New Mexico Environment Department (NMED) Surface Water Quality Bureau (SWQB)

Standard Operating Procedure (SOP) for

LAKE SAMPLING

Approval Signatures

Emily Miller Digitally signed by Emily Miller
Date: 2025.05.22 15:59:48 -06'00'

Emily Miller
Quality Assurance Officer, SWQB

Date

Lynette Guevara Digitally signed by Lynette Guevara
Date: 2025.05.22 17:50:17 -06'00'

Lynette Guevara
Program Manager – Monitoring, Assessment, and Standards Section

Date

1.0 Purpose and Scope

The purpose of this document is to describe the sample collection techniques, preservation requirements, equipment, and quality control activities associated with chemical, physical, and core biological sampling of surface water in lentic environments. The following describes accepted approaches used in the studies of lentic systems of New Mexico. For purposes of this document, the term "lake" shall include natural lakes and ponds, as well as reservoirs, impoundments, and any other human-made lentic waters. Where appropriate this SOP references the chemical sampling techniques used for lotic waters (SWQB SOP 8.2 Chemical Sampling in Lotic Environments) and only discusses where lake sampling differs.

2.0 Responsibilities

The Monitoring, Assessment, and Standards Section (MASS) Program Manager coordinates with the Project Manager(s), Technical Staff, and the QAO as applicable to ensure quality data is collected, verified, and validated to support program commitments. The Program Manager will provide input on the scope and intent of the SOP as it pertains to the program's goals and objectives.

The Quality Assurance Officer (QAO) is involved in the development and revision of this SOP to ensure the SOP meets the requirements of the SWQB's Quality Assurance Project Plan. The QAO, the MASS Program Manager, and SWQB subject matter experts (e.g., the MASS Monitoring Team Supervisor and assigned field staff scientists) will determine if any revisions to this SOP are needed at a minimum of every two (2) years in accordance with the most current SOP 1.1 for the Creation and Maintenance of SOPs (https://www.env.nm.gov/surface-water-quality/sop/). Pending the review and approval of the document, the QAO will ensure the SOP is accessible through the SWQB's website.

The Project Manager (e.g., Monitoring Team Supervisor and assigned field staff scientists) are responsible for organizing and planning data collection activities and ensuring monitoring activities adhere to applicable SOPs and Field Sampling Plans.

Bureau personnel who conduct sampling activities in lentic environments, or who supervise those who do, are responsible for implementing this procedure, using the most up to date field sheets, and are required to sign the SOP acknowledgment statement for Lake Sampling.

3.0 Background and Precautions

3.1 Background

Water quality samples will be collected according to 20.6.4.14.C(3) NMAC which states:

> *"Lake sampling stations shall be located at any site where the attainment of a water quality criterion is to be assessed. Water quality measurements taken at intervals in the entire water column at a sampling station shall be averaged for the epilimnion, or in the absence of an epilimnion, for the upper one-third of the water column of the lake to*

> *determine attainment of criteria, except that attainment of criteria for toxic pollutants shall be assessed during periods of complete vertical mixing, e.g., during spring or fall turnover, or by taking depth-integrated composite samples of the water column.*"

Based on current staff and funding levels, state fiscal year change over financial constraints (July 1), and New Mexico's assessment protocols and related impairments, lake sampling should occur during the growing season, preferably June through September. Assessment details for determining lake impairments can be found in the current Comprehensive Assessment and Listing Methodology (CALM) (NMED/SWQB 2023b or current).

Methods of sample collection, preservation and handling used in this SOP are in accordance, except where otherwise noted, with methods described in the following references:

- "Guidelines establishing test procedures for the analysis of pollutants under the Clean Water Act," 40 CFR Part 136 or any test procedure approved or accepted by EPA using procedures provided in 40 CFR Parts 136.3(d), 136.4 and 136.5;
- Standard Methods for the Examination of Water and Wastewater, latest edition, American Public Health Association (APHA 2017);
- Methods for Chemical Analysis of Water and Waste, and other methods published by EPA Office of Research and Development or Office of Water;
- Techniques of Water Resource Investigations of the USGS;
- Annual Book of American Society for Testing and Materials (ASTM) Standards. Volumes 11.01 and 11.02, Water (I) and (II), latest edition, ASTM International;
- Federal Register, latest methods published for monitoring pursuant to Resource Conservation and Recovery Act regulations;
- National Handbook of Recommended Methods for Water-Data Acquisition, latest edition, prepared cooperatively by agencies of the U.S. Government under the sponsorship of the USGS.
- Federal Register, latest methods published for monitoring pursuant to the Safe Drinking Water Act regulations.
- Clean Lakes Program Guidance Manual (USEPA 1980).
- Subsection C Paragraph (3) of 20.6.4.14 NMAC in the State of New Mexico Standards for Interstate and Intrastate Surface Waters (NMAC 2020).
- Chemical Sampling SOP 8.2 (NMED/SWQB 2024b or current).

3.2 Precautions

All water sampling field activities in lentic waters will be conducted in accordance with this SOP. Site conditions or project-specific data collection objectives may necessitate the use of alternative field procedures not included in this SOP. The use of field methods other than those presented in this SOP must be approved by the MASS Program Manager or QAO and alternative methods must be accurately documented on field forms.

