A1. Title and Approval Sheet
Quality Assurance Project Plan for

MiCorps Volunteer Stream Monitoring Program

Date: February 15, 2023
Version: #1 September 8, 2005
Version: #2 September 28, 2017
Version: #3 February 12, 2021
Version: #4 February 15, 2023
Organization: Muskegon River Watershed Assembly (MRWA)

QAPP Prepared by: Sarah Krzemien
Title: MRWA Project Manager for the Muskegon River Watershed Volunteer Stream Monitoring Program
Signature:
[redacted]

Other responsible individual: Paul Haan
Title: MRWA Executive Director
Signature:
[redacted]

(Other signatures may be added as necessary)

MiCorps Staff Use

Tracking Number:

Funding Source:

MiCorps Reviewer: ______________________________________

☐ Approved ☐ Returned for modifications

Signature of reviewer Date

A2. Table of Contents

Appendices

A3. Distribution List

Paul Steen, Program coordinator
Michigan Clean Water Corps (MiCorps)
Great Lakes Commission

Sarah Krzemien, Project manager
Muskegon River Watershed Assembly
@FSU
1009 Campus Dr, JOH304
Big Rapids, MI 49307-2280

Paul Haan, Executive Director
Muskegon River Watershed Assembly
@FSU
1009 Campus Dr, JOH305
Big Rapids, MI 49307-2280

A4. Program Organization

Team Members:

- **Project Manager and QA Manager**: **MRWA/Sarah Krzemien** will carry out the program, recruit volunteers, coordinate training locations, provide training, perform data input, monitor quality control, oversee monitoring duties at various locations and communicate with volunteers. The project manager will also prepare contracts, reports and other documents needed for the project. They are also responsible for maintaining the QAPP and will serve as the QA Manager.

  Muskegon River Watershed Assembly
  @FSU
  1009 Campus Dr. JOH304
  Big Rapids, MI 49307-2280
  Phone: 231-591-2321
  Email: krzemis@ferris.edu

- **Grant Administrator, MRWA/Sara Lindley**
  Will assist the project manager with their duties in recruiting volunteers, expanding the monitoring database, coordinating training locations, communicating with volunteers, monitoring and ordering equipment, oversee monitoring duties at various locations, along with financial tracking and reporting.

  Muskegon River Watershed Assembly
  @FSU
  1009 Campus Dr. JOH 305
  Big Rapids, MI 49307-2280
  Phone: 231-591-2334
  Email: saralindley@ferris.edu

1. **Field Responsibilities**
   Volunteers will be responsible for macroinvertebrate identification and will attend a one-day training session in identifying macroinvertebrates and conducting stream habitat assessments. An exam will be given to these volunteers and a 95% score is needed before they can assume the field responsibility of macroinvertebrate identification. These volunteers will be the **Team Leaders** or **Qualified Volunteers** for the sites to be monitored. Volunteers who do not take the exam or do not achieve the 95% score will be able to assist the team leader in collecting the samples and assessing the stream habitat but will not assist in macroinvertebrate identification. Volunteers will have oversight from the project manager.

2. **Laboratory Responsibilities**
   The MRWA does not anticipate using parameters that require laboratory processing.

3. **Corrective Action**
   Muskegon River Water Monitoring Project Manager, Sarah Krzemien will be responsible for any corrective actions that are needed.

A5. Problem Definition/Background Definition/Background

The Muskegon River Watershed Assembly Volunteer Stream Monitoring Program will recruit new people and engage past program volunteers to learn about collecting reliable data to monitor, protect and improve water quality for the purpose of documenting changes over time and to determine where best management practices could be implemented for needed improvements. MRWA will expand the program to include new locations and volunteers. The primary actions we envision are based on monitoring results to report the trends and conditions of the stream sections studied. As clarified in other sections of this document, we do not present any results on the ecological conditions until we have three years of benthic community data plus a habitat assessment and one season of temperature measurements. If an extreme change in benthic macroinvertebrates and habitat is observed, we will notify the appropriate authorities about the unverified results immediately and stay in contact with them as they investigate the situation. Our goal is to assist in removing causes of stream deterioration.

There are four goals for the project:

1. Educate Muskegon River Watershed residents on ways to monitor, protect and improve quality of water resources.
2. Sign up stakeholder groups and/or volunteers to provide water monitoring and protection.
3. Monitor stream health in the Muskegon River Watershed and provide reliable data. Document changes in biotic and abiotic conditions over time.
4. Determine problem areas where best management practices can be used.

Water quality monitoring efforts are important to continue in the Muskegon River Watershed due to nonpoint source pollution such as soil erosion, storm water drains, agriculture drains, livestock in streams and dams/lake-level control structures.

The sampling sites were selected due to specific concerns for each site as follows:

- Sand Creek: Reports of agricultural manure applications running in a cool water trout stream (43.33575, -85.87646)
- Tamarack Creek Marble Rd.: Culvert replacement and agricultural runoff (43.40878, -85.41246°)
- Tamarack Creek West Almy Rd.: Culvert replacement and agricultural runoff (43.41017, -85.39702)
- Tamarack Creek at Minnie Farmer Park: Bank stabilization in 2016 and sediment loading from road. (43.39837, -85.46263)
- Brooks Creek at Vista Dr.: Sediment and nutrient loading caused from a housing development. (43.40038, -85.76092)
- Brooks Creek at Marshall Memorial Park: Sediment due to stream bank destabilization, flooding and heavy public use. (43.41681, -85.80463)
- Twin Creek at Twin Creek Nature Preserve near dam removal site
    - Downstream: downstream of former dam site (43.90528, -85.27413)

- Upstream: upstream of former dam site (43.905406, -85.274258)

- Mitchell Creek, Big Rapids near Clay Cliffs
  - Downstream: (43.698135, -85.493814)
  - Upstream: (43.697614, -85.494376)
- Macks Creek, Stanwood at the mouth: Creek is located south of Rogers dam and has a privately-owned dam on it
  - Downstream: downstream of dam on private property (43.606857, -85.48076)
  - Upstream: upstream of dam on private property (43.605326, -85.479062)
- Wheeler Drain Site, Newaygo County: site of future culvert replacement
  - Downstream: above the E. 108th St. road crossing off of Walnut Ave. (43.358335, -85.759735)
  - Middle Drain: downstream of the Walnut Ave. road crossing on Grant Public School property. Near first large eroding streambank (43.352365, -85.760688)
  - Upper Drain: upriver of the Walnut Ave. road crossing and upstream from the Grant Public Schools property (43.352351, -85.761316)
- Buckhorn: dam removal
  - Downstream: downstream of dam beginning at the foot bridge (43.79251, -85.50084)
  - Upstream: upstream of foot bridge and dam site (43.794448, -85.50228)
- Cut River: downstream edge of island 100 ft. from Highway 100 culvert to riverbend upstream of island 300 ft. downstream from dam (44.433848, -84.670410)
- Big Creek: Dewey Ave. Culvert 150’ on either side of road center line (44.497382, -84.777824)

Additional sites may be added depending on the number of volunteer monitors. Actions taken based on monitoring results will include reporting the results and conditions for the sections studied to the community and to take action where possible to improve any diminished sites found. Results will be presented after three years of benthic community data collection, along with a habitat assessment and one season of temperature measurements. If extreme changes in the benthic community are observed, appropriate authorities will be notified regarding these unverified results and remain in contact as needed during a further investigation. The goal is to determine problem areas where best management practices can be used.

A6. Program Description

This program includes recruiting people to become trained volunteer monitors for at least eleven sites in the lower and mid portion of the Muskegon River Watershed. They will be trained prior to the first sampling event and then will receive personal training from experienced monitors as well. They will learn how to sample, identify macroinvertebrates, record data and preserve samples and other protocols necessary for accurate monitoring and collection. The project manager will manage all data records, quality control measures and reporting. The office manager will ensure outreach and education are conducted through newspaper articles, social media and the MRWA website. Administrative reporting will be conducted by the project manager, with grant administrator providing financial reporting assistance.

A7. Data Quality Objectives

Precision/Accuracy:
Accuracy is the degree of agreement between the sampling result and the true value of the parameter or condition being measured. Accuracy is most affected by the equipment and the procedure used to measure the parameter. Precision refers to how well you can reproduce the result on the same sample, regardless of accuracy.

The purpose of this project is to gauge stream health by measuring the total diversity of macroinvertebrate taxa. Since there is inherent variability in accessing the less common taxa in any stream site and program resources do not allow project managers to perform multiple independent (duplicate) collections of the sampling sites, our goal for precision and accuracy is conservative. A given site's Stream Quality Index (SQI) score or total diversity (D) measure across macroinvertebrate taxa will be noted as "preliminary" until three spring sampling events and three fall sampling events have been completed.

Precision and accuracy will be maintained through standardized MiCorps procedures. The project manager will be trained in MiCorps procedures at the annual MiCorps training led by MiCorps staff. MiCorps staff has a method validation review (the "side-by-side" visit) with the project manager to ensure their expertise. This review included supervising the project manager's macroinvertebrate sampling and sorting methodology to ensure that they are consistent with MiCorps protocol. All cases of collecting deficiencies will be promptly followed (during that visit) by additional training in the deficient tasks and a subsequent method validation review may be scheduled for the following collecting season.

Upon request, MiCorps staff may also verify the accuracy of the program's macroinvertebrate identification. If a problem arises with a subset of macroinvertebrates, a thorough check may be requested.

Precision and accuracy will be maintained by conducting consistent volunteer team leader training. Volunteer team leaders will be trained when joining the program and retrained every three years (at a minimum).

Techniques under review shall include:

- collecting style (must be thorough and vigorous);
- habitat diversity (must include all available habitats and be thorough in each one);
- picking style (must be able to pick thoroughly through all materials collected and pick all sizes and types of macroinvertebrates);

- variety and quantity of organisms (must ensure that diversity and abundance at site is represented in sample);
- transfer of collected macroinvertebrates from the net to the sample jars (specimens must be properly handled, and jars correctly labeled).

Precision and accuracy will be maintained through careful macroinvertebrate identification. Volunteers may identify macroinvertebrates in the field, but these identifications and counts are not official. All macroinvertebrate samples are stored in alcohol to be identified at a later identification session. Volunteers can be designated as identification experts as determined by the judgment of the project manager. All field identifications and counts will be checked by an expert with access to a scope, keys, and field guides. The project manager will check at least 10% of the specimens processed by experts to verify results (with a concentration on hard to identify taxa). If more than 10% of specimens checked were misidentified, then the project manager will review all the specimens processed by that expert and reassess if that person should be considered an expert for future sampling events.

Bias: At every sample site, a different team will sample there at least once every three years to examine the effects of bias in individual collection styles. Measures of D and SQI for these samples will be compared to the median results from the past three years and each should be within two standard deviations of the median. If the sample falls outside this range, then the project manager needs to conduct a more thorough investigation to determine which team or individuals needs corrective education. The project manager will accompany teams to observe their collection techniques and note any divergence from protocols. The project manager may also perform an independent collection (duplicate sample) no less than a week after the team's original collection and no more than two weeks after.

The following describes the analysis used for the project manager's duplicate sampling: Resulting diversity measures by teams are compared to the project manager's results and each should have a relative percent difference (RPD) of less than 40%. This statistic is measured using the following formula:

RPD = [(Xm - Xv) / (mean of Xm and Xv)] x 100, where Xm is the project manager's measurement and Xv is the volunteer measurement for each parameter.

Teams that do not meet quality standards are retrained in the relevant methods and the project manager will reevaluate their collection during a subsequent sampling event.

It is also possible that the project manager can conclude that all sampling was valid and the discrepancy between samples is due to natural variation (such as the site changing over time or unrepresentative sampling conditions).

Completeness: Completeness is a measure of the amount of valid data obtained versus the amount expected to be obtained as specified in the original sampling design. It is usually expressed as a percentage. For example, if 100 samples were scheduled but volunteers sampled only 90 times due to bad weather or broken equipment, the completeness record would be 90%.

Following a quality assurance review of all collected and analyzed data, data completeness is assessed by dividing the number of measurements judged valid by the number of total measurements performed. The data quality objective for completeness for each parameter for each sampling event is 90%. If the program does not meet this standard, the project manager will consult with MiCorps staff to determine the main causes of data invalidation and will develop a course of action to improve the completeness of future sampling events.

Representativeness: Study sites will be selected to represent the full variety of stream habitat types available locally. All available habitats within the study site will be sampled and documented to ensure a thorough sampling of all the organisms inhabiting the site. Resulting data from the monitoring program will be used to represent the ecological conditions of the contributing watershed.

Sampling after extreme weather conditions may result in samples not being representative of the normal stream conditions. The project manager will compare suspect samples to the long-term record as follows:

- Measures of D and SQI for every sample will be compared to the median results from the past three years and each should be within two standard deviations of the median. If the sample falls outside this range, it can be excluded from the long-term data record (though can be included in an "outlier" database.).

Comparability: Comparability represents how well data from one stream or study site can be compared to data from another. To ensure data comparability, all volunteers participating in the monitoring program follow the same sampling methods and use the same units of reporting. The methods for sampling and reporting are based on MiCorps standards that are taught at annual trainings by MiCorps staff. The project manager will train volunteers to follow those same methods to ensure comparability of monitoring results among other MiCorps programs. To the extent possible, the monitoring of all study sites will be completed on a single day, and certainly within a two-week time frame.

If a project manager leaves the position and a new project manager is hired, the new hire will attend the next available training given by MiCorps staff.

A8. Special Training/Certifications

MiCorps training will be held for program leaders. The project manager and leaders will attend the MiCorps training in May. Training will be provided to volunteer stream monitors for macroinvertebrate and habitat assessment. New volunteers will also receive one to one training from experienced volunteers at sampling events.

Section B: Program Design and Processes

B1. Study Design and Methods

Macroinvertebrate Collection: The benthic population is sampled within a 2-week period in mid-May and mid-September. All equipment to be used for this sampling is listed in Appendix 4, and the SOPs are given in Appendix 2.

a. To sample the benthic community, multiple collections will be taken from each habitat type present at the site, including riffle, rocks or other large objects, leaf packs, submerged vegetation or roots, and depositional areas, while wading and using a D-frame kick net.
b. The trained Collector will transfer the material from the net into white pans.
c. The remaining volunteers (Pickers) will pick out samples of all different types of macroinvertebrates from the pans and place them into jars of 70% ethyl alcohol for later identification.
d. During the collection, the Collector will provide information to the team Streamside Leader in response to questions on the data sheet regarding all habitats to be sampled, the state of the creek, and any changes in methodology or unusual observations.
e. The Streamside Leader will instruct and assist other team members in detecting and collecting macroinvertebrates in the sorting pans, including looking under bark and inside of constructions made of sticks or other substrates. Potential sources of variability such as weather/stream flow differences, season, and site characteristic differences will be noted for each event and discussed in study results. There are places on the data sheet to record unusual procedures or accidents, such as losing part of the collection by spilling. Any variations in procedure should be explained on the data sheet. (Appendix 1.)
f. At the collecting site, all invertebrate sample jars receive a label written in pencil or printed with a laser printer, stating date, location, name of collector, and number of jars containing the collection from this site, which is placed inside the jar. The data sheet also states the number of jars containing the collection from this site. The Streamside Leader is responsible for labeling and securely closing the jars, returning all jars and all equipment to the project manager.
g. Upon return to the program building, the collections are checked for labels, the data sheets are checked for completeness and for correct information on the number of jars containing the collection from the site, and the jars are secured together with a rubber band and site label and placed together in one box.
h. They are stored in the MRWA office until they are examined and counted on the day of identification (one or two weeks later).
i. The data sheets are used on the identification day, after which they remain on file for at least five years.
j. At the time of identifying the sample, the sample identifier checks the data sheet and jars to ensure that all the jars, and only the jars, from that collection are present prior to emptying them into a white pan for sorting. If any specimens become separated from the pan during identification, a site label accompanies them.

k. Identification tools include magnifiers, rulers and forceps.
l. Macroinvertebrates will be identified to the taxonomic Order.
m. For identification, volunteers sort all individuals from a single jar into look-alike groups, and then are joined by an identification expert who confirms the sorting and provides identification of the taxa present. They will use the identification information in the MiCorps Training for Volunteer Stream Monitors and a Guide to Aquatic Invertebrates of the Upper Midwest: Identification Manual for Students, Citizen Monitors and Aquatic Resource Professionals. University of Minnesota by Bouchard, R.W.
n. These identifications are then verified by the project manager per section A7.
o. When identification of a sample is complete, the entire collection is placed in a single jar of fresh alcohol with a poly-seal cap and a printed label inside the jar and stored at the program office indefinitely.
p. The alcohol is carefully changed (to avoid losing small specimens) in the jars every few years.

