Check ONE (*or 2 & average*)
- ◇ Extensive >75% (11)
- ◇ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◈ Nearly absent <5% (1)

COMMENTS

Cover *Maximum 20* 5

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or 2 & average*)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
◇ High (4)	◇ Excellent (7)	◇ None (6)	◇ High (3)
◇ Moderate (3)	◇ Good (5)	◈ Recovered (4)	◇ Moderate (2)
◇ Low (2)	◇ Fair (3)	◇ Recovering (3)	◈ Low (1)
◈ None (1)	◈ Poor (1)	◇ Recent or no recovery (1)	

COMMENTS

Channel *Maximum 20* 7

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ◈ ◈ None or little (3)
- ◈ ◈ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◇ ◇ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◇ Narrow 5-10m (2)
- ◇ ◇ Very narrow <5m (1)
- ◈ ◈ None (0)

FLOOD PLAIN QUALITY (L R)
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian *Maximum 10* 3

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◇ 0.7-<1m (4)
- ◇ 0.4-<0.7m (2)
- ◈ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or 2 & average*)
- ◇ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◇ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◈ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current *Maximum 12* 3

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

◈ No Riffle (metric=0)

Check **ONE** (*ONLY!*) / Check ONE (*or 2 & average*)

RIFFLE DEPTH	RUN DEPTH	RIFFLE/RUN SUBSTRATE	RIFFLE/RUN EMBEDDEDNESS
◇ Best Areas >10cm (2)	◇ Maximum >50cm (2)	◇ Stable (e.g. cobble, boulder) (2)	◇ None (2)
◇ Best Areas 5-10cm (1)	◇ Maximum <50cm (1)	◇ Mod. Stable (e.g. large gravel) (1)	◇ Low (1)
◇ Best Areas <5cm (metric=0)		◇ Unstable (e.g. sand, fine gravel) (0)	◇ Moderate (0)
			◇ Extensive (-1)

COMMENTS

Riffle/Run *Maximum 8* 0

6-GRADIENT

(7.362 ft/mi)

DRAINAGE AREA

(2.96 mi^2)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 30 **% GLIDE:** 70

% RUN: #$ **% RIFFLE:** #$

Gradient *Maximum 10* 6

A157

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◇ >85% - Open	◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◇ 55%-<85%	◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ 30%-<55%	◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
		◇ Old - Succession				
◇ 10%-<30%	◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◇ <10% - Closed	◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
	◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
	◇ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading		◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
		◇ Stable - Bedload				
Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
	◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
	◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
100 Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
		◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
		◇ Snag Removed		◇ Atmosphere Deposition		
		◇ Snag Modified				
Left						

Stream Drawing

A158

IDEM OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42962	Macro	200713801	Tilley Ditch	E Pepmeir Road

Surveyor	Sample Date	County	Macro Sample Type
MSG	7/13/20	Knox	MHAB

◇ Habitat Complete

QHEI Score: 42

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or* 2 & *average*)

BEST TYPES	TOTAL	POOL	RIFFLE	OTHER TYPES	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)				◇ ◇ Hardpan (4)		x	
◇ ◇ Boulders (9)				◇ ◇ Detritus (3)		x	
◇ ◇ Cobble (8)				◇ ◇ Muck (2)			
◇ ◇ Gravel (7)				◇ ◇ Silt (2)		x	
◈ ◈ Sand (6)		x	x	◇ ◇ Artificial (0)			
◇ ◇ Bedrock (5)							

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

(Score natural substrates; ignore sludge from point-sources)

ORIGIN
- ◇ Limestone (1)
- ◈ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◈ Heavy (-2)
- ◇ Moderate (-1)
- ◇ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◈ Extensive (-2)
- ◇ Moderate (-1)
- ◇ Normal (0)
- ◇ None (1)

Substrate 9 *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

- 1 Undercut banks (1)
- 2 Overhanging vegetation (1)
- 0 Shallows (in slow water) (1)
- 1 Rootmats (1)
- 1 Pools > 70cm (2)
- 0 Rootwads (1)
- 0 Boulders (1)
- 0 Oxbows, Backwaters (1)
- 0 Aquatic macrophytes (1)
- 0 Logs and woody debris (1)

AMOUNT

Check ONE (*or* 2 & *average*)
- ◇ Extensive >75% (11)
- ◈ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover Maximum 20 10

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY
- ◇ High (4)
- ◇ Moderate (3)
- ◇ Low (2)
- ◈ None (1)

DEVELOPMENT
- ◇ Excellent (7)
- ◇ Good (5)
- ◇ Fair (3)
- ◈ Poor (1)

CHANNELIZATION
- ◇ None (6)
- ◈ Recovered (4)
- ◇ Recovering (3)
- ◇ Recent or no recovery (1)

STABILITY
- ◇ High (3)
- ◇ Moderate (2)
- ◈ Low (1)

COMMENTS

Channel Maximum 20 7

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION (L R)
- ◈ ◈ None or little (3)
- ◇ ◇ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH (L R)
- ◇ ◇ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◈ Narrow 5-10m (2)
- ◈ ◈ Very narrow <5m (1)
- ◇ ◇ None (0)

FLOOD PLAIN QUALITY (L R)
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◈ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

COMMENTS

Riparian Maximum 10 5

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◇ 0.7-<1m (4)
- ◈ 0.4-<0.7m (2)
- ◇ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or* 2 & *average*)
- ◇ Pool width > riffle width (2)
- ◈ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◇ Very Fast (1)
- ◇ Fast (1)
- ◈ Moderate (1)
- ◈ Slow (1)
- ◇ Interstitial (-1)
- ◇ Intermittent (-2)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◈ *Secondary Contact*

(circle one and comment on back)

COMMENTS

Pool/Current Maximum 12 5

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

◈ No Riffle (metric=0)

Check **ONE** (*ONLY!*)

RIFFLE DEPTH
- ◇ Best Areas >10cm (2)
- ◇ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◇ Maximum <50cm (1)

Check ONE (*or* 2 & *average*)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◇ Extensive (-1)

Riffle/Run Maximum 8 0

COMMENTS

6-GRADIENT

(4.379 ft/mi)

DRAINAGE AREA

(9.299 mi^2)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: 30 % GLIDE: 50

% RUN: 20 % RIFFLE: #$

Gradient Maximum 10 6

A159

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT artificial riffle at bridge was not sampled

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
>85% - Open	Nuisance algae	Public	Private	WWTP	NPDES	CSO
55%-<85%	Invasive macrophytes	Active	Historic	Hardened	Urban	Dirt & Grime
30%-<55%	Excess turbidity	Young – Succession		Contaminated	Landfill	Industry
		Old - Succession				
10%-<30%	Discoloration	Spray		Construction BMPs	Sediment BMPs	
<10% - Closed	Foam/Scum			Logging	Irrigation	Cooling
	Oil sheen	Leveed – One sided		Bank Erosion	Surface Erosion	H2O table
	Trash/Litter	Leveed – Both Banks				
Canopy Upstream Reading		Moving – Bedload		False bank	Manure	Lagoon
		Stable - Bedload				
Right	Nuisance odor	Armoured	Slumps	Wash H2O	Tile	Natural Flow
	Sludge deposits	Islands	Scoured	Acid Mine	Wetlands	Stagnant Flow
	CSOs/SSOs/Outfalls	Relocated	Cutoffs	Quarry Mine	Golf	Home
89 Middle		Impounded	Desiccated	Park	Data Paucity	Lawn
		Flood Control	Drainage	Agriculture	Livestock	
		Snag Removed		Atmosphere Deposition		
		Snag Modified				
Left						

Stream Drawing

A160

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Sample #	QHEI Type	bioSample #	Stream Name	Location
AB42970	Macro	200713802	Tributary of Maria Creek	County Road 700 E, Lane Road

Surveyor	Sample Date	County	Macro Sample Type
RAC	7/13/20	Knox	MHAB

◇ Habitat Complete

QHEI Score: 29

1-SUBSTRATE

Check *ONLY* **Two** substrate *TYPE BOXES*; estimate % or note every type present

Check ONE (*or* 2 & *average*)

BEST TYPES

	TOTAL	POOL	RIFFLE
◇ ◇ Bldrs/Slabs (10)			
◇ ◇ Boulders (9)			
◇ ◇ Cobble (8)			
◇ ◇ Gravel (7)		x	x
◈ ◇ Sand (6)		x	x
◇ ◇ Bedrock (5)			

OTHER TYPES

	TOTAL	POOL	RIFFLE
◇ ◇ Hardpan (4)		x	x
◇ ◇ Detritus (3)			x
◇ ◇ Muck (2)			
◇ ◈ Silt (2)		x	x
◇ ◇ Artificial (0)			x

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ◇ 4 or more (2) ◈ 3 or less (0)

ORIGIN
- ◇ Limestone (1)
- ◈ Tills (1)
- ◇ Wetlands (0)
- ◈ Hardpan (0)
- ◇ Sandstone (0)
- ◇ Rip/Rap (0)
- ◇ Lacustrine (0)
- ◇ Shale (-1)
- ◇ Coal fines (-2)

QUALITY

SILT
- ◈ Heavy (-2)
- ◇ Moderate (-1)
- ◇ Normal (0)
- ◇ Free (1)

EMBEDDEDNESS
- ◈ Extensive (-2)
- ◇ Moderate (-1)
- ◇ Normal (0)
- ◇ None (1)

Substrate 5 *Maximum 20*

COMMENTS

2-INSTREAM COVER

Indicate presence 0 to 3: **0**-Absent; **1**-Very small amounts or if more common of marginal quality; **2**-Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**-Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed rootwad in deep / fast water, or deep, well-defined, functional pools.

		Undercut banks (1)		Pools > 70cm (2)			Oxbows, Backwaters (1)
	2	Overhanging vegetation (1)		Rootwads (1)			Aquatic macrophytes (1)
	1	Shallows (in slow water) (1)		Boulders (1)			Logs and woody debris (1)
		Rootmats (1)					

AMOUNT

Check ONE (*or* 2 & *average*)
- ◇ Extensive >75% (11)
- ◇ Moderate 25-75% (7)
- ◈ Sparse 5-<25% (3)
- ◇ Nearly absent <5% (1)

COMMENTS

Cover *Maximum 20* 5

3-CHANNEL MORPHOLOGY

Check ONE in each category (*Or* 2 & *average*)

SINUOSITY
- ◇ High (4)
- ◇ Moderate (3)
- ◈ Low (2)
- ◇ None (1)

DEVELOPMENT
- ◇ Excellent (7)
- ◇ Good (5)
- ◇ Fair (3)
- ◈ Poor (1)

CHANNELIZATION
- ◇ None (6)
- ◈ Recovered (4)
- ◇ Recovering (3)
- ◇ Recent or no recovery (1)

STABILITY
- ◇ High (3)
- ◇ Moderate (2)
- ◈ Low (1)

COMMENTS

Channel *Maximum 20* 8

4- BANK EROSION & RIPARIAN ZONE

Check **ONE** in each category for ***EACH BANK*** (*Or 2 per bank & average*)

River right looking downstream

EROSION

L R
- ◈ ◈ None or little (3)
- ◈ ◈ Moderate (2)
- ◇ ◇ Heavy/Severe (1)

RIPARIAN WIDTH

L R
- ◇ ◇ Wide >50m (4)
- ◇ ◇ Moderate 10-50m (3)
- ◇ ◇ Narrow 5-10m (2)
- ◇ ◇ Very narrow <5m (1)
- ◈ ◈ None (0)

FLOOD PLAIN QUALITY

L R
- ◇ ◇ Forest, Swamp (3)
- ◇ ◇ Shrub or Old field (2)
- ◇ ◇ Residential, Park, New field (1)
- ◇ ◇ Fenced pasture (1)
- ◈ ◈ Open Pasture/Rowcrop (0)

L R
- ◇ ◇ Conservation Tillage (1)
- ◇ ◇ Urban or Industrial (0)
- ◇ ◇ Mining, construction (0)

Indicate predominant land use(s) past 100m riparian.

Riparian *Maximum 10* 3

COMMENTS severe erosion downstream of reach

5-POOL/GLIDE AND RIFFLE/RUN QUALITY

MAXIMUM DEPTH

Check **ONE** (*ONLY!*)
- ◇ >1m (6)
- ◇ 0.7-<1m (4)
- ◇ 0.4-<0.7m (2)
- ◈ 0.2-<0.4m (1)
- ◇ <0.2m (0) (metric=0)

CHANNEL WIDTH

Check ONE (*or* 2 & *average*)
- ◇ Pool width > riffle width (2)
- ◇ Pool width = riffle width (1)
- ◇ Pool width < riffle width (0)

CURRENT VELOCITY

Check ALL that apply
- ◇ Torrential (-1)
- ◈ Slow (1)
- ◇ Very Fast (1)
- ◇ Interstitial (-1)
- ◇ Fast (1)
- ◇ Intermittent (-2)
- ◇ Moderate (1)
- ◇ Eddies (1)

Indicate for reach – pools and riffles.

RECREATION POTENTIAL
- ◇ *Primary Contact*
- ◇ *Secondary Contact*

(circle one and comment on back)

COMMENTS Stagnant

Pool/Current *Maximum 12* 2

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

◈ **No Riffle (metric=0)**

RIFFLE DEPTH

Check **ONE** (*ONLY!*)
- ◇ Best Areas >10cm (2)
- ◇ Best Areas 5-10cm (1)
- ◇ Best Areas <5cm (metric=0)

RUN DEPTH
- ◇ Maximum >50cm (2)
- ◇ Maximum <50cm (1)

Check ONE (*or* 2 & *average*)

RIFFLE/RUN SUBSTRATE
- ◇ Stable (e.g. cobble, boulder) (2)
- ◇ Mod. Stable (e.g. large gravel) (1)
- ◇ Unstable (e.g. sand, fine gravel) (0)

RIFFLE/RUN EMBEDDEDNESS
- ◇ None (2)
- ◇ Low (1)
- ◇ Moderate (0)
- ◇ Extensive (-1)

Riffle/Run *Maximum 8* 0

COMMENTS

6-GRADIENT

(9.923 ft/mi)

DRAINAGE AREA

(2.623 mi^2)

- ◇ Very low – Low (2-4)
- ◇ Moderate (6-10)
- ◇ High – Very high (10-6)

% POOL: #$ **% GLIDE:** 90

% RUN: 10 **% RIFFLE:** #$

Gradient *Maximum* A161*10* 6

OWQ Biological Studies QHEI (Qualitative Habitat Evaluation Index)

Circle some &
COMMENT

A-CANOPY	B-AESTHETICS	C-MAINTENANCE		D-ISSUES		
◇ >85% - Open	◇ Nuisance algae	◇ Public	◇ Private	◇ WWTP	◇ NPDES	◇ CSO
◈ 55%-<85%	◇ Invasive macrophytes	◇ Active	◇ Historic	◇ Hardened	◇ Urban	◇ Dirt & Grime
◇ 30%-<55%	◇ Excess turbidity	◇ Young – Succession		◇ Contaminated	◇ Landfill	◇ Industry
		◇ Old - Succession				
◇ 10%-<30%	◇ Discoloration	◇ Spray		◇ Construction BMPs	◇ Sediment BMPs	
◇ <10% - Closed	◇ Foam/Scum			◇ Logging	◇ Irrigation	◇ Cooling
	◇ Oil sheen	◇ Leveed – One sided		◇ Bank Erosion	◇ Surface Erosion	◇ H2O table
	◇ Trash/Litter	◇ Leveed – Both Banks				
Canopy Upstream Reading		◇ Moving – Bedload		◇ False bank	◇ Manure	◇ Lagoon
		◇ Stable - Bedload				
Right	◇ Nuisance odor	◇ Armoured	◇ Slumps	◇ Wash H2O	◇ Tile	◇ Natural Flow
	◇ Sludge deposits	◇ Islands	◇ Scoured	◇ Acid Mine	◇ Wetlands	◇ Stagnant Flow
	◇ CSOs/SSOs/Outfalls	◇ Relocated	◇ Cutoffs	◇ Quarry Mine	◇ Golf	◇ Home
84 Middle		◇ Impounded	◇ Desiccated	◇ Park	◇ Data Paucity	◇ Lawn
		◇ Flood Control	◇ Drainage	◇ Agriculture	◇ Livestock	
		◇ Snag Removed		◇ Atmosphere Deposition		
		◇ Snag Modified				
Left						

Stream Drawing

A162

APPENDIX D. REASSESSMENT NOTES FOR THE MARIA CREEK WATERSHED TMDL

General Notes: 2022 TMDL/Watershed Characterization Assessments for Maria Creek TMDL

1	Staff Participating in assessment meetings: Jody Arthur, Allie Gates. Caleb Rennaker, Lindsay Hylton, Paum McMurray, Kevin Gaston, Kayla Webianskyj, Maddie Genco, Ross Carlson, Scott Zello-Deean, Julien Buchbinder, Michel Ruan, Allison McKain (NRCS), Laura Demerest (Sullivan County SWCD), Tim Beckman, Tim Fields, Cameron Yeakle.
2	Assessments based on the best professional judgement (BPJ) of IDEM scientists are notated with "(BPJ)". BPJ is indicated in cases where assessments based on data collected on the reach in question do not explicitly follow the assessment criteria in IDEM's Consolidatred Assessment and Listing Methodology (CALM).
3	Other acronyms used in these notes include:

AUID = Assessment Unit ID	LSITE = Site identifier used in IDEM's AIMS database	WTP = Wastewater treatment plant
RECR = Recreational Use Support	WS = Watershed	CFO = confined feeding operation (may or may not be required to have an IDEM permit)
ALUS = Aquatic Life Use Support	HW = Headwaters	DO = Dissolved Oxygen
IBI = Fish Community Index of Biotic Integrity	US = Upstream	FS = Fully supporting the use
mIBI = Macroinvertebrate Community Index of Biotic Integrity	DS = Downstream	NS = Not supporting the use (impaired)
QHEI = Qualitative Habitat Evaluation Index		

Method Notes: 2022 TMDL/Watershed Characterization Assessments for Maria Creek TMDL

Monitoring Data used in Assessments	Year Assessed	Method Code
2020 Maria Creek TMDL Study (Water column surveys of E. coli)	2021	420
2020 Maria Creek TMDL Study (non-fixed station physical, chemical)	2021	240
2020 Maria Creek TMDL Study (fish community only w/habitat)	2021	330
2020 Maria Creek TMDL Study (biosurveys of multiple taxonmonic groups)	2021	720

Other Method Codes Applied	Year Assessed	Method Code
Assessments for which biological data for one/more assemblages indicated full support and chemical data indicated impairment.	2021	910
Assessments for which biological data for one/more assemblages indicated impairment of and chemical data indicated FS. This code was applied only in cases where there were no chemical exceedances, not in cases where there were chemical exceedances but results were insufficient to determine impairment.	2021	920
Used for aquatic life use assessments in which the biological data for one/more assemblages indicates impairment and their corresponding Qualititative Habitat Evaluation Index (QHEI) scores are greater than or equal to 51 indicating good habitat conditions.	2021	925

Source Notes: 2022 TMDL/Watershed Characterization Assessments for Maria Creek TMDL	
Source Name	**Application to Assessments**
SOURCE UNKNOWN	Associated with all impaired biotic communities (ADBv2 Cause ID: 163) to indicate that additional unidentified stressors may be contributing to impairment; Also applied to metals impairments except where a specific sources are suspected or known.
NON-POINT SOURCE	Non-Point Source. Source is unknown, but there are no permitted point sources upstream.
AGRICULTURE	Agriculture. Agriculture can represent a wide array of potential Agriculture related sources. Agriculture is used when either land-use analysis or impairment point to some type of Agriculture being the source, but a specific type of Agriculture could not be identified.
LIVESTOCK (GRAZING OR FEEDING OPERATIONS)	Livestock (Grazing or Feeding Operations). Insufficient information exists to specifically identify a particular type of animal feeding operation. Includes grazing and unpermitted animal feeding operations. Also includes CAFOs until a permitted facility is identified.
CONFINED ANIMAL FEEDING OPERATIONS (NPS)	Pollution resulting from inappropriate land application of manure from permitted confined feeding operations.
NATURAL SOURCES	Natural Sources. Natural Sources can represent one or a combination of factors that are natural occurring, and no other potential sources can be identified; applies to impairments suspected to be driven entirely by factors natural occurring; does not apply in combination with other source codes.
WET WEATHER DISCHARGES (NON-POINT SOURCE)	Wet Weather Discharges (Non-Point Source). Applied only to recreational use impairments in urban areas during or after wet weather events where a specific point source could not be identified. Does not apply to recreational use impairments downstream of CSOs (COMBINED SEWER OVERFLOWS) or urban-related sources of aquatic life use impairments (UNSPECIFIED URBAN STORMWATER).
UPSTREAM SOURCE	Upstream Source. For impairments where the source is attributable in part or whole to sources upstream of the boundaries of the assessment unit.

AUID	EPA Station Name	IDEM Station ID	Stream	IBI	Integrity Class	QHEI (IBI)	mIBI	Integrity Class	QHEI (mIBI)	2020 Aquatic Life Use (ALU) Notes	ALU Support	ALU_Impairments	ALU Sources	ATTAINS FLAG	ATTAINS METHOD CODE
INB11I4_03	20T-001	WBU-18-0004	Maria Creek	48	Good	66	38	Fair	55	Maria Creek. WBU-18-0004: IBI 48, QHEI 66, mIBI 38, QHEI 55. Chem OK. ALUS assessed as FS for chemistry and biology.	FS (both)				240; 720
INB11I4_T1004	20T-003	WBU-18-0006	Cotton Branch	42	Fair	65	34	Poor	63	Cotton Branch. WBU-18-0006: IBI 42, QHEI 65, mIBI 34, QHEI 63. Chem OK. Suspect habitat is driving the macro impairment (possible Cat 4C). Sampling site was comprised of severeal shallow pools likely created by erosion from US where the stream is more of an ag ditch. A lot of the macro habitat was out of the water making it inaccessible. The difference between the fish score and macro score could have been a difference between the time the macros were sampled and the fish. Stream could have been drier at that time. Runs were broken up by log jams. The substrate was made up of a lot of fine sediments. Although a passing score, the total number of fish was low, which supports an the idea that erosion is driving this impairment.	NS (biology)	BIOLOGICAL INTEGRITY	SOURCE UNKOWN	4C	240; 720; 920; 925
INB11I4_02	20T-004	WBU-18-0007	Maria Creek	16	Very Poor	30	48	Good	28	Maria Creek. WBU-18-0007: IBI 16, QHEI 30, mIBI 48, QHEI 28. Chem OK. Stream was not very deep (average depth 0.3 m); Fish community was dominated by one species, Longear, which is an intolerant species; 79% of the fish were from one feeding guild). A stream this far down in the WS should have more individuals but it doesn't. A typical ag ditch. Erosion could be playing a role; turbidity was 5, and it's a very sandy site. Conductivity was very high. New mine activity US but none discharging at low flow. Very strange site, hard to characterize. High conductivity can impact the electrical field created by the shocker. However, the potential impacts are not something that we would expect to significantly impact the fish score. The results are considered representative. While we didn't get the numbers or diversity we would expect, the site has TSS and turbidity issues. Source Unknown.	NS (biology)	BIOLOGICAL INTEGRITY	SOURCE UNKOWN		240; 720; 920
INB11I2_01	20T-005; 20T-009	WBU-18-0008; WBU-18-0013	Maria Creek	42	Fair	32	42	Fair	30	Maria Creek. WBU-18-0008: IBI 42, QHEI 32, mIBI 42, QHEI 30. Chem OK. WBU-18-0013: IBI 46, QHEI 43, mIBI 36, QHEI 33. Chem OK. ALUS assessed as FS for chemistry and biology.	FS (both)				240; 720
INB11I2_T1004	20T-006	WBU-18-0009	Tilley Ditch	42/50	Fair/	38/51	36	Fair	42	Tilley Ditch. WBU-18-0009: IBI 42/50, QHEI 38/51, mIBI 36, QHEI 42. Chem OK. ALUS assessed as FS for chemistry and biology.	FS (both)				240; 720
INB11I2_T1001	20T-007	WBU-18-0010	Tributary of Maria Creek	40	Fair	46	36	Poor	29	Tributary of Maria Creek. WBU-18-0010: IBI 40, QHEI 46, mIBI 36, QHEI 29. Chem OK. ALUS assessed as FS for chemistry and biology.	FS (both)				240; 720
INB11I2_T1002	20T-008	WBU-18-0011	Tributary of Maria Creek	44	Fair	33	38	Fair	34	Tributary of Maria Creek. WBU-18-0011: IBI 44, QHEI 33, mIBI 38, QHEI 34. DO low 2/11 (3.6-3.92 mg/L) and moderately low 2/11 (4.27-4.99 mg/L). Impaired for DO, probably driven by low flow. No nutrient issues or high percent saturation, and the dates that these values occurred are those during which you would expect low flows. Possible 4C.	FS (biology); NS (chemistry)	DISSOLVED OXYGEN	LOW FLOW	4C	240; 720; 910
INB11I3_05	20T-010	WBU190-0001	Marsh Creek	20	Very Poor	38	44	Fair	35	Marsh Creek. WBU190-0001: IBI 20, QHEI 38, mIBI 44, QHEI 35. Chem OK. However, conductivity is very high, especially for a small stream; mining activity is probably driving the conductivity. Fish catch is often not as high when conductivity is high because the conductivity can impact the electrical field created by the shocker. However, the potential impacts are not something that we would expect to significantly impact the scores. The results are considered representative. While we didn't get the numbers or diversity we might expect, the site has poor habitat is poor, and there are definitely TSS issues that could be driving the impairment. Sources are unknown.	NS (biology)	BIOLOGICAL INTEGRITY	SOURCE UNKOWN		240; 720; 920
INB11I3_04	20T-011	WBU-18-0012	Marsh Creek	20	Very Poor	45	42	Fair	43	Marsh Creek. WBU-18-0012: IBI 20, QHEI 45, mIBI 42, QHEI 43. Chem OK. Conductivity is high. High conductivity can impact the electrical field created by the shocker. However, the potential impacts are not something that we would expect to significantly impact the scores. While we didn't have the diversity we might expect, the results are considered representative. This site is located directly US of WBU-190-0001 and closer to the mine, which is probabl;y what is driving the conductivity. Source unknown.	NS (biology).	BIOLOGICAL INTEGRITY	SOURCE UNKOWN		240; 720; 920
INB11I3_T1002	20T-013; 20T-012	WBU-18-0016; WBU-18-0015	Marsh Creek	44	Fair	37	46	Fair	25	Marsh Creek. WBU-18-0015: IBI 44, QHEI 37, mIBI 46, QHEI 25. Chem OK. WBU-18-0016: IBI 42, QHEI 50, mIBI 40, QHEI 37. Chem OK. ALUS assessed as FS for chemistry and biology.	FS (both)				240; 720
INB11I3_03	20T-013; 20T-012	WBU-18-0016; WBU-18-0015	Marsh Creek	44	Fair	37	46	Fair	25	Marsh Creek. WBU-18-0015: IBI 44, QHEI 37, mIBI 46, QHEI 25. Chem OK. WBU-18-0016: IBI 42, QHEI 50, mIBI 40, QHEI 37. Chem OK. ALUS assessed as FS for chemistry and biology.	FS (both)				240; 720
INB11I3_02	20T-014	WBU-18-0017	Marsh Creek	20	Very Poor	33	NA	NA	NA	Marsh Creek. WBU-18-0017: IBI 20, QHEI 33. No macro data; stream went dry. DO low 2/8 (2.17-2.2 mg/L). Impaired for DO and bological integrity. Only 18 individuals. Stream was about to go dry when sampled. DO was good the rest of the year. DO a candidate for Cat 4C. TSS values support the idea that low flow is driving DO.	NS (both)	BIOLOGICAL INTEGRITY + DISSOLVED OXYGEN	SOURCE UNKOWN (Biological Integrity) + NATURAL SOURCES (Dissolved Oxygen)	4C	240; 330
INB11I1_T1004	20T-015	WBU-18-0014	Tributary of Maria Creek	20	Very Poor	37	32/34	Poor	24/23	Tributary of Maria Creek. WBU-18-0014: IBI 20, QHEI 37, mIBI 32/34, QHEI 24/23. DO low 3/9 (1.65-3.09 mg/L) and moderately low 2/9 (4.2-4.18 mg/L). Impaired for DO. DO could be a flow issue. Stream gets very low, with corresponding low TSS values. DO a possible 4C. Biology may habitat drive. No habitat for bugs; no cover, substrate silt & muck, water was warm. The drainage area small and stream was not very wide; not much room for fish community. 4C candidate.	NS (both)	BIOLOGICAL INTEGRITY + DISSOLVED OXYGEN	SOURCE UNKOWN (Biological Integrity) + Low flow (Dissolved Oxygen)	4C	240; 720
INB11I1_T1005	20T-017	WBU-18-0018	Tributary of Maria Creek	34	Poor	41	42	Fair	44	Tributary of Maria Creek. WBU-18-0018: IBI 34, QHEI 41, mIBI 42, QHEI 44. DO low 3/11 (1.38-3.67 mg/L). Impaired for DO. Freelandville, IN located on a tributary US. Low flow may be driving DO issues. DO values are fine outside of dry period. DO is a Candidate for 4C. Site had a high percentage of pioneering species suggesting stream may be recovering from a recent impact. Total number of individuals good and diversity was good. Elsewhere in the WS, TSS gets high during storm event. TSS may be the impact. A lot of debris on the bridge suggests it is super flashy.	NS (both)	BIOLOGICAL INTEGRITY + DISSOLVED OXYGEN	SOURCE UNKOWN (Biological Integrity) + Low flow (Dissolved Oxygen)	4C	240; 720

AUID	EPA Station Name	IDEM Station ID	Stream	2020 Recreational (RECR) Use Notes	RECR Support	RECR Impairment	RECR Sources	ATTAINS METHOD CODE
INB11I4_03	20T-001	WBU-18-0004	Maria Creek	Maria Creek. WBU-18-0004: GM 482.71cfu/100 mL. One high value driving impairment with remaining values relatively low in comparison. Suspect flushing from US tributaries.	NS	ESCHERICHIA COLI (E. COLI)	UPSTREAM SOURCE	420
INB11I4_T1004	20T-003	WBU-18-0006	Cotton Branch	Cotton Branch. WBU-18-0006: GM 887.3cfu/100 mL. US is all ag w/no buffer. One active CFO in the WS. One high value from a storm event. Other values exceed daily. Land app from CFO waste most likely source.	NS	ESCHERICHIA COLI (E. COLI)	CONFINED ANIMAL FEEDING OPERATIONS (NPS)	420
INB11I4_T1005	20T-004; 20T-001	WBU-18-0007; WBU-18-0004	Beaver Ditch	Beaver Ditch. Stream not sampled. Assessment based on results from Maria Creek sites US and DS of its confluence with Beaver Ditch as well as results from Cotton Branch US. All results indicate increasing impairment in the DS direction suggesting inputs from this tributary. We know that Cotton Branch is impaired and likely contributing to the results we see at the lower site on Maria Creek. And, the land uses along Cotton Branch are identical to those along Beaver Ditch. Little to suggest that conditions are any different in this reach. Same sources apply: Land app from CFO waste.	NS	ESCHERICHIA COLI (E. COLI)	CONFINED ANIMAL FEEDING OPERATIONS (NPS)	420
INB11I4_02	20T-004	WBU-18-0007	Maria Creek	Maria Creek. WBU-18-0007: GM 306.63cfu/100 mL. One flow event driving impairment. US sources likely.	NS	ESCHERICHIA COLI (E. COLI)	UPSTREAM SOURCE	420
INB11I4_T1001	20T-005; 20T-010; 20T-004	WBU-18-0008; WBU190-0001; WBU-18-0007	Maria Creek	Maria Creek - Unnamed Tributary. Stream not sampled. Assessment based on results from Maria Creek site WBU-18-0008 US and Marsh Creek site WBU190-0001, both of which are located US of Maria Creek site WBU-18-0007. All three sites indicate moderate impairment and land uses are relatively homogenous suggesting little reason to expect water quality conditions in this tributary are any different.	NS	ESCHERICHIA COLI (E. COLI)	LIVESTOCK (GRAZING OR FEEDING OPERATIONS) + UPSTREAM SOURCE	420
INB11I2_01	20T-005; 20T-009	WBU-18-0008; WBU-18-0013	Maria Creek	Maria Creek. WBU-18-0008: GM 734.99cfu/100 mL. WBU-18-0013: GM 166.32cfu/100 mL. US site is the lower value. DS site was always very turbid. Couldn't see the bottom. Tributaries coming into lower reach that are clearly impacting DS site. US site is more representative of HW. DS site is more representative of Tilley Ditch WS. Small WTPs at Freelandville RSD. North Knox High School also discharges in this WS on the only stream that passed for E.coli (not a potential source). Some small unpermitted animal operations; pasture-related sources are likely.	NS	ESCHERICHIA COLI (E. COLI)	LIVESTOCK (GRAZING OR FEEDING OPERATIONS) + UPSTREAM SOURCE	420
INB11I2_T1004	20T-006	WBU-18-0009	Tilley Ditch	Tilley Ditch. WBU-18-0009: GM 98.57cfu/100 mL. Site is fully supporting.	FS			420
INB11I2_T1001	20T-007	WBU-18-0010	Tributary of Maria Creek	Tributary of Maria Creek. WBU-18-0010: GM 1710.68cfu/100 mL. All the individual values were high, even at lower flow. Freelandville RSD is located US. TP and N+N are pretty low suggesting the RSD isn't a problem. There is a least one unpermitted faciltity (long barns) into the WS suggesting land of app of CFO waste a potential source. Very little buffer.	NS	ESCHERICHIA COLI (E. COLI)	CONFINED ANIMAL FEEDING OPERATIONS (NPS)	420
INB11I2_T1002	20T-008	WBU-18-0011	Tributary of Maria Creek	Tributary of Maria Creek. WBU-18-0011: GM 1237.53cfu/100 mL. All the individual samples were high. Land use almost all ag fields farmed right up to edge of stream. No readily apparent sources. NPS likely.	NS	ESCHERICHIA COLI (E. COLI)	AGRICULTURE + NON-POINT SOURCE	420
INB11I3_05	20T-010	WBU190-0001	Marsh Creek	Marsh Creek. WBU190-0001: GM 425.09cfu/100 mL. One high value with a high flow. Other values are low. No buffer. Sparse housing and fields. Land application of CFO waste a potential source. No other readily apparent sources.	NS	ESCHERICHIA COLI (E. COLI)	CONFINED ANIMAL FEEDING OPERATIONS (NPS)	420
INB11I3_04	20T-011	WBU-18-0012	Marsh Creek	Marsh Creek. WBU-18-0012: GM 499.26cfu/100 mL. One high value with a high flow. Other values are low. Sparsely populated, land use is mostly ag fields w/little to no buffer. Land application of CFO waste a potential source. No other readily apparent sources.	NS	ESCHERICHIA COLI (E. COLI)	CONFINED ANIMAL FEEDING OPERATIONS (NPS)	420
INB11I3_T1002	20T-013; 20T-012	WBU-18-0016; WBU-18-0015	Marsh Creek	Marsh Creek - Unnamed Tributary. Stream assessed based on Marsh Creek sites US and DS of its confluence. WBU-18-0016: GM 439.81cfu/100 mL. WBU-18-0015: GM 2200.89cfu/100 mL. Sites are pretty close and values really increase in the DS direction. Suspect pasture-related sources along the stream and likely inputs from tributaries in between sites. Land uses are virtually the same along all the tribs (all ag fields w/no buffer). Looks like there may also be an unpermitted feeding operation along the main tributary flowing in from between these sites. Land application of animal waste to bufferless ag fields along these streams might explain the jump in pathogens. Assessment applied to the stream sampled and the tributary flowing in between the sites.	NS	ESCHERICHIA COLI (E. COLI)	CONFINED ANIMAL FEEDING OPERATIONS (NPS)	420
INB11I3_03	20T-013; 20T-012	WBU-18-0016; WBU-18-0015	Marsh Creek	Marsh Creek. WBU-18-0016: GM 439.81cfu/100 mL. WBU-18-0015: GM 2200.89cfu/100 mL. Sites are pretty close and values really increase in the DS direction. Suspect pasture-related sources along the stream and likely inputs from tributaries in between sites. Land uses are virtually the same along all the tribs (all ag fields w/no buffer). Looks like there may also be an unpermitted feeding operation along the main tributary flowing in from between these sites. Land application of animal waste to bufferless ag fields along these streams might explain the jump in pathogens. Assessment applied to the stream sampled and the tributary flowing in between the sites.	NS	ESCHERICHIA COLI (E. COLI)	CONFINED ANIMAL FEEDING OPERATIONS (NPS)	420
INB11I3_02	20T-014	WBU-18-0017	Marsh Creek	Marsh Creek. WBU-18-0017: GM 1209.73cfu/100 mL. Values are consistently high but still highly variable. Land use almost all ag fields w/thin buffer along some stream reaches; mostly farmed right up to edge of stream. No readily apparent sources. NPS likely.	NS	ESCHERICHIA COLI (E. COLI)	AGRICULTURE + NON-POINT SOURCE	420
INB11I1_T1004	20T-015	WBU-18-0014	Tributary of Maria Creek	Tributary of Maria Creek. WBU-18-0014: GM 165cfu/100 mL. Land app of CFO waste. All ag ditch w/no buffer, farmed right up to the stream.	NS	ESCHERICHIA COLI (E. COLI)	CONFINED ANIMAL FEEDING OPERATIONS (NPS)	420
INB11I1_T1005	20T-017	WBU-18-0018	Tributary of Maria Creek	Tributary of Maria Creek. GM 727.95 cfu/100 mL. Results are all over the place. Land app of CFO waste is a likely source. All ag ditch w/no buffer, farmed right up to the stream. Long barns directly south of site. Some small operations US. Freelandville, IN located on a tributary US but does not discharge to this stream. Potential urban influences.	NS	ESCHERICHIA COLI (E. COLI)	CONFINED ANIMAL FEEDING OPERATIONS (NPS) + LIVESTOCK (GRAZING OR FEEDING OPERATIONS) + WET WEATHER DISCHARGES (NON-POINT SOURCE)	420
INB11I1_01	20T-018; 20T-019; 20T-016	WBU-18-0019; WBU-18-0020; WBU190-0002	Maria Creek	Maria Creek. WBU-18-0019: 359.17 cfu/100 mL. WBU190-0002: 283.88 cfu/100 mL. WBU-18-0020: No data. Land app of CFO waste likely. No buffers anywhere to be found and almost all land use is ag fields w/a couple of nonpermitted animals operations in the WS.	NS	ESCHERICHIA COLI (E. COLI)	CONFINED ANIMAL FEEDING OPERATIONS (NPS)	420

APPENDIX E. SAMPLING AND ANALYSIS WORK PLAN FOR THE MARIA CREEK WATERSHED TMDL

2020 Watershed Characterization Work Plan for Maria Creek Watershed (Hydrologic Unit Code 0512011118)

PREPARED BY

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WORK PLAN ORGANIZATION

This work plan is an extension of the existing Watershed Assessment and Planning Branch (WAPB), March 2017 Quality Assurance Project Plan (QAPP) for Indiana Surface Water Programs (Surface Water QAPP) (IDEM 2017a) and serves as a link to the existing QAPP as well as an independent QAPP of the project. Per the United States Environmental Protection Agency (U.S. EPA) 2006 Guidance on Systematic Planning Using the Data Quality Objectives (DQO) Process (U.S. EPA 2006) and the U.S. EPA 2002 Guidance for Quality Assurance Project Plans (U.S. EPA 2002), this work plan establishes criteria and specifications, pertaining to a specific water quality monitoring project, usually described in the following four groups or sections of a QAPP per Guidance for Quality Assurance Project Plans (U.S. EPA 2002).

