A1. Title and Approval Sheet

Quality Assurance Project Plan for
Benzie Watersheds Volunteer Stream Monitoring Project

Date: 2/9/2021
Version #
Organization: Benzie Conservation District

Program and QAPP manager: John Ransom
Title: Program and Quality Assurance Manager

Signature: _____

_____

Signature upon approval:

MiCorps Reviewer: _Paul Steen_____

Signature of reviewer Date

QAPP is approved for two years after the signature date given; afterwards it must be reapproved.

A2. Table of Contents

A3. Distribution List

Marcy Knoll Wilmes Michigan Department of Environment, Great Lakes, and Energy
Paul Steen, Huron River Watershed Council
Tad Peacock, Benzie Conservation District
John Ransom, Benzie Conservation District
Gerald Wilgus, BWVSMP Lead Volunteer
Dave Long, BWVSMP Lead Volunteer

A4. Project Organization

1. **Management Responsibilities –**

   1) John Ransom, Program and Quality Assurance Manager, Benzie Conservation District, 280 S. Benzie Blvd/PO Box 408, Beulah, MI 49617, 231-882-4391, John@benziecd.org. John is the project manager and quality assurance manager for the project. John is the project liaison with ultimate authority for this project. His responsibilities include:

   - Develop and adhere to the Quality Assurance Project Plan.
   - Promote volunteer stream monitoring activities and solicit volunteers and stream access permissions from local community.
   - Research and purchase necessary equipment for performing stream monitoring activities.
   - Coordinate and conduct volunteer stream monitoring training events.
   - Coordinate volunteer stream monitoring field data collection events.
   - Coordinate macroinvertebrate indoor sorting and identification sessions.
   - Catalogue and store collected specimens.
   - Database development, data entry, and data analysis.
   - Write reports and update web-page with latest information on an annual basis to share with volunteers and the general public.
   - Provision of products and deliverables to MiCorps. All data collected will be sent electronically to the MiCorps database manager on an annual basis.
   - Project evaluation.

   2) Tad Peacock, Executive Director, Benzie Conservation District, 280 S. Benzie Blvd/PO Box 408, Beulah, MI 49617, 231-882-4391, tad@benziecd.org. Tad's responsibilities include:

   - Development and submission of status reports following MiCorps guidance on a quarterly basis.
   - Administration and accounting of grant funds.

2. **Field Responsibilities** – Field sampling will be performed by volunteers and project staff. Team leaders and collectors will receive training in field data collection methods by Benzie Conservation District staff and lead volunteers.

1) Gerald Wilgus, Max Bromley, and Dave Long, Lead Volunteers. The lead volunteers are community members with professional experience in macroinvertebrate monitoring. The leads play an integral part in project implementation, and their responsibilities include:
    - Assist with project design and QAPP development.
    - Assist with volunteer recruitment and training.
    - Conduct monitoring site mapping and habitat assessments.
    - Lead field macroinvertebrate collection events. Lead volunteers will fill out site data sheets and coordinate the activities of all volunteer team members including collectors, runners, and pickers.
2) Project Volunteers. Most tasks of the field collection events will be done by volunteers recruited from partner groups and the community in general. Prior to each collection event, there will be at least one training opportunity for volunteers to attend if they choose. Volunteers at field collection events may serve as collectors, runners, or pickers.
    - Collectors will sample all in-stream habitats that exist at the site and provide sample contents to pickers for processing.
    - Runners will take materials from the collectors in buckets and bring it to the pickers.
    - Pickers will pick macroinvertebrate specimens from sample contents provided by the Collector, presort the macroinvertebrates, and preserve at least 100 specimens per site in alcohol for later identification.

3. **Laboratory Responsibilities** – Macroinvertebrate sorting and identification will be conducted either at the Benzie Conservation District office or at the biology classroom of Benzie Central High School. General volunteers will normally assist in order-level identification, and family-level identification will be conducted by the lead volunteers, project manager, and experienced general volunteers.
    1) John T. Ransom, Program and Quality Assurance Manager, Benzie Conservation District, 280 S. Benzie Blvd/PO Box 408, Beulah, MI 49617, 231-882-4391, John@benziecd.org will be responsible for organizing macroinvertebrate identification events (order level) with volunteers and assisting the lead volunteers with family-level macroinvertebrate identification.
    2) Gerald Wilgus, Lead Volunteer will assist with volunteer macroinvertebrate identification events (order level) and conduct family-level macroinvertebrate identification.
4. **Corrective Action –** John T Ransom, Program and Quality Assurance Manager, Benzie Conservation District, 280 S. Benzie Blvd/PO Box 408, Beulah, MI 49617, 231-882-4391, John@benziecd.org will be responsible for initiating, developing, approving, implementing, and reporting corrective actions.

A5. Problem Definition/Background

Benzie County is endowed with a great abundance of high-quality lakes and streams that form a critical component of our beautiful and world-renowned landscape. An example of this renown came in 2011 when viewers of Good Morning America voted Sleeping Bear Dunes National Lakeshore, half of which lies on the Benzie coast of Lake Michigan, the most beautiful place in America. Tourism and agriculture are the two major sources of income and jobs in Benzie County, and our lakes and streams figure prominently in what attracts people to this area. In surveys conducted by the Benzie Conservation District, stakeholders overwhelmingly voted surface water quality as the most important resource concern in Benzie County.

There are currently water quality monitoring programs on all of the major lakes in Benzie County, some of which have been going continuously for more than 20 years. The Benzie Conservation District organized the Benzie Watersheds Coalition, a collaborative group consisting of lake associations, local municipalities, watershed councils, government agencies, and other groups concerned with water quality and watershed management. Unfortunately, the monitoring of streams in the area has been very spotty, and very few sites have consistent long-term data.

The Benzie Conservation District seeks to continue its leading role in the critical job of monitoring and protecting our precious water resources. We cannot allow our most important asset to be squandered away or degraded in any way. The *Benzie Watersheds Volunteer Stream Monitoring Project* will be a tool to educate and engage people in watching over and protecting our streams, giving them a greater sense of stewardship.

The goal of the Benzie Watersheds Volunteer Stream Monitoring Project is to protect and improve the water quality of the streams of the Platte River, Betsie River, and Herring Lakes watersheds of Benzie County. The four specific objectives for the project are:

1. Educate Benzie County residents on monitoring, quality, and protection of our water resources.
2. Engage stakeholder groups and individuals in hands-on water monitoring and protection.
3. To monitor stream health in the three major watersheds of Benzie County. This includes establishing baseline conditions and monitoring deterioration or improvements over time.
4. Identify or verify problem areas where degradation has occurred and where remediation or best management practices can be implemented.

