2017
PERFORMANCE MEASURES MONITORING WORK PLAN FOR SELECTED INDIANA SUB-WATERSHEDS

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SIGNATURE PAGE

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Indiana Department of Environmental Management
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WORK PLAN ORGANIZATION

This Sampling and Analysis Work Plan is an extension of the existing Watershed Assessment and Planning Branch, March 2017, "*Quality Assurance Project Plan (QAPP) for Indiana Surface Water Quality Monitoring Programs*" and serves as a link to the existing QAPP and an independent QAPP for the project. Per the United States Environmental Protection Agency (U.S. EPA) 2006 QAPP guidance (U.S. EPA 2006), this Work Plan establishes criteria and specifications pertaining to a specific water quality monitoring project that are usually described in the following four sections as QAPP elements:

Section I. Project Management/Planning

- Project Objectives
- Background and Project/Task Description
- Project/Task Organization
- Data Quality Objectives (DQOs)

Section II. Measurement/Data Acquisition

- Sampling Procedure
- Analytical Methods
- Sample and Data Acquisition Requirements
- Quality Control (QC) Measures Specific to the Project

Section III. Assessment/Oversight

- External and Internal Checks
- Audits
- Data Quality Assessments (DQAs)
- Quality Assurance/Quality Control (QA/QC) Review Reports

Section IV. Data Validation and Usability

- Data Handling and associated QA/QC activities
- QA/QC Review Reports

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LIST OF ACRONYMS

AIMS:	Assessment Information Management System
ASTM:	American Society for Testing and Materials
AUID:	Assessment Unit Identification
CALM:	Consolidated Assessment Listing Methodology
CFR:	Code of Federal Regulations
CPR:	Cardio-Pulmonary Resuscitation
DO:	Dissolved Oxygen
DQA:	Data Quality Assessment
DQO:	Data Quality Objectives
GPS:	Global Positioning System
IAC:	Indiana Administrative Code
IBC:	Impaired Biotic Community
IBI:	Index of Biotic Integrity
IC:	Indiana Code
IDEM:	Indiana Department of Environmental Management
MDL:	Method Detection Limit
mg/L:	Milligram per liter
MHAB:	Multi-habitat
mL:	Milliliter
mm:	Millimeters
NPDES:	National Pollutant Discharge Elimination System
NPS:	Nonpoint Source Control
NTU:	Nephelometric Turbidity Unit(s)
Nx:	Nutrient
OHEPA	Ohio Environmental Protection Agency
OWQ:	Office of Water Quality
PFD:	Personal Floatation Device
PPE:	Personal Protective Equipment
QA/QC:	Quality Assurance/Quality Control
QAPP:	Quality Assurance Project Plan
QC:	Quality Control
QHEI:	Qualitative Habitat Evaluation Index
RL:	Reporting Limit
RPD:	Relative Percent Difference
SM:	Standard Method
SOLAS:	Safety of Life at Sea
SOP:	Standard Operating Procedures
S.U.:	Standard Units
TMDL:	Total Maximum Daily Load
U.S. EPA:	United States Environmental Protection Agency
USGS:	United States Geological Survey
WAPB:	Watershed Assessment and Planning Branch

DEFINITIONS

Assessment Unit (AU)	Individual segment of a stream or river (measured and reported in miles) used for assessing waters; length of a stream AU can vary. A single AU may or may not represent the entire stream to which it is associated. Example: Large rivers are commonly broken into smaller, separate AUs while smaller streams may be grouped together into a single, “catchment” AU based on hydrology and other factors that can affect water quality
AUID	Unique code used to identify each AU based on the12-digit HUC in which it is located; used for reporting biological, chemical, bacteriological impairments of Indiana streams and rivers to the 303(d) List of Impaired Waterbodies.
Impaired Biotic Communities	Biological communities – the fish and aquatic invertebrates (e.g., insects) in stream – are indicators of the cumulative effects of activities that affect water quality conditions over time. An IBC listing on Indiana’s 303(d) list or in a TMDL 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.
Elutriate	To purify, separate, or remove lighter or finer particles by washing, decanting, and settling.
Fifteen (15) Minute Pick	A component of the IDEM multihabitat macroinvertebrate sampling method in which the one minute kick sample and fifty meter sweep sample collected at a site are combined, elutriated, with macroinvertebrates removed from the resulting sample for 15 minutes while in the field.
Fifty (50) Meter Sweep	A component of the IDEM multihabitat macroinvertebrate sampling method in which approximately 50 meters (m) of shoreline habitat in a stream or river is sampled with a standard 500 micrometer (µm) mesh width D-frame dipnet by taking 20-25 individual “jab” or “sweep” samples, which are then composited.
Hydrologic Unit Code	Numerical sequence unique to every watershed in the United States consisting of two to eight digits (largest region to smallest categorical unit) based on level of classification (size) of watershed; larger watersheds have less HUC digits
Letter of intention	Letter sent to landowners that staff will be sampling a stream accessed at a bridge near their property.

NHD	The NHD is a database created by U.S. EPA and the United States Geological Survey that provides a comprehensive coverage of hydrographic data for the United States. It uniquely identifies and interconnects the stream segments that comprise the nation's surface water drainage system and contains information for other common surface waterbodies such as lakes reservoirs, estuaries, and coastlines.
One (1) minute kick sample	A component of the IDEM multihabitat macroinvertebrate sampling method in which approximately one square meter (m^2) of riffle or run substrate habitat in a stream or river is sampled with a standard 500 micrometer (µm) mesh width D-frame dipnet for approximately one minute.
Perennial	Refers to a water body in which water is present in at least 50% of the stream reach during the time of fish community sampling.
Reach	A segment of a stream used for fish community sampling, equal in length to 15 times the average wetted width of the stream, with a minimum length of 50 meters and a maximum length 500 meters.
Reach Indexing	The process of using the National Hydrography Dataset (NHD) and geographic information systems (GIS) software to delineate waterbody assessment units AUs for the purposes of applying and mapping quality assessment information.
Target	A sampling point which falls on a perennial stream within the basin of interest and the boundaries of Indiana.
TMDL	The sum of the wasteload allocations (effluent limitations) for point sources, load allocations for nonpoint sources and natural background, plus a margin of safety. TMDLs are required for any impaired waters on the CWA 303(d) List.

I. PROJECT MANAGEMENT/PLANNING

Project Objective

A water quality goal of the State of Indiana is to restore and maintain the chemical, physical, and biological integrity of the waters of the State (327-IAC-2-1-1.5). Section 106(e) of the Clean Water Act (CWA) and 40 CFR Part 35.168(a) require the United States Environmental Protection Agency (U.S. EPA) to determine that a state is monitoring the quality of navigable waters, compiling, and analyzing data on water quality and including it in the State's Section 305(b) report. The Indiana Department of Environmental Management (IDEM) Office of Water Quality (OWQ) is responsible for sampling and assessing Indiana's surface water quality pursuant to the CWA Section 305(b) as well as, according to Section 303(d) of the CWA, identifying water bodies of the state that are impaired and need development of a Total Maximum Daily Load (TMDL) to alleviate the impairments.

To that end, all states must submit to the U.S. EPA a biennial Integrated Water Quality Monitoring and Assessment Report (Integrated Report) (IDEM 2016a), encompassing the 305(b) assessment report and the 303(d) list of impaired water bodies (IDEM 2016b). Assessments of the state's waters are facilitated by various Watershed Assessment and Planning Branch programs involving probabilistic and targeted approaches by collecting biological, chemical, physical, and habitat data (US EPA 2005).

Background and Project/Task Description

Performance monitoring is initiated to show improvements in water quality when waterbodies cited in Categories 4A and/or 5A of Indiana's Consolidated List have received documented Nonpoint Source (NPS) control or watershed planning and restoration efforts. This type of monitoring provides chemical, physical, biological, and/or bacteriological data that can be reported to U.S. EPA Region 5's NPS Program showing improvements in watersheds previously listed as impaired. The monitoring design for each waterbody reflects the original sampling effort that was conducted; however a new site was created in the Assessment Information Management System (AIMS) to represent 17W013 at the nearest bridge on the impaired AUID selected for reassessment - INP0945_01. Project site 17W013 was moved to the closest bridge for accessibility.

For this study on the sub-watersheds of:

- Headwaters Curtis Creek (*071200020401*),
- Elliot Ditch (*051201080104*),
- Kenny Ditch-Wea Creek (*051201080106*),
- Kilmore Creek (*051201070306*),
- Jenkins Ditch-South Fork Wildcat Creek (*051201070308*), and
- Ell Creek (*051202090405*)

one or more of the following data types will be used for assessment purposes: Water chemistry and nutrients in-situ water chemistry (all sampling events), *E. coli* bacteriological contamination indicator, fish community, macroinvertebrate assemblages (two sites), and habitat evaluations (every biological sampling site, see Table 1). For biological community status, the community sampled will be variable dependent upon available historical data. The historical biological community data (fish, macroinvertebrate, or both) used to indicate impairment will be used to show subsequent improvement.

The Indiana Water Quality Monitoring Strategy: 2011-2019 (WQMS) (IDEM 2011) facilitates the accomplishment of these CWA requirements, in addition to other IDEM-specific management goals. Following analysis of historical data and statewide restoration activities, performance measures monitoring sites are selected from AUIDs listed on the 303(d) List of Impaired Waters or in an approved TMDL in a watershed for which IDEM has observed significant restoration activities. Sampling parameters may vary among sites and are determined by the impairment indicated by the 303(d) listing or TMDL.

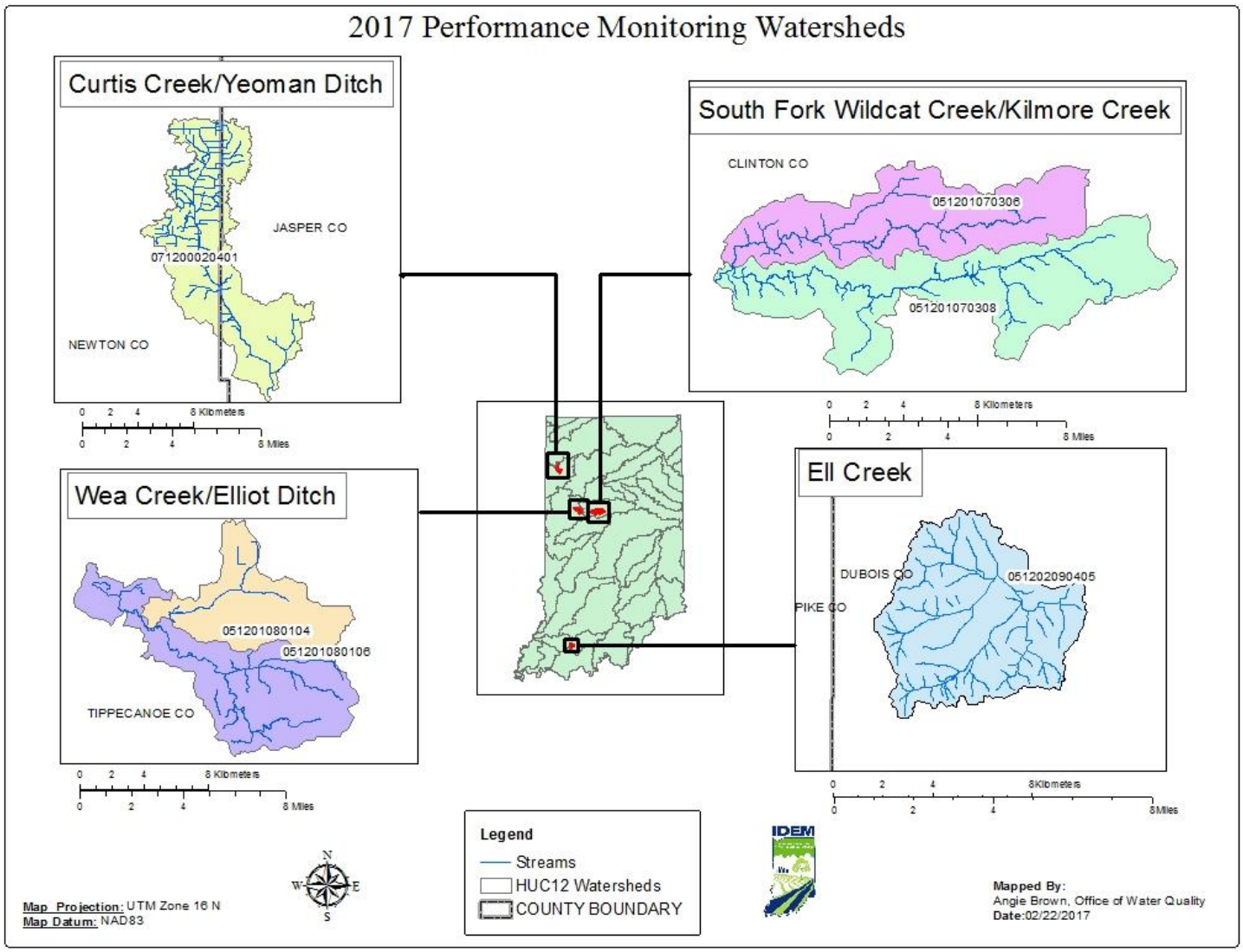
Table 1. Performance monitoring 2017 sampling parameters and stream segment impairments for selected Indiana sub-watersheds

