Quality Assurance Project Plan
Tributary discrete sampling and shoreline mapping

New York State
Department of Environmental Conservation
Division of Water
Bureau of Water Assessment and Monitoring

June, 2019

A. PROJECT MANAGEMENT

A1. Approval Sheet

____Date _________
AJ Smith – Chief, Stream and Lake Monitoring and Assessment Sections, NYSDEC

____Date _________
Alene Onion – Program Manager, NYSDEC

____Date _________
Guy Foster – Project Manager, USGS

____Date _________
RoseAnn Garry – Quality Assurance Officer, NYSDEC

QAPP Update Log

Prepared/Revised By:	Date:	Revision No:	Summary of Changes:
Guy Foster and Alene Onion	May 1, 2019	0	Original document

This QAPP will be approved by DEC Division of Water, Quality Assurance Officer (QAO) before work will begin on this project.

A2. Table of Contents

Table of Contents

A3. Distribution List

The following individuals must receive a copy of this approved QAPP to complete their role in this project. Copies will be distributed electronically, and all sampling personnel will keep a hard copy for reference.

Name	Title	Organization	Document type
RoseAnn Garry	QA Officer	NYSDEC	electronic
Alexander Smith	Chief, NYSDEC Stream and Lake Monitoring and Assessment Sections	NYSDEC	electronic
Alene Onion	Program Manager, NYSDEC Lake Monitoring and Assessment Section	NYSDEC	electronic
Rebecca Gorney	Assistant Program Manager	NYSDEC	electronic
Guy Foster	Project Manager, P.I.	USGS NY WSC	electronic
Jennifer Graham	Research Hydrologist	USGS NY WSC	electronic
Kaitlyn Colella	Hydrologist	USGS NY WSC	electronic
Shawn Fisher	Water Quality Specialist	USGS NY WSC	electronic
Josh Rosen	Hydrologic Technician	USGS NY WSC	electronic

A4. Organization and Responsibilities

Tributary discrete sampling and shoreline mapping is conducted by the USGS New York Water Science Center (USGS NY WSC), a WSC that falls under the oversight of the USGS Northeast Region.

Roles and Responsibilities

The following people and parties will actively participate in this project and its oversight:

<u>NYSDEC Division of Water Stream and Lake Monitoring and Assessment Sections</u>
Alexander J. Smith, Chief, Stream and Lake Monitoring and Assessment Sections, Albany, NY, Alexander.Smith@dec.ny.gov
Responsibilities

1. Oversee program administration
    a. Provide oversight of NYSDEC-USGS workplan
    b. Supervise the Program Manager

Alene M. Onion, Program Manager, Albany, NY alene.onion@dec.ny.gov
Responsibilities

1. Coordination of interactions with the USGS
2. Draft QAPP in collaboration with USGS

Rebecca M. Gorney, Assistant Program Manager, Albany, NY, Rebecca.Gorney@dec.ny.gov
Responsibilities

1. Assist Program Manager with QAPP drafts and maintenance
2. Assist Program Manager with USGS interactions

NYSDEC Division of Water Standards and Analytical Support Section
RoseAnn Garry, Quality Assurance Officer, NYSDEC, Albany, NY, oversees Division of Water Quality Assurance activities and is not subject to the authority of any persons in the Stream Monitoring and Assessment Section at NYSDEC or the USGS. (518) 4028156. roseann.garry@dec.ny.gov
Responsibilities

1. Assist in the oversight of the Division of Water Quality Assurance activities
2. Review the QA project plan to verify that those elements outlined in the *EPA Requirements for QA Project Plans (QA/R-5)* are successfully discussed.
4. Review and approve this QAPP

USGS New York Water Science Center
Guy Foster, USGS Project Manager & Principal Investigator, Troy, NY, gfoster@usgs.gov
Responsibilities

1. Oversight and management of both the in-lake continuous monitoring and discrete sampling project and the tributary discrete sampling and shoreline mapping projects.
2. Communication with NYS DEC Program Manager.
3. Planning and execution of project objectives.
4. Data analysis, interpretation, and writing for USGS projects.

Kaitlyn Colella, USGS Hydrologist, Troy, NY, kcolella@usgs.gov
Responsibilities

1. Data collection, analysis, and interpretation for both the in-lake continuous monitoring and discrete sampling project and the tributary discrete sampling and shoreline mapping project.
2. Assist USGS Project Manager.
3. Project logistics.
4. Data QA/QC for USGS projects.

Jennifer Graham, USGS Research Hydrologist, Troy, NY, jlgraham@usgs.gov
Responsibilities

1. Study design.
2. Data analysis, interpretation, and writing for USGS projects.

Shawn Fisher, USGS Water Quality Specialist, Coram, NY, scfisher@usgs.gov
Responsibilities

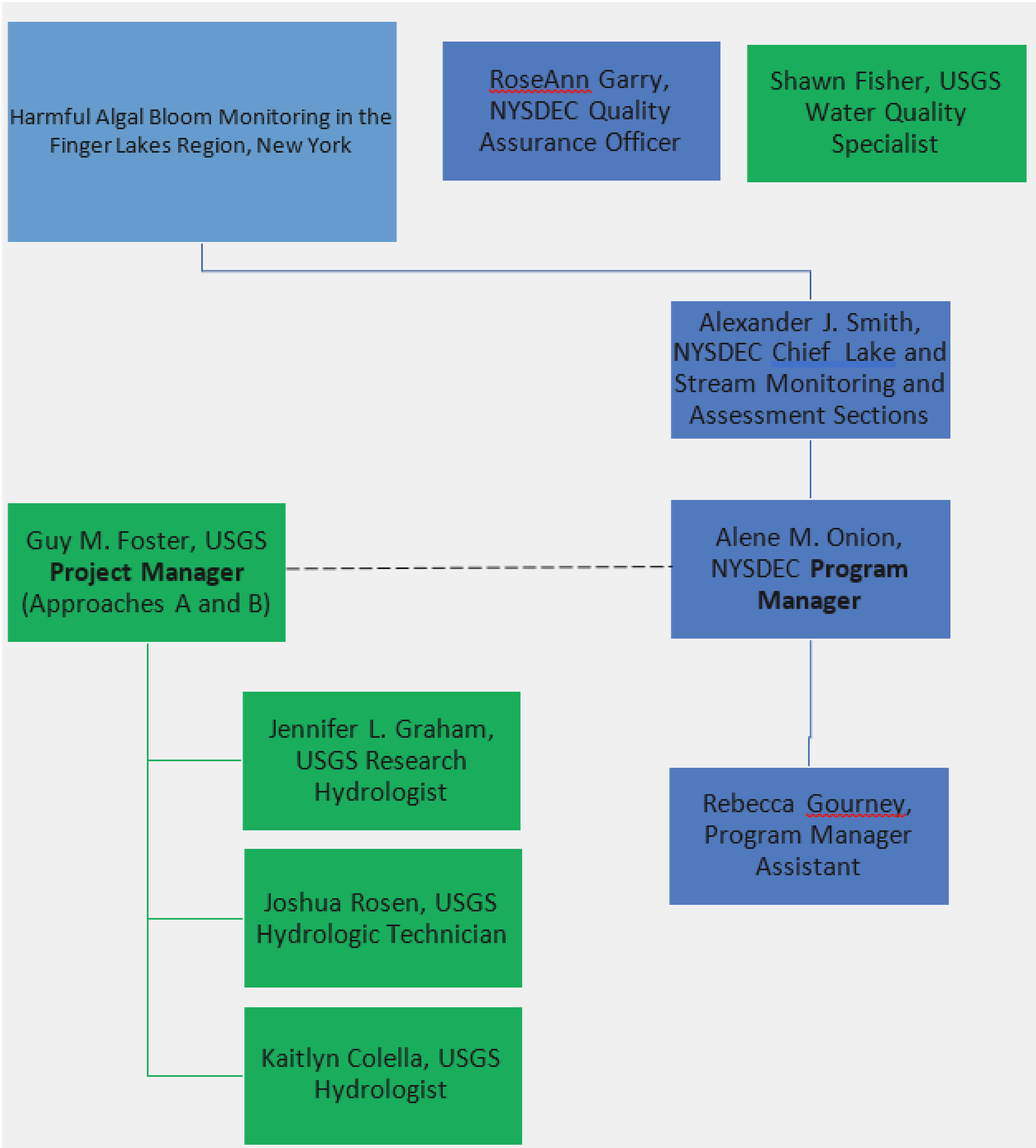
1. Study design and review.
2. Ensures data are collected and analyzed in accordance with published USGS methods and protocols, and data meet USGS data quality objectives.
3. Ensures that non-USGS laboratories and data furnished by other agencies meet USGS data quality criteria.