Although the streams in the project area are generally of high quality, known and potential problem sites do exist as a result of non-point source pollution, degraded/inadequate road/stream crossings, former dam sites, residential development, sedimentation and bank erosion, recreational impacts, point-source pollutants, potential oil and gas exploration, and invasive species. The presence of these threats makes it vital to augment water quality monitoring efforts in Benzie County.

The key elements to accomplishing the goal of the Benzie Watersheds Volunteer Stream Monitoring Project are the education and involvement of the community in water resource stewardship (Objectives 1 & 2). As more people become involved and learn about water monitoring and protection, the more likely they are to take care of local waters and become involved in community decision making that can impact water quality. The data gathered will be useful for community governments and citizens for educational and decision-making purposes.

A6. Project Description

The *Benzie Watersheds Volunteer Stream Monitoring Project* focuses on biological and habitat monitoring as a tool to assess stream water quality and ecosystem integrity. Aquatic macroinvertebrates are collected and identified to determine diversity in the benthic community and the presence of pollution-sensitive macroinvertebrate families. The results of these collections are used to gauge the health of the stream reach. Biological monitoring will be conducted twice a year, once in springtime and once in fall. In addition to biological monitoring, volunteers will conduct a stream habitat assessment at each monitoring site which includes site sketches, photos, stream cross-sections, and descriptions of the habitats present. Habitat assessments will be conducted at the beginning of the project and every two or three years afterwards.

Of equal importance to the monitoring activities, is the education and development of project volunteers. There will be at least two volunteer training activities per year, corresponding to the periods before each field monitoring event. Volunteers will normally be permanent or seasonal residents of Benzie County, and can include all ages from elementary school to seniors. Volunteers can be involved in the program to the extent that their interest, time, and expertise allow. It is hoped that some volunteers will be involved long-term and will increase their knowledge enough to take on leading roles in implementing the project and training new volunteers.

The project will focus on the three main watersheds of Benzie County: **Platte River**, **Betsie River**, and **Herring Lakes**. To begin, there will be one collection team per watershed sampling 3 or 4 sites per event. Depending on volunteer turnout and development, the number of sampling sites and teams may be increased. The sampling sites for each watershed were selected based on the following criteria:

1. Sites with prior benthic macroinvertebrate sampling data
2. Site-level concerns such as road/stream crossings, former dam sites, recreational impacts, etc…

3. Representation of zones along the length of a river or stream that are significantly different from the rest of the watershed.
4. Accessibility

A7. Data Quality Objectives

Precision/Accuracy: Streams monitored in this program are assessed by examining aquatic macroinvertebrate community diversity. Quality control during field data collection, to guarantee precision and accuracy, is accomplished by the Program Manager or team leader who accompanies teams to observe their collection techniques and note any divergence from protocols. In addition, key team members (leaders and collectors) must have attended at least one training event prior to the field collection event. The Program Manager will alternate between teams during each sampling event. If the program expands, and more sites and/or teams are added, the Program manager will accompany new teams during their first macroinvertebrate sampling event and collect duplicate samples.

Techniques reviewed at training events and in the field include [1] collecting style (must be thorough and vigorous), [2] habitat diversity (must include all habitats and be thorough in each one), [3] picking style (must be pick thoroughly through all materials collected and pick all sizes and types) [4] variety and quantity of organisms (must ensure that diversity and abundance at site is represented in sample), and [5] the transfer of collected macroinvertebrates from the net to the sample jars (specimens must be properly handled and jars correctly labeled). Side-by-side sampling results (by program manager) are compared with volunteer team results to determine if there is a strong divergence between measures of stream quality index (SQI) and total diversity (D). If either score varies strongly (using an 80% threshold), then follow-up is carried out wherein program manager reviews methods with team members and encourages attendance at future training sessions.

The accuracy of specimen identification is dependent upon the abilities of the experts aiding in the indoor identification session. Because of the inexperience of most volunteers, the Program Manager will verify all identifications for the first three collection events. This will allow interested volunteers to gain experience in identification without affecting accuracy. Once skilled experts are identified, the Program Manager will review at least 10% of all samples identified. If more than 10% of specimens were misidentified, then all the samples processed by that expert will be reviewed.

Additionally, MiCorps staff conducted a method validation review with the Program Manager to ensure his expertise. This review consisted of a joint duplicate sampling event. No collecting deficiencies were identified and therefore, additional training in deficient tasks was not required.

A given site's Stream Quality Index (SQI) score or total diversity (D) measure across macro-invertebrate taxa will be noted as "preliminary" until three spring sampling events and three fall sampling events have been completed. At least two of these six measures will be collected by different volunteer teams to avoid consistent errors. The resulting measures of D and SQI for each site will be compared to the composite (median) results and each should be within two standard deviations of the median.

Bias: Sites will be sampled by different teams at least once every three years to examine the effects of bias in individual collection styles. A relative percentage difference (RPD) calculation between the new measure and the mean of past measures should be less than 40% for both SQI and D. Sites not meeting this data quality objective will be evaluated by the Program Manager.

Completeness: Following a QA/QC review of all collected and analyzed data, data completeness will be assessed by dividing the number of measurements judged valid by the total number of measurements performed. The data quality objective for completeness for each sampling event is 90%. If the program does not meet the standard, the Program Manager will consult with MiCorps staff to determine the cause of data invalidation and develop a course of action to improve data completeness in future sampling events.

Representativeness: Study sites are selected to represent the full variety of stream habitat types available in each watershed. All available habitats within the study site will be sampled and documented to ensure a thorough sampling of all of the organisms inhabiting the site. Effort has been made to locate sampling sites in areas that represent the differing conditions within each watershed. Resulting data from the monitoring program will be used to represent the ecological conditions of the contributing watershed. Since limited resources are available to allow the program to cover each watershed in its entirety, some subwatersheds will not initially be represented. Additional sampling sites will be added as resources and volunteers allow.

Comparability: To ensure comparability, all volunteers participating in the program will follow the same sampling methods and use the same units of reporting. The methods are based on MiCorps standards, which will increase comparability with other MiCorps programs. Periodic reviews of sampling events by the Program Manager will ensure adherence to these standard methods.

