Appendix L

Quality Assurance Project Plan for the Work Plan Entitled: "Revision of Middle Huron Watershed Management Plan for Ann Arbor"

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5/1/2019
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Technical Reviewer: Alyssa Riley

MDEQ Use Only:

☐ Approved

☐ Returned for Modifications

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1. Project Description

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Volunteer Data Collectors
Program volunteers will assist in data collection under the supervision of Andrea Paine and Ric Lawson. Standard Operating Procedures (SOPs) will be distributed at training, and the QAPP will be made available to them upon request.

All others involved with monitoring will receive a copy of this Quality Assurance Program Plan (QAPP) and any revisions.

1.1 Project Organization

The table below provides an overview of key persons involved in the project and their respective affiliations. Ric Lawson, HRWC Watershed Planner, will have overall responsibility for the management of the Environmental Monitoring and Geomorphic Field Assessment for the Middle Huron Watershed Management Plan for Ann Arbor Project (Project). This role includes implementing the monitoring program, overseeing procedures and quality control and assurance, leading training, and performing data analysis. Andrea Paine, Watershed Planning Associate will coordinate and schedule volunteers, oversee data collection and entry, provide field training and serve as a field manager. Rebecca Esselman, HRWC Watershed Planner and the Administrator for the project, will have long term custody of the monitoring data and will be responsible for its integration into the larger project. Rebecca Esselman will also provide general guidance, oversight and support for the monitoring project. Non-grant funded support will be provided by HRWC volunteers who will collect field data and the City of Ann Arbor's Water Treatment Plant who will analyze water samples.

Table 1. Personnel, Affiliation and Role/Responsibilities of each in the monitoring project

Personnel	Affiliation	Role/Responsibilities
Peter Vincent	MDEQ	Project Officer
Alyssa Riley	MDEQ	Technical Support and review
Kathy David	MDEQ, Jackson District	Support and review
Ric Lawson	HRWC	Monitoring and data collection oversight and management, quality assurance, data review and analysis
Rebecca Esselman	HRWC	Project administration and management, and reporting
Andrea Paine	HRWC	Field data collection, volunteer coordination, and data management assistance
Anita Daly	HRWC	Marketing, communications, public outreach
Wendy Schultz	Ann Arbor WTP	Laboratory management
Project Advisory Team	Local government	Supplemental funding, program review and guidance
Volunteers	HRWC	Assist with field data collection

1.2 Project Description

The main purpose of the overall project is to revise the watershed management plan for a section of the Middle Huron watershed to reflect the current ecological health status and trends in the watershed, strategies completed and emerging priorities for action. The project will include volunteer sampling for a range of physical parameters, chemical concentrations, and bacterial populations to characterize the watershed and contribute data for trend analysis and likely source identification. The goal of data collection is to support a robust analysis of conditions to help target cost-effective solutions. This Quality Assurance Project Plan is specific to new environmental monitoring and geomorphic survey. Following DEQ review and approval, other monitoring and data collection was conducted prior to this project which will also be used in plan development.

1.2.1. Statement of Water Quality Concerns

Portions of the Middle Huron Watershed fail to meet minimum water quality standards or provide designated uses protected under Michigan law (Table 1). Sources of nutrients and bacteria include failing public sewer infrastructure and aging private septic systems. Nonpoint sources of phosphorus include human, natural, and animal sources. In the Ann Arbor area of the Middle Huron, land conversion, lawn and garden care and pet waste are common sources of excess phosphorus. Several tributaries in the Middle Huron watershed are also impaired for poor fish and macroinvertebrate communities. This is primarily due to altered hydrology, erosion and degraded stream channels and habitat. The current WMP also lists several additional concerns, including salts, organic compounds and metals; elevated temperatures; and pharmaceuticals and endocrine disruptors. Further, there are likely emerging pollutant concerns (such as PAHs) that were not considered in the previous version of the WMP.

Table 2. *State-listed impaired waterbodies that include the Ann Arbor section of the Middle Huron watershed*

AUID	Waterbody	Parameter	TMDL Status
040900050402-01	Huron River- Argo Geddes	Pathogens	Approved 2001
040900050402-05	Swift Run	Poor fish and macroinvertebrate community	Approved 2004
040900050402-04	Malletts Creek	Poor fish and macroinvertebrate community	Approved 2004
040900050403-02, 040900050404-02	Ford and Belleville Lakes	Phosphorus	Approved 2000

Watershed management plans (WMPs) have been developed for the middle Huron as a whole and Total Maximum Daily Load (TMDL) Implementation Plans have been developed for all impairments. The Huron River is also listed on the state's Unified Watershed Assessment (UWA) as a Category 1 watershed, indicating its high restoration priority.

Much of the drainage area is developed with significant development pressure on remaining open space. As the Middle Huron communities continue to develop, the potential increases for negative environmental impacts, including water quality impacts from erosion, sedimentation, and increased inputs of stormwater pollutants. Potential impacts on water quantity also increase as wetlands, woodlands, floodplains and other natural features that regulate water quantity are altered or replaced with impervious surfaces. Stormwater runoff from this urban environment alters the hydrology and degrades water quality. Runoff contributes nutrients and sediment to the river resulting in nuisance algal blooms, dangerous levels of pathogens and degraded fish and macroinvertebrate communities.