Joshua Rosen, USGS Hydrologic Technician, Ithaca, NY, jrosen@usgs.gov
Responsibilities

1. Data collection and logistics at the USGS Ithaca Field Office.
2. Assist USGS Project Manager.

USGS Field Staff – as available to assist with field work and data collection under the guidance and direction of the USGS staff listed above.

Figure 1: Organization Chart



A5. Introduction

This document has been prepared to meet the necessary Quality Assurance/Quality Control (QA/QC) requirements for the: "Tributary Discrete Sampling and Shoreline Mapping" project, which is a component of the Harmful Algal Bloom Advanced Monitoring in the Finger Lakes Region study of the New York State Department of Environmental Conservation Division of Water (NYSDEC DOW). All components of this project are covered under the Harmful Algal Bloom Advanced Monitoring in the Finger Lakes Region Management Plan (NYSDEC, 2019). While the Management Plan covers goals, objectives, and procedures common to all component projects, this Quality Assurance Project Plan (QAPP) documents project goals and objectives, standard operating procedures, data review and evaluation procedures, and quality control methods specifically for implementation of this project.

A6. Problem Definition/ Background

The NYSDEC and NYSDOH conduct extensive surveillance, reporting, and documentation of shoreline and open-water cyanobacterial harmful algal blooms (CyanoHABs) to safeguard public health and monitor ecological conditions. Reliable early warning indicators may allow proactive, rather than reactive, management approaches to ensure public health protection during CyanoHAB events. Recent advances in real-time water-quality monitoring technologies will greatly enhance our understanding of CyanoHAB dynamics, which in turn, could improve the ability to provide an early warning for occurrences in New York waterways. The USGS has developed protocols and standardized methods for the use of advanced real-time water-quality instrumentation throughout the United States (Wagner and others, 2006; Pellerin and others, 2013; USGS, variously dated). In particular, CyanoHABs monitoring and model development has been successfully implemented by USGS researchers in Ohio, including the Great Lakes (Francy and others, 2016;), and Kansas (Foster and Graham, 2016; Foster and others 2017; Graham and others 2017; and Foster and others, 2019; and;).

In cooperation with the NYSDEC, the USGS will apply these approaches, as well as novel approaches utilizing recent advances in continuous water quality sensors, in New York to establish an advanced water-quality monitoring program in three of the Finger Lakes recently affected by CyanoHABs: Owasco Lake, Seneca Lake, and Skaneateles Lake. These three lakes encompass the range of trophic and CyanoHAB conditions typically experienced in New York lakes, and knowledge gained from this effort will enhance the scientific understanding of the environmental factors associated with CyanoHAB occurrence and serve to inform the development of an advanced monitoring strategy for the State and Nation. The trophic states at the three sites range from mesotrophic (moderate nutrients) to oligotrophic (low nutrients).

Owasco Lake is a mesotrophic lake that has been affected by several CyanoHABs beginning in 2005, mainly occurring later in the season with some having persisted into early fall. Of those characterized, the population of cyanobacteria in these blooms has been found to be close to 70% of the total biomass present in the lake with either *Microcystis* or *Dolichospermum* genera being dominant (Owasco Management Plan, 2015). Several samples tested positive for the cyanotoxin, microcystin, exceeding the "high toxin" criteria.

Seneca Lake is an oligotrophic to mesotrophic lake that experiences elevated phytoplankton biomass in the spring and fall associated with the beginning and ending of summer (Finger Lakes Institute and others, 2012). Seneca Lake has had recorded cyanobacterial HABs in 2015 and 2016, and elevated cyanotoxins were reported in 2016 (Mantius, 2017).

Skaneateles Lake is an oligotrophic lake that has been ranked as the second cleanest lake in the United States when based on dissolved nitrogen and serves as the source of drinking water for Syracuse, NY and several other small towns and cities in the area. In 2017, the lake experienced a large HAB event that produced low levels of microcystin toxin that were detected in several of the Syracuse drinking-water intakes. Concentrations of microcystin in Skaneateles Lake never exceeded 1 part per billion (ppb). However, because the city of Syracuse is not required to filter water pulled from the lake, there was a large amount of public concern (Upstate Freshwater Institute, 2018).

A two-year, multifaceted approach to monitor the occurrence of and contributing factors to CyanoHABs has been developed. Coordination between the USGS, NYSDEC, NYSDOH, and local partners in the region will be key to the success of this effort. The study has been divided into four major components (Figure 2): in-lake continuous monitoring and discrete sampling (Approach A), tributary discrete sampling and shoreline mapping (Approach B), intensive water-quality sampling of tributaries upstream of the lakes (Approach C), and intensive lake characterization (Approach D). The purpose of this QAPP is to describe the sampling methods and analysis under approach B: Tributary discrete sampling and shoreline mapping.

