



Des Plaines River Watershed Workgroup

Monitoring/Water Quality Improvements Committee

12/17/2020 11:00 am

[Virtual Meeting](#) (Meeting ID: 882 7402 4706, Password: 699676)

Agenda

Discussion and Possible Approval of the Following:

1. Call to Order
2. Roll Call
3. Public Comment
4. 10/15/20 Monitoring/Water Quality Improvements Committee Meeting Minutes
5. Old Business
 - a. none
6. New Business
 - a. Suburban Labs/DRWW Invoice Disagreement
 - b. DRAFT 2021 Water Quality Monitoring Request for Proposals
7. Next Monitoring/Water Quality Improvements Committee Meeting January 21, 2020 at 11:00 am (Pending Executive Board Approval of the 2021 Meeting Schedule)
8. Adjourn



Des Plaines River Watershed Workgroup

Monitoring/Water Quality Improvements Committee

10/15/2020 11:00 am

Virtual Meeting

Meeting Minutes

Discussion and Possible Approval of the Following:

1. Call to Order

Steve Waters called the meeting to order at 11:01 am.

2. Roll Call

Jacob Jozefowski performed roll call. Steve Waters, Mike Adam, Austin McFarlane, and Nick Huber were present. A quorum was present.

3. Public Comment

There was no public comment

4. Approve 09/17/20 Monitoring/Water Quality Improvements Committee Meeting Minutes

Steve Waters motioned to approve the 09/17/2020 DRWW Monitoring/Water Quality Improvement Committee Meeting Minutes. The motion was seconded by Mike Adam and passed with unanimous consensus via roll call vote.

5. Old Business

a. Data Storage

The committee discussed cloud storage options for the DRWW monitoring data. SharePoint was selected because it has permission controls, a simple interface and can be hosted by Lake County at no cost to the DRWW. Mike Adam, Alana Bartoli and Jacob Jozefowski will set up the DRWW SharePoint and write draft data use guidelines.

b. IPS Model Training

The Midwest Biodiversity Institute (MBI) proposed two Integrated Prioritization System (IPS) model training options with substantially different costs. The full scope training would cost \$43,166.88 and a reduced session would cost \$8,230.62. The full scope training would include a potential project analysis component where MBI representatives would work with the workgroups before, during and after the training to apply the IPS model to the project. The reduced session would not have a potential project component or pre/post training.

The committee chose not to pursue training at this time because funding and creating the Nutrient Assessment and Reduction Plan (NARP) is the DRWW's priority right now and the committee is not aware of any immediate need for using the IPS model in the way this training outlines. The committee may reconsider the reduced session IPS model training after NARP completion; however, additional information about the training curriculum would be needed to determine if the high cost is justified. The committee will also reconsider the training if other regional watershed workgroups express interest.

6. New Business

a. November Newsletter

The committee discussed content for the DRWW Annual Report.

b. 2021 Monitoring Contracts

The committee discussed the 2021 monitoring contract with Suburban Labs. The committee would like Suburban Labs to continue monitoring for the DRWW. The DRWW would like to meet with Suburban Labs to discuss resolutions to the invoicing, data exchange and communication issues that have occurred throughout the 2020 monitoring season. The 2021 contract will include more specific language for invoicing.

Steve Waters will meet with Joe Robinson to determine if changes are needed to the DRWW's monitoring strategy. Once the monitoring strategy is finalized, Jacob Jozefowski will write a draft 2021 monitoring contract for Suburban Labs and distribute it to the committee for review.

7. Next Monitoring/Water Quality Improvements Committee Meeting December 17, 2020 at 1:00 pm

8. Adjourn

Steve Waters motioned to adjourn. The motion was seconded by Nick Huber and passed with unanimous consensus via roll call vote.



The Lake County Stormwater Management Commission will only be accepting electronic bid submissions for the Water Quality Monitoring Services for the Des Plaines River Watershed Workgroup.

Purchasing Portal Bid Posting Location: <https://www.lakecountypurchasingportal.com>

Bid Addendum Blog: <https://www.lakecountypurchasingportal.com/addendums/smc202008--strawberry-condos-drainage-improvements-project/>

Bid Posting Date: **Date Time**

Questions Due Date: **TBD**

Bid Due Date: **TBD**

Commented [JJ1]: 1 Week after posting date

Commented [JJ2]: 3 weeks after posting date

Please follow the steps below to upload your electronic Bid Submission:

1. Go to www.lakecountypurchasingportal.com
2. Select **Bid Number: RFP#202005BP**
3. Select register for this bid
4. Enter your username and password
5. Under the Submittals section you will be able to upload your bid submittal
 - a. Select the browse button
 - b. Navigate your computer and select the appropriate file
 - i. Multiple files can be uploaded, each file can be no more than 20 MB
 - c. Select save submittals
 - d. Close the browser

Commented [JJ3]: Number will be updated when bid number is generated.

Please allow sufficient time for any technical issues you may have and upload your bid early. Please email the Project Manager at jiozefowski@lakecountyil.gov to receive confirmation that your submission was successfully received

**Des Plaines River Watershed Workgroup (DRWW)
REQUEST FOR PROPOSALS**

RFP #20062

Water Quality Monitoring Services for Des Plaines River Watershed Workgroup

Commented [JJ1]: Will be updated when number is assigned

This Request for Proposal (RFP) is for the purpose of establishing a contract with a qualified firm to provide water quality monitoring services for the Des Plaines River Watershed Workgroup ("DRWW") as outlined herein.

GENERAL REQUIREMENTS: Proposers are to submit proposals via the Lake County Purchasing Portal. Submit one (1) marked Original and one (1) redacted copy that can be used to comply with the Illinois Freedom of Information Act (FOIA). Please refer to the FOIA statute, 5 ILCS 140/1 et seq., and specifically Section 7 therein, for an explanation of the information that may be redacted.

SUBMISSION LOCATION: Lake County Purchasing Portal (<https://www.lakecountypurchasingportal.com>)

SUBMISSION DATE: **May 6, 2020 by no later than 11:00 a.m. local time**
Proposals received after the time specified will not be opened.

Commented [JJ2]: 3 weeks after posting

CONTACT / QUESTIONS: All contact and questions regarding the Request for Proposal shall be with the Lake County Stormwater Management Commission. Should the proposer require additional information about this RFP, please submit questions on our website at <http://lakecountypurchasingportal.com> by selecting the RFP number and addendum link. Questions may also be submitted via email to jjozefowski@lakecountyil.gov. All questions shall be submitted no less than seven (7) days prior to the RFP opening date.

CONTENTS: The following sections, including this cover sheet, shall be considered integral parts of this solicitation:

- *Cover Sheet
- *General Terms and Conditions
- *Overview
- *Scope of Services
- *Submittal Requirements
- *Evaluation Criteria
- *General Information Sheet
- *References
- *Qualifications
- *Sustainability Statement
- *Addendum Acknowledgement
- *Vendor Disclosure Statement

NOTE TO PROPOSERS: Any and all exceptions to these specifications MUST be clearly and completely indicated in the Submittal Requirements. Attach additional pages if necessary. Please be advised that any exceptions to these specifications may cause your proposal to be disqualified.

If a Proposal includes any exceptions, Proposers must insert an "X" in the following box indicating a RFP submission with exceptions.

GENERAL TERMS & CONDITIONS

Water Quality Monitoring Services for the Des Plaines River Watershed Workgroup

1. **Intent**

DRWW intends to enter into a contract with a qualified proposer to provide water quality monitoring services for the DRWW.

2. **Negotiations**

Lake County and DRWW reserves the right to negotiate specifications, terms and conditions, which may be necessary or appropriate to the accomplishment of the purpose of this RFP.

3. **Confidentiality**

Proposals are subject to the Illinois Freedom of Information Act (FOIA) once an award or final selection is made. As such all Proposers responding are asked to submit one redacted copy of their proposal that can be used by the County to respond to any future FOIA requests for the proposal.

Please refer to the FOIA statute, 5 ILCS 140/1 et seq., and specifically Section 7 therein, for explanation of information that may be redacted. For example, information exempt from disclosure in response to a FOIA request includes but is not limited to: highly personal or objectionable information; trade secrets and commercial or financial information claimed as proprietary, privileged or confidential, the disclosure of which would cause your business competitive harm; valuable formulae, computer geographic systems, designs, drawings and research data when disclosure of the same would produce private gain or public loss; certain construction related technical documents; and information associated with automated data processing operations that, if disclosed, would jeopardize system or data security.

If no redacted copy is provided, the DRWW and Lake County reserve the right to determine what information should be redacted as proprietary, privileged or confidential in response to a FOIA request. A Proposer who fails to provide a redacted copy of its proposal waives its right to maintain any claims against Lake County, its agents or employees and the DRWW, its agents or members for disclosure of this information.

4. **Reserved Rights**

Lake County reserves the right at any time and for any reason to cancel this Request for Proposal or any portion thereof, to reject any or all proposals, or to accept an alternate proposal. The County reserves the right to waive any immaterial defect in any proposal. Unless otherwise specified by the proposer, the County has ninety (90) days to accept. The County may seek clarification from a proposer at any time and failure to respond promptly is cause for rejection. The County may require submission of best and final offers.

5. **Incurred Costs**

Lake County and the DRWW will not be liable for any costs incurred by respondents in replying to this RFP.

6. **Discussion of Proposals**

Lake County may conduct discussions with any proposer who submits a proposal. During the course of such discussions, the County shall not disclose any information derived from one proposal to any other proposer.

7. **Payments**

Payment terms will be agreed upon between the Proposer and the County and will follow the completion of a standard billing cycle. Payments will be made in accordance with the Local Government Prompt Payment Act.

8. **Contract Period**

The proposed contract will commence upon award of the contract and shall be for a one year period with the option to renew for four (4) additional one (1) year periods. At the end of any contract term, Lake County reserves the right to extend this contract for a period of sixty (60) days for the purpose of getting a new contract in place. In the event Lake County exercises its right to institute the aforementioned sixty (60) day extension, prorated rebate calculations

shall be applied. For any year beyond the initial contract term, this contract is contingent upon the appropriation of sufficient funds.

9. Termination

The County and DRWW reserves the right to terminate this contract, or any part of this contract, upon thirty (30) days written notice. In the event that this Contract is terminated due to Proposer's default, the County and DRWW shall be entitled to purchase substitute services elsewhere and charge the Proposer with any or all losses incurred, including attorney's fees and expenses.

10. Responsibility & Default

The Proposer shall be required to assume responsibility for all items listed in this Request for Proposals. The successful proposer(s) shall be considered the sole point of contact for purposes of this contract.

11. Interpretations or Correction of Request for Proposals

Proposers shall promptly notify the DRWW of any ambiguity, inconsistency or error, which they may discover upon examination of the Request for Proposals. Interpretation, correction and changes to the Request for Proposals will be made by addendum. Interpretation, corrections or changes made in any other manner will not be binding.

12. Additional Information

Should the Proposer require additional information about the RFP, please submit questions on our website at <http://lakecountypurchasingportal.com> by selecting RFP number and addendum link. Questions may also be submitted via email to jjozefowski@lakecountyil.gov. All questions shall be submitted no less than seven (7) days prior to RFP opening date. ANY and ALL changes to these specifications are valid only if they are included by written Addendum to all Proposers. No interpretation of the meaning of the plans, specifications or other contract documents will be made orally. Failure of any Proposer to receive any such addendum or interpretation shall not relieve the Proposer from obligation under this RFP as submitted. All addenda so issued shall become part of the RFP documents. Failure to request an interpretation constitutes a waiver to later claim that ambiguities or misunderstandings caused a Proposer to improperly submit a proposal.

13. Addendum Acknowledgement

Any and all changes to the specifications and terms and conditions of this RFP are valid only if they are included by addendum issued by Lake County. Proposers shall acknowledge addenda by signing the enclosed Addendum Acknowledgement form. It is the Proposers responsibility to check for addenda, posted on the website at <http://lakecountypurchasingportal.com> prior to the submittal due date. No notification will be sent when addenda are posted unless there is an addendum within three business days of the submittal due date.

14. Jurisdiction, Venue, Choice of Law

This contract shall be governed by and construed according to the laws of the State of Illinois. Jurisdiction and venue shall be exclusively found in the 19th Judicial Circuit Court, State of Illinois.

15. Taxes

The County and DRWW are exempt from paying certain Illinois State Taxes.

16. Change In Status

The Proposer shall notify Lake County immediately of any change in its status resulting from any of the following: (a) vendor is acquired by another party; (b) vendor becomes insolvent; (c) vendor, voluntary or by operation law, becomes subject to the provisions of any chapter of the Bankruptcy Act; (d) vendor ceases to conduct its operations in normal course of business. Lake County and DRWW shall have the option to terminate its contract with the vendor immediately on written notice based on any such change in status.

17. Breach Notification

The Proposer shall notify Lake County upon discovery of an information breach in accordance with Illinois laws. The Proposer will assume responsibility for all fees associated with a breach. Lake County and DRWW shall have the

option to terminate its contract with the vendor immediately on written notice based on any information breach.

18. Hold Harmless Clause

The Proposer agrees to indemnify, save harmless and defend Lake County and the Des Plaines River Watershed Workgroup its agents, servants, employees, members and each of them against and hold it and them harmless from any and all lawsuits, claims, demands, liabilities, losses, and expenses; including court costs and attorney's fees for or on account of any injury to any person, or any death at any time resulting from such injury, or any damage to property, which may arise or which may be alleged to have arisen out of, or in connection with the work covered by this project. The foregoing indemnity shall apply except if such injury is caused directly by the willful and wanton conduct of Lake County, its agents, servants, or employees or any other person indemnified hereafter.

19. Precedence

Where there appears to be variances or conflicts, the following order of precedence shall prevail: Specifications; Lake County General Terms & Conditions, Lake County Request for Proposal Terms & Conditions, and the Proposer's Proposal Response.

20. Exceptions

Any and all exceptions taken by Proposer to the terms of this RFP are to be identified in writing and included in the list of submittals.

21. Non-Discrimination

Proposer shall comply with the Illinois Human Rights Act, 775 ILCS 5/1-101 et seq., as amended and any rules and regulations promulgated in accordance therewith, including, but not limited to the Equal Employment Opportunity Clause, Illinois Administrative Code, Title 44, Part 750 (Appendix A), which is incorporated herein by reference. Furthermore, the Proposer shall comply with the Public Works Employment Discrimination Act, 775 ILCS 10/0.01 et seq., as amended.

22. Reporting Requirements

All awarded vendors will identify and report the type of ownership— L/W/MBE, and/or not L/W/MBE for any work that they or their approved subcontractors will perform. In addition, Lake County requests that all awarded vendors provide an accounting of employees assigned throughout the term of the contract in regards to their home address and ethnicity. Lake County may use any data collected to report on potential of businesses and workers benefitting from County contracts.

23. Lake County Ownership of Information

All information pertaining to records, property, financial or other information acquired under the scope of this contract shall be strictly confidential and the sole property of Lake County. The Proposer shall return all information to Lake County upon termination, and/or request and shall not utilize any of the information for purposes outside of the scope of this contract or without express approval of Lake County. Upon County request, the Proposer must provide all Lake County data in a documented, standard format at no cost to Lake County.

24. Joint Purchasing:

The purchase of goods and services pursuant to the terms of this Contract shall also be offered for purchases to be made by other governmental units, as authorized by the Governmental Joint Purchasing Act, 30 ILCS 525/0.01, et seq. (the "Act"). All purchases and payments made under the Act shall be made directly by and between each governmental unit and the successful Proposer. The Proposer agrees that Lake County shall not be responsible in any way for purchase orders or payments made by the other governmental units. The Proposer further agrees that all terms and conditions of this Contract shall continue in full force and effect as to the other governmental units during extended terms. The credit or liability of each governmental unit shall remain separate and distinct. Disputes between Proposers and governmental units shall be resolved between the immediate parties.

The Proposer and the other governmental units may negotiate such other and further terms and conditions to this Contract ("Other Terms") as individual projects may require. To be effective, other terms shall be reduced to writing and signed by a duly authorized representative of both the successful Proposer and the other governmental unit.

The Proposer shall provide the other governmental units with all required documentation set forth in the solicitation including but not limited to: performance and payment bonds, Certificates of Insurance naming the respective governmental unit as an additional insured, and certified payrolls to the other governmental unit as required.

25. Economic Opportunity Program

Lake County launched a Buy Local. Build Local. Work Local. initiative in 2013 to increase the outreach and procurement opportunities for businesses located within Lake County, including women-owned businesses and minority-owned business enterprises (L/W/MBE). The overarching objective is to maximize participation from these businesses in the County's procurement process, in accordance with applicable law. The County will take all necessary and reasonable steps to assure that business enterprises defined as L/W/MBE shall have a fair opportunity to participate in County contracts. As part of its Economic Opportunity Program (EOP) commitment the County will make every effort to achieve the following objectives:

- (a) To ensure nondiscrimination in the award and administration of contracts;
- (b) To create a level playing field on which L/W/MBEs can compete fairly for contracts by providing any necessary training and assistance in bid preparation;
- (c) To ensure that the County's EOP is narrowly tailored in accordance with applicable law;
- (d) To establish a means for firms identifying themselves as L/W/MBEs to register for procurement opportunities and work cooperatively with contracted firms to report on measures that demonstrates the County's commitment to its EOP; and,
- (e) To help remove barriers to the participation of L/W/MBEs through notification of contract opportunities.

Successful Proposers are encouraged to work with Workforce Development to post any and all opportunities for employment on County contracts. Lake County's Workforce Development mission is to foster and ensure the economic prosperity of the Lake County community by maximizing the potential of businesses and workers. As such, Workforce Development provides a key resource for job seekers and employers.

State law mandates an open and competitive bidding process and requires that publicly procured contracts be awarded to the lowest responsible and responsive bidder with no demonstrated preference based on the bidder's location, race and gender.

26. Insurance

The Proposer must obtain, for the Contract term and any extension of it, insurance issued by a company or companies qualified to do business in the State of Illinois with an A.M. Best Rating of at least A-and provide the County with a Certificate of Insurance 15 days before the start of the project, and thereafter annually for contracts/projects that will last more than one year. Insurance in the following types and amounts is necessary and/or where applicable:

Workers Compensation (Coverage A) and Employers Liability (Coverage B)

Workers Compensation Insurance covering all liability of the Proposer arising under the Worker's Compensation Act and Worker's Occupational Disease Act at limits in accordance with the laws of the State of Illinois. Employers' Liability Insurance shall be maintained to respond to claims for damages because of bodily injury, occupational sickness, or disease or death of the Proposer's employees, with limits listed below:

Employers Liability

- a) Each Accident \$1,000,000
- b) Disease-Policy Limit \$1,000,000
- c) Disease-Each Employee \$1,000,000

Such Insurance shall contain a waiver of subrogation in favor of Lake County, the DRWW and DRWW members.

Commercial General Liability Insurance

In a broad form on an occurrence basis shall be maintained, to include, but not be limited to, coverage for property

damage, bodily injury (including death), personal injury and advertising injury in the following coverage forms where exposure exists:

- Premises and Operations
- Independent Contractors
- Products/Completed Operations
- Liability assumed under an Insured Contract/ Contractual Liability
- Personal Injury and Advertising Injury

With limits of liability not less than:

\$ 1,000,000 Each Occurrence

\$ 1,000,000 Products-Completed Operations

\$ 1,000,000 Personal and Advertising injury limit

\$ 2,000,000 General aggregate; the CGL policy shall be endorsed to provide that the General Aggregate limit applies separately to each of the contractor's projects away from premises owned or rented to contractor.

Automobile Liability Insurance (if applicable)

Automobile liability insurance shall be maintained to respond to claims for damages because of bodily injury, death of a person, or property damage arising out of ownership, maintenance, or use of a motor vehicle. This policy shall be written to cover any auto whether owned, leased, hired, or borrowed.

The Proposer's auto liability insurance, as required above, shall be written with limits of insurance not less than the following:

\$ 1,000,000 Combined single Limit (Each Accident)

Professional Liability – Errors and Omissions (if applicable)

The Engineers/Architects/Consultants for the plans of the project shall be written with limits of insurance not less than the following:

\$ 1,000,000 per claim per policy year

Coverage shall be provided for up to three (3) years after project completion. Policy is to be on a primary basis if other professional liability is carried.

Professional Liability – Cyber Liability (if applicable)

Cyber Liability Insurance for property damage to electronic information and/or data; first and third party risks associated with e-business, internet, etc., with limits of insurance not less than the following:

\$ 1,000,000 per occurrence limit

Technology Errors and Omissions (if applicable)

The Proposer's Software Developer and/or IT Consultant for the plans, including developing and implementing technology for Lake County, or of the project, shall be written with limits of insurance not less than the following:

\$ 1,000,000 per occurrence limit

Excess/ Umbrella Liability (if applicable)

The Proposer's Excess/ Umbrella liability insurance shall be written with the umbrella follow form and outline the underlying coverage, limits of insurance will be based on size of project:

\$ 2,000,000 per occurrence limit (*minimum, and may be higher depending on the project*)

Liability Insurance Conditions

Proposer agrees that with respect to the above required insurance:

- a) The CGL policy shall be endorsed for the general aggregate to apply on a "per Project" basis;
- b) The Proposer's insurance shall be primary in the event of a claim.
- c) Proposer agrees that with respect to the above required insurance, Lake County and the DRWW shall be named as additional insured, including its agents, officers, and employees and be provided with thirty (30) days' notice, in writing by endorsement, of cancellation or material change;

- d) Lake County shall be provided with Certificates of Insurance and endorsements evidencing the above required insurance, prior to commencement of this Contract and thereafter with certificates evidencing renewals or replacements of said policies of insurance at least thirty (30) days prior to the expiration of cancellation of any such policies. Said Notices and Certificates of Insurance shall be provided to:

Lake County Stormwater Management Commission
500 West Winchester Road Ste. 201
Libertyville, IL 60048
Email: jjozefowski@lakecountyil.gov
**Attn: Jacob Jozefowski, Water Resources Professional/Des
Plaines River Watershed Workgroup Technical Coordinator**

Failure to Comply: In the event the Proposer fails to obtain or maintain any insurance coverage required under this agreement, Lake County may purchase such insurance coverage and charge the expense to the Proposer.

OVERVIEW

Water Quality Monitoring Services for the Des Plaines River Watershed Workgroup

I. Intention

The purpose of this Request for Proposal (RFP) is to establish a contract with a qualified vendor to provide water quality sampling and analysis services for the Des Plaines River Watershed Workgroup.

II. Background

The Des Plaines River Watershed Workgroup (DRWW) is a voluntary, dues paying organization with a mission to bring together a diverse coalition of stakeholders to work together to improve water quality in the Des Plaines River and its tributaries in a cost effective manner to meet Illinois EPA requirements. Membership of the DRWW consists of communities, Publicly Owned Treatment Works (POTWs), and other interested parties. The Workgroup consists of Agency members represented by NPDES permit holders, Associate members which are non-permit holding organizations, and individual members. The DRWW will monitor water quality in the river and tributaries, prioritize and implement water quality improvement projects, and secure grant funding to offset the cost. Monitoring data will allow for a greater understanding of the water quality impairments, identify priority restoration activities, and track water quality improvements. The Workgroup is committed to an approach for attaining water quality standards that focuses on stakeholder involvement, monitoring, and locally led decision-making based on sound science.

The project area consists of the Des Plaines River watershed, covering approximately 200 square miles within Lake County, Illinois. The primary tributaries to the main stem Des Plaines River are: North Mill Creek, Mill Creek, Newport Drainage Ditch, Bull Creek, Indian Creek, Buffalo Creek, and Aptakistic Creek. There are 33 municipalities, 12 townships, and two drainage districts that lie wholly or partially within the watershed. There are eight Publicly Owned Treatment Works (POTWs) that discharge approximately 80 million gallons a day of treated wastewater to the Des Plaines River within the service area.

SCOPE OF SERVICES

Water Quality Monitoring Services for the Des Plaines River Watershed Workgroup

1. Conduct Water Quality Sampling and Analysis

Sampling will be conducted using a three-tier monitoring strategy following the attached Illinois EPA approved Quality Assurance Project Plan (QAPP) ([Attachment A](#)). Sampling sites and their associated tier are listed in table 1. Tier 1 sites have been identified by the DRWW as the core sites and are to be sampled for water column analyses along with Sestonic Chlorophyll a. Tier 2 and 3 sites will be sampled for water column analyses. Tier 2 and 3 are differentiated, as Tier 3 sites will not be sampled for sediment analyses in future years (sediment sampling will not occur during this contract period). Water quality sampling will occur at 73 sites during the course of one week. The weekly sampling will continue throughout the following months: February, May, July, August and September. These collected samples will be tested for the water quality monitoring parameters listed in table 2 utilizing agreed upon standard operating procedures and the reporting limits and the laboratory method detection limits listed in table 3 .

For every 20 samples collected, blank and duplicate samples shall also be collected. The blank will be made in the field by pouring deionized water into the same type of sample containers that are used for the surface water. The deionized water will be laboratory grade water from the proposer. This water will be placed inside a pre-cleaned and certified container.

It is the goal of the DRWW that this data be available for use by the Illinois EPA, the Illinois Department of Natural Resources, local decision makers, and all other interested parties; therefore, it is essential that the data collected is accurate, precise, cost-effective, and has low variability, making the results of the assessments comparable.

2. Sampling Schedule

- February 2021
- May 2021
- July 2021
- August 2021
- September 2021

3. Field Log

A field log will be kept each day that samples are collected. The field log will include:

- Name and signature of the field services technician
- Location of sampling site
- Weather and water conditions (if extraordinary condition apply)
- Dates and times of sample collection
- GPS location of sampling (in latitude/longitude and state plane) for first event on each site
- Preservatives
- Field measurements
- Descriptions of any unusual conditions at the sample locations
- Chains of Custody
- Indication of duplicate sample location

4. Sample Custody and Handling

All samples will be placed in non-contaminated containers provided by Proposer. All containers will be properly labeled. The duplicate sample will be labeled with the sample location and identified as "duplicate". When preservation is required, pre-preserved bottles will be used. Samples will be placed inside a cooler with wet ice until they reach the laboratory.

Proper chain of custody documentation will accompany the collected samples. The chain of custody will contain the sample IDs, analyses to be performed, date and time of collection, type and number of containers,

preservatives added, date and time of transfers, and the signature of each person involved in custody transfer. The chain of custody will be placed in a water-resistant plastic bag inside each cooler. Indelible ink will be used on the container labels and chain of custody records. Upon receipt at the laboratory, sample temperature will be recorded on the chain of custody form. A copy of the chain of custody form will be included with the final report.

Preservatives will be added to sample bottles prior to sample collection. Sample containers must only be purchased from reputable suppliers and cannot be re-used.

5. Project Deliverables

- Itemized invoice for each monthly sampling event. Invoices shall describe the work completed; show the actual number hours worked by team member; and actual travel and other expenses that have occurred.
- Results of all analytical analysis no later than 10 business days following the date of collection.
- Electronic data deliverables (EDDs) and the sample results in an editable Microsoft Excel file, as specified in the attached example (Attachment B). Results should be delivered with monthly invoices.
- A final report consisting of a pdf file of all analytical results, analytical methods, chain(s) of custody, and a field log. Any sampling or testing observations which may have affected accuracy will be noted in the report narrative. Any applicable data qualifiers (e.g., matrix spike failure) will also be noted in the project specific comments portion of the report narrative page.

Table 1: DRWW Monitoring Site List

DRWW ID	NewDNRAREA	Lat	Long	River/Stream Name	Subwatershed	Tier 1	Tier 2	Tier 3	Location	Comment
10-1	31.90	42.4248	-87.9973	North Mill	North Mill Creek	1			Millbourne Road	USGS Site (discontinued)
10-2	29.38	42.4442	-88.0007	North Mill	North Mill Creek		2		Kelly Road	Dam removal site - dam is notched
10-3	20.79	42.4661	-88.0090	North Mill Creek	North Mill Creek		2		Route 173	
10-4	5.64	42.4479	-88.0247	North Mill	North Mill Creek		2		Hastings Creek @ Miller Rd	
10-5	3.91	42.4308	-88.0343	North Mill	North Mill Creek		2		Hastings Creek @ Grass Lake Rd	
10-6	0.99	42.4215	-88.0045	Unnamed Trib to North Mill Creek	North Mill Creek			3	List. (W) of Route 45 - need better parking access	
10-7				North Mill	North Mill Creek	1			Edwards Road	Site added in 2019.
11-1	63.80	42.4183	-87.9451	Mill Creek	Mill Creek		2		Dilley's Road	
11-2	59.88	42.4154	-87.9690	Mill Creek	Mill Creek	1			Hunt Club Road	sample at POTW call Austin 847-377-7134 USGS Site
11-3	21.34	42.3989	-87.9824	Mill Creek	Mill Creek		2		Starns School Road	
11-4	18.33	42.3833	-88.0041	Mill Creek	Mill Creek		2		Route 45	
11-5	9.35	42.3620	-88.0151	Mill Creek	Mill Creek		2		Washington St	
11-6	4.32	42.3350	-88.0397	Mill Creek	Mill Creek		2		Wick Street	
12-1	7.35	42.4835	-87.9128	Newport Drainage Ditch	Newport Drainage Ditch		2		Newport Drainage Ditch @ Kilbourne Ave	
12-2	2.82	42.4581	-87.8968	Newport Drainage Ditch	Newport Drainage Ditch		2		W. 21st Street along Union Pacific RR	
13-1	232.03	42.3438	-87.9411	Des Plaines River	Upper Des Plaines River	1			Hwy 120	USGS Site
13-10	4.02	42.4042	-87.9061	Suburban Country Club Trib	Upper Des Plaines River		2		Suburban Country Club Trib @ Shirley Dr	
13-11	2.37	42.4444	-87.9527	Slocum Corners Creek	Upper Des Plaines River		2		N. Mill Creek Rd.; E. of I-94	
13-12	2.35	42.4023	-87.8949	Suburban Country Club Trib	Upper Des Plaines River		3		E. of Northwestern Ave.	Removed from chemical analyses in 2019
13-13	1.06	42.3654	-87.9014	Unnamed trib. - Greenleaf Creek	Upper Des Plaines River		3		Swanson Trigg Conservation Area - 42.3700 -87.9085	
13-14	1.10	42.3480	-87.9570	Unnamed Trib to Belvidere Rd Trib	Upper Des Plaines River		3		Leonard Dr.	
13-15	1.92	42.3259	-87.9784	Bull's Brook	Upper Des Plaines River		3		Almond Rd.	
13-16	252.75	42.3051	-87.9542	Des Plaines River	Upper Des Plaines River		2		Dst. Buckley Rd.	Need to access via Desplaines Trail
13-17	0.84	42.3002	-87.9390	Unnamed Trib to Des Plaines River	Upper Des Plaines River		3		Behind pump station off of Sprucewood Lane	
13-18	214.84	42.3075	-87.9245	Des Plaines River	Upper Des Plaines River	1			40' Above Riffle Structure	Access through Wetlands Research property
13-19				Des Plaines River	Upper Des Plaines River		3		Below Riffle Structure	Access through Wetlands Research property
15-2	225.36	42.3691	-87.9176	Des Plaines River	Upper Des Plaines River	1			McCure Ave	Canoe launch
15-3	228.29	42.3806	-87.9140	Des Plaines River	Upper Des Plaines River	1			Above Hwy 41	
15-4	145.54	42.4208	-87.9304	Des Plaines River	Upper Des Plaines River	1			Madison Road	
15-5	137.29	42.4623	-87.9428	Des Plaines River	Upper Des Plaines River	1			Hwy 173	
15-6	123.67	42.4892	-87.9258	Des Plaines River	Upper Des Plaines River	1			Russel Road	USGS Site
15-7	2.69	42.3184	-87.9617	Bull's Brook @ Rt 21	Upper Des Plaines River		2		N. Milwaukee Ave.	
15-8	3.71	42.3427	-87.9454	Belvidere Rd Tributary	Upper Des Plaines River		2		Belvidere Rd Tributary @ Highway 21 and 120	
15-9	4.08	42.3528	-87.9367	Stone Roller @ Lake Carina	Upper Des Plaines River		2		Stone Roller @ Lake Carina	
16-1	11.67	42.3119	-87.9637	Bull Creek	Bull Creek		2		Hwy 21	
16-2	2.87	42.3061	-87.9690	Bull Creek	Bull Creek		2		Route 137	
16-3	0.99	42.3101	-87.9906	Bull Creek	Bull Creek		3		N. Countryside Drive	
16-4	5.08	42.3025	-88.0008	W. Branch Bull Creek	Bull Creek		2		Northwind Blvd. - access 1600 behind warehouse	
16-5	1.33	42.2793	-88.0028	Bull Creek	Bull Creek		3		Adj. University Drive	call Clay K 847-312-3657
16-6	2.39	42.2877	-88.0229	Bull Creek	Bull Creek		2		Hazelnut Xing	
15-1	36.43	42.1981	-87.9231	Indian Creek	Indian Creek		2		Marriot Inn parking lot - adj. Cranes Landing GC	
15-10	2.22	42.2301	-88.0376	West Branch Indian Creek	Indian Creek		3		Gilmer Rd.	
15-11	1.70	42.2196	-88.0256	Forest Lake Drain	Indian Creek		3		Hawthorne Grove Rd.	
15-12	2.06	42.1969	-88.0399	Kildeer Creek	Indian Creek		3		IL Rt. 22	
15-13	3.43	42.1957	-88.0012	Kildeer Creek	Indian Creek		3		Willowbrook Rd. S. of Half Day Rd.	
15-2	35.02	42.2065	-87.9616	Indian Creek	Indian Creek		2		Sullivan Woods Preserve, North of Creelview Dr.	
15-3	3.07	42.2627	-87.9655	Indian Creek	Indian Creek		2		Gregg's Parkway	
15-4	6.77	42.2044	-87.9750	Indian Creek	Indian Creek		2		Port Clinton Rd at Kildeer Creek	
15-5	17.26	42.2105	-87.9876	Indian Creek	Indian Creek		2		Oakwood Rd.	
15-6	3.66	42.2394	-88.0231	Indian Creek	Indian Creek		2		Washitaw Ave	
15-7	2.85	42.1943	-88.0300	Indian Creek	Indian Creek		2		Salem Lake Drive S. of Rt 22	
15-8	9.36	42.2149	-87.9662	Seavey Drainage Ditch	Indian Creek		2		Near Vernon Hills GC	
15-9	2.68	42.2446	-88.0356	Indian Creek	Indian Creek		2		N. Midlothian Rd.	
16-1	358.85	42.1094	-87.8878	Des Plaines River	Lower Des Plaines River	1			Palantine Frontage Rd.	
16-10	2.00	42.2505	-87.9255	Werhane Lake Drain	Lower Des Plaines River		3		St. Marys Rd.	
16-2	323.96	42.1531	-87.9102	Des Plaines River	Lower Des Plaines River		2		E. Lake Cook Rd.	
16-3	314.68	42.1676	-87.9134	Des Plaines River	Lower Des Plaines River	1			Deerfield Rd.	
16-4	273.21	42.2004	-87.9185	Des Plaines River	Lower Des Plaines River	1			Half Day Rd.	USGS Site
16-5	268.06	42.2405	-87.9392	Des Plaines River	Lower Des Plaines River	1			Illinois Route 60 - Town Line Rd.	
16-6	260.11	42.2767	-87.9391	Des Plaines River	Lower Des Plaines River	1			Rockland Rd.	
16-7	266.48	42.2490	-87.9426	Des Plaines River	Lower Des Plaines River		2		Hollister Dam site - adj. to Hollister Intl.	
16-8	268.90	42.2271	-87.9368	Des Plaines River	Lower Des Plaines River		2		Wright Woods Dam site - immediately ust. bike bridge	Dam removal access route - need key
16-9	1.19	42.1709	-87.9069	Unnamed Trib to Des Plaines River	Lower Des Plaines River		3		Timberleaf Lane	
17-1	29.23	42.2218	-87.8960	Buffalo Creek	Buffalo Creek		2		Route 21	
17-2	22.10	42.1519	-87.9692	Lake Cook Rd @ Farrington Ditch	Buffalo Creek		2		Lake Cook Rd @ Farrington Ditch	
17-3	3.29	42.1609	-87.9907	Buffalo Creek	Buffalo Creek		2		Chester Road	
17-4	8.55	42.1536	-87.9966	Buffalo Creek	Buffalo Creek		2		Lake Cook Rd @ Buffalo Creek Trib	
17-5	1.19	42.1858	-88.0580	Unnamed trib.	Buffalo Creek		3		Quentin Rd.	
18-1	5.50	42.1635	-87.9224	Aptakisic	Aptakisic Creek		2		Aspen Road	
18-2	4.94	42.1646	-87.9277	Aptakisic	Aptakisic Creek		2		Pekara Rd. West of Hwy. 21	
18-3	2.26	42.1777	-87.9608	Aptakisic Creek	Aptakisic Creek		2		Copperwood Dr. bike xing	
18-4	1.09	42.1812	-87.9667	Aptakisic Creek	Aptakisic Creek		3		N. Buffalo Grove Rd.	
18-5	0.99	42.1815	-87.9657	Unnamed Trib to Aptakisic Creek	Aptakisic Creek		3		Dst. Aptakisic Rd.; W of N. Buffalo Grove Rd.	

Tier 1 Sites will be established as "core" sites which will receive bi-annual Biological Assessment and continuous monitoring.

TABLE 2: Water Quality Sampling Parameters

Parameter	Analysis Type (Laboratory or In-Situ)	DRWW Frequency	Tier 1	Tier 2	Tier 3
			Number of Sample Events		
<u>Demand</u>					
Chloride	Laboratory	Feb, Aug	2	2	2
Conductivity	In-Situ	Feb, Aug	2	2	2
pH	In-Situ	Feb, Aug	2	2	2
Total Organic Carbon			0	0	0
Sulfate	Laboratory	Feb, Aug	2	2	2
Total Suspended Solids	Laboratory	Feb, May, July, Aug, Sept	5	5	5
Volatile Suspended Solids			0	0	0
Dissolved Oxygen			0	0	0
Water Temperature	In-Situ	Feb, Aug	2	2	2
Turbidity			0	0	0
<u>Metals</u>					
Total Hardness	Laboratory	Feb, Aug	2	2	2
Iron			0	0	0
Sodium			0	0	0
Arsenic			0	0	0
Manganese			0	0	0
Mercury - Low Level Detection Limit			0	0	0
Copper			0	0	0
Nickel			0	0	0
Zinc			0	0	0
<u>Nutrients</u>					
Ammonia	Laboratory	Feb, May, July, Aug, Sept	5	5	5
Total Nitrates (NO2 + NO3)	Laboratory	Feb, May, July, Aug, Sept	5	5	5
Total Kjeldahl Nitrogen	Laboratory	Feb, May, July, Aug, Sept	5	5	5
Total phosphorus	Laboratory	Feb, May, July, Aug, Sept	5	5	5
Dissolved Reactive Phosphorus	Laboratory	Feb, May, July, Aug, Sept	5	5	5
Sestonic Chlorophyll a	Laboratory	May, July, Aug, Sept	4	0	0
<u>Bacteria</u>					
<i>E. coli</i>	Laboratory	Feb, Aug	2	2	2
<u>Water Organics</u>					
Polychlorinated Biphenyls			0	0	0
Pesticides			0	0	0
Methoxychlor			0	0	0
PNA's			0	0	0
Volatile Organic Compounds			0	0	0
<u>Sediment Metals</u>					
Aluminum			0	0	0
Arsenic			0	0	0
Barium			0	0	0
Beryllium			0	0	0
Boron			0	0	0
Cadmium			0	0	0
Chromium			0	0	0
Cobalt			0	0	0
Copper			0	0	0
Fluoride			0	0	0
Iron			0	0	0

Parameter	Analysis Type (Laboratory or In-Situ)	DRWW Frequency	Tier 1	Tier 2	Tier 3
			Number of Sample Events		
Lead			0	0	0
Manganese			0	0	0
Mercury			0	0	0
Nickel			0	0	0
Potassium			0	0	0
Silver			0	0	0
Sodium			0	0	0
Strontium			0	0	0
Vanadium			0	0	0
Zinc			0	0	0
Sediment Organics					
Polychlorinated Biphenyls			0	0	0
Pesticides			0	0	0
Methoxychlor			0	0	0
PNAs			0	0	0
Total Kjeldahl Nitrogen			0	0	0
Phosphorus			0	0	0
Cyanide			0	0	0
Herbicides (2, 4, D, 2,4,5 TP)			0	0	0
Phenols			0	0	0

TABLE 3: Test Methods and Reporting Limits

Parameter	Method	MDL/Reporting Limit
Demand		
Chloride	325.2, EPA	0.5 mg/L
Conductivity	2510B, SM18th Ed.	2 µmhos/cm
pH	4500-H B, SM18th Ed.	N/A
TOC	5310B	1 mg/L
Sulfate	375.4, EPA	1 mg/L
TSS	2540D, SM18th Ed.	0.2 mg/L
VSS	2540E	0.2 mg/L
DO	4500 YSI field meter	0.1 mg/L
Temperature	170.1	°C
Turbidity	180.1	0.1 mg/L
Metals		
Total Hardness	2340B, SM18th Ed.	0.05 mg/L
Iron	200.7, EPA	0.005 mg/L
Sodium	200.7	0.1 mg/L
Arsenic	200.8	0.0008 mg/L
Manganese	200.8	0.002 mg/L
Mercury * (LOW LEVEL DETECTION LIMIT)	245.1, EPA or *1631 low det	0.0002 mg/L or 0.5 Ng/L
Copper	200.8, EPA	0.0005 mg/L
Nickel	200.8	0.0004 mg/L
Zinc	200.8, EPA	0.007 mg/L
Nutrients		
Ammonia	4500 NH3 D, SM18th Ed.	0.1 mg/L
Total Nitrates (NO2 + NO3)	352.1, EPA	0.05 mg/L
TKN	4500 NH3 C, SM18th Ed.	0.124 mg/L

Parameter	Method	MDL/Reporting Limit
Phosphorous	200.8, EPA	0.02 mg/L
Dissolved reactive Phosphorus	SM4500P E	0.026 mg/L
Chlorophyll a		
Sestonic Chlorophyll a	SM 10200H	4 mg/M ³
Bacteria		
E-coli	9213D	1 CFU/100ml
Water Organics		
PCBs	8082, EPA	0.1 ug/L
Pesticides	8081, EPA	0.025 ug/L
Methoxychlor	8081 EPA	0.25 ug/L
PNAs	8270, EPA	0.1 ug/L
VOCs	8260, EPA	1.0 ug/L
Sediment Organics		
PCBs	8082, EPA	16.7 ug/Kg
Pesticides	8081, EPA	0.833 ug/Kg
Methoxychlor	8081 EPA	0.833 ug/Kg
PNAs	8270, EPA	40 ug/Kg
Herbicides (2,4,D & 2,4,5 TP)	8321	0.004 ug/Kg
Sediment inorganics		
TKN	4500 NH3E	100 mg/Kg
Phosphorus	6010B, EPA	2.3 mg/Kg
Cyanide	9014	0.005 mg/Kg
Phenols	420.1	0.005 mg/Kg
Sediment Metals		
Aluminum	6010B, EPA	2.50 mg/Kg
Arsenic	6010B, EPA	1.15 mg/Kg
Barium	6010B, EPA	0.125 mg/Kg
Beryllium	6010B, EPA	0.0025 mg/Kg
Boron	6010B, EPA	0.05 mg/Kg
Cadmium	6010B, EPA	0.075 mg/Kg
Chromium	6010B, EPA	0.0600 mg/Kg
Cobalt	6010B, EPA	0.625 mg/Kg
Copper	6101B EPA	0.150 mg/Kg
Iron	6010B, EPA	0.625 mg/Kg
Lead	6010B, EPA	0.6 mg/Kg
Manganese	6010B, EPA	0.625 mg/Kg
Mercury	245.1	0.02 mg/Kg
Nickel	6010B, EPA	0.235 mg/Kg
Potassium	6010B, EPA	2.5 mg/Kg
Silver	6010B, EPA	0.06 mg/Kg
Sodium	6010B EPA	1.25 mg/Kg
Strontium	6010B, EPA	0.120 mg/Kg
Vanadium	6101B EPA	0.150 mg/Kg
Zinc	6010B, EPA	0.075 mg/Kg
Fluoride	4500	0.05 mg/Kg

SUBMITTAL REQUIREMENTS

Water Quality Monitoring Services for the Des Plaines River Watershed Workgroup

I. Detailed Submittal Requirements

Proposals should be prepared as simple as possible and provide a straightforward, concise description of the proposed products and services to satisfy the requirements of the RFP. Attention should be given to accuracy, completeness, relevance and clarity of content. The proposal should be organized into the following major sections:

- Section 1.0 – Executive Summary
- Section 2.0 – Company Background
- Section 3.0 – Scope of Services
- Section 4.0 – Updated Standard Operating Procedure
- Section 5.0 – Project Experience
- Section 6.0 – Client References
- Section 7.0 – Project Team
- Section 8.0 – Project Fee
- Section 9.0 – Project Schedule
- Section 10.0 – Exceptions to the RFP
- Section 11.0 – Sustainability Statement
- Section 12.0 – Vendor Disclosure Statement

Section 1.0 – Executive Summary

The introductory material must include a title page with the RFP number, subject, name of the Proposer, address, telephone number, e-mail address, the date, a letter of transmittal and a table of contents. The executive summary should be limited to a brief narrative summarizing the proposal.

Section 2.0 – Company Background

In this section provide information about the company so that the DRWW can evaluate the Proposer's stability and ability to support the commitments set forth in the response to this RFP. Information in this section should contain the following information in addition to the General Information Sheet that is also included as an exhibit to this RFP:

- Company name and location of the corporate headquarters and of the nearest office to Lake County.
- The number of years the company has been in business and the number of years the company has been providing services to the public sector.
- Include information on the company's customer base, such as the number of public sector clients the company serves, the number of local government clients, and the number of public sector clients in the state.
- Identify if the company serves other industries.
- Include a brief summary of the company's organizational characteristics such as the number of employees, their backgrounds, whether the company is privately held, publicly traded, or if it is a subsidiary to a parent company.
- Describe any other business affiliations (e.g., subsidiaries, joint ventures, "soft dollar" arrangements with brokers).
- Identify the individuals who will be the account representative for Lake County, including office locations, telephone numbers and email addresses

Section 3.0 – Scope of Services

This section of the proposal should include a general discussion of the Proposer's overall understanding of the project and the scope of services. For each task that is identified in the scope of services outlined in the specifications, please identify your firm's approach and response to address the desired service outlined. This shall include but is not limited to:

- A flow diagram and written narrative showing your firm's understanding of the sequence of events, tasks, and milestones associated with the work, including a thorough description of your familiarity of the watershed, goals and objectives of the monitoring plan. The firm shall describe strengths and skill acquired from past studies with water bodies that are similar to that described in the specifications. The firm shall also describe its knowledge of the watershed and strengths and skills developed from past work in the DRWW service area.
- Project schedule, indicating major milestones and task durations.

- Describe all assumptions and exclusions.
- Discuss your current workload and ability to perform this project.
- Present your understanding of the management and quality assurance / quality control (QA/QC) requirements of this project. This shall include but is not limited to the ability to manage and coordinate the project, including communications between the DRWW and its consultants. Provide an example of a Quality Assurance Project Plan prepared by your firm for another project. This example may be a separate document. Also, include an organization chart depicting your team's organization structure. Include sub-consultants to be utilized.
- The proposal will describe the procedures to ensure that defensible and quality data are collected and reported. The proposal shall clearly define how samples will be taken at all sites defined herein.
- Provide the name and qualifications of the testing laboratory to be used.

Section 4.0 – Updated Standard Operating Procedure

Update the attached Standard Operation Procedures (Attachment C) to reflect proposers lab protocol while maintaining compliance with the Illinois EPA approved QAPP (Attachment A).

Section 5.0 – Project Experience

- Name and location of the project.
- Project manager's name and address.
- Indicate if your firm was the prime contractor or a subcontractor. If the work was done as a sub, furnish the name and address of the prime contractor.
- Dates of contract performance.
- Value of work completed by your firm.
- Scope of work completed by your firm.
- Contact names, addresses, and phone numbers of project references (a minimum of one contact must be provided for each project).
- Narrative describing the project, equipment and software used and data delivery method, any unique or special conditions under which the work was performed, and any unusual findings resulting from your work.

Section 6.0– Client References

The County considers references to be an important factor in its decision to award a contract. Proposers should supply references that will be available to speak with the County. Three references should be provided that provided similar type of work completed in the past five years. A reference sheet is included as a submittal as part of this RFP document.

Section 7.0– Project Team

Provide individual resumes of key members of the staff to be assigned to this project and his/her associated firm. Provide an overall listing showing their names, years of experience, and the number of years they have been employed by your firm. This should include, at a minimum, the following personnel as applicable:

- Project Manager
- Water Quality Scientist(s) or Engineer(s)
- Data Specialist(s)
- Field Sampling Personnel Other resumes maybe included as may be appropriate.

The Project Manager must be an employee of the proposing firm.

Section 8.0– Project Fee

Proposed "not to exceed" project fee, including staff billing rates and an estimate of the number of hours that each personnel assigned to the project team will spend on each task and on the project as a whole. Proposed project fees should be itemized by task included in proposed scope of services.

Section 9.0– Project Schedule

Proposed project schedule, organized by the tasks included in proposed scope of services including all outcomes and outputs and proposed deadlines.

Section 10.0 – Exceptions to the RFP

All requested information to this RFP must be supplied as this document and subsequent proposals submitted help form the basis for a contract with the selected contractor. Proposers may take exception to certain requirements in this RFP. All exceptions shall be clearly identified in this section and written explanation shall include the scope of the exceptions, the ramifications of the exceptions for the County and the descriptions of the advantages or disadvantages to the County as a result of the exception. The County, at its sole discretion, may reject any exceptions or specifications within the proposal.

Section 11.0 – Sustainability Statement

Lake County is committed to green and sustainable practices and good environmental stewardship. Consequently, Proposers are asked to provide a Statement of Sustainability to demonstrate that they are also incorporating sustainability into their firms' practices. A Sustainability Statement form is included as part of the RFP. Proposers are asked to provide a clear description of your firm's sustainable practices, policies, or procedures in the following areas: waste minimization, energy efficiency, water efficiency, staff and education.

Section 12.0 - Vendor Disclosure Statement

This disclosure statement is being filed in accordance with the Lake County Ethics Ordinance and Lake County Purchasing Ordinance. Effective January 2019 the Lake County Board implemented a Vendor Disclosure Statement Policy, which require vendors to disclose any familial relationships between a Lake County elected official, department director, deputy director, manager and owners, principals or officers of the vendor's company as well as campaign contributions to County elected officials.

EVALUATION CRITERIA

Water Quality Monitoring Services for the Des Plaines River Watershed Workgroup

The DRWW will conduct a comprehensive, fair, and impartial evaluation of proposals received in response to this procurement effort. All proposals will be evaluated by how well the proposal satisfies the described/stated needs, rather than how exactly the proposal matches the strictest interpretation of the terminology and design concepts stated herein. Newly emerging technologies, additional features, and the ability of the proposed solutions to adapt will be a consideration. Properly submitted proposals will be reviewed by the DRWW Executive Board. Proposals will be evaluated according to the following criteria and scoring system:

Evaluation Factors:

	Points
<u>1. Project Understanding and Approach:</u> Demonstrate project understanding, approach, schedule, ability and experience in developing QAPPs, and ability to complete scope of services as described within the RFP	35
<u>2. Project Experience and References:</u> Applicant’s work on similar projects and references.	20
<u>3. Project Team:</u> Project team’s experience and qualifications; laboratory certification.	25
<u>4. Project Fee</u>	20

Interviews

Lake County reserves the right, as part of the evaluation process, to ask for additional materials, interview, or schedule site visits to any locations serviced by Proposers. Site visits may be scheduled or unscheduled as determined by the County. If applicable, the County shall contact Proposers to arrange an interview. Information provided as part of the interview may be used by Evaluation Committee to re-evaluate and re-rank Proposers.

Additional Investigations

The County reserves the right to make such additional investigations as it deems necessary to establish the competence and financial stability of any firm submitting a proposal.

Best and Final Offer

The County reserves the right to request a Best and Final Offer (BAFO) if additional information or modified terms are necessary for the Evaluation Committee to complete its evaluation and ranking. A BAFO will not be used solely to reduce pricing. If a BAFO is requested, all qualified Proposers will be provided an opportunity to submit a modified Response. Only one BAFO request will be issued by the County. The information received from the BAFO will be used by the Evaluation Committee to re-evaluate and re-rank the Proposers.

GENERAL INFORMATION

Water Quality Monitoring Services for the Des Plaines River Watershed Workgroup

This section must be completed and returned with proposal. Attach additional pages as required to complete required documentation.

AUTHORIZED NEGOTIATORS:

Name: _____ Phone: _____ Email: _____

Name: _____ Phone: _____ Email: _____

In submitting this proposal, it is understood that Lake County reserves the right to reject any or all Proposals, to accept an alternate Proposal, and to waive any informalities in any Proposal.

BUSINESS ORGANIZATION: (check one only)

Sole Proprietor: An individual whose signature is affixed to this proposal.

Partnership: State full names, titles, and addresses of all responsible principals and/or partners on attached sheet.

Corporation: State of incorporation: _____

Non-profit Corporation

501c3-- U.S. Internal Revenue Code

By signing this proposal document, the Proposer hereby certifies that it is not barred from proposing on this contract as a result of a violation of either Section 33E-3 or 33E-4 of the Illinois Criminal Code of 1961, as amended.

Business Name

Signature

Title

Email

Print or Type Name

Date

REFERENCES

Water Quality Monitoring Services for the Des Plaines River Watershed Workgroup

List below other organizations (users of similar size and structure to Lake County preferred) for which these or other similar services have been provided:

Agency Name: _____
Address _____
City, State, Zip Code _____
Telephone Number _____
Contact Person _____
Email Address _____
Dates of Service _____

Agency Name _____
Address _____
City, State, Zip Code _____
Telephone Number _____
Contact Person _____
Email Address _____
Dates of Service _____

Agency Name _____
Address _____
City, State, Zip Code _____
Telephone Number _____
Contact Person _____
Email Address _____
Dates of Service _____

Agency Name _____
Address _____
City, State, Zip Code _____
Telephone Number _____
Contact Person _____
Email Address _____
Dates of Service _____

SUSTAINABILITY STATEMENT INSTRUCTIONS

Lake County is committed to green and sustainable practices and good environmental stewardship. Consequently, we are asking Proposers to provide a Statement of Sustainability to ensure our vendors are also incorporating sustainability into their firms' practices.

INSTRUCTIONS

On the following Sustainability Statement form, provide a clear description of your firm's sustainable practices, policies, or procedures. These practices may include, but may not be limited to, the following categories and examples:

Waste Minimization within your office or facilities, such as a recycling programs, double-sided copying, electronic internal communications (i.e. memos), use of recycled-content materials and reusable cups, limiting printing, electronic document management, instituting green purchasing policies, using green cleaning supplies and practices, or reducing packaging in materials you procure or supply.

Energy Efficiency within your office, facilities, or firm, such as lighting retrofits, photo-sensor switches for lighting, effective use of daytime lighting, using Energy Star rated appliances or equipment, using an alternative fuel or having efficient fleet policies, an anti-idling policy, or indoor temperature management (i.e. turning the thermostat up in the summer and down in the winter).

Water Efficiency within the office, facilities, or firm, such as faucet or fixture retrofits, switching from individual bottled water to office water coolers or drinking fountains, and installing drought-tolerant landscaping.

Staff encouraged to adopt sustainable practices and supported by your firm through public transit benefits, bicycle accommodations, telecommuting options, support for green seminar attendance, becoming US Green Building Council LEED accredited, or creating an internal "green team."

Education of your staff about green practices, education of your business peers about your green accomplishments, education of your community by your sustainability, or notice of any environmental awards your firm has achieved.

CONTINUE TO NEXT PAGE

SUSTAINABILITY STATEMENT

Attach additional sheets if necessary.

Waste Minimization

Energy Efficiency

Water Efficiency

Staff

Education



Addendum Acknowledgement

The undersigned acknowledges receipt of the following addenda:

ADDENDUM #	SIGNATURE

I have examined and carefully prepared the submittal documentation in detail before submitting my response to Lake County.

Bid Number: _____
Company Name: _____
Authorized
Representative: _____
Authorized *Signature*
Representative: _____
Print
Date: _____

It is the vendor's responsibility to check for addenda, posted on the website at <http://lakecountypurchasingportal.com> prior to the submittal due date. No notification will be sent when addenda are posted unless there is an addendum within three business days of the submittal due date.

If the submittal has already been received by Lake County, vendors are required to acknowledge receipt of addendum via email to purchasing@lakecountyiil.gov prior to the due date.

Submittals that do not acknowledge addenda may be rejected.

All responses are to be submitted in a sealed envelope. Envelopes are to be clearly marked with required submittal information.



VENDOR DISCLOSURE STATEMENT

Vendor Name:			
Address:			
Contact Person:		Contact Phone #:	
Bid/RFP/SOI/Contract/Renewal:	RFP #20062		

Vendors wishing to contract with Lake County for goods and services in an amount greater than \$30,000 shall submit this form in advance of award. This disclosure statement is not required for utility companies regulated by the Illinois Commerce Commission or local units of government. Vendors shall disclose:

- A familial relationship between a Lake County elected official, department director, deputy director and manager and owners, principals, executives, officers, account managers or other similar managerial positions of the vendor's company. Familial relationship is defined as a spouse (including civil partner), child, stepchild, parent, stepparent, grandparent, in-laws (including parent, grandparent, sibling, or child), relatives and non-relatives living in the same residence, and offspring born to any aforementioned person.
- All political campaign contributions made by the vendor or an owner, principal, executive, officer, account manager, or other similar managerial position of the vendor to any county board member, county board chair, or countywide elected official within the last five years.

If there is nothing to report in a section, please state none in the appropriate space.

FAMILIAL RELATIONSHIPS

List names and departments/agencies of Lake County employees or public officials with whom owners, principals, or officers of the vendor's company have a familial relationship and the nature of the relationship. Attach additional pages as necessary. (Provide all names or state none in the space below. Do not leave blank.)

Name and Department/Agency of Lake County Employee/Public Official	Familial Relationship

CAMPAIGN CONTRIBUTIONS

List campaign contributions that have been made within the last five years that exceed \$150 annually. Attach additional pages as necessary. (Provide all names or state none in the space below. Do not leave blank.)

Recipient	Donor	Description (e.g., cash, type of item, in-kind service, etc.)	Amount/Value	Date Made

Continuing disclosure is required if information changes. This Vendor Disclosure Statement form is available at www.lakecountylil.gov.

The full text of the County's Ethics and Procurement policies and ordinances are available at www.lakecountylil.gov.

I hereby acknowledge that the information above is accurate and complete, that I am an authorized signer on behalf of the vendor, that I have read and understand these disclosure requirements, and that I agree to update this information if there are any related changes by submitting a new Vendor Disclosure Statement.

Authorized Signature:		Title:	
Printed Name:		Date:	

Vendors must insert "x" in the following box indicating exception and provide a brief narrative for exception.



Mill Creek

**Quality Assurance Project Plan: Bioassessment of the Des Plaines River
Watershed**

Lake County, Illinois

Des Plaines River Watershed Workgroup
500 W. Winchester Rd.
Libertyville, IL 60048

A1. Title and Approval Page

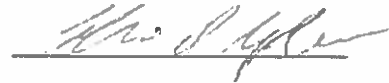
**Quality Assurance Project Plan: Bioassessment of the Des Plaines River
Watershed**

Effective Date: July 15, 2015

Des Plaines River Watershed Workgroup
500 W. Winchester Rd.
Libertyville, IL 60048

Submitted by:

Chris O. Yoder, Principal Investigator, Midwest Biodiversity
Institute

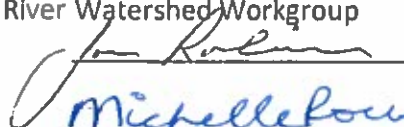


Approvals:

Peter A. Precario, Executive Director, Midwest Biodiversity
Institute



Joe Robinson, Monitoring Committee Chair, Des Plaines River Watershed Workgroup
(DRWW)



Michelle Rousey, Illinois EPA, Quality Assurance Officer



Peter Kolb, President, Des Plaines River Watershed Workgroup
(DRWW)



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List of Acronyms

BCG – biological condition gradient
CPUE – catch per unit effort
CV – coefficient of variation
CWA – Clean Water Act
DC – direct current
DELT – deformities, eroded fins and body parts, lesions, and tumors
DO – dissolved oxygen
DRWW – Des Plaines River Watershed Workgroup
EB – Executive Board
EDD – Electronic Data Deliverable
GPP – Generator Powered Pulsator
GPS – Geographical Positioning System
IBI – Index of Biotic Integrity
ICI – Invertebrate Community Index
IDNR – Illinois Department of Natural Resources
Illinois EPA – Illinois Environmental Protection Agency
INHS – Illinois Natural History Survey
LCS – Laboratory Control Spike
LCSMC – Lake County Stormwater Management Commission
LIMS – Laboratory Information Management System
MAIS – Macroinvertebrate Aggregated Index for Streams
MBI – Midwest Biodiversity Institute
MDL – Method Detection Limit
MS – Matrix Spike
MSD – Matrix Spike Duplicate
NELAP – National Environmental Laboratory Accreditation Program
NPDES – National Pollutant Discharge Elimination System
NSWRD – North Shore Water Reclamation District
OCDL – Ohio Credible Data Law
Ohio EPA – Ohio Environmental Protection Agency
OSUMB - Ohio State University Museum of Biodiversity
PCBs – Polychlorinated Biphenyls
PI – Principal Investigator
PNAs – Polynuclear Aromatic Hydrocarbons
POTW – Publically Owned Treatment Works
QAM – Quality Assurance Manual
QAO – Quality Assurance Officer
QAPP – Quality Assurance Project Plan
QA/QC – Quality Assurance and Quality Control
QHEI – Qualitative Habitat Evaluation Index
QMP – Quality Management Plan
RPD – Relative Percent Difference

SL – Suburban Laboratory
SOP – Standard Operating Procedure
SU – Standard Unit
TOC – Total Organic Carbon
TKN – Total Kjeldahl Nitrogen
TMDL – Total Maximum Daily Load
TSS – Total Suspended Solids
U.S. EPA – United States Environmental Protection Agency
UTM – Universal Transverse Mercator
VOCs – Volatile Organic Compounds
VSS – Volatile Suspended Solids
y-o-y – young of the year

Introduction

The Illinois Environmental Protection Agency (Illinois EPA) requires the development of a Quality Assurance Project Plan (QAPP) for any activity involving the collection and analysis of environmental data. A QAPP presents the policies and procedures, organization, objectives, quality assurance requirements, and quality control activities designed to achieve the type and quality of environmental data necessary to support project or program objectives. It is the policy of Illinois EPA that no data collection or analyses will occur without an approved QAPP or equivalent documentation, per the agency Quality Management Plan (QMP). All in-house and external environmental data collection activities are subject to this requirement. All contracts must address quality assurance requirements (e.g., data quality and reporting requirements) when those contracts pertain to, or have an impact on, data collection or analysis activities. Additionally, all grants and contracts need to address quality assurance requirements specified in applicable state acquisition or procurement regulations. The Des Plaines River Watershed Monitoring QAPP presented herein follows United States Environmental Protection Agency (U.S. EPA) requirements and guidance for the development of a project specific QAPP as detailed in the documents EPA Requirements for Quality Assurance Project Plans (U.S. EPA 2001) and EPA Guidance for Quality Assurance Project Plans (U.S. EPA 2002).

Group A: Project Management Elements

A.3: Distribution List

The proposed project is of interest and potential use to Illinois state agencies and non-governmental organizations, each with specific interests in the protection and restoration of aquatic ecosystems. The following agency staff are recognized as technical advisers given their regional and/or statewide knowledge and expertise and the QAPP will be distributed to them electronically. The original, approved QAPP with signatures will be retained by the Monitoring Committee Chair of the Des Plaines River Watershed Workgroup (DRWW).

Illinois EPA, Roy Smogor, Springfield
Illinois EPA, Howard Essig, Des Plaines
Illinois Department of Natural Resources (IDNR), Steve Pescitelli, Plano

In addition, the following entities will also be included in the distribution list as follows:

Des Plaines River Watershed Workgroup (all members)
Lake County Forest Preserve District
Lake County Stormwater Management Commission (LCSMC)
Lake County Public Works

Lake County Department of Transportation
 Lake County Planning, Building and Development
 North Shore Water Reclamation District (NSWRD)
 Lake County Des Plaines River Watershed Municipalities

In order to maintain open communication amongst interested parties, below is a table of contact information.

Table 1: DRWW Contact Information Associated with the Functional Organization for Bioassessment Monitoring				
Name	Role	Organization	Phone	Email
Peter Kolb	DRWW President	Lake County Public Works	847-377-7500	pkolb@lakecountyil.gov
Joe Robinson	Monitoring Committee Chair	NSWRD	847-623-6060	jorobinson@northshorewrd.org
Mike Warner	Administrative Agent	LCSMC	847-377-7716	mwarner@lakecountyil.gov
Andrea Cline	Technical Agent	Geosyntec	630-203-3366	acline@geosyntec.com
Chris Yoder	Bioassessment and Analysis Contractor	Midwest Biodiversity Institute	614-457-6000 Ext. 1102	cyoder@mwbinst.com
Patrick Rodriguez	Water and Sediment Chemistry Contractor	Suburban Laboratories, Inc.	708-544-3260	pat@suburbanlabs.com

A.4: Project/Task Organization

The bioassessment of the Des Plaines River Watershed will consist of biologic sampling including fish, macroinvertebrates, and habitat and water column and sediment sampling to evaluate ecosystem quality and stressors. All phases of the bioassessment will be coordinated and overseen by the Midwest Biodiversity Institute (MBI). The Research Director, MBI will serve as the Principal Investigator (PI) and overall project coordinator. Senior consultant staff will be assigned various aspects of the project under the oversight of the PI. The MBI PI will also be directly responsible for maintenance of the QAPP through the project period of July 15, 2015 through December 31, 2017. Fish, macroinvertebrates, habitat, and sediment collection will be completed by MBI. The water column chemistry collection and analysis and sediment analysis will be completed by Suburban Laboratories. Patrick Rodriguez, the laboratory project manager, will coordinate and oversee both the water column and subsequent sediment subsequent laboratory analysis. MBI will be responsible for analyzing all data and compiling a final report. A functional table of organization appears in Figure 1.

Advice and assistance with the design of the proposed study has been sought and will continue to be provided by members of the Des Plaines River Watershed Workgroup and Illinois EPA and DNR. Each agency and organization will benefit from the data and analyses produced by the proposed study as it affects key water quality management issues such as National Pollutant Discharge Elimination System (NPDES) permitting, stormwater management, Total Maximum Daily Load (TMDL) development and assessment, and standards setting. Users of this study will benefit from the results and how it relates to the development of water quality and biological criteria that are protective of the indigenous aquatic fauna.

A.5: Problem Definition and Background

The proposed study will document the existing status of the rivers and streams in the watersheds of the Des Plaines River within Lake County, Illinois. The study will emphasize the direct assessment of biological assemblages by sampling fish and macroinvertebrates using standardized sampling and assessment methodologies. In addition to determining aquatic life status, the project will also ascertain the associated causes and sources associated with biological impairments by using paired chemical, physical, and other stressor data and information within a systematic analytical process detailed in a comprehensive plan of study (Appendix A).

A.6: Project Description

This study will be performed in the Des Plaines River and tributaries within Lake County located in the northeastern region of Illinois and in accordance with the Monitoring Strategy (Appendix A including sampling station map and frequency of sampling). Biological sampling will consist of utilizing two assemblages, fish and macroinvertebrates. Water column and sediment chemistry data will also be collected at the same monitoring sites. Sediment data will be collected concurrently with biological sampling, and water column chemistry data will be collected annually with increased frequency. This QAPP specifies the methods and equipment that will be used for all sampling. These estimates are based on the anticipated application of the specific protocols that will likely be used – some adjustments may be required based on the pre-survey reconnaissance and during sampling. A Qualitative Habitat Evaluation Index (QHEI) will be collected at each fish sampling site and will be completed by the crew leader (Appendix B). Field chemical/physical parameters will be collected using a commercially available field meter capable of measuring temperature, dissolved oxygen (DO), conductivity, and pH. Additional chemical parameters will be sampled in the water column and sediment as detailed in Appendix A. Biological laboratory methods will follow the assigned methods and will also include fish voucher verification and macroinvertebrate taxonomy to the lowest practicable level as specified by the request for proposals. Chemical laboratory methods will follow prescribed methods as dictated in Appendix F. Habitat, biological, and water column and sediment chemistry methods and their specifications are described in detail in Appendices A-G.

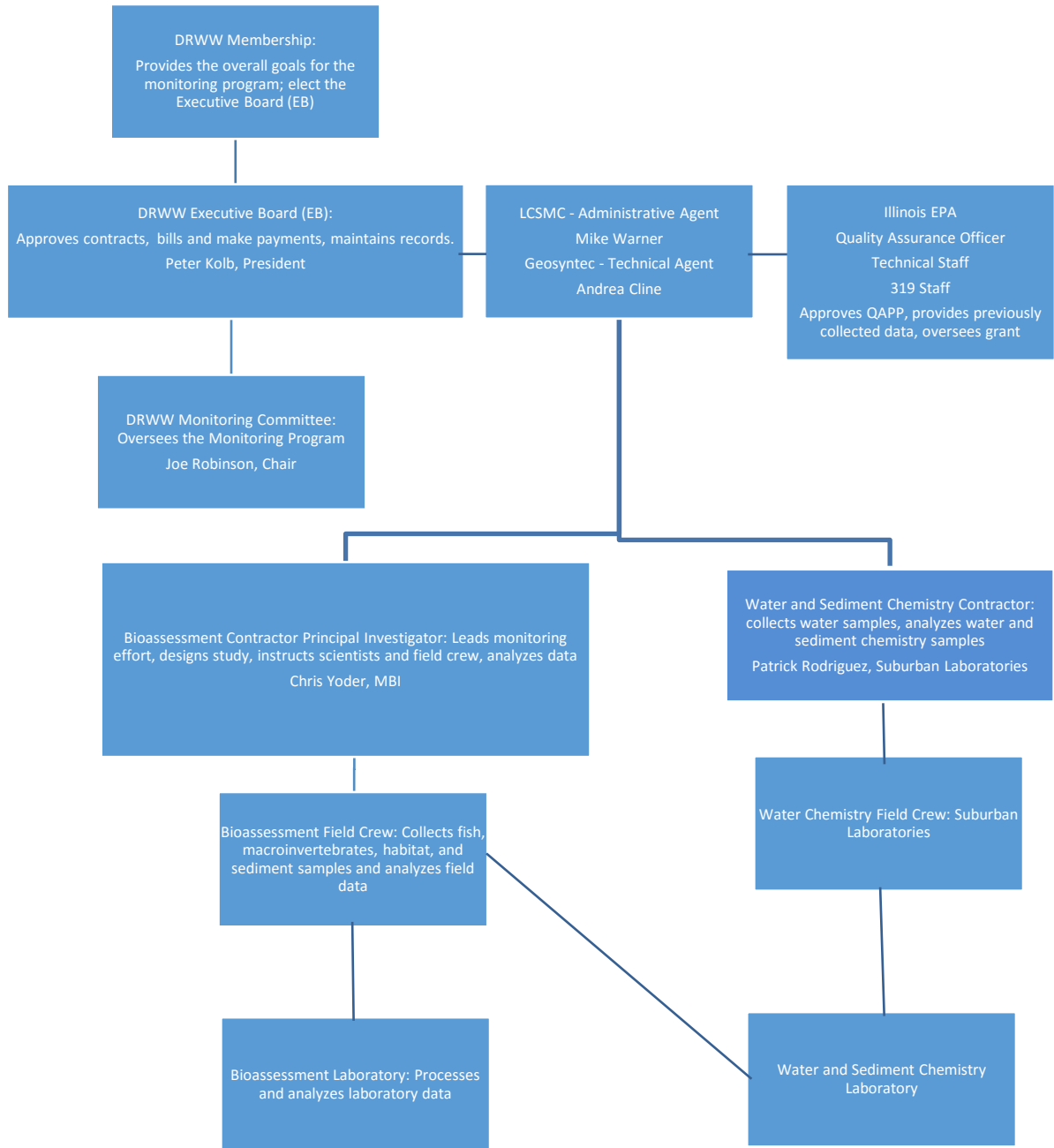


Figure 1: Functional organization for project implementation and management.

A.7: Quality Objectives and Criteria

The accuracy and precision of the biological assessments and water column and sediment investigations is a product of the congruence of the methods and their execution. The properties of the biological assemblage data typified by this study has been previously documented (Ohio EPA 1989, Rankin and Yoder 1990, Fore *et al.* 1993). The methods employed for water column and sediment data collection are accepted as common practice by the Illinois EPA due to consistency and replicability. The types of methods that will be applied in this study have been shown to minimize variability in assessment results, while the sources of variability are known and controlled. This makes the results more useful and reliable for use by Illinois EPA, Illinois DNR, and other organizations. An important goal for bioassessment programs is to employ methods and equipment which are sufficiently effective so as to produce a sufficiently representative sample (accuracy), ensure reproducibility (precision), do so with a reasonable effort (cost-effective), and minimize potential bias from different operators (variability), thus making the results of the assessment comparable. The attributes of each media and the associated data quality objectives and criteria are addressed within this section.

Data Attributes - Fish Assemblage:

The basic attributes of fish data are counts and weights of fish delineated either individually or in the aggregate by species. Species level taxonomy is the minimum data quality objective and identifications to subspecies will be determined when appropriate. Scientific nomenclature will follow that adopted by the American Fisheries Society (AFS; Nelson *et al.* 2004). The historical and spatial distribution of the Illinois ichthyofauna and taxonomy is well described in Smith (1979) and by the Illinois Natural History Survey (INHS)¹. Information will also be recorded about the occurrence of external anomalies, diseases, parasites, and other abnormalities that are observed on each fish that is weighed and/or counted following the methods used by Ohio EPA (1989) and further described by Sanders *et al.* (1999). Qualitative habitat data will also be produced at each fish sampling location using the methodology originally developed by Rankin (1989, 1995; Ohio EPA 2006; Appendix B) and with the most recent updates by MBI. This includes the characterization and categorization of habitat attributes including substrate types and quality, cover types and extent, channel morphology and modification, riparian and bank composition and condition, pool-run-riffle quality and extent, and local gradient.

Data Attributes - Macroinvertebrate Assemblage:

The basic attributes of the macroinvertebrate data to be produced by the proposed study are counts of each taxa identified to the lowest taxonomic level that is practical for most orders and families. All samples will be processed in the laboratory following

¹ The Fishes of Illinois maintained by INHS at: http://www.inhs.uiuc.edu/animals_plants/fish/

Illinois EPA and Ohio EPA (1989) methods. Keys specified in Ohio EPA (1989) and by Illinois EPA will be used to make the identifications.

Data Attributes – Field Water Quality:

The basic attributes of the data to be produced by field measurement are listed in Table 2. The parameters include temperature (°C), dissolved oxygen (DO; mg/l), conductivity (µS/cm²), and pH (Standard Units) and these will be measured at each biological sampling site at the time of each sampling event. Temperature and conductivity are important for determining what electrofishing equipment is needed and what settings are required. The pH and DO data are intended to supplement the more frequent data provided by the chemical sampling crew. These parameters are useful for conditions to support aquatic life and measuring the secondary effects of nutrient enrichment. The conductivity data is also useful for evaluation dissolved solids in runoff (e.g., chlorides from road salt, etc.).

Table 2: Precision, accuracy, and measurement range for field parameters.				
Parameter	Meter	Precision	Accuracy @20°C	Measurement Range
pH	YSI 556	±0.2 S.U.	±0.01 S.U.	0-14 S.U.
Dissolved Oxygen	YSI 556	±0.01 mg/l	±0.3 mg/l	0-20 mg/l
Conductivity	YSI 556	±2%	±2%	0-4000 µS/cm
Temperature	YSI 556	±0.5°C	±0.5°C	0-100°C

Data Attributes – Water Column and Sediment Chemistry:

The basic attributes of water column and sediment chemistry data are measures of concentration by parameter. These sampled parameters are listed in Table 3 and Table 4 for water column and sediment, respectively, and are analyzed by Suburban Laboratories within a general ten business days turn-around time. All parameters are analyzed using the laboratory standard operating procedures (SOPs) and analytical methods listed in the *Sediment and Surface Water Collection SOP* of Appendix F. The samples are reported based on method detection limits (MDL) and reporting limits (RL) that are specified within Appendix F and are compared to the minimum measurement criteria addressed in the *Sensitivity* section. All data is also compared to data quality objectives including the limit of sensitivity, precision, and accuracy. These data quality objectives for the water column samples are detailed in Table 3.

Table 3: Precision, accuracy, and limit of sensitivity for water column chemistry parameters.			
Parameter	Accuracy (% Recovery)	Precision (Relative Percent Difference [RPD])	Limit of Sensitivity *
<u>Demand</u>			
Chloride	90% -110%	20%	5 mg/L
Conductivity	90% - 110%	20%	1 µmhos/cm
Total Organic Carbon (TOC)	90% - 110%	10%	1 mg/L
Sulfate	90% - 110%	20%	2 mg/L
Total Suspended Solids (TSS)	N/A	10%	0.2 mg/L
Volatile Suspended Solids (VSS)	N/A	10%	0.2 mg/L
Turbidity	90% - 110%	20%	0.1 NTU
<u>Metals</u>			
Total Hardness	90% - 110%	20%	0.05 mg/L
Arsenic (As)	90% - 110%	20%	0.0008 mg/L
Calcium (Ca)	90%-110%	20%	0.015 mg/L
Copper (Cu)	90% - 110%	20%	0.001 mg/L
Iron (Fe)	90% - 110%	20%	0.0117 mg/L
Magnesium (Mg)	90%-110%	20%	0.01 mg/L
Manganese (Mn)	90% - 110%	20%	0.002 mg/L
Mercury (Hg)	90% - 110%	20%	0.0001 mg/L
Nickel (Ni)	90% - 110%	20%	0.0004 mg/L
Sodium (Na)	90% - 110%	20%	0.03 mg/L
Zinc (Zn)	90% - 110%	20%	0.003 mg/L
Low Level Mercury (Hg)	90% - 110 %	21%	0.5 ng/L
<u>Nutrients</u>			
Ammonia (NH ₃ -N)	90% - 110%	20%	0.1 mg/L
Total Nitrates (NO ₂ +NO ₃)	90% - 110%	20%	0.05 mg/L
Total Kjeldahl Nitrogen (TKN)	90% - 110%	20%	0.5 mg/L
Total Phosphorus	90% - 110%	20%	440 µg/L
Dissolved Reactive Phosphorus (Orthophosphate)	90% - 110%	20%	0.026 mg/L
<u>Bacteria</u>			
E. Coli	N/A	N/A	1 MPN/100 mL

Organics			
Pesticides			
4,4'-DDD	85% - 115%	21.90%	0.05 µg/L
4,4'-DDE	85% - 115%	13.30%	0.05 µg/L
4,4'-DDT	85% - 115%	23.80%	0.05 µg/L
Aldrin	85% - 115%	18.10%	0.025 µg/L
alpha-BHC	85% - 115%	19.60%	0.025 µg/L
alpha-Chlordane	85% - 115%	13.60%	0.025 µg/L
beta-BHC	85% - 115%	16.90%	0.025 µg/L
Chlordane	85% - 115%	20%	0.1 µg/L
delta-BHC	85% - 115%	22.70%	0.025 µg/L
Dieldrin	85% - 115%	21.80%	0.05 µg/L
Endosulfan I	85% - 115%	12.30%	0.025 µg/L
Endosulfan II	85% - 115%	13.40%	0.05 µg/L
Endosulfan sulfate	85% - 115%	13.60%	0.05 µg/L
Endrin	85% - 115%	12.50%	0.05 µg/L
Endrin aldehyde	85% - 115%	23.60%	0.05 µg/L
Endrin ketone	85% - 115%	13%	0.05 µg/L
gamma-BHC	85% - 115%	20.20%	0.025 µg/L
gamma-Chlordane	85% - 115%	13.40%	0.025 µg/L
Heptachlor	85% - 115%	19.40%	0.025 µg/L
Heptachlor epoxide	85% - 115%	18.80%	0.025 µg/L
Methoxychlor	85% - 115%	21.50%	0.25 µg/L
Toxaphene	85% - 115%	25.40%	0.2 µg/L
Polychlorinated Biphenyls (PCBs)			
Aroclor 1016	85% - 115%	30%	0.1 µg/L
Aroclor 1221	85% - 115%	30%	0.1 µg/L
Aroclor 1232	85% - 115%	30%	0.1 µg/L
Aroclor 1242	85% - 115%	30%	0.1 µg/L
Aroclor 1248	85% - 115%	30%	0.1 µg/L
Aroclor 1254	85% - 115%	30%	0.1 µg/L
Aroclor 1260	85% - 115%	30%	0.1 µg/L
Total PCBs	85% - 115%	30%	0.7 µg/L
Polynuclear Aromatic Hydrocarbons (PNAs)			
Acenaphthene	80%-120%	30%	0.1 µg/L
Acenaphthylene	80%-120%	30%	0.1 µg/L
Anthracene	80%-120%	30%	0.1 µg/L

Benzo(a)anthracene	80%-120%	30%	0.1 µg/L
Benzo(a)pyrene	80%-120%	30%	0.1 µg/L
Benzo(b)fluoranthene	80%-120%	30%	0.1 µg/L
Benzo(g,h,i)perylene	80%-120%	30%	0.1 µg/L
Benzo(k)fluoranthene	80%-120%	30%	0.1 µg/L
Chrysene	80%-120%	30%	0.1 µg/L
Dibenzo(a,h)anthracene	80%-120%	30%	0.1 µg/L
Fluoranthene	80%-120%	30%	0.1 µg/L
Fluorene	80%-120%	30%	0.1 µg/L
Indeno(1,2,3-cd)pyrene	80%-120%	30%	0.1 µg/L
Naphthalene	80%-120%	30%	0.1 µg/L
Phenanthrene	80%-120%	30%	0.1 µg/L
Pyrene	80%-120%	30%	0.1 µg/L
Volatile Organic Compounds (VOCs)			
1,1,1-Trichloroethane	80%-120%	20%	1 µg/L
1,1,2,2-Tetrachloroethane	80%-120%	20%	1 µg/L
1,1,2-Trichloroethane	80%-120%	20%	1 µg/L
1,1-Dichloroethane	80%-120%	20%	1 µg/L
1,1-Dichloroethene	80%-120%	20%	1 µg/L
1,2-Dibromo-3-chloropropane	80%-120%	20%	1 µg/L
1,2-Dichlorobenzene	80%-120%	20%	1 µg/L
1,2-Dichloroethane	80%-120%	20%	1 µg/L
1,2-Dichloropropane	80%-120%	20%	1 µg/L
1,3-Dichlorobenzene	80%-120%	20%	1 µg/L
1,4-Dichlorobenzene	80%-120%	20%	1 µg/L
2-Butanone	80%-120%	20%	10 µg/L
2-Chloroethyl vinyl ether	80%-120%	20%	10 µg/L
2-Hexanone	80%-120%	20%	25 µg/L
4-Methyl-2-pentanone	80%-120%	20%	25 µg/L
Acetone	80%-120%	20%	25 µg/L
Acrolein	80%-120%	20%	25 µg/L
Acrylonitrile	80%-120%	20%	25 µg/L
Benzene	80%-120%	20%	1 µg/L
Bromodichloromethane	80%-120%	20%	1 µg/L
Bromoform	80%-120%	20%	1 µg/L
Bromomethane	80%-120%	20%	1 µg/L
Carbon disulfide	80%-120%	20%	1 µg/L
Carbon tetrachloride	80%-120%	20%	1 µg/L
Chlorobenzene	80%-120%	20%	1 µg/L

Chloroethane	80%-120%	20%	1 µg/L
Chloroform	80%-120%	20%	1 µg/L
Chloromethane	80%-120%	20%	1 µg/L
cis-1,2-Dichloroethene	80%-120%	20%	1 µg/L
cis-1,3-Dichloropropene	80%-120%	20%	1 µg/L
Dibromochloromethane	80%-120%	20%	1 µg/L
Dichlorodifluoromethane	80%-120%	20%	1 µg/L
Ethylbenzene	80%-120%	20%	1 µg/L
m,p-Xylene	80%-120%	20%	2 µg/L
Methyl tert-butyl ether	80%-120%	20%	1 µg/L
Methylene chloride	80%-120%	20%	5 µg/L
o-Xylene	80%-120%	20%	1 µg/L
Styrene	80%-120%	20%	1 µg/L
Tetrachloroethene	80%-120%	20%	1 µg/L
Toluene	80%-120%	20%	1 µg/L
trans-1,2-Dichloroethene	80%-120%	20%	1 µg/L
trans-1,3-Dichloropropene	80%-120%	20%	1 µg/L
Trichloroethene	80%-120%	20%	1 µg/L
Trichlorofluoromethane	80%-120%	20%	1 µg/L
Vinyl chloride	80%-120%	20%	1 µg/L
Total Xylenes	80%-120%	20%	2 µg/L

* The limit of sensitivity is defined by the MDL. All laboratory instruments utilize a calibration defining instrument response. Any measurement falling above the upper calibration range is diluted to fall within range.

The limit of sensitivity, and precision and accuracy measurements for sediment data are detailed in Table 4.

Parameter	Accuracy (% Recovery)	Precision (RPD)	Limit of Sensitivity *
Metals			
Metals (19)			
Aluminum (Al)	90% - 110%	20%	2.5 mg/Kg
Arsenic (As)	90% - 110%	20%	1.15 mg/Kg
Barium (Ba)	90% - 110%	20%	0.125 mg/Kg
Beryllium (Be)	90% - 110%	20%	0.05 mg/Kg
Boron (B)	90% - 110%	20%	0.625 mg/Kg
Cadmium (Cd)	90% - 110%	20%	0.75 mg/Kg
Chromium (Cr)	90% - 110%	20%	0.06 mg/Kg
Cobalt (Co)	90% - 110%	20%	0.125 mg/Kg
Copper (Cu)	90% - 110%	20%	0.15 mg/Kg

Iron (Fe)	90% - 110%	20%	0.625 mg/Kg
Lead (Pb)	90% - 110%	20%	0.6 mg/Kg
Manganese (Mn)	90% - 110%	20%	0.06 mg/Kg
Mercury (Hg)	90% - 110%	20%	0.2 mg/Kg
Nickel (Ni)	90% - 110%	20%	0.235 mg/Kg
Potassium (K)	90% - 110%	20%	2.5 mg/Kg
Silver (Ag)	90% - 110%	20%	0.06 mg/Kg
Sodium (Na)	90% - 110%	20%	1.25 mg/Kg
Strontium (Sr)	90% - 110%	20%	0.12 mg/Kg
Vanadium (V)	90% - 110%	20%	0.15 mg/Kg
Zinc (Zn)	90% - 110%	20%	1 mg/Kg
Fluoride	90% - 110%	20%	0.5 mg/Kg
<u>Organics</u>			
Pesticides			
4,4'-DDD	85% - 115%	18.50%	0.05 µg/Kg
4,4'-DDE	85% - 115%	28.80%	0.05 µg/Kg
4,4'-DDT	85% - 115%	37.20%	0.05 µg/Kg
Aldrin	85% - 115%	28.80%	0.025 µg/Kg
alpha-BHC	85% - 115%	33.10%	0.025 µg/Kg
alpha-Chlordane	85% - 115%	25.80%	0.025 µg/Kg
beta-BHC	85% - 115%	38.80%	0.025 µg/Kg
Chlordane	85% - 115%	50%	0.1 µg/Kg
delta-BHC	85% - 115%	17.30%	0.025 µg/Kg
Dieldrin	85% - 115%	34.10%	0.05 µg/Kg
Endosulfan I	85% - 115%	38.70%	0.025 µg/Kg
Endosulfan II	85% - 115%	29%	0.05 µg/Kg
Endosulfan sulfate	85% - 115%	25.70%	0.05 µg/Kg
Endrin	85% - 115%	30.80%	0.05 µg/Kg
Endrin aldehyde	85% - 115%	36.20%	0.05 µg/Kg
Endrin ketone	85% - 115%	27.30%	0.05 µg/Kg
gamma-BHC	85% - 115%	26.80%	0.025 µg/Kg
gamma-Chlordane	85% - 115%	29.30%	0.025 µg/Kg
Heptachlor	85% - 115%	20.50%	0.025 µg/Kg
Heptachlor epoxide	85% - 115%	33.40%	0.025 µg/Kg
Methoxychlor	85% - 115%	51.40%	0.25 µg/Kg
Toxaphene	85% - 115%	50%	0.2 µg/Kg
PCBs			
Aroclor 1016	85% - 115%	50%	16.7 µg/Kg
Aroclor 1221	85% - 115%	50%	16.7 µg/Kg

Aroclor 1232	85% - 115%	50%	16.7 µg/Kg
Aroclor 1242	85% - 115%	50%	16.7 µg/Kg
Aroclor 1248	85% - 115%	50%	16.7 µg/Kg
Aroclor 1254	85% - 115%	50%	16.7 µg/Kg
Aroclor 1260	85% - 115%	50%	16.7 µg/Kg
PNA s			
Acenaphthene	80%-120%	30%	40 µg/Kg
Acenaphthylene	80%-120%	30%	40 µg/Kg
Anthracene	80%-120%	30%	40 µg/Kg
Benzo(a)anthracene	80%-120%	30%	40 µg/Kg
Benzo(a)pyrene	80%-120%	30%	40 µg/Kg
Benzo(b)fluoranthene	80%-120%	30%	40 µg/Kg
Benzo(g,h,i)perylene	80%-120%	30%	40 µg/Kg
Benzo(k)fluoranthene	80%-120%	30%	40 µg/Kg
Chrysene	80%-120%	30%	40 µg/Kg
Dibenzo(a,h)anthracene	80%-120%	30%	40 µg/Kg
Fluoranthene	80%-120%	30%	40 µg/Kg
Fluorene	80%-120%	30%	40 µg/Kg
Hexachlorobenzene	80%-120%	30%	40 µg/Kg
Indeno(1,2,3-cd)pyrene	80%-120%	30%	40 µg/Kg
Naphthalene	80%-120%	30%	40 µg/Kg
Phenanthrene	80%-120%	30%	40 µg/Kg
Pyrene	80%-120%	30%	40 µg/Kg
VOC s			
1,1,1-Trichloroethane	80% - 120%	20%	1 µg/Kg
1,1,2,2-Tetrachloroethane	80% - 120%	20%	1 µg/Kg
1,1,2-Trichloroethane	80% - 120%	20%	1 µg/Kg
1,1-Dichloroethane	80% - 120%	20%	1 µg/Kg
1,1-Dichloroethene	80% - 120%	20%	1 µg/Kg
1,2-Dibromo-3-chloropropane	80% - 120%	20%	1 µg/Kg
1,2-Dichlorobenzene	80% - 120%	20%	1 µg/Kg
1,2-Dichloroethane	80% - 120%	20%	1 µg/Kg
1,2-Dichloropropane	80% - 120%	20%	1 µg/Kg
1,3-Dichlorobenzene	80% - 120%	20%	1 µg/Kg
1,4-Dichlorobenzene	80% - 120%	20%	1 µg/Kg
2-Butanone	80% - 120%	20%	10 µg/Kg
2-Chloroethyl vinyl ether	80% - 120%	20%	10 µg/Kg
2-Hexanone	80% - 120%	20%	25 µg/Kg
4-Methyl-2-pentanone	80% - 120%	20%	25 µg/Kg

Acetone	80% - 120%	20%	25 µg/Kg
Acrolein	80% - 120%	20%	25 µg/Kg
Acrylonitrile	80% - 120%	20%	25 µg/Kg
Benzene	80% - 120%	20%	1 µg/Kg
Bromodichloromethane	80% - 120%	20%	1 µg/Kg
Bromoform	80% - 120%	20%	1 µg/Kg
Bromomethane	80% - 120%	20%	1 µg/Kg
Carbon disulfide	80% - 120%	20%	1 µg/Kg
Carbon tetrachloride	80% - 120%	20%	1 µg/Kg
Chlorobenzene	80% - 120%	20%	1 µg/Kg
Chloroethane	80% - 120%	20%	1 µg/Kg
Chloroform	80% - 120%	20%	1 µg/Kg
Chloromethane	80% - 120%	20%	1 µg/Kg
cis-1,2-Dichloroethene	80% - 120%	20%	1 µg/Kg
cis-1,3-Dichloropropene	80% - 120%	20%	1 µg/Kg
Dibromochloromethane	80% - 120%	20%	1 µg/Kg
Dichlorodifluoromethane	80% - 120%	20%	1 µg/Kg
Ethylbenzene	80% - 120%	20%	1 µg/Kg
m,p-Xylene	80% - 120%	20%	2 µg/Kg
Methyl tert-butyl ether	80% - 120%	20%	1 µg/Kg
Methylene chloride	80% - 120%	20%	5 µg/Kg
o-Xylene	80% - 120%	20%	1 µg/Kg
Styrene	80% - 120%	20%	1 µg/Kg
Tetrachloroethene	80% - 120%	20%	1 µg/Kg
Toluene	80% - 120%	20%	1 µg/Kg
trans-1,2-Dichloroethene	80% - 120%	20%	1 µg/Kg
trans-1,3-Dichloropropene	80% - 120%	20%	1 µg/Kg
Trichloroethene	80% - 120%	20%	1 µg/Kg
Trichlorofluoromethane	80% - 120%	20%	1 µg/Kg
Vinyl chloride	80% - 120%	20%	1 µg/Kg
Total Xylenes	80% - 120%	20%	2 µg/Kg
Herbicides			
2,4-D	85% - 115%	N/A	0.0033 mg/Kg
2,4,5-TP	85% - 115%	N/A	0.0033 mg/Kg
Inorganics			
TKN	90% - 110%	20%	100 mg/Kg
Phosphorus	90% - 110%	20%	2.3 mg/Kg
Cyanide (low)	90% - 110%	20%	0.1 mg/Kg
Phenols	90% - 110%	20%	0.005 mg/Kg

* The limit of sensitivity is defined by the MDL. All laboratory instruments utilize a calibration defining instrument response. Any measurement falling above the upper calibration range is diluted to fall within range.

Representativeness

Representativeness is the measure of the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Representativeness of data will be ensured using established field and laboratory procedures and their consistent application. To aid in the evaluation of the representativeness of the sample data, water column field blank samples and laboratory blank samples will be evaluated for the presence of the sampled parameters.

Representativeness – Reference Sites

Data (fish, macroinvertebrate, habitat, water column chemistry, and sediment chemistry) will be collected from selected regional reference sites in northeastern Illinois preferably to include existing Illinois EPA and Illinois DNR reference sites, potentially being supplemented with other sites that meet the Illinois EPA criteria for reference conditions. One purpose of this data will be to index the methods used in this study to the reference condition as defined by Illinois EPA. In addition, the current Illinois EPA reference network does not yet include smaller headwater streams; hence reference data is needed to accomplish an assessment of that data.

Representativeness of Fish Data

Pulsed direct current (D.C.) electrofishing is a widely used methodology for collecting data on stream fish assemblages in the Midwestern U.S. While electrofishing does not collect all of the species present in a stream, it can collect more than 75-80% of the species that are present and approximate their relative abundances (Yoder and Smith 1999). This meets the purposes and requirements for biological assessments and biological criteria in that sufficiently representative data is produced to provide reliable signal about the health and well-being of the entire resource without the need to accomplish an exhaustive faunal inventory. The collection of relative abundance data includes the use of a standardized sampling procedure designed to produce a sufficiently representative sample of the fish assemblage at a site with a reasonable expenditure of effort (i.e., 2-3 hours/site; Yoder and Smith 1999).

Representativeness of Macroinvertebrate Data

The multi-habitat methodology of Illinois EPA (Appendix D) will be the primary method employed in this study. It produces a 300 organism subsample that represents all habitat types present at a site. A minimum 300 feet long reach is established and is intended to meet qualitative criteria of representativeness and including one stream habitat cycle (i.e., pool-run-riffle sequence). Wider width sites will be extended to 600 feet.

Representativeness of Water Chemistry Data

Water column chemistry samples will be collected using a grab sample method. The collection bucket will be washed with phosphate-free detergent and blank water, and then rinsed with river water to remove any potential sources of contamination in addition to sample decontamination between sampling locations. Samples will be collected from the center or point of the river or stream that appear under most uniform conditions.

Representativeness of Sediment Chemistry Data

Surficial sediment samples will be collected as composites in the method appropriate to the waterbody as specified in Appendix F. Samples will be collected in areas that were not previously disturbed by earlier sampling or wading. Composite samples will be collected from downstream to upstream to minimize potential disturbances. Care will also be taken to prevent material loss in the collection method and sampling equipment will be rinsed and decontaminated between sampling locations.

Precision and Accuracy

Precision is a measure of agreement among repeated measurements of the same property under identical, or substantially similar, conditions; calculated as either the range or as the standard deviation. Precision may also be expressed as a percentage of the mean of the measurements, such as relative range or relative standard deviation (coefficient of variation).

Precision will be measured in the laboratory during the analysis of laboratory matrix spike (MS) and matrix spike duplicate (MSD) samples which are analyzed once per batch or at a rate of one per twenty samples. The analyses of the duplicate samples are considered acceptable if the calculated relative percent difference (RPD) of the measurements is within the acceptance limits listed in Table 3 and Table 4 for water column and sediment samples, respectively. For this study, the results of the duplicate analyses are used to calculate the RPD for evaluating precision using the following formula:

$$\text{RPD} = [(A - B) / (A + B)/2] * 100$$

where

A = Original sample concentration

B = Duplicate sample concentration

Accuracy is a measure of the overall agreement of a measurement to a known value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations. Accuracy will be measured during the analysis of environmental water by using laboratory control spike (LCS) samples. In the laboratory, samples of deionized water will be fortified (or spiked) with the analytes of interest. These LCS samples will be analyzed with each batch of

samples. The analyses of the LCS samples are considered acceptable if the calculated concentrations for all analytes of interest are within the acceptance limits listed in Tables 3 and 4 for the water column and sediment samples, respectively.

The results of the spiked samples are used to calculate the percent recovery for evaluating accuracy using the following formula:

$$\text{Percent Recovery} = [(S - U) / T] * 100$$

where

S = Spiked sample concentration

U = Unspiked sample concentration

T = True spike concentration

Precision and Accuracy - Fish and Macroinvertebrate Assemblages:

The Consultant employs fish and macroinvertebrate methods of which the precision and accuracy of the resulting data are known. Ohio EPA (1987) extensively tested the reproducibility, accuracy, and precision of the electrofishing sampling protocols in both wadeable streams and non-wadeable rivers and of the macroinvertebrate field methods. Based on a combination of data analyses from specially designed methods testing studies and the aggregate Ohio database, the reproducibility of an Ohio Index of Biotic Integrity (IBI) and Invertebrate Community Index (ICI) score was determined to be 4 units out of a 0-60 (12-60 for IBI) scoring scale (Rankin and Yoder 1999). Rankin and Yoder (1990) showed coefficient of variations (CV) were on the order of 8-10% at least impacted and high quality sites. CVs increased at sites with lower IBI and ICI scores, presumably due to the effect of stressors at increasingly impacted sites. Fore *et al.* (1993) performed more extensive statistical analyses of the Ohio database and determined that IBI scores were reproducible to an error margin of 2-3 units when fish numbers were >200/0.3 km. Their power analysis confirmed that the Ohio IBI was capable of distinguishing 6 discrete scoring ranges that approximate the delineations of the IBI scale into the qualitative descriptions of exceptional, good, fair, poor, and very poor. Angermier and Karr (1986) analyzed other statistical properties of the IBI focusing on the extent of redundancy among metrics. The results of their analysis showed that careful construction and derivation of an IBI following the original guidance of Karr *et al.* (1986) should produce a robust and non-redundant set of metrics.

Accuracy can also be examined in terms of the assessment produced by the subject method. Biological assessments are viewed as a direct measure of the aquatic life protection goals of the Clean Water Act (CWA) and State water quality standards (as opposed to the surrogate assessment provided by chemical water quality criteria). This has given rise to the concept and interest in biological criteria and adoption by U.S. EPA of a national program, methods, and the development of formal implementation procedures. The issue at stake here is the accuracy of the delineation of waters as impaired or unimpaired for CWA purposes (e.g., TMDLs, NPDES). Historically, States and U.S. EPA based these decisions on chemical water quality data and comparison to State

and national water quality criteria. However, studies that compared the relative performance of chemical and biological data and their respective abilities to detect impairment showed that biological data was far superior in its ability to detect impairment and minimize type II assessment error (Rankin and Yoder 1990; Yoder and Rankin 1998). It is implicit in these studies that the better standardized and calibrated the biological assessment method and assessment criteria, the more capable the method of detecting impairment and establishing a relative degree of departure from a baseline criterion and a measurement of biological condition that is continuous along the Biological Condition Gradient (BCG).

Precision and Accuracy – Water Column and Sediment Data:

The in-stream and analytical water column and sediment data will be recorded and analyzed based on the precision and accuracy parameters highlighted in the *Data Attributes – Water Column and Sediment Chemistry* section.

Measurement Range and Comparability

Comparability is a measure of the confidence with which one data set or method can be compared to another. Comparability will be maximized by using standard analytical methods and standardized, documented sampling techniques. Documentation will include all sampling locations, conditions, and field sampling methods. All results will be reported in standard units or, for field parameters, as defined in the method. All laboratory calibrations will be performed using standards traceable to the National Institute for Standards and Technology (NIST) or another certified reference standard source.

Theoretically there is no upper limit to most of the raw data parameters that comprise the baseline biological data that will be produced by this study. The practical range of these parameters is dependent on the natural attributes of the regional fish and macroinvertebrate assemblages and the effectiveness of the sampling gear and procedure. For example, in the Des Plaines River sub basins we expect a wading electrofishing sample to produce 15-25 species and several hundred fish among those species. In higher quality areas, the number of species might increase to more than 30 with thousands of individuals. However, in terms of regional reference condition and potential, the resulting biological assessment should rate a biological assemblage the same with respect to its similarity to or departure from a regional reference condition. This is critical to establishing biological assessments that are comparable across the U.S. Thus the derivation of reference condition is a critical step in the bioassessment process and is one of the factors that influence comparability.