Three mainstem and numerous tributary dams further alter the hydrologic and sediment regime of the river through Ann Arbor.

1.2.2 Project Goals

The overall project goal is to revise the watershed management plan for a section of the Middle Huron watershed to reflect the current ecological health status and trends in the watershed, strategies completed and emerging priorities for action. The updated plan will meet Clean Water Act Section 319 and Clean Michigan Initiative WMP requirements. The planning effort will facilitate a deeper dive into strategies with appropriate partners and stakeholder groups with the most direct influence over actions that will reduce impairments and improve water and habitat quality. This will occur as part of a longer term effort to revise the entirety of the Middle Huron WMP in three sections that are each similar in geography, landuse, and threats.

Goal 1. Enhance understanding of system through additional data collection and analyses. Objectives:

- Conduct hydrologic assessment utilizing a calibrated stormwater (SWMM) model built for the City of Ann Arbor since the last WMP revision.
- Complete watershed wide geomorphology assessment including direct survey of targeted stream reaches.
- Analyze water quality and biological data collected through HRWC monitoring programs to identify changes in status and trends in river condition
- Compute seasonal pollutant loading and trends for watershed sections and compare against Total Maximum Daily Load (TMDL) targets.
- Evaluate progress made through implementation since previous revision.

Goal 2. Incorporate climate change into the WMP to improve understanding of the threats and appropriately define actions that consider future climate conditions.

- Simulate runoff scenarios under various storm events
- Describe historical trends and future scenarios including a discussion of uncertainty
- Utilize this information to inform WMP actions, strategies, implementation and evaluation

Goal 3. Develop specific recommendations for critical areas that contribute to the impairments within each tributary watershed. Recommendations will be developed with partner and public input. Recommendations will have defined leads, cost, and timelines to facilitate swift implementation of high priority actions.

Objectives:

- Refine the action plan strategies with more detail on locations, commitments, timeline, short and long-term milestones, and costs
- Give partners clear priorities and establish responsible parties so actions can be easily incorporated into planning and capital improvement plans
- Utilize the Landscape Level Wetland Functional Assessment (LLWFA) for the Middle Huron to determine wetland protection and restoration priorities
- Estimate reductions achievable through each potential project.

Timetable

The grant project began in September 2017. The environmental monitoring and geomorphic survey timetable is below:

Collect existing data and information	September 2017 – August 2018
Develop and approve QAPP	May 2018 – February 2019
Collect environmental monitoring data (outside of grant funding)	Annually April – September
Collect environmental monitoring data (match to grant funding)	April – September 2019
Conduct hydrologic model analysis	May 2018 – April 2019
Conduct geomorphic surveys	March – September 2019
Analyze data and incorporate into WMP	December 2018 – July 2019

1.4 Training Requirements

The program manager and listed HRWC staff have been trained in proper collection techniques as part of professional education programs. HRWC will meet with technical advisors from the MDEQ prior to volunteer field training to review and refine geomorphic survey techniques. This will ensure that proper sampling and survey techniques are used. Volunteers will only be used to assist with surveys. All volunteer collectors will receive classroom introductory orientation from HRWC staff prior to sampling scheduling. Volunteers will receive further field training at sampling sites prior to initial sampling or survey work. Orientation and field training by HRWC staff is mandatory for volunteers. Volunteers will be accompanied by the program manager or HRWC field staff on their first sampling experience. Training includes instruction and demonstration of all field techniques, SOPs and data handling procedures.

2. Measurement and Data Acquisition

2.1. Project Objectives

The environmental monitoring tasks are designed to achieve the following objectives.

Objective 1: To update water quality status and trends of the Huron River and its major tributaries in dry and wet weather conditions. This status will include statistical expression of concentrations of chemical parameters, physical measures (i.e. pH, temperature, and conductivity), bacterial colony counts, and stream flow. Trends will be expressed as a statistical evaluation (generally using regression) of change in parametric values over time.

Objective 2: To determine progress toward meeting state water quality standards and TMDL limits by matching collection methods and analytic statistics to the standards (if available) for each parameter. Specific parameters targeted include total phosphorus (TP), total suspended solids (TSS), *E. coli*, pH dissolved oxygen (DO) and total dissolved solids (TDS). If a particular standard is exceeded, a frequency of violation will be determined. Incremental progress toward meeting a standard will be measured by comparing the relevant statistic or statistics in 2018-19 to those from past years (where data is available). All statistics will be reported by site. For example, if a site was above a water quality standard for 50% of samples in 2013, but 2018-19 results show only 10% of samples above the standard, then a

40% overall decrease and 80% progress toward the water quality standard will be reported for that site (and the tributary it represents).

Objective 3: To update seasonal and average daily loading rates for chemical concentrations. Loading rates will be calculated using a statistical model for various end points in the system. These rates will be compared to previous calculations to determine loading trends, and to TMDL goals (where applicable). The objective for TMDL drainage areas will be to determine if overall loading are being met rather than segmented loading allocations.

