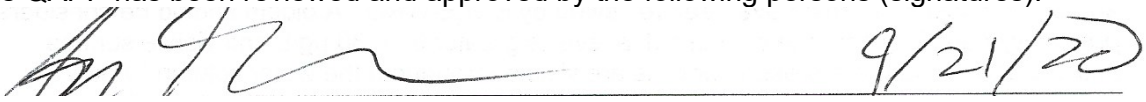
Work Plan and Quality Assurance Project Plan (QAPP)

2020 Michigan Inland Lake Harmful Algal Bloom Monitoring
Michigan Department of Environment, Great Lakes, and Energy (EGLE), Water Resources Division

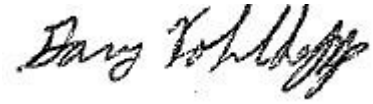
Prepared by Aaron Parker, Project Lead
EGLE
September, 2020

QAPP Approval

This QAPP has been reviewed and approved by the following persons (signatures):



Aaron Parker, Project Lead — Date
Senior Aquatic Biologist – Lake Michigan Unit
Surface Water Assessment Section, EGLE



9/21/20

Gary Kohlhepp, Project Supervisor — Date
Supervisor – Lake Michigan Unit
Surface Water Assessment Section, EGLE

Table 1: Distribution list for the Michigan Inland Lake Harmful Algal Bloom Monitoring Work Plan and Quality Assurance Project Plan.

Name	Affiliation	Project Role
Dawn Roush	EGLE	Lakes Erie, Huron, Superior Unit Supervisor
Kevin Goodwin	EGLE	Field sampling, response efforts
Kelly Turek	EGLE	Field sampling, response efforts
Sarah Holden	EGLE	Field sampling, response efforts
Piotr Pawlak	DHHS	Laboratory cyanotoxin analysis
Kelly Ploehn	EGLE	Executive Division communications
Alexandra Rafalski	DHHS	Communication with local health departments

Susan Peters	DHHS	Communication with local health departments

1. Introduction

The Michigan Department of Environment, Great Lakes, and Energy (EGLE) – Water Resources Division (WRD) receives reports each year about nuisance algal conditions from district staff, lake associations, and the broader public. The number of such reports, particularly the occurrence of cyanobacteria blooms and concern over the possible presence of toxins such as microcystin, has increased in recent years. As a result, the EGLE–WRD established an internal work group in 2013 to develop an approach to monitor, assess, and report on nuisance and harmful algal conditions, and to improve our understanding of the nature, extent, and frequency of algal blooms in inland waters and nearshore Great Lakes. The need to understand and address harmful algal blooms (HABs) became more urgent in August 2014. At that time, severe blooms were observed in the western basin of Lake Erie, and access to drinking water for hundreds of thousands of people was temporarily interrupted due to elevated levels of a cyanobacterial toxin associated with the bloom. This event caused the EGLE-WRD to re-examine and expedite our efforts related to HABs. This work plan focuses on inland lakes; however, we have other work focusing on blue-green algae sampling along Great Lakes shorelines. That project was initiated in 2012 at Lake Erie and expanded in 2016 to collect and analyze samples for microcystin from Saginaw Bay beaches.

The term “harmful algal bloom” generally describes accumulations of cyanobacteria that are aesthetically unappealing and produce algal toxins. The EGLE–WRD developed the following definition for a HAB: “An algal bloom in recreational waters is harmful if microcystin levels are at or above the 20 ug/L WHO non-drinking water guideline, or other algal toxins are at or above appropriate guidelines that have been reviewed by EGLE-WRD.” A bloom should be considered *potentially* harmful when “the chlorophyll-*a* level is greater than 30 µg/L and visible surface accumulations/scum are present, or cells are visible throughout the water column.” A key concept of this HAB definition is that while high chlorophyll-*a* concentration and visible surface/water column algal accumulation can indicate potential problems, water samples must be analyzed for the presence of toxins to confirm that a bloom may, in fact, be harmful to humans. Visual appearances of blooms cannot be used as a reliable predictor of toxin content. Even in toxin-producing blooms, there may be great variability in where the toxin is located. In the future, this definition may be updated if EGLE, or another organization, develop algal toxin water quality standards.

