2019 Reference Site Monitoring Work Plan

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SIGNATURE PAGE

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Indiana Department of Environmental Management
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IDEM Quality Assurance Staff reviewed and approved this Sampling and Analysis Work Plan.

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WORK PLAN ORGANIZATION

This sampling and analysis work plan is an extension of the existing Watershed Assessment and Planning Branch (WAPB), March 2017 Quality Assurance Project Plan (QAPP) for Indiana Surface Water Programs (Surface Water QAPP) and serves as a link to the existing QAPP and an independent QAPP of the project. Per the United States Environmental Protection Agency 2002 (U.S. EPA 2006) Guidance for QAPPs, this work plan establishes criteria and specifications pertaining to a specific water quality monitoring project usually described in the following four element groups or sections as QAPP elements:

Section A. Project Management

- A.1 Project Objective
- A.2 Project or Task Organization and Schedule
- A.3 Background and Project or Task Description
- A.4 Data Quality Objectives (DQOs)
- A.5 Training and Staffing Requirements

Section B. Measurement and Data Acquisition

- B.1 Sampling Design and Site Locations
- B.2 Sampling Methods
- B.3 Analytical Methods
- B.4 Quality Control and Custody Requirements
- B.5 Field Parameter Measurements/Instrument Testing/Calibration

Section C. Assessment and Oversight

- C.1 External and Internal Checks
- C.2 Audits
- C.3 Data Quality Assessments (DQAs)
- C.4 Quality Assurance and Quality Control (QA/QC) Review Reports

Section D. Data Validation and Usability

- D.1 Data Handling and associated QA/QC activities
- D.2 QA/QC Review Reports
- D.3 Laboratory and Estimated Cost

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ATTACHMENTS

LIST OF APPENDICES

LIST OF ACRONYMS

AIMS	Assessment Information Management System
ALUS	Aquatic Life Use Support
ASTM	American Society for Testing and Materials
CAC	Chronic Aquatic Criterion
CALM	Consolidated Assessment Listing MethodologyDO Dissolved Oxygen
IAC	Indiana Administrative Code
IBI	Index of Biotic Integrity
IDEM	Indiana Department of Environmental Management
MHAB	Multihabitat
OHEPA	Ohio Environmental Protection Agency
OWQ	Office of Water Quality
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QC	Quality Control
QAPP	Quality Assurance Project Plan
QHEI	Qualitative Habitat Evaluation Index
S.U.	Standard Units
SOP	Standard Operating Procedures
U.S. EPA	United States Environmental Protection Agency
WAPB	Watershed Assessment and Planning Branch

DEFINITIONS

Elutriate	To purify, separate, or remove lighter or finer particles by washing, decanting, and settling.
Fifteen-(15-)minute pick	A multihabitat macroinvertebrate sampling method in which the one-minute kick sample and fifty-meter sweep sample collected at a site are first combined and elutriated. Macroinvertebrates are then manually removed from the resulting sample for 15 minutes.
Fifty-(50-)meter sweep	A multihabitat macroinvertebrate sampling method in which approximately 50 meters (50m) of all available habitat in a stream or river is sampled with a standard 500 µm mesh width D-frame dipnet by taking 20—25 individual “jab” or “sweep” samples, which are then composited.
Macroinvertebrate	Aquatic animals which lack a backbone, are visible without a microscope, and spend some period of their lives in or around water.
One-(1-)minute kick sample	A multihabitat macroinvertebrate sampling method in which approximately 1 m² of riffle or run substrate habitat in a stream or river is sampled with a standard 500 µm mesh width D-frame dipnet for approximately 1 minute.
Ocular reticle	A thin piece of glass marked with a linear or areal scale that is inserted into a microscope ocular, superimposing the scale onto the image viewed through the microscope.
Periphyton	Algae attached to an aquatic substrate.
Reach	A segment of a stream used for sampling.
Seston	Organic matter suspended in the water column generally comprised of phytoplankton, bacteria, and fine detritus.

A. PROJECT MANAGEMENT

A.1 Project Objective

The objective of the 2019 Reference Site Monitoring Project is to provide physical, chemical, and biological data from reference sites. These sites are located in areas with the least amount of anthropogenic disturbance and considered the most natural remaining areas within a specified geographic boundary. Candidate sampling reference sites are chosen based on abiotic factors such as land use, water chemistry, and in-stream physical habitat that function as potential stressors to the aquatic assemblages (i.e., fish, macroinvertebrate, and diatom communities) of the stream or river ecosystem. Data obtained from the chosen sites are used to establish and refine the Index of Biotic Integrity (IBI) for aquatic assemblages as well as biological criteria for aquatic life use assessments.

The IBI is composed of 12 biological assemblage characteristics or metrics that assess the aquatic communities' structural, compositional, and functional integrity. Different IBI metrics may be used depending on variables such as what part of the state is being sampled (ecoregion) and size of the stream (drainage area). The 12 different metrics can each score 0, 1, 3, or 5, which represents the deviation from expected community structure (i.e., 5 = no deviation from expectations, 0 = severe deviation from expected community structure). The total IBI score can range from 0 (severe disturbance) to 60 (excellent, compared to "least impacted" conditions). For more information on fish and macroinvertebrate IBI calculations, view Appendices 2 and 3 .

A.2 Project or Task Organization and Schedule

Sampling for this project will begin in April and continue through October 2019. Chemical, physical, and biological parameters will be collected. Laboratory processing and data analysis for the project will continue through spring of 2020 (see Table 1).

Table 1. Tasks, Schedule, and Evaluation

Activity	Date(s)	Number of Sites	Frequency of Sampling related activity	Parameters to be sampled	How evaluated
Site reconnaissance	Jan through end of Mar	30 to ensure a minimum of 20 sites sampled during all three sampling events	Until 30 accessible target sites confirmed or Mar deadline reached	Safety to access stream and proper equipment for sampling	Land owner approval and best professional judgment
Biological sampling	Jun 4 through Nov 15	Minimum of 20 sites, 30 if water present in at least half the sampling reach	Once each for: Fish community (Jun 3-Oct 18), Macroinvertebrate community (Jul 15 – Nov 15) (both may occur on same day from Jul 15 – Oct 18)	Fish Community Macroinvertebrate Community Habitat Quality	Fish Index of Biotic Integrity (IBI) Macroinvertebrate IBI QHEI evaluated separately for fish and macroinvertebrate communities.
Water chemistry	Apr, May, Sep	30 to ensure a minimum of 20 sites sampled during all three sampling events	Three times: Once each in Apr, May, and Sep, with a minimum of 30 days between sampling events	Total Phosphorous Nitrogen, Nitrate + Nitrite Dissolved Oxygen (DO) pH Algal conditions **From Table 2 (details below)** -Metals, dissolved -Arsenic	**Nutrient Benchmarks:** >0.3 mg/L (for nutrients) >10.0 mg/L (for nutrients) <4.0 mg/L; >12 mg/L (for nutrients) >9.0 Standard Units (SU) (for nutrients); <6 or >9 SU (aquatic life) Excessive (for nutrients, based on observation) **Water Quality Standard Limits:** 190 ug/L

Activity	Date(s)	Number of Sites	Frequency of Sampling related activity	Parameters to be sampled	How evaluated
				-Un-ionized ammonia as N -Chloride -Sulfate -Dissolved Solids	 750 mg/L
Algal samples	Sep	Minimum of 20 sites, 30 if water present in at least half the sampling reach	Once, with the 3rd water chemistry sample, Sep	Algal diatoms Algal Biomass: Periphyton (Include Seston, if the drainage area >1000 square miles)	Diatom identification and enumeration Chlorophyll *a* and Pheophytin *a*

A.3 Background and Project or Task Description

The Reference Site Monitoring Project is operated through the WAPB OWQ IDEM. Other organizations assisting with data preparation, collection, and analysis include private laboratories under contract with the state of Indiana (Request For Proposals 16-74, see IDEM 2016a), Department of Biological and Environmental Sciences at Georgia College and State University, U.S. EPA Region V, and the Indiana Department of Natural Resources. Landowners and property managers throughout the state also participate in the Reference Site Monitoring Project through assisting staff with access to remote stream locations for collection of samples.

The Reference Site Monitoring Project provides physical, chemical, and biological data to continuously refine and calibrate the IBI for aquatic assemblages. Refining and Calibrating are accomplished through sampling reference sites in Indiana over 10 years to assess and characterize overall water quality and biological integrity. The following parameters are investigated and the data utilized for IBI and biological criteria refinement as well as assessment purposes: water chemistry; algal samples (seston and periphyton); fish, macroinvertebrate, and diatom assemblages; and habitat evaluations.

A.4 Data Quality Objectives (DQO)

The DQO process (U.S. EPA 2006) is U.S. EPA's recommended planning process for environmental data collection activities. It provides a basis for balancing decision uncertainty with available resources. The DQO process is required for all significant environmental data collection projects and is a seven-step, systematic-planning process used to clarify study objectives; define the types and quantity of data needed to achieve the objectives; and establish decision criteria for evaluating data quality. The DQO process for the 2019 Reference Site Monitoring Project is identified in the following seven steps:

1. State the Problem

Surface waters of the state are designated for full body contact recreation; will be capable of supporting a well-balanced, warm water aquatic community; and in some northern portions of the state, put-and-take trout fishing [327 IAC 2-1-3]. Indiana is required to assess all waters of the state to determine their designated use attainment status. This project gathers biological (algal, fish, and macroinvertebrate), chemical, and habitat data at reference sites for the purpose of refining Indiana's IBI metrics and biological criteria thresholds, to more accurately assess aquatic life use attainment status.

2. Identify the Goals of the Study

The objective of this project is to sample reference sites throughout Indiana to determine whether the reference sites chosen still meet criteria for a reference site; collect reference data against which ALUS assessments can be measured; and develop the Diatom IBI to provide a more sensitive tool to determine ALUS status to refine and further validate IBI metrics and biological criteria thresholds every 10 years.

3. Identify the Information Inputs

Field monitoring activities are required to collect physical description, chemical, algal, biological, and habitat data. Samples will be collected for chemical parameters as well as biological communities. Collection procedures for field measurements, algal, chemical, biological, and habitat data will be described in detail under Section II MEASUREMENT/DATA ACQUISITION.

Water Quality Criteria

Chemical sampling data are used to validate the absence of anthropogenic disturbance or a minimal level of allowed disturbance at reference sites (U.S. EPA 2013). Thus, each site will be evaluated as "supporting" or "nonsupporting" when compared with water quality criteria shown in Table 2, which is derived from tables contained in [327 IAC 2-1-6] following Indiana's 2018 Consolidated Assessment Listing Methodology (IDEM 2018a, CALM 2018b).

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

Parameter	Level	Criterion
Metals (dissolved)	Calculated based on hardness	Calculated Chronic Aquatic Criterion (CAC)
Arsenic III (dissolved)	190 µg/L	Calculated CAC
Ammonia as Nitrogen	Calculated based on pH and temperature	Calculated CAC
Chloride	Calculated based on hardness and sulfate values	Calculated CAC
DO	At least 5.0 mg/L (warm water aquatic life)	Not less than 4.0 mg/L at any time.
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
Nitrogen, Nitrate + Nitrite	≤10 mg/L	Human Health point of drinking water intake
Sulfate	Calculated based on hardness and chloride	In all waters outside the mixing zone
Dissolved Solids	750 mg/L	Not-to-Exceed at point of drinking water intake

CAC = Chronic Aquatic Criterion, S.U. = Standard Units

Nutrient Criteria

In addition to the chemical criteria listed in Table 2, data for several nutrient parameters will be evaluated against the benchmarks below (IDEM 2018b). Assuming a minimum of three sampling events, if two or

more of the conditions below are met on the same date, the waterbody assessment unit will be classified as nonsupporting due to nutrients.

- Total Phosphorus: one or more measurements >0.3 mg/L.
- Nitrogen, (Nitrate + Nitrite): one or more measurements >10.0 mg/L.
- DO: one or more measurements <4.0 mg/L, or measurements that are consistently at or close to the standard, in the range of 4.0—5.0 mg/L, or >12.0 mg/L.
- pH: one or more measurements >9.0 S.U. or measurements consistently at or close to the standard, ranging from 8.7—9.0 S.U.
- Algal Conditions: visually observed as "excessive" by trained staff using best professional judgment. Further explanation of this observance is documented in Measurement and Data Acquisition under Algal Community Data on page 34.