All reported loading calculations will be accompanied by a discussion of loading estimate assumptions, caveats, and qualifiers. Further, loading estimate standard error or other statistical error calculations will be included to express precision of estimates.

The geomorphic survey tasks are designed to achieve the following objectives.

Objective 1: To determine which representative stream reaches in the watershed are physically stable, which are actively eroding and which are aggrading. This will be determined by an evaluation of Bank Assessment for Non-point source Consequences of Sediment (BANCS) model, which includes Bank Erosion Hazard Index (BEHI) and Near Bank Stress (NBS) metrics computed at stream survey locations. Specifically, bankfull cross-section and longitudinal metrics, such as width, depth, cross-sectional area, discharge, riffle spacing, and riffle and pool slopes will be calculated for targeted sites. These will be taken at multiple locations in the stream reach to confirm the representation of the survey site, or adjust the stability metrics.

Objective 2: To develop a prioritized inventory of degraded stream reaches throughout the watershed. Reaches will be compared to regional reference curves (Stantec, 2015), where appropriate, using a range of functional metrics, but primarily bankfull width, depth, area and estimated discharge. The degree to which a reach varies from reference standards (computed by drainage area), along with metrics from objective 1 above, will contribute to restoration priority determination. Reaches that are heavily altered by development (such as contained in concrete channels or heavily rip-rapped banks) will not be given high priority for stream restoration since restoration designs will be unlikely to be stable under such highly altered condition.

2.2 Project Design

The design of the data collection project is divided into two efforts: environmental monitoring and geomorphology. Each subsection below will describe aspects of the efforts separately.

2.2.1 Environmental Sampling

Environmental sampling will occur at representative sites across the study watershed to provide the status, variability and trends in different physical, chemical and bacterial measures. Trained volunteers will collect samples and direct measures during the growing season, twice per month from April through September. Current environmental sampling sites are shown in Figure 1. These sites includes two types of sites: long-term and investigative sites. Sites were selected such that long-term sites are tributary end-points or river sites, and investigative sites are upstream and sampled for a single season. Investigative sites are sampled the same day as the long-term site downstream of them. New investigative sites are selected each year. Criteria used for identifying sites include: high pollutant values found the previous year, bracketing project sites, follow-up on volunteer or citizen field observations, and general watershed coverage. Sampling is conducted as part of an ongoing, separately funded program sponsored by the Middle Huron Partners. Some sampling will be conducted with match funding to the WMP project in 2019-20.

Sampling will be scheduled such that all sites are sampled in one week. Samples will be collected in wet or dry weather conditions to determine storm water runoff relationships (see section 2.2.2).