Section I. Project Management

- Project Objective
- Project or Task Organization and Schedule
- Background and Project or Task Description
- Data Quality Objectives
- Training and Staffing Requirements

Section II. Data Generation and Acquisition

- Sampling Procedures
- Analytical Methods
- Sample and Data Acquisition Requirements
- Quality Control Measures Specific to the Project

Section III. Assessment and Oversight

- External and Internal Checks
- Audits
- Data Quality Assessments
- Quality Assurance and Quality Control Review Reports

Section IV. Data Validation and Usability

- Data Handling and Associated Quality Assurance and Quality Control activities

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LIST OF ACRONYMS

AIMS	Assessment Information Management System
ASTM	American Society for Testing and Materials
AUID	Assessment Unit IDs
CFU	Colony Forming Units
DO	Dissolved Oxygen
DQA	Data Quality Assessment
DQO	Data Quality Objectives
E. coli	*Escherichia coli*
GPS	Global Positioning System
HUC	Hydrologic Unit Code
IAC	Indiana Administrative Code
IBI	Index of Biotic Integrity
IDEM	Indiana Department of Environmental Management
μS/cm	Micro Siemens per Centimeter
mg/L	Milligram per liter
MHAB	Multihabitat
mL	Milliliter
NTU	Nephelometric Turbidity Unit(s)
OHEPA	Ohio Environmental Protection Agency
OWQ	Office of Water Quality
PPE	Personal Protective Equipment
QA/QC	Quality Assurance and Quality Control
QAPP	Quality Assurance Project Plan
QHEI	Qualitative Habitat Evaluation Index
S.U.	Standard Units
SM	Standard Methods
SOP	Standard Operating Procedures
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TMDL	Total Maximum Daily Load
U.S. EPA	United States Environmental Protection Agency
WAPB	Watershed Assessment and Planning Branch

DEFINITIONS

Assessment Unit	Reaches of waterbodies, with similar features, assigned unique identifiers to which all assessment information for that specific reach is associated and which allow for mapping with geographic information systems
Elutriate	To purify, separate, or remove lighter or finer particles by washing, decanting, and settling.
Geometric site	Sampling site chosen according to its drainage area within a watershed.
Fifteen-(15-)minute pick	A multihabitat macroinvertebrate sampling method in which the one-minute kick sample and fifty-meter sweep sample collected at a site are first combined and elutriated. Macroinvertebrates are then manually removed from the resulting sample for 15 minutes.
Fifty-(50-)meter sweep sample	A multihabitat macroinvertebrate sampling method in which approximately 50 meters (50m) of all available habitat in a stream or river is sampled with a standard 500 micrometer (500 µm) mesh width D-frame dipnet by taking 20-25 individual "jab" or "sweep" samples, which are then composited.
Macroinvertebrate	Aquatic animals which lack a backbone, are visible without a microscope, and spend some period of their lives in or around water.
One-(1-)minute kick sample	A multihabitat macroinvertebrate sampling method in which approximately one square meter (1 m^2) of riffle or run substrate habitat in a stream or river is sampled with a standard 500 micrometer (500 µm) mesh width D-frame dipnet for approximately one (1) minute.
Pour point	The outlet of a subwatershed or the common point where all the water flows out of any given subwatershed.
Reach	A segment of a stream used for sampling.
Targeted site	A sampling site intentionally selected based on specific monitoring objectives or decisions to be made.

I. PROJECT MANAGEMENT

A. Project Objective

IDEM selected the Maria Creek watershed (10-digit Hydrologic Unit Code or HUC 0512011118) (see Figure 2, Table 3) for a watershed characterization project. The main objective of the watershed characterization monitoring project is to use an intensive targeted watershed design that characterizes the current condition of an individual watershed. This type of monitoring provides valuable data for the purposes of assessment, TMDL development, watershed planning, and allows for future comparisons to evaluate changes in the water quality within the watershed studied. Selecting a spatial monitoring design, with sufficient sampling density to accurately characterize water quality conditions, is a critical step in the process of developing an adequate local scale watershed study.

The water quality data generated from this monitoring effort is anticipated to provide information needed to characterize the watershed for the TMDL program, for local water quality managers, to identify sources of impairment, to designate critical areas, and to enable users in making valid and informed watershed decisions. By design, this project also adds new stream reaches which allow for assessment of aquatic life use support, recreational use support, and future comparisons to evaluate changes in water quality.

The approved 303(d) list for 2018 submitted to the U.S. EPA (IDEM 2018a) identifies 55.00 miles of impaired streams in the Maria Creek watershed with some reaches affected by multiple impairments. The total number of miles per each impairment in the Maria Creek watershed is reported in the following ways:

- Category 5(a): Impaired Biotic Community (IBC), 22.64 miles
- Category 5(a): Dissolved Oxygen Impaired (DO), 5.14 miles
- Category 5(a): *Escherichia coli (E. coli)*, 55.00 miles

Assessment data have been collected in this watershed from multiple IDEM programs and projects.

B. Project or Task Organization and Schedule

The main project objective is to provide a comprehensive assessment of the Maria Creek watershed streams' capability to support aquatic life and recreational uses. Sampling will begin in November 2019 and end in October 2020. Barring any hazardous weather conditions or unexpected physical barriers to access a site, sampling activities will be conducted for physical, chemical, bacteriological parameters, and biological communities.

Sampling activity timeframes include:

1. Site reconnaissance activities will be completed in June 2019. Reconnaissance activities will be conducted in the office and through physical site visits.
2. Water chemistry will be sampled monthly at all watershed sites during the recreational season, defined as April through October in [327 IAC 2-1-6]. During the months of November through March, only sites at the pour point of each 12-digit HUC will be sampled monthly (six sites for this project). The first sampling event will be conducted in November 2019 and the study will conclude in October 2020.
3. Biological sampling activities will begin in the summer of 2020 and end no later than October 18, 2020. Fish and macroinvertebrate community sampling will be conducted at all watershed sites via the observation, counting, and collection techniques described in the "Sampling Methods and Sample Handling" section of this work plan. Habitat quality will also be assessed at all watershed sites. Fish and macroinvertebrate community collection specific dates cannot be given, since sampling may be postponed due to a high water event resulting in scouring of the stream substrate or instream cover creating non-representative samples. Bacteriological sampling for *E. coli* at all sites in the watershed will take place monthly from April through October of 2020. In addition, *E. coli* samples will be collected five times from each site at equally spaced intervals over a 30-day period during the recreational season of April to October 2020 to determine a geometric mean.

C. Background and Project or Task Description

The Watershed Characterization Monitoring program was instituted to assist in characterizing existing conditions in watersheds throughout the state. The Maria Creek watershed data set will be utilized by the TMDL program, and shared with local watershed groups and any other interested parties. This monitoring will provide data for TMDL development and watershed planning, and will aid in future evaluations of changes within the basin. For this study, the following data will be used for assessment purposes: water chemistry, bacteriological contamination in the form of *E. coli*, fish community, macroinvertebrate assemblages, and habitat evaluations.

D. Data Quality Objectives (DQOs)

The DQO process (U.S. EPA 2006) is a planning tool for data collection activities. The process provides a basis for balancing decision uncertainty with available resources. The DQO process is recommended by U.S. EPA when selecting between two alternatives or deriving an estimate of contamination. The DQO process is a seven-step systematic planning process used to clarify study objectives; define the types of data needed to achieve the objectives; and establish decision criteria for evaluating data quality. Results of the DQO seven step process, for the watershed characterization monitoring of the Maria Creek watershed, are documented in the following seven sections.

1. State the Problem

   Indiana is required to assess all waters of the state to determine their designated use attainment status**.** Surface waters of the state are designated for full-body contact recreation; will be capable of supporting a well-balanced, warm water aquatic community; and put-and-take trout fishing [327 IAC 2-1-3] in some northern portions of the state. Data from the intensive sampling of the Maria Creek watershed is needed to fully characterize the current water quality of the watershed. This project will gather water chemistry, bacteriological, biological (fish and macroinvertebrates), and habitat data for the purpose of assessing the designated use attainment status of the Maria Creek watershed.

2. Identify the Goals of the Study

   The main objective of this study is to fully assess whether the surface waters in this watershed are supporting or nonsupporting for aquatic life use and recreational use. In addition, the data from the watershed characterization monitoring will be used for TMDL development and may also be used for watershed planning and future comparisons to evaluate changes in water quality within the watershed studied.

3. Identify Information Inputs

   Grab samples will be collected at the surface water sampling locations for *E. coli* and the parameters listed in Table 5. Field measurements (Table 6) will be conducted at each site during each sampling event. Visual field observations will include weather conditions, stream conditions, and percent stream canopy at each sampling location. All samples collected for bacteriological samples will be analyzed for *E. coli* using SM9223B (IDEM 2019a) Idexx Colilert Enzyme Substrate Standard Method. Surface water chemistry samples will be collected monthly, and processed and analyzed by TestAmerica Laboratories, using the analytical methods listed in Table 5. A fish and macroinvertebrate community sample will be collected once at each site with a corresponding habitat evaluation.

4. Define the Boundaries of the Study

The Maria Creek Watershed covers 96.62 square miles and is located in Sullivan and Knox counties. The watershed is approximately 73% Agriculture, 14% Forest, 6% Developed Land (combined types), 5% Pasture/Hay, and 1% other uses. See Figure 1 for the Maria Creek Watershed land use.

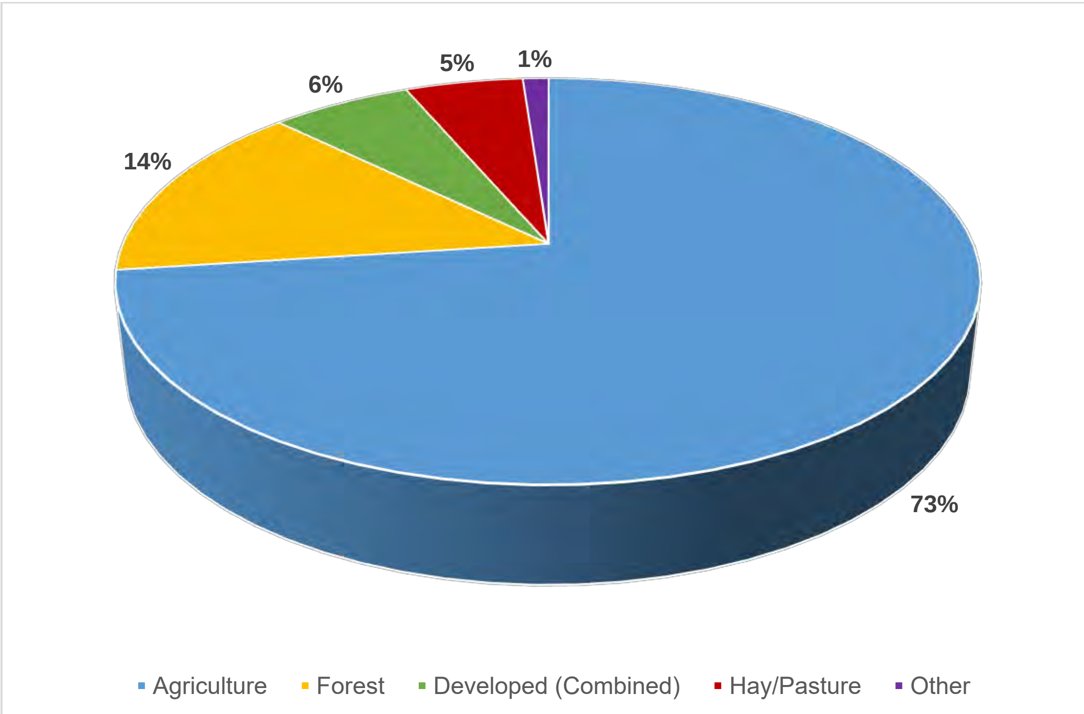
Sampling locations for the 2020 Maria Creek Watershed Characterization study are listed in Table 3 and can be viewed spatially in Figure 2.

Site reconnaissance activities will be completed in June 2019. Sampling activities will begin in November 2019 and will conclude in October 2020. Water chemistry will be sampled monthly during the recreational season, defined as April through October in [327 IAC 2-1-6]. Biological sampling activities will be conducted in the summer of 2020 and end no later than October 18, 2020. Bacteriological sampling activities will be conducted from April through October of 2020.

Sampling activities will not be conducted when stream flow is potentially too dangerous for staff to enter the stream, there are hazardous weather conditions (e.g. thunderstorms or heavy rain in the vicinity), or there are unexpected physical barriers to accessing the site. The field crew chief will make the final determination as to whether or not a stream is safe to enter.

Even when weather conditions and stream flow are safe, sample collections for biological communities may be postponed at a particular site for one to four weeks. The cause of the postponement would be a high water event resulting in scouring of the stream substrate or instream cover creating non-representative samples.

Figure 1. Maria Creek Watershed Land Use



[4] Data collected/calculated from USDA National Agricultural Statistics Service 2018 Cropland Data Layer

5. Develop the Analytical Approach

   Samples will be collected for physical, chemical, and bacteriological parameters, as well as biological communities. Samples will be analyzed for *E.coli* in the IDEM *E. coli* mobile laboratory or IDEM Shadeland laboratory with the Idexx™ Colilert Test. The Colilert Test is a multiple-tube enzyme substrate standard method SM-9223B (Clesceri et al. 2012). Samples will be analyzed for nutrient and general chemistry parameters at TestAmerica Laboratories. The nutrient and general chemistry parameters and respective test methods are listed in Table 5 of this work plan. Field parameters of DO, pH, water temperature, specific conductance, and DO percent saturation will be measured with a datasonde. Turbidity will be measured with a Hach™ turbidity kit.

6. Specify Performance or Acceptance Criteria

   Sampling design error is minimized by utilizing a comprehensive checklist of informational sources, evaluation of historical information, and a thorough watershed presurvey. Described in Section B.1.5.3 of the Surface Water QAPP (IDEM 2017a), this sampling design has been formulated to address data deficiencies and render the optimum amount of data needed to fill gaps in the decision process.

   Good quality data are essential for minimizing decision error. By minimizing both sampling design error and measurement error for physical and biological parameters, more confidence can be placed in the conclusions drawn on the stressors and sources affecting the water quality in the study area.

Site specific aquatic life use and recreational use assessments include program specific controls to identify the introduction of errors. These controls include blanks and duplicates for water chemistry and bacteriological samples; biological site revisits or duplicates; and laboratory controls through verification of species identifications as described in field procedure manuals (IDEM 1992a, 1992b, 2002, 2015, 2017a, 2018c, 2019a, 2019b, 2019c.2019d).

The QA/QC process detects deficiencies in the data collection as set forth in the Surface Water QAPP (IDEM 2017a). The QAPP requires all contract laboratories to adhere to rigorous standards during sample analyses and to provide good quality usable data. Laboratory accreditation is verified before the lab contract is awarded and before the project begins. Laboratory performance studies are reviewed annually in October. Chemists within the WAPB review the laboratory analytical results for quality assurance. Lab QA/QC for each data set is compared against acceptance limits as specified in laboratory methods, the laboratory's QA Manual, the Surface Water QAPP Section B5.3 (Laboratory Quality Control Checks), and the Surface Water QAPP Section D3 (Reconciliation with Data Quality Objectives). The data is validated based on the QA/QC review. Any data which is "Rejected" due to analytical problems or errors will not be used for water quality assessment decisions. Any data flagged as "Estimated" may be used on a case-by-case basis and is noted in the QA/QC report. Criteria for acceptance or rejection of results as well as application of data quality flags is presented in the following Surface Water QAPP tables:

- Table D3-1: Data Qualifiers and Flags
- Table A7-1: Precision and Accuracy Goals for Data Acceptability by Matrix (Precision and accuracy goals with acceptance limits for applicable analytical methods)
- Table B2.1.1.8-2: Field Parameters

Further investigation will be conducted, in response to consistent "rejected" data, to determine the source of error. Field techniques, used during sample collection and preparation along with laboratory procedures, will be subject to evaluation by both the WAPB QA manager and project manager to troubleshoot error introduced throughout the entire data collection process. Corrective actions will be implemented once the source of error is determined.

Sites will be evaluated as supporting or nonsupporting following the decision-making processes described in Indiana's 2020 Consolidated Assessment Listing Methodology (CALM). Indiana's 2020 CALM has not yet been drafted but will be based upon Indiana's 2018 CALM (IDEM 2018b) and the water quality criteria shown in Table 1.

Recreational use attainment decisions will be based on bacteriological criteria developed to protect primary contact recreational activities [327 IAC 2-1-6]. Aquatic life use support decisions will include independent evaluations of biological and chemical data. The fish assemblage data will be evaluated at each site using the appropriate IBI (Simon and Dufour, 2005). Macroinvertebrate multihabitat samples will also be evaluated using a statewide IBI developed for lowest practical taxonomic level identifications.

Indiana narrative biological criteria [327 IAC 2-1-3] states that "(2) All waters, except [limited use waters] will be capable of supporting: (A) a well-balanced, warm water aquatic community." The water quality standard definition of a "well-balanced aquatic community" is "[327 IAC 2-1-9] (59)] An aquatic community that: (A) is diverse in species composition; (B) contains several different trophic levels; and (C) is not composed mainly of pollution tolerant species." An interpretation or translation of narrative biological criteria into numeric criteria would be as follows: A stream segment is nonsupporting for aquatic life use when the monitored fish or macroinvertebrate community receives an Index of Biotic Integrity (IBI) score of less than 36 (on a scale of 0-60 for fish and 12-60 for macroinvertebrate communities), which is considered "Poor" or "Very Poor" (IDEM 2018b).

In addition, data for several nutrient parameters will be evaluated with the benchmarks listed below (IDEM 2018b). Assuming a minimum of three sampling events, if two or more of the conditions below are met on the same date, the waterbody will be classified as nonsupporting due to nutrients.

- Total Phosphorus (TP):
  - One or more measurements greater than 0.3 mg/L
- Nitrogen (measured as Nitrate + Nitrite):
  - One or more measurements greater than 10.0 mg/L
- Dissolved Oxygen (DO):
  - Any measurement less than 4.0 mg/L
  - Any measurements consistently at or close to the standard, range 4.0-5.0 mg/L
- Percent Saturation
  - Any measurement greater than 120%
- pH:
  - Any measurement greater than 9.0 Standard Units (SU)
  - Measurements consistently at or close to the standard, range 8.7-9.0 SU

Assessment of each site sampled will be reported to U.S. EPA in the 2022 update of Indiana's Integrated Water Monitoring and Assessment Report (Integrated Report). Site-specific data will be used to classify associated assessment units into one of five major categories in the State's Consolidated 303(d) list. Category definitions are available in Indiana's CALM (IDEM 2018b, pp. G-46 and G-47).

Table 1. Water Quality Criteria [327 IAC Article 2]

Parameters	Water Quality Criteria	Criterion
E. coli (April-October Recreational season)	≤125 MPN/100 mL	5-Sample Geometric Mean
	≤235 MPN/100 mL	Single Sample Maximum
Total Ammonia (NH_3-N)	Calculated based on pH and Temperature	Calculated CAC
Nitrate+Nitrite-Nitrogen	≤10 mg/L	Human Health point of drinking water intake
Sulfate	Calculated based on hardness and chloride	In all waters outside the mixing zone
Dissolved Oxygen	At least 5.0 mg/L (Warm Waters)	Daily Average
	Not less than 4.0 mg/L at any time	Single Reading
pH	6.0 – 9.0 S.U. except for daily fluctuations that exceed 9.0 due to photosynthetic activity	Single Reading
Temperature	Varies Monthly	1% Annual; Maximum Limits
Chloride	Calculated based on hardness and sulfate values	Calculated CAC
Dissolved Solids	750 mg/L	Public water supply

MPN = Most Probable Number, CAC = Chronic Aquatic Criterion, S.U. = Standard Units

7. Optimize the Plan for Obtaining Data

   A Modified Geometric Design (OHEPA 1999, 2012) site selection process in Attachment 1 will be used in this study to get the necessary spatial representation of the entire study area. Sites within this watershed have been selected based on a geometric progression of drainage areas and then located to the nearest bridge. Sample sites at road crossings allow for more efficient sampling of the watershed.

E. Training and Staffing Requirements

Table 2. Project Roles, Experience, and Training

Role	Required Training or Experience	Responsibilities	Training References
Project Manager	- AIMS II Database experience - Demonstrated experience in project management and QA/QC procedures	- Establish Project in the AIMS II database - Oversee development of Project Work Plan - Oversee entry and QC of field data - Querying data from AIMS II to determine results not meeting Water Quality Criteria	- IDEM 2017a, 2017b - U.S. EPA 2006
Field Crew Chief Biological Community Sampling	- At least one year of experience in sampling methodology and taxonomy of aquatic communities in the region - Annually review the Principles and Techniques of Electrofishing - Annually review relevant safety procedures - Annually review relevant Standard Operating Procedures (SOP) documents for field operations	- Completion of field data sheets - Taxonomic accuracy - Sampling efficiency and representation - Voucher specimen tracking - Overall operation of the field crew when remote from central office - Adherence to safety and field SOP procedures by crew members - Ensure that multiprobe analyzers are calibrated weekly prior to field sampling activities - Ensure that field sampling equipment is functioning properly and loaded into field vehicles prior to field sampling activities	- YSI 2017 - IDEM 1992a, 1992b, 2002, 2008, 2010a, 2010b, 2015, 2017a, 2018c, 2019b, 2019c, 2019d - Newhouse 1998a, 1998b -YSI 2018
Field Crew Members Biological Community Sampling	- Complete hands-on training for sampling methodology prior to participation in field sampling activities - Review the Principles and Techniques of Electrofishing - Review relevant safety procedures - Review relevant SOP documents for field operations	- Follow all safety and SOP procedures while engaged in field sampling activities - Follow direction of field crew chief while engaged in field sampling activities	- YSI 2017 - IDEM 1992a, 1992b, 2002, 2008, 2010a, 2010b, 2015, 2017a, 2018c, 2019b, 2019c, 2019d - Newhouse 1998a, 1998b - YSI 2018

Role	Required Training or Experience	Responsibilities	Training References
Field Crew Chief – Water Chemistry and/or Bacteriological Sampling	- At least one year of experience in sampling methodology - Annually review relevant safety procedures - Annually review relevant SOP documents for field operations	- Completion of field data sheets - Sampling efficiency and representation - Overall operation of the field crew when remote from central office - Adherence to safety and field SOP procedures by crew members - Ensure that multiprobe analyzers are calibrated weekly prior to field sampling activities - Ensure that field sampling equipment is functioning properly and loaded into field vehicles prior to field sampling activities	- YSI 2017 - IDEM 1997, 2002, 2008, 2010a, 2010b, 2015, 2017a, 2019a - YSI 2018
Field Crew Members – Water Chemistry and/or Bacteriological Sampling	- Complete hands-on training for sampling methodology prior to participation in field sampling activities - Review relevant safety procedures - Review relevant SOP documents for field operations	- Follow all safety and SOP procedures while engaged in field sampling activities - Follow direction of field crew chief while engaged in field sampling activities	- YSI 2017 - IDEM 1997, 2002, 2008, 2010a, 2010b, 2015, 2017a, 2019a - YSI 2018
Laboratory Supervisor – Biological Community Sample Processing	- At least one year of experience in taxonomy of aquatic communities in the region - Annually review relevant safety procedures - Annually review relevant SOP documents for laboratory operations	- Adherence to safety and SOP procedures by laboratory staff - Assist with identification of fish or macroinvertebrate specimens - Verify taxonomic accuracy of samples - Voucher specimen tracking - QC calculations on data sheets, check for completeness - Ensure data are entered into AIMS II correctly	- IDEM 1992a, 1992b, 2008, 2010a, 2010b, 2017b - Newhouse 1998a, 1998b

Role	Required Training or Experience	Responsibilities	Training References
Laboratory Staff – Biological Community Sample Processing	- Complete hands-on training for laboratory sample processing methodology prior to laboratory sample processing activities - Annually review relevant safety procedures and relevant SOP documents for laboratory operations	- Adhere to safety and SOP procedures - Follow Laboratory Supervisor direction while processing samples - Identify fish or macroinvertebrate specimens - Perform necessary calculations on data, enter field sheets	- IDEM 1992a, 1992b, 2008, 2010a, 2010b, 2017b - Newhouse 1998a, 1998b
Laboratory Supervisor – Water Chemistry and/or Bacteriological Sample Processing	- Annually review relevant safety procedures - Annually review relevant SOP documents for field operations	- Adherence to safety and SOP procedures by laboratory staff - Completion of laboratory data sheets - Check data for completeness - Perform all necessary calculations on the data - Ensure that data are entered into the AIMS II Data Base	- IDEM 1997, 2002, 2008, 2010a, 2010b, 2015a, 2017a, 2017b, 2019a - Newhouse 1998a
Quality Assurance Officer	- Familiarity with QA/QC practices and methodologies - Familiarity with the Surface Water QAPP and data qualification methodologies	- Ensure adherence to QA/QC requirements of Surface Water QAPP - Evaluate data collected by sampling crews for adherence to project work plan - Review data collected by field sampling crews for completeness and accuracy - Perform a data quality analysis of data generated by the project - Assign data quality levels based on the data quality analysis - Import data into the AIMS II data base - Ensure that field sampling methodology audits are completed according to WAPB procedures	- IDEM 2017a, 2017b - U.S. EPA 2006

II. DATA GENERATION AND ACQUISITION

A. Sampling Sites and Sampling Design

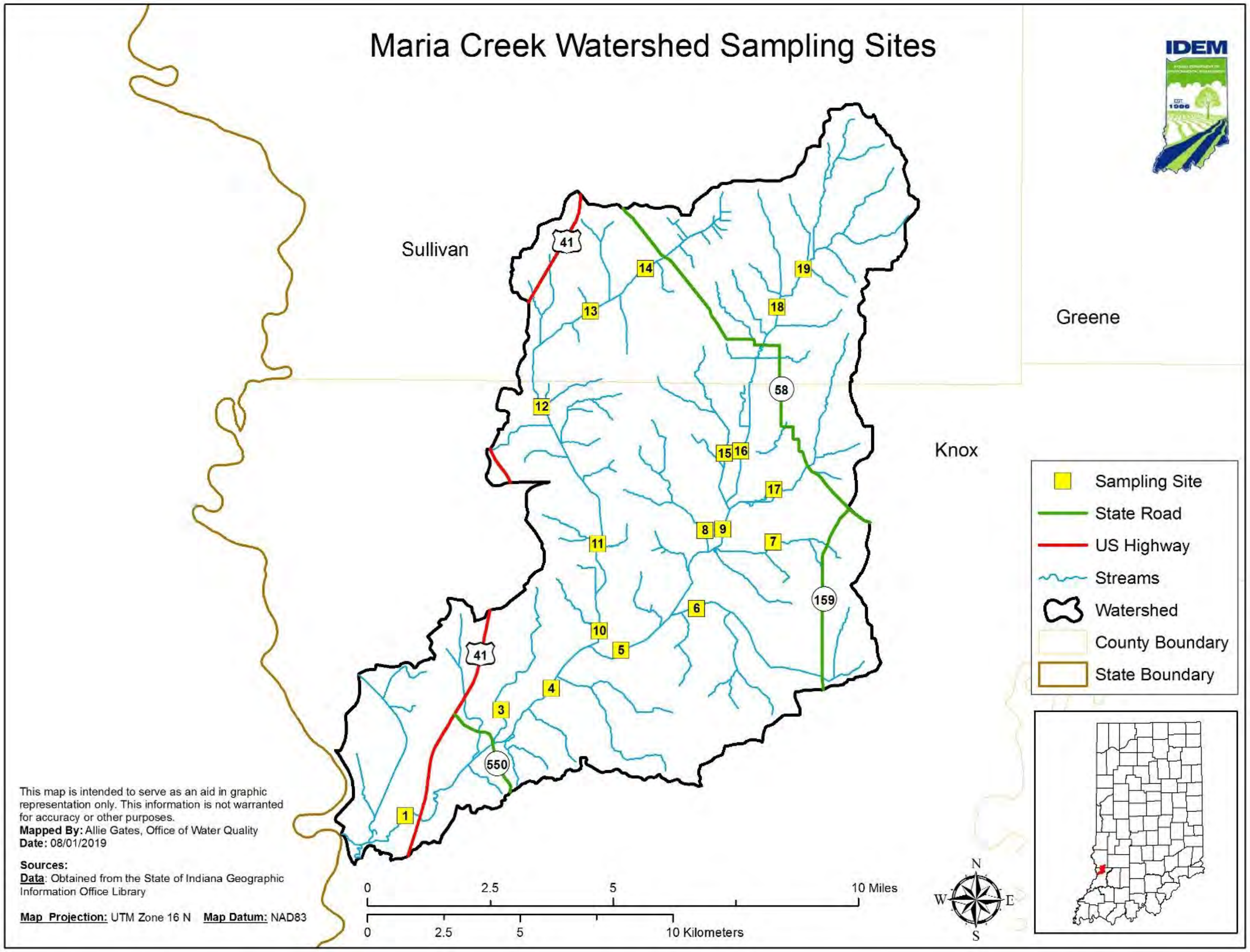
Sample sites will be chosen using a modified geometric site selection process as well as targeted site selection in order to obtain the necessary spatial representation of the entire watershed. Sites within this watershed will be selected based on a geometric progression of drainage areas starting with the area at the mouth of the main stem stream and then working upstream through the tributaries to the headwaters. Monitoring sites will then be established at the nearest bridge. Best professional judgement determined rejection of one site during reconnaissance, because a stream reach previously draining into Maria Creek now appears to drain into a pond. The site located on this stream reach will no longer be sampled.

A more complete description of the Modified Geometric Design Steps for Watershed Characterization Studies selection process is included as Attachment 1. Sample sites will also be chosen at the bridge nearest to the pour point of each 12-digit HUC in the watershed, or chosen to characterize sources for TMDL development.