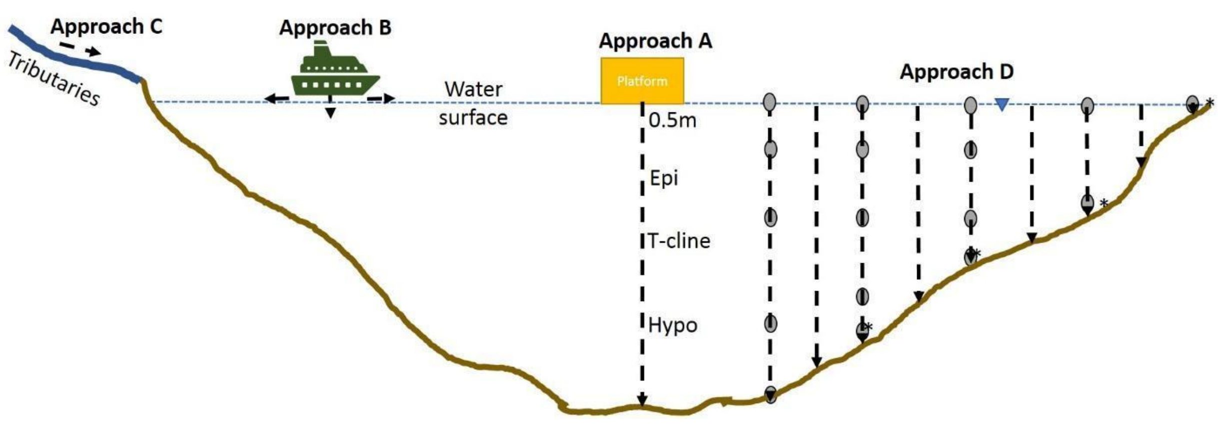


Figure 2: Schematic explaining the four major components of the Harmful Algal Bloom Advanced Monitoring in the Finger Lakes Region study.

A7. Description of Strategy

- This project will collect discrete and continuous water-quality data on Owasco and Seneca Lakes during summer of 2019:
    - Discrete samples will be collected just below the surface for nutrient (inorganic forms of nitrogen and total nitrogen; total phosphorus and orthophosphate), chlorophyll-*a*, phycocyanin and dissolved and total organic carbon analyses. A secchi depth will be collected as well.
- Continuous water-quality data will be collected using conducted using multiparameter sondes capable of continuously measuring temperature, specific conductance, pH, turbidity, dissolved oxygen and dissolved oxygen percent saturation, chlorophyll fluorescence, phycocyanin fluorescence, fluorescent dissolved organic matter, and nitrate (nitrate dependent on instrument availability).
- Data will will be collected on two occasions— one early season (June – July) and one late season (September – October)—between June and October. Near-surface (~0.5 to 1.0 meters) grab samples will be collected at about 12 locations along the lakeshore.. Lake surface sample locations will be chosen to provide coverage of the entire lake, generally following a longitudinal transect from inlet to outlet. Near-shore locations will be located near major tributary outlets, and were chosen in coordination with DEC.
- The USGS will coordinate the timing of this sampling with the NYSDEC, who will run concurrent sampling under Approaches C and D described in the QAMP (NYSDEC 2019).

A8. Quality Objectives and Criteria

For all USGS projects, all data collection methods will follow published USGS protocols and data quality criteria contained within the following citations and summarized in Table 1:

Graham, J.L., Loftin, K.A., Ziegler, A.C., and Meyer, M.T., 2008, Cyanobacteria in lakes and reservoirs—Toxin and taste-and-odor sampling guidelines (ver. 1.0): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A7, section 7.5, September, accessed May 14, 2019, at http://pubs.water.usgs.gov/twri9A/.

Hambrook Berkman, J.A., and Canova, M.G., 2007, Algal biomass indicators (ver. 1.0): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A7, section 7.4, accessed October 21, 2016, at https://pubs.water.usgs.gov/twri9A/.

Pellerin, B.A., Bergamaschi, B.A., Downing, B.D., Saraceno, J.F., Garrett, J.A., and Olsen, L.D., 2013, Optical techniques for the determination of nitrate in environmental waters: Guidelines for instrument selection, operation, deployment, maintenance, quality assurance, and data reporting: U.S. Geological Survey Techniques and Methods 1–D5, 37 p.

Stelzer E.A., Loftin K.A., Struffolino P., 2013, Relations between DNA- and RNA-based molecular methods for cyanobacteria and microcystin concentration at Maumee Bay State Park Lakeside

Beach, Oregon, Ohio, 2012: U.S. Geological Survey Scientific Investigations Report 2013-5189, 9 p., http://dx.doi.org/10.3133/sir20135189

U.S. Geological Survey, variously dated, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1–A10, accessed October 20, 2016, at https://water.usgs.gov/owq/FieldManual/.

Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods, book 1, chap. D3, 51 p. plus 8 attachments, accessed April 10, 2006, at https://pubs.water.usgs.gov/tm1d3.

Wilde, F.D., Sandstrom, M.W., and Skrobialowski, S.C., 2014, Selection of equipment for water sampling (ver. 3.1): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A2, accessed December 13, 2017, at https://pubs.water.usgs.gov/twri9A2/.

Comparability

Comparability is defined as "the confidence with which one data set can be compared to another" (Stanley & Verner, 1985). Confidence in the comparability data for this project is based on the commitment of project staff to use only approved sampling and analysis methods and QA/QC protocols in accordance with quality system requirements and as described in this QAPP. The following will also ensure data comparability of sampling and laboratory procedures in this project:
Under this study only two USGS laboratories are being used for chemical and biological analysis of samples. The use of the USGS laboratories will allow the comparison of data from other studies across the State and Nation.

A contract laboratory to the USGS will be used for phycocyanin analyses. Required performance criteria for these analyses will meet the standards described in Table 1 and laboratories will be required to meet other USGS data quality specifications and criteria.

Guidance for sampling is presented in the United States Geologic Survey manuals listed above. These manuals will be used to assure that the samples collected are in accordance with the guidance and project goals.

Data Quality

Analytical procedures, for the analysis of chemical parameters in various sampling media, have been selected to give the lowest detection limits available with current standard published methods. Available method detection and reporting limits are outlined in Table 1.

If the reporting limits can't be met, the data result will be reported as is and qualified.

Dissolved Organic Matter, Chlorophyll, and Phycocyanin Fluorescence Sensors

There is currently no specific USGS guidance for dissolved organic matter, chlorophyll, and phycocyanin fluorescence sensors. Therefore, for the purposes of this project, the guidance values established by Wagner and others, 2006 for turbidity will be used for chlorophyll and phycocyanin fluorescence data quality and data rating standards. Experience with the chlorophyll and phycocyanin fluorescence sensors has shown this standard to be a reasonable guideline. USGS guidance is currently in review (Foster and others, 2019 *in review*), and this QAPP will be updated appropriately upon publication.