Biological Criteria:
Indiana narrative biological criteria [327 IAC 2-1-3] states that "(2) All waters, except as described in subdivision (5)," (i.e., limited use waters) "will be capable of supporting: (A) a well-balanced, warm water aquatic community". The water quality standard definition of a "well-balanced aquatic community" is "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 (59)]. An interpretation or translation of narrative biological criteria into numeric criteria is illustrated by the table in Appendix 2. A stream segment is nonsupporting for aquatic life use when the monitored fish or macroinvertebrate community receives an IBI score of less than 36 which is considered "Poor" or "Very Poor" (IDEM 2018b). Stream segements with IBI scores greater than or equal to 36 ("Fair" to "Excellent" on the scale of 0 to 60) are supporting for aquatic life use.

Assessment of each site sampled will be reported to U.S. EPA in the 2022 update of Indiana's Integrated Water Monitoring and Assessment Report. Site specific data will be used to classify associated assessment units (AU) into one of five major categories in the state's consolidated 303(d) list. Category definitions are available in Indiana's CALM (IDEM 2018b pages N-40 and N-41).

To develop the IBI for diatoms, as well as biological criteria for aquatic life use assessments, periphyton will be collected and analyzed separately for benthic diatoms and chlorophyll a in conjunction with chemical data from each site along with physical site descriptions. Once collected, the diatom samples will be preserved and transported to the laboratory where algae will be identified and enumerated as part of the development of algal metrics.

4. Define the Boundaries for the Study

In 2019, reference sites were chose in two separate areas of the state to allow flexibility in sampling, as a result of high water or bad weather preventing IDEM projects' sampling in other areas of the state. If the flow

is not dangerous for staff to enter the stream; barring any hazardous weather conditions; or unexpected physical barriers to access the site. Even if the weather conditions and stream flow are safe, sample collections for algal and biological communities may also be postponed at a particular site for one to four weeks due to scouring of the stream substrate or instream cover following a high water event resulting in nonrepresentative samples.Further explanation of site selection is explained in *B.2.5 Sampling Methods* in *Section B. Measurement/Data Acquisition* of this work plan. **Develop the Analytical Approach**
All potential reference sites will be evaluated for aquatic life use support (ALUS) status. For assessment purposes in the Indiana Integrated Water Monitoring and Assessment Report, ALUS decisions will include independent evaluations of chemical and biological criteria as outlined in Indiana's 2018 CALM (IDEM 2018b). The fish and macroinvertebrate assemblage will be evaluated at each site using the appropriate IBI. Specifically, a site will be considered nonsupporting for aquatic life use when IBI scores are less than 36. Given more recent data, assessment decisions will be reported in the 2022 Indiana Integrated Water Monitoring and Assessment Report resulting in stream segments being delisted for impaired biotic community (now fully supporting aquatic life use), or listed as nonsupporting for aquatic life use due to a change in water quality or habitat that has impaired the biotic community.

Sites not supporting aquatic life use or sites violating the minimal allowable amount of disturbance will be rejected as reference sites due to chemical or physical alterations detected by current sampling efforts. To avoid circularity in deriving IBI calibrations, reference sites will not be chosen based on biological attributes (i.e., excellent IBI metrics or total scores) (U.S. EPA 2013).

After 10 years, however, IDEM may discover additional reference sites through review of land use criteria, chemical, and in-stream physical habitat data for sites where biological assemblage information is obtained during additional projects between 2014 and 2024.

IDEM's intention is to use algal metrics, once determined, as part of nutrient criteria being developed for Indiana's surface waters. Eventually, IDEM also plans to use algal metrics with macroinvertebrate and fish metrics for ALUS decisions. Given that ecological tolerances for many diatom species are known, changes in diatom community composition can be used to diagnose the environmental stressors affecting ecological health (Stevenson 1998; Stevenson and Pan 1999). Thus, periphyton IBI metrics have been developed and tested in many regions (Kentucky Department of Environmental Protection KDEP 1993; Hill 1997). The periphyton assemblage to include chlorphyll a and diatoms may be used to assess biological integrity of a waterbody without any other information. However, periphyton are most effective when used in conjunction with habitat and macroinvertebrate assessments, particularly because of the close relationship between periphyton and these elements of stream

ecosystems (Barbour et al. 1999). For this reason, algal sampling will be conducted at the same sites where macroinvertebrates, fish, habitat, chemical, and physical data will be collected as part of the Reference Site Monitoring Program.

Table 3. List of 2019 Reference Sites for the Lower White (05120202) and Lower East Fork White (05120208) Watersheds

AIMS Site Name	Event ID	Stream Name and Location	County	Hydrologic Unit Code (HUC)	Latitude (DD)	Longitude (DD)	Drainage Area (mi^2)	Gradient (ft/mi)	Site Status
WEL090-0013	19R112	Henderson Creek @ CR off of SR 446	Lawrence	051202080804	38.9619444	-86.3688889	13	16.8	Approved
WEL090-0015	19R113	Wolf Creek @ CR 825 N	Lawrence	051202080806	38.9763889	-86.4777778	1.5	42.2	Approved
WEL040-010	19R114	Leatherwood Creek @ Cement Plant Rd	Lawrence	051202081003	38.8541431	-86.4704723	36	14.04	Approved
WWL-03-0029	19R116	Tributary of Richland Creek @ W Hendricks Rd	Monroe	051202020301	39.1589273	-86.6475142	5.5	105.2	Approved
WWL020-0054	19R117	Raccoon Creek @ Heddings Rd.	Owen	051202020207	39.2048429	-86.7566831	23.2	12.7	Approved
WWL020-0055	19R118	Fish Creek @ CR 550 S.	Owen	051202020209	39.2124524	-86.9057538	54	3.1	Approved
WWL-03-0015	19R119	Tributary of Richland Creek @ CR 525 N	Greene	051202020302	39.1025935	-86.7232878	3.7	17.5	Approved
WWL-03-0018	19R120	Camp Creek @ CR 515/460	Greene	051202020305	39.0950222	-86.8329276	3.0	12.1	Approved
WEL-09-0004	19R122	Indian Creek @ E SR 54	Greene	051202080902	38.9613814	-86.6982947	43.82	4.94	Approved
WWL-03-0022	19R124	Little Clifty Branch @ CR 875 E	Greene	051202020306	38.9882975	-86.7790281	3.4	19.7	Approved
WWL-03-0021	19R125	Ore Branch @ Private Drive Off of Ore Branch Rd	Greene	051202020308	39.0272846	-86.8703551	3.1	24.8	Approved
WWL-03-0033	19R126	Stalcup Branch @ CR 140 S	Greene	051202020306	39.0011582	-86.8351621	10.2	17.8	Approved
WWL-03-0010	19R129	Tributary of Black Ankle Creek @ CR 560 E	Greene	051202020307	38.9453013	-86.8404815	2.2	20.8	Approved
WWL-02-0003	19R132	Rattlesnake Creek @ Hyden Road	Owen	051202020204	39.2822672	-86.8059042	21.6	8.3	Approved
WWL-03-0036	19R133	Beech Creek @ CR 900 E	Greene	051202020304	39.0644062	-86.7743589	13.8	12.3	Approved

Table 4. List of 2019 Reference Sites for the Upper White (05120201), Driftwood (05120204), and Flatrock-Haw (05120205) Watersheds

AIMS Site Name	Event ID	Stream Name and Location	County	Hydrologic Unit Code (HUC)	Latitude (DD)	Longitude (DD)	Drainage Area (mi^2)	Gradient (ft/mi)	Site Status
WWU100-0110	19R097	Honey Creek @ CR 850 N (Bridge)	Henry	051202010801	40.05517	-85.49448	6.95	29.18	Approved
WWU100-0101	19R098	Deer Creek @ CR 575 N or CR 625 N	Henry	051202010803	40.02227	-85.53266	5.86	28.72	Approved
WWU100-0099	19R099	Mud Creek @ CR 575 N (Bridge)	Henry	051202010803	40.01328	-85.57018	3.09	33.4	Approved
WWU100-0083	19R101	Fall Creek @ CR 200 E (Rangeline Rd Bridge)	Madison	051202010804	40.01585	-85.63389	64.53	6.82	Approved
WWU100-0089	19R102	Lick Creek @ Connecticut Ave/W 1025 S (br	Madison	051202010807	39.95157	-85.85769	37.29	7.98	Approved
WWU100-0075	19R103	Lick Creek @ CR 1000 S (Reformatory Rd Bri	Madison	051202010805	39.95983	-85.72612	20.2	5.71	Approved
WWU100-0069	19R104	Lick Creek @ CR 1050 S (Bridge)	Madison	051202010807	39.95189	-85.77009	27.34	8.41	Approved
WWU100-0063	19R105	Lick Creek @ CR 400 E (Bridge)	Madison	051202010805	39.9753	-85.59548	1.56	11.3	Approved
WED040-0003	19R106	Brandywine Creek @ SR 9 (Bridge)	Shelby	051202040303	39.68694	-85.77389	65.8	4.9	Approved
WED020-0023	19R107	Big Blue River @ N Morristown Road	Shelby	051202040805	39.58169	-85.76206	299.75	4.21	Approved
WED030-0028	19R108	Little Blue River @ German Road	Shelby	051202040205	39.53976	-85.72694	100.41	4.67	Approved
WEF050-0006	19R110	Lewis Creek @ SR 252 (bridge)	Shelby	051202050503	39.36361	-85.85806	81.5	7.3	Approved
WWU-14-0005	19R111	North Prong Stotts Creek @ 2530 Firestatic	Morgan	051202011405	39.46689	-86.31262	21.9	11	Approved
WWU100-0041	19R130	Fall Creek @ CR 850 N @ Dietrich Memoria	Henry	051202010801	40.05524	-85.52735	16.26	6.65	Approved
WWU100-0104	19R131	Fall Creek @ Rock Bridge @ CR 850 N	Henry	051202010801	40.05516	-85.484	3.46	27.04	Approved

5. Specify Performance or Acceptance Criteria

Good quality data are essential for minimizing decision error. By identifying errors in the sampling design; measurement; and laboratory for physical, chemical, and biological parameters, more confidence can be placed in IBI calibrations and biological threshold determinations as well as aquatic life use assessments.

Site specific aquatic life use assessments include program specific controls to identify the introduction of errors. These controls include water chemistry blanks and duplicates; biological site revisits or duplicates; and laboratory controls through verification of species identifications as described in field procedure manuals (IDEM 2002; Ohio Environmental Protection Agency OHEPA 2006) and standard operating procedures (SOPs, IDEM 1992a, 1992b, 1992c, 2010a, 2015b, 2018c, 2018d, 2019b).

The QA/QC process detects deficiencies in the data collection as set forth in the for the Surface Water QAPP (IDEM 2017a). The QAPP requires all contract laboratories to adhere to rigorous standards during sample analyses and to provide good quality usable data. Chemists within the WAPB review the laboratory analytical results for quality assurance (QA). Any data which is “Rejected” due to analytical problems or errors will not be used for water quality assessment decisions. Any data flagged as “Estimated” may be used on a case-by-case basis. Criteria for acceptance or rejection of results as well as application of data quality flags is presented in the following Surface Water QAPP tables:

- Table D3-1 – Data Qualifiers and Flags
- Table A7-1 – Precision and Accuracy Goals for Data Acceptability by Matrix (Precision and accuracy goals with acceptance limits for applicable analytical methods)
- Table B2.1.1.8-2 – Field Parameters

Further investigation will be conducted, in response to consistent “rejected” data, to determine the source of error. Field techniques, used during sample collection and preparation along with laboratory procedures, will be subject to evaluation by both the WAPB QA Manager and Project Manager to troubleshoot error introduced throughout the entire data collection process. Corrective actions will be implemented once the source of error is determined.

6. Develop the Plan for Obtaining Data

Sampling locations in this project have been selected based on sites that were previously sampled from 2003—2013. Reference sites were least impacted by anthropogenic sources, and had good habitat and water chemistry results compared to other sites sampled over the 10-year period. Sampling locations may be near bridges or in rem27ote areas due to being a historical probabilistic monitoring site.

Indiana's 2018 CALM requires at least three samples in order to complete an assessment for aquatic life use with water chemistry data. Sampling for water chemistry will occur in April, May, and September.

The primary filter used in selecting reference sites is land use criteria:

- Percent of agricultural or urban areas
- Impervious surface area
- Human population density and distribution
- Road density and crossings
- Proportion of active mining
- Proportion of protected lands
- Proximity to permitted facilities, confined feeding operations, and Superfund sites.