Site reconnaissance activities will be conducted in-house and through physical site visits. In-house activities include preparation and review of site maps and aerial photographs. Physical site visits include verification of accessibility, safety considerations, equipment needed to properly sample the site, and property owner consultations, if required. All information will be recorded on the IDEM OWQ Site Reconnaissance Form (Attachment 2) and entered into the AIMS II database. Precise coordinates for each site will be determined during the physical site visits or at the beginning of the sampling phase of this project, using a Trimble Juno ™ SB Global Positioning System or a Trimble Juno 3D GPS (IDEM 2015), both of which have an accuracy of two to five meters. These coordinates will be entered into the AIMS II database. Digital photos will also be taken upstream and downstream of the site during reconnaissance. Digital photos will be stored on the shared drive upon return to the office in a specific folder for the Maria Creek watershed characterization. Photos will be labeled with the site number and indication of whether the photo faces upstream or downstream.

“Sampling Locations for Watershed Characterization of Maria Creek” (Table 3) provides a list of the selected sampling sites with the stream name, AUID, AIMS Site Number, County Name, and the latitude and longitude of each site. Figure 2, titled “Maria Creek Watershed Characterization Sampling Area,” gives a spatial overview of the site locations for this project.

Figure 2. Maria Creek Watershed Characterization Sampling Area



[1] Map site numbers refer to last two digits of site number from Table 1; e.g., 20T-010 is site 10 on map

Table 3. Sampling Locations for Watershed Characterization of Maria Creek (HUC 0512011118)

Site #	AIMS Site #	Stream Name	Location	County	Latitude	Longitude	AUID
20T-001	WBU-18-0004	Maria Creek	N Old 41	Knox	38.77347	-87.4728	INB11I4_03
20T-003	WBU-18-0006	Cotton Branch	E Springtown Rd	Knox	38.80484	-87.4368	INB11I4_T1004
20T-004	WBU-18-0007	Maria Creek	N Perry Rd	Knox	38.81132	-87.4179	INB11I4_02
20T-005	WBU-18-0008	Maria Creek	N Risley Rd	Knox	38.82277	-87.3917	INB11I2_01
20T-006	WBU-18-0009	Tilley Ditch	E Pepmeir Rd	Knox	38.83516	-87.3632	INB11I2_T1004
20T-007	WBU-18-0010	Tributary of Maria Creek	Lane Rd	Knox	38.85491	-87.3343	INB11I2_T1001
20T-008	WBU-18-0011	Tributary of Maria Creek	E Lower Freelandville Rd	Knox	38.85826	-87.3601	INB11I2_T1002
20T-009	WBU-18-0013	Maria Creek	E Lower Freelandville Rd	Knox	38.85857	-87.3534	INB11I2_01
20T-010	WBU190-0001	Marsh Creek	CR 500 NE Rd	Knox	38.82846	-87.3999	INB11I3_05
20T-011	WBU-18-0012	Marsh Creek	E Hunley Rd	Knox	38.85412	-87.4006	INB11I3_04
20T-012	WBU-18-0015	Marsh Creek	E Moody Rd	Knox	38.89458	-87.4221	INB11I3_03
20T-013	WBU-18-0016	Marsh Creek	S CR 50 E	Sullivan	38.92285	-87.4038	INB11I3_03
20T-014	WBU-18-0017	Marsh Creek	S CR 5 SE	Sullivan	38.93554	-87.383	INB11I3_02
20T-015	WBU-18-0014	Tributary to Maria Creek	Freelandville Rd	Knox	38.88103	-87.3528	INB 11I1_T1004
20T-016	WBU190-0002	Maria Creek	CR 1050 N	Knox	38.88173	-87.3467	INB11I1_01
20T-017	WBU-18-0018	Tributary to Maria Creek	Lane Rd	Knox	38.87045	-87.334	INB11I1_T1005
20T-018	WBU-18-0019	Maria Creek	E CR 1050 S	Sullivan	38.92436	-87.3331	INB11I1_01
20T-019	WBU-18-0020	Maria Creek	E CR 975 S	Sullivan	38.93558	-87.3232	INB11I1_01

[2] 20T-### gray shading of the Site # denotes that these are the selected pour points for this project (6 sites).

B. Sampling Methods and Sample Handling

1. Water Chemistry Sampling

   One team of two staff will collect water chemistry grab samples, record water chemistry field measurements, and record physical site descriptions on the IDEM OWQ Stream Sampling Field Data Sheet (Attachment 3). All water chemistry sampling will adhere to the Water Quality Surveys Section Field Procedure Manual Section 2.1 (IDEM 2002). Samples will be preserved as specified below in Table 4, and all applicable holding times will be followed.

Table 4. Water Chemistry Sample Handling

Parameter	Preservative	Holding Times
Alkalinity (as $CaCO_3$)	Ice	14 days
Solids, Total Residue (TS)	Ice	7 days
Solids, Nonfilterable Residue (TSS)	Ice	7 days
Solids, Filterable Residue (TDS)	Ice	7 days
Sulfate (Dissolved)	Ice	28 days
Chloride	Ice	28 days
Hardness (as $CaCO_3$)	HNO_3	6 months
Nitrogen, as Ammonia	H_2SO_4	28 days
Nitrogen, Kjeldahl (TKN)	H_2SO_4	28 days
Nitrogen, Nitrate-nitrite	H_2SO_4	28 days
Phosphorous (Applicable to all)	H_2SO_4	28 days
Total Organic Carbon (TOC)	H_2SO_4	28 days
Chemical Oxygen Demand	H_2SO_4	28 days
Calcium	HNO_3	6 months
Magnesium	HNO_3	6 months

2. Bacteriological Sampling

   The bacteriological sampling will be conducted by one team consisting of one or two staff. Samples will be processed in an IDEM fixed or mobile *E. coli* laboratory equipped with all materials and equipment necessary to perform the Colilert® Test Method (Standard Method 9223B), per Project Organization and Schedule (above) (IDEM 2019a). The expected time frame for bacteriological sampling will be April through October of 2020. Staff will collect the samples in a 120 mL presterilized wide-mouth container from the center of flow, if the stream is wadeable, or from the shoreline using a pole sampler, if the stream is not wadeable. This is subject to field staff determination based on available PPE, turbidity, and other factors. However, streams waist deep or shallower are generally considered wadeable. All samples will be consistently labeled, cooled, and held at a temperature less than 10ºC during transport. Samples will be preserved with 0.0008% $Na_2S_2O_3$ for CL_2. While still in the field and at the end of each sampling run, water samples will be processed and analyzed for *E. coli* within the six-hour holding time for collection and transportation, and the two-hour holding time for sample processing (IDEM 2019a).

The IDEM mobile *E. coli* laboratory facilitates *E. coli* testing by eliminating the necessity of transporting samples to distant contract laboratories within a six hour holding time. The IDEM mobile *E. coli* laboratory (van) provides a work space containing sample storage; supplies for Colilert® Quanti-tray testing; and all equipment needed for collecting, preparing, incubating, and analyzing results in the same manner as the IDEM fixed *E. coli* laboratory. All supplies will be obtained from IDEXX Laboratories, Inc., Westbrook, Maine.

3. Fish Community Measurements

The fish community sampling will be completed by teams of three to five staff. Sampling will be performed using various standardized electrofishing methodologies dependent upon the stream size and site accessibility. Fish assemblage assessments will be performed in a sampling reach of 15 times the average wetted width, with a minimum reach of 50 meters and a maximum reach of 500 meters (IDEM 2018c). An attempt will be made to sample all habitat types available within the sample reach to ensure adequate representation of the fish community present at the time of the sampling event. The list of possible electrofishers utilized include: the Smith-Root LR-24 or LR-20B Series backpack electrofishers; the Smith-Root model 1.5KVA electrofishing system; the Smith-Root model 2.5 Generator Powered Pulsator electrofisher, with RCB-6B junction box and rat-tail cathode cable; or Midwest Lake Electrofishing Systems (MLES) Infinity Control Box with MLES junction box and rat-tail cathode cable, assembled in a canoe (if parts of the stream are not wadeable, the system may require the use of a dropper boom array outfitted in a canoe or possibly a 12 foot Loweline™ boat); or for nonwadeable sites, the Smith-Root Type VI-A electrofisher assembled in a 16-foot Loweline™ boat (IDEM 2018c).

Sample collections during high flow or turbid conditions will be avoided due to 1) low collection rates which result in non-representative samples and 2) safety considerations for the sampling team. Sample collection during late autumn will be avoided due to the cooling of water temperature, which may affect the responsiveness of some species to the electrical field. This lack of responsiveness can result in samples that are not representative of the streams' fish assemblage (IDEM 2018c).

Fish will be collected using dipnets with fiberglass handles and netting of 1/8 inch mesh bag. Fish collected in the sampling reach will be sorted by species into baskets or buckets. Young-of-the-year fish less than 20 millimeters (mm) total length will not be retained in the community sample (IDEM 2018c).

For each field taxonomist (generally the crew leader), a complete set of fish vouchers will be retained for each new or different species encountered during the summer sampling season. Vouchers may consist of either preserved specimens or digital images. Prior to processing fish specimens and completion of the IDEM OWQ Fish Collection Data Sheet (Attachment 4), one to two individuals per new species encountered will be preserved in 3.7% formaldehyde solution to serve as representative fish vouchers, if the fish specimens can be positively identified and the individuals for preservation are small enough to fit in a 2000 mL jar. If however, the specimens are too large to preserve, a photo of key characteristics (e.g., fin shape, size, body coloration) will be taken for later examination (IDEM 2018c). Also, prior to sampling, 10% of the sites will be randomly selected for revisiting and a few representative individuals of all species found at the site will be preserved or photographed to serve as vouchers. Taxonomic characteristics for possible species encountered in the basin of interest will be reviewed prior to field work.

Fish specimens should also be preserved if positive identification cannot be made in the field (e.g., those co-occurring like the Striped and Common Shiners or are difficult to identify when immature); individuals that appear to be hybrids or have unusual anomalies; or dead specimens that are taxonomically valuable for undescribed taxa (e.g., Red Shiner or Jade Darter); life history studies; or research projects (IDEM 2018c).

Data will be recorded for nonpreserved fish on the IDEM OWQ Fish Collection Data Sheet (Attachment 4) consisting of the following: number of individuals; minimum and maximum total length in millimeters (mm); mass weight in grams (g); and number of individuals with deformities, eroded fins, lesions, tumors, and other anomalies (DELTs). Once the data is recorded, specimens will be released within the sampling reach from which they were collected, when possible. Data will be recorded for preserved fish specimens following taxonomic identification in the laboratory (IDEM 2018c).

4. Macroinvertebrate Community Measurements

The macroinvertebrate community sampling may be conducted immediately following the fish community sampling event or on a different date by crews of two to three staff. Samples will be collected using a modification of the U.S. EPA Rapid Bioassessment Protocol multihabitat (MHAB) approach using a D-frame dip net with 500 µm mesh (Plafkin et al. 1989; Klemm et al. 1990; Barbour et al. 1999; IDEM 2019b). The IDEM MHAB approach (IDEM 2019b) is composed of a 1-minute “kick” sample within a riffle or run (collected by disturbing one square meter of stream bottom substrate in a riffle or run habitat and collecting the dislodged macroinvertebrates within the dip net) and a 50-meter “sweep” sample of all available habitats (collected by disturbing habitat such as emergent vegetation, root wads, coarse particulate organic matter, depositional zones, logs, and sticks; and collecting the dislodged macroinvertebrates within the dip net). The 50 meter length of riparian corridor that is sampled at each site will be defined using a rangefinder or tape measure. If the stream is too deep to wade, a boat will be used to sample the 50 meter zone along the shoreline with the best available habitat. In addition, a 1-minute kick sample will not be collected if the stream is too deep to wade and there is no available shoreline to collect the sample. However, it is unlikely that the streams encountered during this watershed characterization will be too deep to collect the sample. The 1-minute “kick” and 50-meter “sweep” samples are combined in a bucket of water.

The combined sample will be elutriated through a U.S. Standard Number 35 (500 µm) sieve a minimum of five times so that all rocks, gravel, sand, and large pieces of organic debris are removed from the sample. The remaining sample is then transferred from the sieve to a white plastic tray. The collector (while still on-site) will conduct a 15-minute pick of macroinvertebrates at a single organism rate endeavoring to pick for maximum organism diversity, and relative abundance through turning and examining the entire sample in the tray. The resulting picked sample will be preserved in 80% isopropyl alcohol, returned to the laboratory for identification at the lowest practical taxonomic level (usually genus or species level, if possible); and evaluated using the MHAB macroinvertebrate IBI. Before leaving the site, an IDEM OWQ Macroinvertebrate Header Form (IDEM 2019c, Attachment 5) will be completed for the sample.

5. Habitat Assessments

   Habitat assessments will be completed immediately following macroinvertebrate and fish community sample collections at each site using a slightly modified version of the Ohio Environmental Protection Agency (OHEPA) QHEI, 2006 edition (Rankin 1995; OHEPA 2006). A separate IDEM OWQ Biological QHEI (Attachment 6) must be completed for these two sample types, since the sampling reach length may differ (i.e., 50 meters for macroinvertebrates and between 50 and 500 meters for fish). See IDEM 2019d for a description of the method used in completing the QHEI.

6. Field Parameter Measurements

   Dissolved oxygen (DO), pH, water temperature, specific conductance, and DO percent saturation will be measured with a datasonde, during each sampling event regardless of the sample type collected. Measurement procedures and operation of the datasonde shall be performed according to the manufacturers’ manuals (YSI 2017; YSI 2018) and Sections 2.10 – 2.13 of the Water Quality Surveys Section Field Procedure Manual (IDEM 2002). Turbidity will be measured with a Hach™ turbidity kit and the meter number written in the comments under the field parameter measurements. If a Hach™ turbidity kit is not available, the datasonde measurement for turbidity will be recorded and noted in the comments. During each sampling run, field observations from each site and ambient weather conditions at the time of sampling will be noted and documented on IDEM Stream Sampling Field Data Sheets (Attachment 3).

C. Analytical Methods

1. Laboratory Procedure for *E. coli* Measurements:

   All waters sampled will be processed and analyzed for *E. coli* in the IDEM *E. coli* mobile laboratory or IDEM Shadeland laboratory, which is equipped with required materials and equipment necessary for the Idexx™ Colilert Test. The Colilert Test is a multiple-tube enzyme substrate standard method SM-9223B Enzyme Substrate Coliform Test Method (Clesceri et al., 2012). The *E. coli* test method and quantification limit are identified below in Table 5.

2. Nutrient and General Chemistry Parameters Measurements:

   Analyses of nutrient and general chemistry parameters will be performed at TestAmerica Laboratories, in accordance with preapproved test methods and within the allotted time frames. The nutrient and general chemistry parameters, and respective test methods and quantification limits are identified below in Table 5.

Table 5. *E.coli*, Nutrient, and General Chemistry Parameters Test Methods[4]

Parameter	Method	Limits of Quantification	Units
E. coli	SM-9223B Enzyme Substrate Test	1.0	*MPN/100 mL
Alkalinity (as $CaCO_3$)	EPA 310.2	10.0	mg/L
Solids, Total Residue (TS)	SM 2540B	10.0	mg/L
Solids, Nonfilterable Residue (TSS)	SM 2540D	1.0	mg/L
Solids, Filterable Residue (TDS)	SM 2540C	10.0	mg/L
Sulfate (Dissolved)	EPA 300.0	0.05	mg/L
Chloride	EPA 300.0	0.06	mg/L
Hardness (as $CaCO_3$)	SM 2340B	1.41	mg/L
Nitrogen, as Ammonia	SM 4500NH3-D	0.10	mg/L
Nitrogen, Kjeldahl (TKN)	SM4500N(Org)-B	0.30	mg/L
Nitrogen, Nitrate-nitrite	SM4500NO3-F	0.10	mg/L
Phosphorous (Applicable to all)	EPA 365.1	0.05	mg/L
Total Organic Carbon (TOC)	SM 5310C	1.0	mg/L

Parameter	Method	Limits of Quantification	Units
Chemical Oxygen Demand	EPA 410.4	10.0	mg/L
Calcium	EPA 200.7	40	mg/L
Magnesium	EPA 200.7	100	mg/L

* Clesceri et al., 2012. 1 MPN = 1 CFU/100 mL [4] Methods accredited by EPA (State of Illinois, 2018)

3. Field Parameters Measurements:

   The field measurements of DO, temperature, pH, conductivity, and turbidity will be taken each time a sample is collected. The field parameters, respective test methods, and sensitivity limits are identified below in Table 6. The datasonde should be located in the center of flow during sampling. The field staff member collecting the sample should wait for all readings to stabilize before recording the readings on the IDEM Stream Sampling Field Data Sheet (Attachment 3).

Table 6. Field Parameters Test Methods

Parameter	Method	Sensitivity Limit	Units
DO (Datasonde optical)	ASTM D888-09(C)	0.01	mg/L
DO (Winkler Titration)	SM 4500-OC[5]	0.2	mg/L
DO % Saturation (Datasonde optical)	ASTM D888-09(C)	0.01	%
Turbidity (Datasonde)	SM2130B	0.02	NTU
Turbidity (Hach Turbidimeter)	EPA 180.1[5]	0.01	NTU
Specific Conductance (Datasonde)	SM 2510B	1.0	µS/cm
Temperature (Datasonde)	SM 2550B(2)	0.1	°C
Temperature (field meter)	SM 2550B(2)[5]	0.1	°C
pH (Datasonde)	EPA 150.2	0.01	SU
pH (field meter)	SM 4500-HB[5]	0.01	SU

[5] Method used for Field Calibration Verification

D. Quality Control and Custody Requirements

Quality assurance protocols will follow part B5 of the Surface Water QAPP (IDEM 2017a).

1. Field Instrument Testing and Calibrations

   The datasonde will be calibrated prior to each week’s sampling (IDEM 2002). Calibration results and drift values will be recorded, maintained, stored, and archived in log books located in the calibration laboratories at the Shadeland facility. The drift value is the difference between two successive calibrations. Field parameter calibrations will conform to the procedures as described in the instrument users’ manuals (YSI 2017; YSI 2018). The DO component of the calibration procedure will be conducted using the air calibration method (IDEM 2002, page 74). The unit will be field checked for accuracy once during the week by comparison with a Winkler DO test (IDEM 2002, page 64), Hach™ turbidity, and an Oaktown Series 5 pH meter. Weekly calibration verification results will be recorded on the field calibrations portion of the IDEM OWQ Stream Sampling Field Data Sheets (Attachment 3) and entered into the AIMS II database. A Winkler DO test will also be conducted at sites where the DO concentration is 4.0 mg/L or less.

2. Field Measurement Data

   In-situ water chemistry field data will be collected in the field using calibrated or standardized equipment and recorded on the IDEM OWQ Stream Sampling Field Data Sheet (Attachment 3). The same staff member will collect and record the data. Calculations may be done in the field or later at the office. Analytical results, which have limited QC checks, will be included in this category. Detection limits and ranges have been set for each analysis (Table 6). Quality control checks (such as duplicate measurements, measurements of a secondary standard, or measurements using a different test method or instrument) performed on field or laboratory data, are usable for estimating precision, accuracy, and completeness for the project, as described in the Surface Water QAPP (IDEM 2017a Section C1.1 on page 176 and Section A7.2 page 56).

3. Bacteriological Measurement Data

   Analytical results, from an IDEM fixed or mobile *E. coli* laboratory, include QC check sample results from which precision, accuracy, and completeness can be determined for each batch of samples. Raw data will be archived by analytical batch for easy retrieval and review. Chain of custody procedures will be followed, including: time of collection, time of setup, time of reading the results, and time and method of disposal (IDEM 2002). The field staff member who collected the samples signs the chain of custody form upon delivery of samples to the laboratory. Any method deviations will be thoroughly documented in the raw data. All QA/QC samples will be tested according to the following guidelines:

Field Duplicate:	Field Duplicates will be collected at a frequency of one per batch or at least one for every 20 samples collected (≥ 5%).
Field Blank:	Field Blanks will be collected at a frequency of one per batch or at least one for every 20 samples collected (≥ 5%).
Laboratory Blank:	Laboratory Blanks (sterile laboratory water blanks) will be tested at a frequency of one per day.
Positive Control:	Each lot of media will be tested for performance using *E. coli* bacterial cultures.
Negative Controls:	Each lot of media will be tested for performance using non-*E. coli* and noncoliform bacterial cultures.

4. Water Chemistry Measurement Data

   Sample bottles and preservatives will be certified for purity by the manufacturer. Damaged sample bottles and preservatives are not used, and preservatives are not used past their stated expiration date. The purity of sample bottles and preservatives is checked via field blanks. Sample collection containers for each parameter, preservative, and holding time (Table 4) will adhere to U.S. EPA requirements. Field duplicates and matrix spike/matrix spike duplicates shall be collected at the rate of one per sample analysis set or one per every 20 samples, whichever is greater. Additionally, field blank samples will be taken at a rate of one set per sample analysis set or one per every 20 samples, whichever is greater. A chain of custody (COC) form created by the AIMS II database IDEM OWQ COC (Attachment 7) and an IDEM Water Sample Analysis Request form (Attachment 8) accompany each sample set through the analytical process. The field staff member who collected the samples signs the COC form upon delivery of samples to the laboratory. Additionally, a Test America COC form (Attachment 9) will accompany samples sent to the lab. Shipping labels will be created using Test America account numbers.

5. Fish Community Measurement Data

   Fish community sampling revisits will be performed at a rate of 10 percent of the total fish community sites sampled, in this case, two in the watershed (IDEM 2018c). Revisit sampling will be performed with at least two weeks of recovery between the initial and revisit sampling events. The fish community revisit sampling and habitat assessment will be performed with either a partial or complete change in field team members (IDEM 2018c). The resulting IBI and QHEI total score between the initial visit and the revisit will be used to evaluate precision, as described in the QAPP for Biological Community and Habitat Measurements (IDEM 2019e). The IDEM OWQ COC form (Attachment 7) is used to track samples from the field to the laboratory. A field staff member from the crew signs the COC form after sampling is complete, and the samples and COC form are relinquished to a lab custodian to verify that the sampling information is accurate. All raw data are: 1) checked for completeness; 2) utilized to calculate derived data (e.g., total weight of all specimens of a taxon), which is entered into the AIMS II database; and 3) checked again for data entry errors.

6. Macroinvertebrate Community Measurement Data

   Duplicate macroinvertebrate field samples will be collected at a rate of 10 percent of the total macroinvertebrate community sites sampled, in this case, two in the watershed. The macroinvertebrate community duplicate sample and corresponding habitat assessment will be performed by the same team member who performed the original sample, immediately after the initial sample is collected. The 50 meter section of stream and riffle area utilized for the duplicate sample are different from those used for the original sample but should feature as similar habitat types and availability as possible.

This will result in a precision evaluation based on a 10% duplicate of samples collected, as described in the QAPP for Biological Community and Habitat Measurements (IDEM 2019e).

The IDEM OWQ COC form (Attachment 7) is used to track samples from the field to the laboratory. A field staff member from the crew completes the OWQ COC form after sampling is complete. After completion of weekly field sampling activities, the OWQ COC form is used by the laboratory custodian to check in samples prior to long-term storage. Laboratory identifications and QA/QC of taxonomic work is maintained by the laboratory supervisor of the Probabilistic Monitoring Section of IDEM.

III. ASSESSMENT AND OVERSIGHT

A. Field and laboratory performance and system audits

Performance and system audits will be conducted to ensure good quality data. The field and laboratory performance checks include: precision measurements by relative percent difference of field and laboratory duplicate (IDEM 2017a, pp. 56, 61-63); accuracy measurements by percent of recovery of matrix spike and matrix spike duplicate samples analyzed in the laboratory (IDEM 2017a, pp. 58, 61-63); and completeness measurements by the percent of planned samples that are actually collected, analyzed, reported, and usable for the project (IDEM 2017a, page 58). Fish taxonomic identifications made by IDEM staff in the laboratory may be verified by regionally recognized non-IDEM freshwater fish taxonomists. Ten percent of macroinvertebrate samples (the initial samples taken at sites where duplicate samples were collected) will be sent off to Rithron Associates, Inc. (Missoula, MT) for verification by an outside taxonomist (IDEM 2019c).

Laboratory audits are performed at the beginning of a laboratory contract and at least once a year during the contract. The audit includes any or all of the operational quality control elements of the laboratory's quality assurance system. All applicable elements of this quality assurance project plan and the laboratory contract requirements are addressed including, but not limited to, sampling handling, sample analysis, record keeping, preventative maintenance, proficiency testing, personnel requirements, training, and workload. (IDEM 2017a, pp. 177—178).

Field audits will be conducted biannually by staff of the IDEM WAPB to ensure that sampling activities adhere to approved SOPs. Audits will be systematically conducted by WAPB staff to include all WAPB personnel that engage in field sampling activities. WAPB field staff involved with sample collection and preparation will be evaluated by staff trained in the associated sampling SOPs, and in the processes related to conducting an audit. Staff will produce an evaluation report documenting each audit for review by those field staff audited as well as WAPB management. Corrective actions will be communicated to, and implemented by, field staff as a result of the audit process.

Quality assurance reports are submitted by the QA officer upon completion of the data validation of a dataset, to the program manager or WAPB branch chief. The QA manager, relevant section chief, project manager, any technical staff working on corrective actions, and quality assurance staff receive copies of the progress reports when new developments arise. The section chief, project officer, or QA officer is responsible for working with relevant staff members to develop corrective actions and notifying the QA manager of corrective action progress. Depending on the associated corrective actions, either the section chief or the QA officer approves the final corrective action (IDEM 2017a, page 179).

B. Data Quality Assessment Levels

The samples and various types of data collected by this program will be intended to meet the quality assurance criteria and rated DQA Level 3, as described in the Surface Water QAPP (IDEM 2017a, page 182).

IV. DATA VALIDATION AND USABILITY

Quality assurance reports to management, and data validation and usability are also important components of Indiana's Surface Water QAPP which ensures good quality data for this project. Quality assurance reports are submitted by the QA officer upon completion of the data validation of a dataset to the program manager or WAPB branch chief. This is done to ensure that problems arising during the sampling and analysis phases of the project are investigated and corrected (IDEM 2017a, page 179). As described in Section D of the Surface Water QAPP (IDEM 2017a), data are reduced (converted from raw analytical data into final results in proper reporting units); validated (qualified based on the performance of field and laboratory QC measures incorporated into the sampling and analysis procedures); and reported (described so as to completely document the calibration, analysis, QC measures, and calculations). These steps allow users to assess the data to ensure the project DQOs have been met.

A. Quality Assurance, Data Qualifiers, and Flags

The various data qualifiers and flags will be used for quality assurance and validation of the data and are found on pages 184-185 of the Surface Water QAPP (IDEM 2017a).

B. Data Usability

The environmental data collected and its usability will be qualified per each lab or field result obtained and classified into one or more of the four categories: Acceptable Data, Enforcement Capable Results, Estimated Data, and Rejected Data as described on page 184 of the Surface Water QAPP (IDEM 2017a).

C. Information, Data, and Reports

Data collected in 2019-2020 will be recorded in the AIMS II database and presented in two compilation summaries. The first summary will be a general compilation of the watershed field and water chemistry data prepared for use in the 2022 Indiana Integrated Report. The second summary will be in database report format containing biological results and habitat evaluations, which will be produced for inclusion in the Integrated Report as well as individual site folders. All site folders are maintained at the WAPB facility. All data and reports will be made available to public and private entities, which may find the data useful for municipal, industrial, agricultural, and recreational decision making processes (TMDL, NPDES permit modeling, watershed restoration projects, water quality criteria refinement, etc.,). This work plan will be uploaded into the virtual file cabinet, all field sheets will be stored in the AIMS II database, and results will be uploaded to U.S. EPA's Water Quality Portal via the Water Quality Exchange (formerly Storet), allowing the data to be shared with U.S. EPA and others. The Water Quality Exchange is a framework that allows states, tribes, and other data partners to submit and share water quality monitoring data via the web to the Water Quality Portal.

D. Laboratory and Estimated Cost

Laboratory analysis and data reporting for this project will comply with the Surface Water QAPP (IDEM 2017a); Request for Proposals 16-074 (see IDEM 2016); the IDEM QMP (IDEM 2018d); and TestAmerica contract SCM # 19855. Analytical tests on general chemistry and nutrient parameters outlined in Table 5 will be performed by TestAmerica Laboratories in University Park, Illinois with a total estimated cost of $28,500. IDEXX Laboratories, Inc., Westbrook, Maine supplies the bacteriological sampling supplies, with a total estimated cost of $1,400. Bacteriological samples will be tested and analyzed by IDEM staff. All fish and macroinvertebrate samples will be collected and analyzed by IDEM staff. Ten percent of macroinvertebrate samples will be verified by Rhithron Associates, Inc. in Missoula, Montana with a total estimated cost of $440. The anticipated budget for laboratory cost for the project is $30,340.

E. Reference Manuals and Personnel Safety

Table 7. Personnel Safety and Reference Manuals

Role	Required Training or Experience	Training References	Training Notes
All Staff that Participate in Field Activities	- Basic First Aid and Cardio-Pulmonary Resuscitation (CPR) - Personal Protective Equipment (PPE) Policy - Personal Flotation Devices	- A minimum of 4 hours of in-service training provided by WAPB (IDEM 2010c) - IDEM 2008 - February 29, 2000 WAPB internal memorandum regarding use of approved Personal Flotation Devices	-Staff lacking 4 hours of in-service training or appropriate certification will be accompanied in the field at all times by WAPB staff meeting Health and Safety Training requirements - When working on boundary waters as defined by Indiana Code (IC) 14-8-2-27 or between sunset and sunrise on any waters of the state, all personnel in the watercraft must wear a high intensity whistle and Safety of Life at Sea (SOLAS) certified strobe light.

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ATTACHMENTS

Attachment 1: Modified Geometric Design Steps for Watershed Characterization Studies

Introduction

A relatively new design that has recently been implemented in Indiana is termed the Geometric Site Selection process. This design is employed within watersheds that correspond to the 12-14 digit HUC scale in order to fulfill multiple water quality management objectives, not just the conventional focus on status assessment. The design is employed at a spatial scale that is representative of the scale at which watershed management is generally being conducted.

Sites within the watershed are allocated based on a geometric progression of drainage areas starting with the area at the mouth of the main stem river or stream (pour point) and working "upwards" through the various tributaries to the primary headwaters. This approach allocates sampling sites in a semi-random fashion and according to the stratification of available stream and river sizes based on drainage area. The Geometric Site Selection process is then modified by adding a targeted selection of additional sampling sites that are used to focus on localized management issues such as point source discharges, habitat modifications, and other potential impacts within a watershed. These sites are then "snapped to bridges" to facilitate safe and easy access to the stream. This design also fosters data analysis that takes into consideration overlying natural and human caused influences within the streams of a watershed. The design has been particularly useful for watersheds that are targeted for TMDL development because missing, incomplete, or outdated assessments can be addressed prior to TMDL development.

Selection Process

In ArcGIS, download from NHD Plus site (http://www.horizon-systems.com/nhdplus/HSC-wthMS.php) the following files for Region 5 (and then again for Region 7) and zip them into the appropriate file structure.

File Description	File Name (.zip***)	Format
Region 05, Version 01_01, Catchment Grid	NHDPlus05V01_01_Catgrid	ESRI Grid
Region 05, Version 01_01, Catchment Shapefile	NHDPlus05V01_01_Catshape	Shapefile
Region 05, Version 01_02, Catchment Flowline Attributes	NHDPlus05V01_02_Cat_Flowline_Attr	DBF
Region 05, Version 01_02, Elevation Unit a	NHDPlus05V01_02_Elev_Unit_a	ESRI Grid
Region 05, Version 01_02, Elevation Unit b	NHDPlus05V01_02_Elev_Unit_b	ESRI Grid
Region 05, Version 01_02, Elevation Unit c	NHDPlus05V01_02_Elev_Unit_c	ESRI Grid
Region 05, Version 01_01, Flow Accumulation and Flow Direction Unit a	NHDPlus05V01_01_FAC_FDR_Unit_a	ESRI Grid
Region 05, Version 01_01, Flow Accumulation and Flow Direction Unit b	NHDPlus05V01_01_FAC_FDR_Unit_b	ESRI Grid
Region 05, Version 01_01, Flow Accumulation and Flow Direction Unit c	NHDPlus05V01_01_FAC_FDR_Unit_c	ESRI Grid
Region 05, Version 01_02, National Hydrography Dataset	NHDPlus05V01_03_NHD	Shapefile and DBF
Region 05, Version 01_01, Stream Gage Events	NHDPlus05V01_01_StreamGageEvent	Shapefile
Region 05, Version 01_01, QAQC Sinks Spreadsheet	NHDPlus05V01_01_QAQC_Sinks	Excel Spreadsheet

Create a new point shapefile (or geodatabase featureclass) named Geometric Design within ArcCatalog with the same projection as the unzipped layers above.

Within an ArcMap project, add the following:

- nhdflowline layer
- Geometric Design layer
- catchment shapefile
- the FlowlineAttributesFlow table

Add the following fields to the nhdflowline layer:

- LENGTHMi (type: double, precision: 9, scale 4)
- DrainMi (type: double, precision: 9, scale 4)
- MinElev (type: double, precision: 9, scale 4)
- MaxElev (type: double, precision: 9, scale 4)
- Gradient (type: double, precision: 9, scale 4)

Add the following field to the GeometricDesign layer (use the add field-batch tool):

- Geometric (type: double, precision: 5, scale 2)
- Lat (type: double, precision: 8, scale 5)
- Long (type: double, precision: 8, scale 5)
- COMID (type: long, precision: 9)

Join the nhdflowline layer with the FlowlineAttributesFlow table based on the COMID field.

Use the field calculator within the nhdflowline attribute table, with the appropriate metric to imperial conversion to populate the following fields:

- LENGTHMi (from LENGTHKM – kilometers to miles)
- DrainMia (from CumDrainage – square kilometers to square miles (sq mi))
- MinElev (from MinElevSmo – meters to feet)
- MaxElev (from MaxElevSmo – meters to feet)

- Gradient ((MaxElev-MinElev)/LENGTHMI).

Unjoin the FlowlineAttributesFlow table.

Label the "nhdflowline" layer based new "LengthMi" field – note: this field shows the cumulative drainage at the *end* of the line segment, which is rarely more than 2-3 miles in between nodes.

Calculate the geometric break points (i.e., for a 500 sq mi watershed: 500, 250, 125, 62.5, 31, 15, 7, 4, 2).

It is recommended to change the symbology (Symbology: Show Quantities: Classification (Manual)) of the actual flowline to reflect the drainage. This will help identify when and where sites need to be allocated.

Start a new editing session, with the GeometricDesign layer as your target layer.

Add a new point within this layer to the pour point for the watershed (500 sq mi in this case).