Quality Control Sampling (Accuracy and Precision)

In order to monitor the integrity of this sampling effort, this project employs the use of USGS protocols for QC sampling of water quality data. QC samples will include replicates, laboratory and field blanks and source solution blanks (DOC analysis).

It's important to note that the term replicate here is used equivalent to the QC samples NYSDEC Lakes and Streams Sections collected called field duplicate samples.

The type and frequency of QC samples collected, which represents about 10% of all samples, is dependent on sampling method, parameters for analysis, and field conditions at the time of sampling (see Table 5). During the course of the field season, at least one sequential replicate sample will be collected from each depth at each lake; analysis for all analytes will be replicated and replicates will be collected throughout the course of the field season (approximately one replicate sample per field visit). Laboratory and field blanks will be collected at the beginning and end of the sample season. Laboratory blanks will be used to evaluate equipment cleaning procedures and field blanks will be used to evaluate potential sources of contamination during sample processing. All laboratory blanks will include a source solution blank sample. Inorganic and organic blank samples will be collected, with an emphasis on nutrient, carbon, cyanotoxin, and genetic analyses. Sample collection personnel have gone through proper training on the collection and frequency of these samples. A detailed description of QC sampling is contained in USGS TWRI, book 9 (specific chapters include 4.3 and 5, which also contain references to other sections and technical publications). Further discussion of the USGS Quality management system can be found in the USGS document QMS_1.1.pdf (http://wwwnwql.cr.usgs.gov/USGS/QMS_1.1.pdf). QC samples will be held to the same limits as for environmental samples as indicated in Table 1.

Representativeness

Sampling in this project is meant to characterize tributary inputs and bloom forming locations in the waterbody. These are not meant to be representative of the entire waterbody and only represent the specific sampling locations. Evaluation of QC replicate samples are conducted to see if they are within the set limits given in Table 1.

Completeness

Completeness is a measure of the number of samples to be collected and analyzed compared to the number of samples actually collected and analyzed, expressed as a percentage. For this project, it is expected that a 100% sampling rate will be achieved unless unforeseen problems occur. The study design minimum is 80% of the samples collected per month and to record observations from at least one HAB event.

[NWIS, National Water Information System; n/a, not applicable; NWQL, USGS National Water Quality Laboratory; SC, USGS NWQL Laboratory Schedule]

Parameter	Units	Instrument	NWIS Parameter Code	Method	Accuracy	Range	Resolution	Laboratory Reporting Level	Limit of Quantitation	Recovery at LOQ (%)	Precision[1]	Bias[2]	Laboratory
Continuous Water-Quality Data:													
Temperature	°C	Xylem YSI EXO	00010	THM01	± 0.2	-5 to 50	± 0.001	n/a	n/a	n/a	n/a	n/a	Field
Dissolved Oxygen	mg/L	Xylem YSI EXO	00300	LUMIN	± 0.1	0 to 50	± 0.01	n/a	n/a	n/a	n/a	n/a	Field
pH	standard units	Xylem YSI EXO	00400	PROBE	± 0.1	0 to 14	± 0.01	n/a	n/a	n/a	n/a	n/a	Field
Specific Conductance	µS/cm	Xylem YSI EXO	00095	SC001	± 1 %	0 to 100000	± 0.00001	n/a	n/a	n/a	n/a	n/a	Field
Turbidity	FNU	Xylem YSI EXO	63680	TS213	± 0.3	0 to 4000	± 0.01	n/a	n/a	n/a	n/a	n/a	Field
Chlorophyll Fluorescence	RFU	Xylem YSI EXO	32320	n/a	n/a	0 to 100	± 0.01	n/a	n/a	n/a	n/a	n/a	Field
Chlorophyll Fluorescence	µg/L	Xylem YSI EXO	32318	n/a	n/a	0 to 400	± 0.01	n/a	n/a	n/a	n/a	n/a	Field

Phycocyanin Fluorescence	RFU	Xylem YSI EXO	32321	n/a	n/a	0 to 100	± 0.01	n/a	n/a	n/a	n/a	n/a	Field
Phycocyanin Fluorescence	µg/L	Xylem YSI EXO	32319	n/a	n/a	0 to 100	± 0.01	n/a	n/a	n/a	n/a	n/a	Field
Dissolved Organic Matter Fluorescence	RFU	Xylem YSI EXO	32322	n/a	n/a	0 to 100	± 0.01	n/a	n/a	n/a	n/a	n/a	Field
Dissolved Organic Matter Fluorescence	µg/L QSE	Xylem YSI EXO	32295	n/a	n/a	0 to 300	± 0.01	0.07	n/a	n/a	n/a	n/a	Field
Nitrate	mg/L	s::can nitro::lyser	99133	n/a	± 2%	0.00 to 100	± 0.005	0.005	n/a	n/a	n/a	n/a	Field
Discrete Water-Quality Data:													
Total organic carbon	mg/L	n/a	00680	SM 5310B	n/a	n/a	n/a	0.7	0.7	70-130	20	70-130	NWQL SC 2833
Dissolved organic carbon	mg/L	n/a	00681	O-1122092	n/a	n/a	n/a	0.23	0.23	70-130	20	70-130	NWQL SC 2833
Chlorophyll *a*	µg/L		70953	EPA 445.0	n/a	n/a	n/a	0.1	0.1	70-130	20	70-130	NWQL SC 2833
Ammonia	mg/L	n/a	00680	I-2525-89 and I2522-90	na	n/a	n/a	0.01	0.01	70-130	20	70-130	NWQL SC 2833
Total Kjeldahl Nitrogen	mg/L	n/a	00625	I-4515-91	n/a	n/a	n/a	0.07	0.07	70-130	20	70-130	NWQL SC 2833
Dissolved Kjeldahl Nitrogen	mg/L	n/a	00623	I-2515-91	n/a	n/a	n/a	0.07	0.07	70-130	20	70-130	NWQL SC 2833

Nitrite	mg/L	n/a	00613	I-2540-90 and I-2542-89	n/a	n/a	n/a	0.001	0.001	70-130	20	70-130	NWQL SC 2833
Nitrate plus nitrite	mg/L	n/a	00631	I-2547-11	n/a	n/a	n/a	0.04	0.04	70-130	20	70-130	NWQL SC 2833
Total phosphorus	mg/L	n/a	00665	EPA 365.1	n/a	n/a	n/a	0.004	0.004	70-130	20	70-130	NWQL SC 2833
Dissolved phosphorus	mg/L	n/a	00666	EPA 365.1	n/a	n/a	n/a	0.003	0.003	70-130	20	70-130	NWQL SC 2833
Orthophosphorus	mg/L	n/a	00671	I-2601-90 and I2606-89	n/a	n/a	n/a	0.004	0.004	70-130	20	70-130	NWQL SC 2833
Phycocyanin	µg/L	n/a	52905	Fluorometry	n/a	n/a	n/a	0.3	0.3	n/a	20	n/a	Contract
[1]Precision is defined as the relative percentage difference between laboratory control samples and laboratory control sample duplicates													
[2]Bias is defined as the percentage recovery of laboratory control samples													
[3]Best available p-codes; correct p-codes will be requested													
[4]Sum of green/brown, mixed, and cyanobacteria µg/L													
[5]At 0 to 30 C; ±0.75 mmHg at -52 to 60 C													
[6]±5% at relative humidities between 90 and 100 percent													

A9. Training

USGS personnel are responsible for conducting sampling. USGS personnel have received training in the sample collection and processing procedures required by this study. Additional training, which may be needed for aspects of the study, e.g. global positioning system determinations, is conducted by the USGS as needed and appropriate. Training and documentation are the responsibility of the USGS project manager.