The resulting assessments and biological indices have discrete scoring ranges, within which the raw data is stratified and compressed. For example, the original IBI and many of its contemporary applications use a scoring range of 12-60, i.e., metric scores of 5, 3, and 1 are assigned to each of 12 metrics. Newly developed IBIs have employed a

scoring range of 0-100, which is intuitively more meaningful as a theoretical scoring range and communication tool. The rigor, adequacy of the method, development, and calibration ultimately determines the accuracy, precision, and reproducibility of the index, its statistical rigor, and its resulting assessment.

The water column and sediment samples will be collected as grab and composite samples at specified locations within the assemblage range. Sampling protocols specified within this QAPP will minimize external factors and allow for consistency and comparability between samples. Collection of duplicate samples will also be used to confirm consistency in technique and reproducibility of sample collection to further support data comparisons.

Bias

Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction. The accuracy of the water column and sediment samples will be assessed in order to identify and address any bias encountered.

Completeness

Completeness is a measure of the amount of valid data needed to be obtained from a measurement system. The percent completeness is calculated by dividing the number of valid sample results by the total number of samples planned, and multiplying the result by 100 percent. Completeness will be reported as the percentage of all measurements judged valid. The following equation will be used to determine completeness:

$$\text{Percent Completeness} = (V/T) * 100$$

where

V = Valid number of sample results

T = Total number of samples planned

For this project, the QA objective for degree of completeness for both field and laboratory data is 90 percent. If completeness is less than the target of 90 percent representatives at the DRWW will evaluate the data to determine whether there are enough data to complete the study or if additional data collection is necessary.

It is expected that all of the data collected by the proposed study will be used for multiple purposes. The collection of the biological, habitat, and water column and sediment chemistry will be spatially integrated. This will provide enough information to compare the biological responses exhibited by the fish and macroinvertebrate assemblages with the exposure suggested by the habitat and water quality data at the same sampling sites. Sediment data integrates conditions over time more so than the water column grab sample data. All sampling protocols are designed to control the conditions under which sampling takes place so as to minimize external and confounding influences (e.g., high flows) and to ensure the data is comparable and representative.

Sensitivity

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing different levels of the variable of interest. Many analytes measured for this project are present in analytically low concentrations throughout the biota, surface water, and sediment. All analytes are subject to chemical, biological, and physical processes that will alter their presence in the rivers and tributaries. It is the intent of this project to employ methods of measurements that will detect and quantify all analytes of interest wherever possible.

Although there are many intended and potential uses of the data, minimum measurement criteria will be established at the lowest analyte concentration required for planned uses of the measurement data. Minimum measurement criteria are State of Illinois water quality standards for general use waters where applicable. Where no minimum measurement criteria can be identified, the water column samples will be analyzed to the lowest concentration readily achievable by Suburban Laboratories. The monitored parameters and the established minimum measurement criteria are shown in Table 5. No table is constructed for sediment samples due to limited State of Illinois sediment standards.

Table 5 also gives the minimum measurement objectives for the project. The minimum measurement objectives will be set at approximately one-fifth of the minimum measurement criteria shown to ensure that parameters will be measured with reasonable accuracy at the minimum measurement criteria concentrations, and measured to reasonable levels below the minimum measurement criteria.

The minimum measurement objective for any analyte will be achieved when the analytical procedure selected for sample analysis can be shown to have a MDL at or below the minimum measurement objective. Table 5 compares the minimum measurement objective against the reporting limit achieved by Suburban Laboratories. All analytes with the exception of Total Mercury and Total Phosphorous meet the minimum measurement objectives. Total Mercury and Total Phosphorous do not meet the minimum measurement objectives due to laboratory instrument sensitivity; however, both analytes meet the minimum measurement criteria.

Analyte MDLs shall be determined by the USEPA method given in the Code of Federal Regulations (CFR), Volume 40, Part 136, Appendix B. The MDL is defined as “the minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero.” Since the MDL procedure is based upon precision obtained for a standard greater than the MDL, it also is a measure of method sensitivity at concentrations near the MDL.

For analytes without minimum measurements criteria, the minimum measurement objectives will be understood to be the MDL level that is readily achievable using analytical methods generally employed at Suburban Laboratories. For parameters

where MDLs are not applicable such as pH and dissolved oxygen, the minimum measurement objectives shown in Table 5 are the sensitivity to be obtained by the measurement method. The accuracy and precision completeness for each parameter are also indicated in Tables 3 and 4 for the water column and sediment, respectively.

Table 5: Minimum measurement criteria, minimum measurement objectives, method MDLs, and laboratory RLs for regulated, sampled parameters.

Parameter	Minimum Measurement Criteria	Minimum Measurement Objectives	Method* MDL	RL
Total Chloride	500 mg/L ^C	100 mg/L	1 mg/L	1 mg/L
pH, field	6.5 - 9.0 pH unit	0.1 pH unit ^S	NA	NA
Total Sulfate	1870 mg/L ^C	374 mg/L	1 mg/L	2 mg/L
Dissolved Oxygen	5.0 mg/L (min) ^C	0.1 mg/L ^S	NA	N/A
Dissolved Arsenic	190 µg/L ^C	38 µg/L	0.04 µg/L ^M	0.8 µg/L
Dissolved Copper	32 µg/L ^C	6.4 µg/L	0.5 µg/L ^M	1 µg/L
Dissolved Iron	1.0 mg/L ^C	0.2 mg/L	NA	11.7 µg/L
Total Manganese	152 µg/L ^C	30.4 µg/L	0.04 µg/L ^M	2 µg/L
Total Mercury	1.2 ng/L ^C	0.24 ng/L	0.2 ng/L	0.5 ng/L
Dissolved Nickel	14 µg/L ^C	2.8 µg/L	0.03 µg/L ^M	0.4 µg/L
Total Zinc	61 µg/L ^C	12.2 µg/L	0.2 µg/L ^M	3 µg/L
Ammonia (NH ₃ -N)	15.0 mg/L ^G	3.0 mg/L	0.023 mg/L	0.1 mg/L
Phosphorus, Total	0.05 mg/L ^G	0.01 mg/L	0.002 mg/L	0.044 mg/L

NA = Not applicable

* Limits are current and subject to change

^S = Required sensitivity

^G = State of Illinois General Use Water Quality Standard

^C = State of Illinois General Use Water Quality Standard that is based on acute or chronic standards and in some cases, variable based on the hardness of the water body.

^M = Method Detection Limit based on the Selection Ion Monitoring Mode for direct aqueous analysis.

A.8: Training and Certification

The methods and protocols used in the proposed study require implementation by adequately trained and skilled biologists, field technicians, and laboratory staff. For the bioassessment, the lead biologist(s) must be well trained and experienced in all aspects of conducting the sampling, making decisions that affect quality in the field, being familiar with the study area, and knowing how to identify all species of fish and taxa of macroinvertebrates that will be encountered. Biological crew leaders must also be knowledgeable about safety procedures for boat electrofishing and boat and water safety. All crew leaders will be certified as Level 3 Qualified Data Collectors under the Ohio Credible Data Law (OCDL) or equivalent.

Field personnel assigned to this project will be directly supervised by the principal investigator and will have been trained by the principal investigator in an apprenticeship format (training documentation provided upon request). Of particular importance will be training in the electrofishing procedure, use of the modified QHEI, and the identification of external anomalies on fish. Each will follow the procedures outlined in Ohio EPA (1989) and Rankin (1989). Bioassessment laboratory personnel will adhere to the laboratory's internal protocols.

For the water column and sediment investigation, all laboratory staff utilizing the methods and protocols addressed in this study meet or exceed the educational requirements outlined in Suburban Laboratories' QAM (Quality Assurance Manual). For each analysis, the chemist must demonstrate proficiency for each individual analysis. The proficiency requirements are typically defined in the specific method, within the U.S. EPA program for which the work is performed, within the National Environmental Laboratory Accreditation Program (NELAP) requirements, as well as Suburban Laboratories' QAM.

Field technicians assigned to this project, for the purpose of collecting samples and performing the analyses that are required to be completed in the field, have received adequate training from trained and experienced personnel. Field technicians will operate under the guidance and supervision of the Field Services Manager. The field technicians are trained to be compliant with the requirements set forth by NELAP, U.S. EPA, and Suburban Laboratories' QAM where applicable.

A.9: Documents and Records

The Quality Assurance Project Plan and all updates will be maintained by the DRWW in a secure location for five years. Revisions to the QAPP will be noted as to version and date and signed by the lead signatories. A detailed plan of study will be used to guide the execution of the annual field sampling.

Field Data Recording

Field data and observations will be recorded using standard data forms and field sheets. Fish data is recorded using the data sheet in Figure 2. Habitat data will be recorded using the QHEI data sheet in Figure 3. Initial water column chemistry data when grab samples are collected will be recorded using the data sheet in Figure 4. Sample times will be recorded for sediment sampling in conjunction with the bioassessment record keeping of Figure 2. All data will be entered into a relational database. All biological, chemical, and habitat data is initially managed by the consultants, transformed, analyzed, and then transferred to DRWW.

Figure 2. Field data sheet for recording electrofishing collection data and for entry into the database.

Fish Data Sheet

Page ____ of ____

Crew Leader _____ Boat Driver _____ Netters _____ Project Code: _____
 Field Crew: _____ Time of Day: _____ Site Code: _____
 River/ Stream: _____ Location: _____
 Date: _____ Distance: _____ Temp: _____ Seconds Fished: _____
 River Code: _____ Sampler Type: _____ Conductivity: _____ Lat/Long (Beg): _____
 RM: _____ Secchi Depth: _____ Diss. Oxy.: _____ Lat/Long (Mid): _____
 Voltage: _____ Volt. Range: _____ D.O. %sat.: _____ Lat/Long (End): _____
 % Range: _____ Amperage: _____ pH: _____ Lat/Long (X-Loc): _____

Anomalies: A- anchor worm; B- black spot; C- leeches; D- deformities; E- eroded fins; F- fungus; L- lesions; M- multiple DELT anomalies; N- blind
 P- parasites; Y- popeye; S- emaciated; W- swirled scales; T- tumors; Z- other. [Heavy (H) or Light (L) code may be combined with above codes.]

Species	# Weighed	# Counted	Individual or Batch Weights or Length/ Weight				Anomalies				Lunker
<input type="checkbox"/>	10x										<input type="checkbox"/>
<input type="checkbox"/>	10x										<input type="checkbox"/>
<input type="checkbox"/>	10x										<input type="checkbox"/>
<input type="checkbox"/>	10x										<input type="checkbox"/>
<input type="checkbox"/>	10x										<input type="checkbox"/>
<input type="checkbox"/>	10x										<input type="checkbox"/>
<input type="checkbox"/>	10x										<input type="checkbox"/>
<input type="checkbox"/>	10x										<input type="checkbox"/>
<input type="checkbox"/>	10x										<input type="checkbox"/>
<input type="checkbox"/>	10x										<input type="checkbox"/>

Mass Weighing Convention: _____ Total Weight: 536 (12) Number Weighed: _____ Vouchers Collected:

Figure 2. Fish data sheet (continued)

Page ____ of ____

Species	# Weighed	# Counted	Individual or Batch Weights or Length/ Weight				Anomalies				Lunker
V:	10x										<input type="checkbox"/>
V:	10x										<input type="checkbox"/>
V:	10x										<input type="checkbox"/>
V:	10x										<input type="checkbox"/>
V:	10x										<input type="checkbox"/>
V:	10x										<input type="checkbox"/>
V:	10x										<input type="checkbox"/>
V:	10x										<input type="checkbox"/>
V:	10x										<input type="checkbox"/>
V:	10x										<input type="checkbox"/>
V:	10x										<input type="checkbox"/>
V:	10x										<input type="checkbox"/>
V:	10x										<input type="checkbox"/>
V:	10x										<input type="checkbox"/>

Figure 3. QHEI field sheet.

Qualitative Habitat Evaluation Index Field Sheet QHEI Score:

River Code: _____ RM: _____ Stream: _____
 Site Code: _____ Project Code: _____ Location: _____
 Date: _____ Scorer: _____ Latitude: _____ Longitude: _____

1.) SUBSTRATE (Check ONLY Two Substrate TYPE BOXES; Estimate % percent)

TYPE	POOL	RIFFLE	POOL	RIFFLE	SUBSTRATE ORIGIN	SUBSTRATE QUALITY	
<input type="checkbox"/> -BLDR/SLBS [10]	<input type="checkbox"/> -GRAVEL [7]	Check ONE (OR 2 & AVERAGE)			Check ONE (OR 2 & AVERAGE)		Substrate <input style="width: 30px; height: 30px;" type="text"/> Max 20
<input type="checkbox"/> -Lg BOULD [10]	<input type="checkbox"/> -SAND [8]	<input type="checkbox"/> -LIMESTONE [1]			SILT: <input type="checkbox"/> -SILT HEAVY [-2]		
<input type="checkbox"/> -BOULDER [9]	<input type="checkbox"/> -BEDROCK [5]	<input type="checkbox"/> -TILLS [1]			<input type="checkbox"/> -SILT MODERATE [-1]		
<input type="checkbox"/> -COBBLE [8]	<input type="checkbox"/> -DETRITUS [3]	<input type="checkbox"/> -WETLANDS [0]			<input type="checkbox"/> -SILT NORMAL [0]		
<input type="checkbox"/> -HARDPAN [4]	<input type="checkbox"/> -ARTIFICIAL [0]	<input type="checkbox"/> -HARDPAN [0]			<input type="checkbox"/> -SILT FREE [1]		
<input type="checkbox"/> -MUCK [2]	<input type="checkbox"/> -SILT [2]	<input type="checkbox"/> -SANDSTONE [0]			EMBEDDED <input type="checkbox"/> -EXTENSIVE [-2]		
		<input type="checkbox"/> -RIP / RAP [0]			NESS: <input type="checkbox"/> -MODERATE [-1]		
		<input type="checkbox"/> -LACUSTRINE [0]			<input type="checkbox"/> -NORMAL [0]		
		<input type="checkbox"/> -SHALE [-1]			<input type="checkbox"/> -NONE [1]		
		<input type="checkbox"/> -COAL FINES [-2]					

NUMBER OF SUBSTRATE TYPES: -4 or More [2] -3 or Less [0]

(High Quality Only, Score 5 or >)

COMMENTS: _____

2.) INSTREAM COVER (Give each cover type a score of 0 to 3; see back for instructions)

(Structure)	TYPE: Score All That Occur	AMOUNT: (Check ONLY one or check 2 and AVERAGE)	
<input type="checkbox"/> UNDERCUT BANKS [1]	<input type="checkbox"/> POOLS > 70 cm [2]	<input type="checkbox"/> -EXTENSIVE > 75% [11]	Cover <input style="width: 30px; height: 30px;" type="text"/> Max 20
<input type="checkbox"/> OVERHANGING VEGETATION [1]	<input type="checkbox"/> ROOTWADS [1]	<input type="checkbox"/> -MODERATE 25 - 75% [7]	
<input type="checkbox"/> SHALLOWS (IN SLOW WATER) [1]	<input type="checkbox"/> BOULDERS [1]	<input type="checkbox"/> -SPARSE 5 - 25% [3]	
<input type="checkbox"/> ROOTMATS [1]	<input type="checkbox"/> LOGS OR WOODY DEBRIS [1]	<input type="checkbox"/> -NEARLY ABSENT < 5% [1]	

COMMENTS: _____

3.) CHANNEL MORPHOLOGY: (Check ONLY one PER Category OR check 2 and AVERAGE)

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY	MODIFICATIONS / OTHER	
<input type="checkbox"/> -HIGH [4]	<input type="checkbox"/> -EXCELLENT [7]	<input type="checkbox"/> -NONE [6]	<input type="checkbox"/> -HIGH [3]	<input type="checkbox"/> -SNAGGING <input type="checkbox"/> -IMPOUNDMENT	Channel <input style="width: 30px; height: 30px;" type="text"/> Max 20
<input type="checkbox"/> -MODERATE [3]	<input type="checkbox"/> -GOOD [5]	<input type="checkbox"/> -RECOVERED [4]	<input type="checkbox"/> -MODERATE [2]	<input type="checkbox"/> -RELOCATION <input type="checkbox"/> -ISLAND	
<input type="checkbox"/> -LOW [2]	<input type="checkbox"/> -FAIR [3]	<input type="checkbox"/> -RECOVERING [3]	<input type="checkbox"/> -LOW [1]	<input type="checkbox"/> -CANOPY REMOVAL <input type="checkbox"/> -LEVEED	
<input type="checkbox"/> -NONE [1]	<input type="checkbox"/> -POOR [1]	<input type="checkbox"/> -RECENT OR NO RECOVERY [1]		<input type="checkbox"/> -DREDGING <input type="checkbox"/> -BANK SHAPING	
		<input type="checkbox"/> -IMPOUNDED [-1]		<input type="checkbox"/> -ONE SIDE CHANNEL MODIFICATIONS	

COMMENTS: _____

4.) RIPARIAN ZONE AND BANK EROSION (check ONE box PER bank or check 2 and AVERAGE per bank)

RIPARIAN WIDTH

L R (Per Bank)	L R (Most Predominant Per Bank)	L R	L R (Per Bank)	
<input type="checkbox"/> -VERY WIDE > 100m [5]	<input type="checkbox"/> -FOREST, SWAMP [3]	<input type="checkbox"/> -CONSERVATION TILLAGE [1]	<input type="checkbox"/> -NONE / LITTLE [3]	Riparian <input style="width: 30px; height: 30px;" type="text"/> Max 10
<input type="checkbox"/> -WIDE > 50m [4]	<input type="checkbox"/> -SHRUB OR OLD FIELD [2]	<input type="checkbox"/> -URBAN OR INDUSTRIAL [0]	<input type="checkbox"/> -MODERATE [2]	
<input type="checkbox"/> -MODERATE 10 - 50m [3]	<input type="checkbox"/> -RESIDENTIAL, PARK, NEW FIELD [1]	<input type="checkbox"/> -OPEN PASTURE, ROWCROP [0]	<input type="checkbox"/> -HEAVY / SEVERE [1]	
<input type="checkbox"/> -NARROW 5 - 10m [2]	<input type="checkbox"/> -FENCED PASTURE [1]	<input type="checkbox"/> -MINING / CONSTRUCTION [0]		
<input type="checkbox"/> -VERY NARROW < 5m [1]				
<input type="checkbox"/> -NONE [0]				

COMMENTS: _____

River Right Looking Downstream

5.) POOL / GLIDE AND RIFFLE / RUN QUALITY

MAX DEPTH (Check 1 ONLY!)	MORPHOLOGY (Check 1 or 2 & AVERAGE)	CURRENT VELOCITY (POOLS & RIFFLES!)	
<input type="checkbox"/> -1m [6]	<input type="checkbox"/> -POOL WIDTH > RIFFLE WIDTH [2]	<input type="checkbox"/> -EDDIES [1] <input type="checkbox"/> -TORRENTIAL [-1]	Pool / Current <input style="width: 30px; height: 30px;" type="text"/> Max 12
<input type="checkbox"/> -0.7m [4]	<input type="checkbox"/> -POOL WIDTH = RIFFLE WIDTH [1]	<input type="checkbox"/> -FAST [1] <input type="checkbox"/> -INTERSTITIAL [-1]	
<input type="checkbox"/> -0.4 to 0.7m [2]	<input type="checkbox"/> -POOL WIDTH < RIFFLE WIDTH [0]	<input type="checkbox"/> -MODERATE [1] <input type="checkbox"/> -INTERMITTENT [-2]	
<input type="checkbox"/> -0.2 to 0.4m [1]	<input type="checkbox"/> -IMPOUNDED [-1]	<input type="checkbox"/> -SLOW [1] <input type="checkbox"/> -VERY FAST [1]	
<input type="checkbox"/> -< 0.2m [POOL = 0]		<input type="checkbox"/> -NONE [-1]	

COMMENTS: _____

CHECK ONE OR CHECK 2 AND AVERAGE

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS	
<input type="checkbox"/> -Best Areas > 10cm [2]	<input type="checkbox"/> -MAX > 50 cm [2]	<input type="checkbox"/> -STABLE (e.g., Cobble, Boulder) [2]	<input type="checkbox"/> -NONE [2]	Rifle / Run <input style="width: 30px; height: 30px;" type="text"/> Max 8
<input type="checkbox"/> -Best Areas 5 - 10cm [1]	<input type="checkbox"/> -MAX < 50 cm [1]	<input type="checkbox"/> -MOD. STABLE (e.g., Large Gravel) [1]	<input type="checkbox"/> -LOW [1]	
<input type="checkbox"/> -Best Areas < 5cm [0]		<input type="checkbox"/> -UNSTABLE (Fine Gravel, Sand) [0]	<input type="checkbox"/> -MODERATE [0]	
<input type="checkbox"/> -NO RIFFLE but RUNS present [0]			<input type="checkbox"/> -EXTENSIVE [-1]	Gradient
<input type="checkbox"/> -NO RIFFLE / NO RUN [Metric = 0]				<input style="width: 30px; height: 30px;" type="text"/> Max 10

COMMENTS: _____

6.) GRADIENT (ft / mi): _____ DRAINAGE AREA (sq. mi.): _____ % POOL: % GLIDE:
 % RIFFLE: % RUN:

*Best areas must be large enough to support a population of riffle-obligate species

Gradient Score from Table 2 of Users Manual based on gradient and drainage area.

Figure 3. QHEI field data sheet (continued).

Is Sampling Reach Representative of the Stream? (Y/N) _____ If Not, Explain: _____

Lat / Long (Beg): _____
 Lat / Long (Mid): _____
 Lat / Long (End): _____
 Lat / Long (X-Loc): _____

Subjective Rating (1-10) Aesthetic Rating (1-10)

First Sampling Pass Gear: _____ Distance: _____ Water Clarity: _____ Water Stage: _____ Canopy - % open: _____

Yes No
 Is Stream Ephemeral (no pools, totally dry or only damp spots)?
 Is there water upstream? How far: _____
 Is there water close downstream? How far: _____
 Is Dry Channel mostly natural?


-Low -Moderate -High

Stream Drawing: _____

Major Suspected Sources of Impacts (Check All That Apply):
 None
 Industrial
 WWTP
 Agriculture
 Livestock
 Silviculture
 Construction
 Urban Runoff
 CSOs
 Suburban Impacts
 Mining
 Channelization
 Riparian Removal
 Landfills
 Natural
 Dams
 Other Flow Alteration
 Other: _____

Instructions for scoring the alternate cover metric: Each cover type should receive a score of between 0 and 3, where: 0 = Cover type absent; 1 = cover type in very small amounts or if more common of marginal quality; 2 = cover type present in moderate amounts, but not of highest quality or in small amounts of highest quality; 3 = cover type of highest quality in moderate or greater amounts. Examples of highest quality include: very large boulders in deep or fast water, large diameter logs that are stable, well developed rootwads in deep / fast water, or deep, well-defined, functional pools.

Figure 4. Water column chemistry field data sheet.

		SUBURBAN LABORATORIES, Inc.									
		FIELD DATA SHEET									
<u>FIELD SAMPLING INFORMATION</u>											
CLIENT NAME:											
SITE ID:											
DATE/TIME SAMPLES COLLECTED:											
FIELD SAMPLING TECHNICIAN:											
		(Print Name)									
<u>FIELD MEASUREMENT DATA</u>											
FIELD METER MANUFACTURER/SERIAL #:											
DATE/TIME OF FIELD METER READING:											
pH (pH units):											
TEMPERATURE (°C):											
CONDUCTIVITY (µmhos/cm or µS/cm):											
DISSOLVED OXYGEN mg/L:											

Reporting

Progress reports will be made on a periodic basis and in accordance with the contract that supports the survey by the contractor. These will be distributed by the Des Plaines River Watershed Workgroup (see A.3). A final report will be produced by the contractor in accordance with the requirements of the original bioassessment plan.

Group B: Data Generation and Acquisition

B.1: Sampling Process Design

Monitoring sites are located on the main stem, tributaries, and within the headwaters, as shown in Appendix A, Figure 1 and Table 1. Publically Owned Treatment Works (POTWs) are sampled above and below to determine to what effect effluent impacts the receiving waters. Sites are also located to determine the influences of tributary streams and other features, for example, the impact of online lakes (Appendix A).

B.2: Sampling Methods

Biological sampling for fish and macroinvertebrate assemblage data, as well as sampling methods for habitat, water column chemistry and sediment chemistry will follow established protocols of the Illinois DNR (2001) and Illinois EPA (1997, 2005) *and* be capable of producing comparable data and assessments. In some cases, the applicable protocol will need to be determined in the field, thus the best two candidates are listed in these instances. The specifications for the different equipment and methods are described in Table 6 for fish assemblage and Table 7 for macroinvertebrates.

Fish Assemblage Methods

Methods for the collection of fish at wadeable sites will be performed using a tow-barge or long-line pulsed D.C. electrofishing equipment based on a T&J 1736 DCV electrofishing unit described by Ohio EPA (1989) and as used by the consultant. A Wisconsin DNR battery powered backpack electrofishing unit will be used as an alternative to the long line and in accordance with the channel dimension restrictions described by Ohio EPA (1989). Generally, a three-person crew is required to execute the sampling protocol for each type of wading equipment. Sampling effort is determined by distance and ranges from 150-200 meters in length.

Table 6. Fish assemblage sampling method and gear specifications for the Des Plaines River biological assessment by geometric site level.

Parameter	Site Levels ²		
	Levels 6-7	Levels 2-6	Levels 1-2
Waterbody Size ³ Channel Dimensions: ⁴	<1.0-5.0 mi ² <0.3-0.5m depth; 1-2m width	5.0-75 mi ² 0.5-1.0m depth; 2-10m width	75-150 mi ² >1.0m depth; 10-100m width
Platform:	Backpack or Bank set/long line	Tow boat or Bank set/long line	12' boat 14' raft
Power Source: ⁵	12v battery or 300W alternator; ⁶ 1750 W alternator ⁷	1750-2500W alternator	2500 or 5000 W alternator
Amperage Output:	1.5-2A; 2-4A	4-8A	8-20A
Volts D.C. Output:	100-200; 150-300	150-300; 300-1000	500-1000
Anode Location:	Net ring w/assist netters	Net ring w/assist netters	Boom w/droppers; bow netter
Sampling Direction:	Upstream	Upstream	Downstream
Distance Sampled:	0.10-0.15km	0.15-0.20km	0.5km
Catch Per Unit Effort Basis (CPUE) : ⁸	per 0.3km	per 0.3km	per 1.0km
Time Sampled	1800-3600 sec	1800-3600 sec	2500-3500 sec
Time of Sampling:	Daylight	Daylight	Daylight
Crew Size ⁹	2-3	3	2

² Site levels described under Watershed Monitoring Design and described for each site in Tables 7-9.

³ Watershed size upstream from the sampling site.

⁴ Size dimensions are approximate and may vary by site – these should not be used as primary criteria.

⁵ Wattage (W) is sustained output (not peak output).

⁶ Back pack units can be either battery or generator powered.

⁷ This is used with the long line sampling method.

⁸ Basis for determining relative abundance parameters.

⁹ Crew consists of a qualified crew leader and field technicians.

Non-wadeable sites will be sampled with either a boat or raft -mounted pulsed D.C. electrofishing device. A Smith-Root 5.0 GPP unit will be used on a 12' john boat following the design of Ohio EPA. A Smith-Root 2.5 Generator Powered Pulsator (GPP) unit is used on a 14' raft. Sampling effort for this method is 500 meters. A summary of the key aspects of each method appear in Table 6.

Fish Sampling Reach Selection and Delineation

Sampling distance will be measured with a Geographic Positioning System (GPS) unit or laser range finder. When using the GPS unit each zone is measured by determining cumulative lineal distance based on waypoints established by the GPS unit. When using the laser range finder, measurements are taken in increments of 50-100 meters using fixed objects as focal points. Sampling site locations are delineated using the GPS mechanism and indexed to latitude/longitude and Universal Transverse Mercator (UTM) coordinates at the beginning, end, and mid-point of each site. Range finders are calibrated prior to being used in the field on a marked course and adjusted as necessary. The boundaries of each electrofishing zone are clearly marked on stationary objects (e.g. trees, bridge piers, etc.) with trail flagging or spray marking and fixed landmarks are referenced. This enables accurate relocation of sites in the event repeat visits are made. The location of each sampling site will be indexed by river mile (using river mile zero as the mouth of the river). A description of the sampling location shall also include proximity to a fixed local landmark such as a bridge, road, discharge outfall, railroad crossing, park, tributary, dam, etc. The field crew involved with the sampling is noted on the field sheet with crew duties listed (driver, netters, primary identifier, etc.).

Sampling Procedure

The tow-barge or longline pulsed D.C. electrofishing apparatus will be the preferred gear employed at wadeable sites. Electric current is converted, controlled, and regulated by a T&J 1736DCV alternator-pulsator that produces up to 1750 Watts at 100-300 volts DC at 2-7 amperes. The electrode anode array consists of the metal net ring hoop. The cathode consists of a woven steel cable strand on the front of the towboat or trailing the longline behind the sampler. A wading electrofishing crew consists of a primary netter who operates the anode, an assist netter and a third member who pulls the tow barge or attends to the long-line and keeps the collected fish cool and oxygenated by frequently changing water in a live well, bucket, or floating live well.

At wadeable sites, the accepted procedure is to slowly and methodically sample *upstream* sampling the best available habitat along the shoreline and/or midstream and sampling in and around submerged cover (undercut banks, log jams, root wads, emergent beds of vegetation, etc.) to advantageously position the netters to capture stunned and immobilized fish. Riffle/run areas are sampled using strategies that include "riffle raking", which consists of "casting" the primary net ring (anode) upstream and allowing it to "float" downstream into the assist net. The assist netter also looks for fish attempting to swim downstream around the anode. Backwater and other margin

habitats are sampled if present. Although sampling effort is measured by distance, the time fished is an important indicator of adequate effort. Time fished can legitimately vary over the same distance as dictated by cover and current conditions and the number of fish encountered. In all cases, there is a minimum time that shall be spent sampling each zone regardless of the catch. This is generally in the range of 1200-1500 seconds for 150-200 meters and upwards to 2500 seconds where there is extensive instream cover and diverse current flows. Safety features include easily accessible toggle switches on the electrofishing unit and positive pressure thumb switches operated by the netter. All crew members wear rubber gloves and chest waders. Sampling will be conducted during a June 15-October 15 seasonal index period.

Boat sites will be sampled using a boat-rigged, pulsed D.C. electrofishing apparatus. This consists of a 12' john boat that is specifically constructed and modified for electrofishing. Electric current is converted, controlled, and regulated by Smith-Root 5.0 GPP alternator-pulsator that produces up to 1000 volts DC at 2-20 amperes depending on the relative conductivity. The pulse configuration consists of a fast rise, slow decay wave that can be adjusted to 30, 60, or 120 Hz (pulses per second). Generally, electrofishing is conducted at 120 Hz, depending on which selection is producing the optimum combination of voltage and amperage output and most effectively stunning fish. This is determined on a trial and error basis at the beginning of each boat electrofishing zone and the settings will generally hold for all similar rivers and reaches. The voltage range is selected based on what percentage of the power range produces the highest amperage readings. Generally, the high range is used at conductivity readings less than 50-100 $\mu\text{s}/\text{m}^2$ and the low range is used at higher conductivities up to 1200 $\mu\text{s}/\text{m}^2$. Lower conductivities usually produce lower amperage readings.

The electrode array consists of four 8-10' long cathodes (negative polarity; 1" diameter flexible steel conduit) which are suspended from the bow and 4 anodes (positive polarity) suspended from a retractable boom, the number used to be dependent on the conductivity of the water. Each anode consists of a 3/8" woven steel cable strand 4' in length that are spaced equally on the boom cross member. Gangs of anodes can be added or detached as conductivity conditions change; anodes are increased at low conductivity and reduced at high conductivity. The anodes are suspended from a retractable boom that extends 2.75 meters in front of the bow. The width of the array is 0.9 meters. Anodes and cathodes are replaced when they are lost, damaged, or become worn.

A 12' boat or 14' raft electrofishing crew consists of a boat driver and one netter. Limited access to free-flowing segments may necessitate launching at an upstream location and recovering at a downstream location. Put-in and take-out sampling is conducted where navigational barriers preclude contiguous navigation. The accepted sampling procedure is to slowly and methodically maneuver the electrofishing boat/raft in a *down current* direction along the shoreline maneuvering in and around submerged

cover to advantageously position the netter(s) to pick up stunned and immobilized fish. This may require frequent turning, backing, shifting between forward and reverse, changing speed, etc. depending on current velocity and cover density and variability. The driver's task is to maneuver the electrofishing boat/raft in a manner that advantageously positions the netter to pick up stunned and immobilized fish. The driver also monitors and adjusts the 2.5/5.0 GPP pulsator to provide the maximum, yet safe operational mode in terms of voltage range, pulse setting, and amperage. In areas with extensive woody debris and submergent aquatic macrophytes, it is necessary to maneuver the boat/raft in and out of these "pockets" of habitat and wait for fish to appear within the netters field of view. In moderately swift to fast current the procedure is to electrofish with or slightly faster than the current through the fast water sections and then return upstream to more thoroughly sample the eddies and edges of the faster water. It is often necessary to pass over these swift water areas twice to ensure an adequate sample. Electrofishing efficiency is enhanced by keeping the boat/raft and electric field moving with or at a slightly faster rate than the prevailing current velocity. Fish are usually oriented into the current and must turn sideways or swim into the approaching electric field to escape. As such they present an increased voltage gradient making the fish more susceptible to being immobilized by the electric current. Sampling in an upstream direction is prohibited as this compresses the electrical field towards the surface, which significantly diminishes sampling effectiveness. Although sampling effort is measured by distance, the time fished is an important indicator of adequate effort. Time fished can legitimately vary over the same distance as dictated by cover and current conditions and the number of fish encountered. In all cases, there is a minimum time that shall be spent sampling each zone regardless of the catch. This is generally in the range of 2000-2500 seconds for a 0.5 km site, but could range higher where there is extensive instream cover and slack flows.

Safety features include easily accessible toggle switches on the pulsator unit and next to the driver and a foot pedal switch operated by the primary netter. The netters wear jacket style life preservers, rubber gloves, and all crew members wear chest waders.

All netters for both the wadeable and non-wadeable methods are required to wear polarized sunglasses to facilitate seeing stunned fish in the water during each daytime electrofishing run. The nets in the anode and in the assist net each consist of 7.62mm Atlas mesh knotless netting. A concerted effort is made to capture every fish sighted by all crew members. Since the ability of the netters to see stunned and immobilized fish is partly dependent on water clarity, sampling is conducted only during periods of "normal" water clarity and flows. Periods of high turbidity and high flows are avoided due to their negative influence on sampling efficiency and site access. If high flow conditions prevail, sampling will be delayed until flows and water clarity return to seasonal, low flow norms.

General Cautions Concerning Field Conditions

Electrofishing shall be conducted only during “normal” summer-fall water flow and clarity conditions. What constitutes normal can vary considerably from region to region. Generally normal water conditions in the Midwest occur during below annual average river flows. Under these conditions the surface of the water generally will have a placid appearance. Abnormally turbid conditions are to be avoided as are high water levels and elevated current velocities. In addition to safety concerns, any of these conditions can adversely affect sampling efficiency and may rule out data applicability for bioassessment purposes. Since the ability of the netter to see and capture stunned fish is crucial, sampling shall take place only during periods of normal water clarity and flow. Floating debris such as twigs, tree limbs, flotsam, and other trash are usually visible on the surface during elevated flow events. Such conditions shall be avoided and sampling delayed until the water returns to a "normal" flow and clarity. High flows shall also be avoided for obvious safety reasons in addition to the reductions in sampling efficiency. Boat mounted methods are particularly susceptible as it becomes more difficult to maneuver the boat into areas of cover and the fish assemblage is locally displaced by the elevated flow events. It may take several days or even weeks for the assemblage to return to their normal summer-fall distribution patterns. Thus sampling may need to be delayed by a similar time period if necessary. Knowing this requires local knowledge and a familiarity with flow gage readings and conditions. Generally, these conditions coincide with low flow durations of approximately 80% or greater, i.e., flows that are exceeded 80% of the time for the period of record. These statistics are available for most Midwest rivers from the U.S. Geological Survey at: <http://waterdata.usgs.gov/>.

Field Sample Processing Procedures

Captured fish are immediately placed in a live well, bucket, or live net for processing. Water is replaced and/or aerated regularly to maintain adequate dissolved oxygen levels in the water and to minimize mortality. Special handling procedures may be necessary for species of special concern. Fish not retained for voucher or other purposes are released back into the water after they have been identified to species, examined for external anomalies, and weighed, except at level 6 and 7 sites where only numbers are recorded. Every effort is made to minimize holding and handling times. The majority of captured fish are identified to species in the field; however, any uncertainty about the field identification of individual fish requires their preservation for later laboratory identification. Fish are preserved for future identification in borax buffered 10% formalin and labeled by date, river or stream, and geographic identifier (e.g., river mile). Identification is required to the species level at a minimum and may be necessary to the sub-specific level in certain instances. A number of regional ichthyology keys will be used and include the Fishes of Illinois (Smith 1979). Assistance will be solicited from Illinois DNR and the Field Museum of Natural History.

The sample from each zone is processed by enumerating and recording weights by species. Weights will be recorded at main stem sites. Fish weighing less than 1000

grams will be weighed to the nearest gram on a spring dial scale (1000 g x 2g) with those weighing more than 1000 grams weighed to the nearest 25 grams on a 12 kg spring dial scale (12 kg x 50 g) or a hand held spring scale for fish larger than 12 kg. Scales are checked before each sampling run with National Bureau of Standards check weights and adjusted accordingly. Samples that are comprised of two or more distinct size classes of fish (e.g., young of the year, juveniles, and adults) are processed as separate size groupings. These are recorded separately on the field data sheet by adding an A, B, or Y to the species code, A for adults, B for juveniles, and Y for young-of-year (y-o-y). For example, if both adult and juvenile white suckers occur in the same sample the adult numbers and weights are recorded as family-species code 40-016A with juvenile numbers and weights recorded as 40-016B. Although each is listed separately on the fish data sheet they are treated in the aggregate as a single sample of the same species in any subsequent data analyses. The data management programs used are designed to calculate relative numbers and weight data based on the input of the weighted subsample data. Larval fish will not be included in the data, as these are difficult to identify and offer questionable information to an assemblage assessment (Angermier and Karr 1986). Fish measuring less than 15-20 mm in length are generally not included in the data recording as a matter of practice.

The incidence of external anomalies will be recorded following procedures outlined by Ohio EPA (1989) and refinements made by Sanders *et al.* (1999). The frequency of DELT anomalies (deformities, eroded fins and body parts, lesions, and tumors) is a good indication of stress caused by chronic agents, intermittent stresses, and chemically contaminated sediments. The percent DELT anomalies is a metric of most fish assemblage assessments that have been developed across the U.S.

A qualitative habitat assessment using an appropriate and updated modification of the QHEI (Ohio EPA 1989, 2006; Rankin 1989) will be completed by the fish crew leader. The QHEI is a physical habitat index designed to provide an empirical, quantified evaluation of the lotic macrohabitat characteristics that are important to fish assemblages. The QHEI was developed within several constraints associated with the practicalities of conducting a large-scale monitoring program, i.e., the need for a rapid assessment tool that yields meaningful information and which takes advantage of the knowledge and insights of experienced field biologists who are conducting biological assessments. This index has been used widely outside of Ohio and parallel habitat evaluation techniques are in widespread existence throughout the U.S. The QHEI incorporates the types and quality substrate, the types and amounts of instream cover, several characteristics of channel morphology, riparian zone extent and quality, bank stability and condition, and pool-run-riffle quality and characteristics. Slope or gradient is also factored into the QHEI score. We will follow the specific guidance and scoring procedures outlined in Ohio EPA (1989,2006) and Rankin (1989) with more recent modifications made by MBI that may not appear in the 2006 manual. The QHEI users guide (Ohio EPA 2006) appears in Appendix B.

Macroinvertebrate Assemblage Methods

The macroinvertebrate assemblage will be sampled using three principal methods. The attributes of each are summarized in Table 6. The Illinois EPA multihabitat method (Appendix D) will be used as a matter of preference at all sites where it is feasible. The Macroinvertebrate Aggregated Index for Streams (MAIS) method (Appendix D) adapted for application to Illinois streams will be used in lieu of the multihabitat method in small headwater streams and artificial substrates (Ohio EPA 1989) will be used at larger sites. This will be determined during sampling.

Illinois EPA Multi-Habitat Sampling Procedure

The Illinois EPA multi-habitat method for sampling stream macroinvertebrates provides information useful for determining the biological integrity of a stream, as reflected in selected attributes of the macroinvertebrate assemblage living in a stream. These biological attributes represent how macroinvertebrates respond to and integrate the chemical, physical, and biological effects of human-induced impacts (both negative and positive) on streams and their watersheds, e.g., point- or nonpoint-source impacts, stream-restoration efforts. The multi-habitat approach allocates sampling effort based on the relative amounts of several predefined macroinvertebrate habitat types that occur in the sampling reach.

Table 7. Macroinvertebrate assemblage sampling method and gear specifications for the Des Plaines River biological assessment by geometric site level.

Parameter	Site Levels ¹⁰		
	Levels 6-7	Levels 2-6	Levels 1-2
Waterbody Size ¹¹ Channel Dimensions: ¹²	<1.0-5.0 mi ² <0.3-0.5m depth; 1-2m width	5.0-75 mi ² 0.5-1.0m depth; 2-10m width	75-150 mi ² >1.0m depth; 10-100m width
Protocol:	Qualitative Dip- Net, handpick	Multi-habitat Illinois EPA Method	Multi-habitat or Artificial Substrate
Collection device:	D-frame dip net	D-frame dip net	D-frame dip net;
Effort:	20 sweeps habitat defined 300 feet	20 sweeps; habitat defined 300 feet	20 sweeps; habitat defined 300-600 feet
CPUE Basis: ¹³	No. individuals per site	No. individuals per site	No. ind./site; No./m ²
Subsample:	300 organisms	300 organisms	300 organisms;
Taxonomic Resolution:	Lowest Practicable	Lowest practicable	Lowest practicable
Crew Size ¹⁴	2	2	2

¹⁰ Site levels described under Watershed Monitoring Design and described for each site in Tables 7-9.

¹¹ Watershed size upstream from the sampling site.

¹² Size dimensions are approximate and may vary by site – these should not be used as primary criteria.

¹³ Basis for determining relative abundance parameters.

¹⁴ Crew consists of a qualified crew leader and one field technician.

The Illinois EPA multi-habitat method specifies the selection of a sampling reach that has instream and riparian habitat conditions typical of the entire assessment reach, has flow conditions that approximate typical summer base flow, has no highly influential tributary streams, contains one riffle/pool sequence or analog (i.e., run/bend meander or alternate point-bar sequence), if present, and, where the multi-habitat method is applicable, is at least 300 feet long and up to 800 feet long in order to meet the qualitative criteria for a site. The method is applicable if conditions allow the sampler to collect macroinvertebrates (i.e., to take samples with a dip net) in all bottom-zone and bank-zone habitat types that occur in a sampling reach. The habitat types are defined explicitly in Appendix D. Conditions must also allow the sampler to apply the 11-transect multi-habitat sampling method, as described in *"Standard Operating Procedure for Methods to Collect Aquatic Macroinvertebrates with Grab Samplers"* in Appendix B: *Methods Utilized to Determine the Types and Amounts of Pertinent Macroinvertebrate Habitats in Perennial Wadeable Streams for 20-Job Allocation* (Illinois EPA 2011b) or to estimate with reasonable accuracy via visual or tactile cues the amount of each of several bottom-zone and bank-zone habitat types. If conditions (e.g., inaccessibility, water turbidity, or excessive water depths) prohibit the sampler from estimating with reasonable accuracy the composition of the bottom zone or bank zone throughout the entire sampling reach, then the multi-habitat method is not applicable. In most cases, if more than one-half of the wetted stream channel cannot be seen, touched, or otherwise reliably characterized by the sampler, it is unlikely that reasonably accurate estimates of the bottom-zone and bank-zone habitat types are attainable; thus, the multi-habitat method is not applicable.

Water Column Chemistry Methods

The water column will be sampled annually at the locations and frequency specified in Appendix A. The sampling will consist of on-site field measurements and water samples which will be analyzed within the laboratory. On-site monitoring will be conducted using a multi-parameter sonde to measure dissolved oxygen, pH, specific conductance, and temperature. The sonde will be deployed as specified in Appendix F.

Analytical samples will be collected following the methods specified in Appendix A and Appendix F. For sample collection, all sample bottles shall be kept closed until they are filled. Additionally, all sampling equipment shall be decontaminated between each sample collection site. The sampler will wear a new pair of gloves for decontamination and a new pair for sample collection at each collection site sampled. Samples will be collected in the manner appropriate for the waterbody with care to not disturb sediments during sample collection. Laboratory analytical sample bottles will then be placed on ice to maintain analytical temperature requirements described in Table 8. All samples will be recorded on the log sheet/ chain of custody that is maintained from sample collection to sample acceptance at the laboratory and shown in Figure 4.

Table 8: Water column sampling containers, parameters, preservation, and holding time.				
Sample Container	Parameters	Chemical Preservation	Thermal Preservation	Analytical Holding Time
1000 mL HPDE bottle	pH	Unpreserved	Sample readings collected in the field	15 minutes
	DO			
	Conductivity			
	Temperature			
1000 mL HPDE Bottle (2)	TSS	Unpreserved	Must be received at or below 6° C	7 days
	VSS			7 days
	Turbidity			2 days
	Chloride			28 days
	Sulfate			28 days
	Dissolved Reactive Phosphorus			2 days
	Conductivity			28 days
40 mL Amber Glass Vials (2)	TOC	H ₂ SO ₄	Must be received at or below 6° C	28 days
500 mL HPDE Bottle	Metals (As, Mn, Cu, Ni, Zn, Na, Fe, Ca, Mg)	HNO ₃	Must be received at or below 6° C	6 months
	Phosphorus			
	Total Hardness			
250 mL Glass Bottle	Hg via Method 1631	BrCl	No requirement for temperature	28 days, must be preserved within 48 hours
500 mL HPDE Bottle	NH ₃ -N	H ₂ SO ₄	Must be received at or below 6° C	28 days
	TKN			28 days
	Total Nitrates (NO ₂ + NO ₃)			28 days
120 mL HPDE Bottle	E.coli	Na ₂ S ₂ O ₃	Must be received at or below 6° C	8 hours
1000 mL Amber Glass Bottle (2)	Pesticides	Unpreserved	Must be received at or below 6° C	40 days
	PCB			
	PNAs			
40 mL Amber Glass Vials (3)	VOCs	HCl	Must be received at or below 6° C	14 days

Sediment Chemistry Methods

Surficial sediment samples will be collected concurrently with the bioassessment as composites across locations specified in Appendix A. All samples will be collected in the manner appropriate to the waterbody as dictated in Appendix F with the bottleware and analytes specified in Table 9. Surface sediment samples will be collected in locations of minimal disturbance from other sampling efforts. For sample collection, all sample bottles shall be kept closed until they are filled and all sampling equipment shall be

decontaminated between each sample collection site. The sampler will wear a new pair of gloves for decontamination and a new pair for sample collection at each collection site sampled. Sample bottles will then be placed on ice to maintain analytical temperature requirements described in Table 9. All samples will be recorded on the log sheet/ chain of custody that is maintained from sample collection to sample acceptance at the laboratory.

Table 9: Sediment sampling containers, parameters, preservation, and holding time.

Sample bottle	Parameters	Chemical Preservation	Thermal Preservation	Analytical Holding Time
9 oz. Amber Glass Jar	Metals (Al, As, Ba, Be, B, Cd, Cr, Co, Cu, Fe, Pb, Mn, Hg, Ni, K, Ag, Na, Sr, V, Zn)	Unpreserved	Must be received at or below 6° C	6 months
	Fluoride			28 days
	Pesticides			40 days
	PCBs			40 days
	PNAs			40 days
	TKN			28 days
	Phosphorus			6 months
	Cyanide (low)			14 days
	Phenols			28 days
4 oz. Amber Glass Jar	VOCs	Unpreserved	Must be received at or below 6° C	14 days
4 oz. Amber Glass Jar	Herbicides	Unpreserved	Must be received at or below 6° C	40 days

B.3: Sample Handling and Custody

The sample products produced by this project will be fish and macroinvertebrate assemblage data, habitat assessments, and water column and sediment data. All data will be collected and managed by the associated consultant. All samples will be documented with appropriate data sheets and notations of the primary collectors and constitute a documentation of the chain-of-custody process. Completed field forms, laboratory forms, and the qualitative habitat assessment data sheets will comprise the hard copy documentation. Any subsequent changes that are made to the field and lab sheets are initialed and dated.

For the fish, macroinvertebrate, and habitat data collection, all field data sheets are logged by the field crew leader (back-up copies are made to prevent loss) and assure that all sites are sampled according to the bioassessment plan. Data is entered from the field and laboratory sheets into the data management system in the format presented in the field data sheets (Figures 2 and 3). Each entry is logged by basin-river code, date of entry, river mile or other site locator, and date of sampling. The data sheets are assembled in a notebook along with site description sheets, maps of the sampling sites,

the QHEI field sheet, and the bioassessment plan. After the data have been entered into the database the entries are proofread by the lead biologist for accuracy. All corrections or updates are then entered into the database.

Fish voucher specimens and macroinvertebrate samples will be archived for the purpose of confirming identifications and to serve as a permanent record. Photographs will also be used to record fish species occurrence, particularly larger species that are not easily preserved and stored. Fish will be transferred from 10% formalin to wash water and then to a series of ethyl alcohol washes from 35% to 50% to 70%. Voucher specimens will be deposited in the vertebrate collection at The Ohio State University Museum of Biodiversity (OSUMB)¹⁵. All photographs will be maintained by the consultant in an archived electronic file. Macroinvertebrates are transferred from 10% formalin to 70% ethyl alcohol for processing and permanent storage at MBI in Hilliard, Ohio. All samples are archived by the consultant for a minimum of 10 years.

For the water column and sediment investigation, all field forms, including documentation of sampling and calibration, and laboratory forms will be managed by the consultant. Laboratory and method protocols will be employed to ensure that samples are preserved, maintained at required temperatures, and analyzed within required hold times that are listed in Table 8 and Table 9. The consultant will also follow laboratory protocols concerning data quality assurance and quality control (QA/QC) and reporting as referenced in B.10. All reported data and metadata will be submitted to MBI who will utilize the data in analyses.

B.4: Analytical Methods

The principal analytical tools used for the biological data are those associated with basic data analysis. Data manipulation will be performed on personal computers using relational databases such as FoxPro, Access, and Excel. Appropriate modifications to those routines are initiated as needed to satisfy project objectives. Data will also be exported to various statistical and graphic packages such as Kaliedagraph for presentation graphics and S-Plus for statistical analyses. Habitat will be assessed using the QHEI following the methods in Appendix B.

Fish and macroinvertebrate data will be reduced to standard relative abundance and species/taxa richness and composition metrics. The Illinois EPA fish Index of Biotic Integrity (IBI) will be calculated with the fish data. The macroinvertebrate data will be analyzed using existing and developing indices of Illinois EPA.

Water column and sediment data will be analyzed in the laboratory based on the analyte-specific methods and SOPs specified in Appendix F. Reported laboratory data shall then be analyzed using data manipulation on personal computers in relational

¹⁵ Fish collections are taken to the OSUMB where they are given an accession number and then catalogued into the permanent collections.

databases such as FoxPro, Access, and Excel. The data will be assessed for temporal and spatial variability, when appropriate. Additionally, the water column and sediment data will be integrated into the analysis of the bioassessment data and other stressor data.

Products of this study will include a determination of biological status for all flowing waters, identification of stressor variables associated with biological impairments, spatial analyses of patterns in biological response variables, and recommendations for management actions as appropriate.

B.5: Quality Control

Quality control consists of ensuring that the data collected are the result of the proper execution of the sampling protocols and that the data are reproducible and precise. The precautions taken for each assemblage group and media in the field and laboratory are different, but the objective remains the same, to produce data that is of a sufficient quality so as to reduce type I and type II assessment errors.

Field Quality Control

Fish Assemblage

Quality control of electrofishing includes adhering to sampling protocols and monitoring the power output variables. Other important measures of adequate effort include time electrofished and the effort made by the netters to capture stunned and immobilized fish. There is an inherent degree of judgment involved in the assessment of individual crew member performance and this will be performed by the crew leader and the principal investigator. The quality of identifications made in the field will be evaluated by the principal investigator and also based on the retention of voucher specimens that will be verified independent of the field crew. Selected field audits of crew performance will be performed by the principal investigator. The field crew will be responsible for reporting any quality control issues, including deviations in procedure, to the principal investigator. In turn, the principal investigator will be responsible for reporting any issues to the DRWW representatives, the LCSMC Administrative Agent, and the Geosyntec Technical Agent. The DRWW representatives will determine the course of correction action that is required, and the principal investigator will be responsible for performing this correction action and writing the corrective action reports.

Habitat Assessment

Annual crew leader training in using the QHEI is a requirement that assures consistent interpretation of QHEI variables and the resulting QHEI score and to make users aware of any recent modifications and updates. Visual identity is the key to being able to properly use the QHEI and this is reinforced by the required training, the annual refresher, and in the QHEI field guide which contains ample photographs and illustrations. Each QHEI is re-examined at all two pass fish sampling sites. The field crew will be responsible for reporting any quality control issues, including deviation in procedure, to the principal investigator. In turn, the principal investigator will be

responsible for reporting any issues to the DRWW representatives, the LCSMC Administrative Agent, and the Geosyntec Technical Agent. The DRWW representatives will determine the course of correction action that is required, and the principal investigator will be responsible for performing this correction action and writing the corrective action reports.

Macroinvertebrate Assemblage

The quality of macroinvertebrate sample collection and processing involves strict adherence to the specific protocols, re-sampling selected sites, and independent identification and enumeration of selected samples. A 10% subset of all sites will be re-sampled with the Illinois EPA multi-habitat method. This will allow the establishment of baseline variability within a seasonal index period to be established. A 10% subset of laboratory processed samples will also be identified and enumerated by an independent taxonomist. The results of this process will be used to reconcile the data prior to its use in the bioassessment. The field crew will be responsible for reporting any quality control issues, including deviations in procedure, to the principal investigator. In turn, the principal investigator will be responsible for reporting any issues to the DRWW representatives, the LCSMC Administrative Agent, and the Geosyntec Technical Agent. The DRWW representatives will determine the course of correction action that is required, and the principal investigator will be responsible for performing this correction action and writing the corrective action reports.

Water Column Sampling

Quality control of water column sampling involves the adherence to multiple sampling protocols and collection of quality control samples. Sampling protocols include sample location selection under representative flow conditions, care to minimize any disturbances during collection, efficient decontamination, proper application and calibration of field meters, and proper sample handling. Quality control samples will be collected and analyzed to ensure reproducibility and quality of sampling, transportation, and decontamination processes. These quality control samples will include a field blanks for VOCs and metals and duplicate samples for each analyte at a rate of one per every twenty samples collected. Analysis of water column parameters must fall within the methodology, reporting limits, quantification limits, and precision and accuracy as detailed in Table 2 and Table 3. The field crew will be responsible for reporting any quality control issues, including deviation in procedure, to the laboratory project manager. In turn, the project manager will be responsible for reporting any issues to the DRWW representatives, the LCSMC Administrative Agent, and the Geosyntec Technical Agent. The DRWW representatives will determine the course of correction action that is required, and the project manager will be responsible for performing this correction action and writing the corrective action reports.

Sediment Sampling

Quality control of sediment is based in the adherence to sampling protocols and collection of quality control samples. This protocol includes sample location selection, sampling methodology to minimize losses, sample preparation, and sample handling. Duplicates will also be collected to assess consistent sampling techniques and data reproducibility. Duplicate samples will be analyzed at a rate of one per twenty samples. Analysis of sediment parameters must fall within the methodology, reporting limits, quantification limits, and precision and accuracy as detailed in Table 4. The field crew will be responsible for reporting any quality control issues, including deviation in procedure, to the principal investigator. In turn, the principal investigator will be responsible for reporting any issues to the DRWW representatives, the LCSMC Administrative Agent, and the Geosyntec Technical Agent. The DRWW representatives will determine the course of correction action that is required, and the principal investigator will be responsible for performing this correction action and writing the corrective action reports.

Laboratory Quality Control

Quality control will be maintained at the laboratory based on strict adherence to analytical methods and SOPs listed in Appendix F and the Suburban Laboratory Quality Assurance Manual Revision 4 (2014). Under the methods specified in the manual, the laboratory will run internal QA/QC samples including blanks, MS, MSD, and LCS samples. The laboratory will also calibrate instruments as specified in B.7 to ensure quality control. When appropriate, the data will be qualified as specified in D.1 in order to report any analysis quality control issues. Additionally, any variances in procedure will be reported to the laboratory project manager. The project manager will be responsible for reporting any issues to the DRWW representatives, the LCSMC Administrative Agent, and the Geosyntec Technical Agent. The DRWW representatives will determine the course of correction action that is required, and the project manager will be responsible for performing this correction action and writing the corrective action reports.

B.6: Instrument/Equipment Testing, Inspection, and Maintenance

All equipment is used and maintained in accordance with manufacturer's specifications. Safety logs are maintained for major pieces of sampling equipment (boats, trailers, vehicles). The electrofishing equipment is evaluated for performance during all phases of sampling as described previously in B.2 and performance characteristics are recorded on the field data sheets. All connections and switches must be in good condition to ensure acceptable performance and are inspected several times each day by the sampling crew. Malfunctioning and worn parts are replaced immediately with spare parts carried by each sampling crew. All engines undergo maintenance as prescribed by the manufacturer for intensive use. All water column and sediment sampling equipment are inspected and repaired or replaced as necessary prior to use.

Analytical field meters used by the sampling crew are maintained in accordance with the manufacturer's specifications and calibration logs are maintained.

B.7: Instrument/Equipment Calibration and Frequency

Field meters used by the field crews are calibrated daily by the crew leader in accordance with the manufacturer's recommendations and specifications and in accordance with the parameter tolerances in Table 2. Standard calibration solutions are used from the manufacturer and within expiration limits. Equipment is adjusted as needed following B.6. Daily calibrations of the field meters will be recorded and the records will be maintained by Suburban Laboratories after being entered into the Laboratory Information Management System (LIMS) software discussed in B.10. In addition, calibration checks will be conducted on field meters after the completion of calibration.

B.8: Inspection/Acceptance of Supplies and Consumables

All supplies used in this project undergo an initial inspection for usability and suitability by the project lead at MBI. Outdated solutions and standards are replaced. Any open or broken sample containers are decontaminated or replaced. No hazardous reagents or sensitive supplies will be used in the field during this project.

B.9: Non-direct Measurements

We will make an effort to access historical information about the water column and sediment chemistry and fish and macroinvertebrate fauna of the study area. This will be especially valuable in evaluating the historical trends through time. Some expert judgment may be necessary to evaluate the quality and accuracy of this information.

B.10: Data Management

Fish and macroinvertebrate assemblage data and habitat data are entered directly via the electronic data entry routine from the field sheets (Figures 2 and 3). All data entry codes follow those specified in Ohio EPA (1987) and those added by the consultant for non-Ohio fish species. All entries are proofread by the data entry analyst and corrections are made in the electronic database. All corrections are noted and initialed by the data entry operator and confirmed by the project manager. Other checks on data entry accuracy are made via the routine processing and analysis of the data. Both desktop and laptop personal computers are used to manage data, which is processed in software including Excel, Access, and FoxPro. Data is stored on the consultant's secure server.

Water column and sediment chemistry data are processed through various laboratory equipment, which is then entered into LIMS software. Access to LIMS is granted to authorized users with a specific password through Omega software. The data is secure within this software and retained indefinitely. Data will be reported to Illinois EPA using the "Electronic Data Deliverable (EDD) Master Structure and Format".

All bioassessment, water column, and sediment data is reported to the DRWW, the LCSMC Administrative Agent, and the Geosyntec Technical Agent through electronic data deliverables (EDDs). Both desktop and laptop personal computers are used to manage data. Additionally, the data is maintained by the DRWW's secure County network drive and is backed-up daily in two locations. The procedure for retaining and filing of data sheets and field notes was described in B.2.

Group C: Assessment and Oversight

C.1: Assessments and Response Actions

Due to the well-defined and relatively localized scope of the project, assessment and oversight will be the joint responsibility of the DRWW project coordinator and the principal investigator. However, the stakeholder agencies and organizations will be afforded an opportunity to make inspections and audits of the field sampling, the equipment, laboratory procedures, and the results if they so wish. This will be coordinated by the DRWW project coordinator and the principal investigator. The principal investigator will be responsible for documenting any corrective action taken as based on the assessments.

C.2: Reports to Management

The principal investigator will file periodic verbal and/or written reports with the DRWW project coordinator. The reports may concern but are not limited to project status, the results of performance evaluations and audits, the results of periodic data quality assessments, and significant QA/QC problems. Recipients may comment directly to the project sponsor lead and the principal investigator.

Group D: Data Validation and Usability

D.1: Data Review, Validation, and Verification

Data acceptance will initially be evaluated in the field and post-hoc during data management using the processes described in B.2 and B.5. However, later inspection of the data may also raise issues of acceptance. A systematic process will be used to reconcile any inconsistencies or issues prior to conditioning or disqualifying already collected data. Analytical data will be qualified by Suburban Laboratories, and the qualifiers will be reported with the data. The defined list of qualifiers can be seen in Table 10.

Table 10: Suburban Laboratories reportable qualifiers for water column and sediment samples.

Qualifier	Definition
*	Value exceeds Maximum Contaminant Level
B	Analyte detected in the associated Method Blank
c	Analyte not in SLI scope of accreditation
C	Value is below Minimum Concentration Limit
E	Estimated, detected above quantitation range
G	Refer to case narrative page for specific comments
H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limit (QL)
N	Tentatively identified compound
ND	Not Detected at the Reporting Limit
P	Present
R	RPD outside accepted recovery limits
S	Spike Recovery outside accepted recovery limits
W	Sample container temperature is out of limit as specified at testcode

D.2: Verification and Validation of Methods

Most of the raw data will be field validated in accordance with the processes described in B.2, B.3, B.4, and B.10. Post-sampling validation will entail verification of identifications made in the field and later in the laboratory. Laboratory generated data will follow established procedures detailed in Appendices E, F, and G.

D.3: Reconciliation with User Requirements

The sampling and analytical approach proposed for this project are designed to provide the opportunity to adjust and modify methods as appropriate to obtain results that meet the project goals and objectives. Initial methods scoping may be done to assure comparability and making adjustments, modifications, and refinements to the methods described in B.2. Other changes and modifications may not be apparent until the project is completed and the data is fully analyzed and discussed. These changes will be documented in progress reports and the final report and will include a detailed description of all data analyses used. The QAPP will be reviewed annually and updated as necessary by the DRWW. All changes will be recorded.

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Appendix A:

Preliminary Monitoring Strategy for the Des Plaines River Watershed



Monitoring Strategy for the Des Plaines River Watershed

Purpose

This Monitoring Strategy for the Des Plaines River Watershed in Lake County Illinois was developed by the Monitoring Committee of the Des Plaines River Watershed Workgroup (DRWW). The Monitoring Strategy was written and submitted to comply with the terms of Illinois Environmental Protection Agency's (Illinois EPA) Financial Assistance Agreement (FAA) 3191506. This Monitoring Strategy exceeds the minimum requirements of the Agreement and includes items that are in excess of what is required or eligible under the Section 319 program.

The Monitoring Strategy is considered a living document. The DRWW Monitoring Committee will use adaptive management to review the results of the monitoring program and will revise and update the Monitoring Strategy if changes are needed. A memo from Midwest Biodiversity Institute recommending an enhancement of the monitoring station locations based on a Geometric Site Analysis is attached to this Monitoring Strategy (Attachment 1). Two Quality Assurance Project Plans (QAPPs) have been developed for the monitoring program. The Bioassessment QAPP and the Flow Monitoring QAPP are appended to and inform this Monitoring Strategy (Appendices A and B).

Introduction and Background

The Des Plaines River Watershed covers over 130,000 acres or just over 200 square miles. The river starts just west of Kenosha, Wisconsin and flows south through Racine and Kenosha Counties in Wisconsin, and then through Lake, Cook, and Will Counties in Illinois. The river then joins the Sanitary and Ship Canal in Lockport, flows west through Joliet, before converging with the Kankakee River to form the Illinois River. The Illinois River then flows into the Mississippi River which flows south to the Gulf of Mexico.

Portions of the Des Plaines River, tributaries and lakes within the watershed in Lake County are listed as impaired by the Illinois EPA and do not meet their designated uses under the Clean Water Act. Segments are listed as impaired for pollutants including arsenic, chloride, dissolved oxygen, fecal coliform, iron, manganese, methoxychlor, mercury, phosphorous, polychlorinated biphenyls, and total suspended solids. Phosphorous is currently limited by regulatory action through Publically Owned Treatment Works (POTWs) National Pollutant Discharge Elimination System (NPDES) permits. In addition, Total Maximum Daily Loads (TMDLs) have been completed for some stream segments and lakes within the watershed and more will continue to be developed. However, it is unclear as to whether any of these regulatory mechanisms will ultimately allow for the impaired waterbodies to meet Clean Water Act standards.

The Des Plaines River Watershed Workgroup (DRWW) brings together local stakeholders to 1) better determine stressors to the aquatic system through a long term water quality monitoring program; and 2) to work together to preserve and enhance water quality in the Des Plaines River and its tributaries. The preliminary monitoring strategy was developed by the DRWW Monitoring Committee. Illinois EPA

Section 319(h) grant funds under Agreement Number 3191506 will be used to refine this strategy, creating a final monitoring strategy and for implementation of the monitoring strategy. Data collected under this monitoring program will be used in the development of the Des Plaines River watershed-based plan. Data will be uploaded on at least an annual basis following the Illinois EPA requirements for reporting surface-water -monitoring data format (EDDMasterStructureAndFormat_VersionAsOf2015_06_30_ToChrisDavis_2016_02_1...) as described in the Data and Reporting Section of this strategy. The data is anticipated to be uploaded to Illinois EPA by December 31st of each year.

Program Goals

The DRWW will undertake a comprehensive monitoring program to fulfill the following goals:

- Develop and implement a comprehensive monitoring program that will include chemical, physical, and biological components that will accurately identify the quality of stream and river ecosystems as well as stressors associated with non-attainment of water quality standards and designated uses. The DRWW monitoring program will establish baseline conditions, and then measure progress towards meeting water quality standards.
- Assist NPDES permittees in meeting monitoring permit requirements, including monitoring requirements for upstream and downstream of POTWs and Municipal Separate Storm Sewer Systems (MS4s). (Note: Costs for permit required monitoring are not included in Illinois EPA grant funded activities.)

The proposed monitoring program will document the existing water quality status of the rivers and streams of the Des Plaines River watershed within Lake County, Illinois. The monitoring program will emphasize the direct assessment of biological assemblages by sampling fish and macroinvertebrates using standardized sampling and assessment methodologies. In addition to determining aquatic life status, the monitoring program will also ascertain the associated causes and sources associated with biological impairments by using paired chemical, physical, and other stressor data and information within a systematic analytical process detailed in a comprehensive plan of study, specifically monitoring habitat and water and sediment chemistry.

Budget and Timeline

The DRWW will use annual membership dues to support the comprehensive monitoring program. Qualified contractors will be secured through a competitive bid process to provide the bioassessment and flow monitoring services. The estimated monitoring program cost is \$415,546 for years 2015-2017 as presented below. Eleven (11) of the thirty-six (36) water chemistry and sediment parameters being monitored are required for permit reporting at 12 of the 44 monitoring sites. This permit-required monitoring cost will not be used as 319 grant match. Attachment 2 to this strategy includes tabular analysis of the sampling cost estimate by parameter and frequency for four sampling efforts. The permit-required sampling cost is separated from 319 grant-eligible match costs. Tracking the sampling costs by parameter, site and frequency in this manner will allow for accurate accounting of grant-eligible expenses. Based on the 2015 grant-eligible cost analysis, approximately 83% of the total monitoring cost is for voluntary monitoring that is eligible for 319 grant match. Therefore, seventeen (17%) of the budgeted water chemistry monitoring cost was used to estimate the permit required sampling cost in the monitoring program cost estimate.

Estimated Monitoring Program Cost:

Program Component	2015-2017 Est. Cost	Req'd by		2015-2017 Est. Match
		Permit (est.17%)	319 Grant	
Development of Monitoring Strategy and QAPP	\$47,500	-	\$47,500	0
Water Chemistry Sampling	\$114,508	\$19,466	-	\$95,042
Sediment Analysis	\$41,265	-	-	\$41,265
Biological Monitoring and Assessment	\$157,425	-	-	\$157,425
Flow Monitoring	\$34,257	-	-	\$34,257
ESTIMATED TOTAL COST	\$394,955	\$19,466	\$47,500	\$327,989

Data collection for the monitoring program covered under FAA 3191506 runs from July 1, 2015 - October 31, 2017. A final monitoring program report will be submitted to Illinois EPA by January 31, 2018.

Monitoring Plan

The monitoring program consists of two components: bioassessment consisting of fish, macroinvertebrate, habitat and water and sediment chemistry monitoring; and flow monitoring. Water column chemistry monitoring will be completed annually with a tiered site design, as shown in Table 2. The collecting of fish and macroinvertebrates samples and habitat assessment will be completed on an annual rotating basis with a subset of sites being completed each year dependent on cost and available funds. Sediment chemistry will be conducted concurrently with biological sites. Flow monitoring data may be used for modeling purposes or to calculate pollutant concentrations in the future. The monitoring design and protocol is modeled after the DuPage River Salt Creek Workgroup and the Lower DuPage River Watershed Coalition (Yoder 2012).

Monitoring Sites and Equipment

Water and sediment chemistry and biological monitoring will be conducted at 44 sites and flow monitoring at 21 sites throughout the Des Plaines River watershed within Illinois as shown in Figures 1 and 2 and listed in Table 1. Monitoring sites are located on the main stem, tributaries, and within the headwaters, and were selected to investigate the contribution of point sources and non-point sources. POTWs are bracketed with monitoring sites located both upstream and downstream to determine POTW effluent impacts on the receiving waters. Sites are also located to determine the influences of tributary streams and other features, for example, the impact of online lakes.

Necessary equipment for the monitoring program is presented in Table 2 and is described in the monitoring sections that follow. All of the monitoring equipment is being provided by the contractors. Fifteen (15) stream dataloggers and two (2) barometric pressure dataloggers will be purchased, installed and maintained by the contractor on behalf of the DRWW at a cost not to exceed \$7,000, which is included in the flow monitoring contract and budgeted as DRWW grant match. DRWW will maintain ownership of the dataloggers after the flow monitoring contract is completed.

Water Column and Sediment Chemistry Monitoring

Water column and sediment chemistry will be sampled using a tiered site design to allow for more frequent monitoring of sites with greater flow and tributary area while still allowing for comprehensive coverage of the watershed. Water samples will be collected using grab samples upstream of the

monitoring station unless otherwise noted in site description maps. If high pollutant loads are detected, follow up sampling at a refined scale may be undertaken to further determine the cause. Table 3 shows the parameters and summarizes the frequency of sampling described below for water column and sediment chemistry monitoring. Monitoring sites in Figures 1 and 2 are also color coded to represent the three tiers described below: Tier 1 is red, Tier 2 is green, and Tier 3 is blue.

- Tier 1: 10 sites located on the mainstem Des Plaines River and Mill Creek that will be monitored monthly May through September and in November and March (seven times per year) for all demand¹, nutrient, and bacteria parameters; annually under low flow conditions for water column metals, water organics; and once every three years concurrent with the bioassessment for sediment metals and sediment organics.
- Tier 2: 10 sites located on the Des Plaines and tributary streams will be monitored monthly from May through September and in November and March (seven times per year) for the majority of demand, nutrient, and bacteria parameters; annually under low flow conditions for water column metals, water organics; and once every three years concurrent with the bioassessment for sediment metals and sediment organics.
- Tier 3: 24 stream stations located on the Des Plaines and tributary streams within the watershed will be monitored for water chemistry that will occur monthly from May through September and in November and March (seven times per year) for the majority of demand, nutrient, and bacteria parameters; and once every three years concurrent with the bioassessment for sediment metals and sediment organics.

Equipment necessary to complete the water column and sediment chemistry monitoring will be provided by the contractor and may include buckets, collection bottles, and gloves. A detailed equipment list is included in Table 2.

Biological Monitoring

The biological monitoring will be conducted on a rotating basis, monitoring fish and macroinvertebrate assemblages and habitat with a portion of the stations sampled each year. Biological sampling for fish and macroinvertebrate assemblage data and habitat will follow established protocols of the Illinois Department of Natural Resources (Illinois DNR; 2001) and Illinois EPA (1997, 2005) and be capable of producing comparable data and assessments. Sampling methods will be determined based on whether the stream is non-wadeable or wadeable. Ultimately methods will be determined by the contractor and documented in the Quality Assurance Project Plan (QAPP). Equipment necessary to complete the bioassessment will be provided by the contractor and may include electrofishing equipment, nets, and an analytical field meter (see Table 2 for a complete list).

Flow Monitoring

Through a combination of the installation of new data loggers and obtaining data from existing equipment, flow will be monitored at 21 locations within the Des Plaines River watershed project area. Flow monitoring locations include six existing United States Geological Survey (USGS) gage stations and 15 additional locations. The collected flow monitoring data will be used to calculate pollutant loading. Equipment necessary to measure stream cross sections and for flow monitoring will be provided by the contractor. DRWW will maintain ownership of the newly purchased dataloggers allowing for their use in succeeding years for the DRWW monitoring program (see Table 2 for a complete equipment list).

¹ Demand parameters include: chloride, conductivity, pH, TOC, sulfate, total suspended solids, volatile suspended solids, dissolved oxygen, temperature, and turbidity.

Quality Assurance Project Plan

All monitoring will be conducted under two Illinois EPA approved QAPPs. The DRWW will use the DuPage River Salt Creek Workgroup's (DRSCW) approved QAPP and adapt it to be watershed specific for the bioassessment monitoring. A separate QAPP has been developed and submitted to Illinois EPA for flow monitoring. Both QAPPs are appended to this Monitoring Strategy.

Illinois EPA requires the development of a QAPP for any activity involving the collection and analysis of environmental data. A QAPP presents the policies and procedures, organization, objectives, quality assurance requirements, and quality control activities designed to achieve the type and quality of environmental data necessary to support project or program objectives. It is the policy of Illinois EPA that no data collection or analyses will occur without an approved QAPP. All in-house and external environmental data collection activities are subject to this requirement. All contracts must address quality assurance requirements (e.g., data quality and reporting requirements) when those contracts pertain to, or have an impact on, data collection or analysis activities. Additionally, all grants and contracts need to address quality assurance requirements specified in applicable state acquisition or procurement regulations. The DRWW QAPP will follow U.S. and Illinois EPA guidance for the development of a project specific QAPP.

Data and Reporting

Suburban Labs, the water and sediment chemistry contractor, will send water column and sediment chemistry data to the DRWW following analysis via email in the format of one final report of laboratory analysis in pdf form per site. After data have been collected at each site for that sampling event (occurring seven times annually), the laboratory will send an Excel spreadsheet summarizing all sites and parameters. DRWW staff will take this data and format it to fit the Illinois EPA requirements for reporting surface-water -monitoring data format (EDDMasterStructureAndFormat_VersionAsOf2015_06_30_ToChrisDavis_2016_02_1...).

Midwest Biodiversity Institute (MBI), the bioassessment contractor, will send biological data to the DRWW within ten weeks of sample collection and it will ultimately be appended to the project database. An annual data submittal will be provided to the DRWW within two months of the final field event. This report will be provided electronically and as a hard copy, with chain-of-custody forms and laboratory reports attached.

MBI will also be responsible for completing a final monitoring report, analyzing the results of the water column and sediment chemistry as well as the fish, macroinvertebrate, and habitat data. Interpretative statistics, such as long-term central tendencies, will be based on all available data within the database, developed over time, including past data collection efforts.

Burns & McDonnell, the flow monitoring contractor, will report the flow data monthly in an editable Microsoft Excel file, and will provide a final report in PDF format with all analytical results, analytical method, chain(s) of custody and a field log.

Data will be submitted annually to Illinois EPA by December 31st. All data will be submitted to Illinois EPA by December 31, 2017.

References

- Illinois DNR. 2001. IDNR stream fisheries sampling guidelines. Watershed Protection Section, Springfield, IL. 9 pp.
- Illinois EPA. 2005. Methods of collecting macroinvertebrates in streams (July 11, 2005 draft). Bureau of Water, Springfield IL. BOW No. xxxx. 6 pp.
- Illinois EPA. 1997. Quality assurance methods manual. Section G: Procedures for fish sampling, electrofishing safety, and fish contaminant methods. Bureau of Water, Springfield, IL. 39 pp.
- Yoder, C.O. 2012. Quality Assurance Project Plan: Biological and Habitat Assessment of the DuPage River and Salt Watersheds.

Figure 1: Sampling locations with municipal overlay and aerial background.

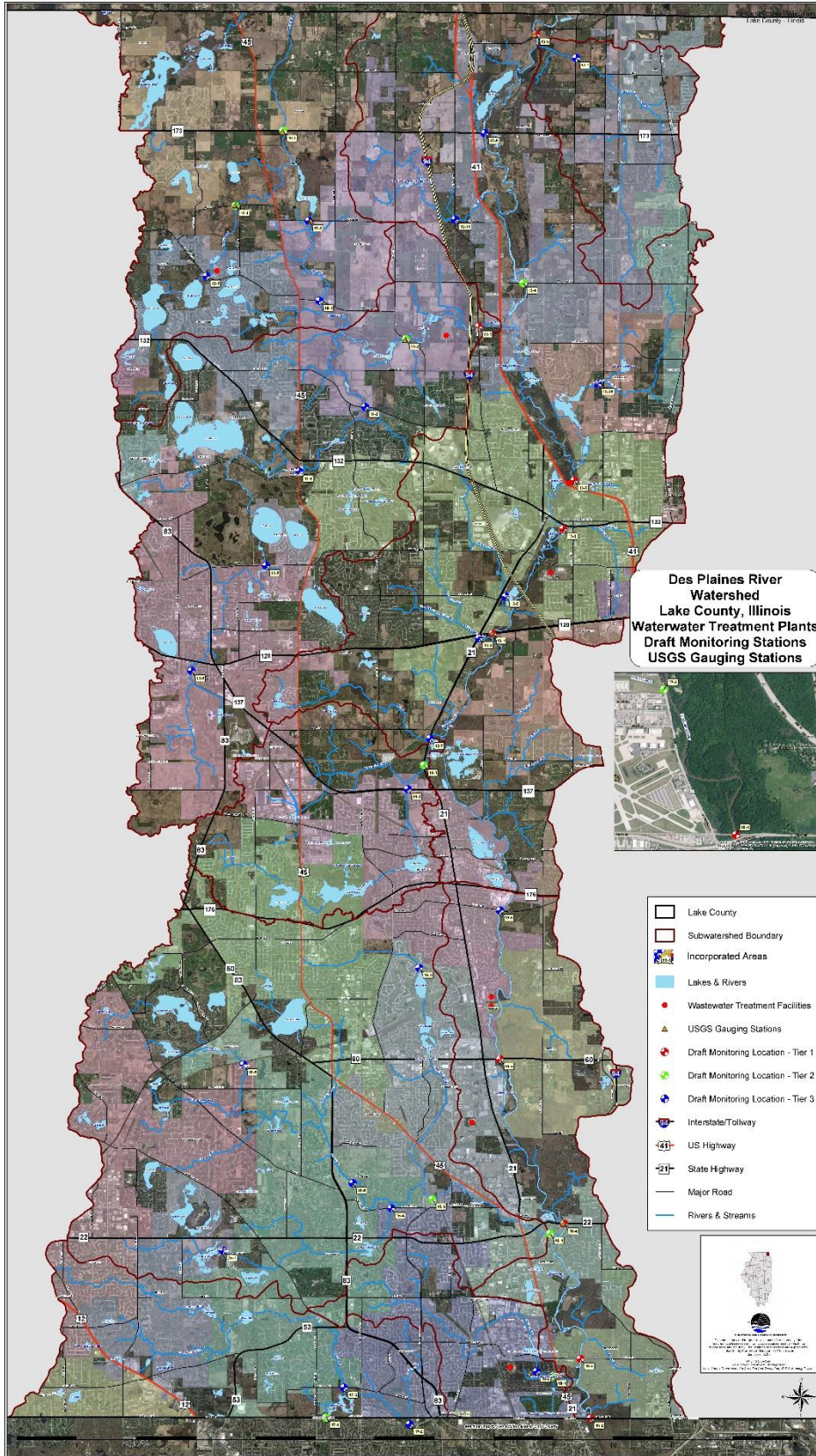


Figure 2: Sampling locations with municipal boundaries background.

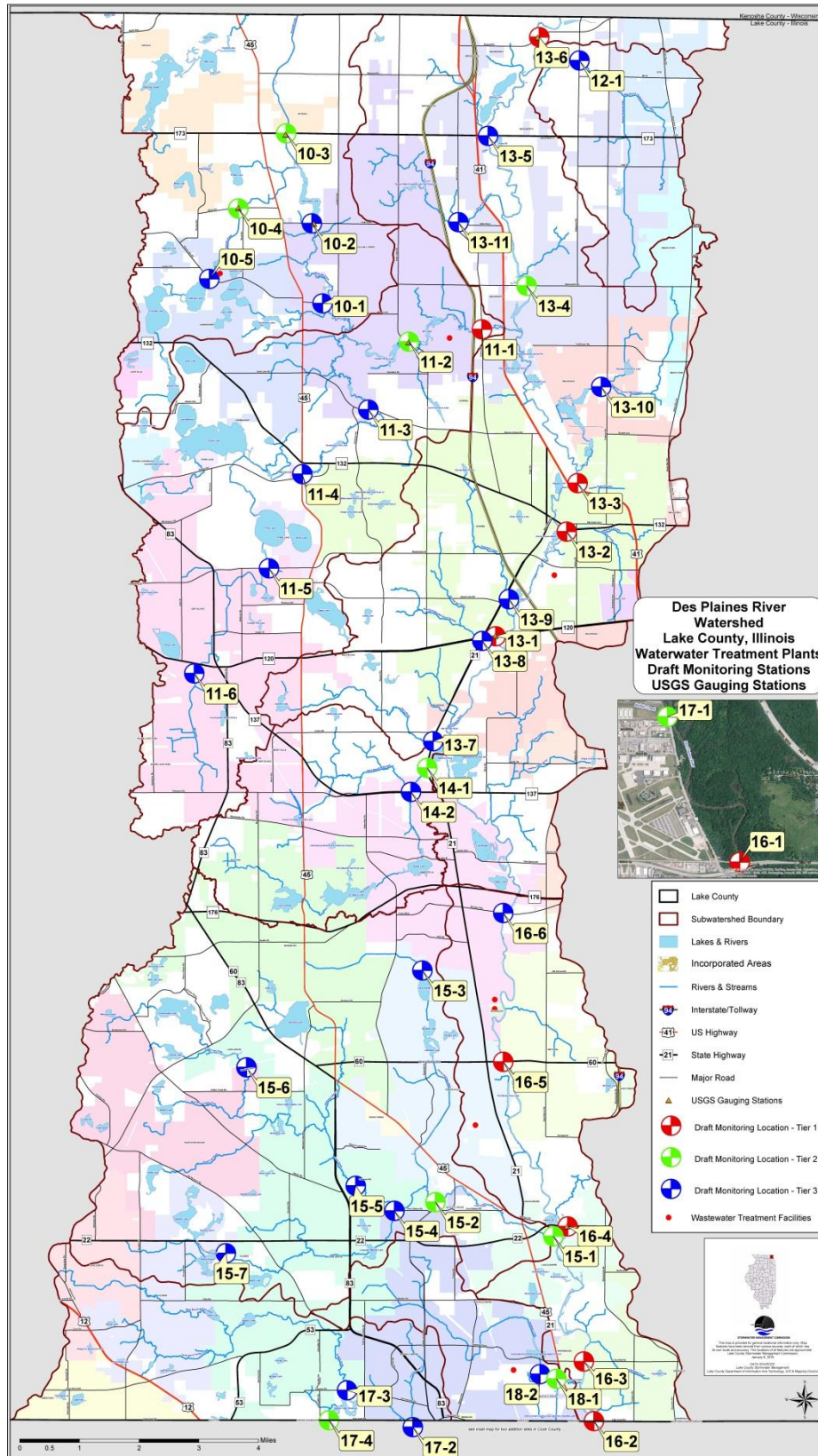


Table 1: Water Quality Sampling Locations

Des Plaines River Sample Locations	Street	Station ID*	Bioassessment		
			Tier Designation		
Upper Des Plaines	Russell Rd	13-6	1		
	Highway 173	13-5			3
	Wadsworth Rd	13-4		2	
	Above Highway 41	13-3*	1		
	McClure Ave	13-2	1		
	Highway 120	13-1	1		
Lower Des Plaines	Rockland Rd	16-6			3
	Highway 60	16-5*	1		
	Half Day Rd	16-4	1		
	Deerfield Rd	16-3*	1		
	Lake Cook Rd	16-2	1		
	Willow Rd	16-1	1		
Upper Des Plaines Tributaries	Bull's Brook @ Route 21	13-7*			3
	Belvidere Rd Tributary @ Highway 21 and 120	13-8*			3
	Stoneroller @ Lake Carina	13-9*			3
	Suburban Country Club Tributary @ Shirley Dr	13-10			3
	Slocum Corners Creek @ Mill Creek Rd	13-11*			3
Newport	Newport Drainage Ditch @ Kilbourne Ave	12-1*			3
North Mill	Milburn Rd	10-1			3
	Kelly Rd	10-2			3
	Route 173	10-3		2	
	Hastings Creek @ Miller Rd	10-4		2	
	Hastings Creek @ Grass Lake Rd	10-5			3
Mill Creek	Dilley's Rd	11-1*	1		
	Hunt Club Rd	11-2		2	
	Stearns School Rd	11-3			3
	Route 45	11-4			3
	Washington St	11-5			3
	Wick St	11-6			3
Bull Creek	Bull Creek @ Route 21	14-1*		2	
	Route 137	14-2			3
Indian Creek	Marriot Lincolnshire Grounds	15-1*		2	
	Sullivan Wood Preserve, North of Creek View Dr	15-2		2	
	Greggs Parkway	15-3			3
	Port Clinton Rd @ Kildeer Creek	15-4*			3
	Oak Wood Rd	15-5*			3
	Washitay Ave	15-6			3
	Salem Lake Dr	15-7			3
Aptakisic	Pekara Rd	18-2			3
	Aspen Rd	18-1*		2	
Buffalo Creek	Lake Cook Rd @ Farington Ditch	17-2			3
	Checker	17-3			3
	Lake Cook Rd @ Buffalo Creek Tributary A	17-4		2	
	Route 21	17-1*		2	
		Total	10	10	24
* Flow monitoring will be conducted at these station locations					

Table 2: Equipment Needed:

Water Chemistry Sampling Equipment	Sediment Sampling Equipment	Biological Sampling Equipment
1-gallon HDPE bucket	Stainless steel bowl	Bucket
Sample bottles	ASTM-EE11 No. 230 sieve	Personal protective equipment
Disposable gloves	Stainless steel spoon	Geographical Positioning System
Cooler	Sample bottles	Measuring tape/stick
Ice	Ice	Formaldehyde
Portable analytical field meter	Disposable gloves	Scale
Vehicle	Cooler	Boat
Nylon rope	Aluminum foil	Generator Powered Pulsator
Field books/log sheets/chain of custody	Field books/log sheets/chain of custody	Field books/log sheets/chain of custody
Antibacterial soap	Antibacterial soap	Electrofishing equipment
Markers	Markers	Nets
Labels	Labels	Stakes
Sampling pole	Vehicle	Anchors
Map book	Map book	Map book
Distilled or reagent-grade deionized water	Distilled or reagent-grade deionized water	
	Isopropyl alcohol	
	Non-phosphate detergent	
	Cleaning brush with non-metallic bristles	
Flow Monitoring Equipment		
Stream dataloggers (15)		
Barometric pressure dataloggers (2)		
Survey rod		
Laser level		
Real time kinematic (RTK) or global positioning system (GPS)		

Table 3: Water Quality Sampling Parameters

Parameter	DRWW Frequency	Tier 1	Tier 2	Tier 3
<u>Demand</u>		Number of Sample Events		
Chloride	monthly May-Sept, Nov, Mar	7	7	7
Conductivity	monthly May-Sept, Nov, Mar	7	7	7
pH	monthly May-Sept, Nov, Mar	7	7	7
TOC	monthly May-Sept, Nov, Mar	7	0	0
Sulfate	monthly May-Sept, Nov, Mar	7	0	0
TSS	monthly May-Sept, Nov, Mar	7	7	0
Volatile Suspended Solids	monthly May-Sept, Nov, Mar	7	7	0
DO	monthly May-Sept, Nov, Mar	7	7	7
Temperature	monthly May-Sept, Nov, Mar	7	7	7
Turbidity	monthly May-Sept, Nov, Mar	7	7	7
<u>Metals</u>				
Total Hardness	annually under low flow conditions	1	1	0
Iron	annually under low flow conditions	1	0	0
Sodium	annually under low flow conditions	1	0	0
Arsenic	annually under low flow conditions	1	0	0
Manganese	annually under low flow conditions	1	1	0
Mercury	annually under low flow conditions	1	0	0
Copper	annually under low flow conditions	1	0	0
Nickel	annually under low flow conditions	1	0	0
Zinc	annually under low flow conditions	1	0	0
<u>Nutrients</u>				
Ammonia	monthly May-Sept, Nov, Mar	7	7	0
Total Nitrates (NO ₂ + NO ₃)	monthly May-Sept, Nov, Mar	7	7	7
TKN	monthly May-Sept, Nov, Mar	7	7	0
Total phosphorus	monthly May-Sept, Nov, Mar	7	7	7
Dissolved reactive phosphorus	monthly May-Sept, Nov, Mar	7	7	0
<u>Bacteria</u>				
E. coli	monthly May-Sept, Nov, Mar	7	7	7
<u>Water Organics</u>				
PCBs	annually under low flow conditions	1	0	0
Pesticides	annually under low flow conditions	1	0	0
Methoxychlor	annually under low flow conditions	1	0	0
PNAs	annually under low flow conditions	1	0	0
VOCs	annually under low flow conditions	1	0	0
<u>Sediment Metals</u>				
Aluminum	concurrent w/ bioassessment	1	1	1
Arsenic	concurrent w/ bioassessment	1	1	1
Barium	concurrent w/ bioassessment	1	1	1
Beryllium	concurrent w/ bioassessment	1	1	1
Boron	concurrent w/ bioassessment	1	1	1
Cadmium	concurrent w/ bioassessment	1	1	1
Chromium	concurrent w/ bioassessment	1	1	1
Cobalt	concurrent w/ bioassessment	1	1	1

Table 3 (cont.): Water Quality Sampling Parameters

Parameter	DRWW Frequency	Tier 1	Tier 2	Tier 3
Sediment Metals		Number of Sample Events		
Copper	concurrent w/ bioassessment	1	1	1
Fluoride	concurrent w/ bioassessment	1	1	1
Iron	concurrent w/ bioassessment	1	1	1
Lead	concurrent w/ bioassessment	1	1	1
Manganese	concurrent w/ bioassessment	1	1	1
Mercury	concurrent w/ bioassessment	1	1	1
Nickel	concurrent w/ bioassessment	1	1	1
Potassium	concurrent w/ bioassessment	1	1	1
Silver	concurrent w/ bioassessment	1	1	1
Sodium	concurrent w/ bioassessment	1	1	1
Strontium	concurrent w/ bioassessment	1	1	1
Vanadium	concurrent w/ bioassessment	1	1	1
Zinc	concurrent w/ bioassessment	1	1	1
Sediment Organics				
PCBs	concurrent w/ bioassessment	1	1	1
Pesticides	concurrent w/ bioassessment	1	1	1
Methoxychlor	concurrent w/ bioassessment	1	1	1
PNAs	concurrent w/ bioassessment	1	1	1
VOCs	concurrent w/ bioassessment	1	1	1
TKN	concurrent w/ bioassessment	1	1	1
Phosphorus	concurrent w/ bioassessment	1	1	1
Cyanide	concurrent w/ bioassessment	1	1	1
Herbicides (2, 4, D, 2,4,5 TP)	concurrent w/ bioassessment	1	1	1
Phenols	concurrent w/ bioassessment	1	1	1

To: Andrea Cline, Geosyntec
From: Chris Yoder, MBI
Subject: DRWW Monitoring Sites Analysis
Date: January 29, 2016

In partial fulfillment of Task 1: Refine Monitoring Plan of the *Technical Services Agreement between the Des Plaines River Watershed Workgroup and Midwest Biodiversity Institute for Bioassessment Monitoring* the following review of the Des Plaines River Watershed Workgroup (DRWW) monitoring design was accomplished. The following documents are used to further support the monitoring design:

- DRWW & Geometric Site Analysis 20160124 (Excel spreadsheet listing all proposed sites, their location, river/stream name, and proposed sampling)
- DRWW Geometric Sites 20160119 (PDF map showing sampling locations)

The first step in the review was to develop a “draw” of geometric sites for the Des Plaines River watershed in Lake County. This consists of deriving geometric “panels” of drainage areas by determining the drainage area of the Upper Des Plaines and then halving each successive drainage area stopping at ≈ 1 square mile. The panels are referred to as “levels” with level 1 being the drainage area at the mouth and then proceeding upstream to find all possible drainage areas for each level. This analysis of the DRWW monitoring design consists of an Excel file with two worksheets. The first worksheet is the detailed list of geometric sites derived by selecting all possible sites in Lake County for each of geometric drainage area panels as follows:

Level 10:	<1 sq. mi.
Level 9:	1-2.5 sq. mi.
Level 8:	2.5-5 sq. mi.
Level 7:	5-10 sq. mi.
Level 6:	10-20 sq. mi.
Level 5:	20-40 sq. mi.
Level 4:	40-79 sq. mi.
Level 3:	79-158 sq. mi.
Level 2:	158-316 sq. mi.
Level 1:	>316 sq. mi.

The derivation of levels started at 316 square miles since that is the drainage area (DA) of the Upper Des Plaines River. The succeeding levels are derived by simply halving each successive level which yields the DA of the next level. The level numbers are assigned in an “upstream” direction, hence the smallest DAs have the highest level number. A geometric site is then

geographic information systems (GIS) to locate the coordinates for a potential site. This yielded a total of 40 geometric sites in Lake County. The next step is to fill gaps in the spatial coverage by adding targeted sites to cover extended “vacant” segments, upstream and downstream of point sources, marked changes in habitat, major tributary confluences, etc. The resulting combination of sites is termed an Intensive Pollution Survey Design because the objectives are to include virtually all Clean Water Act (CWA) jurisdictional streams (i.e., a visible bed and bank) in a watershed and to account for longitudinal pollution gradients resulting from stressor inputs including point, nonpoint source, and other stressors (e.g., habitat) and along the direction in which they exert their effects, i.e., in a downstream direction. The current DRWW sites fulfill this step, hence they were accepted as filling the gaps in the geometric derivation. A few targeted sites may be added to the Des Plaines mainstem as some of the DRWW sites leave significant gaps in the mainstem. This can be addressed in the detailed study planning phase and in consultation with DRWW.

The combination of geometric and DRWW sites were then sorted by DA (smallest to largest) with the current DRWW sites included to determine the extent of any overlap. Column G in the DRWW & Geometric Sites Analysis 20160124 spreadsheet lists whether the site is geometric or an existing DRWW site. Next, Google Earth was used to conduct a desktop reconnaissance of each geometric site which was the basis for either listing a site for an “on ground” reconnaissance or dropping it from further consideration (sites shaded in red on the spreadsheet). A stream with a visible bed and bank was retained for further consideration. A few sites were in lakes or wetland complexes with no visible stream in the immediate vicinity hence these were dropped. “Neighboring” DRWW sites were located to determine if there was functional overlap. Three geometric sites were dropped for this reason.

The second worksheet in the Excel spreadsheet is the summary of the geometric selection of sites and their overlap with DRWW sites. Geometric sites were given a G-# code and in the order they were found via GIS. As expected, the geometric selection added mostly small headwater sites in DA Levels 9 and 10, i.e., <2.5 square miles. The rate of addition falls off rapidly at DAs >5-10 square miles and this is not unexpected in the Upper Des Plaines as it is a trellised watershed as opposed to dendritic. The net result is 77 total sites for Lake County which is a net addition of 32 sites to the DRWW design. This is true only if *all* Level 10 sites are included – this level alone adds 18 new sites, some of which may be rejected following the on-ground reconnaissance. Level 9 adds 7 sites thus these two panels alone add 25 of the 32 “new” sites. These small streams can be sampled rather quickly for biological assemblages and habitat and they only need to be sampled once. This will add perhaps 1-2 weeks to the fish and macroinvertebrate field effort, which could be covered by the \$7-8,000 difference between our estimate and the contract total. The impact on the macroinvertebrate lab budget is more of a fixed cost by adding samples for analysis. The potential increase in chemical sample analyses even if these sites are done at a lower frequency, i.e., 2 samples per summer-fall index period, will be more costly. It is not recommended to perform analyses for toxics or organics nor sediment chemistry at these sites unless there is a very good reason to do so.

There are other options for dealing with the addition of sites including doing only fish and qualitative habitat evaluation index (QHEI) as an initial assessment and then ramping up the indicators in a future monitoring cycle. Another approach would be to divide Lake County into two or three areas that are sampled on a rotating basis which allows for a concentration of effort for the same annual cost. The larger sites (i.e., >20-30 square miles) would be sampled annually with the attendant subwatersheds rotated in and out on an annual basis. An advantage of a rotating basin approach is that it increases overall sampling density resulting in better spatial coverage as opposed to scattering a fixed effort over an entire jurisdiction. The latter approach simply dilutes the resulting information about condition and stressors by leaving gaps in the spatial coverage, which is a prescription for missing impairments and incremental change, especially in an urban-suburban-rural setting like Lake County where full attainment of aquatic life goals may be decades in the making. A rotating design has been very effective in the DuPage-Salt Creek watersheds and the concentrated effort has revealed some relationships that would have been missed by a less intensive design.

Other detail about the biological, habitat, and chemical sampling by site is also included on the first worksheet to show how the sampling can be attenuated to the size of the stream or river at a site. The current DRWW approach could be easily inserted into this matrix, various options developed, and then decisions made about how to proceed from there based on cost. The chemical sampling frequencies can also be subject to modification as the different options are considered. The same matrix from part of a similar design from Hamilton County, Ohio that was executed in 2014 as part of a four year rotation among 11 watersheds and 3 mainstem rivers is included as an example of a stratified approach - this particular watershed is about 130 square miles.

In terms of comments about specific indicators, the collection of chlorophyll a in the water samples and benthic chlorophyll a at the larger stream sites at least once during the summer is recommended. Some states (e.g., Ohio, Minnesota) are developing eutrophication based approaches to nutrient criteria as opposed to having only nitrogen (N) and phosphorus (P) concentration criteria. These procedures determine the trophic status of a site based on the fish and macroinvertebrate index of biotic integrity (IBIs), the diel D.O. flux, chlorophyll a, and the total inorganic nitrogen (TIN) and P concentrations. The assessment of a site is weighted towards the biological indicators and chlorophyll a and less so to the chemical concentrations because the latter are much more variable by comparison and are not well suited to serving as a not-to-exceed criteria in the Water Quality Standards (WQS). It is not known that Illinois EPA will be looking at this approach, but doing this would put the DRWW in a better position to negotiate an arrangement similar what the DuPage River Salt Creek Workgroup (DRSCW) has negotiated for nutrients where publically owned treatment works (POTW) limits for N and P are being deferred pending other restoration outcomes. This will add to the overall monitoring cost, but the value over the long term may well outweigh the upfront costs in terms of POTW treatment costs.

Lastly, however DRWW chooses to define it there needs to be a unique site identifier for each site so that the biological, chemical/physical, and habitat results can be merged in the analysis.

Because of the peculiarities in how the sampling sites for each indicator is set up relying on Global Positioning System (GPS) coordinates would become hopelessly disorganized. The DRWW sites already have a code which is based on a systematic approach to deriving these numbers. DRSCW uses an alpha-numeric code (e.g., West Branch DuPage is WB##, etc.). River miles will also need to be assigned to each DRWW sampling site. There is a method of doing this for Illinois. This can wait until we develop the detailed study plan.