Since our evaluation is based on the diversity in the community, we attempt to include a complete sample of the different groups present, rather than a random sub-sample. We do not assume that a single collection represents all the diversity in the community, but rather we consider our results reliable only after repeated collections spanning at least three years. Our results are compared with other locations in the same river system that have been sampled in the same way. All collectors attend an in-stream training session, and a different team will be sent to a site at least once every two years at a minimum, but, when possible, collectors will be sent to different sites every collection event to diminish the effects of bias in individual collecting styles. Samples where the diversity measures diverge substantially from past samples at the same site are resampled by a new team within two weeks. If a change is confirmed, the site becomes a high priority for the next scheduled collection. Field checks include checking all data sheets to make sure each habitat type available was sampled, and the team leader examines several picking trays to ensure that all present families have been collected.

Habitat analysis:
Streamside Leaders and Collectors, with Pickers assisting as well, will complete a Habitat Assessment once every two years during the fall season immediately following the macroinvertebrate sampling or at least within two weeks of the sample event. The Habitat Assessment will follow the procedure and datasheet given in Appendix 1. A site sketch will accompany the assessment. The Habitat Assessment is a critical piece of the monitoring process and will be used to monitor changes in stream habitat over time, which may result in changes in water quality and corresponding macroinvertebrate diversity.

As many of the parameters within the Habitat Assessment are qualitative, personal bias is inherent. To account for bias and personal discrepancies, Streamside Leaders will have on hand a copy of MiCorps Stream Monitoring Procedures, which details the qualitative criteria, and helps clarify questions. Streamside Leaders will read questions aloud to their group and form consensus on question answers. Since the information reviewed in the Habitat Assessment hold considerable educational value for volunteers and the goals of the MiCorps program, it is important that Streamside Leaders inform other group members of the purpose of the Assessment and encourage feedback from the group. However, final decisions on the scoring remains the responsibility of only those team members who have undergone the volunteer training and have been certified by the project manager. All final Habitat Assessment data sheets will be reviewed by the project manager for correctness and completeness. There are places on the data sheet to record unusual procedures or accidents. Any variation in procedure should be explained on the data sheet. As a critical role of the Habitat Assessment is to inform us of any areas of habitat degradation that could impact water quality, any concerns noted in the data sheet will be reviewed by the project manager and appropriate action will be taken to resolve and/or address noted concerns including informing appropriate authorities.

Volunteers will monitor stream health in the Muskegon River Watershed at specific sites as listed below. These sites were selected due to studies showing concerns with nutrient and/or sediment runoff. They will document changes in conditions over time. Monitoring data will be entered by a trained volunteer and/or by the project manager in the MiCorps Data Exchange Network. All sites will be monitored and results from monitoring activities will be reported.

Sampling sites for the lower and mid Muskegon River Watershed are in Mecosta, Montcalm, Newaygo and Osceola counties:

1. MWA-06-37-01, 43.33575° N, -85.87646° W, Sand Creek @ Wisner Ave. Reports of Agriculture manure applications running into this cool water trout stream.
2. MWA-04-31-06, 43.40878° N, -85.41246° W, Tamarack Creek @ Marble Rd. Culvert replacement in 2016, agriculture runoff.
3. MWA-04-31-07, 43.41017° N, -85.39702° W, Tamarack Creek @ West Almy Rd. Culvert replacement in 2016, agriculture runoff.
4. MWA-4-31-08, 43.39837° N, -85.46263° W, Tamarack Creek @ Minnie Farmer Park. Bank stabilization in 2016 and sediment loading from road.
5. MWA-06-43-05, 43.40038° N, -85.76092° W, Brooks Creek @ Vista Dr. Sediment and nutrient loading caused from housing development
6. MWA-06-31-06, 43.41681° N, -85.80463° W, Brooks Creek @Marshall Memorial Park. Sediment due to stream bank destabilization, flooding and heavy public use.
7. MWA-02-28-01, 43.794448° N, -85.50228°W, beginning immediately upstream of foot bridge below Northland Dr. And south of 207th avenue. Access at Icehouse parking lot
8. MWA-02-28-02, 43.79251°N, -85.50084°W, downstream of Buckhorn dam site beginning at the foot bridge immediately upstream from the confluence with the Muskegon River and extending 300’ upstream
9. MWA-07-22-03, 43.905406°N, -85.274258°W, immediately upstream of former dam site in the Twin Creek Nature Area
10. MWA-07-22-04, 43.90528°N, -85.27413°W, immediately downstream of former dam site beginning 100’ above the observation platform at Twin Creek Nature Preserve

11. MWA-06-44-01, 43.352351°N, -85.761316°W, immediately upriver of the Walnut Ave. road crossing and upstream from the Grant Public Schools property
12. MWA-06-44-02, 43.352365°N, -85.760688°W, immediately downstream of the Walnut Ave. road crossing on Grant Public School property; site starts near first large eroding streambank
13. MWA-06-44-03, 43.358335°N, -85.759735°W, immediately above the E. 108th St. road crossing off of Walnut Ave.
14. MWA-02-29-01, 43.605326°N, -85.479062°W, immediately upstream of dam on private property
15. MWA-02-29-02, 43.606857°N, -85.480768°W, downstream of dam on private property; a few 100 feet upstream of the confluence with the Muskegon River
16. MWA-02-25-13, 43.6978°N, -85.49432°W, upstream from the starting point of the Clay Cliffs erosion site
17. MWA-02-25-05, 43.69901667°N, -85.49008333°W, 100 feet below footbridge at Big Rapids Community Pool
18. MWA-08-02-02, 44.433848°N, -84.670410°W, Cut River at the downstream edge of island 100 ft. From Highway 100 culvert to riverbend upstream of island 300 ft. downstream from dam
19. MWA-08-05-01, 44.497382°N, -84.777824°W, Big Creek at Dewey Ave. Culvert 150' on either side of road center line

(See sample maps for volunteers to find sites in Appendix 5)

Equipment: All equipment will be stored in a clean, dry space after decontamination procedures in the field.

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/)

Chain of custody for samples: At the collecting site, all invertebrate sample jars receive a label written in pencil (or computer generated beforehand), stating the date, location, site number, name of collectors and number of jars containing the collection from this site (See label example in Appendix 3). A label will be placed inside every jar. If more than one jar is used, each jar will be labeled with the same information noting the number of jars used. The datasheet will also state the number of jars containing the collection from each site. The Team Leader is responsible for labeling and securely closing the macroinvertebrate sample jar(s) and retaining custody of them.

The project manager will take all jar(s) from the first sampling event for each group and will keep the jars at the MRWA offices for a minimum of three years. After the first collection, the Team Leader is responsible to keep the collection jars in their custody for a minimum of a three-year period. If more than one jar is used, they will be secured together with a rubber band and placed together in one box properly labeled. All jars will be stored in a cool place. Alcohol will be changed periodically in the jars according to MiCorps specifications.

B2. Instrument/Equipment Testing, Inspection, and Maintenance

The project manager will be responsible for inspecting equipment and ensuring nets are secured to their poles, there are no tears in the nets and that sampling jars are clean, forceps meet properly, and waders do not leak and are clean. Equipment will be stored in the MRWA storage room at Ferris State University. A checklist of equipment (Appendix 4) will be contained in every training participant's notebook and will be contained in each container of equipment. Each Team Leader will be responsible to check the list of equipment for completeness and make sure the equipment is clean, in working order and not damaged. If Team Leaders find damaged or missing equipment, they will report this information to the project manager immediately. The project manager will replace the equipment and document changes in a prompt manner.

3. Inspection/Acceptance for Supplies and Consumables

All supplies and consumables will be stored in a clean dry area. For storage, all items must be put away in a clean, dry condition. The project manager is in charge of proper storage conditions for supplies and consumables. Items are not stored until they are clean, dry and ready for use (see Appendix 4).

B4. Non direct Measurements

There are no non-direct measurements associated with this program.

B5. Data Management

Raw data will be entered and managed in Microsoft Excel workbooks. Data will be entered into the MiCorps Data Exchange (MDE) within one month of the collection. All data will be backed up biweekly and a hard drive kept off premises. Computer passwords will ensure security.

Data sheets will be entered directly into the online MiCorps database by a single trained volunteer for storage within the MDE. Data sheets will be kept on file in the MRWA office for at least five years.

For Macroinvertebrates, the data will be summarized for reporting into four metrics: all taxa, insects, Ephemeroptera + Plecoptera + Trichoptera (EPT) and sensitive taxa. Units of measurement are families counted in each metric. The stream quality index from the MiCorps datasheet will be computed. The calculation method can be found in Appendix 1.

Habitat: specific measures are used from habitat surveys to investigate problem areas at each site. The percentage of stream bed composed of fines (sand and smaller particles) is calculated and changes are tracked over time as an indicator of sediment deposition.

All field data sheets and electronically entered data will be compared for accuracy by the project manager. All calculations will be checked twice. Hard copies of all computer entered data will be reviewed for errors and compared to field data sheets.

Section C: System Assessment, Correction and Reporting

C1. System Audits and Response Actions

Volunteer Team Leaders trained by the project manager ensure that quality assurance protocols are followed and report any issues possibly affecting data quality. When significant issues are reported, the project manager may accompany groups in the field to perform side-by-side sampling and verify the quality of work by the volunteer team. If a group is determined to have done a poor job sampling, a performance audit to evaluate how people are doing their jobs of collecting and analyzing the data is accomplished through side-by-side sampling and identification. During side by-side sampling a team of volunteers and an outside expert sample the same stream. The statistic for checking this side-by-side sample is given in the Bias section (A7).

A system audit is conducted following each spring and fall monitoring event to evaluate the process of the project. The system audit consists of the project manager, any other program leader, and one or two active volunteers, and is a start to end review of the monitoring process and how things could be improved for the next event.

If deviation from the QAPP is noted at any point in the sampling or data management process, the affected samples will be flagged and brought to the attention of the project manager and the team that collected the sample. Re-sampling is conducted as long as the deviation is noted soon after occurrence and volunteers are available (two-week window). Otherwise, a gap must be left in the monitoring record and the cause noted. All corrective actions are documented and communicated to MiCorps staff. Details of the process for assessing data quality are outlined in section A7. Response to quality control problems is also included in section A7.

C2. Data Review, Verification, and Validation

A standardized data-collection form is used to facilitate Spot-Assistant, or a single trained volunteer to review the data forms before they are stored in a computer or file cabinet. After data has been compiled and entered into a computer file, it is verified with raw data from field survey forms.

C3. Reconciliation with Data Quality Objectives
Data quality objectives will be reviewed annually by the project manager to ensure that objectives are being met. Deviations from the data quality objectives will be reported to the project manager and MiCorps staff for assessment and corrective action. Also, data quality issues will be recorded as a separate item in the database and provided to the project manager and data users. Response to and reconciliation of problems that occur in data quality are outlined in Section A7.

C4. Reporting
Throughout the duration of this program, internal quality control reports will be documented with a final report sent to MiCorps upon the completion of the grant period. Quality control reports provide information regarding problems or issues arising in quality control of the project. These could include, but are not limited to, deviation from quality control methods outlined in this document relating to field data collection procedures, indoor identification, data input, diversity calculations and statistical analyses. Program staff generates annual reports sharing results of the program with volunteers, special interest groups, local municipalities, and relevant state agencies. Data and reports are made available via the organization’s web page.

MiCorps Site ID#:________________

Michigan Clean Water Corps

Stream Macroinvertebrate Datasheet

Site Name: ____

Date:______________________________ Collection Start Time:______________(AM/PM)

Major Watershed:______________________ HUC Code (if known):____________________

Latitude:_____________________________ Longitude:______________________________

Names of Team members: ____

Stream Conditions:

Average water depth:______________________feet

Notable weather conditions of the last week:_____________________________________

Are there any current site conditions that may impede normal macroinvertebrate sampling? (weather, flooding, poor visibility, etc?)

Habitat Types: Check the habitats that were sampled. Include as many as possible.
Remind the Collector to

____Riffles ____Backwater areas ____Submerged Wood
____Rocks ____Leaf Packs
____Aquatic Plants ____Pools
____Runs ____Undercut banks/Overhanging Vegetation

Did you see any crayfish? #:___________, Clams/mussels? #_______________

remember to include them in the assessment on the other side!

Do not take crayfish, fish, clams, and mussels from the water.