A10. Documentation and Records

Data generated by USGS laboratories are reported back to the New York Water Science Center via the National Water Information System (NWIS). Data generated by contract laboratories to the USGS will be returned electronically and entered into NWIS manually. Further discussion on data storage and management is given under the Data Management section of this document.

B. Data Generation and Acquisition

B1. Rationale of Monitoring Design

Selection of Sites to be Sampled

The survey design began with a review of the available information from NYSDEC and USGS data sets including NYSDEC stream and lake water quality data, NYSDEC HAB monitoring data, as well as preliminary data collected by USGS in 2018. Local officials, health departments, and planning agencies were contacted to gain information, and to ensure collaborative aspects of the study are met. A log of contacts will be maintained by USGS and NYSDEC of those contacts made but will not be published in final data reports due to the sensitively of protecting water supplies.

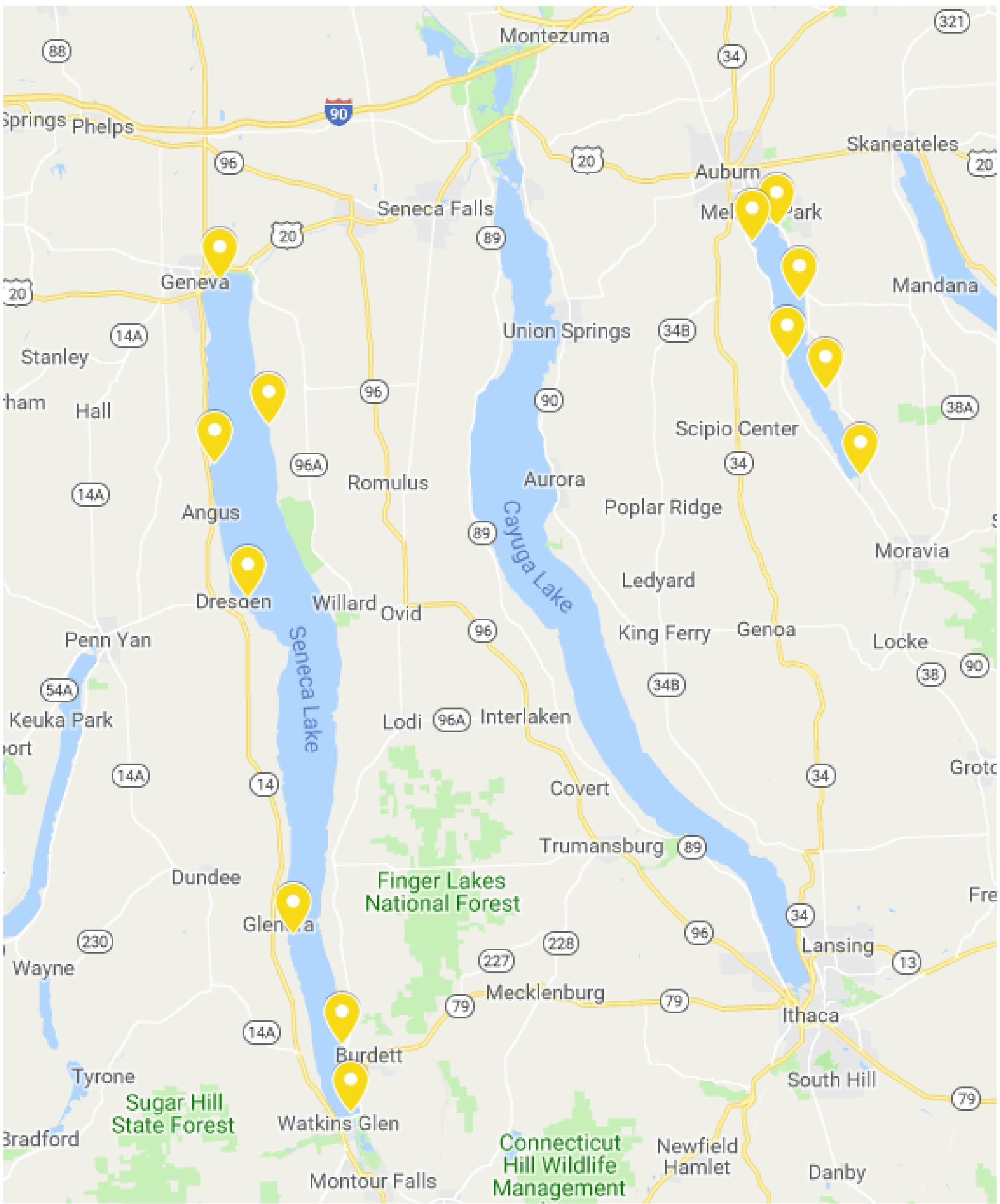
Near-shore locations are selected to capture the major tributary inputs, historic cyanoHABs and conditions observed during sampling. Roughly 50% of the locations are selected to capture the major tributary inputs (see table 2 and figure 3 below). The remainder are selected by field staff based on visual and probe measurements observed in the field and informed by the historic cyanoHAB locations.