Geo Level	DA Range	Geo Sites	Geo Drop	DRWW Sites	Net Total Sites
10	0-0.99	22	-4	0	18
9	1.00-2.50	7	0	1	8
8	2.51-5.00	4	-1	10	13
7	5.01-10.00	2	0	8	10
6	10.01-20.0	3	-2	3	4
5	20.01-40.00	1	0	8	9
4	40.01-79.00	0	0	2	2
3	79.01-158.0	0	0	3	3
2	158.01-316	1	-1	8	8
1	>316	0	0	2	2
		40	-8	45	77



Legend

DRWW Site

● DRWW Site

Geometric Sites

Geometric Level

◆ 2

◆ 5

◆ 6

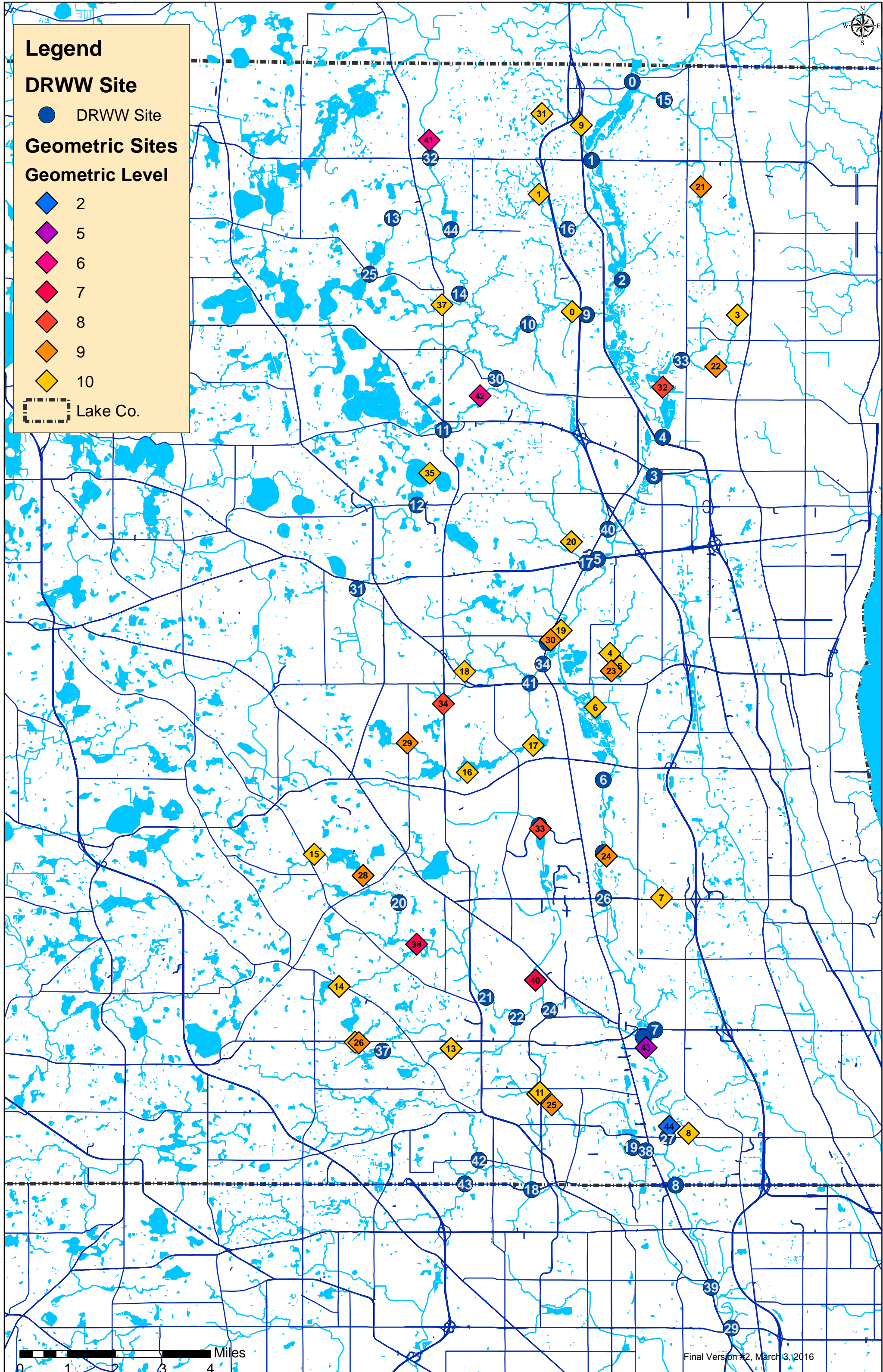
◆ 7

◆ 8

◆ 9

◆ 10

⬜ Lake Co.



0 1 2 3 4 Miles

Attachment 2: CALCULATION OF DES PLAINES RIVER WATERSHED WATER CHEMISTRY MONITORING PROGRAM GRANT MATCH FOR FAA#3191506

****monthly parameters required by POTW permit** Permit required samples, upstream and downstream, are required at 12 sites: 6 Tier 1 sites, 3 Tier 2 sites, 3 Tier 3 sites. Add 1 QA/QC sample for every 20 samples. Sampling months are August, September, November, March, May, June, July (7 times annually). This quote is for 4 months: August, September, November, and March

2015 PRICE QUOTATION	Tier 1 (10 Total/6 Permit Req'd sites x 4months) + QA/QC Samples (Not in E/F)				Tier 2 (10 Total/3 Permit Req'd sites x 4months) + QA/QC Samples (Not in E/F)				Tier 3 (24 Total/3 Permit Req'd sites x 4months) + QA/QC Samples (Not in E/F)				
	Quoted Price	Proposed Quantity	Total	Quantity Permit Req'd Samples	Permit Req'd Total	Proposed Quantity	Total	Quantity Permit Req'd Samples	Permit Req'd Total	Proposed Quantity	Total	Quantity Permit Req'd Samples	Permit Req'd Total
Demand													
Chloride	\$ 14.00	48	\$ 672.00	0	\$ -	48	\$ 672.00	0	\$ -	112	\$ 1,568.00	0	\$ -
Conductivity ¹	\$ 5.00	48	\$ 240.00	0	\$ -	48	\$ 240.00	0	\$ -	112	\$ 560.00	0	\$ -
**pH	\$ 5.00	48	\$ 240.00	24	\$ 120.00	48	\$ 240.00	12	\$ 60.00	112	\$ 560.00	12	\$ 60.00
**TOC	\$ 25.00	48	\$ 1,200.00	24	\$ 600.00	0	\$ -	0	\$ -	0	\$ -	0	\$ -
Sulfate	\$ 20.00	48	\$ 960.00	0	\$ -	0	\$ -	0	\$ -	0	\$ -	0	\$ -
**TSS	\$ 8.00	48	\$ 384.00	24	\$ 192.00	48	\$ 384.00	12	\$ 96.00	0	\$ -	0	\$ -
**Volatile Suspended Solids	\$ 8.00	48	\$ 384.00	24	\$ 192.00	48	\$ 384.00	12	\$ 96.00	0	\$ -	0	\$ -
**DO	\$ 5.00	48	\$ 240.00	24	\$ 120.00	48	\$ 240.00	12	\$ 60.00	112	\$ 560.00	12	\$ 60.00
**Temperature	\$ 5.00	48	\$ 240.00	24	\$ 120.00	48	\$ 240.00	12	\$ 60.00	112	\$ 560.00	12	\$ 60.00
Turbidity	\$ 5.00	48	\$ 240.00	0	\$ -	48	\$ 240.00	0	\$ -	112	\$ 560.00	0	\$ -
	Total		\$ 4,800.00	Total	\$ 1,344.00	Total	\$ 2,640.00	Total	\$ 372.00	Total	\$ 4,368.00	Total	\$ 180.00
Metals													
Total Hardness	\$ 4.00	10	\$ 40.00	0	\$ -	10	\$ 40.00	0	\$ -	0	\$ -	0	\$ -
Metals (Fe, Na, As, Mn, Cu, Ni, Zn)	\$ 56.00	10	\$ 560.00	0	\$ -	0	\$ -	0	\$ -	0	\$ -	0	\$ -
Low Level Mercury	\$ 120.00	10	\$ 1,200.00	0	\$ -	0	\$ -	0	\$ -	0	\$ -	0	\$ -
Manganese	\$ 7.00	0	\$ -	0	\$ -	10	\$ 70.00	0	\$ -	0	\$ -	0	\$ -
	Total		\$ 1,800.00	Total	\$ -	Total	\$ 110.00	Total	\$ -	Total	\$ -	Total	\$ -
Nutrients													
**Ammonia	\$ 15.00	48	\$ 720.00	24	\$ 360.00	48	\$ 720.00	12	\$ 180.00	0	\$ -	0	\$ -
**Total Nitrates (NO2+NO3)	\$ 20.00	48	\$ 960.00	24	\$ 480.00	48	\$ 960.00	12	\$ 240.00	112	\$ 2,240.00	12	\$ 240.00
**TKN	\$ 28.00	48	\$ 1,344.00	24	\$ 672.00	48	\$ 1,344.00	12	\$ 336.00	0	\$ -	0	\$ -
**Total Phosphorus	\$ 15.00	48	\$ 720.00	24	\$ 360.00	48	\$ 720.00	12	\$ 180.00	112	\$ 1,680.00	12	\$ 180.00
**Dissolved Reactive Phosphorus	\$ 30.00	48	\$ 1,440.00	24	\$ 720.00	48	\$ 1,440.00	12	\$ 360.00	0	\$ -	0	\$ -
	Total		\$ 5,184.00	Total	\$ 2,592.00	Total	\$ 5,184.00	Total	\$ 1,296.00	Total	\$ 3,920.00	Total	\$ 420.00
Bacteria													
E. Coli	\$ 25.00	48	\$ 1,200.00	0	\$ -	48	\$ 1,200.00	0	\$ -	112	\$ 2,800.00	0	\$ -
	Total		\$ 1,200.00	Total	\$ -	Total	\$ 1,200.00	Total	\$ -	Total	\$ 2,800.00	Total	\$ -
Water Organics													
PCBs/Pesticides	\$ 105.00	10	\$ 1,050.00	0	\$ -	0	\$ -	0	\$ -	0	\$ -	0	\$ -
Methoxychlor	\$ 100.00	10	\$ 1,000.00	0	\$ -	0	\$ -	0	\$ -	0	\$ -	0	\$ -
PNAs	\$ 80.00	10	\$ 800.00	0	\$ -	0	\$ -	0	\$ -	0	\$ -	0	\$ -
VOCs	\$ 90.00	10	\$ 900.00	0	\$ -	0	\$ -	0	\$ -	0	\$ -	0	\$ -
	Total		\$ 3,750.00	Total	\$ -	Total	\$ -	Total	\$ -	Total	\$ -	Total	\$ -
Sediment Metals													
Metals (19)	\$ 152.00	10	\$ 1,520.00	0	\$ -	10	\$ 1,520.00	0	\$ -	24	\$ 3,648.00	0	\$ -
Mercury	\$ 20.00	10	\$ 200.00	0	\$ -	10	\$ 200.00	0	\$ -	24	\$ 480.00	0	\$ -
Fluoride	\$ 15.00	10	\$ 150.00	0	\$ -	10	\$ 150.00	0	\$ -	24	\$ 360.00	0	\$ -
	Total		\$ 1,870.00	Total	\$ -	Total	\$ 1,870.00	Total	\$ -	Total	\$ 4,488.00	Total	\$ -
Sediment Organics													
PCBs/Pesticides	\$ 105.00	10	\$ 1,050.00	0	\$ -	10	\$ 1,050.00	0	\$ -	24	\$ 2,520.00	0	\$ -
Methoxychlor	\$ 100.00	10	\$ 1,000.00	0	\$ -	10	\$ 1,000.00	0	\$ -	24	\$ 2,400.00	0	\$ -
PNAs	\$ 80.00	10	\$ 800.00	0	\$ -	10	\$ 800.00	0	\$ -	24	\$ 1,920.00	0	\$ -
VOCs	\$ 90.00	10	\$ 900.00	0	\$ -	10	\$ 900.00	0	\$ -	24	\$ 2,160.00	0	\$ -
TKN	\$ 28.00	10	\$ 280.00	0	\$ -	10	\$ 280.00	0	\$ -	24	\$ 672.00	0	\$ -
Phosphorus	\$ 15.00	10	\$ 150.00	0	\$ -	10	\$ 150.00	0	\$ -	24	\$ 360.00	0	\$ -
Cyanide (low)	\$ 32.00	10	\$ 320.00	0	\$ -	10	\$ 320.00	0	\$ -	24	\$ 768.00	0	\$ -
Herbicides (2,4,D, 2,4,5 TP)	\$ 250.00	10	\$ 2,500.00	0	\$ -	10	\$ 2,500.00	0	\$ -	24	\$ 6,000.00	0	\$ -
Phenols	\$ 30.00	10	\$ 300.00	0	\$ -	10	\$ 300.00	0	\$ -	24	\$ 720.00	0	\$ -
	Total		\$ 7,300.00	Total	\$ -	Total	\$ 7,300.00	Total	\$ -	Total	\$ 17,520.00	Total	\$ -
			Permit Total	\$ 3,936.00			Permit Total	\$ 1,668.00			Permit Total	\$ 600.00	
¹ denotes field measurement	Sampling Charge	\$ 2,000.00	Sampling Charge	\$ 2,000.00	Sampling Charge	\$ 4,800.00							
Note 1: Quantity of samples is estimated	Analysis Subtotal	\$ 16,734.00	Analysis Subtotal	\$ 9,134.00	Analysis Subtotal	\$ 11,088.00							
Note 2: Field QC samples billed as actual samples (~12 duplicates and ~12 Field Blanks)	Grand Total	\$ 18,734.00	Grand Total	\$ 11,134.00	Grand Total	\$ 15,888.00							

Tier 1	Tier 2	Tier 3
Est. Total	Est. Total	Est. Total
Nonpermi \$ 12,798.00	Nonpermi \$ 7,466.00	Nonpermi \$ 10,488.00

Estimated Total Cost for Monitoring Analysis August 2015 through April 2016:	\$36,956.00	
Estimated Total for Non-Permit Req'd Analysis August 2015 through April 2016:	\$30,752.00	83%
Estimated Total for Permit Req'd Analysis August 2015 through April 2016:	\$ 6,204.00	17%

Appendix B:

**Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat
Evaluation Index (QHEI)**

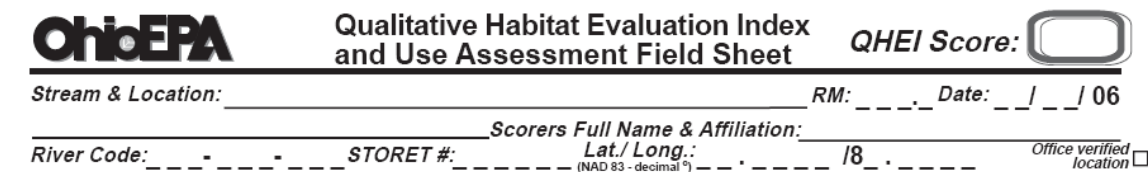
Methods for Assessing Habitat in Flowing Waters: Using the Qualitative Habitat Evaluation Index (QHEI)

Introduction

This document summarizes the methodology for completing a general evaluation of macrohabitat, generally done by the fish field crew leader while sampling each location using the Ohio EPA Site Description Sheet - Fish (Appendix 1). This form is used to tabulate data and information for calculating the Qualitative Habitat Evaluation Index (QHEI). The following guidance should be used when completing the site evaluation form.

Header/Geographical Information

Complete site identification information is critical to making field data useful. Figure 1 illustrates the location information required for the QHEI.



The image shows the header section of the Ohio EPA Qualitative Habitat Evaluation Index and Use Assessment Field Sheet. It includes the Ohio EPA logo, the title 'Qualitative Habitat Evaluation Index and Use Assessment Field Sheet', and a 'QHEI Score' field with a box for the score. Below the title are fields for 'Stream & Location', 'RM', 'Date', 'Scorers Full Name & Affiliation', 'River Code', 'STORET #', 'Lat./ Long.', and an 'Office verified location' checkbox.

Figure 1. Header of Ohio EPA QHEI Sheet

1) Stream & Location, River Mile (RM), Date. The official stream name may be found in the Gazetteer of Ohio Streams (Ohio DNR 2001) or on USGS 7.5 minute topographic maps. If the stream is unnamed, a name and stream code is assigned by the Ohio ECOS Database Coordinator. Usually the name of a nearby landmark is used for the stream name. The River Mile (RM) designations used are found on 7.5 minute topo maps stored at the Ohio EPA, Division of Surface Water, Lazarus Government Center, Front Street (PEMSO RMI maps), one of five Ohio EPA District offices (maps for that district), and the Ohio EPA, Ecological Assessment Section at Grove City. These maps should soon be available as Adobe PDF files. A brief description of the sampling location should include proximity to a local landmark such as a bridge, road, discharge outfall, railroad crossing, park, tributary, dam, etc.

2) QHEI Scorers Full Name/Institution. The full name of the person who filled out the sheet are listed, along with the institution, company etc. QHEI information is to be completed someone who has successfully completed the QHEI training (e.g., crew leader). Ohio EPA will track the level of qualifications for each scorer. Level 2 QHEI practitioners have completed the two day training and successfully scored an additional site in a manner similar to EPA staff; Level 3 practitioners have additional training and have submitted three sites scored independently which will be verified as similar to EPA staff.

3) River Code, STORET, and Lat/Long. The River Code is Ohio EPA river code (PEMSO system) and the STORET # is the official unique Station Identifier used to link all data collected at a given "site" or "station" deemed to be similar for assessment purposes within a certain spatial area.

Habitat Characteristics: QHEI Metrics

The Qualitative Habitat Evaluation Index (QHEI) is a physical habitat index designed to provide an empirical, quantified evaluation of the general lotic macrohabitat characteristics that are important to fish communities. A detailed analysis of the development and use of the QHEI is available in Rankin (1989) and Rankin (1995). The QHEI is composed of six principal metrics each of which are described below. The maximum possible QHEI site score is 100. Each of the metrics are scored individually and then summed to provide the total QHEI site score. This is completed at least once for each sampling site during each year of sampling. An exception to this convention would be when substantial changes to the macrohabitat have occurred between sampling passes. Standardized definitions for pool, run, and riffle habitats, for which a

variety of existing definitions and perceptions exist, are essential for accurately using the QHEI. For consistency the following definitions are taken from Platts et al. (1983). It is recommended that this reference also be consulted prior to scoring individual sites.

Riffle and Run Habitats:

Riffle - areas of the stream with fast current velocity and shallow depth; the water surface is visibly broken.



Figure 2. Riffle cross-section.

RUN



Figure 3. Run cross-section.

bed is often flat beneath a run and the water surface is not visibly broken.

Pool and Glide Habitats:

Pool - an area of the stream with slow current velocity and a depth greater than riffle and run areas; the stream bed is often concave and stream width frequently is the greatest; the water surface slope is nearly zero.

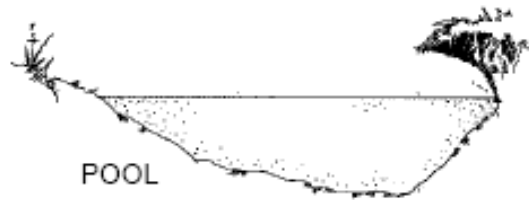


Figure 4. Pool cross-section.

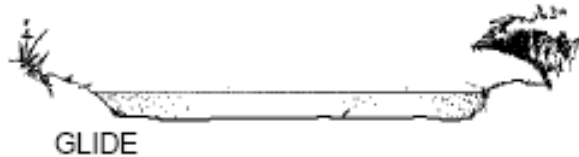


Figure 5. Glide cross-section.

Glide - this is an area common to most modified stream channels that do not have distinguishable pool, run, and riffle habitats; the current and flow is similar to that of a canal; the water surface gradient is nearly zero. HINT: These habitat types typically grade into one another. For example a run gradually changes into a pool. When measuring typical depths of

these features take measurements where the feature is clearly of that type, not where they are grading from one type to another. The following is a description of each of the six QHEI metrics and the individual metric components. Guidelines on how to score each is presented. Generally, metrics are scored by checking boxes. In certain cases the biologist completing the QHEI sheet may interpret a habitat characteristic as being intermediate between the possible choices; in cases where this is allowed (denoted by the term "Double-Checking") two boxes may be checked and their scores averaged.

Metric 1: Substrate (Figure 6).

This metric includes two components, substrate type¹ and substrate quality. **Substrate type** Check the two most common substrate types in the stream reach. If one substrate type predominates (greater than approximately 75- 80% of the bottom area OR what is clearly the most functionally predominant substrate) then this substrate type should be checked twice. **DO NOT CHECK MORE THAN TWO BOXES.** Note the category for artificial substrates. Spaces are provided to note the presence (by check marks, or estimates of % if time allows) of all substrate types present in pools (includes pools and glides) and riffles (includes riffles and runs) that each comprise sufficient quantity to support species that may commonly be associated with

¹ We suggest that QHEI practitioners should conduct some pebble count assessments which help calibrate an investigators ability to identify predominant substrates.

that substrate type. This section must be filled out completely to permit future analyses of this metric. If there are more than four or more high quality substrate types in the zone that are present in sufficient amounts (see above) then check the appropriate box for number of best types. This metrics award points to those sites with a diversity of high quality substrate types. Substrate origin refers to the parent material from which the substrate type(s) originated. This can be double-checked if two origin types are common (e.g., tills & limestone). See end of this section for some definitions.

1] **SUBSTRATE** Check *ONLY* Two substrate **TYPE BOXES**; estimate % or note every type present


BEST TYPES		OTHER TYPES		ORIGIN		QUALITY		
<input type="checkbox"/> BLDR /SLABS [10]	<input type="checkbox"/> POOL RIFFLE	<input type="checkbox"/> HARDPAN [4]	<input type="checkbox"/> POOL RIFFLE	<input type="checkbox"/> LIMESTONE [1]	<input type="checkbox"/> SILT	<input type="checkbox"/> HEAVY [-2]	<input type="checkbox"/> MODERATE [-1]	
<input type="checkbox"/> BOULDER [9]	<input type="checkbox"/>	<input type="checkbox"/> DETRITUS [3]	<input type="checkbox"/>	<input type="checkbox"/> TILLS [1]	<input type="checkbox"/>	<input type="checkbox"/> NORMAL [0]	<input type="checkbox"/> FREE [1]	
<input type="checkbox"/> COBBLE [8]	<input type="checkbox"/>	<input type="checkbox"/> MUCK [2]	<input type="checkbox"/>	<input type="checkbox"/> WETLANDS [0]	<input type="checkbox"/>	<input type="checkbox"/> EXTENSIVE [-2]	<input type="checkbox"/> MODERATE [-1]	
<input type="checkbox"/> GRAVEL [7]	<input type="checkbox"/>	<input type="checkbox"/> SILT [2]	<input type="checkbox"/>	<input type="checkbox"/> HARDPAN [0]	<input type="checkbox"/>	<input type="checkbox"/> NORMAL [0]	<input type="checkbox"/> NONE [1]	
<input type="checkbox"/> SAND [6]	<input type="checkbox"/>	<input type="checkbox"/> ARTIFICIAL [0]	<input type="checkbox"/>	<input type="checkbox"/> SANDSTONE [0]	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
<input type="checkbox"/> BEDROCK [5]	<input type="checkbox"/>	(Score natural substrates; ignore sludge from point-sources)		<input type="checkbox"/> RIP/RAP [0]	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
NUMBER OF BEST TYPES:		<input type="checkbox"/> 4 or more [2]		<input type="checkbox"/> LACUSTURINE [0]	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Comments		<input type="checkbox"/> 3 or less [0]		<input type="checkbox"/> SHALE [-1]	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
				<input type="checkbox"/> COAL FINES [-2]	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Figure 6. QHEI substrate metric.

Substrate quality.

Substrate origin refers to the "parent" material that the stream substrate is derived from. Check ONE box under the substrate origin column unless the parent material is from multiple sources (e.g., limestone and tills).

Embeddedness is the degree that cobble, gravel, and boulder substrates are surrounded, impacted in, or covered by fine materials (sand and silt). Substrates should be considered embedded if >50% of surface of the substrates are embedded in fine material. Embedded substrates cannot be easily dislodged. This also includes substrates that are concreted or "armor-plated". Naturally sandy streams are not considered embedded; however, a sand predominated stream that is the result of anthropogenic activities that have buried the natural coarse substrates is considered embedded.

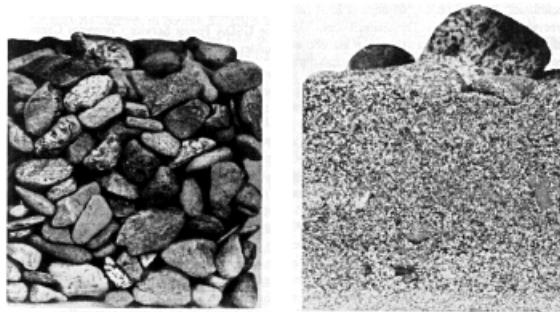


Figure 7. Side view of clearly un-embedded and embedded substrates.

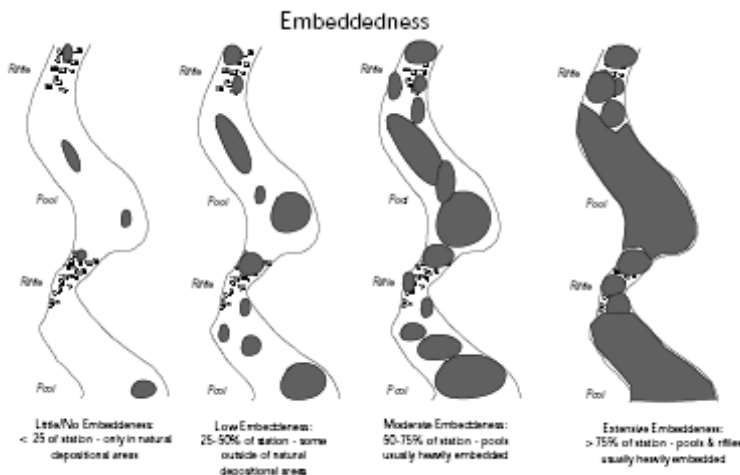
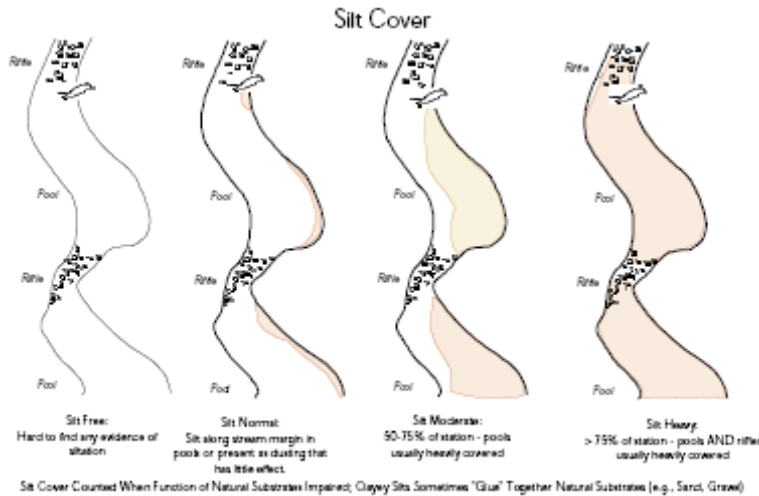


Figure 8. Illustration of example of pervasiveness of embeddedness for this QHEI component.

This can be very difficult to perceive. One help is to examine fresh point bars and look at the most common large materials that have been recently moved. According to Kappesser (1993), for gravel-bed rivers, the median of these large pieces should be equivalent to the median of the pieces on a riffle (based on a Wolman pebble count). If the riffles are finer than this, then sediment is aggrading in the reach and is evidence of embedded conditions. In some cases one can dig through the fine surface materials and fine coarser materials buried below. In this metric we are estimating the

pervasiveness of embedded conditions through-out a station. Boxes are checked for extensiveness (*i.e.*, pervasiveness throughout the area of the sampling zone) of the embedded substrates as follows: Extensive – > 75% of site area, Moderate – 50-75%, Normal² – 25-50%, None³ – < 25%.

Silt Cover is the extent that substrates are covered by a silt layer (*i.e.*, a 1 inch thick or obviously affecting aquatic habitats). Silt cover differs from the embeddedness metric in that it only considers the fine silt size particles whereas fine gravels, sands, and other fines are considered in assessing embedded conditions. **Silt Heavy** means that nearly the entire stream bottom is layered with a deep covering of silt. (pool/glides and all but the fastest areas of riffle/runs). **Moderate** means extensive covering by silts, but with some areas of cleaner substrate (*e.g.*, riffles).



Normal silt cover includes areas where silt is deposited in small amounts along the stream margin or is present as a “dusting” that appears to have little functional significance. If substrates are exceptionally clean the **Silt Free** box should be checked.

Substrate types are defined as:

- Bedrock** - solid rock forming a continuous surface.
- Boulder** - rounded stones over 256 mm in diameter (10 in.) or large “slabs” more than 256 mm in length (Boulder

Figure 9. Illustration of example of degrees of pervasiveness of silt cover.

slabs)⁴.

- Cobble** - stones from 64- 256 mm (2 1/2 - 10 in.) in diameter.
- Gravel** - mixture of rounded coarse material from 2-64 mm (1/12 - 2 1/2 in.) in diameter. Note the wide range of sizes included under gravel. In the riffle metric we distinguish between large and fine gravels
- Sand** - materials 0.06 - 2.0 mm in diameter, gritty texture when rubbed between fingers.
- Silt** - 0.004 - 0.06 mm in diameter, generally this is fine material which feels “greasy” when rubbed between fingers.
- Hardpan** - particles less than 0.004 mm in diameter, usually clay, which forms a dense, gummy surface that is difficult to penetrate.
- Marl** - calcium carbonate; usually grayish-white; often contains fragments of mollusk shells.
- Detritus** - dead, unconsolidated organic material covering the bottom which could include sticks, wood and other partially or un-decayed coarse plant material.
- Muck** - black, fine, flocculent, completely decomposed organic matter (does not include sewage sludge).
- Artificial** - substrates such as rock baskets, gabions, bricks, trash, concrete etc., placed in the stream for reasons OTHER than habitat mitigation.

Sludge is defined as a thick layer of organic matter that is decidedly of human or animal origin. NOTE: SLUDGE THAT ORIGINATES FROM POINT SOURCES IS NOT INCLUDED; THE SUBSTRATE SCORE IS BASED ON THE UNDERLYING MATERIAL. This scenario is rare today and was done to prevent underestimating stream habitat potential affect by discharges.

Substrate Metric Score: Although the sum of the individual metric scores can be greater than 20 the maximum substrate core allowed for this metric is 20 points.

² In some earlier training materials “normal” was described as “low” (*e.g.*, see Figure 7).

³ In some earlier training materials “None” was described as “little-no” (*e.g.*, see Figure 7).

⁴ A version of the QHEI used in Maine distinguishes large boulders.



Example of stream with heavily embedded substrates.



Example of spongy deposits of fine gravels and sands from recent erosion activities.

Substrate Origin Identification Tips:

- Limestone: Often contains fossils, easily scratched with knife, usually bedrock or flat boulders and cobbles
- Tills: Sediments deposited by glaciers; particles often rounded. Can be carried into non-glaciated areas
- Wetlands: Usually organic muck and detritus
- Hardpan: Clay - smooth, usually slippery
- Sandstone: Contains rounded fragment of sand "cemented" together
- Rip/Rap: Artificial boulders
- Lacustrine: Old lake bed sediments
- Shale: "Claystone," sedimentary rock made of silt/clay, soft and cleaves easily
- Coal Fines: Black fragments of coal, generally SE Ohio only



We suggest that QHEI practitioners gain some experience in pebble count procedures. Conducting Wolman or Zig-Zag pebble counts helps to improve the ability to visually estimate predominant substrate sizes and size categories.



Stream characterized by cobble and boulder-size substrates.

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

<input type="checkbox"/> UNDERCUT BANKS [1]	<input type="checkbox"/> POOLS > 70cm [2]	<input type="checkbox"/> OXBOWS, BACKWATERS [1]	AMOUNT Check ONE (Or 2 & average) <input type="checkbox"/> EXTENSIVE >75% [11] <input type="checkbox"/> MODERATE 25-75% [7] <input type="checkbox"/> SPARSE 5-<25% [3] <input type="checkbox"/> NEARLY ABSENT <5% [1]
<input type="checkbox"/> OVERHANGING VEGETATION [1]	<input type="checkbox"/> ROOTWADS [1]	<input type="checkbox"/> AQUATIC MACROPHYTES [1]	
<input type="checkbox"/> SHALLOWS (IN SLOW WATER) [1]	<input type="checkbox"/> BOULDERS [1]	<input type="checkbox"/> LOGS OR WOODY DEBRIS [1]	
<input type="checkbox"/> ROOTMATS [1]			

Comments

Cover
Maximum
20

Figure 10. Instream cover (structure) metric.

Metric 2: Instream Cover (Figure 10).

This metric scores presence of instream cover types and amount of overall instream cover. Ohio EPA has been phasing in an alternative scoring system for this metric, but for this 2006, the total scoring still follows the existing methods. The changes will be discussed later.

Existing Scoring Method:

Each cover type that is present in an amount occurs in sufficient quantity to support species that may commonly be associated with the habitat type should be scored.⁵ Cover should not be counted when it is in areas of the stream with insufficient depth (usually < 20 cm) to make it useful. For example a logjam in 5 cm of water contributes very little, if any cover, and at low flow may be dry. Other

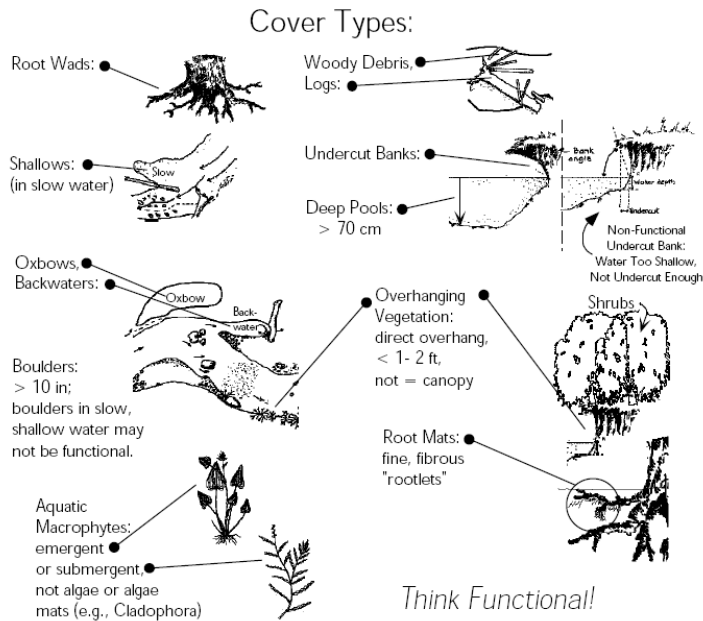


Figure 11. Examples of major cover/structure types measured with QHEI.

cover types with limited function in shallow water include undercut banks and overhanging vegetation, boulders, and rootwads. Under amount, one or two boxes may be checked. Extensive cover is that which is present throughout the sampling area, generally greater than about 75% of the stream reach sampled. Cover is moderate when it occurs over 25- 75% of the sampling area. Cover is sparse when it is present in less than 25% of the stream margins (sparse cover usually exists in one or more isolated patches). Cover is nearly absent when no large patch of any type of cover exists anywhere in the sampling area. This situation is usually

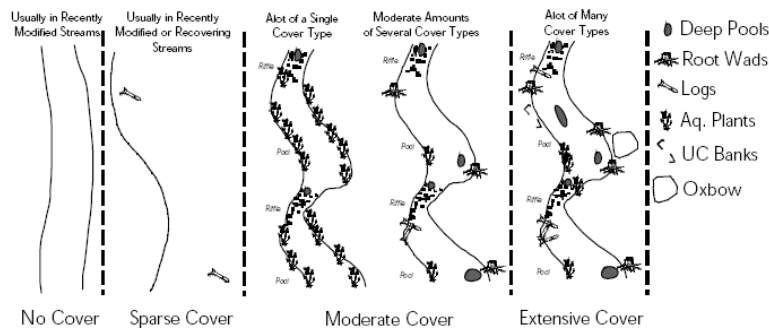


Figure 12. Illustration of the four categories of cover amounts.

found in recently channelized streams or other highly modified reaches (e.g. ship channels). If cover is thought to be intermediate in amount between two categories, check two boxes and average their scores. For wide streams cover amount is estimated along the swath of stream sampled (or that would be sampled) with an electrofisher. In smaller streams

⁵ We had mentioned a 5% rule of thumb for an amount threshold if biological experience is low - this would be a linear, not an areal amount.

(smaller wadeable and headwater streams) this generally covers most of the stream width. If a single type of cover is extensive and others are absent or uncommon then the total is scored as moderate because of the low diversity of types.

A desire to investigate and measure variation in amount and quality of individual cover types lead to a change in scoring of this metric. Over the next year or so the existing scoring method (each cover type scored on a presence/absence rating and a cumulative cover amount score) will be replaced with the following scoring method that focuses on scoring each cover type on a gradient of amount and quality. Each cover type would receive a score of 0-3 where:

- 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 logs that are stable, well developed rootwads in deep/fast water, or deep, well-defined, functional pools.

The cover ratings have been collected for about the last five years and an assessment of their relation to biological measures will be used to adjust a final scoring for this metric. At present, continue scoring these as present/absent and use the overall cover metric score. Cover types include: 1) undercut banks, 2) overhanging vegetation, 3) shallows (in slow water)⁶, 4) logs or woody debris, 5) deep pools (> 70 cm), 6) oxbows, backwaters, or side channels, 7) boulders, 8) aquatic macrophytes, and 9) rootwads (tree roots that extend into stream). Do not check undercut banks AND rootwads unless undercut banks exist along with rootwads as a major component. Although the theoretical maximum score is > 20 the maximum score assigned for the QHEI for the instream cover metric is limited to 20 points.



High quality logs and woody debris in deep water.



High quality rootwad in deep, fast water.

⁶ Shallows are habitats that provide nursery areas for small fish.



Example of good quality shallow habitat with aquatic macrophyte bed that acts as nursery habitat.



High quality boulder in fast water



Root Mats



Importance of logs and woody debris in large rivers.



Functional overhanging vegetation

Metric 3: Channel Morphology (Figure 13)

This metric emphasizes the quality of the stream channel that relates to the creation and stability of macrohabitat. It includes channel sinuosity (i.e. the degree to which the stream meanders), channel development, channelization, and channel stability. One box under each should be checked unless conditions are considered to be intermediate between two categories; in these cases check two boxes and average their scores.

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

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY
<input type="checkbox"/> HIGH [4]	<input type="checkbox"/> EXCELLENT [7]	<input type="checkbox"/> NONE [6]	<input type="checkbox"/> HIGH [3]
<input type="checkbox"/> MODERATE [3]	<input type="checkbox"/> GOOD [5]	<input type="checkbox"/> RECOVERED [4]	<input type="checkbox"/> MODERATE [2]
<input type="checkbox"/> LOW [2]	<input type="checkbox"/> FAIR [3]	<input type="checkbox"/> RECOVERING [3]	<input type="checkbox"/> LOW [1]
<input type="checkbox"/> NONE [1]	<input type="checkbox"/> POOR [1]	<input type="checkbox"/> RECENT OR NO RECOVERY [1]	

Comments

Channel
Maximum
20




Figure 13. Channel morphology metric.

a) *Sinuosity* - **No sinuosity** is a straight channel. **Low sinuosity** is a channel with only 1 or 2 poorly defined outside bends in a sampling reach, or perhaps slight meandering within modified banks. **Moderate sinuosity** is more than 2 outside bends, with at least one bend well defined. **High sinuosity** is more than 2 or 3 well defined outside bends with deep areas outside and shallow areas inside. Sinuosity may be more conceptually described by the ratio of the stream distance between two points on the channel of a stream and the straight-line distance between these same two points, taken from a topographic map. This metric measures the formation of pools and increased habitat area as the primary “functions” of sinuosity as related to aquatic life. Check one box or select two and average.

b) *Development* - This refers to the development of riffle/pool complexes. **Poor** means riffles are absent, or if present, shallow with sand and fine gravel substrates; pools, if present are shallow. Glide habitats, if predominant, receive a **Poor** rating. **Fair** means riffles are poorly developed or absent; however, pools are more developed with greater variation in depth. **Good** means better defined riffles present with larger substrates (gravel, rubble or boulder); pools have variation in depth and there is a distinct transition between pools and riffles. **Excellent** means development is similar to the **Good** category except the following characteristics must be present: pools must

Table 1: Scoring criteria for pool/riffle development metric.

	Excellent	Good	Fair	Poor
Pool	> 1 m deep, well defined	0.7-1.0 m deep, well defined	Some depth variation	Shallow, if present
Glide	Not common	Not common	Common	Predominant
Riffle	Deep, well defined riffles, large substrates	Defined riffles, large substrates	Poorly defined riffles or riffles absent	Absent of shallow with fine substrates
Run	> 0.5 m deep, well defined	Deep, well defined	Usually absent	Absent

This metric can be double-checked. For situations, for example where riffles are excellent and pools are only fair, it is advantageous to check the excellent and the fair box rather than checking the good box as an average to keep information on the variance in quality.

have a maximum depth of >1 m and deep riffles and runs (>0.5 m) must also be present. In streams sampled with wading methods, a sequence of riffles, runs, and pools must occur more than once in a sampling zone. Check one box or check two and average.

Note how well defined (i.e., distinct) the riffle and pool are in this high quality headwater stream pictured on the left. Also note the large tree in the riparian



c) *Channelization* - This refers to anthropogenic channel modifications. **Natural** refers to no obvious direct moving or alteration of the channel and a natural appearance. **Recovered** refers to streams that have been channelized in the past, but which have recovered most of their natural channel characteristics. **Recovering** refers to channelized streams which are still in the process of regaining their former, natural however, these habitats are still degraded. This category also applies to those streams, especially in the Huron/ Erie Lake Plain ecoregion (NW Ohio), that were channelized long ago and have a riparian border of mature trees, but still have Poor channel characteristics. **Recent** or **No Recovery** refers to streams that were recently channelized or those that show no significant recovery of habitats (e.g. drainage ditches, grass lined or rock rip-rap banks, etc.). The specific type of habitat modification is checked in the last two columns but not scored.



A channelized stream channel starting to revert towards more natural channel features.



Unstable channel features and low stability.

d) *Stability* - This refers to channel stability. Artificially stable (concrete) stream channels receive a High score. Even though they generally have a negative influence on fish assemblages, the negative effects are related to features other than their stability. Channels with **Low stability** are usually characterized by fine substrates in riffles that often change location, have unstable and severely eroding banks, and a high bedload that slowly creeps downstream. Sometimes these unstable riffles form diagonally across the channel (see figure, right). Channels with **Moderate stability** are those that appear to maintain stable riffle/ pool and channel characteristics, but which exhibit some symptoms of instability, e.g. high bedload, eroding or false banks, or shows the effects of wide fluctuations in water level. Channels with **High stability** have stable banks and substrates, and little or no erosion and bedload. e) *Modifications/Other* - Check the appropriate box if impounded, islands present, or leveed (these are not included in the QHEI scoring) as well as the appropriate source of habitat modifications. The maximum QHEI metric score for Channel Morphology is 20 points.

Metric 4: Riparian Zone and Bank Erosion (Figure 14)

This metric emphasizes the quality of the riparian buffer zone and quality of the floodplain vegetation. This includes riparian zone width, floodplain quality, and extent of bank erosion. Each of the three components requires scoring the left and right banks (looking downstream). The average of the left and right banks is taken to derive the component value. One box per bank should be checked unless conditions are considered to be intermediate between two categories; in these cases check two boxes and average their scores.

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

River right looking downstream

EROSION		RIPARIAN WIDTH		FLOOD PLAIN QUALITY	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Indicate predominant land use(s) past 100m riparian. **Riparian** Maximum 10

Figure 14. Bank erosion and riparian zone metric.

a) *Bank Erosion* - A modified Streambank Soil Alteration Ratings from Platts et al. (1983) is used here; check one box for each side of the stream and average the scores. False banks are used in the sense of Platts et al. (1983) to mean banks that are no longer adjacent to the normal flow of the channel but have been moved back into the floodplain most commonly as a result of livestock trampling. 1) **None** - streambanks are stable and not being altered by water flows or animals (e.g. livestock) - Score 3. 2) **Little** - streambanks are stable, but are being lightly altered along the transect line; less than 25% of the streambank is receiving any kind of stress, and if stress is being received it is very light; less than 25% of the streambank is false, broken down or eroding - Score 3. 3) **Moderate** - streambanks are receiving moderate alteration along the transect line; at least 50 percent of the streambank is in a natural stable condition; less than 50% of the streambank is false, broken down or eroding; false banks are rated as altered - Score 2. 4) **Heavy** - streambanks have received major alterations along the transect line; less than 50% of the streambank is in a stable condition; over 50% of the streambank is false, broken down, or eroding - Score 1. 5) **Severe** - streambanks along the transect line are severely altered; less than 25% of the streambank is in a stable condition; over 75% of the streambank is false, broken down, or eroding - Score 1



Severe bank erosion.

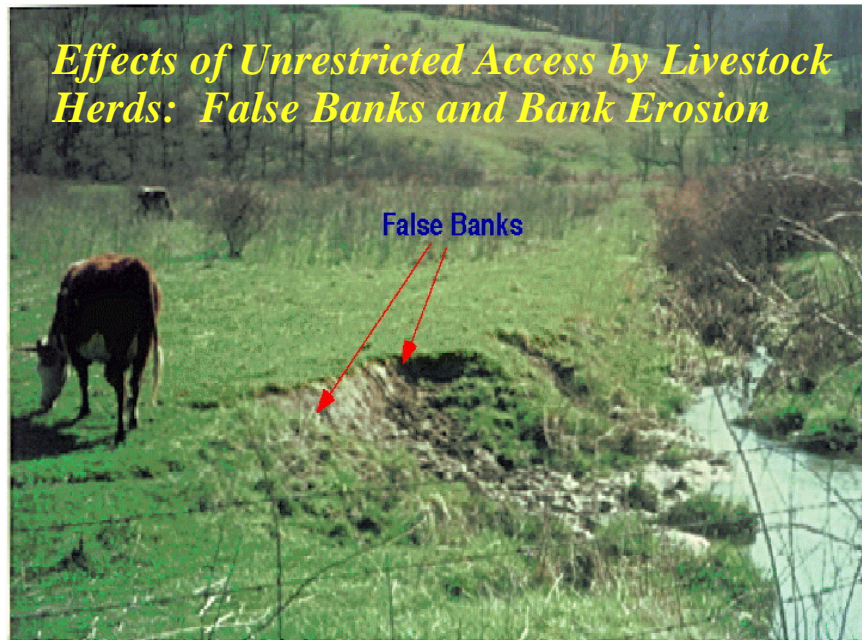
b) *Riparian Width* - This is the width of the riparian (stream side) vegetation. Width estimates are only done for **forest, shrub, swamp, and old field vegetation** if it has **woody** components (e.g., willows). Old field refers to a fairly mature successional field that has stable, woody plant growth; this generally does not include weedy urban or industrial lots that often still have high runoff potential. Two boxes, one each for the left and right bank (looking downstream), should be checked and then averaged.

c) *Floodplain Quality* - The two most predominant floodplain quality types should be checked, one each for the left and right banks (includes urban, residential, etc.), and then averaged. By floodplain we mean the areas immediately outside of the riparian zone or greater than 100 meters from the stream, whichever is wider on each side of the stream. The concept is to identify land uses that might deliver harmful runoff to the stream. These are areas adjacent to the stream that can have direct runoff and erosion effects during normal wet weather. This is considered a ground truthing exercise and we suggest those interested in estimating of the effects of adjacent or riparian land uses use now well-developed GIS approaches. We do not limit it to the riparian zone and it is much less encompassing than the stream basin.

The maximum score for Riparian Zone and Erosion metric is 10 points.



Estimating riparian zone width.



Example of un-restricted livestock access and the formation of "false" banks.

Metric 5: Pool/Glide and Riffle-Run Quality (Figure 15)

This metric emphasizes the quality of the pool, glide and/or riffle-run habitats. This includes pool depth, overall diversity of current velocities (in pools and riffles), pool morphology, riffle-run depth, riffle-run substrate, and riffle-run substrate quality.

5] POOL / GLIDE AND RIFFLE / RUN QUALITY		CURRENT VELOCITY		Recreation Potential Primary Contact Secondary Contact <small>(circle one and comment on back)</small>
MAXIMUM DEPTH	CHANNEL WIDTH	Check ALL that apply		
Check ONE (ONLY!)	Check ONE (Or 2 & average)	<input type="checkbox"/> TORRENTIAL [-1]	<input type="checkbox"/> SLOW [1]	Pool / Current Maximum 12
<input type="checkbox"/> > 1m [6]	<input type="checkbox"/> POOL WIDTH > RIFFLE WIDTH [2]	<input type="checkbox"/> VERY FAST [1]	<input type="checkbox"/> INTERSTITIAL [-1]	
<input type="checkbox"/> 0.7-<1m [4]	<input type="checkbox"/> POOL WIDTH = RIFFLE WIDTH [1]	<input type="checkbox"/> FAST [1]	<input type="checkbox"/> INTERMITTENT [-2]	
<input type="checkbox"/> 0.4-<0.7m [2]	<input type="checkbox"/> POOL WIDTH > RIFFLE WIDTH [0]	<input type="checkbox"/> MODERATE [1]	<input type="checkbox"/> EDDIES [1]	
<input type="checkbox"/> 0.2-<0.4m [1]		<small>Indicate for reach - pools and riffles.</small>		
<input type="checkbox"/> < 0.2m [0]				
Comments				

Figure 15. Pool/glide and riffle/run metric

A) Pool/Glide Quality

1) *Maximum depth* of pool or glide; check one box only (Score 0 to 6). Pools or glides with maximum depths of less than 20 cm are considered to have lost their function and the total metric is scored a 0. No other characteristics need be scored in this case.

2) *Current Types* - check each current type that is present in the stream (including riffles and runs; score -2 to 4), definitions are: **Torrential** - extremely turbulent and fast flow with large standing waves; water surface is very broken with no definable, connected surface; usually limited to gorges and dam spillway tailwaters. **Very Fast** - turbulent flow that may make it difficult to stand and creates pulsating effect again leg. **Fast** - mostly non-turbulent flow with small standing waves in riffle/run areas; water surface may be partially broken, but there is a visibly connected surface. **Moderate** - non-turbulent flow that is detectable and visible (i.e. floating objects are readily transported downstream); water surface is visibly connected. With moderate current water flows around rather than over objects. Little drop around depth rod. **Slow** - water flow is perceptible, but very sluggish. **Eddies** - small areas of circular current motion usually formed in pools immediately downstream from riffle-run areas. **Interstitial** - water flow that is perceptible only in the interstitial spaces between substrate particles in riffle-run areas. **Intermittent** - no flow is evident anywhere leaving standing pools that are separated by dry areas. The role of bank erosion in sediment delivery to streams is often underestimated. Higher gradient stream showing typical locations of fast, moderate, and slow areas and eddies.

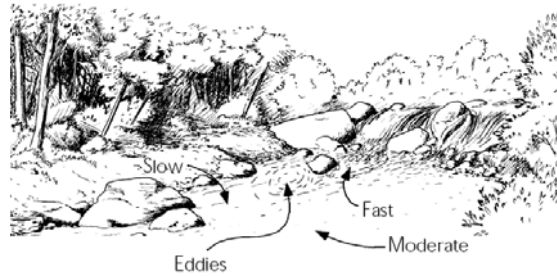


Figure 16. Typical locations of various current velocity types in a stream.

4) *Morphology* - Check **Wide** if pools are wider than riffles, **Equal** if pools and riffles are the same width, and **Narrow** if the riffles are wider than the pools (Score 0 to 2, see Figure 17). If the morphology varies throughout the site average the types. If the entire stream area (including areas outside of the sampling zone) is pool or riffle, then check riffle = pool.

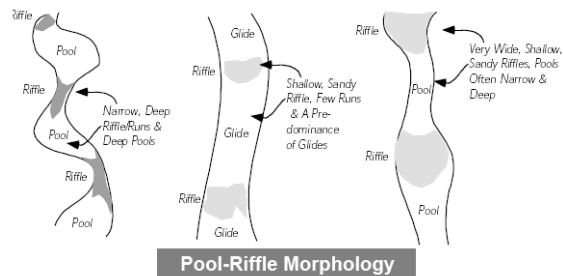


Figure 17. Pool morphology metric categories.

Although the theoretical maximum score for the pool metric is greater than 12 the maximum score assigned for the QHEI for the Pool Quality metric is limited to 12 points.



Illustration of the importance of pool depth to aquatic life



Estimating current velocity, Sharp drop from front to back of rod and boot indicates fast current velocities.

B) Riffle-Run Quality (Figure 18)

This entire metric is scored 0 if no riffles are present.

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: NO RIFFLE [metric=0]

Check ONE (Or 2 & average).

RIFFLE DEPTH	RUN DEPTH	RIFFLE / RUN SUBSTRATE	RIFFLE / RUN EMBEDDEDNESS
<input type="checkbox"/> BEST AREAS > 10cm [2]	<input type="checkbox"/> MAXIMUM > 50cm [2]	<input type="checkbox"/> STABLE (e.g., Cobble, Boulder) [2]	<input type="checkbox"/> NONE [2]
<input type="checkbox"/> BEST AREAS 5-10cm [1]	<input type="checkbox"/> MAXIMUM < 50cm [1]	<input type="checkbox"/> MOD. STABLE (e.g., Large Gravel) [1]	<input type="checkbox"/> LOW [1]
<input type="checkbox"/> BEST AREAS < 5cm [metric=0]		<input type="checkbox"/> UNSTABLE (e.g., Fine Gravel, Sand) [0]	<input type="checkbox"/> MODERATE [0]
Comments			<input type="checkbox"/> EXTENSIVE [-1]




Figure 18. Riffle-run metric.

1) *Riffle* - select one box that most closely describes the depth characteristics of the best riffle in the zone (Score 0 to 2). The best riffle is selected because we want to identify bottlenecks during harsh periods (e.g., drought). Estimate depths in areas that are clearly riffle, not transitional between a riffle and a run. If the riffle is generally less than 5 cm in depth, riffles are considered to have lost their function and the entire riffle metric is scored a 0.

2) *Run Depth* - select one box that most closely describes the depth characteristics of the runs (Score 0 to 2). Estimate depth in areas that are clearly run, not transitional between a pool and a run or a riffle and a run.

3) *Riffle/Run Substrate Stability*— select one box from each that best describes the substrate type and stability of the riffle habitats (Score 0 to 2).

4) *Riffle/Run Embeddedness*— Embeddedness is the degree that cobble, gravel, and boulder substrates are surrounded or covered by fine material (sand, silt); here in the riffle/runs only. We consider substrates embedded if >50% of surface of the substrates are embedded in fine material—these substrates cannot be easily dislodged. This also includes substrates that are concreted. Boxes are checked for pervasiveness of (riffle/ run area of sampling zone) embedded substrates: **Extensive** — > 75% of stream area, **Moderate** — 50-75%, **Sparse** — 25- 50%, **Low** — < 25%. The maximum score assigned for the QHEI for the Riffle/Run Quality metric is 8 points.

Metric 6: Map Gradient

Local or map gradient is calculated from USGS 7.5 minute topographic maps by measuring the elevation drop through the sampling area. This is done by measuring the stream length between

6] GRADIENT (ft/mi)
DRAINAGE AREA (mi²)

□	VERY LOW - LOW [2-4]
□	MODERATE [6-10]
□	HIGH - VERY HIGH [10-6]

Figure 19. QHEI Stream gradient metric.

the first contour line upstream and the first contour line downstream of the sampling site and dividing the distance by the contour interval. If the contour lines are closely "packed" a minimum distance of at least one mile should be used. Some judgment may need to be exercised in certain anomalous areas (e.g. in the vicinity of waterfalls, impounded areas, etc.) and this can be compared to an infield, visual estimate which is recorded next to the gradient metric on the front of the sheet. Scoring for ranges of stream gradient takes into account the varying influence of gradient with stream size, preferably measured as drainage area in square miles or stream width. Gradient classifications (Table V-4-3) were modified from

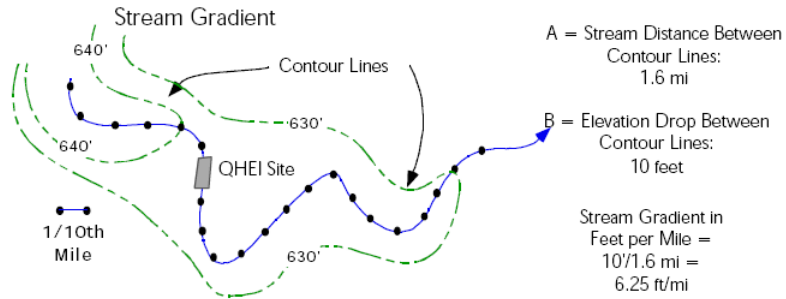


Figure 20. Illustration of methodology for determining stream gradient from topographic maps.

Trautman (p 139, 1981) and scores were assigned, by stream size category, after examining scatter plots of IBI vs. natural log of gradient in feet/mile (see Rankin 1989). Scores are listed in Table 2. The maximum QHEI metric score for Gradient is 10 points

Table 2 Classification of stream gradients for Ohio by stream size. Modified from Trautman (p 139, 1981). Scores were derived from plots of IBI versus stream gradient for each stream size category.

Stream Width	Drainage Area (sq mi)	Gradient (feet/mile)						
		Very Low	Low	Low-Moderate	Moderate	Moderate-High	High	Very High ¹
≤ 4.7	< 9.2	0 - 1.0 2	1.1 - 5.0 4	5.1 - 10.0 6	10.1 - 15.0 8	15.1 - 20 10	20.1 - 30 10	30.1 - 40 8
4.8 - 9.2	9.2 - 41.6	0 - 1.0 2	1.1 - 3.0 4	3.1 - 6.0 6	6.1 - 12.0 10	12.1 - 18 10	18.1 - 30 8	30.1 - 40 6
9.3 - 13.8	41.7 - 103.7	0 - 1.0 2	1.1 - 2.5 4	2.6 - 5.0 6	5.1 - 7.5 8	7.6 - 12 10	12.1 - 20 8	20.1 - 30 6
13.9 - 30.6	103.8 - 622.9	0 - 1.0 4	1.1 - 2.0 6	2.1 - 4.0 8	4.1 - 6.0 10	6.1 - 10 10	10.1 - 15 8	15.1 - 25 6
> 30.6	> 622.9		0 - 0.5 6	0.6 - 1.0 8	1.1 - 2.5 10	2.6 - 4.0 10	4.1 - 9 10	> 9 8

¹Any site with a gradient greater than the upper bound of the "very high" gradient classification is assigned a score of 4.

Computing the Total QHEI Score: To compute the total QHEI score, add the components of each metric to obtain the metric scores and then sum the metric scores to obtain the total QHEI score. The QHEI metric scores cannot exceed the Metric Maximum Score indicated below.

Narrative ranges of QHEI scores

For communicating general habitat quality to the public general narrative categories have been assigned to QHEI scores. Habitat influences on aquatic life, however, occur at multiple spatial scales and these narrative ranges are general and not always definitely predictable of aquatic assemblages are any given site.

Table 2. General narrative ranges assigned to QHEI scores. Ranges vary slightly in headwater (≤ 20 sq mi) vs. larger waters.			
Narrative Rating	Color	QHEI Range	
		Headwaters	Larger Streams
Excellent	Blue	≥ 70	≥ 75
Good	Green	55- to 69	60 to 74
Fair	Yellow	43 to 54	45 to 59
Poor	Orange	30 to 42	30 to 44
Very Poor	Red	< 30	< 30

QHEI SCORING (Maximum = 100)			
QHEI Metric	Metric Component	Component Scoring Range	Metric Max. Score
1) Substrate	a) Type	0 to 21	20
	b) Quality	-5 to 3	
2) Instream Cover	a) Type	0 to 10	20
	b) Amount	1 to 11	
3) Channel Morphology	a) Sinuosity	1 to 4	20
	b) Development	1 to 7	
	c) Channelization	1 to 6	
	d) Stability	1 to 3	
4) Riparian Zone	a) Width	0 to 4	10
	b) Quality	0 to 3	
	c) Bank Erosion	1 to 3	
5a) Pool Quality	a) Max. Depth	0 to 6	12
	b) Current	-2 to 4	
	c) Morphology	0 to 2	
5b) Riffle Quality	a) Depth	0 to 4	8
	b) Substr. Stab.	0 to 2	
	c) Substr. Embd.	-1 to 2	
6) Gradient		2 to 10	10

Additional Information/Back of QHEI Sheet

Additional information is recorded on the reverse side of the Site Description Sheet. Several versions of the reverse of the QHEI sheet have been produced over the past 10 years, but this description is based on the most recent revision of the Ohio EPA sheet (Figure 21).

AJ SAMPLED REACH Comment RE: Reach consistency/ Is reach typical of stream?, Recreation/ Observed - Inferred, Other/ Sampling observations, Concerns, Access directions, etc.

Check ALL that apply

METHOD <input type="checkbox"/> BOAT <input type="checkbox"/> WADE <input type="checkbox"/> L. LINE <input type="checkbox"/> OTHER DISTANCE <input type="checkbox"/> 0.5 Km <input type="checkbox"/> 0.2 Km <input type="checkbox"/> 0.15 Km <input type="checkbox"/> 0.12 Km <input type="checkbox"/> OTHER meters <input type="checkbox"/> > 95%- OPEN <input type="checkbox"/> 55%-<85% <input type="checkbox"/> 30%-<55% <input type="checkbox"/> 10%-<30% <input type="checkbox"/> <10%- CLOSED	STAGE 1st -sample pass-- 2nd <input type="checkbox"/> HIGH <input type="checkbox"/> UP <input type="checkbox"/> NORMAL <input type="checkbox"/> LOW <input type="checkbox"/> DRY CLARITY 1st -sample pass-- 2nd <input type="checkbox"/> < 20 cm <input type="checkbox"/> 20-<40 cm <input type="checkbox"/> 40-70 cm <input type="checkbox"/> > 70 cm/ CTB <input type="checkbox"/> SECCHI DEPTH CANOPY 1st _____ cm 2nd _____ cm	BJ AESTHETICS <input type="checkbox"/> NUISANCE ALGAE <input type="checkbox"/> INVASIVE MACROPHYTES <input type="checkbox"/> EXCESS TURBIDITY <input type="checkbox"/> DISCOLORATION <input type="checkbox"/> FOAM / SCUM <input type="checkbox"/> OIL SHEEN <input type="checkbox"/> TRASH / LITTER <input type="checkbox"/> NUISANCE ODOR <input type="checkbox"/> SLUDGE DEPOSITS <input type="checkbox"/> CSOs/SSOs/OUTFALLS CJ RECREATION AREA DEPTH POOL: <input type="checkbox"/> >100ft ² <input type="checkbox"/> >3ft	DJ MAINTENANCE <small>Circle some & COMMENT</small> PUBLIC / PRIVATE / BOTH / NA ACTIVE / HISTORIC / BOTH / NA YOUNG-SUCCESSION-OLD SPRAY / SNAG / REMOVED MODIFIED / DIPPED OUT / NA LEVEED / ONE SIDED RELOCATED / CUTOFFS MOVING-BEDLOAD-STABLE ARMORED / SLUMPS ISLANDS / SCURED IMPOUNDED / DESICCATED FLOOD CONTROL / DRAINAGE	EJ ISSUES WWTP / CSO / NPDES / INDUSTRY HARDENED / URBAN / DIRT&GRIME CONTAMINATED / LANDFILL BMPs-CONSTRUCTION-SEDIMENT LOGGING / IRRIGATION / COOLING BANK / EROSION / SURFACE FALSE BANK / MANURE / LAGOON WASH H ₂ O / TILE / H ₂ O TABLE ACID / MINE / QUARRY / FLOW NATURAL / WETLAND / STAGNANT PARK / GOLF / LAWN / HOME ATMOSPHERE / DATA PAUCITY	FJ MEASUREMENTS \bar{x} width \bar{x} depth max. depth \bar{x} bankfull width bankfull \bar{x} depth W/D ratio bankfull max. depth floodprone \bar{x}^2 width entrench. ratio Legacy Tree:
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Stream Drawing:

A – Sampling Characteristics

- 1) *Methods Used* – A series of check boxes to record the type of sampling completed in the reach.
- 2) *Distance* – Distance assessed for the QHEI and/or fish assessment.
- 3) *Stage* – Estimate of flow stage during assessment. Since some sites are sampled twice, a box is included for each sampling effort.
- 4) *Clarity* – Estimate of water clarity during assessment. Since some sites are sampled twice, a box is included for each sampling effort. There are also two places to record Secchi depths, if taken.
- 5) *Canopy* – Estimate of average width of canopy

B. Aesthetics

- 1) Check all of the boxes that apply in terms of aesthetic characteristics of the site

C. Recreation

1) Record whether there exists, within the area, greater than 100 ft² of water greater than three feet in depth. This is used to estimate whether full body immersion is possible or likely.

D. Maintenance

1) Record what types of stream maintenance activities or special features occur in the sampling zone. Some of this information was previously on the front of the sheet and is used as an aid when determining aquatic life uses (e.g., existing on ongoing channel maintenance).

E. Issues

1) Record various potential sources of impact that may occur in or near the site.

F. Measurements

1) If some quantitative measurements of stream channel characteristics are collected they may be recorded here. It is likely, however, that more detailed stream measurements (e.g., geomorphic assessment) will be recorded on separate forms.

G) *Stream Maps and Diagram*

Stream maps for each site can be very important. The act of drawing a map usually helps to identify habitat types scored with the QHEI. It can also help later samples identify sampling sites and determine whether changes have occurred. The level of detail of the drawings will likely vary with the objective. For example, sites assessed for 401 purposes should have as much detail as possible to help in later decisions of habitat limitations or high potential. Two or three cross-sections of the stream can provide useful information on the stream bank, stream bottom, stream channel, and floodplain characteristics.

QHEI Pool/Riffle Development Metric

Excellent Pool/Riffle Development:

Pools - > 1 m Deep
Glides - Only Transitional Habitats
Runs - > 0.5 m Deep
Riffles - Deep, Large Substrates
Morphology - All Habitats Easily Definable, Riffles Narrow and Deep, Pools Wide with Deep and Shallow Sections



Good Pool/Riffle Development:

Pools - > 0.7 m Deep
Glides - Mostly Transitional Habitats
Runs - Deep, but < 0.5 m
Riffles - Some Deep Areas, Large Substrates (At Least Large Gravels)
Morphology - All Habitats Fairly Well Definable, Riffles Typically Narrower Than Most Pools



Fair Pool/Riffle Development:

Pools - Show Some Depth Variation
Glides - Common
Runs - Typically Absent
Riffles - Poorly Defined, Shallow
Morphology - Habitat Types Not As Distinct, Glides Typically Difficult to Separate From Pools and Riffles



Poor Pool/Riffle Development:

Pools - Shallow if Present
Glides - Predominant
Runs - Absent
Riffles - Absent, Or if Present Unstable and Shallow With Fine Substrates
Morphology - Mostly Glide Characteristics, Riffles Ephemeral if Present



Stream & Location: _____ RM: _____ Date: ___/___/06

Scorers Full Name & Affiliation: _____

River Code: _____ STORET #: _____ Lat./Long.: _____ Office verified location []

1] SUBSTRATE Check ONLY Two substrate TYPE BOXES; estimate % or note every type present Check ONE (Or 2 & average)

Substrate assessment section with categories: BEST TYPES, OTHER TYPES, ORIGIN, QUALITY, and NUMBER OF BEST TYPES. Includes checkboxes for various substrate types like BLDR/SLABS, BOULDER, COBBLE, GRAVEL, SAND, BEDROCK, etc.

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

Instream Cover assessment section with categories: UNDERCAT BANKS, OVERHANGING VEGETATION, SHALLOWS, ROOTMATS, POOLS, ROOTWADS, BOULDERS, OXBOWS, BACKWATERS, AQUATIC MACROPHYTES, LOGS OR WOODY DEBRIS, and AMOUNT.

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

Channel Morphology assessment section with categories: SINUOSITY, DEVELOPMENT, CHANNELIZATION, STABILITY, and AMOUNT.

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

Bank Erosion and Riparian Zone assessment section with categories: EROSION, RIPARIAN WIDTH, FLOOD PLAIN QUALITY, and CONSERVATION TILLAGE.

5] POOL / GLIDE AND RIFFLE / RUN QUALITY

Pool / Glide and Riffle / Run Quality assessment section with categories: MAXIMUM DEPTH, CHANNEL WIDTH, CURRENT VELOCITY, and Recreation Potential.

Indicate for functional riffles; Best areas must be large enough to support a population of riffle-obligate species: Check ONE (Or 2 & average). [] NO RIFFLE [metric=0]

Riffle / Run Substrate assessment section with categories: RIFFLE DEPTH, RUN DEPTH, RIFFLE / RUN SUBSTRATE, and RIFFLE / RUN EMBEDDEDNESS.

6] GRADIENT (ft/mi) and DRAINAGE AREA (mi^2) assessment section with categories: GRADIENT and DRAINAGE AREA.

A/ SAMPLED REACH

Check ALL that apply

Comment RE: Reach consistency/ Is reach typical of stream?, Recreation/ Observed - Inferred, Other/ Sampling observations, Concerns, Access directions, etc.

METHOD **STAGE**

- BOAT 1st -sample pass- 2nd
- WADE HIGH
- L. LINE UP
- OTHER NORMAL
- LOW
- DRY

DISTANCE

- 0.5 Km
- 0.2 Km
- 0.15 Km
- 0.12 Km
- OTHER

CLARITY

- 1st --sample pass-- 2nd
- < 20 cm
 - 20-<40 cm
 - 40-70 cm
 - > 70 cm/ CTB
 - SECCHI DEPTH

_____ meters

CANOPY

- > 85%- OPEN
- 55%-<85%
- 30%-<55%
- 10%-<30%
- <10%- CLOSED

- 1st _____ cm
- pass
- 2nd _____ cm

C/ RECREATION

AREA DEPTH

POOL: >100ft² >3ft

B/ AESTHETICS

- NUISANCE ALGAE
- INVASIVE MACROPHYTES
- EXCESS TURBIDITY
- DISCOLORATION
- FOAM / SCUM
- OIL SHEEN
- TRASH / LITTER
- NUISANCE ODOR
- SLUDGE DEPOSITS
- CSOs/SSOs/OUTFALLS

D/ MAINTENANCE

- PUBLIC / PRIVATE / BOTH / NA
- ACTIVE / HISTORIC / BOTH / NA
- YOUNG-SUCCESSION-OLD
- SPRAY / SNAG / REMOVED
- MODIFIED / DIPPED OUT / NA
- LEVEED / ONE SIDED
- RELOCATED / CUTOFFS
- MOVING-BEDLOAD-STABLE
- ARMOURED / SLUMPS
- ISLANDS / SCOURED
- IMPOUNDED / DESICCATED
- FLOOD CONTROL / DRAINAGE

Circle some & COMMENT

E/ ISSUES

- WWTP / CSO / NPDES / INDUSTRY
- HARDENED / URBAN / DIRT&GRIME
- CONTAMINATED / LANDFILL
- BMPs-CONSTRUCTION-SEDIMENT
- LOGGING / IRRIGATION / COOLING
- BANK / EROSION / SURFACE
- FALSE BANK / MANURE / LAGOON
- WASH H₂O / TILE / H₂O TABLE
- ACID / MINE / QUARRY / FLOW
- NATURAL / WETLAND / STAGNANT
- PARK / GOLF / LAWN / HOME
- ATMOSPHERE / DATA PAUCITY

F/ MEASUREMENTS

- \bar{x} width
- \bar{x} depth
- max. depth
- \bar{x} bankfull width
- bankfull \bar{x} depth
- W/D ratio
- bankfull max. depth
- floodprone x² width
- entrench. ratio

Legacy Tree:

Stream Drawing:

Appendix C:

IDNR Fisheries Stream Sampling Guidelines (2001)

IDNR Fisheries Stream Sampling Guidelines (2001)

IDNR fisheries managers and others involved with the management of Illinois streams need accurate and consistent data on which to base their decisions. Guidelines for IDNR stream sampling help standardize the collection of stream-fish information. Standardized collection allows valid comparisons among sites by minimizing variability in sampling technique. Such comparisons are necessary for effective management and stewardship of stream resources throughout the state. Because Illinois streams differ greatly in physical and biological characteristics, statewide sampling guidelines must be flexible enough to accommodate this variability. These guidelines are intended to optimize data standardization while also accommodating the practical need to adjust sampling procedures to particular situations.

These guidelines were developed for professional, experienced fishery biologists, thoroughly acquainted with the operation, handling and maintenance of the sampling equipment; use of this equipment by inexperienced or uninitiated personnel could result in serious injury.

Background

The baseline and monitoring data collected by the Division of Fisheries provide sport fish population assessments which are important to stream fisheries management and protection (e.g., Sallee et al. 1991, Putman et al. 1995). Additionally, the sampling conducted by Fisheries biologists assists with delineating threatened and endangered species distributions (e.g., Burr et al. 1996) and fish community assessments. As part of the fish community assessments, fisheries data are used for characterizing stream health through the use of the Index of Biotic Integrity (Karr 1981, Karr et al. 1986). Subsequently, the IBI was revised by Hite and Bertrand (1989) and adapted for use in Illinois through the Biological Stream Characterization (BSC) Work Group. The IBI is a major component of the BSC rating of streams (Illinois EPA 1996a) and is used in the Aquatic Life Use-Assessment of the IEPA 305(b) (Illinois EPA 1996b) report to the US EPA, which rates the water quality of Illinois streams. The BSC is also incorporated into the Illinois EPA Targeted Watershed Approach to stream protection and restoration (Illinois EPA 1997).

Stream Sampling Guidelines address the three main objectives of the Division's stream fish sampling. These objectives are: 1) Fish community composition, 2) Sport fishery characterization and 3) Special (targeted) fish studies.

The goal of fish community sampling is to determine the identity and number of fish species present (species richness) and the relative number of individuals of each species (relative abundance) in a stream segment. Because length and weight of individual fish are routinely measured, estimates of species-specific population size and age structure can be obtained. Stream segment fish biomass estimates can also be calculated.

The second objective, Sport fishery characterization, is useful to the Fisheries Division in its

strategic planning efforts and for informing the public on sport fishing opportunities in Illinois streams.

Special (targeted) fish studies are conducted to obtain detailed estimates of population size, population age and growth structure, or migration and movement patterns of particular target species. These studies are often conducted with specific management objectives in mind, such as fish stocking assessments, watershed management evaluations or fisheries response to habitat improvement efforts.

Section 1. Station Selection Criteria

Stations should be selected based upon the following criteria:

1. Sites which have been previously sampled (particularly during the 1981 - 1998 cooperative basin survey effort) should receive priority over sites for which no data have been collected.
2. If no historical fisheries data are available, then site selection should be based on general characteristics of stream habitat, location relative to tributaries or point source pollution, relative position within the watershed (e.g., headwaters, middle, mouth). Consideration should be given for *both* representative and unique habitats. For example, if a stream is predominantly channelized, then at least one station should be placed in a channelized reach, even if this is not considered the "best" section of the stream.
3. IEPA ambient water quality or macroinvertebrate sampling sites. Typically, IEPA ambient water quality sites have a substantial water chemistry data set and therefore can be supportive for fisheries data.

Section 2. Sampling station selection

A reconnaissance trip is strongly recommended to familiarize the lead biologist with each potential sampling site. During the reconnaissance, the upstream and downstream limits of the sampling station may be determined and noted on the Stream Reconnaissance Form. The information on the reconnaissance forms should be sufficient to allow any IDNR fisheries biologist to lead the sampling. Although stream conditions can change from time of reconnaissance to time of sampling, this information can reduce confusion regarding where the sample is to be collected.

A reasonable attempt must be made to obtain landowner permission prior to sampling. The process of landowner contact can begin during reconnaissance, or by contacting the Natural Resources Conservation Service, in the county in which the stream segment to be sampled is located, to obtain the name, address and telephone number of the landowner in question. Landowners can then be contacted by phone and/or mail for permission to sample. Landowner information should be filed for subsequent sampling efforts.

Stream sampling locations should be chosen based on the physical characteristics, including stream width and depth, that will influence the amount of stream sampled. Stream segments to be sampled should be selected based upon habitat. Habitat diversity will also influence the length of stream sampled.

For non-channelized or old channelized (> 40 years) streams, *at least one* and preferably two to three pool/riffle sequences should be sampled. The number of pool/riffle sequences will depend upon the geological conditions, stream size and other factors, but this should be a minimum goal. No station should be less than 100 meters in length. If the hydraulic habitat is of a homogeneous nature (e.g., channelized), then a minimum of 15-21x normal base-flow width should be sampled. Normal base-flow is that volume of water that occupies the stream channel up to the vegetation (forbs, grasses, shrubs) line.

Setting the Station limits

Using the the habitat criteria listed above, the upstream and downstream limits of the station are blocked with nets. When setting the nets, every effort should be made to avoid disturbing the area to be sampled. Crew members should not enter the area to be sampled until the nets have been secured and should remain downstream of the sampling area to minimize turbidity disturbance. The preferred location for setting the nets are constrictions or upstream limits of riffles. Consideration should be given to the effects of hydraulic modifications to the stream caused by a bridge, because bridges often present anomalous habitat conditions, they should generally be avoided. The nets should be long enough to block the entire stream width. Net height should be 6 ft and mesh should be 0.25 inch bar measure. Net stakes should be used to prevent the net from collapsing during the sampling. Usually, one stake for every 10 ft of stream width should be used in low flow conditions. More stakes may be required at higher stream discharges. The stakes are to be placed through the lead line and angled upstream. Metal bottom anchors (J-hooks) should be placed through the lead line to minimize fish escape. These may be supplemented with rocks. The float line should be pulled sufficiently taut to keep fish from jumping over the net, but not so tight that the lead line lifts off the stream bottom.

General Stream Conditions for Sampling

To maintain consistency with IDNR historical collections and optimize efficiency, sampling should be conducted during typical summer **low-flow** conditions. This is typically from early July to mid-September, although sampling could be conducted in June in far southern Illinois. Sampling should not be conducted at high flows without sufficient justification. Due to the lack of gauging stations on small-to-intermediate sized streams, it is difficult to develop standardized criteria for determining the range of flows that is acceptable for sampling, rather this is at the discretion of the lead biologist. Fish sampling and habitat data must be collected at the same flow levels, preferably on the same day or contiguous days.

Related to stream flow, water clarity (turbidity) is a critical component to sampling efficiency. Ambient turbidity will vary regionally in Illinois. For example, in south-central Illinois, the presence of clay-laden soils contributes to high turbidity levels even in low or no-flow conditions. By comparison, northern Illinois streams with rocky substrates, may have very low turbidity even in high flows. Turbidity should be characteristic for low-flow conditions. In eutrophic streams, phytoplankton blooms or floating aquatic macrophytes may also reduce visibility.

General Fish Sampling Procedures

Wadable sampling techniques should be used in streams with a **average depth of 1.5 ft or less.**

Deep pools, up to 3.5 ft may be encountered in these streams, but they should not be common. When flow is present, wadable electrofishing is conducted from downstream to upstream. This is necessary to avoid creating plumes of silt in the area to be sampled. The increased turbidity limits visibility and reduces sampling efficiency. Only in “no-flow” or pooled conditions can sampling in an upstream to downstream direction be considered an option. Boat sampling and minnow seining may be conducted in either direction.

For all electrofishing, the amount of shocking time and length of stream sampled should be recorded. For minnow seining, the number and length of hauls, width of net used for each haul and average depth should be recorded.

When electrofishing, fish should not be kept in the dip nets and repeatedly subjected to the electrical field. Dip net handles must be made of non-conductive fiberglass or similar material and the net mesh should not be larger than 0.25 inch bar measure.

In community sampling, it is extremely important that ALL nettable fish be collected. Every fish is important and could represent another species. To obtain this type of coverage, all representative habitats should be sampled and must be included in the sampling station.

A reasonable effort should be made to keep all fish alive. For most sampling, an oxygen supply is required and to prevent undue stress which may cause mortality, the use of a 0.5% solution (0.04 lbs per gallon) of non-iodized salt is used. For wadable streams an “R” oxygen bottle provides a convenient source. During any electrofishing effort, if it appears that the number of fish is excessive and will result in stressed fish, then fish must either be redistributed to holding containers with adequate oxygen or sampling must be stopped and fish processed. If sampling is stopped, a block net should be placed at the location where sampling is interrupted. Fish should then be processed and released downstream of the station. A floating cage can also be used to hold fish while being processed. Upon completion of fish processing, sampling should then resume upstream of the temporary block net.

Section 3. Fish Sampling Techniques

Gear selection criteria

- 1) Boat electrofishing, supplemented with minnow seine hauls, is the method of choice when the habitats present within the station can be reasonably sampled with a boat (i.e., motor lower unit does not frequently contact the substrate and there is enough depth to operate the boat).
- 2) The electric seine (with block nets) should be used when the station is entirely wadeable (average depth is 1.5 ft or less) and narrow enough to block.
- 3) The backpack shocker (with block nets) is used when conditions won't permit use of boat electrofishing or electric seine (e.g., small headwater streams).

Boat electrofishing

A boat sampling crew should consist of a minimum of two (2) and up to five (5) people. Although only two people (one netter, one motor operator) are able to sample at a time, the additional people can collect water chemistry data and conduct minnow seining. When the electrofishing crew returns to the access site, fish can be processed immediately by two people and electrofishing can continue for the next run.

For small, non-wadable streams a 12'-14' boat is the preferred size as it allows movement over riffles and in confined areas. Dip net mesh size should be .125 to .25 inch. The motor operator and netter must communicate by using a variety of hand signals because generator noise usually precludes verbal communication. The netter and motor operator must watch for underwater obstructions, livestock fences or other potential hazards, and immediately alert one another to their presence. If anglers are encountered, the motor operator should either turn off the electricity to the electrodes or divert course to reduce disturbance.

If sampling is to be conducted upstream and downstream of the access point, then the downstream segment should be sampled first. This will reduce the likelihood of recapturing fish that are processed from the first sampling run. Because the effects of electrofishing differ among fish species, the crew should often check behind the boat for stunned fish. Frequent circling is recommended to assure adequate coverage of the station.

As at wadable sites, the actual length of a boat sampling station will vary with the stream size, habitat diversity and presence of impassable obstructions. Typically, a boat station will cover from 0.25 mile to one (1) mile. The electrofishing crew should sample all available habitats, including open water and midchannel areas, not just shoreline habitats. Electrofishing time must be accurately recorded. The length of stream sampled (combined length along both banks and midchannel) should be estimated (to within 10ft). This can be done on site (with tape measure or rangefinder) or may be measured on USGS topographic 7.5 minute quadrangle. Unlike wadable sites, boat sampling stations are sampled for a given time (usually 15 or 30 min individual runs), rather than for a pre-determined distance.

When sampling in shallow water it may be necessary to get out of the boat to push the boat or retrieve fish. If this occurs, the power to the electrodes must be turned off before getting out of the boat.

Minnow Seine

The major emphasis of minnow seine sampling is to determine species occurrences. Minnow seine samples are usually collected to supplement boat electrofishing samples. A minnow seine crew should have a minimum of two (2) and optimally three (3) people. Minnow seining should not be the exclusive gear for non-headwater streams (>10 ft) wide. In headwater streams, conditions may be conducive for efficient minnow seining because stream width and depth allow sufficient 'sampling space' for this method. The length of seine used will vary with stream conditions, depth should be 6 ft and mesh should be 0.125 to 0.25 inch (bar measure). For pool or run conditions, an area relatively clear of obstructions should be selected. Sampling may be conducted either in an upstream or downstream direction. Number and length(s) of seine hauls should be recorded with the fish data. Circular sweeps allow sampling where debris or other obstructions restrict linear sampling. Riffles or deep, fast runs can be sampled by placing the net across the riffle and having a crew member kick from upstream towards the net. If it is a large riffle, select an area up to 15 ft in width and place the net across that area. Then, one or more persons should walk upstream approximately 20 ft and begin kicking the substrate; moving downstream toward the net. When they arrive at the net, "kickers" should reach into the water, find the lead line and purse the net.

For all minnow seine sampling, it is very important that the lead line be kept on the bottom. If an impediment is encountered during a haul, attempts should be made to quickly dislodge or bypass the obstruction. When beaching the seine, keep the lead line pressed to the substrate and pull the seine towards shore. Quickly remove all fish from the seine and process (or preserve). The number and length(s) of seine hauls should be recorded with the fish data.

Electric Seine

For electric seine sampling, the crew should consist of a minimum of five (5) persons with an optimum of six (6). One (1) person is responsible for generator operation and assuring that fish are kept oxygenated. Three (3) members of the crew net fish and two (2) members operate the brails of the electric seine. Skilled brail operators may also opt to carry a dip net for maximum efficiency in confined areas. All persons will wear heavy duty (lineman) rubber gloves and either hip boots or chest waders (preferred). Prior to activating the seine, one of the brail operators must indicate verbally that the seine is going to be turned "ON". Similarly, when it is turned "OFF" one of the operators must indicate that the seine is "OFF".

The pace of sampling should accommodate the netters so that when large numbers of fish are present, the operators should reduce forward progress until fish have been netted and placed in live wells. When appropriate, brush, logs, or shoreline cover should be sampled by having one or both of the brail operators wrap around the cover. The netters should keep pace with the brail operators as they surround the object, to collect stunned fish. Using their dip nets, the netters may need to push the electric seine into the brush or deeper pool to assure full coverage. After this process, the seine could briefly be turned off for the crew to regroup.

If the stream is wider than the electric seine the sampling crew should follow the thalweg, concentrating on instream cover and minimizing deep water fish escape routes. If depth is sufficient across the channel, a second pass may be needed to cover the "unsampled" side.

Riffles should be sampled by first carrying the electric seine upstream of the riffle and having the netters place the nets side by side at the downstream end of the riffle. The brail operators, with the seine "ON", should then kick the riffle to dislodge fish. Depending upon the length of the riffle, this could be done multiple times. If time and manpower allows, a minnow seine can be positioned below the riffle instead of or in addition to side by side dip nets.

Backpack Electrofisher

The backpack electrofishing crew will consist of a minimum of two (2) persons, with three (3) optimal. One person will operate the backpack, one person will net fish and carry a bucket to hold stunned fish. Block nets will be set as noted above. All persons will wear rubber gloves and either hip boots or chest waders. Electrofishing settings will be contingent upon water conditions including conductivity and depth, but settings should be sufficient to optimize collection, but to minimize harm to fish.

Backpack shocking is generally done in an upstream direction for reasons noted above. For optimal catch efficiency, the anode probe is thrust into cover (e.g., undercut bank, log jam) with

the power "OFF", then drawn slowly back to the operator with the power "ON". This minimizes scaring fish and utilizes the galvanotaxic response of fish to DC current.

Section 4. Habitat and Methods Data

Procedures for completion of stream investigation forms and stream methods and habitat form are in the Operations Manual - FDM 6230 and FDM 6230.1, respectively.

Section 5. Fish Workup

1) Small fishes (e.g. minnows, darters and y-o-y sunfishes) and fishes not easily identified should be preserved in 10% formalin as quickly as possible for ease of identification and value as voucher specimens. Make sure preserved samples are clearly labeled with sampling location, method and date.

2) Weigh and measure length of all fishes greater than or equal to 6", measure length of smaller fishes

3) All reasonable effort should be made to return fish alive back to the stream.

4) Dead fish should be buried (preferred) or scattered throughout the surrounding area at least 50 ft from the stream in areas unlikely to cause inconvenience to stream users or landowners.

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Appendix D:

Methods of Collecting Macroinvertebrates in Streams

Illinois Environmental Protection Agency

Bureau of Water

Document Control Number 167

**Standard Operating Procedure for
Sample Processing for the Macroinvertebrate Index of
Biotic Integrity (mIBI)**

Surface Water Section
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1.0 Scope and Application

The instructions included in this Standard Operating Procedure (SOP) describe how to obtain a $300 \pm 20\%$ fixed-count macroinvertebrate subsample and how to enumerate and identify the individual members at the proper taxonomic resolution in order to properly compute and interpret the macroinvertebrate Index of Biotic Integrity (mIBI).

The SOP is part of a larger mIBI protocol that includes specific macroinvertebrate collection, identification, computation, and application instructions. To ensure a correct application of the mIBI, follow the protocols outlined in the module "*Calculation of the macroinvertebrate Index of Biotic Integrity (mIBI)*". To ensure that samples are appropriate for the mIBI, follow the protocol described in "*Methods to Collect Aquatic Macroinvertebrates from Wadeable Streams for Biotic Integrity Assessments*".

The mIBI represents how macroinvertebrates respond to and integrate the chemical, physical and biological effects of human-caused impacts on streams and their watersheds when compared to a subset of least disturbed locations sampled during 2001.

2.0 Summary of Method(s)

- Collect samples according to the method outlined in "*Methods to Collect Aquatic Macroinvertebrates from Wadeable Streams for Biotic Integrity Assessments*".
- Rinse the sample with water to remove preservatives.
- Assign unique numbers to identify each of the thirty 6x6-cm grid cells in the screened subsample tray.
- Load the rinsed sample materials into the screened subsample tray.
- Evenly distribute the materials over the subsample tray.
- Submerge the loaded subsample tray in water to partially suspend the sample materials.
- Remove the subsample tray from the water to facilitate random distribution of the sample over the entire screen.
- Randomly select four cells from the gridded subsample tray.
- Place the contents of the selected cells into a shallow white pan. Partially fill the pan with liquid to facilitate macroinvertebrate sorting.
- Sort $300 \pm 20\%$ aquatic macroinvertebrates using a ring-light magnifier. Exclude macroinvertebrates (e.g., semi-aquatic taxa and others listed in, "*Illinois Environmental Protection Agency Tolerance List and Functional Feeding Group Classification*", in Appendix A.) from the $300 \pm 20\%$ count.

- If fewer than $300 \pm 20\%$ macroinvertebrate exist in the initial four cells, randomly select and sort additional sample material, one cell at a time, until the target number of organisms is obtained.
- If greater than $300 \pm 20\%$ macroinvertebrates exist in the initial four cells then reduce the amount of material and macroinvertebrates sorted. Place all of the materials from the initial four cells into a second gridded screen and conduct a "Level-2" subsample. Subsample the second gridded screen as before and obtain materials from the four ("Level-2") cells. Repeat as necessary (e.g., "Level-3", "Level-4" etc.) until the subsample contains $300 \pm 20\%$ macroinvertebrates.
- The subsample is complete.
- Identify macroinvertebrate with the taxonomic keys listed below in "10.0 Macroinvertebrate Keys".
- Refer to the module "Calculation of the macroinvertebrate Index of Biotic Integrity (mIBI)", for information on the required levels of taxonomic resolution for specimen identification.

3.0 Interferences and Corrective Action

Proper application of the mIBI requires properly collected samples. To collect mIBI samples, follow the instructions outlined in the module "Method to Collect Aquatic Macroinvertebrates from Wadeable Streams for Biotic Integrity Assessments". In addition, a $300 \pm 20\%$ individual fixed-count subsample is required since this sample size was utilized to develop metric score expectations and mIBI interpretation criteria.

4.0 Safety

To reduce exposure to sample preservatives, protective eyewear and latex gloves should be worn. Process samples in a well ventilated area or under a fume hood. Depending on the preservative utilized, several rinsing and soaking steps may be needed to prepare the sample for processing.

5.0 Equipment and Supplies

Standardized gridded screen (595 micron screen, 30 cells, each 6 cm^2), shallow watertight tray for submerging the gridded screen, 6 cm scoop, 6 cm^2 metal dividing frame, forceps, scissors, white plastic or enamel pan for sorting, ring-light, specimen vials with caps or stoppers, sample labels, standard laboratory bench sheets, 95 percent ethanol for storage of specimens, sample log and tracking sheets.

6.0 General Guidelines (in part from Barbour et. al., 1999)

The procedures, outlined below, follow the methods established in the US EPA Rapid Bioassessment Protocol (Barbour et. al. 1999). These procedures use a fixed-count sub-sampling approach for sorting organisms from the materials included in the sample matrix. The reason for the subsample requirement is that the volume of material collected with the proportionally allocated multihabitat collection approach is typically impractical to process in its entirety. Sub-sampling reduces the effort required for the sorting and identification aspects of macroinvertebrate samples and provides a more

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expedient expenditure of time (Barbour and Gerritsen 1996).

To facilitate processing and identification, the randomized $300 \pm 20\%$ fixed count subsample is sorted and preserved separately from the remaining sample. Document the level-of-effort, or proportion of sample processed by recording this information on the Laboratory Bench Sheet.

The instructions in this SOP describe two phases of macroinvertebrate sorting. The “Phase-1” sort is the source of all mIBI information. A “Phase-1” sort refers to the sub-sampling process utilized to randomly select $300 \pm 20\%$ macroinvertebrates from the sample. A “Phase-1” sort can progress in stages and each stage corresponds to a particular “sub-sample level”. The level of sub-sampling needed to meet the $300 \pm 20\%$ target depends on the density of macroinvertebrates in the sample. “Phase-2” sort refers to a fifteen minute search conducted on all remaining unsorted material to check for obviously unique taxa not found during “Phase-1” sub-sampling. “Phase-2” organisms are placed in a separate vial and are not included as part of the subsample. Exclude taxa obtained during the “Phase-2” sort from all mIBI computations. “Phase-2” taxa may be utilized, independent of the mIBI, as an aid when making water quality interpretations.

6.1 Specific Guidelines (in part from Barbour et. al., 1999)

- Record sample collection information on the benthic macroinvertebrate tracking sheets. These sheets are located in the sample log-book. Record sample label information plus the information from the Illinois EPA field assessment form on the benthic macroinvertebrate laboratory bench sheet. This information will include sample ID/station code, method of collection, allocation of jabs, number of containers per sample, initials of collector, start time, duration and sample collection date.
- Thoroughly rinse the sample in a No. 30 mesh (595- μ m openings) sieve to remove preservative and fine sediment. Depending on the preservative utilized, this step may need to be initiated several days prior to sub-sampling and this step may need to be repeated daily. The log-book containing sample tracking sheets should be posted in the lab or sorting area to track this process. Large organic material (whole leaves, twigs, algal or macrophyte mats, etc.) not removed in the field should be rinsed, visually inspected, and discarded. Use large Rubbermaid type tubs to facilitate this activity. If the samples have been preserved in alcohol, it will be necessary to soak the sample contents in water for about 15 minutes to hydrate the benthic organisms, which will prevent them from floating on the water surface during sorting. If the sample is stored in more than one container, the contents of all containers for a given sample should be combined and homogenized at this time.
- Use Oregon Department of Environmental Quality standardized sub-sampling gear (Caton, 1991) to obtain $300 \pm 20\%$ randomly selected macroinvertebrates from the 20-jab sample. The subsample gear has two parts- the first part is a shallow watertight tray and the second part is a 600-micron screen. The screened tray is equally-divided into a grid of 30 clearly marked cells and each cell measures 6x6-cm. Place the screened tray into the watertight tray and spread the entire sample onto the screened grid. Pour enough water into the gear to immerse the sample. This activity will help suspend the sample and facilitate a more even distribution of sample materials over the screened grid. Then lift the screen out of the tray, which will cause the sample materials to settle evenly onto the screen. When samples are too large to be effectively-sorted in a single tray, place half of the homogenized sample in each of two gridded trays.

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- Assign a unique number (e.g., 1-30) to each of the 30 cells in the grid of the screened tray. Randomly select four of the thirty gridded tray cells. Use a random number table or computerized random number generator to randomly select the four numbers. If two gridded trays are needed then eight cells should be selected- four from each of the two trays. The material contained in the four, randomly- selected, cells make the subsample.
- Beginning with the first-four randomly-selected cells (eight cells if two trays were used), remove all organisms and debris contained within the boundary of the pertinent cells and place these materials into a white pan to sort. When transferring organisms from the grid to the sorting pan, consider any organisms that straddle adjoining cells to be on the cell containing the head. In those instances where it may not be possible to determine the location of the head (worms for instance), the organism is considered to be in the cell containing most of its body. When a selected cell has organic debris lying over or entangled among the materials in an adjacent cells, it may be necessary to use a pair of scissors to cut materials along the gridline. Cutting will help prevent the unintended transfer of debris-entangled macroinvertebrates from one cell to another.
- After placing the randomly-selected materials into a shallow white pan, add a small amount of liquid to facilitate sorting. Use a ring light (approximately 1.75X) in the sorting process (this provides focused light on the sorting pan and helps standardize the visual acuity among sorters). Sort through the debris, and remove and count all the macroinvertebrates in the pan.
- If it becomes obvious, at any point during the sorting process, that the density of macroinvertebrates contained in the initial four-cells will exceed the subsample target ($300 \pm 20\%$), then suspend the sort. Exceeding the target number of organisms before all four cells are sorted essentially amounts to a “*false-start*”. If a “*false-start*” occurs, place the just-sorted organisms back in with the unsorted portion of the initial four-cell subsample. Re-homogenize the material in the subsample. At this point, the composition of the re-homogenized material is as if the four cells were never sorted and were just now randomly selected and transferred from the subsample to the sorting tray. Since the “*false-start*” establishes that too many organisms exist in the re-homogenized material, these four cells must undergo a “*Level-2*” subsample before another sort is attempted. To perform the “*Level-2*” subsample, transfer the re-homogenized materials from the initial four cells into a second gridded tray. Distribute these materials evenly over the second tray and randomly select four new cells one at a time. The four newly-selected cells represent the “*Level-2*” subsample. Perform material dispersion and cell selection for the “*Level-2*” subsample in the same manner as for the initial four cells. It is important to note that *if* the target number of organisms is routinely exceeded in the first four cells, the sorter may elect to automatically perform the “*Level-2*” subsample rather than waste time due to “*false-start*” sorting.
- If the density of organisms is large enough that many more than the targeted number of organisms are contained in the four cells, then transfer the contents of the cells to a third gridded pan and continue as before. If the targeted subsample amount of $300 \pm 20\%$ organisms is reached, the subsample is finished. If less than the targeted $300 \pm 20\%$ organisms exist, continue randomly selecting and sorting cells, one-at-a-time, until the targeted subsample number is obtained. If picking through the entire next cell is likely to result in a subsample with greater than $300 \pm 20\%$ organisms, then subsample that single cell in the same manner as before. That is, spread the contents of the last cell into another gridded pan. Pick cells, one-at-a-time, until $300 \pm 20\%$ organisms are reached. The total number of cells for each subsample level should be noted on the laboratory bench sheet. Each cell selected for sorting, must be sorted in its entirety.

- Except for one situation, a $300 \pm 20\%$ organism fixed count subsample is required for all macroinvertebrate samples utilized for the mIBI. The exception occurs when the entire sample contains fewer than 240 total individuals. In this situation, the subsample will never reach the $300 \pm 20\%$ organism target. Use extreme caution when interpreting mIBI results based on fewer than 240 macroinvertebrates. A $300 \pm 20\%$ individuals fixed-count subsample is required since this sample size was utilized to develop metric score expectations and mIBI interpretation criteria
- Until the target number of organisms is obtained, be careful not to accidentally disturb the subsample tray between these activities (e.g., removing cell contents or while sorting) because this may cause a redistribution of specimens that could possibly change the probability of selection if additional cells must be sorted.
- It is important to note that organisms, which are damaged beyond recognition, should not be included in the subsample count. Likewise, exclude all Hemiptera and most semi-aquatic Coleoptera from the subsample count. Regardless of the number of semi-aquatic taxa omitted, the subsample procedure continues until the fixed-count target of $300 \pm 20\%$ organisms is attained. Refer to the tolerance assignments in Appendix A, to identify ineligible semi-aquatic taxa. The ineligible taxa have tolerance values of 99.9.
- Once this initial phase of sorting is completed and the target number of organisms is obtained, a fifteen minute "Phase-2" sort is conducted on all remaining unsorted material to check for obviously unique taxa not found while obtaining the require $300 \pm 20\%$ macroinvertebrates. "Phase-2" organisms will be placed in a separate vial and will not be included as part of the initial subsample. Also, exclude taxa obtained during the "Phase-2" sort from all mIBI computations. "Phase-2" taxa may be useful, independent of the m-IBI, as an aid when making site quality interpretations.
- Note the type of sample, sample ID/station code, sorter, date sorted and any comments regarding the sample (e.g., description of organic material in sample -- sand, fine organics), and sorting time on the bench sheet.
- For 10% of the samples, save the unsorted sample residue in a container labeled "sample residue"; this container should include the original sample label. Save the sorted debris in a separate container labeled "sorted residue" in addition to original label information. Length of storage and archival is to be determined.
- Place specimens sorted as the subsample ($300 \pm 20\%$ organisms) into a glass vial, and preserve in 95 percent ethanol. Label the vial inside with the station code, stream name, collection date and sample ID/station code.

- Any entirely-sorted sample that falls below the designated subsample size of $300 \pm 20\%$ may provide spurious information. Use extreme caution when interpreting mIBI results based on fewer than 240 macroinvertebrates. A $300 \pm 20\%$ individuals fixed-count subsample is required since this sample size was utilized to develop metric score expectations and mIBI interpretation criteria

7.0 Quality Control (QC) for mIBI samples

- Ten percent of the sorted samples in each lot should be examined by laboratory QC personnel or a qualified co-worker. A lot is defined as a special study, basin study, entire index period, or individual sorter. The QC worker will examine the cells chosen and the tray used for sorting and will look for organisms missed by the sorter. Organisms found will be added to the sample vial. If the QC worker finds that less than 10% of the organisms remain in the sorting tray, the sample passes; if more than 10% are found, the sample fails. If 10 percent of the sample lot fails, another 10 percent is randomly selected until failure no longer occurs or the entire lot is checked. Sorters in-training will have their samples 100 percent checked until sorting efficiency reaches 90%. The results of the QC check are recorded on the Benthic Macroinvertebrate Laboratory Bench Sheet.
- After laboratory processing is complete for a given sample, all sieves, pans, trays, etc., that have come in contact with the sample will be rinsed thoroughly, examined carefully, and picked free of organisms or debris.

8.0 Organism Identification for mIBI Calculations

8.1 General Guidelines

- The taxonomic resolution of macroinvertebrate identification varies for mIBI calculations. In general, it is preferred to identify organisms to species level whenever practical. However, for mIBI calculations use generic resolution for insects and non-sphaerid bivalves, class resolution for leeches, worms and flatworms, and family resolution for crayfish, fingernail clams, and mussels. the taxonomic keys listed below for macroinvertebrate identification. Refer to "*Calculation of the macroinvertebrate Index of Biotic Integrity (mIBI)*" for specific information about the level of taxonomic resolution required for a given taxonomic group.
- When there is a question concerning the correct identification of a specimen, send it to other recognized authorities for confirmation.
- A voucher (reference) collection must be maintained to help resolve questions regarding the accuracy of taxonomic identifications. These specimens should be properly labeled, preserved and stored in the laboratory for future reference. Specimen labels should include the name(s) of the verifying person(s). Senior taxonomist must verify 10% of the sample identifications.
- Information on samples completed (through the taxonomy process) is recorded in the sample notebook or bench sheet to track the progress of each sample within the sample lot. The tracking of each sample will be updated as each step is completed (i.e., rinsing, sub-sampling, sorting and taxonomy).