1.1. Proposal

The majority of sampling will be conducted as response monitoring for waterbodies with complaints about significant cyanobacteria blooms. The intent of this component of the HABs monitoring plan is to provide a structure for monitoring when EGLE-WRD staff believe collecting algal toxin data is warranted. We expect to monitor individual lakes and to analyze samples with both field test strips and quantitative MS analysis. The number of waterbodies assessed will depend on the frequency of complaints. The number of samples per response lake will depend on cyanotoxin results. If the initial sample results indicate elevated toxin levels, then regular follow-up monitoring may be conducted, as feasible, until concentrations decline.

Four lakes will be sampled in 2020 for Total Maximum Daily Load (TMDL) follow-up monitoring. Those lakes are: Lake Allegan, Allegan County; Lake Macatawa, Ottawa County; Ford Lake, Washtenaw County; and Belleville Lake, Wayne County. Sampling will tentatively begin in May, 2020 however, sampling may begin later (or delayed to 2021) if travel restrictions continue in response to the spread of COVID-19.

Finally, EGLE is planning to assess the trophic status at 10-12 lakes throughout the state. Cyanobacterial toxin sampling will be included in that sampling effort. The exact level of effort for sampling those lakes is still tentative and dependent on when travel restrictions are lifted for EGLE staff. When a list of lakes is finalized, the appropriate health departments will be notified.

1.2. Study Objectives

This work plan is designed to address the following objectives:

- Measure the geographical extent of HABs in Michigan inland lakes (i.e. how widespread is the problem); and
- Quantify algal toxin concentrations in lakes with public reports of concerning algal blooms.

1.3. Project Organization and Responsibility

Table 3 contains a list of key personnel involved in the execution of this Work Assignment. Contact information for these personnel is also provided. Other staff may assist as needed.

Table 3. Personnel and monitoring/sample analysis responsibilities.

Personnel Name	Affiliation & Contact Information	Monitoring Responsibilities
Aaron Parker	EGLE-Water Resources Division 517-342-4415 parkera7@michigan.gov	Project Lead, status and trend monitoring, targeted lake sampling, TMDL lake HABs monitoring coordination, response monitoring, QA oversight
Kevin Goodwin	EGLE-Water Resources Division 517-284-5552 goodwink@michigan.gov	HABs committee, targeted lake sampling
Sarah Holden	EGLE- Water Resources Division 517-342-4083 holdens1@michigan.gov	HABs committee, targeted lake sampling
Piotr Pawlak	Michigan Department of Health and Human Services 517-335-9959 pawlakp@michigan.gov	cyanotoxins analysis

1.3.1. Project Lead

The EGLE Project Lead (Aaron Parker) is responsible for the implementation of the study and its associated QAPP. In addition, the EGLE Project Lead is responsible for:

- Ensuring an adequate QAPP is developed and distributed to all appropriate project personnel;
- Ensuring the overall goal and requirements outlined in the QAPP are met through effective organizing and planning;
- Ensuring effective lines of communication; and
- Ensuring all data products are reviewed and approved according to accepted policies and guidelines before being released.

1.3.2. Project Supervisor

Gary Kohlhepp is the Lake Michigan Unit Supervisor and the Project Supervisor. His responsibilities include:

- Ensuring the project is appropriately organized and has effective lines of communication;
- Ensuring program roles are clearly understood;
- Ensuring Standard Operating Procedures (SOPs) that describe current practices are written, approved, and distributed to appropriate project personnel;
- Implementing program-level corrective actions on an as-needed basis; and
- Reviewing reports to ensure quality assurance (QA) goals are met.

1.3.3. Monitoring Staff

The SWAS biologists (Sarah Holden, Kevin Goodwin, and Aaron Parker) are all on the HABs work group and will be used as available to conduct the project sampling and be responsible for following field/sampling SOPs and project QAPPs. Other SWAS staff may assist with sampling as needed. All collection and delivery of samples will be performed by these staff as well. Their responsibilities include:

- Keeping well-informed of the sampling schedule;
- Ensuring the monitoring staff commitments for all surveys are met;
- Ensuring effective lines of communication;
- Ensuring all quality assurance/quality control (QA/QC) requirements are followed;
- Managing the day-to-day field sampling activities to ensure field procedures and activities conform to the requirements of the applicable SOPs;
- Resolving day-to-day problems in the implementation of this monitoring study;
- Reviewing records and field data for accuracy, validity, and completeness; and
- Communicating problems to the Project Lead.