Table 3: In Lake Discrete Sampling Locations

Lake	Site	Location	Justification	North	West
Owasco	1	Owasco Inlet	Off-Trib Mouth	42.75624	-76.4641
Owasco	2	Dutch Hollow Brook	Off-Trib Mouth	42.858	-76.512
Owasco	3	Sucker Brook	Off-Trib Mouth	42.9	-76.529
Owasco	4	Veness Brook	Off-Trib Mouth	42.891	-76.548
Owasco	5	Unnamed trib at Firelane 26	Off-Trib Mouth	42.824	-76.521
Owasco	6	Unnamed trib at Cornell Site 12	Off-Trib Mouth	42.805	-76.491
Seneca	1	Keuka Outlet C	Off-Trib Mouth	42.685	-76.946
Seneca	2	Catharine Creek	Off-Trib Mouth	42.387	-76.865
Seneca	3	Big Stream	Off-Trib Mouth	42.49	-76.91
Seneca	4	Kashong Creek	Off-Trib Mouth	42.763	-76.971

Seneca	5	Tug Hollow (Glen Eldridge)	Off-Trib Mouth	42.426	-76.871
Seneca	6	Reeder Creek	Habs hot spot	42.785	-76.929
Seneca	7	Castle Creek	Off-Trib Mouth / high septic density	42.869	-76.968

Figure 3: In Lake Discrete Sampling Locations



Selection of Monitoring Parameters

Continuously Monitored Parameters
The continuously monitored parameters collected via boat-based mapping are a combination of metrics to characterize water quality conditions in lakes that may be driving cyanoHABs:

- Multiparameter sondes and nitrate analyzers will be used to conduct boat-based near shore mapping and will include sensors for temperature, specific conductance, dissolved oxygen, pH, fluorescent dissolved organic matter, turbidity, and chlorophyll and phycocyanin fluorescence.

Discretely Monitored Parameters
The discretely monitored parameters were selected to correlate continuously monitored water-quality parameters with laboratory data to develop surrogates for more informed monitoring. Grab samples will be collected just below the surface, processed and immediately placed on ice, and shipped to NWQL. Samples will be analyzed for the following physiochemical parameters:

- Nutrient concentrations
- Dissolved and total organic carbon concentrations
- Chlorophyll a and phycocyanin pigment concentrations
- Secchi Depth

B2. Sample Collection, Handling, Custody and Shipping Procedures

Discrete samples taken at one-meter depth (lake-surface) will be collected via peristaltic pump through cleaned and rinsed Teflon tubing, directly into sample bottles. For surface grabs (near-shore tributary sampling), sample bottles will also be filled by pumping directly into the sample bottle. Filtered samples will run directly through .45 µm inline filters that have been pre-rinsed with 2 liters of deionized water (a new filter will be used at each sample location). All sampling personnel will wear a clean pair of powder-free latex gloves for each sample.

Chlorophyll and phycocyanin samples will be processed onsite, collected on glass fiber filters. Records of volume filtered for on sample label and on ASR (in comments to NWQL), filter will be wrapped in aluminum foil, then place in petri dish, and kept dark.

Continuous water-quality monitors will be hard-mounted on the side of the boat using aluminum speed-rail brackets. The water-quality monitors (both multiparameter and nitrate) will be mounted horizontally approximately 0.5 meters below the water surface. Data will be logged internally, and time synchronized with onboard GPS. Data collection interval will be every 30 seconds.

All data collection methods will follow published USGS protocols and data quality criteria contained within the following:

Hambrook Berkman, J.A., and Canova, M.G., 2007, Algal biomass indicators (ver. 1.0): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A7, section 7.4, accessed October 21, 2016, at https://pubs.water.usgs.gov/twri9A/.

U.S. Geological Survey, variously dated, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1–A10, accessed October 20, 2016, at https://water.usgs.gov/owq/FieldManual/.

Wilde, F.D., Sandstrom, M.W., and Skrobialowski, S.C., 2014, Selection of equipment for water sampling (ver. 3.1): U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chap. A2, accessed December 13, 2017, at https://pubs.water.usgs.gov/twri9A2/.

The USGS National Field Manual for the Collection of Water Quality Data (https://water.usgs.gov/owq/FieldManual/) provides guidelines and standard procedures for properly collecting, processing, and shipping a water sample for each analysis identified in this study. Sampler blanks and and spiked blanks will be collected at the beginning and end of the field season specifically to ensure use of a PVC sampler did not negatively affect organic analytes. Sample will be processed using the appropriate sample bottles and filters (Table 3), and which will then immediately be placed on ice. Samples will be shipped on ice to the following laboratories: USGS National Water Quality Laboratory (NWQL) in Denver, Colorado, for nutrients, chlorophyll *a*, and total and dissolved organic carbon (Table 4). A total of six-quality control samples per lake will be collected per year, including replicate samples, field blanks, and equipment blanks.

Sample results will be reviewed, quality assured, approved and entered into publicly available USGS databases (https://waterdata.usgs.gov/nwis; https://www.sciencebase.gov/catalog/).

Table 3: Sample bottle, preservatives, and filters for each analyte

Analyte*	**Laboratory**	**Laboratory Schedule**	**Laboratory Code**	**NWIS Parameter Code**	**Bottle Type**	**Filter**	**Rinse**	**Preservative**	**Store**	**Container ID**
TOC	NWQL	2833	3211	00680	125 mL based amber glass bottle (Q28FLD)	No	No	No	Chill	TOC
DOC	NWQL	2833	2629	00681	125 mL based amber glass bottle (Q28FLD)	Pall 0.45 um capsule filter (Q398FLD)	Filter with IBW	1 mL 4.5N H2SO4 (Q438FLD)	Chill	DOC
Ammonia	NWQL	2833	3116	00608	125 mL brown polyethylene (Q760FLD)	Pall 0.45 um capsule filter (Q398FLD)	Filter with IBW; bottle with filtered	No	Chill	FCC
DKN	NWQL	2833	1985	00623	125 mL brown polyethylene (Q760FLD)	Pall 0.45 um capsule filter (Q398FLD)	Filter with IBW; bottle with filtered	No	Chill	FCC
NO2	NWQL	2833	3117	00613	125 mL brown polyethylene (Q760FLD)	Pall 0.45 um capsule filter (Q398FLD)	Filter with IBW; bottle with filtered	No	Chill	FCC
NO3+NO2	NWQL	2833	3156	00631	125 mL brown polyethylene (Q760FLD)	Pall 0.45 um capsule filter (Q398FLD)	Filter with IBW; bottle with filtered	No	Chill	FCC
DP	NWQL	2833	2331	00666	125 mL brown polyethylene (Q760FLD)	Pall 0.45 um capsule filter (Q398FLD)	Filter with IBW; bottle with filtered	No	Chill	FCC
PO4	NWQL	2833	3118	00671	125 mL brown polyethylene (Q760FLD)	Pall 0.45 um capsule filter (Q398FLD)	Filter with IBW; bottle	No	Chill	FCC

							with filtered			
TKN	NWQL	2833	1986	00625	125 mL clear polyethylene Q407FLD/Q417FLD)	No	Yes, raw sample	1 mL 4.5N H2SO4 (Q438FLD)	Chill	WCA
TP	NWQL	2833	2333	00665	125 mL clear polyethylene Q407FLD/Q417FLD)	No	Yes, raw sample	1 mL 4.5N H2SO4 (Q438FLD)	Chill	WCA
Chlorophyll	NWQL	2833	3152	70953	1 L amber polyethylene (Fisher 02-925-3E)	Glass fiber filter; wrap in foil; place in petri dish (Q5BACT) x 2	No	No	Freeze/Dark	CHL
Pheophytin	NWQL	2833	3152	62360	1 L amber polyethylene (Fisher 02-925-3E)	Glass fiber filter; wrap in foil; place in petri dish (Q5BACT) x 2	No	No	Freeze/Dark	CHL
Phycocyanin	Contract	n/a	n/a	52905	1 L amber polyethylene (Fisher 02-925-3E)	Glass fiber filter; wrap in foil; place in petri dish (Q5BACT) x 2	No	No	Freeze/Dark	CHL
*Analytes highlighted in the same color (light gray or white) are all analyzed from the same sample bottle.										