Headwaters Curtis Creek (071200020401)				
AIMS site number	**Project site number**	**Stream**	**Impairment**	**AUID**
UMI040-0042	17W001	Curtis Creek	Impaired Biotic Communities (IBC)	INK0241_01
UMI040-0048	17W002	Curtis Creek	*E. coli*	INK0241_01
UMI040-0017	17W003	Yeoman Ditch	*E. coli*	INK0241_T1004
Elliot Ditch (051201080104)				
WLV020-0005	17W004	Elliot Ditch	IBC*	INB0814_01
Kenny Ditch-Wea Creek (051201080106)				
WLV020-0004	17W005	Wea Creek (U/S of Elliot Ditch Confluence)	*E. coli*	INB0816_01
WLV020-0003	17W006	Wea Creek (D/S of Elliot Ditch Confluence)	*E. coli*	INB0816_02
Kilmore Creek (051201070306)				
WAW040-0123	17W007	Boyles Ditch	IBC**, *E.coli*	INB0736_T1005
WAW-03-0001	17W008	Kilmore Creek (U/S of Boyles Ditch Confluence)	*E.coli*	INB0736_04
WAW040-0066	17W009	Kilmore Creek (D/S of Boyles Ditch Confluence)	*E.coli*	INB0736_04
Jenkins Ditch-South Fork Wildcat Creek (051201070308)				
WAW-03-0004	17W010	Tributary of South Fork Wildcat Creek	IBC**	INB0738_T1002
WAW040-0065	Nutrient 17N009	South Fork Wildcat Creek	*E.coli*	INB0738_02
Ell Creek (051202090405)				
WPA040-0090	17W011	Tributary of Ell Creek	IBC**, Dissolved Oxygen	INP0945_T1001
WPA040-0095	17W012	Tributary of Ell Creek	*E.coli,* Nutrients	INP0945_T1003
WPA-04-0027	17W013	U/S Ell Creek (headwaters)	*E.coli,* Nutrients	INP0945_01
WPA040-0096	17W014	U/S Ell Creek (above Tributary)	*E.coli,* Nutrients	INP0945_01
WPA040-0098	17W015	D/S Ell Creek (near Patoka River Confluence)	*E.coli,* Nutrients	INP0945_01

*IBC – macroinvertebrate community only, no fish data available for comparison
**IBC – fish community only, no macroinvertebrate data available for comparison
Nutrient Pilot site

Study Area for the 2017 Monitoring Program

Figure 1. Location of 2017 Performance Monitoring selected Indiana Sub-watersheds



Sampling will be conducted in five counties across the six Indiana sub-watersheds listed throughout this work plan to assess the impact of U.S. EPA NPS funding of watershed management plan implementation (Figure 1). Historical sampling in sub-watersheds *071200020401*, *051201080104, 051201080106, 051201070306, 051201070308,* and *051202090405* indicated impairments for biology, *E. coli*, DO, and/or Nutrients; 16 sites across the selected sub-watersheds will be sampled for one or more of these parameters. It is anticipated that the water quality data collected will highlight improvements in watersheds, such that waterbodies previously identified as impaired are now meeting Indiana State Water Quality Standards.

Sub-watershed Headwaters Curtis Creek 071200020401: In 2017, three sites will be sampled in Headwaters Curtis Creek. Two sites will be sampled for *E. coli* and one will be sampled for biology (see Table 1). Both sites to be sampled for *E. coli* are located in Jasper County; and one site to be sampled for both fish and macroinvertebrate communities is in Newton County (Figure 2, Table 2).

Sub-watershed Elliot Ditch 051201080104: One site will be sampled for biology in Tippecanoe County (see Figure 3, Table 2). Previous biological sampling indicated impairment consequent to the collection of macroinvertebrate community data; therefore to show subsequent improvement, this will be the only community assessed.

Sub-watershed Kenny Ditch-Wea Creek 051201080106: Two sites will be sampled for *E. coli*; located in Tippecanoe County (see Figure 3, Table 2).

Sub-watershed Kilmore Creek 051201070306: Three sites will be sampled for *E. coli* in Clinton County. One of the three selected sites (located on Boyles Ditch) will also be sampled for biology (see Figure 4, Table 2). Previous biological sampling on Boyles Ditch indicated impairment consequent to the collection of fish community data; therefore to show subsequent improvement, this will be the only community assessed.

Sub-watershed Jenkins Ditch-South Fork Wildcat Creek 051201070308: A total of two sites will be sampled; located in Clinton County (Figure 4, Table 2). One site will be sampled for fish community and one separate site will be sampled for *E. coli*. Previous biological sampling on Tributary of South Fork Wildcat Creek indicated impairment consequent to the collection of fish community data; therefore to show subsequent improvement, this will be the only community assessed. <u>Note on nomenclature differentiation</u>: Site 17N009 was also chosen as a part of the 2017 Diel Oxygen Pilot Project, which accounts for the difference in the “project site number” naming convention.

Sub-watershed Ell Creek 051202090405: A total of five sites will be sampled in Dubois County. One site (17W011) will be sampled for fish community and DO--It is important to note that DO will need to be sampled a minimum of 3 times. Previous biological sampling on Ell Creek indicated impairment consequent to the collection of fish community data; therefore to show subsequent improvement, this will be the only community assessed. Four sites (17W012-17W015) will be sampled for both nutrient and *E. coli* impairments. To ensure data minimum is met for 17W011, it is recommended to sample for dissolved oxygen during each round of water chemistry for sites 17W012-17W015 (see Figure 5, Table 2).

Figure 2. Performance monitoring sampling area, AUID stream segments, and site sampling parameters for Headwaters Curtis Creek (071200020401) sub-watershed

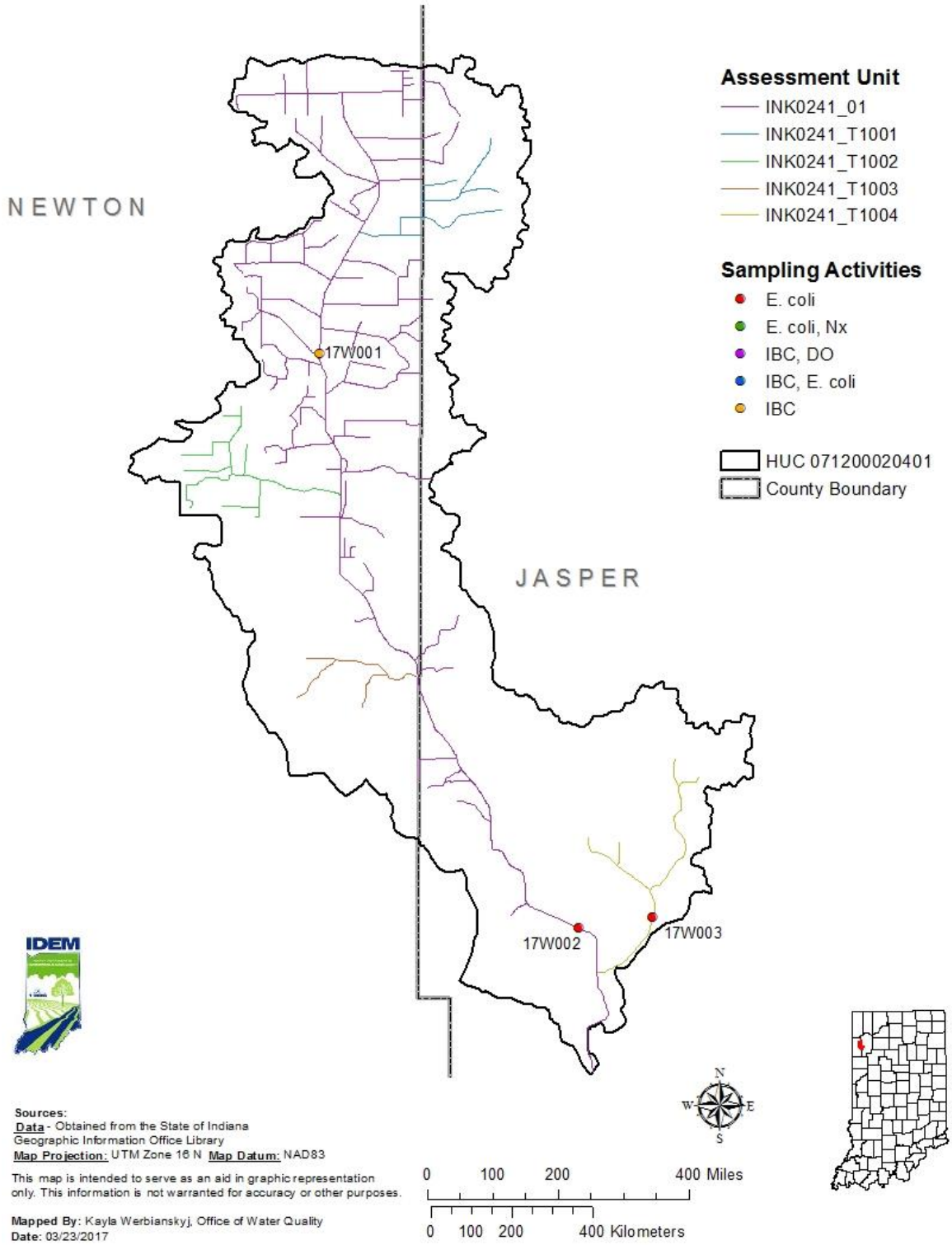


Figure 3. Performance monitoring sampling area, AUID stream segments, and site sampling parameters for sub-watersheds Elliot Ditch (051201080104) and Kenny Ditch-Wea Creek (051201080106)

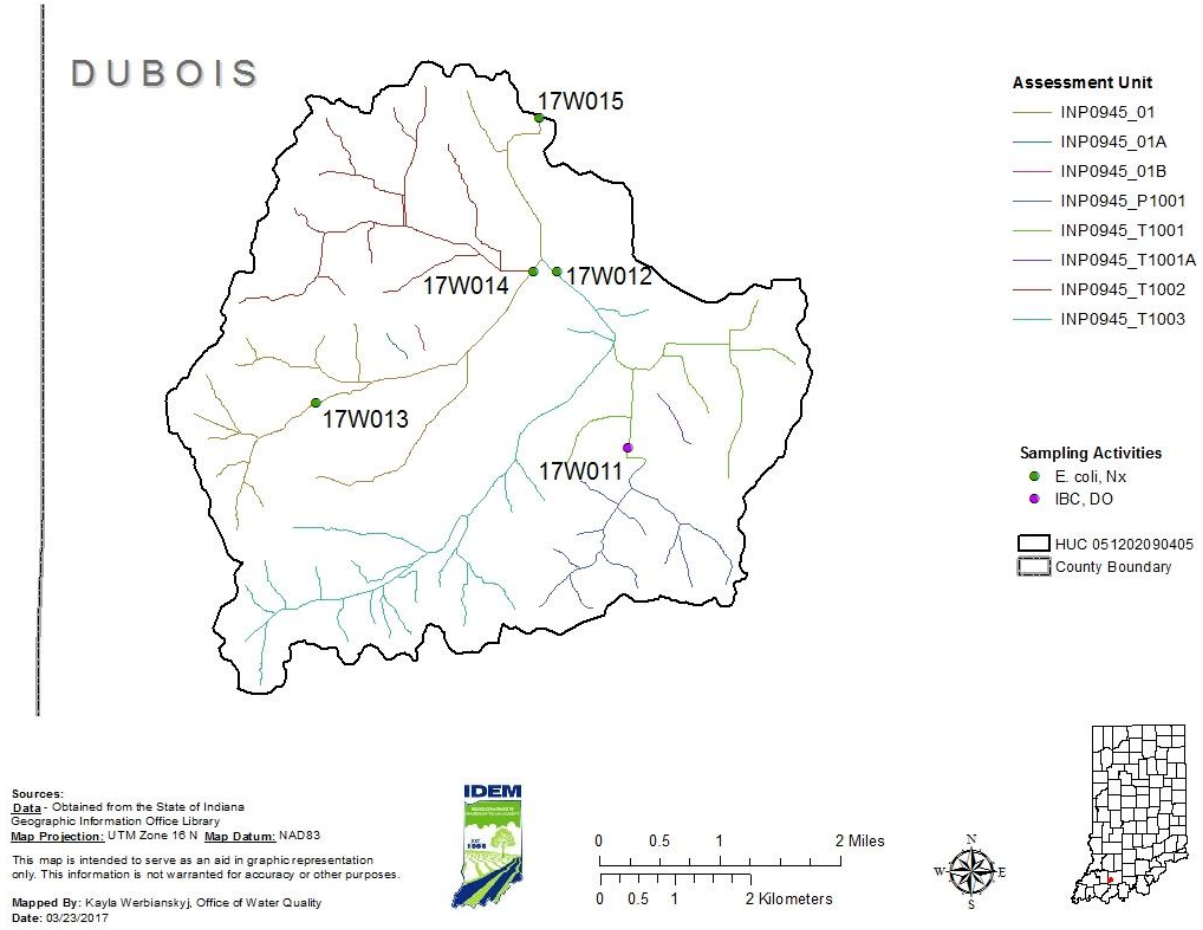


Figure 4. Performance monitoring sampling area, AUID stream segments, and site sampling parameters for Kilmore Creek (051201070306) and Jenkins Ditch-South Fork Wildcat Creek (051201070308)