2. SAMPLING AND ANALYTICAL PROCEDURES

2.1. Sampling Locations and Schedule

Response Lakes
Response lakes will be sampled based on reports and documentation of significant algal blooms. We expect to monitor lakes predominantly in the southern region of the state, from which most of the bloom reports tend to originate. We are planning to limit response monitoring to a maximum of 20 lake trips, although this number is flexible based on the status of other monitoring responsibilities. When a response is initiated after receiving a complaint, the project lead or project supervisor will notify District staff and DHHS staff. DHHS staff will notify the appropriate local health departments about which waterbodies are being sampled.

District staff will also be provided with Abraxis test strips and trained on how to use them. To respond to lakes in a timely manner, district staff will be encouraged to collect samples and run the initial test strip analysis on the samples. Depending on the initial results, district staff and the project lead will arrange further sample analysis at the laboratory, additional sample collections, or closure of the response.

2.2. Sampling Methods

2.2.1. Field Protocols

Photographs
During each visit, photos will be taken if they are likely to provide helpful documentation of the visual extent of the algal bloom in at least one near-shore sampling location. Photos should be taken to generally cover the range of conditions present (i.e. looking down into the water, looking out across the lake, near shore conditions, and use of props to provide visual evidence of the amount of algae present). Other photos will be taken as needed to capture any other noteworthy conditions. Pictures will be taken from the same location to facilitate comparison over time if a lake is sampled more than once. Upon return to the office, pictures will be downloaded to the designated network drive and folder for storage.

Survey cellular phone application
Field survey data will be collected using the EGLE HABS survey in the Survey123 application (Appendix A). After each survey is complete it will be sent to the ArcGIS cloud server. Those data will then be exported onto a network drive from the server. Water quality data and location coordinates collected using an EXO Sonde unit will be logged into the device. Field data will be downloaded off of the sonde unit after each collection and saved on the project manager's computer. In the event that the Survey123 application is not functioning properly, data sheets will be filled out. Upon return to the office sonde data will be downloaded and will be submitted to the Project Lead for data entry and storage. Either the Survey123 application or sonde unit will be used to record the location of each sampling station.

Water Samples
Three shoreline sites and one center lake location will generally be sampled at all lakes for cyanotoxins. Response lakes that do not have public boat access will be limited to shoreline sampling. If boat access is not available or a boat is not available, then the project lead will typically find shoreline sites at public access areas along the lake such as parks, beaches, boat launches, etc. using Google Earth prior to sampling. All lakes will be sampled for total microcystin (qualitative Abraxis test strips) and a suite of cyanotoxins (LC/MS/MS quantitative see 2.2.2.). Cyanotoxin samples will be collected in 250 ml polyethylene terephthalate (PETG) sample bottles that have been triple-rinsed with site water. Shoreline sampling locations will be distributed approximately evenly around the shoreline of each lake. However, downwind locations, bays which may be used for recreation (i.e. have shoreline homes, access sites), or beaches will be preferentially targeted. Shoreline surface samples (top ~ ½ inch of water) will be collected in water approximately 1 to 6 feet deep. Ambient water that is representative of the site will be sampled. However, if a visible algal scum is present at a site, additional scum samples may be collected.

At the center location of all lakes temperature, conductivity, pH, dissolved oxygen, phycocyanin, and chlorophyll-a will be measured using a YSI sonde along a depth gradient. Phycocyanin and chlorophyll-a will also be measured at the surface and 2-4 feet of water at each shoreline location. Sonde calibration will follow established protocols at the start of each sampling day and a calibration sheet will be completed and stored at the EGLE Filley Street facility.

Surface water samples will be collected from the center of the lake in the top ½ inch of water using new 250 milliliter (ml) PETG (quantitative cyanotoxins) sample bottles that have been triple-rinsed with site water. The following four sample bottles will be collected: (1) General Chemistry Acidic (GA) and (1) Neutral (GN), (1) Chlorophyll-a, and (1) cyanotoxins. Following

sampling, preservatives will be added to the chlorophyll-a and GA bottles and then all sample bottles will be placed in a cooler on ice for transport and storage prior to delivery to the laboratory.