Collection Finish Time: _____________(AM/PM) Picking Finish Time:_________(AM/PM)

Identifications made/supervised by:____

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

Datasheet checked for completeness by:______________________________________ Datasheet version 11/13/2020
Data entered into MiCorps database by:______________________________________ Date:____________

MiCorps Site ID#:________________

Michigan Clean Water Corps

IDENTIFICATION AND ASSESSMENT

*** Do NOT count empty shells, pupae, or terrestrial macroinvertebrates***
Taxa are listed from most pollution sensitive to most pollution tolerant

Count	Common Name	Scientific Taxa	Sensitivity Rating (0-10)	Count x Sensitivity
	Helgrammite (Dobsonfly)	Megaloptera, Corydalidae	0.0	
	Clubtail Dragonfly	Odonata, Gomphidae	1.0	
	Sensitive True Flies (water snipe fly, net-winged midge, dixid midge)	Athericidae, Blephariceridae, Dixidae,	1.0	
	Stonefly	Plecoptera	1.3	
	Caddisfly	Trichoptera	3.2	
	Mayfly	Ephemeroptera	3.5	
	Alderfly	Megaloptera, Sialidae	4.0	
	Scud	Amphipoda	4.0	
	Dragonfly	Odonata	4.0	
	Beetle	Coleoptera	5.1	
	Somewhat Sensitive True Flies	Dipterans (those not listed elsewhere)	6.0	
	Crayfish	Decapoda	6.0	
	Bivalves/Snails	Pelecypoda, Gastropoda	6.9	
	True Bug	Hemiptera	7.7	
	Damselfly	Odonata	7.7	
	Sowbug	Isopoda	8.0	
	Tolerant True Fly (mosquito, rat-tailed maggot, soldier fly)	Cuclidae, Syphridae, Stratiomyidae	8.7	
	Leech	Hirundinae	10.0	
	Aquatic Worm	Oligochaeta	10.0	

	Total Abundance

Sum of (Count x Sensitivity):	

First: If your total abundance is Less than 30 → Automatically give it a WQR of 10 (Very Poor rating)
Less than 60 → Automatically give it a WQR of 7 (Poor rating)

Water Quality Rating		Degree of Organic Pollution
0.0-3.50	excellent	Pollution unlikely
3.51-4.50	very good	Slight pollution possible
4.51-5.50	good	Some pollution possible
5.51-6.50	fair	Fairly substantial pollution likely
6.51-7.50	fairly poor	Substantial pollution likely
7.51-8.50	poor	Very substantial pollution likely
8.51-10.0	very poor	Severe pollution likely

Water Quality Rating =

Sum of (Count x Sensitivity)
Divided By
Total Abundance

= ______________________

Datasheet checked for completeness by:________________________________ Datasheet version 11/13/2020
Data entered into MiCorps database by:________________________________ Date:____________

STREAM HABITAT ASSESSMENT

I. Stream, Team, Location Information

Site ID:__________________ Date:____________________ Time:______________________

Site Name:________________________________ Lat/Long _____________________________

Names of Team members:____

II. Stream and Riparian Habitat

A. General Information *Circle one or more answers as appropriate*							Notes and Observations: Give further explanation when needed.
1	Average Stream Width (ft)	< 10	10-25	25-50	>50		
2	Average Stream Depth (ft)	<1	1-3	>3	>5		
3	Has this stream been channelized? (Stream shape constrained through human activity- look for signs of dredging, armored banks, straightened channels)	Yes, currently	Yes, sometime in the past	No	Don't know		
4	Estimate of current stream flow	Dry or Intermittent	Stagnant	Low	Medium	High	
5	Highest water mark (in feet above the current level)	<1	1-3	3-5	5-10	>10	
6	Which of these habitat types are present?	Riffles	Pools	Large woody debris	Large rocks	Undercut bank	
		Overhanging vegetation	Rooted Aquatic Plants	Other:	Other:	Other:	
7	Estimate of turbidity	Clear	Slightly Turbid (can partially see to bottom)		Turbid (cannot see to bottom)		
8	Is there a sheen or oil slick visible on the surface of the water?	No	Yes				
9	If yes to #8, does the sheen break up into pieceswhen poked with a stick?	Yes (sheen is most likely natural)		No (sheen could be artifical)			
10	Is there foam present on the surface of the water?	No	Yes				
11	Does the foam smell soapy and look white and pillow like or look gritty with dirt mixed in?	Soapy (foam could be artifical)		Gritty (foam is most likely natural)			
The following are optional measurements not currently funded by MiCorps							
8	Water Temperature						
9	Dissolved Oxygen						
10	pH						
11	Water Velocity						

MiCorps Site ID#:___________ Date:_________________

II. Stream and Riparian Habitat (continued)

B. Streambed Substrate

Estimate percent of stream bed composed of the following substrate.

Leave blank if group will take transects and pebble counts (in Section IV).

Substrate type	*Size*	*Percentage*
Boulder	>10" diameter	
Cobble	2.5 - 10" diameter	
Gravel	0.1 - 2.5" diameter	
Sand	coarse grain	
Silt/Detritus/Muck	fine grain/organic matter	
Hardpan/Bedrock	solid clay/rock surface	
Artificial	man-made	
Other (specify)		
Can't see		

You may wish to take photos of unstable or eroded banks for your records. Record date and location.

Comments:

C. Bank stability and erosion.

Summarize the extent of erosion along <u>each bank separately</u> on a scale of 1 through 10, by circling a value below. Left/right banks are identified by looking downstream.

Excellent	Good	Marginal	Poor
Banks Stable. No evidence of erosion or bank failure. Little potential for problems during floods. < 5% of bank affected.	Moderately stable. Small areas of erosion. Slight potential for problems in extreme floods. 5-30% of bank in reach has areas of erosion.	Moderately unstable. Erosional areas occur frequently and are somewhat large. High erosion potential during floods. 30-60% of banks in reach are eroded.	Unstable. Many eroded areas. > 60% banks eroded. Raw areas frequent along straight sections and bends. Bank sloughing obvious.
LEFT BANK 10 - 9	LEFT BANK 8 - 7 - 6	LEFT BANK 5 - 4 - 3	LEFT BANK 2 - 1 - 0
RIGHT BANK 10 - 9	RIGHT BANK 8 - 7 - 6	RIGHT BANK 5 - 4 - 3	RIGHT BANK 2 - 1 - 0

MiCorps Site ID#:___________ Date:_________________

II. Stream and Riparian Habitat (continued)

D. Plant Community

What percentage of the stream is covered by overhanging vegetation/tree canopy?

<10% 10-50% 50-90% >90%

Using the given scale, estimate the relative abundance of the following:

Plants in the stream:		*Plants on the bank/riparian zone:*	
Algae on Surfaces of Rocks or Plants, or floating	Filamentous Algae (Streamers)	Shrubs	Trees
Macrophytes (Standing Plants)	**0= Absent 1= Rare 2= Common 3= Abundant**	Herbaceous plants	**0= Absent 1= Rare 2= Common 3= Abundant**
Identified species (optional)		Identified species (optional)	

E. Riparian Zone

The riparian zone is the vegetated area that surrounds the stream. Right/Left banks are identified by looking downstream.

1. Left Bank

Circle those land-use types that you can see from this stream reach.

Wetlands Forest Mowed Grass Park Shrubby/Grassy Field Agriculture

Construction Commercial Industrial Highways Golf Course Other___________

2. Right Bank

Circle those land-use types that you can see from this stream reach.

Wetlands Forest Mowed Grass Park Shrubby/Grassy Field Agriculture

Construction Commercial Industrial Highways Golf Course Other___________

3. Summarize the size and quality of the riparian zone along each bank separately on a scale of 1 through 10, by circling a value below.

Excellent	Good	Marginal	Poor
Width of riparian zone >150 feet, dominated by vegetation, including trees, understory shrubs, or non-woody macrophytes or wetlands; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	Width of riparian zone 75-150 feet; human activities have impacted zone only minimally.	Width of riparian zone 10-75 feet; human activities have impacted zone a great deal.	Width of riparian zone ,10 feet; little or no riparian vegetation due to human activities.
LEFT BANK 10 - 9	LEFT BANK 8 - 7 - 6	LEFT BANK 5 - 4 - 3	LEFT BANK 2 - 1 - 0
RIGHT BANK 10 - 9	RIGHT BANK 8 - 7 - 6	RIGHT BANK 5 - 4 - 3	RIGHT BANK 2 - 1 - 0

MiCorps Site ID#:___________ Date:________________

III. Sources of Degradation

1. Does a team need to come out and collect trash?

2. Based on **what you can see** from this location, what are potential causes and level of severity of any degradation at this stream?

(Severity: S – slight; M – moderate; H – high) (Indicate all that apply)							
Crop Related Sources	S	M	H	Land Disposal	S	M	H
Grazing Related Sources	S	M	H	On-site Wastewater Systems	S	M	H
Intensive Animal Feeding Operations	S	M	H	Silviculture (Forestry)	S	M	H
Highway/Road/Bridge Maintenance and Runoff	S	M	H	Resource Extraction (Mining)	S	M	H
Channelization	S	M	H	Recreational/Tourism Activities (general)	S	M	H
Dredging	S	M	H	• Golf Courses	S	M	H
Removal of Riparian Vegetation	S	M	H	• Marinas/Recreational Boating (water releases)	S	M	H
Bank and Shoreline Erosion/ Modification/Destruction	S	M	H	• Marinas/Recreational Boating (bank or shoreline erosion)	S	M	H
Flow Regulation/ Modification (Hydrology)	S	M	H	Debris in Water	S	M	H
Invasive Species	S	M	H	Industrial Point Source	S	M	H
Construction: Highway, Road, Bridge, Culvert	S	M	H	Municipal Point Source	S	M	H
Construction: Land Development	S	M	H	Natural Sources	S	M	H
Urban Runoff	S	M	H	Source(s) Unknown	S	M	H

Additional comments:

Michigan Clean Water Corps

MiCorps Site ID#:___________ Date:_________________

IV. Optional quantitative measurements

A. Transects and Pebble Counts

To take quantitative stream habitat measurements, conduct 10 transects of your stream reach. Required equipment: tape measure long enough to stretch across the stream, and graduated rod or stick to measure water depth. Data sheet is on the next page.

Directions:
1) Determine stream width.
2) Use the rod to measure depth (D) and substrate (S) at more than 10 but less than 20 regular intervals along the entire transect. (For streams less than 10 feet wide, measure every ½ foot, for streams about 10 feet wide, measure every foot, etc.)
3) At every depth measurement, identify the single piece of substrate that the rod lands on. If it is a mix of substrates, randomly pick one of them, and the next time you find a similar grouping, pick the other(s).
4). For every measurement, enter the reading on the tape measure, the depth, and the substrate on the data sheet on the next page.

Data use: The depth and tape measure reading can be used to produce stream cross-section profiles. The pebble count can be used to give a more accurate percentage breakdown of the stream substrate than simply making an eyeball estimate (see Section II-B).

B. Bank Height

Vertical banks higher than 3 feet are usually unstable, while banks less than 1 foot, especially with overhang, provide good habitat for fish. While doing the transects, measure bank heights and record the angle of the bank (right, acute, or obtuse) as indicated on the data sheet. Left/right banks are identified by looking downstream.

Data use: Calculate the percentage of banks with right, obtuse, and acute angles. Right angles indicate higher erosive potential, while acute angles improve the habitat structure of a stream.

V. Final Check

This data sheet was checked for completeness by: ______________________________

Name of person who entered data into data exchange: ____________________________

Date of data entry:____

VI. Credits

This habitat assessment was created for the MiCorps Volunteer Stream Monitoring Program from a combination of habitat assessments from the Huron River Watershed Council, the Friends of the Rouge River, and the Michigan Department of Environmental Quality. Version 1.0, June 2009. Version 2.0, November 2020.

MiCorps Site ID#:___________ Date:_________________

STREAM TRANSECT DATASHEET

B: Boulder -- more than 10"
C: Cobble -- 2.5 - 10"
G: Gravel – 0.1 – 2.5"
S: Sand -- fine particles, gritty

F: Fines: Silt/Detritus/Muck
H: Hardpan/Bedrock
A: Artificial
O: Other (specify)

T= Reading on tape
D = Depth
S = Substrate

	EXAMPLE			Transect #			Transect #			Transect#		
Stream Width	13.3 feet											
	T	D	S	T	D	S	T	D	S	T	D	S
Beginning Water's Edge:	1.5											
1	2.5	0.4	G									
2	3.5	0.4	G									
3	4.5	0.4	G									
4	5.5	0.2	C									
5	6.5	0	S									
6	7.5	0.6	S									
7	8.5	0.7	G									
8	9.5	0.7	G									
9	10.5	0.6	C									
10	11.5	0.7	B									
11	12.5	0.4	G									
12	13.5	0.3	F									
13	14.5	0.2	F									
14												
15												
16												
17												
18												
19												
Ending Water's Edge	14.8											

Bank Side	L	R		L	R		L	R		L	R	
Bank Height	1.7 feet	0.5 feet										
Does the bank have an undercut?	N	Y										
If so, how wide is it?		1 ft										
Bank Angles: Sketch												

Sketch examples:

Undercut (Acute) Obtuse Right

Site ID:

Stream Name: Location:

Site Sketch

Finish Time: (am/pm)

Datasheet checked for completeness by: ____________________

Field Quality Control Measures have been met and are verified by:____________________

Data entered into MRWA database – date: ____________________

Data entered into MiCorps database by: ____________________ Date: ____________________

Appendix 2

MiCorps Volunteer Stream Monitoring Procedures December 2020

Prepared by:
Paul Steen, Huron River Watershed Council
Jo Latimore, Michigan State University

MiCorps Stream Monitoring Procedures, December 2020 2

Adapted from: "Stream Crossing Watershed Survey Procedure, April 27, 2000"

Prepared by: Charlie Bauer, Saginaw Bay District Greg Goudy, Cadillac District Scott Hanshue, Great Lakes and Environmental Assessment Section Gary Kohlhepp, Great Lakes and Environmental Assessment Section Megan McMahon, Shiawassee District Ralph Reznick, Nonpoint Source Unit

Surface Water Quality Division Michigan Department of Environmental Quality

MiCorps Stream Monitoring Procedures, December 2020 3

I. **Overview**

A. OBJECTIVES

This set of stream monitoring forms is intended to be used as a quick screening tool to increase the amount of information available on the ecological quality of Michigan's streams and rivers, and the sources of degradation to the rivers. This document is designed to provide standardized assessment and data recording procedures that can be used by trained volunteers participating in the Michigan Clean Water Corps (MiCorps) Volunteer Stream Monitoring Program.

This stream monitoring procedure is designed to address several general objectives:

- Increase the information available on the ecological quality of Michigan rivers and the sources of pollutants, for use by state biologists, local communities and monitoring groups.
- Provide consistent data collection and management statewide.
- Serve as a screening tool to identify issues and the need for more thorough investigations.

B. TRAINING

All MiCorps Volunteer Stream Monitoring Program leaders must have received basic training in the stream assessment methods described below from MiCorps staff. Trained program leaders are then qualified to train their program volunteers in these procedures.

C. GENERAL CONCEPTS

The procedures and data forms provided below include two types of assessment: Stream Habitat Assessment and Macroinvertebrate Sampling.

The Stream Habitat Assessment is a visual assessment of stream conditions and watershed characteristics. The assessment should include approximately 300 feet of stream length. Only observations that are actually seen are to be recorded. No "educated guesses" are to be made about what should be there or is probably there. If something cannot be seen, it should not be recorded. The one exception is if a significant pollutant source or stream impact is known to be upstream of a particular site, a comment about its presence can be made in the comment section of the form.

The Macroinvertebrate Sampling procedure should be used in conjunction with the Stream Habitat Assessment because each approach provides a different piece of the stream condition puzzle. Because of their varying tolerances to physical and chemical conditions, macroinvertebrates indicate the ecological condition of the stream, while the

MiCorps Stream Monitoring Procedures, December 2020 4

habitat assessment provides clues to the causes of stream degradation.

Macroinvertebrate data used to calculate the Water Quality Rating (WQR), which provides a straightforward summary of stream conditions and can be used to compare conditions between study sites.

D. SURVEY DESIGN

1. Selecting Monitoring Sites

One of the basic questions in planning stream monitoring is the location of study sites: how many stream sites should be surveyed within a watershed to adequately characterize it, and where should they be located? That depends on a variety of factors including the heterogeneity of land use, soils, topography, hydrology, and other characteristics within the watershed. Consequently, this question can only be answered on a watershed-by-watershed basis.

A general EGLE guideline is to try to survey 30% of the stream road-crossing sites within a watershed, with the sites distributed such that each sub watershed (and in turn their sub watersheds) are assessed to provide a representative depiction of conditions found throughout the watershed. At least one site should be surveyed in each tributary, with the location of this site being near the mouth of the tributary. The distribution of sampling stations within the watershed should also achieve adequate geographic coverage. Consider establishing stations upstream and downstream of suspected pollutant source areas, or major changes in land use, topography, soil types, water quality, and stream hydrology (flow volume, velocity or sinuosity). If the intent of monitoring is to meet additional, watershed-specific objectives, then additional data may be needed.

When beginning a MiCorps monitoring program, it is likely not possible to get to 30% coverage of stream road-crossing sites due to volunteer numbers and budget constraints. MiCorps will require at least 6 sites to qualify for receiving a grant. Place these as close to the mouth of different tributaries as you can, with at least two on the main branch of your system, if you have one, on public land or land you have permission to access. As your program grows, you can growth your monitoring reach to new locations.

In all cases, the site should be representative of the area of stream surveyed, it should contain a diverse range of the available in-stream cover, and it should contain some gravel/cobble bottom substrates if possible. Remember that each study site should allow for the assessment of 300 feet of stream length.