A8. Special Training/Certifications

The Program Manager coordinates trainings and ensures that all program personnel and volunteers are properly trained. The Program Manager received Volunteer Stream Monitoring Grantee Training provided by MiCorps staff. This training provides information about basic stream monitoring methods established by MiCorps. Topics covered included stream

macroinvertebrate sampling and identification (to the order level), habitat assessment, data management and entry into the MiCorps database, attracting and retaining volunteers, and program evaluation. The training included both indoor and field components, and was conducted by Huron River Watershed Council and Great Lakes Commission staff.

Volunteer team Leaders and Collectors are trained by the Program Manager and/or lead volunteers in basic stream monitoring methods prior to field day collections. The training covers program goals and objectives, macroinvertebrate collection methods, filling out field data sheets, safety issues, and quality assurance practices. At least one training event will be hosted by the Conservation District prior to each field collection event, with additional training possible according to need. A spreadsheet will be developed by the Program Manager that lists all volunteers that have received training as well as the date of the training. Leaders and collectors, as well as other volunteers, are encouraged to attend training at least every three years to refresh their knowledge of program components and to learn about any changes incorporated into the program. Training refreshers are also accomplished through side-by-side monitoring with the Program Manager.

B1. Study Design & Methods

Monitoring Sites: Monitoring sites were chosen to assess water quality in areas of concerns and to monitor longitudinal variation in stream systems. The Program Manager and lead volunteers visited potential monitoring sites on target streams and assessed the sites in terms of habitat diversity present, accessibility, and safety. A geographical information system (GIS) was used to develop maps depicting stream channels, sample sites and watershed boundaries in the study area.

The **Betsie River watershed** is located in Grand Traverse, Manistee, and Benzie Counties, and drains roughly 155,026 acres. The Betsie River originates at Green Lake in Grand Traverse County and flows for nearly 50 miles to Betsie Lake and Lake Michigan near Elberta and Frankfort in Benzie County. The two largest tributaries to the Betsie River are the Little Betsie River and Dair Creek. The Betsie River has been a state-designated Natural River since 1973. The river has two former hydroelectric dam sites, a waterfowl flooding in the headwaters, and an additional former dam site on Dair Creek. In 1989, the hydroelectric dam near Thompsonville washed out, adding thousands of cubic yards of sediment to the river. There have been more than 20 years of efforts to reduce sediments and restore erosion sites. Some of the resource concerns for the Betsie River watershed are: sedimentation and bank erosion, former dam sites, deteriorated and/or inadequate road/stream crossings, invasive species, recreational use, and residential development.

Sampling sites for the Betsie River watershed:

1. (BCD_Betsie_B1) Lewis Bridge Canoe Access, Betsie River (Betsie River main stream upstream of River Road near Adams Road). Longitude: -86.167874, latitude: 44.618761.

This is a typical area of the lower river, having a mostly sand substrate, slower currents, and patches of emergent and submergent vegetation. The surrounding area is mostly hardwood swamp.

2. (BCD_Betsie_B2) Wolfe Road Bridge, Betsie River mainstream (upstream from canoe access towards the bridge). Longitude: -85.949242, Latitude: 44.528654. Former site of the Thompsonville Dam, this is a typical site in the middle reaches of the main stream, having diverse in-stream habitats and being surrounded by pine and hardwood forests.
3. (BCD_Betsie_B3) Little Betsie River, Bentley Road east crossing (upstream of bridge). Longitude: -85.909975, Latitude: 44.534803. Site of a recent road/stream crossing improvement, this is a major tributary to the Betsie.

The **Platte River watershed** is located primarily in Benzie County, and drains roughly 123,200 acres, including lakes. The Platte originates from a series of lakes in western Grand Traverse County and flows for about 20 miles before it reaches Platte Lake and then another 5 miles to the confluence with Lake Michigan. The river mouth is located in Sleeping Bear Dunes National Lakeshore and much of the river proper lies within the Pere Marquette State Forest. The Platte River State Fish Hatchery is located on the upper river. The facility raises coho and chinook salmon and is the main egg take station for coho salmon in the upper Great Lakes. In the past, the hatchery contributed massive phosphorus discharges into the river, resulting in a lawsuit and years of legal negotiations between the Platte Lake Improvement Association and the DNR Fisheries Division. As a result, hatchery operations have improved to the point that it is now a zero-discharge facility. The main resource concerns for the Platte River watershed are: phosphorus levels, residential development, deteriorated and/or inadequate road/stream crossings, invasive species, runoff from urban and agricultural areas, and a small tributary with contaminated water from a documented case of fruit waste dumping.

Sampling sites for the Platte River watershed:

1. (BCD_Platte_P1) Reynolds Road bridge, Platte River main stream (downstream). Longitude: -85.861781, Latitude: 44.706925. This warm-water site is just downstream from Lake Ann. The old undersized culverts were replaced in 2012 with a timber bridge and habitat restoration was implemented on the entire stream channel and riverbank.
2. (BCD_Platte_P2) US-31 bridge at Veterans Memorial State Forest Campground, Platte River main stream (downstream from canoe access). Longitude: -85.943964, Latitude: 44.65929. This site is about ¼ mile downstream from the State Fish Hatchery, which was the cause of the lawsuit over phosphorus discharges. It is mostly fast-flowing with a gravel substrate. Riparian areas are mostly forested.
3. (BCD_Platte_P3) Indian Hill Road bridge, Platte River main stream (downstream of bridge). Longitude: -86.038903, Latitude: 44.670812. This is an area of sand/mud substrate where large *Hexagenia* mayfly hatches have historically occurred, but have been much lower in recent years according to area fishermen. Lampricide treatments are also conducted in this area, and the area is just downstream from the village of Honor, and its potential non-point source pollution.

The **Herring Lakes watershed** is located almost entirely in the southwest corner of Benzie County and encompasses 16,210 acres. Herring Creek flows through both Upper Herring Lake and Lower Herring Lake before reaching Lake Michigan. The upper watershed consists of a myriad of small tributaries flowing through primarily agricultural land, forests, and a large wetland. Herring Creek forms at the junction of various tributaries just upstream of Upper Herring Lake. The primary resource concerns in the Herring Lakes watershed are: fecal, nutrient, and pesticide contamination from agricultural and residential areas, and sedimentation.

