Quality Assurance Project Plan (QAPP)
Middle Grand River Watershed Monitoring 2014

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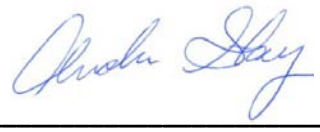

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Distribution List

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- Erin Campbell, Associate Environmental Planner

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- Regina Young, Environmental Health Director

We will make this QAPP available to the Middle Grand River Steering Committee members on the www.middlegrandriver.org website.

Project Organization

The Eaton Conservation District (ECD) is responsible for grant administrative activities, including coordinating the entire water quality monitoring. We will collaborate with Ionia Conservation District, and the Tri-County Regional Planning Commission.

Table 1. Middle Grand River Watershed Planning Project Leadership

Name and Title	Responsibilities	Contact Information
Andrea Stay, Executive Director, Eaton Conservation District	Overall project administration	Phone: 517-543-5848 X111 E-mail: andrea.stay@ mi.nacdnet.net
Rachael Loucks, Watershed Planning Coordinator, Eaton Conservation District	Project planning and oversight; development and implementation of QAPP for water quality monitoring; data entry; and report preparation	Phone: 517-543-5848 X113 Email: rachael.loucks@macd.org

Project Description

A TMDL for *E.coli* was put into place in December of 2012 for the following stretches of the Grand River: Grand River (AUID # 040500040702-01) 16 miles, Grand River (AUID # 040500040703-01) 17 miles, Moores Park Reservior (AUID # 040500040703-02) 110 acres, Grand River (AUID # 040500040703-02) 12

miles, Grand River downstream of Waverly Rd, extending to confluence of Carrer Creek (AUID # 040500040704-03) 10 miles, Grand River and Spring Brook (AUID # 040500040308-01) 45 miles, and Grand River (AUID # 040500040308-02) 1 mile.

The western part of the Middle Grand River Watershed (Sandstone Creek, Frayer Creek, Winchell and Union Drain, Sebewa Creek, Cryderman Lake Drain subwatersheds) is not included in the *E. coli* TMDL. However, watershed planning partners have expressed concern over potential high bacteria concentrations. The Barry-Eaton Health Department and the Eaton County Drain Commissioners office have discussed that a high number of illicit connections, failing septic tanks, large livestock facilities, and concerns over manure management practices have been observed in this area.

In the summer of 2012, Eaton Conservation District (ECD) collected land use and agricultural practice information from all subwatersheds in the project area. These results showed the types of livestock present in the watershed, tillage practices being used, function of the land in relation to livestock (grazing/pasture lands or feeding/holding area) and animal access to surface water. The western portion of the watershed exhibited high livestock densities. In fact 76% of the livestock found in the watershed reside in the western portion.

In the Columbia, Silver, and Skinner subwatersheds, ECD completed preliminary *E.coli* data collection and source tracking for presence of bovine, equine, and human markers in 2012. ECD will further delineate the stretches that have the highest contribution of human sources of *E. coli*. Data from this monitoring effort will be used to inform the Health Department of potential hot spot areas of human sources of *E. coli*. These data collected in the western portion could potentially expand the impaired reach for *E.coli.*

Training Requirements/Certification

For *E.coli* monitoring, no training is required since ECD staff will collect the samples and deliver them to appropriate labs (e.g., MDEQ drinking water lab or Michigan State University Center for Water Science) for analysis. Although no formal training is required to collect *E.coli* samples, ECD staff will follow the sampling guidelines provided by MDEQ (Appendix B). Furthermore, any volunteers collecting samples will become familiar with the QAPP and MDEQ sampling guidelines prior to sample collection.

Study Objectives

One goal of collecting *E.*coli data is to further delineate the areas that are contributing Human Sources to the TMDL reach of the Middle Grand River Watershed. An additional goal is to undertake a baseline study to determine whether *E.coli* is present, and if so, whether levels exceed Water Quality Standards in the following Middle Grand River subwatersheds: Sandstone Creek, Frayer Creek, Winchell and Union Drain, Sebewa Creek and Cryderman Lake Drain. This study design focuses on characterizing the water quality impairments, and seeking to determine the sources of those impairments. Specifically, this study will address the following questions:

1. Where are the specific human sources of *E.*coli in the tributaries that were initially identified by ECD, during the 2012 monitoring, as containing human markers?

2. What are the current *E.coli* levels in the western portion of the Middle Grand River Watershed?
3. What are the probable *E.coli* sources in the western portion of the Middle Grand River Watershed?

Study Design

The study will collect data to inform the watershed management plan. Site selection criteria are outlined below.

The *E.*coli sampling will be performed in seven of the subwatersheds of the Middle Grand River Watershed within Ingham, Eaton and Ionia County. The seven subwatersheds are Columbia Creek HUC -701; Silver Creek HUC -703; Sandstone Creek HUC -705; Frayer Creek HUC -706; Winchell and Union Drain HUC -707; Sebewa Creek HUC -708; Cryderman Lake Drain HUC -709.