2. Time of Year and Monitoring Frequency

The time of year in which monitoring is conducted is important. For comparisons of monitoring data from year to year, data should be collected during the same season(s) each year. Ideally, macroinvertebrate sampling should take place in spring and again in early fall. Different macroinvertebrate communities are likely to be encountered during these different seasons, and sampling twice a year will provide a more complete picture of the total stream

community. All sampling must be conducted within a two-week window, and preferably, all on the same day. To provide comparable results from year to year, sampling should be conducted at approximately the same time each year.

Habitat Assessment should be done in early spring before leaf-out, or in the fall after streamside vegetation dies back, allowing visual assessments of stream characteristics. Stream habitat assessments should not be conducted when there is snow on the ground or ice on the water because important features may be hidden from view. Surveys conducted during or shortly after storm runoff events may help to identify sources of pollutants, but high-water obscures bank conditions and increased stream turbidity may make assessment of instream conditions difficult. Furthermore, all sites within a single watershed should be surveyed as closely together in time as possible to facilitate relative data comparisons among stations surveyed under similar stream flow and seasonal conditions.

MiCorps recommends repeating habitat assessment every 1 to 5 years, depending on the level of your concern for changes or impacts.

II. Stream Habitat Assessments

A. GENERAL INSTRUCTIONS

With your team (3-5 members preferably, though it can be done with 2 people), slowly walk the length of the 300-foot station length, taking in the stream's features as you go. It will be helpful to have each member be familiar with the datasheet ahead of time, so that the team knows what to look for. After observing the creek, start answering the questions together, with one member reading the questions and the other team members giving their opinions. The datasheet is filled out in a democratic method, attempting to come to agreement on the answer. If a majority agreement can't be reached, record both answers on your datasheet or where appropriate, take an average result.

Always take photos while conducting the Stream Habitat Assessment. Photographs are useful for interpretation of Stream Habitat Assessment data and for later comparisons among different sites. Site photos should show the bank conditions and some of the riparian corridor. Additional photos may be taken to highlight a particular item of concern in the stream or upland landscape. Be sure to document photos as they are taken, to simplify identification later.

As the team walks and afterwards fills out the assessment, one team member is in charge of drawing a site sketch (there is no MiCorps template for this; you can choose your methodology). The goal of a site sketch is to make the location understandable for anyone who has never been there, to make it easier to plan future outings, and to track long term changes. Draw a bird's eye view of the study site. It is important to include a north arrow, the direction of water flow, both sides of the stream channel, upland areas, parking location, and roads in the sketch, if applicable.

B. DATA SHEET

1. Stream, Team, Location Information

MiCorps Site ID#: You should create a unique numbering system for your sites. A suggested approach would be to use your organizations abbreviations and combine it with a

MiCorps Stream Monitoring Procedures, December 2020 6

number. For example, HRWC-1. You want to pick a numbering system that won't accidently copy another organization's numbering system. MiCorps staff will contact you if your numbering system is not unique.

Date: Record the month, day and year.

Time: Record the time when the monitoring activity began.

Site Name: Use a combination of the stream name and location from which you access the study site. For example, Arms Creek at Walsh Road.

Stream name: Use the stream or river name found on the U.S. Geological Survey (USGS) topographic map for the area and note also the local name if it is different. For tributary streams to major rivers, record the tributary stream name here, not the major river name. If the tributary is an unnamed tributary, record as "Unnamed Tributary to" followed by the name of the next named stream downstream. For example, a station on an unnamed tributary of Hogg Creek would be recorded as "Unnamed Tributary to Hogg Creek".

Location: This is often the name of the road from which you access the study site, or name of the public park. It is very important to indicate whether the site is upstream or downstream of the road. If the same road crosses a single stream two or more times, it is sometimes desirable to record the road name relative to the nearest crossroads (e.g. "Green Road between Brown Road and Hill Road").

Location Information: Record the latitude and longitude coordinates of the study site. Ideally, these coordinates will correspond to the midpoint of the stream study reach. Google Maps now allows for very easy latitude/longitude identification. Just right click on the map and these coordinates will be given.

Names of Team members: Record the name of all the team members participating in the assessment, and circle the one recording the data, in case questions come up later.

2. Stream and Riparian Habitat

A. General Information

1. Avg. Stream Width (ft): Circle the range that represents the average stream width in feet. This can be a best guess, or you can choose to take width measurements of the stream at several points along the 300-foot assessment area, and indicate the average width here. These measurements are also useful in creating the Stream Site Sketch.

2. Avg. Stream Depth (ft): Circle the appropriate depth range in feet. Take depth measurements at several points within the 300-foot assessment area and take the average depth. This observation is for the average depth of the stream that is consistently observed. For example, if the stream is generally shallow (<1ft), but has a pool that is 3ft deep, circle the <1ft category since a pool is not representative of the average depth of <1ft observed over most of the stream.

3. Has this stream been channelized? Stream shape constrained through human activity look for signs of dredging, armored banks, straightened channels.

Yes, currently: You see active construction, or vegetation removal, or scraping of banks, and the river lacks turns and meanders.

Yes, sometimes in the past: The river lacks turns and meanders, but there are signs of water flow induced erosion, and vegetation has recovered from any construction at the site.

No: The stream has bends and meanders and you do not see the signs noted above. (note that you might only notice bends and meanders in small creeks; rivers bend and meander at a much higher geographic scale)

4. Estimate of current stream flow: All of these pieces of information can help you make this determination. 1) The volunteer's knowledge of recent weather conditions (e.g., how much it has rained recently). 2) Visual stream observations (look for event related conditions water running off the land into the stream, fast stream water velocity, increased water turbidity, an increase in the amount of debris being carried by the stream), 3) The team's knowledge (or best guess) of what is typical flow for that (or a similar) stream, in that geographic area, for that season of the year.

Dry = No standing or flowing water, sediments may be wet.
Stagnant = Water present but not flowing, can be shallow or deep.
Low = Flowing water present, but flow volume would be considered to be below average for the stream.

Medium = Water flow is in average range for the stream.
High = Water flow is above average for the stream.

5. Highest water mark (in feet above the current level): Look for signs that the water was once higher: debris trapped against bridges, or trees, and erosion along banks above the water level.

6. Which of these habitat types are present?

Good quality streams have a wide variety of habitat available to fish and macroinvertebrates to: (1) protect them from predators, (2) avoid certain stream conditions such as fast flow velocities or direct sunlight, and 3) provide surfaces and structure on which food grows, collects, or tries to hide. Circle all the habitat types on the data form that are present in the stream reach for your 300-foot station. Types of habitat include the following:

Riffles: Riffles are areas of naturally occurring, short, relatively shallow, zones of fast-moving water, typically followed by a pool. The water surface is visibly broken (often by small standing waves) and the river bottom is normally made up of gravel, rubble and/or boulders. Riffles are not normally visible at high water and may be difficult to identify in large rivers. The size of, and distance between, riffles is related to stream size. In large mainstream reaches, such as the Manistee or Muskegon rivers, riffles may be present. in the form of rapids.

Pool: Pools are areas of relatively deep, slow-moving water. The key word here is “relatively”. Water depth sufficient to classify an area as a pool can vary from around 8 inches in small streams, to several feet in wadable streams, to tens of feet in large rivers. Pools are often located on the outside bend of a river channel and downstream of a riffle zone or obstruction. The water surface of a pool is relatively flat and unbroken. The presence of pools in large rivers may be difficult to identify because of an increase in relative scale, and an often-limited ability to see to the bottom of deep or turbid stream reaches.

Large woody debris: Logs, branches, and roots both above and below the water surface.

Large rocks: rocks that are 10 inches in diameter or larger.

Undercut Banks: Stream banks that overhang the stream because water has eroded some of the material beneath them.

Overhanging Vegetation: Terrestrial vegetation that extends out from shore over the surface of the stream within a foot or two of the water surface (includes trees, shrubs, grasses, etc.). This category also includes sweeping vegetation, which is terrestrial shoreline vegetation that extends into the water itself (such as low hanging branches on shrubs) and is therefore often "swept" in a downstream direction by the current.

Rooted Aquatic Plants: Aquatic macrophytes provide breaks in water flow, cover, and a food source, becoming good habitat for both fish and macroinvertebrates.

7. Estimate of turbidity: Water appears cloudy—it is rarely transparent, and the level of the cloudiness is called turbidity. Turbidity is caused by suspended particulates such as silt, sand, algae, or fine organic matter. Highly turbid water is opaque to varying degrees, preventing the observer from seeing very far into it. Note that water can have a color to it that is not turbidity, such as the brown transparent water often associated with swampy areas.

8. Is there a sheen or oil slick visible on the surface of the water?

9. If yes to #8, does the sheen break up when poked with a stick?

An oily appearing sheen on the water surface caused by petroleum products. A thin sheen will often have a rainbow of hues visible. The sheen can be distinguished from bacterial sheens by remaining viscous when poked with a stick or otherwise physically disturbed, whereas bacterial sheens break into distinct platelets.

10. Is there foam present on the surface of the water?

11. If yes to #10, does the foam smell soapy and look white and pillow like or look gritty with dirt mixed in?

Naturally occurring foam often looks like soap suds on the water surface and can be white, grayish or brownish. Foam is produced when water with dissolved organic material is aerated and can range in extent from individual bubbles to mats several feet high. Foam is typically produced in streams when water flows through rapids or past surface obstructions such as logs, sticks and rocks. Simple wave action can produce foam in lakes. This naturally occurring foam is quite common. If the suds are a bright white color, billowy and pillow-like, soapy, or smell perfumed, it is not natural foam. Volunteers used to touch the foam to feel for grittiness, but MiCorps does not advise that anymore as the foam could be PFAS, which you should not handle.

The following are optional measurements not currently funded by MiCorps *(water temperature, dissolved oxygen, pH, water velocity)*

MiCorps Stream Monitoring Procedures, December 2020 9

B. Streambed Substrate

Substrate is the material that makes up the bottom of the stream. In general, good quality substrates (from an aquatic habitat perspective) contain a large amount of course aggregate material—such as gravels and cobbles—with a minimal amount of fine particles surrounding or covering the interstitial pore spaces. These stable materials provide the solid surfaces necessary for the colonization of attached algae and the development of diverse macroinvertebrate communities.

Using the particle size and composition guidance provided below, identify the percent areal extent of each substrate type present. The composition estimate should include the entire area of the stream bottom in the study site (typically, 300 feet of stream). Sometimes it is not possible to determine the substrate type all the way across a river because it is too deep or the water is turbid. In these cases, assign the appropriate percentage amount to the “unknown” category.

Substrate Type and Sizes

Boulder: Rocks 10 inches diameter or larger.

Cobble: Rocks 2.5 inch to 10 inches in diameter.

Gravel: 0.1 -2.5 inch diameter

Sand: Coarse grained, <0.1 inch diameter particles

Silt-Muck-Detritus: Silt is usually clay, very fine sands, or organic soils, 0.004 to 0.06 millimeters in diameter. Muck is decomposing organic material of very fine diameter. Detritus is small particles of organic material such as pieces of leaves, sticks, and plants.

Hardpan-Bedrock: Solid surface. Hardpan is usually packed clay. Bedrock is a solid rock surface (the tops of buried boulders are not bedrock).

Artificial: Human made, such as concrete piers, sheet piling or rock riprap (that portion of shoreline erosion protection structures that extends below the water surface is considered substrate).

Other (specify): If something doesn’t fit into the above categorizes, it goes here.

Can’t see: The portion of the stream bottom for which a substrate type determination cannot be made because the bottom cannot be seen due to water depth or turbidity.

C. Bank stability and erosion

Bank erosion may occur as a result of natural flow conditions, or may be caused by human activities. Determine the severity of erosion that has taken place through the

MiCorps Stream Monitoring Procedures, December 2020 10

explanations given for the categories excellent, good, marginal, and poor, and then circle one of the numbers in that category to give a more specific rating.

Excellent: Banks Stable. No evidence of erosion or bank failure. Little potential for problems during floods. < 5% of bank affected.

Good: Moderately stable. Small areas of erosion. Slight potential for problems in extreme floods. 5-30% of bank in reach has areas of erosion.

Marginal: Moderately unstable. Erosional areas occur frequently and are somewhat large. High erosion potential during floods. 30-60% of banks in reach are eroded

Poor: Unstable. Many eroded areas. > 60% banks eroded. Raw areas frequent along straight sections and bends. Bank sloughing obvious.

D. Plant Community

Estimate the percentage of the stream covered overhanging vegetation/tree canopy? Circle one: <10%, 10-50%, 50-90%, >90%. These are very wide windows because a general sense of the situation is all that is needed. Is the stream fully exposed to the sun, fully shaded, or somewhere in between? The level of sun exposure will affect how biota hides and water temperature fluctuations.

For the various type of plants listed, rate each group as absent, rare, common, or abundant. The groups are:

<u>Plants in the Stream</u>: Floating Algae: The abundance of suspended algae (single celled organisms that may or may not form colonies) or algae on the surface or rocks or plants should be recorded here.

Filamentous Algae: Algae that appear in stringy or ropy strands, such as Cladophora. The strands may or may not be attached to other objects in the waterbody.

Macrophytes: This category refers to aquatic plants. By definition, macrophytes are any plant species that can be readily seen without the use of optical magnification. However, the usage here is directed primarily toward <u>aquatic vascular plants</u>—plants with a vascular system that typically includes roots, stems and/or leaves. This includes duckweed, as it is a floating vascular plant. Certain large algae species that superficially look like vascular plants, such as Chara, can be recorded here as well. If the person conducting the survey is knowledgeable about aquatic plants, the particular type or species of plant(s) can be noted in the comment section at the end of the form. Floating, suspended, or filamentous algae species should be recorded in one of the algae categories and not here.

<u>Plants on the bank/riparian zone</u>

Shrubs: Woody, low lying plants.
Trees: Woody, tall plants.
Herbaceous: Non-woody plants including grasses, forbs, and so on.

E. Riparian Zone

The riparian vegetative width is the width of the streamside natural vegetation zone along the stream banks. The width is measured from the edge of the stream to the end of the contiguous block of natural vegetation. Natural vegetation is defined as including trees, shrubs, old fields, wetlands, or planted vegetative buffer strips (often used in agricultural areas and stormwater runoff control). Agricultural crop land and lawns are not considered natural vegetation for the purposes of this question. A stream with grass mowed to the very edge is said to have no riparian zones. A stream set in a deep forest will have a riparian zone that spreads further than you can even see.

For both the left and right bank (which is determined by looking downstream), circle the land use types that you can see along your 300-foot stretch.

Then, rate the riparian zone from excellent to poor, and then circle one of the numbers in that category to give a more specific rating, similar to how you rated bank erosion in C.

Excellent: Width of riparian zone >150 feet, dominated by vegetation, including trees, understory shrubs, or non-woody macrophytes or wetlands; vegetative disruption through grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.

Good: Width of riparian zone 75-150 feet; human activities have impacted zone only minimally.

Marginal: Width of riparian zone 10-75 feet; human activities have impacted zone a great deal.

Poor Width of riparian zone ,10 feet; little or no riparian vegetation due to human activities.

III. Sources of Degradation

The intent of this section is to evaluate the relative importance of potential sources in terms of <u>pollutant contribution</u> to the waterbody at a given site in the watershed. The evaluation assesses the <u>potential for pollutant inputs</u> at the site, <u>NOT</u> pollutant impacts, or the potential for pollutant impacts. Pollutant impacts, as indicated by visual manifestations (like erosion, changes to substrate, oil, foam, etc) were evaluated previously.