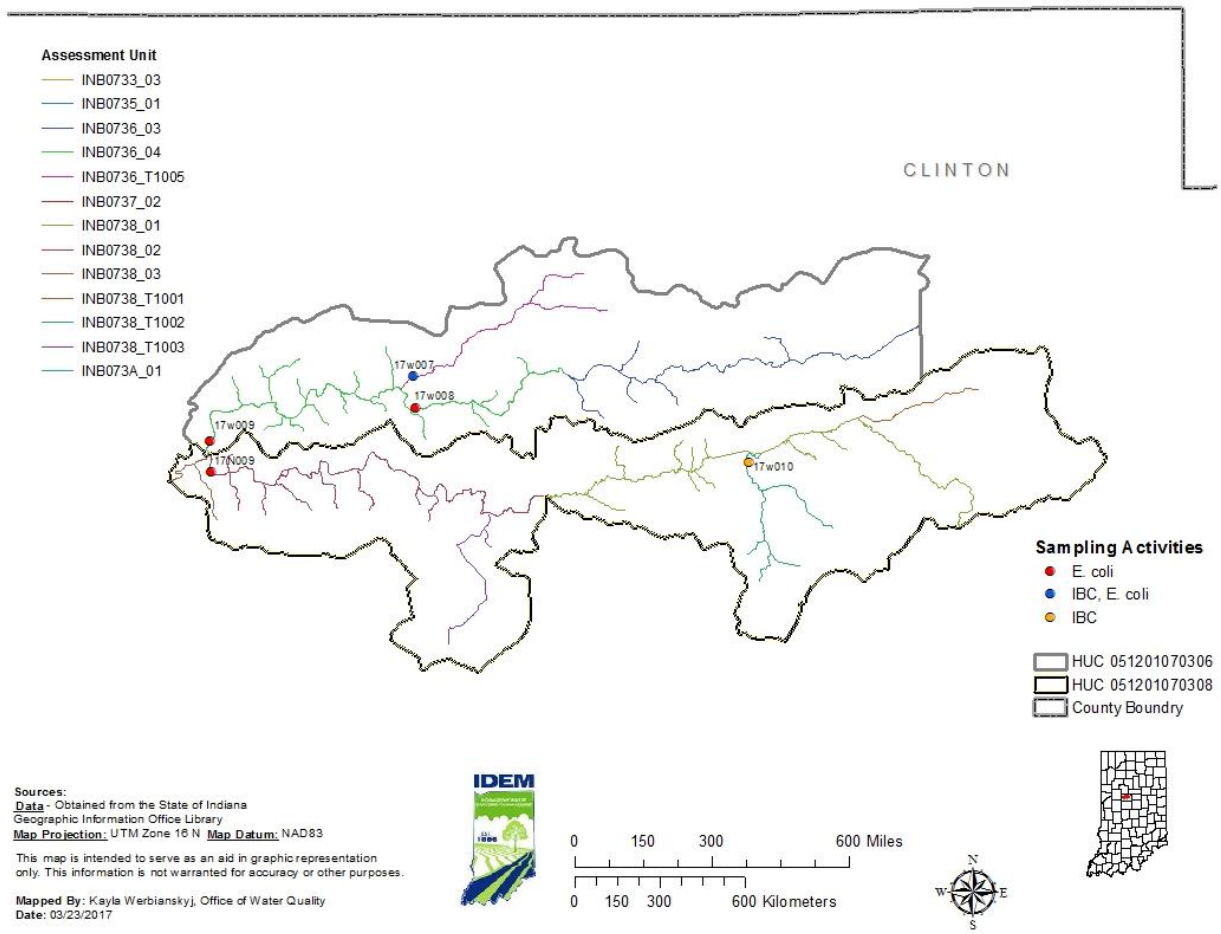


Figure 5. Performance monitoring sampling area, AUID stream segments, and site sampling parameters for Ell Creek (051202090405) sub-watershed

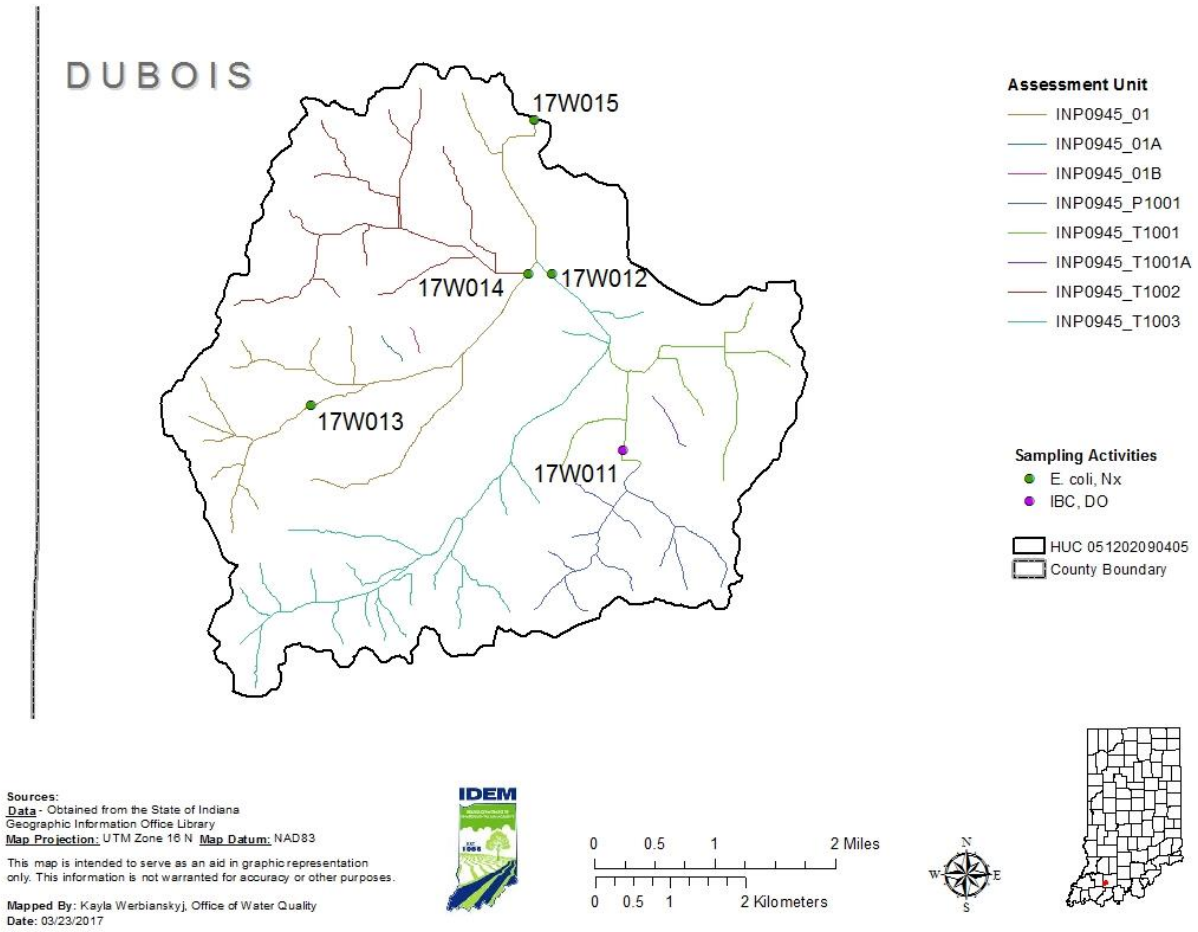


Table 2. Site information for 2017 Performance Monitoring sites in selected Indiana sub-watersheds

HUC 12	HUC 12 Name	Latitude	Longitude	Site	Event	Stream	Location	County
071200020401	Headwaters Curtis Creek	41 01 41.184266	-87 18 01.698706	[1]UMI040-0042	17W001	Curtis Creek	N 400 E	Newton
		40 55 27.414715	-87 14 17.171467	[4]UMI040-0048	17W002	Curtis Creek	CR 1000 W bridge	Jasper
		40 55 34.366712	-87 13 13.457320	[4]UMI040-0017	17W003	Yeoman Ditch	CR 600 S bridge	Jasper
051201080104	Elliot Ditch	40 22 15.694990	-86 54 15.208869	[1]WLV020-0005	17W004	Elliot Ditch	SR 231 bridge	Tippecanoe
051201080106	Kenny Ditch-Wea Creek	40 21 39.437377	-86 54 35.944138	[4]WLV020-0004	17W005	Wea Creek	Old Romney Rd	Tippecanoe
		40 23 05.722871	-86 57 01.444775	[4]WLV020-0003	17W006	Wea Creek	Lilly Rd bridge	Tippecanoe
051201070306	Kilmore Creek	40 20 38.167460	-86 33 14.179117	[3]WAW040-0123	17W007	Boyles Ditch	CR 400 N bridge	Clinton
		40 20 10.164243	-86 33 11.051518	[4]WAW-03-0001	17W008	Kilmore Creek	N CR 250 W bridge	Clinton
		40 19 41.838964	-86 37 05.823429	[4]WAW040-0066	17W009	Kilmore Creek	Gasoline Rd bridge	Clinton
051201070308	Jenkins Ditch-South Fork Wildcat Creek	40 19 21.123052	-86 26 51.957798	[1]WAW-03-0004	17W010	Tributary of South Fork Wildcat Creek	CR 250 N bridge	Clinton
		40 19 15.347474	-86 37 5.8299220	[4]WAW040-0065	17N009	South Fork Wildcat Creek		Clinton
051202090405	Ell Creek	38 17 57.506850	-86 58 58.202936	[2]WPA040-0090	17W011	Tributary of Ell Creek	SR 64	Dubois
		38 19 14.092324	-86 59 37.396623	[5]WPA040-0095	17W012	Tributary of Ell Creek	W 400 S bridge	Dubois
		38 18 16.993233	-87 01 49.962300	[5]WPA-04-0027	17W013	Ell Creek	CR 650 W bridge	Dubois
		38 19 13.716611	-86 59 49.994557	[5]WPA040-0096	17W014	Ell Creek	W 400 S bridge	Dubois
		38 20 20.551708	-86 59 46.844817	[5]WPA040-0098	17W015	Ell Creek	Ell Creek Rd bridge	Dubois

[1]IBC impairment only
[2]IBC and DO impairments
[3]IBC and *E.coli* impairments
[4]*E. coli* impairment only
[5]*E. coli* and nutrient impairments

Project/Task Organization

Sampling of waterbodies in the sub-watersheds of *071200020401*, *051201080104, 051201080106, 051201070306, 051201070308,* and *051202090405* will occur between May and October during the 2017 sampling season (Table 3).

Deadlines and Time Frames for Sampling Activities

a. Site reconnaissance activities for all watersheds will be completed in March 2017. All sites are accessed at bridge crossings if possible. Staff will seek land owner approval (if necessary) for biological sampling to access the stream safely with the appropriate equipment. Landowners unable to be contacted will be sent a letter of intention with the project manager's contact information. Reconnaissance activities will be conducted in the office and through physical site visits if needed.

b. Biological sampling (IBC) for sites will begin in June 2017 and end no later than October 17, 2017 (see Table 3). Three sites (17W007, 17W010, and 17W011) will each be sampled once for fish community and habitat quality. Site 17W004 will be sampled once for macroinvertebrate community and habitat quality. *In-situ* water chemistry parameters (see Table 4) will be collected with biology. One site (17W001) in Headwaters Curtis Creek will be sampled for both biological parameters (fish community and macroinvertebrate community), (Table 1). The biological community used to reassess impairments will be concurrent with historical data available. All data and results will be reported to EPA for a potential Success Story or Measure W approval.

c. Bacteriological sampling (*E. coli*) for sub-watersheds *071200020401, 051201080106, 051201070306, 051201070308,* and *051202090405* will be conducted during the recreational season of April to October 2017. Each site will be sampled five times at equally spaced intervals over a 30-day period to determine a geometric mean.

d. General Water Chemistry and Nutrients (Nx)--Ammonia, Phosphorus, and Nitrogen will be sampled on three discrete occasions between May and October at four targeted sites in the Ell Creek sub-watershed, (see Table 1 for these sites). See Table 7 for a list of these parameters.

e. In situ Water Chemistry—Dissolved Oxygen (DO), Dissolved Oxygen Percent Saturation, pH, Temperature, Specific Conductance and Turbidity readings will be collected with all sampling events in all sub-watersheds. In order to reassess a prior impairment for DO, a site will need to be sampled three times for that parameter (IDEM, 2016a). Since site 17W011 will be sampled once for DO during the biological visit, two additional samples will need to be taken to meet the data minimum for assessments. See Table 8 for a list of parameters and corresponding methods.

Table 3. Performance monitoring time frames for sampling activities relative to the cause of impairment per stream in selected sub-watersheds in 2017

2017	Reconnaissance	*E.coli*	Nutrients	IBC	In situ Water Chemistry
Headwaters Curtis Creek	March	April-October	X	June-Oct 17	Every Sampling Event
Elliot Ditch	March	X	X	*July 11-Oct 17	Every Sampling Event
Kenny Ditch-Wea Creek	March	April-October	X	X	Every Sampling Event
Kilmore Creek	March	April-October	X	June-Oct 17	Every Sampling Event
Jenkins Ditch-South Fork Wildcat Creek	March	April-October	X	June-Oct 17	Every Sampling Event
Ell Creek	March	April-October	May-July	June-Oct 17	[t]Every Sampling Event

- "X" denotes that the watershed will not be sampled for the corresponding parameter

- [t]Dissolved oxygen sampled minimum of two additional times at site 17W011
- *Macroinvertebrates only, sampling index begins July 11

Samples will be collected for physical, chemical, and biological communities if the flow is not dangerous for staff to enter the stream and barring any hazardous weather conditions or unexpected physical barriers to site access. Unexpected physical barriers could include an impassable log jam, fence or physical installations, and domestic and wildlife dangers. Flow is considered dangerous at flood stages, so staff will use best professional judgement following or during a high water event. Staff will use USGS current water data, daily streamflow condition readings on the USGS website to determine if discharge is elevated too far from median flow to sample. Typically, streamflow discharge in the 75th percentile or greater would be considered too high to sample. Since there are not stream gaging stations on all streams and rivers, especially headwater streams, staff may travel to sites and use best professional judgement at the site when determining to collect a sample. Even if the weather conditions and stream flows are safe, sample collections for biological communities may also be postponed at least one week due to scouring of the stream substrate or instream cover following a high water event resulting in non-representative samples.

Data Quality Objectives (DQOs)

The DQO process (U.S. EPA 2006) is a planning tool for data collection activities. It provides a basis for balancing decision uncertainty with available resources. The DQO is required for all significant data collection efforts for a project. It is a seven step systematic planning process used to clarify study objectives, define the appropriate types of data, and establish decision criteria on which to base the final use of the data. The DQO for Performance Monitoring in Selected Indiana Sub-watersheds is identified in the following seven steps:

1. Description of 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” and “will be capable of supporting” a “well-balanced, warm water aquatic community” [327 IAC 2-1-3]. This project will gather bacteriological, biological (fish and macroinvertebrate) and habitat, and/or chemical data for the purpose of reassessing the designated use attainment status of the impaired assessment unit identification (AUID) segments on waterbodies in the sub-watersheds of 071200020401, 051201080104, 051201080106, 051201070306, 051201070308, and 051202090405. Table 1 lists the impaired AUID segments to be reassessed in 2017.