Table 4: Contact and shipping information for each laboratory providing analyses

Laboratory	Contact	E-mail	Phone	Shipping Address	Shipping Instructions*
National Water Quality Laboratory		labhelp@usgs.gov	303-236-3707 866-275-6975	National Water Quality Laboratory U.S. Geological Survey Bldg 95, Entrance E3 Denver Federal Center Denver, CO 80225	Ship in cooler with ice. Double line cooler with two bags. Place samples and ice in inner bag. Remove excess air and tie inner bag shut. Tie outer bag shut. Samples for chlorophyll and pheophytin analysis are shipped separately on dry ice.
Ohio Microbiology Lab	Erin Stelzer	GS-W-OHCLB_OWML@usgs.gov	614-430-7730	ATTN: OWML U.S. Geological Survey 6460 Busch Blvd, Suite 100 Columbus, OH 43229	Ship in cooler with ice. Double line cooler with two bags. Place samples and ice in inner bag. Remove excess air and tie inner bag shut. Tie outer bag shut. **Email the lab when samples are shipped to let them know they are on the way**.
PhycoTech	Kam Truhn	info@phycotech.com	1-269-983-3654	PhycoTech, Inc. 620 Broad Street, Suite 100 St. Joseph, MI 49085	Ship in cooler with ice. Double line cooler with two bags. Place samples and ice in inner bag. Remove excess air and tie inner bag shut. Tie outer bag shut. **Fill out the analysis request form and upload to the PhycoTech dropbox (https://www.phycotech.com/Resources/Analysis-Request-Form) or send via email to info@phycotech.com to let them know samples are on the way.**
*ship all samples with their associated analytical service request (ASR) forms enclosed in a sealed zip-locked bag, along with return shipping label.					

Table 5: Quality Control Samples Collected by this Project

Parameter	QC Sample Type	When QC Sample is Collected	Where QC sample is collected	Water to be used for Blank Samples
Inorganics: Nutrients	Field Blank and Laboratory Blank (including a source solution blank)	Beginning and End of the Field Season	From each sampling depth	Inorganic blank water
Organics: Total and Dissolved Organic Carbon	Field Blank and Laboratory Blank	Beginning and End of the Field Season	From each sampling depth	Nitrogen-purged, volatile organic carbon pesticide grade water

	(including a source solution blank)			
Biological: chlorophyll, phycocyanin, cyanotoxin synthetase gene, and microcystin analyses	Field Blank and Laboratory Blank (including a source solution blank)	Beginning and End of the Field Season	From each sampling depth	Deionized water
Phytoplankton	Field Blank and Laboratory Blank (including a source solution blank)	Not collected		
Inorganics: Nutrients	Replicate Samples	Once per field visit	From each sampling depth	
Organics: Total and Dissolved Organic Carbon	Replicate Samples	Once per field visit	From each sampling depth	
Biological: chlorophyll, phycocyanin, cyanotoxin synthetase gene, and microcystin analyses	Replicate Samples	Once per field visit	From each sampling depth	
Phytoplankton	Replicate Samples	Once per field visit	From each sampling depth	

B3. Analytical Methods

Analytical methods for both field and laboratory analyses are listed in Table 1. Samples will be analyzed at the USGS National Water Quality Laboratory (NWQL) in Denver, Colorado, for nutrients, chlorophyll *a*, and total and dissolved organic carbon.

Interim data will be provided quarterly to The Project Manager for review. All final analytical results including QC results will be provided to The Program Manager and Project Manager upon completion of the project by March 31, 2020.

B4. Quality Control

Sequential field replicate samples will be collected throughout the field season; at least one sequential replicate sample will be collected from each depth at each lake. Sequential field replicates will be analyzed for the full suite of analytes measured in routinely collected samples (see Tables 1 and 2). Inorganic and organic laboratory and field blanks will be collected at the beginning and end of the field season. Inorganic blank water will be used for inorganic blanks (USGS central supply item number Q378FLD); inorganic blank water will be used for nutrient analyses. Nitrogen-purged, volatile organic carbon pesticide grade water will be used for organic blanks (USGS central supply item number N1580); organic blank water will be used for total and dissolved organic carbon analyses. Collection of all QC samples will follow the guidance detailed in USGS TRWI Book 9.

For more information regarding Quality control sampling, see Data Validation and Data Quality sections of this document.

B5. Instrument/Equipment Testing, Inspection and Maintenance

Instrument preparation for sampling is described in section B2. When not in use, instruments are kept at USGS offices in enclosed, climate controlled locations. Instruments are maintained as per manufacturers guidelines: https://www.ysi.com/File%20Library/Documents/Manuals/EXO-User-Manual-Web.pdf; https://www.s-can.at/products/spectrometer-probes?categorylayout=0&showcategory=1&showproducts=1&productsublayout=0&scrollto=product-140
Upon receipt of a new instrument, USGS staff inspect and perform basic function and calibration testing. Instruments that do not meet manufacturers specifications are returned.

Instrumentation is calibrated, maintained, and operated in accordance with the following USGS published methods:

Pellerin, B.A., Bergamaschi, B.A., Downing, B.D., Saraceno, J.F., Garrett, J.A., and Olsen, L.D., 2013, Optical techniques for the determination of nitrate in environmental waters: Guidelines for instrument selection, operation, deployment, maintenance, quality assurance, and data reporting: U.S. Geological Survey Techniques and Methods 1–D5, 37 p.

U.S. Geological Survey, variously dated, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1–A10, accessed October 20, 2016, at https://water.usgs.gov/owq/FieldManual/.

Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods, book 1, chap. D3, 51 p. plus 8 attachments, accessed April 10, 2006, at https://pubs.water.usgs.gov/tm1d3.

Instrument/Equipment Calibration and Frequency

Instruments are calibrated as noted in section B2. Calibrations are performed the day prior to use, in USGS facilities. When in use for several consecutive days, instruments are checked and recalibrated at the beginning and end of the week. Calibration data is archived, and entered into USGS databases.