Evaluating potential sources of pollutants to a waterbody is a <u>three-step process</u>: identification of potential sources, evaluation of pathways for pollutants to get to the waterbody, and finally evaluation of the severity (magnitude) of this pollutant input or loading. The three steps of this process will result in scoring identified sources on the survey sheet as Slight, Moderate, or High Priority in terms of the severity or amount of their pollutant contribution to the waterbody at the site being surveyed.

<u>(1) Source Identification</u>

Visually evaluate the various land use/land change activities at the site for potential sources of pollution. Note all potential sources for the area that can be seen (choosing from among the list of sources on the data sheet). For example, is there evidence of soil disturbance at the site, or land uses such as residential lawns, agricultural fields, parking lots, urban areas, etc., near the waterbody? Use the source definitions provided to help identify what potential sources may exist. If it is known that a significant source exists upstream of the study site, such as a wastewater treatment plant, it may be important to note the presence of that source, but it should be recorded in the comments section since it was not visible at the site.

<u>(2) Pollutant Pathway</u>

Next, for each potential source that has been identified, evaluate how pollutants could get from the source to the water. An evaluation of likely pathways for pollutants to enter the waterbody provides information regarding the potential for the identified sources to contribute pollutants. The following provides a quick outline of some visual observations to consider in evaluating pollutant pathways. Pay particular attention to likely water runoff patterns at the site that may occur during rainfall or snowmelt events.

- Gully/rill erosion provides a direct pathway for pollutants to enter the stream in a concentrated flow when the land slopes toward the stream. Pollutants associated with eroding soils will vary depending on the type of land use activity.
- Tile/pipe discharges are potential direct pathways for pollutants.
- Bare soils near the edge of a waterbody provide a likely pathway for sediment to get to the waterbody.
- Maintained lawns to the edge of a waterbody provide a likely pathway for nutrients and pesticides to the waterbody.
- Land disturbance/use activities to the edge of a waterbody provide a likely pathway for various pollutants to the waterbody.
- Open areas of disturbed soils and/or bare soils devoid of vegetation provide a potential pathway for pollutants via wind erosion.
- Steep streambanks (steeper than a 2:1 slope) devoid of vegetation are likely pathways for sediment.
- No canopy over the waterbody is a pathway for dramatic thermal increase in water temperature during the day.
- Impervious surfaces (parking lots, roads, roof tops, etc.) provide a likely pathway for various pollutants, and may increase flows in the watershed causing flashiness.

- Culverts/bridges may not be aligned with the stream, or may be undersized, and could provide a likely pathway for flow to create streambank erosion both upstream and downstream of the culvert or bridge.

(3) Severity Ranking
Finally, for each source for which a pathway has been identified, evaluate how severe the pollutant loading is. Rank each source identified as Slight, Moderate or High severity for the contribution of pollutants, based on the magnitude or quantity of pollutants likely to be delivered to the stream. The surveyor must use their judgement on assigning a slight, moderate, or high rating.

The severity ranking is based only on pollutant inputs from the specific source at the site, not on visible stream impacts or impacts the pollutant may cause downstream. The pollutant loads from the identified source(s) may or may not have an impact at the site.
Evaluation of the source, location and pathways can provide a reasonable assessment of the severity of the pollutant loading. The following provides a quick outline of some visual observations to consider in evaluating the severity of pollutant loading.

- Proximity to waterbody – generally the closer the use, or land disturbance activity, is to the waterbody, the greater the likelihood for pollutant delivery.
- Slope to waterbody – generally the steeper the slope/topography to the waterbody, the greater the likelihood of overland pollutant delivery.
- Conveyance to waterbody (ditch, pipe, etc.) – generally a conveyance from the use, or land disturbance activity, increases the likelihood of pollutant delivery.
- Imperviousness – impermeable surfaces reduce the amount of land area available for water infiltration and increase the potential for overland runoff. Additionally, if a watershed is greater than 10% impervious, it will start to show some systemic problems due to impacts from flow. If a watershed is greater than 25% impervious, the natural hydrology is generally heavily impaired.
- Intensity and type of use, or land disturbance activity – generally the more intensive the activity the greater the likelihood for the generation of pollutants. Certain activities may have specific types of pollutants associated with them.
- Size of erosion area – generally the larger the erosion area the greater the likelihood for sediment delivery.
- Soil type – clay is less permeable than sand, and therefore would create a greater potential for overland runoff of pollutants.
- Presence and type of vegetation – the greater the vegetative buffer around a waterbody, the better the filtration of pollutants from nearby land

disturbance and use activities. Certain types of vegetative buffers work better than others and should be evaluated on a case-by-case basis.

MiCorps Stream Monitoring Procedures, December 2020 14

Potential Source Category Definitions:

Source Category	Use this Source Category if …
Crop Related Sources	… there is a reasonably clear pathway for pollutants to enter the waterbody from the farmed area. Possible pathways: farming to the edge of the drain, gully/rill erosion off field, tile discharge, wind erosion off field.
Grazing Related Sources	… there is clear evidence that grazing of animals near or in the waterbody has resulted in the degradation of streambanks or stream beds, sedimentation, nutrient enrichment, and/or potential bacterial contamination.
Intensive Animal Feeding Operations	… there is a reasonably clear pathway for pollutants to enter the waterbody from either runoff from the operation or land application of animal manure. Possible pathways: overland flow, tile discharge.
Highway/Road/Bridge Maintenance and Runoff (Transportation NPS)	… there is clear evidence that transportation infrastructure is creating increased flow, runoff of pollutants, or erosion areas in or adjacent to the waterbody.
Channelization	… there is clear evidence that the natural river channel has been straightened to facilitate drainage.
Dredging	… there is clear evidence that a waterbody has been recently dredged. Evidence might include: spoil piles on side of waterbody, disturbed bottom, disturbed banks.
Removal of Riparian Vegetation	… there is clear evidence that vegetation along the waterbody has been recently removed (within the last few years).
Bank and Shoreline Erosion/ Modification/Destruction	… there is clear evidence that the banks or shoreline of a waterbody have been modified either through human activities or natural erosion processes.
Flow Regulation/ Modification (Hydrology)	… there is reasonably clear evidence that flow modifications in the watershed have created unstable flows resulting in streambank erosion.
Upstream Impoundment	… there is reasonably clear evidence that an upstream impoundment has contributed to impacts on downstream sites. Impacts may be: nuisance algae, increased temperatures, streambank erosion from unstable flows.

Construction: Highway/ Road /Bridge/Culvert	… there is clear evidence that on-going or recent construction of transportation infrastructure is contributing pollutants to the waterbody.
Construction: Land Development	… there is clear evidence that on-going or recent land development is contributing pollutants to the waterbody.
Urban Runoff (Residential/ Urban NPS)	… there is a reasonably clear pathway for pollutants to enter the waterbody from an urban/residential area. Possible pathways: gully/rill erosion, pipe/storm sewer discharge, wind erosion, runoff from lawns or impervious surfaces.
Land Disposal	… there is a reasonably clear pathway for pollutants to enter the waterbody from an area where waste materials (trash, septage, hazardous waste, etc.) have been either land applied or dumped. Possible pathways: gully/rill erosion, pipe discharge, wind erosion, or direct runoff.

On-site Wastewater Systems (e.g., septic systems)	… there is reasonably clear evidence of nutrient enrichment and/or sewage odor is present, and there is reason to believe the area is unsewered.
Silviculture (Forestry NPS)	… there is a reasonably clear pathway for pollutants to enter the waterbody from the forest management area. Possible pathways: logging to the edge of the waterbody, gully/rill erosion off site, pumped drainage, erosion from logging roads, wind erosion off site.
Resource Extraction (Mining NPS)	… there is a reasonably clear pathway for pollutants to enter the waterbody from the mined area. Possible pathways: gully/rill erosion off site, pumped drainage, runoff from mine tailings, wind erosion off site.
Recreational/Tourism Activities (general)	… you are unable to clearly identify the recreational source as related to a golf course, or recreational boating activity. Foot traffic causing erosion would fall into this category.
Golf Courses	… there is a reasonably clear pathway for pollutants to enter the waterbody from the golf course area. Possible pathways: overland runoff, gully/rill erosion off course, tile discharge, wind erosion off course.
Marinas/Recr. Boating (water releases)	… if you can reasonably determine that releases of pollutants to a waterbody such as septage or oil/gasoline are due to recreational boating activities.

Marinas/Recr. Boating (streambank erosion)	… you can reasonably determine that streambank erosion is due to wake from recreational boating activities.
Debris in Water	… debris in the water either is discharging a potential pollutant, or is causing in stream impacts due to modifications of flow. Possible examples: Leaking barrel, Refrigerator, Tires, etc. This does not include general litter (e.g., paper products).
Industrial Point Source	… there is reasonably clear evidence that an upstream industrial point source has contributed pollutants.
Municipal Point Source	… there is reasonably clear evidence that an upstream municipal point source has contributed pollutants.
Natural Sources	… there is reasonably clear evidence that natural sources are contributing pollutants. Possible examples: streambank erosion, pollen, foam, etc.
Source(s) Unknown	… if you see an impact but are unable to clearly identify any likely sources.

Additional Comments:
Any observations about the site that were not covered elsewhere on the survey form should be recorded in this section. If certain survey responses require clarification or elaboration, those should be described here as well. The comment section can also be used to add detail to the site characterization, such as listing the types of aquatic plants or algae present, if known.

In addition, any unique conditions or issues that arose or were observed during the assessment process should be noted here.

MiCorps Stream Monitoring Procedures, December 2020 16

IV. Optional Quantitative Measurements

A. Transects and Pebble Counts

To take quantitative stream habitat measurements, conduct 10 transects of your stream reach. A transect is a measuring tape line stretched out perpendicularly across the stream, going from bank to bank. At 10-20 locations along this line, you will take depth measurements and record the substrate type.

Required equipment: tape measure long enough to stretch across the stream, and graduated rod or stick to measure water depth. Data sheet is on the next page.

Directions:

1) Determine stream width.
2) Use the rod to measure depth (D) and substrate (S) at more than 10 but less than 20 regular intervals along the entire transect. (For streams less than 10 feet wide, measure every ½ foot, for streams about 10 feet wide, measure every foot, etc.)

3) At every depth measurement, identify the single piece of substrate that the rod lands on. If it is a mix of substrates, randomly pick one of them, and the next time you find a similar grouping, pick the other(s).
4) For every measurement, enter the reading on the tape measure, the depth, and the substrate on the data sheet on the next page.

Data use: The depth and tape measure reading can be used to produce stream cross-section profiles. The pebble count can be used to give a more accurate percentage breakdown of the stream substrate than simply making an eyeball estimate (see Section II-B).

B. Bank Height

Vertical banks higher than 3 feet are usually unstable, while banks less than 1 foot, especially with overhang, provide good habitat for fish. While doing the transects, measure bank heights and record the angle of the bank (right, acute, or obtuse) as indicated on the data sheet. Left/right banks are identified by looking downstream.

Data use: Calculate the percentage of banks with right, obtuse, and acute angles. Right angles indicate higher erosive potential, while acute angles improve the habitat structure of a stream.

V. Final Check

Completeness: A volunteer team member other than the person who filled out the data sheets must check the data sheet for completeness before the team leaves the site. This verification of completeness should be noted at the bottom of each page.

Name of person who entered data into data exchange: This field is for use in case problems come up with the data entry.

Date of date entry: This field is for use in case problems come up with the data entry.
MiCorps Stream Monitoring Procedures, December 2020 17
Stream Transect Datasheet
MiCorps Stream Monitoring Procedures, December 2020 18
III. Stream Macroinvertebrate Monitoring Protocols
A. TEAM COMPOSITION

MiCorps macroinvertebrate collection is carried out by teams of staff and/or volunteers consisting of no fewer than 3 people and up to 6 or 7. More people than that is acceptable but as more join a team, crowding and equipment issues can hamper team effectiveness.

One team member is the Collector, who must be trained in collection techniques. This person is the only one to enter the water and use the net to pull out debris and macroinvertebrates. However, on larger rivers or streams with overgrown banks it is helpful to have a Collector's

Assistant in waders assisting the Collector by carrying trays back and forth from the Collector to the Pickers.

There should also be a Team Leader, who has preferably been to a special training but at a minimum has participated in the monitoring previously. The Team Leader directs the rest of the team, the Pickers, who do not have to be trained ahead of time. On-site directions are sufficient as the Picker role is very easy and done under direct supervision of the Team Leader. The Pickers and Leader sit on the bank of the stream to pick insects out of the trays and put the specimens in the sample vials. The Team Leader also fills out data sheets, watches the time, and keeps the team organized.

B. SAMPLING

The sampling effort expended to collect benthic macroinvertebrates at each 300-foot site should be sufficient to ensure that all types of benthic invertebrate habitats are sampled in the stream reach. This generally will be about 35-45 minutes of total sampling time per station. You should be flexible on the timing for Collectors who move slowly in the water, because of either tricky wading and walking conditions or inexperience. If sampling goes slow, sample longer than 45 minutes at your discretion; the goal is to keep the total effort the same across all sampling outings.

Macroinvertebrate samples should be collected from all available habitats within the stream reach using a dip net with a 1-millimeter (mm) mesh, or by hand picking bigger items like logs and rocks.

Available habitat types can include but aren't limited to riffles, pools, cobbles, aquatic plants, runs, stream margins, leaf packs, undercut banks, overhanging vegetation, and submerged wood. Habitat and substrate types from which macroinvertebrates were collected (or collections were attempted) should be recorded on the form; include as many as possible. People on the bank can aid the Collector by reminding them of the different habitat types to sample.

As the Collector obtains debris in their net, the debris is dumped into white trays along the bank. The Pickers will then sort through the debris and place the macroinvertebrates into jar(s) of 70% ethanol preservative for later identification. The Team leader should show Pickers how to sort through the tray, and to inspect rocks and other debris, emphasizing hidden locations under bark and in caddisfly cases. The Team leader should stress

patience. Use some water to get things moving as a dry sample is nearly impossible to pick through.

Be sure that every jar has a laser printer label (or handwritten with pencil) to avoid the ink running. Place labels inside the jar with the alcohol and not taped to the outside.

The Pickers should work for about one hour in total or until they have gone through all the debris provided by the Collector, whichever comes first. The team should set a timer or mark the start time in order to be accurate. The teams must strive to get at least 100 specimens. They are not expected to count it, but generally they should have a good sense as they go if they are meeting that benchmark. The Water Quality Rating (WQR) is designed to be most accurate with sample sizes of at least 100 specimens.

C. COLLECTING TECHNIQUES IN DIFFERENT HABITATS

General Techniques

1. Collecting should begin at the downstream end of the stream reach and work upstream.
2. Please note that many mussels are endangered or threatened. Don't collect mussels and clams; don't even take them out of the water or dislodge them. Make a note on the datasheet if they are found.
3. While crayfish are not endangered, they are too big usually to fit in sample jars. Make note of crayfish and them release them as well.
4. Remember - BE AGGRESIVE- the animals are holding on tight to rocks, branches, and leaves to avoid being carried downstream and you want to shake them loose!
5. Always point opening of net upstream so the current does not wash out your net.
6. Lift up carefully in sweeping motions to avoid losing organisms.

Riffles/Runs:

1. Keep in mind that flow has a big impact on the types of animals that can live there. Both riffles and runs are areas of faster moving water. A riffle (white water present, larger rocks) and a run (no white water, smaller gravel sized rocks) will likely yield different animals.
2. Put net on bottom of stream, stand upstream, hold net handle upright.
3. Use kicking/shuffling motion with feet to dislodge rocks. You are trying to shake organisms off rocks as well as kick up organisms that are hiding under the rocks. Dig down with your toes an inch or two. Some people use their hands to rub organisms off rocks, but beware of sharp objects on the stream bottom.