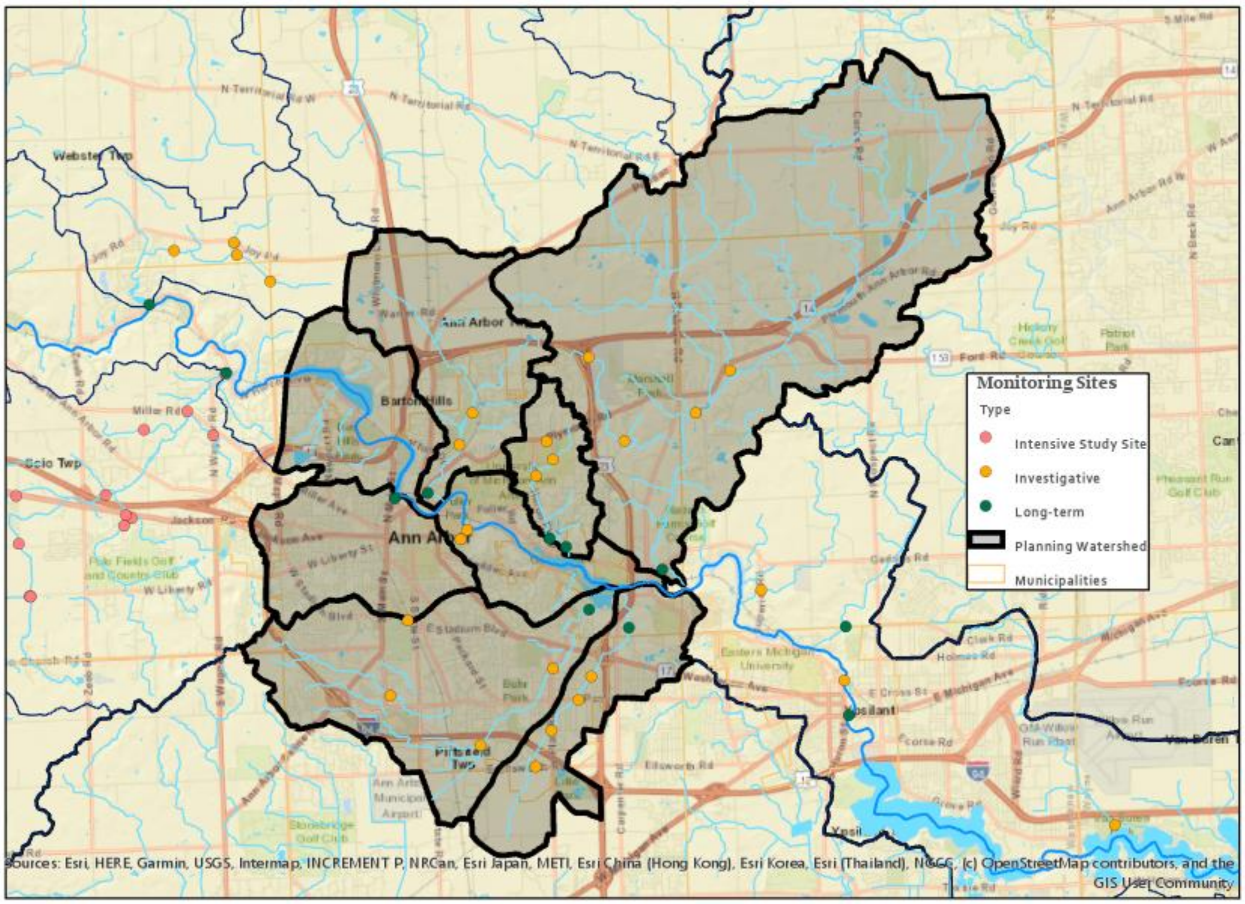

Figure 1. Map illustrates volunteer sampling sites in the planning watershed. Long-term sites are sampled every year, and investigative sites were sampled for one season. New investigative sites added in 2019 are also included.

2.2.2 Wet-weather sampling

Storm events will be targeted for sampling to determine differences. During the course of scheduled sampling, it is anticipated that wet-weather events will occur. HRWC staff will track storms in advance to determine the forecasted storm timing and likely size. HRWC has access to numerous automatic samplers and has installed several remote-controlled stations across the watershed. Currently, one of these stations is located at the long-term station for Malletts Creek near the USGS station. A computer controller at the station will initiate sample collection based on forecast data from surrounding weather stations, and stream level data from a sonic depth sensor. Staff can also view the data and trigger samples manually. Ideally, samples will be taken at several points in the hydrograph (see Appendix B for storm sampling methods).

Wet weather sampling will be in response to precipitation events of 0.25 inches or greater within a 12-hour period or 0.5 inches within a 24-hour period. Dry weather sampling will be in response to precipitation events of <0.1 inches within the previous 72-hour time period. Actual rainfall will be accounted for by averaging measurements from local weather stations reported through the Weather Underground website (www.weatherunderground.com). This general criterion is being used to ensure that the samples collected are representative of runoff events. Tributaries respond differently to storms, however, and the true measure will be to determine if the flow in the target tributary has returned to levels near those that preceded the previous wet weather event. This may require less or more than 72 hours. Data loggers will capture water level and stream discharge which will provide a hydrograph. Samples will be collected using standard grab sampling procedures described in section 2.3, and detailed in Appendix B.

2.2.3 Geomorphic Surveys

Geomorphic analysis consist of desktop and rapid field techniques that generally follow methods outlined in Watershed Assessment of River Stability and Sediment Supply (Rosgen, 2006). See the WARSSS outline in Appendix D for details. The analysis will be limited by data availability and obtainability, and, as stated in the goals in section 2.1, focus on reaches that may be impaired by physical or previous hydrologic alterations. Specific selection criteria are discussed below. The analysis will focus on watershed assessment of selected Prediction Level Assessment (PLA) methods to generate a prioritized inventory of impaired streams due to 1) hydrologic processes, 2) channel processes, or 3) hillslope processes. Specifically, the study team will conduct rapid assessment using the BANCS model (section 2.1, objective 1), and follow-up with estimated bankfull dimensions of selected reaches and cross-sections to identify restoration priorities (section 2.1, objective 2).

The study will begin with an initial desktop analysis following Reconnaisance Level Assessment (RLA) steps to identify and assess representative reaches. All mapped streams within the study watershed will be subdivided into reaches designated as reasonable lengths between branch points. A reach contributing area (RCA, or drainage area) will be created for each reach. A set of statistics will be generated from available GIS and aerial data for each reach, including stream length, stream slope, valley slopes, and soil erosivity. Land use characteristics will be generated for each RCA such as total area and percent cover in urban, impervious, agriculture, and natural (wooded/wetland). Within urban areas, the percent of area in underground storm pipes will also be calculated. An attempt will be made to obtain historic aerial photographs of the watershed to identify original stream paths and assess stream alteration. A rough sinuosity statistic will be calculated by estimating stream valley length. Reaches that are dominated by urban piping and channelization will be eliminated from field analysis consideration, as such reaches have lost natural geomorphology and function and must be treated for hydrologic alteration. Remaining stream reaches will be further classified by chemical (phosphorus, nitrogen, DO, TDS, TSS) and biological (bacteria, macroinvertebrate diversity) impairment from previous monitoring results. Reaches will be ranked by likelihood of hydrologic or sediment impairment.