Nutrient samples (GA: one bottle for total phosphorus, total Kjeldahl nitrogen, and nitrate+nitrite; GN: one bottle for orthophosphate; and one chlorophyll-a bottle) will be submitted to the EGLE Environmental Laboratory for analysis. Quantitative cyanotoxin samples will be submitted to the Michigan Department of Health and Human Services (MDHHS) lab for analysis using LC/MS/MS. Qualitative microcystin samples will be analyzed by EGLE using Abraxis test strips.

Qualitative microcystin samples may be held on ice or refrigerated for 48 hours prior to analysis. If microcystin samples are held longer than 48 hours, they should be frozen with care taken to reduce volume to allow for expansion, typically leaving head space above the 'shoulder' in the sample bottle.

2.2.2. Sample Analysis

See Table 4 for analytical methods and reporting limits for all sample analyses. Nutrient and chlorophyll-a samples will be submitted to the EGLE lab for analysis. Quantitative cyanotoxin samples will be submitted to Michigan Department of Health and Human Services (DHHS) laboratory for LC-MS-MS analysis of these toxins: Anatoxin-a, cylindrospermopsin, nodularin, and ten different microcystin congeners. Qualitative microcystin samples will be tested using Abraxis test strips (PN52022) at the EGLE Filley Street facility, or by the Great Lakes Environmental Center following procedures provided with the test strips.

Table 4. Analytical methods and reporting limits.

Parameter	Analytical Method	Reporting Level (µg/l)
Microcystin RR	LC/MS/MS	0.5
Microcystin YR	LC/MS/MS	0.5
Microcystin HTYR	LC/MS/MS	0.5
Microcystin LR	LC/MS/MS	0.5
Microcystin LR ASP3	LC/MS/MS	0.5
Microcystin WR	LC/MS/MS	0.5
Microcystin LA	LC/MS/MS	0.5
Microcystin LY	LC/MS/MS	0.5
Microcystin LW	LC/MS/MS	0.5
Microcystin LF	LC/MS/MS	0.5
Nodularin	LC/MS/MS	0.5
Anatoxin-a	LC/MS/MS	0.5
Cylindrospermopsin	LC/MS/MS	0.5
Qualitative total microcystin	Abraxis test strips (PN52022)	1
Total Phosphorus	EPA 365.4	10
Kjeldahl Nitrogen	EPA 351.2	100
Ammonia	EPA 350.1	10
Nitrate+Nitrite	EPA 353.2	10
Ortho-phosphate	EPA 365.1	10
Chlorophyll a	10200H (Standard Methods)	1

2.2.3. Corrective Action

Monitoring staff will maintain close communication with the Project Lead. Adjustments to the sampling schedule, or adjustments to any other aspects of the study, will only be made in consultation with the Project Lead. All field and laboratory personnel are responsible for notifying the Project Lead of circumstances that may necessitate any adjustments. Changes to the project work plan will be reflected through submission of work plan amendments, as necessary.

2.2.4. Chain of Custody

Proper sample handling and custody procedures ensure the custody and integrity of samples from the time of sampling, continuing through transport, sample receipt, preparation and analysis. All chain of custody procedures will be followed for both the State of Michigan Labs.

2.3. Reporting

2.3.1. Data Management

All field notes and data sheets will be maintained in the SWAS raw data file (field notes will only be used in the event that the Survey123 application is not functioning [section 2.2.1]). Electronic copies of scanned field sheets and water chemistry results will be saved to a designated network drive and folder for storage. Results will be shared with Alexandra Rafalski and Susan Peters at DHHS as soon as they are available. After each sampling event, the initial microcystin test strip results will be sent to DHHS, who will then report the results to the appropriate county

health departments (see Appendix B for example of data that will be sent to DHHS after each sampling event). Microcystin results will be uploaded to the Water Quality Exchange website.

2.3.2. Final Report

A final report will be prepared by the Project Lead to communicate the results of this study and raw toxin data to interested parties. Because previous response sampling has occurred as late as November, the report will be completed in 2021.

3. DATA QUALITY OBJECTIVES AND CRITERIA

The primary objective of this project is to investigate the concentration of cyanotoxins in Michigan inland lakes. To achieve this, SWAS biologists will collect algal bloom condition, water quality data, and quantitative toxin data at 10-20 response lakes, 4 TMDL lakes, and possibly several additional lakes for a separate project. The response and TMDL lakes will be sampled to determine if lakes with reports of algal blooms have algal toxin concentrations at levels of concern.