2. Identify the Decision for the Data Collection

The goal of this study is to reassess whether the targeted stream segments on waterbodies in the sub-watersheds of 071200020401, 051201080104, 051201080106, 051201070306, 051201070308, and 051202090405 are “supporting” or “non-supporting” for the designated use attainment related to each previously identified impairment (see Table 1). This comparison will be in correlation with water quality criteria included in Table 4 [327 IAC 2-1-6], nutrient criteria, and/or biological criteria following Indiana’s 2016 Consolidated Assessment Listing Methodology (CALM, IDEM 2016a).

For a description of all sites, including AUID stream segments; location; waterbodies; 12-digit hydrologic unit code identification; and Impairments, see Table 1. A total of 16 sites will be assessed for improvement across 071200020401, 051201080104, 051201080106, 051201070306, 051201070308, and 051202090405 sub-watersheds. Sites will be assessed for one or more of the following parameters: biology, *E. coli*, nutrients, and dissolved oxygen for improvement based on the Indiana narrative biological criteria [327 IAC 2-1-3]. There will be one site assessed for dissolved oxygen improvement and four sites assessed for nutrient improvement following the benchmarks listed in the nutrient benchmarks section below (IDEM 2016a). Twelve sites across five sub-watersheds will be evaluated for bacteriological improvement. All water quality criterions can be viewed in Table 4.

Nutrient Benchmarks

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 non-supporting due to nutrients.

- Total Phosphorus: one or more measurements >0.3 mg/L
- Nitrogen (measured as NO_3+NO_2): one or more measurements >10.0 mg/L
- Dissolved Oxygen: any measurement <4.0 mg/L or >12.0 mg/L; or measurements consistently at or close to the standard (e.g., readings of 4.0-5.0 mg/L)
- pH: >9.0 Standard Units (S.U.) or measurements consistently at or close to the standard (e.g., readings of 8.7-9.0 S.U.)
- Algal conditions-- Algae are described as "excessive" based on field observations and best professional judgement by IDEM scientists.

Biological Criteria:

Indiana narrative biological criteria [327 IAC 2-1-3] states that "all waters, except as described in subdivision (5)," (i.e., limited use waters) "will be capable of supporting" a "well-balanced, warm water aquatic community." The water quality standard definition of a "well-balanced aquatic community" is "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" [327 IAC 2-1-9]. An interpretation or translation of narrative biological criteria into numeric criteria would be as follows: A stream segment is non-supporting 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 2016a). There are no sites in this project with known distributions of salmonids.

Table 4. Water Quality Criteria [327 IAC 2-1-6]

Parameter	Level	Criterion
Dissolved Oxygen	At least 5.0 mg/L (warm water aquatic life)	Not less than 4.0 mg/L.
pH	6.0 - 9.0 S.U.	Must remain between 6.0 and 9.0 S.U. except for daily fluctuations that exceed 9.0 due to photosynthetic activity
Total Ammonia (NH3-N)	Calculated based on pH and Temperature	Calculated CAC
Nitrate- N+Nitrite-N	10 mg/L	Human Health point of drinking water intake
Chloride	Calculated based on hardness and sulfate	CAC
Sulfate	Calculated based on hardness and chloride	In all waters outside the mixing zone
E. coli (April-October Recreational season)	125 CFU/100mL or 125 MPN/100 mL 235 CFU/100 mL or 235 MPN/100 mL	5 sample geometric mean based on at least 5 samples equally spaced over a 30 day period Not to exceed in any one sample in a 30 day period except in cases where there are at least 10 samples, 10% of the samples may exceed the criterion
Dissolved Solids	750 mg/L	Public water supply

CAC = Chronic Aquatic Criterion, S.U. = Standard Units, MPN = Most Probable Number, CFU = Colony Forming Unit

3. Inputs to the Decision

Field monitoring activities are required to collect physical, chemical, biological and habitat data. These data are required to address the necessary decisions previously described. Monitoring activities will take place at previously sampled sites for which permission to access has been granted by the necessary landowners or property managers. Collection procedures for in situ water chemistry measurements, chemical, biological and habitat data will be described in detail under Section II MEASUREMENT/DATA ACQUISITION.

4. Define the Boundaries of the Study

There are 16 sites across six Indiana sub-watersheds. The 12 digit sub-watersheds include: Headwaters Curtis Creek (*071200020401*), Elliot Ditch (*051201080104*), Kenny Ditch-Wea Creek (*051201080106*), Kilmore Creek (*051201070306*), Jenkins Ditch-South Fork Wildcat Creek (*051201070308*), and Ell Creek (*051202090405*). Sampling for *07120002040; 051201080104 and 051201080106; 051201070306 and 051201070308; 051202090405* will occur in the following counties: Newton and Jasper; Tippecanoe; Clinton; and Dubois, respectively. HUC *07120002040* drains 121.09 sq. miles of land; predominantly used for Cultivated Crops (78.67%). HUC *051201080104* drains 55.13 sq. miles; predominant use of land is Cultivated Crops, covering 33.72%, followed by Developed land (low, medium intensity and open space combined) at 43.21%. HUC *051201080106* drains 98.46 sq miles; land is predominantly used for Cultivated Crops (57.95 % cover). HUC *051201070306* drains 61.49 sq. miles of land; predominantly used for Cultivated Crops (83.01 %). HUC *051201070308* drains 110.78 sq. miles; land use is predominantly Cultivated Crops (78.57%). HUC *051202090405* drains 33.72 sq. miles of land, with the predominant use described as Cultivated Crops (44.46%) and Deciduous Forest (22.71%).

5. Develop a Decision Rule

Assessment decisions (305(b)/303(d)) will be reported in the 2018 Indiana Integrated Report. 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 as outlined in Indiana's 2016 Consolidated Assessment and Listing Methodology (CALM, IDEM 2016a) and based on water quality criteria expressed in Indiana's Water Quality Standards (327 IAC 2-1).

The fish and/or macroinvertebrate assemblage will be evaluated at selected sites using the appropriate IBI (Simon 1990, 1991, DRAFT; Simon and Dufour 1998) (see Appendix 1 for more details). Macroinvertebrate multi-habitat samples will also be evaluated using the Macroinvertebrate IBI developed for lowest practical taxonomic level identifications (see Appendix 2 for more details). For fish, IBI scores range from 0 (minimum) to 60 (maximum). For macroinvertebrates, the mIBI scores range from 0 (minimum) to 60 (maximum). A site will be determined non-supporting for aquatic life use when one or both biological communities score less than or equal to 35.

6. Specify Tolerable Limits on Decision Errors

Site specific aquatic life use assessments include program specific controls to minimize the introduction of errors. These controls include water chemistry equipment checks, duplicates, and laboratory controls through verification of species identifications. Field Procedure Manuals (IDEM 2002;) and standard operating procedures (IDEM 1992a, IDEM 1992b, 1992c, 1992d, 1992e, 2010a, 2016) dictate consistent and proven techniques for sample collection to assure representative samples and minimize measurement error. The QA/QC process detects deficiencies in the data collection as set forth in the IDEM QAPP for the Indiana Surface Water Quality Monitoring Program (IDEM 2017). The field and laboratory performance includes precision measurements by relative percent difference of field and laboratory duplicates; accuracy measurements by percent recovery of MS/MSD samples analyzed in the laboratory; and completeness measurements by the percent of planned samples that are actually collected, analyzed, reported, and usable for the project.

7. Optimize the Design for Obtaining Data

Six Indiana sub-watersheds previously cited on the 303(d) list for impairment(s) or in an approved TMDL that have undergone restoration activities are targeted in this study. These activities will be discussed in a write-up to U.S. EPA for reporting watershed improvement, or outlined in a Success Story Document. Sites in the watershed that historically documented the impairment(s) were chosen as sampling sites.

Table 5. Training and Staffing Requirements

Role	Required Training/Experience	Responsibilities	Training References
Project MTanager	-Bachelor of Science Degree in biology, toxicology, or other closely related field plus four years of experience in aquatic ecosystems (Masters Degree with two years aquatic ecosystems experience may substitute) -Database experience -Annually review the Principles and Techniques of Electrofishing -Annually review relevant safety procedures -Annually review relevant SOP documents for field operations	-Establish Project in the AIMS II database -Oversee development of Project Work Plan -Oversee entry and QC of field data -Oversee querying of data from AIMS II database to determine results not meeting aquatic life use Water Quality Criteria -Sample shipments to contract laboratory -Assign analysis tasks to the samples -Track contract laboratory expenditures	-AIMS II Database User Guide -U.S. EPA 2006 QA Documents on developing Work Plans (QAPPs)
Field Crew Chief	-Bachelor of Science Degree in biology or other closely related field -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 SOP documents for field operations	-Completion of field data sheets -Taxonomic accuracy -Overall operation of field crew when remote from central office -Adherence to safety and field SOP by crew members -Ensure field sampling equipment is functioning properly and all equipment loaded into vehicles prior to field sampling activities -Maintaining proper preservation of samples -Hold an active First Aid and CPR certification	-IDEM 1992a, 1992b, 1992c, 1992d, 2002, 2008, 2010b, 2010c, 2016 -U.S. EPA, 1994a -Novotny, 1974 -Cowx, 1990 Cowx and Lamarque, 1990 -Appendix 1 and 2 -See attachments 1-5 for field data sheets
Field Crew	-Complete hands-on	-Follow all safety and	-IDEM 1992a, 1992b,

Members	training for sampling methodology prior to field sampling activities -Review the Principles and Techniques of Electrofishing -Review relevant safety procedures -Review relevant SOP documents for field and sample processing operations	SOP procedures while engaged in field sampling activities -Follow direction of Field Crew Chief while conducting field sampling activities -Hold an active First Aid and CPR certification	1992c, 1992d, 2002, 2008, 2010b, 2010c, 2016 -U.S. EPA, 1994a -Novotny, 1974 -Cowx, 1990 -Cowx and Lamarque, 1990
Quality Assurance Officer	-Bachelor of Science in chemistry or a related field of study -Familiarity with QA/QC practices and methodologies -Familiarity with the WAPB QAPP and data qualification methodologies	-Ensure adherence to QA/QC requirements of WAPB 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 database -Ensure that field sampling methodology audits are completed according to WAPB procedures	-IDEM 2004, 2012b -U.S. EPA 2006 documentation on QAPP Development and data qualification -AIMS II Database User Guide

II. Measurement/Data Acquisition

Sampling Sites/Sampling Design

As is described in the “Performance Monitoring in Targeted Watersheds Objective” section of this work plan, the six target sites were sampled previously and cited on the 303(d) List of Impaired Waters or an approved TMDL.

Site reconnaissance activities are 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. Final coordinates for each site will be confirmed during the reconnaissance activities for assessing that current conditions have not significantly changed using a Trimble Juno TM SB Global Positioning System (GPS) with an accuracy of one to three meters (IDEM 2015c). These coordinates will also be confirmed in the AIMS II database.

Table 2 provides a list of the selected sampling sites with the Site Number, AIMS Site Number, 12-Digit Hydrologic Unit Code (HUC) name and code, Stream Name, Location, County, and the Latitude and Longitude of each site. Figures 1 through 6 depict the various sampling site locations for this project.

Sampling Methods and Sample Handling

Bacteriological Sampling

The bacteriological sampling will be conducted by one team consisting of one or two staff. The work effort will require an average of one hour per site per week. Samples will be collected in an IDEM E. coli Mobile Laboratory equipped with all materials and equipment necessary for the Colilert® E. coli Test Method. Five samples from each site (12 sites total) will be collected at equally spaced intervals over a thirty day period. Staff will collect the samples in a 120 mL pre-sterilized wide mouth container from the center of flow (if stream is wadeable) or from the shoreline using a pole sampler (if not). All samples will be consistently labeled, cooled, and held at a temperature less than 10ºC during transport. All E. coli samples will be collected on a schedule such that any sampling crew can deliver them to the IDEM E. coli Laboratory for analyses within the bacteriological holding time of six hours (Table 6). All supplies will be obtained from IDEXX Laboratories, Inc., Westbrook, Maine.

Table 6. Bacteriological and Water Chemistry sample container, preservative, and holding time requirements

Container	Preservative[4]	Parameter[1]	Holding Time
1 L, HDPE plastic, narrow mouth	$H2SO_4$ < pH 2	Chemical Oxygen Demand*	28 days
		Ammonia-N*	
		Nitrate + Nitrite-N*	
		Total Kjeldahl Nitrogen*	
		Total Phosphorus*	
		Total Organic Carbon*	
	None	Sulfate**	
		Chloride**	
		Alkalinity as $CaCO_3$**	14 days
		Solids (All Forms)**	7 days
	HNO_3 < pH 2	Hardness (as $CaCO_3$)**- Calculated	6 months
120 mL, pre-sterilized, wide mouth	$Na_2S_2O_3$	*E.coli****	6 hours

[1] All samples iced to 4 degrees Celsius
[2] Sulfuric Acid shall be ACS Reagent Grade. Nitric Acid is ACS Trace Metal Grade. $Na_2S_2O_3$ (ACS Reagent Grade) sufficient for a concentration of 100mg/L in the sample.
*Nutrient parameters
**General Chemistry parameters
***Bacteriological parameter

Water Chemistry Sampling – All samples

During three discrete sampling events, one team of two staff will collect water chemistry grab samples record in situ water chemistry measurements as described below in the section for In situ Water Chemistry Measurements. Staff will also note physical site descriptions on the IDEM Stream Sampling Field Data Sheet (Attachment 1). All water chemistry sampling will adhere to the Water Quality Surveys Section Field Procedure Manual (IDEM 2002). Water chemistry sampling is typically completed within 30 minutes per site, depending on accessibility. Table 6 lists preservatives and holding times for chemistry and nutrient sampling. General Chemistry and Nutrient test methods and reporting limits can be viewed in Table 7.