Depending on the scale of reaches remaining following desktop analysis, either the entire group or a set of the highest likelihood stream reaches will be included for field evaluation. Stream reaches will first be evaluated by “creek walking” teams. Ideally, all viable streams will be surveyed by creek walking teams. These teams will make observations of erosion and alteration using BEHI and NBS metrics, and make rough estimates of bankfull width and depth, bank angle, bank slope, and bank ratios (Appendix D).

Along reaches that appear to be likely restoration candidates, a pebble count survey will be completed as well. Based on evaluation of creek walk data, a team of experienced surveyors will survey cross-sections and profiles of high priority reaches. HRWC will review the survey targets with DEQ staff. Cross-section locations will be marked with bank top and toe pins to allow for return surveys approximately 1 year later. Survey segments of at least 20 bankfull widths will be conducted using standard survey equipment (see list is section 2.3.2). For these segments, more accurate measures of bankfull dimensions (width, depth, area, and discharge) will be measured or estimated, along with reach slope and numerous stream stability measures and ratios in the Reference Reach Spreadsheet Tool (Mecklenburg, 2006) and PLA guidance. These calculations will be used to compare to reference reach dimensions and statistics (as appropriate) as a final evaluation of degree of impairment, stream bank and bed stability, and estimate sediment load (using the BANCS model). A return survey will be used to refine erosion rate calculations. From this analysis, a rank-order list of stream reaches for the watershed will be developed for making restoration or remediation recommendations in the WMP.

2.3 Sample Collection Methods

Stream sampling for parameters listed below will be conducted every other week starting in April, 2019 at sites selected as described in section 2.2. The monitoring teams, consisting of at least two individuals, after picking up equipment at the HRWC offices, will travel to a pre-designated site and first complete a field data sheet (see Appendix E) that documents the location, date, time, team members and weather conditions for the current and previous days. The field data sheet is also used to record information about the water samples, such as how many samples were collected and how they were labeled. The team will then collect a sample following standard procedures detailed in Appendix B.

The team will then travel to additional sites and sample from those sites. Each team will be scheduled to sample 2-3 sites per day. Upon completion of the fieldwork, the monitoring team will deliver the grab samples to the Ann Arbor Water Treatment Plant laboratory for processing and analysis of nutrients and bacteria concentrations and return equipment and forms to the HRWC office. Upon receipt of samples, lab staff prepare samples as necessary for analysis by adding preservative (i.e. acid) to nutrient samples and beginning incubation of bacteria samples. Sample delivery is scheduled such that staff are available to process samples to meet holding times.

Following subsections describe in detail the parameters to be measured, analytical protocols, equipment to be used, and specific protocols for grab sampling and wet weather sampling. See the Appendices for detailed sample collection protocols.

2.3.1 Parameters to be measured

With supplemental support from the Middle Huron Partners, the following parameters will be measured at long term sites in Figure 1 and selected investigative sites. This monitoring is not paid for by grant funds, but will be used for watershed management plan update, and reported as match funding.

- Water level and discharge (in cubic feet per second) @ 10 minute intervals
- Total Phosphorus (TP in mg/l) – lab analysis
- Total Suspended Solids (TSS in mg/l) – lab analysis
- Nitrate and Nitrite (N-N in mg/l) – lab analysis
- *Escherichia coli* (in colony forming units per 100 ml) – lab analysis
- Sodium (mg/l) – lab analysis

- Chloride (mg/l) – lab analysis
- Dissolved oxygen (in mg/l) – field measure
- Water temperature (in degrees Celsius) – field measure
- Conductivity (in microSiemens/cm) – field measure
- Total Dissolved Solids (mg/l) – field measure
- pH (standard units) – field measure

All parameters will be collected biweekly, April through September. See the discussion in section 2.3.4 for stream discharge procedures. Table 3 below includes analytical specifics for each parameter. For *E. coli*, the lab will dilute samples to allow for quantification at high bacteria concentrations.

Table 3. Analytical specifics for measured parameters

Parameter	Method	Detection Limit/Range	Sample Volume (ml)	Bottle Type	Preserva-tive	Hold Time
Total phosphorus	SM20 4500-P B.5 and E	0.01 ppm	100 or 250	plastic	none	48 hrs
Total Suspended solids	SM 20 2540 D	0.1 ppm	750	plastic	none	none
Nitrate/nitrite	SM20 4500 – NO3 B / SM20 4500 – NO2 B	NO_2 - 0.1 ppb NO_3 - 0.2 ppm	750	plastic	none	48 hrs
E. Coli	SM20 9213 D	0 per 100 ml	100	Sterile plastic[1]	None[2]	6 hrs[3]
Sodium, chloride	SM20 4500	0.01 ppm	750	plastic	none	48 hrs
Dissolved Oxygen	YSI Pro Plus	0.0 - 19.9 mg/l	NA; measured with field instrument			
Conductivity	YSI Pro Plus	0 - 200 mS/cm	NA; measured with field instrument			
TDS	YSI Pro Plus	0 – 100 g/l (calculated from conductivity)	NA; measured with field instrument			
pH	YSI Pro Plus	0 - 14 pH	NA; measured with field instrument			
Temperature	YSI Pro Plus	0 - 50 °C	NA; measured with field instrument			
Flow	Marsh-McBirney Flomate 2000	-0.5 to +19.99 ft/sec	NA; measured with field instrument			

Continuous level and flow	HRXL-MaxSonar sensors	1 mm @ 1 m above	NA

[1] Sterilized 100 ml (or larger) bottles will be used.