3.1. Data Quality Objectives

A mixture of variables may affect data quality, including staff training, sample collection/handling procedures and equipment, sample analysis techniques, and record keeping. To control these variables, the Data Quality Objective (DQO) process is used. DQOs developed for this project specify discrete parameters in four areas: Observational Precision and Accuracy, Representativeness, Completeness, and Comparability. A brief description of each of these parameters is presented below.

3.1.1. Observational Precision and Accuracy

Precision is the degree of agreement between two or more measurements, while accuracy is a measurement of correctness. For this study, lake and shoreline conditions are assessed through the use of qualitative and semi-quantitative observations (Appendix A). Observational data that are qualitative will be either gathered collaboratively by two staff or be gathered by one and independently confirmed by the second staff person in the field prior to departing from the site. Accuracy is ensured by measuring necessary data with standardized and calibrated field equipment including metric measuring rods, optic range finders, and water chemistry sondes.

Because of the qualitative and semi-quantitative types of data gathered, use of consistent, trained staff and a system of checks and balances in the field are critical to maintaining precision between staff and accuracy for all staff measurements. Categorical assessments or estimations of extent will be agreed upon by two staff after each arrive at their independent assessment, with discrepancies discussed and resolved to create a process by which staff are routinely calibrating their estimations.

Field data quality is addressed, in part, by consistent performance of sample procedures as laid out in this QAPP. Quality is enhanced by the training and experience of project staff and documentation of sampling activities. This QAPP and the Work plan will be distributed to all field sampling personnel who will be required to read and verify they understand the procedures and requirements.

3.1.2. Representativeness

Because the objective of this project is to investigate the concentration of cyanotoxins in Michigan inland lakes, key factors considered in the design of the sampling plan included: (1) encompassing a wide geographic range of lakes with the goal of capturing the range of broad variation in conditions related to cyanobacteria blooms and (2) performing these sampling protocols during specified sample frame that is relevant to questions of nutrient expression (May through late October), and sampling in response to reports of algal blooms to understand not only conditions but the persistence thereof.

3.1.3. Completeness

The Survey 123 application, sonde data, field sheets, photographs, and samples will be reviewed and confirmed prior to departing each sampling site during each sampling event. Additionally, field sheets will be re-reviewed following each sampling event to confirm that all information was filled out completely. If a sample bottle is lost or damaged during shipping, we will use the results generated by the other samples at a lake to draw conclusions about the missing data as appropriate.

3.1.4. Comparability

Comparability is a measure of the confidence with which one data set can be compared with another. Field and laboratory data comparability will be ensured by conducting sample collection and preservation, and laboratory analysis in accordance with this QAPP. Well-established sample locations, clear definition of the assessed locations at each lake, limiting the participating trained field staff, use of the same labs for specified parameters, and following routine processes and order (e.g., first center lake sample collection and then shoreline sample collection) all serve to reduce variability associated with sampling error. The objective is to facilitate observations and conclusions that can be made from comparing the results both over time and over geographic extent.

3.2. Quality Assurance and Quality Control

Field staff will complete all required fields in the Survey123 application. The data will be reviewed by the originator in the field prior to departing each survey site and then reviewed again in the office for completeness prior to being scanned and stored. The final report for this study will be reviewed for accuracy before being submitted the Project Sponsor.

3.3. Special Training

All field personnel conducting inland lake harmful algae bloom monitoring will receive guidance in monitoring procedures relevant to this study and adherence to quality assurance and control involved in these protocols. Staff will conduct sampling with the project lead or with other staff who have conducted sampling with the project lead to ensure consistency in field protocols and be provided copies of the QAPP and field guide cheat sheet (Appendix B).

3.4. Progress and Analysis Quality Control

This QAPP and other supporting materials will be distributed to all personnel involved in the work assignment. All project members will conform to the following guidelines:

All technical assessment activities including data interpretation, calculations, or other related computational activities are subject to audit or peer review. Thus, project members are

instructed to maintain careful written and electronic records for all aspects of the assessment process.