8.1.1 Specific Guidelines for Organism Identification

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- For identification and enumeration, examine organisms under a stereoscopic dissecting microscope. The microscope should have a magnification range of 7X to 120X. After they are identified and counted, all organisms are returned to a single sample vial containing 95% ethanol and the original field sample label, OR original field sample label information (see previous page, section 6.1. "For 10% of the samples, save the unsorted sample residue in a container labeled "sample residue"; this container should include the original sample label. Save the sorted debris in a separate container labeled "sorted residue" in addition to original label information."
- Some taxa require slide mounts for proper identification (e.g., chironomid larvae). Before mounting chironomids, the larvae are made more transparent (cleared) to facilitate the observation of internal structures utilized in taxonomic identification. The process of clearing and mounting the larvae may make certain characteristics difficult to see. Membranous structures such as the Lauterborn organs and the antennal blade become very faint after treatment in warm KOH. Overnight clearing in cool (room temperature) KOH is less damaging and will make structures more visible (Simpson and Bode, 1980). The anal and ventral tubules, preanal papillae, eyespots and body coloration should be observed under a dissecting microscope before the specimen is cleared. Another clearing/mounting agent is CMC-10 mounting media from Masters Group, Inc..
- After being picked from the sample, chironomid larvae should be sorted into groups based on location of eyespots, shape of head and possession of ventral tubules.
- Clear the larvae of soft tissue by placing them in cool 10% potassium hydroxide (KOH) overnight;
Or
- Heat the KOH on a hot plate (low only) until the head capsule clears, approximately 20-30 minutes.
- Rinse out the KOH by soaking the larvae in distilled water approximately 10 minutes.
- Place the larvae through a graded alcohol series (50%, 70% and 95%) to remove all the water. Failure to remove the water may cause bubbles to appear. Minimum time per rinse is 10 minutes.
- Place approximately two drops of Canada balsam (Permount or other suitable mounting medium) on a microscope slide and arrange the midge with the ventral side up.
- Cover with a coverslip and press down on the head capsule to expose the mouthparts.
- Note: On large larvae the abdomen may prevent the depression of the head capsule. In such cases, mount the abdomen under a separate coverslip, but on the same slide.

9.0 Sample Integrity and Disposition

- To ensure the integrity of each sample, a label containing the information discussed in the subsection on labeling is included in each vial. In order to maintain chain-of-custody, samples are the responsibility of the collecting biologist. Keep samples in a secure location at all times (e.g. lock the vehicle whenever vacant). Final disposition of samples is also the responsibility of

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the collecting biologist.

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10.0 Macroinvertebrate Keys

Use any available literature as an aid to identify the organisms. However, take the final identification and recorded name from the following references.

PLATYHELMINTHES

TURBELLARIA: Family (Pennak, 1989 pgs 124-51)

ANNELIDA

OLIGOCHAETA: Class (Pennak, 1989 pg 290) / (Kathman and Brinkhurst, 1998)

HIRUDINEA: Family (Pennak, 1989 pgs 314-333)

ARTHROPODA

CRUSTACEA

ISOPODA: Genus (Pennak, 1989 pgs 462-73)

AMPHIPODA

Hyaellidae: species (Pennak, 1989 pgs. 474-88)

Gammaridae: Genus (Pennak, 1989 pgs. 474-88)

DECAPODA

Cambaridae: Genus/species (Page, 1985 INHS Bull. 33:4)

Palaemonidae: species (Page, 1985 INHS Bull. 33:4)

INSECTA

EPHEMEROPTERA

Siphonuridae: Genus (Merritt and Cummins, 1996)

Isonychiidae: Genus (Merritt and Cummins, 1996)

Baetidae: Genus/species (Merritt and Cummins, 1996 / Morihara and McCafferty, 1979 TAES V.105 / Burks, 1953)

Heptageniidae: Genus/species (Merritt and Cummins, 1996 / Burks, 1953 / Lewis, 1974) / Bednarik and McCafferty, 1979)

Ephemerellidae: Genus (Merritt and Cummins, 1996)

Tricorythidae: Genus (Merritt and Cummins, 1996)

Caenidae: Genus (Merritt and Cummins, 1996)

Baetiscidae: Genus (Merritt and Cummins, 1996)

Leptophlebiidae: Genus (Merritt and Cummins, 1996)

Potamanthidae: Genus (Merritt and Cummins, 1996)

Emphemeridae: Genus (Merritt and Cummins, 1996)

Palingeniidae: Genus (Merritt and Cummins, 1996)

Polymitarcyidae: Genus (Merritt and Cummins, 1996)

ODONATA

ANISOPTERA

Cordulegasteridae: Genus (Merritt and Cummins, 1996 / Needham and Westfall, 1995 / Needham, Westfall and May, 2000).

Gomphidae: Genus (Merritt and Cummins, 1996 / Needham and Westfall, 1955 / Needham Westfall and May, 2000)

Aeshnidae (or Aeschnidae): Genus/species (Merritt and Cummins, 1996 / Needham and Westfall, 1955 / Needham, Westfall and May, 2000)

Corduliidae: Genus (Merritt and Cummins, 1996 / Needham and Westfall, 1955 / Needham, Westfall and May, 2000)

Libellulidae: Genus (Merritt and Cummins, 1996 / Needham and Westfall, 2000)

ZYGOPTERA

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Calopterygidae: Genus (Merritt and Cummins, 1996 / Westfall and May, 1996)
Coenagrionidae: Genus (Merritt and Cummins, 1996 / Westfall and May, 1996)
Lestidae: Genus (Merritt and Cummins, 1996 / Westfall and May, 1996)

PLECOPTERA

Pteronarcyidae: Genus (Merritt and Cummins, 1996)
Taeniopterygidae: Genus (Merritt and Cummins, 1996)
Nemouridae: Genus (Merritt and Cummins, 1996)
Leuctridae: Genus (Merritt and Cummins, 1996)
Capniidae: Genus (Merritt and Cummins, 1996)
Perlidae: Genus (Merritt and Cummins, 1996)
Perlodidae: Genus (Merritt and Cummins, 1996)
Chloroperlidae: Genus (Merritt and Cummins, 1996)

HEMIPTERA

Gerridae: Genus (Merritt and Cummins, 1996)
Notonectidae: Genus (Merritt and Cummins, 1996)
Pleidae: Genus (Merritt and Cummins, 1996)
Belostomatidae: Genus (Merritt and Cummins, 1996)
Corixidae: Genus (Merritt and Cummins, 1996)

MEGALOPTERA

Sialidae: Genus (Merritt and Cummins, 1996)
Corydalidae: Genus/species (Merritt and Cummins, 1996)

NEUROPTERA

Sisyridae: Genus (Merritt and Cummins, 1996)

TRICHOPTERA

Hydropsychidae: Genus/species (Merritt and Cummins, 1996 / Schmude and Hilsenhoff, 1986)
Philopotamidae: Genus (Merritt and Cummins, 1996)
Polycentropodidae: Genus (Merritt and Cummins, 1996)
Psychomyiidae: Genus (Merritt and Cummins, 1996)
Glossosomatidae: Genus (Merritt and Cummins, 1996)
Hydroptilidae: Genus (Merritt and Cummins, 1996)
Rhyacophilidae: Genus (Merritt and Cummins, 1996)
Brachycentridae: Genus (Merritt and Cummins, 1996)
Lepidostomatidae: Genus (Merritt and Cummins, 1996)
Molannidae: Genus (Merritt and Cummins, 1996)
Phryganeidae: Genus (Merritt and Cummins, 1996)
Helicopsychidae: species (Merritt and Cummins, 1996)
Leptoceridae: Genus/species (Merritt and Cummins, 1996 / Glover and Floyd, 2004 / Floyd, 1995)

LEPIDOPTERA

Pyralidae: Genus (Merritt and Cummins, 1996)

COLEOPTERA

Gyrinidae: Genus (Merritt and Cummins, 1996)
Psephenidae (larvae only): Genus (Merritt and Cummins, 1996)
Scirtidae: Genus (Merritt and Cummins, 1996)
Haliplidae: Genus (Merritt and Cummins, 1996)
Hydrophilidae: Genus (Merritt and Cummins, 1996)

Dytiscidae: Genus (Merritt and Cummins, 1996)

Dryopidae: Genus (Merritt and Cummins, 1996)

Elmidae: Genus (Merritt and Cummins, 1996)

DIPTERA

Tipulidae: Genus (Merritt and Cummins, 1996)

Chaoboridae: Genus (Merritt and Cummins, 1996)

Culicidae: Genus (Merritt and Cummins, 1996)

Dixidae: Genus (Merritt and Cummins, 1996)

Psychodidae: Genus (Merritt and Cummins, 1996)

Simuliidae: Genus (Merritt and Cummins, 1996)

Chironomidae: Genus/species (Merritt and Cummins, 1996 / Epler, 1992)

Stratiomyidae: Genus (Merritt and Cummins, 1996)

Tabanidae: Genus (Merritt and Cummins, 1996)

Empididae: Genus (Merritt and Cummins, 1996)

Syrphidae: Genus (Merritt and Cummins, 1996)

Ephydriidae: Genus (Merritt and Cummins, 1996)

Sciomyzidae: Genus (Merritt and Cummins, 1996)

Muscidae: Genus (Merritt and Cummins, 1996)

Athericidae: Genus (Merritt and Cummins, 1996)

MOLLUSCA

GASTROPODA: Genus (Pennak, 1989)

PELECYPODA

Corbiculidae: species (Pennak, 1989 / Cummings and Mayer, 1992)

Sphaeriidae: Genus (Pennak, 1989 / Cummings and Mayer, 1992)

Unionidae: Genus/species (Pennak, 1989 / Cummings and Mayer, 1992)

Note:

Class = key to the class level

Family = key to the family level

Genus = key to the genus level

Genus/species = contain genera with only one species for our area or genera which add large numbers and diversity to our samples at the species level. Current species level key are indicated for those genera.

species = only one species should occur for this group in our Illinois occurrence list.

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Illinois Environmental Protection Agency

Bureau of Water

Document Control Number 168

**Standard Operating Procedure for
Method to Collect Aquatic Macroinvertebrates from
Wadeable Streams for Biotic Integrity Assessments**

Surface Water Section

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1.0 Scope and Application

The instructions outlined in this Standard Operating Procedure (SOP) describe how to collect and preserve aquatic macroinvertebrate samples from perennial streams and rivers using a quantitative multiple-habitat, 20-jab method (see below). Use these samples to calculate an index of biotic integrity (IBI) and assess the physical, chemical and biological condition of the resource. Collect samples between June 1st and October 15th. These protocols apply to perennial streams and wadeable rivers that typically range in size from 2nd through 6th order. In some situations, these protocols may apply to intermittent streams that meet specific base flow criterion (see below in Section 6.1). Use the macroinvertebrate Index of Biotic Integrity (mIBI) to evaluate 20-jab samples.

Aquatic macroinvertebrates are invertebrates that are visible to the unaided eye, retained in a U.S. Standard No. 30 sieve (595-micron mesh size) and live at least a portion of their lives in the water. Refer to Appendix A for the list of IBI-applicable aquatic macroinvertebrates.

The framework outlined in this SOP is a modification of the “*Multihabitat Approach: D-frame dip-net*” collection methodology that was outlined in EPA, (1999). The modifications consist of additional dip allocation criteria, which improve dip allocation consistency when collecting macroinvertebrates. Hereafter, refer to this modified macroinvertebrate collection method as, the “20-jab” approach.

2.0 Summary of Method(s).

- Collect aquatic macroinvertebrate samples from perennial, 2nd through 6th order wadeable streams.
- Collect aquatic macroinvertebrate samples between June 1st and October 15th.
- Collect the sample with 20- dip-net jabs.
- Use a 600-micron mesh, 18x9-inch rectangular-frame, dip-net.
- Clean equipment between each sample.
- Sample an 18x18-inch area of habitat with each dip-net jab.
- Allocate 20 jabs in the sample reach.
- Use the mean water width of the sample reach to determine how to allocate the 20 jabs among the edge-zone and bottom-zone (*e.g.*, \bar{x} stream width = bank-zone jabs: <10ft=10, 10-29ft=8, 30-59ft=6 and \geq 60ft=4). See Table 1, in Appendix B.
- Establish the relative amounts of each of the pertinent habitat types within the bottom- zone and bank-zone.
- Bottom zone habitats are: *coarse particle substrate, fine particle substrate, vegetation and plant detritus*. See Table 1, in Appendix B.
- Edge zone habitats are: *submerged terrestrial vegetation, submerged tree roots and brush-debris-jams*. See Table 1, in Appendix B.
- Distribute the bank-zone and bottom-zone jab allotments proportionally among the pertinent habitat types within each of the two respective zones (see Equation 1 and Section 6.2.4).
- Summarize the number of jabs allocated to each habitat in the sample reach.
- Perform 20 jabs.
- Use the jab allocation summary and perform the allocated number of jabs in each of the pertinent habitat types.
- Take jabs in the more productive areas of each habitat type. More productive areas typically occur where current velocity is relatively high and the substrate is relatively stable.
- Distribute multiple jabs within more productive areas, of a particular habitat type, equally along the entire length of the sample reach when possible.

- Composite the collected materials into a 600-micron sieve bucket or a suitably sized watertight plastic tub after each jab is completed.
- Sieve the collected materials to remove excess water (as needed). As needed, discard excess debris after removing all clinging macroinvertebrates- retain these macroinvertebrates in the sample.
- Preserve the sample with 95% ethanol and return it to the lab for subsequent sub-sampling and identification.

3.0 Interferences and Corrective Action.

- Macroinvertebrate communities vary seasonally. Collect aquatic macroinvertebrate samples between June 1st and October 15th.
- Specimens left on the equipment between samples can give false results. Remove all specimens from the equipment before subsequent samples are collected.
- Improper sample preservation makes specimen identification more difficult. Take care to use large enough containers and adequate amounts of 95% ethanol during the initial preservation of the sample. Safeguard preserved samples that contain a relatively large amount of organic matter by decanting the original, spent, preservative and refilling the container using fresh 95% ethanol - perform this maintenance within 1-week of sample collection. Repeat as needed to maintain the sample preservative.

4.0 Safety.

Follow the general field-safety guidelines in the Illinois EPA, Bureau of Water's Surface Water Section, Field Safety Manual (Document Control Number 151) (Illinois EPA, 1994).

5.0 Equipment and Supplies.

- Nitex bottom kick net with an 18x9-inch rectangular opening and a 600-micron mesh size.
- Sieve bucket with a 600-micron stainless steel mesh bottom.
- Plastic rinse pan
- Forceps
- Sample bottles
- 95% ethanol

6.0 General Guidelines

Collect Macroinvertebrate Samples with the 20-jab Method.

6.1 Select a sampling reach that:

- has instream and riparian habitat conditions typical of the entire assessment reach,
- has flow conditions that approximate typical summer base flow,
- has perennial flow, or if intermittent, has continuous width and depth that extends throughout the sampling reach, which should be at least 300 feet. The length of the sample reach should not exceed 800 feet.
- has no highly influential tributary streams,
- has at least one riffle/pool sequence or analog (i.e., run/bend meander or alternate point-bar sequence), if present.,

6.1.1 The 20-jab approach is applicable if:

- Conditions allow the sampler to collect macroinvertebrates (i.e., to take jabs with a dip-net) in all pertinent bottom-zone and bank-zone habitat types that occur in the sampling reach.

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AND

- Conditions allow the sampler to apply the 11-transect habitat-characterization, as described in Section E of this manual or to estimate the amount of each of several bottom-zone and bank-zone habitat types using the non-transect method (Appendix B).
- In general, the 20-jab approach applies if more than 50% of the stream is accessible and adequately characterized.
- Between each sample, pick equipment clean of macroinvertebrates and debris. Rinse all sampling equipment in ambient water before collecting the sample.

6.2 Jab allotment (sample reach)

6.2.1 Determine jab allotment for the bottom-zone and bank-zone.

- Follow the instructions provided in *Appendix B* to identify bottom-zone and bank-zone jab allotments. Specifically, use Table 1 (Appendix B) and mean water width of the sample reach to determine the number of jabs allocated to the bottom-zone and bank-zone. Essentially, allocate fewer jabs along the edge as stream size increases. Depending on stream size, jab allotment will range from 4-10 jabs in the bank-zone and from 10-16 jabs in the bottom-zone.

6.2.2 Identify the type and amount of bank-zone and bottom-zone habitat.

- Identify the relative amount of pertinent habitat type in each of the respective bank-zone and bottom-zone. Follow the instructions provided in *Appendix B* to identify the presence and relative proportion of pertinent habitat in the sample reach. Specifically, use the appropriate habitat characterization method, 11-transect versus non-transect method, in Appendix B., to determine the relative proportion of pertinent habitat in each collection-zone. Pertinent bottom-zone habitat types are *fine substrate, coarse substrate, detritus and vegetation* (Table 1, in Appendix B). Pertinent bank-zone habitat types are *submerged terrestrial vegetation, submerged tree roots and brush-debris jams* (Table 1, in Appendix B).

6.2.3 Summarize and record the relative amount of each of the pertinent habitat types in the collection-zones.

6.2.4 Determine jab allotments for each of the various habitat types within the bottom-zone and bank-zone.

- Take the jab allocation assigned to a particular collection-zone (Section 6.2.3) and in turn, redistribute this allotment of jabs proportionally among the various habitat types within the respective zone (Section 6.2.4). Essentially, allocate more jabs to the more frequently encountered habitat types.
- Based on the definition of each bottom-zone habitat type (Table 1 in Appendix B) and Equation 1 (see below), translate the relative percentage of the given habitat type (Section 6.2.3) to the number of jabs allocated to *fine substrate, coarse substrate, detritus and vegetation*. Similarly, translate the relative percentage of the given bank-zone habitat type to the number of jabs allocated to *submerged terrestrial vegetation, submerged tree roots and brush-debris jams*.
- If rounding results in more than 20 jabs for the total allocation across all habitat types, decrease the number of jabs allocated to the most-abundant habitat type to limit the total to 20.
- If rounding results in less than 20 jabs for the total allocation across all habitat types, increase the number of jabs allocated to the most-abundant habitat type to expand the total to 20.

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Number of jobs to perform in a particular habitat type within a particular bank-zone or bottom-zone =		
Percentage or length of pertinent habitat type (Table 1 in Appendix B)	÷	Sum of percentages or lengths of all pertinent habitat types
		x
		Number of collection zone jobs allocated (Table 1 in Appendix B)

6.2.5 Summarize job allocation

- Within each of the two collection-zones (bank-zone and bottom-zone), summarize the jobs allocated among each pertinent habitat type. For each zone, if the relative percentage of a habitat type is less than 5%, do not allocate jobs to that type. When transforming relative amounts of habitat types into numbers of jobs, round to the nearest whole number (Equation 1).
- In certain circumstances, rounding to the 20 job target is allowable (see section 6.2.4).
- Occasionally a stream reach will lack bank-zone habitat. In this instance, allocate all 20 jobs to the bottom-zone habitats.

6.2.6 Record the number of jobs allocated to each bottom-zone and bank-zone habitat type.

6.3 Perform 20 jobs.

6.3.1 General guidelines for jobs:

- Collect macroinvertebrates with 20, dip-net jobs, according to the computed job allotment summary obtained in Section 6.2.6.
- Use an 18x9-inch rectangular dip-net with a Standard #30 (600-micron) mesh size.
- One person performs all jobs taken within both collection zones (bank-zone or bottom-zone).
- For each of the given habitat types, take jobs in the more productive, areas. More productive areas generally occur where current velocity is relatively high. To minimize the potential for sampling bias attributable to uneven spatial distribution of macroinvertebrates throughout an entire sampling reach, distribute multiple jobs in more productive, areas of a particular habitat type as evenly as possible throughout the sampling reach-- providing the particular habitat type and multiple productive areas within the particular habitat type occur throughout the sample reach. In each of the two collection-zones, bank versus bottom, if there is not enough sampling area to allow performing all of the jobs allocated to a particular habitat type in the given zone, then, perform the remaining jobs among the remaining habitat

types in the given zone. Allocate these remaining jabs in proportions as close as possible to the original allotments. If the bank-zone lacks bank-zone habitat, re-allocate all 20 jabs proportionally among bottom-zone habitats.

- Between jabs (as needed), composite the dip-net contents into a 600-micron sieve bucket or large plastic tub. These containers facilitate debris removal and provide convenient storage when compositing the materials collected with the 20 jabs prior to sample preservation.
- Debris removal (e.g., coarse-particle substrates) greatly facilitates laboratory sub-sampling and sorting of the preserved sample. To remove large objects from the sample, place the material in a dip net, sieve bucket or watertight tub and vigorously agitate, rinse, brush, or pick the objects (as needed) to remove attached organisms. Discard the debris after all macroinvertebrates are removed. Retain all detached macroinvertebrates and return them to the sieve bucket. To remove ultra-fine particles (e.g., silt), rinse the sample in a sieve bucket until the unwanted particles are washed away. Be careful to not splash out any organisms. Remove sand by transferring the collected materials from the dip-net into a shallow plastic pan. Add a small amount of water to the pan (e.g., ~1-inch deep) and swirl the contents being careful to not splash out any organisms. Pour the water and dislodged organisms into the sieve bucket while retaining as much of the sand as possible in the rinse pan.
- After rinsing, drain, bottle and preserve the sample.

6.3.2 Specific instructions:

- To perform a jab, place the net immediately downstream from the targeted bottom-zone or bank-zone habitat type and dislodge macroinvertebrates by disturbing an 18x18-inch area of substrate. At higher water velocities, these activities will flush dislodged substrate and macroinvertebrates directly into the stationary dip-net. At lower velocities, the same activity becomes ineffective and an additional step is required. Immediately after the upper layer of an 18x18-inch patch of substrate is collected, direct several net sweeps through the plume of materials that forms and is momentarily-suspended directly above the just-sampled patch of streambed. If possible, sweep in an upstream direction.
- When large, coarse-particle substrates (e.g., cobble and boulders) are sampled, wash, brush, or pick surface-clinging organisms from each object. Retain all of the dislodged organisms and discard the cleaned object. As needed, use a dip-net, sieve bucket or watertight tub to composite the materials collected with each jab(s). Use the sieve bucket or dip-net to remove excess water or fine particle materials from the sample.
- When fine-particle streambed substrates (e.g., silt/mud, sand) are sampled, disturb and collect bottom materials from the upper 1-inch of streambed in an 18x18-inch patch by repeatedly bumping the leading edge of the dip-net along the streambed surface until the entire sample area is disturbed. Immediately after the upper layer of material from the 18x18-inch patch is collected, complete the jab by repeatedly sweeping the net upstream through the plume of materials that becomes dislodged and momentarily-suspended over the disturbed area of streambed. Before preserving the sample, remove excess fines and sediment (see above).
- Large, pieces of wood are sampled if they occupy an 18x18-inch sample area AND if their dimensions allow fitting these objects into the dip-net AND they have microbial conditioning. When sampling large woody-debris, wash, brush, or pick surface-clinging macroinvertebrates from the collected materials and retain these organisms in the dip net. After all macroinvertebrates are retained, discard the woody debris.

7.0 Sample Preservation.

After completing 20-jabs, sieve and transfer the collected materials to an appropriate leak-proof jar(s). Label the container and preserve the sample with 95% ethanol by immersing the sample material. If a sample contains large amounts of organic debris, check for sufficient preservation within five days (or sooner) of initial "fixing". As needed, decant the spent preservative and add more 95% ethanol to ensure continued sample preservation. Thereafter, periodically check and re-preserve the sample as needed.

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Illinois Environmental Protection Agency

Bureau of Water

Document Control Number 169

**Standard Operating Procedure for
Methods to Collect Aquatic Macroinvertebrates with
Multi-plate Artificial Substrate Samplers**

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1.0 Scope and Application

The Standard Operating Procedure (SOP) describes how to collect aquatic macroinvertebrates with multi-plate, artificial substrate samplers. Use these samples to evaluate aquatic life designated use attainment as well as NPDES permit compliance. The methods outlined in this SOP, generally applies to flowing waters that are non-wadeable.

Aquatic macroinvertebrates are invertebrates that are visible to the unaided eye, retained in a U.S. Standard No. 30 sieve (595-micron mesh size) and live at least a portion of their lives in the water. Refer to Appendix A for the list of SOP-applicable aquatic macroinvertebrates.

2.0 Summary of Method

- Use multi-plate artificial substrate samplers when rivers and streams are non-wadeable.
- Collect macroinvertebrates during June 1st through October 15th.
- Sample in a manner that places three multi-plate artificial substrate samplers per monitoring site.
- Set the samplers in locations that have at least 0.3 feet per second current velocity.
- Place one sampler on the Right Descending Side,
- Place one sampler on the Left Descending Side
- Place one sampler in the Center of Flow.
- The ideal situation for sampler placement by may not always be possible. To ensure colonization of an adequate representation of the macroinvertebrate community, a minimum of three circular multi-plate samplers are installed by IEPA biological staff at each sampling location and left for a period of four to six weeks (Weber, 1976). Samplers should be hung together to be considered as replicates. In larger river systems, such as the Illinois, Mississippi, Ohio, and Wabash, it is recommended that three replicates (one set) be installed near each bank.
- In all cases, suspend samplers well up in the photic zone.
- Retrieve the samplers after 4-6 weeks.
- At a given monitoring site, composite the macroinvertebrates obtained from the three samplers.
- Randomly subsample the composited macroinvertebrates to a fixed count of 300 ± 20 percent individuals.

3.0 Interferences and Corrective Action

Factors affecting colonization of artificial substrates by macroinvertebrates have been discussed in studies by Mason et al. (1973) and Roby (1976) and summarized in methods manuals prepared by the U.S. Geological Survey (Slack et al, 1973) and the U.S. Environmental Protection Agency (Weber, 1973). Variables affecting artificial substrate performance are minimized when possible and consistent between sampling stations. Factors affecting macroinvertebrate colonization which are considered when planning and conducting aquatic investigations are listed below:

- Depth of sample placement
- Light intensity – shading
- Stream velocity
- Season
- Duration of sample placement
- Fluctuating water levels

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- Organism selectivity
- Sedimentation of sampler surfaces
- Predation
- Detritus accumulation
- Organism drift
- Vandalism

Advantages and Limitations (Modified from Weber, 1973)

While some of the factors affecting artificial substrate performance are considered as drawbacks to this sampling approach, there are definite advantages to be considered in utilizing artificial substrates. Some of the more important advantages and limitations of artificial substrates are listed below:

Advantages

- The confounding effects of substrate differences are reduced.
- A higher level of precision is obtained as compared to other sampling devices.
- Quantitatively comparable data are obtained from environments which are virtually impossible to sample with other devices.
- Samples usually contain negligible amounts of extraneous material, permitting quick laboratory processing.
- Artificial substrates may be used as a bioassay tool (Burks and Wilhm, 1977).
- Statistical inferences may be made when replicate samples are taken.
- Substrate standardization allows comparison of data from different investigators.
- In addition to the above, use of uniform artificial substrates allows:
 - biomass and/or productivity estimates
 - calculation of diversity indices
 - detection of subtle differences in certain macroinvertebrate communities not readily apparent from qualitative studies

Limitations

- The need for a long exposure period (4-6 weeks) makes the samplers unsuited for short-term studies.
- Samplers and floats are sometimes difficult to anchor in place and may present a navigation hazard.
- Samplers are vulnerable to vandalism and are often lost.
- Samplers provide no measure of the condition of the natural substrate at a station or of the effect of pollution on that substrate, including settled solids.
- Samplers only record the community that develops during the sampling period, thus reducing the value of the collected fauna as indicators of prior conditions.
- Samplers are selective for drift organisms.

4.0 Safety

Follow the general field-safety guidelines in the Illinois EPA, Bureau of Water Surface Water Section, Field Safety Manual (Document Control Number 151) (Illinois EPA, 1994).

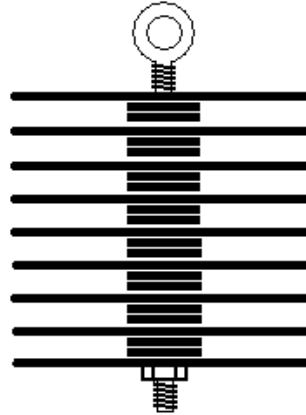
5.0 Equipment and Supplies

- Circular hardboard multi-plate artificial substrate samplers (see schematic)
- 2x8x16-inch concrete blocks (1-per sampler)
- An assortment of assorted length threaded rod plus a sufficient number of threaded couplers to join the rods to the cinder blocks and the multi-plate artificial substrate samplers to the rods.
- Sieve bucket with a 600-micron stainless mesh bottom
- Forceps
- Sample bottles
- 95% ethanol

6.0 General Instructions

A wide variety of artificial substrates has been developed for the evaluation of benthic macroinvertebrate communities. The first samplers of this type consisted of trays of rocks placed in lakes (Moon, 1935). Other investigators have used barbecue baskets filled with limestone rocks (Mason, et al, 1973) or round spheres (Jacobi, 1971). The hardboard multi-plate type sampler was first used by Hester and Dendy (1962) and numerous variations of this artificial substrate design have subsequently evolved (Arthur and Horning, 1969; Fullner, 1971; Parsons and Tatum, 1974; and McDaniel, 1974). Fullner (1971), concluded in a study comparing the effectiveness of basket and multi-plate samplers that the multi-plate sampler collected a wide variety of invertebrates and its performance compared favorably to that of the basket sampler. Mason et al. (1973) similarly found that multi-plate samplers yield samples comparable to the basket samplers and concluded that acceptable collecting efficiency is attained with three replicates.

Weber (1973) recommended using circular multi-plate samplers consisting of 14 hardboard plates, each 7.5 cm in diameter. A modification of this design was developed for use by Illinois EPA staff biologists in 1974 (see Figure 1).



Sampler design consists of nine circular hardboard plates 0.35 mm thick and 7.25 cm in diameter each separated by two circular hardboard spacers 0.35 mm thick and 2.1 cm in diameter. Plates and spacers are strung on a 3/16" eye bolt and secured with a 3/16" nut. Each sampler has 717.4 cm (0.072 m) available for macroinvertebrate colonization. Note that the above diagram is not to scale.

Figure 1. Circular multi-plate hardboard artificial substrate sampler

Applicable Sampler Use

Use multi-plate artificial substrate samplers for sample reaches that are non-wadeable. In general, the multi-plate sampler approach is applicable if less than 50% of the stream is accessible by wading.

Sampler Placement

Install multi-plate samplers in areas which are representative of overall water quality of the stream in question. Use one cinder block to anchor each sampler. Affix a threaded rod to a 2x8x16-inch cinder block, or equivalent, and attach a multi-plate sampler to the free end of the rod. Use threaded couplers to connect the threaded rod(s), multi-plate samplers and cinder blocks. Use various length rods to account for the various water depths encountered among monitoring sites and to suspend samplers well up in the photic zone. Care is taken when placing samplers in water with fluctuating levels.

- Always install multi-plate samplers in flow with a velocity ≥ 0.3 feet per second (Ohio EPA, 1988).
- Place multi-plate sampler at three locations within a given monitoring site.
- Place one sampler on the Right Descending Side,
- Place one sampler on the Left Descending Side
- Place one sampler in the Center of Flow.
- The ideal situation for sampler placement by may not always be possible. To ensure colonization of an adequate representation of the macroinvertebrate community, a minimum of three circular

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multi-plate samplers are installed by IEPA biological staff at each sampling location and left for a period of four to six weeks (Weber, 1976). Samplers should be hung together to be considered as replicates. In larger river systems, such as the Illinois, Mississippi, Ohio, and Wabash, it is recommended that three replicates (one set) be installed near each bank.

- In all cases, suspend the samplers well up in the photic zone.

In deeper waters, suspend the samplers by other methods (e.g., floats, docks etc.). In all cases, suspend the samplers well up in the photic zone.

Sampler Retrieval

Artificial substrate samplers collected after the colonization period of 4-6 weeks and are retrieved individually with the aid of a container with a No. 30 mesh screen bottom. Samplers, once located, are raised very slowly until the collection container can be placed under the sampler and the wire cut. Each sampler along with all organisms attached are then placed in a container of 95% ethanol. If time permits, each circular multi-plate sampler is placed in a bucket of screened water and dismantled. The organisms and debris are then removed from the substrate material. This is accomplished by shaking the material in the bucket of water and by scraping or brushing actions. Care is taken to ensure removal of all the specimens. The water in the bucket is then poured through a U.S. Standard No. 30 sieve to remove the fine particles. All organisms detached in the retrieval process are then placed in sample containers containing 95% ethanol.

Sample processing

- At a given monitoring site, composite the macroinvertebrates obtained from the three samplers.
- Randomly subsample the composited macroinvertebrates to a fixed count of 300 ± 20 percent individuals.

Table 1. Nine plate circular artificial substrate conversions, organisms per sampler to estimated number organisms per square meter.

<u>#/Sampler</u>	<u>#/m2</u>	<u>#/Sampler</u>	<u>#/m2</u>	<u>#Sampler</u>	<u>#/m2</u>	<u>#/Sampler</u>	<u>#/m2</u>
1	14	26	364	51	714	76	1064
2	28	27	378	52	728	77	1078
3	42	28	392	53	742	78	1092
4	56	29	406	54	756	79	1106
5	21	30	1290	55	2365	80	3440
6	258	31	1333	56	2408	81	3483
7	301	32	1376	57	2451	82	3526
8	344	33	1419	58	2494	83	3569
9	387	34	1462	59	2537	84	3612
10	430	35	1505	60	2580	85	3655
11	473	36	1548	61	2623	86	3698
12	516	37	1591	62	2666	87	3741
13	559	38	1634	63	2709	88	3784
14	602	39	1677	64	2752	89	3827
15	645	40	1720	65	2795	90	3870
16	688	41	1763	66	2838	91	3913
17	731	42	1806	67	2881	92	395
18	774	43	1849	68	2924	93	3999
19	817	44	1892	69	2967	94	4042
20	860	45	1935	70	3010	95	4085
21	903	46	1978	71	3053	96	4128
22	946	47	2021	72	3096	97	417
23	989	48	2064	73	3139	98	4214
24	1032	49	2107	74	3182	99	4257
25	1075	50	2150	75	3225	100	4300

Table 1. Nine plate circular artificial substrate conversions, organisms per sampler to estimated number organisms per square meter.

<u>#/Sampler</u>	<u>#/m2</u>	<u>#/Sampler</u>	<u>#/m2</u>	<u>#Sampler</u>	<u>#/m2</u>	<u>#/Sampler</u>	<u>#/m2</u>
1	14	26	364	51	714	76	1064
2	28	27	378	52	728	77	1078
3	42	28	392	53	742	78	1092
4	56	29	406	54	756	79	1106
5	70	30	420	55	770	80	1120
6	84	31	434	56	784	81	1134
7	98	32	48	57	798	83	1148
8	112	33	462	58	812	83	1162
9	126	34	476	59	826	84	1176
10	140	35	490	60	840	85	1190
11	154	36	504	61	854	86	1204
12	168	37	518	62	868	87	1218
13	182	38	532	63	882	88	1232
14	196	39	546	64	896	89	1246
15	210	40	560	65	910	90	1260
16	224	41	574	66	924	91	1274
17	238	42	588	67	938	92	1288
18	252	43	602	68	952	93	1302
19	266	44	616	69	966	94	1316
20	280	45	630	70	980	95	133
21	294	46	644	71	994	96	134
22	308	47	658	72	1008	97	1358
23	322	48	672	73	1022	98	1372
24	336	49	686	74	1036	99	1386
25	350	50	700	75	1050	100	1400

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Illinois Environmental Protection Agency
Bureau of Water
Document Control Number 173

**Standard Operating Procedure for
Methods to Collect Aquatic Macroinvertebrates
with Grab Samplers**

Surface Water Section
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1.0 Scope and Application

The Standard Operating Procedure (SOP) describes how to collect aquatic macroinvertebrates with grab samplers. Occasionally these types of alternative macroinvertebrate collection approaches are required. These alternative approaches are needed when the usual methods of hand-picking, kick sampling or net sweeps are impractical because of the physical setting of the sample reach. Excessive depth in large river systems is one example that may preclude the use of one collection method over another. When conventional sampling devices are impractical, substitute artificial substrate samplers, petite ponar and/or Ekman grabs when appropriate. The time of year, water depth and/or water velocity as well as the study objectives are simultaneously evaluated in order to identify an appropriate sample collection method.

Grabs are devices designed to penetrate the substrate by virtue of their own weight and leverage, and have spring or gravity activated closing mechanisms. In shallow waters, some of these devices may be rigged on poles or rods and physically pushed into the substrate to a predetermined depth. Grabs with spring-activated closing devices include the Ekman, Shipek and Smith-McIntyre; gravity-closing grabs include the Petersen, Ponar and Orange Peel.

Grab samplers currently used by Illinois EPA biological staff include the Petersen, Ponar, Petite Ponar and Ekman. Of the above devices, the Petite Ponar and Ekman are lightweight and designed for hand line operation. The Petersen and Ponar grabs, weighing about 70 lbs. each, are not recommended for hand-line use.

Mechanical grabs are designed for sampling bottom substrates in lakes and slow-to-moderate velocity streams. Because bottom substrates and stream velocity differs widely in the aquatic environment, certain inherent design limitations of grab samplers should be understood before utilizing these samplers in macroinvertebrate investigations.

Aquatic macroinvertebrates are invertebrates that are visible to the unaided eye, retained in a U.S. Standard No. 30 sieve (595-micron mesh size) and live at least a portion of their lives in the water. Refer to Appendix A for the list of SOP-applicable aquatic macroinvertebrates.

2.0 Summary of Method

- Depending on the survey goals, choose an appropriate sample collection location
- Clean the grab sampling equipment
- Set the sampler trigger device
- With a rope, lower the grab sampler to the stream or lake bottom and trigger the jaw closing mechanism
- Retrieve the sampler and empty the grab contents into a sieve bucket
- As needed, rinse the sample in ambient water to remove unwanted debris
- Place the sample in watertight plastic sample bottles
- Label and preserve the sample with 95% Ethanol

3.0 Interferences and Corrective Action

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The time of year has an effect on the size, number and general availability of aquatic forms. Investigations for which the objective is to determine the maximum impact of a certain municipality or industry on a stream community are ideally conducted during summer periods of low stream flow and maximum temperatures. Sampling at other times may also be necessary. Dilution for organic and/or toxic wastes will generally be minimal during low flow periods and elevated stream temperatures will produce maximum fluctuations in diurnal oxygen concentrations. Macroinvertebrate samples collected for basin investigations or long term monitoring stations should be collected during the same time frame to preclude seasonal variability in distribution and abundance from meaningful data evaluations. Illinois EPA conducts macroinvertebrate sampling between June 1st and October 15.

Advantages and Limitations (Modified from Weber, 1973)

Advantages

- Quantitatively comparable data are obtained from environments which are virtually impossible to sample with other devices.
- Statistical inferences may be made when replicate samples are taken.
- Allows biomass and/or productivity estimates

Limitations

- Depth of Penetration and Angle of Closure
- Depth of penetration is a very serious problem and depends on the weight of sampler as opposed to the particle size and degree of compaction of the bottom sediments. The Ekman Grab is light in weight and most useful for sampling soft, finely divided substrates composed of varying proportions of fine sand, clay silt, pulpy peat, and muck. For clay hard pan and coarse substrates, such as coarse sand and gravel, the heavier grabs such as the Ponar and Petersen, are most satisfactory. Auxiliary weights may be added to aid penetration of the substrate and to add stability in heavy currents and rough waters.
- Because of differences in the depth of penetration and the angle of "bite" upon closure, data from the different grabs are not comparable. The Ekman essentially encloses a square which is equal in area from the surface to maximum depth of penetration before closure. In soft substrates, for which this grab is best suited, the penetration is quite deep and the angular closure of the spring-loaded jaws has very little effect on the volume of sample collected. In essence, this means that if the depth of penetration is 15 cm. the organisms lying at that depth have the same opportunity to be sampled as those lying near the surface.
- In clam-shell type devices, such as the Petersen and Ponar, the original penetration is often quite shallow. Because of the sharp angle of "bite" upon closure, the area enclosed by the jaws, as they close, decreases at increasing depths of substrate penetration. Therefore, within the enclosed area, organisms found at greater depths do not have an equal opportunity to be sampled.
- Incomplete Jaw Closure:
- Probably one of the most frustrating aspects of sampling macroinvertebrates with various types of grabs relates to the problem of incomplete closure of the jaws resulting in loss of the sample. Any object, such as clumps of vegetation, woody debris and gravel, that cannot be sheared by the closing action of the jaws often prevents complete closure. In the order of their decreasing ability to shear obstructing materials, the common grabs may be ranked: Ponar, Petersen and Ekman. If the Ekman is filled to within more than 5 cm of the top, there may be loss of substrate material on retrieval. An

advantage of the Ekman grab is that the surface of the sediment can be examined upon retrieval, and only those samples in which the sediment surface is undisturbed are retained.

- Bottom Wash-Out:
- All grabs produce a "shock" wave as they descend. This disturbance can affect the efficiency of the sampler by causing an outward wash (blow-out) of flocculent materials near the mud-water interface that may result in inadequate sampling of near-surface organisms such as phantom midge larvae, and some chironomid midges. The shock wave of the Ekman grab is minimized by the use of hinged, freely-opening top flaps. The Ponar grab is a modified Petersen with side curtains and a screen on the top, allowing water to pass, and thus reducing the shock wave. The shock wave effect is minimized in hand sampling by first obtaining the approximate sampling depth in a trial grab and then marking this depth on the rope with a knot or other means. When approaching this mark on subsequent grabs, the rate of descent is substantially reduced in the final few meters to minimize the bottom wash-out effect.
- In many of the larger rivers, stream velocity presents special problems to grab type sampling devices. In areas of moderate depth and high velocity, it is extremely difficult, if not impossible to get a grab sampler to sit flat on the bottom substrate to achieve a consistent sample "bite". Grab samplers are not used in high velocity situations where a uniform "bite" cannot be ascertained for proper quantification of sample data.

4.0 Safety

Follow the general field-safety guidelines in the Illinois EPA, Bureau of Water Surface Water Section, Field Safety Manual (Document Control Number 151) (Illinois EPA, 1994).

The Petite Ponar dredge is a heavy, center-pivot sampler that presents a pinching hazard when closing. Use caution when handling an open Ponar sampler. Keep the safety pin that locks the jaws open in place at all times other than when collecting a sample. The Eckman dredge is a messenger style spring-loaded jaw sampler that presents a pinching hazard when closing. Use care when handling the sampler while collecting a sample. Transport the sampling device with the jaws in the closed position.

5.0 Equipment and Supplies

- Dredge Sampler Equipment: Petite Ponar dredge or Eckman dredge
- Sieve bucket with Stainless Steel mesh (600 micrometer mesh size)
- Pan (minimum size 12x12x3 inch)
- Ethanol alcohol (90%)
- Non-phosphate Detergent (e.g., Liqui-Nox®)
- Cleaning Brush with non-metallic bristles
- Waterproof Marker and pencil
- Tape and paper for labels
- Sample Bottles:
 - Several plastic 1 gallon jugs
 - Several 250-500 ml plastic bottles
- Forceps

5.0 General Instructions

The spatial and temporal distribution of aquatic macroinvertebrates necessitates special attention be given to: survey objectives, site selection, sampling season and selection of sampling equipment.

5.1 Determine the Survey objectives

Comparative water quality studies

- physicochemical
- chemical

Faunal studies

5.2 Sampling Season

Macroinvertebrate samples collected for basin investigations or long term monitoring stations should be collected during the same time frame to preclude seasonal variability in distribution and abundance from meaningful data evaluations. Illinois EPA conducts macroinvertebrate sampling between June 1st and October 15.

5.3 Select the appropriate sampling gear

Selection of quantitative sampling equipment is influenced by many factors, some of which include study objectives, manpower considerations and equipment availability. Stream size, depth, velocity and type of bottom substrate are other factors which influence selection of appropriate sampling equipment.

5.4 Site Selection

Select an appropriate sampling location based on the type and goals of the study. In general, the sampling locations should be:

- representative of overall stream conditions
- comparable in bottom substrate, depth, velocity and shading

Walk, wade or float (via boat or canoe) to the desired sampling location. Clean and rinse all sampling equipment before use as follows:

- Between each individual sample, the equipment should be picked clean of any debris
- All equipment can then be rinsed with ambient lake water
- All macrophytes and any other debris must be removed from the boat and trailer to avoid the spread of aquatic invasive species.

5.5 Grab Sample Collection

After verifying that the grab sampler is clean set the sampler trigger device. With a rope, lower the grab sampler to the stream or lake bottom and trigger the jaw closing mechanism. The Petite Ponar dredge is a heavy, center-pivot sampler with jaws that trigger shut when the dredge bumps the bottom. The Eckman dredge is a messenger style spring-loaded jaw unit that snaps shut after the weighted messenger is released from the surface, travels down the anchor line and strikes the samplers trigger mechanism. Use

care when handling the sampler while collecting a sample. Transport the sampling device with the jaws in the closed position. Keep the safety pin that locks the jaws open in place at all times other than when collecting a sample.

Slowly retrieve the dredge from the water and empty the grab contents into a sieve bucket. While retrieving the dredge, take care not to create unnecessary turbulence, water currents or waves that might unintentionally flush macroinvertebrates out of the dredge.

5.6 Process the Grab Sample

Macroinvertebrate samples collected with grab devices are field processed prior to adding preservatives and returning to the office. Samples are processed by placing the bottom materials in a square tub and homogenizing this material with an adequate quantity of water. This mixture of organic matter, sediment and aquatic organisms are then to be poured through a Wildco three gallon wash bucket (No. 30 mesh) to facilitate removal of the finer materials. Aquatic invertebrates and debris retained in the wash bucket are then transferred to a container with appropriate preservative. For samples collected with the Ekman or Petite Ponar, conversion of number of organisms per sample to numbers per square meter is made by using Table 1.

Table 1. Conversion of number of organisms per sample to numbers per square meter for samples collected with the Ekman or Petite Ponar dredges.

<u>#/Sampler</u>	<u>#/m2</u>	<u>#/Sampler</u>	<u>#/m2</u>	<u>#Sampler</u>	<u>#/m2</u>	<u>#/Sampler</u>	<u>#/m2</u>
1	43	26	1118	51	2193	76	3268
2	86	27	1161	52	2236	77	3311
3	129	28	1204	53	2279	78	3354
4	172	29	1247	54	2322	79	3397
5	21	30	1290	55	2365	80	3440
6	258	31	1333	56	2408	81	3483
7	301	32	1376	57	2451	82	3526
8	344	33	1419	58	2494	83	3569
9	387	34	1462	59	2537	84	3612
10	430	35	1505	60	2580	85	3655
11	473	36	1548	61	2623	86	3698
12	516	37	1591	62	2666	87	3741
13	559	38	1634	63	2709	88	3784
14	602	39	1677	64	2752	89	3827
15	645	40	1720	65	2795	90	3870

16	688	41	1763	66	2838	91	3913
17	731	42	1806	67	2881	92	395
18	774	43	1849	68	2924	93	3999
19	817	44	1892	69	2967	94	4042
20	860	45	1935	70	3010	95	4085
21	903	46	1978	71	3053	96	4128
22	946	47	2021	72	3096	97	417
23	989	48	2064	73	3139	98	4214
24	1032	49	2107	74	3182	99	4257
25	1075	50	2150	75	3225	100	4300

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Illinois Environmental Protection Agency

Bureau of Water

Document Control Number 176

**Macroinvertebrate Tolerance List and
Functional Feeding Group Classification**

Surface Water Section

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Appendix A. Illinois Environmental Protection Agency Macroinvertebrate Tolerance List and Functional Feeding Group Classification

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Phylogenetic Order

Major Group	Bios ID	Taxon	Tolerance	Functional Feeding Group
Phylum Platyhelminthes	1	Platyhelminthes	99.9	
Class Turbellaria	2	Turbellaria	6	PR
Order Tricladida	3	Tricladida	6	CG
Family Planariidae	4	Planariidae	6	
	5	Dugesia sp.	6	
	6	Dugesia tigrina	6	PR
	7	Planaria sp.	6	
Phylum Nematomorpha	15	Nematomorpha	99.9	PA
Class Gordioida	18	Gordius sp.	99.9	
Phylum Annelida	30	Annelida	99.9	CG
Class Oligochaeta	31	Oligochaeta	10	CG
Order Branchiobdellida	32	Branchiobdellida	10	PA
Family Branchiobdellidae	33	Branchiobdellidae	10	CG
Order Lumbriculida	34	Lumbriculida	10	
Family Lumbriculidae	35	Lumbriculidae	10	CG
Order Haplotaxida	36	Haplotaxida	10	
Family Aeolosomatidae	37	Aeolosomatidae	10	CF
Family Enchytraeidae	38	Enchytraeidae	10	CG
Family Lumbricidae	39	Lumbricidae	10	CG
Order Tubificida	212	Tubificida	10	
Family Naididae	40	Naididae	10	CG
	41	Allonais sp.	10	CG
	42	Allonais pectinata	10	
	43	Amphichaeta sp.	10	CG
	44	Amphichaeta leydigi	10	
	45	Arcteonais sp.	10	
	46	Arcteonais lomondi	10	CG
	47	Bratislavia sp.	10	CG
	48	Bratislavia unidentata	10	CG
	49	Chaetogaster sp.	10	SH
	50	Chaetogaster diaphanus	10	PR
	51	Chaetogaster diastrophus	10	PR
	52	Chaetogaster limnaei	10	PR
	53	Dero sp.	10	CG
	54	Dero digitata	10	CG
	55	Dero furcata	10	CG
	56	Dero lodeni	10	CG
	57	Dero nivea	10	CG
	109	Dero pectinata	10	CG
	58	Nais sp.	10	CG

Functional Feeding Group (ffg)

C=scrapper, PA=parasite, PR=predator, OM=omnivore, GC=gatherer/collector, FC=filter/collector, SH=shredder, PI=piercer

9.9=Taxon excluded from mIBI computation

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59	Nais barbata	10	CG
60	Nais behningi	10	CG
61	Nais bretscheri	10	CG
62	Nais communis	10	CG
63	Nais elinguis	10	CG
64	Nais pardalis	10	CG
65	Nais simplex	10	CG
66	Nais variabilis	10	CG
110	Paranais sp.	10	
67	Paranais frici	10	
68	Ophidonais sp.	10	
69	Ophidonais serpentina	10	CG
70	Pristina sp.	10	CG
71	Pristina aequiseta	10	CG
72	Pristina leidyi	10	CG
73	Pristina breviseta	10	CG
74	Pristina longiseta	10	
75	Pristina osborni	10	CG
76	Pristina synclites	10	CG
77	Slavina sp.	10	CG
78	Slavina appendiculata	10	CG
79	Specaria sp.	10	CG
80	Specaria josinae	10	CG
81	Stephensoniana sp.	10	
82	Stephensoniana trivandrana	10	CG
83	Stylaria sp.	10	
84	Stylaria fossularis	10	CG
85	Stylaria lacustris	10	CG
86	Uncinais sp.	10	
87	Uncinais uncinata	10	
88	Vejdovskyella sp.	10	CG
89	Vejdovskyella intermedia	10	CG
90	Wapsa sp.	10	
91	Wapsa mobilis	10	
Family Tubificidae	92 Tubificidae	10	CG
	93 Aulodrilus pigueti	10	CG
	94 Branchiura sp.	10	CG
	95 Branchiura sowerbyi	10	CG
	96 Ilyodrilus sp.	10	
	97 Ilyodrilus templetoni	10	CG
	98 Limnodrilus sp.	10	CG
	99 Limnodrilus cervix	10	CG
	100 Limnodrilus claparedianus	10	CG
	101 Limnodrilus hoffmeisteri	10	CG

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	102	<i>Limnodrilus udekemianus</i>	10	CG
	103	<i>Tubifex</i> sp.	10	CG
	104	<i>Tubifex tubifex</i>	10	CG
	105	<i>Potamothenis vejovskyi</i>	10	
	108	<i>Quadrilobus multisetosus</i>	10	CG
Class Hirudinea	249	Hirudinea	8	PR
Order Rhynchobdellida	151	Rhynchobdellida	8	
Family Glossiphoniidae	152	Glossiphoniidae	8	PR
	153	<i>Actinobdella</i> sp.	8	
	154	<i>Actinobdella inequiannulata</i>	8	
	155	<i>Alboglossiphonia</i> sp.	8	
	156	<i>Alboglossiphonia heteroclita</i>	8	PR
	157	<i>Batracobdella</i> sp.	8	PR
	158	<i>Batracobdella phalera</i>	8	
	159	<i>Batracobdella picta</i>	8	
Order Pharyngobdellidae	209	Pharyngobdellidae	8	
Family Erpobdellidae	208	<i>Desserobdella phalera</i>	8	
	210	<i>Gloiodbella elongata</i>	8	
Family Glossiphoniidae	160	<i>Glossiphonia</i> sp.	8	PR
	161	<i>Glossiphonia complanata</i>	8	PR
	162	<i>Helobdella</i> sp.	8	PA
	163	<i>Helobdella elongata</i>	8	PR
	164	<i>Helobdella fusca</i>	8	PA
	165	<i>Helobdella papillata</i>	8	PR
	166	<i>Helobdella stagnalis</i>	8	PR
	167	<i>Helobdella triserialis</i>	8	PA
	168	<i>Placobdella montifera</i>	8	PR
	169	<i>Placobdella</i> sp.	8	PR
	170	<i>Placobdella multilineata</i>	8	PR
	171	<i>Placobdella ornata</i>	8	PR
	172	<i>Placobdella papillifera</i>	8	PA
	173	<i>Placobdella parasitica</i>	8	PA
	174	<i>Placobdella pediculata</i>	8	
	175	<i>Theromyzon</i> sp.	8	PR
	176	<i>Theromyzon biannulatum</i>	8	
Family Piscicolidae	177	Piscicolidae	7	
	178	<i>Cystobranchnus verrilli</i>	7	
	179	<i>Cystobranchnus</i> sp.	7	
	180	<i>Myzobdella</i> sp.	7	
	181	<i>Myzobdella lugubris</i>	7	PR
	182	<i>Piscicola</i> sp.	7	PR
	183	<i>Piscicola milneri</i>	7	PR
	184	<i>Piscicola punctata</i>	7	PR
	185	<i>Piscicolaria</i> sp.	7	

Functional Feeding Group (ffg)

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	186	<i>Piscicolaria reducta</i>	7	
Order Gnathobdellida	211	Gnathobdellida	7	
Family Hirudinidae	188	Hirudinidae	8	PR
	189	<i>Haemopsis</i> sp.	7	PR
	190	<i>Haemopsis marmorata</i>	7	
	191	<i>Haemopsis terrestris</i>	7	
	192	<i>Macrobdella</i> sp.	7	
	193	<i>Macrobdella decora</i>	7	
	194	<i>Philobdella</i> sp.	7	
	195	<i>Philobdella gracilis</i>	7	PR
Family Erpobdellidae	197	Erpobdellidae	8	PR
	198	<i>Dina</i> sp.	8	PR
	199	<i>Dina dubia</i>	8	
	200	<i>Dina parva</i>	8	
	201	<i>Erpobdella</i> sp.	8	
	202	<i>Erpobdella punctata</i>	8	PR
	203	<i>Mooreobdella</i> sp.	8	PR
	204	<i>Mooreobdella fervida</i>	8	
	205	<i>Mooreobdella microstoma</i>	8	PR
	206	<i>Nephelopsis</i> sp.	8	
	207	<i>Nephelopsis obscura</i>	8	PR
Phylum Arthropoda	250	Arthropoda	99.9	
Class Crustacea	251	Crustacea	99.9	CG
Order Isopoda	252	Isopoda	99.9	CG
Family Asellidae	253	Asellidae	6	CG
	254	<i>Caecidotea</i> sp.	6	CG
	256	<i>Caecidotea brevicaudus</i>	6	
	347	<i>Caecidotea communis</i>	6	CG
	257	<i>Caecidotea forbesi</i>	6	
	258	<i>Caecidotea intermedia</i>	6	
	259	<i>Caecidotea kendeighi</i>	6	
	263	<i>Caecidotea tridentata</i>	6	
	268	<i>Caecidotea packardi</i>	6	
	269	<i>Caecidotea spatulata</i>	6	
	270	<i>Caecidotea stygia</i>	6	
	255	<i>Asellus</i> sp.	6	
	272	<i>Lirceus</i> sp.	4	CG
	273	<i>Lirceus fontinalis</i>	4	CG
	274	<i>Lirceus garmani</i>	4	CG
	275	<i>Lirceus lineatus</i>	4	CG
	276	<i>Lirceus louisianae</i>	4	
Order Amphipoda	325	Amphipoda	4	CG
Family Talitridae	326	Hyalellidae	4	
	327	<i>Hyalella</i> sp.	4	CG

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	328	<i>Hyalella azteca</i>	5	CG
Family Gammaridae	329	Gammaridae	4	CG
	341	<i>Gammarus</i> sp.	3	
	344	<i>Gammarus pseudolimnaeus</i>	3	CG
	345	<i>Gammarus troglophilus</i>	3	
	346	<i>Gammarus fasciatus</i>	3	CG
	330	<i>Stygobromus</i> sp.	4	PR
	331	<i>Stygobromus subtilis</i>	4	
	332	<i>Bactrurus</i> sp.	1	
Family Crangonyctidae	348	Crangonyctidae	4	
	335	<i>Crangonyx</i> sp.	4	CG
	336	<i>Crangonyx forbesi</i>	4	CG
	337	<i>Crangonyx gracilis</i>	4	CG
	338	<i>Crangonyx minor</i>	4	
	339	<i>Crangonyx packardi</i>	4	
	340	<i>Crangonyx pseudogracilis</i>	4	
Order Decapoda	400	Decapoda	99.9	SH
Family Cambaridae	401	Cambaridae	5	CG
	402	<i>Cambarellus</i> sp.	5	SH
	403	<i>Cambarellus puer</i>	5	CG
	404	<i>Cambarellus shufeldtii</i>	5	CG
	405	<i>Cambarus</i> sp.	5	CG
	406	<i>Cambarus diogenes</i>	5	
	407	<i>Cambarus rusticiformis</i>	5	
	408	<i>Cambarus tenebrosus</i>	5	
	409	<i>Fallicambarus</i> sp.	5	
	410	<i>Fallicambarus fodiens</i>	5	
	411	<i>Orconectes</i> sp.	5	
	412	<i>Orconectes illinoiensis</i>	5	
	413	<i>Orconectes immunis</i>	5	
	414	<i>Orconectes indianensis</i>	5	
	415	<i>Orconectes kentuckiensis</i>	5	
	416	<i>Orconectes lancifer</i>	5	
	417	<i>Orconectes placidus</i>	5	
	418	<i>Orconectes propinquus</i>	5	
	419	<i>Orconectes rusticus</i>	5	
	420	<i>Orconectes stannardi</i>	5	
	421	<i>Orconectes virilis</i>	5	
	430	<i>Orconectes bisectus</i>	5	
	422	<i>Procambarus</i> sp.	5	SH
	423	<i>Procambarus acutus</i>	5	SH
	424	<i>Procambarus clarki</i>	5	
	425	<i>Procambarus gracilis</i>	5	
	426	<i>Procambarus viaeviridis</i>	5	

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Family Palaemonidae	427	Palaemonidae	4	
	428	Palaemonetes sp.	4	
	429	Palaemonetes kadiakensis	4	
Class Insecta	475	Insecta	99.9	
Order Ephemeroptera	476	Ephemeroptera	3	CG
Family Acanthametropodidae	2605	Acanthametropodidae		
	478	Acanthametropus sp.	3	PR
	479	Acanthametropus pecatonica	3	
Family Ameletidae	2604	Ameletidae		
	480	Ameletus sp.	0	CG
	481	Ameletus lineatus	0	
Family Siphonuridae	477	Siphonuridae	3	CG
	482	Siphonurus sp.	2	CG
	483	Siphonurus alternatus	2	
	484	Siphonurus quebecensis	2	
	485	Siphonurus rapidus	2	
Family Oligoneuriidae	486	Oligoneuriidae	3	CF
Family Isonychiidae	487	Isonychia sp.	3	CF
	488	Isonychia arida	3	
	489	Isonychia bicolor	3	CG
	490	Isonychia rufa	3	
	491	Isonychia sayi	3	
	492	Isonychia sicca	3	
Family Metretopodidae	493	Metretopodidae	3	
	494	Siphloplecton sp.	2	CG
	495	Siphloplecton basale	2	
	496	Siphloplecton interlineatum	2	
Family Baetidae	497	Baetidae	4	CG
	652	Acentrella sp.	4	
	2203	Acerpenna sp.	4	SH
	506	Acerpenna macdunnoughi	4	CG
	498	Baetis sp.	4	CG
	645	Baetis amplus	4	CG
	653	Baetis armillatus	4	
	499	Baetis brunneicolor	4	CG
	500	Baetis ephippiatus	4	
	501	Baetis flavistriga	4	CG
	502	Baetis frondalis	4	
	503	Baetis hageni	4	CG
	504	Baetis intercalaris	7	
	646	Baetis levitans	4	
	505	Baetis longipalpus	6	
	507	Baetis propinquus gr.	4	
	508	Acerpenna pygmaeus	4	

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	509	Baetis quilleri	4	
	510	Baetis tricaudatus	1	CG
	650	Barbaetis cestus	4	
	647	Baetis vagans	4	
	511	Callibaetis sp.	4	CG
	512	Callibaetis ferrugineus	4	
	513	Callibaetis fluctuans	4	
	514	Callibaetis skokianus	4	
	515	Centroptilum sp.	2	CG
	661	Dipheteron hageni	4	
	643	Procladius sp.	4	
	516	Cloeon sp.	3	
	517	Cloeon alamance	3	
	518	Cloeon rubropictum	3	
	519	Heterocloeon sp.	4	SC
	520	Heterocloeon curiosum	4	SC
	651	Plauditus sp.	3	
	660	Plauditus armillatus	4	
	657	Plauditus punctiventris	3	
	521	Pseudocloeon sp.	4	SC
	522	Pseudocloeon carolina	4	
	523	Pseudocloeon dubium	4	SC
	524	Pseudocloeon myrsum	4	
	525	Pseudocloeon parvulum	4	
	656	Pseudocloeon propinquus gr.	4	
	526	Pseudocloeon punctiventris	4	
	527	Paracloeodes sp.	4	SC
	2233	Paracloeodes minutus	5	
Family Arthropleidae	2603	Arthropleidae		
	531	Arthroplea sp.	3	CF
	532	Arthroplea bipunctata	3	
Family Heptageniidae	528	Heptageniidae	3.5	SC
	529	Anepeorus sp.	3.5	PR
	530	Anepeorus simplex	3.5	
	533	Epeorus sp.	1	SC
	534	Epeorus vitreus	0	
	535	Heptagenia diabasia	4	
	644	Nixe sp.	4	SC
	655	Nixe perfida	4	
	536	Heptagenia sp.	3	SC
	537	Heptagenia flavescens	2	
	538	Heptagenia hebe	3	
	539	Heptagenia lucidipennis	3	
	540	Heptagenia maculipennis	3	SC

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541	Heptagenia marginalis	1	SC
542	Heptagenia perfida	1	
543	Heptagenia pulla	0	SC
544	Rhithrogena sp.	0	SC
545	Rhithrogena pellucida	0	SC
550	Stenacron sp.	4	SC
548	Stenacron interpunctatum	4	
648	Leucrocuta sp.	3	SC
654	Leucrocuta hebe	3	
649	Leucrocuta maculipennis	3	
551	Maccaffertium sp.	4	SC
565	Maccaffertium ares	3	
552	Maccaffertium exiguum	5	
553	Maccaffertium quinquespinum	5	
556	Maccaffertium integrum	4	
557	Maccaffertium luteum	1	SC
559	Maccaffertium mediopunctatum	2	SC
558	Maccaffertium nepotellum	5	
560	Maccaffertium modestum	3	SC
561	Maccaffertium annexum	4	
563	Maccaffertium pulchellum	3	SC
562	Maccaffertium rubromaculatum	2	
564	Maccaffertium terminatum	4	SC
566	Maccaffertium vicarium	3	SC
659	Stenonema sp.	4	SC
554	Stenonema femoratum	7	SC
Family Ephemerellidae	567 Ephemerellidae	3.5	CG
	568 Attenella sp.	2	CG
	569 Attenella attenuata	2	CG
	570 Dannella sp.	2	
	571 Dannella lita	2	CG
	572 Dannella simplex	2	CG
	573 Drunella sp.	1	PR
	574 Ephemerella cornuta	1	
	575 Drunella cornutella	1	SC
	576 Ephemerella lata	1	
	577 Ephemerella walkeri	1	
	578 Ephemerella sp.	2	CG
	579 Ephemerella aurivillii	2	CG
	580 Ephemerella catawba	2	CG
	581 Ephemerella dorothea	2	CG
	582 Ephemerella excrucians	2	CG
	583 Ephemerella invaria	2	CG
	584 Ephemerella needhami	2	CG

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	585	<i>Ephemerella rotunda</i>	2	
	586	<i>Ephemerella subvaria</i>	2	CG
	587	<i>Eurylophella</i> sp.	4	SC
	588	<i>Eurylophella aestiva</i>	4	
	589	<i>Eurylophella bicolor</i>	4	CG
	590	<i>Ephemerella coxalis</i>	4	
	591	<i>Eurylophella funeralis</i>	4	
	592	<i>Eurylophella lutulenta</i>	4	CG
	593	<i>Eurylophella temporalis</i>	4	CG
	594	<i>Serratella</i> sp.	1	CG
	595	<i>Serratella deficiens</i>	1	CG
	596	<i>Ephemerella frisoni</i>	1	
	597	<i>Serratella sordida</i>	1	CG
Family Leptohyphidae	598	Leptohyphidae	5.5	CG
	662	Leptohyphe sp.	5.5	CG
	599	<i>Tricorythodes</i> sp.	5	CG
Family Caenidae	600	Caenidae	5.5	CG
	601	<i>Brachycercus</i> sp.	3	CG
	602	<i>Caenis</i> sp.	6	CG
Family Baetiscidae	603	Baetiscidae	3	CG
	604	<i>Baetisca bajkovi</i>	3	
	605	<i>Baetisca</i> sp.	3	CG
	606	<i>Baetisca lacustris</i>	3	
	607	<i>Baetisca laurentina</i>	3	
	608	<i>Baetisca obesa</i>	3	
Family Leptophlebiidae	609	Leptophlebiidae	3	CG
	610	<i>Choroerpes</i> sp.	2	CG
	611	<i>Choroerpes basalis</i>	2	CG
	612	<i>Habrophlebiodes</i> sp.	2	SC
	613	<i>Habrophlebiodes americana</i>	2	
	614	<i>Leptophlebia</i> sp.	3	CG
	615	<i>Paraleptophlebia</i> sp.	2	CG
	616	<i>Paraleptophlebia moerens</i>	2	
	617	<i>Paraleptophlebia ontario</i>	2	
	618	<i>Paraleptophlebia praepedita</i>	2	
	619	<i>Paraleptophlebia sticta</i>	2	
Family Potamanthidae	620	Potamanthidae	5	CF
	621	<i>Anthopotamus</i> sp.	4	
	623	<i>Anthopotamus myops</i>	4	
Family Ephemeridae	625	Ephemeridae	5	CG
	626	<i>Ephemera</i> sp.	3	CG
	627	<i>Ephemera simulans</i>	3	CG
	628	<i>Hexagenia</i> sp.	6	CG
	629	<i>Hexagenia atrocaudata</i>	6	CG

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	630	Hexagenia bilineata	6	CG
	631	Hexagenia limbata	5	CG
	632	Hexagenia munda	5	
	633	Hexagenia rigida	6	CG
Family Palingeniidae	635	Pentagenia sp.	4	CF
	636	Pentagenia vittigera	4	CG
Family Polymitarciidae	637	Polymitarciidae	3	CG
	638	Ephoron sp.	2	CG
	639	Ephoron album	2	CG
	640	Ephoron leukon	2	CG
	641	Tortopus sp.	4	CG
Order Odonata	700	Odonata	99.9	PR
Family Cordulegastridae	702	Cordulegastridae	4.5	PR
	703	Cordulegaster sp.	2	PR
	704	Cordulegaster maculata	2	PR
	705	Cordulegaster obliqua	2	PR
Family Gomphidae	706	Gomphidae	4.5	PR
	2602	Erpetogomphus sp.	2	
	2229	Erpetogomphus designatus	2	
	713	Dromogomphus sp.	4	PR
	714	Dromogomphus spinosus	4	PR
	707	Arigomphus sp.	7	PR
	722	Gomphus sp.	7	PR
	738	Gomphus amnicola	7	
	716	Gomphus crassus	7	
	723	Gomphus exilis	7	
	717	Gomphus externus	7	PR
	724	Gomphus graslinellus	7	
	710	Gomphus lentulus	7	
	719	Gomphus lineatifrons	7	
	725	Gomphus lividus	7	PR
	739	Gomphus notatus	7	
	740	Gomphus plagiatus	7	
	726	Gomphus quadricolor	7	
	711	Gomphus submedianus	7	
	741	Gomphus spiniceps	7	
	720	Gomphus vastus	7	PR
	712	Gomphus villosipes	7	
	879	Gomphurus sp.	7	
	737	Stylurus sp.	7	PR
	728	Hagenius sp.	3	PR
	729	Hagenius brevistylus	3	PR
	735	Lanthus sp.	6	PR
	730	Ophiogomphus sp.	2	PR

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	731	<i>Ophiogomphus rupinsulensis</i>	2	
	732	<i>Progomphus</i> sp.	5	PR
	733	<i>Progomphus obscurus</i>	5	PR
	734	<i>Stylogomphus</i> sp.	4.5	PR
	736	<i>Stylogomphus albistylus</i>	4.5	PR
Family Aeshnidae	742	Aeshnidae	4.5	PR
	743	<i>Aeshna</i> sp.	4	PR
	744	<i>Aeshna canadensis</i>	4	
	746	<i>Aeshna constricta</i>	4	PR
	747	<i>Aeshna umbrosa</i>	4	
	748	<i>Aeshna verticalis</i>	4	
	749	<i>Anax</i> sp.	5	PR
	750	<i>Anax junius</i>	5	PR
	751	<i>Basiaeschna</i> sp.	2	PR
	752	<i>Basiaeschna janata</i>	2	PR
	753	<i>Boyeria</i> sp.	3	PR
	754	<i>Boyeria vinosa</i>	3	PR
	755	<i>Epiaeschna</i> sp.	1	PR
	756	<i>Epiaeschna heros</i>	1	PR
	758	<i>Nasiaeschna</i> sp.	2	PR
	757	<i>Nasiaeschna pentacantha</i>	2	PR
Family Macromiidae	759	Macromiidae	4.5	PR
	760	<i>Didymops</i> sp.	4	PR
	761	<i>Didymops transversa</i>	4	PR
	762	<i>Macromia</i> sp.	3	PR
	764	<i>Macromia georgina</i>	3	PR
	765	<i>Macromia illinoiensis</i>	3	PR
	766	<i>Macromia pacifica</i>	3	
	767	<i>Macromia taeniolata</i>	3	PR
Family Corduliidae	768	Corduliidae	4.5	PR
	769	<i>Cordulia</i> sp.	2	PR
	770	<i>Cordulia shurtleffi</i>	2	
	771	<i>Epitheca</i> sp.	4	PR
	772	<i>Epicordulia</i> sp.	4.5	PR
	773	<i>Epicordulia princeps</i>	4.5	PR
	774	<i>Helocordulia</i> sp.	2	PR
	775	<i>Neurocordulia</i> sp.	3	PR
	776	<i>Neurocordulia molesta</i>	3	PR
	777	<i>Neurocordulia obsoleta</i>	3	PR
	778	<i>Neurocordulia yamaskanensis</i>	3	
	779	<i>Somatochlora</i> sp.	1	PR
	781	<i>Somatochlora filosa</i>	1	
	782	<i>Somatochlora linearis</i>	1	PR
	783	<i>Somatochlora tenebrosa</i>	1	

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	784	Tetragoneuria sp.	4.5	PR
	785	Tetragoneuria cynosura	4.5	PR
Family Libellulidae	787	Libellulidae	4.5	PR
	788	Celithemis sp.	2	PR
	789	Celithemis elisa	2	
	790	Celithemis eponina	2	
	791	Celithemis monomelaena	2	
	792	Erythemis sp.	5	PR
	793	Erythemis simplicicollis	5	PR
	794	Erythrodiplax sp.	5	PR
	795	Ladona sp.	4.5	PR
	796	Ladona julia	4.5	
	797	Leucorrhinia sp.	4.5	PR
	799	Leucorrhinia intacta	4.5	
	800	Libellula sp.	8	PR
	801	Libellula cyanea	8	
	802	Libellula incesta	8	PR
	803	Libellula luctuosa	8	
	804	Libellula pulchella	8	
	805	Libellula quadrimaculata	8	
	806	Libellula semifasciata	8	PR
	807	Libellula vibrans	8	PR
	809	Pachydiplax sp.	8	PR
	810	Pachydiplax longipennis	8	PR
	811	Pantala sp.	7	PR
	812	Pantala flavescens	7	
	813	Pantala hymenaea	7	
	814	Perithemis sp.	4	PR
	815	Perithemis tenera	4	PR
	816	Plathemis sp.	3	PR
	817	Plathemis lydia	3	PR
	818	Sympetrum sp.	4	PR
	819	Sympetrum ambiguum	4	PR
	820	Sympetrum corruptum	4	
	821	Sympetrum obstrusum	4	
	822	Sympetrum rubicundulum	4	
	823	Sympetrum semicinctum	4	
	824	Sympetrum vicinum	4	
	825	Tamea sp.	4	PR
	826	Tamea carolina	4	PR
	827	Tamea lacerata	4	
	828	Tamea onusta	4	
	829	Zygoptera	99.9	PR
Family Calopterygidae	830	Calopterygidae	3.5	PR

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	831	Calopteryx sp.	4	PR
	832	Calopteryx aequabilis	4	
	833	Calopteryx maculata	4	PR
	834	Hetaerina sp.	3	PR
	835	Hetaerina americana	3	PR
	836	Hetaerina titia	3	PR
Family Lestidae	837	Lestidae	99.9	PR
	838	Archilestes sp.	1	PR
	839	Archilestes grandis	1	
	840	Lestes sp.	6	PR
	841	Lestes disjunctus	6	
	842	Lestes eurinus	6	
	843	Lestes forcipatus	6	
	844	Lestes inaequalis	6	
	845	Lestes rectangularis	6	
	846	Lestes vigilax	6	
Family Coenagrionidae	847	Coenagrionidae	5.5	PR
	848	Amphiagrion sp.	5	PR
	849	Amphiagrion saucium	5	
	850	Anomalagrion sp.	5.5	PR
	851	Anomalagrion hastatum	5.5	PR
	852	Argia sp.	5	PR
	853	Argia apicalis	5	PR
	854	Argia bipunctulata	5	
	997	Argia fumipennis	5	PR
	855	Argia moesta	5	PR
	856	Argia sedula	5	PR
	857	Argia tibialis	5	PR
	858	Argia translata	5	
	859	Argia violacea	5	PR
	860	Chromagrion sp.	5.5	PR
	861	Chromagrion conditum	5.5	
	862	Coenagrion sp.	5.5	PR
	863	Enallagma sp.	6	PR
	864	Enallagma aspersum	6	
	865	Enallagma civile	6	
	866	Enallagma divagans	6	PR
	867	Enallagma exsulans	6	
	868	Enallagma geminatum	6	
	869	Enallagma hageni	6	
	870	Enallagma signatum	6	PR
	871	Enallagma traviatum	6	
	872	Enallagma vesperum	6	PR
	873	Ischnura sp.	6	PR

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	874	<i>Ischnura posita</i>	6	PR
	875	<i>Ischnura verticalis</i>	6	
	876	<i>Nehalennia</i> sp.	7	PR
	877	<i>Nehalennia gracilis</i>	7	
	878	<i>Nehalennia irene</i>	7	
Order Plecoptera	925	Plecoptera	1.5	PR
Family Pteronarcyidae	927	<i>Pteronarcys</i> sp.	2	SH
Family Taeniopterygidae	928	Taeniopterygidae	1.5	SH
	929	<i>Oemopteryx</i> sp.	1.5	SH
	930	<i>Oemopteryx glacialis</i>	1.5	
	931	<i>Strophopteryx</i> sp.	1.5	
	932	<i>Strophopteryx fasciata</i>	1.5	SH
	933	<i>Taeniopteryx</i> sp.	2	SH
	934	<i>Taeniopteryx nivalis</i>	2	SH
	935	<i>Taeniopteryx parvula</i>	2	SH
Family Nemouridae	936	Nemouridae	1.5	SH
	937	<i>Amphinemura</i> sp.	1.5	SH
	938	<i>Nemoura</i> sp.	1	SH
	939	<i>Nemoura venosa</i>	1	
	940	<i>Prostoia</i> sp.	1.5	SH
	941	<i>Soyedina</i> sp.	1.5	SH
Family Leuctridae	942	Leuctridae	1.5	SH
	943	<i>Leuctra</i> sp.	1	SH
Family Capniidae	944	Capniidae	1.5	SH
	945	<i>Allocaepnia</i> sp.	2	SH
	946	<i>Allocaepnia mystica</i>	1.5	
	947	<i>Allocaepnia recta</i>	1.5	
	948	<i>Allocaepnia vivipara</i>	1.5	SH
	949	<i>Capnia</i> sp.	1	SH
	950	<i>Capnia vernalis</i>	1	
	951	<i>Paracapnia</i> sp.	1.5	SH
	952	<i>Paracapnia angulata</i>	1.5	
	953	<i>Paracapnia opis</i>	1.5	
Family Perlidae	954	Perlidae	1.5	PR
	955	<i>Acroneuria</i> sp.	1	PR
	956	<i>Acroneuria abnormis</i>	1	PR
	957	<i>Acroneuria arida</i>	1	PR
	958	<i>Acroneuria carolinensis</i>	1	PR
	959	<i>Acroneuria evoluta</i>	1	PR
	960	<i>Acroneuria internata</i>	1	PR
	961	<i>Acroneuria lycorias</i>	1	PR
	962	<i>Attaneuria</i> sp.	1.5	
	963	<i>Attaneuria ruralis</i>	1.5	PR
	964	<i>Neoperla</i> sp.	1	PR

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	965	Neoperla clymene	1	PR
	966	Paragnetina sp.	1.5	PR
	967	Paragnetina media	1.5	PR
	968	Perlesta sp.	4	PR
	971	Atoperla sp.	1	
	969	Perlesta placida	4	
	970	Perlinella sp.	2	PR
	972	Perlinella drymo	2	PR
	973	Perlinella ephyre	2	PR
	974	Phasganophora sp.	1.5	PR
	975	Phasganophora capitata	1.5	
Family Perlodidae	976	Perlodidae	1.5	PR
	977	Hydroperla sp.	1	PR
	978	Hydroperla crosbyi	1	
	979	Isogenoides sp.	1.5	PR
	980	Isoperla sp.	2	PR
	981	Isoperla bilineata	2	
	982	Isoperla clio	2	
	996	Isoperla confusa	2	
	983	Isoperla cotta	2	
	984	Isoperla dicala	2	
	985	Isoperla lata	2	
	986	Isoperla marlynia	2	
	987	Isoperla nana	2	
	988	Isoperla richardsoni	2	
Family Chloroperlidae	989	Chloroperlidae	1.5	PR
	990	Chloroperla sp.	3	
	991	Alloperla sp.	1.5	PR
	992	Hastaperla sp.	1.5	SC
	993	Hastaperla brevis	1.5	
	994	Rasvena sp.	1.5	
	995	Rasvena terna	1.5	CG
Order Hemiptera	1050	Hemiptera	99.9	PR
Family Hebridae	1051	Hebridae	99.9	PR
	1052	Hebrus sp.	99.9	PR
	1053	Merragata sp.	99.9	PR
Family Mesoveliidae	1054	Mesoveliidae	99.9	PR
	1055	Mesovelia sp.	99.9	PR
	1056	Mesovelia mulsanti	99.9	PR
Family Gerridae	1057	Gerridae	99.9	PR
	1058	Gerris sp.	99.9	PR
	1059	Limnogonus sp.	99.9	PR
	1060	Limnogonus hesione	99.9	
	1061	Metrobates sp.	99.9	PR

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	1062	Rheumatobates sp.	99.9	PR
	1063	Trepobates sp.	99.9	PR
Family Veliidae	1064	Veliidae	99.9	PR
	1065	Microvelia sp.	99.9	PR
	1066	Rhagovelia sp.	99.9	PR
Family Notonectidae	1067	Notonectidae	99.9	PR
	1068	Buenoa sp.	99.9	PR
	1069	Notonecta sp.	99.9	PR
Family Pleidae	1070	Pleidae	99.9	PR
	1071	Neoplea sp.	99.9	PR
	1072	Neoplea striola	99.9	
Family Naucoridae	1073	Naucoridae	99.9	PR
	1074	Pelocoris sp.	99.9	PR
	1075	Pelocoris femoratus	99.9	PR
Family Nepidae	1076	Nepidae	99.9	PR
	1077	Nepa sp.	99.9	PR
	1078	Nepa apiculata	99.9	
	1079	Ranatra fusca	99.9	PR
	1080	Ranatra sp.	99.9	PR
	1081	Ranatra kirkaldyi	99.9	PR
	1082	Ranatra nigra	99.9	PR
Family Belostomatidae	1083	Belostomatidae	99.9	PR
	1084	Belostoma sp.	99.9	PR
	1085	Belostoma flumineum	99.9	PR
	1086	Lethocerus sp.	99.9	PR
	1087	Lethocerus americans	99.9	
	1088	Lethocerus griseus	99.9	
	1089	Lethocerus uhleri	99.9	
Family Corixidae	1090	Corixidae	99.9	PR
	1091	Hesperocorixa sp.	99.9	PR
	1092	Hesperocorixa interrupta	99.9	
	1094	Hesperocorixa laevigata	99.9	
	1096	Hesperocorixa lucida	99.9	
	1097	Hesperocorixa nitida	99.9	
	1098	Hesperocorixa obliqua	99.9	
	1100	Hesperocorixa vulgaris	99.9	
	1101	Palmacorixa sp.	99.9	PR
	1102	Palmacorixa buenoi	99.9	
	1103	Palmacorixa gillettei	99.9	
	1104	Palmacorixa nana	99.9	
	1105	Ramphocorixa sp.	99.9	PR
	1106	Ramphocorixa acuminata	99.9	
	1107	Sigara sp.	99.9	PR
	1108	Sigara alternata	99.9	

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	1109	<i>Sigara compressoidea</i>	99.9	
	1111	<i>Sigara hubbelli</i>	99.9	
	1113	<i>Sigara modesta</i>	99.9	
	1115	<i>Sigara signata</i>	99.9	
	1117	<i>Trichocorixa</i> sp.	99.9	PR
	1118	<i>Trichocorixa calva</i>	99.9	
	1119	<i>Trichocorixa kanza</i>	99.9	
	1120	<i>Trichocorixa macroceps</i>	99.9	
Order Megaloptera	1175	Megaloptera	3.5	
Family Sialidae	1176	Sialidae	3.5	PR
	1177	<i>Sialis</i> sp.	4	PR
	1180	<i>Sialis infumata</i>	4	
	1181	<i>Sialis itasca</i>	4	
	1183	<i>Sialis mohri</i>	4	PR
	1184	<i>Sialis vagans</i>	4	
	1185	<i>Sialis velata</i>	4	
Family Corydalidae	1186	Corydalidae	3	PR
	1187	<i>Chauliodes</i> sp.	4	PR
	1188	<i>Chauliodes pectinicornis</i>	4	PR
	1189	<i>Chauliodes rastricornis</i>	4	PR
	1190	<i>Corydalis</i> sp.	3	PR
	1191	<i>Corydalis cornutus</i>	3	PR
	1192	<i>Nigronia</i> sp.	2	PR
	1193	<i>Nigronia fasciatus</i>	2	PR
	1194	<i>Nigronia serricornis</i>	2	PR
Order Neuroptera	1250	Neuroptera	99.9	PR
Family Sisyridae	1251	Sisyridae	1	PR
	1252	<i>Climacea</i> sp.	1	
	1253	<i>Climacea areolaris</i>	1	
	1254	<i>Sisyra</i> sp.	1	PR
	1255	<i>Sisyra vicaria</i>	1	
Order Trichoptera	1300	Trichoptera	3.5	
Family Hydropsychidae	1301	Hydropsychidae	5.5	CF
	1302	<i>Cheumatopsyche</i> sp.	6	CF
	1304	<i>Diplectrona</i> sp.	2	CF
	1303	<i>Diplectrona metaqui</i>	2	
	1305	<i>Diplectrona modesta</i>	2	CF
	1306	<i>Hydropsyche</i> sp.	5	CF
	1307	<i>Hydropsyche aerata</i>	5	CF
	1308	<i>Hydropsyche arinale</i>	5	
	1309	<i>Hydropsyche betteni</i>	5	CF
	1310	<i>Hydropsyche bidens</i>	5	
	1333	<i>Ceratopsyche cheilonis</i>	4	
	1332	<i>Ceratopsyche bronta</i>	4	CF

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	1311	Hydropsyche cuanis	5	
	1312	Hydropsyche dicantha	5	CF
	1313	Hydropsyche frisoni	5	CF
	1314	Hydropsyche hageni	5	
	1316	Hydropsyche incommoda	5	
	1493	Ceratopsyche morosa	4	
	1317	Hydropsyche orris	4	CF
	1318	Hydropsyche phalerata	2	CF
	1319	Hydropsyche placoda	4	
	1320	Hydropsyche scalaris	5	CF
	1492	Ceratopsyche alternans	5	CF
	1321	Hydropsyche simulans	5	CF
	1322	Hydropsyche valanis	5	CF
	1323	Hydropsyche venularis	5	CF
	1324	Macronema sp.	2	CF
	2217	Macrostemum sp.	2	CF
	1325	Macronema zebratum	2	CF
	1326	Parapsyche sp.	5.5	PR
	1327	Parapsyche apicalis	5.5	
	1328	Potamyia sp.	4	CF
	1329	Potamyia flava	4	CF
	1330	Ceratopsyche sp.	4	CF
	1496	Ceratopsyche alhedra	4	
	1499	Ceratopsyche slossonae	4	
	1337	Ceratopsyche sparna	4	
Family Philopotamidae	1338	Philopotamidae	3.5	CF
	1339	Chimarra sp.	3	CF
	1340	Chimarra aterrima	3	CF
	1341	Chimarra feria	3	CF
	1342	Chimarra obscura	3	CF
	1343	Chimarra socia	3	CF
	1344	Dolophilodes sp.	0	CG
	1345	Dolophilodes distinctus	0	
	1346	Wormaldia sp.	3.5	CF
	1348	Wormaldia shawnee	3.5	
Family Polycentropodidae	1349	Polycentropodidae	3.5	CF
	1350	Cynellus sp.	5	CF
	1351	Cynellus fraternus	5	CF
	1352	Neureclipsis sp.	3	CF
	1353	Neureclipsis crepuscularis	3	CF
	1354	Neureclipsis bimaculata	3	CF
	1355	Nyctiophylax sp.	1	CF
	1356	Phylocentropus sp.	3.5	CF
	1357	Phylocentropus placidus	3.5	

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	1358	Polycentropus sp.	3	PR
	1359	Polycentropus centralis	3	PR
	1360	Polycentropus cinereus	3	PR
	1361	Polycentropus flavus	3	PR
	1362	Polycentropus glacialis	3	PR
	1363	Polycentropus interruptus	3	PR
	1364	Polycentropus remotus	3	PR
Family Psychomyiidae	1365	Psychomyiidae	3.5	CG
	1366	Lype sp.	3.5	SC
	1367	Lype diversa	3.5	SC
	1368	Psychomyia sp.	2	SC
	1369	Psychomyia flavida	2	CG
Family Glossosomatidae	1370	Glossosomatidae	3.5	SC
	1372	Agapetus sp.	2	SC
	1371	Agapetus illini	2	
	1373	Glossosoma sp.	3.5	SC
	1374	Glossosoma intermedium	3.5	SC
	1375	Protophila sp.	1	SC
Family Hydroptilidae	1376	Hydroptilidae	3.5	PH
	1377	Agraylea sp.	2	PH
	1378	Agraylea multipunctata	2	
	1379	Hydroptila sp.	2	SC
	1500	Hydroptila waubesiana	2	
	1380	Ithytrichia sp.	1	SC
	1381	Leucotrichia sp.	3	SC
	1382	Leucotrichia pictipes	3	
	1384	Mayatrichia sp.	1	SC
	1383	Mayatrichia ayama	1	SC
	1385	Neotrichia sp.	4	SC
	1386	Ochrotrichia sp.	4	CG
	1387	Orthotrichia sp.	1	SC
	1388	Oxyethira sp.	2	MH
	1389	Stactobiella sp.	3.5	SH
	1390	Stactobiella palmata	3.5	
Family Rhyacophilidae	1391	Rhyacophilidae	3.5	PR
	1392	Rhyacophila sp.	1	PR
	1393	Rhyacophila fenestra	1	
	1394	Rhyacophila fuscata	1	PR
	1395	Rhyacophila lobifera	1	
	1396	Rhyacophila vibox	1	
Family Brachycentridae	1397	Brachycentridae	3.5	CF
	1398	Brachycentrus sp.	1	CF
	1399	Brachycentrus americanus	1	CF
	1400	Brachycentrus lateralis	1	CF

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	1401	Brachycentrus numerosus	1	CF
	1402	Brachycentrus occidentalis	1	CF
	1403	Micrasema sp.	3.5	MH
	1404	Micrasema rusticum	3.5	
Family Lepidostomatidae	1405	Lepidostomatidae	3.5	SH
	1406	Lepidostoma sp.	3	SH
	1407	Lepidostoma liba	3	
Family Limnephilidae	1408	Limnephilidae	3.5	SH
	1409	Anabolia sp.	3.5	SH
	1410	Frenesia sp.	3.5	SH
	1411	Frenesia missa	3.5	
	1412	Goera sp.	3.5	SC
	1413	Hesperophylax sp.	3.5	SH
	1414	Hesperophylax designatus	3.5	SH
	1415	Hydatophylax sp.	2	SH
	1416	Hydatophylax argus	2	SH
	1417	Ironoquia sp.	3.5	SH
	1418	Leptophylax sp.	3.5	SH
	1420	Limnephilus sp.	3	SH
	1421	Neophylax sp.	3	SC
	1422	Neophylax concinnus	3	
	1423	Platycentropus sp.	3	SH
	1424	Platycentropus radiatus	3	
	1425	Pseudostenophylax sp.	3.5	SH
	1426	Pseudostenophylax uniformis	3.5	
	1427	Pycnopsyche sp.	3	SH
	1428	Pycnopsyche guttifer	3	SH
	1429	Pycnopsyche lepida	3	
	1430	Pycnopsyche luculenta	3	
	1431	Pycnopsyche scabripennis	3	SH
	1432	Pycnopsyche subfasciata	3	SH
Family Molannidae	1433	Molannidae	3.5	CG
	1434	Molanna sp.	3.5	SC
	1435	Molanna blenda	3.5	
	1436	Molanna tryphena	3.5	
	1437	Molanna uniophila	3.5	
Family Phryganeidae	1438	Phryganeidae	3.5	SH
	1439	Agrypnia sp.	3	SH
	1441	Agrypnia vestita	3	
	1442	Banksiola sp.	2	SH
	1443	Banksiola crotchii	2	
	1444	Fabria sp.	3.5	SH
	1445	Fabria inornata	3.5	
	1446	Oligostomis sp.	3.5	PR

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	1447	Oligostomis ocelligera	3.5	PR
	1448	Phryganea sp.	3	
	1449	Ptilostomis sp.	3	SH
Family Helicopsychidae	1450	Helicopsychidae	3.5	SC
	1451	Helicopsyche sp.	2	SC
	1452	Helicopsyche borealis	2	SC
Family Leptoceridae	1453	Leptoceridae	3.5	CG
	1454	Ceraclea sp.	3	CG
	1456	Ceraclea ancylus	3	
	1457	Ceraclea cancellata	3	
	1458	Ceraclea diluta	3	
	1459	Ceraclea flava	3	
	1460	Ceraclea maculata	3	
	1462	Ceraclea nepha	3	
	2510	Ceraclea transversa	3	
	1463	Ceraclea resurgens	3	
	1466	Leptocerus sp.	3	SH
	1467	Leptocerus americanus	3	
	1468	Mystacides sp.	2	CG
	1470	Mystacides sepulchralis	2	
	1471	Nectopsyche sp.	3	SH
	1472	Nectopsyche albida	3	
	1473	Nectopsyche candida	3	
	1474	Nectopsyche diarina	3	
	1475	Nectopsyche exquisita	3	
	1476	Nectopsyche pavida	3	
	1477	Oecetis sp.	5	PR
	1478	Oecetis avara	5	PR
	1479	Oecetis cinerascens	5	PR
	1480	Oecetis eddlestoni	5	PR
	1481	Oecetis inconspicua	5	PR
	2521	Oecetis nocturna	5	
	1482	Oecetis ochracea	5	
	1483	Setodes sp.	3.5	
	1484	Trienodes sp.	3	MH
	1486	Trienodes injustus	3	
	1487	Trienodes marginatus	3	sh
	1488	Trienodes tardus	3	SH
Family Sericostomatidae	1489	Sericostomatidae	3.5	SH
	1490	Agarodes distincta	3.5	
Order Lepidoptera	1550	Lepidoptera	99.9	SH
	1501	Crambidae	99.9	SH
Family Pyralidae	1551	Pyralidae	99.9	SH
	1552	Munroessa sp.	99.9	SH

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	1554	Nymphula sp.	99.9	SH
	1555	Paraponyx sp.	99.9	SH
	1556	Petrophila sp.	5	SC
	1557	Synclyta sp.	99.9	SH
Order Coleoptera	1600	Coleoptera	99.9	PR
Family Gyrinidae	1601	Gyrinidae	99.9	PR
	1602	Dineutus sp. (larvae only)	4	PR
	1603	Dineutus assimilis (larvae only)	4	PR
	1604	Dineutus discolor (larvae only)	4	PR
	1607	Gyrinus sp. (larvae only)	4	PR
	1608	Gyrinus aeneolus (larvae only)	4	PR
	1609	Gyrinus analis (larvae only)	4	
Family Psephenidae	1614	Psephenidae	4	SC
	1616	Psephenus sp.	4	SC
	1615	Psephenus herricki	4	SC
Family Scirtidae	1617	Helodidae	7	SC
	1618	Cyphon sp.	7	SC
	1619	Cyphon americanus	7	
	1620	Cyphon collaris	7	
	1621	Cyphon modestus	7	
	1622	Cyphon nebulosus	7	
	1623	Cyphon obscurus	7	
	1624	Cyphon punctatus	7	
	1625	Cyphon perplexus	7	
	1626	Scirtes sp.	7	SH
	1627	Scirtes orbiculatus	7	
	1628	Scirtes tibialis	7	
Family Haliplidae	1629	Haliplidae	99.9	SH
	1630	Haliplus sp.	99.9	MH
	1631	Haliplus fasciatus	99.9	SH
	1632	Haliplus immaculicollis	99.9	
	1633	Haliplus leopardus	99.9	
	1634	Haliplus pantherinus	99.9	
	1635	Haliplus triopsis	99.9	
	1636	Peltodytes sp.	99.9	SH
	1637	Peltodytes duodecimpunctatus	99.9	
	1638	Peltodytes dunavani	99.9	
	1639	Peltodytes lengi	99.9	
	1640	Peltodytes sexmaculatus	99.9	
Family Hydrophilidae	1641	Hydrophilidae	99.9	PR
	1642	Anacaena sp.	99.9	
	1643	Anacaena limbata	99.9	
	1644	Berosus sp.	99.9	PR
	1646	Berosus fraternus	99.9	

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1647	Berosus infuscatus	99.9	
1649	Berosus peregrinus	99.9	
1650	Berosus pugnax	99.9	
1651	Berosus striatus	99.9	CG
1652	Crenitis sp.	99.9	PR
1653	Cymbiodyta sp.	99.9	CG
1655	Cymbiodyta chamberlaini	99.9	
1656	Cymbiodyta semistriata	99.9	
1657	Cymbiodyta vindicata	99.9	
1658	Enochrus sp.	99.9	CG
1660	Enochrus cinctus	99.9	
1662	Enochrus consortus	99.9	
1663	Enochrus hamiltoni	99.9	
1664	Enochrus ochraceus	99.9	
1665	Enochrus perplexus	99.9	
1666	Enochrus pygmaeus	99.9	
1667	Enochrus sayi	99.9	
1803	Helocombus sp.	99.9	
1668	Helophorus sp.	99.9	SH
1669	Hydrobius sp.	99.9	PR
1670	Hydrobius fuscipes	99.9	
1673	Hydrochara sp.	99.9	CG
1674	Hydrochus sp.	99.9	SH
1675	Hydrophilus sp.	99.9	PR
1676	Laccobius sp.	99.9	PR
1677	Laccobius agilis	99.9	
1678	Laccobius minutoides	99.9	
1679	Paracymus sp.	99.9	PR
1680	Paracymus subcupreus	99.9	
1681	Tropisternus sp.	99.9	PR
1682	Tropisternus blatchleyi	99.9	
1684	Tropisternus lateralis	99.9	CG
1685	Tropisternus mixtus	99.9	
1686	Tropisternus natator	99.9	
Family Dytiscidae	1687 Dytiscidae	99.9	PR
	1688 Acilius sp.	99.9	PR
	1689 Acilius fraternus	99.9	
	1691 Acilius semisulcatus	99.9	
	1692 Agabates sp.	99.9	PR
	1694 Agabus sp.	99.9	PR
	1696 Agabus ambiguus	99.9	
	1698 Agabus disintegratus	99.9	
	1703 Bidessonotus sp.	99.9	PR
	1704 Bidessonotus inconspicuus	99.9	

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	1705	Celina sp.	99.9	PR
	1706	Celina hubbelli	99.9	
	1707	Copelatus sp.	99.9	PR
	1708	Copelatus chevrolati	99.9	
	1709	Copelatus glyphicus	99.9	
	1710	Coptotomus sp.	99.9	PR
	1713	Cybister sp.	99.9	PR
	1714	Cybister fimbriolatus	99.9	
	1715	Deronectes sp.	99.9	PR
	1717	Dytiscus sp.	99.9	PR
	1719	Dytiscus hybridus	99.9	
	1720	Hydaticus sp.	99.9	PR
	1721	Hydaticus modestus	99.9	
	1722	Hydroporus sp.	99.9	PR
	1725	Hydroporus clypealis	99.9	
	1726	Hydroporus consimilus	99.9	
	1728	Hydroporus niger	99.9	
	1729	Hydroporus rufilabris	99.9	
	1733	Hydroporus vittatipennis	99.9	
	1734	Hydrovatus sp.	99.9	PR
	1735	Hydrovatus pustalatus	99.9	PR
	1736	Hygrotus sp.	99.9	PR
	1737	Ilybius sp.	99.9	PR
	1738	Ilybius biguttulus	99.9	
	1739	Laccophilus sp.	99.9	PR
	1740	Laccophilus fasciatus	99.9	PR
	1741	Laccophilus maculosus	99.9	
	1742	Laccophilus proximus	99.9	PR
	1744	Laccornis sp.	99.9	PR
	1745	Liodessus sp.	99.9	PR
	1748	Matus sp.	99.9	PR
	1749	Matus bicarinatus	99.9	
	1751	Rhantus sp.	99.9	PR
	1752	Rhantus binotatus	99.9	
	1753	Thermonectus sp.	99.9	PR
	1754	Thermonectus basillaris	99.9	PR
	1755	Thermonectus ornatcollis	99.9	
	1756	Uvarus sp.	99.9	PR
Family Psephenidae	1760	Dicranopselaphus	4	SC
	1761	Ectopria sp.	4	SC
	1762	Ectopria nervosa	4	SC
	1763	Ectopria thoracica	4	
Family Dryopidae	1764	Dryopidae	4	SH
	1765	Helichus sp.	4	SH

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	1766	Helichus fastigiatus	4	
	1767	Helichus lithophilus	4	
	1768	Helichus striatus	4	
	1769	Pelonomus sp.	4	CG
	1770	Pelonomus obscurus	4	
Family Elmidae	1771	Elmidae	5	CG
	1772	Ancyronyx sp.	2	
	1773	Ancyronyx variegatus	2	CG
	1774	Dubiraphia sp.	5	CG
	1775	Dubiraphia bivittata	2	
	1776	Dubiraphia minima	5	
	1777	Dubiraphia quadrinotata	7	
	1778	Dubiraphia vittata	7	
	1779	Macronychus sp.	2	
	1780	Macronychus glabratus	2	
	1781	Microcylloepus sp.	2	CG
	1782	Microcylloepus pusillus	2	CG
	1783	Optioservus sp.	4	SC
	1784	Optioservus fastiditus	4	SC
	1785	Optioservus ovalis	4	SC
	1786	Optioservus trivittatus	4	SC
	1787	Promoresia sp.	5	SC
	1788	Stenelmis sp.	7	SC
	1789	Stenelmis bicarinata	7	SC
	1790	Stenelmis crenata	7	
	1791	Stenelmis decorata	7	SC
	1792	Stenelmis lateralis	7	SC
	1793	Stenelmis markeli	7	SC
	1794	Stenelmis mera	7	SC
	1795	Stenelmis musgravei	7	SC
	1796	Stenelmis sexlineata	7	SC
	1797	Stenelmis vittipennis	6	
Family Curculionidae	1799	Curculionidae	99.9	SH
	1800	Listronotus sp.	99.9	CF
Family Scirtidae	1801	Elodes sp.	7	
	1802	Prionocyphon sp.	7	SC
Order Diptera	1850	Diptera	10	
Family Blephariceridae	1851	Blephariceridae	0	SC
	1852	Blepharicera sp.	0	SC
Family Tipulidae	1853	Tipulidae	4	SH
	1854	Tipula sp.	4	SH
	1855	Antocha sp.	5	CG
	1856	Dicranota sp.	4	PR
	1857	Eriocera sp.	7	PR