[2] Thiosulfate tablets will be included in sample containers at sites where chlorine degradation is a concern.

[3] Samples will be kept on ice immediately following collection and will be stored under refrigeration until analysis can be conducted. Every effort will be made to get samples incubating within six hours. Logistics may not allow them to start at this short hold time. Sample results that exceed this hold time limit can be separated and analyzed separately.

2.3.2 Equipment

A YSI Professional Plus (Pro Plus) multimeter monitoring instrument will be used to collect additional parameters including pH, DO, conductivity and temperature. The all probes are calibrated prior to each sampling week, and the DO sensor is calibrated prior to each use.

Stream flow measurements will be made using a top-setting rod that allows all adjustments to be made from above water, with a Marsh McBirney Flo-Mate (Model 2000) portable flow meter.

"WaterMark" Style C staff gauge, graduated to hundredths and marked at every foot and every tenth, will be used to measure relative stream water level at long-term sites.

ISCO 3700 (or similar) automatic sampling units will be used at the Malletts Creek site and possibly other long-term sites, to collect samples during storm events. In 2019, samplers are also scheduled to be installed at two investigative sites in the School Girls Glen for a separate project, but the data will also be used for the WMP.

Ultrasonic HRXL-MaxSonar sensors will be installed with autosampler stations. They will be used to measure continuous relative distance, which will be converted to water level, based on staff gage readings. Level will be converted to flow based on level-discharge curves.

A Sokkia B21 automatic leveling scope mounted on a standard survey tripod will be used to read elevations.

Sokkia 25' leveling rod for setting field elevation points.

Pursuit XR-700 rangefinder for determining long distance. A 300-ft (graded in decimal feet) tape will be used for near distances.

2.3.3 Grab Sampling

Collectors will obtain a sufficient supply of sample bottles, pre-marked labels, a cooler (with freezer pack), and field data sheets. They will follow sampling protocols (see Appendix B) to collect grab samples and deliver to the laboratory for analysis. *E. coli* sample sets will consist of 3 representative samples collected from near each bank and the center of each stream site to be consistent with the water quality standard. Duplicate sampling will be done at a rate of about 10% of all samples. A large sample will be collected and split between the two samples, pouring alternately. Sampling staff and volunteers will put on sterile gloves prior to any sampling at each site.

2.3.4 Flow Monitoring

Water level and discharge will be recorded using ultrasonic sensors at autosampler stations. The sensor collects frequent distance measurements. Distance to sensor is converted to water level by subtracting the distance from the total distance to the stream bottom. Water level data points will be converted to discharge by developing a rating curve by collecting at least seven flow measurements spanning the range of water levels, following flow procedures included in the Appendix C.

2.3.5 Creek Walking Surveys

A team of volunteers will walk up or down accessible, targeted stream reaches (identified in section 2.2.3) and collect basic information to help identify targets for follow-up geomorphic surveys. Each team will visit a pre-determined reach and walk the reach from one point to another. Along the way they will make observations and periodically measure BEHI and NBS ratings at likely erosion locations. The team will stop, take a photograph and make BEHI and NBS measurements at each of these locations. Teams will use a line level, tape measure, and depth staff to measure bank statistics such as bank height, bankfull height, root depth, and bankfull width. In reaches that appear to the team to be good restoration candidates, the team will conduct a pebble count survey. Data is recorded on field sheets (see Appendix E) and data and photos get uploaded to HRWC's Info Stream (www.hrwc.org/maps).

2.3.6 Geomorphic Surveys

Following the selection of follow-up survey sites, a team of staff, assisted by trained volunteers, will survey a stream length of at least 20 bankfull widths using professional survey equipment. Surveys will begin by establishing a reasonable benchmark elevation, and marking the bank top and toe with bank pins. The longitudinal profile elevations will be surveyed along the stream thalwag and bankfull indicators. At each riffle (or glide if true riffles are not present), the team will survey the profile of a stream cross-section, taking care to target bankfull indicators and enough floodplain to calculate entrenchment ratio. Data will be recorded on field sheets or in the survey instrument, and then transferred to the Reference Reach Spreadsheet tool (Mecklenburg, 2006). See Appendix D for cross-section survey methods. Otherwise, survey methods will follow guidelines as described in section 2.2.3. Surveys will be repeated following at least one spring flow event to determine erosion rate estimates.

2.3.7 External Data

The development of any watershed management plan requires the evaluation of all relevant, valid and available data. Many data sources will be used, some of which cannot be anticipated at this time, but will be subject to DEQ review and approval. The following dataset are currently anticipated to be used to supplement monitoring and survey data discussed throughout the rest of this document.