The Project Supervisor will perform surveillance activities throughout the duration of the project to ensure that management and technical aspects are being properly implemented according to the schedule and quality requirements specified in the data review and technical approach documentation. These surveillance activities will include ensuring:

- Project milestones are achieved and documented
- Corrective actions are implemented
- Budgets are followed
- Peer reviews are performed
- Data are properly stored and maintained

3.5. Reports to Management

The Project Lead will provide periodic progress reports to the Project Supervisor. As appropriate, these reports will inform the Project Sponsor of the following:

- Adherence to project schedule
- Deviations from approved QAPP, as determined from project assessment and oversight activities
- The impact of these deviations on analytical tool application quality and uncertainty
- The need for, and results, of response actions to correct the deviations
- Potential uncertainties in decisions based on analytical tool results and data

Appendix A

Harmful Algal Bloom Survey123 application

EGLE HABs Sample Collection Form

Waterbody:

Site ID:

Sampled By:
ENTER LAST NAME ONLY

Parker

Collection Date:

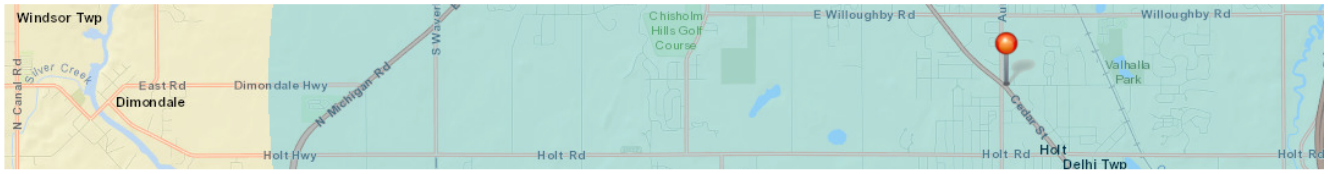
Friday, April 3, 2020

Collection Time:

8:21 AM

Location
CLICK ON MAP AND VERIFY LOCATION OF SURVEY

42.647°N 84.523°W ± 8481 m

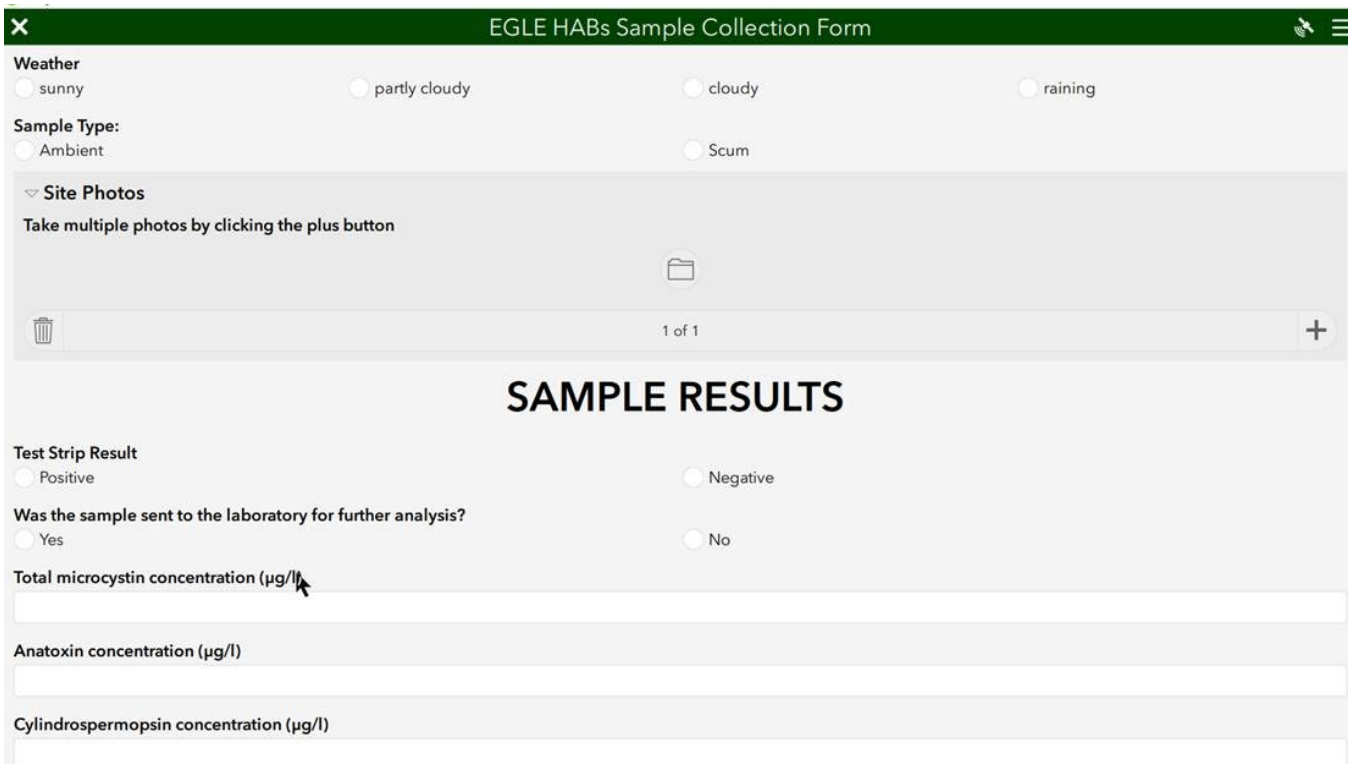


Watershed:

Upper Grand

County:

Ingham


EGLE HABs Sample Collection Form
Weather
sunny
partly cloudy
cloudy
raining
Sample Type:
Ambient
Scum
Site Photos
Take multiple photos by clicking the plus button
1 of 1
SAMPLE RESULTS
Test Strip Result
Positive
Negative
Was the sample sent to the laboratory for further analysis?
Yes
No
Total microcystin concentration (µg/l)
Anatoxin concentration (µg/l)
Cylindrospermopsin concentration (µg/l)

HABS FIELD GUIDE

Sampling Description

One lake center location: • Integrated CA (2X secchi) • Water Chem Nutrients (GA & GN) • Secchi • Sonde measurements (6 depths)	3 shoreline locations: • Secchi • Surface grabs Cyanotoxin • Algal community sample collection (one site) • Sonde measurements (2 depths)

Sample Types

GA: 250ml standard sampling bottle; total phosphorus, total Kjeldahl nitrogen, and nitrate+nitrite; EGLE Lab
GN: 250ml standard sampling bottle, orthophosphate; EGLE Lab
CA: 250 amber CA bottle; Chlorophyll a; EGLE Lab
Algal Toxins: 250 ml PETG bottle (square); Test strip sampled pulled from this bottle. Then bottle to DHHS Lab for: Anatoxin-A , Cylindrospermopsin, Microcystins

Sample Locations

Surface grabs: ~1 foot from surface of water. Can use chlorophyll sampling bottle or submerge bottle past elbow.
Shoreline sampling locations should be distributed approximately evenly around the lake. However, downwind locations, bays which may be used for recreation, areas impacted by river outlets, or beaches will be preferentially targeted.

Equipment List

Field Equipment	Bottles per Lake	Boat Gear	Etc.
YSI	4 250ml PETG bottles	Boat, Motor, Anchor	Bottle Labels
Secchi	1 Chl A bottle	Gas Can	Sharpies, Pencils
Chl Sampling Bottle	3 Standard 250ml bottles	Extras for Dups/Blanks	Gloves
Chem Kit	Extras for Dups/Blanks	Throwables, Life Vests	Cooler, Ice
		Depth finder	Field Sheets/Lake Maps

Field Sheets/Labeling

Label all bottles with Lake Name, Sample Date, Storet, and Station #
Lake outline/bathymetric map to mark shoreline sample locations
HABs field sheet
EGLE Lab Sheet
DHHS Lab Sheet

Sample Storage

Samples should be refrigerated if not analyzed for test strip microcystin and taken to the lab on the day of sampling

Shipping/Sample Delivery

GA, GN, CA samples will be delivered to the DEQ Lab within 48 hours of collection.
Cyanotoxins will be delivered to the DHHS Lab within 48 hours of collection.

Project Contacts

Aaron Parker 517-342-4415 (w)
Gary Kohlhepp 517-284-5540 (w)

Appendix B

Lake	County	Site	Latitude	Longitude	Waterbody type	Month	Day	Year	Recreational use?	Reason for sample	Site visual assessment	Sample type (scum or ambient)	Algal Strip Result (Total MC ug/l)	Chlorphyll a conc (ug/l)	Phycocyanin conc (ug/l)	Total microcystins (lab; ug/l)	Anatoxin (lab; ug/l)	Cylindrospermopsin (lab; ug/l)	Comments
Mona	*Muskegon*	*S1 - Beach*	*43.176218*	*-86.24658*	*Lake*	*7*	*7*	*2017*	*Yes*	*Targeted lake*	*no scum present*	*ambient*	*>10*	*30*	*35*				