Quiet Place/pool:

1. Scoop some sediment up in your net. Some animals burrow into the muck.

Tip: When your net is full of muck, it is very heavy. To clean the excess muck out of your net: keep the top of the net out of the water to avoid losing animals, then sway the net back and forth, massaging the bottom of the net with your hand. When choosing a soft bottom area try to find one that contains silt since it is a far more productive habitat than just sand.

2. Don't oversample muck. Not much will live here, and it is difficult to sort through. Process one or two nets worth and then don't go back to this habitat.

Undercut Bank/Overhanging Vegetation or Roots:

1. Jab the net into the undercut bank while pulling the net up. Move in a quick bottom to surface motion to scrape the macroinvertebrates from roots. Do this several times.
2. If you notice roots or overhanging vegetation, put the net under the bank at the base of the plants. Shake the vegetation using your net, trying to shake off the animals clinging to these plants. Feel free to use your hands if you are sure the plants are not poisonous.

Submerged or emergent vegetation:

1. Keeping the net opening pointed upstream, move the net through vegetation trying to shake the vegetation and catch any animals.
2. Use your hands to agitate the vegetation and dislodge the animals into the net.

Rocks/Logs:

1. Small logs and rocks can be pulled out of the water by hand and given to the team to search for animals. Hint for Logs: Be sure to check under bark.

Hint for Rocks: Caddisfly homes often look like small piles of sticks, clumps of small gravel, or even tiny circular pieces of algae attached to rocks.

Leaf Packs:

1. Look for a decomposing leaf pack. A “good” leaf pack has dark brown-black skeletonized leaves. Slimy leaves are an indication that they are decaying. Scoop a few into your net and let the team pull them apart and look for animals.
2. Sometimes a little water in the pan with the leaves will help dislodge the animals.

D. CLEANING YOUR GEAR

Remember to clean the net and pans before leaving the site to avoid transporting animals or plants. If you plan to use the gear again within the next month, air drying is not sufficient. In that case, you must clean out the treads of the waders, get all dirt of debris out of the equipment, and use a dilute bleach or similar disinfectant to sanitize the gear. For full instructions on decontamination processes, see https://www.hrwc.org/volunteer/decontaminate/.

E. IDENTIFICATION

Identification can be performed in the field or in an indoor setting (recommended), as desired by the monitoring organizations. Volunteers who lack identification experience must be overseen by an identification expert or program’s scientific advisor; in any case, the final identification must be confirmed by this person(s).

The organisms in the collection should be identified to order, sub-order, or family, as indicated on the MiCorps datasheet, using taxonomic keys. The abundance of each taxon in the stream study site should be recorded on the datasheet.

F. STREAM MACROINVERTEBRATE DATASHEET

Front page

MiCorps Stream Monitoring Procedures, December 2020 21

MiCorps Site ID#: You should create a unique numbering system for your sites. A suggested approach would be to use your organizations abbreviations and combine it with a number. For example, HRWC-1. You want to pick a numbering system that won't accidently copy another organization's numbering system. MiCorps staff will contact you if your numbering system is not unique.

Site Name: Use a combination of the stream name and location from which you access the study site. For example, Arms Creek at Walsh Road.
Stream name: Use the stream or river name found on the U.S. Geological Survey (USGS) topographic map for the area and note also the local name if it is different. For tributary streams to major rivers, record the tributary stream name here, not the major river name. If the tributary is an unnamed tributary, record as "Unnamed Tributary to" followed by the name of the next named stream downstream. For example, a station on an unnamed tributary of Hogg Creek would be recorded as "Unnamed Tributary to Hogg Creek".
Location: This is often the name of the road from which you access the study site, or name of the public park. It is very important to indicate whether the site is upstream or downstream of the road. If the same road crosses a single stream two or more times, it is sometimes desirable to record the road name relative to the nearest crossroads (e.g., "Green Road between Brown Road and Hill Road").

Date: Record the month, day and year.

Collection Start Time: Record the time when the monitoring activity began.

Major Watershed: Record the name of the major watershed where the study site is located (e.g., Grand River Watershed, St. Mary's River Watershed), and the corresponding HUC Code, if known.

Longitude and Latitude: Record the latitude and longitude coordinates of the study site. Ideally, these coordinates will correspond to the midpoint of the stream study reach.

Names of Team members: Record the name of all the team members participating in the assessment, and circle the one recording the data, in case questions come up later.

Stream Conditions: This section is important for interpreting the data after the collection and identification. If results are much worse than normal, this information will help the program manager conclude that conditions on the sample day were not representative of the stream's normal range of conditions and may flag the site for resample or strike the results from the long-term dataset.

Average Water Depth: This value can be taken from the Stream Habitat Assessment datasheet, if completed at the same time. Otherwise, to measure average water depth (ft), three measurements should be made at random points along the representative reach length being surveyed, and these values averaged for a mean depth.

Notable weather condition of the last week: Substantial rainfall or drought especially can cause fluctuations in macroinvertebrate results.

MiCorps Stream Monitoring Procedures, December 2020 22

Are there are current site conditions that may impede normal macroinvertebrate sampling? This is left open for volunteers to comment on anything that would affect the study (for example, weather, flooding, poor visibility like high turbidity, difficult wading conditions, etc.).

Habitat types: A list of stream microhabitat are provided so that the Streamside Leader can remind the Collector of what different places to sample. Sample as many of these as possible, checking them off as you go.

Did you see any crayfish or clams/mussels? Do not collect these, but record the number that you see so you can use them in your water quality rating.

Collection Finish Time and Picking Finish Time: Record the time the collector stops their work in the stream and the time when Pickers put the last specimen in the collection jars.

Identifications made/supervised: Record who was responsible for giving the final identification of the specimens.

Backpage:

Identification and Assessment:

MiCorps requires stream monitoring programs to identify macroinvertebrates to the Order level primarily, sometimes sub-Orders, and sometimes Family. This system was built to be a balance between scientific accuracy and ability of volunteers to learn how to identify insects with a moderate level of effort. While requiring genus-species level identification would be most scientifically accurate, it would prevent the program from being conducted as a volunteer program.

With counts and identifications complete, it is possible to produce a single score for the site. This scoring system is based on the Hilsenhoff Biotic Index, a scheme established by Dr. William Hilsenhoff, a famous (for this field) entomology professor from the University of Wisconsin Madison. Hilsenoff and those who took up his work afterwards have assigned pollution sensitivity ratings to most macroinvertebrate species, genera, and families. Using the sensitivity ratings, a type of weighted average can be calculated to generate the pollution tolerance rating (or water quality rating) for macroinvertebrate samples on a scale of 0 (very pollution sensitive) to 10 (very pollution tolerant).

In MiCorps protocols, we are not identifying macroinvertebrates to the lower taxonomic levels, so leeway had to be taken with Hilsenhoff's sensitivity score to produce an average sensitivity rating for each of the taxonomic groups on the datasheet. This was done by averaging the sensitivity ratings of the different families and assigning the result to the larger taxonomic group. For example, the sensitivity ratings for the eight families of stoneflies found in Michigan were averaged for a result of 1.1. Thus 1.1 is the sensitivity for MiCorps Stonefly group.
MiCorps Stream Monitoring Procedures, December 2020 23
In other words, the sensitivity ratings that MiCorps uses are best estimates for that taxonomic order but are not perfect. Again, this loss of accuracy is because of the balance that needs to be met between identification and volunteer/program leader ability.

The final MiCorps score given to each site is called the WQR (Water Quality Rating).

To calculate the WQR, follow these steps:

1. As you identify your macroinvertebrates, record the number you found for each type in the left column marked "Count". When you are done, add up all the "Count" column to get a total abundance.
2. Multiply the "Count" by the given Sensitivity Rating for each taxa group and record it in the column "Count x Sensitivity". For example, if you found 30 mayflies you would multiply 30 x 3.4 and record 102 in the "Count x Sensitivity" column.
3. Add up all the values in the "Count x Sensitivity" column and record this in the box "Sum of (Count x Sensitivity).
4. Divide the "Sum of (County x Sensitivity)" by the "Total Abundance." The result is the site's Water Quality Rating (WQR). The lower the score, the more pollution sensitive insects are found, and the better the water quality.
5. Important Note about Abundance: This rating scale does not work when macroinvertebrate abundance is low, as a few sensitive taxa can pull the score down to very healthy levels, biasing the results. To correct for this, if abundance is less than 30, the site is automatically given a WQR of 10 (very poor). If the abundance is less than 60, the site is automatically given a WQR of 7 (poor rating). Teams should be striving to collect at least 100 specimens from each site. If the team collects from 60-99 specimens, then score the site as normal and input it into the MiCorps data exchange as normal but consider the rating to be somewhat tentative and strive for higher abundances in future visits.

Appendix 3

Sample Tags and Labels

Jar labels (laser printing/copying only; placed inside the jars to be visible from the outside):

Muskegon River Water Monitoring Program

Site Number: ____________________ Date: ____________________

Location: ____

Name of Collectors: ____

Number of Jars used:

First-Aid Kit Form:

First-aid Kit Item	Item(s) used (no. and date)	Date MRWA is contacted	Date replenished
First Aid Guide			
2 – Ibuprofen tablets			
4 – ¾"x 3" plastic bandages			
2 – ¾" x 3" fabric bandages			
1 – knuckle fabric bandage			
1 – large butterfly wound closure			
2 – alcohol cleansing pads			
2 – antiseptic cleansing pads			
2 – antibiotic cleansing wipes			
1 – antibiotic ointment pack			
1 – insect sting relief pad			
1 – 2"x2" moleskin square			
1 – lip ointment			

Appendix 4
Muskegon River Water Monitoring Program Equipment Checklist

Check in “Pickup Time” Column if items are present. Check in “After Monitoring” column if items are present when you return the monitoring equipment. Write in the “Your Notes” section if items are missing or there is a need to contact the MRWA* to replenish items.

Check At Pickup Time	**Item**	**Things to Notice**	**Your Notes**		Check After Monitoring
	1 D-Frame Net	Make sure net is clean and free from soil and insects			
	1 Waders	Make sure they are clean and free from soil and insects			
	Decontamination Kit	Make sure the contents are complete from the list inside the bucket.			
	Items below are in plastic container:				
	1 Yardstick				
	1 Sorting Tray	Make sure tray is clean and free from soil and insects			
	2 Forceps				
	Jars and Lids	Are there at least 5 jars in the container?			
	Preservative	Is there enough preservative for your monitor event and the next?			
	1 – 6” Ruler				
	2 Magnifying Glasses				
	1 Reel-style Measure Tape				
	1 Water Bottle				
	1 Thermometer				
	1 First-Aid Kit and List	Do any items need replenishing?			

Decontamination Kit Contents/Checklist

- 3 gallon bucket and lid
- This booklet
- Lint roller
- 8 oz spray bottle for diluted bleach
- 16 oz spray bottle for tap water
- Soft-bristled scrub brush
- Hoof pick
- Scrap towels
- Bleach wipes
- Eye wash solution
- Safety goggles
- Reusable latex gloves
- 6 mL oral syringe
- Sample vials for mud snails

A jug of commercially available bleach is also required but not provided with this kit.

Critical Equipment	Criteria for Acceptance/ Inspection/Maintenance Procedures (When Team Leader picks up or returns equipment)	Purchase date		Replacement date
D-Frame net	No holes in aquatic net bag & is securely fastened to pole. net is clean and clear of all substances After use: Clean and rinse net after every collection to prevent transfer of biological matter. If zebra mussels are found at a site, the net will not be used at another site until thoroughly cleaned. Person responsible for inspection: Team Leader MRWA will inspect on yearly basis Agency responsible for replacement: MRWA will keep at least one spare net bag			
White sorting tray	Tray is clean and clear of all substances. After use: Clean and rinse after every collection to prevent transfer of biological matter Team Leader responsible MRWA will inspect on yearly basis and keep at least one spare tray			
Waders	Waders contain no holes & are clean and clear of all substances.			

	After use: Clean and rinse waders after every collection to prevent transfer of biological matter. If zebra mussels are found at a site, waders will not be used at another site until thoroughly cleaned. Team Leader is responsible MRWA will inspect on yearly basis MRWA will return waders to Cabela's for replacement			
First-aid Kits	**Contain all items listed on kit in ready to use condition Write down, on form enclosed in the kit, any item used. If an item is fully consumed, contact MRWA for replacements. Team Leader is responsible MRWA will inspect on yearly basis and keep extra first-aid items.**			
Collecting Jars	**Clean and free of any debris or dirt. All jars have lids**			
Clipboards	**In storage**			
Data sheets	**Store in file cabinet in Project Managers office and on MRWA website**			
Macroinvertebrates Samples	**Locate on shelves in storage with proper labels, dates**			

Item	**Source**	**Description**	**Item #**	**Price**	**Date Purchased**	**Date Replaced**
For Invertebrate Sampling						
D-Frame Collection Nets	Fisher Scientific	LaMotte D-Net w/ Expandable Pole (12")	S85027	$108.00/ea		
		LaMotte Replacement Bag (12")	S85027B	$23.75/ea.		
Sorting Trays	Ward's	Tray with Pour Lip	470020-966	$49.95/ea.		
Forceps	Wards	Featherweight Forceps	470018-872	$6.90/ea		
Pipettes	Amazon	3mL Plastic Transfer Pipettes	Sold by Moveland LLC US	$7.99/120pcs		
Preservative	Carolina Biological	70% ethanol	86-1263	$32.50 (3.8 liters)		
Jars	Amazon	Hoa Kihn Glass jars w/plastic lids, 4 oz., pkg. of 30	Sold by ZELINUS	$30.99/pkg		
6" Rulers	www.shoplet.com	Clear plastic	UNV59025	$2.01/2pcs		
Magnifying glasses	Fisher Scientific	2.5" magnifying glass	S04173	$5.00/ea		

Reel-style measuring tapes	www.northerntool.com	Open Reel Tape Measure (100')	77142	$6.99/ea		
Yardsticks	www.shoplet.com	Metal ends (36")	ACM10425	$6.87/ea		
Waders	Cabela's	White River Fly Shop Three Forks Felt Sole Chest Waders	Men: 2640439	Under $100		
First-aid Kits Small	Amazon.com	13 piece first aid	First Aid Only	$2.75/ea		
First Aid Kit Large	Amazon.com	330 piece First Aid Kit	THRIAID	$45.99/ea		
Compasses	Wards	Magnetic compass w/ beveled top	470001-824	$6.10/ea		
Thermometer	Wards	Total Immersion Alcohol	470104-556	$9.95/ea		
Water Bottle	Amazon	50 Strong sports water bottle, 6-pack, 22oz. Plastic	Sold by J.L.Main	$24.00/pkg		
Container to hold all	Wal-Mart	Rubbermaid container , 95 qt	FG3Q3500CLMCB	$98.75/ea		
70% Isopropyl Alcohol	Amazon	Four 1-gallon containers	MAXTITE	$72.50/pkg		
Hand Sanitizer	Amazon	Purell Singles Advanced Hand Sanitizer Gel-125 count	Purell	$11.09/pkg		
Ziploc Bags	Amazon	Gallon bags 28 Count	Ziploc	$5.99/pkg		
Metal ID Rings	Amazon	50 count 1 inch loose leaf metal rings	Antner	$6.99/pkg		

Equipment for macroinvertebrate collection will consist of:
D-frame kick net
Decontamination Kit
White collection pan
Forceps and magnifying glasses
Jars, lids and preservative (70% isopropyl alcohol)
6" rulers and yardsticks

Stream habitat assessment and safety equipment will consist of:
Compasses
First-aid kits
Waders

Literature will consist of a notebook containing but not limited to the following:
Standard operating procedures
A Key to Macroinvertebrate Life in the River