Site selection was based on the predominate land use being rural residential and agricultural, information from the Barry-Eaton Health Department and the Eaton County Drain Commissioners office regarding high potential for illicit connections, failing septic tanks, large livestock facilities, and concerns over manure management practices and identified tributaries from ECD's 2012 monitoring containing human markers. Based on these criteria, *E.coli* source tracking will be performed at the locations identified in Table 2 and *E.coli* monitoring will be performed at the locations identified in Table 3.

Table 2. Middle Grand River Watershed Source Tracking Locations

Source Tracking				
Site #	Monitoring Location	Subwatershed	Longitude	Latitude
1	Eifert Rd. (Middle)	Columbia Creek	-84.54256	42.57329
2	Windsor Hwy.	Silver Creek	-84.659381	42.647391

Table 3. Middle Grand River Watershed *E.coli* Monitoring Locations

***E.coli* Monitoring**				
Site #	Monitoring Location	Subwatershed	Longitude	Latitute
1	St. Joe Hwy, West of Hartel Rd	Sandstone Creek	84.4530362	42.4335039
2	Jefferson St, East of Franklin (Grand Ledge	Sandstone Creek	84.4544877	42.4519553
3	Eaton Hwy, West 1/4 mi. of Oneida	Frayer Creek	84.4751978	42.4613375
4	M-100 and Cochran Rd	Frayer Creek	84.5013439	42.4521026
5	Tupper Lake, 1/4 mi. West of Sanders Rd	Frayer Creek	84.5148092	42.475835
6	Shaytown, South of McWhorter Rd	Winchell and Union Drain	84.5832041	42.438104
7	Clinton Hwy, East of Sunfield	Winchell and Union Drain	84.5926197	42.4258433
8	Tupper Lake, West of Turner Rd	Cryderman Lake Drain	84.5248522	42.476049
9	Musgrove Hwy, West of Welfare Rd	Cryderman Lake Drain	84.5248522	42.476049
10	Kent Rd, South of Market Rd	Cryderman Lake Drain	84.5451754	42.5059701
11	St. Joe Hwy, West of Shaytown	Sebewa Creek	84.5854667	42.433612
12	Musgrove Hwy, West of Keefer Rd	Sebewa Creek	84.5744862	42.4757946
13	Petrie Rd, South of Bippley Rd	Sebewa Creek	84.5831807	42.4818582
14	Keefer Rd, South of Emery Rd	Sebewa Creek	84.5721108	42.4917524
15	Keefer Rd, North of Bippley Rd	Sebewa Creek	84.5721038	42.494927

We will document the weather conditions during the sampling period for the data types outlined above. To accomplish this, we will use the Michigan State University Enviro-Weather website (http://www.enviroweather.msu.edu/weather.php?stn=msu) East Lansing station to document conditions on the day of data collection. The sampling locations will be at road stream crossings where right-of-way access is possible.

Parameters, Data Collection, and Analysis

Below is a description of the parameters to be measured and the associated data collection methods for each parameter type.

***E.coli* Monitoring**

E.coli will be monitored at 15 locations (Table 3) throughout the western portion of the Middle Grand Watershed (e.g., Sandstone Creek, Frayer Creek, Winchell and Union Drain, Cryderman Lake Drain and Sebewa Creek). Beginning in August, samples will be collected once a week for 10 weeks at each of the 15 sites.

For each *E.coli* sampling location, three samples (left, right, and center) will be collected to calculate a geometric mean for each site for each week. The collection protocol will include: 'grab' samples, in which sample collection staff will wear clean disposable gloves and replace them after each site; samples will be placed immediately on ice following collection; when sampling from a river, sample collection staff will ensure that the river has flow or that flow conditions are within the normal range; and sample collection staff will avoid sampling the surface layer of the water, disturbing sediment,

debris and aquatic vegetation and targeting stagnant areas. Duplicates will be collected according to the quality control guidance provided by MDEQ. (Appendix B).

The samples will be collected using clean Unit #30 bottles provided by the MDEQ Drinking Water Laboratory. The samples will be labeled appropriately with site, date and collection time. Sampling will follow the procedures outlined by the MDEQ Drinking Water Laboratory EQP 2300 form. The samples will be delivered to the MDEQ Drinking Water Analysis Laboratory (3350 North M.L. King Blvd., P.O. Box 30270, Lansing, MI 48909; Phone: 517-335-8184) within 6 hours of being collected and by 3 p.m. on Monday - Thursday. Chain of custody forms will be maintained at all times (Appendix C). We will begin with lab analysis for 10-10,000 colony counts, and if results exceed 10,000, we will begin using the 10-1,000,000 colony count at the next sampling event, to more accurately detect the actual levels.