Travel upstream through the main stem and "find" the next place on the stream where the river drainage brackets 250 sq mi. Use the catchment shapefile layer to identify more precisely the drainage value if needed.

Populate the "Geometric" field within the GeometricDesign layer accordingly to the identified drainage level, then change the symbology (Symbology: Categories: Unique Values: Geometric field) of this layer to reflect the drainage levels.

Proceed through the watershed (either around the outer portions or start with largest values and work in), adding points accordingly to each geometric level. Change the symbology to find areas or levels that were missed. Note – the drainage level must be exact. Use the catchment shapefile to subtract drainage areas from larger drainage areas until the exact drainage level is reached. It is ok to "skip" a geometric level if it is not exactly reached. Sometimes there are large tributaries whose contribution to the main stem skips a drainage level.

Populate the COMID (manually), and Lat/Long (right click on field and select calculate geometry – lat = x-coordinates and long = y-coordinates) accordingly for reference within the GeometricDesign Layer.

Once sites are selected in this fashion, they will need to be snapped to a bridge or access point.

Additional sites should be placed at pour points of subwatersheds (12-digit HUCs) to meet TMDL document requirements.

Once the initial sites are selected, the following features are taken into account to move or add sites:

- Permitted facilities
- Urban areas
- Historical sampling sites
- Assessment Unit IDs (AUID)
- External stakeholder information
- Resources - maximum of 35 sites per project

After refining site selections, there may be additional sites added to ensure spatial representation of the project area.

Sites may be removed or changed after site reconnaissance if there are problems accessing the site or if sites are dry.

Notes regarding the NHD dataset:

All units are initially set to metric and need to be converted to imperial.

Within the nhdflowline layer, the GNIS_Name/ID refers to the whole river name and ID, while the COMID is a unique identifier for the particular segment.

There is *not* a value GNIS_Name/ID for every river, especially where primary streams and ditches are concerned.

Segments within the nhdflowline layer are based on linear miles between “nodes,” which are broken up (typically) by tributary. Typically these lengths are less than 2-3 miles.

The cumulative drainage values in the NHD dataset have been compared against other and deemed “reasonable” (read – not statistically compared). Also note that the drainage is calculated through the model to be at the pour point of that segment.

The elevation values, however, are **not** reliable and require supervision. These values are calculated from the associated digital elevation model (DEM) and sometimes have null values for either the maximum or minimum elevation values. In addition, the length of the stream is not long enough (i.e. >1 mile) to calculate gradient. In either case, this associated value is helpful to identify contour changes against a USGS contour map. However, to note the calculated gradient from the NHD information has been observed to be within several tenths of mile compared to a manual calculation of gradient.

Important tables from NHD

- FlowlineAttributesFlow (found in: Region 05, Version 01_02, Catchment Flowline Attributes)
- Key fields: CumDrainag, Max ElevRaw, MinElevSmo,

Important Layers from NHD

- Region 05, Version 01_01, Catchment Shapefile
- Region 05, Version 01_02, National Hydrography Dataset

Attachment 2: IDEM OWQ Site Reconnaissance Form

IDEM

Site Reconnaissance Form

EPA Site Identifier	Rank

Recon #:
Trip #:

Site Number: ______ Stream: ______ County: ______

Location Description: ______

Reconnaissance Data Collected

	Recon Date	Crew Members	

Avg. Width (m)	Avg. Depth (m)	Max. Depth (m)	Nearest Town

Water Present? ☐ Site Wadeable? ☐ Riffle/Run Present? ☐ Road/Public Access Possible? ☐

Site Impacted by Livestock? ☐ Collect Sediment? ☐ Gauge Present? ☐

Landowner/Contact Information

First Name	Last Name

Street Address: ______

City	State	Zip

Telephone	E-Mail Address

Pamphlet Distributed? ☐ Please Call In Advance? ☐ Results Requested? ☐

Rating, Results, Comments, and Planning

Site Rating By Category (1=easy, 10=difficult)
Access Route
Safety Factor
Sampling Effort

Reconnaissance Decision

- Pre-Recon
- Recon in process
- Approved Site
- No, Landowner denied access
- No, Dry
- No, Stream channel missing
- No, Physical barriers
- No, Impounded stream
- No, Marsh/Wetland
- No, Bridge gone or not accessible
- No, Unsafe due to traffic or location
- No, Site impacted by backwater
- No, Other

Equipment Selected

Circle Equipment Needed

- Backpack
- Boat
- Totebarge
- Longline
- Scanoe
- Seine
- Weighted Handline
- Waders
- Gill Net

Comments

Sketch of Stream & Access Route – Indicate Flow, Direction, Obstacles, & Land Use (Use Back of Page, If Necessary)

Attachment 3: IDEM OWQ Stream Sampling Field Data Sheet

IDEM Stream Sampling Field Data Sheet

Analysis Set #	EPA Site ID	Rank

Sample #	Site #	Sample Medium	Sample Type	Duplicate Sample #

Stream Name:		River Mile:		County:	

Site Description:	

Survey Crew Chief	Sample Collectors				Sample Collected		Hydrolab #	Water Depth/Gage Ht (ft)	Water Flow (cf/sec)	Flow Estimated?	Algae?	Aquatic Life?
	1	2	3	4	Date	Time						
										☐	☐	☐

Sample Taken?	Aliquots	Water Flow Type	Water Appearance	Canopy Closed %
☐ Yes ☐ No; Frozen	☐ 1 ☐ 2 ☐ 3 ☐ 4	☐ Riffle ☐ Dry ☐ Stagnant	☐ Clear ☐ Green ☐ Sheen	☐ 0-20% ☐ 60-80%
☐ No; Stream Dry ☐ No; Other	☐ 6 ☐ 8 ☐ 12 ☐ 24	☐ Pool ☐ Run ☐ Flood	☐ Murky ☐ Black ☐ Other	☐ 20-40% ☐ 80-100%
☐ No; Owner refused Access	☐ 48 ☐ 72 ☐ AS-Flow	☐ Glide ☐ Eddy ☐ Other	☐ Brown ☐ Gray (Septic/Sewage)	☐ 40-60%

Special Notes:	

Field Data:

Date (m/d/yy)	24-hr Time (hh:mm)	D.O. (mg/l)	pH	Water Temp (°C)	Spec Cond (µohms/cm)	Turbidity (NTU)	% Sat.	Chlorine (mg/l)	Chloride (mg/l)	Chlorophyll (mg/l)	Weather Codes SC	WD	WS	AT
Comments														
Comments														
Comments														
Comments														
Comments														
Comments														

Measurement Flags		
	<	< Min. Meter Measurement
	>	> Max. Meter Measurement
	E	Estimated (See Comments)
	R	Rejected (See Comments)

Weather Code Definitions

SC Sky Conditions		WD Wind Direction	WS Wind Strength	AT Air Temp
1 Clear	8 Rain	00 North (0 degrees)	0 Calm	1 < 32
2 Scattered	9 Snow	09 East (90 degrees)	1 Light	2 33-45
3 Partly	10 Sleet	18 South (180 degrees)	2 Mod./Light	3 46-60
4 Cloudy		27 West (270 degrees)	3 Moderate	4 61-75
5 Mist			4 Mod./Strong	5 76-85
6 Fog			5 Strong	6 > 86
7 Shower			6 Gale	

Field Calibrations:

Date (m/d/yy)	Time (hh:mm)	Calibrator Initials	Calibrations Type	Meter #	Value	Units

Calibration Type	
	pH DO Turbidity

Preservatives/Bottle Lots:

Group: Preservative	Preservative Lot #	Bottle Type	Bottle Lot #

Groups: Preservatives		Bottle Types	
GC	General Chemistry: Ice	2000P	2000mL Plastic, Narrow Mouth
Nx	Nutrients: H2SO4	1000P	1000mL Plastic, Narrow Mouth
Metals	Metals: HNO3	500P	500mL Plastic, Narrow Mouth
CN	Cyanide: NaOH	250P	250mL Plastic, Narrow Mouth
O&G	Oil & Grease: H2SO4	1000G	1000mL Glass, Narrow Mouth
Toxics	Toxics: Ice	500G	500mL Glass, Wide Mouth
Ecoli	Bacteriology: Ice	250G	250mL Glass, Wide Mouth
VOA	Volatile Organics: HCl & Thiosulfate	125G	125mL Glass, Wide Mouth
Pest	Pesticides: Ice	40GV	40mL Glass Vial
Phen	Phenols: H2SO4	120PB	120ml Plastic (Bacteria Only)
Sed	Sediment: Ice	1000PF	1000mL Plastic, Corning Filter
Gly	Glyphosate: Thiosulfate	500PF	500mL Plastic, Corning Filter
Hg	Mercury(1631): HCl	60P	60mL Plastic
Cr6	ChromiumVI(1636): NaOH	250T	250mL Teflon
MeHg	Methyl Mercury(1630): HCl	500T	500mL Teflon
		125T	125mL Teflon

Data Entered By: ________________ QC1: ________________

QC2: ________________

Stream Sampling Field Data Sheet

Attachment 4: IDEM OWQ Fish Collection Data Sheet

IDEM
OWQ-WATERSHED ASSESSMENT AND PLANNING BRANCH

Event ID____________ Voucher jars______ Unknown jars______ Equipment_____________ Page ____ of ____
Voltage______ Time fished (sec)______ Distance fished (m)______ Max. depth (m)______ Avg. depth (m)______
Avg. width (m)_____ Bridge in reach____ Is reach representative____ If no, why____________________
Elapsed time at site (hh:mm)___:___ Comments____________________________

Museum data: Initials________ ID date________ Jar count________ Fish Total________

Coding for Anomalies: D – deformities E – eroded fins L – lesions T – tumor M – multiple DELT anomalies O – other (A – anchor worm C – leeches W – swirled scales Y – popeye S – emaciated F – fungus P – parasites) H – heavy L – light (these codes may be combined with above codes)

TOTAL # OF FISH	WEIGHT (s) (mass g)				(length mm)	ANOMALIES					
					Min length	D	E	L	T	M	O
					Max length						
V P											
					Min length	D	E	L	T	M	O
					Max length						
V P											
					Min length	D	E	L	T	M	O
					Max length						
V P											
					Min length	D	E	L	T	M	O
					Max length						
V P											
					Min length	D	E	L	T	M	O
					Max length						
V P											
					Min length	D	E	L	T	M	O
					Max length						
V P											

KRW: Rev/09.26.18 Calculation:______ QC1 + Entry______ QC 1______ QC 2______

Attachment 5: IDEM OWQ Macroinvertebrate Header Form

IDEM

Office of Water Quality: Macroinvertebrate Header

L-Site	Stream Name	Location	County	Surveyor

Sample Date	Sample #	Macro#	# Containers

Macro Sample Type:
☐ Black Light ☐ Kick
☐ CPOM ☐ MHAB
☐ Hester-Dendy ☐ Qualitative

☐ Normal ____________
☐ Duplicate ____________
☐ Replicate ____________

☐ **Habitat Complete** ☐ **Sample Quality Rejected**

Riparian Zone/Instream Features

Macro Sub Sample (Field or Lab): ________________

Macro Reach Sampled (m): ______________________

Watershed Erosion:
☐ Heavy
☐ Moderate
☐ None

Watershed NPS Pollution:
☐ No Evidence
☐ Obvious Sources
☐ Some Potential Sources

Stream Depth Riffle (m):	Stream Depth Run (m):	Stream Depth Pool (m):

Distances Riffle-Riffle (m):	Distances Bend-Bend (m):

Stream Width (m):	High Water Mark (m):

Stream Type:
☐ Cold
☐ Warm

Turbidity (Est):
☐ Clear ☐ Slightly Turbid
☐ Opaque ☐ Turbid

☐ **Channelization** ☐ **Dam Present**

Predominant Surrounding Land Use: ☐ Forest ☐ Field/Pasture ☐ Agricultural ☐ Residential ☐ Commercial ☐ Industrial
Other ____________

Sediment

Sediment Odors: ☐ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None Other ____________

Sediment Deposits: ☐ Sludge ☐ Sawdust ☐ Paper Fiber ☐ Sand ☐ Relic Shells Other ____________

Sediment Oils: ☐ Absent ☐ Moderate ☐ Profuse ☐ Slight

☐ Are the undersides of stones, which are not deeply embedded, black?

Substrate Components

(Note: Select from 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, or 100% for each inorganic/ organic substrate component)

Inorganic Substrate Components (% Diameter)						
Bedrock	Boulder (>10 in)	Cobble (2.5-10 in)	Gravel (0.1-2.5 in)	Sand (gritty)	Silt	Clay (slick)

Organic Substrate Components (% Type)			
Detritus (sticks, wood)	Detritus (CPOM)	Muck/Mud (black, fine FPOM)	Marl(gray w/ shell fragments)

Water Quality

Water Odors: ☐ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ None Other ____________

Water Surface Oils: ☐ Slick ☐ Sheen ☐ Glob ☐ Flocks ☐ None

IDEM 03/8/18

Attachment 6: IDEM OWQ Biological Qualitative Habitat Evaluation Index (front)

IDEM

OWQ Biological QHEI (Qualitative Habitat Evaluation Index)

Sample # | bioSample # | Stream Name | Location

Surveyor | Sample Date | County | Macro Sample Type | ☐ Habitat Complete | **QHEI Score:**

1] *SUBSTRATE* Check ONLY Two predominant substrate TYPE BOXES and check every type present

BEST TYPES (PREDOMINANT / PRESENT P/G R/R)
- ☐☐ BLDR/SLABS [10] ☐☐
- ☐☐ BOULDER [9] ☐☐
- ☐☐ COBBLE [8] ☐☐
- ☐☐ GRAVEL [7] ☐☐
- ☐☐ SAND [6] ☐☐
- ☐☐ BEDROCK [5] ☐☐

OTHER TYPES (PREDOMINANT / PRESENT P/G R/R)
- ☐☐ HARDPAN [4] ☐☐
- ☐☐ DETRITUS [3] ☐☐
- ☐☐ MUCK [2] ☐☐
- ☐☐ SILT [2] ☐☐
- ☐☐ ARTIFICIAL [0] ☐☐

(Score natural substrates; ignore sludge from point-sources)

NUMBER OF BEST TYPES: ☐ 4 or more [2] ☐ 3 or less [0]

Check ONE (Or 2 & average)

ORIGIN
- ☐ LIMESTONE [1]
- ☐ TILLS [1]
- ☐ WETLANDS [0]
- ☐ HARDPAN [0]
- ☐ SANDSTONE [0]
- ☐ RIP/RAP [0]
- ☐ LACUSTRINE [0]
- ☐ SHALE [-1]
- ☐ COAL FINES [-2]

QUALITY

SILT
- ☐ HEAVY [-2]
- ☐ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ FREE [1]

EMBEDDEDNESS
- ☐ EXTENSIVE [-2]
- ☐ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ NONE [1]

Substrate Maximum 20

Comments

2] *INSTREAM COVER* Indicate presence 0 to 3: 0–Absent; 1–Very small amounts or if more common of marginal quality; 2–Moderate amounts, but not of highest quality or in small amounts of highest quality; 3–Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed root wad in deep/fast water, or deep, well-defined, functional pools.)

- ___ UNDERCUT BANKS [1]
- ___ OVERHANGING VEGETATION [1]
- ___ SHALLOWS (IN SLOW WATER) [1]
- ___ ROOTMATS [1]
- ___ POOLS > 70cm [2]
- ___ ROOTWADS [1]
- ___ BOULDERS [1]
- ___ OXBOWS, BACKWATERS [1]
- ___ AQUATIC MACROPHYTES [1]
- ___ LOGS OR WOODY DEBRIS [1]

AMOUNT Check ONE (Or 2 & average)
- ☐ EXTENSIVE > 75% [11]
- ☐ MODERATE 25 - 75% [7]
- ☐ SPARSE 5 - < 25% [3]
- ☐ NEARLY ABSENT < 5% [1]

Cover Maximum 20

Comments

3] *CHANNEL MORPHOLOGY* Check ONE in each category (Or 2 & average)

SINUOSITY
- ☐ HIGH [4]
- ☐ MODERATE [3]
- ☐ LOW [2]
- ☐ NONE [1]

DEVELOPMENT
- ☐ EXCELLENT [7]
- ☐ GOOD [5]
- ☐ FAIR [3]
- ☐ POOR [1]

CHANNELIZATION
- ☐ NONE [6]
- ☐ RECOVERED [4]
- ☐ RECOVERING [3]
- ☐ RECENT OR NO RECOVERY [1]

STABILITY
- ☐ HIGH [3]
- ☐ MODERATE [2]
- ☐ LOW [1]

Channel Maximum 20

Comments

4] *BANK EROSION AND RIPARIAN ZONE* Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

EROSION (L R)
- ☐☐ NONE/LITTLE [3]
- ☐☐ MODERATE [2]
- ☐☐ HEAVY/SEVERE [1]

RIPARIAN WIDTH (L R)
- ☐☐ WIDE > 50m [4]
- ☐☐ MODERATE 10-50m [3]
- ☐☐ NARROW 5-10m [2]
- ☐☐ VERY NARROW [1]
- ☐☐ NONE [0]

FLOOD PLAIN QUALITY (L R)
- ☐☐ FOREST, SWAMP [3]
- ☐☐ SHRUB OR OLD FIELD [2]
- ☐☐ RESIDENTIAL, PARK, NEW FIELD [1]
- ☐☐ FENCED PASTURE [1]
- ☐☐ OPEN PASTURE, ROWCROP [0]

(L R)
- ☐☐ CONSERVATION TILLAGE [1]
- ☐☐ URBAN OR INDUSTRIAL [0]
- ☐☐ MINING /CONSTRUCTION [0]

Indicate predominant land use(s) past 100m riparian.

Riparian Maximum 10

Comments

5] *POOL/GLIDE AND RIFFLE/RUN QUALITY*

MAXIMUM DEPTH Check ONE (ONLY!)
- ☐ > 1m [6]
- ☐ 0.7 - < 1m [4]
- ☐ 0.4 - < 0.7m [2]
- ☐ 0.2 - < 0.4m [1]
- ☐ < 0.2m [0] [metric = 0]

CHANNEL WIDTH Check ONE (Or 2 & average)
- ☐ POOL WIDTH > RIFFLE WIDTH [2]
- ☐ POOL WIDTH = RIFFLE WIDTH [1]
- ☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY Check ALL that apply
- ☐ TORRENTIAL [-1]
- ☐ VERY FAST [1]
- ☐ FAST [1]
- ☐ MODERATE [1]
- ☐ SLOW [1]
- ☐ INTERSTITIAL [-1]
- ☐ INTERMITTENT [-2]
- ☐ EDDIES [1]

Indicate for reach – pools and riffles.

Recreation Potential (Check one and comment on back)
- ☐ Primary Contact
- ☐ Secondary Contact

Pool/Current Maximum 12

Comments

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

Check ONE (Or 2 & average)

☐ NO RIFFLE [metric = 0]

RIFFLE DEPTH
- ☐ BEST AREAS > 10cm [2]
- ☐ BEST AREAS 5 - 10cm [1]
- ☐ BEST AREAS < 5 cm [metric = 0]

RUN DEPTH
- ☐ MAXIMUM > 50cm [2]
- ☐ MAXIMUM < 50cm [1]

RIFFLE/RUN SUBSTRATE
- ☐ STABLE (e.g., Cobble, Boulder) [2]
- ☐ MOD. STABLE (e.g., Large Gravel) [1]
- ☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE/RUN EMBEDDEDNESS
- ☐ NONE [2]
- ☐ LOW [1]
- ☐ MODERATE [0]
- ☐ EXTENSIVE [-1]

Riffle/Run Maximum 8

Comments

6] *GRADIENT* (ft/mi)

DRAINAGE AREA (mi²)

- ☐ VERY LOW - LOW [2 – 4]
- ☐ MODERATE [6 - 10]
- ☐ HIGH - VERY HIGH [10 - 6]

%POOL: **%GLIDE:**

%RUN: **%RIFFLE:**

Gradient Maximum 10

Entered ________ QC1 ________ QC2 ________ IDEM 02/28/2018

Attachment 6 (continued): IDEM OWQ Biological Qualitative Habitat Evaluation Index (back)

IDEM

OWQ Biological QHEI (Qualitative Habitat Evaluation Index)

COMMENT ______________________________

A-CANOPY
- ☐ > 85% - Open
- ☐ 55% - < 85%
- ☐ 30% - < 55%
- ☐ 10% - < 30%
- ☐ < 10% - Closed

B-AESTHETICS
- ☐ Nuisance algae
- ☐ Invasive macrophytes
- ☐ Excess turbidity
- ☐ Discoloration
- ☐ Foam/Scum
- ☐ Oil sheen
- ☐ Trash/Litter
- ☐ Nuisance odor
- ☐ Sludge deposits
- ☐ CSOs/SSOs/Outfalls

C-RECREATION

	Area	Depth
Pool:	☐ > 100 ft^2	☐ > 3 ft

D-MAINTENANCE
- ☐ Public ☐ Private
- ☐ Active ☐ Historic
- Succession: ☐ Young ☐ Old
- ☐ Spray ☐ Islands ☐ Scoured
- Snag: ☐ Removed ☐ Modified
- Leveed: ☐ One sided ☐ Both banks
- ☐ Relocated ☐ Cutoffs
- Bedload: ☐ Moving ☐ Stable
- ☐ Armoured ☐ Slumps
- ☐ Impounded ☐ Desiccated
- ☐ Flood control ☐ Drainage

E-ISSUES
- ☐ WWTP ☐ CSO ☐ NPDES
- ☐ Industry ☐ Urban
- ☐ Hardened ☐ Dirt & Grime
- ☐ Contaminated ☐ Landfill
- BMPs: ☐ Construction ☐ Sediment
- ☐ Logging ☐ Irrigation ☐ Cooling
- Erosion: ☐ Bank ☐ Surface
- ☐ False bank ☐ Manure ☐ Lagoon
- ☐ Wash H_2O ☐ Tile ☐ H_2O Table
- Mine: ☐ Acid ☐ Quarry
- Flow: ☐ Natural ☐ Stagnant
- ☐ Wetland ☐ Park ☐ Golf
- ☐ Lawn ☐ Home
- ☐ Atmospheric deposition
- ☐ Agriculture ☐ Livestock

Looking upstream (> 10m, 3 readings; ≤ 10m, 1 reading in middle); Round to the nearest whole percent

	Right	Middle	Left	Total Average
% open	___ %	___ %	___ %	___ %

Stream Drawing:

IDEM 02/28/2018

Attachment 7: IDEM OWQ Chain of Custody Form

IDEM

Indiana Department of Environmental Management

OWQ Chain of Custody Form

Project:
OWQ Sample Set or Trip #:

I Certify that the sample(s) listed below was/were collected by me, or in my presence. Date:________________________

Signature:____ Section:________________________

Sample Media (☐ Water, ☐ Algae,☐ Fish, ☐ Macro, ☐ Cyanobacteria/Microcystin, ☐ Sediment)

Lab Assigned Number / Event ID	IDEM Control Number	Sample Type	ID	1000 ml P.N.M.	1000 ml G.N.M.	40 ml Vial	120 ml P (Bact)	2000 ml Nalgene	250 ml Nalgene	125 ml Glass	Date and Time Collected		One check per bottle present
											Date	Time	

P = Plastic G = Glass N.M. = Narrow Mouth Bact = Bacteriological Only — Should samples be iced? Y N

M = MS/MSD B = Blank D = Duplicate R = Revisit

Carriers

I certify that I have received the above sample(s).

Signature	Date	Time	Seals Intact		Comments
Relinquished By:			Y	N	
Received By:					
Relinquished By:			Y	N	
Received By:					
Relinquished By:			Y	N	
Received By:					
IDEM Storage Room #					

Lab Custodian

I certify that I have received the above sample(s), which has/have been recorded in the official record book. The same sample(s) will be in the custody of competent laboratory personnel at all times, or locked in a secured area.

Signature:________________________________ Date:______________ Time:____________

Lab:________________________________ Address:________________________________

Revision Date: 4/27/2016

Attachment 8: IDEM OWQ Water Sample Analysis Request Form

Indiana Department of Environmental Management
Office of Water Quality
Watershed Planning and Assessment Branch
www.idem.IN.gov

Water Sample Analysis Request

Project Name: 2020 Maria Creek **Composite** ☐ **Grab** ☒

OWQ Sample Set	19BLW	IDEM Sample Nos.	AB
Crew Chief	Tim Beckman	Lab Sample Nos.	
Collection Date		Lab Delivery Date	

Anions and Physical Parameters

Parameter	Test Method	Total	Dissolved
Alkalinity	SM2320B	☒ **	☐
Total Solids	SM2540B	☒ **	
Suspended Solids	SM2540D	☒ **	
Dissolved Solids	SM2540C		☒ **
Sulfate	300.0	☐ **	☒ **
Chloride	300.0	☐ **	☒ **
Hardness (Calculated)	SM-2340B	☒ **	☐
Fluoride	300.0	☐ **	☐

Priority Pollutant Metals Water Parameters

Parameter	Test Method	Total	Dissolved
Antimony	200.8	☐	☐
Arsenic	200.8	☐	☐
Beryllium	200.8	☐	☐
Cadmium	200.8	☐	☐
Chromium	200.7	☐	☐
Copper	200.8	☐	☐
Lead	200.8	☐	☐
Mercury, Low Level	1631, Rev E	☐	☐
Nickel	200.8	☐	☐
Selenium	200.8	☐	☐
Silver	200.8	☐	☐
Thallium	200.8	☐	☐
Zinc	200.7	☐	☐

Cations and Secondary Metals Parameters

Parameter	Test Method	Total	Dissolved
Aluminum	200.7, 200.8	☐	☐
Barium	200.8	☐	☐
Boron	200.8	☐	☐
Calcium	200.7, 200.8	☒ ***	☐
Cobalt	200.8	☐	☐
Iron	200.7	☐	☐
Magnesium	200.7, 200.8	☒ ***	☐
Manganese	200.8	☐	☐
Sodium	200.7	☐	☐
Silica, Total Reactive	200.7	☐	☐
Strontium	200.8	☐	☐

Organic Water Parameters

Parameter	Test Method	Total
Priority Pollutants: Organochlorine Pesticides and PCBs	608	☐
Priority Pollutants: VOCs - Purgeable Organics	624	☐
Priority Pollutants: Base/Neutral Extractables	625	☐
Priority Pollutants: Acid Extractables	625	☐
Phenolics, 4AAP	420.2	☐
Oil and Grease, Total	1664A	☐

Nutrient & Organic Water Chemistry Parameters

Parameter	Test Method	Total	Dissolved
Ammonia Nitrogen	SM4500NH3-G	☒	☐
$CBOD_5$	SM5210B	☐	
Total Kjeldahl Nitrogen (TKN)	SM4500N(Org)	☒	☐
Nitrate + Nitrite	SM4500NO3-F	☒	☐
Total Phosphorus	SM4500P-E	☒	☐
TOC	SM 5310C	☒	☐
COD	SM5220C	☒	☐
Cyanide (Total)	SM4500CN-E	☐	☐
Cyanide (Free)	SM4500CN-I	☐ *	☐
Cyanide (Amenable)	SM4500CN-G	☐ *	☐
Sulfide, Total	SM4500S2-F	☐	☐

RFP 16-074 Contract Number:	SCM # 19855 PO # 0020000771

30 day reporting time required.

Notes:

** = **DO NOT RUN PARAMETER IF SAMPLE IDENTIFIED AS A BLANK ON THE CHAIN OF CUSTODY**

* = **RUN ONLY IF TOTAL CYANIDE IS DETECTED**

*** = *Report Calcium, Magnesium as Total Hardness components*

Send reports (Fed. Ex. or UPS) to:
Tim Bowren - IDEM
Bldg. 20 STE 100
2525 North Shadeland Ave.
Indianapolis, IN 46219

Deliver reports to:
Tim Bowren – IDEM
Bldg. 20 STE 100
2525 North Shadeland Ave.
Indianapolis, IN 46219

Testing Laboratory: Test America
Attn: Robin Kintz
2417 Bond Street
University Park, IL 60484

Phone: 708.534.5200

Attachment 9: Test America Chain of Custody Form

TestAmerica Chicago
2417 Bond Street

University Park, IL 60484-3101
phone 708.534.5200 fax 708.534.5211

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☐ Other:

TestAmerica Laboratories, Inc.

Client Contact	**Project Manager:**	**Site Contact:**	**Date:**
Your Company Name here	**Tel/Fax:**	**Lab Contact:**	**Carrier:**
Address	**Analysis Turnaround Time**		
City/State/Zip	☐ CALENDAR DAYS ☐ WORKING DAYS		
(xxx) xxx-xxxx Phone	TAT if different from Below ________		
(xxx) xxx-xxxx FAX	☐ 2 weeks		
Project Name:	☐ 1 week		
Site:	☐ 2 days		
P O #	☐ 1 day		

COC No:
_______ of _______ COCs
Sampler:
For Lab Use Only:
Walk-in Client:
Lab Sampling:
Job / SDG No.:

Sample Identification	Sample Date	Sample Time	Sample Type (C=Comp, G=Grab)	Matrix	# of Cont.	Filtered Sample (Y / N)	Perform MS / MSD (Y / N)																Sample Specific Notes:

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other ____________

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.

☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ Return to Client ☐ Disposal by Lab ☐ Archive for________ Months

Special Instructions/QC Requirements & Comments:

Custody Seals Intact: ☐ Yes ☐ No | Custody Seal No.: | Cooler Temp. (^{o}C): Obs'd:________ Corr'd:_________ Therm ID No.:___________

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:

Form No. CA-C-WI-002, Rev. 4.11, dated 1/24/2017

Attachment 10: Eurofins TestAmerica Chicago Laboratory Accreditation

STATE OF ILLINOIS

ENVIRONMENTAL PROTECTION AGENCY
NELAP - RECOGNIZED
ENVIRONMENTAL LABORATORY ACCREDITATION

is hereby granted to

Eurofins TestAmerica Chicago
2417 Bond Street
University Park, IL 60484

NELAP ACCREDITED

Accreditation Number #100201

According to the Illinois Administrative Code, Title 35, Subtitle A, Chapter II, Part 186, ACCREDITATION OF LABORATORIES FOR DRINKING WATER, WASTEWATER AND HAZARDOUS WASTES ANALYSIS, the State of Illinois formally recognizes that this laboratory is technically competent to perform the environmental analyses listed on the scope of accreditation detailed below.

The laboratory agrees to perform all analyses listed on this scope of accreditation according to the Part 186 requirements and acknowledges that continued accreditation is dependent on successful ongoing compliance with the applicable requirements of Part 186. Please contact the Illinois EPA Environmental Laboratory Accreditation Program (IL ELAP) to verify the laboratory's scope of accreditation and accreditation status. Accreditation by the State of Illinois is not an endorsement or a guarantee of validity of the data generated by the laboratory.

Primary Accrediting Authority:Illinois

Celeste M Crowley

Celeste M. Crowley
Supervisor
Environmental Laboratory Accreditation Program

Certificate No: 1002012019-2
Expiration Date: 4/30/2020
Issued On: 6/28/2019

State of Illinois
Environmental Protection Agency

Certificate No.: 1002012019-2

Awards the Certificate of Approval to:

Eurofins TestAmerica Chicago
2417 Bond Street
University Park, IL 60484

Accreditation Start: 4/30/2018 Accreditation End: 4/30/2020

The Illinois Environmental Laboratory Accreditation Program encourages all clients and data users to verify the most current scope of accreditation for Eurofins TestAmerica Chicago.