In situ Water Chemistry 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 media type being collected (Table 8). Measurement procedures and operation of the Datasonde shall be performed according to the manufacturers' manuals (Hydrolab Corporation 2002; YSI 2002) 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 will be written in the comments under the in situ parameter measurements. If a Hach™ turbidity kit is not available, the Datasonde measurement for turbidity will be recorded. All in situ measurements taken from the Datasonde, Hach™ and weather codes at each site will be recorded on the IDEM "Stream Sampling Field Data Sheet" (Attachment 1). The same protocol will be used with all calibration equipment (Temperature/pH probe, Winkler DO, Hach™ pre-calibrated gels) at one site, once per week. A photo will also be taken upstream and downstream of the site during each sampling event.

Table 7. Water chemistry and Nutrient Test Methods and Reporting Limits

Parameter	Test Method	IDEM Reporting Limit (mg/L)	ISDH Lab Reporting Limit (mg/L)
Chemical Oxygen Demand (Low level)*	SM5220D	10.0	10.000
Ammonia-N*	EPA 350.1	0.10	0.100
Nitrate + Nitrite-N*	EPA 353.1	0.1	0.100
Total Kjeldahl Nitrogen*	EPA 351.2	0.30	0.300
Total Phosphorus*	EPA 365.1	0.3	0.030
Total Organic Carbon*	SM5310B	1.0	1.000
Sulfate**	EPA 375.2	0.5	5.000
Alkalinity as $CaCO_3$**	EPA 310.2	10.0	10.000
Solids, Suspended Total, (TSS) **	SM2540D	4.0	6.000
Solids, Total (TS) **	SM2540B	1.0	10.000
Solids, Total Dissolved (TDS) **	SM2540C	10.0	10.000
Calcium	200.7	(used to calculate hardness as $CaCO_3$)	0.200
Magnesium	200.7	(used to calculate hardness as $CaCO_3$)	0.200
Hardness (as $CaCO_3$) ** - Calculated	SM2340B	0.4	2.0
Hardness (as $CaCO_3$) ** - Colorimetric	EPA 130.1	1.0	30.000

*Nutrient parameters
**General chemistry parameters

Table 8. In situ Water Chemistry and Bacteriological parameters showing method and IDEM quantification limit

Parameters	Method[1]	IDEM Quantification Limit
E. coli (Enzyme Substrate Coliform Test)***	SM 9223B	[2]1 MPN / 100 mL
Dissolved Oxygen (data sonde optical)	ASTM D888-09	0.05 mg/L
Dissolved Oxygen (data sonde)	SM 4500-OG	0.03 mg/L
Dissolved Oxygen (Winkler Titration)	SM 4500-OC[3]	0.20 mg/L
Dissolved Oxygen % Saturation (data sonde optical)	ASTM D888-09	0.05 %
Dissolved Oxygen % Saturation (data sonde)	SM 4500-OG	0.01 %
pH (data sonde)	EPA 150.2	0.10 S.U.

pH (field pH meter)	SM 4500H-B[3]	0.10 S.U.
Specific Conductance (data sonde)	SM 2510B	1.00 µmhos/cm
Temperature (data sonde)	SM 2550B(2)	0.1 Degrees Celsius (°C)
Temperature (field meter)	SM 2550B(2)[3]	0.1 Degrees Celsius (°C)
Turbidity (Hach™ turbidity kit)	EPA 180.1	0.05 NTU[4]

[1] SM = Standard Method
[2] MPN (Most Probable Number) = 1 CFU (Colony Forming Unit)
[3] Method used for Field Calibration Check
[4] NTU = Nephelometric Turbidity Unit(s)
***Bacteriological parameter

Fish Community Sampling

The fish community sampling will be completed by teams of three to five staff. Sampling will be performed using various standardized electrofishing methodologies, depending on 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 (Simon 1990, 1991, DRAFT; Simon and Dufour 1998; U.S. EPA 1995). 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. If depth and velocity of the stream has not drastically changed, the list of electrofishers to be utilized should nearly match the type of equipment used during the original sampling event which include: the Smith-Root LR-24 or LR-20B Series backpack electrofishers, the Smith-Root model 2.5 Generator Powered Pulsator electrofisher with RCB-6B junction box and a dropper boom array outfitted in a canoe or possibly a 12 foot Loweline™ boat, or for non-wadeable sites the Smith-Root Type VI-A electrofisher assembled in a 16 foot Loweline™ boat (IDEM 1992a, 1992b, 1992c, 1992d).

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 collections during late autumn and seasonal cold temperatures will be avoided due to the lack of responsiveness to the electrical field by some species that can also result in samples that are not representative of the streams fish assemblage (Simon 1990; U.S. EPA 1995).

Fish will be collected using dip nets with fiberglass handles and netting of 1/8-inch bag mesh. Fish collected in the sampling reach will be sorted by species into baskets and buckets. Young-of-the year fish less than 20 millimeters (mm), total length, will not be retained in the community sample (Simon 1990; U.S. EPA 1995).

For each field taxonomist (generally the crew leader), a complete set of fish vouchers are retained for any 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 fish collection datasheet (Attachment 2), 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 2016d, p. 8). 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 they cannot be positively identified in the field (i.e., those that co-occur like the Striped and Common Shiner or are difficult to identify when immature), individuals that appear to be hybrids or have anomalies, as well as dead specimens that are taxonomically valuable for un-described taxa (e.g., Red Shiner or Jade Darter), life history studies, or research projects.

Data will be recorded for non-preserved fish on the IDEM Fish Collection Data Sheet (Attachment 2) consisting of the following: number of individuals, minimum and maximum total length (mm), mass weight in grams (g), and number of individuals with deformities, eroded fins, lesions, tumors, and other anomalies (DELTs). Once the data have been recorded, specimens will be released within the sampling reach from

which they were collected. Data will be recorded for preserved fish specimens following taxonomic identification in the laboratory.

Macroinvertebrate Sampling

Macroinvertebrate sampling will not be conducted on sites impaired for IBC in sub-watersheds of 051201070306, 051201070308, and 051202090405; historically, fish community sampling was the only biological parameter collected. It was determined that for the scope of this project, improvement or success can only be confirmed by the re-analysis of parameters previously sampled which initially impaired the site. Macroinvertebrate collection will occur on one site (17W004) in the Elliot Ditch sub-watershed (051201080104). This site is currently impaired for IBC (resulting from macroinvertebrate studies in 1991 and 1999). Prior to 2004, the sampling method for macroinvertebrates was restricted to a riffle kick. The MHAB method provides the ability to sample a wider range of encountered in-stream habitat types as opposed to the Kick method which focused exclusively on riffle and run habitats (and was often not collected when these habitat types were not available). Therefore, MHAB sampling methodology will be used to collect all macroinvertebrate samples. Macroinvertebrates will also be collected for one site (17W001) in the Headwaters Curtis Creek sub-watershed (071200020401). A 2009 probabilistic monitoring study which collected both communities indicated impairment on Curtis Creek.

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 are collected using a modification of the U.S. EPA Rapid Bioassessment Protocol multi-habitat (MHAB) approach using a D-frame dipnet (Barbour et al. 1999; IDEM 2010a; Klemm et al. 1990; Plafkin et al. 1989). The IDEM MHAB approach (IDEM 2010a) 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 dipnet) and a 50-meter “sweep” sample of shoreline habitats (collected by disturbing habitats such as emergent vegetation, root wads, coarse particulate organic matter, depositional zones, logs and sticks and collecting the dislodged macroinvertebrates within the dipnet). 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 that has the best available habitat. The 1-minute “kick” and 50-meter “sweep” samples are combined in a bucket of water which 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 where the collector (while still on-site) will conduct a 15-minute pick of macroinvertebrates at a single organism rate with an effort to pick for maximum organism diversity and relative abundance through turning and examination of the entire sample in the tray. The resulting picked sample will be preserved in 70% isopropyl alcohol and 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 (Attachment 3) will be completed for the sample.

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) Qualitative Habitat Evaluation Index (QHEI), 2006 edition (OHEPA 2006; Rankin 1995). The modifications include additional fields for substrate and instream cover; however these modifications do not alter the calculations. A separate QHEI (Attachment 4) must be completed for these two media types since the sampling reach length may differ (i.e. 50 meters for macroinvertebrates and between 50 and 500 meters for fish, depending on the stream width). See IDEM 2016c For a description of the method used in completing the QHEI.

Analytical Methods

Bacteriological Sampling

Bacteriological samples will be analyzed using the Standard Method (SM) 9223B Enzyme Substrate Coliform Test Method (see Table 8 for quantification limits). Samples will be collected using 120 mL pre-sterilized wide mouth containers and adhere to the six hour holding time (Table 6). Analytical results from the IDEM E. coli Laboratory include quality control (QC) check sample results from which precision, accuracy, and completeness can be determined for each batch of samples. Raw data are archived by analytical batch for easy retrieval and review. Chain of custody physical procedures must be followed by the crew chief including: recording time of collection, time of setup, time of reading the results, and time and method of disposal. All transfers to another party or repository should be noted with the date, time, and relinquishing/receiving individuals. Any method deviations will be thoroughly documented in the comments section of the raw data sheet.

All QA/QC samples will be tested according to the following guidelines:

Field Duplicate:	Field Duplicates will be collected at a frequency of 1 per batch or at least 1 for every 20 samples collected (≥ 5%).
Field Blank:	Field Blanks will be collected at a frequency of 1 per batch or at least 1 for every 20 samples collected (≥ 5%).
Laboratory Blank:	Laboratory Blanks (sterile laboratory water blanks) will be tested at a frequency of 1 per day.
Positive Control:	Each lot of media will be tested for performance using bacterial cultures for positive *E. coli*.
Negative Controls:	Each lot of media will be tested for performance using bacterial cultures for total coliform other than *E. coli* and a noncoliform.

Quality assurance documentation for each batch of samples consists of a chain of custody form, a QA/QC summary sheet, and spreadsheets of results. This documentation is submitted to the Technical and Logistical Services Section for QA review and the assignment of an appropriate Data Quality Assessment (DQA) Level.

Water Chemistry Data—Nutrients and Hardness

Sample bottles and preservatives certified for purity will be used. See SDS forms to be aware of the health and safety hazards associated with all chemicals and preservatives. Sample collection container for each parameter/preservative and holding times will adhere to U.S. EPA requirements (see Table 6). Field duplicates and matrix spike/matrix spike duplicates (MS/MSD) 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 using ASTM D1193-06(2011) Type I water will be taken at a rate of one set per sampling crew for each week of sampling activity. Nutrient test methods and reporting limits can be viewed in Table 7. The samples should be kept in coolers on ice at 4, +/- 2 degrees C during transport. All samples will be dropped off within 3 days of collection to be analyzed by the Indiana State Health Department; lab is located in Indianapolis, Indiana.

In situ Water Chemistry Measurements:

Table 8 lists the in situ water chemistry field parameters with their respective test method and IDEM quantification limit. During each sampling event, field observations from each site and ambient weather conditions at the time of sampling are noted and documented on the IDEM Stream Sampling Field Data Sheet (Attachment 1). A photo will also be taken upstream and downstream of the site during each sampling event.

Laboratory Competency and Certifications

The ISDH Laboratory offers organic and inorganic analysis. The laboratory participates annually in multiple proficiency test studies. In addition, ISDH certifies Indiana laboratories for drinking water methods. ISDH itself is certified for drinking water methods for the analysis of nitrate, nitrite, fluoride, arsenic, lead, and copper.

Quality Control and Custody Requirements

Quality assurance protocols will follow part B5 of the "Quality Assurance Project Plan (QAPP) for the Indiana Surface Water Quality Monitoring and Total Maximum Daily Load (TMDL) Program," Revision 3, by Timothy Bowren and Dr. Syed Ghiasuddin (IDEM 2004).

The IDEM OWQ Chain-of-Custody Form is used to track samples from the field to the laboratory (Attachment 5). Fish taxonomic identifications made in the laboratory may be verified by regionally recognized non-IDEM freshwater fish taxonomists (e.g., Brant Fisher, Nongame Aquatic Biologist, Indiana DNR).. Records of laboratory identifications and QA/QC of taxonomic work is maintained by the laboratory supervisor of the Probabilistic Monitoring Section of IDEM. All data: 1) are checked for completeness; 2) have calculations performed; 3) are entered into the database; and 4) are checked again for data entry errors.

Field Instrument Testing and Calibrations

The Datasonde used for collecting in situ water chemistry will be calibrated immediately 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. If a drift value fails, the Datasonde will read "Fail." If failure occurs, perform corrective measures such as changing solutions, pH probes, or DO membranes, as stated in the users' manuals. After corrective measures have been performed, correctly re-calibrate the failed media, and continue. Field parameter calibrations for in situ water chemistry will conform to the procedures as described in the instrument users' manuals (Hydrolab Corporation 2002; YSI 2002). The DO component of the calibration procedure will be conducted using the air calibration method. The unit will be field checked for accuracy once during the week by comparison with a Winkler DO test. Field tests for Hach™ turbidity, pH and temperature meters will also be used once per week. A Winkler DO test will be conducted at all sites where the DO concentration is 4.0 mg/L or less. Weekly calibration verification results will be recorded on the stream sampling field data sheets (Attachment 1) and entered into the AIMS II database.

Field Analysis Data

In situ water chemistry field data are collected in the field using calibrated or standardized equipment. Calculations may be done in the field (preferred) or later at the office. Analytical results, which have limited QC checks, are included in this category. Detection limits and ranges have been set for each analysis (Table 4). Quality control checks (such as duplicate measurements, measurements of a secondary standard, or measurements using a different test method or instrument) which are performed on field or laboratory data are usable for estimating precision, accuracy, and completeness for the project.

III. ASSESSMENT/OVERSIGHT

Field and laboratory performance and system audits will be performed to ensure good quality data. Field audits will be conducted to ensure that sampling activities adhere to approved SOPs. Audits are systematically conducted by WAPB Quality Assurance 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 QA staff trained in the associated sampling SOPs, and in the processes related to conducting an audit. QA 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 (IDEM 2004, p. 126).

Data Quality Assessment Levels

The samples and various types of data collected by this program are intended to meet the quality assurance criteria and DQA Levels as described in the WAPB QAPP (IDEM 2004, pp 128-129).