Human Sewage Source Tracking

For each identified human sewage location (Eifert Rd and Windsor Hwy), ECD will contract with Environmental Canine Services (ECS) to walk the drains in Silver and Columbia creek for a total of 12 miles. This will occur in late June of 2014.

ECS has dogs trained to signal when human sources of *E.coli* are detected. Another MDEQ grantee (e.g., Ottawa County Health Department) has subcontracted with ECS for detecting human sources of *E.coli* in surface waters and beaches. The Standard Operating Procedures (SOP) for ECS is in Appendix A.

The handler will not be knowledgeable of source locations or previous *E.coli* concentrations. Canine handlers and ECD staff will record results of the scent test analysis. All sites inspected will be assigned an ID number. The canine's reaction is recorded with the site ID number. This information in hard copy will be provided to Eaton Conservation District. The canine is placed on leash in a highly visible vest when investigating open drains. The canine is walked to the site for inspection. For example, the canine is walked to the bottom of the drain when accessible and taken to the drain end (Appendix A).

Global Positioning System (GPS) Quality Control

Coordinates of all sites will be obtained on-site using a GPS unite, and recorded in decimal degrees to five decimal places, using the World Geodetic System (WGS) 1984 coordinate system. The reception of a minimum of four satellites by the GPS receiver is required.

Data Quality Objectives for all Measurements

Table 4. Data quality objectives for watershed data

Activity	Accuracy	Precision	Representativeness /Comparability
E.coli sampling	Collect a duplicate every 20th sample or once per survey, whichever is more frequent.	Relative percent difference (RPD) ≤20%. If >20%, data must be flagged appropriately, however, *E.coli* is a highly variable parameter and data will not be discarded solely on a high RPD. If both the sample and the duplicate fall within 0-299 *E.coli*/100 mL or conversely, both samples are more than 300 *E.coli*/100 mL, then the data are considered acceptable. When the RPD is >30%, and the samples indicate a split between attainment and non-attainment, then the sampling event represented	Three samples (right, left, center) for each sampling location to generate a geomean.

		by the duplicate set would be deemed questionable.	
E.coli sampling	A factory-sealed bottle of drinking water will be used as field blank.	This will be kept in a cooler during sampling. While wearing gloves, the bottle will be opened and closed at each site. If a blank comes back as anything greater than non-detectable, then cross-contamination occurred and none of the data collected that day will be used.	

Quality Control Requirements

Quality assurance/Quality control (QA/QC) guidelines and rules have been established to ensure the reliability and validity of the data collected. The Project Manager will ensure compliance with QA/QC.

The objectives are to:

- Ensure all field analyses and sample collection procedures are documented, including any changes in administrative or technical procedures;
- Ensure all procedures are conducted according to sound scientific principles;
- Ensure all equipment is clean and properly functioning;
- Monitor performance of procedures by a systematic inspection program and provide for corrective action, if necessary;
- Ensure all analytical procedures are conducted according to sound scientific principles;
- Monitor the performance of the laboratory by a systematic inspection program and provide for corrective action, if necessary; and
- Ensure all data are properly recorded and archived.

Data Analysis and Interpretation

All laboratory procedures for *E.coli* analysis comply with the MDEQ procedures since it is their lab who will be analyzing the data. The MDEQ Drinking Water Analysis Laboratory uses EPA 1103.1. The *E.coli* geometric mean for each location will be calculated using the Excel formula =GEOMEAN(data range). Mathematically, this should be the n^{th} root of each of the samples multiplied together. Interpretation of data generated through field collection will be conducted in collaboration with stakeholders on the technical sub-committee and including staff from the MDEQ.

Supplies inspection

The bottles for *E.coli* water quality analysis will be Unit #30 bottles provided by the MDEQ Drinking Water Laboratory. Gloves, ice, clean coolers, factory-sealed bottles of drinking water are to be used as blanks.

Data Acquisition Activities Not Covered Under This QAPP

The Eaton Conservation District is collaborating with the Michigan Department of Environmental Quality to share data. We will be using Microsoft Bing Maps (2012) and GIS data files available from the U.S. Department of Agriculture – Natural Resources Conservation Service, and the Tri-County Regional Planning Commission. Throughout this project we will review historic data and reports from Michigan Department of Environmental Quality biosurveys and Michigan Department of Natural Resources fisheries surveys.

Data Review, Validation, and Verification

All data generated through this project must be reviewed to evaluate the data against the approved methods (verification) and to determine if the data meet the data quality objectives (validation). The review process involves:

- Preliminary review of the data collected in the field and in the laboratory;
- Secondary review of field records and analytical results to verify the data against method requirements;
- Review of the data for reasonableness;
- Validation by an objective third party, if necessary; and
- Assessment of the data for its usability to meet project goals.