In altered watersheds, chemical and in-stream physical habitat data may be used as a secondary filter to select reference sites and develop biological expectations for:

- "Least disturbed condition" (best available condition given widespread disturbance)
- "Minimally disturbed condition" (nearly absent human disturbance)
- "Historical condition" (prior to major industrialization, urbanization, and intense agricultural practices) (Stoddard et al. 2006)

Ideally, reference sites should be sampled at least once every 10 years to monitor for changes in the biological expectations for "least disturbed condition" and possible revisions to biological criteria. Sampling at reference sites should include a minimum of two biological communities (fish, macroinvertebrates, or diatoms), habitat evaluations, and at least *in-situ* water chemistry. Ideally, additional samples for laboratory water chemistry parameters, algal biomass, and flow could be collected, as resources allow.

The Indiana Department of Environmental Management (IDEM) Office of Water Quality (OWQ) worked with U.S. EPA and Tetra Tech in March 2015 to develop a framework and criteria for reference site selection (U.S. EPA Assistance Agreement I 96555711-1 IDEM). IDEM provided Tetra Tech with 1458 site locations previously sampled for fish or macroinvertebrates or both between 2003 and 2013, for possible selection as reference sites. Land use factors were the primary filter used by Tetra Tech to identify 324 potential reference sites. IDEM further narrowed the list by using in-stream chemical and physical data as a secondary filter.

A minimum of 20 reference sites are required in each of the natural environmental gradient classifications (i.e., ecoregion, stream size, etc.) to ensure an adequate level of statistical confidence in the linear regression models developed from the data. The model outputs will then accurately indicate changes in biological assemblage structure, given certain explanatory variables. Increasing the number of reference sites, however,

reduces variability in calibrating the IBI and setting biological criteria thresholds (U.S. EPA 2013, Tetra Tech personal communication).

Based on the spatial distribution of the sites and available resources, IDEM will conduct site reconnaissance and sampling of reference sites with the goal of at least 20 reference sites each year over the next 10 years to refine biological indices, water quality criteria, and possibly develop other assessment indicators and thresholds.

A.5 Training and Staffing Requirements

Table 5. Project Roles, Experience, and Training

Role	Required Training/Experience	Responsibilities	Training References
Project Manager	-Bachelor of Science Degree in biology or other closely related area plus four years of experience in aquatic ecosystems (Master's Degree with two years aquatic ecosystems experience may substitute) -Database experience -Experience in project management and QA/QC procedures	-Establish Project in the Assessment Information Management System (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	-AIMS II Database User Guide IDEM 2017b -Surface Water QAPP 2017a -U.S. EPA 2006 QA Documents on developing Work Plans (QAPPs)
Field Crew Chief - Fish or Macroinvertebrate Community Sampling	-Bachelor of Science Degree in biology or other closely related area -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 -Sampling efficiency and representation -Voucher specimen tracking -Overall operation of field crew when remote from central office -Adherence to safety and field SOP procedures by crew members -Ensure datasondes calibrated weekly, field sampling equipment is functioning properly, and all equipment loaded into vehicles prior to field sampling activities	-Barbour et al. 1999 -Hydrolab Corporation 2002 -IDEM 1992e, 2002, 2010a, 2010b, 2010c, 2015a, 2017a, 2018 2019a -Klemm et al. 1990-Plafkin et al. 1989 -Simon and Dufour 2005 -YSI 2006
Field Crew members - Fish or Macroinvertebrate Community Sampling	-Complete hands-on 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 operations	-Follow all safety and SOP procedures while engaged in field sampling activities -Follow direction of Field Crew Chief while conducting field sampling activities	-Barbour et al. 1999 -Hydrolab Corporation 2002 -IDEM 2002, 2010a, 2010b, 2010c, 2015a, 2017a, 2018c, 2019a, 2019b -Klemm et al. 1990 -Plafkin et al. 1989 -Simon and Dufour 2005 -YSI 2006

Role	Required Training/Experience	Responsibilities	Training References
Field Crew Chief - Water Chemistry and Algal Sampling	-Bachelor of Science Degree in biology or other closely related area -At least one year of experience in sampling methodology -Annually review relevant safety procedures -Annually review relevant SOP documents for field operations	-Field data sheets complete -Sampling efficiency and representation -Overall operation of field crew when remote from central office -Adherence to safety and field SOP procedures by crew members -Ensure datasondes calibrated weekly, field sampling equipment is functioning properly, and all equipment loaded into vehicles prior to field sampling activities	-Hydrolab Corporation 2002 -IDEM 1997, 2002, 2010b, 2010c, 2015a, 2015b, 2017a, 2018d -YSI 2006
Field Crew Members - Water Chemistry and Algal Sampling	-Complete hands-on training for sampling methodology prior to field sampling activities -Review relevant safety procedures and SOP documents for field operations	-Follow all safety and SOP procedures while conducting field sampling activities -Follow direction of Field Crew Chief while conducting field sampling activities	-Hydrolab Corporation 2002 -IDEM 1997, 2002, 2010b, 2010c, 2015a, 2015b, 2017a, 2018d -YSI 2006
Laboratory Supervisor - Fish or Macroinvertebrate Community Sample Processing	-Bachelor of Science Degree in biology or other closely related area -At least one year of experience in taxonomy of aquatic communities in the region -Annually review relevant safety procedures -Annually review relevant SOP documents for laboratory operations	-Adherence to safety and SOP procedures by laboratory staff -Assist with identification of fish/macroinvertebrate specimens -Verify taxonomic accuracy of samples -Voucher specimen tracking -QC calculations on data sheets, check for completeness -Ensure data are entered into AIMS II correctly	-IDEM1992e, 2008, 2010b, 2010c, 2012, 2017a, 2018c -AIMS II Database User Guide 2017b
Laboratory Staff - Fish or Macroinvertebrate Community Sample Processing	-Complete hands-on training for laboratory sample processing methodology prior to laboratory sample processing activities -Annually review relevant safety procedures and relevant SOP documents for laboratory operations	-Adhere to safety and SOP procedures -Follow Laboratory Supervisor direction while processing samples -Identify fish/ macroinvertebrate specimens -Perform necessary calculations on data, enter field sheets	-IDEM1992e, 2008, 2010b, 2010c, 2012, 2017a, 2018c -AIMS II Database User Guide 2017b

Role	Required Training/Experience	Responsibilities	Training References
Laboratory Supervisor - Water Chemistry and Algal Sample Processing	-Bachelor of Science Degree in biology or other closely related area -Annually review relevant safety procedures -Annually review relevant SOP documents for field operations	-Adherence to safety and SOP procedures by laboratory staff -Identification of diatoms -Completion of laboratory data sheets -Check data for completeness -Perform all necessary calculations on the data -Ensure that data are entered into the AIMS II database	-IDEM 2010b, 2010c, 2012, 2015b, 2017a, - Barbour et al. 1999 -AIMS II Database User Guide 2017b
Quality Assurance Officer	-Bachelor of Science in chemistry or a related field of study -Familiarity with QA/QC practices and methodologies -Familiarity with the Surface Water QAPP and data qualification methodologies	-Ensure adherence to QA/QC requirements of Surface Water QAPP -Evaluate data collected by sampling crews for adherence to project Work Plan -Review data collected by field sampling crews for completeness and accuracy -Perform a data quality analysis of data generated by the project -Assign data quality levels based on the data quality analysis -Import data into the AIMS II database -Ensure that field sampling methodology audits are completed according to WAPB procedures	-IDEM 2017a, 2012 -U.S. EPA 2006 documentation on QAPP development and data qualification -AIMS II Database User Guide 2017b
Personnel Safety and Reference Manuals	-Basic First Aid and Cardiopulmonary Resuscitation (CPR) -Personal Protective Equipment (PPE) Policy -Personal Flotation Devices (PFD)	-A minimum of 4 hours of in-service training provided by WAPB (IDEM 2010b) -IDEM 2008 -February 29, 2000 WAPB internal memorandum regarding use of approved PFDs	-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 -When working on Boundary waters as defined by Indiana Code (IC) [IC 14-8-2-27] or between sunset and sunrise

Role	Required Training/Experience	Responsibilities	Training References
			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.

B. MEASUREMENT AND DATA ACQUISITION

B.1 Sampling Design and Site Locations

The reference site locations, proposed in this project, have been selected because they were previously sampled for fish and/or macroinvertebrates with habitat evaluations and some water chemistry results. After evaluating watershed characteristics (land use, pollution sources, road density, percent impervious surface, etc.) as well as habitat and chemistry results, these reference site locations were considered least impacted by anthropogenic sources.

Site reconnaissance activities will be conducted in-house and through physical site visits. In-house activities include preparation and review of site maps and aerial photographs. Physical site visits include verification of accessibility, safety considerations, equipment needed to properly sample the site, and property owner consultations, if required. All information will be recorded on the IDEM Site Reconnaissance Form (Attachment 1) and entered into the AIMS II database. Precise coordinates for each site will be determined during the physical site visits or at the beginning of the sampling phase of this project, using a Trimble Juno™ SB Global Positioning System (GPS) or a Trimble Juno 3D GPS, both of which have an accuracy of two to five meters (IDEM 2015a). These coordinates will be entered into the AIMS II database. Table 3 and Figure 1 provide location information for reference sites sampled in 2019 from the Lower White and Lower East Fork White Basins. Table 4 and Figure 2 provide location information for reference sites sampled in 2019 from the Upper White, Driftwood, and Flatrock-Haw Basins.

Figure 1. 2019 Reference Sites for the Upper White (05120201), Driftwood (05120204), and Flatrock-Haw (05120205) Basins