Sampling sites for the Herring Lakes watershed:

1. (BCD_Herring_H1) Elberta Resort Road, Herring Creek (upstream from bridge). Longitude: -86.205467, Latitude: 44.570814. This is the connection between Upper and Lower Herring Lakes.
2. (BCD_Herring_H2) Swamp Road, south tributary crossing (upstream of culvert). Longitude: -86.140225, Latitude: 44.542763. This small tributary often exhibits elevated *E. coli* levels, but supports a population of brook trout.
3. (BCD_Herring_H3) Raymond Road tributary crossing (upstream of culvert). Longitude: -86.165277, Latitude: 44.566302. This is another tributary to Herring Creek that supports a population of brook trout.
4. (BCD_Herring_H4) Gorivan Road crossing, Herring Creek (beginning about 200 feet upstream of road crossing). Longitude: -86.170235, Latitude: 44.558877. This crossing is just upstream from Upper Herring Lake, and consistently exhibits elevated *E. coli* and phosphorus levels. The confluence of several tributaries to form Herring Creek occurs just upstream of this crossing.

Equipment for Field Macroinvertebrate Collection: Field sampling gear includes D-frame nets, white sorting trays, waders, five gallon buckets, 4 oz. plastic sample jars, 70% ethanol, plastic and metal forceps, eye droppers, ice cube trays, plastic squirt bottles, food strainers, field data sheets (order level), clipboards, and pencils. The Program Manager and Lead Volunteers will organize and prepare equipment for each team prior to the sampling event. Two sample jars will be prepared for each site. Each jar will be half-filled with 70% ethanol and pre-labeled in pencil on an adhesive label with the site name, date, and watershed.

Study Methods for Field Macroinvertebrate Collection: For each sampling event, monitoring by volunteers will be completed within the same two week period each year. If a site is temporarily inaccessible, due to factors such as prolonged high water, the monitoring time may be extended for two additional weeks. If the issue concerning inaccessibility is continued beyond the extended dates, then no monitoring data will be collected during that time and there will be a gap in the data. If a team is unable to monitor their site during the specified time, the Team Leader will contact the Project Manager as soon as possible and no later than the end of the first week in the sampling window in order for the Manager to arrange for another team to complete the monitoring. If no team is available, the Project Manager will

be responsible to see that the site is monitored unless sufficient redundancy has been included in the monitoring schedule that additional data is not needed. The morning of the sampling event, the teams will meet at the Benzie Conservation District. There will be a brief welcome and safety review prior to leaving.

Upon arriving at the site, the leader and collector will inspect the sampling gear to ensure that it is clean. If there is debris or aquatic life on any of the equipment, water withdrawn from the stream with a clean container will be used to clean the equipment at a distance of not less than 100 feet from any water body. The Leader will instruct and assist other team members in techniques for finding and collecting macroinvertebrates in the sorting pans. A trained aquatic macroinvertebrate Collector will collect numerous samples at each site with the goal of sampling each habitat type (i.e., riffles, runs, pools, woody debris, etc.) in the stream reach three times. The Collector will also gather rocks, logs, sticks and other debris to collect macroinvertebrates from. Collectors should start downstream and work upstream. Collection sites should include 300 feet of stream length. Sites on small streams will be sampled for a minimum of 30 minutes while those on large streams will be sampled for at least one hour. D-frame nets will be used to sample all habitat types. The contents of the net may be emptied directly into white sorting trays, or the nets may be emptied into clean buckets for runners to bring to the picking area. Plastic squirt bottles with river water will be used to ensure all material from collection nets is passed to the buckets and/or trays. Volunteers will pick aquatic organisms from the tray using forceps, squirt bottles, eye droppers, or strainers. The picked organisms will be placed directly in the pre-labeled sample bottles for that site filled with 70% ethanol. Examples of interesting or rare taxa can be temporarily placed in ice cube trays so that all volunteers can see them. These organisms must be placed in the sample jars prior to leaving the site. Volunteer teams are encouraged to collect a minimum of 100 specimens per site, but an emphasis will be placed on collecting a variety of aquatic organisms as opposed to quantity.

The Leader will fill out all sections of the field datasheet. The Collector will provide information to the team Leader in response to questions on the data sheet that review all habitats to be sampled, stream conditions, and any changes in methodology or unusual observations. Potential sources of variability in the stream reach being sampled, such as weather, stream flow, turbidity, and erosion, will be noted on the datasheet. The field data sheet will include sections to record unusual procedures or accidents, such as losing part of the collection by spilling.

The Leader and Collector will decide together whether a site needs to have an extended collection time or other variations in procedure. Before leaving the site, the Team Leader will aensure, the equipment is inspected, cleaned, and sanitized with a dilute bleach prior to reusing. The site will be inspected to make sure that no equipment or refuse is left behind.

As teams complete their field sampling, all equipment, data sheets, and sample jars will be turned over to the Program Manager at the Conservation District office. Equipment will be inspected, cleaned, and stored, and the labeled sample jars will be stored until the

identification event takes place. The field data sheets will also be inspected for completeness by the Program Manager. Any omissions or questions will be directed to the Team Leader and corrected in a timely fashion.

Equipment for Laboratory Identification of Macroinvertebrate Specimens: The bug ID events for general volunteers will be held at the Benzie Conservation District. Equipment used during ID events includes: stereo microscopes, hand magnifying lenses, plastic and metal forceps, petri dishes, eye droppers, plastic sorting trays, aquatic macroinvertebrate flashcards, and macroinvertebrate references. Order-level and family-level data sheets for each sampling site will be on hand as well as the labeled sample bottles.

Methods for Laboratory Identification of Macroinvertebrate Specimens: There will be two general styles of laboratory identification events; scheduled events for general volunteers and family-level identification by the Program Manager and volunteer experts in the office. For the general volunteer identification events, the focus will be primarily in educating the volunteers on macroinvertebrates to order level with some family-level identification (using the standard MiCorps Order-level datasheet). The Identification Events will be organized and led by the Program Manager. This type of event is necessary to allow volunteers to gain skills, experience, and interest in identification. All ID's will be considered preliminary until verified by the Program Manager. The specimens for each site will be in two separate bottles preserved in ethanol. Before beginning, the contents of one bottle will be transferred to the other, and excess alcohol can be transferred to the empty bottle. It is ideal to work in two-person teams with one person identifying and the second recording data. As each specimen is identified and recorded, it will be transferred to the second bottle. It is important to keep the bottle of identified specimens separate from the unidentified. When all specimens from a site are identified, all specimens should be in one bottle with sufficient alcohol to cover all specimens. This will be the final storage vessel for the specimens for that site and date. The second bottle can be re-used for future sampling events. All data sheets and sample bottles will be turned over to the Program Manager for verification.