- Geographic data. HRWC has a rich repository of relevant information on the location of watershed features such as streams, soils, land use, land cover, infrastructure, and geology to name just a few. All data sources are documented.
- Ann Arbor stormwater model data. The City of Ann Arbor developed a SWMM model for their stormwater system that includes detailed information on conveyance structures and their dimensions and connectivities. HRWC will utilize information embedded in the model to provide information on hydrologic response to storms, and supplement geomorphology information on open stream channels. The model development report will be shared as an appendix to the WMP. Original sources of survey data will be included where used.

- U.S. Geological Survey streamflow. Flow data from the two gage stations in the watershed will be used to determine hydrologic dynamics, confirm model results and provide a source for seasonal loading calculations.
- Weather station data. HRWC will obtain rainfall data from a range of weather stations to use for rainfall patterns and dynamics, development of rainfall-runoff relations, and determination of significant rainfall events triggering storm sampling. National weather service stations, municipal stations, and private weather stations published on Weather Underground will be utilized. Wherever possible, multiple stations will be evaluated in combination to increase precision of rainfall estimates. Data source(s) will be included wherever used.
- Historical water quality summaries. To get an historical perspective on how the watershed has changed over the years, HRWC will evaluate and reference historical water studies conducted by a wide range of entities. All original sources will be cited.
- Other current water quality data. HRWC endeavors to collect all relevant chemistry and biological data from reputable agencies to include in an overall evaluation of the current state of the watershed. Any external data source included in an analysis will be cited where used.

2.4 Data Quality Objectives

Accuracy and precision statistics for each of the measured parameters are included in Table 4 below.

Table 4. Accuracy and precision of measured parameters

Parameter	Accuracy	Repeatability/ Precision
E. Coli	0 CFU for blanks	25% for duplicates
Direct discharge (Flow)	± 2% of reading ± 0.05 ft/sec	± 0.05 ft/sec
Water level (ultrasonic sensors)	± 1% of reading	± 1 mm @ 1 m
Total Phosphorus	2.8% (from spikes)	3.5%
Total Suspended Solids	.0001 mg/l (from blanks)	19.6%
Nitrate/nitrite	NO_2: 6.0% (spikes) NO_3: 4.3% (spikes)	3.0% 7.2%
Sodium, chloride	2.8% (from spikes)	3.5%
Dissolved Oxygen	0.1 mg/l	±0.1 mg/l
Conductivity	0-1 mS/cm: 0.01 mS/cm 1-10 mS/cm: 0.1 mS/cm 10-100 mS/cm: 1 mS/cm	1%/F.S.
TDS	See conductivity. TDS calculated from conductivity	1%/F.S.
pH	0.1 pH	±0.05 pH
Temperature	1°C	±0.3°C

Accuracy of *E. coli* measurement and most chemical parameters cannot be calculated or tested except by testing the accuracy of absent (blank) samples. Field blanks and duplicates will be prepared and analyzed at a rate of one for every 10 sample sets. The Ann Arbor lab will verify handling procedures using blanks. The Ann Arbor lab maintains a separate QAPP for their lab procedures. This can be reviewed or obtained upon request. The lab is a certified drinking water lab and has thus had their lab procedures reviewed and approved by MDEQ for compliance. The lab is also certified by U.S. EPA as to meet national waste water testing standards, and thus undergoes review and assessment by EPA. Details on these certifications can also be obtained from the lab.

For field parameters and survey measurements, the following objectives will apply.

2.4.1 Precision

Volunteers attend both classroom-style and field training to learn the procedures and protocol for collecting water quality samples, measuring flow/discharge, and conducting surveys. Volunteer teams are then observed in the field periodically to audit monitoring activities. Rechecks of flow measurements or survey observations selected randomly along the channel transect are used to determine precision of monitoring teams' technique. Laboratory blanks and duplicates will be run for 5-10% of all samples collected.

Following the state standard for *E. coli* measurement, samples are collected in triplicate from representative locations in the stream at a given site. Using the geometric mean of this sample set should reduce the overall variability of sampling and improve precision. A target relative percent difference for field duplicates is 35%.

The data collection manager will resurvey a select set of sites for BANCS precision estimate.

2.4.2 Bias

The following approaches will minimize systematic or persistent distortion of data collection:

- Volunteer collectors will rotate across sites
- Survey staff will rotate roles/jobs

2.4.3 Accuracy

No standards exist to compare field estimates of stream discharge or survey elevations against, so efforts are made to reduce measurement error and maintain sampling consistency. New volunteers and student interns will receive training that includes practice in the stream. They will then take water samples, and measure flow or survey in teams of two or three members, accompanied by trainers on their first outing for stream monitoring. Periodically trainers will accompany them as an additional check on proper technique and sampling protocol. Stream reach surveys will be conducted by trained staff accompanied by volunteer assistants.

2.4.4 Representativeness

Monitoring sites have been selected to be representative of the chemical and bacterial concentrations entering the Huron River from tributaries. As such the measures should indicate concentration range from each tributary. By taking baseflow samples at regular intervals, the dataset should be representative of the conditions at the output of these tributaries. Including wet-weather samples should test for bacteria presence across different runoff conditions.