Instrumentation is calibrated, maintained, and operated in accordance with the following USGS published methods:

Pellerin, B.A., Bergamaschi, B.A., Downing, B.D., Saraceno, J.F., Garrett, J.A., and Olsen, L.D., 2013, Optical techniques for the determination of nitrate in environmental waters: Guidelines for instrument selection, operation, deployment, maintenance, quality assurance, and data reporting: U.S. Geological Survey Techniques and Methods 1–D5, 37 p.

U.S. Geological Survey, variously dated, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1–A10, accessed October 20, 2016, at https://water.usgs.gov/owq/FieldManual/.

Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods, book 1, chap. D3, 51 p. plus 8 attachments, accessed April 10, 2006, at https://pubs.water.usgs.gov/tm1d3.

B6. Inspection/Acceptance for Supplies and Consumables

Most consumables are purchased by the USGS New York Water Science Center through central USGS supply, from the NWQL in Colorado. A listing of consumables, USGS central supply numbers, or vendor and part numbers, for sample processing and preservation is available in Table 2; a listing of additional consumables (all available through USGS central supply) can be found in USGS TRWI Book 9..

B7. Data Management

Field data recorded at site locations determined during spatial data collection will be identical to, and collected in the same was as, data collected at predetermined sites. Latitude and longitude will be recorded at all sample locations. Sites without pre-existing USGS station names and identification numbers will be established as sites in NWIS as soon as possible after sample collection and will follow USGS naming and numbering conventions.
Part of the metadata collected during each discrete sample includes an event code; each sample will be designated as either routine (USGS NWIS Event Code 9) or algal bloom (USGS NWIS Event Code L). Continuous and discrete water-quality data collected by the USGS is processed, reviewed and approved, and stored in the USGS National Water Information System (NWIS), a federally supported, public facing,

persistent database that stores USGS water data (https://waterdata.usgs.gov/nwis). Metadata associated with the data and information about the sites will also be available through NWIS and summarized on the project webpage (https://ny.water.usgs.gov/maps/habs/). These data are readily available and broadly used by academia for advanced research and analysis. Data collected by non-USGS personnel and (or) analyzed by non-USGS laboratories may be entered into the NWIS at the discretion of the Science Center, provided that data-collection methods and quality assurance information have been reviewed and found acceptable. Data used to generate interpretive reports, including those collected and analyzed by the NYSDEC, will also be publicly available through the USGS ScienceBase project webpage and the report webpage. Records related to field monitors and equipment (for example, calibration logs and field visit notes) will be archived along with data review and processing records at the completion of the project. All electronic files will be archived on a dedicated drive at the USGS Troy Office (O:\^^Station Folders^^). Paper files will be stored in the active file's location in the Troy office throughout the study and moved for storage in the file room at the completion of the study. Paper files may be moved to a national repository after active reference ceases. All data and records will be maintained in accordance with the New York Water Science Center File Maintenance and Disposition plan Schedule Item Numbers 1400-30 through 1400-60.

C Assessment/Oversight

C1. Assessment and Response Actions

Personnel from the Troy, NY office of the USGS complete bi-annual reviews throughout the project. The bi-annual review includes audits of project management, field activities, laboratory activities, and database management. Assessment results are immediately communicated verbally to the USGS Project Manager. The USGS Center Director, the Associate Director, or the Deputy Director for Science issue corrective actions, or stop work orders, for identified problems. The USGS Project Manager is responsible for documentation of changes to the project design.

C2. Reports to Management

The following reports and reporting activities are carried out during this project:

- Identification of potential HABs will be communicated to the NYSDEC as soon as possible via the NYSDEC NYHABs online tool..
- Discrete water-quality analyses are made available to the NYSDEC through NWIS by the USGS as soon as they have been reviewed and approved. Review and approval will be conducted on a quarterly basis, in accordance with USGS records guidance.
- All water-quality data will be released to the public through the USGS NWIS site for New York and a series of ScienceBase data releases.
- In addition, a USGS Scientific Investigations Report or journal article describing study results and potential approaches for the development of an advanced CyanoHAB monitoring strategy for the State and Nation will be written and publicly available following at least two years of data collection.

D Data Review and Evaluation

D1. Data Review, Verification and Validation

Continuous water-quality data are reviewed and approved on a quarterly basis in accordance with the established USGS guidelines described in Wagner and others (2006). Quality of continuous-water quality data are rated as excellent (requiring corrections of less than plus or minus [±] 5 percent), good (requiring corrections of <±10 percent), fair (requiring corrections of <±15 percent), or poor (requiring corrections of >±15 percent).

Discrete-water quality data is reviewed on receipt from the NWQL, the Ohio Microbiology Laboratory, and contract laboratories, and again at the end of the sampling season. QA samples including blanks and replicates are reviewed, and corrective actions to sampling procedures taken if necessary. If blank samples indicate contamination of environmental samples, environmental samples are censored to a value 4 times the blank concentration; these constituents are assigned a "V" remark code in the NWIS data set to indicate likely contamination. Outliers in the chemistry data set that cannot be explained will not be approved. Limitations on data are documented within the databases in which they are stored.

It is expected that from time to time ongoing and perhaps unexpected changes will need to be made to the project. The Project Manager shall authorize all changes or deviations in the operation of the project. Decisions about major changes (e.g. changes in platform location or study design) to the project will be made jointly by the USGS and the DEC. Any significant changes will be noted in the next progress report and shall be considered an amendment to the QAPP. All verification and validation methods will be noted in the analysis provided in the final project report.

D2. Verification and Validation Methods

This project will undertake the following specific steps to measure/estimate the effect of data errors: Each sampling activity (on-lake and near shore) will include two concurrent replicates, at randomly selected sample sites for all constituents being analyzed (nutrients, carbon, chlorophyll, and phycocyanin). Replicate results will be compared using relative percent (Zar, 1999) using a threshold of 10 percent for inorganic and 20 percent for organic constituents. Replicate samples that exceed these thresholds will be flagged as outliers in published databases, and end-users will have relevant sample data to determine usability.

Continuous water-quality data will be reviewed and approved using published USGS methods as described in sections A7 and B5.

Data anomalies

All data are reviewed, and quality assured prior to publication by USGS personnel. Data that is considered erroneous is flagged in USGS databases for end-user judgement in their usability. Missing water-quality data is not estimated and will be left blank in published USGS databases. Continuous water-quality data does go through a visual QA assessment and review prior to approval, where transient "spikes" of erroneous data are typically removed.

Completeness

The completeness of analytical results is calculated to determine if sufficient analytical results are provided to achieve the project objectives. Completeness is calculated using the following equation:

$$\% \, Completeness = \frac{V}{n} \, x \; 100\%$$

Where:

V = number of valid samples

n = number of valid samples necessary to achieve project objectives

Ideally, 100% of the data should be available. However, the possibility of unavailable data due to accidents, insufficient sample volume, broken or lost samples, etc. is to be expected. Therefore, it will be a general goal of the project(s) that 90% data completion is achieved.

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