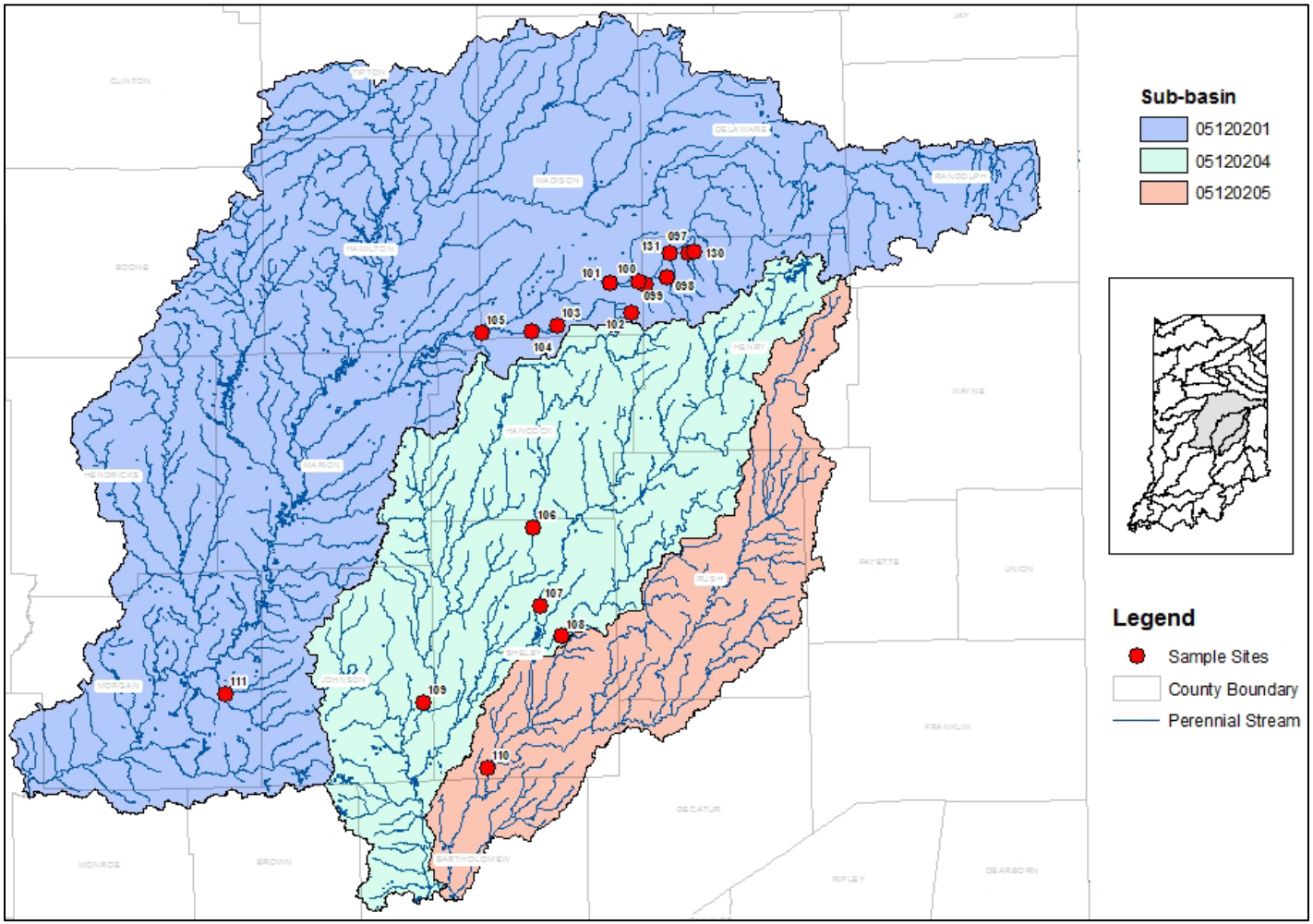
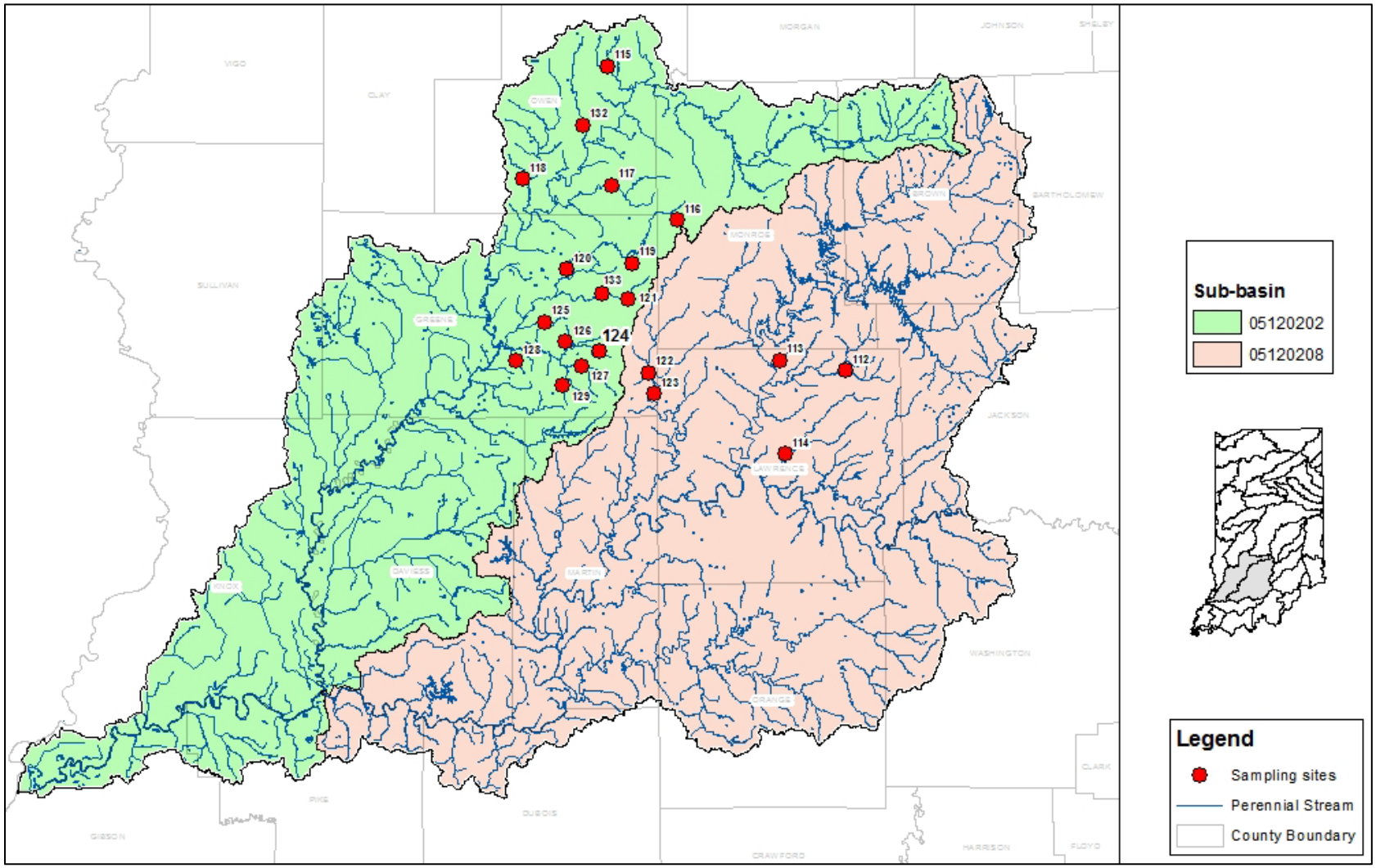


Figure 2. 2019 Reference Sites for the Lower White (05120202) and Lower East Fork White (05120208) Basins



B.2 Sampling Methods

1. Water Chemistry

During three discrete sampling events, one team of two staff will collect water chemistry grab samples, record water chemistry field measurements, and record physical site descriptions on the IDEM Stream Sampling Field Data Sheet (Attachment 2). All water chemistry sampling will adhere to the Water Quality Surveys Section Field Procedure Manual 2.1 (IDEM 2002).

2. Field Parameter Measurements

DO, pH, water temperature, specific conductance, and DO percent saturation will be measured with a Datasonde, during each sampling event regardless of the sample type being collected. Measurement procedures and operation of the Datasonde shall be performed according to the manufacturers' manuals (Hydrolab Corporation 2002; YSI 2006) and Sections 2.10—2.13 of the Water Quality Surveys Section Field Procedure Manual (IDEM 2002). Turbidity will be measured with a Hach™ turbidity kit and the meter number written in the comments under the field parameter measurements. If a Hach™ turbidity kit is not available, the Datasonde measurement for turbidity will be recorded and noted in the comments. All field parameter measurements and weather codes will be recorded on the IDEM Stream Sampling Field Data Sheet (Attachment 2). A digital photo will also be taken upstream and downstream of the site during each sampling event (IDEM 2018d).

3. Algal Sampling

In addition to standard water chemistry sampling, one team of two staff will collect chlorophyll *a* and pheophytin *a* from the seston community at sites with a drainage area greater than 1000 square miles and periphyton communities at all sites during the third round of water chemistry. Sampling for an average site that includes all of the above parameters will require approximately 2.5 hours of effort. The Algal Biomass Lab Data Sheet (Attachment 3) and Physical Description of Stream Site Form (Attachment 4) will be used to record information regarding substrates sampled for periphyton and physical parameters of the stream sampling area. See IDEM 2018d for a description of methods used in algal community sampling.

4. Laboratory Procedures for Diatom Identification and Enumeration

See IDEM 2015b for a description of methods used in diatom identification and enumeration.

5. 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 dependent upon the stream size and site accessibility. Fish assemblage assessments will be performed in a sampling reach of 15

times the average wetted width, with a minimum reach of 50 meters and a maximum reach of 500 meters (IDEM 2018c). An attempt will be made to sample all habitat types available within the sample reach to ensure adequate representation of the fish community present at the time of the sampling event. The possible list of electrofishers to be utilized include: the Smith-Root LR-24 or LR-20B Series backpack electrofishers; the Smith-Root model 1.5KVA electrofishing system; the Smith-Root model 2.5 Generator Powered Pulsator (GPP) electrofisher with RCB-6B junction box and rat-tail cathode cable; or Midwest Lake Electrofishing Systems (MLES) Infinity Control Box with MLES junction box and rat-tail cathode cable, assembled in a canoe (if parts of the stream are not wadeable, the system may require the use of a dropper boom array outfitted in a canoe or possibly a 12 foot Loweline™ boat; or for nonwadeable sites, the Smith-Root Type VI-A electrofisher assembled in a 16-foot Loweline™ boat (IDEM 1992a, 1992b, 1992c, 2018c).

Sample collections during high flow or turbid conditions will be avoided due to 1) low collection rates which result in nonrepresentative samples and 2) safety considerations for the sampling team. Sample collection during late autumn will be avoided due to the cooling of water temperature, which may affect the responsiveness of some species to the electrical field. This lack of responsiveness can result in samples that are not representative of the stream's fish assemblage (IDEM 2018c).

Fish will be collected using dipnets with fiberglass handles and netting of 1/8-inch mesh bag. Fish collected in the sampling reach will be sorted by species into baskets and/or buckets. Young-of-the-year fish less than 20 millimeters (mm) total length will not be retained in the community sample (IDEM 2018c).

For each field taxonomist (generally the crew leader), a complete set of fish vouchers 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 Data Sheet (Attachment 5), one to two individuals per new species encountered will be preserved in 3.7% formaldehyde solution to serve as representative fish vouchers, if the fish specimens can be positively identified and the individuals for preservation are small enough to fit in a 2000 mL jar. If however, the specimens are too large to preserve, a photo of key characteristics (e.g., fin shape, size, body coloration) will be taken for later examination (IDEM 2018c). Also, prior to sampling, 10% of the sites will be randomly selected for revisiting and a few representative individuals of all species found at the site will be preserved or photographed to serve as vouchers. Taxonomic characteristics for possible species encountered in the basin of interest will be reviewed prior to field work. Fish specimens should also be preserved if they cannot be positively identified in the field (i.e., those that co-occur like the Striped and Common Shiners, or are difficult to identify when immature); individuals that appear to be hybrids or have unusual

anomalies; or dead specimens that are taxonomically valuable for undescribed taxa (e.g., Red Shiner or Jade Darter); life history studies; or research projects (IDEM 2018c).

Data will be recorded for nonpreserved fish on the IDEM Fish Collection Data Sheet (Attachment 5) consisting of the following: number of individuals; minimum and maximum total length in millimeters (mm); mass weight in grams (g); and number of individuals with deformities eroded fins, lesions, tumors, and other anomalies (DELTs). Once the data is recorded, specimens are released within the sampling reach from which they were collected, when possible. Data will be recorded for preserved fish specimens following taxonomic identification in the laboratory (IDEM 2018c).

6. Macroinvertebrate Sampling

The macroinvertebrate community sampling may be conducted immediately following the fish community sampling event or on a different date by crews of two to three staff. Samples are collected using a modification of the U.S. EPA Rapid Bioassessment Protocol multi-habitat (MHAB) approach using a D-frame dip net with 500 µm mesh (Plafkin et al. 1989; Barbour et al. 1999; Klemm et al. 1990; IDEM 2010a). 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 dip net) and a 50 meter “sweep” sample of all available habitats (collected by disturbing habitat such as emergent vegetation, root wads, coarse particulate organic matter, depositional zones, logs, and sticks and collecting the dislodged macroinvertebrates within the dip net). The 50 meter length of riparian corridor that is sampled at each site will be defined using a tape measure or rangefinder. If the stream is too deep to wade, a boat will be used to sample the 50 meter zone along the shoreline with the best available habitat. The 1-minute “kick” and 50 meter “sweep” samples are combined in a bucket of water. the combined sample will be elutriated through a U.S. standard number 35 (500 µm) sieve a minimum of five times so that all rocks, gravel, sand, and large pieces of organic debris are removed from the sample. The remaining sample is then transferred from the sieve to a white plastic tray. The collector (while still on-site) will conduct a 15-minute pick of macroinvertebrates at a single organism rate endeavoring to pick for maximum organism diversity, and relative abundance through turning and examining the entire sample in the tray. The resulting picked sample will be preserved in 80% isopropyl alcohol; returned to the laboratory for identification at the lowest practical taxonomic level (usually genus or species level, if possible); and evaluated using the MHAB mIBI. Before leaving the site, an IDEM OWQ Macroinvertebrate Header Form (IDEM 2019a, Attachment 6) will be completed for the sample.

In addition to the standard MHAB method of macroinvertebrate collection, three other macroinvertebrate sampling methods will be employed at each

reference site. These three additional sampling methods were developed to validate components of the MHAB method. Specifically the 15-minute field pick and use of a 50 meter sample zone instead of a sample zone that is a multiple of the stream width (i.e., 15 times the streams wetted width). These methods were first employed at randomly selected sites in the 2013 and 2014 sample seasons (IDEM 2014). Analysis of the previous samples may prove an alternate method is superior, at which point only that method and the MHAB method will be used at reference sites. The three alternate methods are:

1. Keeping the "unpicked" remainder of the MHAB sample after completion of the 15-minute pick. The "unpicked" sample will be preserved and later subsampled in lab.
2. Collection of three "jabs" taken with a D-frame dipnet at each equally spaced transect. Transects are calculated by measuring the wetted width of the stream at the site location times 15 and divide by 10 (10 transects x 3 jabs = 30 jabs total).
3. Collection of two 0.25 square meter "kick" samples taken with a 0.5 meter wide bottom kick net at each transect. Samples are collected from alternating thirds of each transect. Transects are calculated by measuring the wetted width of the stream at the site location times 15 and divide by 10 (10 transects x 2 kicks of $0.25m^2$ = $5m^2$ of stream substrate).