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	1858	Erioptera sp.	4	CG
	2221	Gonomyia sp.	4	CG
	1859	Heliopsis sp.	5	CG
	1860	Hesperoconopa sp.	2	CG
	1861	Hexatoma sp.	4	PR
	1862	Limnophila sp.	4	PR
	1863	Limonia sp.	3	SH
	1864	Ormosia sp.	4	CG
	1865	Pedicia sp.	4	PR
	1866	Pilaria sp.	4	PR
	1867	Prionocera sp.	4	SH
	1868	Pseudolimnophila sp.	2	PR
Family Chaoboridae	1869	Chaoboridae	8	PR
	1870	Chaoborus sp.	8	PR
	1871	Corethrella sp.	8	PR
Family Culicidae	1873	Culicidae	8	CG
	1875	Aedes sp.	8	CF
	1876	Aedes atropalpus	8	
	1879	Aedes canadensis	8	
	1880	Aedes cinereus	8	
	1881	Aedes communis	8	
	1882	Aedes dorsalis	8	
	1885	Aedes flavescens	8	
	1888	Aedes sollicitans	8	
	1889	Aedes sticticus	8	
	1890	Aedes stimulans	8	
	1894	Aedes triseriatus	8	
	1895	Aedes trivittatus	8	
	1896	Aedes vexans	8	
	1897	Anopheles sp.	6	CF
	1898	Anopheles barberi	6	
	1899	Anopheles crucians	6	
	1900	Anopheles earlei	6	
	1901	Anopheles punctipennis	6	
	1902	Anopheles quadrimaculatus	6	
	1903	Anopheles walkeri	6	
	1904	Culex sp.	8	CF
	1905	Culex erraticus	8	
	1906	Culex peccator	8	
	1907	Culex pipiens	8	CF
	1908	Culex quinquefasciatus	8	
	1909	Culex restuans	8	
	1910	Culex salinarius	8	
	1911	Culex tarsalis	8	

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	1912	Culiseta sp.	8	CG
	1913	Culiseta inornata	8	
	1914	Culiseta melanura	8	
	1917	Mansonia sp.	8	CG
	1918	Mansonia perturbans	8	
	1919	Psorophora sp.	8	PR
	1920	Psorophora ciliata	8	
	1921	Psorophora confinnis	8	PR
	1922	Psorophora cyanescens	8	
	1923	Psorophora discolor	8	
	1924	Psorophora ferox	8	
	1925	Psorophora horrida	8	
	1926	Psorophora howardi	8	
	1927	Psorophora varipes	8	
	1928	Uranotaenia sp.	8	CF
	1929	Uranotaenia sapphirina	8	
Family Dixidae	1930	Dixidae	10	CG
	1931	Dixa sp.	10	CG
	2238	Dixella sp.	10	
Family Psychodidae	1933	Psychodidae	11	CG
	2165	Telmatoscopus sp.	11	CG
	1934	Pericoma sp.	11	CG
	1935	Psychoda sp.	11	CG
Family Ceratopogonidae	1936	Ceratopogonidae	5	PR
	1937	Atrichopogon sp.	2	PR
	1938	Bezzia sp.	5	CG
	2166	Ceratopogon sp.	5	PR
	1939	Culicoides sp.	5	PR
	1940	Dasyhelea sp.	5	CG
	1941	Forcipomyia sp.	5	SC
	2167	Monohelea sp.	5	PR
	2223	Nilobezzia sp.	5	PR
	1942	Palpomyia sp.	6	PR
	2596	Serromyia sp.	5	
	1943	Probezzia sp.	5	PR
	2224	Sphaeromyias sp.	5	
	1945	Stilobezzia sp.	5	
Family Simuliidae	1946	Simuliidae	6	CF
	1947	Cnephia sp.	4	CF
	1948	Cnephia pecuarum	4	
	1949	Prosimulium sp.	2	CF
	1950	Prosimulium magnum	2	
	1951	Prosimulium mixtum	2	
	1952	Simulium sp.	6	CF

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	1953	<i>Simulium clarkei</i>	4	
	1954	<i>Simulium corbis</i>	0	
	1955	<i>Simulium decorum</i>	4	CF
	1956	<i>Simulium jenningsi</i>	4	CF
	1957	<i>Simulium luggeri</i>	2	
	1958	<i>Simulium meridionale</i>	1	CF
	1959	<i>Simulium tuberosum</i>	4	CF
	1960	<i>Simulium venustum</i>	6	CF
	1961	<i>Simulium verecundum</i>	6	
	1962	<i>Simulium vittatum</i>	8	CF
Family Chironomidae	1963	Chironomidae	6	CG
Tribe Tanypodinae	2206	Tanypodinae	6	PR
	1965	<i>Ablabesmyia</i> sp.	6	CG
	2168	<i>Ablabesmyia annulata</i>	6	
	2169	<i>Ablabesmyia hauberi</i>	6	
	2501	<i>Ablabesmyia janta</i>	6	
	2502	<i>Ablabesmyia janta</i> var II	6	
	1966	<i>Ablabesmyia mallochi</i>	6	
	1967	<i>Ablabesmyia monilis</i>	6	PR
	1968	<i>Ablabesmyia parajanta</i>	6	
	1969	<i>Ablabesmyia peleensis</i>	6	
	2170	<i>Ablabesmyia tarella</i>	6	
	1970	<i>Clinotanypus</i> sp.	6	PR
	1971	<i>Clinotanypus pinguis</i>	6	PR
	1973	<i>Coelotanypus</i> sp.	4	PR
	1972	<i>Coelotanypus concinnus</i>	6	PR
	2171	<i>Conchapelopia</i> sp.	6	PR
	1974	<i>Djalmabatista</i> sp.	6	PR
	2239	<i>Djalmabatista pulchra</i>	6	
	1975	<i>Guttipelopia</i> sp.	6	PR
	2214	<i>Hayesomyia</i> sp.	5	
	2215	<i>Helopelopia</i> sp.	4	PR
	2509	<i>Hudsonimyia</i> sp.	6	
	1976	<i>Labrundinia</i> sp.	4	PR
	2512	<i>Labrundinia neopilosella</i>	4	
	2241	<i>Labrundinia pilosella</i>	4	
	2172	<i>Labrundinia virescens</i>	6	PR
	1977	<i>Larsia</i> sp.	6	PR
	1978	<i>Macropelopia</i> sp.	7	PR
	2211	<i>Meropelopia</i> sp.	3	
	1979	<i>Natarsia</i> sp.	6	PR
	1980	<i>Nilotanypus</i> sp.	6	PR
	2174	<i>Nilotanypus fimbriatus</i>	6	PR
	2173	<i>Paramerina</i> sp.	6	PR

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	1981	Pentaneura sp.	3	PR
	1982	Procladius sp.	8	PR
	1983	Psectrotanypus sp.	8	PR
	2225	Rheopelopia sp.	3	PR
	1984	Tanypus sp.	8	PR
	2516	Tanypus carinatus	8	
	2175	Tanypus neopunctipennis	8	
	2508	Tanypus punctipennis	8	
	2515	Tanypus stellatus	8	
	1985	Thienemannimyia sp.	6	PR
	2176	Thienemannimyia senata	6	
	1986	Zavreliomyia sp.	8	
	2235	Zavreliomyia sinuosa com	8	
Tribe Diamesinae	2210	Diamesinae	6	
	1988	Diamesa sp.	4	CG
	1989	Odontomesa sp.	6	CG
	1990	Potthastia sp.	6	
	1991	Prodiamesa sp.	3	CG
	1992	Pseudodiamesa sp.	1	CG
	1993	Sympotthastia sp.	6	CG
	1994	Syndiamesa sp.	6	CG
Tribe Orthocladiinae	1995	Orthocladiinae	6	CG
	2202	Orthocladius sp./Cricotopus sp.	6	
	1996	Brillia sp.	6	SH
	1997	Cardiocladius sp.	6	PR
	1998	Chaetocladius sp.	6	CG
	1999	Corynoneura sp.	2	CG
	2177	Corynoneura taris	2	CG
	2000	Cricotopus sp.	8	SH
	2001	Cricotopus bicinctus	10	
	2002	Cricotopus intersectus	8	SH
	2003	Cricotopus sylvestris	8	
	2004	Cricotopus trifascia	6	
	2209	Epoicocladius sp.	6	CG
	2005	Eukiefferiella sp.	4	CG
	2006	Heterotrissocladius sp.	6	CG
	2007	Hydrobaenus sp.	2	SC
	2250	Gymnometriocnemus sp.	6	
	2578	Lopescladius sp.	4	
	2008	Metriocnemus sp.	6	CG
	2009	Nanocladius sp.	3	CG
	2178	Nanocladius distinctus	3	CG
	2010	Orthocladius sp.	4	CG
	2216	Parakiefferiella sp.	5	

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	2011	Parametriocnemus sp.	4	CG
	2179	Paraphaenocladus sp.	6	CG
	2012	Psectrocladius sp.	5	CG
	2597	Psilometriocnemus sp.	6	
	2013	Pseudorthocladus sp.	6	CG
	2014	Rheocricotopus sp.	6	CG
	2180	Rheocricotopus fuscipes	6	
	2246	Rheocricotopus robacki	6	
	2015	Smittia sp.	6	CG
	2220	Stilocladus sp.	6	
	2213	Tvetenia sp.	5	
	2016	Thienemanniella sp.	2	CG
	2017	Thienemanniella xena	2	CG
	2200	Zalutschia sp.	6	SH
Tribe Chironomini	2205	Chironomini	6	CG
	2201	Axarus sp.	6	CG
	2019	Chironomus sp.	11	CG
	2020	Chironomus anthracinus	11	
	2021	Chironomus attenuatus	10	
	2022	Chironomus decorus	11	
	2023	Chironomus plumosus	11	
	2024	Chironomus riparius	11	
	2186	Chironomus staegeri	11	
	2025	Cladopelma sp.	6	CG
	2026	Cryptochironomus sp.	8	PR
	2027	Cryptochironomus digitatus	8	
	2028	Cryptochironomus fulvus	8	PR
	2029	Cryptotendipes sp.	6	CG
	2030	Demicryptochironomus sp.	6	CG
	2031	Dicrotendipes sp.	6	CG
	2523	Dicrotendipes lucifer	6	
	2032	Dicrotendipes modestus	6	CG
	2033	Dicrotendipes neomodestus	6	CG
	2034	Dicrotendipes nervosus	6	
	2517	Dicrotendipes simpsoni	6	
	2524	Dicrotendipes tritonus	6	
	2035	Einfeldia sp.	10	CG
	2189	Einfeldia austeni	10	
	2240	Einfeldia pagana	10	
	2036	Endochironomus sp.	6	SH
	2037	Endochironomus nigricans	6	SH
	2038	Endochironomus subtendens	6	SH
	2039	Glyptotendipes sp.	10	CF
	2533	Glyptotendipes amplus	10	

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2040	Glyptotendipes lobiferus	10	SH
2041	Glyptotendipes paripes	10	
2042	Harnischia sp.	6	CG
2255	Hyporhygma quadripunctatum	4	
2043	Kiefferulus sp.	7	CG
2518	Lipiniella sp.	6	
2044	Microchironomus sp.	6	CG
2045	Microtendipes sp.	6	CF
2046	Microtendipes caducus	6	
2047	Microtendipes pedellus	6	CF
2208	Nilothauma sp.	3	
2048	Parachironomus sp.	8	PR
2194	Parachironomus carinatus	8	PR
2195	Parachironomus directus	8	
2242	Parachironomus frequens	8	
2049	Parachironomus monochromus	8	
2525	Parachironomus pectinatella	4	
2520	Parachironomus tenuicaudatus	8	
2050	Paracladopelma sp.	4	CG
2537	Paracladopelma nereis	4	CG
2052	Paralauterborniella sp.	6	CG
2243	Paralauterborniella nigrohalteralis	6	
2053	Paratendipes sp.	3	CG
2251	Pagastiella sp.	6	
2244	Paratendipes albimanus	3	
2054	Phaenopsectra sp.	4	SC
2055	Phaenopsectra flavipes	4	SC
2507	Phaenopsectra obediens gr.	4	
2245	Phaenopsectra punctipes gr.	4	
2057	Polypedilum sp.	6	SH
2540	Polypedilum aviceps	6	
2058	Polypedilum convictum gr.	6	SH
2065	Polypedilum digitifer	6	SH
2060	Polypedilum fallax	6	SH
2541	Polypedilum flavum	6	
2061	Polypedilum halterale	4	SH
2062	Polypedilum illinoense	5	SH
2059	Polypedilum obtusum	6	SH
2063	Polypedilum scalaenum	6	SH
2064	Polypedilum simulans	6	SH
2066	Pseudochironomus sp.	5	CG
2198	Pseudochironomus fulviventris	5	
2199	Pseudochironomus prasinatus	5	
2218	Robackia sp.	3	CG

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	2067	Saetheria sp.	6	CG
	2514	Seatheria tylus	4	
	2068	Stenochironomus sp.	3	SH
	2069	Stenochironomus hilaris	3	CG
	2219	Stelechomyia	6	CG
	2247	Stelechomyia pulpulchra	99.9	CG
	2070	Stictochironomus sp.	5	
	2519	Stictochironomus cafferarius	5	
	2248	Stictochironomus devinctus	5	
	2071	Tribelos sp.	5	CG
	2197	Tribelos fuscicorne	4	CG
	2232	Tribelos jucundus	5	
	2072	Xenochironomus sp.	4	PR
	2513	Xenochironomus xenolabis	6	
	2227	Xestochironomus sp.	6	
	2249	Xylotopus par.	6	
	3433	Zavreliella sp.	2	PR
	2254	Zavreliella marmorata	2	
Tribe Tanytarsini	2207	Tanytarsini	6	CF
	2074	Cladotanytarsus sp.	7	CG
	2503	Cladotanytarsus daviese	7	
	2504	Cladotanytarsus species a	7	
	2236	Cladotanytarsus species b	7	
	2505	Cladotanytarsus species c	7	
	2237	Cladotanytarsus species f	7	
	2506	Cladotanytarsus species h	7	
	2075	Micropsectra sp.	4	CG
	2076	Paratanytarsus sp.	6	CG
	2077	Rheotanytarsus sp.	6	CF
	2226	Stempellina sp.	2	CG
	2212	Stempellinella sp.	2	CG
	2228	Sublettea sp.	6	CF
	2078	Tanytarsus sp.	7	CF
	2230	Tanytarsus guerlus	7	
	2231	Tanytarsus glabrescan	7	
Family Ptychopteridae	2079	Ptychopteridae	8	CG
	2080	Bittacomorpha sp.	8	CG
	2081	Ptychoptera sp.	8	CG
Family Stratiomyidae	2082	Stratiomyidae	10	CG
	2092	Allognosta sp.	10	CG
	2083	Odostomia sp.	10	CG
	2084	Odostomia cincta	10	
	2085	Oxycera sp.	10	SC
	2086	Stratiomys sp.	10	CF

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	2087	Stratiomys discalis	10	
	2088	Stratiomys meigeni	10	
Family Tabanidae	2089	Tabanidae	7	PR
	2090	Atylotus sp.	7	PR
	2091	Atylotus bicolor	7	
	2143	Chlorotabanus sp.	7	
	2093	Chrysops sp.	7	CG
	2094	Chrysops aberrans	7	
	2097	Chrysops brunneus	7	
	2098	Chrysops callidus	7	
	2100	Chrysops cincticornis	7	
	2101	Chrysops dimmocki	7	
	2103	Chrysops flavidus	7	
	2105	Chrysops geminatus	7	
	2106	Chrysops macquarti	7	
	2108	Chrysops moechus	7	
	2109	Chrysops montanus	7	
	2110	Chrysops niger	7	
	2115	Chrysops striatus	7	
	2116	Chrysops univittatus	7	
	2118	Chrysops vittatus	7	
	2119	Hybomitra sp.	7	PR
	2125	Tabanus sp.	7	PR
	2126	Tabanus atratus	7	
	2127	Tabanus cymatophorus	7	
	2128	Tabanus fairchildi	7	
	2130	Tabanus lineola	7	
	2131	Tabanus marginalis	7	
	2132	Tabanus nigrescens	7	
	2133	Tabanus pumilus	7	
	2134	Tabanus quinquevittatus	7	
	2135	Tabanus reinwardtii	7	
	2136	Tabanus sparus	7	
	2137	Tabanus stygius	7	
	2139	Tabanus subsimilis	7	
	2140	Tabanus sulcifrons	7	
	2141	Tabanus superjumentarius	7	
	2142	Tabanus trimaculatus	7	
Family Dolichopodidae	2144	Dolichopodidae	5	PR
	2145	Hydrophorus sp.	99.9	PR
	2594	Raphium sp.	99.9	
Family Empididae	2146	Empididae	6	PR
	2147	Hemerodromia sp.	6	PR
	2595	Rhamphomyia sp.	1.0	

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Family Syrphidae	2148	Syrphidae	11	CG
	2149	Chrysogaster sp.	11	CG
	2150	Eristalis sp.	11	CG
Family Ephydriidae	2151	Ephydriidae	8	CG
	2152	Ephydra sp.	8	CG
Family Sciomyzidae	2153	Sciomyzidae	10	PR
	2154	Dictya sp.	10	PR
	2155	Dictya pictipes	10	
Family Muscidae	2156	Muscidae	8	PR
	2157	Limnophora sp.	8	PR
Family Athericidae	2158	Athericidae	10	
	2159	Atherix sp.	10	PR
	2160	Atherix variegata	4	PR
Phylum Mollusca	2300	Mollusca	99.9	
Class Gastropoda	2301	Gastropoda	99.9	SC
Order Mesogastropoda	2599	Mesogastropoda	99.9	
Family Viviparidae	2302	Viviparidae	6	SC
	2303	Campeloma sp.	7	SC
	2304	Lioplax sp.	7	SC
	2305	Viviparus sp.	1	SC
	2306	Valvatidae	6	SC
	2307	Valvata sp.	2	SC
Family Bithyniidae	2308	Bithyniidae	6	
	2309	Bithynia sp.	6	
Family Hydrobiidae	2310	Hydrobiidae	6	SC
	2312	Amnicola sp.	4	SC
	2313	Amnicola walkeri	4	
	2314	Cincinnatia sp.	6	SC
	2315	Marstonia sp.	6	
	2316	Probythinella sp.	6	
	2317	Pyrgulopsis sp.	6	SC
	2318	Somatogyrus sp.	6	
Family Pleuroceridae	2319	Pleuroceridae	6	
	2320	Elimia sp.	6	SC
	2321	Goniobasis sp.	5	SC
	2322	Leptoxis sp.	6	
	2323	Lithasia sp.	6	
	2324	Pleurocera sp.	7	SC
	2325	Pleurocera acuta	7	SC
Family Pomatiopsidae	2326	Pomatiopsidae	6	
	2327	Pomatiopsis sp.	6	
Family Physidae	2328	Physidae	9	SC
	2329	Aplexa sp.	7	
	2330	Physa sp.	9	SC

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	2351	Physa acuta	9	
	2361	Physa integra	9	CG
	2331	Physella sp.	9	SC
	2352	Physella sayi	9	
Family Lymnaeidae	2332	Lymnaeidae	7	SC
	2333	Acella sp.	7	
Order Basommatophora	2598	Basommatophora	7	
	2334	Fossaria sp.	7	SC
	2362	Fossaria obrussa	7	
	2335	Lymnaea sp.	7	SC
	2336	Pseudosuccinea sp.	7	SC
	2355	Pseudosuccinea columella	7	SC
	2337	Stagnicola sp.	7	SC
	2338	Stagnicola emarginatus	7	
Family Planorbidae	2339	Planorbidae	6.5	SC
	2340	Gyraulus sp.	6	SC
	2341	Helisoma sp.	7	SC
	2342	Menetus sp.	6.5	SC
	2343	Planorbella sp.	6.5	SC
	2357	Planorbella truncata	6.5	
	2344	Planorbula sp.	7	SC
	2345	Promenetus sp.	6.5	CG
Family Ancyliidae	2346	Ancyliidae	7	SC
	2347	Ferrissia sp.	7	SC
	2358	Ferrissia rivularis	7	SC
	2348	Laevapex sp.	6	SC
	2359	Laevapex fuscus	6	SC
	2360	Laevapex diaphanus	6	SC
Class Pelecypoda	2400	Pelecypoda	99.9	CF
Order Unionoida	2600	Unionoida	99.9	
Family Unionidae	2401	Unionidae	1.5	CF
	2402	Actinonaias sp.	1.5	
	2403	Actinonaias carinata	1	
	2404	Actinonaias ellipsiformis	1.5	
	2405	Actinonaias ligamentina	1.5	
	2406	Alasmidonta sp.	1.5	CF
	2407	Alasmidonta calceolus	1.5	
	2408	Alasmidonta marginata	1	
	2409	Alasmidonta triangulata	1.5	
	2410	Amblema sp.	1.5	
	2411	Amblema plicata	1.5	
	2412	Anodonta sp.	3	CF
	2413	Anodonta grandis	3	
	2415	Anodonta imbecilis	3	

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2416	Anodonta suborbiculata	3	
2417	Anodontoides sp.	1.5	CF
2418	Anodontoides ferussacianus	1.5	
2419	Arcidens sp.	1.5	CF
2420	Arcidens confragosus	1.5	
2421	Carunculina sp.	7	CF
2500	Toxolasma paruvus	7	
2423	Carunculina parva	7	
2424	Toxolasma texasensis	7	
2425	Cyclonaias sp.	1.5	
2426	Cyclonaias tuberculata	1.5	
2427	Cyprogenia sp.	1.5	
2428	Cyprogenia irrorata	1.5	
2429	Dysnomia sp.	1.5	
2431	Dysnomia triquetra	1.5	
2432	Elliptio sp.	2	CF
2433	Elliptio crassidens	2	
2434	Elliptio dilatata	2	
2435	Fusconaia sp.	1	
2436	Fusconaia ebena	1	
2437	Fusconaia flava	1	
2438	Lampsilis sp.	1	CF
2439	Lampsilis teres	1	CF
2498	Lampsilis fasciola	1	
2441	Lampsilis radiata	1	
2442	Lampsilis ventricosa	1	
2443	Lampsilis orbiculata	1	
2444	Lampsilis higginsii	1	
2445	Lasmigona sp.	1.5	
2446	Lasmigona complanata	1.5	
2447	Lasmigona compressa	1.5	
2448	Lasmigona costata	1.5	
2449	Leptodea sp.	1.5	CF
2450	Leptodea fragilis	1.5	
2451	Ligumia sp.	1	CF
2452	Ligumia recta	1	
2453	Ligumia subrostrata	1	
2454	Megaloniaias sp.	1.5	
2455	Megaloniaias nervosa	1.5	
2456	Obliquaria sp.	1	
2457	Obliquaria reflexa	1	
2458	Obovaria sp.	1.5	
2459	Obovaria olivaria	1.5	
2460	Obovaria subrotunda	1.5	

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	2462	<i>Plagiola lineolata</i>	1.5	
	2463	<i>Plethobasus</i> sp.	1.5	
	2464	<i>Plethobasus cyphus</i>	1.5	
	2465	<i>Pleurobema</i> sp.	1.5	
	2466	<i>Pleurobema cordatum</i>	1.5	
	2467	<i>Proptera</i> sp.	1	
	2468	<i>Proptera alata</i>	1	
	2469	<i>Proptera capax</i>	1	
	2470	<i>Proptera laevissimus</i>	1	
	2471	<i>Ptychobranhus</i> sp.	1.5	
	2472	<i>Ptychobranhus fasciolaris</i>	1.5	
	2473	<i>Quadrula</i> sp.	1.5	
	2474	<i>Quadrula cyclindrica</i>	1.5	
	2475	<i>Quadrula metanerva</i>	1.5	
	2476	<i>Quadrula nodulata</i>	1.5	
	2477	<i>Quadrula pustulosa</i>	1.5	
	2478	<i>Quadrula quadrula</i>	1.5	
	2479	<i>Strophitus</i> sp.	4	
	2480	<i>Strophitus undulatus</i>	4	
	2481	<i>Tritogonia</i> sp.	1	
	2482	<i>Tritogonia verrucosa</i>	1	
	2483	<i>Truncilla</i> sp.	1	
	2484	<i>Truncilla donaciformis</i>	1	
	2485	<i>Truncilla truncata</i>	1	
	2486	<i>Uniomerus</i> sp.	1.5	
	2487	<i>Uniomerus tetralasmus</i>	1.5	
	2488	<i>Villosa</i> sp.	1	
	2489	<i>Villosa iris</i>	1	
	2490	<i>Villosa lienosa</i>	1	
Order Venerioda	2601	Veneroida	5	
Family Pisidiidae	2499	Pisidiidae	5	
Family Sphaeriidae	2491	Sphaeriidae	5	
	2492	<i>Musculium</i> sp.	5	CF
	2493	<i>Musculium transversum</i>	5	CF
	2494	<i>Pisidium</i> sp.	5	CF
	2495	<i>Sphaerium</i> sp.	5	CG
Family Corbiculidae	2497	<i>Corbicula</i> sp.	4	CF
Family Dreissenidae	2234	<i>Dreissena polymorpha</i>	99.9	

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Bios ID	Taxon	Tolerance	Functional Feeding Group
2168	Ablabesmyia annulata	6	
2169	Ablabesmyia hauberi	6	
2501	Ablabesmyia janta	6	
2502	Ablabesmyia janta var II	6	
1966	Ablabesmyia mallochi	6	
1967	Ablabesmyia monilis	6	PR
1968	Ablabesmyia parajanta	6	
1969	Ablabesmyia peleensis	6	
1965	Ablabesmyia sp.	6	CG
2170	Ablabesmyia tarella	6	
2605	Acanthametropodidae		
479	Acanthametropus pecatonica	3	
478	Acanthametropus sp.	3	PR
2333	Acella sp.	7	
652	Acentrella sp.	4	
506	Acerpenna macdunnoughi	4	CG
508	Acerpenna pygmaeus	4	
2203	Acerpenna sp.	4	SH
1689	Acilius fraternus	99.9	
1691	Acilius semisulcatus	99.9	
1688	Acilius sp.	99.9	PR
956	Acroneuria abnormis	1	PR
957	Acroneuria arida	1	PR
958	Acroneuria carolinensis	1	PR
959	Acroneuria evoluta	1	PR
960	Acroneuria internata	1	PR
961	Acroneuria lycorias	1	PR
955	Acroneuria sp.	1	PR
154	Actinobdella inequiannulata	8	
153	Actinobdella sp.	8	
2403	Actinonaias carinata	1	
2404	Actinonaias ellipsiformis	1.5	
2405	Actinonaias ligamentina	1.5	
2402	Actinonaias sp.	1.5	
1876	Aedes atropalpus	8	
1879	Aedes canadensis	8	
1880	Aedes cinereus	8	
1881	Aedes communis	8	
1882	Aedes dorsalis	8	
1885	Aedes flavescens	8	
1888	Aedes sollicitans	8	
1875	Aedes sp.	8	CF

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1889	<i>Aedes sticticus</i>	8	
1890	<i>Aedes stimulans</i>	8	
1894	<i>Aedes triseriatus</i>	8	
1895	<i>Aedes trivittatus</i>	8	
1896	<i>Aedes vexans</i>	8	
37	Aeolosomatidae	10	CF
744	<i>Aeshna canadensis</i>	4	
746	<i>Aeshna constricta</i>	4	PR
743	<i>Aeshna</i> sp.	4	PR
747	<i>Aeshna umbrosa</i>	4	
748	<i>Aeshna verticalis</i>	4	
742	Aeshnidae	4.5	PR
1692	<i>Agabetes</i> sp.	99.9	PR
1696	<i>Agabus ambiguus</i>	99.9	
1698	<i>Agabus disintegratus</i>	99.9	
1694	<i>Agabus</i> sp.	99.9	PR
1371	<i>Agapetus illini</i>	2	
1372	<i>Agapetus</i> sp.	2	SC
1490	<i>Agarodes distincta</i>	3.5	
1378	<i>Agraylea multipunctata</i>	2	
1377	<i>Agraylea</i> sp.	2	PH
1439	<i>Agrypnia</i> sp.	3	SH
1441	<i>Agrypnia vestita</i>	3	
2407	<i>Alasmidonta calceolus</i>	1.5	
2408	<i>Alasmidonta marginata</i>	1	
2406	<i>Alasmidonta</i> sp.	1.5	CF
2409	<i>Alasmidonta triangulata</i>	1.5	
156	<i>Alboglossiphonia heteroclita</i>	8	PR
155	<i>Alboglossiphonia</i> sp.	8	
946	<i>Allocapnia mystica</i>	1.5	
947	<i>Allocapnia recta</i>	1.5	
945	<i>Allocapnia</i> sp.	2	SH
948	<i>Allocapnia vivipara</i>	1.5	SH
2092	<i>Allognosta</i> sp.	10	CG
42	<i>Allonais pectinata</i>	10	
41	<i>Allonais</i> sp.	10	CG
991	<i>Alloperla</i> sp.	1.5	PR
2411	<i>Amblyma plicata</i>	1.5	
2410	<i>Amblyma</i> sp.	1.5	
2604	Ameletidae		
481	<i>Ameletus lineatus</i>	0	
480	<i>Ameletus</i> sp.	0	CG
2312	<i>Amnicola</i> sp.	4	SC
2313	<i>Amnicola walkeri</i>	4	

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849	<i>Amphiagrion saucium</i>	5	
848	<i>Amphiagrion</i> sp.	5	PR
44	<i>Amphichaeta leydigi</i>	10	
43	<i>Amphichaeta</i> sp.	10	CG
937	<i>Amphinemura</i> sp.	1.5	SH
325	<i>Amphipoda</i>	4	CG
1409	<i>Anabolia</i> sp.	3.5	SH
1643	<i>Anacaena limbata</i>	99.9	
1642	<i>Anacaena</i> sp.	99.9	
750	<i>Anax junius</i>	5	PR
749	<i>Anax</i> sp.	5	PR
2346	Ancyliidae	7	SC
1772	<i>Ancyronyx</i> sp.	2	
1773	<i>Ancyronyx variegatus</i>	2	CG
530	<i>Anepeorus simplex</i>	3.5	
529	<i>Anepeorus</i> sp.	3.5	PR
30	Annelida	99.9	CG
2413	<i>Anodonta grandis</i>	3	
2415	<i>Anodonta imbecilis</i>	3	
2412	<i>Anodonta</i> sp.	3	CF
2416	<i>Anodonta suborbiculata</i>	3	
2418	<i>Anodontoides ferussacianus</i>	1.5	
2417	<i>Anodontoides</i> sp.	1.5	CF
851	<i>Anomalagrion hastatum</i>	5.5	PR
850	<i>Anomalagrion</i> sp.	5.5	PR
1898	<i>Anopheles barberi</i>	6	
1899	<i>Anopheles crucians</i>	6	
1900	<i>Anopheles earlei</i>	6	
1901	<i>Anopheles punctipennis</i>	6	
1902	<i>Anopheles quadrimaculatus</i>	6	
1897	<i>Anopheles</i> sp.	6	CF
1903	<i>Anopheles walkeri</i>	6	
623	<i>Anthopotamus myops</i>	4	
621	<i>Anthopotamus</i> sp.	4	
1855	<i>Antocha</i> sp.	5	CG
2329	<i>Aplexa</i> sp.	7	
839	<i>Archilestes grandis</i>	1	
838	<i>Archilestes</i> sp.	1	PR
2420	<i>Arcidens confragosus</i>	1.5	
2419	<i>Arcidens</i> sp.	1.5	CF
46	<i>Arcteonais lomondi</i>	10	CG
45	<i>Arcteonais</i> sp.	10	
853	<i>Argia apicalis</i>	5	PR
854	<i>Argia bipunctulata</i>	5	

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997	<i>Argia fumipennis</i>	5	PR
855	<i>Argia moesta</i>	5	PR
856	<i>Argia sedula</i>	5	PR
852	<i>Argia</i> sp.	5	PR
857	<i>Argia tibialis</i>	5	PR
858	<i>Argia translata</i>	5	
859	<i>Argia violacea</i>	5	PR
707	<i>Arigomphus</i> sp.	7	PR
532	<i>Arthroplea bipunctata</i>	3	
531	<i>Arthroplea</i> sp.	3	CF
2603	Arthropleidae		
250	Arthropoda	99.9	
253	Asellidae	6	CG
255	<i>Asellus</i> sp.	6	
2158	Athericidae	10	
2159	<i>Atherix</i> sp.	10	PR
2160	<i>Atherix variegata</i>	4	PR
971	<i>Atoperla</i> sp.	1	
1937	<i>Atrichopogon</i> sp.	2	PR
963	<i>Attaneuria ruralis</i>	1.5	PR
962	<i>Attaneuria</i> sp.	1.5	
569	<i>Attenella attenuata</i>	2	CG
568	<i>Attenella</i> sp.	2	CG
2091	<i>Atylotus bicolor</i>	7	
2090	<i>Atylotus</i> sp.	7	PR
93	<i>Aulodrilus pigueti</i>	10	CG
2201	<i>Axarus</i> sp.	6	CG
332	<i>Bactrurus</i> sp.	1	
497	Baetidae	4	CG
645	<i>Baetis amplus</i>	4	CG
653	<i>Baetis armillatus</i>	4	
499	<i>Baetis brunneicolor</i>	4	CG
500	<i>Baetis ephippiatus</i>	4	
501	<i>Baetis flavistriga</i>	4	CG
502	<i>Baetis frondalis</i>	4	
503	<i>Baetis hageni</i>	4	CG
504	<i>Baetis intercalaris</i>	7	
646	<i>Baetis levitans</i>	4	
505	<i>Baetis longipalpus</i>	6	
507	<i>Baetis propinquus</i> gr.	4	
509	<i>Baetis quilleri</i>	4	
498	<i>Baetis</i> sp.	4	CG
510	<i>Baetis tricaudatus</i>	1	CG
647	<i>Baetis vagans</i>	4	

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604	Baetisca bajkovi	3	
606	Baetisca lacustris	3	
607	Baetisca laurentina	3	
608	Baetisca obesa	3	
605	Baetisca sp.	3	CG
603	Baetiscidae	3	CG
1443	Banksiola crotchi	2	
1442	Banksiola sp.	2	SH
650	Barbaetis cestus	4	
752	Basiaeschna janata	2	PR
751	Basiaeschna sp.	2	PR
2598	Basommatophora	7	
158	Batracobdella phalera	8	
159	Batracobdella picta	8	
157	Batracobdella sp.	8	PR
1085	Belostoma flumineum	99.9	PR
1084	Belostoma sp.	99.9	PR
1083	Belostomatidae	99.9	PR
1646	Berosus fraternus	99.9	
1647	Berosus infuscatus	99.9	
1649	Berosus peregrinus	99.9	
1650	Berosus pugnax	99.9	
1644	Berosus sp.	99.9	PR
1651	Berosus striatus	99.9	CG
1938	Bezzia sp.	5	CG
1704	Bidessonotus inconspicuus	99.9	
1703	Bidessonotus sp.	99.9	PR
2309	Bithynia sp.	6	
2308	Bithyniidae	6	
2080	Bittacomorpha sp.	8	CG
1852	Blepharicera sp.	0	SC
1851	Blephariceridae	0	SC
753	Boyeria sp.	3	PR
754	Boyeria vinosa	3	PR
1397	Brachycentridae	3.5	CF
1399	Brachycentrus americanus	1	CF
1400	Brachycentrus lateralis	1	CF
1401	Brachycentrus numerosus	1	CF
1402	Brachycentrus occidentalis	1	CF
1398	Brachycentrus sp.	1	CF
601	Brachycercus sp.	3	CG
32	Branchiobdellida	10	PA
33	Branchiobdellidae	10	CG
95	Branchiura sowerbyi	10	CG

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94	Branchiura sp.	10	CG
47	Bratislavia sp.	10	CG
48	Bratislavia unidentata	10	CG
1996	Brillia sp.	6	SH
1068	Buena sp.	99.9	PR
256	Caecidotea brevicaudus	6	
347	Caecidotea communis	6	CG
257	Caecidotea forbesi	6	
258	Caecidotea intermedia	6	
259	Caecidotea kendeighi	6	
268	Caecidotea packardi	6	
254	Caecidotea sp.	6	CG
269	Caecidotea spatulata	6	
270	Caecidotea stygia	6	
263	Caecidotea tridentata	6	
600	Caenidae	5.5	CG
602	Caenis sp.	6	CG
512	Callibaetis ferrugineus	4	
513	Callibaetis fluctuans	4	
514	Callibaetis skokianus	4	
511	Callibaetis sp.	4	CG
830	Calopterygidae	3.5	PR
832	Calopteryx aequabilis	4	
833	Calopteryx maculata	4	PR
831	Calopteryx sp.	4	PR
403	Cambarellus puer	5	CG
404	Cambarellus shufeldtii	5	CG
402	Cambarellus sp.	5	SH
401	Cambaridae	5	CG
406	Cambarus diogenes	5	
407	Cambarus rusticiformis	5	
405	Cambarus sp.	5	CG
408	Cambarus tenebrosus	5	
2303	Campeloma sp.	7	SC
949	Capnia sp.	1	SH
950	Capnia vernalis	1	
944	Capniidae	1.5	SH
1997	Cardiocladius sp.	6	PR
2423	Carunculina parva	7	
2421	Carunculina sp.	7	CF
1706	Celina hubbelli	99.9	
1705	Celina sp.	99.9	PR
789	Celithemis elisa	2	
790	Celithemis eponina	2	

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791	<i>Celithemis monomelaena</i>	2	
788	<i>Celithemis</i> sp.	2	PR
515	<i>Centroptilum</i> sp.	2	CG
1456	<i>Ceraclea ancylus</i>	3	
1457	<i>Ceraclea cancellata</i>	3	
1458	<i>Ceraclea diluta</i>	3	
1459	<i>Ceraclea flava</i>	3	
1460	<i>Ceraclea maculata</i>	3	
1462	<i>Ceraclea nepha</i>	3	
1463	<i>Ceraclea resurgens</i>	3	
1454	<i>Ceraclea</i> sp.	3	CG
2510	<i>Ceraclea transversa</i>	3	
2166	<i>Ceratopogon</i> sp.	5	PR
1936	Ceratopogonidae	5	PR
1496	<i>Ceratopsyche alhedra</i>	4	
1492	<i>Ceratopsyche alternans</i>	5	CF
1332	<i>Ceratopsyche bronta</i>	4	CF
1333	<i>Ceratopsyche cheilonis</i>	4	
1493	<i>Ceratopsyche morosa</i>	4	
1499	<i>Ceratopsyche slossonae</i>	4	
1330	<i>Ceratopsyche</i> sp.	4	CF
1337	<i>Ceratopsyche sparna</i>	4	
1998	<i>Chaetocladius</i> sp.	6	CG
50	<i>Chaetogaster diaphanus</i>	10	PR
51	<i>Chaetogaster diastrophus</i>	10	PR
52	<i>Chaetogaster limnaei</i>	10	PR
49	<i>Chaetogaster</i> sp.	10	SH
1869	Chaoboridae	8	PR
1870	<i>Chaoborus</i> sp.	8	PR
1188	<i>Chauliodes pectinicornis</i>	4	PR
1189	<i>Chauliodes rastricornis</i>	4	PR
1187	<i>Chauliodes</i> sp.	4	PR
1302	<i>Cheumatopsyche</i> sp.	6	CF
1340	<i>Chimarra aterrima</i>	3	CF
1341	<i>Chimarra feria</i>	3	CF
1342	<i>Chimarra obscura</i>	3	CF
1343	<i>Chimarra socia</i>	3	CF
1339	<i>Chimarra</i> sp.	3	CF
1963	Chironomidae	6	CG
2205	Chironomini	6	CG
2020	<i>Chironomus anthracinus</i>	11	
2021	<i>Chironomus attenuatus</i>	10	
2022	<i>Chironomus decorus</i>	11	
2023	<i>Chironomus plumosus</i>	11	

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2024	<i>Chironomus riparius</i>	11	
2019	<i>Chironomus</i> sp.	11	CG
2186	<i>Chironomus staegeri</i>	11	
990	<i>Chloroperla</i> sp.	3	
989	Chloroperlidae	1.5	PR
2143	<i>Chlorotabanus</i> sp.	7	
611	<i>Choroterpes basalis</i>	2	CG
610	<i>Choroterpes</i> sp.	2	CG
861	<i>Chromagrion conditum</i>	5.5	
860	<i>Chromagrion</i> sp.	5.5	PR
2149	<i>Chrysogaster</i> sp.	11	CG
2094	<i>Chrysops aberrans</i>	7	
2097	<i>Chrysops brunneus</i>	7	
2098	<i>Chrysops callidus</i>	7	
2100	<i>Chrysops cincticornis</i>	7	
2101	<i>Chrysops dimmocki</i>	7	
2103	<i>Chrysops flavidus</i>	7	
2105	<i>Chrysops geminatus</i>	7	
2106	<i>Chrysops macquarti</i>	7	
2108	<i>Chrysops moechus</i>	7	
2109	<i>Chrysops montanus</i>	7	
2110	<i>Chrysops niger</i>	7	
2093	<i>Chrysops</i> sp.	7	CG
2115	<i>Chrysops striatus</i>	7	
2116	<i>Chrysops univittatus</i>	7	
2118	<i>Chrysops vittatus</i>	7	
2314	<i>Cincinnatia</i> sp.	6	SC
2025	<i>Cladopelma</i> sp.	6	CG
2503	<i>Cladotanytarsus daviese</i>	7	
2074	<i>Cladotanytarsus</i> sp.	7	CG
2504	<i>Cladotanytarsus</i> species a	7	
2236	<i>Cladotanytarsus</i> species b	7	
2505	<i>Cladotanytarsus</i> species c	7	
2237	<i>Cladotanytarsus</i> species f	7	
2506	<i>Cladotanytarsus</i> species h	7	
1253	<i>Climacea areolaris</i>	1	
1252	<i>Climacea</i> sp.	1	
1971	<i>Clinotanypus pinguis</i>	6	PR
1970	<i>Clinotanypus</i> sp.	6	PR
517	<i>Cloeon alamance</i>	3	
518	<i>Cloeon rubropictum</i>	3	
516	<i>Cloeon</i> sp.	3	
1948	<i>Cnephia pecuarum</i>	4	
1947	<i>Cnephia</i> sp.	4	CF

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1972	Coelotanypus concinnus	6	PR
1973	Coelotanypus sp.	4	PR
862	Coenagrion sp.	5.5	PR
847	Coenagrionidae	5.5	PR
1600	Coleoptera	99.9	PR
2171	Conchapelopia sp.	6	PR
1708	Copelatus chevrolati	99.9	
1709	Copelatus glyphicus	99.9	
1707	Copelatus sp.	99.9	PR
1710	Coptotomus sp.	99.9	PR
2497	Corbicula sp.	4	CF
704	Cordulegaster maculata	2	PR
705	Cordulegaster obliqua	2	PR
703	Cordulegaster sp.	2	PR
702	Cordulegastridae	4.5	PR
770	Cordulia shurtleffi	2	
769	Cordulia sp.	2	PR
768	Corduliidae	4.5	PR
1871	Corethrella sp.	8	PR
1090	Corixidae	99.9	PR
1186	Corydalidae	3	PR
1191	Corydalus cornutus	3	PR
1190	Corydalus sp.	3	PR
1999	Corynoneura sp.	2	CG
2177	Corynoneura taris	2	CG
1501	Crambidae	99.9	SH
336	Crangonyx forbesi	4	CG
337	Crangonyx gracilis	4	CG
338	Crangonyx minor	4	
339	Crangonyx packardi	4	
340	Crangonyx pseudogracilis	4	
335	Crangonyx sp.	4	CG
1652	Crenitis sp.	99.9	PR
2001	Cricotopus bicinctus	10	
2002	Cricotopus intersectus	8	SH
2000	Cricotopus sp.	8	SH
2003	Cricotopus sylvestris	8	
2004	Cricotopus trifascia	6	
348	Crangonyctidae	4	
251	Crustacea	99.9	CG
2027	Cryptochironomus digitatus	8	
2028	Cryptochironomus fulvus	8	PR
2026	Cryptochironomus sp.	8	PR
2029	Cryptotendipes sp.	6	CG

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1905	Culex erraticus	8	
1906	Culex peccator	8	
1907	Culex pipiens	8	CF
1908	Culex quinquefasciatus	8	
1909	Culex restuans	8	
1910	Culex salinarius	8	
1904	Culex sp.	8	CF
1911	Culex tarsalis	8	
1873	Culicidae	8	CG
1939	Culicoides sp.	5	PR
1913	Culiseta inornata	8	
1914	Culiseta melanura	8	
1912	Culiseta sp.	8	CG
1799	Curculionidae	99.9	SH
1714	Cybister fimbriolatus	99.9	
1713	Cybister sp.	99.9	PR
2425	Cyclonaias sp.	1.5	
2426	Cyclonaias tuberculata	1.5	
1655	Cymbiodyta chamberlaini	99.9	
1656	Cymbiodyta semistriata	99.9	
1653	Cymbiodyta sp.	99.9	CG
1657	Cymbiodyta vindicata	99.9	
1619	Cyphon americanus	7	
1620	Cyphon collaris	7	
1621	Cyphon modestus	7	
1622	Cyphon nebulosus	7	
1623	Cyphon obscurus	7	
1625	Cyphon perplexus	7	
1624	Cyphon punctatus	7	
1618	Cyphon sp.	7	SC
2428	Cyprogenia irrorata	1.5	
2427	Cyprogenia sp.	1.5	
1351	Cyrnellus fraternus	5	CF
1350	Cyrnellus sp.	5	CF
179	Cystobranchnus sp.	7	
178	Cystobranchnus verrilli	7	
571	Dannella lita	2	CG
572	Dannella simplex	2	CG
570	Dannella sp.	2	
1940	Dasyhelea sp.	5	CG
400	Decapoda	99.9	SH
2030	Demicryptochironomus sp.	6	CG
54	Dero digitata	10	CG
55	Dero furcata	10	CG

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56	<i>Dero lodeni</i>	10	CG
57	<i>Dero nivea</i>	10	CG
109	<i>Dero pectinata</i>	10	CG
53	<i>Dero sp.</i>	10	CG
1715	<i>Deronectes sp.</i>	99.9	PR
208	<i>Desserobdella phalera</i>	8	
1988	<i>Diamesa sp.</i>	4	CG
2210	<i>Diamesinae</i>	6	
1760	<i>Dicranopselaphus</i>	4	SC
1856	<i>Dicranota sp.</i>	4	PR
2523	<i>Dicrotendipes lucifer</i>	6	
2032	<i>Dicrotendipes modestus</i>	6	CG
2033	<i>Dicrotendipes neomodestus</i>	6	CG
2034	<i>Dicrotendipes nervosus</i>	6	
2517	<i>Dicrotendipes simpsoni</i>	6	
2031	<i>Dicrotendipes sp.</i>	6	CG
2524	<i>Dicrotendipes tritonus</i>	6	
2155	<i>Dictya pictipes</i>	10	
2154	<i>Dictya sp.</i>	10	PR
760	<i>Didymops sp.</i>	4	PR
761	<i>Didymops transversa</i>	4	PR
199	<i>Dina dubia</i>	8	
200	<i>Dina parva</i>	8	
198	<i>Dina sp.</i>	8	PR
1603	<i>Dineutus assimilis</i> (larvae only)	4	PR
1604	<i>Dineutus discolor</i> (larvae only)	4	PR
1602	<i>Dineutus sp.</i> (larvae only)	4	PR
661	<i>Dipheter hageni</i>	4	
1303	<i>Diplectrona metaqui</i>	2	
1305	<i>Diplectrona modesta</i>	2	CF
1304	<i>Diplectrona sp.</i>	2	CF
1850	Diptera	10	
1931	<i>Dixa sp.</i>	10	CG
2238	<i>Dixella sp.</i>	10	
1930	Dixidae	10	CG
2239	<i>Djalmabatista pulchra</i>	6	
1974	<i>Djalmabatista sp.</i>	6	PR
2144	Dolichopodidae	5	PR
1345	<i>Dolophilodes distinctus</i>	0	
1344	<i>Dolophilodes sp.</i>	0	CG
2234	<i>Dreissena polymorpha</i>	99.9	
713	<i>Dromogomphus sp.</i>	4	PR
714	<i>Dromogomphus spinosus</i>	4	PR
575	<i>Drunella cornutella</i>	1	SC

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573	Drunella sp.	1	PR
1764	Dryopidae	4	SH
1775	Dubiraphia bivittata	2	
1776	Dubiraphia minima	5	
1777	Dubiraphia quadrinotata	7	
1774	Dubiraphia sp.	5	CG
1778	Dubiraphia vittata	7	
5	Dugesia sp.	6	
6	Dugesia tigrina	6	PR
2429	Dysnomia sp.	1.5	
2431	Dysnomia triquetra	1.5	
1687	Dytiscidae	99.9	PR
1719	Dytiscus hybridus	99.9	
1717	Dytiscus sp.	99.9	PR
1762	Ectopria nervosa	4	SC
1761	Ectopria sp.	4	SC
1763	Ectopria thoracica	4	
2189	Einfeldia austeni	10	
2240	Einfeldia pagana	10	
2035	Einfeldia sp.	10	CG
2320	Elimia sp.	6	SC
2433	Elliptio crassidens	2	
2434	Elliptio dilatata	2	
2432	Elliptio sp.	2	CF
1771	Elmidae	5	CG
1801	Elodes sp.	7	
2146	Empididae	6	PR
864	Enallagma aspersum	6	
865	Enallagma civile	6	
866	Enallagma divagans	6	PR
867	Enallagma exsulans	6	
868	Enallagma geminatum	6	
869	Enallagma hageni	6	
870	Enallagma signatum	6	PR
863	Enallagma sp.	6	PR
871	Enallagma traviatum	6	
872	Enallagma vesperum	6	PR
38	Enchytraeidae	10	CG
2037	Endochironomus nigricans	6	SH
2036	Endochironomus sp.	6	SH
2038	Endochironomus subtendens	6	SH
1660	Enochrus cinctus	99.9	
1662	Enochrus consortus	99.9	
1663	Enochrus hamiltoni	99.9	

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1664	<i>Enochrus ochraceus</i>	99.9	
1665	<i>Enochrus perplexus</i>	99.9	
1666	<i>Enochrus pygmaeus</i>	99.9	
1667	<i>Enochrus sayi</i>	99.9	
1658	<i>Enochrus</i> sp.	99.9	CG
533	<i>Epeorus</i> sp.	1	SC
534	<i>Epeorus vitreus</i>	0	
627	<i>Ephemera simulans</i>	3	CG
626	<i>Ephemera</i> sp.	3	CG
579	<i>Ephemerella aurivillii</i>	2	CG
580	<i>Ephemerella catawba</i>	2	CG
574	<i>Ephemerella cornuta</i>	1	
590	<i>Ephemerella coxalis</i>	4	
581	<i>Ephemerella dorothea</i>	2	CG
582	<i>Ephemerella excrucians</i>	2	CG
596	<i>Ephemerella frisoni</i>	1	
583	<i>Ephemerella invaria</i>	2	CG
576	<i>Ephemerella lata</i>	1	
584	<i>Ephemerella needhami</i>	2	CG
585	<i>Ephemerella rotunda</i>	2	
578	<i>Ephemerella</i> sp.	2	CG
586	<i>Ephemerella subvaria</i>	2	CG
577	<i>Ephemerella walkeri</i>	1	
567	Ephemerellidae	3.5	CG
625	Ephemeridae	5	CG
476	Ephemeroptera	3	CG
639	<i>Ephoron album</i>	2	CG
640	<i>Ephoron leukon</i>	2	CG
638	<i>Ephoron</i> sp.	2	CG
2152	<i>Ephydra</i> sp.	8	CG
2151	Ephydridae	8	CG
756	<i>Epiaeschna heros</i>	1	PR
755	<i>Epiaeschna</i> sp.	1	PR
773	<i>Epicordulia princeps</i>	4.5	PR
772	<i>Epicordulia</i> sp.	4.5	PR
771	<i>Epitheca</i> sp.	4	PR
2209	<i>Epoicocladus</i> sp.	6	CG
1857	<i>Eriocera</i> sp.	7	PR
1858	Erioptera sp.	4	CG
2150	<i>Eristalis</i> sp.	11	CG
2229	<i>Erpetogomphus designatus</i>	2	
2602	<i>Erpetogomphus</i> sp.	2	
202	<i>Erpobdella punctata</i>	8	PR
201	<i>Erpobdella</i> sp.	8	

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197	Erpobdellidae	8	PR
793	Erythemis simplicicollis	5	PR
792	Erythemis sp.	5	PR
794	Erythrodiplax sp.	5	PR
2005	Eukiefferiella sp.	4	CG
588	Eurylophella aestiva	4	
589	Eurylophella bicolor	4	CG
591	Eurylophella funeralis	4	
592	Eurylophella lutulenta	4	CG
587	Eurylophella sp.	4	SC
593	Eurylophella temporalis	4	CG
1445	Fabria inornata	3.5	
1444	Fabria sp.	3.5	SH
410	Fallicambarus fodiens	5	
409	Fallicambarus sp.	5	
2358	Ferrissia rivularis	7	SC
2347	Ferrissia sp.	7	SC
1941	Forcipomyia sp.	5	SC
2362	Fossaria obrussa	7	
2334	Fossaria sp.	7	SC
1411	Frenesia missa	3.5	
1410	Frenesia sp.	3.5	SH
2436	Fusconaia ebena	1	
2437	Fusconaia flava	1	
2435	Fusconaia sp.	1	
329	Gammaridae	4	CG
346	Gammarus fasciatus	3	CG
344	Gammarus pseudolimnaeus	3	CG
341	Gammarus sp.	3	
345	Gammarus troglophilus	3	
2301	Gastropoda	99.9	SC
1057	Gerridae	99.9	PR
1058	Gerris sp.	99.9	PR
210	Gloiobdella elongata	8	
161	Glossiphonia complanata	8	PR
160	Glossiphonia sp.	8	PR
152	Glossiphoniidae	8	PR
1374	Glossosoma intermedium	3.5	SC
1373	Glossosoma sp.	3.5	SC
1370	Glossosomatidae	3.5	SC
2533	Glyptotendipes amplus	10	
2040	Glyptotendipes lobiferus	10	SH
2041	Glyptotendipes paripes	10	
2039	Glyptotendipes sp.	10	CF

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211	Gnathobdellida	7	
1412	Goera sp.	3.5	SC
706	Gomphidae	4.5	PR
738	Gomphus amnicola	7	
716	Gomphus crassus	7	
723	Gomphus exilis	7	
717	Gomphus externus	7	PR
724	Gomphus graslinellus	7	
710	Gomphus lentulus	7	
719	Gomphus lineatifrons	7	
725	Gomphus lividus	7	PR
739	Gomphus notatus	7	
740	Gomphus plagiatus	7	
726	Gomphus quadricolor	7	
722	Gomphus sp.	7	PR
741	Gomphus spiniceps	7	
711	Gomphus submedianus	7	
720	Gomphus vastus	7	PR
879	Gomphurus sp.	7	
712	Gomphus villosipes	7	
2321	Goniobasis sp.	5	SC
2221	Gonomyia sp.	4	CG
18	Gordius sp.	99.9	
1975	Guttipelopia sp.	6	PR
2250	Gymnometriocnemus sp.	6	
2340	Gyraulus sp.	6	SC
1601	Gyrinidae	99.9	PR
1608	Gyrinus aeneolus (larvae only)	4	PR
1609	Gyrinus analis (larvae only)	4	
1607	Gyrinus sp. (larvae only)	4	PR
613	Habrophlebiodes americana	2	
612	Habrophlebiodes sp.	2	SC
190	Haemopis marmorata	7	
189	Haemopis sp.	7	PR
191	Haemopis terrestris	7	
729	Hagenius brevistylus	3	PR
728	Hagenius sp.	3	PR
1629	Haliplidae	99.9	SH
1631	Haliplus fasciatus	99.9	SH
1632	Haliplus immaculicollis	99.9	
1633	Haliplus leopardus	99.9	
1634	Haliplus pantherinus	99.9	
1630	Haliplus sp.	99.9	MH
1635	Haliplus triopsis	99.9	

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36	Haplotaxida	10	
2042	Harnischia sp.	6	CG
993	Hastaperla brevis	1.5	
992	Hastaperla sp.	1.5	SC
2214	Hayesomyia sp.	5	
1051	Hebridae	99.9	PR
1052	Hebrus sp.	99.9	PR
1766	Helichus fastigiatus	4	
1767	Helichus lithophilus	4	
1765	Helichus sp.	4	SH
1768	Helichus striatus	4	
1452	Helicopsyche borealis	2	SC
1451	Helicopsyche sp.	2	SC
1450	Helicopsychidae	3.5	SC
2341	Helisoma sp.	7	SC
1859	Helius sp.	5	CG
163	Helobdella elongata	8	PR
164	Helobdella fusca	8	PA
165	Helobdella papillata	8	PR
162	Helobdella sp.	8	PA
166	Helobdella stagnalis	8	PR
167	Helobdella triserialis	8	PA
1803	Helocombus sp.	99.9	
774	Helocordulia sp.	2	PR
1617	Helodidae	7	SC
2215	Helopelopia sp.	4	PR
1668	Helophorus sp.	99.9	SH
2147	Hemerodromia sp.	6	PR
1050	Hemiptera	99.9	PR
535	Heptagenia diabasia	4	
537	Heptagenia flavescens	2	
538	Heptagenia hebe	3	
539	Heptagenia lucidipennis	3	
540	Heptagenia maculipennis	3	SC
541	Heptagenia marginalis	1	SC
542	Heptagenia perfida	1	
543	Heptagenia pulla	0	SC
536	Heptagenia sp.	3	SC
528	Heptageniidae	3.5	SC
1860	Hesperoconopa sp.	2	CG
1092	Hesperocorixa interrupta	99.9	
1094	Hesperocorixa laevigata	99.9	
1096	Hesperocorixa lucida	99.9	
1097	Hesperocorixa nitida	99.9	

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1098	Hesperocorixa obliqua	99.9	
1091	Hesperocorixa sp.	99.9	PR
1100	Hesperocorixa vulgaris	99.9	
1414	Hesperophylax designatus	3.5	SH
1413	Hesperophylax sp.	3.5	SH
835	Hetaerina americana	3	PR
834	Hetaerina sp.	3	PR
836	Hetaerina titia	3	PR
520	Heterocloeon curiosum	4	SC
519	Heterocloeon sp.	4	SC
2006	Heterotrissocladus sp.	6	CG
629	Hexagenia atrocaudata	6	CG
630	Hexagenia bilineata	6	CG
631	Hexagenia limbata	5	CG
632	Hexagenia munda	5	
633	Hexagenia rigida	6	CG
628	Hexagenia sp.	6	CG
1861	Hexatoma sp.	4	PR
249	Hirudinea	8	PR
188	Hirudinidae	8	PR
2509	Hudsonimyia sp.	6	
328	Hyaella azteca	5	CG
327	Hyaella sp.	4	CG
326	Hyaellidae	4	
2119	Hybomitra sp.	7	PR
1721	Hydaticus modestus	99.9	
1720	Hydaticus sp.	99.9	PR
1416	Hydatophylax argus	2	SH
1415	Hydatophylax sp.	2	SH
2007	Hydrobaenus sp.	2	SC
2310	Hydrobiidae	6	SC
1670	Hydrobius fuscipes	99.9	
1669	Hydrobius sp.	99.9	PR
1673	Hydrochara sp.	99.9	CG
1674	Hydrochus sp.	99.9	SH
978	Hydroperla crosbyi	1	
977	Hydroperla sp.	1	PR
1641	Hydrophilidae	99.9	PR
1675	Hydrophilus sp.	99.9	PR
2145	Hydrophorus sp.	99.9	PR
1725	Hydroporus clypealis	99.9	
1726	Hydroporus consimilis	99.9	
1728	Hydroporus niger	99.9	
1729	Hydroporus rufilabris	99.9	

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1722	Hydroporus sp.	99.9	PR
1733	Hydroporus vittatipennis	99.9	
1307	Hydropsyche aerata	5	CF
1308	Hydropsyche arinale	5	
1309	Hydropsyche betteni	5	CF
1310	Hydropsyche bidens	5	
1311	Hydropsyche cuanis	5	
1312	Hydropsyche dicantha	5	CF
1313	Hydropsyche frisoni	5	CF
1314	Hydropsyche hageni	5	
1316	Hydropsyche incommoda	5	
1317	Hydropsyche orris	4	CF
1318	Hydropsyche phalerata	2	CF
1319	Hydropsyche placoda	4	
1320	Hydropsyche scalaris	5	CF
1321	Hydropsyche simulans	5	CF
1306	Hydropsyche sp.	5	CF
1322	Hydropsyche valanis	5	CF
1323	Hydropsyche venularis	5	CF
1301	Hydropsychidae	5.5	CF
1379	Hydroptila sp.	2	SC
1500	Hydroptila waubesiana	2	
1376	Hydroptilidae	3.5	PH
1735	Hydrovatus pustalatus	99.9	PR
1734	Hydrovatus sp.	99.9	PR
1736	Hygrotus sp.	99.9	PR
2255	Hyporhygma quadripunctatum	4	
1738	Ilybius biguttulus	99.9	
1737	Ilybius sp.	99.9	PR
96	Ilyodrilus sp.	10	
97	Ilyodrilus templetoni	10	CG
475	Insecta	99.9	
1417	Isonychia sp.	3.5	SH
874	Isonychia posita	6	PR
873	Isonychia sp.	6	PR
875	Isonychia verticalis	6	
979	Isogenoides sp.	1.5	PR
488	Isonychia arida	3	
489	Isonychia bicolor	3	CG
490	Isonychia rufa	3	
491	Isonychia sayi	3	
492	Isonychia sicca	3	
487	Isonychia sp.	3	CF
981	Isoperla bilineata	2	

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982	Isoperla clio	2	
996	Isoperla confusa	2	
983	Isoperla cotta	2	
984	Isoperla dicala	2	
985	Isoperla lata	2	
986	Isoperla marlynia	2	
987	Isoperla nana	2	
988	Isoperla richardsoni	2	
980	Isoperla sp.	2	PR
252	Isopoda	99.9	CG
1380	Ithytrichia sp.	1	SC
2043	Kiefferulus sp.	7	CG
2512	Labrundinia neopilosella	4	
2241	Labrundinia pilosella	4	
1976	Labrundinia sp.	4	PR
2172	Labrundinia virescens	6	PR
1677	Laccobius agilis	99.9	
1678	Laccobius minutoides	99.9	
1676	Laccobius sp.	99.9	PR
1740	Laccophilus fasciatus	99.9	PR
1741	Laccophilus maculosus	99.9	
1742	Laccophilus proximus	99.9	PR
1739	Laccophilus sp.	99.9	PR
1744	Laccornis sp.	99.9	PR
796	Ladona julia	4.5	
795	Ladona sp.	4.5	PR
2360	Laevapex diaphanus	6	SC
2359	Laevapex fuscus	6	SC
2348	Laevapex sp.	6	SC
2498	Lampsilis fasciola	1	
2444	Lampsilis higginsii	1	
2443	Lampsilis orbiculata	1	
2441	Lampsilis radiata	1	
2438	Lampsilis sp.	1	CF
2439	Lampsilis teres	1	CF
2442	Lampsilis ventricosa	1	
735	Lanthus sp.	6	PR
1977	Larsia sp.	6	PR
2446	Lasmigona complanata	1.5	
2447	Lasmigona compressa	1.5	
2448	Lasmigona costata	1.5	
2445	Lasmigona sp.	1.5	
1550	Lepidoptera	99.9	SH
1407	Lepidostoma liba	3	

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1406	Lepidostoma sp.	3	SH
1405	Lepidostomatidae	3.5	SH
1453	Leptoceridae	3.5	CG
1467	Leptocerus americanus	3	
1466	Leptocerus sp.	3	SH
2450	Leptodea fragilis	1.5	
2449	Leptodea sp.	1.5	CF
662	Leptohyphe sp.	5.5	CG
598	Leptohyphidae	5.5	CG
614	Leptophlebia sp.	3	CG
609	Leptophlebiidae	3	CG
1418	Leptophylax sp.	3.5	SH
2322	Leptoxis sp.	6	
841	Lestes disjunctus	6	
842	Lestes eurinus	6	
843	Lestes forcipatus	6	
844	Lestes inaequalis	6	
845	Lestes rectangularis	6	
840	Lestes sp.	6	PR
846	Lestes vigilax	6	
837	Lestidae	99.9	PR
1087	Lethocerus americanus	99.9	
1088	Lethocerus griseus	99.9	
1086	Lethocerus sp.	99.9	PR
1089	Lethocerus uhleri	99.9	
799	Leucorrhinia intacta	4.5	
797	Leucorrhinia sp.	4.5	PR
1382	Leucotrichia pictipes	3	
1381	Leucotrichia sp.	3	SC
654	Leucrocuta hebe	3	
649	Leucrocuta maculipennis	3	
648	Leucrocuta sp.	3	SC
943	Leuctra sp.	1	SH
942	Leuctridae	1.5	SH
801	Libellula cyanea	8	
802	Libellula incesta	8	PR
803	Libellula luctuosa	8	
804	Libellula pulchella	8	
805	Libellula quadrimaculata	8	
806	Libellula semifasciata	8	PR
800	Libellula sp.	8	PR
807	Libellula vibrans	8	PR
787	Libellulidae	4.5	PR
2452	Ligumia recta	1	

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2451	Ligumia sp.	1	CF
2453	Ligumia subrostrata	1	
1408	Limnephilidae	3.5	SH
1420	Limnephilus sp.	3	SH
99	Limnodrilus cervix	10	CG
100	Limnodrilus claparedianus	10	CG
101	Limnodrilus hoffmeisteri	10	CG
98	Limnodrilus sp.	10	CG
102	Limnodrilus udekemianus	10	CG
1060	Limnogonus hesione	99.9	
1059	Limnogonus sp.	99.9	PR
1862	Limnophila sp.	4	PR
2157	Limnophora sp.	8	PR
1863	Limonia sp.	3	SH
1745	Liodessus sp.	99.9	PR
2304	Lioplax sp.	7	SC
2518	Lipiniella sp.	6	
273	Lirceus fontinalis	4	CG
274	Lirceus garmani	4	CG
275	Lirceus lineatus	4	CG
276	Lirceus louisianae	4	
272	Lirceus sp.	4	CG
1800	Listronotus sp.	99.9	CF
2323	Lithasia sp.	6	
2578	Lopescladius sp.	4	
39	Lumbricidae	10	CG
34	Lumbriculida	10	
35	Lumbriculidae	10	CG
2335	Lymnaea sp.	7	SC
2332	Lymnaeidae	7	SC
1367	Lype diversa	3.5	SC
1366	Lype sp.	3.5	SC
561	Maccaffertium annexum	4	
565	Maccaffertium ares	3	
552	Maccaffertium exiguum	5	
556	Maccaffertium integrum	4	
557	Maccaffertium luteum	1	SC
559	Maccaffertium mediopunctatum	2	SC
560	Maccaffertium modestum	3	SC
558	Maccaffertium nepotellum	5	
563	Maccaffertium pulchellum	3	SC
553	Maccaffertium quinquespinum	5	
562	Maccaffertium rubromaculatum	2	
551	Maccaffertium sp.	4	SC

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564	<i>Maccaffertium terminatum</i>	4	SC
566	<i>Maccaffertium vicarium</i>	3	SC
193	<i>Macrobdella decora</i>	7	
192	<i>Macrobdella</i> sp.	7	
764	<i>Macromia georgina</i>	3	PR
765	<i>Macromia illinoensis</i>	3	PR
766	<i>Macromia pacifica</i>	3	
762	<i>Macromia</i> sp.	3	PR
767	<i>Macromia taeniolata</i>	3	PR
759	Macromiidae	4.5	PR
1324	<i>Macronema</i> sp.	2	CF
1325	<i>Macronema zebratum</i>	2	CF
1780	<i>Macronychus glabratus</i>	2	
1779	<i>Macronychus</i> sp.	2	
1978	<i>Macropelopia</i> sp.	7	PR
2217	<i>Macrostemum</i> sp.	2	CF
1918	<i>Mansonia perturbans</i>	8	
1917	<i>Mansonia</i> sp.	8	CG
2315	<i>Marstonia</i> sp.	6	
1749	<i>Matus bicarinatus</i>	99.9	
1748	<i>Matus</i> sp.	99.9	PR
1383	<i>Mayatrichia ayama</i>	1	SC
1384	<i>Mayatrichia</i> sp.	1	SC
2455	<i>Megaloniais nervosa</i>	1.5	
2454	<i>Megaloniais</i> sp.	1.5	
1175	Megaloptera	3.5	
2342	<i>Menetus</i> sp.	6.5	SC
2211	<i>Meropelopia</i> sp.	3	
1053	<i>Merragata</i> sp.	99.9	PR
2599	Mesogastropoda	99.9	
1056	<i>Mesovelgia mulsanti</i>	99.9	PR
1055	<i>Mesovelgia</i> sp.	99.9	PR
1054	Mesoveliidae	99.9	PR
493	Metretopodidae	3	
2008	<i>Metriocnemus</i> sp.	6	CG
1061	<i>Metrobates</i> sp.	99.9	PR
1404	<i>Micrasema rusticum</i>	3.5	
1403	<i>Micrasema</i> sp.	3.5	MH
2044	<i>Microchironomus</i> sp.	6	CG
1782	<i>Microcylloepus pusillus</i>	2	CG
1781	<i>Microcylloepus</i> sp.	2	CG
2075	<i>Micropsectra</i> sp.	4	CG
2046	<i>Microtendipes caducus</i>	6	
2047	<i>Microtendipes pedellus</i>	6	CF

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2045	Microtendipes sp.	6	CF
1065	Microvelia sp.	99.9	PR
1435	Molanna blanda	3.5	
1434	Molanna sp.	3.5	SC
1436	Molanna tryphena	3.5	
1437	Molanna uniophila	3.5	
1433	Molannidae	3.5	CG
2300	Mollusca	99.9	
2167	Monohelea sp.	5	PR
204	Mooreobdella fervida	8	
205	Mooreobdella microstoma	8	PR
203	Mooreobdella sp.	8	PR
1552	Munroessa sp.	99.9	SH
2156	Muscidae	8	PR
2492	Musculium sp.	5	CF
2493	Musculium transversum	5	CF
1470	Mystacides sepulchralis	2	
1468	Mystacides sp.	2	CG
181	Myzobdella lugubris	7	PR
180	Myzobdella sp.	7	
40	Naididae	10	CG
59	Nais barbata	10	CG
60	Nais behningi	10	CG
61	Nais bretscheri	10	CG
62	Nais communis	10	CG
63	Nais elinguis	10	CG
64	Nais pardalis	10	CG
65	Nais simplex	10	CG
58	Nais sp.	10	CG
66	Nais variabilis	10	CG
2178	Nanocladius distinctus	3	CG
2009	Nanocladius sp.	3	CG
757	Nasiaeschna pentacantha	2	PR
758	Nasiaeschna sp.	2	PR
1979	Natarsia sp.	6	PR
1073	Naucoridae	99.9	PR
1472	Nectopsyche albida	3	
1473	Nectopsyche candida	3	
1474	Nectopsyche diarina	3	
1475	Nectopsyche exquisita	3	
1476	Nectopsyche pavidata	3	
1471	Nectopsyche sp.	3	SH
877	Nehalennia gracilis	7	
878	Nehalennia irene	7	

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876	Nehalennia sp.	7	PR
15	Nematomorpha	99.9	PA
938	Nemoura sp.	1	SH
939	Nemoura venosa	1	
936	Nemouridae	1.5	SH
965	Neoperla clymene	1	PR
964	Neoperla sp.	1	PR
1422	Neophylax concinnus	3	
1421	Neophylax sp.	3	SC
1071	Neoplea sp.	99.9	PR
1072	Neoplea striola	99.9	
1385	Neotrichia sp.	4	SC
1078	Nepa apiculata	99.9	
1077	Nepa sp.	99.9	PR
207	Nephelopsis obscura	8	PR
206	Nephelopsis sp.	8	
1076	Nepidae	99.9	PR
1354	Neureclipsis bimaculata	3	CF
1353	Neureclipsis crepuscularis	3	CF
1352	Neureclipsis sp.	3	CF
776	Neurocordulia molesta	3	PR
777	Neurocordulia obsoleta	3	PR
775	Neurocordulia sp.	3	PR
778	Neurocordulia yamaskanensis	3	
1250	Neuroptera	99.9	PR
1193	Nigronia fasciatus	2	PR
1194	Nigronia serricornis	2	PR
1192	Nigronia sp.	2	PR
2223	Nilobezzia sp.	5	PR
2174	Nilotanypus fimbriatus	6	PR
1980	Nilotanypus sp.	6	PR
2208	Nilothauma sp.	3	
655	Nixe perfida	4	
644	Nixe sp.	4	SC
1069	Notonecta sp.	99.9	PR
1067	Notonectidae	99.9	PR
1355	Nyctiophylax sp.	1	CF
1554	Nymphula sp.	99.9	SH
2457	Obliquaria reflexa	1	
2456	Obliquaria sp.	1	
2459	Obovaria olivaria	1.5	
2458	Obovaria sp.	1.5	
2460	Obovaria subrotunda	1.5	
1386	Ochrotrichia sp.	4	CG

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700	Odonata	99.9	PR
1989	Odontomesa sp.	6	CG
2084	Odostomia cincta	10	
2083	Odostomia sp.	10	CG
1478	Oecetis avara	5	PR
1479	Oecetis cinerascens	5	PR
1480	Oecetis eddlestoni	5	PR
1481	Oecetis inconspicua	5	PR
2521	Oecetis nocturna	5	
1482	Oecetis ochracea	5	
1477	Oecetis sp.	5	PR
930	Oemopteryx glacialis	1.5	
929	Oemopteryx sp.	1.5	SH
31	Oligochaeta	10	CG
486	Oligoneuriidae	3	CF
1447	Oligostomis ocelligera	3.5	PR
1446	Oligostomis sp.	3.5	PR
69	Ophidonais serpentina	10	CG
68	Ophidonais sp.	10	
731	Ophiogomphus rupinsulensis	2	
730	Ophiogomphus sp.	2	PR
1784	Optioservus fastiditus	4	SC
1785	Optioservus ovalis	4	SC
1783	Optioservus sp.	4	SC
1786	Optioservus trivittatus	4	SC
430	Orconectes bisectus	5	
412	Orconectes illinoiensis	5	
413	Orconectes immunis	5	
414	Orconectes indianensis	5	
415	Orconectes kentuckiensis	5	
416	Orconectes lancifer	5	
417	Orconectes placidus	5	
418	Orconectes propinquus	5	
419	Orconectes rusticus	5	
411	Orconectes sp.	5	
420	Orconectes stannardi	5	
421	Orconectes virilis	5	
1864	Ormosia sp.	4	CG
1995	Orthocladiinae	6	CG
2010	Orthocladus sp.	4	CG
2202	Orthocladus sp./Cricotopus sp.	6	
1387	Orthotrichia sp.	1	SC
2085	Oxycera sp.	10	SC
1388	Oxyethira sp.	2	MH

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810	<i>Pachydiplax longipennis</i>	8	PR
809	<i>Pachydiplax</i> sp.	8	PR
2251	<i>Pagastiella</i> sp.	6	
429	<i>Palaemonetes kadiakensis</i>	4	
428	<i>Palaemonetes</i> sp.	4	
427	<i>Palaemonidae</i>	4	
1102	<i>Palmacorixa buenoi</i>	99.9	
1103	<i>Palmacorixa gilletteii</i>	99.9	
1104	<i>Palmacorixa nana</i>	99.9	
1101	<i>Palmacorixa</i> sp.	99.9	PR
1942	<i>Palpomyia</i> sp.	6	PR
812	<i>Pantala flavescens</i>	7	
813	<i>Pantala hymenaea</i>	7	
811	<i>Pantala</i> sp.	7	PR
952	<i>Paracapnia angulata</i>	1.5	
953	<i>Paracapnia opis</i>	1.5	
951	<i>Paracapnia</i> sp.	1.5	SH
2194	<i>Parachironomus carinatus</i>	8	PR
2195	<i>Parachironomus directus</i>	8	
2242	<i>Parachironomus frequens</i>	8	
2049	<i>Parachironomus monochromus</i>	8	
2525	<i>Parachironomus pectinatella</i>	4	
2048	<i>Parachironomus</i> sp.	8	PR
2520	<i>Parachironomus tenuicaudatus</i>	8	
2537	<i>Paracladopelma nereis</i>	4	CG
2050	<i>Paracladopelma</i> sp.	4	CG
2233	<i>Paracloeodes minutus</i>	5	
527	<i>Paracloeodes</i> sp.	4	SC
1679	<i>Paracymus</i> sp.	99.9	PR
1680	<i>Paracymus subcupreus</i>	99.9	
967	<i>Paragnetina media</i>	1.5	PR
966	<i>Paragnetina</i> sp.	1.5	PR
2216	<i>Parakiefferiella</i> sp.	5	
2243	<i>Paralauterborniella nigrohalteralis</i>	6	
2052	<i>Paralauterborniella</i> sp.	6	CG
616	<i>Paraleptophlebia moerens</i>	2	
617	<i>Paraleptophlebia ontario</i>	2	
618	<i>Paraleptophlebia praepedita</i>	2	
615	<i>Paraleptophlebia</i> sp.	2	CG
619	<i>Paraleptophlebia sticta</i>	2	
2173	<i>Paramerina</i> sp.	6	PR
2011	<i>Parametriocnemus</i> sp.	4	CG
67	<i>Paranais frici</i>	10	
110	<i>Paranais</i> sp.	10	

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2179	Paraphaenocladus sp.	6	CG
1555	Paraponyx sp.	99.9	SH
1327	Parapsyche apicalis	5.5	
1326	Parapsyche sp.	5.5	PR
2076	Paratanytarsus sp.	6	CG
2244	Paratendipes albimanus	3	
2053	Paratendipes sp.	3	CG
1865	Pedicia sp.	4	PR
2400	Pelecypoda	99.9	CF
1075	Pelocoris femoratus	99.9	PR
1074	Pelocoris sp.	99.9	PR
1770	Pelonomus obscurus	4	
1769	Pelonomus sp.	4	CG
1638	Peltodytes dunavani	99.9	
1637	Peltodytes duodecimpunctatus	99.9	
1639	Peltodytes lengi	99.9	
1640	Peltodytes sexmaculatus	99.9	
1636	Peltodytes sp.	99.9	SH
635	Pentagenia sp.	4	CF
636	Pentagenia vittigera	4	CG
1981	Pentaneura sp.	3	PR
1934	Pericoma sp.	11	CG
814	Perithemis sp.	4	PR
815	Perithemis tenera	4	PR
969	Perlesta placida	4	
968	Perlesta sp.	4	PR
954	Perlidae	1.5	PR
972	Perlinella drymo	2	PR
973	Perlinella ephyre	2	PR
970	Perlinella sp.	2	PR
976	Perlodidae	1.5	PR
1556	Petrophila sp.	5	SC
2055	Phaenopsectra flavipes	4	SC
2507	Phaenopsectra obediens gr.	4	
2245	Phaenopsectra punctipes gr.	4	
2054	Phaenopsectra sp.	4	SC
209	Pharyngobdellidae	8	
975	Phasganophora capitata	1.5	
974	Phasganophora sp.	1.5	PR
195	Philobdella gracilis	7	PR
194	Philobdella sp.	7	
1338	Philopotamidae	3.5	CF
1448	Phryganea sp.	3	
1438	Phryganeidae	3.5	SH

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1357	Phylocentropus placidus	3.5	
1356	Phylocentropus sp.	3.5	CF
2351	Physa acuta	9	
2361	Physa integra	9	CG
2330	Physa sp.	9	SC
2352	Physella sayi	9	
2331	Physella sp.	9	SC
2328	Physidae	9	SC
1866	Pilaria sp.	4	PR
183	Piscicola milneri	7	PR
184	Piscicola punctata	7	PR
182	Piscicola sp.	7	PR
186	Piscicolaria reducta	7	
185	Piscicolaria sp.	7	
177	Piscicolidae	7	
2499	Pisidiidae	5	
2494	Pisidium sp.	5	CF
168	Placobdella montifera	8	PR
170	Placobdella multilineata	8	PR
171	Placobdella ornata	8	PR
172	Placobdella papillifera	8	PA
173	Placobdella parasitica	8	PA
174	Placobdella pediculata	8	
169	Placobdella sp.	8	PR
2462	Plagiola lineolata	1.5	
7	Planaria sp.	6	
4	Planariidae	6	
2343	Planorbella sp.	6.5	SC
2357	Planorbella truncata	6.5	
2339	Planorbidae	6.5	SC
2344	Planorbula sp.	7	SC
817	Plathemis lydia	3	PR
816	Plathemis sp.	3	PR
1424	Platycentropus radiatus	3	
1423	Platycentropus sp.	3	SH
1	Platyhelminthes	99.9	
660	Plauditus armillatus	4	
657	Plauditus punctiventris	3	
651	Plauditus sp.	3	
925	Plecoptera	1.5	PR
1070	Pleidae	99.9	PR
2464	Plethobasus cyphus	1.5	
2463	Plethobasus sp.	1.5	
2466	Pleurobema cordatum	1.5	

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2465	Pleurobema sp.	1.5	
2325	Pleurocera acuta	7	SC
2324	Pleurocera sp.	7	SC
2319	Pleuroceridae	6	
1349	Polycentropodidae	3.5	CF
1359	Polycentropus centralis	3	PR
1360	Polycentropus cinereus	3	PR
1361	Polycentropus flavus	3	PR
1362	Polycentropus glacialis	3	PR
1363	Polycentropus interruptus	3	PR
1364	Polycentropus remotus	3	PR
1358	Polycentropus sp.	3	PR
637	Polymitarcyidae	3	CG
2540	Polypedilum aviceps	6	
2058	Polypedilum convictum gr.	6	SH
2065	Polypedilum digitifer	6	SH
2060	Polypedilum fallax	6	SH
2541	Polypedilum flavum	6	
2061	Polypedilum halterale	4	SH
2062	Polypedilum illinoense	5	SH
2059	Polypedilum obtusum	6	SH
2063	Polypedilum scalaenum	6	SH
2064	Polypedilum simulans	6	SH
2057	Polypedilum sp.	6	SH
2326	Pomatiopsidae	6	
2327	Pomatiopsis sp.	6	
620	Potamanthidae	5	CF
105	Potamothenix vejdvovskyi	10	
1329	Potamyia flava	4	CF
1328	Potamyia sp.	4	CF
1990	Potthastia sp.	6	
1867	Prionocera sp.	4	SH
1802	Prionocyphon sp.	7	SC
71	Pristina aequisetata	10	CG
73	Pristina breviseta	10	CG
72	Pristina leidyi	10	CG
74	Pristina longiseta	10	
75	Pristina osborni	10	CG
70	Pristina sp.	10	CG
76	Pristina synclites	10	CG
1943	Probezzia sp.	5	PR
2316	Probythinella sp.	6	
423	Procambarus acutus	5	SH
424	Procambarus clarki	5	

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425	<i>Procambarus gracilis</i>	5	
422	<i>Procambarus</i> sp.	5	SH
426	<i>Procambarus viaeviridis</i>	5	
1982	<i>Procladius</i> sp.	8	PR
643	<i>Proclaeon</i> sp.	4	
1991	<i>Prodiamesa</i> sp.	3	CG
733	<i>Progomphus obscurus</i>	5	PR
732	<i>Progomphus</i> sp.	5	PR
2345	<i>Promenetus</i> sp.	6.5	CG
1787	<i>Promoresia</i> sp.	5	SC
2468	<i>Proptera alata</i>	1	
2469	<i>Proptera capax</i>	1	
2470	<i>Proptera laevis</i> sp.	1	
2467	<i>Proptera</i> sp.	1	
1950	<i>Prosimulium magnum</i>	2	
1951	<i>Prosimulium mixtum</i>	2	
1949	<i>Prosimulium</i> sp.	2	CF
940	<i>Prostoia</i> sp.	1.5	SH
1375	<i>Protoptila</i> sp.	1	SC
2012	<i>Psectrocladius</i> sp.	5	CG
1983	<i>Psectrotanypus</i> sp.	8	PR
1614	<i>Psephenidae</i>	4	SC
1615	<i>Psephenus herricki</i>	4	SC
1616	<i>Psephenus</i> sp.	4	SC
2198	<i>Pseudochironomus fulviventris</i>	5	
2199	<i>Pseudochironomus prasinatus</i>	5	
2066	<i>Pseudochironomus</i> sp.	5	CG
522	<i>Pseudocloeon carolina</i>	4	
523	<i>Pseudocloeon dubium</i>	4	SC
524	<i>Pseudocloeon myrsum</i>	4	
525	<i>Pseudocloeon parvulum</i>	4	
656	<i>Pseudocloeon propinquus</i> gr.	4	
526	<i>Pseudocloeon punctiventris</i>	4	
521	<i>Pseudocloeon</i> sp.	4	SC
1992	<i>Pseudodiamesa</i> sp.	1	CG
1868	<i>Pseudolimnophila</i> sp.	2	PR
2013	<i>Pseudorthocladius</i> sp.	6	CG
1425	<i>Pseudostenophylax</i> sp.	3.5	SH
1426	<i>Pseudostenophylax uniformis</i>	3.5	
2355	<i>Pseudosuccinea columella</i>	7	SC
2336	<i>Pseudosuccinea</i> sp.	7	SC
2597	<i>Psilometriocnemus</i> sp.	6	
1920	<i>Psorophora ciliata</i>	8	
1921	<i>Psorophora confinnis</i>	8	PR

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1922	Psorophora cyanescens	8	
1923	Psorophora discolor	8	
1924	Psorophora ferox	8	
1925	Psorophora horrida	8	
1926	Psorophora howardi	8	
1919	Psorophora sp.	8	PR
1927	Psorophora varipes	8	
1935	Psychoda sp.	11	CG
1933	Psychodidae	11	CG
1369	Psychomyia flavida	2	CG
1368	Psychomyia sp.	2	SC
1365	Psychomyiidae	3.5	CG
927	Pteronarcys sp.	2	SH
1449	Ptilostomis sp.	3	SH
2472	Ptychobranchnus fasciolaris	1.5	
2471	Ptychobranchnus sp.	1.5	
2081	Ptychoptera sp.	8	CG
2079	Ptychopteridae	8	CG
1428	Pycnopsyche guttifer	3	SH
1429	Pycnopsyche lepida	3	
1430	Pycnopsyche luculenta	3	
1431	Pycnopsyche scabripennis	3	SH
1427	Pycnopsyche sp.	3	SH
1432	Pycnopsyche subfasciata	3	SH
1551	Pyralidae	99.9	SH
2317	Pyrgulopsis sp.	6	SC
2474	Quadrula cyclindrica	1.5	
2475	Quadrula metanerva	1.5	
2476	Quadrula nodulata	1.5	
2477	Quadrula pustulosa	1.5	
2478	Quadrula quadrula	1.5	
2473	Quadrula sp.	1.5	
108	Quistradrilus multisetosus	10	CG
1106	Ramphocorixa acuminata	99.9	
1105	Ramphocorixa sp.	99.9	PR
1079	Ranatra fusca	99.9	PR
1081	Ranatra kirkaldyi	99.9	PR
1082	Ranatra nigra	99.9	PR
1080	Ranatra sp.	99.9	PR
2594	Raphium sp.	99.9	
994	Rasvena sp.	1.5	
995	Rasvena terna	1.5	CG
1066	Rhagovelia sp.	99.9	PR
2595	Rhamphomyia sp.	1	

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1752	Rhantus binotatus	99.9	
1751	Rhantus sp.	99.9	PR
2180	Rheocricotopus fuscipes	6	
2246	Rheocricotopus robacki	6	
2014	Rheocricotopus sp.	6	CG
2225	Rheopelopia sp.	3	PR
2077	Rheotanytarsus sp.	6	CF
1062	Rheumatobates sp.	99.9	PR
545	Rhithrogena pellucida	0	SC
544	Rhithrogena sp.	0	SC
1393	Rhyacophila fenestra	1	
1394	Rhyacophila fuscula	1	PR
1395	Rhyacophila lobifera	1	
1392	Rhyacophila sp.	1	PR
1396	Rhyacophila vibox	1	
1391	Rhyacophilidae	3.5	PR
151	Rhynchobdellida	8	
2218	Robackia sp.	3	CG
2067	Saetheria sp.	6	CG
2153	Sciomyzidae	10	PR
1627	Scirtes orbiculatus	7	
1626	Scirtes sp.	7	SH
1628	Scirtes tibialis	7	
2514	Seatheria tylus	4	
1489	Sericostomatidae	3.5	SH
595	Serratella deficiens	1	CG
597	Serratella sordida	1	CG
594	Serratella sp.	1	CG
2596	Serromyia sp.	5	
1483	Setodes sp.	3.5	
1176	Sialidae	3.5	PR
1180	Sialis infumata	4	
1181	Sialis itasca	4	
1183	Sialis mohri	4	PR
1177	Sialis sp.	4	PR
1184	Sialis vagans	4	
1185	Sialis velata	4	
1108	Sigara alternata	99.9	
1109	Sigara compressoidea	99.9	
1111	Sigara hubbelli	99.9	
1113	Sigara modesta	99.9	
1115	Sigara signata	99.9	
1107	Sigara sp.	99.9	PR
1946	Simuliidae	6	CF

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1953	<i>Simulium clarkei</i>	4	
1954	<i>Simulium corbis</i>	0	
1955	<i>Simulium decorum</i>	4	CF
1956	<i>Simulium jenningsi</i>	4	CF
1957	<i>Simulium luggeri</i>	2	
1958	<i>Simulium meridionale</i>	1	CF
1952	<i>Simulium</i> sp.	6	CF
1959	<i>Simulium tuberosum</i>	4	CF
1960	<i>Simulium venustum</i>	6	CF
1961	<i>Simulium verecundum</i>	6	
1962	<i>Simulium vittatum</i>	8	CF
477	Siphonuridae	3	CG
483	<i>Siphonurus alternatus</i>	2	
484	<i>Siphonurus quebecensis</i>	2	
485	<i>Siphonurus rapidus</i>	2	
482	<i>Siphonurus</i> sp.	2	CG
495	<i>Siphloplecton basale</i>	2	
496	<i>Siphloplecton interlineatum</i>	2	
494	<i>Siphloplecton</i> sp.	2	CG
1254	<i>Sisyra</i> sp.	1	PR
1255	<i>Sisyra vicaria</i>	1	
1251	Sisyridae	1	PR
78	<i>Slavina appendiculata</i>	10	CG
77	<i>Slavina</i> sp.	10	CG
2015	<i>Smittia</i> sp.	6	CG
781	<i>Somatochlora filosa</i>	1	
782	<i>Somatochlora linearis</i>	1	PR
779	<i>Somatochlora</i> sp.	1	PR
783	<i>Somatochlora tenebrosa</i>	1	
2318	<i>Somatogyrus</i> sp.	6	
941	<i>Soyedina</i> sp.	1.5	SH
80	<i>Specaria josinae</i>	10	CG
79	<i>Specaria</i> sp.	10	CG
2491	Sphaeriidae	5	
2495	<i>Sphaerium</i> sp.	5	CG
2224	<i>Sphaeromias</i> sp.	5	
1390	<i>Stactobiella palmata</i>	3.5	
1389	<i>Stactobiella</i> sp.	3.5	SH
2338	<i>Stagnicola emarginatus</i>	7	
2337	<i>Stagnicola</i> sp.	7	SC
2219	<i>Stelechomyia</i>	6	CG
2247	<i>Stelechomyia pulpulchra</i>	99.9	CG
2226	<i>Stempellina</i> sp.	2	CG
2212	<i>Stempellinella</i> sp.	2	CG

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548	<i>Stenacron interpunctatum</i>	4	
550	<i>Stenacron</i> sp.	4	SC
1789	<i>Stenelmis bicarinata</i>	7	SC
1790	<i>Stenelmis crenata</i>	7	
1791	<i>Stenelmis decorata</i>	7	SC
1792	<i>Stenelmis lateralis</i>	7	SC
1793	<i>Stenelmis markeli</i>	7	SC
1794	<i>Stenelmis mera</i>	7	SC
1795	<i>Stenelmis musgravei</i>	7	SC
1796	<i>Stenelmis sexlineata</i>	7	SC
1788	<i>Stenelmis</i> sp.	7	SC
1797	<i>Stenelmis vittipennis</i>	6	
2069	<i>Stenochironomus hilaris</i>	3	CG
2068	<i>Stenochironomus</i> sp.	3	SH
554	<i>Stenonema femoratum</i>	7	SC
659	<i>Stenonema</i> sp.	4	SC
81	<i>Stephensoniana</i> sp.	10	
82	<i>Stephensoniana trivandrana</i>	10	CG
2519	<i>Stictochironomus cafferarius</i>	5	
2248	<i>Stictochironomus devinctus</i>	5	
2070	<i>Stictochironomus</i> sp.	5	
1945	<i>Stilobezzia</i> sp.	5	
2220	<i>Stilocladius</i> sp.	6	
2082	Stratiomyidae	10	CG
2087	<i>Stratiomys discalis</i>	10	
2088	<i>Stratiomys meigeni</i>	10	
2086	<i>Stratiomys</i> sp.	10	CF
2479	<i>Strophitus</i> sp.	4	
2480	<i>Strophitus undulatus</i>	4	
932	<i>Strophopteryx fasciata</i>	1.5	SH
931	<i>Strophopteryx</i> sp.	1.5	
330	<i>Stygobromus</i> sp.	4	PR
331	<i>Stygobromus subtilis</i>	4	
84	<i>Stylaria fossularis</i>	10	CG
85	<i>Stylaria lacustris</i>	10	CG
83	<i>Stylaria</i> sp.	10	
736	<i>Stylogomphus albistylus</i>	4.5	PR
734	<i>Stylogomphus</i> sp.	4.5	PR
737	<i>Stylurus</i> sp.	7	PR
2228	<i>Sublettea</i> sp.	6	CF
819	<i>Sympetrum ambiguum</i>	4	PR
820	<i>Sympetrum corruptum</i>	4	
821	<i>Sympetrum obstrusum</i>	4	
822	<i>Sympetrum rubicundulum</i>	4	

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823	<i>Sympetrum semicinctum</i>	4	
818	<i>Sympetrum</i> sp.	4	PR
824	<i>Sympetrum vicinum</i>	4	
1993	<i>Sympothastia</i> sp.	6	CG
1557	<i>Synclita</i> sp.	99.9	SH
1994	<i>Syndiamesa</i> sp.	6	CG
2148	Syrphidae	11	CG
2089	Tabanidae	7	PR
2126	<i>Tabanus atratus</i>	7	
2127	<i>Tabanus cymatophorus</i>	7	
2128	<i>Tabanus fairchildi</i>	7	
2130	<i>Tabanus lineola</i>	7	
2131	<i>Tabanus marginalis</i>	7	
2132	<i>Tabanus nigrescens</i>	7	
2133	<i>Tabanus pumilus</i>	7	
2134	<i>Tabanus quinquevittatus</i>	7	
2135	<i>Tabanus reinwardtii</i>	7	
2125	<i>Tabanus</i> sp.	7	PR
2136	<i>Tabanus sparus</i>	7	
2137	<i>Tabanus stygius</i>	7	
2139	<i>Tabanus subsimilis</i>	7	
2140	<i>Tabanus sulcifrons</i>	7	
2141	<i>Tabanus superjumentarius</i>	7	
2142	<i>Tabanus trimaculatus</i>	7	
928	Taeniopterygidae	1.5	SH
934	<i>Taeniopteryx nivalis</i>	2	SH
935	<i>Taeniopteryx parvula</i>	2	SH
933	<i>Taeniopteryx</i> sp.	2	SH
2206	Tanypodinae	6	PR
2516	<i>Tanypus carinatus</i>	8	
2175	<i>Tanypus neopunctipennis</i>	8	
2508	<i>Tanypus punctipennis</i>	8	
1984	<i>Tanypus</i> sp.	8	PR
2515	<i>Tanypus stellatus</i>	8	
2207	Tanytarsini	6	CF
2231	<i>Tanytarsus glabrescan</i>	7	
2230	<i>Tanytarsus guerlus</i>	7	
2078	<i>Tanytarsus</i> sp.	7	CF
2165	<i>Telmatoscopus</i> sp.	11	CG
785	<i>Tetragoneuria cynosura</i>	4.5	PR
784	<i>Tetragoneuria</i> sp.	4.5	PR
1754	<i>Thermonectus basillaris</i>	99.9	PR
1755	<i>Thermonectus ornatcollis</i>	99.9	
1753	<i>Thermonectus</i> sp.	99.9	PR

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176	<i>Theromyzon biannulatum</i>	8	
175	<i>Theromyzon</i> sp.	8	PR
2016	<i>Thienemanniella</i> sp.	2	CG
2017	<i>Thienemanniella xena</i>	2	CG
2176	<i>Thienemannimyia senata</i>	6	
1985	<i>Thienemannimyia</i> sp.	6	PR
1854	<i>Tipula</i> sp.	4	SH
1853	Tipulidae	4	SH
641	<i>Tortopus</i> sp.	4	CG
2500	<i>Toxolasma paruvus</i>	7	
2424	<i>Toxolasma texasensis</i>	7	
826	<i>Tremea carolina</i>	4	PR
827	<i>Tremea lacerata</i>	4	
828	<i>Tremea onusta</i>	4	
825	<i>Tremea</i> sp.	4	PR
1063	<i>Trepobates</i> sp.	99.9	PR
1486	<i>Triaenodes injustus</i>	3	
1487	<i>Triaenodes marginatus</i>	3	sh
1484	<i>Triaenodes</i> sp.	3	MH
1488	<i>Triaenodes tardus</i>	3	SH
2197	<i>Tribelos fuscicorne</i>	4	CG
2232	<i>Tribelos jucundus</i>	5	
2071	<i>Tribelos</i> sp.	5	CG
1118	<i>Trichocorixa calva</i>	99.9	
1119	<i>Trichocorixa kanza</i>	99.9	
1120	<i>Trichocorixa macroceps</i>	99.9	
1117	<i>Trichocorixa</i> sp.	99.9	PR
1300	Trichoptera	3.5	
3	Tricladida	6	CG
599	<i>Tricorythodes</i> sp.	5	CG
2481	<i>Tritogonia</i> sp.	1	
2482	<i>Tritogonia verrucosa</i>	1	
1682	<i>Tropisternus blatchleyi</i>	99.9	
1684	<i>Tropisternus lateralis</i>	99.9	CG
1685	<i>Tropisternus mixtus</i>	99.9	
1686	<i>Tropisternus natator</i>	99.9	
1681	<i>Tropisternus</i> sp.	99.9	PR
2484	<i>Truncilla donaciformis</i>	1	
2483	<i>Truncilla</i> sp.	1	
2485	<i>Truncilla truncata</i>	1	
103	<i>Tubifex</i> sp.	10	CG
104	<i>Tubifex tubifex</i>	10	CG
212	Tubificida	10	
92	Tubificidae	10	CG

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2	Turbellaria	6	PR
2213	Tvetenia sp.	5	
86	Uncinaiis sp.	10	
87	Uncinaiis uncinata	10	
2486	Uniomerus sp.	1.5	
2487	Uniomerus tetralasmus	1.5	
2401	Unionidae	1.5	CF
2600	Unionoida	99.9	
1929	Uranotaenia sapphirina	8	
1928	Uranotaenia sp.	8	CF
1756	Uvarus sp.	99.9	PR
2307	Valvata sp.	2	SC
2306	Valvatidae	6	SC
89	Vejdovskyella intermedia	10	CG
88	Vejdovskyella sp.	10	CG
1064	Veliidae	99.9	PR
2601	Veneroida	5	
2489	Villosa iris	1	
2490	Villosa lienosa	1	
2488	Villosa sp.	1	
2302	Viviparidae	6	SC
2305	Viviparus sp.	1	SC
91	Wapsa mobilis	10	
90	Wapsa sp.	10	
1348	Wormaldia shawnee	3.5	
1346	Wormaldia sp.	3.5	CF
2072	Xenochironomus sp.	4	PR
2513	Xenochironomus xenolabis	6	
2227	Xestochironomus sp.	6	
2249	Xylotopus par.	6	
2200	Zalutschia sp.	6	SH
3433	Zavreliella sp.	2	
2254	Zavreliella marmorata	2	
2235	Zavreliymia sinuosa com	8	
1986	Zavreliymia sp.	8	PR
829	Zygoptera	99.9	PR

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Illinois Environmental Protection Agency

Bureau of Water

Document Control Number 177

**Methods Utilized to Determine the Types and Amounts of
Pertinent Macroinvertebrate Habitats in Perennial Wadeable
Streams for 20-Jab Allocation**

Surface Water Section

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Springfield, Illinois 62794-9276

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Appendix B. Methods utilized to determine the types and amounts of pertinent macroinvertebrate habitats in perennial wadeable streams for 20-jab allocation.

Use the average stream width in the sampling reach to allocate jabs between bank-zone and bottom-zone habitats. Use Table 1 (see below) to identify all pertinent, macroinvertebrate habitats. Note that Table 1 definitions were developed exclusively for 20-jab collections and may not fulfill the requirements of other sampling methods.

Table 1 (Appendix B). 20-jab macroinvertebrate collection-zone criteria and categories plus habitat types.

Mean water width (to nearest foot)	Assumed width of bank-zone	Bank-zone jabs	Bottom-zone jabs
< 10 ft	25% of water width per bank	10	10
10-29 ft	20% of water width per bank	8	12
30-59 ft	15% of water width per bank	6	14
≥60	10% of water width per bank	4	16

Bottom-zone habitat type	Definition
- <i>Fine substrate</i> :	Streambed surface predominantly comprising silt/mud to fine gravel (i.e., particles < 8mm in diameter of intermediate dimension).
- <i>Coarse substrate</i> :	Streambed surface predominantly comprising medium gravel to boulder (i.e., particles ≥ 8 mm in diameter of intermediate dimension).
- <i>Plant detritus</i> :	Streambed surface predominantly comprising nonliving plant material (e.g., leaves, twigs).
- <i>Vegetation</i> :	Streambed surface predominantly comprising living plant material (e.g., aquatic macrophytes, filamentous algae, submerged terrestrial plants).