	Primary AB
Field of Testing /Matrix: ***CWA (Non Potable Water)***	
Method **EPA 120.1**	
Conductivity	IL
Method **EPA 160.4**	
Residue-volatile	IL
Method **EPA 1664A Rev: 1**	
Oil & Grease	IL
Method **EPA 1664B**	
Oil & Grease	IL
Method **EPA 180.1 Rev: 2**	
Turbidity	IL
Method **EPA 200.7 Rev: 4.4**	
Aluminum	IL
Antimony	IL
Arsenic	IL
Barium	IL
Beryllium	IL
Boron	IL
Cadmium	IL
Calcium	IL
Chromium	IL
Cobalt	IL
Copper	IL
Iron	IL
Lead	IL
Magnesium	IL
Manganese	IL
Molybdenum	IL
Nickel	IL
Potassium	IL
Selenium	IL
Silica as SiO2	IL
Silver	IL
Sodium	IL
Thallium	IL
Tin	IL
Titanium	IL
Vanadium	IL
Zinc	IL

Attachment 12: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***CWA (Non Potable Water)***	
Method **EPA 200.8 Rev: 5.4**	
Aluminum	IL
Antimony	IL
Arsenic	IL
Barium	IL
Beryllium	IL
Boron	IL
Cadmium	IL
Calcium	IL
Chromium	IL
Cobalt	IL
Copper	IL
Iron	IL
Lead	IL
Magnesium	IL
Manganese	IL
Molybdenum	IL
Nickel	IL
Potassium	IL
Selenium	IL
Silver	IL
Sodium	IL
Thallium	IL
Tin	IL
Titanium	IL
Vanadium	IL
Zinc	IL
Method **EPA 218.6 Rev: 3.3**	
Chromium VI	IL
Method **EPA 245.1 Rev: 3**	
Mercury	IL
Method **EPA 300.0 Rev: 2.1**	
Bromide	IL
Chloride	IL
Fluoride	IL
Nitrate	IL
Nitrate plus Nitrite as N	IL
Nitrite	IL
Orthophosphate as P	IL
Sulfate	IL
Method **EPA 350.1 Rev: 2**	
Ammonia	IL
Method **EPA 353.2 Rev: 2**	
Nitrate	IL
Nitrate plus Nitrite as N	IL
Method **EPA 420.4 Rev: 1**	
Total phenolics	IL
Method **EPA 608**	
4,4'-DDD	IL

Attachment 13: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***CWA (Non Potable Water)***	
4,4'-DDE	IL
4,4'-DDT	IL
Aldrin	IL
alpha-BHC (alpha-Hexachlorocyclohexane)	IL
Aroclor-1016 (PCB-1016)	IL
Aroclor-1221 (PCB-1221)	IL
Aroclor-1232 (PCB-1232)	IL
Aroclor-1242 (PCB-1242)	IL
Aroclor-1248 (PCB-1248)	IL
Aroclor-1254 (PCB-1254)	IL
Aroclor-1260 (PCB-1260)	IL
beta-BHC (beta-Hexachlorocyclohexane)	IL
Chlordane (tech.)(N.O.S.)	IL
delta-BHC	IL
Dieldrin	IL
Endosulfan I	IL
Endosulfan II	IL
Endosulfan sulfate	IL
Endrin	IL
Endrin aldehyde	IL
gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)	IL
Heptachlor	IL
Heptachlor epoxide	IL
Methoxychlor	IL
Toxaphene (Chlorinated camphene)	IL
Method **EPA 624**	
1,1,1-Trichloroethane	IL
1,1,2,2-Tetrachloroethane	IL
1,1,2-Trichloroethane	IL
1,1-Dichloroethane	IL
1,1-Dichloroethylene	IL
1,2-Dichlorobenzene (o-Dichlorobenzene)	IL
1,2-Dichloroethane (Ethylene dichloride)	IL
1,2-Dichloropropane	IL
1,3-Dichlorobenzene	IL
1,4-Dichlorobenzene	IL
2-Chloroethyl vinyl ether	IL
Acrolein (Propenal)	IL
Acrylonitrile	IL
Benzene	IL
Bromodichloromethane	IL
Bromoform	IL
Carbon tetrachloride	IL
Chlorobenzene	IL
Chlorodibromomethane	IL
Chloroethane (Ethyl chloride)	IL
Chloroform	IL
cis-1,3-Dichloropropene	IL
Ethylbenzene	IL
Methyl bromide (Bromomethane)	IL
Methyl chloride (Chloromethane)	IL

Attachment 14: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***CWA (Non Potable Water)***	
Methyl tert-butyl ether (MTBE)	IL
Methylene chloride (Dichloromethane)	IL
Tetrachloroethylene (Perchloroethylene)	IL
Toluene	IL
trans-1,2-Dichloroethylene	IL
trans-1,3-Dichloropropylene	IL
Trichloroethene (Trichloroethylene)	IL
Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	IL
Vinyl chloride	IL
Xylene (total)	IL
Method **EPA 625**	
1,2,4-Trichlorobenzene	IL
1,2-Dichlorobenzene (o-Dichlorobenzene)	IL
1,3-Dichlorobenzene	IL
1,4-Dichlorobenzene	IL
2,2'-Oxybis(1-chloropropane), bis(2-Chloro-1-methylethyl)ether	IL
2,4,5-Trichlorophenol	IL
2,4,6-Trichlorophenol	IL
2,4-Dichlorophenol	IL
2,4-Dimethylphenol	IL
2,4-Dinitrophenol	IL
2,4-Dinitrotoluene (2,4-DNT)	IL
2,6-Dinitrotoluene (2,6-DNT)	IL
2-Chloronaphthalene	IL
2-Chlorophenol	IL
2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	IL
2-Nitrophenol	IL
3,3'-Dichlorobenzidine	IL
4-Bromophenyl phenyl ether	IL
4-Chloro-3-methylphenol	IL
4-Chlorophenyl phenylether	IL
4-Nitrophenol	IL
Acenaphthene	IL
Acenaphthylene	IL
Anthracene	IL
Benzidine	IL
Benzo(a)anthracene	IL
Benzo(a)pyrene	IL
Benzo(b)fluoranthene	IL
Benzo(g,h,i)perylene	IL
Benzo(k)fluoranthene	IL
bis(2-Chloroethoxy)methane	IL
bis(2-Chloroethyl) ether	IL
bis(2-Ethylhexyl) phthalate (DEHP)	IL
Butyl benzyl phthalate	IL
Chrysene	IL
Dibenz(a,h) anthracene	IL
Diethyl phthalate	IL
Dimethyl phthalate	IL
Di-n-butyl phthalate	IL
Di-n-octyl phthalate	IL

Attachment 15: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***CWA (Non Potable Water)***	
Fluoranthene	IL
Fluorene	IL
Hexachlorobenzene	IL
Hexachlorobutadiene	IL
Hexachlorocyclopentadiene	IL
Hexachloroethane	IL
Indeno(1,2,3-cd) pyrene	IL
Isophorone	IL
Naphthalene	IL
Nitrobenzene	IL
n-Nitrosodimethylamine	IL
n-Nitrosodi-n-propylamine	IL
n-Nitrosodiphenylamine	IL
Pentachlorophenol	IL
Phenanthrene	IL
Phenol	IL
Pyrene	IL
Method **SM 2320 B-1997**	
Alkalinity as CaCO3	IL
Method **SM 2340 B-1997**	
Hardness	IL
Method **SM 2510 B-1997**	
Conductivity	IL
Method **SM 2540 B-1991 Rev: 18th ED**	
Residue-total	IL
Method **SM 2540 C-1997**	
Residue-filterable (TDS)	IL
Method **SM 2540 D-1997**	
Residue-nonfilterable (TSS)	IL
Method **SM 2540 E-1997**	
Residue-volatile	IL
Method **SM 2540 F-1997**	
Residue-settleable	IL
Method **SM 3500-Cr B-2009**	
Chromium VI	IL
Method **SM 4500-Cl F-2000**	
Total residual chlorine	IL
Method **SM 4500-Cl G-2000**	
Total residual chlorine	IL
Method **SM 4500-Cl$^-$ E-1997 Rev: 21st ED**	
Chloride	IL
Method **SM 4500-CN$^-$ E-1999**	
Cyanide	IL
Method **SM 4500-CN$^-$ G-1999**	
Available Cyanide	IL
Method **SM 4500-F$^-$ C-1997 Rev: 21st ED**	
Fluoride	IL

Attachment 16: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***CWA (Non Potable Water)***	
Method **SM 4500-H+ B-2000**	
pH	IL
Method **SM 4500-NH3 G Rev: 21st ED**	
Ammonia	IL
Total Kjeldahl Nitrogen (TKN)	IL
Method **SM 4500-NO2⁻ B-2000**	
Nitrite	IL
Method **SM 4500-NO3⁻ F-2000**	
Nitrate	IL
Nitrate plus Nitrite as N	IL
Method **SM 4500-O G-2001**	
Oxygen, dissolved	IL
Method **SM 4500-P E-1999**	
Orthophosphate as P	IL
Phosphorus	IL
Method **SM 4500-S2⁻ F-2000**	
Sulfide	IL
Method **SM 4500-SO4⁻ E-1997**	
Sulfate	IL
Method **SM 5210 B-2001**	
Biochemical oxygen demand	IL
Carbonaceous BOD, CBOD	IL
Method **SM 5220 C-1997 Rev: 21st ED**	
Chemical oxygen demand	IL
Method **SM 5310 B-2000**	
Total organic carbon	IL
Method **SM 5310 C-2000**	
Total organic carbon	IL

Attachment 17: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***CWA (Solid & Hazardous Material)***	
Method **EPA 120.1**	
Conductivity	IL
Method **EPA 160.4**	
Residue-volatile	IL
Method **EPA 1664A Rev: 1**	
Oil & Grease	IL
Method **EPA 1664B**	
Oil & Grease	IL
Method **EPA 200.7 Rev: 4.4**	
Aluminum	IL
Antimony	IL
Arsenic	IL
Barium	IL
Beryllium	IL
Boron	IL
Cadmium	IL
Calcium	IL
Chromium	IL
Cobalt	IL
Copper	IL
Iron	IL
Lead	IL
Magnesium	IL
Manganese	IL
Molybdenum	IL
Nickel	IL
Potassium	IL
Selenium	IL
Silica as SiO2	IL
Silver	IL
Sodium	IL
Thallium	IL
Tin	IL
Titanium	IL
Vanadium	IL
Zinc	IL
Method **EPA 350.1 Rev: 2**	
Ammonia	IL
Method **EPA 353.2 Rev: 2**	
Nitrate	IL
Nitrate plus Nitrite as N	IL
Method **EPA 420.4 Rev: 1**	
Total phenolics	IL
Method **SM 2320 B-1997**	
Alkalinity as CaCO3	IL
Method **SM 2510 B-1997**	
Conductivity	IL
Method **SM 4500-Cl^- E-1997 Rev: 21st ED**	

Attachment 18: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***CWA (Solid & Hazardous Material)***	
Chloride	IL
Method **SM 4500-CN¯ E-1999**	
Cyanide	IL
Method **SM 4500-CN¯ G-1999**	
Available Cyanide	IL
Method **SM 4500-F¯ C-1997 Rev: 21st ED**	
Fluoride	IL
Method **SM 4500-NH3 G Rev: 21st ED**	
Ammonia	IL
Total Kjeldahl Nitrogen (TKN)	IL
Method **SM 4500-NO2¯ B-2000**	
Nitrite	IL
Method **SM 4500-NO3¯ F-2000**	
Nitrate	IL
Nitrate plus Nitrite as N	IL
Method **SM 4500-P E-1999**	
Orthophosphate as P	IL
Phosphorus	IL
Method **SM 4500-S2¯ F-2000**	
Sulfide	IL
Method **SM 5210 B-2001**	
Biochemical oxygen demand	IL
Carbonaceous BOD, CBOD	IL
Method **SM 5220 C-1997 Rev: 21st ED**	
Chemical oxygen demand	IL
Method **SM 5310 C-2000**	
Total organic carbon	IL

Attachment 19: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***RCRA (Non Potable Water)***	
Method **EPA 1010A**	
Ignitability	IL
Method **EPA 1311 Rev: 0**	
Toxicity Characteristic Leaching Procedure (TCLP)	IL
Method **EPA 1312 Rev: 0**	
Synthetic Precipitation Leaching Procedure (SCLP)	IL
Method **EPA 6010B Rev: 2**	
Aluminum	IL
Antimony	IL
Arsenic	IL
Barium	IL
Beryllium	IL
Boron	IL
Cadmium	IL
Calcium	IL
Chromium	IL
Cobalt	IL
Copper	IL
Iron	IL
Lead	IL
Lithium	IL
Magnesium	IL
Manganese	IL
Molybdenum	IL
Nickel	IL
Potassium	IL
Selenium	IL
Silica as SiO2	IL
Silver	IL
Sodium	IL
Strontium	IL
Thallium	IL
Tin	IL
Titanium	IL
Vanadium	IL
Zinc	IL
Method **EPA 6010C**	
Aluminum	IL
Antimony	IL
Arsenic	IL
Barium	IL
Beryllium	IL
Boron	IL
Cadmium	IL
Calcium	IL
Chromium	IL
Cobalt	IL
Copper	IL
Iron	IL
Lead	IL

Attachment 20: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***RCRA (Non Potable Water)***	
Lithium	IL
Magnesium	IL
Manganese	IL
Molybdenum	IL
Nickel	IL
Potassium	IL
Selenium	IL
Silica as SiO2	IL
Silver	IL
Sodium	IL
Strontium	IL
Thallium	IL
Tin	IL
Titanium	IL
Vanadium	IL
Zinc	IL
Method **EPA 6020A Rev: 1**	
Aluminum	IL
Antimony	IL
Arsenic	IL
Barium	IL
Beryllium	IL
Boron	IL
Cadmium	IL
Calcium	IL
Chromium	IL
Cobalt	IL
Copper	IL
Iron	IL
Lead	IL
Magnesium	IL
Manganese	IL
Molybdenum	IL
Nickel	IL
Potassium	IL
Selenium	IL
Silver	IL
Sodium	IL
Thallium	IL
Vanadium	IL
Zinc	IL
Method **EPA 7196A Rev: 1**	
Chromium VI	IL
Method **EPA 7199 Rev: 0**	
Chromium VI	IL
Method **EPA 7470A Rev: 1**	
Mercury	IL
Method **EPA 8015B Rev: 2**	
Diesel range organics (DRO)	IL
Gasoline range organics (GRO)	IL

Attachment 21: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***RCRA (Non Potable Water)***	
Method **EPA 8015C**	
Diesel range organics (DRO)	IL
Gasoline range organics (GRO)	IL
Method **EPA 8015D**	
Diesel range organics (DRO)	IL
Gasoline range organics (GRO)	IL
Method **EPA 8081A Rev: 1**	
4,4'-DDD	IL
4,4'-DDE	IL
4,4'-DDT	IL
Alachlor	IL
Aldrin	IL
alpha-BHC (alpha-Hexachlorocyclohexane)	IL
alpha-Chlordane, cis-Chlordane	IL
Atrazine	IL
beta-BHC (beta-Hexachlorocyclohexane)	IL
Chlordane (tech.)(N.O.S.)	IL
delta-BHC	IL
Dieldrin	IL
Endosulfan I	IL
Endosulfan II	IL
Endosulfan sulfate	IL
Endrin	IL
Endrin aldehyde	IL
Endrin ketone	IL
gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)	IL
gamma-Chlordane	IL
Heptachlor	IL
Heptachlor epoxide	IL
Isodrin	IL
Kepone	IL
Methoxychlor	IL
Simazine	IL
Toxaphene (Chlorinated camphene)	IL
Method **EPA 8081B**	
4,4'-DDD	IL
4,4'-DDE	IL
4,4'-DDT	IL
Alachlor	IL
Aldrin	IL
alpha-BHC (alpha-Hexachlorocyclohexane)	IL
alpha-Chlordane, cis-Chlordane	IL
Atrazine	IL
beta-BHC (beta-Hexachlorocyclohexane)	IL
Chlordane (tech.)(N.O.S.)	IL
delta-BHC	IL
Dieldrin	IL
Endosulfan I	IL
Endosulfan II	IL
Endosulfan sulfate	IL

Attachment 22: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***RCRA (Non Potable Water)***	
Endrin	IL
Endrin aldehyde	IL
Endrin ketone	IL
gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)	IL
gamma-Chlordane	IL
Heptachlor	IL
Heptachlor epoxide	IL
Isodrin	IL
Kepone	IL
Methoxychlor	IL
Simazine	IL
Toxaphene (Chlorinated camphene)	IL
Method **EPA 8082 Rev: 0**	
Aroclor-1016 (PCB-1016)	IL
Aroclor-1221 (PCB-1221)	IL
Aroclor-1232 (PCB-1232)	IL
Aroclor-1242 (PCB-1242)	IL
Aroclor-1248 (PCB-1248)	IL
Aroclor-1254 (PCB-1254)	IL
Aroclor-1260 (PCB-1260)	IL
Method **EPA 8082A**	
Aroclor-1016 (PCB-1016)	IL
Aroclor-1221 (PCB-1221)	IL
Aroclor-1232 (PCB-1232)	IL
Aroclor-1242 (PCB-1242)	IL
Aroclor-1248 (PCB-1248)	IL
Aroclor-1254 (PCB-1254)	IL
Aroclor-1260 (PCB-1260)	IL
Method **EPA 8151A**	
2,4,5-T	IL
2,4-D	IL
2,4-DB	IL
Dalapon	IL
Dicamba	IL
Dichloroprop (Dichlorprop)	IL
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	IL
Pentachlorophenol	IL
Picloram	IL
Silvex (2,4,5-TP)	IL
Method **EPA 8260B**	
1,1,1,2-Tetrachloroethane	IL
1,1,1-Trichloroethane	IL
1,1,2,2-Tetrachloroethane	IL
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	IL
1,1,2-Trichloroethane	IL
1,1-Dichloroethane	IL
1,1-Dichloroethylene	IL
1,1-Dichloropropene	IL
1,2,3-Trichlorobenzene	IL
1,2,3-Trichloropropane	IL

Attachment 23: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***RCRA (Non Potable Water)***	
1,2,4-Trichlorobenzene	IL
1,2,4-Trimethylbenzene	IL
1,2-Dibromo-3-chloropropane (DBCP)	IL
1,2-Dibromoethane (EDB, Ethylene dibromide)	IL
1,2-Dichlorobenzene (o-Dichlorobenzene)	IL
1,2-Dichloroethane (Ethylene dichloride)	IL
1,2-Dichloropropane	IL
1,3,5-Trichlorobenzene	IL
1,3,5-Trimethylbenzene	IL
1,3-Dichlorobenzene	IL
1,3-Dichloropropane	IL
1,4-Dichlorobenzene	IL
1,4-Dioxane (1,4- Diethyleneoxide)	IL
1-Chlorohexane	IL
2,2-Dichloropropane	IL
2-Butanone (Methyl ethyl ketone, MEK)	IL
2-Chloroethyl vinyl ether	IL
2-Chlorotoluene	IL
2-Hexanone	IL
2-Methylnaphthalene	IL
2-Nitropropane	IL
4-Chlorotoluene	IL
4-Isopropyltoluene (p-Cymene,p-Isopropyltoluene)	IL
4-Methyl-2-pentanone (MIBK)	IL
Acetone	IL
Acetonitrile	IL
Acrolein (Propenal)	IL
Acrylonitrile	IL
Allyl chloride (3-Chloropropene)	IL
Benzene	IL
Benzyl chloride	IL
Bromobenzene	IL
Bromochloromethane	IL
Bromodichloromethane	IL
Bromoform	IL
Carbon disulfide	IL
Carbon tetrachloride	IL
Chlorobenzene	IL
Chlorodibromomethane	IL
Chloroethane (Ethyl chloride)	IL
Chloroform	IL
Chloroprene (2-Chloro-1,3-butadiene)	IL
cis-1,2-Dichloroethylene	IL
cis-1,3-Dichloropropene	IL
Dibromomethane (Methylene bromide)	IL
Dichlorodifluoromethane (Freon-12)	IL
Diethyl ether	IL
Di-isopropylether (DIPE) (Isopropyl Ether)	IL
Ethanol	IL
Ethyl acetate	IL
Ethyl methacrylate	IL

Attachment 24: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***RCRA (Non Potable Water)***	
Ethylbenzene	IL
Hexachlorobutadiene	IL
Iodomethane (Methyl iodide)	IL
Isobutyl alcohol (2-Methyl-1-propanol)	IL
Isopropylbenzene	IL
m+p-xylene	IL
Methacrylonitrile	IL
Methyl bromide (Bromomethane)	IL
Methyl chloride (Chloromethane)	IL
Methyl methacrylate	IL
Methyl tert-butyl ether (MTBE)	IL
Methylene chloride (Dichloromethane)	IL
m-Xylene	IL
Naphthalene	IL
n-Butyl alcohol (1-Butanol, n-Butanol)	IL
n-Butylbenzene	IL
n-Propylbenzene	IL
o-Xylene	IL
Pentachloroethane	IL
Propionitrile (Ethyl cyanide)	IL
p-Xylene	IL
sec-Butylbenzene	IL
Styrene	IL
tert-Butyl alcohol	IL
tert-Butylbenzene	IL
Tetrachloroethylene (Perchloroethylene)	IL
Tetrahydrofuran (THF)	IL
Toluene	IL
trans-1,2-Dichloroethylene	IL
trans-1,3-Dichloropropylene	IL
trans-1,4-Dichloro-2-butene	IL
Trichloroethene (Trichloroethylene)	IL
Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	IL
Vinyl acetate	IL
Vinyl chloride	IL
Xylene (total)	IL
Method **EPA 8270C Rev: 3**	
1,2,4,5-Tetrachlorobenzene	IL
1,2,4-Trichlorobenzene	IL
1,2-Dichlorobenzene (o-Dichlorobenzene)	IL
1,2-Diphenylhydrazine	IL
1,3,5-Trinitrobenzene (1,3,5-TNB)	IL
1,3-Dichlorobenzene	IL
1,3-Dinitrobenzene (1,3-DNB)	IL
1,4-Dichlorobenzene	IL
1,4-Dinitrobenzene	IL
1,4-Dioxane (1,4- Diethyleneoxide)	IL
1,4-Naphthoquinone	IL
1,4-Phenylenediamine	IL
1-Chloronaphthalene	IL
1-Methylnaphthalene	IL

Attachment 25: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***RCRA (Non Potable Water)***	
1-Naphthylamine	IL
2,2'-Oxybis(1-chloropropane), bis(2-Chloro-1-methylethyl)ether	IL
2,3,4,6-Tetrachlorophenol	IL
2,4,5-Trichlorophenol	IL
2,4,6-Trichlorophenol	IL
2,4-Dichlorophenol	IL
2,4-Dimethylphenol	IL
2,4-Dinitrophenol	IL
2,4-Dinitrotoluene (2,4-DNT)	IL
2,6-Dichlorophenol	IL
2,6-Dinitrotoluene (2,6-DNT)	IL
2-Acetylaminofluorene	IL
2-Chloronaphthalene	IL
2-Chlorophenol	IL
2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	IL
2-Methylaniline (o-Toluidine)	IL
2-Methylnaphthalene	IL
2-Methylphenol (o-Cresol)	IL
2-Naphthylamine	IL
2-Nitroaniline	IL
2-Nitrophenol	IL
2-Picoline (2-Methylpyridine)	IL
3,3'-Dichlorobenzidine	IL
3,3'-Dimethylbenzidine	IL
3-Methylcholanthrene	IL
3-Methylphenol (m-Cresol)	IL
3-Nitroaniline	IL
4-Aminobiphenyl	IL
4-Bromophenyl phenyl ether	IL
4-Chloro-3-methylphenol	IL
4-Chloroaniline	IL
4-Chlorophenyl phenylether	IL
4-Dimethyl aminoazobenzene	IL
4-Methylphenol (p-Cresol)	IL
4-Nitroaniline	IL
4-Nitrophenol	IL
4-Nitroquinoline 1-oxide	IL
5-Nitro-o-toluidine	IL
7,12-Dimethylbenz(a) anthracene	IL
a-a-Dimethylphenethylamine	IL
Acenaphthene	IL
Acenaphthylene	IL
Acetophenone	IL
Aniline	IL
Anthracene	IL
Aramite	IL
Benzidine	IL
Benzo(a)anthracene	IL
Benzo(a)pyrene	IL
Benzo(b)fluoranthene	IL
Benzo(g,h,i)perylene	IL

Attachment 26: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

Field of Testing /Matrix: ***RCRA (Non Potable Water)***	Primary AB
Benzo(k)fluoranthene	IL
Benzoic acid	IL
Benzyl alcohol	IL
bis(2-Chloroethoxy)methane	IL
bis(2-Chloroethyl) ether	IL
bis(2-Ethylhexyl) phthalate (DEHP)	IL
Butyl benzyl phthalate	IL
Carbazole	IL
Carbofuran (Furaden)	IL
Chlorobenzilate	IL
Chrysene	IL
Diallate	IL
Dibenz(a, j) acridine	IL
Dibenz(a,h) anthracene	IL
Dibenzofuran	IL
Diethyl phthalate	IL
Dimethoate	IL
Dimethyl phthalate	IL
Di-n-butyl phthalate	IL
Di-n-octyl phthalate	IL
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	IL
Diphenylamine	IL
Ethyl methanesulfonate	IL
Famphur	IL
Fluoranthene	IL
Fluorene	IL
Hexachlorobenzene	IL
Hexachlorobutadiene	IL
Hexachlorocyclopentadiene	IL
Hexachloroethane	IL
Hexachlorophene	IL
Hexachloropropene	IL
Indeno(1,2,3-cd) pyrene	IL
Isodrin	IL
Isophorone	IL
Isosafrole	IL
Kepone	IL
Methapyrilene	IL
Methyl methanesulfonate	IL
Methyl parathion (Parathion, methyl)	IL
Naphthalene	IL
Nitrobenzene	IL
n-Nitrosodiethylamine	IL
n-Nitrosodimethylamine	IL
n-Nitroso-di-n-butylamine	IL
n-Nitrosodi-n-propylamine	IL
n-Nitrosodiphenylamine	IL
n-Nitrosomethylethalamine	IL
n-Nitrosomorpholine	IL
n-Nitrosopiperidine	IL
n-Nitrosopyrrolidine	IL

Attachment 27: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***RCRA (Non Potable Water)***	
o,o,o-Triethyl phosphorothioate	IL
Parathion	IL
Pentachlorobenzene	IL
Pentachloronitrobenzene	IL
Pentachlorophenol	IL
Phenacetin	IL
Phenanthrene	IL
Phenol	IL
Phorate	IL
p-Phenylenediamine	IL
Pronamide (Kerb)	IL
Pyrene	IL
Pyridine	IL
Safrole	IL
Thionazin (Zinophos)	IL
Method **EPA 8270D**	
1,2,4,5-Tetrachlorobenzene	IL
1,2,4-Trichlorobenzene	IL
1,2-Dichlorobenzene (o-Dichlorobenzene)	IL
1,2-Diphenylhydrazine	IL
1,3,5-Trinitrobenzene (1,3,5-TNB)	IL
1,3-Dichlorobenzene	IL
1,3-Dinitrobenzene (1,3-DNB)	IL
1,4-Dichlorobenzene	IL
1,4-Dinitrobenzene	IL
1,4-Dioxane (1,4- Diethyleneoxide)	IL
1,4-Naphthoquinone	IL
1,4-Phenylenediamine	IL
1-Chloronaphthalene	IL
1-Methylnaphthalene	IL
1-Naphthylamine	IL
2,2'-Oxybis(1-chloropropane), bis(2-Chloro-1-methylethyl)ether	IL
2,3,4,6-Tetrachlorophenol	IL
2,4,5-Trichlorophenol	IL
2,4,6-Trichlorophenol	IL
2,4-Dichlorophenol	IL
2,4-Dimethylphenol	IL
2,4-Dinitrophenol	IL
2,4-Dinitrotoluene (2,4-DNT)	IL
2,6-Dichlorophenol	IL
2,6-Dinitrotoluene (2,6-DNT)	IL
2-Acetylaminofluorene	IL
2-Chloronaphthalene	IL
2-Chlorophenol	IL
2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	IL
2-Methylaniline (o-Toluidine)	IL
2-Methylnaphthalene	IL
2-Methylphenol (o-Cresol)	IL
2-Naphthylamine	IL
2-Nitroaniline	IL
2-Nitrophenol	IL

Attachment 28: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

Field of Testing /Matrix: ***RCRA (Non Potable Water)***	Primary AB
2-Picoline (2-Methylpyridine)	IL
3,3'-Dichlorobenzidine	IL
3,3'-Dimethylbenzidine	IL
3-Methylcholanthrene	IL
3-Methylphenol (m-Cresol)	IL
3-Nitroaniline	IL
4-Aminobiphenyl	IL
4-Bromophenyl phenyl ether	IL
4-Chloro-3-methylphenol	IL
4-Chloroaniline	IL
4-Chlorophenyl phenylether	IL
4-Dimethyl aminoazobenzene	IL
4-Methylphenol (p-Cresol)	IL
4-Nitroaniline	IL
4-Nitrophenol	IL
4-Nitroquinoline 1-oxide	IL
5-Nitro-o-toluidine	IL
7,12-Dimethylbenz(a) anthracene	IL
a-a-Dimethylphenethylamine	IL
Acenaphthene	IL
Acenaphthylene	IL
Acetophenone	IL
Aniline	IL
Anthracene	IL
Aramite	IL
Benzidine	IL
Benzo(a)anthracene	IL
Benzo(a)pyrene	IL
Benzo(b)fluoranthene	IL
Benzo(g,h,i)perylene	IL
Benzo(k)fluoranthene	IL
Benzoic acid	IL
Benzyl alcohol	IL
bis(2-Chloroethoxy)methane	IL
bis(2-Chloroethyl) ether	IL
bis(2-Ethylhexyl) phthalate (DEHP)	IL
Butyl benzyl phthalate	IL
Carbazole	IL
Carbofuran (Furaden)	IL
Chlorobenzilate	IL
Chrysene	IL
Diallate	IL
Dibenz(a, j) acridine	IL
Dibenz(a,h) anthracene	IL
Dibenzofuran	IL
Diethyl phthalate	IL
Dimethoate	IL
Dimethyl phthalate	IL
Di-n-butyl phthalate	IL
Di-n-octyl phthalate	IL
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	IL

Attachment 29: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

Field of Testing /Matrix: ***RCRA (Non Potable Water)***	Primary AB
Diphenylamine	IL
Ethyl methanesulfonate	IL
Famphur	IL
Fluoranthene	IL
Fluorene	IL
Hexachlorobenzene	IL
Hexachlorobutadiene	IL
Hexachlorocyclopentadiene	IL
Hexachloroethane	IL
Hexachlorophene	IL
Hexachloropropene	IL
Indeno(1,2,3-cd) pyrene	IL
Isodrin	IL
Isophorone	IL
Isosafrole	IL
Kepone	IL
Methapyrilene	IL
Methyl methanesulfonate	IL
Methyl parathion (Parathion, methyl)	IL
Naphthalene	IL
Nitrobenzene	IL
n-Nitrosodiethylamine	IL
n-Nitrosodimethylamine	IL
n-Nitroso-di-n-butylamine	IL
n-Nitrosodi-n-propylamine	IL
n-Nitrosodiphenylamine	IL
n-Nitrosomethylethalamine	IL
n-Nitrosomorpholine	IL
n-Nitrosopiperidine	IL
n-Nitrosopyrrolidine	IL
o,o,o-Triethyl phosphorothioate	IL
Parathion	IL
Pentachlorobenzene	IL
Pentachloronitrobenzene	IL
Pentachlorophenol	IL
Phenacetin	IL
Phenanthrene	IL
Phenol	IL
Phorate	IL
p-Phenylenediamine	IL
Pronamide (Kerb)	IL
Pyrene	IL
Pyridine	IL
Safrole	IL
Thionazin (Zinophos)	IL
Method **EPA 9014 Rev: 0**	
Cyanide	IL
Method **EPA 9020B Rev: 2**	
Total organic halides (TOX)	IL
Method **EPA 9034 Rev: 0**	

Attachment 30: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***RCRA (Non Potable Water)***	
Sulfide	IL
Method **EPA 9038 Rev: 0**	
Sulfate	IL
Method **EPA 9040B Rev: 2**	
pH	IL
Method **EPA 9040C**	
pH	IL
Method **EPA 9050A Rev: 1**	
Conductivity	IL
Method **EPA 9056A**	
Bromide	IL
Chloride	IL
Fluoride	IL
Nitrate	IL
Nitrite	IL
Sulfate	IL
Total Phosphate	IL
Method **EPA 9060A**	
Total organic carbon	IL
Method **EPA 9066 Rev: 0**	
Total phenolics	IL
Method **EPA 9071B**	
Oil & Grease	IL
Method **EPA 9095A**	
Paint Filter Test	IL
Method **EPA 9095B**	
Paint Filter Test	IL
Method **EPA 9251 Rev: 0**	
Chloride	IL

Attachment 31: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***RCRA (Solid & Hazardous Material)***	
Method **EPA 1010A**	
Ignitability	IL
Method **EPA 1311 Rev: 0**	
Toxicity Characteristic Leaching Procedure (TCLP)	IL
Method **EPA 1312 Rev: 0**	
Synthetic Precipitation Leaching Procedure (SCLP)	IL
Method **EPA 6010B Rev: 2**	
Aluminum	IL
Antimony	IL
Arsenic	IL
Barium	IL
Beryllium	IL
Boron	IL
Cadmium	IL
Calcium	IL
Chromium	IL
Cobalt	IL
Copper	IL
Iron	IL
Lead	IL
Lithium	IL
Magnesium	IL
Manganese	IL
Molybdenum	IL
Nickel	IL
Potassium	IL
Selenium	IL
Silica as SiO2	IL
Silver	IL
Sodium	IL
Strontium	IL
Thallium	IL
Tin	IL
Titanium	IL
Vanadium	IL
Zinc	IL
Method **EPA 6010C**	
Aluminum	IL
Antimony	IL
Arsenic	IL
Barium	IL
Beryllium	IL
Boron	IL
Cadmium	IL
Calcium	IL
Chromium	IL
Cobalt	IL
Copper	IL
Iron	IL
Lead	IL

Attachment 32: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***RCRA (Solid & Hazardous Material)***	
Lithium	IL
Magnesium	IL
Manganese	IL
Molybdenum	IL
Nickel	IL
Potassium	IL
Selenium	IL
Silica as SiO2	IL
Silver	IL
Sodium	IL
Strontium	IL
Thallium	IL
Tin	IL
Titanium	IL
Vanadium	IL
Zinc	IL
Method **EPA 7196A Rev: 1**	
Chromium VI	IL
Method **EPA 7471B**	
Mercury	IL
Method **EPA 8015B Rev: 2**	
Diesel range organics (DRO)	IL
Gasoline range organics (GRO)	IL
Method **EPA 8015C**	
Diesel range organics (DRO)	IL
Gasoline range organics (GRO)	IL
Method **EPA 8015D**	
Diesel range organics (DRO)	IL
Gasoline range organics (GRO)	IL
Method **EPA 8081A Rev: 1**	
4,4'-DDD	IL
4,4'-DDE	IL
4,4'-DDT	IL
Alachlor	IL
Aldrin	IL
alpha-BHC (alpha-Hexachlorocyclohexane)	IL
alpha-Chlordane, cis-Chlordane	IL
Atrazine	IL
beta-BHC (beta-Hexachlorocyclohexane)	IL
Chlordane (tech.)(N.O.S.)	IL
delta-BHC	IL
Dieldrin	IL
Endosulfan I	IL
Endosulfan II	IL
Endosulfan sulfate	IL
Endrin	IL
Endrin aldehyde	IL
Endrin ketone	IL
gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)	IL
gamma-Chlordane	IL

Attachment 33: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***RCRA (Solid & Hazardous Material)***	
Heptachlor	IL
Heptachlor epoxide	IL
Isodrin	IL
Kepone	IL
Methoxychlor	IL
Simazine	IL
Toxaphene (Chlorinated camphene)	IL
Method **EPA 8081B**	
4,4'-DDD	IL
4,4'-DDE	IL
4,4'-DDT	IL
Alachlor	IL
Aldrin	IL
alpha-BHC (alpha-Hexachlorocyclohexane)	IL
alpha-Chlordane, cis-Chlordane	IL
Atrazine	IL
beta-BHC (beta-Hexachlorocyclohexane)	IL
Chlordane (tech.)(N.O.S.)	IL
delta-BHC	IL
Dieldrin	IL
Endosulfan I	IL
Endosulfan II	IL
Endosulfan sulfate	IL
Endrin	IL
Endrin aldehyde	IL
Endrin ketone	IL
gamma-BHC (Lindane, gamma-HexachlorocyclohexanE)	IL
gamma-Chlordane	IL
Heptachlor	IL
Heptachlor epoxide	IL
Isodrin	IL
Kepone	IL
Methoxychlor	IL
Simazine	IL
Toxaphene (Chlorinated camphene)	IL
Method **EPA 8082 Rev: 0**	
Aroclor-1016 (PCB-1016)	IL
Aroclor-1221 (PCB-1221)	IL
Aroclor-1232 (PCB-1232)	IL
Aroclor-1242 (PCB-1242)	IL
Aroclor-1248 (PCB-1248)	IL
Aroclor-1254 (PCB-1254)	IL
Aroclor-1260 (PCB-1260)	IL
Method **EPA 8082A**	
Aroclor-1016 (PCB-1016)	IL
Aroclor-1221 (PCB-1221)	IL
Aroclor-1232 (PCB-1232)	IL
Aroclor-1242 (PCB-1242)	IL
Aroclor-1248 (PCB-1248)	IL
Aroclor-1254 (PCB-1254)	IL