Reconciliation of Data with DQOs

Project data will be reconciled with the data quality objectives through the validation process. Data that does not meet these objectives will be qualified and discussed in the final report.

Data Management

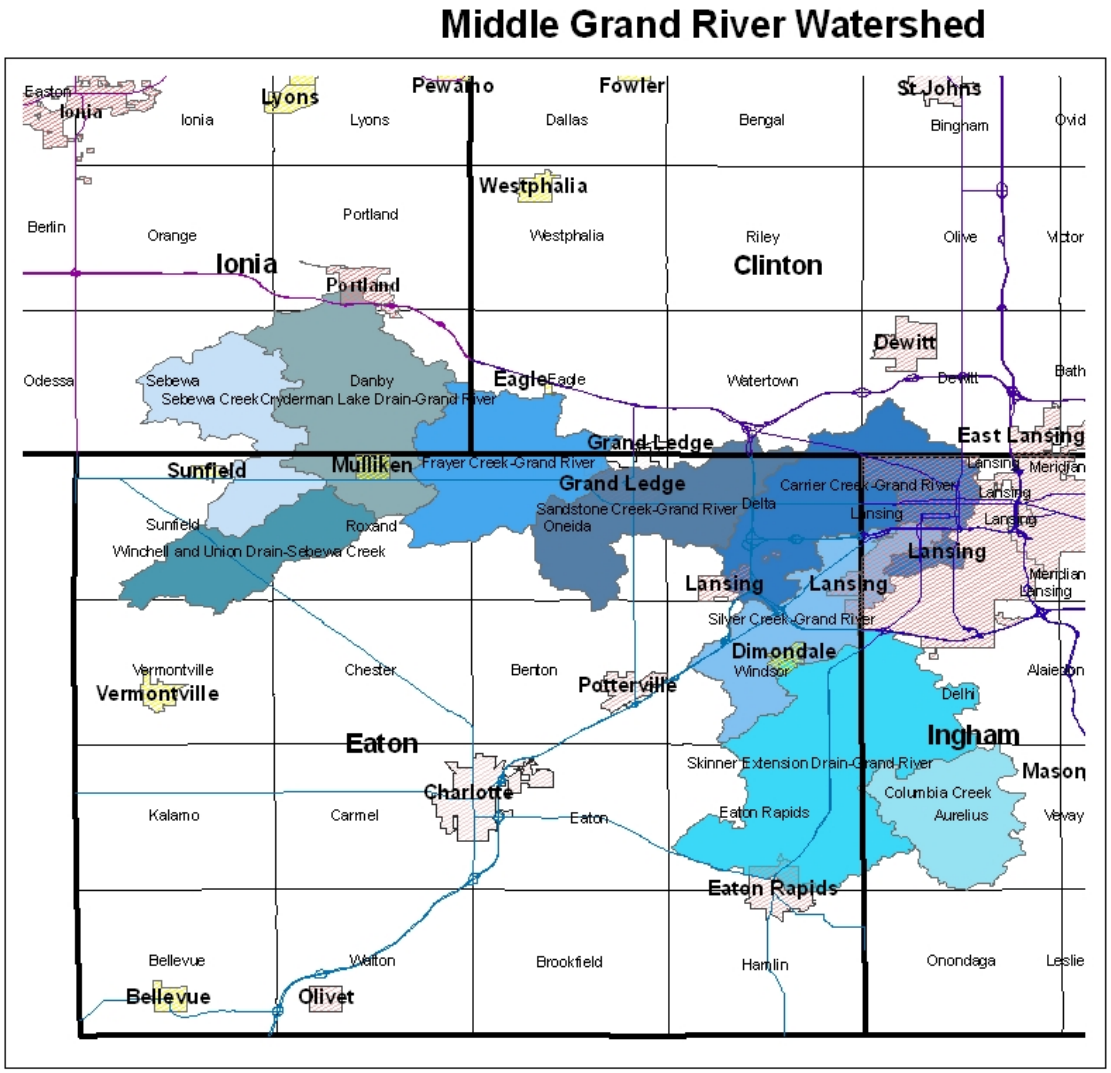
All field datasheets and lab result summary datasheets will be stored in notebook binders at the Eaton Conservation District. Data will be entered into electronic databases that are password restricted to ensure the data are not compromised in any way. Electronic data and analysis will be compiled and archived on CD-ROMs and an external drive. All project data will be complete and in one central location for external review. According to our contract, *E.coli* will be in a format suitable for entry into the U.S. Environmental Protection Agency's STORET database following the templates available on http://www.michigan.gov/deq/0,1607,7-135-3313_3682_3714-152031--,00.html (accessed March 22, 2012).

Raw *E.coli* data and site lat/longs (in decimal degrees) will be supplied to MDEQ at the end of each sampling season in a format provided by MDEQ staff.