Bank-zone habitat type	Definition
- <i>Submerged terrestrial vegetation</i> :	Living, terrestrial plants (along stream banks) of which submerged portions provide cover or attachment sites for macroinvertebrates.
- <i>Submerged tree roots</i> :	Living tree roots (along stream banks) of which submerge portions provide cover or attachment sites for macroinvertebrates.
- <i>Brush-debris jams</i> :	Non-living, submerged, woody material (e.g., branches, twigs, smaller logs) that occurs <u>above</u> the streambed surface and that appears to have microbial conditioning. Exclude recent deadfall that lacks microbial conditioning.

When using the definitions in Table 1, (see above) base all classifications on conditions that exist within the sample reach at the time of the macroinvertebrate collection. If water turbidity or excessive depth prevents seeing the entire wetted stream channel throughout the sampling reach, the sampler may use tactile cues to obtain a reasonably accurate estimate of the amount of each habitat type. However, in most cases, if more than half of the wetted stream channel cannot be seen, touched, or otherwise appropriately-characterized, it is unknown that the 20-jab method will apply.

Habitat characterization methods

Two approved habitat characterization methods exist for use with the 20-jab sample approach. Review the criteria (see below) included with the 11-transect and the non-transect methods and decide which of the two habitat characterizations apply. Based on this decision, use the pre-defined habitat types (Table 1 above) and the chosen characterization method to determine the amount of pertinent macroinvertebrate habitat present in the sample reach. It is important to note the difference between 11-transect and non-transect methods. The 11-transect method establishes 11- equally spaced transects, which results in a relatively consistent number of observation points based on stream width. It should also be pointed out that observations taken along the transect do not always represent the predominant substrate at a given point. In many situations there is an intermixture of substrate types along a transect (e.g. silt, sand and fine gravel). In these circumstances an equal number of points in a transect are assigned to each of the substrate types in the intermixture (e.g. 3-silt, 3-sand, 3-fine gravel). More importantly, it is unknown how well the substrate types observed at the established points along a transect represent the relative amounts of substrate types that occur between the transects. These unknowns may be significant since the area between the transects is the majority of the sample reach. Conversely, the non-transect approach provides an estimate of the relative amounts of each substrate type throughout the sample reach. Both the 11-transect and non-transect methods rely on visual and tactile cues and both methods provide estimates that account for the intermixture of substrates as described above.

1.0 11-transect habitat characterization method

Use the 11-transect method if: the type or amount of habitat encountered during the last appraisal differs obviously from the present appraisal OR; the 11-transect habitat method has never been applied in the sample reach OR; the habitat appraisal would be made by qualified, trained personnel with fewer than two years of experience in measuring and characterizing instream physical habitat (including stream-bottom composition) for purposes of natural-resource management.

Table 2 (Appendix B). 11-transect “point-increment” habitat categories.

Substrates Types:		Instream Cover Types:
Name	Particle-Size Range	
¹ Silt/mud	< 0.062 mm	⁶ Submerged terrestrial vegetation
¹ Sand	0.062 – 2 mm	⁷ Submerged tree roots
¹ Fine gravel	2 – 8 mm	⁵ Brush-debris jam
² Medium gravel	8 – 16 mm	Boulder (not embedded)
² Coarse gravel	16 – 64 mm	Undercut bank
² Small cobble	64 – 128 mm	Rock/clay ledge
² Large cobble	128 – 256 mm	⁵ Log
² Boulder	256 – 4000 mm	⁴ Aquatic vegetation
Bedrock	> 4000 mm	Other (please specify)
Bottom Types:		
Claypan/Compacted soil		
³ Plant detritus		
⁴ Vegetation		

Point-increment observation to collection-zone translation

- ¹Fine substrate (Bottom-zone habitat type)
- ²Coarse substrate (Bottom-zone habitat type)
- ³Plant detritus (Bottom-zone habitat type)
- ⁴Vegetation (Bottom-zone OR Bank-zone) (macrophytes, filamentous algae and submerged terrestrial vegetation)
- ⁵Brush-debris jams (Bank-zone habitat type)
- ⁶Submerged terrestrial vegetation (Bank-zone habitat type)
- ⁷Submerged tree roots (Bank-zone habitat type)

- When applicable, coarsely measure and estimate habitat conditions by applying the appropriate parts of the 11-transect method as described in *Section E*: of this manual. Specifically, use the point-transect approach to identify the predominant “substrate type” or “bottom type” (Table 2 in Appendix B) at each of many points distributed regularly on the wetted stream bed throughout the entire sampling reach. Also, per each of ten segments in the sampling reach, coarsely measure the area occupied by each of the nine “instream cover type”(s) (Table 2 in Appendix B). Often there is an intermixture of substrate types. In these situations an equal number of points in a transect are assigned to each of the substrate types in the intermixture (e.g. 3-silt, 3-sand, 3-fine gravel). Instream cover is measured in square feet for the 11-transect method.

Bottom-zone habitat classification based on 11-transect methodology

Refer to the assumed width of bank-zone criteria provided in Table 1 to determine the width of the bottom-zone.

Based on 11-transect habitat information, translate each of the pertinent point-increment transect observations of “*substrate*” and “*bottom type*” (Table 2) into an observation point that is classified as one of the four corresponding 20-jab “*bottom-zone*” habitat types (Table 1). Note that claypan and bedrock are not considered as a bottom-zone habitat type for applying the 20-jab method and the area of wetted stream bottom that consists of claypan should be ignored (in the denominator in Equation 1) when

considering the relative percentage of relevant bottom-zone habitat types. Explicit translation instructions are included in the Table 2 footnotes.

Per each of the four 20-jab bottom-zone habitat types, calculate the number of times a specified types occur among all of the 11-transect point-increment observations.

Use Equation 1 (see below) to calculate the relative percentage of each of the four, 20-jab, bottom-zone habitat types in the sampling reach as:

Equation 1. *Relative percentage of each bottom-zone habitat type =*

$$\frac{\text{Sum of the points (from all transects) at which the bottom-zone habitat type occurred}}{\text{Sum of the points (from all transects) at which any of the four bottom-zone habitat types occurred}} \times 100$$

Record the relative percentage result for each, 20-jab, bottom-zone habitat type. Note: claypan and bedrock are not included in bottom zone allocations (Table 2).

Bank-zone habitat classification based on 11-transect methodology

Refer to the assumed width of bank-zone criteria provided in Table 1 to determine the width of the bank-zone collection area.

Submerged terrestrial vegetation

- With the 11-transect habitat characterization method, the spatial coverage of submerged terrestrial vegetation is determined for both banks within each of the ten stream segments delineated by the eleven transects. In each of the ten segments, use a known distance such as the length of a wading rod or the distance between transects, to coarsely measure the total length (ft) of *submerged terrestrial vegetation* present (Table 2). Sum the ten segment totals and record this grand total as the amount of *submerged terrestrial vegetation* that occurs along the banks of the sample reach. The linear amount (ft) of submerged terrestrial vegetation that occurs along the banks of the sample reach- as determined by the 11-transect method- is considered equivalent to the amount of submerged terrestrial vegetation that occurs in the assumed bank-zone of the 20-jab collection area.

Submerged tree roots

- With the 11-transect habitat characterization method, the spatial coverage of submerged tree roots is determined for both banks within each of the ten stream segments delineated by the eleven transects. In each of the ten segments, use known distance such as the length of a wading rod or the distance between transects, to coarsely measure the total length (ft) of *submerged tree roots* present (Table 2). Sum the ten segment totals and record this grand total as the amount of *submerged tree roots* that occurs along the banks of the sample reach. The linear amount (ft) of submerged tree roots that occurs along the banks of the sample reach- as determined by the 11-transect method- is considered equivalent to the amount of submerged tree roots that occurs in the assumed bank-zone of the 20-jab collection area.

Brush-debris jams

- The amount of *log plus brush-debris jam* habitat is calculated in a slightly different manner than the previous two bank-zone habitats. Here, consider each *log plus brush-debris jams* as bank-zone habitat, regardless of where the woody materials are located in the sample reach—

provided that the woody material occurs at a depth and water velocity that allow safe and sufficient sampling of macroinvertebrates with a dip net. Coarsely measure the single longest dimension covered by each log and brush-debris jam. Sum these lengths to yield the total length of *logs* plus *brush-debris jams* within each of the ten stream segments. In turn, sum the ten segment totals and record the grand total length of *log* plus *brush-debris jams* that occurs in the sample reach.

Use Equation 2 (see below) to calculate the relative percentage of each bank-zone habitat type in the sampling reach as

Equation 2. *Relative percentage of each bank-zone habitat type =*

<i>Total length that a given bank-zone habitat type occurred in the sample reach</i>	\div	<i>Sum of total length for each of the three bank-zone habitat types that occur in the sample reach</i>	$\times 100$
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Record the relative percentage of each bank-zone habitat type.

2.0 Non-Transect habitat characterization method

For qualified, trained personnel having two or more years of experience in measuring and characterizing instream physical habitat (including stream-bottom composition) for purposes of natural-resource management, use either the 11-transect (see above) or the non-transect approach to characterize macroinvertebrate habitat within the sample reach.

Bottom-zone habitat classification based on non-transect estimations

- Estimate and record the percent surface area of the relevant portion of wetted stream bottom that consists of each of the four bottom-zone habitat types (Table 1). Note that claypan and bedrock are not considered as a bottom-zone habitat type for applying the 20-jab method and the area of wetted stream bottom that consists of claypan should be ignored (in the denominator in Equation 1) when considering the relative percentage of relevant bottom-zone habitat types.

Bank-zone habitat classification based on non-transect estimations

- Estimate and record the percentage of bank length occupied by each of the three bank-zone habitat types. Estimate and record *logs plus submerged terrestrial vegetation* (Table 1 in Appendix B) and *submerged tree roots* (Table 1 in Appendix B) as the length of bank-zone covered by each habitat type in the sampling reach. When estimating the amount of *logs plus brush-debris jams* (Table 1) in the sampling reach, consider all logs and brush-debris jams as bank-zone habitat, regardless of where the snag occurs in the sample reach—provided that the log and brush-debris jam occurs at a depth and water velocity that allow safe and sufficient sampling of macroinvertebrates with a dip-net. Estimate the single longest dimension covered by each log and brush-debris jam and then sum these lengths to yield the total length of *logs plus Brush-debris jams* in the sample reach. The percentage of bank length is from IEPA STREAM ASSESSMENT FORM-Non-Transect Habitat Information.



Illinois Environmental Protection Agency

Bureau of Water

Document Control Number 178

**Genus-List: Macroinvertebrate-Index of Biotic Integrity
(m-IBI) Tolerance List and Functional Feeding
Group Classification**

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Phylogenetic Order

Major Group	Bios ID	Taxon	Tolerance	Functional Feeding Group
Phylum Platyhelminthes	1	Platyhelminthes	99.9	
Class Turbellaria	2	Turbellaria	6	PR
Phylum Nematomorpha	15	Nematomorpha	99.9	PA
Phylum Annelida	30	Annelida	99.9	CG
Class Oligochaeta	31	Oligochaeta	10	CG
Class Hirudinea	249	Hirudinea	8	PR
Phylum Arthropoda	250	Arthropoda	99.9	
Class Crustacea	251	Crustacea	99.9	CG
Order Isopoda	252	Isopoda	99.9	CG
Family Asellidae	253	Asellidae	6	CG
	254	Caecidotea sp.	6	CG
	255	Asellus sp.	6	CG
	272	Lirceus sp.	4	CG
Order Amphipoda	325	Amphipoda	4	CG
Family Talitridae	326	Hyaellidae	4	
	327	Hyaella sp.	4	CG
Family Gammaridae	329	Gammaridae	4	CG
	341	Gammarus sp.	3	CG
	330	Stygobromus sp.	4	PR
	332	Bactrurus sp.	1	
Family Crongonyctidae	348	Crongonyctidae	4	
	335	Crangonyx sp.	4	CG
Order Decapoda	400	Decapoda	99.9	SH
Family Cambaridae	401	Cambaridae	5	CG
Family Palaemonidae	427	Palaemonidae	4	
	428	Palaemonetes sp.	4	
Class Insecta	475	Insecta	99.9	
Order Ephemeroptera	476	Ephemeroptera	3	CG
Family Acanthametropodidae	2605	Acanthametropodidae		
	478	Acanthametropus sp.	3	PR
Family Ameletidae	2604	Ameletidae		
	480	Ameletus sp.	0	CG
Family Siphonuridae	477	Siphonuridae	3	CG
	482	Siphonurus sp.	2	CG
Family Oligoneuriidae	486	Oligoneuriidae	3	CF
Family Isonychiidae	487	Isonychia sp.	3	CF
Family Metretopodidae	493	Metretopodidae	3	
	494	Siphloplecton sp.	2	CG

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Family Baetidae	497	Baetidae	4	CG
	652	Acentrella sp.	4	
	2203	Acerpenna sp.	4	SH
	498	Baetis sp.	4	CG
	511	Callibaetis sp.	4	CG
	515	Centroptilum sp.	2	CG
	663	Dipheter sp.	4	
	643	Proclueon sp.	4	
	519	Heterocloeon sp.	4	SC
	651	Plauditus sp.	3	
	521	Pseudocloeon sp.	4	SC
	527	Paracloeodes sp.	4	SC
Family Arthropleidae	2603	Arthropleidae	3	CF
	531	Arthroplea sp.	3	CF
Family Heptageniidae	528	Heptageniidae	3.5	SC
	529	Anepeorus sp.	3.5	PR
	533	Epeorus sp.	1	SC
	644	Nixe sp.	4	SC
	536	Heptagenia sp.	3	SC
	544	Rhithrogena sp.	0	SC
	550	Stenacron sp.	4	SC
	648	Leucocuta sp.	3	SC
	551	Maccaffertium sp.	4	SC
	659	Stenonema sp.	4	SC
Family Ephemerellidae	567	Ephemerellidae	3.5	CG
	568	Attenella sp.	2	CG
	570	Dannella sp.	2	CG
	573	Drunella sp.	1	PR
	578	Ephemerella sp.	2	CG
	587	Eurylophella sp.	4	SC
	594	Serratella sp.	1	CG
Family Leptohyphidae	598	Leptohyphidae	5.5	CG
	662	Leptohyphe sp.	5.5	CG
	599	Tricorythodes sp.	5	CG
Family Caenidae	600	Caenidae	5.5	CG
	601	Brachycercus sp.	3	CG
	602	Caenis sp.	6	CG
Family Baetiscidae	603	Baetiscidae	3	CG
	605	Baetisca sp.	3	CG
Family Leptophlebiidae	609	Leptophlebiidae	3	CG
	610	Choroerpes sp.	2	CG
	612	Habrophlebiodes sp.	2	SC

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	614	Leptophlebia sp.	3	CG
	615	Paraleptophlebia sp.	2	CG
Family Potamanthidae	620	Potamanthidae	5	CF
	621	Anthopotamus sp.	4	
Family Ephemeridae	625	Ephemeridae	5	CG
	626	Ephemera sp.	3	CG
	628	Hexagenia sp.	6	CG
Family Palingeniidae	635	Pentagenia sp.	4	CF
Family Polymitarciidae	637	Polymitarciidae	3	CG
	638	Ephoron sp.	2	CG
	641	Tortopus sp.	4	CG
Order Odonata	700	Odonata	99.9	PR
Family Cordulegastridae	702	Cordulegastridae	4.5	PR
	703	Cordulegaster sp.	2	PR
Family Gomphidae	706	Gomphidae	4.5	PR
	2602	Erpetogomphus sp.	2	
	713	Dromogomphus sp.	4	PR
	707	Arigomphus sp.	7	PR
	722	Gomphus sp.	7	PR
	737	Stylurus sp.	7	PR
	728	Hagenius sp.	3	PR
	735	Lanthus sp.	6	PR
	730	Ophiogomphus sp.	2	PR
	732	Progomphus sp.	5	PR
	734	Stylogomphus sp.	4.5	PR
Family Aeshnidae	742	Aeshnidae	4.5	PR
	743	Aeshna sp.	4	PR
	749	Anax sp.	5	PR
	751	Basiaeschna sp.	2	PR
	753	Boyeria sp.	3	PR
	755	Epiaeschna sp.	1	PR
	758	Nasiaeschna sp.	2	PR
Family Macromiidae	759	Macromiidae	4.5	PR
	760	Didymops sp.	4	PR
	762	Macromia sp.	3	PR
Family Corduliidae	768	Corduliidae	4.5	PR
	769	Cordulia sp.	2	PR
	771	Epithea sp.	4	PR
	772	Epicordulia sp.	4.5	PR
	774	Helocordulia sp.	2	PR
	775	Neurocordulia sp.	3	PR
	779	Somatochlora sp.	1	PR

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	784	Tetragoneuria sp.	4.5	PR
Family Libellulidae	787	Libellulidae	4.5	PR
	788	Celithemis sp.	2	PR
	792	Erythemis sp.	5	PR
	794	Erythrodiplax sp.	5	PR
	795	Ladona sp.	4.5	PR
	797	Leucorrhinia sp.	4.5	PR
	800	Libellula sp.	8	PR
	809	Pachydiplax sp.	8	PR
	811	Pantala sp.	7	PR
	814	Perithemis sp.	4	PR
	816	Plathemis sp.	3	PR
	818	Sympetrum sp.	4	PR
	825	Tramea sp.	4	PR
	829	Zygoptera	99.9	PR
Family Calopterygidae	830	Calopterygidae	3.5	PR
	831	Calopteryx sp.	4	PR
	834	Hetaerina sp.	3	PR
Family Lestidae	837	Lestidae	99.9	PR
	838	Archilestes sp.	1	PR
	840	Lestes sp.	6	PR
Family Coenagrionidae	847	Coenagrionidae	5.5	PR
	848	Amphiagrion sp.	5	PR
	852	Argia sp.	5	PR
	860	Chromagrion sp.	5.5	PR
	862	Coenagrion sp.	5.5	PR
	863	Enallagma sp.	6	PR
	873	Ischnura sp.	6	PR
	876	Nehalennia sp.	7	PR
Order Plecoptera	925	Plecoptera	1.5	PR
Family Pteronarcyidae	927	Pteronarcys sp.	2	SH
Family Taeniopterygidae	928	Taeniopterygidae	1.5	SH
	929	Oemopteryx sp.	1.5	SH
	931	Strophopteryx sp.	1.5	SH
	933	Taeniopteryx sp.	2	SH
Family Nemouridae	936	Nemouridae	1.5	SH
	937	Amphinemura sp.	1.5	SH
	938	Nemoura sp.	1	SH
	940	Prostoia sp.	1.5	SH
	941	Soyedina sp.	1.5	SH
Family Leuctridae	942	Leuctridae	1.5	SH
	943	Leuctra sp.	1	SH

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Family Capniidae	944	Capniidae	1.5	SH
	945	Allocapnia sp.	2	SH
	949	Capnia sp.	1	SH
	951	Paracapnia sp.	1.5	SH
Family Perlidae	954	Perlidae	1.5	PR
	955	Acroneuria sp.	1	PR
	962	Attaneuria sp.	1.5	PR
	964	Neoperla sp.	1	PR
	966	Paragnetina sp.	1.5	PR
	968	Perlesta sp.	4	PR
	971	Atoperla sp.	1	
	970	Perlinella sp.	2	PR
	974	Phasganophora sp.	1.5	PR
Family Perlodidae	976	Perlodidae	1.5	PR
	977	Hydroperla sp.	1	PR
	979	Isogenoides sp.	1.5	PR
	980	Isoperla sp.	2	PR
Family Chloroperlidae	989	Chloroperlidae	1.5	PR
	990	Chloroperla sp.	3	
	991	Alloperla sp.	1.5	PR
	992	Hastaperla sp.	1.5	SC
	994	Rasvena sp.	1.5	CG
Order Hemiptera	1050	Hemiptera	99.9	PR
Order Megaloptera	1175	Megaloptera	3.5	
Family Sialidae	1176	Sialidae	3.5	PR
	1177	Sialis sp.	4	PR
Family Corydalidae	1186	Corydalidae	3	PR
	1187	Chauliodes sp.	4	PR
	1190	Corydalus sp.	3	PR
	1192	Nigronia sp.	2	PR
Order Neuroptera	1250	Neuroptera	99.9	PR
Family Sisyridae	1251	Sisyridae	1	PR
	1252	Climacea sp.	1	
	1254	Sisyra sp.	1	PR
Order Trichoptera	1300	Trichoptera	3.5	
Family Hydropsychidae	1301	Hydropsychidae	5.5	CF
	1330	Ceratopsyche sp.	4	CF
	1302	Cheumatopsyche sp.	6	CF
	1304	Diplectronea sp.	2	CF
	1306	Hydropsyche sp.	5	CF
	1324	Macronema sp.	2	CF
	2217	Macrostemum sp.	2	CF

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	1326	Parapsyche sp.	5.5	PR
	1328	Potamyia sp.	4	CF
Family Philopotamidae	1338	Philopotamidae	3.5	CF
	1339	Chimarra sp.	3	CF
	1344	Dolophilodes sp.	0	CG
	1346	Wormaldia sp.	3.5	CF
Family Polycentropodidae	1349	Polycentropodidae	3.5	CF
	1350	Cyrnellus sp.	5	CF
	1352	Neureclipsis sp.	3	CF
	1355	Nyctiophylax sp.	1	CF
	1356	Phylocentropus sp.	3.5	CF
	1358	Polycentropus sp.	3	PR
Family Psychomyiidae	1365	Psychomyiidae	3.5	CG
	1366	Lype sp.	3.5	SC
	1368	Psychomyia sp.	2	SC
Family Glossosomatidae	1370	Glossosomatidae	3.5	SC
	1372	Agapetus sp.	2	SC
	1373	Glossosoma sp.	3.5	SC
	1375	Protophila sp.	1	SC
Family Hydroptilidae	1376	Hydroptilidae	3.5	PH
	1377	Agraylea sp.	2	PH
	1379	Hydroptila sp.	2	SC
	1380	Ithytrichia sp.	1	SC
	1381	Leucotrichia sp.	3	SC
	1384	Mayatrichia sp.	1	SC
	1385	Neotrichia sp.	4	SC
	1386	Ochrotrichia sp.	4	CG
	1387	Orthotrichia sp.	1	SC
	1388	Oxyethira sp.	2	MH
	1389	Stactobiella sp.	3.5	SH
Family Rhyacophilidae	1391	Rhyacophilidae	3.5	PR
	1392	Rhyacophila sp.	1	PR
Family Brachycentridae	1397	Brachycentridae	3.5	CF
	1398	Brachycentrus sp.	1	CF
	1403	Micrasema sp.	3.5	MH
Family Lepidostomatidae	1405	Lepidostomatidae	3.5	SH
	1406	Lepidostoma sp.	3	SH
Family Limnephilidae	1408	Limnephilidae	3.5	SH
	1409	Anabolia sp.	3.5	SH
	1410	Frenesia sp.	3.5	SH
	1412	Goera sp.	3.5	SC
	1413	Hesperophylax sp.	3.5	SH

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	1415	Hydatophylax sp.	2	SH
	1417	Ironoquia sp.	3.5	SH
	1418	Leptophylax sp.	3.5	SH
	1420	Limnephilus sp.	3	SH
	1421	Neophylax sp.	3	SC
	1423	Platycentropus sp.	3	SH
	1425	Pseudostenophylax sp.	3.5	SH
	1427	Pycnopsyche sp.	3	SH
Family Molannidae	1433	Molannidae	3.5	CG
	1434	Molanna sp.	3.5	SC
Family Phryganeidae	1438	Phryganeidae	3.5	SH
	1439	Agrypnia sp.	3	SH
	1442	Banksiola sp.	2	SH
	1444	Fabria sp.	3.5	SH
	1446	Oligostomis sp.	3.5	PR
	1448	Phryganea sp.	3	
	1449	Ptilostomis sp.	3	SH
Family Helicopsychidae	1450	Helicopsychidae	3.5	SC
	1451	Helicopsyche sp.	2	SC
Family Leptoceridae	1453	Leptoceridae	3.5	CG
	1454	Ceraclea sp.	3	CG
	1466	Leptocerus sp.	3	SH
	1468	Mystacides sp.	2	CG
	1471	Nectopsyche sp.	3	SH
	1477	Oecetis sp.	5	PR
	1483	Setodes sp.	3.5	
	1484	Trienodes sp.	3	SH
Family Sericostomatidae	1489	Sericostomatidae	3.5	SH
	1502	Agarodes sp.	3.5	
Order Lepidoptera	1550	Lepidoptera	99.9	SH
Family Pyralidae	1551	Pyralidae	99.9	SH
	1556	Petrophila sp.	5	SC
Order Coleoptera	1600	Coleoptera	99.9	PR
Family Gyrinidae	1601	Gyrinidae	99.9	PR
	1602	Dineutus sp. (larvae only)	4	PR
	1607	Gyrinus sp. (larvae only)	4	PR
Family Psephenidae	1614	Psephenidae	4	SC
	1760	Dicranopselaphus sp.	4	SC
	1761	Ectopria sp.	4	SC
	1616	Psephenus sp.	4	SC
Family Scirtidae	1617	Helodidae	7	SC
	1618	Cyphon sp.	7	SC

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	1626	Scirtes sp.	7	SH
Family Dryopidae	1764	Dryopidae	4	SH
	1765	Helichus sp.	4	SH
	1769	Pelonomus sp.	4	CG
Family Elmidae	1771	Elmidae	5	CG
	1772	Ancyronyx sp.	2	CG
	1774	Dubiraphia sp.	5	CG
	1779	Macronychus sp.	2	
	1781	Microcylloepus sp.	2	CG
	1783	Optioservus sp.	4	SC
	1787	Promoresia sp.	5	SC
	1788	Stenelmis sp.	7	SC
Family Scirtidae	1801	Elodes sp.	7	
	1802	Prionocyphon sp.	7	SC
Order Diptera	1850	Diptera	10	
Family Blephariceridae	1851	Blephariceridae	0	SC
	1852	Blepharicera sp.	0	SC
Family Tipulidae	1853	Tipulidae	4	SH
	1854	Tipula sp.	4	SH
	1855	Antocha sp.	5	CG
	1856	Dicranota sp.	4	PR
	1857	Eriocera sp.	7	PR
	1858	Erioptera sp.	4	CG
	2221	Gonomyia sp.	4	CG
	1859	Helius sp.	5	CG
	1860	Hesperoconopa sp.	2	CG
	1861	Hexatoma sp.	4	PR
	1862	Limnophila sp.	4	PR
	1863	Limonia sp.	3	SH
	1864	Ormosia sp.	4	CG
	1865	Pedicia sp.	4	PR
	1866	Pilaria sp.	4	PR
	1867	Prionocera sp.	4	SH
	1868	Pseudolimnophila sp.	2	PR
Family Chaoboridae	1869	Chaoboridae	8	PR
	1870	Chaoborus sp.	8	PR
	1871	Corethrella sp.	8	PR
Family Culicidae	1873	Culicidae	8	CG
	1875	Aedes sp.	8	CF
	1897	Anopheles sp.	6	CF
	1904	Culex sp.	8	CF
	1912	Culiseta sp.	8	CG

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	1917	Mansonia sp.	8	CG
	1919	Psorophora sp.	8	PR
	1928	Uranotaenia sp.	8	CF
Family Dixidae	1930	Dixidae	10	CG
	1931	Dixa sp.	10	CG
	2238	Dixella sp.	10	
Family Psychodidae	1933	Psychodidae	11	CG
	2165	Telmatoscopus sp.	11	CG
	1934	Pericoma sp.	11	CG
	1935	Psychoda sp.	11	CG
Family Ceratopogonidae	1936	Ceratopogonidae	5	PR
	1937	Atrichopogon sp.	2	PR
	1938	Bezzia sp.	5	CG
	2166	Ceratopogon sp.	5	PR
	1939	Culicoides sp.	5	PR
	1940	Dasyhelea sp.	5	CG
	1941	Forcipomyia sp.	5	SC
	2167	Monohelea sp.	5	PR
	2223	Nilobezzia sp.	5	PR
	1942	Palpomyia sp.	6	PR
	2596	Serromyia sp.	5	
	1943	Probezzia sp.	5	PR
	2224	Sphaeromyias sp.	5	
	1945	Stilobezzia sp.	5	
Family Simuliidae	1946	Simuliidae	6	CF
	1947	Cnephia sp.	4	CF
	1949	Prosimulium sp.	2	CF
	1952	Simulium sp.	6	CF
Family Chironomidae	1963	Chironomidae	6	CG
Tribe Tanypodinae	2206	Tanypodinae	6	PR
	1965	Ablabesmyia sp.	6	CG
	1970	Clinotanypus sp.	6	PR
	1973	Coelotanypus sp.	4	PR
	2171	Conchapelopia sp.	6	PR
	1974	Djalmabatista sp.	6	PR
	1975	Guttipelopia sp.	6	PR
	2214	Hayesomyia sp.	5	
	2215	Helopelopia sp.	4	PR
	2509	Hudsonimyia sp.	6	
	1976	Labrundinia sp.	4	PR
	1977	Larsia sp.	6	PR
	1978	Macropelopia sp.	7	PR

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	2211	Meropelopia sp.	3	
	1979	Natarsia sp.	6	PR
	1980	Nilotanypus sp.	6	PR
	2173	Paramerina sp.	6	PR
	1981	Pentaneura sp.	3	PR
	1982	Procladius sp.	8	PR
	1983	Psectrotanypus sp.	8	PR
	2225	Rheopelopia sp.	3	PR
	1984	Tanypus sp.	8	PR
	1985	Thienemannimyia sp.	6	PR
Tribe Diamesinae	2210	Diamesinae	6	
	1988	Diamesa sp.	4	CG
	1989	Odontomesa sp.	6	CG
	1990	Potthastia sp.	6	
	1991	Prodiamesa sp.	3	CG
	1992	Pseudodiamesa sp.	1	CG
	1993	Sympotthastia sp.	6	CG
	1994	Syndiamesa sp.	6	CG
Tribe Orthoclaadiinae	1995	Orthoclaadiinae	6	CG
	2202	Orthocladius sp./Cricotopus sp.	6	
	1996	Brillia sp.	6	SH
	1997	Cardiocladius sp.	6	PR
	1998	Chaetocladius sp.	6	CG
	1999	Corynoneura sp.	2	CG
	2209	Epoicocladius sp.	6	CG
	2005	Eukiefferiella sp.	4	CG
	2006	Heterotrissocladius sp.	6	CG
	2007	Hydrobaenus sp.	2	SC
	2250	Gymnometriocnemus sp.	6	
	2578	Lopescladius sp.	4	
	2008	Metriocnemus sp.	6	CG
	2009	Nanocladius sp.	3	CG
	2216	Parakiefferiella sp.	5	
	2011	Parametriocnemus sp.	4	CG
	2179	Paraphaenocladius sp.	6	CG
	2012	Psectrocladius sp.	5	CG
	2597	Psilometriocnemus sp.	6	
	2013	Pseudorthocladius sp.	6	CG
	2014	Rheocricotopus sp.	6	CG
	2015	Smittia sp.	6	CG
	2220	Stilocladius sp.	6	
	2213	Tvetenia sp.	5	

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	2016	Thienemanniella sp.	2	CG
	2200	Zalutschia sp.	6	SH
Tribe Chironomini	2205	Chironomini	6	CG
	2201	Axarus sp.	6	CG
	2019	Chironomus sp.	11	CG
	2025	Cladopelma sp.	6	CG
	2026	Cryptochironomus sp.	8	PR
	2029	Cryptotendipes sp.	6	CG
	2030	Demicryptochironomus sp.	6	CG
	2031	Dicrotendipes sp.	6	CG
	2035	Einfeldia sp.	10	CG
	2036	Endochironomus sp.	6	SH
	2039	Glyptotendipes sp.	10	CF
	2042	Harnischia sp.	6	CG
	2255	Hyporhygma sp.	4	
	2043	Kiefferulus sp.	7	CG
	2518	Lipiniella sp.	6	
	2044	Microchironomus sp.	6	CG
	2045	Microtendipes sp.	6	CF
	2208	Nilothauma sp.	3	
	2048	Parachironomus sp.	8	PR
	2050	Paracladopelma sp.	4	CG
	2053	Paratendipes sp.	3	CG
	2251	Pagastiella sp.	6	
	2054	Phaenopsectra sp.	4	SC
	2057	Polypedilum sp.	6	SH
	2066	Pseudochironomus sp.	5	CG
	2218	Robackia sp.	3	CG
	2067	Saetheria sp.	6	CG
	2068	Stenochironomus sp.	3	SH
	2219	Stelechomyia sp.	6	CG
	2070	Stictochironomus sp.	5	
	2071	Tribelos sp.	5	CG
	2072	Xenochironomus sp.	4	PR
	2227	Xestochironomus sp.	6	
	2249	Xylotopus par.	6	
	1986	Zavreliomyia sp.	8	PR
Tribe Tanytarsini	2207	Tanytarsini	6	CF
	2074	Cladotanytarsus sp.	7	CG
	2075	Micropsectra sp.	4	CG
	2076	Paratanytarsus sp.	6	CG
	2077	Rheotanytarsus sp.	6	CF

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	2226	Stempellina sp.	2	CG
	2212	Stempellinella sp.	2	CG
	2228	Sublettea sp.	6	CF
	2078	Tanytarsus sp.	7	CF
Family Ptychopteridae	2079	Ptychopteridae	8	CG
	2080	Bittacomorpha sp.	8	CG
	2081	Ptychoptera sp.	8	CG
Family Stratiomyidae	2082	Stratiomyidae	10	CG
	2092	Allognosta sp.	10	CG
	2083	Odostomia sp.	10	CG
	2085	Oxycera sp.	10	SC
	2086	Stratiomys sp.	10	CF
Family Tabanidae	2089	Tabanidae	7	PR
	2090	Atylotus sp.	7	PR
	2143	Chlorotabanus sp.	7	
	2093	Chrysops sp.	7	CG
	2119	Hybomitra sp.	7	PR
	2125	Tabanus sp.	7	PR
Family Dolichopodidae	2144	Dolichopodidae	5	PR
Family Empididae	2146	Empididae	6	PR
	2147	Hemerodromia sp.	6	PR
	2595	Rhamphomyia sp.	1.0	
Family Syrphidae	2148	Syrphidae	11	CG
	2149	Chrysogaster sp.	11	CG
	2150	Eristalis sp.	11	CG
Family Ephydriidae	2151	Ephydriidae	8	CG
	2152	Ephydra sp.	8	CG
Family Sciomyzidae	2153	Sciomyzidae	10	PR
	2154	Dictya sp.	10	PR
Family Muscidae	2156	Muscidae	8	PR
	2157	Limnophora sp.	8	PR
Family Athericidae	2158	Athericidae	10	
	2159	Atherix sp.	10	PR
Phylum Mollusca	2300	Mollusca	99.9	
Class Gastropoda	2301	Gastropoda	99.9	SC
Order Mesogastropoda	2599	Mesogastropoda	99.9	
Family Viviparidae	2302	Viviparidae	6	SC
	2303	Campeloma sp.	7	SC
	2304	Lioplax sp.	7	SC
	2305	Viviparus sp.	1	SC
Family Valvatidae	2306	Valvatidae	6	SC
	2307	Valvata sp.	2	SC

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Family Bithyniidae	2308	Bithyniidae	6	
	2309	Bithynia sp.	6	
Family Hydrobiidae	2310	Hydrobiidae	6	SC
	2312	Amnicola sp.	4	SC
	2314	Cincinnatia sp.	6	SC
	2315	Marstonia sp.	6	
	2316	Probythinella sp.	6	
	2317	Pyrgulopsis sp.	6	SC
	2318	Somatogyrus sp.	6	
Family Pleuroceridae	2319	Pleuroceridae	6	
	2320	Elimia sp.	6	SC
	2321	Goniobasis sp.	5	SC
	2322	Leptoxis sp.	6	
	2323	Lithasia sp.	6	
	2324	Pleurocera sp.	7	SC
Family Pomatiopsidae	2326	Pomatiopsidae	6	
	2327	Pomatiopsis sp.	6	
Family Physidae	2328	Physidae	9	SC
	2329	Aplexa sp.	7	
	2330	Physa sp.	9	SC
	2331	Physella sp.	9	SC
Family Lymnaeidae	2332	Lymnaeidae	7	SC
	2333	Acella sp.	7	
Order Basommatophora	2598	Basommatophora	7	
	2334	Fossaria sp.	7	SC
	2335	Lymnaea sp.	7	SC
	2336	Pseudosuccinea sp.	7	SC
	2337	Stagnicola sp.	7	SC
Family Planorbidae	2339	Planorbidae	6.5	SC
	2340	Gyraulus sp.	6	SC
	2341	Helisoma sp.	7	SC
	2342	Menetus sp.	6.5	SC
	2343	Planorbella sp.	6.5	SC
	2344	Planorbula sp.	7	SC
	2345	Promenetus sp.	6.5	CG
Family Ancyliidae	2346	Ancyliidae	7	SC
	2347	Ferrissia sp.	7	SC
	2348	Laevapex sp.	6	SC
Class Pelecypoda	2400	Pelecypoda	99.9	CF
Order Unionoida	2600	Unionoida	99.9	
Family Unionidae	2401	Unionidae	1.5	CF
Order Venerioida	2601	Venerioida	5	

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Family Sphaeriidae	2491	Sphaeriidae/Pisidiidae	5	
Family Corbiculidae	2497	Corbicula sp.	4	CF
Family Dreissenidae	2234	Dreissena sp.	99.9	

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Alphabetic Order

Major Group	Bios ID	Taxon	Tolerance	Functional Feeding Group	
Family Acanthametropodidae	1965	Ablabesmyia sp.	6	CG	
	2605	Acanthametropodidae			
	478	Acanthametropus sp.	3	PR	
	2333	Acella sp.	7		
	652	Acentrella sp.	4		
	2203	Acerpenna sp.	4	SH	
	955	Acroneuria sp.	1	PR	
	1875	Aedes sp.	8	CF	
	743	Aeshna sp.	4	PR	
	Family Aeshnidae	742	Aeshnidae	4.5	PR
1372		Agapetus sp.	2	SC	
1502		Agarodes sp.	3.5		
1377		Agraylea sp.	2	PH	
1439		Agrypnia sp.	3	SH	
945		Allocapnia sp.	2	SH	
2092		Allognosta sp.	10	CG	
991		Alloperla sp.	1.5	PR	
Family Ameletidae		2604	Ameletidae		
		480	Ameletus sp.	0	CG
	2312	Amnicola sp.	4	SC	
	848	Amphiagrion sp.	5	PR	
	937	Amphinemura sp.	1.5	SH	
Order Amphipoda	325	Amphipoda	4	CG	
	1409	Anabolia sp.	3.5	SH	
	749	Anax sp.	5	PR	
Family Ancyliidae	2346	Ancyliidae	7	SC	
	1772	Ancyronyx sp.	2	CG	
	529	Anepeorus sp.	3.5	PR	
Phylum Annelida	30	Annelida	99.9	CG	
	1897	Anopheles sp.	6	CF	
	621	Anthopotamus sp.	4		

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	1855	Antocha sp.	5	CG
	2329	Aplexa sp.	7	
	838	Archilestes sp.	1	PR
	852	Argia sp.	5	PR
	707	Arigomphus sp.	7	PR
	531	Arthroplea sp.	3	CF
Family Arthropleidae	2603	Arthropleidae	3	CF
Phylum Arthropoda	250	Arthropoda	99.9	
Family Asellidae	253	Asellidae	6	CG
	255	Asellus sp.	6	CG
Family Athericidae	2158	Athericidae	10	
	2159	Atherix sp.	10	PR
	971	Atoperla sp.	1	
	1937	Atrichopogon sp.	2	PR
	962	Attaneuria sp.	1.5	PR
	568	Attenella sp.	2	CG
	2090	Atylotus sp.	7	PR
	2201	Axarus sp.	6	CG
	332	Bactrurus sp.	1	
Family Baetidae	497	Baetidae	4	CG
	498	Baetis sp.	4	CG
	605	Baetisca sp.	3	CG
Family Baetiscidae	603	Baetiscidae	3	CG
	1442	Banksiola sp.	2	SH
	751	Basiaeschna sp.	2	PR
Order Basommatophora	2598	Basommatophora	7	
	1938	Bezzia sp.	5	CG
	2309	Bithynia sp.	6	
Family Bithyniidae	2308	Bithyniidae	6	
	2080	Bittacomorpha sp.	8	CG
	1852	Blepharicera sp.	0	SC
Family Blephariceridae	1851	Blephariceridae	0	SC
	753	Boyeria sp.	3	PR
Family Brachycentridae	1397	Brachycentridae	3.5	CF
	1398	Brachycentrus sp.	1	CF

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	601	Brachycercus sp.	3	CG
	1996	Brillia sp.	6	SH
	254	Caecidotea sp.	6	CG
Family Caenidae	600	Caenidae	5.5	CG
	602	Caenis sp.	6	CG
	511	Callibaetis sp.	4	CG
Family Calopterygidae	830	Calopterygidae	3.5	PR
	831	Calopteryx sp.	4	PR
Family Cambaridae	401	Cambaridae	5	CG
	2303	Campeloma sp.	7	SC
	949	Capnia sp.	1	SH
Family Capniidae	944	Capniidae	1.5	SH
	1997	Cardiocladius sp.	6	PR
	788	Celithemis sp.	2	PR
	515	Centroptilum sp.	2	CG
	1454	Ceraclea sp.	3	CG
	2166	Ceratopogon sp.	5	PR
Family Ceratopogonidae	1936	Ceratopogonidae	5	PR
	1330	Ceratopsyche sp.	4	CF
	1998	Chaetocladius sp.	6	CG
Family Chaoboridae	1869	Chaoboridae	8	PR
	1870	Chaoborus sp.	8	PR
	1187	Chauliodes sp.	4	PR
	1302	Cheumatopsyche sp.	6	CF
	1339	Chimarra sp.	3	CF
Family Chironomidae	1963	Chironomidae	6	CG
Tribe Chironomini	2205	Chironomini	6	CG
	2019	Chironomus sp.	11	CG
	990	Chloroperla sp.	3	
Family Chloroperlidae	989	Chloroperlidae	1.5	PR
	2143	Chlorotabanus sp.	7	
	610	Choroterpes sp.	2	CG
	860	Chromagrion sp.	5.5	PR
	2149	Chrysogaster sp.	11	CG
	2093	Chrysops sp.	7	CG

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	2314	Cincinnati sp.	6	SC
	2025	Cladopelma sp.	6	CG
	2074	Cladotanytarsus sp.	7	CG
	1252	Climacea sp.	1	
	1970	Clinotanypus sp.	6	PR
	1947	Cnephia sp.	4	CF
	1973	Coelotanypus sp.	4	PR
	862	Coenagrion sp.	5.5	PR
Family Coenagrionidae	847	Coenagrionidae	5.5	PR
Order Coleoptera	1600	Coleoptera	99.9	PR
	2171	Conchapelopia sp.	6	PR
Family Corbiculidae	2497	Corbicula sp.	4	CF
	703	Cordulegaster sp.	2	PR
Family Cordulegastridae	702	Cordulegastridae	4.5	PR
	769	Cordulia sp.	2	PR
Family Corduliidae	768	Corduliidae	4.5	PR
	1871	Corethrella sp.	8	PR
Family Corydalidae	1186	Corydalidae	3	PR
	1190	Corydalus sp.	3	PR
	1999	Corynoneura sp.	2	CG
	335	Crangonyx sp.	4	CG
Family Crangonyctidae	348	Crangonyctidae	4	
Class Crustacea	251	Crustacea	99.9	CG
	2026	Cryptochironomus sp.	8	PR
	2029	Cryptotendipes sp.	6	CG
	1904	Culex sp.	8	CF
Family Culicidae	1873	Culicidae	8	CG
	1939	Culicoides sp.	5	PR
	1912	Culiseta sp.	8	CG
	1618	Cyphon sp.	7	SC
	1350	Cyrnellus sp.	5	CF
	570	Dannella sp.	2	CG
	1940	Dasyhelea sp.	5	CG
Order Decapoda	400	Decapoda	99.9	SH
		Demicryptochironomus		
	2030	sp.	6	CG

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	1988	Diamesa sp.	4	CG
Tribe Diamesinae	2210	Diamesinae	6	
	1760	Dicranopselaphus sp.	4	SC
	1856	Dicranota sp.	4	PR
	2031	Dicrotendipes sp.	6	CG
	2154	Dictya sp.	10	PR
	760	Didymops sp.	4	PR
	1602	Dineutus sp. (larvae only)	4	PR
	663	Dipheter sp.	4	
	1304	Diplectrona sp.	2	CF
Order Diptera	1850	Diptera	10	
	1931	Dixa sp.	10	CG
	2238	Dixella sp.	10	
Family Dixidae	1930	Dixidae	10	CG
	1974	Djalmabatista sp.	6	PR
Family Dolichopodidae	2144	Dolichopodidae	5	PR
	1344	Dolophilodes sp.	0	CG
Family Dreissenidae	2234	Dreissena sp.	99.9	
	713	Dromogomphus sp.	4	PR
	573	Drunella sp.	1	PR
Family Dryopidae	1764	Dryopidae	4	SH
	1774	Dubiraphia sp.	5	CG
	1761	Ectopria sp.	4	SC
	2035	Einfeldia sp.	10	CG
	2320	Elimia sp.	6	SC
Family Elmidae	1771	Elmidae	5	CG
Family Scirtidae	1801	Elodes sp.	7	
Family Empididae	2146	Empididae	6	PR
	863	Enallagma sp.	6	PR
	2036	Endochironomus sp.	6	SH
	533	Epeorus sp.	1	SC
	626	Ephemera sp.	3	CG
	578	Ephemerella sp.	2	CG
Family Ephemerellidae	567	Ephemerellidae	3.5	CG
Family Ephemeridae	625	Ephemeridae	5	CG

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Order Ephemeroptera	476	Ephemeroptera	3	CG
	638	Ephoron sp.	2	CG
	2152	Ephydra sp.	8	CG
Family Ephydriidae	2151	Ephydriidae	8	CG
	755	Epiaeschna sp.	1	PR
	772	Epicordulia sp.	4.5	PR
	771	Epitheca sp.	4	PR
	2209	Epoicocladius sp.	6	CG
	1857	Eriocera sp.	7	PR
	1858	Erioptera sp.	4	CG
	2150	Eristalis sp.	11	CG
	2602	Erpetogomphus sp.	2	
	792	Erythemis sp.	5	PR
	794	Erythrodiplax sp.	5	PR
	2005	Eukiefferiella sp.	4	CG
	587	Eurylophella sp.	4	SC
	1444	Fabria sp.	3.5	SH
	2347	Ferrissia sp.	7	SC
	1941	Forcipomyia sp.	5	SC
	2334	Fossaria sp.	7	SC
	1410	Frenesia sp.	3.5	SH
Family Gammaridae	329	Gammaridae	4	CG
	341	Gammarus sp.	3	CG
Class Gastropoda	2301	Gastropoda	99.9	SC
	1373	Glossosoma sp.	3.5	SC
Family Glossosomatidae	1370	Glossosomatidae	3.5	SC
	2039	Glyptotendipes sp.	10	CF
	1412	Goera sp.	3.5	SC
Family Gomphidae	706	Gomphidae	4.5	PR
	722	Gomphus sp.	7	PR
	2321	Goniobasis sp.	5	SC
	2221	Gonomyia sp.	4	CG
	1975	Guttipelopia sp.	6	PR
		Gymnometriocnemus		
	2250	sp.	6	
	2340	Gyraulus sp.	6	SC

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Family Gyrimidae	1601	Gyrimidae	99.9	PR
	1607	Gyrimus sp. (larvae only)	4	PR
	612	Habrophlebiodes sp.	2	SC
	728	Hagenius sp.	3	PR
	2042	Harnischia sp.	6	CG
	992	Hastaperla sp.	1.5	SC
	2214	Hayesomyia sp.	5	
	1765	Helichus sp.	4	SH
	1451	Helicopsyche sp.	2	SC
Family Helicopsychidae	1450	Helicopsychidae	3.5	SC
	2341	Helisoma sp.	7	SC
	1859	Helius sp.	5	CG
	774	Helocordulia sp.	2	PR
Family Scirtidae	1617	Helodidae	7	SC
	2215	Helopelopia sp.	4	PR
	2147	Hemerodromia sp.	6	PR
Order Hemiptera	1050	Hemiptera	99.9	PR
	536	Heptagenia sp.	3	SC
Family Heptageniidae	528	Heptageniidae	3.5	SC
	1860	Hesperoconopa sp.	2	CG
	1413	Hesperophylax sp.	3.5	SH
	834	Hetaerina sp.	3	PR
	519	Heterocloeon sp.	4	SC
	2006	Heterotrissocladus sp.	6	CG
	628	Hexagenia sp.	6	CG
	1861	Hexatoma sp.	4	PR
Class Hirudinea	249	Hirudinea	8	PR
	2509	Hudsonimyia sp.	6	
	327	Hyaella sp.	4	CG
Family Talitridae	326	Hyaellidae	4	
	2119	Hybomitra sp.	7	PR
	1415	Hydatophylax sp.	2	SH
	2007	Hydrobaenus sp.	2	SC
Family Hydrobiidae	2310	Hydrobiidae	6	SC
	977	Hydroperla sp.	1	PR

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	1306	Hydropsyche sp.	5	CF
Family Hydropsychidae	1301	Hydropsychidae	5.5	CF
	1379	Hydroptila sp.	2	SC
Family Hydroptilidae	1376	Hydroptilidae	3.5	PH
	2255	Hyporhygma sp.	4	
Class Insecta	475	Insecta	99.9	
	1417	Ironoquia sp.	3.5	SH
	873	Ischnura sp.	6	PR
	979	Isogenoides sp.	1.5	PR
Family Isonychiidae	487	Isonychia sp.	3	CF
	980	Isoperla sp.	2	PR
Order Isopoda	252	Isopoda	99.9	CG
	1380	Ithytrichia sp.	1	SC
	2043	Kiefferulus sp.	7	CG
	1976	Labrundinia sp.	4	PR
	795	Ladona sp.	4.5	PR
	2348	Laevapex sp.	6	SC
	735	Lanthus sp.	6	PR
	1977	Larsia sp.	6	PR
Order Lepidoptera	1550	Lepidoptera	99.9	SH
	1406	Lepidostoma sp.	3	SH
Family Lepidostomatidae	1405	Lepidostomatidae	3.5	SH
Family Leptoceridae	1453	Leptoceridae	3.5	CG
	1466	Leptocerus sp.	3	SH
	662	Leptohyphe sp.	5.5	CG
Family Leptohyphidae	598	Leptohyphidae	5.5	CG
	614	Leptophlebia sp.	3	CG
Family Leptophlebiidae	609	Leptophlebiidae	3	CG
	1418	Leptophylax sp.	3.5	SH
	2322	Leptoxis sp.	6	
	840	Lestes sp.	6	PR
Family Lestidae	837	Lestidae	99.9	PR
	797	Leucorrhinia sp.	4.5	PR
	1381	Leucotrichia sp.	3	SC
	648	Leucrocuta sp.	3	SC

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	943	Leuctra sp.	1	SH
Family Leuctridae	942	Leuctridae	1.5	SH
	800	Libellula sp.	8	PR
Family Libellulidae	787	Libellulidae	4.5	PR
Family Limnephilidae	1408	Limnephilidae	3.5	SH
	1420	Limnephilus sp.	3	SH
	1862	Limnophila sp.	4	PR
	2157	Limnophora sp.	8	PR
	1863	Limonia sp.	3	SH
	2304	Lioplax sp.	7	SC
	2518	Lipiniella sp.	6	
	272	Lirceus sp.	4	CG
	2323	Lithasia sp.	6	
	2578	Lopescladius sp.	4	
Family Lymnaeidae	2335	Lymnaea sp.	7	SC
	2332	Lymnaeidae	7	SC
	1366	Lype sp.	3.5	SC
	551	Maccaffertium sp.	4	SC
Family Macromiidae	762	Macromia sp.	3	PR
	759	Macromiidae	4.5	PR
	1324	Macronema sp.	2	CF
	1779	Macronychus sp.	2	
	1978	Macropelopia sp.	7	PR
	2217	Macrostemum sp.	2	CF
	1917	Mansonia sp.	8	CG
	2315	Marstonia sp.	6	
	1384	Mayatrichia sp.	1	SC
Order Megaloptera	1175	Megaloptera	3.5	
	2342	Menetus sp.	6.5	SC
	2211	Meropelopia sp.	3	
Order Mesogastropoda	2599	Mesogastropoda	99.9	
Family Metretopodidae	493	Metretopodidae	3	
	2008	Metriocnemus sp.	6	CG
	1403	Micrasema sp.	3.5	MH
	2044	Microchironomus sp.	6	CG

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	1781	Microcylloepus sp.	2	CG
	2075	Micropsectra sp.	4	CG
	2045	Microtendipes sp.	6	CF
	1434	Molanna sp.	3.5	SC
Family Molannidae	1433	Molannidae	3.5	CG
Phylum Mollusca	2300	Mollusca	99.9	
	2167	Monohelea sp.	5	PR
Family Muscidae	2156	Muscidae	8	PR
	1468	Mystacides sp.	2	CG
	2009	Nanocladius sp.	3	CG
	758	Nasiaeschna sp.	2	PR
	1979	Natarsia sp.	6	PR
	1471	Nectopsyche sp.	3	SH
	876	Nehalennia sp.	7	PR
Phylum Nematomorpha	15	Nematomorpha	99.9	PA
	938	Nemoura sp.	1	SH
Family Nemouridae	936	Nemouridae	1.5	SH
	964	Neoperla sp.	1	PR
	1421	Neophylax sp.	3	SC
	1385	Neotrichia sp.	4	SC
	1352	Neureclipsis sp.	3	CF
	775	Neurocordulia sp.	3	PR
Order Neuroptera	1250	Neuroptera	99.9	PR
	1192	Nigronia sp.	2	PR
	2223	Nilobezzia sp.	5	PR
	1980	Nilotanypus sp.	6	PR
	2208	Nilothauma sp.	3	
	644	Nixe sp.	4	SC
	1355	Nyctiophylax sp.	1	CF
	1386	Ochrotrichia sp.	4	CG
Order Odonata	700	Odonata	99.9	PR
	1989	Odontomesa sp.	6	CG
	2083	Odostomia sp.	10	CG
	1477	Oecetis sp.	5	PR
	929	Oemopteryx sp.	1.5	SH

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Class Oligochaeta	31	Oligochaeta	10	CG
Family Oligoneuriidae	486	Oligoneuriidae	3	CF
	1446	Oligostomis sp.	3.5	PR
	730	Ophiogomphus sp.	2	PR
	1783	Optioservus sp.	4	SC
	1864	Ormosia sp.	4	CG
Tribe Orthoclaadiinae	1995	Orthoclaadiinae	6	CG
		Orthocladus		
	2202	sp./Cricotopus sp.	6	
	1387	Orthotrichia sp.	1	SC
	2085	Oxycera sp.	10	SC
	1388	Oxyethira sp.	2	MH
	809	Pachydiplax sp.	8	PR
	2251	Pagastiella sp.	6	
	428	Palaemonetes sp.	4	
Family Palaemonidae	427	Palaemonidae	4	
	1942	Palpomyia sp.	6	PR
	811	Pantala sp.	7	PR
	951	Paracapnia sp.	1.5	SH
	2048	Parachironomus sp.	8	PR
	2050	Paracladopelma sp.	4	CG
	527	Paracloeodes sp.	4	SC
	966	Paragnetina sp.	1.5	PR
	2216	Parakiefferiella sp.	5	
	615	Paraleptophlebia sp.	2	CG
	2173	Paramerina sp.	6	PR
	2011	Parametriocnemus sp.	4	CG
	2179	Paraphaenocladus sp.	6	CG
	1326	Parapsyche sp.	5.5	PR
	2076	Paratanytarsus sp.	6	CG
	2053	Paratendipes sp.	3	CG
	1865	Pedicia sp.	4	PR
Class Pelecypoda	2400	Pelecypoda	99.9	CF
	1769	Pelonomus sp.	4	CG
Family Palingeniidae	635	Pentagenia sp.	4	CF
	1981	Pentaneura sp.	3	PR

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	1934	Pericoma sp.	11	CG
	814	Perithemis sp.	4	PR
	968	Perlesta sp.	4	PR
Family Perlidae	954	Perlidae	1.5	PR
	970	Perlinella sp.	2	PR
Family Perlodidae	976	Perlodidae	1.5	PR
	1556	Petrophila sp.	5	SC
	2054	Phaenopsectra sp.	4	SC
	974	Phasganophora sp.	1.5	PR
Family Philopotamidae	1338	Philopotamidae	3.5	CF
	1448	Phryganea sp.	3	
Family Phryganeidae	1438	Phryganeidae	3.5	SH
	1356	Phylocentropus sp.	3.5	CF
	2330	Physa sp.	9	SC
	2331	Physella sp.	9	SC
Family Physidae	2328	Physidae	9	SC
	1866	Pilaria sp.	4	PR
	2343	Planorbella sp.	6.5	SC
Family Planorbidae	2339	Planorbidae	6.5	SC
	2344	Planorbula sp.	7	SC
	816	Plathemis sp.	3	PR
	1423	Platycentropus sp.	3	SH
Phylum Platyhelminthes	1	Platyhelminthes	99.9	
	651	Plauditus sp.	3	
Order Plecoptera	925	Plecoptera	1.5	PR
	2324	Pleurocera sp.	7	SC
Family Pleuroceridae	2319	Pleuroceridae	6	
Family Polycentropodidae	1349	Polycentropodidae	3.5	CF
	1358	Polycentropus sp.	3	PR
Family Polymitarcyidae	637	Polymitarcyidae	3	CG
	2057	Polypedilum sp.	6	SH
Family Pomatiopsidae	2326	Pomatiopsidae	6	
	2327	Pomatiopsis sp.	6	
Family Potamanthidae	620	Potamanthidae	5	CF
	1328	Potamyia sp.	4	CF

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	1990	Potthastia sp.	6	
	1867	Prionocera sp.	4	SH
	1802	Prionocyphon sp.	7	SC
	1943	Probezzia sp.	5	PR
	2316	Probythinella sp.	6	
	1982	Procladius sp.	8	PR
	643	Procloeon sp.	4	
	1991	Prodiamesa sp.	3	CG
	732	Progomphus sp.	5	PR
	2345	Promenetus sp.	6.5	CG
	1787	Promoresia sp.	5	SC
	1949	Prosimulium sp.	2	CF
	940	Prostoia sp.	1.5	SH
	1375	Protoptila sp.	1	SC
	2012	Psectrocladius sp.	5	CG
	1983	Psectrotanypus sp.	8	PR
Family Psephenidae	1614	Psephenidae	4	SC
	1616	Psephenus sp.	4	SC
	2066	Pseudochironomus sp.	5	CG
	521	Pseudocloeon sp.	4	SC
	1992	Pseudodiamesa sp.	1	CG
	1868	Pseudolimnophila sp.	2	PR
	2013	Pseudorthocladius sp.	6	CG
	1425	Pseudostenophylax sp.	3.5	SH
	2336	Pseudosuccinea sp.	7	SC
	2597	Psilometriocnemus sp.	6	
	1919	Psorophora sp.	8	PR
	1935	Psychoda sp.	11	CG
Family Psychodidae	1933	Psychodidae	11	CG
	1368	Psychomyia sp.	2	SC
Family Psychomyiidae	1365	Psychomyiidae	3.5	CG
Family Pteronarcyidae	927	Pteronarcys sp.	2	SH
	1449	Ptilostomis sp.	3	SH
	2081	Ptychoptera sp.	8	CG
Family Ptychopteridae	2079	Ptychopteridae	8	CG

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	1427	Pycnopsyche sp.	3	SH
Family Pyralidae	1551	Pyralidae	99.9	SH
	2317	Pyrgulopsis sp.	6	SC
	994	Rasvena sp.	1.5	CG
	2595	Rhamphomyia sp.	1	
	2014	Rheocricotopus sp.	6	CG
	2225	Rheopelopia sp.	3	PR
	2077	Rheotanytarsus sp.	6	CF
	544	Rhithrogena sp.	0	SC
	1392	Rhyacophila sp.	1	PR
Family Rhyacophilidae	1391	Rhyacophilidae	3.5	PR
	2218	Robackia sp.	3	CG
	2067	Saetheria sp.	6	CG
Family Sciomyzidae	2153	Sciomyzidae	10	PR
	1626	Scirtes sp.	7	SH
Family Sericostomatidae	1489	Sericostomatidae	3.5	SH
	594	Serratella sp.	1	CG
	2596	Serromyia sp.	5	
	1483	Setodes sp.	3.5	
Family Sialidae	1176	Sialidae	3.5	PR
	1177	Sialis sp.	4	PR
Family Simuliidae	1946	Simuliidae	6	CF
	1952	Simulium sp.	6	CF
Family Siphonuridae	477	Siphonuridae	3	CG
	482	Siphonurus sp.	2	CG
	494	Siphloplecton sp.	2	CG
	1254	Sisyra sp.	1	PR
Family Sisyridae	1251	Sisyridae	1	PR
	2015	Smittia sp.	6	CG
	779	Somatochlora sp.	1	PR
	2318	Somatogyrus sp.	6	
	941	Soyedina sp.	1.5	SH
Family Sphaeriidae	2491	Sphaeriidae/Pisidiidae	5	
	2224	Sphaeromias sp.	5	
	1389	Stactobiella sp.	3.5	SH

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	2337	Stagnicola sp.	7	SC
	2219	Stelechomyia sp.	6	CG
	2226	Stempellina sp.	2	CG
	2212	Stempellinella sp.	2	CG
	550	Stenacron sp.	4	SC
	1788	Stenelmis sp.	7	SC
	2068	Stenochironomus sp.	3	SH
	659	Stenonema sp.	4	SC
	2070	Stictochironomus sp.	5	
	1945	Stilobezzia sp.	5	
	2220	Stilocladus sp.	6	
Family Stratiomyidae	2082	Stratiomyidae	10	CG
	2086	Stratiomys sp.	10	CF
	931	Strophopteryx sp.	1.5	SH
	330	Stygobromus sp.	4	PR
	734	Stylogomphus sp.	4.5	PR
	737	Stylurus sp.	7	PR
	2228	Sublettea sp.	6	CF
	818	Sympetrum sp.	4	PR
	1993	Sympotthastia sp.	6	CG
	1994	Syndiamesa sp.	6	CG
Family Syrphidae	2148	Syrphidae	11	CG
Family Tabanidae	2089	Tabanidae	7	PR
	2125	Tabanus sp.	7	PR
Family Taeniopterygidae	928	Taeniopterygidae	1.5	SH
	933	Taeniopteryx sp.	2	SH
Tribe Tanypodinae	2206	Tanypodinae	6	PR
	1984	Tanypus sp.	8	PR
Tribe Tanytarsini	2207	Tanytarsini	6	CF
	2078	Tanytarsus sp.	7	CF
	2165	Telmatoscopus sp.	11	CG
	784	Tetragoneuria sp.	4.5	PR
	2016	Thienemanniella sp.	2	CG
	1985	Thienemannimyia sp.	6	PR
	1854	Tipula sp.	4	SH

Functional Feeding Group (ffg)

SC=scrapper, PA=parasite, PR=predator, OM=omnivore, GC=gatherer/collector, FC=filter/collector, SH=shredder, PI=piercer
99.9=Taxon excluded from mIBI computation

**Appendix C. Genus-List: Illinois Environmental Protection Agency
Macroinvertebrate-Index of Biotic Integrity (m-IBI) Tolerance List and
Functional Feeding Group Classification**

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Family Tipulidae	1853	Tipulidae	4	SH
	641	Tortopus sp.	4	CG
	825	Tramea sp.	4	PR
	1484	Trienodes sp.	3	SH
	2071	Tribelos sp.	5	CG
Order Trichoptera	1300	Trichoptera	3.5	
	599	Tricorythodes sp.	5	CG
Class Turbellaria	2	Turbellaria	6	PR
	2213	Tvetenia sp.	5	
Family Unionidae	2401	Unionidae	1.5	CF
Order Unionoida	2600	Unionoida	99.9	
	1928	Uranotaenia sp.	8	CF
	2307	Valvata sp.	2	SC
Family Valvatidae	2306	Valvatidae	6	SC
Order Venerioda	2601	Veneroida	5	
Family Viviparidae	2302	Viviparidae	6	SC
	2305	Viviparus sp.	1	SC
	1346	Wormaldia sp.	3.5	CF
	2072	Xenochironomus sp.	4	PR
	2227	Xestochironomus sp.	6	
	2249	Xylotopus par.	6	
	2200	Zalutschia sp.	6	SH
	1986	Zavrelimyia sp.	8	PR
	829	Zygoptera	99.9	PR

Functional Feeding Group (ffg)

SC=scrapper, PA=parasite, PR=predator, OM=omnivore, GC=gatherer/collector, FC=filter/collector, SH=shredder, PI=piercer
99.9=Taxon excluded from mIBI computation

Appendix E:

Biological Criteria for the Protection of Aquatic Life: Volume III. Standardized Biological Field and
Laboratory Methods for Assessing Fish and Macroinvertebrate Communities

**Biological Criteria for the Protection of Aquatic Life:
Volume III: Standardized Biological Field Sampling and
Laboratory Methods for Assessing Fish and
Macroinvertebrate Communities**

First Update September 30, 1989)



Volume III, pp. V-1-7 to V-1-9. Replaces Tables V-1-1 and V-1-2 with Table V-1.

Table V-1. Current taxonomic keys and the level of taxonomy routinely used by the Ohio EPA for various macroinvertebrate taxonomic classifications.

-
- Porifera: Species (Pennak 1989)
Coelenterata: Genus (Pennak 1989)
Platyhelminthes: Class (Pennak 1989)
Nemertea: Phylum (Pennak 1989)
Nematomorpha: Phylum/genus (Pennak 1989)
Ectoprocta: Genus/species (Thorp and Covich 1991)
Entoprocta: Species (Thorp and Covich 1991)
Annelida
 Oligochaeta: Class (Pennak 1989)
 Hirudinea: Species (Klemm 1982)
Arthropoda
 Crustacea
 Isopoda: Genus (Pennak 1989)
 Amphipoda: Genus (Pennak 1989)
 Gammarus: Species (Holsinger 1972)
 Decapoda
 Cambarus and Fallicambarus: Species (Jezerinac and Thoma 1984, Jezerinac 1993)
 Palaemonetes: Species (Pennak 1989)
 Arachnoidea: Class (Pennak 1989)
 Insecta
 Ephemeroptera: Genus (Edmunds *et al.* 1976, Merritt and Cummins 1996)
 Baetidae: Genus/species (Morihara and McCafferty 1979, McCafferty and Waltz 1990, Lugo-Ortiz and McCafferty 1998)
 Pseudocloeon: Species (McCafferty and Waltz 1995)
 Heptageniidae
 Stenonema: Species (Bednarik and McCafferty 1979)
 Ephemerellidae
 Dannella: Species (Allen and Edmunds 1962)
 Ephemerella: Species (Allen and Edmunds 1965)
 Eurylophella: Species (Funk and Sweeney 1994)
 Serratella: Species (Allen and Edmunds 1963b)
 Baetiscidae
 Baetisca: Species (Burks 1953)
 Ephemeroidea: Species (McCafferty 1975)
 Odonata: Family/genus (Merritt and Cummins 1996)
 Anisoptera: Genus/species (Needham and Westfall 1955, Walker 1958, Walker and Corbett 1975)
 Plecoptera: Genus (Stewart and Stark 1988)
 Perlidae
 Acroneuria: Species (Hitchcock 1974)
 Paragnetina: Species (Hitchcock 1974)
 Perlinella: Species (Kondratieff *et al.* 1988)
 Perlodidae: Species (Hitchcock 1974)
 Hemiptera: Genus (Hilsenhoff 1995, Merritt and Cummins 1996)
 Megaloptera: Genus (Merritt and Cummins 1996)
 Nigronia: Species (Neunzig 1966)
 Neuroptera: Genus (Merritt and Cummins 1996)
 Trichoptera: Genus (Wiggins 1996, Merritt and Cummins 1996)
 Philopotamidae: Species (Ross 1944)
 Hydropsychidae
 Hvdropsyche and Ceratopsyche: Species (Schuster and Etnier 1978)
 Rhyacophilidae
 Rhyacophila: Species (Flint 1962, Weaver and Sykora 1979)
 Leptoceridae
 Ceraclea: Species (Resh 1976)
 Mytastides: Species (Yamamoto and Wiggins 1964)
 Nectopsyche: Species (Haddock 1977)
 Oecetis: Species (Floyd 1995)
 Triaenodes/Ylodes: Species (Glover 1996)
 Lepidoptera: Genus (Merritt and Cummins 1996)
 Coleoptera: Genus (Hilsenhoff 1995, Merritt and Cummins 1996)
 Dryopoidea: Genus/species (Brown 1972)
 Diptera: Family/genus (Merritt and Cummins 1996)
 Ceratopogonidae
 Atrichopogon: Species (Johannsen 1935)
 Chironomidae: Genus/species groups (Wiederholm 1983)
 Ablabesmyia: Species (Roback 1985)
 Labrundinia: Species (Roback 1987)
 Tanypus: Species (Roback 1977)
 Corvnoneura: Species (Simpson and Bode 1980, Bolton In Prep.)
 Eukiefferiella and Tvetenia: Species groups (Bode 1983)
 Nanocladius: Species (Saether 1977, Simpson and Bode 1980, Bolton In Prep.)
 Parakiefferiella: Species (Bolton In Prep.)
 Rheocricotopus: Species (Saether 1985)
 Thienemanniella: Species (Hestenes and Saether 2000)
 Chironomus: Species groups (Oliver and Roussel 1983)
 Dicrotendipes: Species (Epler 1987)
 Endochironomus and Tribelos: Species (Grodhaus 1987)
 Parachironomus: Species (Simpson and Bode 1980, Bolton In Prep.)
 Polypedilum: Species groups/species (Maschwitz 2000, Bolton In Prep.)
 Tanytarsini: Genus/species groups/species (Simpson and Bode 1980, Bolton In Prep.)
 Muscidae: Species (Johannsen 1935)
 Mollusca
 Gastropoda: Genus/species (Burch 1982)
 Pelecypoda
 Sphaeriidae: Genus (Burch 1972)
 Unionidae: Species (Waters 1995)

Volume III, pp. V-1-11 to V-1-15. Add the following new citations to the References section.

- Floyd, M.A. 1995. Larvae of the caddisfly genus Qecetis (Trichoptera: Leptoceridae) in North America. Bulletin of the Ohio Biological Survey Vol. 10, No. 3. 85 pp.
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- Jezerinac, R.F. 1993. A new subgenus and species of crayfish (Decapoda:Cambaridae) of the genus Cambarus, with an amended description of the subgenus Lacunicambarus. Proc. Biol. Soc. Wash. 106(3): pp. 532-544.
- Kondratieff, B.C., R.F. Kirchner, and K.W. Stewart. 1988. A review of Perlinella Banks (Plecoptera: Perlidae). Annals of the Entomological Society of America 81(1):19-27.
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- Waters, G.T. 1995. A guide to the freshwater mussels of Ohio. 3rd edition. The Ohio Department of Natural Resources, Division of Wildlife, Columbus, Ohio.

New Citations (cont)

- Weaver, J.S., III and J.L. Sykora. 1979. The Rhyacophila of Pennsylvania with larval descriptions of R. banksi and R. carpenteri (Trichoptera: Rhyacophilidae). *Annals of Carnegie Museum*. Carnegie Museum of Natural History 48(22): 403-423.
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NOTICE TO USERS

All methods and procedures for the use of biological criteria contained and/or referred to in these volumes supercede those described in any previous Ohio EPA manuals, reports, policies, and publications dealing with biological evaluation, designation of aquatic life uses, or the determination and evaluation of aquatic life use attainment. Users of these criteria and the supporting field methods, data analyses, and study design should conform to that presented or referenced in these volumes (and subsequent revisions) in order to be applicable under the Ohio Water Quality Standards (WQS; OAC 3745-1).

Three volumes comprise the supporting documentation for setting and using biological criteria in Ohio. All three volumes are needed to use the biological criteria, implement the field and laboratory procedures, and understand the principles behind their development, use, and application. These volumes are:

Ohio Environmental Protection Agency. 1987. *Biological criteria for the protection of aquatic life: Volume I. The role of biological data in water quality assessment.* Division of Water Quality Monitoring and Assessment, Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1987. *Biological criteria for the protection of aquatic life: Volume II. Users manual for biological field assessment of Ohio surface waters.* Division of Water Quality Monitoring and Assessment, Surface Water Section, Columbus, Ohio.

Ohio Environmental Protection Agency. 1989. *Biological criteria for the protection of aquatic life: Volume III. Standardized biological field sampling and laboratory methods for assessing fish and macroinvertebrate communities.* Division of Water Quality Monitoring and Assessment, Columbus, Ohio.

In addition, one other publication from the Stream Regionalization Project is recommended to all users:

Whittier, T.R., D.P. Larsen, R.M. Hughes, C.M. Rohm, A.L. Gallant, and J.M. Omernik. 1987. *The Ohio stream regionalization project: a compendium of results.* U.S. EPA - Environmental Res. Lab, Corvallis, OR. EPA/600/3-87/025. 66 pp.

These documents can be obtained by writing:

Ohio Environmental Protection Agency
Division of Water Quality Monitoring and Assessment
1800 WaterMark Drive, P.O. Box 1049
Columbus, Ohio 43266-0149

Other recommended and helpful literature is listed in the references of each volume.

FOREWARD

This volume is excerpted from the Ohio EPA Manual of Surveillance Methods and Quality Assurance Practices (6th Update). The macroinvertebrate methods are from section V, subsection 1 and the fish methods are from section V, subsection 4 of this manual. They are produced here to accompany the supporting technical documentation for the establishment and use of biological criteria in Ohio.

Acknowledgements

Jeff DeShon, Jack Freda, and Mike Bolton provided the primary input to the macroinvertebrate section. Chris Yoder, Marc Smith, Roger Thoma, Randy Sanders, and Ed Rankin were responsible for the fish section. Ed Rankin was the primary originator of the Qualitative Habitat Evaluation Index (QHEI) which is described in the fish section. Pam Jacques provided typing support.

Procedure No. WOPA-SWS-3
 Revision No. 6

Date Issue 9-30-89
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Subsection 1. Macroinvertebrates

J.E. DeShon, J.T. Freda, M. J. Bolton

- Part A) Field Methods - Quantitative Sampling
- Part B) Field Methods - Qualitative Sampling
- Part C) Laboratory Methods - Quantitative Sampling
 - 1) Macroinvertebrate Counts and Identifications
 - 2) Macroinvertebrate Data Analysis
 - a) Invertebrate Community Index
 - b) Community Similarity Index
 - c) Rank Correlation Coefficient
 - d) Coefficient of Variation
- Part D) Laboratory and Data Analysis Methods - Qualitative Sampling

Part A Field Methods - Quantitative Sampling

The primary sampling equipment used for the collection of benthic macroinvertebrates is the modified Hester-Dendy multiple-plate artificial substrate sampler. The sampler is constructed of 1/8 inch tempered hardboard cut into three inch square plates and one inch square spacers. A total of eight plates and twelve spacers are used for each sampler. The plates and spacers are placed on a 1/4 inch eyebolt so that there are three single spaces, three double spaces, and one triple space between the plates. The total surface area of the sampler, excluding the eyebolt, is 145.6 square inches.

Samplers placed in streams are tied to a concrete construction block which anchors them in place and prevents the multiple- plates from coming into contact with the natural substrates. In water deeper than four feet, a float (1 qt. cubitainer) is attached to the samplers to keep them within four feet of the surface. Whenever possible, the samplers are placed in runs rather than pools or riffles and an attempt is made to establish stations in as similar an

ecological situation as possible. All samplers are exposed for a six week period. A set of samplers consists of three multiple-plate samplers (three square feet) at National Ambient Water Quality Monitoring Network (NAWQMN) stations and five multiple-plate samplers at all other sampling locations. All NAWQMN stations and most routine monitoring stations are sampled during the time period of June 15 to September 30.

Retrieval of the samplers is accomplished by cutting them from the block and placing them in one quart plastic containers while still submersed. Care is taken to avoid disturbing the samplers and thereby dislodging any organisms. Enough formalin is added to each container to equal an approximate 10% solution. Qualitative samples of macroinvertebrates inhabiting the natural substrates are also collected at the time of sampler retrieval. In shallow water, samples are taken in a stream segment covering all available habitats in the near vicinity where the samplers were placed. Samples are collected using triangular ring frame 30-mesh dip nets and hand picking with forceps. Grab samplers (i.e., Ekman, Peterson, or Ponar) can also be used in deep water. The qualitative sampling continues until, by gross examination, no new taxa are being taken. A station description sheet (Figure V-1-1) is filled out by the collector at the time of sampler retrieval. The substrate is described using the categories for substrate characterization indicated in the USEPA biological field manual (Weber, 1973).

In those situations where quantitative biological samples are collected from the natural substrates using a Surber square foot sampler (30-mesh netting), the collector stands on the downstream side of the sampler and works the substrate using a hand cultivator with two inch tines. Large rocks are gently scrubbed with a brush. The material collected is placed in sealed containers, preserved in 10% formalin, and transported to the laboratory. Three to five Surber samples are taken at each site.

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Figure V-1-1. Station description sheet used by macroinvertebrate field crews (Front).

Ohio EPA Surface Water Section
 Macroinvertebrate Field Sheet

Stream _____ Stream Code _____ RM _____ Date Collected _____
 Location _____ Date Set _____
 _____ Collected By _____

Sampling Method: HD(No. _____) - DN/HP - Surber - Grab (Type _____) - Other _____
 HD Sampler Site: Depth _____ Canopy _____ Current (Set) _____ Current (Ret) _____
 HD Condition: Disturbed Yes/No Comment: _____
 Debris Yes/No Comment: _____
 Silt/Solids None - Slight - Moderate - Heavy
 DN/HP Sampling: Total Time _____ Habitats: Pool - Riffle - Run - Margin - Backwater

Physical Characteristics

Flow Condition: High - Moderate - Low - Interstitial - Intermittent - Dry
 Current Velocity: Fast - Moderate - Slow - ND
 Channel Morphology: Natural - Channelized - Channelized (Recovered) - Impounded
 Bank Erosion: Extensive - Moderate - Slight - None
 Riffle Development: Extensive - Moderate - Sparse - Absent
 Riffle Quality: Good - Fair - Poor Embedded: Yes/No
 Clarity: Clear - Murky - Turbid
 Color: None - Green - Brown - Grey - Other()
 Canopy: Open - 75% - 50% - 25% - Closed

Substrate Characteristics

Percent of:	Pool	Riffle	Run
Bedrock()	_____	_____	_____
Boulder()	_____	_____	_____
Rubble()	_____	_____	_____
Coarse Gravel	_____	_____	_____
Fine Gravel	_____	_____	_____
Sand	_____	_____	_____
Silt	_____	_____	_____
Clay/Hardpan	_____	_____	_____
Detritus	_____	_____	_____
Peat	_____	_____	_____
Muck	_____	_____	_____
Other()	_____	_____	_____
Macrophytes()	_____	_____	_____
Algae()	_____	_____	_____
Artifacts()	_____	_____	_____
Compaction(F,M,S)	_____	_____	_____
Depth (Average)	_____	_____	_____
Width (Average)	_____	_____	_____

Predominant Land Use (L,R,B)

Forest	Open Pasture	Wetland
Shrub	Closed Pasture	Other
Old Field	Urban	()
Rowcrop	Residential/Park	
Industrial	Mining/Construction	

Riparian Vegetation

Left	Width	Right	Width	Type
_____	_____	_____	_____	Large trees
_____	_____	_____	_____	Small trees
_____	_____	_____	_____	Shrubs
_____	_____	_____	_____	Grass/Weeds
_____	_____	_____	_____	None

Margin Habitat

Undercut Banks	Root Mats
Grass	Water Willow
Shallows	Clay/Hardpan
Rip Rap	Bulkhead
Other()	

Margin Quality: Good - Fair - Poor

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Figure V-1-1 (Continued). Station description sheet used by macroinvertebrate field crews (Back).

Biological Characteristics

Riffle

Predominant Organisms: _____

Other Common Organisms: _____

Density: High - Moderate - Low

Diversity: High - Moderate - Low

Run

Predominant Organisms: _____

Other Common Organisms: _____

Density: High - Moderate - Low

Diversity: High - Moderate - Low

Pool

Predominant Organisms: _____

Other Common Organisms: _____

Density: High - Moderate - Low

Diversity: High - Moderate - Low

Margin

Predominant Organisms: _____

Other Common Organisms: _____

Density: High - Moderate - Low

Diversity: High - Moderate - Low

Other Notable Collections: _____

Potential Pollution Sources: _____

Evidence of Pollution: _____

Photo Numbers: _____

Comments: _____

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In those situations where Ekman, Peterson, or Ponar grab samples are used for quantitative purposes, three to five samples are collected and then treated in essentially the same manner as the Surber samples. The material collected with the grab is washed through a bucket with a 30-mesh screen bottom, placed in sealed containers, preserved in 10% formalin, and returned to the laboratory.

Part B
Field Methods -
Qualitative Sampling

When only qualitative samples are collected the methods are similar to those employed when collecting qualitative samples in conjunction with artificial substrate samples except that:

- a) A more intensive sampling effort is required.
- b) The sampling area is more rigidly defined.
- c) More extensive field notes concerning the biological and physical condition of each station are required.
- d) A preliminary biological community assessment is made on site.

Each station is sampled at least once between June 15 and September 30. Organisms are collected from the natural substrates using triangular ring frame 30-mesh dip nets and forceps, and are preserved in 70% alcohol. Collections are made for a minimum of 30 minutes, then continue until no new taxa are evident in gross examinations. Whenever possible, a riffle, run, margin, and pool habitat are sampled at each station and an attempt is made to sample areas which are physically similar from site to site. Stations should be sampled in order, moving from upstream to downstream, to detect any changes between

sites.

As in quantitative sampling, the station description sheet (Figure V-1-1) is filled out at each station at the time of collection. In addition, the length of sampling time and the presence of riffle, run, margin, and pool habitats are noted. Predominant populations and estimates of community density and diversity in each habitat type are noted on the sheet. A preliminary biological community assessment is made after each station is sampled.

Part C
Laboratory Methods -
Quantitative Sampling

Samples are coded and sample numbers are immediately entered into a log book upon arrival at the laboratory. Samples are given a log number derived from the date, e.g., 871108-10, where 87 represents the year, 11 represents the month, and 08 the day. The number following this six digit date, i.e., the number 10 in the previous example, indicates that this was the 10th sampled logged that day. Other information in the log book includes the name(s) of field personnel that collected the sample, date, stream or lake name, basin name, entity (where applicable), general location, sample type, sampling method(s) used, the person who conducted the analyses, and any other comments considered pertinent to the collection and analysis of the sample.

1) *Macroinvertebrate Counts and Identifications*

Composite samples consisting of five multiple-plate samplers are used in station evaluations for routine monitoring. However, replicate samples (three multiple-plate samplers) are reported to the USEPA for NAWQMN stations. Replicate sets of five multiple-plate samplers can be used if deemed necessary in those cases where sampling is for litigation purposes. In all cases, the multiple-

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plate(s) is (are) disassembled in a bucket of water, cleaned of organisms and debris, and discarded. The organism/debris mixture is then passed through U.S. Standard Testing Sieves number 30 (0.589 mm openings) and number 40 (0.425 mm openings). The material retained in each sieve is preserved in properly labeled and coded jars of 70% alcohol.

The following procedures are used during the course of analyzing an artificial substrate, Surber, or grab sample:

a) Sorting of the sample is done in a white enamel pan followed by scanning under the dissecting microscope (10x magnification). Subsamples are produced using the following guidelines:

1) The Folsom sample splitter is used for all subsampling. (In an effort to determine the accuracy of the Folsom sample splitter, a sample composed of 200 individuals of five frequently collected organisms was prepared and repeatedly split. Statistical analysis of the data yielded a chi-square value of 2.56, $df=4$, which was not significant at the 95% probability level.)

2) After an entire sample has been sorted, subsampling within families containing unmanageable numbers is acceptable.

3) Very large samples may be subsampled prior to sorting - but only after examination in a white enamel pan to remove obvious rare taxa, e.g., crayfish, hellgramites, non-hydropsychid caddisflies.

4) A minimum of 250 organisms is identified, with at least 50-100 midges, 70 caddisflies, 70 mayflies.

b) Dipterans of the family Chironomidae are prepared for identification by clearing the larvae in hot 10% KOH for 30 minutes and then mounting in water on microscope slides. Permanent slides for the voucher collection are mounted in Euparal mounting medium.

c) Material retained in the # 40 screen is counted and identified or counted and extrapolated when identification is impossible or impractical. (Artificial substrate sample only.)

d) Organisms determined to be dead before the time of collection are discarded.

e) When only one sex or life stage can be identified it is assumed that the other sex or stage is the same species.

f) Sections of bryozoan colonies are removed from the plates and saved for identification. Only colonies, not individuals, are counted. (Artificial substrate sample only.)

g) Early instars that cannot be identified are extrapolated where possible.

h) Species level identifications are made where possible and practical. Generic or higher level classifications are made if specimens are damaged beyond identification, in those cases where taxonomy is incomplete or laborious and time-consuming, or where the specimen is an unidentifiable early instar.

i) Organisms are listed in tables following the laboratory table format (Table V-1-1).

j) Two end fragments of an oligochaete are counted as one individual. Fragments without ends are not counted.

k) Any taxonomic key in the laboratory may be used as an aid in the identification of an organism. However, the final identification and name used are taken from the asterisked references in Table V-1-2. Also indicated is the level of taxonomy attainable with the keys listed.

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Table V-1-1. Phylogenetic order for macroinvertebrate listing including level of taxonomy generally used.

Porifera:	Species	Plecoptera	
Coelenterata:	Genus	Pteronarcyidae:	Genus
Platyhelminthes:	Class	Peltoperlidae:	Genus
Nematomorpha:	Genus	Taeniopterygidae:	Genus
Bryozoa:	Species	Nemouridae:	Species
Entoprocta:	Species	Leuctridae:	Genus
Annelida		Capniidae:	Genus
Oligochaeta:	Class	Perlidae:	Species
Hirudinea:	Species	Perlodidae:	Species
Arthropoda		Chloroperlidae:	Genus
Crustacea		Hemiptera	
Isopoda:	Genus	Belostomatidae:	Genus
Amphipoda:	Genus/Species	Nepidae:	Genus
Decapoda:	Species	Pleidae:	Genus
Arachnoidea		Naucoridae:	Genus
Hydracarina:	Class	Corixidae:	Genus
Insecta		Notonectidae:	Genus
Ephemeroptera		Megaloptera	
Siphonuridae:	Genus	Sialidae:	Genus
Baetidae:	Genus	Corydalidae:	Species
Oligoneuriidae:	Genus	Neuroptera:	Genus
Heptageniidae:	Genus/Species	Trichoptera	
Leptophlebiidae:	Genus	Philopotamidae:	Genus/Species
Ephemerellidae:	Species	Psychomyiidae:	Species
Tricorythidae:	Genus	Polycentropodidae:	Genus
Caenidae:	Genus	Hydropsychidae:	Genus/Species
Baetiscidae:	Species	Rhyacophilidae:	Genus/Species
Potamanthidae:	Genus	Glossosomatidae:	Genus
Ephemeridae:	Genus	Hydroptilidae:	Genus/Species
Polymitarcyidae:	Species	Phryganeidae:	Genus
Odonata		Brachycentridae:	Genus
Zygoptera		Limnephilidae:	Genus
Calopterygidae:	Genus	Lepidostomatidae:	Genus
Lestidae:	Species	Beraeidae:	Genus
Coenagrionidae:	Family/Genus	Sericostomatidae:	Genus
Anisoptera		Odontoceridae:	Genus
Aeshnidae:	Species	Molannidae:	Genus
Gomphidae:	Species	Helicopsychidae:	Species
Cordulegastridae:	Species	Calamoceratidae:	Genus
Macromiidae:	Species	Leptoceridae:	Genus/Species
Corduliidae:	Species	Lepidoptera:	Genus
Libellulidae:	Species		

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Coleoptera

Gyrinidae:	Genus
Halplidae:	Genus
Dytiscidae:	Genus
Noteridae:	Genus
Hydrophilidae:	Genus
Hydraenidae:	Genus
Psephenidae:	Species
Dryopidae:	Genus
Scirtidae:	Family
Elmidae:	Genus/Species
Limnichidae:	Genus
Heteroceridae:	Family
Ptilodactylidae:	Family
Chrysomelidae:	Family
Curculionidae:	Family
Lampyridae:	Family

Diptera

Tipulidae:	Genus
Psychodidae:	Genus
Ptychopteridae:	Genus
Dixidae:	Genus
Chaoboridae:	Genus
Culicidae:	Genus
Thaumaleidae:	Genus
Simuliidae:	Genus
Certopogonidae:	Family/Genus/Species
Chironomidae	
Tanypodinae:	Genus/Species
Diamesinae:	Genus/Species
Prodiamesinae:	Genus/Species
Orthocladinae:	Genus/Species
Chironominae	
Chironomini:	Genus/Species
Pseudochironomini:	Genus/Species
Tanytarsini:	Genus/Species
Tabanidae:	Genus/Species
Athericidae:	Species
Stratiomyidae:	Genus
Empididae:	Family
Dolichopodidae:	Family
Syrphidae:	Family/Genus
Sciomyzidae:	Family/Genus
Ephydriidae:	Family/Genus
Muscidae:	Species

Mollusca

Gastropoda:	Family/Genus/Species
Pelecypoda:	Family/Genus/Species

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Table V-1-2 Level of macroinvertebrate taxonomy attainable using keys (Asterisked references are used for final identifications)

<p>Porifera: Pennak* (1978)/Species Coelenterata: Pennak* (1978)/Species Platyhelminthes: Pennak* (1978)/Species Nematomorpha: Pennak* (1978)/Genus Bryozoa: Pennak* (1978)/Species Annelida Hirudinea: Klemm* (1982)/Species Isopoda <i>Asellus</i>: Williams* (1972)/Species Amphipoda Specific Keys: Pennak* (1978)/Species Gammaridae: Holsinger* (1972)/Species Decapoda <i>Cambarus</i> and <i>Fallicambarus</i>: Jezerinac and Thoma* (1982)/Species <i>Procambarus</i> and <i>Orconectes</i>: Jezerinac* (1978)/Species Ephemeroptera Generic Keys: Edmunds et al. (1976), Merritt and Cummins* (1984)/Genus <i>Baetis</i>: Morihara and McCafferty* (1979)/Species <i>Stenonema</i>: Bednarik and McCafferty* (1979)/Species <i>Attenella</i>: Allen and Edmunds* (1961)/Species <i>Dannella</i>: Allen and Edmunds* (1962)/Species <i>Drunella</i>: Allen and Edmunds* (1962)/Species <i>Ephemerella</i>: Allen and Edmunds* (1965)/Species <i>Eurylophella</i>: Allen and Edmunds* (1965)/Species <i>Serratella</i>: Allen and Edmunds* (1963)/Species <i>Ephemeroidea</i>: McCafferty* (1975)/Species Other Species Keys: Burks* (1953)/Species Odonata Generic Keys: Merritt and Cummins* (1984)/Genus Zygoptera: Walker* (1953)/Species Anisoptera: Needham and Westfall* (1955), Walker (1958), Walker and Corbett (1975)/Species Plecoptera Generic Keys: Stewart and Stark* (1988)/Genus Species Keys: Hitchcock* (1974)/Species <i>Agnatina</i>: Stark* (1986)/Species Hemiptera Generic Keys: Hilsenhoff (1982), Merritt and Cummins* (1984)/Genus Megaloptera Generic Keys: Merritt and Cummins* (1984)/Genus <i>Chauliodes</i>: Cuyler* (1958)/Species <i>Nigronia</i>: Neunzig* (1966)/Species</p>	<p>Neuroptera Generic Keys: Merritt and Cummins* (1984)/Genus Trichoptera Generic keys: Wiggins* (1977)/Genus <i>Hydropsyche</i>: Scheffer et al.* (1986)/Genus Schuster and Etnier (1978)/Species <i>Rhyacophila</i>: Flint* (1962)/Species <i>Nectopsyche</i>: Haddock* (1977)/Species Lepidoptera Generic Keys: Merritt and Cummins* (1984)/Genus Coleoptera Generic Keys: Hilsenhoff (1982), Merritt and Cummins* (1984)/Genus Dryopoidea: Brown* (1972)/Species Diptera Generic Keys: McAlpine et al.* (1981) (exc. Chironomidae)/Genus Simuliidae: Stone* (1964)/Species Chironomidae Generic Keys: Wiederholm* (1983)/Genus <i>Ablabesmyia</i>: Roback* (1985)/Species <i>Clinotanypus</i>: Roback* (1976)/Species <i>Coelotanypus</i>: Roback* (1974)/Species <i>Labrundinia</i>: Roback* (1987)/Species <i>Natarsia</i> and <i>Psectrotanypus</i>: Roback* (1978)/Species <i>Nilotanypus</i>: Roback* (1986)/Species <i>Tanypus</i>: Roback* (1977)/Species <i>Pagastia</i>: Oliver and Roussel* (1982)/Species <i>Monodiamesa</i>: Saether* (1973)/Species <i>Brillia</i>: Oliver and Roussel* (1983)/Species <i>Eukiefferiella</i> and <i>Tvetenia</i>: Bode* (1983)/Species group <i>Nanocladius</i>: Saether* (1977)/Species <i>Orthocladius</i> (<i>Orthocladius</i>): Soptonis* (1977)/Species <i>Axarus</i>: Roback* (1963)/Species <i>Dicrotendipes</i>: Epler* (1987)/Species <i>Endochironomus</i>, Tribelos, and <i>Endotribelos</i>: Grodhaus* (1987)/Species <i>Paracladopelma</i> and <i>Saetheria</i>: Jackson* (1977)/Species <i>Polypedium</i> (<i>Polypedilum</i>): Maschwitz* (1976)/Species Other Species keys: Simpson and Bode* (1980)/Species Tabanidae: Pechuman et al.* (1983)/Species Athericidae: Webb (1977)*/Species Muscidae: Johannsen* (1935)/Species Mollusca Gastropoda: Burch* (1982)/Species Pelecypoda: Burch* (1972)/Species</p>
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2) Macroinvertebrate Data Analysis

a) Invertebrate Community Index

The principle measure of overall macroinvertebrate community condition used by the Biological Field Evaluations Group is the Invertebrate Community Index (ICI), a measurement derived in-house from information collected over many years. The ICI is a modification of the Index of Biotic Integrity (IBI) for fish developed by Karr (1981). The ICI consists of ten structural community metrics, each with four scoring categories of 6, 4, 2, and 0 points (Table V-1-3). The point system evaluates a sample against a database of 247 relatively undisturbed reference sites throughout Ohio. Six points will be scored if a given metric has a value comparable to those of exceptional stream communities, 4 points for those metric values characteristic of more typical good communities, 2 points for metric values slightly deviating from the expected range

Table V-1-3. Invertebrate Community Index (ICI) Metrics and Scoring Criteria Based on Macroinvertebrate Community Data From 247 Reference Sites Throughout Ohio.

Metric	Scoring Criteria			
	0	2	4	6
1. Total Number of Taxa	Scoring of each metric varies with drainage area; see Ohio EPA (1987).			
2. Total Number of Mayfly Taxa				
3. Total Number of Caddisfly Taxa				
4. Total Number of Dipteran Taxa				
5. Percent Mayflies				
6. Percent Caddisflies				
7. Percent Tribe Tanytarsini Midges				
8. Percent Other Dipterans and Non-Insects				
9. Percent Tolerant Organisms				
10. Total Number of Qualitative Ephemeroptera, Plecoptera, and Trichoptera (EPT) Taxa				

of good values, and 0 points for metric values strongly deviating from the expected range of good values. The summation of the individual metric scores (determined by

the relevant attributes of an invertebrate sample with some consideration given to stream drainage area) results in the ICI value. Metrics 1-9 are all generated from the artificial substrate sample data while Metric 10 is based solely on the qualitative sample data. More discussion of the derivation of the ICI including descriptions of each metric and the data plots and other information used to score each metric can be found in Ohio EPA (1987).

b) Community Similarity Index

A coefficient of similarity (*c*) between two stations can be calculated using Van Horn's (1950) equation modified from the general formula described by Gleason (1920):

$$c = \frac{2w}{a + b}$$

The variables in this expression can be based either on the number of taxa present or absent at each station or on actual numerical data collected at each site. If the presence/absence method is being used:

- a** = the number of taxa collected at one station,
- b** = the number of taxa collected at the other station, and
- w** = the number of taxa common to both stations.

When actual numerical data are being used, each taxon is assigned a prominence value calculated by multiplying the density of the taxon by the square root of its frequency of occurrence (Beals, 1961; Burlington, 1962). In this case:

- a** = the sum of the prominence values of all of the taxa at one station,
- b** = the sum of the prominence values of all of the taxa at the other station, and
- w** = the sum of the prominence values of all of the taxa of one station which it has in common with the other station. The lower of the two resulting values of *w* is used in the equation.

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c) Rank Correlation Coefficient

A rank correlation coefficient between measured biological, chemical, or other physical data can be calculated using the formula defined by Spearman (1904):

$$r_s = 1 - \frac{6 \sum_{i=1}^n D_i^2}{n(n^2 - 1)}$$

where n = the number of paired observations (x_i, y_i) and
 D_i = the rank of x_i minus the rank of y_i .

d) Coefficient of Variation

In cases where replicate analyses are conducted (e.g., litigation purposes or NAWQMN stations), a coefficient of variation between replicates is determined following the procedures outlined by Li (1964) using the formula:

$$CV = \frac{s}{\bar{x}} \times 100$$

where s = the sample standard deviation and:
 \bar{x} = the sample mean.

Part D

Laboratory Methods and Data Analysis - Qualitative Sampling

Samples are entered and logged as outlined in Subsection 1, part c. Samples are examined using a dissecting microscope and a tabulated listing of the organisms identified is compiled. Dipterans of the family Chironomidae are prepared as outlined in Subsection 1, Part c. Taxonomic guides used for final identifications are the same as listed in Subsection 1, Part c. Assessment of the macroinvertebrate community condition is finalized

using the preliminary assessment made in the field tempered with information on taxa richness and composition from the laboratory identified sample.

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Subsection 4. Fish

Part A) Training

- 1) Sampling Methods
- 2) Species Identification

Part B) Field Methods

- 1) Sampling Site Selection
- 2) Fish Sampling Procedures
 - a) Introduction
 - b) Pulsed D.C. Electrofishing Methods and Equipment
 - c) Passive Gear Methods and Equipment
- 3) Field Counting and Weighing Procedures
 - a) Handling Live Specimens
 - b) Field Identification
 - c) Weighing
 - d) External Anomalies
- 4) Sampling Site Evaluation
 - a) Geographical Information
 - b) Habitat Characteristics: Qualitative Habitat Evaluation Index (QHEI)
 - c) Additional Information

Part C) Laboratory Methods

- 1) Handling Preserved Specimens
 - a) Preservation
 - b) Laboratory Identification and Verification
 - c) Disposition
- 2) Data Handling and Analysis
 - a) Data Sheets
 - b) Data Storage and Compilation
 - c) Analytical Methods

Part A) Training

1) *Sampling Methods*

All new full-time field personnel in the Fish Evaluation Group receive in-house training in the following procedures prior to the start of the field season. A senior staff member also accompanies the new field crew leader for at least the first two weeks of the field sampling season (and thereafter if necessary) instructing in all aspects of the field sampling. Individuals are then permitted to proceed on their own with periodic conferences with the Fish Evaluation Group supervisor to assure the sampling effort is being conducted in accordance with the procedures described herein.

New part-time summer field personnel receive copies of the fish section of the Quality Assurance Manual (Subsection 4) and are given pre-field season training on the procedures involved in the fish sampling program for a one week period prior to the field season.

2) *Species Identification*

All new field personnel, summer or full-time, are given a test consisting of a collection of different Ohio fish species to identify and count to determine their familiarity with Ohio fish taxonomy and their ability to accurately count large numbers of fish. Full-time field crew leaders perform or supervise *all* of the actual field identifications and counts with the summer personnel assisting.

Part B) Field Methods

1) *Sampling Site Selection*

The selection of fish sampling sites is based upon several factors including, but not limited to, the following:

- 1) location of point source dischargers;
- 2) stream use designation evaluation issues;

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- 3) location of physical habitat features (e.g. dams, changes in geology, changes in stream order, presence of a stream confluence, etc.);
- 4) location of nonpoint sources of pollution; and,
- 5) variations in macrohabitat.
- 6) proximity to ecoregion boundaries.

Each study area has a set number of biological sampling sites allocated based on the number and complexity of the priority issues requiring field evaluation. Optimum placement of sampling sites is determined recognizing practical access and resource constraints. The principal objectives of each survey determine where sampling sites will be located. Generally, sites are located upstream from all pollution sources to determine the background condition for the study area. Should the upstream portion of the stream be impacted, an alternate site may be chosen on an adjacent stream with similar watershed characteristics. Reference sites within the same ecoregion may also be used in this role (these are listed in Ohio EPA 1987). The role of upstream sites is not necessarily to provide a biological performance level against which downstream sites are compared since the ecoregion biocriteria fill this niche for the respective aquatic life use designations. Upstream sites are, however, important in defining any site or watershed specific background conditions that might temporarily or permanently influence eventual aquatic life use attainment in the downstream reaches. Selection of sampling sites within a segment is accomplished by selecting the most *typical* habitat available in an effort to represent the current potential of that segment. An attempt should be made to sample typically similar macrohabitats at all sampling sites established within the study area.