Attachment 34: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***RCRA (Solid & Hazardous Material)***	
Aroclor-1260 (PCB-1260)	IL
Method **EPA 8151A**	
2,4,5-T	IL
2,4-D	IL
2,4-DB	IL
Dalapon	IL
Dicamba	IL
Dichloroprop (Dichlorprop)	IL
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	IL
Pentachlorophenol	IL
Picloram	IL
Silvex (2,4,5-TP)	IL
Method **EPA 8260B**	
1,1,1,2-Tetrachloroethane	IL
1,1,1-Trichloroethane	IL
1,1,2,2-Tetrachloroethane	IL
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	IL
1,1,2-Trichloroethane	IL
1,1-Dichloroethane	IL
1,1-Dichloroethylene	IL
1,1-Dichloropropene	IL
1,2,3-Trichlorobenzene	IL
1,2,3-Trichloropropane	IL
1,2,4-Trichlorobenzene	IL
1,2,4-Trimethylbenzene	IL
1,2-Dibromo-3-chloropropane (DBCP)	IL
1,2-Dibromoethane (EDB, Ethylene dibromide)	IL
1,2-Dichlorobenzene (o-Dichlorobenzene)	IL
1,2-Dichloroethane (Ethylene dichloride)	IL
1,2-Dichloropropane	IL
1,3,5-Trichlorobenzene	IL
1,3,5-Trimethylbenzene	IL
1,3-Dichlorobenzene	IL
1,3-Dichloropropane	IL
1,4-Dichlorobenzene	IL
1,4-Dioxane (1,4- Diethyleneoxide)	IL
1-Chlorohexane	IL
2,2-Dichloropropane	IL
2-Butanone (Methyl ethyl ketone, MEK)	IL
2-Chloroethyl vinyl ether	IL
2-Chlorotoluene	IL
2-Hexanone	IL
2-Methylnaphthalene	IL
2-Nitropropane	IL
4-Chlorotoluene	IL
4-Isopropyltoluene (p-Cymene,p-Isopropyltoluene)	IL
4-Methyl-2-pentanone (MIBK)	IL
Acetone	IL
Acetonitrile	IL
Acrolein (Propenal)	IL
Acrylonitrile	IL

Attachment 35: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

Field of Testing /Matrix: ***RCRA (Solid & Hazardous Material)***

	Primary AB
Allyl chloride (3-Chloropropene)	IL
Benzene	IL
Benzyl chloride	IL
Bromobenzene	IL
Bromochloromethane	IL
Bromodichloromethane	IL
Bromoform	IL
Carbon disulfide	IL
Carbon tetrachloride	IL
Chlorobenzene	IL
Chlorodibromomethane	IL
Chloroethane (Ethyl chloride)	IL
Chloroform	IL
Chloroprene (2-Chloro-1,3-butadiene)	IL
cis-1,2-Dichloroethylene	IL
cis-1,3-Dichloropropene	IL
Dibromomethane (Methylene bromide)	IL
Dichlorodifluoromethane (Freon-12)	IL
Diethyl ether	IL
Di-isopropylether (DIPE) (Isopropyl Ether)	IL
Ethanol	IL
Ethyl acetate	IL
Ethyl methacrylate	IL
Ethylbenzene	IL
Hexachlorobutadiene	IL
Iodomethane (Methyl iodide)	IL
Isobutyl alcohol (2-Methyl-1-propanol)	IL
Isopropylbenzene	IL
m+p-xylene	IL
Methacrylonitrile	IL
Methyl bromide (Bromomethane)	IL
Methyl chloride (Chloromethane)	IL
Methyl methacrylate	IL
Methyl tert-butyl ether (MTBE)	IL
Methylene chloride (Dichloromethane)	IL
m-Xylene	IL
Naphthalene	IL
n-Butyl alcohol (1-Butanol, n-Butanol)	IL
n-Butylbenzene	IL
n-Propylbenzene	IL
o-Xylene	IL
Pentachloroethane	IL
Propionitrile (Ethyl cyanide)	IL
p-Xylene	IL
sec-Butylbenzene	IL
Styrene	IL
tert-Butyl alcohol	IL
tert-Butylbenzene	IL
Tetrachloroethylene (Perchloroethylene)	IL
Tetrahydrofuran (THF)	IL
Toluene	IL

Attachment 36: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***RCRA (Solid & Hazardous Material)***	
trans-1,2-Dichloroethylene	IL
trans-1,3-Dichloropropylene	IL
trans-1,4-Dichloro-2-butene	IL
Trichloroethene (Trichloroethylene)	IL
Trichlorofluoromethane (Fluorotrichloromethane, Freon 11)	IL
Vinyl acetate	IL
Vinyl chloride	IL
Xylene (total)	IL
Method **EPA 8270C Rev: 3**	
1,2,4,5-Tetrachlorobenzene	IL
1,2,4-Trichlorobenzene	IL
1,2-Dichlorobenzene (o-Dichlorobenzene)	IL
1,2-Diphenylhydrazine	IL
1,3,5-Trinitrobenzene (1,3,5-TNB)	IL
1,3-Dichlorobenzene	IL
1,3-Dinitrobenzene (1,3-DNB)	IL
1,4-Dichlorobenzene	IL
1,4-Dinitrobenzene	IL
1,4-Dioxane (1,4- Diethyleneoxide)	IL
1,4-Naphthoquinone	IL
1,4-Phenylenediamine	IL
1-Chloronaphthalene	IL
1-Methylnaphthalene	IL
1-Naphthylamine	IL
2,2'-Oxybis(1-chloropropane), bis(2-Chloro-1-methylethyl)ether	IL
2,3,4,6-Tetrachlorophenol	IL
2,4,5-Trichlorophenol	IL
2,4,6-Trichlorophenol	IL
2,4-Dichlorophenol	IL
2,4-Dimethylphenol	IL
2,4-Dinitrophenol	IL
2,4-Dinitrotoluene (2,4-DNT)	IL
2,6-Dichlorophenol	IL
2,6-Dinitrotoluene (2,6-DNT)	IL
2-Acetylaminofluorene	IL
2-Chloronaphthalene	IL
2-Chlorophenol	IL
2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	IL
2-Methylaniline (o-Toluidine)	IL
2-Methylnaphthalene	IL
2-Methylphenol (o-Cresol)	IL
2-Naphthylamine	IL
2-Nitroaniline	IL
2-Nitrophenol	IL
2-Picoline (2-Methylpyridine)	IL
3,3'-Dichlorobenzidine	IL
3,3'-Dimethylbenzidine	IL
3-Methylcholanthrene	IL
3-Methylphenol (m-Cresol)	IL
3-Nitroaniline	IL
4-Aminobiphenyl	IL

Attachment 37: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

Field of Testing /Matrix: **RCRA (Solid & Hazardous Material)**	Primary AB
4-Bromophenyl phenyl ether	IL
4-Chloro-3-methylphenol	IL
4-Chloroaniline	IL
4-Chlorophenyl phenylether	IL
4-Dimethyl aminoazobenzene	IL
4-Methylphenol (p-Cresol)	IL
4-Nitroaniline	IL
4-Nitrophenol	IL
4-Nitroquinoline 1-oxide	IL
5-Nitro-o-toluidine	IL
7,12-Dimethylbenz(a) anthracene	IL
a-a-Dimethylphenethylamine	IL
Acenaphthene	IL
Acenaphthylene	IL
Acetophenone	IL
Aniline	IL
Anthracene	IL
Aramite	IL
Benzidine	IL
Benzo(a)anthracene	IL
Benzo(a)pyrene	IL
Benzo(b)fluoranthene	IL
Benzo(g,h,i)perylene	IL
Benzo(k)fluoranthene	IL
Benzoic acid	IL
Benzyl alcohol	IL
bis(2-Chloroethoxy)methane	IL
bis(2-Chloroethyl) ether	IL
bis(2-Ethylhexyl) phthalate (DEHP)	IL
Butyl benzyl phthalate	IL
Carbazole	IL
Carbofuran (Furaden)	IL
Chlorobenzilate	IL
Chrysene	IL
Diallate	IL
Dibenz(a, j) acridine	IL
Dibenz(a,h) anthracene	IL
Dibenzofuran	IL
Diethyl phthalate	IL
Dimethoate	IL
Dimethyl phthalate	IL
Di-n-butyl phthalate	IL
Di-n-octyl phthalate	IL
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	IL
Diphenylamine	IL
Ethyl methanesulfonate	IL
Famphur	IL
Fluoranthene	IL
Fluorene	IL
Hexachlorobenzene	IL
Hexachlorobutadiene	IL

Attachment 38: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***RCRA (Solid & Hazardous Material)***	
Hexachlorocyclopentadiene	IL
Hexachloroethane	IL
Hexachlorophene	IL
Hexachloropropene	IL
Indeno(1,2,3-cd) pyrene	IL
Isodrin	IL
Isophorone	IL
Isosafrole	IL
Kepone	IL
Methapyrilene	IL
Methyl methanesulfonate	IL
Methyl parathion (Parathion, methyl)	IL
Naphthalene	IL
Nitrobenzene	IL
n-Nitrosodiethylamine	IL
n-Nitrosodimethylamine	IL
n-Nitroso-di-n-butylamine	IL
n-Nitrosodi-n-propylamine	IL
n-Nitrosodiphenylamine	IL
n-Nitrosomethylethalamine	IL
n-Nitrosomorpholine	IL
n-Nitrosopiperidine	IL
n-Nitrosopyrrolidine	IL
o,o,o-Triethyl phosphorothioate	IL
Parathion	IL
Pentachlorobenzene	IL
Pentachloronitrobenzene	IL
Pentachlorophenol	IL
Phenacetin	IL
Phenanthrene	IL
Phenol	IL
Phorate	IL
p-Phenylenediamine	IL
Pronamide (Kerb)	IL
Pyrene	IL
Pyridine	IL
Safrole	IL
Thionazin (Zinophos)	IL
Method **EPA 8270D**	
1,2,4,5-Tetrachlorobenzene	IL
1,2,4-Trichlorobenzene	IL
1,2-Dichlorobenzene (o-Dichlorobenzene)	IL
1,2-Diphenylhydrazine	IL
1,3,5-Trinitrobenzene (1,3,5-TNB)	IL
1,3-Dichlorobenzene	IL
1,3-Dinitrobenzene (1,3-DNB)	IL
1,4-Dichlorobenzene	IL
1,4-Dinitrobenzene	IL
1,4-Dioxane (1,4- Diethyleneoxide)	IL
1,4-Naphthoquinone	IL
1,4-Phenylenediamine	IL

Attachment 39: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

Field of Testing /Matrix: **_RCRA (Solid & Hazardous Material)_**	Primary AB
1-Chloronaphthalene	IL
1-Methylnaphthalene	IL
1-Naphthylamine	IL
2,2'-Oxybis(1-chloropropane), bis(2-Chloro-1-methylethyl)ether	IL
2,3,4,6-Tetrachlorophenol	IL
2,4,5-Trichlorophenol	IL
2,4,6-Trichlorophenol	IL
2,4-Dichlorophenol	IL
2,4-Dimethylphenol	IL
2,4-Dinitrophenol	IL
2,4-Dinitrotoluene (2,4-DNT)	IL
2,6-Dichlorophenol	IL
2,6-Dinitrotoluene (2,6-DNT)	IL
2-Acetylaminofluorene	IL
2-Chloronaphthalene	IL
2-Chlorophenol	IL
2-Methyl-4,6-dinitrophenol (4,6-Dinitro-2-methylphenol)	IL
2-Methylaniline (o-Toluidine)	IL
2-Methylnaphthalene	IL
2-Methylphenol (o-Cresol)	IL
2-Naphthylamine	IL
2-Nitroaniline	IL
2-Nitrophenol	IL
2-Picoline (2-Methylpyridine)	IL
3,3'-Dichlorobenzidine	IL
3,3'-Dimethylbenzidine	IL
3-Methylcholanthrene	IL
3-Methylphenol (m-Cresol)	IL
3-Nitroaniline	IL
4-Aminobiphenyl	IL
4-Bromophenyl phenyl ether	IL
4-Chloro-3-methylphenol	IL
4-Chloroaniline	IL
4-Chlorophenyl phenylether	IL
4-Dimethyl aminoazobenzene	IL
4-Methylphenol (p-Cresol)	IL
4-Nitroaniline	IL
4-Nitrophenol	IL
4-Nitroquinoline 1-oxide	IL
5-Nitro-o-toluidine	IL
7,12-Dimethylbenz(a) anthracene	IL
a-a-Dimethylphenethylamine	IL
Acenaphthene	IL
Acenaphthylene	IL
Acetophenone	IL
Aniline	IL
Anthracene	IL
Aramite	IL
Benzidine	IL
Benzo(a)anthracene	IL
Benzo(a)pyrene	IL

Attachment 40: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

Field of Testing /Matrix: ***RCRA (Solid & Hazardous Material)***	Primary AB
Benzo(b)fluoranthene	IL
Benzo(g,h,i)perylene	IL
Benzo(k)fluoranthene	IL
Benzoic acid	IL
Benzyl alcohol	IL
bis(2-Chloroethoxy)methane	IL
bis(2-Chloroethyl) ether	IL
bis(2-Ethylhexyl) phthalate (DEHP)	IL
Butyl benzyl phthalate	IL
Carbazole	IL
Carbofuran (Furaden)	IL
Chlorobenzilate	IL
Chrysene	IL
Diallate	IL
Dibenz(a, j) acridine	IL
Dibenz(a,h) anthracene	IL
Dibenzofuran	IL
Diethyl phthalate	IL
Dimethoate	IL
Dimethyl phthalate	IL
Di-n-butyl phthalate	IL
Di-n-octyl phthalate	IL
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	IL
Diphenylamine	IL
Ethyl methanesulfonate	IL
Famphur	IL
Fluoranthene	IL
Fluorene	IL
Hexachlorobenzene	IL
Hexachlorobutadiene	IL
Hexachlorocyclopentadiene	IL
Hexachloroethane	IL
Hexachlorophene	IL
Hexachloropropene	IL
Indeno(1,2,3-cd) pyrene	IL
Isodrin	IL
Isophorone	IL
Isosafrole	IL
Kepone	IL
Methapyrilene	IL
Methyl methanesulfonate	IL
Methyl parathion (Parathion, methyl)	IL
Naphthalene	IL
Nitrobenzene	IL
n-Nitrosodiethylamine	IL
n-Nitrosodimethylamine	IL
n-Nitroso-di-n-butylamine	IL
n-Nitrosodi-n-propylamine	IL
n-Nitrosodiphenylamine	IL
n-Nitrosomethylethalamine	IL
n-Nitrosomorpholine	IL

Attachment 41: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

	Primary AB
Field of Testing /Matrix: ***RCRA (Solid & Hazardous Material)***	
n-Nitrosopiperidine	IL
n-Nitrosopyrrolidine	IL
o,o,o-Triethyl phosphorothioate	IL
Parathion	IL
Pentachlorobenzene	IL
Pentachloronitrobenzene	IL
Pentachlorophenol	IL
Phenacetin	IL
Phenanthrene	IL
Phenol	IL
Phorate	IL
p-Phenylenediamine	IL
Pronamide (Kerb)	IL
Pyrene	IL
Pyridine	IL
Safrole	IL
Thionazin (Zinophos)	IL
Method **EPA 9014 Rev: 0**	
Cyanide	IL
Method **EPA 9020B Rev: 2**	
Total organic halides (TOX)	IL
Method **EPA 9034 Rev: 0**	
Sulfide	IL
Method **EPA 9045C Rev: 3**	
pH	IL
Method **EPA 9045D**	
pH	IL
Method **EPA 9050A Rev: 1**	
Conductivity	IL
Method **EPA 9056A**	
Bromide	IL
Chloride	IL
Fluoride	IL
Nitrate	IL
Nitrite	IL
Sulfate	IL
Total Phosphate	IL
Method **EPA 9060A**	
Total organic carbon	IL
Method **EPA 9066 Rev: 0**	
Total phenolics	IL
Method **EPA 9071B**	
Oil & Grease	IL
Method **EPA 9095A**	
Paint Filter Test	IL
Method **EPA 9095B**	
Paint Filter Test	IL
Method **EPA 9251 Rev: 0**	

		Primary AB
Field of Testing /Matrix:	***RCRA (Solid & Hazardous Material)***	
Chloride		IL

Attachment 43: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

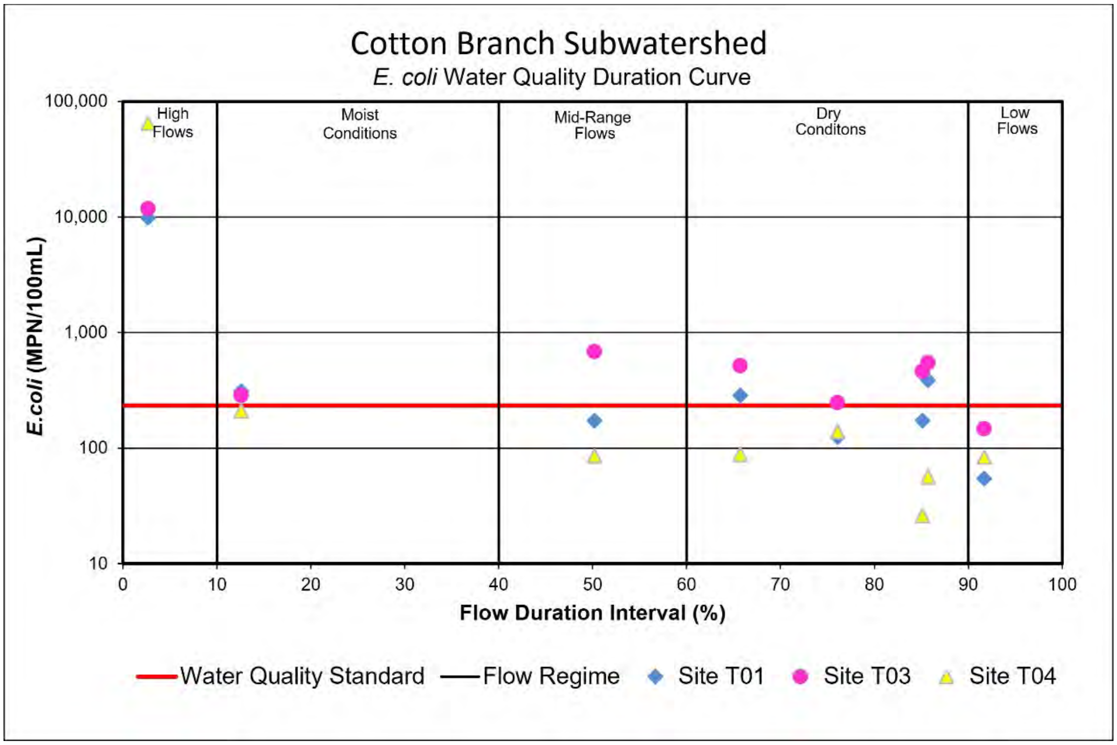
Field of Testing /Matrix: ***SDWA (Potable Water)***	Primary AB
Method **EPA 180.1**	
Turbidity	IL
Method **EPA 200.7 Rev: 4.4**	
Aluminum	IL
Arsenic	IL
Barium	IL
Beryllium	IL
Cadmium	IL
Calcium	IL
Chromium	IL
Copper	IL
Iron	IL
Magnesium	IL
Manganese	IL
Nickel	IL
Silica as SiO2	IL
Silver	IL
Sodium	IL
Zinc	IL
Method **EPA 200.8 Rev: 5.4**	
Aluminum	IL
Antimony	IL
Arsenic	IL
Barium	IL
Beryllium	IL
Cadmium	IL
Chromium	IL
Copper	IL
Lead	IL
Manganese	IL
Molybdenum	IL
Nickel	IL
Selenium	IL
Silver	IL
Thallium	IL
Zinc	IL
Method **EPA 245.1 Rev: 3**	
Mercury	IL
Method **EPA 300.0 Rev: 2.1**	
Chloride	IL
Fluoride	IL
Nitrate	IL
Nitrite	IL
Orthophosphate as P	IL
Sulfate	IL
Method **EPA 353.2 Rev: 2**	
Nitrate	IL
Nitrate plus Nitrite as N	IL
Method **SM 2320 B-1997 Rev: 20th ED**	

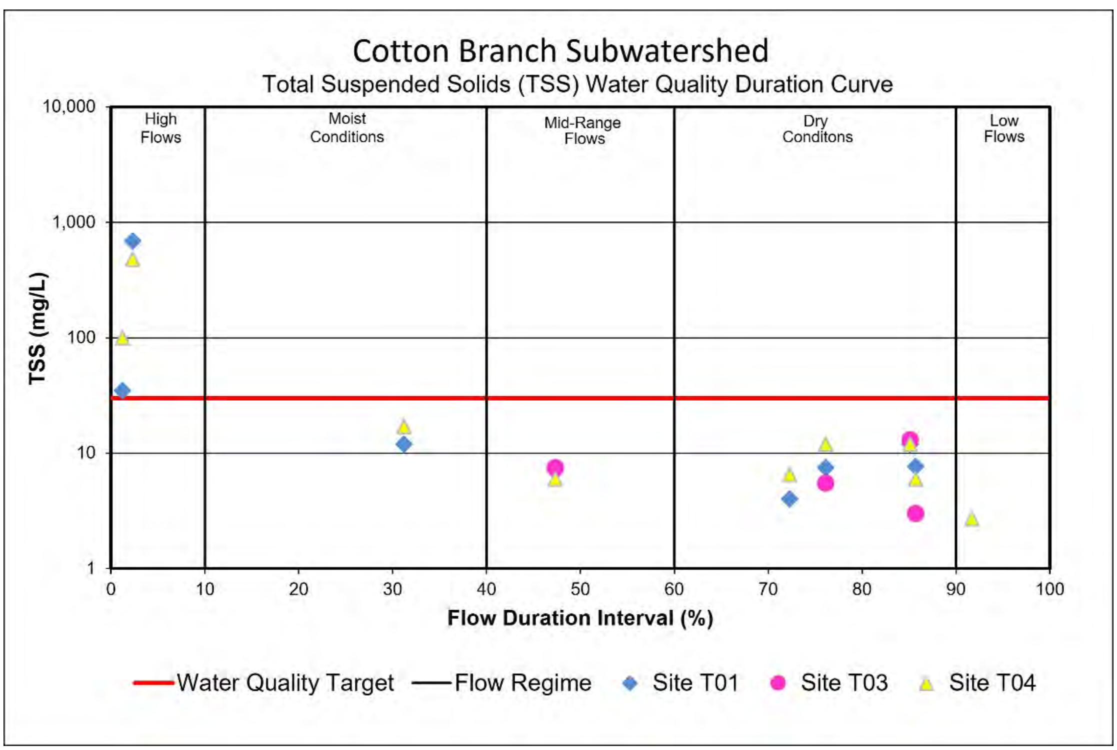
Attachment 44: Eurofins TestAmerica Chicago Laboratory Accreditation (cont.)

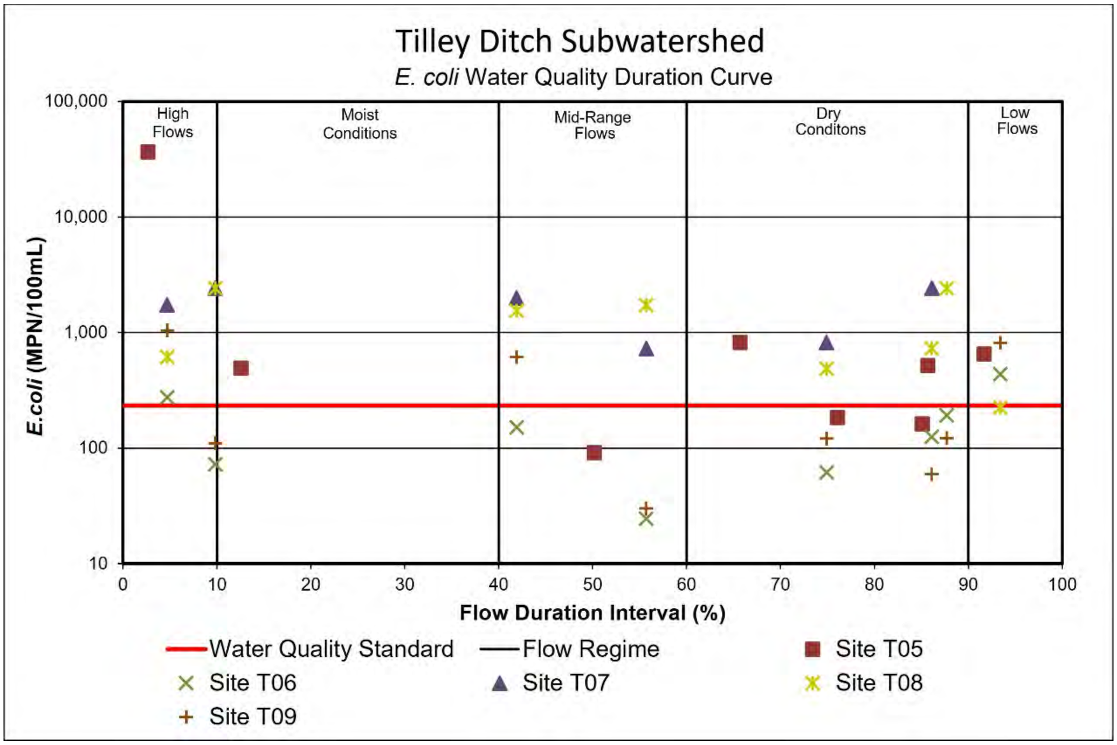
	Primary AB
Field of Testing /Matrix: ***SDWA (Potable Water)***	
Alkalinity as CaCO3	IL
Method **SM 2340 B-1997 Rev: 20th ED**	
Hardness	IL
Method **SM 2510 B-1997 Rev: 20th ED**	
Conductivity	IL
Method **SM 2540 C-1997 Rev: 20th ED**	
Total dissolved solids	IL
Method **SM 4500-Cl F-1993 Rev: 20th ED**	
Chlorine	IL
Method **SM 4500-CN¯ E-1997 Rev: 20th ED**	
Cyanide	IL
Method **SM 4500-F¯ C-1997 Rev: 20th ED**	
Fluoride	IL
Method **SM 4500-H+ B-1996 Rev: 20th ED**	
pH	IL
Method **SM 4500-NO2¯ B-1993 Rev: 20th ED**	
Nitrite	IL
Method **SM 4500-NO3¯ F-1997 Rev: 20th ED**	
Nitrate	IL
Method **SM 4500-P E-1997 Rev: 20th ED**	
Orthophosphate as P	IL
Method **SM 4500-SO4¯ E-1997 Rev: 20th ED**	
Sulfate	IL
Method **SM 5310 B Rev: 21st ED**	
Total organic carbon	IL
Method **SM 5310 C Rev: 20th ED**	
Dissolved organic carbon (DOC)	IL
Total organic carbon	IL

End of Scope of Accreditation

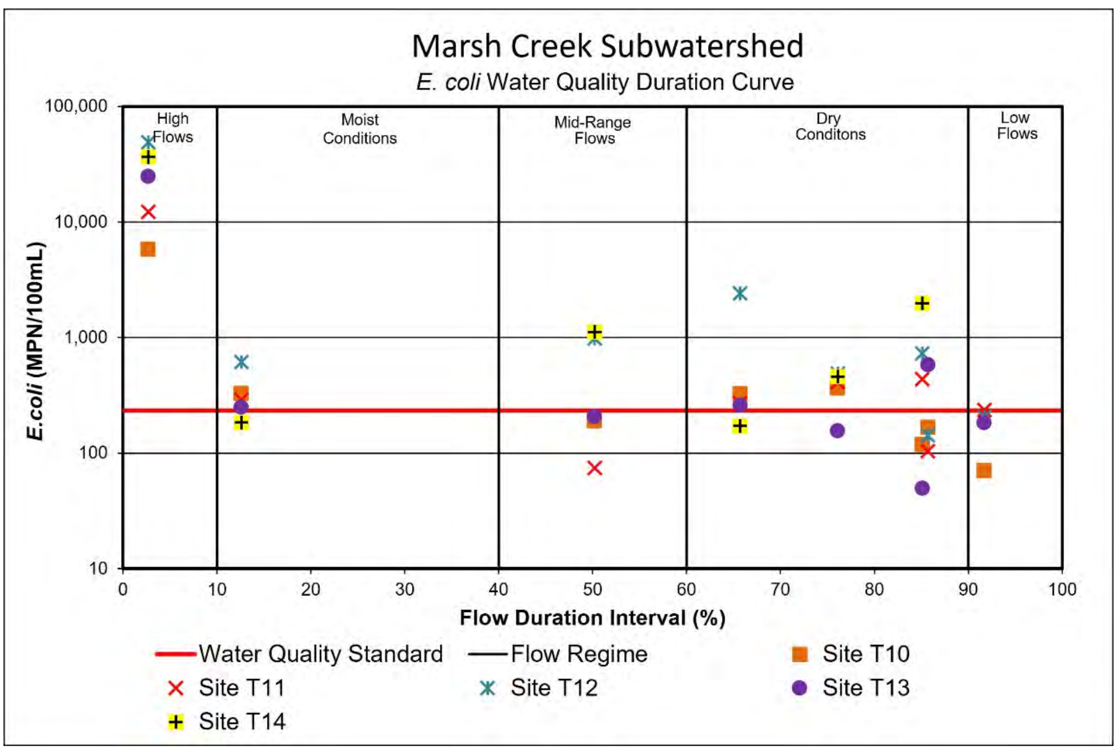
APPENDIX F. WATER QUALITY DURATION GRAPHS FOR THE MARIA CREEK WATERSHED TMDL


Cotton Branch Subwatershed
E. coli Water Quality Duration Curve
High Flows
Moist Conditions
Mid-Range Flows
Dry Conditons
Low Flows
100,000
10,000
1,000
100
10
E.coli (MPN/100mL)
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
Water Quality Standard
Flow Regime
Site T01
Site T03
Site T04

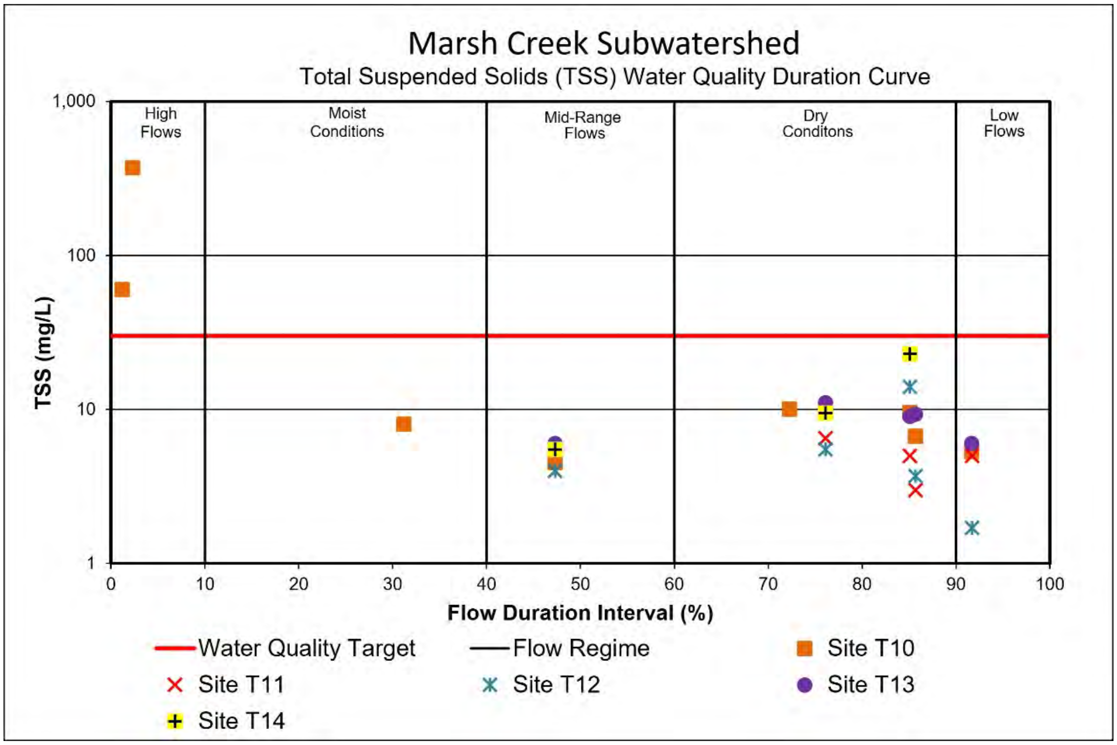

Cotton Branch Subwatershed
Total Suspended Solids (TSS) Water Quality Duration Curve
High Flows
Moist Conditions
Mid-Range Flows
Dry Conditons
Low Flows
10,000
1,000
100
10
1
TSS (mg/L)
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
Water Quality Target
Flow Regime
Site T01
Site T03
Site T04