Dichotomous Key to Stream Macroinvertebrates
Directions on completing the datasheets
Datasheets and pencils

Appendix 5 Location Maps

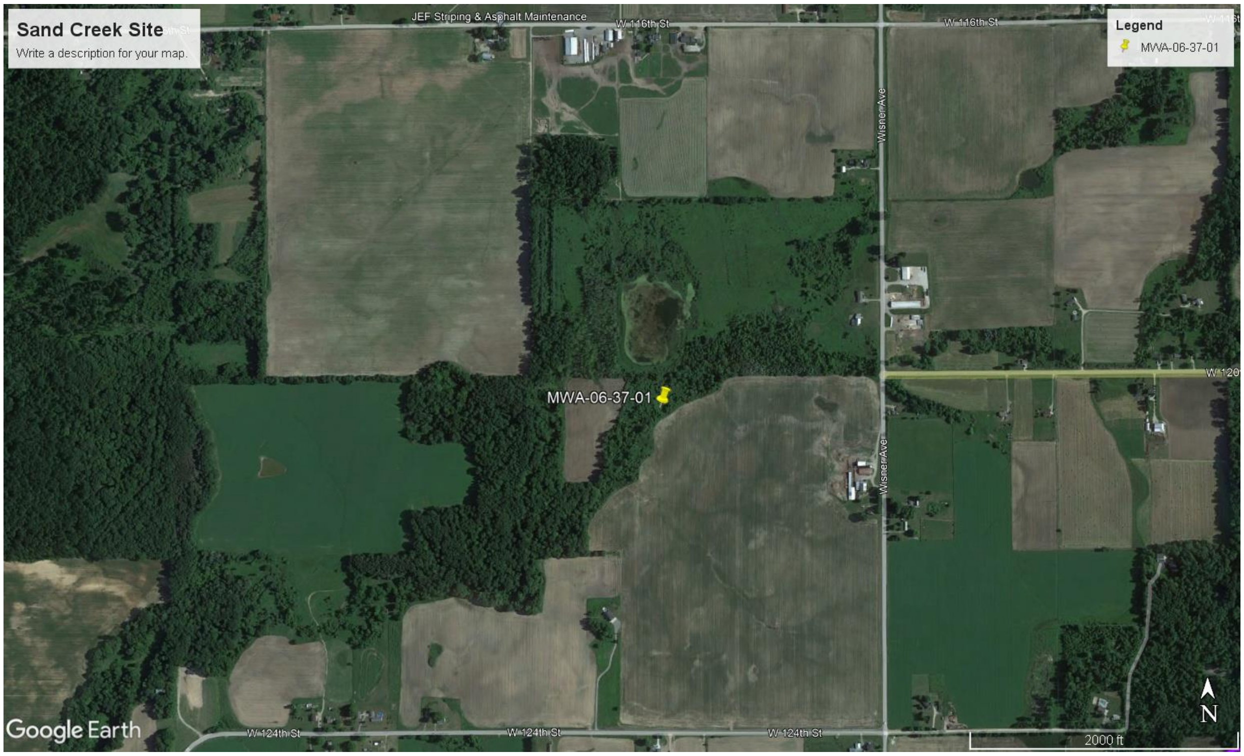

Figure 1: Sand Creek Site. MWA-06-37-01, 43.33575° N, -85.87646° W, Sand Creek @ Wisner Ave. Reports of Agriculture manure applications running into this cool water trout stream.

Figure 2: Tamarack Creek Sites. MWA-04-31-06, 43.40878° N, -85.41246° W, Tamarack Creek @ Marble Rd. Culvert replacement in 2016, agriculture runoff. MWA-04-31-07, 43.41017° N, -85.39702° W, Tamarack Creek @ West Almy Rd. Culvert replacement in 2016, agriculture runoff.

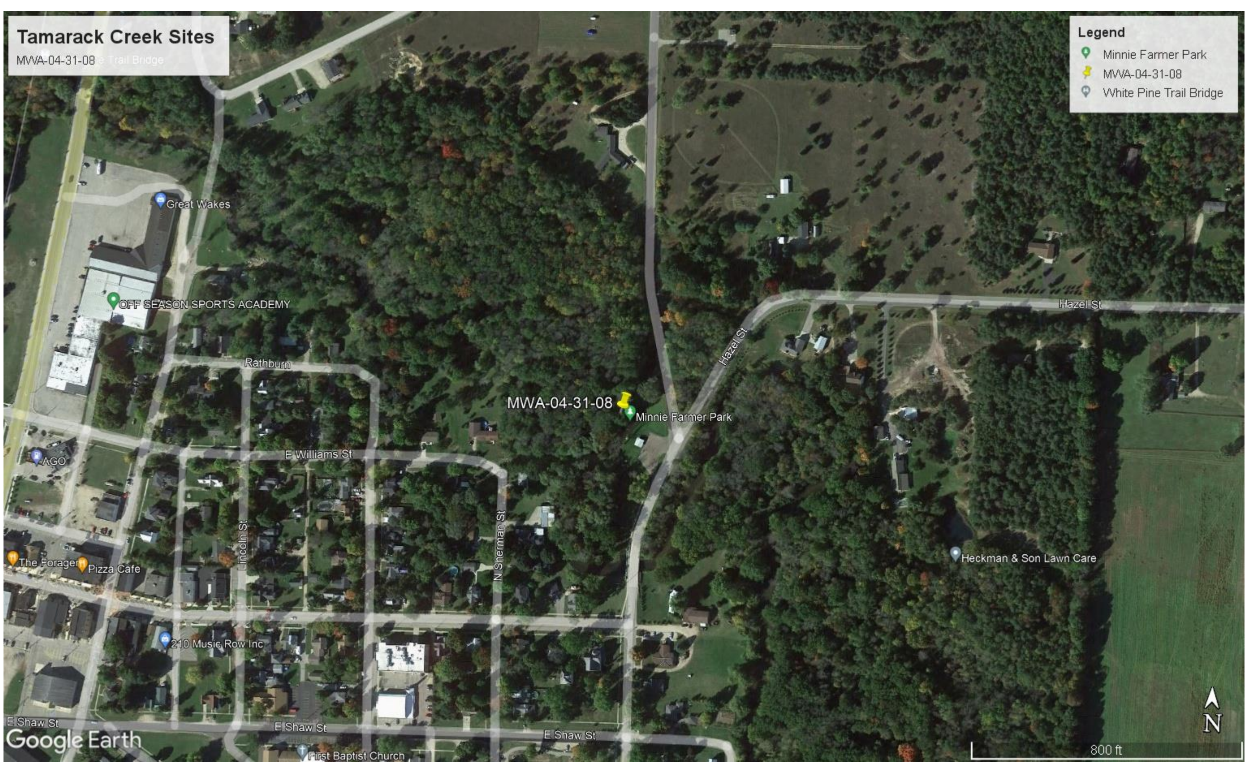

Figure 3: Tamarack Creek Sites. MWA-4-31-08, 43.39837° N, -85.46263° W, Tamarack Creek @ Minnie Farmer Park. Bank stabilization in 2016 and sediment loading from road.

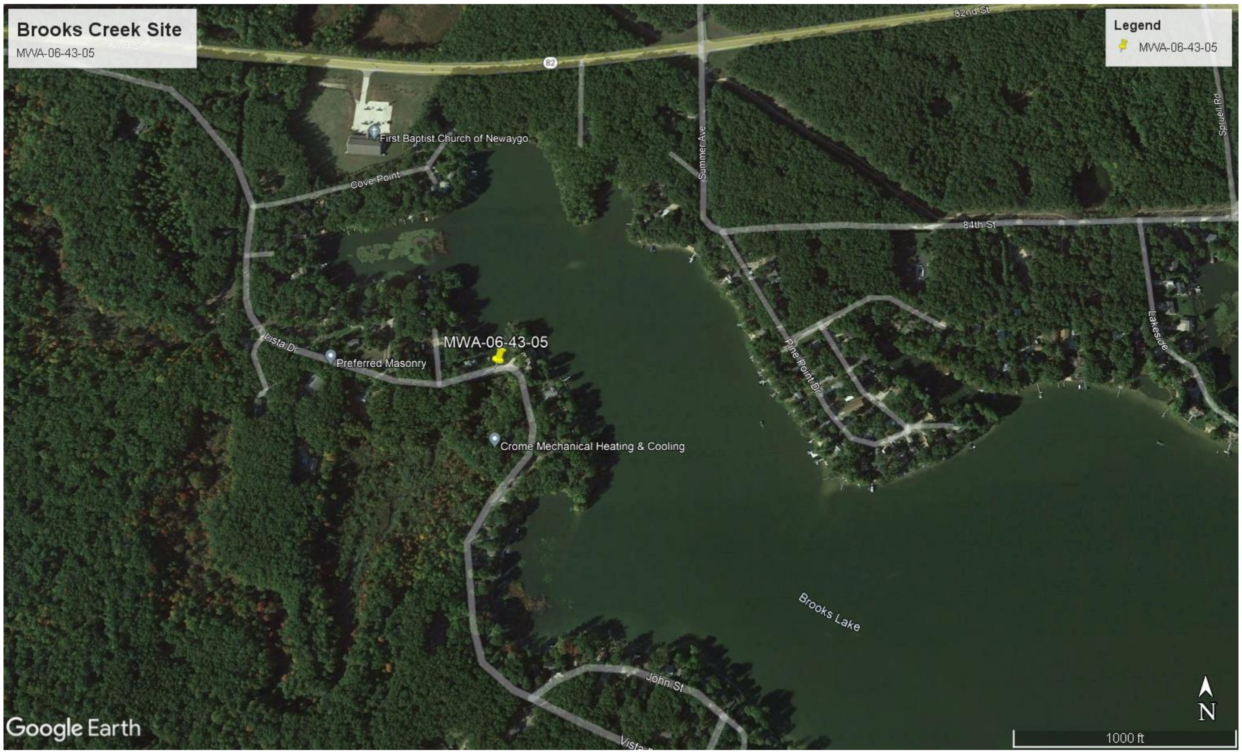

Figure 4: Brooks Creek Site. MWA-06-43-05, 43.40038° N, -85.76092° W, Brooks Creek @ Vista Dr. Sediment and nutrient loading caused from housing development.

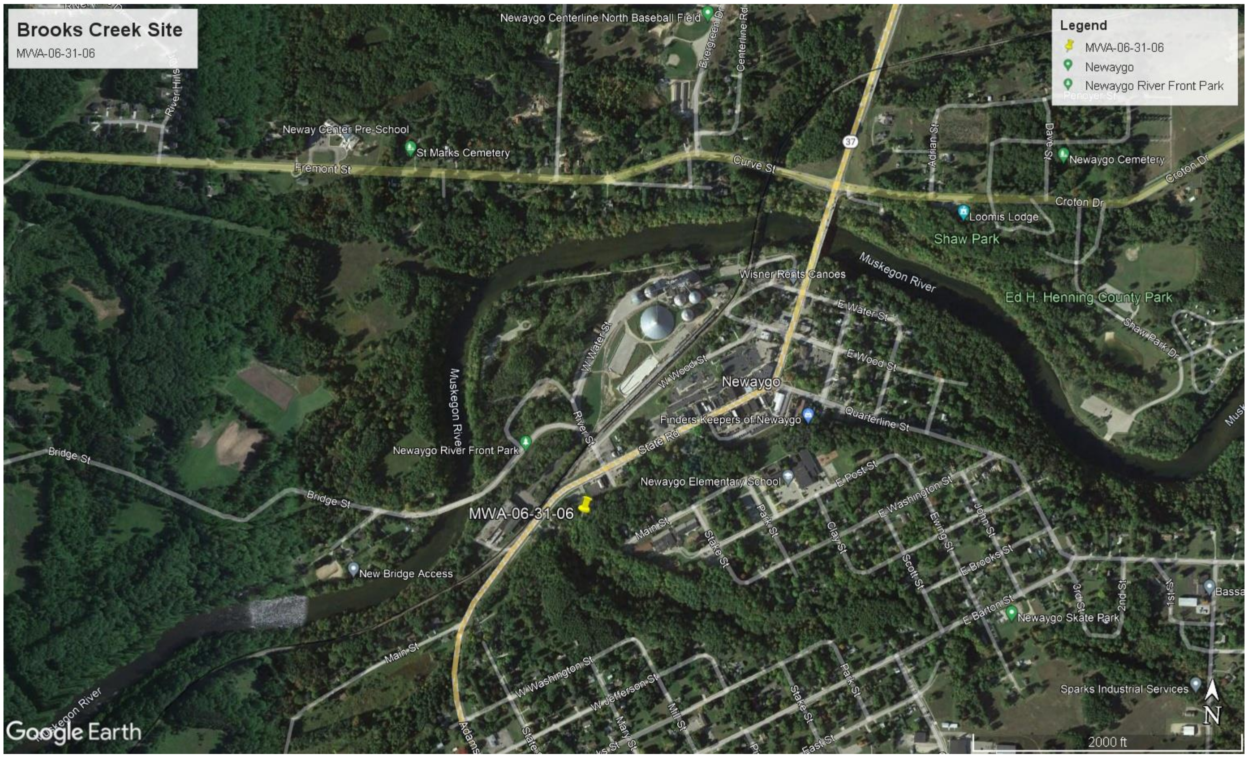

Figure 5: Brooks Creek Site. MWA-06-31-06, 43.41681° N, -85.80463° W, Brooks Creek @Marshall Memorial Park. Sediment due to stream bank destabilization, flooding and heavy public use.

Figure 6: Buckhorn Dam Sites. MWA-02-28-01, 43.794448° N, -85.50228°W, upstream of foot

bridge and dam site. MWA-02-28-02, 43.79251°N, -85.50084°W, downstream of dam site beginning at the foot bridge.

Figure 7: Twin Creek Sites. MWA-07-22-03, 43.905406°N, -85.274258°W, immediately upstream of former dam site in the Twin Creek Nature Area. MWA-07-22-04, 43.90528°N, -85.27413°W, immediately downstream of former dam site beginning 100' above the observation platform at Twin Creek Nature Preserve.