At three reference sites, an additional duplicate set of all four sampling methods will be collected. The samples collected in 2019 will increase the total number of samples collected for the methods comparison study to 80 with 16 sets of duplicate samples.

7. Habitat Assessments

Habitat assessments will be completed immediately following macroinvertebrate and fish community sample collections at each site using a slightly modified version of the Ohio Environmental Protection Agency (OHEPA) QHEI, 2006 edition (Rankin 1995; OHEPA 2006). A separate QHEI (Attachment 7) must be completed for these two sample types, since the sampling reach length may differ (i.e., 50 meters for macroinvertebrates and between 50 and 500 meters for fish). See IDEM 2019b for a description of the method used in completing the QHEI.

B.3 Analytical Methods

Table 6 lists the field parameters with their respective test method and IDEM quantification limits. Table 7 lists the algal parameters with test method and IDEM quantification limits. Table 8 shows water chemistry sample container, preservative, and holding time requirements (all samples iced to 4 Degrees Celsius °C). Table 9 lists numerous parameters (priority metals, anions/physical chemistry, and nutrients/organic) with their respective test methods, IDEM reporting limits, and contract laboratory reporting limits. The IDEM OWQ Chain of Custody Form (Attachment 8) and the 2019 Reference Sites Water Sample

Analysis Request Form (Attachment 9) accompany each sample set through the analytical process.

Diatoms will be collected in the field according to protocols described in IDEM 2018d.

Table 6. Field Parameters Showing Method and IDEM Quantification Limit

Parameters	Method (SM=Standard Method)	IDEM Quantification Limit
DO (datasonde optical)	ASTM D888-09	0.05 mg/L
DO (datasonde)	SM 4500-OG	0.03 mg/L
DO (Winkler titration)	SM 4500-OC [1]	0.20 mg/L
DO % Saturation (datasonde optical)	ASTM D888-09	0.05 %
DO % Saturation (datasonde)	SM 4500-OG	0.01 %
pH (datasonde)	U.S. EPA 150.2	0.10 S.U.
pH (field pH meter)	SM 4500H-B [1]	0.10 S.U.
Specific Conductance (datasonde)	SM 2510B	1.00 µmho/cm
Temperature (datasonde)	SM 2550B(2)	0.1 °C
Temperature (field meter)	SM 2550B(2) [1]	0.1 °C
Turbidity (datasonde)	SM 2130B	0.02 NTU [2]
Turbidity (Hach™ turbidity kit)	EPA 180.1	0.05 NTU [2]

[1] Method used for Field Calibration Check
[2] NTU = Nephelometric Turbidity Unit(s)

Table 7. Algal Parameters Showing Method and USGS Quantification Limit

Algal Parameter	Method	IDEM Quantification Limit
Seston (Corrected) Chlorophyll *a* – Suspended	U.S. EPA 445.0	TBD
Seston Pheophytin *a* – Suspended	U.S. EPA 445.0	TBD
Seston (Uncorrected) Chlorophyll *a* – Suspended	Modified U.S. EPA 445.0	TBD
Periphyton (Corrected) Chlorophyll *a* – Attached	U.S. EPA 445.0	TBD
Periphyton Pheophytin *a* – Attached	U.S. EPA 445.0	TBD
Periphyton (Uncorrected) Chlorophyll *a* – Suspended	Modified U.S. EPA 445.0	TBD

Table 8. Water Chemistry Sample Container, Preservative, and Holding Time Requirements

Parameter	Container	Preservative	Holding
[1]Alkalinity as $CaCO_3$*	1 L, plastic, narrow mouth	None	14 days
[2]Ammonia-N**	1 L, Amber Glass Boston Round, narrow mouth	H_2SO_4 < pH 2	28 days
Chloride*	1 L, plastic, narrow mouth	None	28 days
Chemical Oxygen Demand**	1 L, Amber Glass Boston Round, narrow mouth	H_2SO_4 < pH 2	28 days
Hardness (as $CaCO_3$*) Calculated	1 L, plastic, narrow mouth	HNO_3 < pH 2	6 months
Metals (Total & Dissolved)	1 L, plastic, narrow mouth	HNO_3 < pH 2	6 months
Nitrate + Nitrite-N**	1 L, Amber Glass Boston Round, narrow mouth	H_2SO_4 < pH 2	28 days
Total Phosphorus**	1 L, Amber Glass Boston Round, narrow mouth	H_2SO_4 < pH 2	28 days
Solids (All Forms)*	1 L, plastic, narrow mouth	None	7 days
Sulfate*	1 L, plastic, narrow mouth	None	28 days
Total Kjeldahl Nitrogen**	1 L, Amber Glass Boston Round, narrow mouth	H_2SO_4 < pH 2	28 days
Total Organic Carbon**	1 L, Amber Glass Boston Round, narrow mouth	H_2SO_4 < pH 2	28 days

[1]General chemistry includes all parameters noted with an *.
[2]Nutrients include all parameters noted with a **.

Table 9. Water Chemistry Parameters, Test Method, IDEM, and Laboratory Reporting Limits

Priority Metals

Parameter	Total	Dissolved	Test Method	IDEM requested Reporting Limit (µg/L)	Pace Laboratory Reporting Limit (µg/L)
Aluminum	☒	☒	U.S. EPA 200.8	10	10
Antimony	☒	☒	U.S. EPA 200.8	1	1
Arsenic	☒	☒	U.S. EPA 200.8	2	1
Cadmium	☒	☒	U.S. EPA 200.8	1	0.2
Calcium	☒	☐	U.S. EPA 200.7	20	1,000
Chromium	☒	☒	U.S. EPA 200.8	3	2
Copper	☒	☒	U.S. EPA 200.8	2	1
Lead	☒	☒	U.S. EPA 200.8	2	1
Magnesium	☒	☐	U.S. EPA 200.7	95	1,000
Nickel	☒	☒	U.S. EPA 200.8	1.5	0.5
Selenium	☒	☒	U.S. EPA 200.8	4	1
Silver	☒	☒	U.S. EPA 200.8	0.3	0.5
Zinc	☒	☒	U.S. EPA 200.8	5	3

Anions/Physical

Parameter	Pace Test Method	IDEM requested Reporting Limit (mg/L)	Pace Laboratory Reporting Limit (mg/L)
Alkalinity (as $CaCO_3$)	U.S. EPA 310.2	10	2
Chloride	U.S. EPA 300.0	1	0.25
Dissolved Solids	SM 2540C	10	10
Hardness (as $CaCO_3$) by calculation	SM 2340B	0.4	1
Sulfate	U.S. EPA 300.0	0.05	0.25
Total Solids	SM 2540B	1	10
Total Suspended Solids	SM 2540D	1	5

Nutrients/Organic

Parameter	Pace Test Method	IDEM requested Reporting Limit (mg/L)	Pace Laboratory Reporting Limit (mg/L)
Ammonia-N	U.S. EPA 350.1	0.01	0.1
Chemical Oxygen Demand (COD)	U.S. EPA 410.4	3	10
Nitrogen, Nitrate + Nitrite	U.S. EPA 353.2	0.05	0.1
Total Kjeldahl Nitrogen (TKN)	U.S. EPA 351.2	0.1	0.5
Total Organic Carbon (TOC)	SM 5310C	1	1
Total Phosphorus	U.S. EPA 365.1	0.01	0.05

SM: Standard Methods for the Examination of Water and Wastewater

B.4 Quality Control and Custody Requirements

QA protocols will follow part B5 of the Surface Water QAPP (IDEM 2017a).

1. Water Chemistry Data

Sample bottles and preservatives certified for purity will be used. Sample collection containers for each parameter, preservative, and holding time (Table 8) will adhere to U.S. EPA requirements for water chemistry testing. 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 will be taken at a rate of one per sample analysis set or one per every 20 samples, whichever is greater. The sample collection portion of the Chain of Custody forms will be completed in the field (Attachment 8). Sample collector will be responsible for signing off on Chain of Custody form and ensuring that the lab receiving the samples records the date, time and signs for the samples. All samples collected for water chemistry analysis will be processed by Pace Analytical Services, Inc. (Indianapolis, Indiana) following the specifications set forth in Request for Proposals 16-074 (IDEM 2016a).

2. Algal Community Data

Excessive algal conditions will be recorded by staff if an algal bloom is observed on the waters' surface or in the water column. Staff are not calibrated on this rating (i.e., the decision as to the severity of the bloom is based on best professional judgement), but an algal mat on the surface of the water or a bloom that gives the water the appearance of green paint would be justification for a decision of excessive algal conditions.

To decrease the potential for cross contamination and bias of the algal samples, all equipment that has come in contact with the sample will be cleaned with detergent and rinsed with American Society for Testing and Materials (ASTM) D1193-91 Type III water after sampling has been completed at a given site. All sample labels must be accurately and thoroughly completed, including AIMS II database sample numbers, date, stream name, and sampling location. The sample collection portion of the Chain of Custody forms will be completed in the field (Attachment 8). The form will be completed when samples are transferred to the laboratory. Upon arrival to the laboratory, samples will be checked in by the laboratory manager. For the diatom samples, there will be another Chain of Custody form (Attachment 10) to document when the sample is removed from storage to be processed and made into a permanent mount (IDEM 2015b).

Analysis methods for chlorophyll *a* and pheophytin *a* can be viewed in Table 7. Beginning in 2019, all samples collected for chlorophyll *a* and pheophytin *a* will be processed by the new IDEM WAPB Algal Laboratory. Two methods will be used for the determination of total chlorophyll *a* during this sampling season. The first is the traditional U.S. EPA Method 445.0, which determines a "corrected" total chlorophyll *a* concentration

fluorometrically by measuring both the initial chlorophyll *a* concentration followed by acidification to determine the pheophytin *a* concentration. The total corrected chlorophyll *a* concentration of a sample is determined quantitatively (equations 12.2 – 12.3 in U.S. EPA Method 445.0). The second method used will be the modified U.S. EPA Method 445.0, in which the "uncorrected" total chlorophyll *a* value is measured fluorometrically via a set of very narrow bandpass excitation and emission filters that are specific to chlorophyll *a*. No pheophytin *a* concentration is determined in the modified method, and this method is not impacted by other chlorophyll *a* degradation products which may be prevalent in inland waters. Method quantification limits for both methods will be determined using U.S. EPA Method 445.0 Section 9.0 (Quality Control) during laboratory set up prior to the 2019 sampling season.

Blank filters will be run for periphyton and seston chlorophyll *a*. All chlorophyll *a* and pheophytin *a* filters will be processed in quadruplicate for QC purposes (four filters are processed from the same sample per analysis method). Ten percent of these replicate field samples will be analyzed at a separate laboratory (TBD).

3. QC of the diatom sampling, enumeration, and identification project will be documented by QC checks of both field and laboratory data. See (IDEM 2015b) for description of QA/QC protocols used in diatom identification and enumeration. **Fish Community Data**

Fish community sampling revisits will be performed at a rate of 10 percent of the total fish community sites sampled, in this case, three for the project (IDEM 2018c). Revisit sampling will be performed with at least two weeks of recovery between the initial and revisit sampling events. The fish community revisit sampling and habitat assessment will be performed with either a partial or complete change in field team members (IDEM 2018c). The resulting IBI and QHEI total score between the initial visit and the revisit will be used to evaluate precision. The IDEM OWQ Chain of Custody Form (Attachment 8) is used to track samples from the field to the laboratory. All raw data are: 1) checked for completeness; 2) utilized to calculate derived data (i.e., total weight of all specimens of a taxon), which is entered into the AIMS II database; and 3) checked again for data entry errors.

4. Macroinvertebrate Community Data

Sites at which duplicate macroinvertebrate field samples will be collected are randomly selected prior to the beginning of the field season and occur at a rate of 10 percent of the total macroinvertebrate community sites sampled, approximately 3 for the project. The macroinvertebrate community duplicate sample and corresponding habitat assessment will be performed by the same team member who performed the original sample, immediately after the initial sample is collected. This will result in a precision evaluation based on a 10% duplicate of samples collected. The IDEM OWQ COC form (Attachment 8) is used to track samples from

the field to the laboratory. Laboratory identifications and QA/QC of taxonomic work is maintained by the laboratory supervisor of the Probabilistic Monitoring Section of IDEM.