Data Reporting

The Middle Grand River watershed management planning technical sub-committee and MDEQ project administrators will receive reports on performance and data quality two times during the monitoring season and at the conclusion of the project. The final project report will include results.

Figure 1. Subwatersheds in the Middle Grand River Watershed



EATON CONSERVATION DISTRICT

DEQ Michigan's Nonpoint Source Program

This product was supported in whole by the Nonpoint Source Program, Michigan Department of Enviornmental Quality. For more information on the Middle Grand River watershed management planning project, please contact Heather.Triezenberg @mi.nacdnet.net or 517-543 -5848 Ext. 5.

Created by:
Heather A. Triezenberg
October 4, 2011
Data Source: USDA-NRCS

Appendix A: Canine Scent Tracking Procedures
(Material adapted from Ottawa County Beach Monitoring QAPP)

Background

Environmental Canine Services LLC (ECS) is the leader in illicit discharge detection and source tracking in storm drainage systems. As the first and only company in the world to scent train canines as a rapid screening method to track contaminants in stormwater, ECS has proven to be a cost effective and accurate option for meeting Phase II NPDES requirements. This method is also useful as a rapid screening method to track human fecal contamination at potential sources of contamination located near and at beaches.

ECS handlers receive immediate feedback on the presence or absence of human sewage and/or detergents in the field by using scent trained canines to investigate drainage systems. This immediate feedback allows ECS and their client to track the source immediately and can be used to target "hot spots" that can be sampled for further testing rather than collecting samples from random sites. This quick feedback translates to lower sampling and personnel costs. ECS employees are experienced dog handlers and stormwater professionals.

In March of 2007, an 18-month old German Shepherd mix (named Sable) began specialized scent training for the detection and source tracking of raw human sewage and detergents in storm drain systems. The trainer and handler, Mr. Scott Reynolds was an employee of Tetra Tech in Lansing Michigan. Mr. Reynolds has scent trained and certified canines in multiple disciplines including missing persons location, human remains detection, narcotic, evidence search and building search for hidden persons.

In September of 2009, Mr. Reynolds left Tetra Tech with Sable and started Environmental Canine Services LLC (ECS) with his spouse and president, Karen Reynolds. With over 35 years of combined canine training they immediately began training a one year old Collie mix (named Logan) as a second detection canine. As of June 2010, ECS has two mission ready canines (Sable and Logan) and two additional in training.

Project Description

Conduct canine scent tracking for the identification of potential sources of human fecal contamination near and at surface waters (already identified in this QAPP). Canine scent tracking can be conducted year round.

Quality Objectives and Criteria

Sable began his field trials in July of 2007 while still working with Tetra Tech. For the month of July into mid- August of 2007, all dry-weather flow sample sites that Sable investigated were sampled and sent to a laboratory and tested for the parameters in Table 1. It is noted that the parameters for water testing were predetermined for Illicit Discharge Elimination Program already in place prior to Sable coming on board and could not be changed.

Table 1. Biological and Chemical Testing Parameters

Parameter	Illicit Discharge Likely	Illicit Discharge Unlikely
Bacteriological (*E. coli*)	> 1000 colonies 100/mL	< 1000 colonies 100/mL
Ammonia	> 1.0 mg/L	< 1.0 mg/L
MBAS - Surfactants	> 2.0 mg/L	< 2.0 mg/L

A comparison of 100 sites showed Sable had an accuracy rate of 87% when compared to traditional lab testing. The accuracy rate increased to 92% after removing cases where *E. coli* was the only parameter above the threshold and the suspected source was from an animal. It is noted that the biological testing for *E. coli* does not determine if the source is human or animal.

In June of 2010, ECS with canines Sable and Logan took part in a research study with the City of Santa Barbara and the University of California Santa Barbara. The purpose of the study, funded by the Water Environment Research Foundation (WERF), was to collect water samples from sites investigated by ECS canines and conduct microbial source tracking for human markers. The results have been published and are available to WERF members at www.werf.org, report # U2R09. The report documented the following:

- The canines' results were significantly associated with the presence of human markers.
- Minimum detection limit was associated with *E. coli l*evels at 10 colony forming units per 100 mL sample.
- There were no false negatives given by the dogs.
- In the cases where one human marker was present, canine #2 alerted 100% of the time.
- The canines were instrumental in locating a sanitary sewer leaking into a storm drain.

Special Training

The methods used during the training process are widely accepted training methods in multiple disciplines and are based on positive reinforcement. It should be noted that canines progress at different rates through the training process and respond to different types of rewards (praise, food, toys).

Septage was obtained from a residential septic system and used for the target scent(s). Although the septage contained surfactants, additional training was done using surfactant based detergents, soaps and cleaners. This portion of training provides the canine the ability to detect and source track illicit discharges from potential sources such as residential and commercial laundry and commercial carwashes. In 2009, ECS added chemicals and septage from holding tanks of recreation vehicles (RV) to the training procedures in preparation for a specific project in Santa Barbara California in June of 2010. It should be noted that the only RV holding tank chemicals used in the training process were EPA approved and did not contain Formaldehyde.