IV. DATA VALIDATION AND USABILITY

Quality assurance reports to management and data validation and usability are also important components of the QAPP which insures good quality data for this project. A quality assurance audit report will be submitted for this project should problems arise and need to be investigated and corrected. Data validation and usability will be achieved through data reduction (the process of converting raw analytical data into final results in proper reporting units), data validation (the process of qualifying analytical/ measurement data on the performance of field and laboratory QC measures incorporated into the sampling and analysis procedures), and data reporting (the detailed description of the data deliverables used to completely document the calibration, analysis, QC measures, and calculations).

Data Qualifier Flags

The various data qualifiers and flags that will be used for quality assurance and validation of the data are found on pages 130-131 of the WAPB QAPP (IDEM 2004).

Data Usability

The environmental data collected and its usability are qualified and classified into one or more of the four categories: Acceptable Data, Enforcement Capable Results, Estimated Data, and Rejected Data as described on page 130 of the WAPB QAPP (IDEM 2004).

<u>Information, Data, and Reports</u>

Performance monitoring data that indicates water quality improvement as defined by U.S. EPA's Office of Water's National Water Program Measures WQ-SP12.N11 and WQ-10 will be used to write up Measure W reports and Success Stories to be submitted to U.S. EPA. Sites be assessed to see if restoration activities have improved the water quality on individual AUID stream segments will be included in Measure W reports. Success Stories occur when an entire 12-digit HUC is delisted for an impairment; 40% improvement is necessary for a Success Story.. Additionally, the data will be recorded in the AIMSII database and used in the Indiana Integrated Water Monitoring and Assessment Report. 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, National Pollutant Discharge Elimination System (NPDES) permit modeling, watershed restoration projects, water quality criteria refinement, etc.). (US EPA 2005)

Laboratory and Estimated Cost

Laboratory analysis and data reporting for this project will comply with the WAPB QAPP (IDEM 2004), and the OWQ Quality Management Plan (IDEM 2012b). Analytical tests on general water chemistry and nutrient outlined in Table 7 will be conducted by the Indiana State Department of Health; located in Indianapolis, IN. Three rounds of water chemistry on 4 sites in Ell Creek sub-watershed (051202090405), with QA/QC (Field Blank, MS/MSD, and Duplicate samples), will be completed at no direct cost. Supplies for the bacteriological sampling in selected sub-watersheds will come from IDEXX Laboratories, Inc., Westbrook, Maine. All fish and macroinvertebrate samples will be collected and analyzed by IDEM staff.

Table 9. Personnel Safety and Reference Manuals

Role		Required Training/Experience	Training References	Training Notes
All Staff that Participate in Field Activities		-Basic First Aid and Cardio-Pulmonary Resuscitation (CPR)	-A minimum of 4 hours of in-service training provided by WAPB (IDEM 2010b)	-Staff lacking 4 hours of in-service training or appropriate certification will be accompanied in the field at all times by WAPB staff that meet Health and Safety Training requirements
		Personal Protective Equipment (PPE) Policy -Personal Flotation Devices (PFD)	IDEM 2008 -February 29, 2000 WAPB internal memorandum regarding use of approved PFDs	-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.

REFERENCES

American Public Health Association. 2005. Standard Methods for the Examination of Water and Wastewater, 21st Edition. Washington, DC. American Public Health Association, American Water Works Association, Water Environment Federation,http:/www.standardmethods.org.

American Society for Testing and Materials, 2011, Standard Specification for Reagent Water, D1193-06(2011), Philadelphia, Pennsylvania, http://www.astm.org.

Barbour, M.T., J. Gerritsen, B.D. Snyder and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates and Fish, Second Edition. EPA/841/B-99/002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C. https://nepis.epa.gov/Exe/ZyNET.exe/20004OQK.TXT

Code of Federal Regulations (CFR). 40 CFR Part 136, Appendix B Revised March 12, 2007. Available at http://www.gpo.gov/fdsys/pkg/CFR-2012-title40-vol24/pdf/CFR-2012-title40-vol24-part136-appB.pdf

Hydrolab Corporation. 2002, revision c. Quanta Water Quality Monitoring System Operating Manual. Loveland, Colorado. Available at http://www.hachhydromet.com/web/ott_hach.nsf/id/pa_users_manuals_e.html

IAC (Indiana Administrative Code), Title 327 Water Pollution Control Division, Article 2. Water Quality Standards. Last updated June 11, 2014. Available at http://www.in.gov/legislative/iac/iac_title?iact=327

IC (Indiana Code), Title 14 Natural and Cultural Resources, Article 8 General Provisions and Definitions. Approved Feburary 27, 2013. Available at http://www.in.gov/legislative/ic/2010/title14/ar8/ch2.pdf

IDEM. 1992a, revision 1. Section 3, Quality Assurance Project Plan, Development of Biological Criteria (Fish) for the Ecoregions of Indiana. Biological Studies Section, Surveillance and Standards Branch, Office of Water Management, Indiana Department of Environmental Management, Indianapolis, Indiana.*

IDEM. 1992b, revision 1. Section 4, Standard Operating Procedures for Fish Collections, Use of Seines, Electrofishers, and Sample Processing. Biological Studies Section, Surveillance and Standards Branch, Office of Water Management, Indiana Department of Environmental Management, Indianapolis, Indiana.*

IDEM. 1992c, revision 1. Section 5, Standard Operating Procedures for Conducting Rapid Assessment of Ambient Water Quality Using Fish (RBP-V). Biological Studies Section, Surveillance and Standards Branch, Office of Water Management, Indiana Department of Environmental Management, Indianapolis, Indiana.*

IDEM. 1992d, revision 1. Section 11, Standard Operating Procedures-Appendices of Operational Equipment Manuals and Procedures. Biological Studies Section, Surveillance and Standards Branch, Office of Water Management, Indiana Department of Environmental Management, Indianapolis, Indiana.*

IDEM. 1992e, revision 1. Section 2, Biological Studies Section Hazards Communications Manual (List of Contents). Biological Studies Section, Surveillance and Standards Branch, Office of Water Management, Indiana Department of Environmental Management, Indianapolis, Indiana.*

IDEM. 1997. Water Quality Surveys Section Laboratory and Field Hazard Communication Plan Supplement. IDEM 032/02/018/1998, Revised October 1998. Assessment Branch, Indiana Department of Environmental Management, Indianapolis, Indiana.*

IDEM. 2002. Water Quality Surveys Section Field Procedure Manual, Assessment Branch, Indiana Department of Environmental Management, Indianapolis, Indiana. IDEM, April 2002. https://extranet.idem.in.gov/standards/docs/quality_improvement/qapps/owq_surveys_section_field_manual.pdf

IDEM. 2004. Quality Assurance Project Plan (QAPP) for Indiana Surface Water Quality Monitoring and Total Maximum Daily Load (TMDL) Program, (Rev. 3, Oct. 2004). https://extranet.idem.in.gov/standards/docs/quality_improvement/qapps/owq_surface_water_quality_tmdl.pdf

IDEM. 2008. IDEM Personal Protective Equipment Policy, revised May 1 2008. A-059-OEA-08-P-R0. Office of External Affairs, Indiana Department of Environmental Management, Indianapolis, Indiana. https://extranet.idem.in.gov/standards/docs/policies/oea/Personal_Protective_Equipment_Policy.pdf

IDEM. 2010a. Multi-habitat (MHAB) Macroinvertebrate Collection Technical Standard Operating Procedure. S-001-OWQ-W-BS-10-T-R0. Watershed Planning and Assessment Branch, Office of Water Quality, Indiana Department of Environmental Management, Indianapolis, Indiana. https://extranet.idem.in.gov/standards/docs/sops/owq/S-001-OWQ-W-BS-10-S-R0.pdf

IDEM. 2010b. IDEM Health and Safety Training Policy, revised October 1 2010. A-030-OEA-10-P-R2.Office of External Affairs, Indiana Department of Environmental Management, Indianapolis, Indiana. https://extranet.idem.in.gov/standards/docs/policies/oea/A-30-OEA-10-P-R2.pdf

IDEM. 2010c. IDEM Injury and Illness Resulting from Occupational Exposure Policy, revised October 1 2010. A-034-OEA-10-P-R2. Office of External Affairs, Indiana Department of Environmental Management, Indianapolis, Indiana https://extranet.idem.in.gov/standards/docs/policies/aw/A-034-AW-16-P-R3.pdf

IDEM. 2011. DRAFT Indiana Water Quality Monitoring Strategy 2011-2019. B-001-OWQ-W-00-11-R0. Watershed Assessment and Planning Branch, Office of Water Quality, Indiana Department of Environmental Management, Indianapolis, Indiana.*

IDEM. 2012a. Request for Proposals 12-48, Solicitation for Analyses. IDEM. Indiana Department of Administration. Indianapolis, Indiana. http://www.in.gov/idem/files/idem_qmp_2012.pdf

IDEM. 2012b. IDEM Agency Wide Quality Management Plan. IDEM, Indiana Government Center North, 100 N. Senate Ave., Indianapolis, Indiana, 46204. Available at http://www.in.gov/idem/files/idem_qmp_2012.pdf

IDEM. 2015b. Global Positioning System (GPS) Data Creation Technical Standard Operating Procedure. B-001-OWQ-WAP-XXX-15-T-R0. Office of Water Quality, Watershed Assessment and Planning Branch. Indianapolis, Indiana. Located at https://extranet.idem.in.gov/standards/docs/sops/owq/B-001-OWQ-WAP-XXX-15-T-R0.pdf

IDEM. 2016a. Indiana Integrated Water Monitoring and Assessment Report 2016. Edited by Jody Arthur. Office of Water Quality, Indiana Department of Environmental Management, Indianapolis, Indiana. http://www.in.gov/idem/nps/2639.htm

IDEM. 2016b. Indiana's 2016 Consolidated Assessment and Listing Methodology (CALM). Edited by Jody Arthur. Office of Water Quality, Indiana Department of Environmental Management, Indianapolis, Indiana. http://www.in.gov/idem/nps/files/ir_2016_report_apndx_l_attch_1.pdf

IDEM. 2016c. Procedures for Completing the Qualitative Habitat Evaluation Index. B-003-OWQ-WAP-XX-16-T-R0. Office of Water Quality, Watershed Assessment and Planning Branch. Indianapolis, Indiana. Located at: https://extranet.idem.in.gov/standards/docs/sops/owq/B-003-OWQ-WAP-XX-16-T-R0.pdf

Jin, S., Yang, L., Danielson, P., Homer, C., Fry, J., and Xian, G. 2013. A comprehensive change detection method for updating the National Land Cover Database to circa 2011. Remote Sensing of Environment. 132: 159-175. www.mrlc.gov/downloadfile2.php?file=Preferred_NLCD11_citation.pdf

Klemm, D.J., P.A. Lewis, F.Fulk and J.M. Lazorchak. 1990. Macroinvertebrate Field and Laboratory Methods for Evaluating the Biological Integrity of Surface Waters. EPA/600/4-90/030. Environmental Monitoring Systems Laboratory, Monitoring Systems and Quality Assurance, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio. https://nepis.epa.gov/Exe/ZyNET.exe/30000VCE.txt

Newhouse, S.A. 1998. Field and laboratory operating procedures for use, handling and storage of chemicals in the laboratory. IDEM/32/03/007/1998. Biological Studies Section, Assessment Branch, Office of Water Management, Indiana Department of Environmental Management, Indianapolis, Indiana.*

Ohio Environmental Protection Agency (OHEPA). 2006. Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI). OHIO EPA Technical Bulletin EAS/2006-06-1. Revised by the Midwest Biodiversity Institute for State of Ohio Environmental Protection Agency, Division of Surface Water, Ecological Assessment Section, Groveport, Ohio. Report available at http://www.epa.state.oh.us/portals/35/documents/qheimanualjune2006.pdf

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross and R.M. Hughes. 1989. Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macroinvertebrates and Fish. EPA/440/4-89/001. Assessment and Watershed Protection Division, U.S. Environmental Protection Agency, Washington, D.C. Report available at http://nepis.epa.gov/Exe/ZyNET.exe/9100LGCA.TXT

Rankin, E.T. 1995. Habitat Indices in Water Resource Quality Assessments. pp. 181-208, Chapter 13, Biological Assessment and Criteria: Tools for the Risk-based Planning and Decision Making, edited by Wayne S. Davis and Thomas P. Simon, Lewis Publishers, Boca Raton, Florida.*

Simon, Thomas.P. 1990. Quality Assurance Program Plan: Development of Biological Criteria for the Ecoregions of Indiana. Region V, Environmental Sciences Division, Central Regional Laboratory, Organic Chemistry Section: Biology Team, U.S. Environmental Protection Agency, Chicago, Illinois.*

Simon, T.P. 1991. Development of Index of Biotic Integrity expectations for the ecoregions of Indiana I: Central Cornbelt Plain. EPA 905/9-91/025. Environmental Sciences Division, Monitoring and Quality Assurance Branch: Ambient Monitoring Section, U.S. Environmental Protection Agency Region V, Chicago, Illinois*

Simon, Thomas P. DRAFT. Development of Index of Biotic Integrity Expectations for the Ecoregions of Indiana. Interior River Lowland.*

Simon, T.P. and R.L. Dufour. 1998. Development of Index of Biotic Integrity Expectations for the Ecoregions of Indiana V: Eastern Cornbelt Plain. EPA 905/R-96/004. Water Division, Watershed

and Non-Point Branch, U.S. Environmental Protection Agency Region V, Chicago, Illinois. Report available at http://nepis.epa.gov/Exe/ZyNET.exe/2000BST2.TXT

U.S. EPA. 1983. Methods for the Chemical Analysis of Water and Wastes. Washington, DC: U.S. Environmental Protection Agency. EPA/600/4-79-020.