B.5 Field Parameter Measurements/Instrument Testing/Calibration

The datasonde will be calibrated prior to each week's sampling (IDEM 2002). Calibration results and drift values will be recorded, maintained, stored, and archived in log books located in the calibration laboratories at the Shadeland facility. The drift value is the difference between two successive calibrations. Field parameter calibrations will conform to the procedures as described in the instrument users' manuals (Hydrolab Corporation 2002; YSI 2006). The DO component of the calibration procedure will be conducted using the air calibration method (IDEM 2002, page 74). The unit will be field checked for accuracy once during the week by comparison with a Winkler DO test (IDEM 2002, page 64), Hach™ turbidity, and a pH and temperature meter. Weekly calibration verification results will be recorded on the field calibrations portion of the Stream Sampling Field Data Sheet (Attachment 2) and entered into the AIMS II database. A Winkler DO test will also be conducted at sites where the DO concentration is 4.0 mg/L or less.

In-situ water chemistry field data are collected in the field using calibrated or standardized equipment. Calculations may be done in the field 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 6). QC checks are performed on information for field or laboratory results to estimate precision, accuracy, and completeness for the project, as described in the Surface Water QAPP (IDEM 2017a) Section C1.1 on page 176.

A Nikon© differential interference contrast (DIC) microscope and Nikon© Elements D camera and imaging system will be used for identification and enumeration of diatoms. Branch staff calibrated the ocular reticle in the microscope. The ocular reticle was calibrated at each magnification with a stage micrometer. The calibration should be checked again if the microscope is moved to a new location.

C. ASSESSMENT AND OVERSIGHT

C.1 External and Internal Checks

Field and laboratory performance and system audits will be conducted to ensure good quality data. The field and laboratory performance checks include: precision measurements by relative percent difference (RPD) of field and laboratory duplicate (IDEM 2017a, pp. 56, 61—63), accuracy measurements by percent of recovery of MS/MSD samples analyzed in the laboratory (IDEM 2017a, pp. 58, 61—63), and completeness measurements by the percent of planned samples that are actually collected, analyzed, reported, and usable for the project (IDEM 2017a, page 58). Ten percent of diatom samples will be verified by the Department of Biological and Environmental Sciences of Georgia College and

State University (Milledgeville, Georgia) following the specifications set forth in (IDEM 2015b). Fish taxonomic identifications made by IDEM staff in the laboratory may be verified by regionally recognized non-IDEM freshwater fish taxonomists (e.g., Brant Fisher, Nongame Aquatic Biologist, Indiana DNR). Ten percent of macroinvertebrate samples (the initial samples taken at sites where duplicate samples were collected) will be sent off to Rithron Associates, Inc. (Missoula, MT) for verification by an outside taxonomist (IDEM 2010a).

C.2 Audits

Field audits will be conducted biannually by staff of the IDEM WAPB to ensure that sampling activities adhere to approved SOPs. Audits are systematically conducted by WAPB QA 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 2017a, page 176).

C.3 Data Quality Assessment Levels

The samples and various types of data collected by this program are intended to meet the QA criteria and rated DQA Level 3, as described in the Surface Water QAPP (IDEM 2017a, page 182).

C.4 Quality Assurance and Quality Control (QA/QC) Review Reports

QA reports to management, and data validation and usability are also important components of the Surface Water QAPP, which ensures good quality data for this project.

D. DATA VALIDATION AND USABILITY

A QA audit report will be submitted to the QA Manager and Project Manager for review of this project, should problems arise, need to be investigated, and corrected. As described in Section D of the Surface Water QAPP (IDEM 2017a), data are reduced (converted from raw analytical data into final results in proper reporting units); validated (qualified based on the performance of field and laboratory QC measures incorporated into the sampling and analysis procedures); and reported (described so as to completely document the calibration, analysis, QC measures, and calculations). These steps allow users to assess the data to ensure it meets the project data quality objectives.

D.1. Data Handling and Associated QA/QC Activities

The various data qualifiers and flags that will be used for QA and validation of the data are found on pages 184—185 of the Surface Water QAPP (IDEM 2017a).

D.2. Data Usability

The environmental data collected and its usability are qualified per each lab or field result obtained and classified into one or more of the four categories: Acceptable Data, Enforcement Capable Results, Estimated Data, and Rejected Data as described on page 184 of the Surface Water QAPP (IDEM 2017a).

Data collected in 2019 will be recorded in the AIMS II database and presented in three compilation summaries:

- A general compilation of the 2019 Reference Site field and water chemistry data prepared for use in the Indiana Integrated Water Monitoring and Assessment Report.
- A database report format containing biological results and habitat evaluations, which will be produced for inclusion in the Integrated Report as well as individual site folders.
- Laboratory bench sheets of the species taxa names and enumerations of all diatoms collected.

All data and reports will be made available to public and private entities that find the data useful.

D.3. Laboratory and Estimated Cost

Laboratory analysis and data reporting for this project will comply with the Surface Water QAPP (IDEM 2017a); Request for Proposals 16-74 (see IDEM 2016a); and the IDEM Quality Management Plan (QMP) (IDEM 2018e). Analytical tests on the water chemistry parameters outlined in Table 9 will be performed by Pace Analytical Services in Indianapolis, Indiana. Algal samples will be collected by IDEM staff. Chlorophyll *a* and pheophytin *a* will be analyzed by the IDEM WAPB Algal Chlorophyll Laboratory staff. Diatom identification and enumeration will be performed by IDEM staff or an outside contractor. The Department of Biological and Environmental Sciences, Georgia College and State University will verifyi diatom taxa from ten percent of the sites sampled. All fish and macroinvertebrate samples will be collected and analyzed by IDEM staff. Ten percent of macroinvertebrate samples will be verified by Rhithron Associates, Inc. The anticipated budget for laboratory cost for the project is outlined in Table 10.

Table 10. Total Estimated Laboratory Cost for the Project.

Analysis	Laboratory	Estimated Cost
Water Chemistry	Pace Analytical Services 7726 Moller Road. Indianapolis, Indiana 46268	$43,803
Algal Biomass	IDEM WAPB Algal Laboratory 2525 Shadeland Avenue, Indianapolis, IN 46204	$11,000
Diatom Verification	Department of Biological and Environmental Sciences Georgia College and State University 320 S. Wayne St. Milledgeville, GA 31061	$750
Macroinvertebrate Identification	Rhithron Associates, Inc. 33 Fort Missoula Road	$660

	Missoula, Montana 59804	

Total $50,880

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*Document may be inspected at the Watershed and Assessment Branch office, located at 2525 North Shadeland Avenue, Indianapolis, IN.

F. DISTRIBUTION LIST

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Scott Zello-Dean	IDEM/OWQ/WAPB/Probabilisitic Monitoring Section

Attachment 1 IDEM Site Reconnaissance Form

Site Reconnaissance Form

EPA Site Identifier	Rank
INRB15-001	1
Recon #: R-6551	
Trip #: R15WQW-1	

Site Number: WUW-07-0014 Stream: Mossburg Ditch County: Wells

Location Description: CR 550 W

Reconnaissance Data Collected

Recon Date: 3/9/2015 Crew Members: TAF KAG

Avg. Width (m)	Avg. Depth (m)	Max. Depth (m)	Nearest Town
2	.2	.5	Liberty Center

Water Present? ☑ Site Wadeable? ☑ Riffle/Run Present? ☐ Road/Public Access Possible? ☑

Site Impacted by Livestock? ☐ Collect Sediment? ☐ Gauge Present? ☐

Landowner/Contact Information

First Name: Last Name: Street Address: City: State: Zip: Telephone: E-Mail Address:

Pamphlet Distributed? ☐ Please Call In Advance? ☐ Results Requested? ☐

Rating, Results, Comments, and Planning

Site Rating By Category (1=easy, 10=difficult)
Access Route
2
Safety Factor
4
Sampling Effort
3

Reconnaissance Decision

Pre-Recon
Recon in process
(Approved Site)
No, Landowner denied access
No, Dry
No, Stream channel missing
No, Physical barriers
No, Impounded stream
No, Marsh/Wetland
No, Bridge gone or not accessible
No, Unsafe due to traffic or location
No, Site impacted by backwater
No, Other

Equipment Selected

Circle Equipment Needed

(Backpack)
Boat
Totebarge
Longline
Scanoe
Seine
Weighted Handline
Waders
Gill Net

Comments

Sketch of Stream & Access Route – Indicate Flow, Direction, Obstacles, & Land Use (Use Back of Page, if Necessary)

All crews park off of the CR 550 W bridge, frozen during recon so it was hard to tell where the best parking is. May have to park at the cemetary N of site if there isn't a good pull off. Site ~ 250 feet W of bridge. Site was zipped back to the ditch during recon. Walk N bank to site, do not have S bank permission.

ENT KAG 3.16.15
QC1 KRW 3/16/15
QC2 TAF 3/19/15

40 43 17.540711
-85 19 39.426530

1/16/2015 15:34:42 PM Site Reconnaissance Form, Page 2 of 101

Attachment 2 IDEM Stream Sampling Field Data Sheet

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	◇ 1 ◇ 2 ◇ 3 ◇ 4	◇ Riffle ◇ Dry ◇ Stagnant	◇ Clear ◇ Green ◇ Sheen	◇ 0-20% ◇ 60-80%
◇ No; Stream Dry ◇ No; Other	◇ 6 ◇ 8 ◇ 12 ◇ 24	◇ Pool ◇ Run ◇ Flood	◇ Murky ◇ Black ◇ Other	◇ 20-40% ◇ 80-100%
◇ No; Owner refused Access	◇ 48 ◇ 72 ◇ AS-Flow	◇ Glide ◇ Eddy ◇ Other	◇ Brown ◇ Gray (Septic/Sewage)	◇ 40-60%

Special Notes:

Field Data:

Date (m/d/yy)	24-hr Time (hh:mm)	D.O. (mg/l)	pH	Water Temp (°C)	Spec Cond (µohms/cm)	Turbidity (NTU)	% Sat.	Chlorine (mg/l)	Chloride (mg/l)	Chlorophyll (mg/l)	Weather Codes SC	WD	WS	AT
Comments														
Comments														
Comments														
Comments														
Comments														
Comments														

Measurement Flags		
	<	< Min. Meter Measurement
	>	> Max. Meter Measurement
	E	Estimated (See Comments)
	R	Rejected (See Comments)

Weather Code Definitions

SC Sky Conditions		WD Wind Direction	WS Wind Strength	AT Air Temp
1 Clear	8 Rain	00 North (0 degrees)	0 Calm	1 < 32
2 Scattered	9 Snow	09 East (90 degrees)	1 Light	2 33-45
3 Partly	10 Sleet	18 South (180 degrees)	2 Mod./Light	3 46-60
4 Cloudy		27 West (270 degrees)	3 Moderate	4 61-75
5 Mist			4 Mod./Strong	5 76-85
6 Fog			5 Strong	6 > 86
7 Shower			6 Gale	

Field Calibrations:

Date (m/d/yy)	Time (hh: mm)	Calibrator Initials	Calibrations Type	Meter #	Value	Units

Calibration Type	
	pH
	DO
	Turbidity

Preservatives/Bottle Lots:

Group: Preservative	Preservative Lot #	Bottle Type	Bottle Lot #

Groups: Preservatives		Bottle Types	
GC	General Chemistry: Ice	2000P	2000mL Plastic, Narrow Mouth
Nx	Nutrients: H2SO4	1000P	1000mL Plastic, Narrow Mouth
Metals	Metals: HNO3	500P	500mL Plastic, Narrow Mouth
CN	Cyanide: NaOH	250P	250mL Plastic, Narrow Mouth
O&G	Oil & Grease: H2SO4	1000G	1000mL Glass, Narrow Mouth
Toxics	Toxics: Ice	500G	500mL Glass, Wide Mouth
Ecoli	Bacteriology: Ice	250G	250mL Glass, Wide Mouth
VOA	Volatile Organics: HCl & Thiosulfate	125G	125mL Glass, Wide Mouth
Pest	Pesticides: Ice	40GV	40mL Glass Vial
Phen	Phenols: H2SO4	120PB	120ml Plastic (Bacteria Only)
Sed	Sediment: Ice	1000PF	1000mL Plastic, Corning Filter
Gly	Glyphosate: Thiosulfate	500PF	500mL Plastic, Corning Filter
Hg	Mercury(1631): HCl	60P	60mL Plastic
Cr6	ChromiumVI(1636): NaOH	250T	250mL Teflon
MeHg	Methyl Mercury(1630): HCl	500T	500mL Teflon
		125T	125mL Teflon