The process for scent training illicit discharge canines are outlined below. Proprietary training methods are not included in the descriptions.

- Imprinting: Canine is introduced to the target scent(s) and given a positive reward to build the desire to seek out the target scent to receive a reward. This is performed in a controlled environment with known target scent(s) and environmental conditions.
- Search: The canine is advanced to searching for the hidden target scent (s) in an open area after demonstrating the ability and desire to seek out the target scent. This develops the canines ability to detect and track the scent to the largest concentration in varied controlled environmental conditions
- Alert: The canine is taught to alert the handler to the presence of the target scent(s). Alerts are specific to each canine and may be an aggressive alert (bark, scratching/digging) or a passive alert (sit, down).
- Proofing: Proofing is a method of introducing distraction scents into the training area and teaching the canine to disregard the distracting scents and only seek out the target scent(s). Feces from domestic and wild animal scat, rotting vegetation, and food items are regularly used to create distracting scents.

- Double Blind Trials: Double blind testing is performed under controlled conditions utilizing a third party to set up the testing. The handler has no prior knowledge of the contents of scent boxes used in the testing or if a target scent is included in the testing.

A canine advances to field trials after successfully completing a double blind trial. In field trials, a canine is taken to an outfall or manhole where the condition and quality of dry weather flow is already known. Field trials are used to strengthen the canine's scent abilities in an uncontrolled environment that could include the following conditions: traffic, heat/cold, open drains, mud, insects, brush, etc.

Documentation and Records

All sites inspected will be assigned an ID number. The canine's reaction is recorded with the site ID number. This information in hard copy will be provided to Eaton Conservation District and can be included in summary reports mentioned in the QAPP.

Experimental Design

ECS prefers not to have prior knowledge of the water quality at sites to be investigated. Prior water sampling and information about sites should not be shared with ECS handlers prior to the investigation to eliminate potential influence of canine's investigation.

Sampling Methods

The canine is placed on leash in a highly visible vest when investigating beaches, open drains, and outfalls. The canine is walked to the site for inspection. For example, the canine is walked to the bottom of the drain when accessible and taken to the pipe end. The canine is allowed to sniff the pipe end regardless if dry weather or wet weather flow is present. The canine's reaction is recorded with the site ID number. In the event that the end of the pipe is not accessible to the canine to sniff, the first accessible upstream manhole may be used.

Photos of canine inspection at a storm drain on a beach, example of a passive alert (sit), and an aggressive alert (bark).

When investigating a manhole, catch basin, curb inlets, or other storm drain structures, assisting personnel opening or peering into the structure are asked not to comment or react to condition of structure prior to the canine sniffing to eliminate the handler's possible influence on the canine's investigation. In addition ECS handlers will not look into the structure prior to allowing their canine to sniff.

ECS will use a collected sample when investigating a larger body of water, river, or stream or drain that has suspected illicit discharges (examples include discharges that seep through the bank or overland such as a leaking septic system or homeless/transient camp). Eaton Conservation District staff or volunteers will collect the water samples.

These samples will be assigned ID numbers, removed from the area and placed in a "clean area" such as a parking lot or open park with pavilion access in the event of rain. Care will be taken to reduce cross contamination between samples. The canine will be taken to each sample and allowed to sniff. The canine's

reaction will be recorded for each of the samples. This method allows for a bracketing of potential discharge areas along the waterway to be targeted for further investigation.

Quality Control

In the event a canine's reaction is recognized by the handler to show interest in a specific site, but it has not alerted, the handler may ask for a second canine to check the site. Environmental factors such as excessive heat, vehicle exhaust or heavy traffic may require returning to the site at a later time.

Remaining elements of a QAPP not found in this section either do not apply or are addressed previously.

Reference

Murray, J., Reynolds, S., Holden, P., Van De Werfhorst, L. 2010. Canine Scent and Microbial Source Tracking in Santa Barbara, CA. Water Environmental Research Foundation, Report Number U2R09