Combining numerous measurements from creek walking surveys with more precise geomorphic survey measurements should confirm the representativeness of geomorphic survey locations.

2.4.5 Comparability

Standard procedures are being followed for all measures, which have been and are being utilized in other watersheds. This should allow for results that are comparable to measurements of the same parameters elsewhere.

2.4.6 Completeness

Our objective is to complete multiple measurements of discharge at sufficient water levels to develop a rating curve for each staff gauge or level sensor installed at each monitoring site. We expect to collect chemical and bacteria samples from monitoring sites for base flow and a wet weather events for each. Geomorphic surveys will be completed to establish longitudinal pattern and cross-sectional dimensions. Following validation by the project and field managers, the objective is to maintain results that are 95% valid and at least 90% complete according to the above outcome objectives.

2.5 Quality Control Procedures

All field equipment and lab equipment will be calibrated with a frequency consistent with procedures in each instrument's manual. All YSI probes (i.e. temperature, pH, DO, conductivity, TDS) will be calibrated prior to a new week of sampling. The DO probe is calibrated prior to each outing. All calibration standards will be kept up to date. Dates on all calibration chemicals will be inspected and chemicals replaced as needed. As indicated previously, sampling is conducted in triplicate and will be analyzed for site variation to imply precision. Variability will be reported for each site along with the monitoring data.

3. Data Validation and Reporting

3.1 Data Review, Validation and Verification

Upon completion of field sampling, collectors will deliver samples to the Ann Arbor lab. The data forms will be delivered to HRWC offices where they will be reviewed by the program or field manager for completeness. All equipment will be signed back in and checked for completeness. The program manager will download any water level and discharge measures and record those on the data forms prior to initialing the data forms. The program manager will review all survey sheets or data downloads prior to entering into the reference tool. If any data or equipment is discovered missing, the project manager will make an effort to recover at the time of turn-in. If this is not possible, the data gap will be noted on the data form. Collectors will be instructed on any procedures that were not properly followed. A determination will then be made on the validity of the data collection. If necessary, the collection will be rescheduled.

3.2 Reconciliation with DQOs

Upon receipt of data from laboratory analysis, the results of samples and duplicates will be evaluated to confirm that accuracy and precision objectives are being met. Any exceedances will be reported, and corrective actions will be requested. Further, individual samples will be evaluated with lab staff to determine if any should be deemed invalid. A completeness statistic will also be computed as a percentage of samples validated against the total of samples collected. Any violations of DQOs will be included as caveats in data analysis reports.

3.3 Data Management

Once data are collected from the field, they will be entered into the project database. The database is an Access database that is integrated with other monitoring data collected by the HRWC. The database helps to reduce data entry error by allowing for rapid comparison of new data with historical data to determine if any entries are missing or outside the normal range. Such entries will be rechecked for data entry error or sampling or analytical anomalies. The database is housed on the HRWC server, which is backed up nightly on-site and monthly off-site. Survey data will be entered into the Reference Reach Tool spreadsheets and stored on the same server. The data are compiled and analyzed in Excel to calculate statistics identified in the project objectives (section 2.1) and conduct comparison tests for each site for the measured parameters, as described in that section.

3.4 Reporting

Monitoring, quality control evaluation and data analysis progress will be reported quarterly to the MDEQ Project Officer. Following a comprehensive analysis of the full dataset, the results will be synthesized into a final report for electronic distribution to the MDEQ, Water Resources Division (WRD), community partners of the Middle Huron Partners at quarterly meetings, incorporated into the watershed management plan, and reported on the HRWC Info Stream website. Data collected as part of this grant project will be reported separately to the MDEQ Project Officer. All data will be submitted to the MDEQ Project Officer at the close of the grant in electronic format ready for entry or upload into U.S. EPA's STORET database or other MDEQ compliant format.

3.5 Audits

The necessity of field audits is limited as the field manager accompanies volunteer collectors on a regular basis. The program manager will also conduct field samples on occasion as an additional level of program evaluation.

Any systemic problems discovered through this process by either manager will be discussed and retraining will be scheduled for collectors as needed to address problems. Other programmatic corrective actions will be taken as necessary and communicated to volunteer collectors. If necessary, this program QAPP will be updated with revised procedures. All problems will be reported as soon as staff is aware and via quarterly reports to the MDEQ project officer.

5. Referencecs

Stantec, 2015. *Southern Lower Michigan Regional Curve Project.* DEQ Project number: 2011-0100.

5. Appendices

Included with this document are the following appended documents:

A. Middle Huron Partners Contact List
B. Field sampling and wet weather procedures
C. Flow monitoring procedures
D. Geomorphic Assessment Procedures
    1. Bank Erosion Hazard Index (BEHI) and Near-Bank Stress methods
    2. Cross-section survey methods
E. Field Sampling Forms:
    1. Field Data Form
    2. Flow Monitoring Form
    3. Sample Delivery Form
    4. BEHI and NBS forms
    5. Pebble-count survey form
    6. Geomorphology Survey Form