U.S. EPA. 1995. Region 5 R-EMAP Full Proposal: Spatial Evaluation of the Eastern Corn Belt Plain Rivers and Streams for the Development of Reference Condition using EMAP Sampling Design and Indicators, with Comparison of Results to Nonrandom Intensive Survey results in Ohio. U.S. Environmental Protection Agency, Region V, Water Division, Monitoring Standards and Assessment Section, Chicago, Illinois.*

U. S. EPA. 2005. Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act, July 29, 2005. Washington, D.C.: U.S. Environmental Protection Agency. https://www.epa.gov/sites/production/files/2015-10/documents/2006irg-report.pdf

U.S. EPA. 2006. Guidance on Systematic Planning Using the Data Quality Objectives Process. EPA/240/B-06/001. U.S. EPA, Office of Environmental Information, Washington D.C. https://www.epa.gov/sites/production/files/documents/guidance_systematic_planning_dqo_process.pdf

U.S. EPA. 2017 FY16 NWPG Water Quality Measure Definitions Available at https://www.epa.gov/sites/production/files/2015-10/documents/fy_2017_nwpg_measure_definitions_water_quality_-_copy.pdf

U.S. EPA and the USGS. 2005. National Hydrography Dataset Plus – NHD Plus. Edition 1. Horizon Systems Corporation. http://www.horizon-systems.com/NHDPlus/

YSI Incorporated. 2002, revision b. 6-Series Environmental Monitoring Systems Manual, Yellow Springs, Ohio. Available at http://www.ysi.com/mwg-internal/de5fs23hu73ds/progress?id=fdaTJVUSbg

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Attachment 1. IDEM 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 1	2	3	4	Sample Collected Date	Time	Hydrolab #	Water Depth/Gage Ht (ft)	Water Flow (cf/sec)	Flow Estimated?	Algae?	Aquatic Life?
										☐	☐	☐

Sample Taken?	Aliquots	Water Flow Type	Water Appearance	Canopy Closed %
☐ Yes ☐ No; Frozen ☐ No; Stream Dry ☐ No; Other ☐ No; Owner refused Access	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 6 ☐ 8 ☐ 12 ☐ 24 ☐ 48 ☐ 72 ☐ All-Flow	☐ Riffle ☐ Dry ☐ Stagnant ☐ Pool ☐ Run ☐ Flood ☐ Glide ☐ Eddy ☐ Other	☐ Clear ☐ Green ☐ Sheen ☐ Murky ☐ Black ☐ Other ☐ Brown ☐ Gray (Septic/Sewage)	☐ 0-20% ☐ 60-80% ☐ 20-40% ☐ 80-100% ☐ 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 2. IDEM Fish Collection Data Sheet (front).

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												

MKM: Rev/February 19, 2014

Attachment 2. IDEM Fish Collection Data Sheet (back)

Event ID_____ Page _____ of _____

								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												
								Min length	D	E	L	T	M	O
								Max length						
V		P												
								Min length	D	E	L	T	M	O
								Max length						
V		P												

MKM: Rev/February 19, 2014

Attachment 3. IDEM Office of Water Quality Macroinvertebrate Header Form

Office of Water Quality: Macroinvertebrate Header

L-Site #	Event ID	Stream Name	Location	County	Surveyor

Sample Date	Sample #	Macro#	# Containers

☐ Habitat Complete ☐ Sample Quality Rejected

Macro Sample Type:
☐ Black Light ☐ Kick
☐ CPOM ☐ MHAB
☐ Hester-Dendy ☐ Qualitative

☐ Normal _____
☐ Duplicate _____
☐ Replicate _____

Riparian Zone/Instream Features

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):	Velocity (ft/s):

Stream Type:
☐ Cold
☐ Warm

Turbidity (Est):
☐ Clear ☐ Slightly Turbid
☐ Opaque ☐ Turbid

Salinity (mg/L): _____ **ORP (mV):** _____

☐ **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 03/14/13

Attachment 4. IDEM OWQ Biological Qualitative Habitat Evaluation Index (front).

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; estimate % and check every type present

BEST TYPES (PREDOMINANT P/G R/R)	PRESENT P/G R/R	TOTAL %	OTHER TYPES (PREDOMINANT P/G R/R)	PRESENT P/G R/R	TOTAL %
☐☐ BLDR/SLABS [10]	☐☐	____	☐☐ HARDPAN [4]	☐☐	____
☐☐ BOULDER [9]	☐☐	____	☐☐ DETRITUS [3]	☐☐	____
☐☐ COBBLE [8]	☐☐	____	☐☐ MUCK [2]	☐☐	____
☐☐ GRAVEL [7]	☐☐	____	☐☐ SILT [2]	☐☐	____
☐☐ 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]

Check ONE (Or 2 & average)

ORIGIN	QUALITY (SILT)	QUALITY (EMBEDDEDNESS)
☐ LIMESTONE [1]	☐ HEAVY [-2]	☐ EXTENSIVE [-2]
☐ TILLS [1]	☐ MODERATE [-1]	☐ MODERATE [-1]
☐ WETLANDS [0]	☐ NORMAL [0]	☐ NORMAL [0]
☐ HARDPAN [0]	☐ FREE [1]	☐ NONE [1]
☐ SANDSTONE [0]		
☐ RIP/RAP [0]		
☐ LACUSTRINE [0]		
☐ SHALE [-1]		
☐ COAL FINES [-2]		

Substrate Maximum 20

Comments

2] *INSTREAM COVER* Indicate presence 0 to 3 and estimate percent: **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.)

% Amount	% Amount	% Amount
___ __ UNDERCUT BANKS [1]	___ __ POOLS > 70cm [2]	___ __ OXBOWS, BACKWATERS [1]
___ __ OVERHANGING VEGETATION [1]	___ __ ROOTWADS [1]	___ __ AQUATIC MACROPHYTES [1]
___ __ SHALLOWS (IN SLOW WATER) [1]	___ __ BOULDERS [1]	___ __ LOGS OR 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]

Cover 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 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

L R EROSION	L R RIPARIAN WIDTH	L R FLOOD PLAIN QUALITY	L R
☐☐ NONE/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 [1]	☐☐ FENCED PASTURE [1]	
	☐☐ NONE [0]	☐☐ OPEN PASTURE, ROW CROP [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!))	CHANNEL WIDTH (Check ONE (Or 2 & average))	CURRENT VELOCITY (Check ALL that apply)		Recreation Potential (Circle one and comment on back)
☐ > 1m [6]	☐ POOL WIDTH > RIFFLE WIDTH [2]	☐ TORRENTIAL [-1]	☐ SLOW [1]	☐ Primary Contact
☐ 0.7 - < 1m [4]	☐ POOL WIDTH = RIFFLE WIDTH [1]	☐ VERY FAST [1]	☐ INTERSTITIAL [-1]	☐ Secondary Contact
☐ 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.		

Pool/Current 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 (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., Fine Gravel, Sand) [0]	☐ MODERATE [0]
			☐ EXTENSIVE [-1]

Riffle/Run Maximum 8

Comments

6] *GRADIENT* (ft/mi) ☐ VERY LOW - LOW [2–4] ☐ MODERATE [6 - 10] ☐ HIGH - VERY HIGH [10 - 6]

DRAINAGE AREA (mi²)

%POOL: ____ %GLIDE: ____ %RUN: ____ %RIFFLE: ____

Gradient Maximum 10

IDEM 11/15/12

Attachment 4 (continued). IDEM OWQ Biological QHEI (back).

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 ft²	☐ > 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 11/15/12

Attachment 5. IDEM Field Chain of Custody Form.

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	

Appendix 1. IDEM Fish Community Assessments for Aquatic Life Use

IDEM collects fish along with other data (chemical parameters, nutrients, macroinvertebrate, and habitat) to monitor the health of streams and rivers in Indiana. There are many advantages of using fish for monitoring stream health:

- Many fish have life spans of greater than 3 years allowing detection of degradation in habitat or water chemistry over time (which will alter the expected fish community structure).
- The knowledge of fish life history, feeding, and reproductive behavior is well known and can be used to detect changes in water chemistry or habitat alterations.
- Identification of fish species can usually be made in the field so that fish are returned to the stream and time for laboratory identifications kept minimal.

The Indiana Administrative Code [327 IAC 2-1-3(2)] has narrative biological criteria that states “all waters, except those designated as limited use, will be capable of supporting a well-balanced, warm water aquatic community.” The water quality standard 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 pollution tolerant species” [327 IAC 2-1-9(59)]. To measure whether or not the fish community is meeting this definition, IDEM uses an Index of Biotic Integrity (IBI) which is composed of 12 fish community characteristics chosen based on what part of the state you are sampling (ecoregion) and size of stream (drainage area). The 12 different characteristics can each score a 0, 1, 3, or 5, which represents the deviation from expected fish community structure (i.e. 5 = no deviation from expectations, 1 = severe deviation from expected fish community structure). The total score can range from 0 (no fish) to 60 (excellent, comparable to “least impacted” conditions). Indiana expects streams to score at least 36 (the minimum score required for a “fair” stream integrity classification) out of 60 to meet aquatic life use water quality standards. The chart below, modified from a table developed by Karr et al. 1986, uses total IBI score, integrity class, and attributes to define the fish community characteristics in Indiana streams and rivers.

Total IBI Score	Integrity Class	Attributes
53-60	Excellent	Comparable to “least impacted” conditions, exceptional assemblage of species.
45-52	Good	Decreased species richness (intolerant species in particular), sensitive species present.
36-44	Fair	Intolerant and sensitive species absent, skewed trophic structure.
23-35	Poor	Top carnivores and many expected species absent or rare, omnivores and tolerant species dominant.
12-22	Very Poor	Few species and individuals present, tolerant species dominant, diseased fish frequent.
<12	No Fish	No fish captured during sampling.

Karr, J.R., K.D. Fausch, P.L. Angermeier, P.R. Yant, and I.J Schlosser. 1986. Assessing biological integrity

in running waters: a method and its rationale. Illinois Natural History Survey Special Publication 5. 28 p. Some examples of metrics and fish specimens for the Index of Biotic Integrity (IBI) looking at species composition, trophic levels, and tolerance to water pollution or habitat disturbance.

1. *Number of Species* (generally more species = better quality stream)

2. *Number of Darter, Madtom, Sculpin Species* (species require high dissolved oxygen and clean rocky substrates so higher number = better quality stream)
    - Examples: rainbow darter, brindled madtom, mottled sculpin

   % Large River Individuals (species require habitats typical in great rivers in terms of bottom substrates, current velocity, backwater areas, etc. so higher percentage = better quality river)

    - Examples: chestnut lamprey, channel catfish, bullhead minnow, silver chub

3. *% Headwater Individuals* (species in small streams occupying permanent habitat with low environmental stress so greater percentage = better quality stream)
    - Examples: western blacknose dace, southern redbelly dace, fantail darter

   Number of Sunfish or Centrarchidae Species (species occupy pools which act as “sinks” for potential pollutants and silt so fewer number of these species = low quality stream)

    - Examples: rock bass, bluegill, largemouth bass

4. *Number of Sucker or Round Body Sucker Species* (species do not tolerate habitat and water quality degradation so more = better quality stream)
    - Examples: black redhorse, northern hog sucker

   Number of Minnow Species (generally more minnow species = better quality stream)

    - Examples: spotfin shiner, silverjaw minnow, hornyhead chub

5. *Number of Sensitive Species* (species sensitive to pollution so more species = better quality stream)
    - Examples: greenside darter, smallmouth bass, longear sunfish

6. *% Tolerant Individuals* (species tolerant to pollution so greater percentage = low quality stream)
    - Examples: yellow bullhead, green sunfish, central mudminnow

7. *% Omnivore/Detritivore Individuals* (species that consume at least 25% plant and 25% animal material which makes them opportunistic feeders when other food sources are scarce; thus, greater percentage = lower quality stream)
    - Examples: bluntnose minnow, white sucker, gizzard shad

8. *% Insectivore/Invertivore Individuals* (species whose diet is mainly benthic insects so the metric is a reflection of the food source; thus, lower percentage = lower quality stream)
    - Examples: blackstripe topminnow, emerald shiner, logperch

9. *% Carnivore Individuals* (species whose diet is carnivorous and also reflects the availability of the food source; too high or too low percentage of carnivores = lower quality stream and imbalance of trophic levels)
    - Examples: spotted bass, grass pickerel

   % Pioneer Individuals (species that are first to colonize a stream after environmental disturbance so higher percentage of pioneer individuals = lower quality stream)

    - Examples: creek chub, central stoneroller, johnny darter

10. *Number of Individuals* (generally more individuals = better quality stream)

11. *% Simple Lithophilic Individuals* (species that require clean gravel or cobble for successful reproduction since they simply broadcast their eggs on the substrate, fertilize, and provide no parental care; thus, heavy siltation or environmental disturbance will result in a lower percentage of simple lithophilic species = lower quality stream)
    - Examples: bigeye chub, striped shiner, orangethroat darter

12. *% Individuals with Deformities, Eroded Fins, Lesions, and Tumors (DELT's)* (diseased individuals with external anomalies as a result of bacterial, fungal, viral, and parasitic infections, chemical pollutants, overcrowding, improper diet, and other environmental degradation. Percentages should be absent or very low naturally so higher percentage = low quality stream)
    - Examples: deformed blackstripe topminnow, creek chub with tumors

Appendix 2. Calculating IDEM Macroinvertebrate Index of Biotic Integrity (mIBI)

The purpose of this document is to describe the laboratory processing and data analysis procedures used by the Indiana Department of Environmental Management (IDEM) to calculate the macroinvertebrate Index of Biotic Integrity (mIBI). Standard operating procedures (SOPs) are being developed to describe these processes, but it may be some time before they are finalized.