To address point source discharge concerns, at least one site is situated upstream from the primary process wastewater outfall(s), one within the mixing zone, and sites located at intervals downstream from the mixing zone (i.e.

dependent on stream size and mixing characteristics) to determine the near and far field impacts, the longitudinal extent and severity of any impact, and to determine if and where recovery occurs. Spacing of the downstream sampling sites is based on physical macrohabitat characteristics, access to the segment, other adjacent point and nonpoint sources, stream size, and other factors. An attempt is made to place sampling sites between point sources where sufficient distance between each exists. Sampling sites may also be situated in the mouths of major tributaries to determine any potential effects on the mainstem. Localized areas of macrohabitat modification such as instream impoundments or channelized sections alter macrohabitat available for fish and can affect community structure and function. Generally, these areas are not *typical* of the macrohabitat in a free-flowing river or stream. However, these areas are often times impacted by the principal sources targeted for evaluation in certain study areas (particularly in urban areas), therefore, sampling sites are located within these modified areas as needed. These areas should be sampled in order to understand the underlying influence that they exert on biological performance and eventual aquatic life use attainment.

2) Fish Sampling Procedures

a) Introduction

The principal method used by Ohio EPA to obtain fish relative abundance and distribution data is pulsed direct current electrofishing. As with any single method there exists inherent sampling selectivity and sampling bias. Pulsed D.C. electrofishing is, however, widely viewed as the single most effective method for sampling fish communities in lotic habitats. Twelve different fish sampling techniques have been assigned sampler type codes. Six codes are currently recognized as valid for generating fish relative abundance data for the purpose of calculating Index of Biotic Integrity (IBI) and Modified Index of Well-

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Being (lwb) scores from which aquatic life use attainment is partially judged (Table V-4-1). The remaining codes are assigned to seldom used or currently experimental methods. This system of letter codes superceded a system of numerical codes used prior to 1984. The use of any one of these sampling methods is dependent on the type of information required and the type of aquatic habitat being sampled. Since 1979 certain methods have been modified or abandoned (e.g. seining). The boat mounted and wading electrofishing methods are the most commonly used fish sampling techniques by Ohio EPA in lotic habitats. The boat electrofishing methods (sampler type A) are used to sample the largest streams and rivers (Table V-4-1). Wading methods (sampler types D, E, and F) are used in wadable streams. These are the most frequently used sampler types and are regarded as suitable for calculating IBI and modified lwb scores (Ohio EPA 1987). Sampler type B (18' boat, circular electrode array) is used in the deeper rivers (e.g. Ohio River) and embayments (e.g. Lake Erie tributary river mouths). This is also considered to be an acceptable method. Sampler type C is used in free-flowing rivers to sample riffle habitats. This method is used only to supplement the boat methods and the data is not used to calculate the IBI or modified lwb. Sampler types G and H are seining methods and are no longer in routine use. The fyke net and hoop net methods (types I and J) may be necessary in lentic, wetland, or large river habitats. The experimental gill net method (type K) may be necessary to sample for mid-channel and pelagic species. These *passive* methods (types I through K) are seldom used and only in special situations to supplement routine electrofishing sampling.

Fish sampling is preferably conducted between mid-June and early October, when stream and river flows are generally low, pollution stresses are potentially the greatest, and the fish community is most stable and sedentary. Sampling may be conducted outside of this

time period, but the results may not be applicable for Ohio EPA biocriteria purposes. The use and applicability of this data will be evaluated on a case-by-case basis. Special studies are conducted by the Fish Evaluation Group on a periodic basis to determine the effectiveness of each sampling method, comparability of methods, necessary sampling frequency, evaluate new and emerging techniques, and to better understand gear selectivity and effectiveness.

Table V-4-1. Designation of sampler types and description of fish sampling methods used by Ohio EPA (revised June 1, 1984).

Sampling Method Description	Sampler Type	Relative Abundance Based On	Data Collected	
			#	Wt ^a
Boat-mounted electro-fishing - <i>straight electrode array</i>	A	Per 1.0 km	X	X
Boat-mounted electro-fishing - <i>circular electrode array</i>	B	Per 1.0 km	X	X
Boat longline - riffle method ^b	C	Per 0.3 km	X	X
Sportyak-generator unit	D	Per 0.3 km	X	X
Longline-generator unit	E	Per 0.3 km	X	X
Back-pack electro-fishing - battery unit	F	Per 0.3 km	X	X
Backpack electrofishing-seine combination ^c	G	Per 0.3 km	X	
Seines ^d	H	Per 0.3 km	X	
Fyke net ^d	I	Per 24 hours	X	X
Hoop net ^d	J	Per 24 hours	X	X
Gill net ^d	K	Per 24 hours	X	X
Boat-mounted electro-fishing - <i>straight electrode array</i> NIGHT	N	Per 1.0 km	X	X
Boat mounted electro-fishing - <i>circular electrode array</i> NIGHT	M	Per 1.0 km	X	X
Reserved	L-Z ^e			

^aWeight data is taken if modified lwb is needed.

^bExperimental method in conjunction with sampler type A.

^cDiscontinued method.

^dMethod is not suitable for calculating IBI or modified lwb scores.

^eThese codes are available for methods developed in the future.

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b) Pulsed D.C. Electrofishing Methods and Equipment:

Selection of the Appropriate Sampler Type

Selection of the appropriate sampler type is dependent upon the type of data needed, the type of macrohabitat being sampled, and the size and *depth* of the water body being sampled. This is a critical part of the sampling process since data quality essentially determines data applicability for the purposes of evaluating attainment of aquatic life uses. Thus it is important that the appropriate sampler type be used.

Boat electrofishing methods (sampler type A) are used in moderate to large sized streams and rivers where the use of wading methods are both impractical and less efficient. These include streams and rivers that have pools deep enough to accommodate the 12', 14', or 16' boats and equipment. Sites sampled with the boat methods are referred to as *boat sites*. The usual drainage area range of boat sites is 150 to more than 6000 sq. mi. although the 12' boat method has been used for sites as small as 75 sq. mi. where pool depths exceed 1.5 - 2.0 m and greater. This situation is the most frequently encountered in the Western Allegheny Plateau ecoregion (southeastern Ohio). The 12' electrofishing boat is the smallest of the boat-mounted devices and is used in moderate sized streams that generally cannot be navigated by the larger boats, usually 150 - 400 sq. mi. drainage area. The 14' and 16' electrofishing boats are used in larger rivers where near continuous navigation is possible (usually greater than 400 - 500 sq. mi.). The 18' boat electrofishing method is designed for use in the largest and deepest rivers, impoundments, and embayments. This boat employs either a straight (sampler type A) or circular (sampler type B) electrode array. Night electrofishing may be appropriate for the largest rivers (e.g., Ohio River, impounded sections of the Muskingum R.) where the drainage area exceeds 6000 - 7000 sq. mi. Depending on the electrode array

used this method is termed sampler type N (straight array) or sampler type M (circular array).

Wading methods are used in smaller, wadable streams that cannot accommodate the boat methods due to the physical limitations of the stream channel. These are referred to as *wading sites* and range from the smallest headwater areas (<20 sq. mi. drainage area) to sites of 400 - 500 sq. mi. The Sportyak-generator method (sampler type D) is used in streams that range in size from 5-20 m in width and 0.5 - 1.0m in depth (average). There is a great deal of overlap in terms of drainage area between the sites where either the wading or boat sampler types may be most appropriate. The key factors in making the choice between these two methods is pool width and depth *and* access for the sampling equipment. The longline-generator method (sampler type E) is used in areas where the pools are separated by shallow riffles which make the use of the Sportyak method impractical. Both methods will sample the same site with equal efficiency. The backpack electrofishing method (sampler type F) is used in very shallow, small headwaters streams where the longline method is not necessary to secure an adequate sample. Streams that are more than five times the width of the anode net ring and more than twice the depth of the same should not be sampled with the backpack method (sampler type F). The seining methods (sampler types G and H) were used in the past, but have been discontinued by Ohio EPA. These sampler types are retained only to accommodate data generated by non-Ohio EPA entities and to make possible the use of historical data. Results generated by these latter methods (sampler types G and H) may not be suitable for determining aquatic life use attainment using the IBI and modified Iwb.

Selection of any of the previously described methods is based on the best professional judgement of the field crew leader and information gathered in a pre-survey

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reconnaissance of the stream. Reconnaissance should take place during low-flow conditions if at all possible. Drainage area, stream length, and stream order are good physical indicators which aid in the selection of the appropriate sampling gear. Information to be collected during the reconnaissance includes the general width and depth of the stream, presence of riffles, dams, log jams and other impediments to navigation, access sites, and location of pollution sources and tributaries. All of these factors are used in choosing the appropriate sampler type(s).

General Cautions Concerning Field Conditions

Electrofishing should be conducted *only* during "normal" water flow and clarity conditions. What constitutes "normal" can vary from stream to stream. Generally "normal" water conditions in Ohio occur during *below* annual average river discharge levels. Under these conditions the surface of the water generally will have a "placid" appearance. Abnormally turbid conditions are to be avoided as are elevated flow and current. All of these adversely affect sampling efficiency and may rule out data applicability for calculating the modified Iwb and IBI. Since the ability of the netter to see stunned fish is critical, sampling should take place only during periods of "normal" water clarity and flow. Most Ohio surface waters have some background turbidity due to planktonic algae and suspended sediment and very few, if any, are entirely clear. Rainfall and subsequent runoff can cause increased turbidity due to the increased presence of suspended sediment (clays and silt). In most areas this imparts a light to medium brown coloration in the water. Floating debris such as sticks and other trash are usually obvious on the surface. Visibility under such conditions is seldom more than a few inches. Such conditions should be avoided and sampling should be delayed until the water returns to its "normal" clarity. High flow should be avoided for the obvious safety reasons, but this also reduces sampling efficiency. The boat methods are particularly affected as it becomes more difficult for the driver to maneuver the boat into areas of cover and current

heterogeneity. These cautions apply to all of the electrofishing methods.

Boat Electrofishing Methods and Equipment

The boat methods (sampler types A and B) include the use of 12', 14', 16', and 18' john boats rigged for electrofishing. Equipment type, electrode design, and sampling methods follow the rationale and procedures outlined in Gammon (1973, 1976) and Novotny and Priegel (1974). Figure V-4-1 provides a diagrammatic description of the boat apparatus. A Smith-Root Type VI-A¹ or 3.5 GPP electrofishing unit² is used in the 12', 14', 16' and 18' boats. The Type VI-A unit rectifies 60HZ 240VAC (which is supplied by a 3500 or 4500 watt gasoline powered alternator) to pulsed DC. The pulse configuration consists of a triangular wave that can be adjusted to 60 or 120 pulses/second. Six voltage settings from 166 to 996 VDC in 166 volt increments are available. The voltage setting used in a particular situation is determined on a trial and error basis by increasing the voltage setting until a pulse width of 4-5 milliseconds produces an amperage reading of 8 amperes. In Ohio waters during June through October, relative conductivity values normally range from 300-600 umhos/cm. This generally results in a voltage selection of 336, 504, or 672 VDC. Conductivity values below this range may require higher voltage settings, whereas higher conductivity values may require lower voltage settings. The Smith-Root Model 3.5 GPP gas powered alternator and pulsator also delivers pulsed DC current. The pulse configuration consists of a fast rise, slow decay pulse which can be interrupted into 30, 60 or 120 pulses/second. The voltage range is continuously variable between 0-1000 volts and is adjusted by a percent-of-range rheostat to maintain the output amperage between 4 and 11 amps.

¹Use of product or company name does not signify endorsement.

²Smith-Root, Inc. 14014 N.E. Salmon Creek Ave., Vancouver, Washington 98665.

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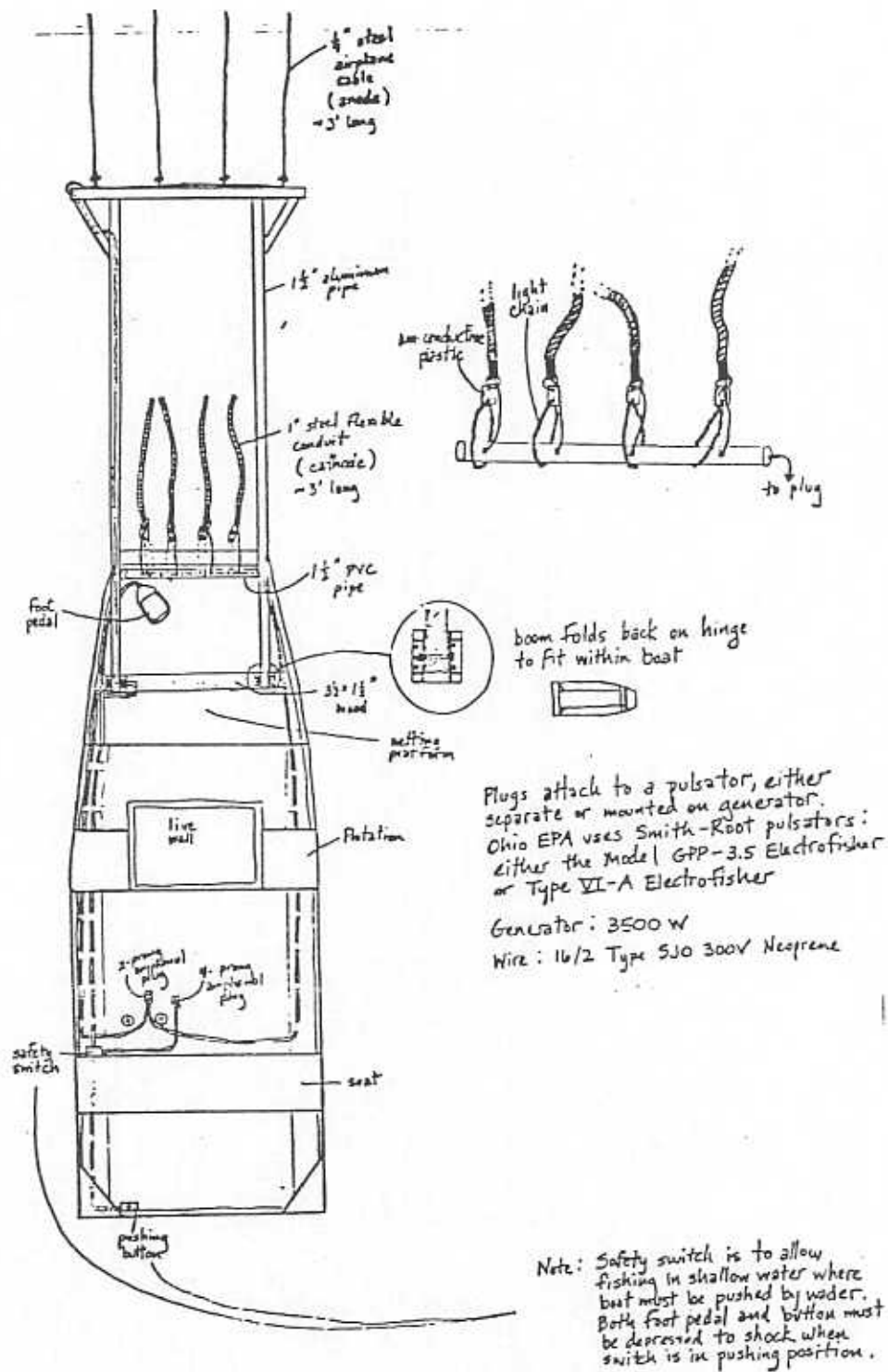


Figure V-4-1. Diagram of the boat electrofishing apparatus used by Ohio EPA to sample large river and stream fish communities.

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The optimum range is selected on a trial and error basis by increasing the range until the indicator light flickers. Other comparable pulsed D.C. electrofishing units are acceptable for use as long as their performance is comparable to the aforementioned designs.

Pulsed DC current is transmitted through the water by an arrangement of anodes and cathodes suspended in the water from the boat. On the 12', 14' and 16' boats, four 32" long 1/4" diameter stainless steel aircraft cable anodes are hung from a retractable aluminum boom which extends in front of the boat. Boom length varies according to boat size and is approximately 3.05m on the 18' boat, 2.75m on the 16' boat, 2.15m on the 14' boat, and 2.0m on the 12' boat. Boom width varies from approximately 1.55 to 1.65m being wider on the larger boats. Four anodes are positioned on the front of the boom in a line perpendicular to the length of the boat. Four 64" lengths of 1" O.D. flexible galvanized steel conduit serve as cathodes, and are suspended directly from the bow in a line perpendicular to the length of the boat. The width of this array ranges from 0.75m on the 12' boat to 0.90m on the larger boats. Anodes and cathodes are replaced when damaged or worn. Safety equipment includes a positive pressure cut-off foot-pedal switch located on the bow deck and an emergency toggle cut-off switch adjacent to the stern seat. There is a magnetic-hydraulic circuit breaker on the Type VI-A electrofishing units.

For night electrofishing the equipment includes four 75 watt floodlamps attached to a guardrail which is mounted on the bow. These floodlamps are powered by 120 VAC produced by a separate gasoline powered generator.

A boat sampling crew consists of a *netter* and a *driver*. It is the netter's primary responsibility to capture all fish sighted; the driver's responsibility is to maneuver the boat as effectively as possible giving the netter the *best*

opportunity to capture stunned fish (the driver may assist in netting stunned fish that appear at the rear or behind the boat). Both tasks are skill dependent with the boat maneuvering task requiring the most experience to gain adequate proficiency. Each sampling zone is fished in a downstream direction by slowly and steadily maneuvering the electrofishing boat as close to shore and submerged objects as possible by rowing or motoring. This may require *frequent* turning, backing, shifting (forward, reverse), changing speed, etc. in areas of moderate to extensive cover. The electrofishing boat is pushed on the transom by the driver when the water is too shallow to motor or row. A hand actuated positive pressure cut-off switch located on the inside of the transom is used during this procedure in addition to the bow foot-pedal switch. Both the netter and driver are clad in chest waders and rubber gloves. The netter also wears a jacket type personal flotation device. Safety equipment includes a positive pressure cut-off switch located on the bow deck and inside the transom.

Boat Sampling Site Selection

Sampling sites are selected along the shoreline with the most diverse macrohabitat features. This is generally along the gradual outside bends of the larger rivers but is not invariable. In free-flowing habitats part of each zone should include a run-type of habitat *if at all practical*. This of course is determined by the availability of such areas. Boat electrofishing zones generally measure 0.5 kilometers (km) in length, although shorter distances may be necessary in given instances. Distance is measured with a Topometric Products Limited (R) Hip Chain (preferred method) or a Ranging 620 optical rangefinder. Sampling sites are measured by securing the hip chain thread to a stationary object and then wading or motoring the length of the sampling zone. The length of the zone is then measured by the hip-chain counter. When using the optical rangefinder each zone is measured in increments approximating 50 m and accumulated to a distance of 0.5

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km. This method is used only with boat methods where the use of the hip chain is impractical. Sampling site locations are verified on 7 1/2 minute USGS topographical maps. Hip chains and rangefinders are calibrated prior to being used in the field on a marked course and adjusted as necessary. The calibration results are recorded in a log book. Water depth in centimeters (cm) is determined to the nearest 10 cm at a minimum of ten locations in each zone with a marked dip net. The average depth is then recorded on the fish data sheet. The boundaries of each electrofishing zone are clearly marked on stationary objects (e.g. trees, bridge piers, etc.) with fluorescent orange paint. The starting point is marked with an arrow pointing in a downstream direction and the ending point is marked with a visible capital "E". This enables accurate relocation of the site on subsequent sampling dates. If the sampling zone is disjunct additional marks are necessary. If the zone stops and then resumes on the same bank then X marks where sampling stops and an arrow indicates where sampling resumes. If the zone switches banks then an arrow pointing skyward indicates the point to switch banks and an arrow pointing down on the opposite shore indicates where the zone resumes. The location of each sampling zone is indexed by river mile (using the river mile index contained in the Ohio EPA PEMSOM RMI system) and marked on 7 1/2 minute USGS topographical maps for permanent reference.

Boat Electrofishing Techniques

Each boat sampling zone is electrofished two or three times during the sampling season starting (whenever possible) at the farthest upstream zone and sampling sequentially downstream until one pass is completed. The remaining one or two sequential passes occur later in the sampling season. Sampling passes should take place at least three to four weeks apart for a three pass effort. If only two passes are planned, five to six weeks should elapse between individual sampling passes. Individual sampling zones are electrofished from upstream to downstream by

slowly and steadily maneuvering the electrofishing boat as close to the shore and submerged objects as possible. It is absolutely critical to sample *carefully*, particularly at difficult sites where there is extensive woody debris *or* moderately fast to swift current. Figure V-4-2 provides a diagrammatic portrayal of how two different boat electrofishing zones should be sampled. In zones with extensive woody debris and slow current it is necessary to maneuver the boat in and out of the "pockets" of habitat formed by the debris. If the water depth approaches 100-200 cm it is usually necessary to "wait" for the fish to appear. In moderately fast or swift current it is necessary to conduct fast turns and maneuvers in order to put the netter in a good position to capture stunned fish. The efficiency is enhanced if the electrofishing boat and electric field can be kept moving downstream at a pace just slightly greater than the current velocity. Fish are usually oriented into the current and must either swim into the approaching electrical field or turn sideways to escape downstream. This latter movement presents an increased voltage gradient making the fish more susceptible to the electric current. It is often necessary to pass over the fast water sections of these zones twice. Also, portions of zones with continuous fast current can be effectively sampled by "backing" the boat downstream and occasionally pausing to allow the netter to capture stunned fish. The driver may need to assist with netting when large numbers of fish are stunned. Attempting to electrofish such fast water areas in an upstream direction *only* will greatly diminish sampling efficiency.

Although sampling is done according to zone length, the amount of time spent electrofishing each zone is an equally important consideration. Time fished can legitimately vary depending on the current, number of fish being collected, and amount and type of cover within a zone. However, there is a general *minimum* amount of time that should be spent sampling each boat zone.

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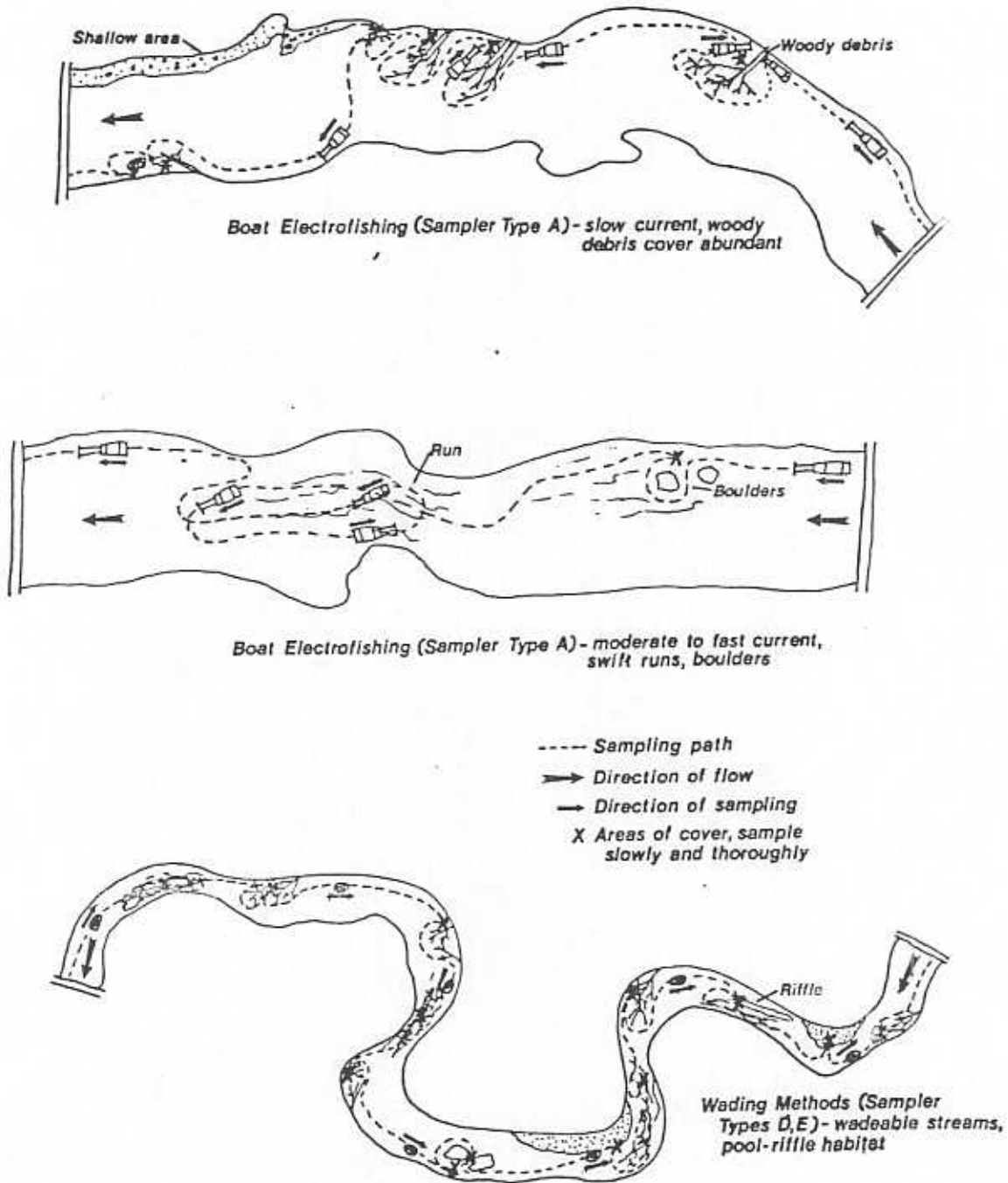


Figure V-4-2. Diagrammatic portrayal of proper boat electrofishing technique at two different river sampling locations and wading methods technique in a typical pool-run-riffle stream habitat.

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Based on an analysis of 1187 electrofishing samples where time fished was compared to various catch results (lwb, numbers, weight, species) that are sensitive to the relative level of effort expended. Inspection of the results show that *at least* 1300 to 1600 seconds should be spent sampling any 0.5 km boat electrofishing zone. This time will likely increase to more than 2000 seconds in slower flowing zones that have numerous downed trees, logs, and other submerged structure. Moderately fast to swift flowing zones may also take longer to sample since the boat must be maneuvered back upstream to cover such areas thoroughly.

Netters are required to wear a pair of polarized sunglasses to facilitate seeing stunned fish in the water during each electrofishing run. An exception to this is with night sampling where sunglasses are not worn. A boat net with an 2.5m long handle and 7.62mm Atlas mesh knotless netting is used to capture stunned fish as they are attracted to the anode array and/or stunned. An effort is made to capture every fish sighted by both the netter and driver.

Captured fish are immediately placed in an on-board livewell for later processing. Water is replaced regularly in warm weather to maintain adequate dissolved oxygen levels in the water and to minimize mortality.

A field crew consists of a minimum of three persons (whenever possible), a boat driver, a netter, and a support vehicle driver. Limited access to most rivers and streams requires the electrofishing boat to be launched at an upstream point with a two person crew. The third crew member is responsible for maintaining contact with the electrofishing boat and meeting the boat at points downstream. Smaller rivers that are not continuously navigable are sampled by locating put-in-and-take-out access points at each sampling location.

The distance of stream or river covered per day is dependent upon the number of sampling zones and ease of navigation. Generally, four to seven zones can be sampled in a 10 to 20 mile segment each day. Relative abundance data collected with this method is expressed as numbers/km and weight (kg)/1.0 km.

The 18' electrofishing boat can be used with either a standard straight electrode array (sampler type A) or with a circular electrode array (sampler type B). The circular array is outfitted according to the specifications listed in Novotny and Priegel (1974). Anode configuration is circular and can be altered by adding or removing electrodes or changing the surface area exposure of each electrode depending on the conductivity of the water. Anodes are added in very low conductivity water less than (100-150 umhos) or removed in extremely high conductivity water greater than (900 umhos). These sampling methods are being tested in rivers where average sampling zone depth is consistently deeper than 150-200 cm (e.g. Lake Erie river mouths, lower Muskingum River, Ohio River, etc.) and in lakes, reservoirs, and impoundments. In these larger and deeper water bodies sampling is also conducted at night. Otherwise, sampling is conducted essentially the same as the methods just described for smaller rivers and streams.

Wading Electrofishing Methods and Equipment and Sampling Techniques

The Sportyak-generator wading method (Sampler type D) is used to sample smaller, wadable streams where access by a 12' john boat is not possible. The longline-generator (sampler type E) method is used in streams that are too shallow to sample with the Sportyak-generator method. The backpack electrofishing method (sampler type F) may be used in lieu of the longline-generator method in *only* the smallest headwaters streams following the restrictions that were previously stated. The Sportyak-generator

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method (Sampler type D) employs a light, plastic boat with the capacity to carry a small portable generator/pulsator, and livewell. The Ohio EPA presently uses a 2.1 m Sportyak to carry a model 1736 DCV T&J combination generator/pulsator pulsed DC electrofishing unit and a 30 gallon plastic holding tank. The T&J electrofishing unit has the capability to supply 125 or 250 volts pulsed DC at a maximum of 1750 watts. At sites which have pool width and depth characteristics that suggest the need for the 12' boat method, but which is not accessible may require the use of the more powerful Smith-Root 3.5 GPP unit rigged for use with the Sportyak. This arrangement provides the additional power needed to efficiently sample pools that are consistently more than 1m deep and wider than 30-40m. A 15.2cm wide by approximately 45.7cm long stainless steel strip attached from the bow of the Sportyak acts as a cathode. Spring cord attached directly to the T&J unit supplies pulsed direct current to the anode. The anode is the net ring attached to a 1.8m long tubular fiberglass net pole. A positive pressure switch mounted on the net pole must be depressed to complete the switch circuit and allow electrical current to the electrodes (see Figure V-4-3 for a diagrammatic description).

Procedures for sampling require a two or three person crew, all wearing chest waders and rubber gloves. The primary netter operates the anode net ring while one crew member guides the Sportyak and the third crew member assists in capturing fish. This method is also diagrammed in Figure V-4-2. All habitat types are thoroughly sampled in an *upstream* direction for a distance of 150-200 m. The primary netter works the net ring beneath undercut banks, in and around brush piles, log jams, large boulders and other submerged structure. An effective technique for capturing fish under such objects is to thrust the anode ring into and under the structure with the current on and then *quickly* withdraw the anode ring in one swift motion. This has the effect of drawing fish out from under such structure making their capture possible. Sampling effort is

usually concentrated on one side of the stream and some switching from one stream bank to the other may be necessary to sample all habitat types. In riffle and run areas the primary netter *rakes* the anode ring from upstream to downstream, allowing it to drift with the current. At the same time the assist netter blocks off an area downstream of the anode ring. This minimizes escape and avoidance of the electrical field by riffle species. When the holding tank is full of fish or sampling is completed the fish are processed (see Fish Counting and Weighing Procedures).

Sampling procedures for the longline method (Sampler type E) are similar. The longline-generator method uses the same electrofishing unit as the Sportyak method. The longline consists of 100 meters of heavily insulated 4-insulator wire. The anode is the net ring (as in the Sportyak method). The cathode is a floating aluminum plate attached 3m behind the net pole. The backpack electrofishing units (Sampler type F) used are a design supplied by the Michigan Department of Natural Resources³ that produces 100 or 200 VDC (pulsed) or a Coeffelt Model BP-2 electrofishing unit⁴ that produces a similar output. Both units are powered by a 12 VDC power source (motorcycle battery). The net ring serves as the anode and is attached to the end of a 1.8m net pole. A positive pressure switch mounted on the net pole is used to turn the unit on and off and as a safety switch. The cathode configuration on the Michigan DNR unit consists of a piece of copper that approximates 1000 cm². A 2.4m long section of 3.8mm plastic jacketed stainless steel cable with a 0.3m section exposed at the tip serves as the cathode for the Coeffelt unit. Both are trailed behind the backpack unit which is worn by the primary netter. Batteries are recharged daily and one charge is usually adequate for sampling one location, or 2-3 hours, whichever occurs first.

³E. Schultz, P.O. Box 225, Grayling, Michigan 49738

⁴ Coeffelt Electronics Co. Inc., 2019 W. Union Ave., Englewood, Colo. 80110.

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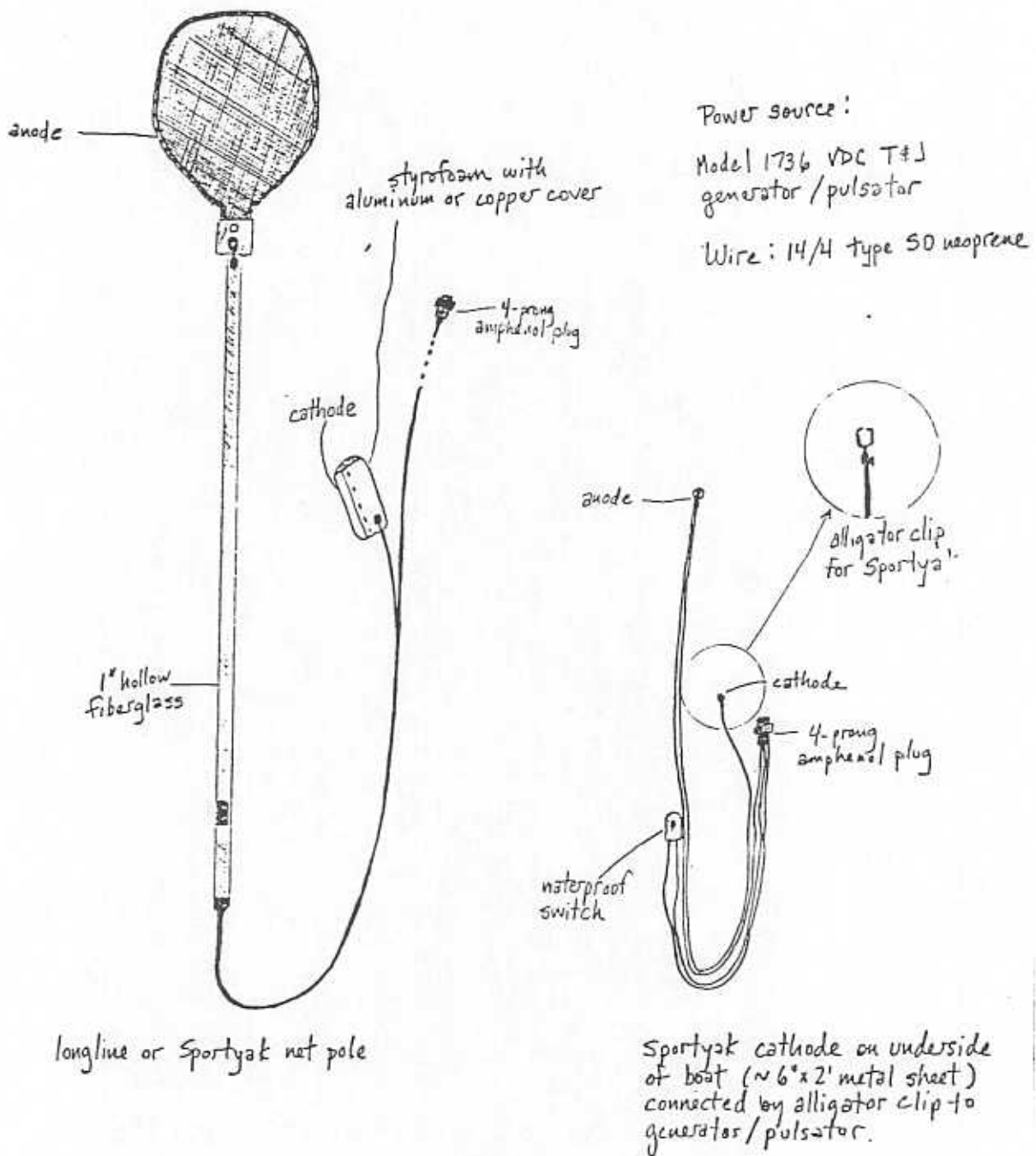


Figure V-4-3. Diagram of the net pole/electrode apparatus used with the Sportyak-generator and long-line electrofishing methods by Ohio EPA to stream fish communities.

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Two or three individual sampling passes are preferred with the wading methods although one pass may be sufficient in small streams or certain non-complex situations. The number of passes affects how the catch data and biological indices are used to make environmental evaluations (Ohio EPA 1987). Relative abundance data is expressed in terms of numbers and weight (kg)/0.3km.

Seine Sampling Methods and Equipment and Sampling Techniques

The procedures and equipment used with the backpack electrofishing/seine methods (sampler type G) are generally the same as the backpack electrofishing method (sampler type F), except that seines are used in conjunction with the backpack electrofishing unit. This method was used to generate relative abundance data suitable for calculating the IBI in the years 1977-1981. The use of seines was discontinued in 1982 due to the relatively high degree of variability in the data caused by differing levels of skill between field crews. A detailed description of the methods can be found in earlier versions of this manual. While this method and seines alone may be used by non-Ohio EPA entities to generate fish relative abundance data it may not be acceptable to generate IBI or modified Iwb scores for aquatic life use attainment purposes. This will be evaluated on a case-by-case basis.

c) Passive Gear Methods and Equipment

Passive gear methods are those in which the sampling device is stationary and the capture of fish is dependent on their movements into the sampling device. These methods are not used on a routine basis by Ohio EPA and are considered experimental.

Four types of passive gear (fyke nets, trap nets, modified hoop nets, and gill nets) may be used to supplement boat electrofishing data in large rivers, estuaries, marshes,

wetlands, lakes or impoundments. Fyke nets and trap nets are used in shallow water while modified hoop nets and gill nets are used in deep or open water.

Fyke nets (Sampler type I) are used in areas where a side channel can be completely blocked off by the two side leads which "funnel" fish into the net. Locations such as tributaries, marsh channels, or other channels off of the main channel are potential sampling sites. Fyke nets are set by anchoring the cod end just upstream of the channel confluence with the river, with the open end facing the main channel. The two side wings are angled toward the shoreline which blocks as much of the channel as possible. A center lead extends into the main channel helping to guide fish into the net. The Maine fyke net consists of a 4.5m body (11.4mm stretched mesh) supported by five square spring steel frames with three internal throats on the first three frames. Two 9m x 1.2 m wings and one 22.5m center lead are attached to the open end of the net. The cod end and all leads are anchored and floats attached to each anchor.

Trap nets (Sampler type J) are used to sample impoundments and wide river channels with slow velocity conditions. Trap nets are set in structurally complex areas where fish movement and density are anticipated to be highest in order to maximize net catches. One center lead is fastened to shore and the net is set perpendicular to the shore with the cod end anchored and marked with a float. Net dimensions are similar to those of the fyke net except a shorter 15m center lead is used. Modified hoop nets are used when sampling the deeper mid-channel areas. Modified hoop nets have been used to successfully capture fish moving upstream and downstream. By connecting two hoop nets together facing in opposite directions and placing them parallel to the flow, it is possible to discern fish movement in both the upstream and downstream directions. Modified hoop nets are set in

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mid-channel parallel to the flow and anchored and marked with floats at both ends.

Gill nets (Sampler type K) are set in open water areas to sample fishes in large rivers, lakes, and impoundments where portions of the fish community are not accessible to shoreline electrofishing. Gill nets can be set at the surface, mid-depth, or on the bottom, depending on the objectives of the sampling and intended target species within the fish community. Gill nets are anchored in open water areas and marked with floats on both ends. Monofilament experimental gill nets are 37.5 m long with 7.5 m panels of 15.2mm, 22.9mm, 25.4mm, 40.6mm, and 50.8mm bar mesh.

All passive gear is checked and emptied 12 to 24 hours after setting. Standard procedures are used to process fish captured by passive gear. Data collected by passive gear can be used to determine relative abundance which are expressed as numbers/24 hours and weight (kg)/24 hours. These results *have not* been used by Ohio EPA to calculate IBI and modified Iwb scores for aquatic life use attainment purposes.

3) Field Counting and Weighing Procedures

a) Handling Live Specimens

All sampling methods require placing captured fish in a livewell for processing when sampling each site is complete or when the livewell is full. Water in the livewell is changed as needed to minimize mortality of the captured fish. Fish are released immediately after they are identified to species, examined for external anomalies, and, if necessary, weighed. Efforts are made to minimize handling and holding times.

b) Field Identification

The majority of captured fish are identified to species in the field; however, any uncertainty about the field

identification of individual fish *requires* their preservation for later laboratory identification (see **Part C**). Fish are preserved for future identification in borax buffered 10% formalin and labeled by date, river or stream, and river mile. Identification is required to the *species* level at a minimum and may be necessary to the sub-specific level in certain instances (*e.g.* banded killifish).

The collection techniques used may not be consistently effective for fish less than 15-20 mm in length, thus inclusion in the catch is not recommended. Also, Angermier and Karr (1986) and Angermier and Schlosser (1988) recommend that fish of this size (young-of-the-year) not be included in IBI calculations as they may unduly bias its function as a long-term aquatic ecosystem health measure. Ohio EPA supports this recommendation.

c) Weighing Procedures

For samples of species which are comprised entirely of one size class (*e.g.* adults, juveniles, young-of-the-year), two methods may be used. For larger species (*e.g.* carp, redhorse, most sunfish), where the adult fish are of a similar size, the catch may be weighed as separate individuals or in aggregate as a species. All results are recorded on the fish data sheet (Figure V-4-4). For catches with more than 15 individuals per species a *subsample* of 15 fish is weighed as individuals or in aggregate. If there is a *noticeable* variation in sizes between individual fish of a species individual weights should be taken using the subsampling technique if necessary. With smaller species (*e.g.* most minnows and darters) mass weighing in aggregate is recommended. If more than 50 individuals of a species comprise the catch a subsample of at least 50 fish is weighed and the remainder are counted. If extremely high numbers of a particular species are collected and the fish are of a relatively uniform size, the number of individuals may be determined by mass weighing all fish collected and extrapolating the numbers from a counted

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and weighed *subsample*.

Samples that are comprised of two distinct size classes of fish (e.g. adults and juveniles) of a species are processed as two, separate size groups. Adults and juveniles are recorded separately on the fish data sheet by adding an "A" to the species code for adults and a "B" for juveniles. For example, if both adult and juvenile white suckers occur in the same sample the adult numbers and weights are recorded as family-species code 40-016A with juvenile numbers and weights recorded as 40-016B. Although each is listed separately on the fish data sheet they are treated as a subsample of the same species in any subsequent data analyses. The FINS (Fish Information System) programs are designed to calculate relative numbers and weight data based on the input of the weighted subsample data.

Individual fish weighing less than 1000 grams (g) are weighed to the nearest 1g on a Homs 1000 spring dial scale (1000g capacity x 2g intervals). Fish weighing more than 1000g are weighed to the nearest 25g on a Universal Accu-weigh spring dial scale M1250 (with air dash pot; 12000 g capacity in 50 g increments). All scales are checked once each week with National Bureau of Standards Class F check weights (up to 2000g in 1g increments) and adjusted as necessary.

d) External Anomalies

All fish that are weighed whether done individually, in aggregate, or subsampled (only the fish that are actually weighed) are examined for the presence of gross external anomalies and their occurrence is recorded on the fish data sheet (Figure V-4-4) and subsequently entered into FINS. In order to standardize the procedure for counting and identifying anomalies the following criteria should be followed.

All fish that are *weighed* are examined for gross external anomalies. These are anomalies that are visible to the naked eye when the fish are captured, identified, sorted, weighed and counted. Table V-4-2 lists the types of anomalies which are recorded on the fish data sheet and subsequently entered into FINS. Exact counts of anomalies present (i.e. the number of tumors, lesions, etc. per fish) are not made; however, light and heavy infestations are noted for certain types of anomalies (Table V-4-2). An external anomaly is defined as the presence of externally visible skin or subcutaneous disorders, and is expressed as percent (weighted) of affected fish among all fish *weighed*. This is computed for each type of anomaly for each species in each sample. It is computed as a weighted number (i.e. based on percent incidence among weighed fish times the total number of that fish species in the sample). Then the total percent anomalies for a specific type of anomaly or group of anomalies can be calculated for one or more sites.

The following is a review of some anomalies commonly encountered in freshwater fishes. These characteristics should be used in determining the types of external anomalies present and in coding the fish data sheet (Fig. V-4-4).

1) *Deformities* - These can affect the head, spinal vertebrae, fins, stomach shape, and have a variety of causes including toxic chemicals, viruses, bacteria (e.g. *Mycobacterium* sp.), infections, and protozoan parasites (e.g. *Myxosoma cerebalis*; Post 1983). Fish with extruded eyes (see Popeye disease) or obvious injuries should not be included.

2) *Eroded fins* - These are the result of a chronic disease principally caused by flexibacteria invading the fins causing a necrosis of the tissue (Post 1983). Necrosis of the fins may also be caused by gryodactylids, a small trematode

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parasite. When necrosis occurs in the tissue at the base of the caudal fin it is referred to as peduncle disease. Erosions also occur on the preopercle and operculum and these *should be* included. In Ohio streams and rivers this anomaly is generally absent in least impacted fish communities, but can have a high incidence in polluted areas. It occurs most frequently in areas with multiple stresses, particularly low or marginal D.O. or high temperatures in combination with chronic toxicity (Pippy and Hare 1969; Sniezko 1962).

Table V-4-2. Codes utilized to record external anomalies on fish.

Anomaly Code	Description
D	Deformities of the head, skeleton, fins, and other body parts.
E	Eroded fins.
L	Lesions, ulcers.
T	Tumors.
M	Multiple DELT anomalies (e.g. lesions and tumors, etc.) on the same individual fish.
AL	Anchor worm - Light infestation: fish with five or fewer attached worms and/or previous attachment sites.
AH	Anchor worm - Heavy infestation: fish with six or more attached worms and/or previous attachment sites.
BL	Black Spot - Light infestation: spots do not cover most of the body with the average distance between spots greater than the diameter of the eye.
BH	Black Spot - Heavy infestation: spots cover most of the body and fins with the average distance between spots less than or equal to the diameter of the eye.
CL	Leeches - Light infestation: fish with five or fewer attached leeches and/or previous attachment sites.
CH	Leeches - Heavy infestation: fish with six or more attached leeches and/or previous attachment sites.
F	Fungus.
I	Ich.
N	Blind - one or both eyes; includes missing and grown over eyes (does not include eyes missing due to popeye disease).
S	Emaciated (poor condition, thin, lacking form).
P	External parasites (other than those already specified).
Y	Popeye disease.
W	Swirled scales.
Z	Other, not included above.

3) *Lesions and Ulcers* - These appear as open sores or exposed tissue and can be caused by viral (e.g. *Lymphocystis* sp.) and bacterial (e.g. *Flexibacter columnaris*, *Aeromonas* spp., *Vibrio* sp.) infections. Prominent bloody areas on fish should also be included. Small, characteristic sores left by anchor worms and leeches should not be included unless they are enlarged by this infection. Obvious injuries, however, should not be included unless they too, are likewise infected. As with eroded fins, lesions often times appear in areas impacted by multiple stresses, particularly marginal D.O. in combination with sublethal levels of toxics.

4) *Tumors* - These result from the loss of carefully regulated cellular proliferative growth in tissue and are generally referred to as neoplasia (Post 1983). In wild fish populations tumors can be the result of exposure to toxic chemicals. Baumann *et al.* (1987) identified polynuclear aromatic hydrocarbons (PAHs) as the cause of hepatic tumors in brown bullheads in the Black River (Ohio). Viral infections (e.g. *Lymphocystis*) can also cause tumors. Parasites (e.g. *Glugea anomala* and *Ceratomyxa shasta*; Post 1983) may cause tumor like masses, but these *should not* be considered as tumors. Parasite masses can be squeezed and broken between the thumb and forefinger whereas true tumors are firm and not easily broken (P. Baumann, pers. comm.).

5) *Anchor worm (Lernaea cyprinacea)* - This is a common parasitic copepod and can be identified by the presence of an adult female which appears as a slender, worm-like body with the head attached (buried) in the flesh of the fish. A small, characteristic sore is left after the anchor worm detaches. Attachment sites are included in the determination of light and heavy infestations. If the former attachment site becomes infected and enlarged as the result of an infection it should be recorded as a lesion.

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6) *Black spot* - This disease is common on fish in Ohio streams and is caused by the larval stage of a trematode parasite (e.g. *Uvulifer ambloplitis* and *Crassiphiala bulboglossa*). They are easily identified as small black cysts (approximately the size of a pin head) on the skin and fins. Black spot has been reported as being most prevalent on fish inhabiting relatively shallow stream and lake habitats which have an abundance of aquatic vegetation with snails and fish eating birds, two of its intermediate animal hosts. It may also increase in frequency in mildly polluted streams or where fish are crowded due to intermittent pooling.

7) *Leeches* - These are parasites belong to the family Piscicolidae and are usually greenish brown in color and 5-25 mm long (Allison *et al.* 1977). Leeches can be identified by the presence of two suckers (one on each end) and the ability to contract or elongate their body. They may occur almost anywhere on the external surface of fish, but are most frequently seen on the anterioventral surface of bullheads (*Ictalurus* sp.). Field investigators should become familiar with the small sores or scars left by leeches as these are included in the determination of light and heavy infestations. If these sores become enlarged and infected they are also regarded as lesions. Leeches are seldom harmful to fish unless the infestation is very heavy.

8) *Fungus* - This is a growth that can appear on a fish's body as a white cottony growth and is most frequently caused by *Saprolegnia parasitica*. This fungus usually attacks an injured or open area of the fish and can eventually cause further disease or death.

9) *Ich* or *Ichthyophthirus multifilis* - This is a protozoan that manifests itself on a fish's skin and fins as a white spotting. This disease rarely occurs in wild fish populations.

10) *Popeye* - This disease is generally identified by bulging eyes and can be caused by gas accumulation in

areas where the water is gas supersaturated. It occurs most frequently in Ohio as the result of fluid accumulation from viral infection, nematodes (*Philometra* sp.), or certain trematode larvae (Rogers and Plumb 1977).

Information on external anomalies is recorded because many are either caused or exacerbated by environmental factors and often times indicate the presence of multiple, sublethal stresses. Komanda (1980) found that morphological abnormalities are uncommon in unimpacted, natural fish populations. The effects of temperature, salinity, dissolved oxygen, diet, chemicals, organic wastes, etc., especially during the ontogeny and larval stages of fishes can be the cause of many types of anomalies (Berra and Au, 1981). The presence of anomalies on fish may act as an index of pollution stress. A high frequency of DELT anomalies (deformities, eroded fins, lesions, and tumors) is a good indication of a stress caused by sublethal stresses, intermittent stresses, and chemically contaminated substrates. The percent DELT anomalies is a metric of the IBI (Ohio EPA 1987). Field investigators are urged to refer to texts on fish health for further information and pictures of specific anomalies. If necessary, affected fish should be preserved for laboratory examination.

4) *Fish Sampling Site Habitat Evaluation:*

Qualitative Habitat Evaluation Index (QHEI)

A general evaluation of macrohabitat is made by the *fish field crew leader* while sampling each location using the Ohio EPA Site Description Sheet - Fish (Figure V-4-5). This form is used to tabulate data and information for calculating the **Qualitative Habitat Evaluation Index (QHEI)**. The following guidance should be used when completing the site evaluation form.

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Figure V-4-5. Front side of the Ohio EPA Site Description Sheet for evaluating the geographical and physical characteristics of fish sampling locations. This is used to record information for the calculation of the Qualitative Habitat Evaluation Index (QHEI).

Ohio EPA Site Description Sheet - Fish

QHEI SCORE:

Stream _____ RM _____ Date _____ River Code _____
 Location _____ Crew: _____

1) SUBSTRATE (Check ONLY Two Substrate TYPE BOXES; Check all types present);

TYPE	POOL RIFFLE	POOL RIFFLE	SUBSTRATE QUALITY	SUBSTRATE SCORE: <input type="text"/>
<input type="checkbox"/> BLDER /SLABS [10]	<input type="checkbox"/> GRAVEL [7]	Substrate Origin (Check all)		Silt Cover (Check One)
<input type="checkbox"/> BOULDER [9]	<input type="checkbox"/> SAND [6]	<input type="checkbox"/> LIMESTONE [1]	<input type="checkbox"/> RIP/RAP [0]	<input type="checkbox"/> SILT HEAVY [-2]
<input type="checkbox"/> COBBLE [8]	<input type="checkbox"/> BEDROCK [5]	<input type="checkbox"/> TILLS [1]	<input type="checkbox"/> HARDPAN [0]	<input type="checkbox"/> SILT MODERATE [-1]
<input type="checkbox"/> HARDPAN [4]	<input type="checkbox"/> DETRITUS [3]	<input type="checkbox"/> SANDSTONE [0]	Extent Of Embeddness (Check One)	
<input type="checkbox"/> MUCK [2]	<input type="checkbox"/> ARTIFIC. [0]	<input type="checkbox"/> SHALE [-1]	<input type="checkbox"/> EXTENSIVE [-2]	<input type="checkbox"/> MODERATE [-1]
TOTAL NUMBER OF SUBSTRATE TYPES: <input type="checkbox"/> > 4 [2] <input type="checkbox"/> <= 4 [0] <input type="checkbox"/> COAL FINES [-2]			<input type="checkbox"/> LOW [0]	<input type="checkbox"/> NONE [1]

NOTE: (Ignore sludge that originates from point-sources; score is based on natural substrates)
 COMMENTS: _____

COVER SCORE:

2) INSTREAM COVER

TYPE (Check All That Apply)

<input type="checkbox"/> UNDERCUT BANKS [1]	<input type="checkbox"/> DEEP POOLS [2]	<input type="checkbox"/> OXBOWS [1]	<input type="checkbox"/> EXTENSIVE > 75% [1]
<input type="checkbox"/> OVERHANGING VEGETATION [1]	<input type="checkbox"/> ROOTWADS [1]	<input type="checkbox"/> AQUATIC MACROPHYTES [1]	<input type="checkbox"/> MODERATE 25-75% [7]
<input type="checkbox"/> SHALLOWS (IN SLOW WATER) [1]	<input type="checkbox"/> BOULDERS [1]	<input type="checkbox"/> LOGS OR WOODY DEBRIS [1]	<input type="checkbox"/> SPARSE 5-25% [3]
			<input type="checkbox"/> NEARLY ABSENT < 5% [1]

AMOUNT (Check ONLY One or check 2 and AVERAGE)
 COMMENTS: _____

3) CHANNEL MORPHOLOGY: (Check ONLY One PER Category OR check 2 and AVERAGE)

CHANNEL:

SINUOSITY	DEVELOPMENT	CHANNELIZATION	STABILITY	MODIFICATIONS/OTHER
<input type="checkbox"/> HIGH [4]	<input type="checkbox"/> EXCELLENT [7]	<input type="checkbox"/> NONE [6]	<input type="checkbox"/> HIGH [3]	<input type="checkbox"/> SNAGGING
<input type="checkbox"/> MODERATE [3]	<input type="checkbox"/> GOOD [5]	<input type="checkbox"/> RECOVERED [4]	<input type="checkbox"/> MODERATE [2]	<input type="checkbox"/> IMPOUND.
<input type="checkbox"/> LOW [2]	<input type="checkbox"/> FAIR [3]	<input type="checkbox"/> RECOVERING [3]	<input type="checkbox"/> LOW [1]	<input type="checkbox"/> RELOCATION
<input type="checkbox"/> NONE [1]	<input type="checkbox"/> POOR [1]	<input type="checkbox"/> RECENT OR NO RECOVERY [1]		<input type="checkbox"/> CANOPY REMOVAL
				<input type="checkbox"/> LEVEED
				<input type="checkbox"/> DREDGING
				<input type="checkbox"/> BANK SHAPING
				<input type="checkbox"/> ONE SIDE CHANNEL MODIFICATIONS

COMMENTS: _____

4) RIPARIAN ZONE AND BANK EROSION - (check ONE box per bank or check 2 and AVERAGE per bank)

RIPARIAN:

River Right Looking Downstream

RIPARIAN WIDTH	EROSION/RUNOFF - FLOOD PLAIN QUALITY	BANK EROSION
L R (Per Bank)	L R (Most Predominant Per Bank)	L R (Per Bank)
<input type="checkbox"/> WIDE > 50m [4]	<input type="checkbox"/> FOREST, SWAMP [3]	<input type="checkbox"/> URBAN OR INDUSTRIAL [0]
<input type="checkbox"/> MODERATE 10-50 [3]	<input type="checkbox"/> OPEN PASTURE/ ROWCROP [0]	<input type="checkbox"/> SHRUB OR OLD FIELD [2]
<input type="checkbox"/> NARROW 5-10m [2]	<input type="checkbox"/> RESID., PARK, NEW FIELD [1]	<input type="checkbox"/> CONSERV. TILLAGE [1]
<input type="checkbox"/> VERY NARROW 1-5m [1]	<input type="checkbox"/> FENCED PASTURE [1]	<input type="checkbox"/> MINING/CONSTRUCTION [0]
<input type="checkbox"/> NONE [0]		

COMMENTS: _____

POOL/GLIDE AND RIFFLE/RUN QUALITY

POOL:

MAX. DEPTH (Check 1)	MORPHOLOGY (Check 1)	POOL/RUN/RIFFLE CURRENT VELOCITY (Check All That Apply)
<input type="checkbox"/> > 1m [6]	<input type="checkbox"/> POOL WIDTH > RIFFLE WIDTH [2]	<input type="checkbox"/> TORRENTIAL [-1]
<input type="checkbox"/> 0.7-1m [4]	<input type="checkbox"/> POOL WIDTH = RIFFLE WIDTH [1]	<input type="checkbox"/> FAST [1]
<input type="checkbox"/> 0.4-0.7m [2]	<input type="checkbox"/> POOL WIDTH < RIFFLE W. [0]	<input type="checkbox"/> MODERATE [1]
<input type="checkbox"/> < 0.4m [1]		<input type="checkbox"/> SLOW [1]
<input type="checkbox"/> < 0.2m [Pool = 0]		<input type="checkbox"/> EDDIES [1]
		<input type="checkbox"/> INTERSTITIAL [-1]
		<input type="checkbox"/> INTERMITTENT [-2]

COMMENTS: _____

RIFFLE:

RIFFLE/RUN DEPTH

RIFFLE/RUN SUBSTRATE

RIFFLE/RUN EMBEDDEDNESS

<input type="checkbox"/> GENERALLY > 10 cm, MAX > 50 [4]	<input type="checkbox"/> STABLE (e.g., Cobble, Boulder) [2]	<input type="checkbox"/> EXTENSIVE [-1]
<input type="checkbox"/> GENERALLY > 10 cm, MAX < 50 [3]	<input type="checkbox"/> MOD. STABLE (e.g., Pea Gravel) [1]	<input type="checkbox"/> MODERATE [0]
<input type="checkbox"/> GENERALLY 5-10 cm [1]	<input type="checkbox"/> UNSTABLE (Gravel, Sand) [0]	<input type="checkbox"/> LOW [1]
<input type="checkbox"/> GENERALLY < 5 cm [Riffle = 0]		<input type="checkbox"/> NONE [2]

COMMENTS: _____

GRADIENT:

6) Gradient (feet/mile): _____ %POOL: _____ %RIFFLE: _____ %RUN: _____

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Geographical Information

1) *Stream, River Mile (RM), Date* – The official stream name may be found in the Gazetteer of Ohio Streams (Ohio DNR, 1960) or on USGS 7.5 minute topographic maps. If the stream is unnamed, a name and stream code is assigned by the *Surface Water Section Database Coordinator*. Usually the name of a nearby landmark is used for the stream name. A basin-river code is also assigned from the FINS river code system. The River Mile (RM) designations used are found on 7.5 minute topo maps stored at the Ohio EPA, Office of Planning, 1800 WaterMark Drive (PEMSO RMI maps), one of five Ohio EPA District offices (maps for that district), and Ohio EPA, Division of Water Quality Monitoring Assessment laboratory at 1030 King Avenue.

2) Specific Location

A brief description of the sampling location should include proximity to a local landmark such as a bridge, road, discharge outfall, railroad crossing, park, tributary, dam, etc.

3) Field Sampling Crew

The field crew involved with the sampling is noted on the sheet with the person who filled out the sheet listed first. QHEI information is to be completed by the crew leader only.

4) Habitat Characteristics: QHEI Metrics

The **Qualitative Habitat Evaluation Index (QHEI)** is a physical habitat index designed to provide an empirical, quantified evaluation of the general lotic *macrohabitat* characteristics that are important to fish communities. A detailed analysis of the development and use of the QHEI is available in Rankin (1989). The QHEI is composed of six principal metrics each of which are described below. The maximum possible

QHEI site score is 100. Each of the metrics are scored individually and then summed to provide the total QHEI site score. This is completed at least once for each sampling site during each year of sampling. An exception to this convention would be when substantial changes to the macrohabitat have occurred between sampling passes. Standardized definitions for pool, run, and riffle habitats, for which a variety of existing definitions and perceptions exist, are essential for accurately using the QHEI. For consistency the following definitions are taken from Platts *et al.* (1983). It is recommended that this reference also be consulted prior to scoring individual sites.

Riffle and Run Habitats:

Riffle - areas of the stream with fast current velocity and shallow depth; the water surface is visibly broken.

Run - areas of the stream that have a rapid, non-turbulent flow; runs are deeper than riffles with a faster current velocity than pools and are generally located downstream from riffles where the stream narrows; the stream bed is often flat beneath a run and the water surface is not visibly broken.

Pool and Glide Habitats:

Pool⁵ - an area of the stream with slow current velocity and a depth greater than riffle and run areas; the stream bed is often concave and stream width frequently is the greatest; the water surface slope is nearly zero.

Glide - this is an area common to most modified stream channels that do not have distinguishable pool, run, and riffle habitats; the current and flow is similar to that of a canal; the water surface gradient is nearly zero.

The following is a description of each of the six QHEI

⁵If a pool or glide has a maximum depth of less than 20 cm, it is deemed to have lost its functionality and the metric is scored a 0.

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metrics and the individual metric components. Guidelines on how to score each is presented. Generally, metrics are scored by checking boxes. In certain cases the biologist completing the QHEI sheet may interpret a habitat characteristic as being intermediate between the possible choices; in cases where this is allowed (denoted by the term "**Double-Checking**") two boxes may be checked and their scores averaged.

Metric 1: Substrate

This metric includes two components, *substrate type* and *substrate quality*.

Substrate type

Check the two most common substrate types in the stream reach. If one substrate type predominates (greater than approximately 75-80% of the bottom area *OR* what is clearly the most *functionally* predominant substrate) then this substrate type should be checked twice. **DO NOT CHECK MORE THAN TWO BOXES.** Note the category for artificial substrates. Spaces are provided to note the presence (by check marks, or estimates of % if time allows) of *all* substrate types present in pools and riffles that each comprise at least 5% of the site (*i.e.*, they occur in sufficient quantity to support species that may commonly be associated with the habitat type). This section must be filled out completely to permit future analyses of this metric. If there are more than four substrate types in the zone that are present in greater than approximately 5% of the sampling area check the appropriate box.

Substrate quality

Substrate *origin* refers to the "parent" material that the stream substrate is derived from. Check **ONE** box under the substrate origin column *unless* the parent material is from multiple sources (*e.g.*, limestone and

tills). **Embeddedness** is the degree that cobble, gravel, and boulder substrates are surrounded, impacted in, or covered by fine materials (sand and silt). Substrates should be considered embedded if >50% of surface of the substrates are embedded in fine material. Embedded substrates cannot be easily dislodged. This also includes substrates that are concreted or "armour-plated". Naturally sandy streams are not considered embedded; however, a sand predominated stream that is the result of anthropogenic activities that have buried the natural coarse substrates is considered embedded. Boxes are checked for *extensiveness* (area of sampling zone) of the embedded substrates as follows: **Extensive** — > 75% of site area, **Moderate** — 50-75%, **Sparse** — 25-50%, **Low** — < 25%.

Silt Cover is the extent that substrates are covered by a silt layer (*i.e.*, more than 1 inch thickness). **Silt Heavy** means that nearly all of the stream bottom is layered with a deep covering of silt. **Moderate** includes extensive coverings of silts, but with some areas of cleaner substrate (*e.g.*, riffles). **Normal** silt cover includes areas where silt is deposited in small amounts along the stream margin *or* is present as a "dusting" that appears to have little functional significance. If substrates are exceptionally clean the **Silt Free** box should be checked.

Substrate types are defined as:

- a) *Bedrock* - solid rock forming a continuous surface.
- b) *Boulder* - rounded stones over 256 mm in diameter (10 in.) or large "slabs" more than 256 mm in length (*Boulder slabs*).
- c) *Cobble* - stones from 64-256 mm (2 1/2 - 10in.) in diameter.
- d) *Gravel* - mixture of rounded coarse material from 2-64 mm (1/12 - 2 1/2 in.) in diameter.
- e) *Sand* - materials 0.06 - 2.0 mm in diameter, gritty texture when rubbed between fingers.

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- f) *Silt* - 0.004 - 0.06 mm in diameter, generally this is fine material which feels "greasy" when rubbed between fingers.
- g) *Hardpan* - particles less than 0.004 mm in diameter, usually clay, which forms a dense, gummy surface that is difficult to penetrate.
- h) *Marl* - calcium carbonate; usually greyish-white; often contains fragments of mollusc shells.
- i) *Detritus* - dead, unconsolidated organic material covering the bottom which could include sticks, wood and other partially or undecayed coarse plant material.
- j) *Muck* - black, fine, flocculent, completely decomposed organic matter (*does not include* sewage sludge).
- k) *Artificial* - substrates such as rock baskets, gabions, bricks, trash, concrete etc., placed in the stream for reasons *OTHER* than habitat mitigation

Sludge is defined as a thick layer of organic matter, that is decidedly of human or animal origin. **NOTE: SLUDGE THAT ORIGINATES FROM POINT SOURCES IS NOT INCLUDED; THE SUBSTRATE SCORE IS BASED ON THE UNDERLYING MATERIAL.**

Substrate Metric Score:

Although the theoretical maximum metric score is > 20 the maximum score allowed for the QHEI is limited to **20 points**.

Metric 2: Instream Cover

This metric consists of *instream cover type* and *instream cover amount*. All of the cover types that are present in greater than approximately 5% of the sampling area (i.e., they occur in sufficient quantity to support species that may commonly be associated with

the habitat type) should be checked. Cover should not be counted when it is in areas of the stream with insufficient depth (usually < 20 cm) to make it useful. For example a logjam in 5 cm of water contributes very little if any cover, and at low flow may be dry. Other cover types with limited utility in shallow water include *undercut banks* and *overhanging vegetation, boulders, and rootwads*. Under *amount*, one or two boxes may be checked. *Extensive* cover is that which is present throughout the sampling area, generally greater than about 75% of the stream reach. Cover is *moderate* when it occurs over 25-75% of the sampling area. Cover is *sparse* when it is present in less than 25% of the stream margins (sparse cover usually exists in one or more isolated patches). Cover is *nearly absent* when no large patch of any type of cover exists anywhere in the sampling area. This situation is usually found in recently channelized streams or other highly modified reaches (e.g. ship channels). If cover is thought to be intermediate in amount between two categories, *check two boxes and average their scores*. Cover types include: 1) undercut banks, 2) overhanging vegetation, 3) shallows (in slow water), 4) logs or woody debris, 5) deep pools (> 70 cm), 6) oxbows, 7) boulders, 8) aquatic macrophytes, and 9) rootwads (tree roots that extend into stream). Do not check undercut banks AND rootwads unless undercut banks exist *along with* rootwads as a major component.

Cover Metric Score:

Although the theoretical maximum score is > 20 the maximum score assigned for the QHEI for the instream cover metric is limited to **20 points**

Metric 3: Channel Morphology

This metric emphasizes the quality of the stream channel that relates to the creation and stability of macrohabitat. It includes channel sinuosity (i.e. the

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degree to which the stream meanders), channel development, channelization, and channel stability. One box under each should be checked unless conditions are considered to be intermediate between two categories; in these cases *check two boxes and average their scores*.

a) *Sinuosity* - **No** sinuosity is a straight channel. **Low** sinuosity is a channel with only 1 or 2 poorly defined outside bends in a sampling reach, or perhaps slight meandering within modified banks. **Moderate** sinuosity is more than 2 outside bends, with at least one bend well defined. **High** sinuosity is more than 2 or 3 well defined outside bends with deep areas outside and shallow areas inside. Sinuosity may be more conceptually described by the ratio of the stream distance between two points on the channel of a stream and the straight-line distance between these same two points, taken from a topographic map. Check *only one* box.

b) *Development* - This refers to the development of riffle/pool complexes. **Poor** means *riffles* are absent, or if present, shallow with sand and fine gravel substrates; *pools*, if present are shallow. Glide habitats, if predominant, receive a **Poor** rating. **Fair** means riffles are poorly developed or absent; however, pools are more developed with greater variation in depth. **Good** means better defined riffles present with larger substrates (gravel, rubble or boulder); pools have variation in depth and there is a distinct transition between pools and riffles. **Excellent** means development is similar to the Good category except the following characteristics must be present: pools must have a maximum depth of >1m and deep riffles and runs (>0.5m) must also be present. In streams sampled with wading methods, a sequence of riffles, runs, and pools must occur more than once in a sampling zone. Check

one box.

c) *Channelization* - This refers to anthropogenic channel modifications. **Recovered** refers to streams that have been channelized in the past, but which have recovered most of their natural channel characteristics. **Recovering** refers to channelized streams which are still in the process of regaining their former, natural characteristics; however, these habitats are still degraded. This category also applies to those streams, especially in the Huron/Erie Lake Plain ecoregion (NW Ohio), that were channelized long ago and have a riparian border of mature trees, but still have **Poor** channel characteristics. **Recent** or **No Recovery** refers to streams that were recently channelized or those that show no significant recovery of habitats (*e.g.* drainage ditches, grass lined or rock rip-rap banks, etc.). The specific type of habitat modification is checked in the last two columns but not scored.

d) *Stability* - This refers to channel stability. Artificially stable (concrete) stream channels receive a **High** score. Even though they are generally a negative influence on fish the negative effects are related to features other than their stability. Channels with **Low** stability are usually characterized by fine substrates in riffles that often change location, have unstable and severely eroding banks, and a high bedload that slowly creeps downstream. Channels with **Moderate** stability are those that appear to maintain stable riffle/pool and channel characteristics, but which exhibit some symptoms of instability, *e.g.* high bedload, eroding or false banks, or show the effects of wide fluctuations in water level. Channels with **High** stability have stable banks and substrates, and little or no erosion and bedload.

e) *Modifications/Other* - Check the appropriate box if

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impounded, islands present, or leveed (these are not included in the QHEI scoring) as well as the appropriate source of habitat modifications.

The maximum QHEI metric score for Channel Morphology is **20 points**.

Metric 4: Riparian Zone and Bank Erosion

This metric emphasizes the quality of the riparian buffer zone and quality of the floodplain vegetation. This includes riparian zone width, floodplain quality, and extent of bank erosion. Each of the three components require scoring the left *and* right banks (looking downstream). The *average* of the left and right banks is taken to derive the component value. One box per bank should be checked unless conditions are considered to be intermediate between two categories; in these cases *check two boxes and average their scores*.

a) *Width of the Floodplain* - This is the width of the riparian (stream side) vegetation. Width estimates are only done for forest, shrub, swamp, and old field vegetation. Old field refers to the a fairly mature successional field that has stable, woody plant growth; this generally does not include weedy urban or industrial lots that often still have high runoff potential. Two boxes, one each for the left and right bank (looking downstream), should be checked and then averaged.

b) *Floodplain Quality* - The two most predominant floodplain quality types should be checked, one each for the left and right banks (includes urban, residential, etc.), and then averaged. By floodplain we mean the areas *immediately outside* of the riparian zone *or greater than 100 feet from the stream*, whichever is wider on each side of the stream. These are areas adjacent to the stream that can have direct runoff and erosional effects during normal wet weather. We do not

limit it to the riparian zone and it is much less encompassing than the stream basin.

c) *Bank Erosion* - The following Streambank Soil Alteration Ratings from Platts *et al.* (1983) should be used; check one box for each side of the stream and average the scores. False banks are used in the sense of Platts *et al.* (1983) to mean banks that are no longer adjacent to the normal flow of the channel but have been moved back into the floodplain most commonly as a result of livestock trampling.

- 1) **None** - streambanks are stable and not being altered by water flows or animals (e.g. livestock) - Score 3.
- 2) **Little** - streambanks are stable, but are being lightly altered along the transect line; less than 25% of the streambank is receiving any kind of stress, and if stress is being received it is very light; less than 25% of the streambank is false, broken down or eroding - Score 3.
- 3) **Moderate** - streambanks are receiving moderate alteration along the transect line; at least 50 percent of the streambank is in a natural stable condition; less than 50% of the streambank is false, broken down or eroding; false banks are rated as altered - Score 2.
- 4) **Heavy** - streambanks have received major alterations along the transect line; less than 50% of the streambank is in a stable condition; over 50% of the streambank is false, broken down, or eroding - Score 1.
- 5) **Severe** - streambanks along the transect line are severely altered; less than 25% of the streambank is in a stable condition; over 75% of the streambank is false, broken down, or eroding - Score 1.

The maximum score for Riparian Zone and Erosion metric is **10 points**.

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Metric 5: Pool/Glide and Riffle-Run Quality

This metric emphasizes the quality of the pool, glide and/or riffle-run habitats. This includes pool depth, overall diversity of current velocities (in pools and riffles), pool morphology, riffle-run depth, riffle-run substrate, and riffle-run substrate quality.

A) Pool/Glide Quality

1) *Maximum depth of pool or glide*; check one box only (Score 0 to 6). Pools or glides with maximum depths of less than 20 cm are considered to have lost their function and the total metric is scored a 0. No other characteristics need be scored in this case.

2) *Current Types* - check each current type that is present in the stream (including riffles and runs; score - 2 to 4), definitions are:

Torrential - extremely turbulent and fast flow with large standing waves; water surface is very broken with no definable, connected surface; usually limited to gorges and dam spillway tailwaters.

Fast - mostly non-turbulent flow with small standing waves in riffle-run areas; water surface may be partially broken, but there is a visibly connected surface.

Moderate - non-turbulent flow that is detectable and visible (i.e. floating objects are readily transported downstream); water surface is visibly connected.

Slow - water flow is perceptible, but very sluggish.

Eddies - small areas of circular current motion usually formed in pools immediately downstream from riffle-run areas.

Interstitial - water flow that is perceptible only in the

interstitial spaces between substrate particles in riffle-run areas.

Intermittent - no flow is evident anywhere leaving standing pools that are separated by dry areas.

4) *Morphology* - Check *Wide* if pools are wider than riffles, *Equal* if pools and riffles are the same width, and *Narrow* if the riffles are wider than the pools (Score 0 to 2). If the morphology varies throughout the site average the types. If the entire stream area (including areas outside of the sampling zone) is pool or riffle, then check riffle = pool.

Although the theoretical maximum score is > 12 the maximum score assigned for the QHEI for the Pool Quality metric is limited to 12 points.

B) Riffle-Run Quality

(score 0 for this metric if no riffles are present)

1) *Riffle/Run Depth* - select one box that most closely describes the depth characteristics of the riffle (Score 0 to 4). If the riffle is generally less than 5 cm in depth riffles are considered to have lost their function and the entire riffle metric is scored a 0.

2) *Riffle/Run Substrate Stability*—select one box from each that best describes the substrate type and stability of the riffle habitats (Score 0 to 2).

3) *Riffle/Run Embeddedness*—**Embeddedness** is the degree that cobble, gravel, and boulder substrates are surrounded or covered by fine material (sand, silt). We consider substrates embedded if >50% of surface of the substrates are embedded in fine material—these substrates cannot be easily dislodged. This also includes substrates that are concreted. Boxes are checked for *extensiveness* (riffle area of sampling

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zone) with embedded substrates: **Extensive** — > 75% of stream area, **Moderate** — 50-75%, **Sparse** — 25-50%, **Low** — < 25%.

The maximum score assigned for the QHEI for the Riffle/Run Quality metric is **8 points**.

Metric 6: Map Gradient

Local or map gradient is calculated from USGS 7.5 minute topographic maps by measuring the elevation drop through the sampling area. This is done by measuring the stream length between the first contour line upstream and the first contour line downstream of the sampling site and dividing the distance by the contour interval. If the contour lines are closely "packed" a minimum distance of at least one mile should be used. Some judgement may need to be exercised in certain anomalous areas (e.g. in the vicinity of waterfalls, impounded areas, etc.) and this can be compared to an in-field, visual estimate which is recorded on the back of the habitat sheet.

Scoring for ranges of stream gradient takes into account the varying influence of gradient with stream size, preferably measured as drainage area in square miles or stream width. Gradient classifications (Table V-4-3) were modified from Trautman (p 139, 1981) and scores were assigned, by stream size category, after examining scatterplots of IBI vs natural log of gradient in feet/mile. Scores are listed in Table V-4-3

The maximum QHEI metric score for Gradient is **10 points**.

Computing the Total QHEI Score:

To compute the total QHEI score, add the components of each metric to obtain the metric scores and then sum the metric scores to obtain the total QHEI score. The

QHEI metric scores cannot exceed the Metric Maximum Score indicated below.

QHEI SCORING (Maximum = 100)

QHEI Metric	Metric Component	Component Scoring Range	Metric Max. Score
1) Substrate	a) Type	0 to 2	2 0
	b) Quality	-5 to 3	
2) Instream Cover	a) Type	0 to 10	2 0
	b) Amount	1 to 11	
3) Channel Morphology	a) Sinuosity	1 to 4	2 0
	b) Development	1 to 7	
	c) Channelization	1 to 6	
	d) Stability	1 to 3	
4) Riparian Zone	a) Width	0 to 4	1 0
	b) Quality	0 to 3	
	c) Bank Erosion	1 to 3	
5a) Pool Quality	a) Max. Depth	0 to 6	1 2
	b) Current	-2 to 4	
	c) Morphology	0 to 2	
5b) Riffle Quality	a) Depth	0 to 4	8
	b) Substr Stab.	0 to 2	
	c) Substr Embd.	-1 to 2	
6) Gradient		2 to 15	10
TOTAL	Maximum Score		100

Additional Information

Additional information is recorded on the reverse side of the Site Description Sheet (Fig. V-4-6) and is described as follows:

- 1) *Additional Comments/Pollution Impacts* - Different types of pollution sources (e.g. wastewater treatment plant, feedlot, industrial discharge, nonpoint source

Table V-4-3. Classification of stream gradients for Ohio, corrected for stream size. Modified from Trautman (p 139, 1981). Scores were derived from plots of IBI versus the natural log of gradient for each stream size category.

Stream Width (m)	Average Drainage Area (sq mi)	Gradient (ft/mile)						
		Very Low	Low	Low-Moderate	Moderate	Moderate High	High	Very High ¹
0.3-4.7	0-9.2	0-1.0 2	1.1-5.0 4	5.1-10.0 6	10.1-15.0 8	15.1-20 10	20.1-30 10	30.1-40 8
4.8-9.2	9.2-41.6	0-1.0 2	1.1-3.0 4	3.1-6.0 6	6.1-12.0 10	12.1-18.0 10	18.0-30 8	30.1-40 6
9.2-13.8	41.6-103.7	0-1.0 2	1.1-2.5 4	2.6-5.0 6	5.1-7.5 8	7.6-12.0 10	12.1-20 8	20.1-30 6
13.9-30.6	103.7-622.9	0-1.0 4	1.1-2.0 6	2.1-4.0 8	4.1-6.0 10	6.1-10.0 10	10.1-15 8	15.1-25 6
>30.6	>622.9	-	0-0.5 6	0.6-1.0 8	1.1-2.5 10	2.6-4.0 10	4.1-9.0 10	>9.0 8

¹ Any site with a gradient > than the upper bound of the "very high" gradient classification is assigned a score of 4.

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Figure V-4-6. Reverse side of the Ohio EPA Site Description Sheet for evaluating the geographical and physical characteristics of fish sampling locations. This is used to record additional information about the sampling site and adjacent area.

Is Reach Representative of Stream? (Y/N) _____ If Not: _____
 Additional Comments/Pollution Impacts: _____

GEAR DISTANC WATER CLARITY WATER STAGE
 FIRST PASS _____ _____ _____ _____ SUBJECTIVE AESTHETIC
 SECOND PASS _____ _____ _____ _____ RATING RATING
 THIRD PASS _____ _____ _____ _____ (1-10) (1-10)
 CANOPY (%OPEN) _____ GRADIENT: 0-LOW 0-MODERATE 0-HIGH PHOTOS: _____

STREAM MEASUREMENTS: AVERAGE WIDTH: _____ AVERAGE DEPTH: _____ MAX DEPTH _____
 LENGTH WIDTH DEPTHS D POOL, GLD, RIF, RUN

LENGTH	WIDTH	DEPTHS D	POOL, GLD, RIF, RUN											

CROSS-SECTIONS OF STREAM

DRAWING OF STREAM

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inputs) are noted with their proximity (in 0.1 mile increments) to the sampling site; any evidence of litter either instream or on the stream bank is also noted.

2) *Sampling Gear/Distance Sampled* - The type of fish sampling gear used during each pass is specified (See Table V-4-1) and any variation in sampling procedures is noted (*e.g.*, sampler type A specifies sampling along one shoreline of 0.5 km, but due to local restrictions, sampling may be performed on both shorelines to accumulate 0.5 km); the total sampling distance in kilometers for each sampling site for each pass is recorded.

3) *Water Clarity* - The following descriptions can be used as a guide:

- a) Clear - bottom is clearly visible (if shallow enough) and the water contains no apparent color or staining.
- b) Stained - usually a brownish (or other) color to the water; the bottom may be visible in shallow areas.
- c) Turbid - bottom seldom visible at more than a few inches; caused by suspended sediment particles.

The apparent source of stained (*e.g.* tannic acid, leaf decay, etc.) and turbid (*e.g.* runoff [clay/silt], algae/diatoms, sewage, etc.) may be specified under additional comments.

4) *Water Stage* - This is the general water level of the stream during each pass; suggested descriptors are: a) flood, b) high, c) elevated, d) normal, e) low, and f) interstitial. (Note: sampling should not be conducted during flood or high flows).

5) *Canopy* - This is the percentage of the sampling site that is *not* covered or shaded by woody bank vegetation. In wide streams and rivers this determination should be made along both sides of the river or stream (*i.e.*, the percent of the sampling path that is open).

6) *Gradient* - Check the box that best describes the

gradient at the site. This will be used to check the accuracy of gradients taken from topographic maps.

7) *Field Crew* - The names of all individuals involved with the sampling/site description at each site are included.

8) *Photographs* - The number of each photograph taken is recorded; the subject of the photograph is briefly described.

9) *Stream Measurements (optional)* - When measuring the individual sampling sites, length, width, and average and maximum depth information should be recorded; each measurement should be recorded as either a riffle, run, or pool or glide by placing an X in the correct box to the right of where measurements are recorded (Figure V-4-6); see the introduction for definitions of riffles, runs, etc.

The number of width measurements is left to the discretion of the field crew leader. Short riffles may require only one or two width measurements while long pools will probably require more depending on the degree of variation that exists in the stream's width. Depth measurements should be made in association with individual width measurements. Depths should be taken at the stream margins and various points across the stream. Up to nine depth measurements may be taken depending on the variability in the stream bottom. Maximum depth is the deepest spot in the stream section sampled. One purpose of this information is to calculate pool volume.

10) *Stream Diagram - Cross-sections*: Two or three cross-sections of the stream are drawn to provide information on features of the stream bank, stream bottom, stream channel, and floodplain. A series of well defined stream channels (downstream view) are shown in Figure V-4-7. Definitions of these terms follow Platts *et al.* (1983):

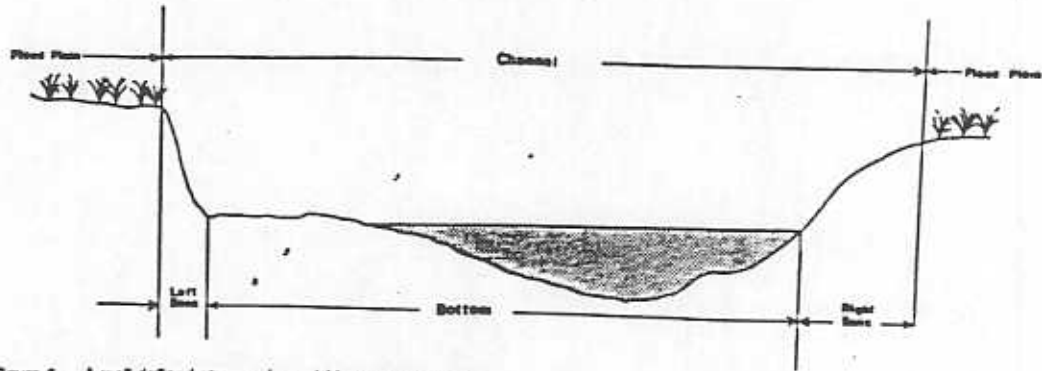


Figure 6. — A well-defined stream channel (downstream view).

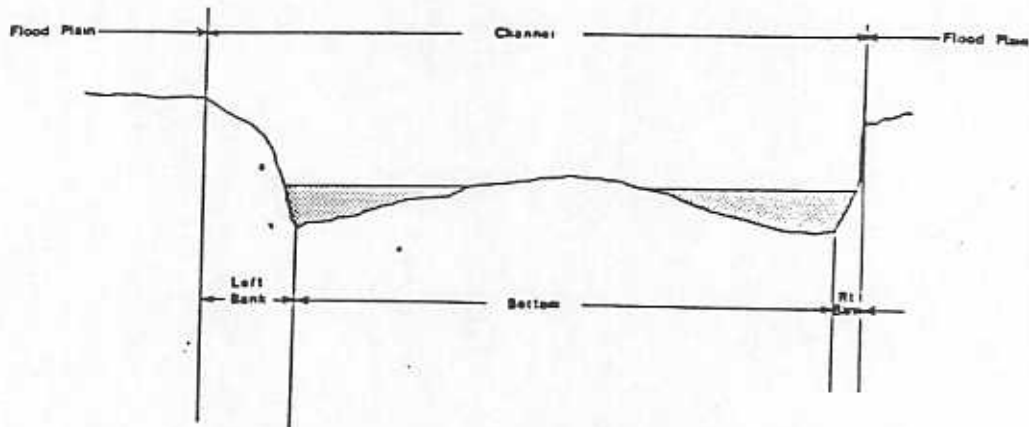


Figure 7. — A well-defined stream channel with concentrated low flows and exposed bottom (downstream view).

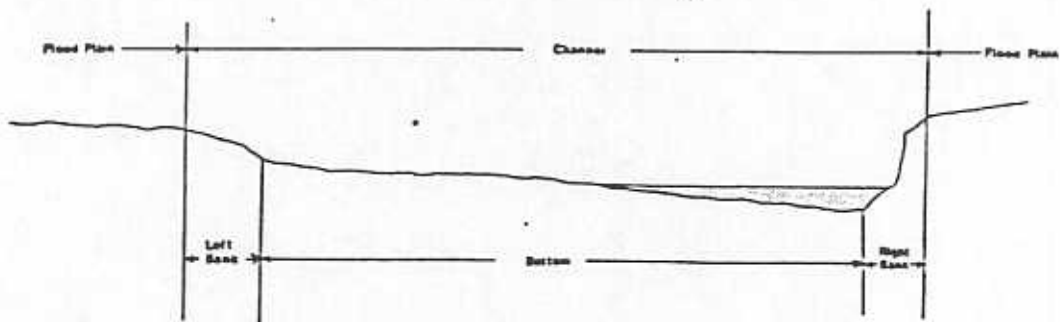


Figure 8. — Stream channel cross channel section on a bend in a stream.

Figure V-4-7. Three variations of a well defined stream channel (downstream view) (from Platts et al. 1983; Figs. 6-8).

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Channel - The cross-section containing the stream that is distinct from the surrounding area due to breaks in the general slope of the land, lack of terrestrial vegetation, and changes in the composition of the substrate materials. The channel is made up of streambanks and stream bottoms.

Banks - The portion of the channel cross-section that tends to restrict lateral movement of water. The banks often have a slope steeper than 45° and exhibit a distinct break in slope from the stream bottom. Also, an obvious change in substrate materials is a reliable delineation of the bank.

Stream bottom - The portion of the channel cross-section not classified as bank. The bottom is usually composed of stream sediments or water transported debris and may be covered by rooted or clinging aquatic vegetation. In some geologic formations, the stream bottom may consist of bedrock rather than sediments.

Flood plain - The area adjacent to the channel that is seasonally submerged under water. Usually the flood plain is a low area covered by various types of riparian vegetation.

Stream Map

The entire sampling zone is sketched in the area provided. Important physical features are noted on the map with standard symbols used where possible. The sampling path taken is described along with any other pertinent information

Part C): Laboratory Methods

1) Handling Preserved Materials

a) Preservation Techniques - Fish that are preserved for subsequent identification or for vouchers are immersed in a fixative solution as soon as possible after capture. This helps retain chromatophore patterns which aid in identification. The recommended fixative is a solution of

one part commercially prepared formalin and nine parts water with one teaspoon of borax added per 1/2 gallon of fixative. The borax acts as a buffer which neutralizes the acidic effect of the formalin, retarding shrinkage, preventing the hardening of soft body parts, and preventing decalcification of the tissues (Lagler *et al.* 1962). Temperatures greater than 80°F (26.7°C) necessitate a stronger solution of one part formalin to seven or eight parts water. Large fish or containers with closely packed fish also require stronger concentrations of formalin. Strong solutions of formalin can cause gaping or distortion of the mouth and gills, thus care should be taken to obtain correct concentrations when making up the solutions. Specimens more than a few inches long should be slit along the right side of the abdomen prior to preservation; fish heavier than 1 - 2 pounds should also be injected in the muscles on each side of the backbone. Fish normally remain in the formalin solution for at least 2-3 weeks to fix the tissues. Fish are then rinsed in clean water to wash off any excess formalin. The fish are allowed to drain for one-half hour. The fish are then placed in a 35% alcohol wash for 2-3 weeks, switched to a 50% alcohol wash for 2-3 weeks, and placed in a 70% aqueous solution of ethyl alcohol for permanent storage.

Preserving containers are labelled as soon as the fish are collected detailing essential aspects of the sample as completely as possible. Minimum information to be recorded is the stream or river name, location, date, river mile, and principal collector. This information may be written on the initial preserving container with a waterproof marker. If paper is used for making labels it should be 100% rag (which is waterproof) and labeled with India ink or a soft lead pencil.

b) Laboratory Identification and Verification - As discussed previously, fish are field identified by the field crew leader and *when the identification is certain*. However, if there is

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any uncertainty the fish are preserved and brought back to the laboratory for verification. In the Ohio EPA laboratory, keys available in Becker (1983), Clay (1975), Pflieger (1975), Scott and Crossman (1973), and Trautman (1957, 1981) are used to identify the preserved fish. Scientific nomenclature follows the recommendations of the American Fisheries Society (Robins *et al.* 1980).

Identifications are verified in-house by at least two trained, full-time Ohio EPA staff. Once taxonomic verification is made, the information is transferred to the fish data sheet for the respective location and either entered into or corrected in FINS. If there remains any question as to the identity of a specimen, it is taken to the Ohio State Museum of Zoology (OSUMZ) for identification by the Curator of Fishes.

c) *Disposition* - Ohio EPA maintains an up-to-date reference collection of Ohio and midwestern U.S. region fishes at the Ohio EPA Fish Laboratory. New species or unique specimens are added to the collection as they are encountered. Duplicate specimens are deposited in the OSUMZ where they are permanently catalogued.

2) Data Handling and Analysis

a) *Data sheets* - Fish data sheets (see example, Figure V-4-4) are completed in the following manner:

1) *Field Crew* - **Sampler** is the individual who actually nets the fish; **Recorder** is the individual who records the data; and **Driver** is the individual who either drives the field vehicle or assists with netting.

2) *Time* - military time sampling started and completed.

3) *River/Stream* - major river or stream being sampled.

4) *Location* - location described as adjacent to, upstream or downstream from a notable landmark.

5) *Date* - month/date/year.

6) *River Code* - assigned number found in FINS RIVLST printout, originally derived from Ohio Gazetteer of Streams

(NOTE: contact Central Office Data Coordinator for unnamed or unlisted stream codes).

7) *River Mile* - river mile (from the middle of the electrofishing zone) to the nearest 0.1 mile determined by inspection of PEMS0 river mile index maps.

8) *Distance* - electrofishing distance in kilometers to the nearest 0.01 km.

9) *Sampler Type* - sampler type letter code should be noted here (letter codes can be found in Table V-4-1).

10) *Depth* - average depth for the sampling zone to the nearest 10 cm, determined by measuring at 10 random locations with marked depth poles.

11) *Data Source* - two digit code designating the group responsible for data collection, *i.e.* Central Office, Southwest District Office, etc. (NOTE: contact Central Office for Data Source codes).

12) *Time Fished* - actual time devoted to sampling fish in seconds.

13) *Number of Species* - number of species of fish captured during each sampling (hybrids and exotics are not included and should be indicated separately).

14) *Species Codes* - each species and any hybrids are recorded by a family-species code following the system presented in Table V-4-5 (located at the end of Subsection 4). External anomalies if any, are recorded, for each species according to guidance stated previously.

Additional information that can be entered into FINS includes purpose of the data, latitude and longitude, site drainage area (sq. mi.), local gradient, sample designation, flow, temperature (°C), and dissolved oxygen (mg/l) (Figure V-4-7).

b) Data Storage and Compilation

All completed fish data sheets are logged by the field crew leaders to prevent loss and assure that all sites are sampled according to the plan of study. The data sheets are filed

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according to survey, river mile, and date, in that order, at the Ohio EPA Fish Laboratory. The Fish Evaluation Group Leader then logs the data sheets onto master tracking sheets kept at the Ohio EPA Fish Laboratory. Data is then entered into the Fish Information System (FINS) which was developed by Ohio EPA for the purpose of storing and analyzing fish relative abundance data. Data are entered in the format presented in Figure V-4-7. Each data entry is then logged by basin-river code, date of entry, river mile, and date of sampling by the Surface Water Section Data Coordinator. Both the fish data sheet and log book are then initialed by the data entry operator. The data sheets are then assembled in a notebook along with site description sheets, maps of the sampling sites and the preliminary study plans. This is then filed for future reference at the Ohio EPA Fish Laboratory. Any subsequent changes that are made to the fish data sheets are initialed and dated. After all data for a survey have been entered into FINS the entered data are proofread by the field crew leader for accuracy. All corrections or updates are then entered into FINS. Occasionally data from a sampling run may be considered invalid for calculating IBI and modified lwb scores (*e.g.* due to elevated water levels during sampling, etc.). Although these data are entered into FINS they are designated as invalid samples for calculating community evaluation indices.

c) Analytical Methods

Relative abundance data are analyzed for both community (all species included) and population (single species) parameters. FINS is designed to perform a wide array of analyses. Presently, summarized data from FINS is downloaded to a Sperry PC/IT microcomputer for further detailed analyses. Relative abundance is expressed in terms of numbers/unit distance (or time for passive gear) and weight (kg)/unit distance (or time for passive gear). Community analyses include the number of species per

sample, cumulative species per sampling location, Shannon indices (H) based on numbers and weight, the modified Index of Well-Being (lwb), and the Index of Biotic Integrity modified for application to Ohio waters and Ohio EPA sampling methods. The specific details of how these indices and evaluations are derived is described in the "Users Manual for Biological Field Evaluation of Ohio Surface Waters" (Ohio EPA 1987).

Table V-4-4. Family-species codes used by Ohio EPA fish field crews to code fish data sheets and for data entry into the Fish Information System (FINS).

FISH INFORMATION SYSTEM (FINS) FAMILY CODES

Family	Code
Petromyzonidae	01
Polyodontidae	04
Acipenseridae	08
Lepisosteidae	10
Amiidae	15
Hiodontidae	18
Clupeidae	20
Salmonidae	25
Osmeridae	30
Umbridae	34
Esocidae	37
Catostomidae	40
Cyprinidae	43
Ictaluridae	47
Anguillidae	50
Cyprinodontidae	54
Poeciliidae	57
Gadidae	60
Percopsidae	63
Aphredoderidae	68
Atherinidae	70
Percichthyidae	74
Centrarchidae	77
Percidae	80
Sciaenidae	85
Cottidae	90
Gasterosteidae	95

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Figure V-4-8. Data entry format used to enter raw fish relative abundance into the Fish Information System (FINS). The example below is data collected on September 9, 1984 in the Scioto R. at river mile 125.6. Species 43-001 includes 34 individuals from which a subsample of 15 were individually weighed. Species 43-043 includes 356 individuals of which a subsample of 54 individuals were collectively or "mass" weighed. Anomalies were recorded from the weighed subsample only.

DATE	09/09/84	DEPTH (CM)	120	PURPOSE	01	INVALID SAMPLE	N
RIV CODE	02-001	DATA SOURCE	01	LATITUDE	39 54 03	DESIGNATION	01
RIV MILE	125.6	STREAM ORDER	6	LONGITUDE	83 00 01	FLOW CFS	345
DISTANCE	0.5	TIME (SEC)	1587	DRAIN. AREA	4500	TEMPERATURE	26.8
SAMPLER TYPE	A	OBSERVED FLOW	C	GRADIENT	4.5	DISS. OXYGEN	5.8

NUMBER OF SPECIES 12 ANOMALIES (Y or N?) Y

FAMILY-SPECIES CODE 43-001-C NUMBER WEIGHED 15 TOTAL COUNT 34
 WEIGHT (GRAMS) ANOMALIES

<u>2350</u>	<u>4550</u>	<u>3450</u>	<u>2000</u>	<u>1225</u>	<u>A</u>	<u>L</u>	<u>P</u>	___	___	___
<u>985</u>	<u>634</u>	<u>5800</u>	<u>1250</u>	<u>1300</u>	<u>2</u>	<u>4</u>	<u>1</u>	___	___	___
<u>2300</u>	<u>3400</u>	<u>230</u>	<u>3250</u>	<u>5700</u>				___	___	___

FAMILY-SPECIES CODE 43-043-C NUMBER WEIGHED 54 TOTAL COUNT 356
 WEIGHT (GRAMS) ANOMALIES

<u>2345</u>	<u>BL</u>	<u>E</u>	___	___	___	___
	12	3	___	___	___	___

(additional weight and anomalies spaces would follow for the remaining 10 species)

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Table V-4-5. Family-species codes used by Ohio EPA fish field crews to code fish data sheets and for data entry into the Fish Information System (FINS). Designation of Ohio fish species for the purposes of the Index of Biotic Integrity, the Modified Index of Well-Being (Iwb), and the Fish Information System (FINS). Explanation of column headings appears at the end of the table.