Appendix B: Considerations for *E.coli* Studies

Guidance for Grant Administrators

Author and Contact: Molly Rippke, rippkem@michigan.gov

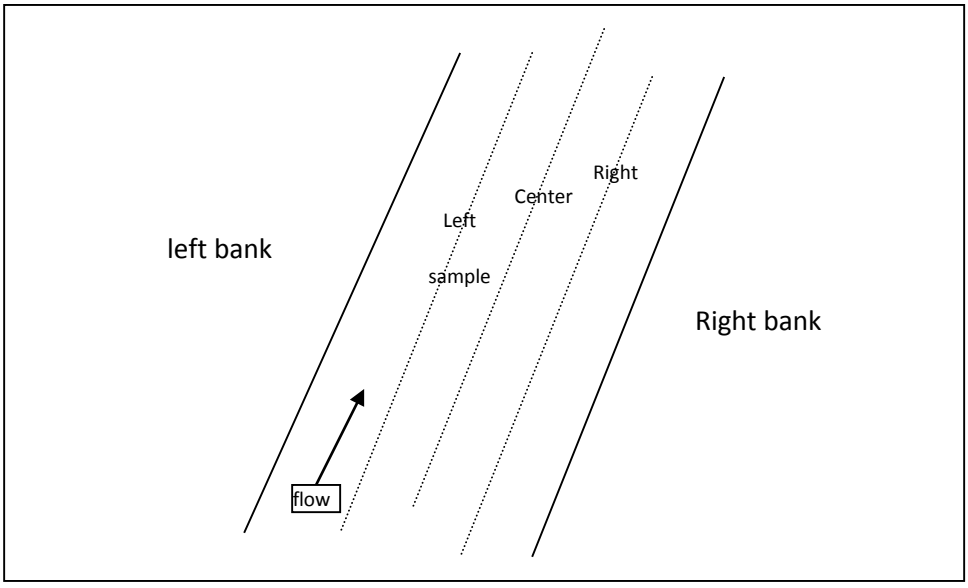
Section A of this document provides guidance for quality assurance of *E. coli* monitoring projects. The guidance within Section A applies to all *E. coli* studies, regardless of the goal of the study, and is designed to assure the usability and reliability of the data. Section B provides general considerations for designing an effective *E. coli* study, to ensure that the goals of the study can be met with the data collected.

Section A: Required Elements for Quality Assurance

Sampling requirements:

As a general rule, studies should include sufficient samples to compare with the WQS. In order to compare results with the total body contact (TBC) WQS, samples must be collected during the TBC recreation season, between May 1 and October 31. This will ensure that the DEQ can use the results if necessary. In order to compare *E. coli* data to the daily maximum Michigan Water Quality standards, it is necessary to have a geometric mean of 3 samples taken on the same sampling event, from representative locations at each site. In a river or stream, the width of the stream is generally divided into quarters, with samples collected at the 25th, 50th, and 75th quartiles. This sampling scheme (often called "left, right, and center") can be seen in Figure 1. An exception to this requirement would be granted in situations where samples were being analyzed for E. coli as part of a stand-alone Microbial Source Tracking study, where the exceedances of the WQS have been well documented in previous or simultaneous studies at each site. In the case of a stand-alone MST study, a single grab sample analyzed both for *E. coli* and biomarkers is sufficient, but it cannot be compared with the WQS.

Figure 1. Sampling scheme for a site located on a river or stream.



General sample collection guidance:

- Samples should be 'grab' samples.
- Sample collection staff should wear clean disposable gloves, and replace them after each site.
- Samples must be placed on ice immediately following collection.

- Hold times (generally 6 hours) and chain of custody should be maintained (NOTE: The DEQ drinking water lab has no chain of custody once samples are dropped off at the front guard desk. This cannot be avoided and it is still fine for grantees to use this lab. Samples are somewhat protected by the security of the building and guard).
- When samples are collected from a river, care should be taken to ensure that the river has flow, or that flow conditions are within the normal range for that particular river (e.g. a river appears stagnant, but this is its normal condition). Do not sample a river if flow is so low that isolated puddles exist.
- Avoid sampling the surface layer of water, which may contain a floating film.
- Avoid disturbing sediment, debris dams or aquatic vegetation.
- If a river is flowing, avoid targeting stagnant areas of the river to maintain the representativeness of the samples.

Quality Control:

- Duplicates should be collected at a rate of 10%, **or a minimum of 1 duplicate per field trip** if less than 5 samples are collected. The results of duplicate analyses should be used to calculate a relative percent difference (RPD) between the samples. The target for the RPD should be ≤20 percent, and data falling outside of this RPD should be flagged; however, E. coli is highly variable parameter and data should not be discarded based solely on a high RPD. If both the sample and the duplicate fall within 0-299 E. coli/100 mL (attainment with the TBC WQS), or conversely, both samples are more than 300 E. coli/100 ml (non-attainment with the TBC WQS), then the data are considered acceptable. When the RPD is >30 percent, and the samples indicate a split between attainment and non-attainment, then the sampling event represented by duplicate set would be deemed questionable.
- Field blanks should be collected at a rate of 5%, with **a minimum of 1 blank per field trip**. Factory sealed bottled drinking water is the ideal choice for a field blank in bacterial studies.
- The maximum level of quantification for E. coli analysis must be specified. Some analysis methods max out quantification at about 2,400 and dilutions would be necessary to obtain quantification at higher levels of bacteria. In studies where E. coli concentrations are expected to be high and comparisons between sites is included as a study goal, adequate dilutions should be performed to quantify to appropriate levels.