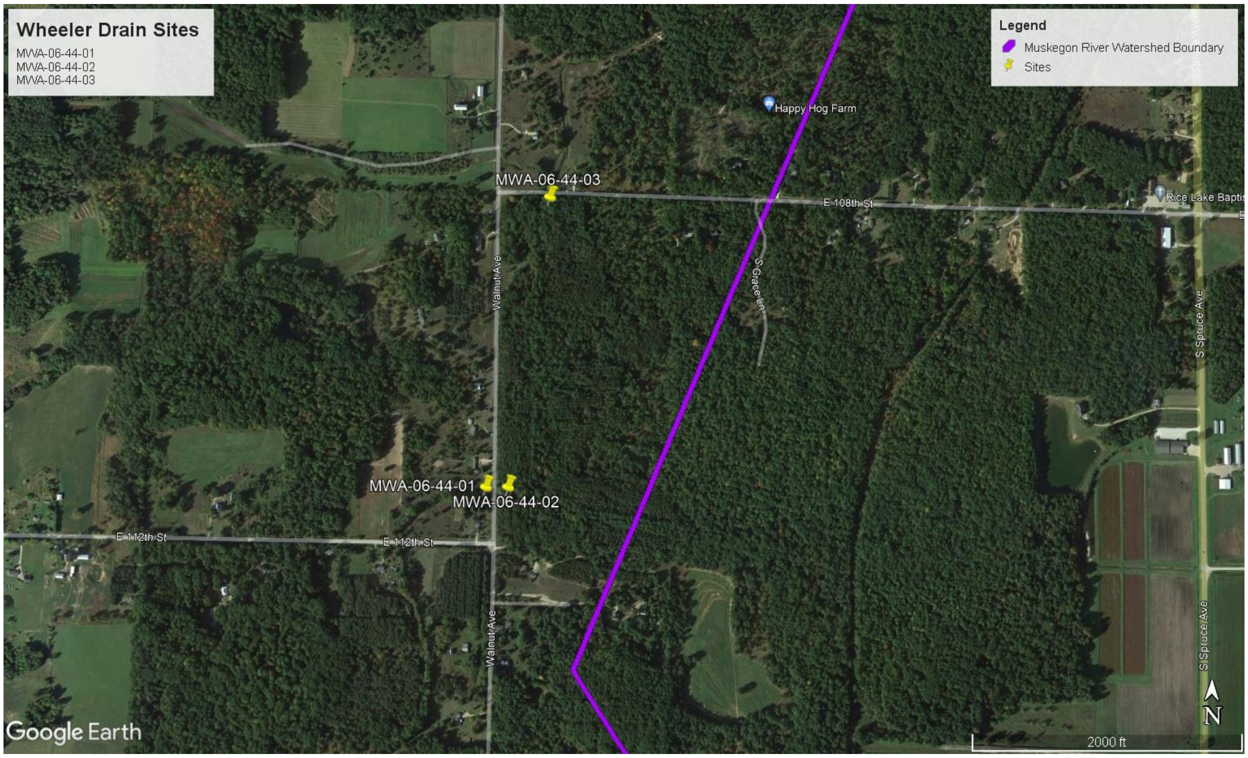

Figure 8: Wheeler Drain Sites. MWA-06-44-01, 43.352351°N, -85.761316°W, immediately upriver of the Walnut Ave. road crossing and upstream from the Grant Public Schools property. MWA-06-44-02, 43.352365°N, -85.760688°W, immediately downstream of the Walnut Ave. road crossing on Grant Public School property; site starts near first large eroding streambank. MWA-06-44-03, 43.358335°N, -85.759735°W, immediately above the E. 108th St. road crossing off of Walnut Ave.

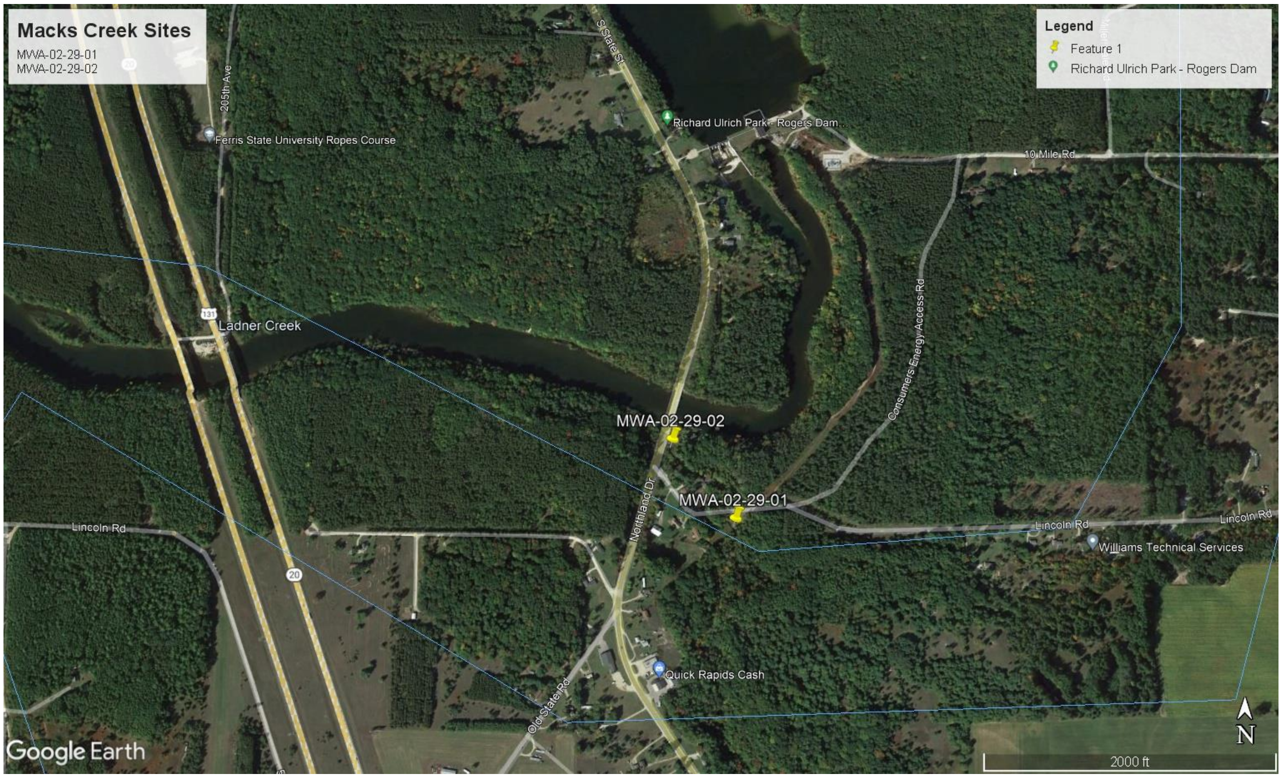

Figure 9: Macks Creek Sites. MWA-02-29-01, 43.605326°N, -85.479062°W, immediately upstream of dam on private property. MWA-02-29-02, 43.606857°N, -85.480768°W, downstream of dam on private property; a few 100 feet upstream of the confluence with the Muskegon River.

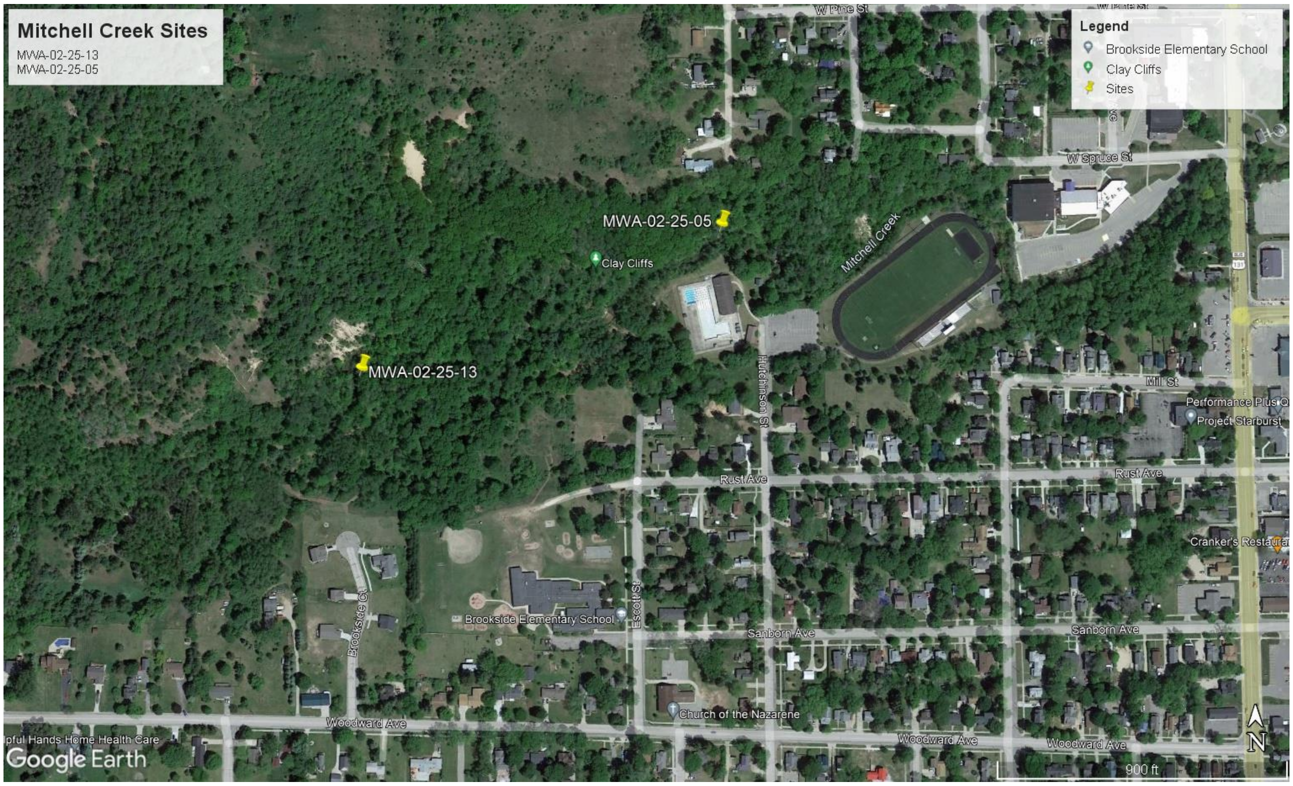

Figure 10: Mitchell Creek Sites. MWA-02-25-13, 43.6978°N, -85.49432°W, upstream from the starting point of the Clay Cliffs erosion site. MWA-02-25-05, 43.69901667°N, -85.49008333°W, 100 feet below footbridge at Big Rapids Community Pool.

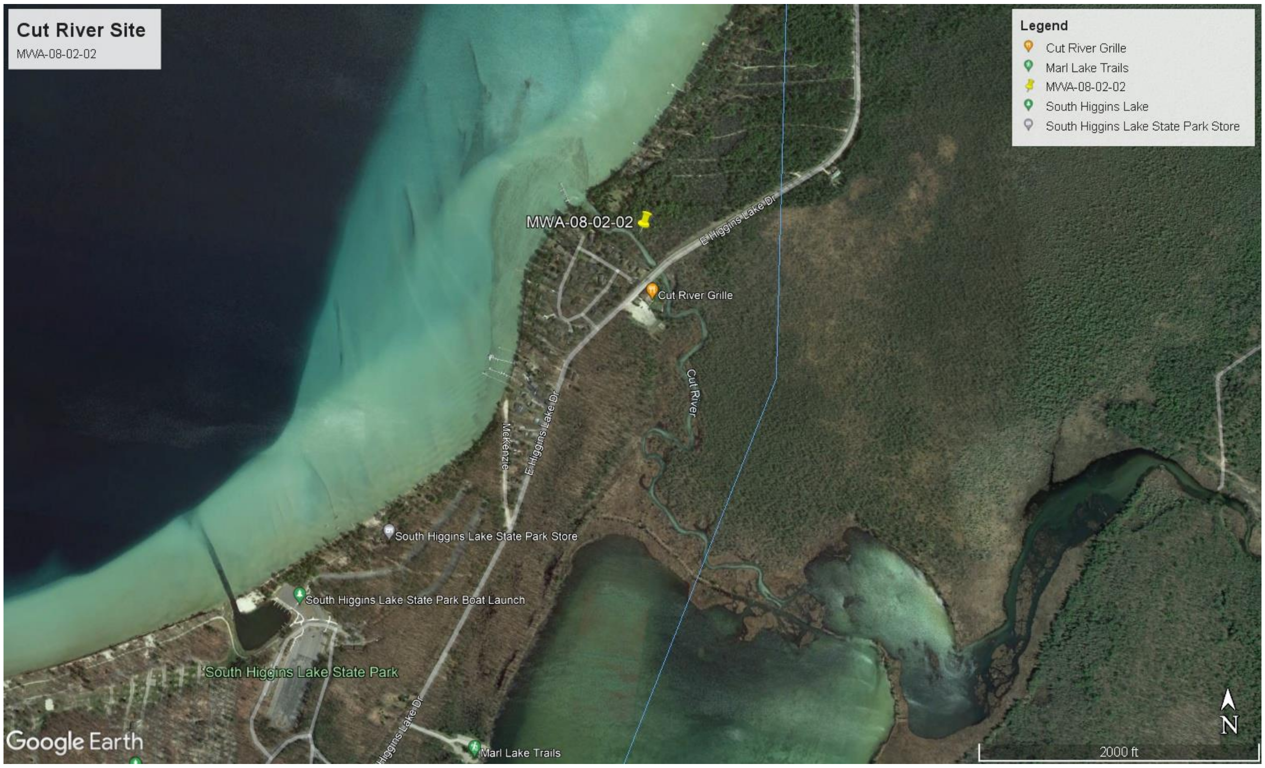

Figure 11: Cut River Site. MWA-08-02-02, 44.433848°N, -84.670410°W, Cut River at the downstream edge of island 100 ft. From Highway 100 culvert to riverbend upstream of island 300 ft. downstream from dam

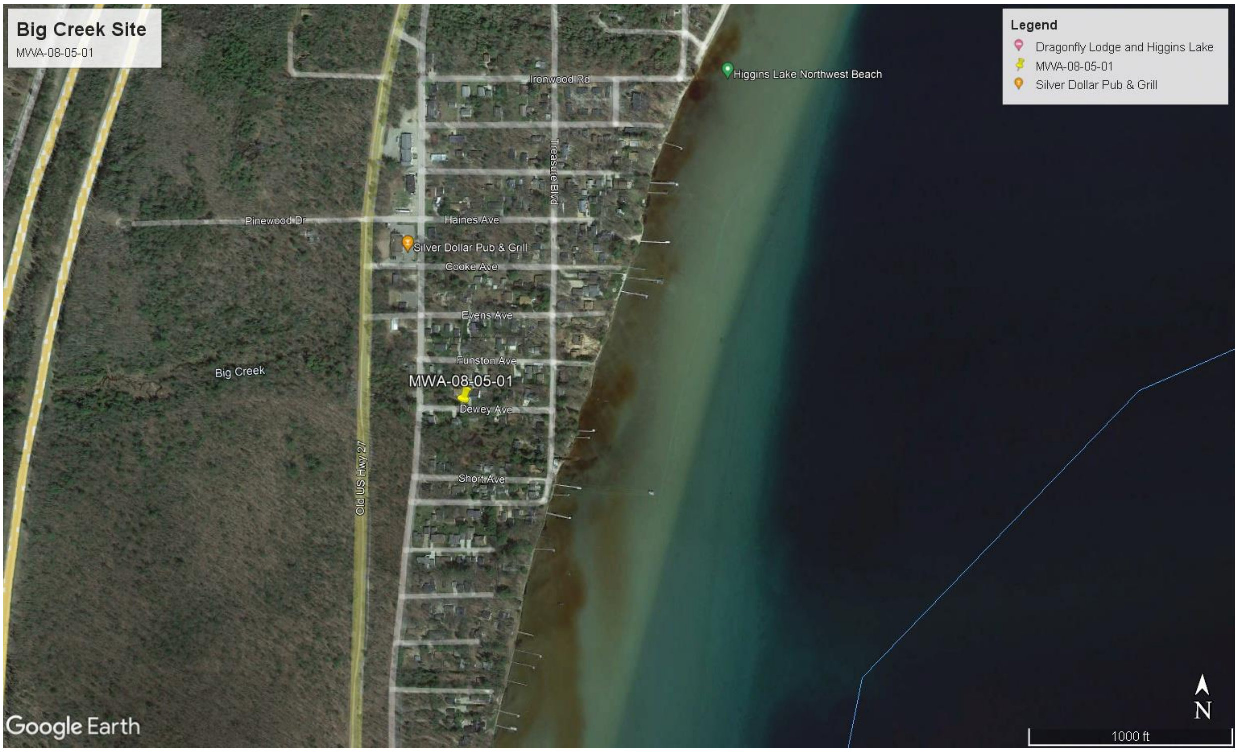

Figure 12: Big Creek Site. MWA-08-05-01, 44.497382°N, -84.777824°W, Dewey Ave. Culvert 150’ on either side of road center line