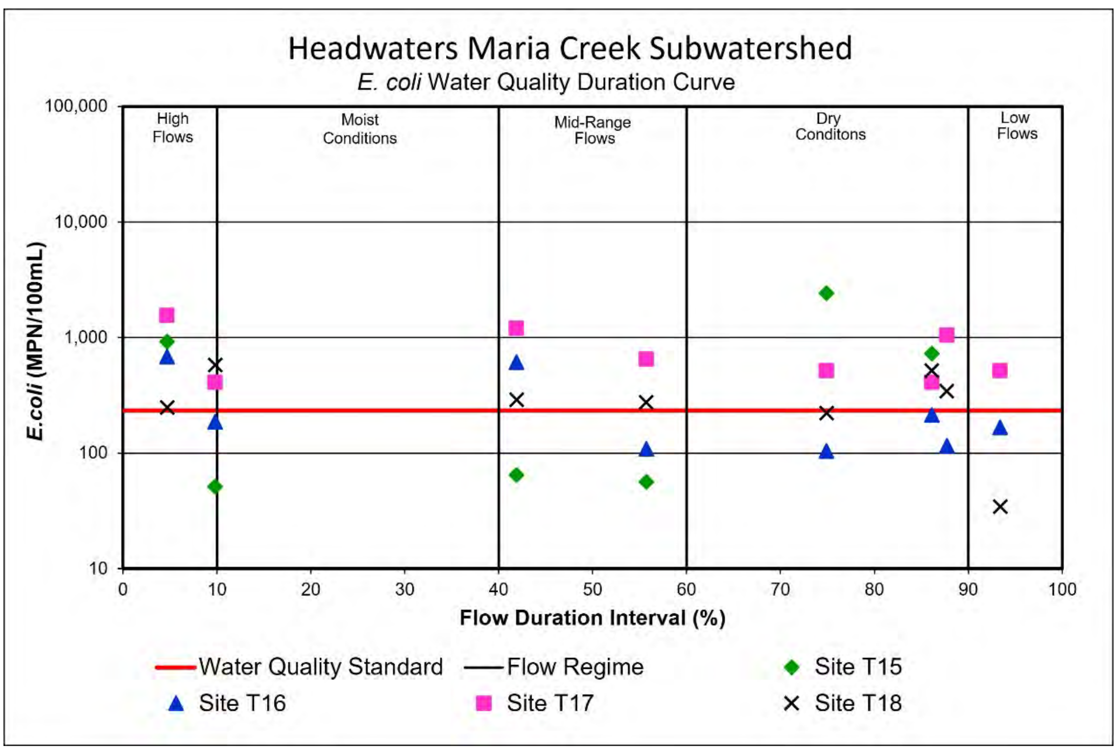


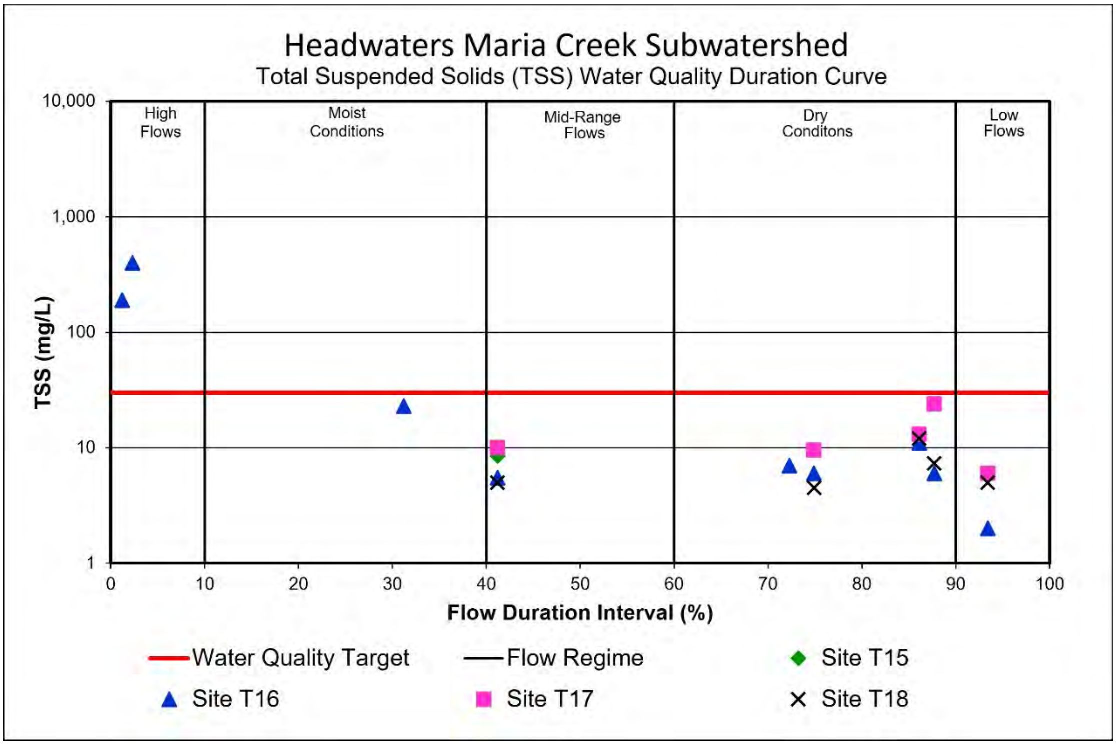
Tilley Ditch Subwatershed
E. coli Water Quality Duration Curve
High Flows
Moist Conditions
Mid-Range Flows
Dry Conditons
Low Flows
E.coli (MPN/100mL)
100,000
10,000
1,000
100
10
0 10 20 30 40 50 60 70 80 90 100
Flow Duration Interval (%)
Water Quality Standard
Flow Regime
Site T05
Site T06
Site T07
Site T08
Site T09



Marsh Creek Subwatershed
E. coli Water Quality Duration Curve
High Flows
Moist Conditions
Mid-Range Flows
Dry Conditons
Low Flows
E.coli (MPN/100mL)
100,000
10,000
1,000
100
10
0 10 20 30 40 50 60 70 80 90 100
Flow Duration Interval (%)
Water Quality Standard
Flow Regime
Site T10
Site T11
Site T12
Site T13
Site T14


Marsh Creek Subwatershed
Total Suspended Solids (TSS) Water Quality Duration Curve
TSS (mg/L)
1,000
100
10
1
High Flows
Moist Conditions
Mid-Range Flows
Dry Conditons
Low Flows
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
Water Quality Target
Flow Regime
Site T10
Site T11
Site T12
Site T13
Site T14


Headwaters Maria Creek Subwatershed
E. coli Water Quality Duration Curve
E.coli (MPN/100mL)
100,000
10,000
1,000
100
10
High Flows
Moist Conditions
Mid-Range Flows
Dry Conditons
Low Flows
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
Water Quality Standard
Flow Regime
Site T15
Site T16
Site T17
Site T18



Headwaters Maria Creek Subwatershed
Total Suspended Solids (TSS) Water Quality Duration Curve
High Flows
Moist Conditions
Mid-Range Flows
Dry Conditons
Low Flows
10,000
1,000
100
10
1
TSS (mg/L)
0
10
20
30
40
50
60
70
80
90
100
Flow Duration Interval (%)
Water Quality Target
Flow Regime
Site T15
Site T16
Site T17
Site T18

APPENDIX G. NPDES EXECUTIVE SUMMARY

Maria Creek Watershed: NPDES Executive Summary

This appendix summarizes the potential point sources of *E. coli* and TSS in the Maria Creek watershed, as regulated through the National Pollutant Discharge Elimination System (NPDES) Program. As authorized by the CWA, the NPDES permit program controls water pollution by regulating facilities that discharge pollutants into waters of the United States. Point sources with NPDES permits within the Maria Creek watershed include municipal wastewater treatment plants (WWTPs), a public water supply, surface and underground coal mining operations, and construction sites.

Overview of Facilities

There are three municipal wastewater treatment plants (WWTPs) located within the Maria Creek watershed. Effluent from these facilities are potential point sources of *E. coli* and TSS. The Freelandville Regional Sewer District operates a minor municipal WWTP (IN0064513). The WWTP is a Class I, 0.088 MGD bio-mechanical treatment facility. The facility has one outfall (Outfall 001) that discharges to an unnamed tributary of Maria Creek. North Knox School Corporation operates a minor semi-public WWTP at North Knox High School (IN0041084). The WWTP is a Class I, 0.022 MGD extended aeration treatment facility. The facility has one outfall (Outfall 001) that discharges into Tilley Ditch. North Knox School Corporation also operates a minor semi-public WWTP at North Knox Intermediate School (IN0041092). The WWTP is a Class I, 0.005 MGD extended aeration treatment facility. The facility has one outfall (Outfall 001) that discharges into an unnamed tributary of Maria Creek.

There is one public water supply located within the Maria Creek watershed, Freelandville Water Association. Effluent from this facility is a potential point source of TSS. Wastewater discharges from Freelandville Water Association are regulated by an individual industrial wastewater permit (IN0059480). Freelandville Water Association has two outfalls (Outfalls 001 and 002) which discharge into an unnamed tributary that flows north into Tilley Ditch. The facility has an average discharge of approximately 0.022 MGD.

There are two surface mining operations located within the Maria Creek watershed, Bear Run Mine (ING040239) and Freelandville Mine (ING040030). Effluent from these facilities are potential point sources of TSS. Discharges from Bear Run Mine and Freelandville Mine are regulated by the coal mining general permit rule (327 IAC 15-7). Bear Run Mine currently has one active outfall (Outfall 068) that discharges within the Maria Creek watershed. Freelandville Mine currently has no permitted outfalls that discharge within the Maria Creek watershed. Therefore, Freelandville Mine will not receive a wasteload allocation for purposes of this TMDL report.

There are two underground mining facilities located within the Maria Creek watershed operated by Sunrise Coal LLC, Carlisle Mine and Oaktown Mine. Effluent from these facilities are potential point sources of TSS. Discharges from Carlisle Mine and Oaktown Mine are regulated by either the coal mining general permit rule or an individual NPDES permit. The discharges from Carlisle Mine, Outfalls 003 and 202 are regulated by the coal mining general permit rule (ING040199), and the discharge from Outfall 005 is regulated by an individual NPDES permit (IN0062791). The discharges from Oaktown Mine, Outfalls 002, 005, and 006 are regulated by the coal mining general permit rule (ING040222), and the discharge from Outfall 001 is regulated by an individual NPDES permit (IN0064629).

Wasteload Allocations (WLAs)

Allowable pollutant loads and associated allocations were calculated for each of the 12-digit HUC subwatersheds and associated assessment units in the Maria Creek watershed. WLAs are typically calculated based on the design flow or estimated flow of the facility and the TMDL target or applicable permit limit. Three municipal WWTPs and one public water supply were calculated following this method. However, coal mining operations within the Maria Creek watershed required additional consideration for WLA calculations. Pollutant concentrations used to calculate wasteloads from each facility are based on known technological limitations of the facilities.

Municipal WWTP permit effluent limits for *E. coli* and TSS were used to determine WLAs for each treatment plant. The effluent limit for TSS is set at the NPDES permit limit of 12 mg/L monthly average for the Freelandville Regional Sewer District. The effluent limit for TSS is set at the NPDES permit limit of 30 mg/L winter monthly average for the North Knox High School WWTP and North Knox Intermediate School WWTP. The effluent limit for *E. coli* is set at the 235 counts/100 mL single sample maximum component of the water quality standard for all three facilities. Average design flow was determined from information reported by the facility during the permitting process (Table 2). Compliance with current NPDES permit limits for each facility is consistent with the assumptions used to determine WLAs in the TMDL for protection of applicable water quality standards.

Freelandville Water Association’s permit effluent limit for TSS is set at the NPDES per limit of 40 mg/L daily maximum. Average design flow was determined from information reported by the facility during the permitting process (Table 2). Compliance with current NPDES permit limits is consistent with the assumptions used to determine WLAs in the TMDL for protection of applicable water quality standards.

Discharges from the Bear Run Mine surface mine and Carlisle and Oaktown mine underground mine outfalls regulated through the general permit rule are believed to be primarily related to precipitation events. An estimated design flow is not available for these discharges. WLAs were therefore calculated by using an estimate of the surface impacts associated with each surface mine operation or underground mine outfall to determine run-off flow volumes, and existing permit limits were used to calculate allowable loadings. Surface impacts were estimated by delineating the disturbed surface area associated with each surface mine operation or underground mine outfall using the most recent aerial imagery available in ArcGIS and calculating the acreage of each area. To determine the WLA, the estimated surface impact acreage was divided by the total subwatershed acreage and multiplied by the corresponding flow values for the subwatershed to determine flow from the facility. Flow based WLAs were then calculated by multiplying the flow values by the target concentration of 70 mg/L daily maximum (Table 1).

Design flow estimates for discharges from underground mine outfalls regulated through individual NPDES permits were estimated based on the unique characteristics of each outfall and how each outfall is utilized by the facility. An analysis of the past two years of flow data for Carlisle Mine, Outfall 005 available from Discharge Monitoring Reports (DMRs) was completed to gain a better understanding of typical discharge from this outfall. Data over the past two years indicated flow was significantly influenced by precipitation events. The flow regime for each discharge event was determined, and the average discharge for each flow regime was calculated. The average discharge for each flow regime was used as the estimated design flow to calculate the WLA for each flow regime. DMRs were also reviewed to determine typical TSS concentrations for discharge events from the past two years. It was determined that TSS concentrations were typically less than 35 mg/L. Therefore, the WLA for the Carlisle Mine, Outfall 005 was calculated using the NPDES permit limit of 35 mg/L monthly average as it is more representative of existing load conditions.

An analysis of the past two years of flow data for Oaktown Mine, Outfall 001 was also completed to gain an understanding of typical discharge from this outfall. Data over the past two years indicated that this outfall does not regularly discharge, and when the outfall does discharge it typically occurs during precipitation events. Due to the irregularity of the discharges from this outfall, the estimated design flow of 0.5 MGD as reported in the facility's permit was used as the estimated design flow to calculate the WLA. DMRs were also reviewed to determine typical TSS concentrations for discharge events from the past two years. It was determined that TSS concentrations were typically less than 35 mg/L. Therefore, the WLA for the Oaktown Mine, Outfall 001 was calculated using the NPDES permit limit of 35 mg/L monthly average as it is more representative of existing load conditions.

The WLA for each coal mining operation outfall will be achieved through compliance with the facility's NPDES general permit coverage or individual permit. The WLAs were estimated based upon consideration of TSS contributions from current operating conditions and current permit limits of each facility. IDEM's analyses of current operating conditions and flow and water quality discharge data from individual facilities indicate that WLAs in Table 1 and Table 2 can be achieved through compliance with each facility's existing NPDES general permit coverage (under 327 IAC 15-7) or individual permit. Therefore, IDEM believes that existing general and individual permit limits are suitable to attain the WLAs described in Table 1 and Table 2. This TMDL does not preclude new or modified mining activities that employ the 70 mg/L daily maximum and 35 mg/L monthly average for TSS under the general permit rule. New or modified discharges under individual permits will be addressed through the NPDES permit process and must follow the assumptions set forth in the TMDL.

Table 1: Individual WLAs for NPDES General Permit Coal Mining Facilities in the Maria Creek Watershed

Subwatershed	Facility Name	Permit Number	AUID	Receiving Stream	Estimated Surface Impacts (Acres)	High Flow Regime TSS WLA (lbs/day)	Low Flow Regime TSS WLA (lbs/day)	NPDES Permit TSS Limit
Marsh Creek	Sunrise Coal Carlisle Mine	ING040199	INB11I3_02	Marsh Creek	283	991.98	18.11	**70 mg/L daily max**
	Sunrise Coal Oaktown Mine	ING040222	INB11I3_04	Marsh Creek	122	428.57	7.83	**70 mg/L daily max**
Cotton Branch	Sunrise Coal Oaktown Mine	ING040222	INB11I4_T1001	Tributary of Maria Creek	20	69.26	0.55	**70 mg/L daily max**
Headwaters Maria Creek	Peabody Midwest Bear Run Mine	ING040239	INB11I1_T1002	Tributary of Maria Creek	2,123	7,249.75	56.90	**70 mg/L daily max**

Understanding Table 1: The WLA for each NPDES permitted facility will be achieved through compliance with the facility's NPDES general permit coverage.

Table 2: Individual WLAs for NPDES Individual Permit Municipal and Industrial Facilities in the Maria Creek Watershed

Subwatershed	Facility Name	Permit Number	AUID	Receiving Stream	Flow Regime	Estimated Design Flow (MGD)	*E. coli* WLA (MPN/day)	NPDES Permit *E. coli* Limit	TSS WLA (lbs/day)	NPDES Permit TSS Limit
Tilley Ditch	Freelandville Regional Sewer District	IN0064513	INB11I2_T1001	Tributary of Maria Creek	All	0.088	7.83E+08	**235 MPN/100 mL Daily Max.**	8.8*	**12 mg/L* Monthly Avg.**
Tilley Ditch	North Knox High School WWTP	IN0041084	INB11I2_T1004	Tilley Ditch	All	0.022	1.96E+08	**235 MPN/100 mL Daily Max.**	5.5*	**30 mg/L* Monthly Avg.**
Cotton Branch	North Knox Intermediate School WWTP	IN0041092	INB11I4_02	Tributary of Maria Creek	All	0.005	4.45E+07	**235 MPN/100 mL Daily Max.**	1.25	**30 mg/L Monthly Avg.**
Tilley Ditch	Freelandville Water Association	IN0059480	INB11I2_T1004	Tributary of Tilley Ditch	All	0.022	NA	NA	NA	**40 mg/L* Daily Max.**
Marsh Creek	Sunrise Coal Carlisle Mine	IN0062791	INB11I3_T1001	Tributary of Marsh Creek	High	1.77	NA	NA	516.88	**35 mg/L Monthly Avg.**
					Moist	0.88			256.98	
					Mid	0.88			256.98	
					Dry	0.66			192.74	
					Low	0.47			137.25	
Marsh Creek	Sunrise Coal Oaktown Mine	IN0064629	INB11I3_04	Marsh Creek	All	0.5	NA	NA	146.01	**35 mg/L Monthly Avg.**

Understanding Table 2: The WLA for each NPDES permitted facility will be achieved through compliance with the facility's NPDES individual permit.

** A TSS TMDL was not developed for the Tilley Ditch subwatershed. The WLAs and TSS limits are referenced from current permit limits for reporting purposes only.*

APPENDIX H. GENERALIZED WATERSHED LOADING FUNCTION ENHANCED (GWLF-E) MODELING FOR THE MARIA CREEK WATERSHED

Hydrologic / Water Quality Modeling for Maria Creek Watershed

Part 1. Model Overview & Data Compilation

MapShed is an established midrange modeling tool first developed as the Generalized Watershed Loading Function Enhanced (GWLF-E) model by Haith and Shoemaker in 1987, and Haith et al. in 1992. The model was refined regularly by Evans, Corradini, and Lehning at Penn State University into an ArcView GIS-based model called AVGWLF (Evans et al., 2007); it has recently transitioned to the open-source MapWindow GIS and now is now called MapShed (Evans & Corradini, 2016).

The GWLF model is an aggregate distributed/lumped parameter watershed model that provides the ability to simulate runoff, sediment, and nutrient (nitrogen (N) and phosphorus (P)) loads from a watershed given variable-size source areas (e.g., agricultural, forested, and developed land). GWLF is considered to be a combined distributed/lumped parameter watershed model. For surface loading, it is distributed in the sense that it allows multiple land use/cover scenarios, but each area is assumed to be homogenous in regard to various attributes considered by the model. Additionally, the model does not spatially distribute the source areas, but simply aggregates the loads from each source area into a watershed total; in other words there is no spatial routing. For sub-surface loading, the model acts as a lumped parameter model using a water balance approach. No distinctly separate areas are considered for sub-surface flow contributions. Daily water balances are computed for an unsaturated zone as well as a saturated sub-surface zone, where infiltration is simply computed as the difference between precipitation and snowmelt minus surface runoff plus evapotranspiration.

With respect to the major processes simulated, GWLF models surface runoff using the Soil Conservation Service Curve Number, or SCS-CN, approach with daily weather (temperature and precipitation) inputs. Erosion and sediment yield are estimated using monthly erosion calculations based on the Universal Soil Loss Equation USLE algorithm (with monthly rainfall-runoff coefficients) and a monthly composite of KLSCP values for each source area (i.e., land cover/soil type combination). The KLSCP factors are variables used in the calculations to depict changes in soil loss erosion (K), the length slope factor (LS), the vegetation cover factor (C), and the conservation practices factor (P). A sediment delivery ratio based on watershed size and transport capacity, which is based on average daily runoff, is then applied to the calculated erosion to determine sediment yield for each source area. Evapotranspiration is determined using daily weather data and a cover factor dependent upon land use/cover type. Finally, a water balance is performed daily using supplied or computed precipitation, snowmelt, initial unsaturated zone storage, maximum available zone storage, and evapotranspiration values.

One of the major strengths of the GWLF model is the simplicity of estimating pollutant loads. However, as the model employs lumped sum average conditions within the watershed, it lacks a high level of localized accuracy and detail when compared to other models. Hydrology and loading estimates are limited to monthly and annual outputs, however run time can be accomplished quickly overall. Additionally, limitations of the model should be recognized in areas that exhibit high amounts of altered hydrology.

MapShed consists of three components. Note that "MapShed" refers both to the overall model (all three components), as well as the first of the three individual components. Each is a standalone executable file which can be independently run.

- MapShed, a MapWindow-based interface using GIS to generate model inputs, (executable: PrjMngr.exe);
- Generalized Watershed Loading Model (GWLF-E), the hydrology and nutrient loading model, (executable: GWLF-E.exe); and
- PRedICT, software to examine various best management practice (BMP) scenarios, (executable: PRedICT.exe)

For execution, the model requires two separate input files containing transport and weather-related data. The transport (transport.dat) file defines the necessary parameters for each source area to be considered (e.g., area size, curve number, etc.) as well as global parameters (e.g., initial storage, 14 sediment delivery ratio, etc.) that apply to all source areas. The weather (weather.dat) file contains daily average temperature and total precipitation values for each year simulated.

Model My Watershed

The Model My Watershed online application was used to determine potential input parameter values for the Maria Creek watershed GWLF-E model when appropriate. Model My Watershed is part of the Stroud Water Research Center's WikiWatershed initiative. WikiWatershed is a web toolkit designed to support citizens, conservation practitioners, municipal decision-makers, researchers, educators, and students to collaboratively advance knowledge and stewardship of fresh water (Stroud Water Research 2017). The toolkit allows users to run a watershed multiyear model across various scales using the GWLF-E (MapShed) model. A 30-year simulation model was run using the application for the Maria Creek watershed. The input file (.gms) was exported and used for assistance in determining various parameter values for the final model.

Part 2. GIS Based Derivation of Input Data

The use of GIS software for deriving input data for watershed simulation models such as GWLF is becoming fairly standard practice due to the inherent advantages of using GIS for manipulating spatial data. In this case, MapShed is used to parameterize input data for the GWLF-E model. In utilizing this interface, the user is prompted to load required GIS files and to provide other information related to various "non-spatial" model parameters (e.g., beginning and end of the growing season; the months during which manure is spread on agricultural land, etc.). This information is subsequently used to automatically derive values for required model input parameters, which are then written to the TRANSPRT.DAT and WEATHER.DAT input files needed to execute the GWLF-E model. Also accessed through the interface are Excel-formatted weather files containing daily temperature and precipitation information. Figure 1 and Table 1 lists GIS datasets and shapefiles used for the Maria Creek watershed calculations via MapShed and provide explanations of how they were used for development of the input files for the GWLF-E model.

Figure 1. Overview of GIS data layers used in MapShed

Data Layers	Short Description	Required
Shape Files		
Weather stations	Weather station locations (points)	Yes
Point Sources	Point source discharge locations (points)	No
Water Extraction	Water withdrawal locations (points)	No
Basins	Basin boundary used for modeling (polygons)	Yes
Streams	Map of stream network (lines)	Yes
Unpaved Roads	Map of unpaved roads (lines)	No
Roads	Map of road network (lines)	No
Counties	County boundaries - for USLE data (polygons)	No
Septic Systems	Septic system numbers and types (polygons)	No
Soils	Contains various soil-related data (polygons)	Yes
Physiographic Provinces	Contains hydrologic parameter data (polygons)	No
Flow Lines	Flow lengths from sub-areas to watershed outlet	No
Grid Files		
Land Use/Cover	Map of land use/cover (16 classes)	Yes
Elevation	Elevation grid	Yes
Groundwater-N	Background estimate of N in mg/l	No
Soil-P	Estimate of soil P in mg/kg (total or soil test P)	No
Urban Areas	Map of urban area boundaries	No

Source: MapShed User Guide (Evans and Corradini 2016)

Table 1: Description of GIS layer files used in developing input files for GWLF-E model for Maria Creek.

Data Layer	Short Description	File Type	File Name	Notes and Source
Weather Stations	Weather station locations	Point	Weatherstation.shp	User created based on Midwestern Regional Climate Center location data
Weather Directory	Weather station directory	CSV-files	Individually named by weather station	Midwestern Regional Climate Center
Basins	Basin boundary used for modeling	Polygon	BasinMaria.shp	Indiana Geographic Information Office
Streams	Map of stream network	Line	Maria_NHD_poly.shp	National Hydrologic Dataset
Soils	Contains various soil related data	Polygon	Soils.shp	SSURGO modified with local data from USDA Web Soil Survey
Land Use/Cover	Map of land use/cover	Grid	LU_ReclassD.tif	2019 Cropland Data Layer reclassified based on MapShed user guide and modified for disturbed areas by user.
DEM	Elevation grid	Grid	DEM_301.tif	Indiana Geographic Information Office with 30 meter resolution

The GIS portion of the model was run by selecting all available weather years, selecting May through September as the growing season, and leaving the default return flow of 0.4 (fraction of irrigation water estimated to return to surface/subsurface flow). The Maria Creek watershed was run first as an aggregate including all sub-basins. The aggregated model was used to calibrate flow to the observed data. The model was run again for all sub-basins individually. Calibrated parameter values from the aggregated model were transferred to each sub-basin model where appropriate. When the GIS portion of the model was completed, a .gms file for each sub-basin was generated, which was used by the GWLF-E section below.

Part 3. GWLF-E Model Input Parameters

In the GWLF-E model, the nonpoint source load calculated is affected by terrain conditions such as amount of agricultural land, land slope, and inherent soil erodibility. It is also affected by farming practices utilized in the area. Various parameters are included in the model to account for these conditions and practices. Some of the more important parameters are summarized below:

- Areal extent of different land use/cover categories: This is calculated directly from a GIS layer of land use/cover.
- Curve number: This determines the amount of precipitation that infiltrates into the ground or enters surface water as runoff. It is based on specified combinations of land use/cover and hydrologic soil type and is calculated directly using digital land use/cover and soils layers.
- K factor: This factor relates to inherent soil erodibility and affects the amount of soil erosion taking place on a given unit of land.
- LS factor: This factor signifies the steepness and length of slopes in an area and directly affects the amount of soil erosion.
- C factor: This factor is related to the amount of vegetative cover in an area. In agricultural areas, the crops grown and the cultivation practices utilized largely control this factor. Values range from 0 to 1.0, with larger values indicating greater potential for erosion.
- P factor: This factor is directly related to the conservation practices utilized in agricultural areas. Values range from 0 to 1.0, with larger values indicating greater potential for erosion.
- Sediment delivery ratio: This parameter specifies the percentage of eroded sediment that is delivered to surface water and is empirically based on watershed size.
- Unsaturated available water-holding capacity: This relates to the amount of water that can be stored in the soil and affects runoff and infiltration. It is calculated using a digital soils layer.
- Other less important factors that can affect sediment loads in a watershed are also included in the model.

The above parameter descriptions were taken from the AVGWLF Version 7.1 Users Guide (Evans et al. 2007).

Land Use/Land Cover

Digital land use/land cover (LULC) data for the Maria Creek watershed were obtained from the National Agricultural Statistics Service Cropland Data Layer (CDL). Land classes were reclassified to those which best fit into the classes required by MapShed according to the user guide. The imagery was acquired in 2019. Table 2 summarizes the acreage in each land use category in the Maria Creek watershed.

Table 2. Urban and rural land uses in the Maria Creek watershed.

Urban Land	*Area (ha)*	*Percent of Total*
Low Density Mixed	1,450	5.87
Medium Density Mixed	36	0.15
High Density Mixed	17	0.07
Disturbed	68	0.28
Total Urban	1,571	6.36
Rural Land		
Cropland	18,216	73.71
Forest	3,616	14.63
Hay/Pasture	1,289	5.22
Wetland	19	0.08
Turfgrass	1	<0.01
Total Rural	23,141	93.64
Grand Total	24,712	100

Rainfall and Runoff Input Data and Parameters

Meteorology:

Hydrology in GWLF is simulated by a water-balance calculation, based on daily observations of precipitation and temperature. A search was made of available Midwestern Regional Climate Center reporting stations. Based on this review, the most appropriate available meteorological data were determined to be from stations in Vincennes, IN (USC00129113) and Lawrenceville, IL (USW00013809). These stations supplied daily data on precipitation and minimum and maximum temperatures. Daily mean temperature weas estimated as the mean of the minimum and maximum values.

Runoff Curve Numbers:

The direct runoff fraction of precipitation in GWLF is calculated using the curve number method from the SCS TR55 method literature based on land-use and soil hydrologic group (SCS 1986). Curve numbers vary from 25 for undisturbed woodland with good soils, to, in theory, 100, for impervious surfaces. The hydrologic soil group was determined from available soils data and curve numbers were calculated for each land use category/soil hydrologic group within MapShed.

Evapotranspiration Cover Coefficients:

Within GWLF-E, potential evapotranspiration (PET) is computed using the method recommended by Hammon (1961). Details on this default method are presented in the original GWLF User's Manual (see Help folder located under the MapShed directory). In this simplified method, PET is a function of the number of daylight hours per day, the saturated water vapor pressure and the mean daily temperature on a given day. When the temperature is < 0, PET=0. The saturated water vapor pressure on a given day is a function of the mean daily temperature. With this method, ET coefficients are assigned by land use/cover type and are area-weighted to determine average values for each month of the year. Within GWLF-E, a smoothing algorithm is utilized to mimic the gradual rise and fall of ET due to changing vegetation cover throughout the year. The percent ET was adjusted to 0.9 based on several calibration runs of the model.

Soil Water Capacity:

Water stored in soil may evaporate, be transpired by plants, or percolate to ground water below the rooting zone. The amount of water that can be stored in soil (the soil water capacity) varies by soil type and rooting depth. Based on soil water capacities reported in the Model My Watershed model input file, a soil water capacity of 17.251 cm was used.

Recession and Seepage Coefficients:

The GWLF model has three subsurface zones: a shallow unsaturated zone, a shallow saturated zone, and a deep aquifer zone. Behavior of the second two stores is controlled by a ground water recession and a deep seepage coefficient. The recession coefficient was set to 0.073 per day and the deep seepage coefficient to 0.05, based on results from the modelmywatershed.org model input file parameters and several calibration runs of the model.

Erosion Parameters

GWLF simulates rural soil erosion using the Universal Soil Loss Equation (USLE). [Note: For land uses indicated as "Buildup-Washoff" or urban, solids loads are generated separately]. This method has been applied extensively, so parameter values are well established. It computes soil loss per unit area (sheet and rill erosion) at the field scale by

$$A = R * K * LS * C * P$$

where, A = rate of soil loss per unit area, R = rainfall erosivity index, K = soil erodibility factor, LS = length-slope factor, C = cover and management factor, and P = support practice factor. Soil loss or erosion at the field scale is not equivalent to sediment yield, as substantial trapping may occur, particularly during overland flow or in first-order tributaries or impoundments. GWLF accounts for sediment yield by (1) computing transport capacity of overland flow, and (2) employing a sediment delivery ratio (DR) which accounts for losses to sediment redeposition.

Rainfall Erosivity (RE):

Rainfall erosivity accounts for the impact of rainfall on the ground surface, which can make soil more susceptible to erosion and subsequent transport. Precipitation-induced erosion varies with rainfall intensity, which shows different average characteristics according to geographic region.

The erosivity coefficient (at) was assigned a value of 0.28 for the growing season and 0.13 for the dormant season, based on estimated erosivity coefficients provided in the Model My Watershed model input file and the GWLF user guide (Haith et al. 1992).

Soil Erodibility (K) Factor:

The soil erodibility factor indicates the inherent erodibility of a given soil type and is a function of soil physical properties and slope. Soil erodibility factors were extracted from local data housed within USDAs Web Soil Survey tool. For each land use category, the K factors of the soil types underlying all land of this category were area-averaged within MapShed to result in an overall K factor for the land use category.

Length-Slope (LS) Factor:

Length-slope (LS) factor is a function of overland runoff and slope and uses a NRCS equation for estimating the relationship between slope length and slope gradient for a given area derived from the DEM and stream layers within MapShed.

Cover and Management (C) and Practice (P) Factors:

Cropping Management (C) factor represents the effect of ground cover conditions, soil conditions, and general management practices on soil erosion. Erosion Control Practice (P) factors depict the effectiveness of various structural and non-structural control practices such as terracing and crop residue management in reducing soil erosion on cultivated land. Representative C values are based on default mean values within the U.S. based on field crops and slope characteristics. Practice (P) factors were set to 1, consistent with recommendations for non-agricultural land. Cropping (C) factors were adjusted based on reported values from the modelmywatershed.org input files for each sub-basin. The C values for cropland used for each sub-basin are reported in Table 3. These are representative values that may differ from actual C and P values based on local agricultural practices such as use of BMPs and crop rotations. If more accurate information on cropping practices is known during the model time period, users can edit this information to better reflect local conditions.

Table 3. Cropping (C) management factors used for cropland land uses for each sub-basin model.

Sub-basin	Cropping Management (C) factor
Marsh Creek	0.215
Tilley Ditch	0.21
HW Maria Creek	0.216
Cotton Branch	0.21

Sediment Delivery Ratio:

A sediment delivery ratio is based on the premise that a certain percentage of the material eroded from the land surface (usually the heavier soil particles) is deposited prior to reaching nearby water bodies. Empirically, the amount that does reach the outlet of a given watershed (called sediment yield) has been related to watershed size. Following the procedure described in Vanoni (1975), sediment delivery ratios calculated using MapShed are based on the relationship:

$$SDR = 0.451(b^{-0.298})$$

where: SDR = sediment delivery ratio, and
b = size of the watershed in square kilometers

The sediment delivery ratio for the entire Maria Creek watershed was calculated at 0.087.

Point Sources:

Sediment loads from mining operations are captured in “disturbed” land uses. However, additional contributions from mining activities may be captured within other land uses due to the nature of activities and classifications from the original land use layer. Point source discharge throughout the Maria Creek watershed for all facilities was estimated at 0.6 MGD and was accounted for in the model inputs.

Part 4. Calibration Results

The results of calibrating the GWLF-E model for the Maria Creek watershed are summarized in the following table and figures. Flow data specific to the Maria Creek watershed was not available. Therefore, a reference gage approach was used and adjusted based on the drainage area ratio. Flow data from USGS gage 03342500 on Busseron Creek near Carlisle, IN was used to calibrate the model. The results shown in Table 4 indicate that the simulated flow modeling period agrees well with observed stream flow data. The greatest errors occur in simulated fall volumes. In general, the hydrologic calibration appears adequate in that it reflects the total water yield, annual variability, and magnitude of individual storm events in the basin (Figures 2 and 3).

Table 4: Maria Creek Watershed Calibration Results for the Simulation Period January 2011 to December 2020. Units are shown in in/yr.

Total Simulated In-stream flow:	16.78	Total Observed In-stream flow:	15.85
Total of highest 10% flows:	5.23	Total of highest 10% flows:	5.00
Total of lowest 50% flows:	4.32	Total of lowest 50% flows:	4.02
Simulated Summer Flow Volume:	2.38	Observed Summer Flow Volume:	2.53
Simulated Fall Flow Volume:	1.94	Observed Fall Flow Volume:	1.48
Simulated Winter Flow Volume:	5.15	Observed Winter Flow Volume:	5.18
Simulated Spring Flow Volume:	7.31	Observed Spring Flow Volume:	6.66
Errors (Simulated-Observed)	%	*Recommended Criteria*[1]	
Error in total volume:	5.87	10	
Error in 50% lowest flows:	7.46	10	
Error in 10% highest flows:	4.60	15	
Seasonal volume error - Summer:	-5.93	30	
Seasonal volume error - Fall:	31.08	30	
Seasonal volume error - Winter:	-0.58	30	
Seasonal volume error - Spring:	9.76	30	

[1]Recommended criteria are from Lumb et al., 1994.

Figure 2. Maria Creek Watershed observed versus simulated monthly stream flows (January 1, 2011 to December 31, 2020). R^2 = 0.72.