FINS Code	Species	Spc Grp	Feed Guild	TOL	IBI Grp	Riv Size	Brd Gld	Hab Pref	Family
01001	Silver lamprey	0	P	-	-	L	N	B	Petromyzontidae
01002	Northern brook lamprey	0	F	R	-	-	N	P	Petromyzontidae
01003	Ohio lamprey	0	P	S	-	-	N	B	Petromyzontidae
01004	Mountain brook lamprey	0	F	S	-	-	N	P	Petromyzontidae
01005	Sea lamprey	0	P	-	E	-	N	B	Petromyzontidae
01006	Least brook lamprey	0	F	-	-	H	N	P	Petromyzontidae
01007	American brook lamprey	0	F	R	-	H	N	P	Petromyzontidae
04001	Paddlefish	0	F	S	-	L	S	B	Polyodontidae
08001	Lake sturgeon	0	V	-	-	L	S	B	Acipenseridae
08002	Shovelnose sturgeon	0	I	-	-	L	S	P	Acipenseridae
10001	Alligator gar	L	P	-	-	L	M	P	Lepisosteidae
10002	Shortnose gar	L	P	-	-	L	M	P	Lepisosteidae
10003	Spotted gar	L	P	-	-	L	M	P	Lepisosteidae
10004	Longnose gar	L	P	-	-	L	M	P	Lepisosteidae
15001	Bowfin	O	P	-	-	-	C	P	Amiidae
18001	Goldeye	W	I	R	-	L	M	B	Hiodontidae
18002	Mooneye	W	I	R	-	L	M	B	Hiodontidae
20001	Skipjack herring	W	P	-	-	L	M	B	Clupeidae
20002	Alewife	O	-	-	E	-	M	P	Clupeidae
20003	Gizzard shad	GS	O	-	-	-	M	P	Clupeidae
20004	Threadfin shad	GS	O	-	-	L	M	P	Clupeidae
25001	Brown trout	SA	-	-	E	-	N	B	Salmonidae
25002	Rainbow trout	SA	-	-	E	-	N	B	Salmonidae
25003	Brook trout	SA	-	-	-	-	N	B	Salmonidae
25004	Lake trout	SA	P	-	F	-	N	P	Salmonidae
25005	Coho salmon	SA	-	-	E	-	N	P	Salmonidae
25006	Chinook salmon	SA	-	-	E	-	N	P	Salmonidae
25007	Cisco or Lake Herring	WF	-	-	-	-	M	P	Salmonidae
25008	Lake whitefish	WF	V	-	-	-	M	P	Salmonidae
30001	Rainbow smelt	0	-	-	-	-	M	P	Osmeridae
34001	Central mudminnow	T	I	T	-	-	C	P	Umbridae
37001	Grass pickerel	P	P	P	-	-	M	P	Esocidae
37002	Chain pickerel	P	P	-	F	-	M	P	Esocidae
37003	Northern pike	P	P	-	F	-	M	P	Esocidae
37004	Muskellunge	P	P	-	F	-	M	P	Esocidae
37005	N. Pike x Muskellunge	P	P	-	E	-	-	-	Esocidae
37006	Grass P. x Chain	P.	P	P.	F	-	-	-	Esocidae
40001	Blue sucker	R	I	R	R	L	S	R	Catostomidae
40002	Bigmouth buffalo	C	I	-	C	L	M	P	Catostomidae
40003	Black buffalo	C	I	-	C	L	M	P	Catostomidae
40004	Smallmouth buffalo	C	I	-	C	L	M	P	Catostomidae
40005	Quillback	C	O	-	C	-	M	P	Catostomidae
40006	River carpsucker	C	O	-	C	L	M	P	Catostomidae

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Table V-4-5. Continued

FINS Code	Species	Spc Grp	Feed Guild	TOL	IBI Grp	Riv Size	Brd Gld	Hab Pref	Family
40007	Highfin carpsucker	C	O	-	C	L	M	P	Catostomidae
40008	Silver redhorse	R	I	M	R	-	S	P	Catostomidae
40009	Black redhorse	R	I	I	R	-	S	P	Catostomidae
40010	Golden redhorse	R	I	M	R	-	S	P	Catostomidae
40011	Shorthead redhorse	R	I	M	R	-	S	P	Catostomidae
40012	Greater redhorse	R	I	R	R	-	S	P	Catostomidae
40013	River redhorse	R	I	I	R	-	S	P	Catostomidae
40014	Harelip sucker	R	-	S	R	-	S	P	Catostomidae
40015	Northern hog sucker	R	I	M	R	-	S	R	Catostomidae
40016	White sucker	R	O	T	W	-	S	B	Catostomidae
40017	Longnose sucker	R	I	-	R	-	S	P	Catostomidae
40018	Spotted sucker	R	I	-	R	-	S	P	Catostomidae
40019	Lake chubsucker	R	I	-	R	-	M	P	Catostomidae
40020	Creek chubsucker	R	I	-	R	P	M	P	Catostomidae
43001	Common carp	G	O	T	G	-	M	P	Cyprinidae
43002	Goldfish	G	O	T	G	-	M	P	Cyprinidae
43003	Golden shiner	N	I	T	N	-	M	P	Cyprinidae
43004	Hornyhead chub	M	I	I	N	-	N	B	Cyprinidae
43005	River chub	M	I	I	N	-	N	B	Cyprinidae
43006	Silver chub	M	I	-	N	L	M	P	Cyprinidae
43007	Bigeye chub	M	I	I	N	-	S	R	Cyprinidae
43008	Streamline chub	M	I	R	N	L	S	R	Cyprinidae
43009	Gravel chub	M	I	M	N	L	S	R	Cyprinidae
43010	Speckled chub	M	I	S	N	L	M	R	Cyprinidae
43011	Blacknose dace	M	G	T	N	H	S	R	Cyprinidae
43012	Longnose dace	M	I	R	N	-	S	R	Cyprinidae
43013	Creek chub	M	G	T	N	P	N	B	Cyprinidae
43014	Tonguetied minnow	M	I	S	N	-	N	P	Cyprinidae
43015	Suckermouth minnow	M	I	-	N	-	S	R	Cyprinidae
43016	Southern redbelly dace	M	H	-	N	H	S	B	Cyprinidae
43017	Redside dace	M	I	I	N	H	S	P	Cyprinidae
43018	Rosyside dace	M	I	S	N	H	S	P	Cyprinidae
43019	Pugnose minnow	N	I	R	N	-	M	P	Cyprinidae
43020	Emerald shiner	N	I	-	N	-	S	P	Cyprinidae
43021	Silver shiner	N	I	I	N	-	S	P	Cyprinidae
43022	Rosyface shiner	N	I	I	N	-	S	R	Cyprinidae
43023	Redfin shiner	N	I	-	N	-	N	P	Cyprinidae
43024	Rosefin shiner	N	I	M	N	-	S	P	Cyprinidae
43025	Striped shiner	N	I	-	N	-	S	B	Cyprinidae
43026	Common shiner	N	I	-	N	-	S	P	Cyprinidae
43027	River shiner	N	I	-	N	L	S	P	Cyprinidae
43028	Spottail shiner	N	I	P	N	L	M	P	Cyprinidae
43029	Blackchin shiner	N	I	S	N	-	M	P	Cyprinidae
43030	Bigeye shiner	N	I	R	N	-	S	B	Cyprinidae
43031	Steelcolor shiner	N	I	P	N	-	M	P	Cyprinidae
43032	Spotfin shiner	N	I	-	N	-	M	B	Cyprinidae

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Table V-4-5. Continued

FINS Code	Species	Spc Grp	Feed Guild	TOL	IBI Grp	Riv Size	Brd Gld	Hab Pref	Family
43033	Bigmouth shiner	N	I	-	N	-	M	B	Cyprinidae
43034	Sand shiner	N	I	M	N	-	M	B	Cyprinidae
43035	Mimic shiner	N	I	I	N	-	M	B	Cyprinidae
43036	Ghost shiner	N	I	-	N	L	M	P	Cyprinidae
43037	Blacknose shiner	N	I	R	N	-	M	P	Cyprinidae
43038	Pugnose shiner	N	I	S	N	-	M	P	Cyprinidae
43039	Silverjaw minnow	M	I	-	N	P	M	B	Cyprinidae
43040	Mississippi silvery minnow	M	H	-	N	-	M	P	Cyprinidae
43041	Bullhead minnow	N	O	-	N	-	C	P	Cyprinidae
43042	Fathead minnow	M	O	T	N	P	C	B	Cyprinidae
43043	Bluntnose minnow	M	O	T	N	P	C	B	Cyprinidae
43044	Central stoneroller	M	H	-	N	-	N	B	Cyprinidae
43045	Common carp x Goldfish	G	O	T	G	-	-	-	Cyprinidae
43046	Popeye shiner	N	I	S	N	-	S	P	Cyprinidae
43047	Grass carp	G	-	-	E	-	M	B	Cyprinidae
43048	Red shiner	N	I	-	E	-	N	P	Cyprinidae
43049	Common x Rosyface Shiner	N	I	-	-	-	-	-	Cyprinidae
43057	Striped shiner/Stoneroller	M	-	-	-	-	-	-	Cyprinidae
43058	Common shiner/Stoneroller	M	-	-	-	-	-	-	Cyprinidae
43059	Striped shiner/Horny chub	M	I	-	-	-	-	-	Cyprinidae
43999	Hybrid Minnow	M	-	-	-	-	-	-	Cyprinidae
47001	Blue catfish	F	C	-	F	L	C	P	Ictaluridae
47002	Channel catfish	F	-	-	F	-	C	P	Ictaluridae
47003	White catfish	F	I	-	E	-	C	P	Ictaluridae
47004	Yellow bullhead	F	I	T	-	-	C	P	Ictaluridae
47005	Brown bullhead	F	I	T	-	-	C	P	Ictaluridae
47006	Black bullhead	F	I	P	-	-	C	P	Ictaluridae
47007	Flathead catfish	F	P	-	F	L	C	B	Ictaluridae
47008	Stonecat	O	I	I	-	-	C	R	Ictaluridae
47009	Mountain madtom	O	I	R	-	-	C	R	Ictaluridae
47010	Northern madtom	O	I	R	-	-	C	R	Ictaluridae
47011	Scioto madtom	O	I	S	-	-	C	R	Ictaluridae
47012	Brindled madtom	O	I	I	-	-	C	B	Ictaluridae
47013	Tadpole madtom	O	I	-	-	-	C	B	Ictaluridae
50001	American eel	O	C	-	-	-	M	P	Anguillidae
54000	Western Banded killifish	T	I	S	-	-	M	P	Cyprinodontidae
54001	Eastern Banded killifish	T	I	T	E	-	M	P	Cyprinodontidae
54002	Blackstripe topminnow	T	I	-	-	-	M	P	Cyprinodontidae
57001	Mosquitofish	O	I	-	E	-	N	P	Poeciliidae
60001	Burbot	O	-	-	-	-	S	B	Gadidae
63001	Trout-perch	O	I	-	-	-	M	P	Percopsidae
68001	Pirate perch	O	I	-	-	-	M	P	Aphredoderidae
70001	Brook silverside	O	I	M	-	-	M	P	Atherinidae
74001	White bass	W	P	-	F	L	M	P	Percichthyidae
74002	Striped bass	W	P	-	E	-	M	P	Percichthyidae
74003	White perch	W	-	-	E	-	M	P	Percichthyidae

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Table V-4-5. Continued

FINS Code	Species	Spc Grp	Feed Guild	TOL	IBI Grp	Riv Size	Brd Gld	Hab Pref	Family
74004	White bass x White perch	W	-	-	-	-	-	-	Percichthyidae
74005	Striped bass x White bass	W	-	-	E	-	-	-	Percichthyidae
77001	White crappie	B	-	-	S	-	C	P	Centrarchidae
77002	Black crappie	B	-	-	S	-	C	P	Centrarchidae
77003	Rock bass	B	C	-	S	-	C	P	Centrarchidae
77004	Smallmouth bass	B	C	M	F	-	C	P	Centrarchidae
77005	Spotted bass	B	C	-	F	-	C	P	Centrarchidae
77006	Largemouth bass	B	C	-	F	-	C	P	Centrarchidae
77007	Warmouth	S	C	-	S	-	C	P	Centrarchidae
77008	Green sunfish	S	I	T	S	P	C	P	Centrarchidae
77009	Bluegill	S	I	P	S	-	C	P	Centrarchidae
77010	Orangespotted sunfish	S	I	-	S	-	C	P	Centrarchidae
77011	Longear sunfish	S	I	M	S	-	C	P	Centrarchidae
77012	Redear sunfish	S	I	-	E	-	C	P	Centrarchidae
77013	Pumpkinseed	S	I	P	S	-	C	P	Centrarchidae
77014	Bluegill x Pumpkinseed	S	-	-	-	-	-	-	Centrarchidae
77015	Green x Bluegill	S	-	-	-	-	-	-	Centrarchidae
77016	Green x Pumpkinseed	S	-	-	-	-	-	-	Centrarchidae
77017	Longear x Bluegill	S	-	-	-	-	-	-	Centrarchidae
77018	Bluegill x Orangespotted	S	-	-	-	-	-	-	Centrarchidae
77019	Green x Orangespotted	S	-	-	-	-	-	-	Centrarchidae
77020	Pumpkinseed x Longear	S	-	-	-	-	-	-	Centrarchidae
77021	Green x Longear	S	-	-	-	-	-	-	Centrarchidae
77022	O'spotted x Pumpkinseed	S	-	-	-	-	-	-	Centrarchidae
77023	Longear x Orangespotted	S	-	-	-	-	-	-	Centrarchidae
77024	Green x Warmouth	S	-	-	-	-	-	-	Centrarchidae
77025	Warmouth x Pumpkinseed	S	-	-	-	-	-	-	Centrarchidae
77998	Green Sunfish Hybrid	S	-	-	-	-	-	-	Centrarchidae
77999	Hybrid Sunfish	S	-	-	-	-	-	-	Centrarchidae
80001	Sauger	V	P	-	F	L	S	P	Percidae
80002	Walleye	V	P	-	F	-	S	P	Percidae
80003	Yellow perch	V	-	-	-	-	M	P	Percidae
80004	Dusky darter	D	I	M	D	-	S	B	Percidae
80005	Blackside darter	D	I	-	D	-	S	B	Percidae
80006	Longhead darter	D	I	S	D	-	S	R	Percidae
80007	Slenderhead darter	D	I	R	D	L	S	R	Percidae
80008	River darter	D	I	-	D	L	S	R	Percidae
80009	Channel darter	D	I	S	D	-	S	P	Percidae
80010	Gilt darter	D	I	S	D	-	S	B	Percidae
80011	Logperch	D	I	M	D	-	S	B	Percidae
80012	Crystal darter	D	I	S	D	-	S	R	Percidae
80013	Eastern sand darter	D	I	R	D	-	S	R	Percidae
80014	Johnny darter	D	I	-	D	P	C	B	Percidae
80015	Greenside darter	D	I	M	D	-	S	R	Percidae
80016	Banded darter	D	I	I	D	-	S	R	Percidae
80017	Variagate darter	D	I	I	D	-	S	R	Percidae

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FINS Code	Species	Spc Grp	Feed Guild	TOL	IBI Grp	Riv Size	Brd Gld	Hab Pref	Family
80018	Spotted darter	D	I	R	D	-	S	R	Percidae
80019	Bluebreast darter	D	I	R	D	-	S	R	Percidae
80020	Tippecanoe darter	D	I	R	D	-	S	R	Percidae
80021	Iowa darter	D	I	-	D	-	M	P	Percidae
80022	Rainbow darter	D	I	M	D	-	S	R	Percidae
80023	Orangethroat darter	D	I	-	D	P	S	B	Percidae
80024	Fantail darter	D	I	-	D	H	C	R	Percidae
80025	Least darter	D	I	-	D	-	N	B	Percidae
80026	Sauger x Walleye	V	P	-	E	-	-	-	Percidae
85001	Freshwater drum	F	-	P	-	L	M	P	Sciaenidae
90001	Spoonhead sculpin	SC	-	-	-	-	C	P	Cottidae
90002	Mottled sculpin	SC	I	-	-	H	C	R	Cottidae
90003	Slimy sculpin	SC	-	-	-	-	-	-	Cottidae
90004	Deepwater sculpin	SC	-	-	-	-	-	-	Cottidae
95001	Brookstickleback	O	I	-	-	H	C	P	Gasterosteidae

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Table V-4-5, Continued

SPCLST - Legend for Species Designations

The following letter symbol designations are used to classify Ohio fish species according to their taxonomic, functional, structural, pollution tolerance, and ecological characteristics. These designations provide the basis for the Fish Information System (FINS) to calculate metrics for the Index of Biotic Integrity (FINIBI) and the Modified Index of Well-Being (FINLS2) as well as other uses.

<u>SPC GRP (Species Group)^a</u>	<u>FEED GUILD (Feeding Guild)^b</u>	<u>IBI GRP (IBI Group)^b</u>
O - Other	P - Piscivore	E - Exotic (non-native)
L - Gars	F - Filter Feeder	F - Sport Species
W - Large River Species	V - Invertivore	R - Round-bodied Sucker
GS - Gizzard Shad	I - Specialist Insectivore	C - Deep-bodied Sucker
SA - Salmonid	O - Omnivore	W - White sucker
WF - Whitefish	G - Generalist	G - Carp/Goldfish
T - Tolerant	H - Herbivore	N - Other Cyprinidae
P - Pickerels	C - Carnivore	S - Sunfish (less Blackbasses)
R - Round-bodied Suckers		D - Darters
C - Deep-bodied Suckers		
G - Carp/Goldfish	<u>TOL (Pollution Tolerance)</u>	<u>RIV SIZ (River Size)</u>
N - Shiners	R - Rare Intolerant	L - Large River Species
M - Minnows	S - Special Intolerant	H - Headwaters Species
F - Catfish, Drum	I - Common Intolerant	P - Pioneering Species
B - Blackbass, Crappie	M - Moderately Intolerant	
S - Sunfish	T - Highly Tolerant	
V - Non-darter Percidae	P - Moderately Tolerant	
D - Darters		
SC - Sculpins	<u>BRD GLD (Breeding Guild)^c</u>	<u>HAB PRF (Habitat Pref.)^c</u>
	N - Complex, no parental care	P - prefers pools
	C - Complex with parental care	R - prefers riffles
	M - simple, miscellaneous	B - prefers both
	S - simple lithophils	

^athese designations are not for use in any FINS analytical programs.

^bdesignations are patterned after Karr et al. (1986).

^cdesignations are patterned after Berkman and Rabeni (1987).

Procedure No. WQPA-SWS-3
 Revision No. 6

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Appendix F:

Sediment and Surface Water Sample Collection SOP

COLLECTION OF STREAM WATER SAMPLES

These methods allow for the collection of grab samples utilizing a high density polyethylene (HDPE) bucket or wide mouth HDPE or glass bottle. This standard operating procedure document (SOP) has been developed to maintain consistent data collection procedures and to ensure the quality of the data collected.

1.0 FIELD EQUIPMENT

The following equipment listed is necessary for sampling procedures.

1. 1-gallon HDPE bucket, nylon rope
2. Distilled or reagent-grade deionized water
3. Sample bottles (provided by Suburban Laboratories, Inc.):
 - a. Two 1000 mL HDPE unpreserved bottle for TSS, VSS, Turbidity Chloride, Sulfate, and Dissolved Orthophosphate
 - b. Two 40 mL amber glass vials with H₂SO₄ preservative for TOC
 - c. One 500 mL HDPE bottle with HNO₃ preservative for Metals (including Phosphorous and Total Hardness)
 - d. One 250 mL glass bottle with BrCl preservative for Hg (Method 1631)
 - e. One 1000 mL HDPE with H₂SO₄ preservative for NH₃-N, TKN and Total Nitrates
 - f. One 120 mL HPDE bottle with Sodium thiosulfate (Na₂S₂O₃) preservative for E. coli
 - g. Two 1000 mL amber glass bottles unpreserved for Pesticides, PCBs and PNAs
 - h. Three 40 mL VOA vials with HCl preservative for VOCs
4. Disposable gloves
5. Cooler and ice
6. Antibacterial soap
7. Sharpie markers and labels
8. Field books/log sheets/chain of custody

9. YSI 556 Multiparameter sonde field meter for pH, temperature, DO, and conductivity
10. Sampling pole

2.0 PREPARATION

The YSI Multiparameter sonde will be calibrated for pH, DO and conductivity each day, prior to sampling using known standards for calibration and calibration checks. The pH will be calibrated using buffers 4, 7 and 10 and the calibration will be checked using the 7 buffer. The DO will be calibrated according to specifications in the user manual. The conductivity will be calibrated using the known standard of 1.412 umhos/cm.

Before samples are collected, sample bottles should be labeled correctly with sampling point, sampling I.D. number, the sampler's initials, and a space for the date and time to be filled in later. Sample bottle lids should also be labeled to prevent contamination between samples.

Coolers and samples bottles should be inspected before samples are collected. If dirt, residual chemicals, or any other types of contaminants are present, the sample bottle should be discarded. The coolers should be washed with mild soap and wiped down if any contaminants are present.

Sampling buckets shall be scrubbed with a solution of soap and water. Make sure the cleaning detergent is free of phosphates (orthophosphate sample).

The sampler's hands should be washed with antibacterial soap prior to sampling events. Disposable gloves will be worn during sample collection, and special care should be taken to avoid touching the inner surface of sample lids or bottles.

3.0 PROCEDURE

Sample bottles should be kept closed until they are filled. At each sample collection site, the sampler will wear a new pair of gloves for decontamination and a new pair for sample collection.

If samples are taken from a bridge, collect the sample from the upstream side of the structure unless otherwise noted in site description maps.

When sample during precipitation events, the sample bucket shall be covered at all times with a lid.

A log-sheet/chain of custody should be maintained during sampling and should include the following information:

- a. Date and time of sample
- b. Signature of collector and transporter
- c. Signature of person who relinquished the sample to lab
- d. Weather conditions during sampling (i.e., air temperature; cloudy, rain, snow)
- e. Time
- f. Sample storage temperature upon receipt in lab
- g. Visual observation of sample
- h. Field measurements (pH, temperature, DO and conductivity)

3.1 Sample Collection HDPE Bucket or Wide Mouth Bottle

The bucket shall be inspected to ensure that it is in good condition. The nylon rope attached should not be frayed or torn.

3.1.1 Decontamination

The bucket and wide mouth bottle must be cleaned before samples are collected and between sampling sites. The equipment shall be cleaned with phosphate-free detergent and blank water. Blank water should be deionized water. The equipment should be scrubbed with detergent and deionized water before the rinsing steps below are followed. Alternatively, a new bottle may be used for each sample.

Step 1 – Blank Water Rinse

- Rinse the inside of the bucket or wide mouth bottle by swirling with blank water.
- Discard the remaining blank water.
- Repeat Step 1.

3.2 Sample Collection Procedure

The stream depth will determine the equipment to be used to collect the sample. To reduce the chance of disturbing the substrate/sediment the following protocols will be followed. Samples may be collected from the bridge with a bucket if the depth is at least twice the height of the bucket. At shallower depths the field technician will use a sampling poll with a wide mouth bottle at the end. As a last resort, the field technician will wade into stream and collect the sample, standing downstream of the collection point so as not to collect kicked up sediment.

Step 1a – River Rinse and Field Measurements from Bucket

- Lower the bucket into the stream and fill.
- Discard the contents.

Step 1b – River Rinse Wide Mouth Bottle

- River rinse by filling the bottle with river water.
- Discard the remaining contents.

Step 2 – Sample Collection - Bucket

- Lower the bucket to mid-depth at center of flow, do not disturb bottom sediment.

Step 2b – Sample Collection - Pole

- Lower the sample bottle attached to the sampling pole to mid-depth at center of flow, do not disturb bottom sediment.

Step 3 – Fill Sample Bottles

Fill each sample bottle. Over filling of sample bottles with preservative should be avoided to prevent loss of preservative.

3.3 Field Measurements

pH, DO, temperature, and conductivity must be measured on site within 15 minutes of collection. Once the first wide mouth liter plastic unpreserved bottle is collected, the YSI 556 probe will immediately be placed into the sample and allowed to level out for a proper field reading. The field results shall be recorded on the log-sheet/chain of custody.

4.0 **SAMPLE HANDLING, TRANSPORTATION, QUALITY ASSURANCE, AND BLANKS**

All samples are placed in a cooler with ice after labeling. Samples are to be transported to the laboratory within the prescribed holding times. All samples will be taken to Suburban Laboratory, Inc.

4.1 Quality Assurance

Field blank and duplicates shall be collected. The laboratory shall adhere to their Quality Assurance Plan Revision 4 for samples received in the lab. Quality control limits and frequency of field quality control samples is specified at the end of this SOP.

4.2 Duplicate Samples

Duplicate samples are to be filled from the same round of stream water. Duplicate samples will be taken every 20 sites/ sampling event.

4.3 Field Blank

Sample bottles should be filled with blank water from unopened blank water containers. One field blank should be performed for VOCs and Metals including Phosphorous and Mercury once per every 20 sites during a given sampling event.

5.0 **CHAIN OF CUSTODY**

Chain of Custody forms must be filled out and accompany all samples to their laboratory. An example is attached.

Sample Collection SOP

Parameter	SOP Document Control Identifier	Suburban Lab SOP Title
<u>Demand</u>		
Chloride	CL_WW1	Determination of Chloride in Water by the Seal AQ2 Discreet Analyzer by Standard Methods 4500-CL E and Industrial Wastes, Using the Seal AQ2 Discreet Analyzer by Standard Methods 4500-N (Org.) D (1997) and USEPA Method 351.2 Rev. 2.0
Conductivity	COND_WW	Conductivity (Specific Conductance, UMHOS/CM at 25C) by Standard Methods 18th and 21st Edition 2510 B and USEPA 120.1
Conductivity	Field Analysis	Field analysis performed with a YSI field probe
pH	Field Analysis	Field analysis performed with a YSI field probe
TOC	TOC_WW1	Total Organic Carbon by Standard Methods 20th Edition 5310B
Sulfate	SO4_WW	Sulfate Ion in Water, Wastewater, by ASTM D516-90, Revision 5
TSS	TSS	Total Suspended Solids Dried at 103-105 ° C by Standard Methods 2540D, 1997 and EPA Method 160.2
VSS	VSS	Total Suspended Solids Dried at 103-105 ° C by Standard Methods 2540D, 1997 and EPA Method 160.2, Revision 6
DO	Field Analysis	Field analysis performed with a YSI field probe
Temperature	Field Analysis	Field analysis performed with a YSI field probe
Turbidity	TURB_WW	Turbidity by Standard Methods 18th Edition 2130 B and USEPA 180.1, Revision 1
Filtered and Preserved	DISSOLVED	None
Residue, Non-Filterable	TSS	Total Suspended Solids Dried at 103-105 ° C by Standard Methods 2540D, 1997 and EPA Method 160.2, Revision 6
<u>Metals</u>		
Total Hardness	200.7WW2	EPA Method 200.7 Rev. 4.4/SW-846 6010B: Determination of Metals in Water, Solids and Wastes by Inductively Coupled Plasma (ICP) Emission Spectrometry, Revision 9A
Calcium	200.7WW2	
Iron	200.7WW2	
Magnesium	200.7WW2	
Sodium	200.7WW2	
Arsenic	200.8WWNonComp	EPA Method 200.8 Rev. 5.4/SW-846 6020A: Determination of Metals in Ground Waters, Surface Water and Drinking Water, Solids and Wastes by Inductively Coupled Plasma - MASS Spectrometry, Revision 5A
Copper	200.8WWNonComp	
Manganese	200.8WWNonComp	
Nickel	200.8WWNonComp	
Zinc	200.8WWNonComp	
Mercury	HG_1631	Determination of Mercury in Water, Solids and Wastes by Cold Vapor Atomic Absorption (CVAA), Revision 7
Low Level Mercury	HG_1631	Method 1631, Revision E: Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry

Sample Collection SOP

<u>Nutrients</u>		
Ammonia (NH3-N)	NH3_SL_WW	Nitrogen-Ammonia Ion Probe Determination: USEPA Method 350.3 and Standard Methods Online Edition 4500 NH3-D, Revision 2A
Total Nitrates (NO2+NO3)	NO2+NO3_WW	Nitrate-Nitrite in Water, Wastewater, by USEPA 353.2, August 1993, Revision 6
Total Kjeldahl Nitrogen (TKN)	TKN_SL_WW	Determination of Total Kjeldahl Nitrogen (TKN) in Drinking, Ground and Surface Waters and Domestic
Total Phosphorus	200.7WW2	EPA Method 200.7 Rev. 4.4/SW-846 6010B: Determination of Metals in Water, Solids and Wastes by Inductively Coupled Plasma (ICP) Emission Spectrometry
Dissolved Reactive Phosphorus (Orthophosphate)	PO4_WW_DIS	Total Phosphorus, Ortho and Poly-Phosphate by Standard Methods 4500-P,B and E and USEPA Method 365.2, Revision 5
<u>Bacteria</u>		
E. Coli	E_COLI_MPN	Quanti-Tray/2000 Insert and Most Probable Number (MPN)Table
<u>Water Organics</u>		
<u>Pesticides</u>		
4,4'-DDD	8081_W	Organochlorine Pesticides by GC-ECD USEPA Methods 608 and SW-846 8081A, Revision 4 Organochlorine Pesticides by GC-ECD USEPA Methods 608 and SW-846 8081A, Revision 4
4,4'-DDE	8081_W	
4,4'-DDT	8081_W	
Aldrin	8081_W	
alpha-BHC	8081_W	
alpha-Chlordane	8081_W	
beta-BHC	8081_W	
Chlordane	8081_W	
delta-BHC	8081_W	
Dieldrin	8081_W	
Endosulfan I	8081_W	
Endosulfan II	8081_W	
Endosulfan sulfate	8081_W	
Endrin	8081_W	
Endrin aldehyde	8081_W	
Endrin ketone	8081_W	
gamma-BHC	8081_W	
gamma-Chlordane	8081_W	
Heptachlor	8081_W	
Heptachlor epoxide	8081_W	
Methoxychlor	8081_W	
Surr: Tetrachloro-m-xylene	8081_W	

Sample Collection SOP

Toxaphene	8081_W	Organochlorine Pesticides by GC-ECD USEPA Methods 608 and SW-846 8081A, Revision 4
PCBs		
Aroclor 1016	8082_W	Determination of Polychlorinated Biphenyls (PCB) Aroclors in Water by Capillary Column Gas Chromatography (GC/ECD) USEPA Method 608 and SW-846 8082, Revision 1
Aroclor 1221	8082_W	
Aroclor 1232	8082_W	
Aroclor 1242	8082_W	
Aroclor 1248	8082_W	
Aroclor 1254	8082_W	
Aroclor 1260	8082_W	
Surr: Tetrachloro-m-xylene	8082_W	
PNAs		
Acenaphthene	8270SIM_W	Semi-Volatile Organic Compounds in Ground Water, Wastewater and Solid Waste by Gas Chromatography and Mass Spectrometry (GC/MS): USEPA Methods 625/SW-846 8270C, Revision 6
Acenaphthylene	8270SIM_W	
Anthracene	8270SIM_W	
Benzo(a)anthracene	8270SIM_W	
Benzo(a)pyrene	8270SIM_W	
Benzo(b)fluoranthene	8270SIM_W	
Benzo(g,h,i)perylene	8270SIM_W	
Benzo(k)fluoranthene	8270SIM_W	
Chrysene	8270SIM_W	
Dibenzo(a,h)anthracene	8270SIM_W	
Fluoranthene	8270SIM_W	
Fluorene	8270SIM_W	
Indeno(1,2,3-cd)pyrene	8270SIM_W	
Naphthalene	8270SIM_W	
Phenanthrene	8270SIM_W	
Pyrene	8270SIM_W	
Surr: 2-Fluorobiphenyl	8270SIM_W	
Surr: 4-Terphenyl-d14	8270SIM_W	
Surr: Nitrobenzene-d5	8270SIM_W	
VOCs		
1,1,1-Trichloroethane	8260_W	Volatile Organic Compounds (VOCs) in Water and Solids by Gas Chromatography/Mass Spectrometry USEPA Methods SW-846/8260B and 624, Revision 7
1,1,2,2-Tetrachloroethane	8260_W	
1,1,2-Trichloroethane	8260_W	
1,1-Dichloroethane	8260_W	
1,1-Dichloroethene	8260_W	

Sample Collection SOP

1,2-Dibromo-3-chloropropane	8260_W	Volatile Organic Compounds (VOCs) in Water and Solids by Gas Chromatography/Mass Spectrometry USEPA Methods SW-846/8260B and 624, Revision 7
1,2-Dichlorobenzene	8260_W	
1,2-Dichloroethane	8260_W	
1,2-Dichloropropane	8260_W	
1,3-Dichlorobenzene	8260_W	
1,4-Dichlorobenzene	8260_W	
2-Butanone	8260_W	
2-Chloroethyl vinyl ether	8260_W	
2-Hexanone	8260_W	
4-Methyl-2-pentanone	8260_W	
Acetone	8260_W	
Acrolein	8260_W	
Acrylonitrile	8260_W	
Benzene	8260_W	
Bromodichloromethane	8260_W	
Bromoform	8260_W	
Bromomethane	8260_W	
Carbon disulfide	8260_W	
Carbon tetrachloride	8260_W	
Chlorobenzene	8260_W	
Chloroethane	8260_W	
Chloroform	8260_W	
Chloromethane	8260_W	
cis-1,2-Dichloroethene	8260_W	
cis-1,3-Dichloropropene	8260_W	
Dibromochloromethane	8260_W	
Dichlorodifluoromethane	8260_W	
Ethylbenzene	8260_W	
m,p-Xylene	8260_W	
Methyl tert-butyl ether	8260_W	
Methylene chloride	8260_W	
o-Xylene	8260_W	
Styrene	8260_W	
Tetrachloroethene	8260_W	
Toluene	8260_W	
trans-1,2-Dichloroethene	8260_W	
trans-1,3-Dichloropropene	8260_W	
Trichloroethene	8260_W	
Trichlorofluoromethane	8260_W	
Vinyl chloride	8260_W	

Sample Collection SOP

Total Xylenes	8260_W	Volatile Organic Compounds (VOCs) in Water and Solids by Gas Chromatography/Mass Spectrometry USEPA Methods SW-846/8260B and 624, Revision 7
Surr: 4-Bromofluorobenzene	8260_W	
Surr: Dibromofluoromethane	8260_W	
Surr: Toluene-d8	8260_W	
<u>Sediment Metals</u>		
Metals		
Aluminum	6010_S_2	EPA Method200.7 Rev 4.4/SW-846 6010B: Determination of Metals in Water, Solids and Wastes by Inductively Coupled Plasma (ICP) Emission Spectrometry
Arsenic	6010_S_2	
Barium	6010_S_2	
Beryllium	6010_S_2	
Boron	6010_S_2	
Cadmium	6010_S_2	
Chromium	6010_S_2	
Cobalt	6010_S_2	
Copper	6010_S_2	
Iron	6010_S_2	
Lead	6010_S_2	
Manganese	6010_S_2	
Nickel	6010_S_2	
Potassium	6010_S_2	
Silver	6010_S_2	
Sodium	6010_S_2	
Strontium	6010_S_2	
Vanadium	6010_S_2	
Zinc	6010_S_2	
Mercury	HG_S	Determination of Mercury in Water, Solids, and Wastes by Cold Vapor Atomic Absorption (CVAA)
Fluoride	FL_S	Fluoride in Water by Selective Electrode: USEPA Method 340.2 and Standard Methods 4500F-C, 1997 and 21st Edition
<u>Sediment Organics</u>		
Pesticides		
4,4'-DDD	8081_S	Organochlorine Pesticides by GC-ECD USEPA Methods 608 and SW-846 8081A
4,4'-DDE	8081_S	
4,4'-DDT	8081_S	
Aldrin	8081_S	
alpha-BHC	8081_S	
alpha-Chlordane	8081_S	
beta-BHC	8081_S	

Sample Collection SOP

Chlordane	8081_S	Organochlorine Pesticides by GC-ECD USEPA Methods 608 and SW-846 8081A
delta-BHC	8081_S	
Dieldrin	8081_S	
Endosulfan I	8081_S	
Endosulfan II	8081_S	
Endosulfan sulfate	8081_S	
Endrin	8081_S	
Endrin aldehyde	8081_S	
Endrin ketone	8081_S	
gamma-BHC	8081_S	
gamma-Chlordane	8081_S	
Heptachlor	8081_S	
Heptachlor epoxide	8081_S	
Methoxychlor	8081_S	
Toxaphene	8081_S	
PCBs		
Aroclor 1016	8082_S	Determination of Polychlorinated Biphenyls (PCB) Aroclors in Water by Capillary Column Gas Chromatography (GC/ECD) USEPA Method 608 and SW-846 8082
Aroclor 1221	8082_S	
Aroclor 1232	8082_S	
Aroclor 1242	8082_S	
Aroclor 1248	8082_S	
Aroclor 1254	8082_S	
Aroclor 1260	8082_S	
PNAs		
Acenaphthene	8270SIM_S	Semi-Volatile Organic Compounds in Ground Water, Waste Water, and Solid Waste by Gas Chromatography and Mass Spectrometry (GC/MS): USEPA Methods 625/SW-846 8270C
Acenaphthylene	8270SIM_S	
Anthracene	8270SIM_S	
Benzo(a)anthracene	8270SIM_S	
Benzo(a)pyrene	8270SIM_S	
Benzo(b)fluoranthene	8270SIM_S	
Benzo(g,h,i)perylene	8270SIM_S	
Benzo(k)fluoranthene	8270SIM_S	
Chrysene	8270SIM_S	
Dibenzo(a,h)anthracene	8270SIM_S	
Fluoranthene	8270SIM_S	
Fluorene	8270SIM_S	
Hexachlorobenzene	8270SIM_S	
Indeno(1,2,3-cd)pyrene	8270SIM_S	
Naphthalene	8270SIM_S	

Sample Collection SOP

Phenanthrene	8270SIM_S	Semi-Volatile Organic Compounds in Ground Water, Waste Water, and Solid Waste by Gas Chromatography and Mass Spectrometry (GC/MS): USEPA Methods 625/SW-846 8270C
Pyrene	8270SIM_S	
VOCs		
1,1,1-Trichloroethane	8260_S	Volatile Organic Compounds (VOCs) in Water and Solids by Gas Chromatography/Mass Spectrometry USEPA Methods SW-846/8260B and 624
1,1,2,2-Tetrachloroethane	8260_S	
1,1,2-Trichloroethane	8260_S	
1,1-Dichloroethane	8260_S	
1,1-Dichloroethene	8260_S	
1,2-Dibromo-3-chloropropane	8260_S	
1,2-Dichlorobenzene	8260_S	
1,2-Dichloroethane	8260_S	
1,2-Dichloropropane	8260_S	
1,3-Dichlorobenzene	8260_S	
1,4-Dichlorobenzene	8260_S	
2-Butanone	8260_S	
2-Chloroethyl vinyl ether	8260_S	
2-Hexanone	8260_S	
4-Methyl-2-pentanone	8260_S	
Acetone	8260_S	
Acrolein	8260_S	
Acrylonitrile	8260_S	
Benzene	8260_S	
Bromodichloromethane	8260_S	
Bromoform	8260_S	
Bromomethane	8260_S	
Carbon disulfide	8260_S	
Carbon tetrachloride	8260_S	
Chlorobenzene	8260_S	
Chloroethane	8260_S	
Chloroform	8260_S	
Chloromethane	8260_S	
cis-1,2-Dichloroethene	8260_S	
cis-1,3-Dichloropropene	8260_S	
Dibromochloromethane	8260_S	
Dichlorodifluoromethane	8260_S	
Ethylbenzene	8260_S	
m,p-Xylene	8260_S	
Methyl tert-butyl ether	8260_S	

Sample Collection SOP

Methylene chloride	8260_S	Volatile Organic Compounds (VOCs) in Water and Solids by Gas Chromatography/Mass Spectrometry USEPA Methods SW-846/8260B and 624
o-Xylene	8260_S	
Styrene	8260_S	
Tetrachloroethene	8260_S	
Toluene	8260_S	
trans-1,2-Dichloroethene	8260_S	
trans-1,3-Dichloropropene	8260_S	
Trichloroethene	8260_S	
Trichlorofluoromethane	8260_S	
Vinyl chloride	8260_S	
Total Xylenes	8260_S	
Herbicides		
2,4-D	8151_S_Sub	Subcontracted to STAT Analysis Corporation
2,4,5-TP	8151_S_Sub	
<u>Sediment Inorganics</u>		
TKN	TKN_S	Determination of Total Kjeldahl Nitrogen (TKN) in Drinking, Ground and Surface Waters, and Domestic and Industrial Wastes, Using the Seal AQ2 Discreet Analyzer by Standard Methods 4500-N(Org.) D (1997) and USEPA Method 351.2 Rev. 2.0
Phosphorus	6010_S_2	EPA Method 200.7 Rev 4.4/SW-846 6010B: Determination of Metals in Water, Solids and Wastes by Inductively Coupled Plasma (ICP) Emission Spectrometry
Cyanide (low)	CN_S	Determination of Cyanide in Water by the Seal AQ2 Discreet Analyzer by Standard Methods 4500-CN-E, G, and I, 1999, and EPA Method 335.4 Rev. 1 (1993), After Distillation by Standard Methods 4500-CN-C
Phenols	PHENOLS_S	Phenolics (Phenols, Total) by USEPA Method 420.1/SW 9065 and Standard Methods 14TH Edition (1975) 510 B&C

* The Suburban Laboratories SOPs are the analytical SOPs used by the laboratory for each parameter.

Sample Collection SOP

Parameter	Method	MDL/ Reporting Limit (RL)	Quantitation Limit (QL)
<u>Demand</u>			
Chloride	SM4500CL-E, 1997	1 mg/L	5 mg/L
Conductivity	SM2510B, 1997	1 µmhos/cm	1 µmhos/cm
Conductivity	Field Parameter	N/A	N/A
pH	Field Parameter	N/A	N/A
TOC	SM5310-B, 2000	1 mg/L	1 mg/L
Sulfate	ASTM-D516, 2004	2 mg/L	6 mg/L
TSS	SM2540D, 1997	0.2 mg/L	5 mg/L
Volatile Suspended Solids	SM2540D, 1997	0.2 mg/L	5 mg/L
DO	Field Parameter	N/A	N/A
Temperature	Field Parameter	N/A	N/A
Turbidity	EPA 180.1, Rev. 2.0, 1993	0.1 NTU	0.2 NTU
<u>Metals</u>			
Total Hardness	EPA 200.7, Rev. 2, 1996	0.05 mg/L	0.15 mg/L
Arsenic (As)	EPA 200.8, Rev 5.4, 1994	0.0008 mg/L	0.0008 mg/L
Calcium (Ca)	EPA 200.7, Rev. 2, 1996	0.015 mg/L	0.05 mg/L
Copper (Cu)	EPA 200.8, Rev 5.4, 1994	0.001 mg/L	0.001 mg/L
Iron (Fe)	EPA 200.8, Rev 5.4, 1994	0.0117 mg/L	0.005 mg/L
Magnesium (Mg)	EPA 200.7, Rev. 2, 1996	0.01 mg/L	0.05 mg/L
Manganese (Mn)	EPA 200.8, Rev 5.4, 1994	0.002 mg/L	0.002 mg/L
Mercury (Hg)	EPA 7470A, Rev. 1, 1994	0.0001 mg/L	0.0005 mg/L
Nickel (Ni)	EPA 200.8, Rev 5.4, 1994	0.0004 mg/L	0.0004 mg/L
Sodium (Na)	EPA 200.7, Rev. 4.4, 1994	0.01 mg/L	0.2 mg/L
Zinc (Zn)	EPA 200.8, Rev 5.4, 1994	0.003 mg/L	0.003 mg/L
Low Level Mercury (Hg)	EPA 1631, Rev. E, 2002	0.5 ng/L	0.5 ng/L
<u>Nutrients</u>			
Ammonia	SM4500NH3-G, 1997	0.1 mg/L	0.3 mg/L
Total Nitrates (NO ₂ +NO ₃)	EPA 353.2, Rev. 2, 1993	0.05 mg/L	0.1 mg/L
TKN	SM4500N-org-D, 1997	0.5 mg/L	2 mg/L
Total Phosphorus	EPA 200.7, Rev 4.4, 1994	0.02 mg/L	0.044 mg/L
Dissolved Reactive Phosphorus (Orthophosphate)	SM4500P-E, 1999	0.026 mg/L	0.05 mg/L
<u>Bacteria</u>			
E. Coli	SM9223-B, 2004	1 MPN/100 mL	1 MPN/100 mL

Sample Collection SOP

Organics			
Pesticides			
4,4'-DDD	EPA 8081A, Rev. 1, 1996	0.05 ug/L	0.05 ug/L
4,4'-DDE	EPA 8081A, Rev. 1, 1996	0.05 ug/L	0.05 ug/L
4,4'-DDT	EPA 8081A, Rev. 1, 1996	0.05 ug/L	0.05 ug/L
Aldrin	EPA 8081A, Rev. 1, 1996	0.025 ug/L	0.025 ug/L
alpha-BHC	EPA 8081A, Rev. 1, 1996	0.025 ug/L	0.025 ug/L
alpha-Chlordane	EPA 8081A, Rev. 1, 1996	0.025 ug/L	0.025 ug/L
beta-BHC	EPA 8081A, Rev. 1, 1996	0.025 ug/L	0.025 ug/L
Chlordane	EPA 8081A, Rev. 1, 1996	0.1 ug/L	0.1 ug/L
delta-BHC	EPA 8081A, Rev. 1, 1996	0.025 ug/L	0.025 ug/L
Dieldrin	EPA 8081A, Rev. 1, 1996	0.05 ug/L	0.05 ug/L
Endosulfan I	EPA 8081A, Rev. 1, 1996	0.025 ug/L	0.025 ug/L
Endosulfan II	EPA 8081A, Rev. 1, 1996	0.05 ug/L	0.05 ug/L
Endosulfan sulfate	EPA 8081A, Rev. 1, 1996	0.05 ug/L	0.05 ug/L
Endrin	EPA 8081A, Rev. 1, 1996	0.05 ug/L	0.05 ug/L
Endrin aldehyde	EPA 8081A, Rev. 1, 1996	0.05 ug/L	0.05 ug/L
Endrin ketone	EPA 8081A, Rev. 1, 1996	0.05 ug/L	0.05 ug/L
gamma-BHC	EPA 8081A, Rev. 1, 1996	0.025 ug/L	0.025 ug/L
gamma-Chlordane	EPA 8081A, Rev. 1, 1996	0.025 ug/L	0.025 ug/L
Heptachlor	EPA 8081A, Rev. 1, 1996	0.025 ug/L	0.025 ug/L
Heptachlor epoxide	EPA 8081A, Rev. 1, 1996	0.025 ug/L	0.025 ug/L
Methoxychlor	EPA 8081A, Rev. 1, 1996	0.25 ug/L	0.25 ug/L
Toxaphene	EPA 8081A, Rev. 1, 1996	0.2 ug/L	0.2 ug/L
PCBs			
Aroclor 1016	EPA 8082, Rev. 0, 1996	0.1 ug/L	0.1 ug/L
Aroclor 1221	EPA 8082, Rev. 0, 1996	0.1 ug/L	0.1 ug/L
Aroclor 1232	EPA 8082, Rev. 0, 1996	0.1 ug/L	0.1 ug/L
Aroclor 1242	EPA 8082, Rev. 0, 1996	0.1 ug/L	0.1 ug/L
Aroclor 1248	EPA 8082, Rev. 0, 1996	0.1 ug/L	0.1 ug/L
Aroclor 1254	EPA 8082, Rev. 0, 1996	0.1 ug/L	0.1 ug/L
Aroclor 1260	EPA 8082, Rev. 0, 1996	0.1 ug/L	0.1 ug/L
Total PCBs	EPA 8082, Rev. 0, 1996	0.7 ug/L	0.7 ug/L
PNAAs			
Acenaphthene	EPA 8270C, Rev. 3, 1996	0.1 ug/L	0.1 ug/L
Acenaphthylene	EPA 8270C, Rev. 3, 1996	0.1 ug/L	0.1 ug/L
Anthracene	EPA 8270C, Rev. 3, 1996	0.1 ug/L	0.1 ug/L
Benzo(a)anthracene	EPA 8270C, Rev. 3, 1996	0.1 ug/L	0.1 ug/L

Sample Collection SOP

Benzo(a)pyrene	EPA 8270C, Rev. 3, 1996	0.1 ug/L	0.1 ug/L
Benzo(b)fluoranthene	EPA 8270C, Rev. 3, 1996	0.1 ug/L	0.1 ug/L
Benzo(g,h,i)perylene	EPA 8270C, Rev. 3, 1996	0.1 ug/L	0.1 ug/L
Benzo(k)fluoranthene	EPA 8270C, Rev. 3, 1996	0.1 ug/L	0.1 ug/L
Chrysene	EPA 8270C, Rev. 3, 1996	0.1 ug/L	0.1 ug/L
Dibenzo(a,h)anthracene	EPA 8270C, Rev. 3, 1996	0.1 ug/L	0.1 ug/L
Fluoranthene	EPA 8270C, Rev. 3, 1996	0.1 ug/L	0.1 ug/L
Fluorene	EPA 8270C, Rev. 3, 1996	0.1 ug/L	0.1 ug/L
Indeno(1,2,3-cd)pyrene	EPA 8270C, Rev. 3, 1996	0.1 ug/L	0.1 ug/L
Naphthalene	EPA 8270C, Rev. 3, 1996	0.1 ug/L	0.1 ug/L
Phenanthrene	EPA 8270C, Rev. 3, 1996	0.1 ug/L	0.1 ug/L
Pyrene	EPA 8270C, Rev. 3, 1996	0.1 ug/L	0.1 ug/L
VOCs			
1,1,1-Trichloroethane	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
1,1,2,2-Tetrachloroethane	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
1,1,2-Trichloroethane	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
1,1-Dichloroethane	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
1,1-Dichloroethene	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
1,2-Dibromo-3-chloropropane	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
1,2-Dichlorobenzene	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
1,2-Dichloroethane	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
1,2-Dichloropropane	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
1,3-Dichlorobenzene	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
1,4-Dichlorobenzene	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
2-Butanone	EPA 8260B, Rev. 2, 1996	10 ug/L	10 ug/L
2-Chloroethyl vinyl ether	EPA 8260B, Rev. 2, 1996	10 ug/L	10 ug/L
2-Hexanone	EPA 8260B, Rev. 2, 1996	25 ug/L	25 ug/L
4-Methyl-2-pentanone	EPA 8260B, Rev. 2, 1996	25 ug/L	25 ug/L
Acetone	EPA 8260B, Rev. 2, 1996	25 ug/L	25 ug/L
Acrolein	EPA 8260B, Rev. 2, 1996	25 ug/L	25 ug/L
Acrylonitrile	EPA 8260B, Rev. 2, 1996	25 ug/L	25 ug/L
Benzene	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
Bromodichloromethane	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
Bromoform	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
Bromomethane	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
Carbon disulfide	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
Carbon tetrachloride	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
Chlorobenzene	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
Chloroethane	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L

Sample Collection SOP

Chloroform	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
Chloromethane	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
cis-1,2-Dichloroethene	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
cis-1,3-Dichloropropene	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
Dibromochloromethane	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
Dichlorodifluoromethane	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
Ethylbenzene	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
m,p-Xylene	EPA 8260B, Rev. 2, 1996	2 ug/L	2 ug/L
Methyl tert-butyl ether	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
Methylene chloride	EPA 8260B, Rev. 2, 1996	5 ug/L	5 ug/L
o-Xylene	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
Styrene	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
Tetrachloroethene	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
Toluene	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
trans-1,2-Dichloroethene	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
trans-1,3-Dichloropropene	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
Trichloroethene	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
Trichlorofluoromethane	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
Vinyl chloride	EPA 8260B, Rev. 2, 1996	1 ug/L	1 ug/L
Total Xylenes	EPA 8260B, Rev. 2, 1996	2 ug/L	2 ug/L
Sediment Metals			
Metals (19)			
Aluminum (Al)	EPA 6010B, Rev. 2, 1996	2.5 mg/Kg	2.5 mg/Kg
Arsenic (As)	EPA 6010B, Rev. 2, 1996	1.15 mg/Kg	5 mg/Kg
Barium (Ba)	EPA 6010B, Rev. 2, 1996	0.125 mg/Kg	0.25 mg/Kg
Beryllium (Be)	EPA 6010B, Rev. 2, 1996	0.05 mg/Kg	0.25 mg/Kg
Boron (B)	EPA 6010B, Rev. 2, 1996	0.625 mg/Kg	5 mg/Kg
Cadmium (Cd)	EPA 6010B, Rev. 2, 1996	0.075 mg/Kg	0.25 mg/Kg
Chromium (Cr)	EPA 6010B, Rev. 2, 1996	0.06 mg/Kg	0.25 mg/Kg
Cobalt (Co)	EPA 6010B, Rev. 2, 1996	0.125 mg/Kg	1.25 mg/Kg
Copper (Cu)	EPA 6010B, Rev. 2, 1996	0.15 mg/Kg	0.25 mg/Kg
Iron (Fe)	EPA 6010B, Rev. 2, 1996	0.625 mg/Kg	1.72875 mg/Kg
Lead (Pb)	EPA 6010B, Rev. 2, 1996	0.6 mg/Kg	1.25 mg/Kg
Manganese (Mn)	EPA 6010B, Rev. 2, 1996	0.06 mg/Kg	0.25 mg/Kg
Mercury (Hg)	EPA 6010B, Rev. 2, 1996	0.02 mg/Kg	0.083 mg/Kg
Nickel (Ni)	EPA 6010B, Rev. 2, 1996	0.235 mg/Kg	1.25 mg/Kg
Potassium (K)	EPA 6010B, Rev. 2, 1996	2.5 mg/Kg	25 mg/Kg
Silver (Ag)	EPA 6010B, Rev. 2, 1996	0.06 mg/Kg	0.25 mg/Kg
Sodium (Na)	EPA 6010B, Rev. 2, 1996	1.25 mg/Kg	2.5 mg/Kg
Strontium (Sr)	EPA 6010B, Rev. 2, 1996	0.12 mg/Kg	0.25 mg/Kg

Sample Collection SOP

Vanadium (V)	EPA 6010B, Rev. 2, 1996	0.15 mg/Kg	1.25 mg/Kg
Zinc (Zn)	EPA 6010B, Rev. 2, 1996	1 mg/Kg	1.25 mg/Kg
<u>Sediment Organics</u>			
Pesticides			
4,4'-DDD	EPA 8081A, Rev. 1, 1996	1.67 µg/Kg	1.67 µg/Kg
4,4'-DDE	EPA 8081A, Rev. 1, 1996	1.67 µg/Kg	1.67 µg/Kg
4,4'-DDT	EPA 8081A, Rev. 1, 1996	0.833 µg/Kg	0.833 µg/Kg
Aldrin	EPA 8081A, Rev. 1, 1996	0.833 µg/Kg	0.833 µg/Kg
alpha-BHC	EPA 8081A, Rev. 1, 1996	0.833 µg/Kg	0.833 µg/Kg
alpha-Chlordane	EPA 8081A, Rev. 1, 1996	0.833 µg/Kg	0.833 µg/Kg
beta-BHC	EPA 8081A, Rev. 1, 1996	0.833 µg/Kg	0.833 µg/Kg
Chlordane	EPA 8081A, Rev. 1, 1996	16.6 µg/Kg	16.6 µg/Kg
delta-BHC	EPA 8081A, Rev. 1, 1996	0.833 µg/Kg	0.833 µg/Kg
Dieldrin	EPA 8081A, Rev. 1, 1996	1.67 µg/Kg	1.67 µg/Kg
Endosulfan I	EPA 8081A, Rev. 1, 1996	0.833 µg/Kg	0.833 µg/Kg
Endosulfan II	EPA 8081A, Rev. 1, 1996	1.67 µg/Kg	1.67 µg/Kg
Endosulfan sulfate	EPA 8081A, Rev. 1, 1996	1.67 µg/Kg	1.67 µg/Kg
Endrin	EPA 8081A, Rev. 1, 1996	1.67 µg/Kg	1.67 µg/Kg
Endrin aldehyde	EPA 8081A, Rev. 1, 1996	1.67 µg/Kg	1.67 µg/Kg
Endrin ketone	EPA 8081A, Rev. 1, 1996	1.67 µg/Kg	1.67 µg/Kg
gamma-BHC	EPA 8081A, Rev. 1, 1996	0.833 µg/Kg	0.833 µg/Kg
gamma-Chlordane	EPA 8081A, Rev. 1, 1996	0.833 µg/Kg	0.833 µg/Kg
Heptachlor	EPA 8081A, Rev. 1, 1996	0.833 µg/Kg	0.833 µg/Kg
Heptachlor epoxide	EPA 8081A, Rev. 1, 1996	0.833 µg/Kg	0.833 µg/Kg
Methoxychlor	EPA 8081A, Rev. 1, 1996	8.33 µg/Kg	8.33 µg/Kg
Toxaphene	EPA 8081A, Rev. 1, 1996	33.3 µg/Kg	33.3 µg/Kg
PCBs			
Aroclor 1016	EPA 8082, Rev. 0, 1996	16.7 µg/Kg	16.7 µg/Kg
Aroclor 1221	EPA 8082, Rev. 0, 1996	16.7 µg/Kg	16.7 µg/Kg
Aroclor 1232	EPA 8082, Rev. 0, 1996	16.7 µg/Kg	16.7 µg/Kg
Aroclor 1242	EPA 8082, Rev. 0, 1996	16.7 µg/Kg	16.7 µg/Kg
Aroclor 1248	EPA 8082, Rev. 0, 1996	16.7 µg/Kg	16.7 µg/Kg
Aroclor 1254	EPA 8082, Rev. 0, 1996	16.7 µg/Kg	16.7 µg/Kg
Aroclor 1260	EPA 8082, Rev. 0, 1996	16.7 µg/Kg	16.7 µg/Kg
PNAs			
Acenaphthene	EPA 8270C, Rev. 3, 1996	40 µg/Kg	40 µg/Kg
Acenaphthylene	EPA 8270C, Rev. 3, 1996	40 µg/Kg	40 µg/Kg
Anthracene	EPA 8270C, Rev. 3, 1996	40 µg/Kg	40 µg/Kg

Sample Collection SOP

Benzo(a)anthracene	EPA 8270C, Rev. 3, 1996	40 µg/Kg	40 µg/Kg
Benzo(a)pyrene	EPA 8270C, Rev. 3, 1996	40 µg/Kg	40 µg/Kg
Benzo(b)fluoranthene	EPA 8270C, Rev. 3, 1996	40 µg/Kg	40 µg/Kg
Benzo(g,h,i)perylene	EPA 8270C, Rev. 3, 1996	40 µg/Kg	40 µg/Kg
Benzo(k)fluoranthene	EPA 8270C, Rev. 3, 1996	40 µg/Kg	40 µg/Kg
Chrysene	EPA 8270C, Rev. 3, 1996	40 µg/Kg	40 µg/Kg
Dibenzo(a,h)anthracene	EPA 8270C, Rev. 3, 1996	40 µg/Kg	40 µg/Kg
Fluoranthene	EPA 8270C, Rev. 3, 1996	40 µg/Kg	40 µg/Kg
Fluorene	EPA 8270C, Rev. 3, 1996	40 µg/Kg	40 µg/Kg
Hexachlorobenzene	EPA 8270C, Rev. 3, 1996	40 µg/Kg	40 µg/Kg
Indeno(1,2,3-cd)pyrene	EPA 8270C, Rev. 3, 1996	40 µg/Kg	40 µg/Kg
Naphthalene	EPA 8270C, Rev. 3, 1996	40 µg/Kg	40 µg/Kg
Phenanthrene	EPA 8270C, Rev. 3, 1996	40 µg/Kg	40 µg/Kg
Pyrene	EPA 8270C, Rev. 3, 1996	40 µg/Kg	40 µg/Kg
VOCs			
1,1,1-Trichloroethane	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
1,1,2,2-Tetrachloroethane	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
1,1,2-Trichloroethane	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
1,1-Dichloroethane	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
1,1-Dichloroethene	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
1,2-Dibromo-3-chloropropane	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
1,2-Dichlorobenzene	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
1,2-Dichloroethane	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
1,2-Dichloropropane	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
1,3-Dichlorobenzene	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
1,4-Dichlorobenzene	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
2-Butanone	EPA 8260B, Rev. 2, 1996	10 µg/Kg	10 µg/Kg
2-Chloroethyl vinyl ether	EPA 8260B, Rev. 2, 1996	10 µg/Kg	10 µg/Kg
2-Hexanone	EPA 8260B, Rev. 2, 1996	25 µg/Kg	25 µg/Kg
4-Methyl-2-pentanone	EPA 8260B, Rev. 2, 1996	25 µg/Kg	25 µg/Kg
Acetone	EPA 8260B, Rev. 2, 1996	25 µg/Kg	25 µg/Kg
Acrolein	EPA 8260B, Rev. 2, 1996	25 µg/Kg	25 µg/Kg
Acrylonitrile	EPA 8260B, Rev. 2, 1996	25 µg/Kg	25 µg/Kg
Benzene	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
Bromodichloromethane	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
Bromoform	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
Bromomethane	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
Carbon disulfide	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
Carbon tetrachloride	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg

Sample Collection SOP

Chlorobenzene	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
Chloroethane	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
Chloroform	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
Chloromethane	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
cis-1,2-Dichloroethene	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
cis-1,3-Dichloropropene	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
Dibromochloromethane	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
Dichlorodifluoromethane	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
Ethylbenzene	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
m,p-Xylene	EPA 8260B, Rev. 2, 1996	2 µg/Kg	2 µg/Kg
Methyl tert-butyl ether	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
Methylene chloride	EPA 8260B, Rev. 2, 1996	5 µg/Kg	5 µg/Kg
o-Xylene	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
Styrene	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
Tetrachloroethene	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
Toluene	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
trans-1,2-Dichloroethene	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
trans-1,3-Dichloropropene	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
Trichloroethene	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
Trichlorofluoromethane	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
Vinyl chloride	EPA 8260B, Rev. 2, 1996	1 µg/Kg	1 µg/Kg
Total Xylenes	EPA 8260B, Rev. 2, 1996	2 µg/Kg	2 µg/Kg
Herbicides (2,4,D, 2,4,5 TP)			
2,4-D	EPA 8151A, Rev. 1, 1996	0.0033 mg/Kg	0.0033 mg/Kg
2,4,5-TP	EPA 8151A, Rev. 1, 1996	0.0033 mg/Kg	0.0033 mg/Kg
<u>Sediment Inorganics</u>			
TKN	SM4500NH3-E, 1992	100 mg/Kg	100 mg/Kg
Cyanide (low)	EPA 9014, Rev. 0, 1996	0.1 mg/Kg	0.1 mg/Kg
Fluoride	EPA 6010B, Rev. 2, 1996	0.05 mg/Kg	0.2mg/Kg
Phenols	EPA 9065, Rev. 0, 1986	0.005 mg/Kg	0.01 mg/Kg

Sample Collection SOP

Parameter	Accuracy (% Recovery)	Precision (RPD)	Limit of Sensitivity*
<u>Demand</u>			
Chloride	90% -110%	20%	5 mg/L
Conductivity	90% - 110%	20%	1 µmhos/cm
Conductivity	N/A	N/A	N/A
pH	N/A	N/A	N/A
TOC	90% - 110%	10%	1 mg/L
Sulfate	90% - 110%	20%	2 mg/L
TSS	N/A	10%	0.2 mg/L
Volatile Suspended Solids	N/A	10%	0.2 mg/L
DO	N/A	N/A	N/A
Temperature	N/A	N/A	N/A
Turbidity	90% - 110%	20%	0.1 NTU
<u>Metals</u>			
Total Hardness	90% - 110%	20%	0.05
Arsenic (As)	90% - 110%	20%	0.0008 mg/L
Calcium (Ca)	90%-110%	20%	0.015 mg/L
Copper (Cu)	90% - 110%	20%	0.001 mg/L
Iron (Fe)	90% - 110%	20%	0.0117 mg/L
Magnesium (Mg)	90%-110%	20%	0.01 mg/L
Manganese (Mn)	90% - 110%	20%	0.002 mg/L
Mercury (Hg)	90% - 110%	20%	0.0001 mg/L
Nickel (Ni)	90% - 110%	20%	0.0004 mg/L
Zinc (Zn)	90% - 110%	20%	0.003 mg/L
Low Level Mercury (Hg)	90% - 110 %	21%	0.5 ng/L
<u>Nutrients</u>			
Ammonia	90% - 110%	20%	0.1 mg/L
Total Nitrates (NO ₂ +NO ₃)	90% - 110%	20%	0.05 mg/L
TKN	90% - 110%	20%	0.5 mg/L
Total Phosphorus	90% - 110%	20%	44 ug/L
Dissolved Reactive Phosphorus (Orthophosphate)	90% - 110%	20%	0.026 mg/L
<u>Bacteria</u>			
E. Coli	N/A	N/A	1 MPN/100 mL
<u>Water Organics</u>			
<u>Pesticides</u>			

Sample Collection SOP

4,4'-DDD	85% - 115%	21.90%	0.05 ug/L
4,4'-DDE	85% - 115%	13.30%	0.05 ug/L
4,4'-DDT	85% - 115%	23.80%	0.05 ug/L
Aldrin	85% - 115%	18.10%	0.025 ug/L
alpha-BHC	85% - 115%	19.60%	0.025 ug/L
alpha-Chlordane	85% - 115%	13.60%	0.025 ug/L
beta-BHC	85% - 115%	16.90%	0.025 ug/L
Chlordane	85% - 115%	20%	0.1 ug/L
delta-BHC	85% - 115%	22.70%	0.025 ug/L
Dieldrin	85% - 115%	21.80%	0.05 ug/L
Endosulfan I	85% - 115%	12.30%	0.025 ug/L
Endosulfan II	85% - 115%	13.40%	0.05 ug/L
Endosulfan sulfate	85% - 115%	13.60%	0.05 ug/L
Endrin	85% - 115%	12.50%	0.05 ug/L
Endrin aldehyde	85% - 115%	23.60%	0.05 ug/L
Endrin ketone	85% - 115%	13%	0.05 ug/L
gamma-BHC	85% - 115%	20.20%	0.025 ug/L
gamma-Chlordane	85% - 115%	13.40%	0.025 ug/L
Heptachlor	85% - 115%	19.40%	0.025 ug/L
Heptachlor epoxide	85% - 115%	18.80%	0.025 ug/L
Methoxychlor	85% - 115%	21.50%	0.25 ug/L
Toxaphene	85% - 115%	25.40%	0.2 ug/L
PCBs			
Aroclor 1016	85% - 115%	30%	0.1 ug/L
Aroclor 1221	85% - 115%	30%	0.1 ug/L
Aroclor 1232	85% - 115%	30%	0.1 ug/L
Aroclor 1242	85% - 115%	30%	0.1 ug/L
Aroclor 1248	85% - 115%	30%	0.1 ug/L
Aroclor 1254	85% - 115%	30%	0.1 ug/L
Aroclor 1260	85% - 115%	30%	0.1 ug/L
Total PCBs	85% - 115%	30%	0.7 ug/L
PNAs			
Acenaphthene	80%-120%	30%	0.1 ug/L
Acenaphthylene	80%-120%	30%	0.1 ug/L
Anthracene	80%-120%	30%	0.1 ug/L
Benzo(a)anthracene	80%-120%	30%	0.1 ug/L
Benzo(a)pyrene	80%-120%	30%	0.1 ug/L
Benzo(b)fluoranthene	80%-120%	30%	0.1 ug/L
Benzo(g,h,i)perylene	80%-120%	30%	0.1 ug/L

Sample Collection SOP

Benzo(k)fluoranthene	80%-120%	30%	0.1 ug/L
Chrysene	80%-120%	30%	0.1 ug/L
Dibenzo(a,h)anthracene	80%-120%	30%	0.1 ug/L
Fluoranthene	80%-120%	30%	0.1 ug/L
Fluorene	80%-120%	30%	0.1 ug/L
Indeno(1,2,3-cd)pyrene	80%-120%	30%	0.1 ug/L
Naphthalene	80%-120%	30%	0.1 ug/L
Phenanthrene	80%-120%	30%	0.1 ug/L
Pyrene	80%-120%	30%	0.1 ug/L
VOCs			
1,1,1-Trichloroethane	80%-120%	20%	1 ug/L
1,1,2,2-Tetrachloroethane	80%-120%	20%	1 ug/L
1,1,2-Trichloroethane	80%-120%	20%	1 ug/L
1,1-Dichloroethane	80%-120%	20%	1 ug/L
1,1-Dichloroethene	80%-120%	20%	1 ug/L
1,2-Dibromo-3-chloropropane	80%-120%	20%	1 ug/L
1,2-Dichlorobenzene	80%-120%	20%	1 ug/L
1,2-Dichloroethane	80%-120%	20%	1 ug/L
1,2-Dichloropropane	80%-120%	20%	1 ug/L
1,3-Dichlorobenzene	80%-120%	20%	1 ug/L
1,4-Dichlorobenzene	80%-120%	20%	1 ug/L
2-Butanone	80%-120%	20%	10 ug/L
2-Chloroethyl vinyl ether	80%-120%	20%	10 ug/L
2-Hexanone	80%-120%	20%	25 ug/L
4-Methyl-2-pentanone	80%-120%	20%	25 ug/L
Acetone	80%-120%	20%	25 ug/L
Acrolein	80%-120%	20%	25 ug/L
Acrylonitrile	80%-120%	20%	25 ug/L
Benzene	80%-120%	20%	1 ug/L
Bromodichloromethane	80%-120%	20%	1 ug/L
Bromoform	80%-120%	20%	1 ug/L
Bromomethane	80%-120%	20%	1 ug/L
Carbon disulfide	80%-120%	20%	1 ug/L
Carbon tetrachloride	80%-120%	20%	1 ug/L
Chlorobenzene	80%-120%	20%	1 ug/L
Chloroethane	80%-120%	20%	1 ug/L
Chloroform	80%-120%	20%	1 ug/L
Chloromethane	80%-120%	20%	1 ug/L
cis-1,2-Dichloroethene	80%-120%	20%	1 ug/L
cis-1,3-Dichloropropene	80%-120%	20%	1 ug/L

Sample Collection SOP

Dibromochloromethane	80%-120%	20%	1 ug/L
Dichlorodifluoromethane	80%-120%	20%	1 ug/L
Ethylbenzene	80%-120%	20%	1 ug/L
m,p-Xylene	80%-120%	20%	2 ug/L
Methyl tert-butyl ether	80%-120%	20%	1 ug/L
Methylene chloride	80%-120%	20%	5 ug/L
o-Xylene	80%-120%	20%	1 ug/L
Styrene	80%-120%	20%	1 ug/L
Tetrachloroethene	80%-120%	20%	1 ug/L
Toluene	80%-120%	20%	1 ug/L
trans-1,2-Dichloroethene	80%-120%	20%	1 ug/L
trans-1,3-Dichloropropene	80%-120%	20%	1 ug/L
Trichloroethene	80%-120%	20%	1 ug/L
Trichlorofluoromethane	80%-120%	20%	1 ug/L
Vinyl chloride	80%-120%	20%	1 ug/L
Total Xylenes	80%-120%	20%	2 ug/L
Sediment Metals			
Metals (19)			
Aluminum (Al)	90% - 110%	20%	2.5 mg/Kg
Arsenic (As)	90% - 110%	20%	1.15 mg/Kg
Barium (Ba)	90% - 110%	20%	0.125 mg/Kg
Beryllium (Be)	90% - 110%	20%	0.05 mg/Kg
Boron (B)	90% - 110%	20%	0.625 mg/Kg
Cadmium (Cd)	90% - 110%	20%	0.75 mg/Kg
Chromium (Cr)	90% - 110%	20%	0.06 mg/Kg
Cobalt (Co)	90% - 110%	20%	0.125 mg/Kg
Copper (Cu)	90% - 110%	20%	0.15 mg/Kg
Iron (Fe)	90% - 110%	20%	0.625 mg/Kg
Lead (Pb)	90% - 110%	20%	0.6 mg/Kg
Manganese (Mn)	90% - 110%	20%	0.06 mg/Kg
Mercury (Hg)	90% - 110%	20%	0.2 mg/Kg
Nickel (Ni)	90% - 110%	20%	0.235 mg/Kg
Potassium (K)	90% - 110%	20%	2.5 mg/Kg
Silver (Ag)	90% - 110%	20%	0.06 mg/Kg
Sodium (Na)	90% - 110%	20%	1.25 mg/Kg
Strontium (Sr)	90% - 110%	20%	0.12 mg/Kg
Vanadium (V)	90% - 110%	20%	0.15 mg/Kg
Zinc (Zn)	90% - 110%	20%	1 mg/Kg
Fluoride	90% - 110%	20%	0.5 mg/Kg

Sample Collection SOP

Sediment Organics			
Pesticides			
4,4'-DDD	85% - 115%	18.50%	0.05 ug/Kg
4,4'-DDE	85% - 115%	28.80%	0.05 ug/Kg
4,4'-DDT	85% - 115%	37.20%	0.05 ug/Kg
Aldrin	85% - 115%	28.80%	0.025 ug/Kg
alpha-BHC	85% - 115%	33.10%	0.025 ug/Kg
alpha-Chlordane	85% - 115%	25.80%	0.025 ug/Kg
beta-BHC	85% - 115%	38.80%	0.025 ug/Kg
Chlordane	85% - 115%	50%	0.1 ug/Kg
delta-BHC	85% - 115%	17.30%	0.025 ug/Kg
Dieldrin	85% - 115%	34.10%	0.05 ug/Kg
Endosulfan I	85% - 115%	38.70%	0.025 ug/Kg
Endosulfan II	85% - 115%	29%	0.05 ug/Kg
Endosulfan sulfate	85% - 115%	25.70%	0.05 ug/Kg
Endrin	85% - 115%	30.80%	0.05 ug/Kg
Endrin aldehyde	85% - 115%	36.20%	0.05 ug/Kg
Endrin ketone	85% - 115%	27.30%	0.05 ug/Kg
gamma-BHC	85% - 115%	26.80%	0.025 ug/Kg
gamma-Chlordane	85% - 115%	29.30%	0.025 ug/Kg
Heptachlor	85% - 115%	20.50%	0.025 ug/Kg
Heptachlor epoxide	85% - 115%	33.40%	0.025 ug/Kg
Methoxychlor	85% - 115%	51.40%	0.25 ug/Kg
Toxaphene	85% - 115%	50%	0.2 ug/Kg
PCBs			
Aroclor 1016	85% - 115%	50%	16.7 ug/Kg
Aroclor 1221	85% - 115%	50%	16.7 ug/Kg
Aroclor 1232	85% - 115%	50%	16.7 ug/Kg
Aroclor 1242	85% - 115%	50%	16.7 ug/Kg
Aroclor 1248	85% - 115%	50%	16.7 ug/Kg
Aroclor 1254	85% - 115%	50%	16.7 ug/Kg
Aroclor 1260	85% - 115%	50%	16.7 ug/Kg
PNAs			
Acenaphthene	80%-120%	30%	40 ug/Kg
Acenaphthylene	80%-120%	30%	40 ug/Kg
Anthracene	80%-120%	30%	40 ug/Kg
Benzo(a)anthracene	80%-120%	30%	40 ug/Kg
Benzo(a)pyrene	80%-120%	30%	40 ug/Kg
Benzo(b)fluoranthene	80%-120%	30%	40 ug/Kg

Sample Collection SOP

Benzo(g,h,i)perylene	80%-120%	30%	40 ug/Kg
Benzo(k)fluoranthene	80%-120%	30%	40 ug/Kg
Chrysene	80%-120%	30%	40 ug/Kg
Dibenzo(a,h)anthracene	80%-120%	30%	40 ug/Kg
Fluoranthene	80%-120%	30%	40 ug/Kg
Fluorene	80%-120%	30%	40 ug/Kg
Hexachlorobenzene	80%-120%	30%	40 ug/Kg
Indeno(1,2,3-cd)pyrene	80%-120%	30%	40 ug/Kg
Naphthalene	80%-120%	30%	40 ug/Kg
Phenanthrene	80%-120%	30%	40 ug/Kg
Pyrene	80%-120%	30%	40 ug/Kg
VOCs			
1,1,1-Trichloroethane	80% - 120%	20%	1 ug/Kg
1,1,2,2-Tetrachloroethane	80% - 120%	20%	1 ug/Kg
1,1,2-Trichloroethane	80% - 120%	20%	1 ug/Kg
1,1-Dichloroethane	80% - 120%	20%	1 ug/Kg
1,1-Dichloroethene	80% - 120%	20%	1 ug/Kg
1,2-Dibromo-3-chloropropane	80% - 120%	20%	1 ug/Kg
1,2-Dichlorobenzene	80% - 120%	20%	1 ug/Kg
1,2-Dichloroethane	80% - 120%	20%	1 ug/Kg
1,2-Dichloropropane	80% - 120%	20%	1 ug/Kg
1,3-Dichlorobenzene	80% - 120%	20%	1 ug/Kg
1,4-Dichlorobenzene	80% - 120%	20%	1 ug/Kg
2-Butanone	80% - 120%	20%	10 ug/Kg
2-Chloroethyl vinyl ether	80% - 120%	20%	10 ug/Kg
2-Hexanone	80% - 120%	20%	25 ug/Kg
4-Methyl-2-pentanone	80% - 120%	20%	25 ug/Kg
Acetone	80% - 120%	20%	25 ug/Kg
Acrolein	80% - 120%	20%	25 ug/Kg
Acrylonitrile	80% - 120%	20%	25 ug/Kg
Benzene	80% - 120%	20%	1 ug/Kg
Bromodichloromethane	80% - 120%	20%	1 ug/Kg
Bromoform	80% - 120%	20%	1 ug/Kg
Bromomethane	80% - 120%	20%	1 ug/Kg
Carbon disulfide	80% - 120%	20%	1 ug/Kg
Carbon tetrachloride	80% - 120%	20%	1 ug/Kg
Chlorobenzene	80% - 120%	20%	1 ug/Kg
Chloroethane	80% - 120%	20%	1 ug/Kg
Chloroform	80% - 120%	20%	1 ug/Kg
Chloromethane	80% - 120%	20%	1 ug/Kg

Sample Collection SOP

cis-1,2-Dichloroethene	80% - 120%	20%	1 ug/Kg
cis-1,3-Dichloropropene	80% - 120%	20%	1 ug/Kg
Dibromochloromethane	80% - 120%	20%	1 ug/Kg
Dichlorodifluoromethane	80% - 120%	20%	1 ug/Kg
Ethylbenzene	80% - 120%	20%	1 ug/Kg
m,p-Xylene	80% - 120%	20%	2 ug/Kg
Methyl tert-butyl ether	80% - 120%	20%	1 ug/Kg
Methylene chloride	80% - 120%	20%	5 ug/Kg
o-Xylene	80% - 120%	20%	1 ug/Kg
Styrene	80% - 120%	20%	1 ug/Kg
Tetrachloroethene	80% - 120%	20%	1 ug/Kg
Toluene	80% - 120%	20%	1 ug/Kg
trans-1,2-Dichloroethene	80% - 120%	20%	1 ug/Kg
trans-1,3-Dichloropropene	80% - 120%	20%	1 ug/Kg
Trichloroethene	80% - 120%	20%	1 ug/Kg
Trichlorofluoromethane	80% - 120%	20%	1 ug/Kg
Vinyl chloride	80% - 120%	20%	1 ug/Kg
Total Xylenes	80% - 120%	20%	2 ug/Kg
Herbicides			
2,4-D	85% - 115%	N/A	0.0033 mg/Kg
2,4,5-TP	85% - 115%	N/A	0.0033 mg/Kg
<u>Sediment Inorganics</u>			
TKN	90% - 110%	20%	100 mg/Kg
Phosphorus	90% - 110%	20%	2.3 mg/Kg
Cyanide (low)	90% - 110%	20%	0.1 mg/Kg
Phenols	90% - 110%	20%	0.005 mg/Kg

* The limit of sensitivity is defined by the MDL. All laboratory instruments utilize a calibration defining instrument response. Any measurement falling above the upper calibration range is diluted to fall within range.

Illinois Environmental Protection Agency

Bureau of Water

Document Control Number 174

**Standard Operating Procedure for
Surficial Sediment Collection**

Surface Water Section

1021 North Grand Avenue East

P.O. Box 19276

Springfield, Illinois 62794-9276

Contact: Bureau of Water, Quality Assurance Officer 217-782-3362

1.0 Scope and Application

This Standard Operating Procedure (SOP) describes how to collect and handle surficial sediment samples from streams and lakes. Surficial sediments are deposited solid materials that have settled from the water column to the stream or lake bottom. The surface layer of sediment is collected and analyzed to identify the presence and amounts of various organic and inorganic compounds. This SOP focuses on collecting surficial sediments within a limited range of particle sizes. To facilitate laboratory analysis and to achieve comparability of results among sediment samples from different streams or different reaches within a stream, all sediment samples submitted for analysis are restricted to comprising particles of 63 microns or smaller in size. For this reason, samplers focus on sites predominated by fine sediments: sand (0.0625 – 2 mm in diameter), silt/mud (0.0039 - 0.0625 mm), clay (< 0.0039 mm), or combinations of these. For streams, this SOP pertains to collecting sediment during low-flow conditions. Both stream and lake sediment samples are typically collected May – October.

2.0 Summary of Method

In Illinois streams and lakes, surficial sediments commonly comprise silt, clay, fine organic material, and larger particles (sand, gravel, etc.). In streams during periods of low flow, the smaller sediment particles settle to the bottom in areas of slowest water velocity such as pools or areas downstream of bars, logs, or other flow obstructions. For streams, the upper ½ inch (1-2 cm) layer of sediment is collected. After retrieval, the sediment is sieved with properly cleaned stainless-steel equipment, placed in quart jars on ice to allow the sediment to settle from the water column. After settling, the supernatant is poured off and the sediment is placed in appropriate bottles and forwarded to the laboratory. For lakes, sediment is collected from the uppermost ½ inch (1-2 cm) layer of dredge-collected material, placed in the appropriate bottles and forwarded to the laboratory.

3.0 Interferences and Corrective Action

3.1 Dirt, oils, or other unintended substances on equipment used to collect a sample can contaminate the sediment sample and bias the laboratory results. Equipment is field cleaned and rinsed prior to use before each station is sampled.

3.2 Use stainless-steel sampling equipment when possible. If stainless-steel equipment is not available, it is acceptable to use other equipment if all non-stainless-steel surfaces that directly contact the sampled sediment are covered with epoxy paint.

3.3 Care should be taken to minimize disturbance of sediment prior to sample collection. When collecting sediment by wading using a hand held spoon, collect the composite portions from downstream to upstream. Avoid areas previously disturbed by earlier sampling (i.e., macroinvertebrate, fish population, etc.). On lakes or large rivers, when deploying an Ekman or

Petite Ponar dredge, lower the sampler slowly to avoid washing out the uppermost sediment layer. Raise the sampler slowly to minimize material loss.

3.4 Larger particles and organic matter may clog the pores of the sieve. Rinse the sieve often in ambient stream water to clear the sieve.

3.5 Minimize windblown material (e.g., plant seeds, dust, etc.) from being deposited in the sample pan and sieve by positioning sieving location in a protected area.

4.0 Safety

4.1 Follow the general field-safety guidelines in Illinois EPA, Bureau of Water's *Surface Water Section Field Safety Manual* (Document Control Number 151).

4.2 Do not use or store isopropyl alcohol near sparks, flames, or any other source of excessive heat. Use caution when storing isopropyl alcohol in a closed vehicle during warm weather.

4.3 Isopropyl alcohol can irritate eyes and skin. Wear protective eyewear, gloves, and an apron (recommended) when using this product. Flush with clean water in the event of eye or dermal contact.

4.4 Collecting a stream or lake sediment sample requires wading into or being on the water. Prior to wading to collect a sample, determine the safety of entering the stream. Be aware that water depth, water velocity, and type of stream bottom influence the ability to safely wade a stream. When collecting a sample by boat, follow all boating-safety guidelines.

4.5 The Petite Ponar dredge is a heavy, center-pivot sampler that presents a pinching hazard when closing. Use caution when handling an open Ponar sampler. Keep the safety pin that locks the jaws open in place at all times other than when collecting a sample. The Eckman dredge is a messenger style spring-loaded jaw sampler that presents a pinching hazard when closing. Use care when handling the sampler while collecting a sample. Transport the sampling device with the jaws in the closed position.

5.0 Equipment and Supplies

Stainless-steel Equipment:

- ASTM-E11 No. 230 sieve (63-micron mesh)
- Pan (minimum size 12x12x3 inch)
- Bowl (minimum size 8 qt. capacity)
- Long-handled "serving" spoon (minimum 12" long)

Grab Sampler:

- Petite Ponar dredge (15 cm x15cm; sample area 232 cm²; dry weight 11 kg.)
- Eckman dredge (15 cm x15cm; sample area 232 cm²; dry weight 3 kg.)

Rope to suspend dredge
One-Quart Glass Jars with Lids and Labels: up to four per site
Aluminum Foil
Isopropyl alcohol (pesticide grade)
Deionized Water
Non-phosphate Detergent (e.g., Liqui-Nox)
Cleaning Brush with non-metallic bristles
Waterproof Marker
Laboratory Sample Bottles:
 One (1) 250-ml glass bottle for organic analysis
 One (1) 250-ml plastic (non-preserved) for metals analysis
Media for Documenting/Describing the Sampling Event and Samples (e.g., hardcopy "Request for Laboratory Analysis" forms, laptop computer)
Coolers with ice for cooling samples

It is the responsibility of the sample technician to select the appropriate sampling equipment and method for the type of media to be collected in order to meet the monitoring objectives.

6.0 Cleaning Sampling Equipment in the Field

Clean and rinse all sampling equipment before using it at each stream reach or lake. Clean equipment as follows:

- Wash all sampling equipment—including quart jars and foil liners (not used for lakes) with a non-phosphate detergent (i.e., Liqui-nox) by using a brush to remove dirt or oil.
- Rinse all equipment with deionized water.
- Rinse all equipment with isopropyl alcohol.
- Rinse again all equipment with deionized water.
- Rinse all equipment with ambient stream or lake water.

7.0 Sediment Sample Collection

7.1 Stream-Sediment Collection – Wadable Streams: Typically, Illinois EPA sediment sampling in streams corresponds closely with biological-assemblage sampling; therefore, the station for sediment sampling is the section of stream (reach) selected for biological sampling. To sufficiently reflect sediment conditions of the stream, the sampler composites sediments from various appropriate sites throughout the sampling reach. Typically, appropriate sediment deposits are in areas of reduced velocity such as pools or areas downstream of gravel (or sand) bars, logs, or other flow obstructions. This section (7.1) refers to sample collection in relatively shallow stream reaches that are accessible by wading.

7.1.1 Clean and rinse all sediment sampling equipment as described in Section 6.0 prior to sampling.

- 7.1.2 Identify multiple sediment-deposition sites throughout the sampling reach. At identified sites, use the long-handled spoon and bowl to collect and composite sediment from the top (i.e., 1/2 inch) layer. To facilitate sieving, try to minimize the amount of sand and larger particles collected.
- 7.1.3 Using a one-quart glass jar and the stainless-steel, 63-micron sieve, pour approximately 2 quarts of sieved stream water through the sieve and into the stainless-steel pan. Use only ambient stream water from the immediate vicinity of sediment collections. Use of water from another source may contaminate and/or dilute the sample.
- 7.1.4 Place a spoonful of sediment into the 63-micron stainless-steel sieve. If there is a considerable amount of aggregated clay/muck in the sediment, add a small amount of water to break down the aggregate to facilitate sieving.
- 7.1.5 Place the sieve in the stainless-steel pan, with the mesh below the water level. Use short (less than 1/2 inch), pulsing strokes of the sieve to pulse water up and down through the sieve. After about 2-3 minutes, stop the pulsing action and raise the sieve out of the water. Most of the 63-micron or smaller particles and all of the water will pass through the sieve and be deposited in the pan.
- 7.1.6 Rinse the sieve in the stream to remove any material remaining in the sieve.
- 7.1.7 Repeat the prior three steps until approximately a 3-4 mm thick layer of sediment is captured in the pan. Generally, 30-45 minutes of sieving is required to assure an adequate amount of sample.
- 7.1.8 By gently rocking the pan with the water and sieved sediment, re-suspend the sediment and pour the contents into up to four rinsed one-quart jars filling the jars to the shoulders. Cover each jar with foil and seal it with the lid. If, after filling the jars, there is a significant amount of settled material in the pan, wait several minutes for the sediment in the jars to settle, pour off the supernatant and re-fill the jars to the shoulders.
- 7.1.9 Properly label the jars and place them in a cooler with sufficient ice (a volume of ice equal to at least the volume occupied by samples, but preferably twice the volume of ice to samples) surrounding the jars to cool them to 6°C or less. Fill out the appropriate sample/sampling documentation (e.g., "Request for Laboratory Analysis" form).
- 7.1.10 Allow the contents of the jars to settle for a minimum of 12 hours (e.g., overnight). After the sediment (including all fine or organic material) has settled, decant the overlying water (supernatant) from each of the jars. Transfer the sediment from the jars into appropriately labeled 250-ml laboratory sample bottles. Fill each bottle to approximately one-half full (i.e., 125 ml) to ensure enough material for lab analysis.

7.1.11 Place laboratory sample bottles into a cooler with sufficient ice to maintain samples at 6°C or less, or place the sample bottles refrigerator. Allow samples to settle for at least 24 hours. After sediments (including all fine or organic material) settle, decant excess water from each bottle (to prevent expansion and cracking) and place it in a standard freezer that maintains a temperature of -10°C or less.

7.2 Stream-Sediment Collection – Non-Wadable Streams: Typically, Illinois EPA sediment sampling in streams corresponds closely with biological-assemblage sampling; therefore, the station for sediment sampling is the section of stream (reach) selected for biological sampling. To sufficiently reflect sediment conditions of the stream, the sampler composites sediments from various appropriate sites throughout the sampling reach. Typically, appropriate sediment deposits are in areas of reduced velocity such as pools or areas downstream of point bars, islands, logs, or other flow obstructions. This section (7.2) refers to sample collection in streams sampled by using a rope-suspended Petite Ponar or Eckman dredge style sampling device. These streams are generally too deep to wade and are accessed by boat.

7.2.1 Clean and rinse all sediment sampling equipment as described in Section 6.0 prior to sampling.

7.2.2 Identify multiple sediment-deposition sites throughout the sampling reach. Set sediment sampler jaws to sampling position and slowly lower the dredge until it contacts the bottom. If using the Petite Ponar dredge, allow enough slack to release the locking pin, thus allowing the jaws to close upon retrieval. Allow a few seconds for the Petite Ponar dredge to sink into the sediment and slowly lift the sample to the surface. If using the Eckman dredge, hold the rope taut after allowing the dredge to sink into the sediment. Release the brass messenger down the rope to trip the dredge mechanism, closing the jaws. Slowly lift the sample to the surface.

7.2.3 Deposit the dredged sediment into a clean stainless-steel pan.

7.2.4 Remove the top ½ inch layer from the sediment sample by using a clean stainless-steel spoon and deposit in a bowl. Repeat collection procedure until a sufficient amount of composited sample is collected.

7.2.5 To process the sample, complete steps described in Sections 7.1.3 – 7.1.11.

7.3 Lake-Sediment Collection - Typical Illinois lake sediments are generally comprised of fine particles. Samples are collected from a boat using a rope-suspended Petite Ponar or Eckman dredge sampling device. Due to the fine particle size of lake sediments, it is not necessary to sieve samples. Occasionally when retrieving a lake-bottom sample with a dredge, the fine sediment will be lost because a stick, shell, or other large debris prevents the jaws from completely closing, allowing the sediment to wash out.

7.3.1 Clean and rinse all sediment sampling equipment as described in Section 6.0 prior to sampling the first station on the lake. Between stations scrub away any mud or other debris with a brush and rinse all collection equipment thoroughly with ambient water.

7.3.2 Set sediment sampler jaws to sampling position and slowly lower the dredge until it contacts the bottom. If using the Petite Ponar dredge, allow enough slack to release the locking pin, thus allowing the jaws to close upon retrieval. Allow a few seconds for the Petite Ponar dredge to sink into the sediment and slowly lift the sample to the surface. If using the Eckman dredge, hold the rope taut after allowing the dredge to sink into the sediment. Release the brass messenger down the rope to trip the dredge mechanism, closing the jaws. Slowly lift the sample to the surface.

7.3.3 Deposit the dredged sediment into a clean stainless-steel pan.

7.3.4 Collect the sample from the top sediment layer (1/2 inch) by using a clean stainless-steel spoon, or collect sediment directly into appropriately labeled 250-ml laboratory sample bottles. Avoid collecting any large organic debris (sticks, leaves, etc.), large particles (sand, gravel etc) and/or sediment material that has come into contact with the pan. Fill each bottle to approximately one-half full (i.e., 125 ml) to ensure enough material for lab analysis. Fill out the appropriate sample/sampling documentation (e.g., "Request for Laboratory Analysis" form).

7.3.5 Place bottles in a cooler with sufficient ice (a volume of ice equal to at least the volume occupied by samples, but preferably twice the volume of ice to samples) to maintain samples at 6°C or less, or place the sample bottles refrigerator. Allow samples to settle for at least 24 hours. After sediments, including all fine or organic material, settle, decant excess water from each bottle (to prevent expansion and cracking) and place it in a standard freezer that maintains a temperature of -10°C or less.

8.0 Sample Preservation, Holding Time and Shipment

Freeze sediment samples until delivery to the laboratory for analysis. Frozen samples may be held for up to six months before laboratory analysis. Take care to adequately pack glass sample bottles in shipping cooler to avoid breakage during shipment to laboratory and to keep samples frozen. Deliver completed RFLA sheets to the laboratory with sample bottles.

9.0 References

American Society for Testing and Materials. 1990. Standard Practice for Decontamination of Field Equipment Used at Nonradioactive Waste Sites. (Designation D 5088 90). Philadelphia, PA.

United States Geological Survey. 1998. Chapter 9. *National Field Manual for the Collection of Water Quality Data*. U.S. Department of the Interior. Reston, Virginia.

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ATTACHMENT C

STANDARD OPERATING PROCEDURES

COLLECTION OF STREAM WATER SAMPLES

These methods allow for the collection of grab samples utilizing a high density polyethylene (HDPE) bucket or wide mouth HDPE or glass bottle. This standard operating procedure document (SOP) has been developed to maintain consistent data collection procedures and to ensure the quality of the data collected.

1.0 FIELD EQUIPMENT

The following equipment listed is necessary for sampling procedures.

1. 1-gallon HDPE bucket, nylon rope
2. Distilled or reagent-grade deionized water
3. Sample bottles:
 - a. One 1000 mL HDPE with H_2SO_4 preservative for $\text{NH}_3\text{-N}$, TKN and Total Nitrates
 - b. One 1000 mL HDPE unpreserved bottle for BOD, TSS, TDS, Chloride, Sulfate
 - c. One 1000 mL HDPE bottle with HNO_3 preservative for Metals, (including Phosphorous and Mercury)
 - d. Two 1000 mL amber glass bottles unpreserved for Pesticides, PCBs and PNAs
 - e. Three 40 mL VOA vials with HCl preservative for VOCs
4. Disposable gloves
5. Cooler and ice
6. Antibacterial soap
7. Sharpie markers and labels

8. Field books/log sheets/chain of custody
9. Portable pH meter
10. Sampling pole

2.0 PREPARATION

Before samples are collected, sample bottles should be labeled correctly with sampling point, sampling I.D. number, the sampler's initials, and a space for the date and time to be filled in later. Sample bottle lids should also be labeled to prevent contamination between samples.

Coolers and samples bottles should be inspected before samples are collected. If dirt, residual chemicals, or any other types of contaminants are present, the sample bottle should be discarded. The coolers should be washed with mild soap and wiped down if any contaminants are present.

Sampling buckets shall be scrubbed with a solution of soap and water. Make sure the cleaning detergent is free of phosphates (orthophosphate sample).

The sampler's hands should be washed with antibacterial soap prior to sampling events. Disposable gloves will be worn during sample collection, and special care should be taken to avoid touching the inner surface of sample lids or bottles.

3.0 PROCEDURE

Sample bottles should be kept closed until they are filled. At each sample collection site, the sampler will wear a new pair of gloves for decontamination and a new pair for sample collection.

If samples are taken from a bridge, collect the sample from the upstream side of the structure unless otherwise noted in site description maps.

When sample during precipitation events, the sample bucket shall be covered at all times with a lid.

A log-sheet/chain of custody should be maintained during sampling and should include the following information:

- a. Date and time of sample
- b. Signature of collector and transporter

- c. Signature of person who relinquished the sample to lab
- d. Weather conditions during sampling (i.e., air temperature; cloudy, rain, snow)
- e. Time
- f. Sample storage temperature upon receipt in lab
- g. Visual observation of sample
- h. Field measurements such as pH

3.1 Sample Collection HDPE Bucket or Wide Mouth Bottle

The bucket shall be inspected to ensure that it is in good condition. The nylon rope attached should not be frayed or torn.

3.1.1 Decontamination

The bucket and wide mouth bottle must be cleaned before samples are collected and between sampling sites. The equipment shall be cleaned with phosphate-free detergent and blank water. Blank water should be deionized water. The equipment should be scrubbed with detergent and deionized water before the rinsing steps below are followed. Alternatively, a new bottle may be used for each sample.

Step 1 – Blank Water Rinse

- Rinse the inside of the bucket or wide mouth bottle by swirling with blank water.
- Discard the remaining blank water.
- Repeat Step 1.

3.2 Sample Collection Procedure

The stream depth will determine the equipment to be used to collect the sample. To reduce the chance of disturbing the substrate/sediment the following protocols will be followed. Samples may be collected from the bridge with a bucket if the depth is at least twice the height of the bucket. At shallower depths the field technician will use a sampling pole with a wide mouth bottle at the end. As a last resort, the field technician will wade into stream and collect the sample, standing downstream of the collection point so as not to collect kicked up sediment.

Step 1a – River Rinse and Field Measurements from Bucket

- Lower the bucket into the stream and fill.
- Discard the contents.

Step 1b – River Rinse Wide Mouth Bottle

- River rinse by filling the bottle with river water.
- Discard the remaining contents.

Step 2 – Sample Collection - Bucket

- Lower the bucket to mid-depth at center of flow, do not disturb bottom sediment.

Step 2b – Sample Collection - Pole

- Lower the sample bottle attached to the sampling pole to mid-depth at center of flow, do not disturb bottom sediment.

Step 3 – Fill Sample Bottles

Fill each sample bottle. Over filling of sample bottles with preservative should be avoided to prevent loss of preservative.

3.3 Field Measurements

Sample pH must be measured on site within 15 minutes of collection. Follow the laboratory and manufacturer's instructions for calibrating, cleaning and using the pH meter. The pH results shall be recorded on the log-sheet/chain of custody.

4.0 SAMPLE HANDLING, TRANSPORTATION, QUALITY ASSURANCE, AND BLANKS

All samples are placed in a cooler with ice after labeling. Samples are to be transported to the laboratory within the prescribed holding times. All samples will be taken to Suburban Laboratory, Inc.

4.1 Quality Assurance

Field blank and duplicates shall be collected. The laboratory shall adhere to their Quality Assurance Plan Revision 8 for samples received in the lab. Quality control limits and frequency of field quality control samples is specified at the end of this SOP.

4.2 Duplicate Samples

Duplicate samples are to be filled from the same round of stream water. Duplicate samples will be taken for all parameters once per month.

4.3 Field Blank

Sample bottles should be filled with blank water from unopened blank water containers. One field blank should be performed for VOCs and Metals including Phosphorous and Mercury once per year.

5.0 CHAIN OF CUSTODY

Chain of Custody forms must be filled out and accompany all samples to their laboratory. An example is below.

CHAIN OF CUSTODY RECORD

Suburban Laboratories, Inc.
 1950 S. Baberib Ave. Geneva, IL 60134
 Tel. 708.544.3260 Fax: 708.544.9587 Toll Free: 800.793.LABS
 www.suburbanlabs.com

Company Name: _____
 Company Address: _____
 City: _____ State: _____ Zip: _____
 Phone: _____ Fax: _____
 Email Address: _____
 Project ID / Location: _____
 Project Manager (Report to): _____
 Sample Collection(s): _____

Page _____ of _____
 PO No. _____
 Shipping Method: _____
 O.C. Reporting Level: 1 2 3

LAB USE ONLY
 SUI Order No. _____
 Sample containers supplied by customer? Yes
 Temperature of Received Samples: _____ °C
 Samples received within 24 hours of collection? Yes

TURNAROUND TIME REQUESTED
 Normal RUSH* *Additional Rush Charges Apply.
 Date & Time Needed: _____
 Normal 3-5 business days for most tests. Rush work must be pre-approved and additional charges apply.

Specify Regulatory Program: None/Info only (Required)
 LUST SP SDWA
 503 Sludge NPDES MWRDOC
 Disposal Other _____ *Please specify in comment section below.

ANALYSIS & METHOD REQUESTED
 Enter an "X" in box below for request:

Additional Rush Charges Approved: Yes
 Additional Rush Charges Not Approved: No

SAMPLE IDENTIFICATION Please use 1 liter per container type	COLLECTION		MATRIX	CONTAINERS		PRESERVATIVE	ANALYSIS & METHOD REQUESTED Enter an "X" in box below for request:	CONDITION CODES 1. Improperly damaged container/cap 2. Improper preservation 3. Insufficient sample volume 4. Headspace not suitable for VOCs 5. Received past holding time 6. Received frozen 7. Label conflicts with COC
	DATE	TIME		GRAB	COMP.			
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								

Comments & Special Instructions: _____
 1. Requisitioned By: _____ Date: _____
 2. Received By: _____ Date: _____
 3. Requisitioned By: _____ Date: _____
 4. Received By: _____ Date: _____
 5. Requisitioned By: _____ Date: _____
 6. Received By: _____ Date: _____
 7. Requisitioned By: _____ Date: _____
 8. Received By: _____ Date: _____

Submission of samples subject to Terms and Conditions on back. Please fill out this form completely, print, sign & submit with samples. Keep a copy for your records.
 Rev. 2010/05

TABLE 2: Test Methods and Reporting Limits

Demand	Method	MDL/Reporting Limit
Chloride	325.2, EPA	0.5 mg/L
Conductivity	2510B, SM18th Ed.	2 µmhos/cm
pH	4500-H B, SM18th Ed.	N/A
TOC	5310B	1 mg/L
Sulfate	375.4, EPA	1 mg/L
TSS	2540D, SM18th Ed.	0.2 mg/L
VSS	2540E	0.2 mg/L
DO	4500 YSI field meter	0.1 mg/L
Temperature	170.1	°C
Turbidity	180.1	0.1 mg/L
Metals		
Total Hardness	2340B. SM18th Ed.	0.05 mg/L
Iron	200.7, EPA	0.005 mg/L
Sodium	200.7	0.1 mg/L
Arsenic	200.8	0.0008 mg/L
Manganese	200.8	0.002 mg/L
Mercury * (LOW LEVEL DETECTION LIMIT)	245.1, EPA or *1631 low det	0.0002 mg/L or 0.5 Ng/L
Copper	200.8, EPA	0.0005 mg/L
Nickel	200.8	0.0004 mg/L
Zinc	200.8, EPA	0.007 mg/L
Nutrients		
Ammonia	4500 NH3 D, SM18th Ed.	0.1 mg/L
Total Nitrates (NO2 + NO3)	352.1, EPA	0.05 mg/L
TKN	4500 NH3 C, SM18th Ed.	0.124 mg/L
Phosphorous	200.8, EPA	0.02 mg/L
Dissolved reactive Phosphorus	SM4500P E	0.026 mg/L
Chlorophyll a		
Sestonic Chlorophyll a	SM 10200H	4 mg/M ³
Bacteria		
E-coli	9213D	1 CFU/100ml
Water Organics		
PCBs	8082, EPA	0.1 ug/L
Pesticides	8081, EPA	0.025 ug/L
Methoxychlor	8081 EPA	0.25 ug/L
PNAs	8270, EPA	0.1 ug/L
VOCs	8260, EPA	1.0 ug/L
Sediment Organics		
PCBs	8082, EPA	16.7 ug/Kg
Pesticides	8081, EPA	0.833 ug/Kg
Methoxychlor	8081 EPA	0.833 ug/Kg
PNAs	8270, EPA	40 ug/Kg
Herbicides (2,4,D & 2,4,5 TP)	8321	0.004 ug/Kg
Sediment inorganics		
TKN	4500 NH3E	100 mg/Kg
Phosphorus	6010B, EPA	2.3 mg/Kg
Cyanide	9014	0.005 mg/Kg
Phenols	420.1	0.005 mg/Kg

TABLE 2: (cont.) Methods and Reporting Limits

	Method	MDL/Reporting Limit
Sediment Metals		
Aluminum	6010B, EPA	2.50 mg/Kg
Arsenic	6010B, EPA	1.15 mg/Kg
Barium	6010B, EPA	0.125 mg/Kg
Beryllium	6010B, EPA	0.0025 mg/Kg
Boron	6010B, EPA	0.05 mg/Kg
Cadmium	6010B, EPA	0.075 mg/Kg
Chromium	6010B, EPA	0.0600 mg/Kg
Cobalt	6010B, EPA	0.625 mg/Kg
Copper	6101B EPA	0.150 mg/Kg
Iron	6010B, EPA	0.625 mg/Kg
Lead	6010B, EPA	0.6 mg/Kg
Manganese	6010B, EPA	0.625 mg/Kg
Mercury	245.1	0.02 mg/Kg
Low level Mercury	1631	0.5 Ng/L
Nickel	6010B, EPA	0.235 mg/Kg
Potassium	6010B, EPA	2.5 mg/Kg
Silver	6010B, EPA	0.06 mg/Kg
Sodium	6010B EPA	1.25 mg/Kg
Strontium	6010B, EPA	0.120 mg/Kg
Vanadium	6101B EPA	0.150 mg/Kg
Zinc	6010B, EPA	0.075 mg/Kg
Fluoride	4500	0.05 mg/Kg