The Program Manager will do all the family-level identification of macroinvertebrate specimens until volunteer experts with sufficient skills become available. The Program Manager will do the identification as time allows at the District office using the same protocol as the other identification events. Samples will be identified to family level and recorded on the MiCorps family-level datasheet. This data will be used to cross-check any prior identifications made by volunteers on the order-level data sheet. As volunteer experts become trained and available for family-level identification, the Program Manager will verify at least 10% of these identifications. Any errors will be reviewed with the volunteer expert, and if more than 10% of identifications are wrong, then all specimens identified by that expert will be verified as indicated in Section A7.

Methods and Equipment for Stream Habitat Assessment:

Habitat assessments will be conducted in the fall during a two-week period once every 2-3 years. A descriptive procedure is provided to volunteers to guide them through the process. Photos are used to document areas of erosion, degradation, or concern. Monitoring procedures and methods will follow MiCorps guidelines. Data sheet is attached.

Equipment for stream habitat assessments includes a nylon tape measure and a wooden measuring stick, both marked in feet and tenths of feet. A digital camera will be used to take photographs of habitat conditions and a pencil sketch of the sampling site will be included on the data sheet.

Annual Events Schedule for Stream Monitoring:

Volunteer Recruitment: *When:* Year-round, but most effort comes in one-month period prior to spring and fall sampling events. *Who:* District staff, lead volunteers, and general volunteers.
Volunteer Training Events: *When:* At least twice yearly 1-3 weeks prior to spring and fall sampling events. Additional events can be created as necessary. *Who:* Program Manager, lead volunteers, volunteer experts.
Spring Field Macroinvertebrate Sampling: *When:* 1st week in May. *Who:* Program Manager, lead volunteers, general volunteers.
Fall Field Macroinvertebrate Sampling: *When:* 1st week in October. *Who:* Program Manager, lead volunteers, general volunteers.
Indoor Identification Events: *When:* 1-2 weeks after spring and fall sampling events. *Who:* Program Manager, lead volunteers, volunteer experts.
Equipment Purchasing: *When:* As needed. *Who:* Program Manager.

Decontamination Procedures

a. Conduct a visual inspection of gear before and after any sampling; thoroughly inspect and remove all plants, dirt and mud, and any other visible debris like seeds, shoots, animals, insects, and eggs from clothing and equipment.
b. If going to another site on the same sampling day, disinfect with dilute bleach and allow to sit for 10 minutes before rinsing with tap water and towel dry all equipment before leaving the site.
c. After sampling is done for the day, let dry for at least 5 days before using gear again.
d. If necessary, Team Leaders should use high pressure hot washes to clean monitoring equipment if areas are known to be infected by invasive species.
e. Be on the lookout for New Zealand mud snails.
f. Additional details can be found in the MiCorps Volunteer Monitoring Invasive Species Prevention Kit Use Guide which is located with monitoring supplies, or https://www.hrwc.org/volunteer/decontaminate/)

B2. Instrument/Equipment Testing, Inspection, and Maintenance

In the days prior to a monitoring event, the Program Manager will check all equipment carefully. Supplies for each team will be put together including 2 buckets, 2 nets, 2 plastic sorting trays, 3 plastic forceps, 2 metal forceps, one eye dropper, one turkey baster, one mesh food strainer, one ice cube tray, 2 plastic squirt bottles, clipboard and pencils, datasheets for each site, and pre-labeled jars with alcohol (2 per site). All equipment will be stored at the Benzie Conservation District office in Beulah.

- **D-frame kick nets:** will be inspected before and after each sampling session to look for any defects or tears in the nets.
- **Collection jars** (4 oz plastic): each jar and lid will be inspected for cracks or defects before each use. Jars will be labeled and half-filled with 70% ethanol prior to the collection event. After jars are in use they will be inspected for leaky tops, improper seals, cracks, and chips.
- **Forceps**: will be cleaned and inspected to make sure the tips meet before each sampling event.
- **Buckets, trays, eye droppers, ice cube trays, food strainers, squirt bottles**: will be inspected to make sure they are clean and not damaged.
- **Magnifiers/Dissection Scopes**: will be cleaned and inspected to make sure they are functioning properly before and after each identification event.
- **Decontamination Kit:** will be inspected to make sure all equipment is clean and in working condition and squirt bottles with disinfectant solution is filled.

B3. Inspection/Acceptance for Supplies and Consumables

- **D-frame Kick Nets** – Purchased August 2012, replace when damaged beyond repair
- **Collection Jars** – Purchase August 2012, resupply as needed.
- **Forceps** – Purchased August 2012, replace when tips do not meet when squeezed
- **Magnifier/Dissection Scope** – Purchased in August 2012, replace when no longer functional
- **Ethanol** – Purchased August 2012, replace when all is consumed or past expiration date
- **Sorting Trays** – Purchased July 2012, replace when they no longer function as needed
- **Buckets, trays, eye droppers, ice cube trays, food strainers, squirt bottles** – Purchased August 2012, will be replaced when broken or worn out.
- **Decontamination Kits** – obtained in 2019, replace when disinfectant is consumed and when tools are no longer functional

Prior to a monitoring event, BCD staff will make sure there are ample data sheets, labels, and that all equipment is in order.

B4. Non-direct Measurements

This section is not applicable to our project.

B5. Data Management and Analysis

All data are recorded on original field (order-level) and laboratory (family-level) paper data sheets. These data sheets are stored in hard copy and electronically at the BCD office. Raw data will be entered and managed in a Microsoft Excel spreadsheet. All data is backed up before and after each sampling event's data has been entered. Data will be entered by the Program Manager into the program's MS Excel database for long-term storage. Once a year, all new data will be entered into the MiCorps data exchange system. Data sheets will be filed with the BCD indefinitely. Field data sheets are checked by the Project Manager upon return to the BCD office. Any omissions or confusions are clarified as soon as possible.

The Program Manager will enter data into the spreadsheet which is then used for both analysis and reporting. The final data tables are checked against the field and laboratory data sheets. The results of monitoring will then be posted on the BCD website and in their newsletter, as well as distributed directly to other participating groups/community organizations.

Aquatic macroinvertebrates collected by volunteers during sampling events are identified to the family level or lowest taxonomic level possible. Although reference literature for taxonomic identification is dependent upon the preference of the expert, copies of *Aquatic Insects of North America* by R. W. Merritt and K. W. Cummins, *Aquatic Insects of Wisconsin* by W. L. Hilsenhoff, and *Guide to Aquatic Invertebrates of the Upper Midwest* by R.W. Bouchard, Jr. are available during indoor identification sessions.