Data Management

Raw *E. coli* data and site lat/longs (in decimal degrees) should be supplied to the DEQ at the end of each sampling season in a format provided by DEQ staff. This will allow DEQ staff to have easy access to the data for 303(d) listing purposes. An excel spreadsheet template is available by contacting Molly Rippke (rippkem@michigan.gov). This requirement for data submission should be contained in the QAPP.

EPA Approved Methods:

The methods in the below table are approved for specific uses by the EPA. Some may provide enumeration (concentration), while others may provide a 'most probable number' which is an estimate. Many QAPPs will refer to the trade name of the E. coli test kit they are using, but should also state the EPA approved method that the product is designed to use.

1680 EPA	Fecal Coliforms in Sewage Sludge (Biosolids) by Multiple-Tube Fermentation using Lauryl Tryptose Broth (LTB) and EC Medium

1681 EPA	Fecal Coliforms in Sewage Sludge (Biosolids) by Multiple-Tube Fermentation using A-1 medium
1603 EPA	Escherichia coli (E. coli) in Water by Membrane Filtration Using Modified membrane-Thermotolerant Escherichia coli Agar (Modified mTEC)
1604 EPA	Total Coliforms and Escherichia coli in Water by MembraneFiltration Using a Simultaneous DetectionTechnique (MI Medium) (PDF) (18 pp, 384K)
9223 #	Standard Methods for the Examination of Water and Wastewater 20th Edition: Colilert, Colisure and Colilert-18 media are approved (2008). These methods give a 'most probable number' based on the detection of an enzyme produced by *E. coli*.
9222	Standard Methods for the Examination of Water and Wastewater 19th Edition
9213D	Standard Methods for the Examination of Water and Wastewater 20th Edition
1103.1 EPA*	Escherichia coli (E. coli) in Water by Membrane Filtration Using membrane-Thermotolerant Escherichia coli Agar (mTEC)
m-ColiBlue24 Test	m-ColiBlue 24 Test, "Total Coliforms and *E. coli* Membrane Filtration Method with m-ColiBlue 24 Broth," Method No. 10029,

* - Hach Method 8367 is a version of 1103.1. Make sure the QAPP states they will be following EPA approved method 1103.1.

- provides a 'most probable number' result

Section B: Guidance for Effective, Goal Oriented Study Design

Length of Study Considerations:

The length of the study would be defined by both the resources and the goals of the study. Some guidelines follow:

- To list a water body as impaired, the DEQ requires 5 weeks of weekly data per site/water body if the data are exceeding the 30-day geometric mean of 130 E. coli per 100 mL. These five weeks are required to calculate a 30-day geometric mean, and should be collected within a 30 day period. More is better, if feasible. Five weeks of data are probably not sufficient to discern temporal or spatial trends.
- To list an impaired waterbody as attaining, the DEQ requires 6 weeks of data to demonstrate that water quality has truly improved and no standards are being violated.
- To characterize the magnitude of *E. coli* concentrations in multiple locations, to compare them, or look for trends and 'hot-spots' for future prioritization, we recommend a study period of between 5 and 16 weeks. The longer the study period, the more reliable the interpretation of the data will be, so it is important to consider the goal of the study and the implications if management decisions are to be made based upon these data.
- To compare upstream vs. downstream (of a contamination source), of multiple sites on the same branch of a river, a longer study period is recommended.

Site Location Considerations:

The locations of the study sites should be defined by the goals of the study. Some guidelines follow:

- To maximize the value of data, sampling of low order tributaries, where watersheds are a manageable size for pollution reduction activities, is more valuable than sampling large tributaries.
- When sampling up- vs. downstream of a potential or known source, consider the following:
    - other sources of contamination may exist further upstream of the 'upstream' site; therefore, anticipated data trends may not occur.
    - A source on a large river may be diluted to the point that it is not detectable in results
    - See 'wet vs. dry weather considerations'.
- When sampling for MST, consider that a high order tributary is more likely to have multiple animal sources, because it would encompass a large watershed and would be expected to have more sources. A positive hit on a particular biomarker in a large river may not yield practical results.

Wet vs. Dry weather considerations:

When attempting to determine sources of *E. coli*, or monitor effectiveness of best management practices, consider both the types of sources you are focusing your effort on, and the weather/flow conditions you would expect that type of source to be affecting the surface water. Dry weather sources (illicit connects direct to surface water, animals with direct stream access, contaminated groundwater, etc) and wet weather sources (farm run-off, urban runoff, etc) should be targeted accordingly. Example: Dry weather monitoring is unlikely to pick up the affects of manure spreading; therefore if the study goal is to assess land-applied manure sources then wet weather targeted monitoring would be appropriate.

Appendix C: Chain of Custody Form

-See Attachment