Data Entered By: _____ QC1: _____
QC2: _____

Attachment 3 IDEM Algal Biomass Lab Data Sheet

Algal Biomass Lab Datasheet

Sample #	Site	Stream

Supporting Site Information

Traditional Forestry % Closed Canopy: ☐ <=10m ☐ >10m (Measure center only if width <=10m, record to nearest whole percent)

	North	East	South	West	Average x 1.04 =
Left Bank					
Center					
Right Bank					
Total %CC (Average from above, or Center only = %CC)				100 - %CC	

Phytoplankton Information

Sampling Method: ☐ Grab Sample (Dip) ☐ Multiple Verticles Number of Verticles:

Chlorphyll A	Blank	Filter 1	Filter 2	Filter 3	Filter 4
Sample Time					
Sample Volume (mL)					

Periphyton Information

Periphyton Habitat: ☐ Epilithic (Area-Scape) ☐ Epidendric (Cylinder Scrape) ☐ Epipsammic (Petri Dish)

Diatom Sample Collected: ☐ Yes ☐ No | Diatom Volume: mL | Formalin Volume: mL | Slurry Volume mL

Chlorphyll A	Blank	Filter 1	Filter 2	Filter 3	Filter 4
Sample Time					
Sample Volume (mL)					

Periphyton Area Calculation

Cylinder Scrape

Snag #	Length (cm)(L)	Circumference U_1	U_2	U_3	U	Area (L * U)
1						
2						
3						
4						
5						
				Total Area (cm²)		

Area Scrape (Using SG-32)

Rock#	1	2	3	4	5
Area (cm²)	7.38	7.38	7.38	7.38	7.38
Total (cm²)	36.9				

Petri Dish

Number of Discrete Samples (n):	
Total Area of One Sampler (a):	19.01 cm²
Total Sample Area (n * a):	

Stream Discharge / Rainfall Information

Nearest USGS Gage Site: ☐ Upstream ☐ Downstream ☐ No USGS Gage Near

River miles from site:	Discharge CFS at sampling: CFS
Gage location:	Discharge days since 50% flow exceeded: days
Rainfall data source: ☐ NOAA ☐ CoCoRaHS ☐ Indiana State Climate Office ☐ USGS gage rain gauge ☐ Other:	
Total precipitation at sampling: in. on date:	Cumulative rain 7 days previous to sampling: in.
Rain station location, county:	Inches since last rainfall previous to sampling: in.
	Days since last rainfall previous to sampling: days

Identifier	Date	Reviewer 1	Date	Reviewer 2	Date	Notes:
		☐ Review 1 Completed		☐ Review 2 Completed		

Attachment 4 IDEM Physical Description of Stream Site Form (front)

Revised 4/20/12

Probabilistic Monitoring Section Physical Description of Stream Site

Stream :_____ **AIMS #**_____ **Program #:**_____

Date: _____ **Time:** _____ **Crew Chief:**_____ **Crew**_____

General Stream Description:

_____
_____
_____
_____
_____

Characteristics at the site and immediately upstream (check All that apply).

Outer Riparian Zone L R	Inner Riparian Zone L R	L.Width(m)	R.Width(m)
☐ ☐ Agricultural Row crop	☐ ☐ Agricultural Rowcrop	_____	_____
☐ ☐ Agricultural Pasture	☐ ☐ Agricultural Pasture	_____	_____
☐ ☐ Devoid of Vegetation	☐ ☐ Devoid of Vegetation	_____	_____
☐ ☐ Fallow	☐ ☐ Fallow	_____	_____
☐ ☐ Forested	☐ ☐ Forest	_____	_____
☐ ☐ Residential	☐ ☐ Residential	_____	_____
☐ ☐ Commercial/Industrial	☐ ☐ Commercial/Industrial	_____	_____
☐ ☐ Weeds and Scrub	☐ ☐ Treeline	_____	_____
☐ ☐ Other _____	☐ ☐ Weeds and Scrub		
	☐ ☐ Other _____	_____	_____

Flow above site	Flow at site	Substrate (if visable)
☐ Riffle	☐ Riffle	☐ Cobble
☐ Pool	☐ Pool	☐ Boulder
☐ Eddy	☐ Eddy	☐ Sand
☐ Run	☐ Run	☐ Muck
☐ Glide	☐ Glide	☐ Silt
☐ Other _____	☐ Other _____	☐ Gravel
_____	_____	☐ Bedrock
_____	_____	☐ Other _____

Characteristics at site and immediately upstream (check ONE).

Water Description	Sinuosity of Channel	Discharge Pipe Present
☐ Clear	☐ High	☐ No
☐ Grey (Septic)	☐ Moderate	☐ Yes
☐ Murky	☐ Low	If yes, Effluent Flowing?
☐ Black	☐ Channelized	☐ No
☐ Brown		☐ Yes
☐ Green		Description of Effluent _____
☐ Other _____		_____

Continued on back

Attachment 4 IDEM Physical Description of Stream Site Form (back)

Revised 4/20/12

Stream Bank

Functional Slope: L R	Bank Erosion: L R	
☐☐ 0-30°	☐☐ Low	Percent Canopy Closed: _____
☐☐ 31-50°	☐☐ Moderate	Stream Stage 1-5 (Low-High): _____
☐☐ 51-70°	☐☐ High	Velocity of Stream 1-5 (Slow-Fast): _____
☐☐ 71-90°		

Visible Stream Degradation? ☐ Yes ☐ No

Description: _____

Aquatic Life Observed? ☐ Yes ☐ No

Description: _____

Algae Observed? ☐ Yes ☐ No

Description: _____

Rooted Macrophytes Observed? ☐ Yes ☐ No

Description: _____

Additional Comments:

_____
_____
_____
_____

Follow Up Date:_____Time:_____Crew Chief:_____Crew:_____
_____
_____
_____
_____

Follow Up Date:_____Time:_____Crew Chief:_____Crew:_____
_____
_____
_____
_____

Photography Date:_____ Time:_____ Number(s):_____; _____;_____

Notes (include items relevant for determining scale – items of known measurement, etc.)

_____
_____
_____

Attachment 5 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											

KRW: Rev/09.26.18 Calculation:________ QC1 + Entry________ QC 1 ________ QC 2________

Attachment 6 IDEM OWQ Macroinvertebrate Header Form

Office of Water Quality: Macroinvertebrate Header

L-Site	Stream Name	Location	County	Surveyor

Sample Date	Sample #	Macro#	# Containers

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

☐ Normal _____
☐ Duplicate _____
☐ Replicate _____

☐ **Habitat Complete** ☐ **Sample Quality Rejected**

Macro Sub Sample (Field or Lab): _____

Macro Reach Sampled (m): _____

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):

Stream Type:
☐ Cold
☐ Warm

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

☐ **Channelization** ☐ **Dam Present**

Predominant Surrounding Land Use: ☐ Forest ☐ Field/Pasture ☐ Agricultural ☐ Residential ☐ Commercial ☐ Industrial
Other

Sediment

Sediment Odors: ☐ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ Anaerobic ☐ None Other

Sediment Deposits: ☐ Sludge ☐ Sawdust ☐ Paper Fiber ☐ Sand ☐ Relic Shells Other

Sediment Oils: ☐ Absent ☐ Moderate ☐ Profuse ☐ Slight

☐ Are the undersides of stones, which are not deeply embedded, black?

Substrate Components

(Note: Select from 0%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, or 100% for each inorganic/ organic substrate component)

Inorganic Substrate Components (% Diameter)						
Bedrock	Boulder (>10 in)	Cobble (2.5-10 in)	Gravel (0.1-2.5 in)	Sand (gritty)	Silt	Clay (slick)

Organic Substrate Components (% Type)			
Detritus (sticks, wood)	Detritus (CPOM)	Muck/Mud (black, fine FPOM)	Marl(gray w/ shell fragments)

Water Quality

Water Odors: ☐ Normal ☐ Sewage ☐ Petroleum ☐ Chemical ☐ None Other

Water Surface Oils: ☐ Slick ☐ Sheen ☐ Glob ☐ Flocks ☐ None

IDEM 03/8/18

Attachment 7 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 and check every type present

BEST TYPES PREDOMINANT	PRESENT P/G	PRESENT R/R	OTHER TYPES PREDOMINANT	PRESENT P/G	PRESENT R/R
☐☐ 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
- ☐ LIMESTONE [1]
- ☐ TILLS [1]
- ☐ WETLANDS [0]
- ☐ HARDPAN [0]
- ☐ SANDSTONE [0]
- ☐ RIP/RAP [0]
- ☐ LACUSTRINE [0]
- ☐ SHALE [-1]
- ☐ COAL FINES [-2]

QUALITY

SILT
- ☐ HEAVY [-2]
- ☐ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ FREE [1]

SILT/NUISANCE
- ☐ EXTENSIVE [-2]
- ☐ MODERATE [-1]
- ☐ NORMAL [0]
- ☐ NONE [1]

Substrate Maximum 20

Comments

2] *INSTREAM COVER* Indicate presence 0 to 3: **0**–Absent; **1**–Very small amounts or if more common of marginal quality; **2**–Moderate amounts, but not of highest quality or in small amounts of highest quality; **3**–Highest quality in moderate or greater amounts (e.g., very large boulders in deep or fast water, large diameter log that is stable, well developed root wad in deep/fast water, or deep, well-defined, functional pools.)

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

AMOUNT
Check ONE (Or 2 & average)
- ☐ EXTENSIVE > 75% [11]
- ☐ MODERATE 25 - 75% [7]
- ☐ SPARSE 5 - < 25% [3]
- ☐ NEARLY ABSENT < 5% [1]

Cover Maximum 20

Comments

3] *CHANNEL MORPHOLOGY* Check ONE in each category (Or 2 & average)

SINUOSITY
- ☐ HIGH [4]
- ☐ MODERATE [3]
- ☐ LOW [2]
- ☐ NONE [1]

DEVELOPMENT
- ☐ EXCELLENT [7]
- ☐ GOOD [5]
- ☐ FAIR [3]
- ☐ POOR [1]

CHANNELIZATION
- ☐ NONE [6]
- ☐ RECOVERED [4]
- ☐ RECOVERING [3]
- ☐ RECENT OR NO RECOVERY [1]

STABILITY
- ☐ HIGH [3]
- ☐ MODERATE [2]
- ☐ LOW [1]

Channel Maximum 20

Comments

4] *BANK EROSION AND RIPARIAN ZONE* Check ONE in each category for EACH BANK (Or 2 per bank & average)

River right looking downstream

L	R	EROSION
☐	☐	NONE/LITTLE [3]
☐	☐	MODERATE [2]
☐	☐	HEAVY/SEVERE [1]

L	R	RIPARIAN WIDTH
☐	☐	WIDE > 50m [4]
☐	☐	MODERATE 10-50m [3]
☐	☐	NARROW 5-10m [2]
☐	☐	VERY NARROW [1]
☐	☐	NONE [0]

L	R	FLOOD PLAIN QUALITY
☐	☐	FOREST, SWAMP [3]
☐	☐	SHRUB OR OLD FIELD [2]
☐	☐	RESIDENTIAL, PARK, NEW FIELD [1]
☐	☐	FENCED PASTURE [1]
☐	☐	OPEN PASTURE, ROWCROP [0]

L	R	
☐	☐	CONSERVATION TILLAGE [1]
☐	☐	URBAN OR INDUSTRIAL [0]
☐	☐	MINING /CONSTRUCTION [0]

Indicate predominant land use(s) past 100m riparian.

Riparian Maximum 10

Comments

5] *POOL/GLIDE AND RIFFLE/RUN QUALITY*

MAXIMUM DEPTH
Check ONE (ONLY!)
- ☐ > 1m [6]
- ☐ 0.7 - < 1m [4]
- ☐ 0.4 - < 0.7m [2]
- ☐ 0.2 - < 0.4m [1]
- ☐ < 0.2m [0] [metric = 0]

CHANNEL WIDTH
Check ONE (Or 2 & average)
- ☐ POOL WIDTH > RIFFLE WIDTH [2]
- ☐ POOL WIDTH = RIFFLE WIDTH [1]
- ☐ POOL WIDTH < RIFFLE WIDTH [0]

CURRENT VELOCITY
Check ALL that apply
- ☐ TORRENTIAL [-1]
- ☐ VERY FAST [1]
- ☐ FAST [1]
- ☐ MODERATE [1]
- ☐ SLOW [1]
- ☐ INTERSTITIAL [-1]
- ☐ INTERMITTENT [-2]
- ☐ EDDIES [1]

Indicate for reach – pools and riffles.