Four biotic diversity indices are used to rate the water quality of each stream, make comparisons between streams and perform trend analyses within the same stream over time. Diversity indices to be used include: MiCorps Stream Quality Index, Total Taxa, EPT, and a Hilsenhoff Sensitive Families. The MiCorps Stream Quality Index (SQI) is based on a mix of order-level data and some easily-identified family-level data. It divides the identified taxa into three groups: sensitive, somewhat sensitive, and tolerant. The number of taxa in each group is used to calculate the SQI. The formula is found on the order-level data sheet (see appendix). The Total Taxa index is the total number of families found at a sample site during one sample event. The EPT index is the total number of families belonging to the Ephemeroptera (mayfly), Plecoptera (stonefly), and Trichoptera (caddisfly) orders found at a sample site during one sample event. The Hilsenhoff Sensitive Families Index was developed by William L. Hilsenhoff, and is the total number of sensitive families (those receiving ratings of 0, 1, & 2 by Hilsenhoff). All biotic diversity index scores are calculated on the datasheets and all information from the datasheet is entered into a Microsoft Excel® spreadsheet.

Descriptive statistics are used to present data for annual stream monitoring reports. Statistical analysis of data will be performed to examine variation between sample sites and trends within sites over time, though statistical procedures for data analysis have not yet been determined. Before conducting statistical analysis, Benzie Conservation District staff will consult with professional statisticians for guidance in choosing the correct statistical procedure and performing statistical analyses.

C1. Assessments and Response Actions

Data quality assessments will be conducted after every field sampling event (twice annually) and after sample identification (twice annually). The Program Manager and Lead Volunteers will conduct in-field quality assurance, and the Program Manager will conduct the assessment of data sheets after the event. The Program Manager will closely monitor indoor identification events for quality assurance and assess all data prior to final entry into the MiCorps Data Exchange Network. Corrective actions will be the responsibility of the Program Manager and Lead Volunteers. Positive assessments or corrective actions will be reported to program volunteers involved by the Program Manager. In the event of corrective actions, they will be reported to MiCorps in quarterly progress reports.

C2. Data Review, Verification, and Validation

Project volunteers and volunteer team leaders will be trained in proper field and laboratory procedures by the Program Manager or MiCorps staff to ensure that quality assurance protocols are followed in the field. The Program Manager will review all field data sheets for completeness within a week of sampling. Eventually, the Program Manager will accompany teams in the field to perform side-by- side sampling and verify the quality of work by the volunteer team. The Program Manager will verify all order-level identifications and perform all family-level identifications for at least the first year of the program. Details of this process and data quality objectives are outline in section A7. Response to quality control problems is also included in section A7.

If deviation from the QAPP is noted at any point in the sampling or data management process, the affected samples are flagged in the database and are not used for stream assessment or comparisons. Re-sampling is conducted if feasible, given that the deviation is noted soon after occurrence and volunteers are available. Otherwise, a gap must be left in the monitoring record and the cause noted. All corrective actions are documented and communicated to MiCorps.

As noted in A7, all data will be considered preliminary until at least three full years of monitoring have been completed at a site.

C3. Reconciliation with Data Quality Objectives

Data quality objectives are described in section A7. The following points will be assessed for DQO during different phases of the program:

Equipment Quality Control:

1. All field sampling gear for each team is gathered and inspected. Field sampling gear includes D-frame nets, white sorting trays, waders, five gallon buckets, plastic and metal forceps, eye droppers, ice cube trays, plastic squirt bottles, and food strainers.
2. Sample bottles: Sample bottles will be pre-labeled in pencil with sampling date, watershed, and site name. Sample bottles will be half-filled with 70% ethanol. For each team, there will be 2 bottles per site.
3. Data sheets: Each team will have a clipboard and at least two pencils. The clipboard will have a pre-labeled (with site name) data sheet for each sampling site.

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All equipment must be cleaned, dried and stored securely after sampling events.

Field Procedures Quality Control:

1. Each team will have at least one trained team leader and/or collector.
2. The team leader is responsible for filling out datasheets.
3. The team leader will monitor collection at each site for: [1] collecting style (must be thorough and vigorous), [2] habitat diversity (must include all habitats and be thorough in each one), [3] picking style (must be pick thoroughly through all materials collected and pick all sizes and types) [4] variety and quantity of organisms (must ensure that diversity and abundance at site is represented in sample), and [5] the transfer of collected macroinvertebrates from the net to the sample jars (specimens must be properly handled and jars correctly labeled).
4. 300 feet of stream length will be sampled.
5. Sampling should last at least 30 min-1 hour, depending on stream size.
6. Roughly 100 organisms should be collected at each site, with an emphasis on collecting diversity versus quantity.
7. Replicate benthic macroinvertebrate sampling must be performed during side-by-side field data collection when a new volunteer team starts monitoring and then every 3-5 years thereafter. A program manager or qualified expert will accompany the team and collect benthic macroinvertebrate data to compare diversity indices with those of the team and thus, verify quality control in collection techniques and thoroughness.
8. Once every three years, volunteer monitoring teams are switched to different sites than what they normally monitor to check for potential sampling bias.
9. Before leaving a site, the team leader will assure that: the data sheet has been filled out including notes of any difficulties or observations, sample bottles are sealed, equipment has been fully decontaminated and rinsed, and all refuse is picked up.

Indoor Sorting and Identification Quality Control:

1. All jars with macroinvertebrate specimens must be checked by a program manager upon receipt from the volunteer team to assure that they are labeled and properly closed.
2. Field datasheets used by volunteers must be checked for completeness and to verify that the correct number of containers from the sample site is indicated on the form.
3. Prior to identification, datasheets and containers must be checked to ensure that all containers, and only containers from that collection site are present prior to opening the jars to begin identification.
4. During the indoor session, if any specimens are separated from the pan during sorting and identification, a site label must accompany them.
5. All samples must be checked and verified by a qualified expert. The Program Manager will verify all order-level identifications and perform all family-level identifications until qualified volunteers are found to help with these tasks.
6. Following identification, all specimens from the sample site in question must be stored in 70% ethanol in an air-tight container and a label included in the container that includes all relevant information (watershed, sample site location, and sample event date).