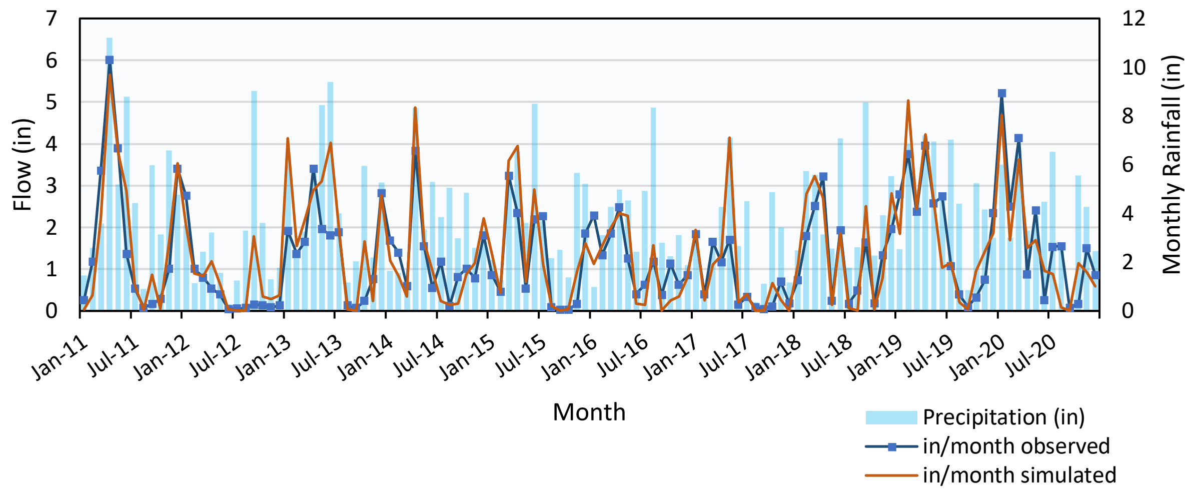
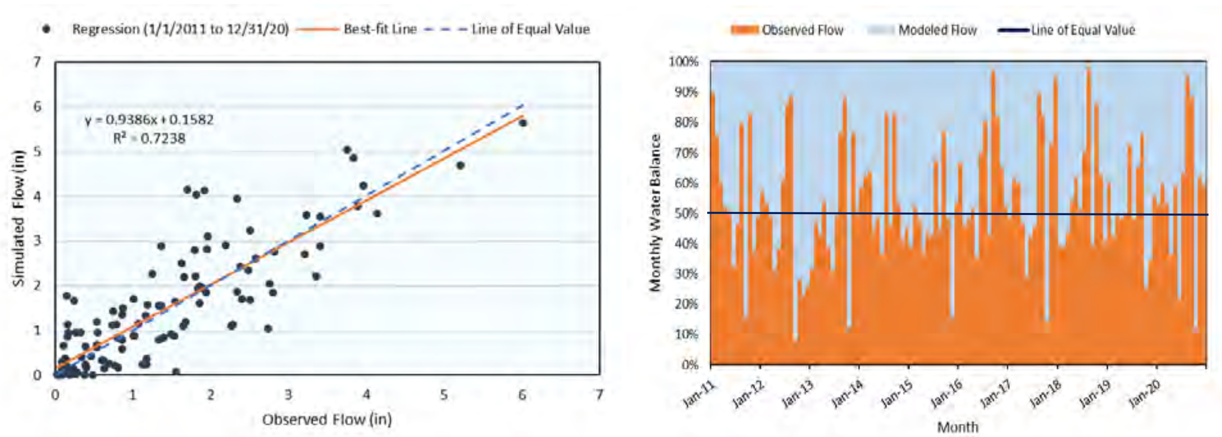


Figure 3. Time series hydrologic calibration results for Maria Creek Watershed (January 1, 2011 to December 2020)



Part 5. Subwatershed Modeling Results

Modeling results indicate that cropland and stream banks contribute the greatest sediment loadings throughout the Maria Creek watershed. Cropland contributes the overwhelming majority of annual sediment comprising approximately 90% of the overall loading. Overall, Headwaters of Maria Creek subwatershed is contributing the greatest annual load on average to the Maria Creek watershed while Marsh Creek is contributing the least amount of loading. Although similar in land uses, Headwaters of Maria Creek contributes nearly twice the annual loading to the Maria Creek watershed as Marsh Creek. This may be due to the unique soil characteristics between the two subwatersheds. Soil erodibility (K) and length-slope (LS) factors are both on average lower in Marsh Creek for cropland land uses compared to Headwaters of Maria Creek. Additionally, Marsh Creek has a greater unsaturated soil water holding capacity compared to Headwaters of Maria Creek. Results of the GWLF-E modeling for Maria Creek are summarized in Table 5 and Figures 4 and 5 below. Source contributions of sediment should be considered when selecting best management practices (BMPs) which will result in the greatest load reductions overall. Results from the GWLF-E sediment modeling were calculated for informational purposes on source loadings and do not take place of the total maximum daily loads or reductions established within this document for the Maria Creek watershed.

Table 5. Average annual sediment loads (in tons) by source for subwatersheds in the Maria Creek watershed.

Source		Marsh Creek	Tilley Ditch	Headwaters Maria Creek	Cotton Branch	**Maria Creek Watershed**
Rural	Cropland	11,230.4	18,093.2	21,107.0	15,308.0	**65,738.4**
	Stream Bank	657.2	1,255.0	858.5	2,370.4	**5,141.1**
	Hay/Pasture	238.4	269.2	480.6	332.0	**1,320.1**
	Forest	22.0	58.6	152.5	127.1	**360.2**
	Wetland	1.3	0.5	1.8	0.8	**4.4**
	Turfgrass	0.0	0.0	0.0	0.7	**0.7**
Urban	Disturbed	25.0	4.3	127.1	1.2	**157.6**
	Low Density Mixed Urban	16.5	14.6	16.0	17.3	**64.4**
	Medium Density Mixed Urban	2.9	1.0	1.0	3.7	**8.6**
	High Density Mixed Urban	1.4	0.5	1.6	0.5	**4.0**
Total (tons)		12,195	19,697	22,746	18,162	**72,799**

Figure 4. Average annual sediment loading from sources in each subwatershed (January 1, 2011 to December 31, 2020)

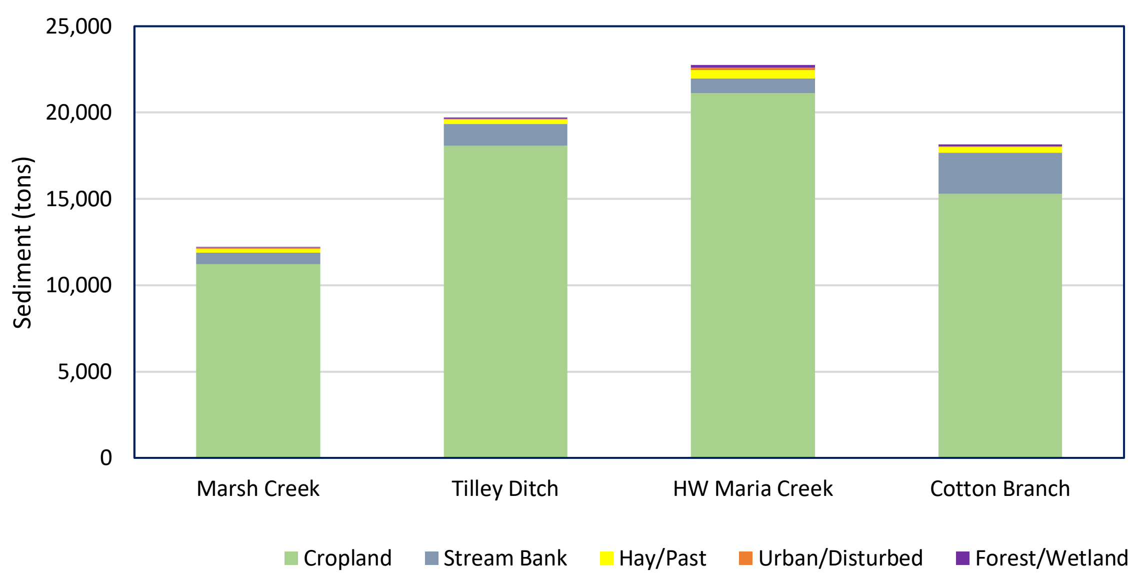
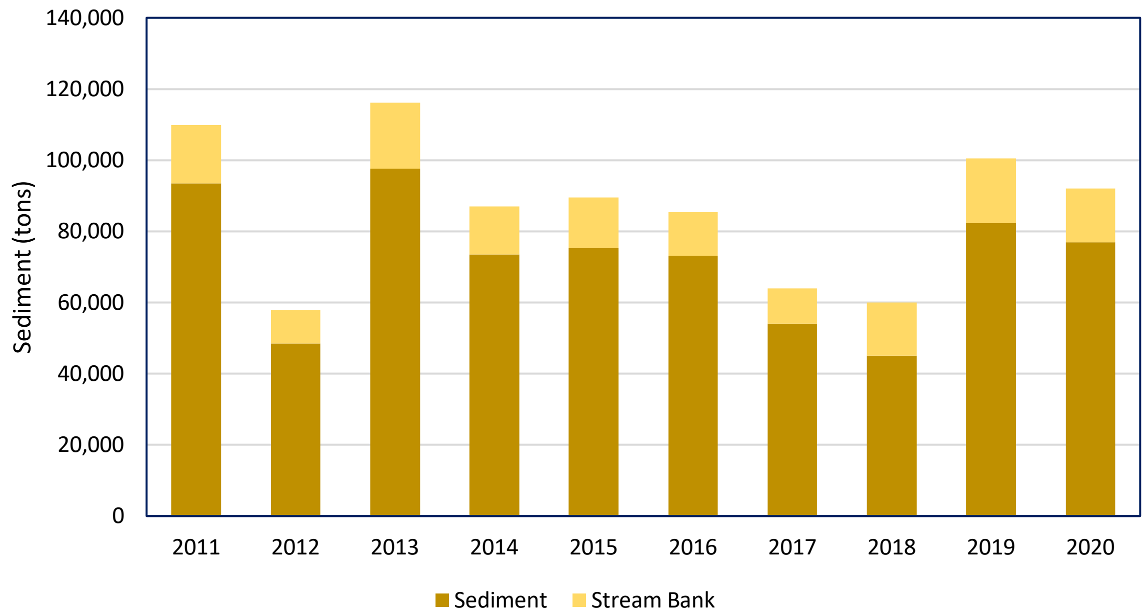
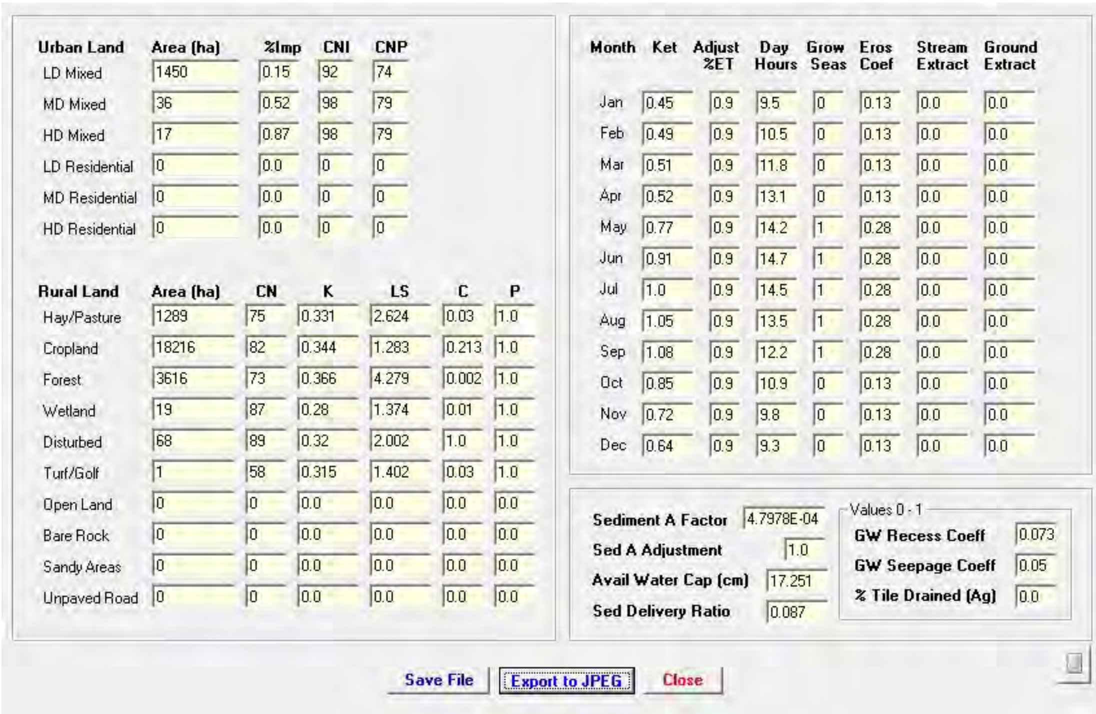


Figure 5. Modeled sediment loads (in tons) for the Maria Creek watershed from 2011 to 2020.



Part 6. GWLF-E Model Inputs

Figure 6. Transport file parameters for aggregated Maria Creek watershed GWLF-E model.



Urban Land	Area (ha)	%Imp	CNI	CNP
LD Mixed	1450	0.15	92	74
MD Mixed	36	0.52	98	79
HD Mixed	17	0.87	98	79
LD Residential	0	0.0	0	0
MD Residential	0	0.0	0	0
HD Residential	0	0.0	0	0

Rural Land	Area (ha)	CN	K	LS	C	P
Hay/Pasture	1289	75	0.331	2.624	0.03	1.0
Cropland	18216	82	0.344	1.283	0.213	1.0
Forest	3616	73	0.366	4.279	0.002	1.0
Wetland	19	87	0.28	1.374	0.01	1.0
Disturbed	68	89	0.32	2.002	1.0	1.0
Turf/Golf	1	58	0.315	1.402	0.03	1.0
Open Land	0	0	0.0	0.0	0.0	0.0
Bare Rock	0	0	0.0	0.0	0.0	0.0
Sandy Areas	0	0	0.0	0.0	0.0	0.0
Unpaved Road	0	0	0.0	0.0	0.0	0.0

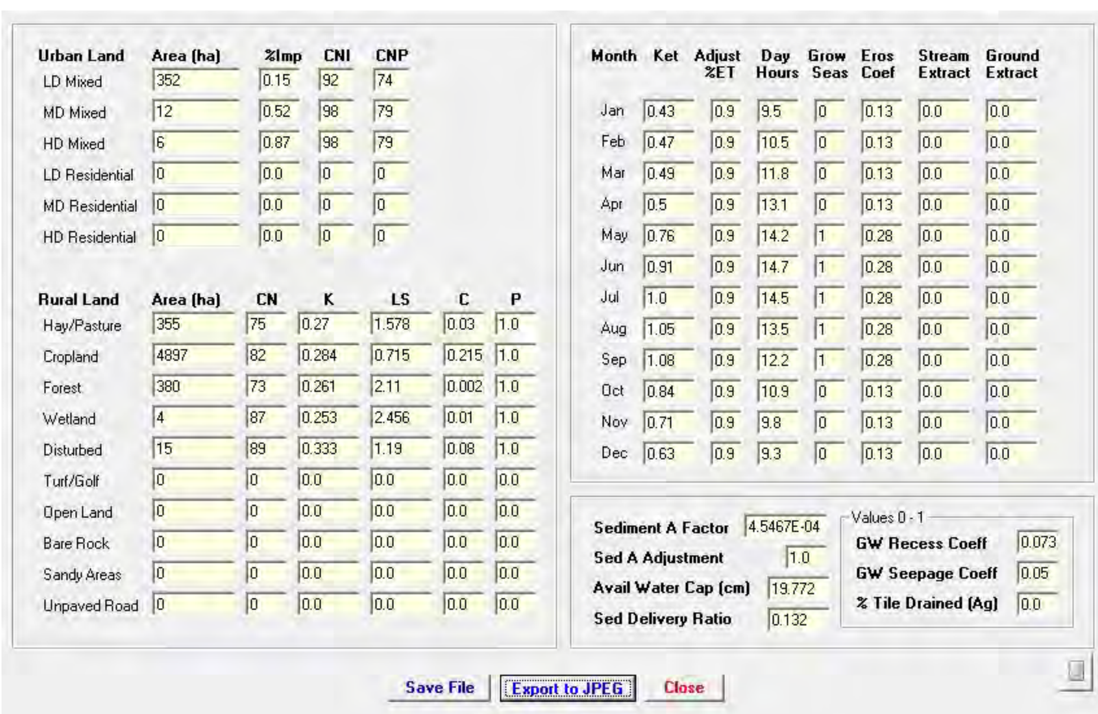
Month	Ket	Adjust %ET	Day Hours	Grow Seas	Eros Coef	Stream Extract	Ground Extract
Jan	0.45	0.9	9.5	0	0.13	0.0	0.0
Feb	0.49	0.9	10.5	0	0.13	0.0	0.0
Mar	0.51	0.9	11.8	0	0.13	0.0	0.0
Apr	0.52	0.9	13.1	0	0.13	0.0	0.0
May	0.77	0.9	14.2	1	0.28	0.0	0.0
Jun	0.91	0.9	14.7	1	0.28	0.0	0.0
Jul	1.0	0.9	14.5	1	0.28	0.0	0.0
Aug	1.05	0.9	13.5	1	0.28	0.0	0.0
Sep	1.08	0.9	12.2	1	0.28	0.0	0.0
Oct	0.85	0.9	10.9	0	0.13	0.0	0.0
Nov	0.72	0.9	9.8	0	0.13	0.0	0.0
Dec	0.64	0.9	9.3	0	0.13	0.0	0.0

Sediment A Factor	4.7978E-04
Sed A Adjustment	1.0
Avail Water Cap (cm)	17.251
Sed Delivery Ratio	0.087

Values 0 - 1

GW Recess Coeff	0.073
GW Seepage Coeff	0.05
% Tile Drained (Ag)	0.0

Figure 7. Transport file parameters for Marsh Creek subwatershed GWLF-E model.



Urban Land	Area (ha)	%Imp	CNI	CNP
LD Mixed	352	0.15	92	74
MD Mixed	12	0.52	98	79
HD Mixed	6	0.87	98	79
LD Residential	0	0.0	0	0
MD Residential	0	0.0	0	0
HD Residential	0	0.0	0	0

Rural Land	Area (ha)	CN	K	LS	C	P
Hay/Pasture	355	75	0.27	1.578	0.03	1.0
Cropland	4897	82	0.284	0.715	0.215	1.0
Forest	380	73	0.261	2.11	0.002	1.0
Wetland	4	87	0.253	2.456	0.01	1.0
Disturbed	15	89	0.333	1.19	0.08	1.0
Turf/Golf	0	0	0.0	0.0	0.0	0.0
Open Land	0	0	0.0	0.0	0.0	0.0
Bare Rock	0	0	0.0	0.0	0.0	0.0
Sandy Areas	0	0	0.0	0.0	0.0	0.0
Unpaved Road	0	0	0.0	0.0	0.0	0.0

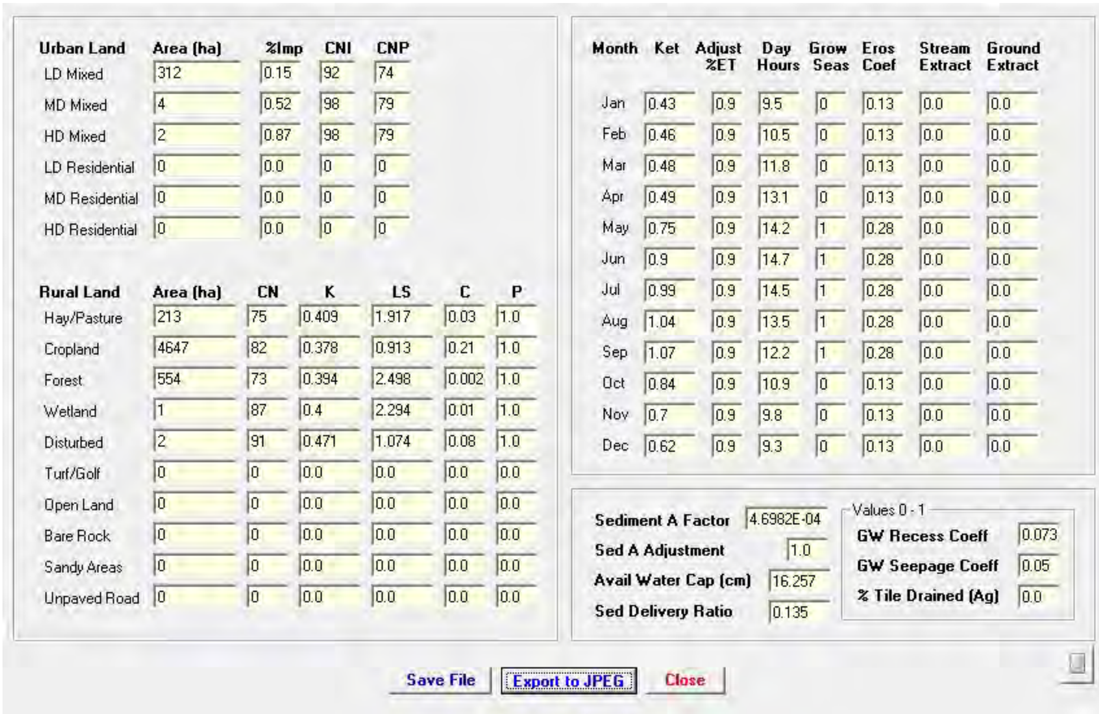
Month	Ket	Adjust %ET	Day Hours	Grow Seas	Eros Coef	Stream Extract	Ground Extract
Jan	0.43	0.9	9.5	0	0.13	0.0	0.0
Feb	0.47	0.9	10.5	0	0.13	0.0	0.0
Mar	0.49	0.9	11.8	0	0.13	0.0	0.0
Apr	0.5	0.9	13.1	0	0.13	0.0	0.0
May	0.76	0.9	14.2	1	0.28	0.0	0.0
Jun	0.91	0.9	14.7	1	0.28	0.0	0.0
Jul	1.0	0.9	14.5	1	0.28	0.0	0.0
Aug	1.05	0.9	13.5	1	0.28	0.0	0.0
Sep	1.08	0.9	12.2	1	0.28	0.0	0.0
Oct	0.84	0.9	10.9	0	0.13	0.0	0.0
Nov	0.71	0.9	9.8	0	0.13	0.0	0.0
Dec	0.63	0.9	9.3	0	0.13	0.0	0.0

Sediment A Factor	4.5467E-04
Sed A Adjustment	1.0
Avail Water Cap (cm)	19.772
Sed Delivery Ratio	0.132

Values 0 - 1

GW Recess Coeff	0.073
GW Seepage Coeff	0.05
% Tile Drained (Ag)	0.0

Figure 8. Transport file parameters for Tilley Ditch subwatershed GWLF-E model.



Urban Land	Area (ha)	%Imp	CNI	CNP
LD Mixed	312	0.15	92	74
MD Mixed	4	0.52	98	79
HD Mixed	2	0.87	98	79
LD Residential	0	0.0	0	0
MD Residential	0	0.0	0	0
HD Residential	0	0.0	0	0

Rural Land	Area (ha)	CN	K	LS	C	P
Hay/Pasture	213	75	0.409	1.917	0.03	1.0
Cropland	4647	82	0.378	0.913	0.21	1.0
Forest	554	73	0.394	2.498	0.002	1.0
Wetland	1	87	0.4	2.294	0.01	1.0
Disturbed	2	91	0.471	1.074	0.08	1.0
Turf/Golf	0	0	0.0	0.0	0.0	0.0
Open Land	0	0	0.0	0.0	0.0	0.0
Bare Rock	0	0	0.0	0.0	0.0	0.0
Sandy Areas	0	0	0.0	0.0	0.0	0.0
Unpaved Road	0	0	0.0	0.0	0.0	0.0

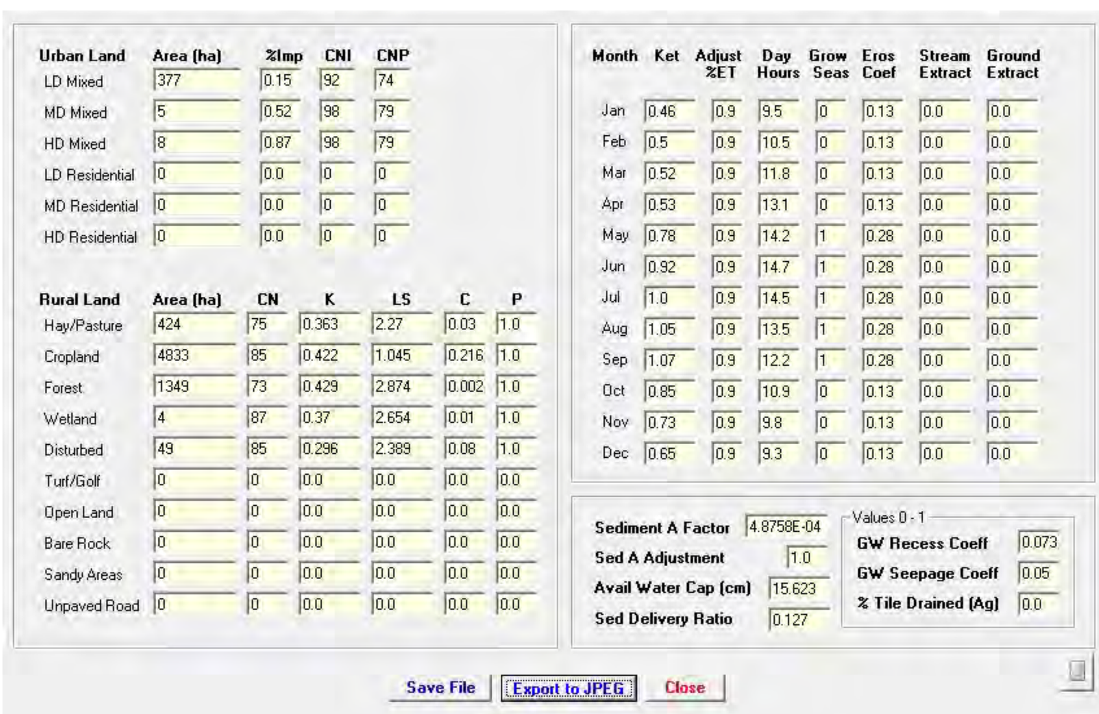
Month	Ket	Adjust %ET	Day Hours	Grow Seas	Eros Coef	Stream Extract	Ground Extract
Jan	0.43	0.9	9.5	0	0.13	0.0	0.0
Feb	0.46	0.9	10.5	0	0.13	0.0	0.0
Mar	0.48	0.9	11.8	0	0.13	0.0	0.0
Apr	0.49	0.9	13.1	0	0.13	0.0	0.0
May	0.75	0.9	14.2	1	0.28	0.0	0.0
Jun	0.9	0.9	14.7	1	0.28	0.0	0.0
Jul	0.99	0.9	14.5	1	0.28	0.0	0.0
Aug	1.04	0.9	13.5	1	0.28	0.0	0.0
Sep	1.07	0.9	12.2	1	0.28	0.0	0.0
Oct	0.84	0.9	10.9	0	0.13	0.0	0.0
Nov	0.7	0.9	9.8	0	0.13	0.0	0.0
Dec	0.62	0.9	9.3	0	0.13	0.0	0.0

Sediment A Factor 4.6982E-04
Sed A Adjustment 1.0
Avail Water Cap (cm) 16.257
Sed Delivery Ratio 0.135

Values 0 - 1
GW Recess Coeff 0.073
GW Seepage Coeff 0.05
% Tile Drained (Ag) 0.0

Save File
Export to JPEG
Close

Figure 9. Transport file parameters for Headwaters Maria Creek subwatershed GWLF-E model.



Urban Land	Area (ha)	%Imp	CNI	CNP
LD Mixed	377	0.15	92	74
MD Mixed	5	0.52	98	79
HD Mixed	8	0.87	98	79
LD Residential	0	0.0	0	0
MD Residential	0	0.0	0	0
HD Residential	0	0.0	0	0

Rural Land	Area (ha)	CN	K	LS	C	P
Hay/Pasture	424	75	0.363	2.27	0.03	1.0
Cropland	4833	85	0.422	1.045	0.216	1.0
Forest	1349	73	0.429	2.874	0.002	1.0
Wetland	4	87	0.37	2.654	0.01	1.0
Disturbed	49	85	0.296	2.389	0.08	1.0
Turf/Golf	0	0	0.0	0.0	0.0	0.0
Open Land	0	0	0.0	0.0	0.0	0.0
Bare Rock	0	0	0.0	0.0	0.0	0.0
Sandy Areas	0	0	0.0	0.0	0.0	0.0
Unpaved Road	0	0	0.0	0.0	0.0	0.0

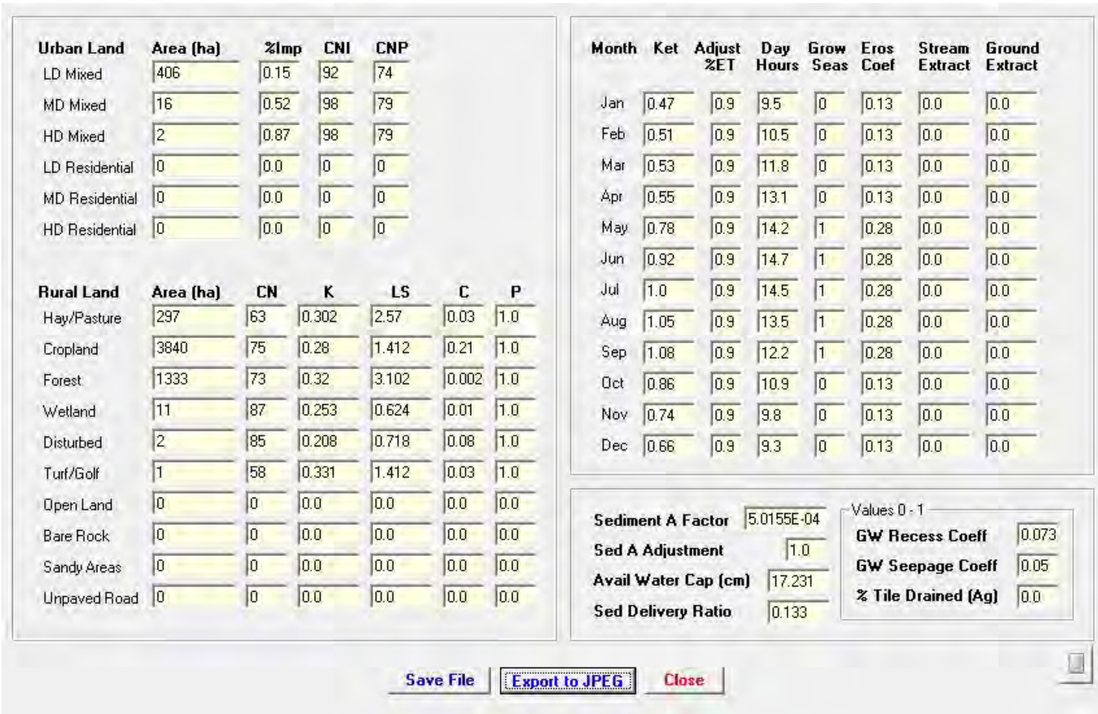
Month	Ket	Adjust %ET	Day Hours	Grow Seas	Eros Coef	Stream Extract	Ground Extract
Jan	0.46	0.9	9.5	0	0.13	0.0	0.0
Feb	0.5	0.9	10.5	0	0.13	0.0	0.0
Mar	0.52	0.9	11.8	0	0.13	0.0	0.0
Apr	0.53	0.9	13.1	0	0.13	0.0	0.0
May	0.78	0.9	14.2	1	0.28	0.0	0.0
Jun	0.92	0.9	14.7	1	0.28	0.0	0.0
Jul	1.0	0.9	14.5	1	0.28	0.0	0.0
Aug	1.05	0.9	13.5	1	0.28	0.0	0.0
Sep	1.07	0.9	12.2	1	0.28	0.0	0.0
Oct	0.85	0.9	10.9	0	0.13	0.0	0.0
Nov	0.73	0.9	9.8	0	0.13	0.0	0.0
Dec	0.65	0.9	9.3	0	0.13	0.0	0.0

Sediment A Factor 4.8758E-04
Sed A Adjustment 1.0
Avail Water Cap (cm) 15.623
Sed Delivery Ratio 0.127

Values 0 - 1
GW Recess Coeff 0.073
GW Seepage Coeff 0.05
% Tile Drained (Ag) 0.0

Save File
Export to JPEG
Close

Figure 10. Transport file parameters for Cotton Branch subwatershed GWLF-E model.



Urban Land	Area (ha)	%Imp	CNI	CNP
LD Mixed	406	0.15	92	74
MD Mixed	16	0.52	98	79
HD Mixed	2	0.87	98	79
LD Residential	0	0.0	0	0
MD Residential	0	0.0	0	0
HD Residential	0	0.0	0	0

Rural Land	Area (ha)	CN	K	LS	C	P
Hay/Pasture	297	63	0.302	2.57	0.03	1.0
Cropland	3840	75	0.28	1.412	0.21	1.0
Forest	1333	73	0.32	3.102	0.002	1.0
Wetland	11	87	0.253	0.624	0.01	1.0
Disturbed	2	85	0.208	0.718	0.08	1.0
Turf/Golf	1	58	0.331	1.412	0.03	1.0
Open Land	0	0	0.0	0.0	0.0	0.0
Bare Rock	0	0	0.0	0.0	0.0	0.0
Sandy Areas	0	0	0.0	0.0	0.0	0.0
Unpaved Road	0	0	0.0	0.0	0.0	0.0

Month	Ket	Adjust %ET	Day Hours	Grow Seas	Eros Coef	Stream Extract	Ground Extract
Jan	0.47	0.9	9.5	0	0.13	0.0	0.0
Feb	0.51	0.9	10.5	0	0.13	0.0	0.0
Mar	0.53	0.9	11.8	0	0.13	0.0	0.0
Apr	0.55	0.9	13.1	0	0.13	0.0	0.0
May	0.78	0.9	14.2	1	0.28	0.0	0.0
Jun	0.92	0.9	14.7	1	0.28	0.0	0.0
Jul	1.0	0.9	14.5	1	0.28	0.0	0.0
Aug	1.05	0.9	13.5	1	0.28	0.0	0.0
Sep	1.08	0.9	12.2	1	0.28	0.0	0.0
Oct	0.86	0.9	10.9	0	0.13	0.0	0.0
Nov	0.74	0.9	9.8	0	0.13	0.0	0.0
Dec	0.66	0.9	9.3	0	0.13	0.0	0.0

Sediment A Factor	5.0155E-04
Sed A Adjustment	1.0
Avail Water Cap (cm)	17.231
Sed Delivery Ratio	0.133

Values 0 - 1

GW Recess Coeff	0.073
GW Seepage Coeff	0.05
% Tile Drained (Ag)	0.0

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