An SOP describing the methods used by IDEM to collect macroinvertebrate samples with a multi-habitat (MHAB) sampling method is available at http://monitoringprotocols.pbworks.com/f/S-001-OWQ-W-BS-10-S-R0.pdf. The index period for collection of macroinvertebrate samples with the MHAB sampling method is July 15 to October 30. The entire sample is processed in the laboratory as subsampling has already been performed in the field. All macroinvertebrate individuals are counted with the exception of empty snail and clam shells, micro-crustaceans (Ostracoda, Branchiopoda, Copepoda), larval and pupal insect exuviae, and terrestrial insects (including the terrestrial adults of aquatic insect larvae); invertebrate specimens missing their head are also excluded. The level of taxonomic resolution used in the identification of macroinvertebrates may depend in large part on the condition (instar and physical condition) of the specimens and the availability of taxonomic resources that are comprehensive and appropriate for Indiana's fauna. Specimens are generally identified to the “lowest practical" taxonomic level. Oligochaeta (aquatic worms, Hirudinea and Branchiobdellida), Planaria and Acari are only identified to family or a higher level; freshwater snails and clams are identified to genus; freshwater crustacea are identified to genus (Amphipoda and Isopoda) or species (Decapoda); aquatic insects are identified to family (Collembola and several Dipteran families) or genus and species (all other insects). The following table lists insect genera that are often identified to species (and may contain multiple species in a sample) and taxonomic resources commonly used by IDEM biologists for their identification (full citations for these resources are listed in the Taxonomic References at the end of this document.

Ephemeroptera:
Baetidae: *Baetis* (separate *B. intercalaris* and *B. flavistriga* with Moriharra and McCafferty 1979, leave everything else at *Baetis)*
Caenidae: *Caenis:* Provonsha 1990
Heptageniidae: *Mccaffertium* (formerly *Stenonema* subgenus *Mccaffertium*): Bednarik and McCafferty 1979
Odonata:
Gomphidae: *Dromogomphus*: Westfall and Tennessen 1979
Coenagrionidae: *Argia* and *Enallagma*: Westfall and May 1996
Hemiptera:
Corixidae: *Trichocorixa* and *Palmacorixa*: Hungerford 1948, Hilsenhoff 1984
Megaloptera:
Corydalidae: *Chauliodes* and *Nigronia*: Rasmussen and Pescador 2002
Coleoptera:
Haliplidae: *Peltodytes*: Brigham 1996
Dytiscidae: *Neoporus*, *Heterosternuta*, *Laccophilus*, *Coptotomus*: Larson et al. 2000.
Hydrophilidae: *Tropisternus*, *Berosus*, *Enochrus*: Hilsenhoff 1995A and 1995B.
Elmidae: *Stenelmis*, *Dubiraphia*, *Optioservus*: Hilsenhoff and Schmude, Hilsenhoff 1982
Trichoptera:
Philopotamidae: *Chimarra*: Hilsenhoff 1982
Leptoceridae: *Nectopsyche*: Glover and Floyd 2004
Hydropsychidae: *Hydropsyche*: Schuster and Etnier 1978
Diptera:
Chironomidae: *Ablabesmyia*: Roback 1985 (sub-genus/ species group)
Polypedilum: Maschwitz and Cook 2000 (sub-genus/ species group)
Cricotopus/Orthocladius: Merritt et al 2007 (sub-genus/ species group)
After all organisms in the sample have been identified to the lowest practical taxon, those taxa are then associated with their corresponding tolerance, functional feeding group and habit values (found in the

spreadsheet "Indiana Macroinvertebrate Attributes"). Organisms without a tolerance value, functional feeding group or habit are not included in the calculations for those specific metrics (this may become more evident while looking at the metric example on page 3). For taxa metrics, all of the taxa listed for a specific group (EPT, Diptera) are counted, regardless of level of identification (i.e.,. if there were 4 taxa under the Chironomidae family (1 family level ID, 1 *Cricotopus* genus level ID, and 2 distinct species level IDs under the *Cricotopus* genus) this would be considered 4 taxa).

The metrics are then calculated as follows:
1 - Total Number of Taxa: Numerical count of all identified taxa in the sample
2 - Total Number of Individuals: Numerical count of the number of individual specimens in the sample
3 - Total Number of EPT Taxa: Numerical count of all Ephemeroptera, Plecoptera and Trichoptera taxa in the sample
4 - Total Number of Diptera Taxa: Numerical count of all Diptera taxa in the sample
5 - % Orthocladiinae + Tanytarsini of Chironomidae: Number of individuals in the chironomid subfamily Orthocladiinae and tribe Tanytarsini divided by the total number of Chironomidae in the sample
6 - % Non-insect (minus crayfish): Number of individuals, except for crayfish, that are not in the Class Insecta (Isopoda, Amphipoda, Acari, snails, freshwater clams, Oligochaeta, Nematoda, Nematomorpha) divided by the total number of individuals in the sample
7 - % Intolerant: Number of individuals with a tolerance value of 0-3 divided by the total number of individuals in the sample
8 - % Tolerant: Number of individuals with a tolerance value of 8-10 divided by the total number of individuals in the sample
9 - % Predators: Number of individuals with a functional feeding group designation of "Predator" divided by the total number of individuals in the sample
10 - % Shredders + Scrapers: Combined number of individuals in the functional feeding groups "Shredder" and "Scraper" divided by the total number of individuals in the sample
11 - % Collector-Filterers: Number of individuals in the functional feeding group "Collector-Filterer" divided by the total number of individuals in the sample
12 - % Sprawlers: Number of individuals with a habit specificity of "Sprawler" divided by the total number of individuals in the sample

These metric values are then scored as a 1, 3 or 5 according to the criteria in the following table:

Metric	1	3	5
Number of Taxa	< 21	≥ 21 and <41	≥ 41
Number of Individuals	< 129	≥ 129 and < 258	≥ 258
Number of EPT Taxa			
Drainage Area: < 5 mi^2	< 2	≥ 2 and < 4	≥ 4
Drainage Area: ≥ 5 and < 50 mi^2	< 4	≥ 4 and < 8	≥ 8
Drainage Area: ≥ 50 mi^2	< 6	≥ 6 and < 12	≥ 12
% Orthocladiinae + Tanytarsini of Chironomidae	≥ 47	≥ 24 and < 47	< 24
% Non-insects Minus Crayfish	≥ 35	≥ 18 and < 35	< 18
Number of Diptera Taxa	< 7	≥ 7 and < 14	≥ 14
% Intolerant	< 15.9	≥ 15.9 and < 31.8	≥ 31.8
% Tolerant	≥ 25.3	≥ 12.6 and < 25.3	< 12.6
% Predators	< 18	≥ 18 and < 36	≥ 36
% Shredders + Scrapers	< 10	≥ 10 and < 20	≥ 20
% Collector-Filterers	≥ 20	≥ 10 and < 20	< 10
% Sprawlers	< 3	≥ 3 and < 6	≥ 6

Most scoring classifications are the same regardless of stream drainage area; the exception is the "Number of EPT Taxa" metric which increases with increasing drainage area. After all metrics have been scored, the individual metric scores are summed and the total is the mIBI score for that particular site. Scores less than 36 are considered impaired while those greater than or equal to 36 are unimpaired.

Example of Derivation of Metric Scores for the Macroinvertebrate Index of Biotic Integrity

TAXA NAME	FEED GRP	TOL	HAB/BHV	# OF IND
Heptagenia	SC	3		1
Leucrocuta	SC	2	cn	1
Acerpenna pygmaea	OM	2	sw	1
Baetis flavistriga	GC	3	sw	1
Callibaetis	GC	6	sw	1
Ephemera simulans				1
Ischnura verticalis	PR			1
Berosus peregrinus	SH	6	sw	1
Dubiraphia	GC	5	cn	1
Macronychus glabratus	OM	3	cn	1
Ceratopsyche bronta		5		1
Pycnopsyche	SH	3	sp	1
Chrysops	GC	5		1
Procladius	PR	7	sp	1
Paraphaenocladius	GC		sp	1
Lirceus	GC	8	cr	1
Ferrissia rivularis	SC	6		1
Physella	SC	8		1
Corbicula fluminea	FC	6		1
NAIDIDAE	GC	8		1
Acariformes		4		1
Maccaffertium pulchellum	SC	2		2
Tricorythodes	GC	3	sw	2
Boyeria vinosa	PR	4	cb	2
Rheumatobates	PR		sk	2
Trepobates	PR			2
Stenelmis	SC	5	cn	2
Polypedilum flavum				2
Stictochironomus	OM	4	bu	2
Caenis latipennis	GC			3
Palmacorixa nana	PI	4	sw	3
Cheumatopsyche	FC	3	cn	3
Orconectes	GC	4		3
Hetaerina americana	PR			4
Ancyronyx variegatus	OM	4		5
Baetis intercalaris	OM	3	sw	6
Peltodytes duodecimpunctata				6
Trepobates inermis				7
Dubiraphia minima				7
Hyalella azteca	GC	8	cr	9
Polypedilum illinoense		7		16
Stenelmis sexlineata				**18**
Grand Total				127

Metrics	Metric Values	Metric Scores
Total Number of Taxa	42	**3**

Total Abundance of Individuals	127	**1**
Number of EPT Taxa	13	**5**
% Orthocladinae + Tanytarsinii of Chironomidae	4.55	**5**
% Non-Insects - Crayfish	11.81	**5**
Number of Diptera Taxa	6	**1**
% Intolerant Taxa (Score 0 - 3)	14.96	**1**
% Tolerant Taxa (Score 8 - 10)	9.45	**5**
% Predators	9.45	**1**
% Shredders + Scrapers	7.87	**1**
% Collector-Filterers	3.15	**5**
% Sprawlers	2.36	**1**
MIBI Score		**34**

Taxonomic References

Bednarik A.F. and W.P. McCafferty. 1979. Biosystematic revision of the genus *Stenonema* Ephemeroptera: Heptageniidae). Canadian Bulletin of Fisheries and Aquatic Sciences 201: 1-73. http://www.famu.org/mayfly/pubs/pub_b/pubbednarika1979p1.pdf

Brigham, W.L. 1996. Key to adult *Peltodytes* of the U.S. and Canada (Coleoptera: Haliplidae). http://www.inhs.uiuc.edu/biod/waterbeetles/haliplidae/peltodytes/key-us.html

Glover, J.B. and M. A. Floyd. 2004. Larvae of the genus *Nectopsyche* (Trichoptera:Leptoceridae) in eastern North America, including a new species from North Carolina. Journal of the North American Benthological Society 23(3) 526-541.

Hilsenhoff WL. 1982. Using a biotic index to evaluate water quality in streams. Department of Natural Resources, Technical Bulletin 132, Madison, Wisconsin. http://www.famu.org/mayfly/pubs/pub_h/pubhilsenhoffw1982p1.pdf

Hilsenhoff, W.L. 1984. Aquatic Hemiptera of Wisconsin. Great Lakes Entomologist 17: 29-50.

Hilsenhoff, W.L. 1995. Aquatic Hydrophilidae and Hydraenidae of Wisconsin (Coleoptera). I. Introduction, key to genera of adults, and distribution, habitat, life cycle, and identification of species of *Helophorus* Fabricius, *Hydrochus* Leach, and *Berosus* Leach (Hydrophilidae), and Hydraenidae. The Great Lakes Entomologist 28(1): 25-53.

Hilsenhoff, W.L. 1995. Aquatic Hydrophilidae and Hydraenidae of Wisconsin (Coleoptera). II. Introduction, key to genera of adults, and distribution, habitat, life cycle, and identification of species of Hydrobini and Hydrophili (Hydrophilidae: Hydrohilinae). The Great Lakes Entomologist 28(2): 97-126.

Hilsenhoff, W.L. and K.L. Schmude. 1992. Riffle beetles of Wisconsin (Coleoptera: Dryopidae, Elmidae, Lutrochidae, Psepheniidae) with notes on distribution, habitat, and identification. The Great Lakes Entomologist 25(3): 191-213.

Hungerford H.B. 1948. The Corixidae of the Western Hemisphere (Hemiptera). Reprint of The University of Kansas Science Bulletin 32:1-827, reprinted (1977) by Entomological Reprint Specialists: Los Angeles, California.

Larson, D.J., Y. Alarie, and R.E. Roughley. 2000. Predaceous Diving Beetles (Coleoptera: Dytiscidae) of the Nearctic Region, with emphasis on the fauna of Canada and Alaska. NRC Research Press, Ottawa.

Maschwitz, D.E. and E. F. Cook. 2000. Revision of the Nearctic Species of the Genus *Polypedilum* Kieffer (Diptera: Chironomidae) in the Subgenera *P*. (*Polypedilum*) Kieffer and *P*. (*Urespedilum*) Oyewo and Saether. Ohio Biological Survey Bulletin (New Series) 12(3). 135 pp.

Morihara D.K. and McCafferty W.P. 1979. The *Baetis* larvae of North America (Ephemeroptera: Baetidae). Transactions of the American Entomological Society 105:139-221. http://www.famu.org/mayfly/pubs/pub_m/pubmoriharad1979p139.pdf

Provonsha A.V. 1990. A revision of the genus *Caenis* in North America (Ephemeroptera: Caenidae). Transactions of the American Entomological Society 116:801-884. http://www.famu.org/mayfly/pubs/pub_p/pubprovonshaa1990p801.pdf

Rasmussen, A.K. and M.L. Pescador. 2002. A Guide to the Megaloptera and Aquatic Neuroptera of Florida. http://publicfiles.dep.state.fl.us/dear/labs/biology/biokeys/megaloptera.pdf

Roback, S.S. 1985. The immature chironomids of the eastern United States VI - genus *Ablabesmyia*. Proceedings of the Academy of Natural Sciences of Philadelphia 137(2): 153-212.

Schuster, G.A. and D.A. Etnier. 1978. Manual for the Identification of the Larvae of the Caddisfly Genera *Hydropsyche* Pictet and *Symphitopsyche* Ulmer in Eastern and Central North America (Trichoptera:Hydropsychidae) EPA -600-4-78-060. http://www.epa.gov/bioiweb1/pdf/EPA-600-4-78-060AManualfortheidentificationofthecaddisfly_shusterandetnier.pdf

Westfall, M.J., Jr. and M.L. May. 2006. Damselflies of North America (Revised Edition).

Westfall, M.J. Jr. and K.J. Tennessen. 1979. Taxonomic clarification within the genus *Dromogomphus* Selys (Odonata: Gomphidae). Florida Entomologist 62(3). 266-273. http://fulltext10.fcla.edu/DLData/SN/SN00154040/0062_003/98p0013e.pdf

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