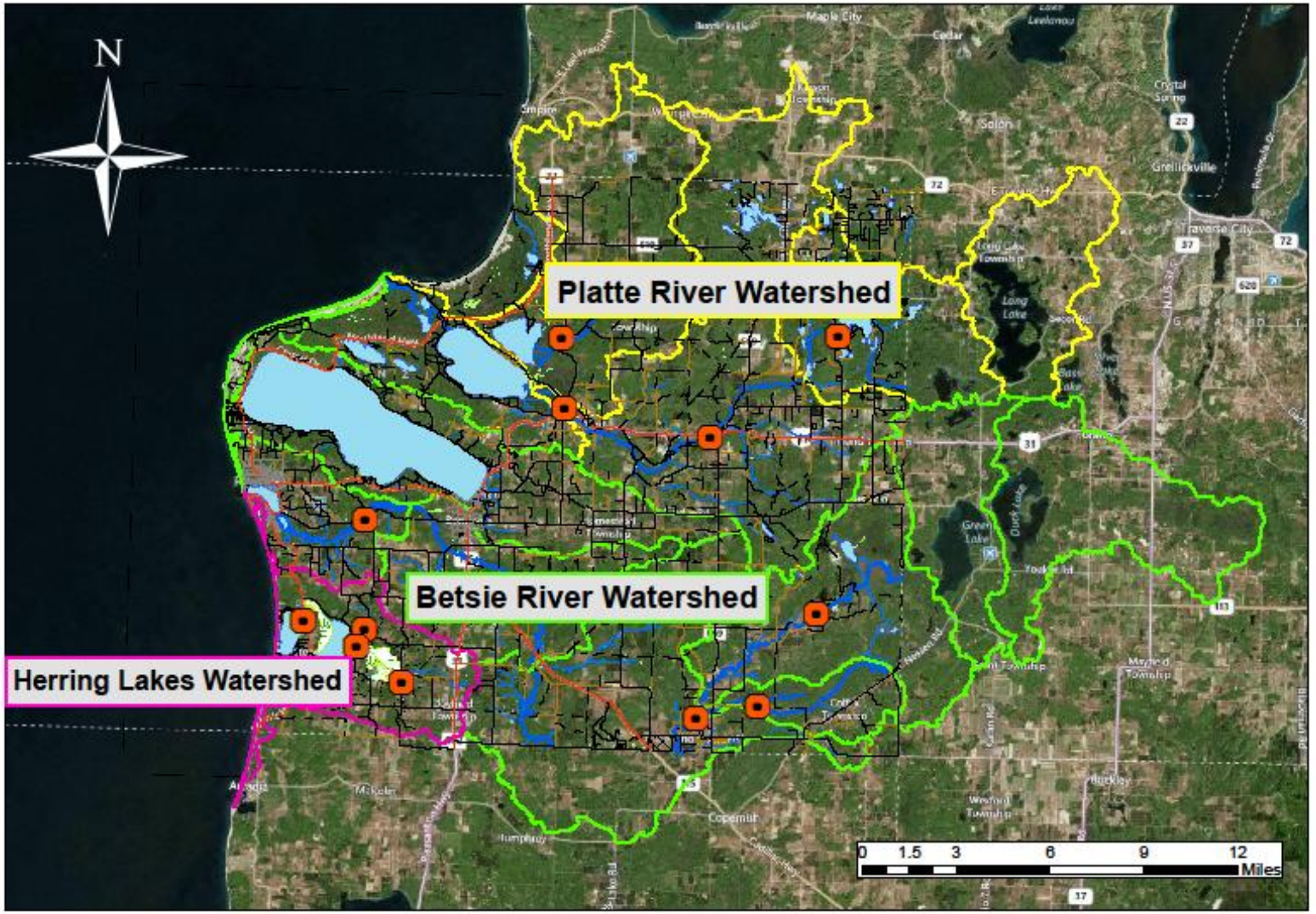
Data Analysis Quality Control:

1. Field datasheets must be reviewed for errors upon receipt by the Program Manager to minimize errors before entry into the spreadsheet and MiCorps Data Exchange.
2. Calculations for diversity indices must be verified by the Program Manager to minimize errors before entry into the spreadsheet and MiCorps Data Exchange.
3. Data entered into the computer must be reviewed by comparing hard copy print outs of spreadsheet with field data sheets.

C4. Reporting

The Program Manager has the primary responsibility for performing and verifying the QC points from C3 and A7. Program volunteers will be given timely feedback on their QC performance, especially if deficiencies are identified. QC reports will be given to MiCorps in Quarterly Status Reports in the event of corrective actions.

Appendix A. Stream sampling sites.



Appendix B. Order-level field data sheet, page 1.

MiCorps Site ID#:_____

Michigan Clean Water Corps

Stream Macroinvertebrate Datasheet

Stream Name: _____

Location:_____ (Circle one: *Upstream* or *Downstream* of road?)

Date:_____ Collection Start Time:_____ (AM/PM)

Major Watershed:_____ HUC Code (if known):_____

Latitude:_____ Longitude:_____

Monitoring Team:

Name of Person Completing Datasheet:_____

Collector:_____

Other Team Members:_____

Stream Conditions: Average Water Depth:_____ feet

Is the substrate covered with excessive silt? ____ No ____ Yes (describe:_____)

Substrate Embeddedness in Riffles: ____ 0-25% ____ 25-50% _____ > 50% ____ Unsure

Did you observe any fish or wildlife? ( ) Yes ( ) No If so, please describe:_____

Macroinvertebrate Collection: Check the habitats that were sampled. Include as many as possible.

____ Riffles
____ Cobbles
____ Aquatic Plants
____ Runs
____ Stream Margins
____ Leaf Packs
____ Pools
____ Undercut banks/Overhanging Vegetation
____ Submerged Wood
____ Other (describe:_____ _____)

Did you see, but not collect, any **live crayfish**? (___ Yes ___ No), or **large clams**? (___ Yes ___ No)
remember to include them in the assessment on the other side!

Collection Finish Time:_____(AM/PM)

Datasheet checked for completeness by:_____ Datasheet version 10/08/05
Data entered into MiCorps database by:_____ Date:_____

Appendix B. Order-level field data sheet, page 2.

MiCorps Site ID#:_____

Michigan Clean Water Corps

IDENTIFICATION AND ASSESSMENT

Use letter codes [**R** (rare) = 1-10, **C** (common) = 11 or more] to record the approximate numbers of organisms in each taxa found in the stream reach.