Recreation Potential (Check one and comment on back)
- ☐ Primary Contact
- ☐ Secondary Contact

Pool/ Current Maximum 12

Comments

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species:

☐ NO RIFFLE [metric = 0]

RIFFLE DEPTH
Check ONE (Or 2 & average)
- ☐ BEST AREAS > 10cm [2]
- ☐ BEST AREAS 5 - 10cm [1]
- ☐ BEST AREAS < 5 cm [metric = 0]

RUN DEPTH
- ☐ MAXIMUM > 50cm [2]
- ☐ MAXIMUM < 50cm [1]

RIFFLE/RUN SUBSTRATE
- ☐ STABLE (e.g., Cobble, Boulder) [2]
- ☐ MOD. STABLE (e.g., Large Gravel) [1]
- ☐ UNSTABLE (e.g., Fine Gravel, Sand) [0]

RIFFLE/RUN EMBEDDEDNESS
- ☐ NONE [2]
- ☐ LOW [1]
- ☐ MODERATE [0]
- ☐ EXTENSIVE [-1]

Riffle/ Run Maximum 8

Comments

6] *GRADIENT* (ft/mi)

DRAINAGE AREA (mi^2)

- ☐ VERY LOW - LOW [2 – 4]
- ☐ MODERATE [6 - 10]
- ☐ HIGH - VERY HIGH [10 - 6]

%POOL: ☐ %GLIDE: ☐
%RUN: ☐ %RIFFLE: ☐

Gradient Maximum 10

Entered _____ QC1 _____ QC2 _____ IDEM 02/28/2018

Attachment 7 (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:

Attachment 8 IDEM OWQ 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	
P = Plastic	G = Glass	N.M. = Narrow Mouth		Bact = Bacteriological Only						Should samples be iced?		Y	N
M = MS/MSD	B = Blank	D = Duplicate		R = Revisit									

Carriers

I certify that I have received the above sample(s).

Signature	Date	Time	Seals Intact		Comments
Relinquished By:			Y	N	
Received By:					
Relinquished By:			Y	N	
Received By:					
Relinquished By:			Y	N	
Received By:					
IDEM Storage Room #					

Lab Custodian

I certify that I have received the above sample(s), which has/have been recorded in the official record book. The same sample(s) will be in the custody of competent laboratory personnel at all times, or locked in a secured area.

Signature:_____ Date:_____ Time:_____

Lab:_____ Address:_____

Revision Date: 4/27/2016

Attachment 9 2019 Reference Sites Water Sample Analysis Request Form

Indiana Department of Environmental Management
Office of Water Quality
Watershed Planning and Assessment Branch
www.idem.IN.gov

Water Sample Analysis Request

Project Name: 2019 Reference Sites **Composite** ☐ **Grab** ☒

OWQ Sample Set	19WQW	IDEM Sample Nos.	
Crew Chief	Raissa Espejo	Lab Sample Nos.	
Collection Date	Apr. - Oct.	Lab Delivery Date	

Anions and Physical Parameters

Parameter	Test Method	Total	Dissolved
Alkalinity	310.2	☒ **	☐
Total Solids	SM2540B	☒ **	
Suspended Solids	SM2540D	☒ **	
Dissolved Solids	SM2540C		☒ **
Sulfate	300.0	☐ **	☒ **
Chloride	300.0	☐ **	☒
Hardness (Calculated)	SM-2340B	☒ **	☐
Fluoride	SM4500-F-C	☐ **	☐

Priority Pollutant Metals Water Parameters

Parameter	Test Method	Total	Dissolved
Antimony	200.8	☒	☒
Arsenic	200.8	☒	☒
Beryllium	200.8	☐	☐
Cadmium	200.8	☒	☒
Chromium	200.7	☒	☒
Copper	200.8	☒	☒
Lead	200.8	☒	☒
Mercury, Low Level	1631, Rev E.	☐	☐
Nickel	200.8	☒	☒
Selenium	200.8	☒	☒
Silver	200.8	☒	☒
Thallium	200.8	☐	☐
Zinc	200.7	☒	☒

Cations and Secondary Metals Parameters

Parameter	Test Method	Total	Dissolved
Aluminum	**200.7**, 200.8	☒	☒
Barium	200.8	☐	☐
Boron	200.8	☐	☐
Calcium	**200.7**, 200.8	☒ ***	☐
Cobalt	200.8	☐	☐
Iron	200.7	☐	☐
Magnesium	**200.7**, 200.8	☒ ***	☐
Manganese	200.8	☐	☐
Sodium	200.7	☐	☐
Silica, Total Reactive	200.7	☐	☐
Strontium	200.8	☐	☐

Send reports (Fed. Ex. or UPS) to:

Tim Bowren - IDEM
STE 100
2525 North Shadeland Ave.
Indianapolis, IN 46219

Deliver reports to:

Tim Bowren – IDEM
STE 100
2525 North Shadeland Ave.
Indianapolis, IN 46219

Organic Water Parameters

Parameter	Test Method	Total
Priority Pollutants: Oranochlorine Pesticides and PCBs	608	☐
Priority Pollutants: VOCs - Purgeable Organics	624	☐
Priority Pollutants: Base/Neutral Extractables	625	☐
Priority Pollutants: Acid Extractables	625	☐
Phenolics, 4AAP	420.4	☐
Oil and Grease, Total	1664A	☐

Nutrient & Organic Water Chemistry Parameters

Parameter	Test Method	Total	Dissolved
Ammonia Nitrogen	SM4500NH3-G	☒	☐
$CBOD_5$	SM5210B	☐	
Total Kjeldahl Nitrogen (TKN)	SM4500N(Org)	☒	☐
Nitrate + Nitrite	353.2	☒	☐
Total Phosphorus	365.1	☒	☐
TOC	SM 5310C	☒	☐
COD	410.4	☒	☐
Cyanide (Total)	335.4	☐	☐
Cyanide (Free)	SM4500CN-I	☐ *	☐
Cyanide (Amenable)	SM4500CN-G	☐ *	☐
Sulfide, Total	376.2	☐	☐

RFP 16-74 Contract Number:	018620 (Pace-Indy) PO # 0017549294-6 (Pace-Indy)

30 day reporting time required.

Notes:

** = **DO NOT RUN PARAMETER IF SAMPLE IDENTIFIED AS A BLANK ON THE CHAIN OF CUSTODY**

* = **RUN ONLY IF TOTAL CYANIDE IS DETECTED**

*** = *Report Calcium, Magnesium as Total Hardness components*

Testing Laboratory: Pace Analytical Services, Inc.
Attn: Sue Brotherton
Phone: 317-228-3136 7726 Moller Road
Indianapolis, IN 46268

Attachment 10 Biological Samples Laboratory Chain of Custody Form

IDEM

INDIANA DEPARTMENT OF
ENVIRONMENTAL MANAGEMENT
OFFICE OF WATER QUALITY BIOLOGICAL STUDIES SECTION
LABORATORY CHAIN OF CUSTODY

ROOM # ______

By placing your initials below, you are certifying that the sample(s) listed below was/were processed by you or in your presence in the processing room noted below and returned to the noted storage room.

Sample Type AD = Algae Diatom AS = Algae, Soft F = fish M = macro	Event ID or Macro #	IDEM Sample #	# of 2000 mL Nalgene Jar	# of 250 mL Nalgene Jar	# of 125 mL Glass Jar	Removed from Storage for Processing		Processing Room #	Initials	Placed in Storage after Processing		Storage Room #	Initials	# of Olive Voucher Jars	# of Slides	# of Close Top Test Tubes	Sample Split P = Permanent T = Temporary
	(YY____) or ( )	(AB)				Date (mm/dd/yyyy)	Time (24hr)			Date (mm/dd/yyyy)	Time (24hr)						
							:				:						
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Lab: Indiana Department of Environmental Management

Address: 2525 N. Shadeland Ave., Laboratory Room 121, 124, 125, Indianapolis, IN 46219

Appendix 1 List of IDEM Documents and SOPs used in the Development of the 2019 Reference Site Monitoring Program Sampling and Analysis Work Plan.

(IDEM 1992a) revision 1. Section 4, Standard Operating Procedures for Fish Collections, Use of Seines, Electrofishers, and Sample Processing. Biological Studies Section, Surveillance and Standards Branch, OWM, IDEM, Indianapolis, Indiana.*

(IDEM 1992b), revision 1. Section 11, Standard Operating Procedures-Appendices of Operational Equipment Manuals and Procedures. Biological Studies Section, Surveillance and Standards Branch, OWM, IDEM, Indianapolis, Indiana.*

(IDEM 1992c), revision 1. Section 2, Biological Studies Section Hazards Communications Manual (List of Contents). Biological Studies Section, Surveillance and Standards Branch, OWM, IDEM, 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, IDEM, Indianapolis, Indiana.*

(IDEM 2002) Water Quality Surveys Section Field Procedure Manual. Assessment Branch, IDEM, Indianapolis, Indiana.

(IDEM 2008) IDEM Personal Protective Equipment Policy, revised May 1, 2008. A-059-OEA-08-P-R0. IDEM, Indianapolis, Indiana.

(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, IDEM, Indianapolis, Indiana.

(IDEM 2010b) IDEM Health and Safety Training Policy, revised October 1, 2010. A-030-OEA-10-P-R2. IDEM, Indianapolis, Indiana.

(IDEM 2010c) IDEM Injury and Illness Resulting from Occupational Exposure Policy, revised October 1 2010. A-034-OEA-10-P-R2. IDEM, Indianapolis, Indiana.

(IDEM 2015a) 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.

(IDEM 2015b) Processing and Identification of Diatom Samples Technical Standard Operating Procedure. B-002-OWQ-WAP-TGM-15-T-R0. Office of Water Quality, Watershed Assessment and Planning Branch. Indianapolis, Indiana.

(IDEM 2017a) Quality Assurance Project Plan (QAPP) for Indiana Surface Waters, (Rev. 4, Mar. 2017). B-001-OWQ-WAP-XX-17-Q-R4. Assessment Branch, OWQ, IDEM, Indianapolis, Indiana.

(IDEM 2017b) AIMS II Database User Guide. Watershed Assessment and Planning Branch. Office of Water Quality, Indiana Department of Environmental Management. Indianapolis, Indiana.*

(IDEM 2018a). Indiana Integrated Water Monitoring and Assessment Report 2018. Edited by Jody Arthur. Office of Water Quality, Indiana Department of Environmental Management, Indianapolis, Indiana.

(IDEM 2018b). Indiana's 2018 Consolidated Assessment and Listing Methodology (CALM). Edited by Jody Arthur. Office of Water Quality, Indiana Department of Environmental Management, Indianapolis, Indiana.

(IDEM 2018c) Fish Community Field Collection Procedures. B-009-OWQ-WAP-XXX-18-T-R0. Office of Water Quality. Watershed Assessment and Planning Branch. Indianapolis, Indiana.

(IDEM 2018d). Phytoplankton and Periphyton Field Collection Procedures. B-004-OWQ-WAP-XX-18-T-R1. Office of Water Quality, Watershed Assessment and Planning Branch. Indianapolis, Indiana.

(IDEM 2018e). IDEM Agency Wide Quality Management Plan. IDEM, Indiana Government Center North, 100 N. Senate Ave., Indianapolis, Indiana, 46204.

(IDEM 2019a). Procedures for Completing the Macroinvertebrate Header Field Data Sheet. B-010-OWQ-WAP-XXX-19-T-R0. Office of Water Quality, Watershed Assessment and Planning Branch. Indianapolis, Indiana.

(IDEM 2019b). Procedures for Completing the Qualitative Habitat Evaluation Index. B-003-OWQ-WAP-XX-19-T-R1. Office of Water Quality, Watershed Assessment and Planning Branch. Indianapolis, Indiana.

*This document may be inspected at the Watershed and Assessment Branch office, located at 2525 North Shadeland Avenue, Indianapolis, IN.

Appendix 2 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 three 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 utilized for laboratory identifications kept minimal.

The Indiana Administrative Code [327 IAC 2-1-3(a)(2); 327 IAC 2-1.5-5(a)(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 that 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 meets 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 the size of stream (drainage area). The 12 different characteristics can score a 0, 1, 3, or 5, each of which represents a 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 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 3 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 was recently completed (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, microcrustaceans (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).
- 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 (subgenus/ species group)
Polypedilum: Maschwitz and Cook 2000 (subgenus/ species group)
Cricotopus/Orthocladius: Merritt et al 2007 (subgenus/ 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 provided). 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 - % Noninsect (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
% Noninsects 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**
% Noninsects - 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**

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