*** Do NOT count empty shells, pupae, or terrestrial macroinvertebrates***

Group 1: Sensitive

_____ Caddisfly larvae (Trichoptera)
EXCEPT Net-spinning caddis
_____ Hellgrammites (Megaloptera)
_____ Mayfly nymphs (Ephemeroptera)
_____ Gilled (right-handed) snails (Gastropoda)
_____ Stonefly nymphs (Plecoptera)
_____ Water penny (Coleoptera)
_____ Water snipe fly (Diptera)

Group 2: Somewhat-Sensitive

_____ Alderfly larvae (Megaloptera)
_____ Beetle adults (Coleoptera)
_____ Beetle larvae (Coleoptera)
_____ Black fly larvae (Diptera)
_____ Clams (Pelecypoda)
_____ Crane fly larvae (Diptera)
_____ Crayfish (Decapoda)
_____ Damselfly nymphs (Odonata)
_____ Dragonfly nymphs (Odonata)
_____ Net-spinning caddisfly larvae
(Hydropsychidae; Trichoptera)
_____ Scuds (Amphipoda)
_____ Sowbugs (Isopoda)

Group 3: Tolerant

_____ Aquatic worms (Oligochaeta)
_____ Leeches (Hirudinea)
_____ Midge larvae (Diptera)
_____ Pouch snails (Gastropoda)
_____ True bugs (Hemiptera)
_____ Other true flies (Diptera)

STREAM QUALITY SCORE

Group 1:
_____ # of R's * 5.0 = _____
_____ # of C's * 5.3 = _____
Group 1 Total = _____

Group 2:
_____ # of R's * 3.0 = _____
_____ # of C's * 3.2 = _____
Group 2 Total = _____

Group 3:
_____ # of R's * 1.1 = _____
_____ # of C's * 1.0 = _____
Group 3 Total = _____

Total Stream Quality Score = _____
(Sum of totals for groups 1-3; round to nearest whole number)

Check one:
_____ Excellent (>48)
_____ Good (34-48)
_____ Fair (19-33)
_____ Poor (<19)

Identifications made by:_____

Rate your confidence in these identifications: Quite confident 5 4 3 2 1 Not very confident

Datasheet checked for completeness by:_____ Datasheet version 10/08/05
Data entered into MiCorps database by:_____ Date:_____

Appendix C. Family-level data sheet, page 1.

MiCorp Site ID#_____

Identification verified by:_____(optional)

Michigan Clean Water Corps

AQUATIC MACROINVERTEBRATE IDENTIFICATION WITH INSECT FAMILIES

Use letter code [R (rare) = 1-10, C (common) = 11 or more] to record the approximate numbers of organisms in each taxa found in the stream reach. Only use the blank by the main taxa heading (i.e. ANNELIDA, COLEOPTERA) when there are organisms that cannot be identified to the lower taxonomic levels. Enter both the family level data as well as the order level data into the Michigan Data Exchange.

ANNELIDA— Segmented Worm_____
Hirudinea _____
Oligochaeta _____

COLEOPTERA — Beetles_____
Chrysomelidae _____
Curculionidae _____
Dryopidae _____
Dytiscidae _____
Elmidae _____
Gyrinidae _____
Haliplidae _____
Hydraenidae _____
Hydrophilidae _____
Lampyridae _____
Lutrochidae _____
Noteridae _____
Psephenidae _____
Ptilodactylidae _____
Scirtidae _____
Staphylinidae _____

COLLEMBOLA — Springtail_____

CRUSTACEA— Crustaceans_____
Amphipoda _____
Decapoda _____
Isopoda _____

DIPTERA — True Flies_____
Athericidae _____
Blephariceridae _____
Ceratopogonidae _____
Chaoboridae _____
Chironomidae _____
Culicidae _____
Dixidae _____
Dolichopodidae _____
Empididae _____
Ephydridae _____
Muscidae _____
Phoridae _____
Psychodidae _____
Ptychopteridae _____
Sarcophagidae _____
Sciomyzidae _____
Simuliidae _____
Stratiomyidae _____

DIPTERA— continued
Syrphidae _____
Tabanidae _____
Tipulidae _____

EPHEMEROPTERA — Mayflies____
Acanthametropodidae _____
Ameletidae _____
Ametropodidae _____
Arthropleidae _____
Baetidae _____
Baetiscidae _____
Caenidae _____
Ephemerellidae _____
Ephemeridae _____
Heptageniidae _____
Isonychiidae _____
Leptohyphidae _____
Leptophlebiidae _____
Metretopodidae _____
Neoephemeridae _____
Oligoneuridae _____
Polymitarcyidae _____
Potamanthidae _____
Pseudironidae _____
Siphlonuridae _____
Tricorythidae _____

GASTROPODA — Snails, Limpets__
Ancylidae _____
Physidae _____
Planorbidae _____
Right-handed snail _____

HEMIPTERA — True Bugs_____
Belostomatidae _____
Corixidae _____
Gelastocoridae _____
Gerridae _____
Hebridae _____
Hydrometridae _____
Mesoveliidae _____
Naucoridae _____
Nepidae _____
Notonectidae _____
Pleidae _____
Saldidae _____
Veliidae _____

Appendix C. Family-level data sheet, page 2.

MiCorp Site ID#_____

Michigan Clean Water Corps

AQUATIC MACROINVERTEBRATE IDENTIFICATION WITH INSECT FAMILIES (PAGE 2)

HYDRACARINA — Water mites_____

LEPIDOPTERA — Moths and Butterflies_____
Cosmopterigidiae _____
Nepticulidae _____
Noctuidae _____
Pyralidae _____
Tortricidae _____

MEGALOPTERA — Alderflies,Dobsonflies___
Corydalidae _____
Sialidae _____

ODONATA — Damselflies, Dragonflies____
Aeshnidae _____
Calopterygidae _____
Coenagrionidae _____
Cordulegastridae _____
Corduliidae _____
Gomphidae _____
Lestidae _____
Libellulidae _____
Macromiidae _____
Petaluridae _____

PELECYPODA — Bivalves_____
Corbiculidae _____
Dreissenidae _____
Sphaeriidae _____
Unionidae _____

PLATYHELMINTHES— Flatworms____
Turbellaria _____

PLECOPTERA— Stoneflies_____
Capniidae _____
Chloroperlidae _____
Leuctridae _____
Nemouridae _____
Perlidae _____
Perlodidae _____
Pteronarcyidae _____
Taeniopterygidae _____

TRICHOPTERA — Caddisflies_____
Apataniidae _____
Brachycentridae _____
Dipseudopsidae _____
Glossosomatidae _____
Goeridae _____
Helicopsychidae _____
Hydropsychidae _____
Hydroptilidae _____
Lepidostomatidae _____
Leptoceridae _____
Limnephilidae _____
Molannidae _____
Odontoceridae _____
Philopotamidae _____
Phryganeidae _____
Polycentropodidae _____
Psychomyiidae _____
Rhyacophilidae _____
Sericostomatidae _____
Uenoidae _____

Datasheet checked for completeness by:_____ Datasheet version 6/6/08
Data entered into MiCorps database by:_____ Date:_____