Organic samples collected with equipment that is not constructed of glass, fluoropolymer, or stainless steel are inconsistent with sampling methods described in Table II of 40 CFR Part 136.3 (e). However,

previous results from samples collected using non-compliant equipment have not shown detections of organic analytes that would implicate the sampling equipment as a potential source of contamination. Regardless, organic results obtained using non-compliant equipment should be flagged with a SWQB validation code.

3.3 Safety

Use gloves when handling caustic and acidic substances and waters suspected to have high bacterial contamination. Follow lab safety procedures if preparing Lugol's solution. All reagent containers and chemicals must be properly stored, labeled, and properly disposed. Take precautions to minimize exposure to chemicals in the lab and in the field.

Boating Safety

All personnel operating and working aboard watercraft must complete a US Coast Guard boating safety course every three years. Do not operate the watercraft in hazardous weather conditions such as thunderstorms or high winds/rough water. If weather conditions become hazardous while out on water sampling must cease and you must return to boat ramp as safely as possible. Before leaving the boat ramp, check that engine coolant water is discharging and isn't clogged with debris. Failure to do so may lead to engine overheating. All personnel must wear US Coast Guard type lll personal flotation devices (PFD) while on board a watercraft.

Before launching the boat, make sure the drain plug(s) is securely fastened to the drain and that the following safety equipment is present onboard the watercraft:

- Oars
- First aid kit
- Fire extinguisher
- PFDs for all onboard
- Throw rope
- Cell phone or radio
- Whistle

4.0 Definitions

For common definitions and acronyms not defined in this SOP, refer to the most up to date SWQB Quality Management Plan for Environmental Data Operations.

Depth-integrated composite sample or composite sample – Multiple samples collected at different depths and integrated to represent entire water column or specific region of water column.

Epilimnion – The top-most layer in a thermally stratified lake, occurring above the deeper hypolimnion.

Euphotic zone – the depth of water in a lake that is exposed to enough light for photosynthesis to occur estimated at 2.8 times the Secchi depth (French et al. 1982).

Hypolimnion – The dense, bottom layer of water in a thermally-stratified lake. It is the layer that lies below the thermocline.

Grab sample – Water sample collected at the surface of the lake.

Littoral – The shallow or nearshore areas of a body of water.

Oligotrophic – An oligotrophic lake has low nutrient concentrations and low plant growth with abundant oxygen in deeper parts.

Profile measurement – Interval measurements taken with a sonde, which include temperature, DO (concentration and percent saturation), pH, turbidity, salinity, and specific conductivity.

SLD – Department of Health Scientific Laboratory Division.

Thermocline – Zone of the water column where the temperature changes one degree C or more per meter of depth. In a thermally stratified lake, the thermocline is a relatively thin transition between the warmer, shallower layer (epilimnion) and the colder, deeper layer (hypolimnion).

Constituents/Analytes Acronyms:

DO – Dissolved Oxygen

DOC – Dissolved Organic Carbon

TOC- Organic Carbon

HAB – Harmful Algal Bloom

Rads – Radionuclide Sample

TDS – Total Dissolved Solids

TSS – Total Suspended Solids

5.0 Equipment

Required equipment for lakes sampling is detailed in the Lake/Reservoir Sampling Equipment Checklist. Lugol's solution must be prepared in the laboratory prior to the field sampling event as follows:

Lugol's Solution Preparation Steps:

1. Using a Mettler balance or equivalent. Measure 25 g KI and 12.5 g of I_2.
2. Cover the I_2 reagent with tinfoil as it is light sensitive and will evaporate.

3. Combine 225 ml DI water and dry chemicals in a large flask. This must be performed in a fume hood.

4. Add a magnetic stir bar and place on a hotplate equipped with stirring action.

5. Warm slightly while stirring to facilitate dissolution of the dry chemicals. ***Do Not Boil!***

6. In about an hour, once the solution is completely dissolved, pour into an opaque container using a glass funnel.

7. Add 25 ml Glacial Acetic acid to container and cap tightly.

8. Invert several times to mix solution.

9. Label container with date, contents, and pH (usually around 2.4 s.u.)

6.0 Lake Sample Collection (Step-by Step Process Description)

Lake water samples must be collected in accordance with 20.6.4.14.C(3) NMAC and this SOP. For biological data (i.e., phytoplankton, chlorophyll a, zooplankton, E. *coli and* microcystins) refer to Section 6.3-6.8 of this SOP.

Lake sampling stations shall be located at least 250 feet from a point source discharge when data will be used for assessment of water quality standards.

All lake samples which require preservation and filtration will be processed within 15 minutes of sample collection in accordance with 40 CFR 136.3 (e) Table II. However, due to wind, waves, weather and unforeseen events, preservation may not occur within 15 mins of sample collection but as soon as practically possible.

A plastic (acrylic), polyethylene, or fluoropolymer Kemmerer must be used for collecting water chemistry samples for TSS/TDS, anions, nutrients, DOC, metals, phytoplankton, and chlorophyll *a*. Organic samples must be collected using a fluoropolymer (i.e., PTFE, Teflon®) Kemmerer and composited in a glass or fluoropolymer carboy.

6.1 Lake Profile Measurements at Monitoring Location

Prior to beginning lake sampling ensure the Lake and Reservoir Field Sheets are drafted for planned sampling stations (monitoring Location IDs, RIDs, etc.).

The first step is to locate the index site for sampling parameters except E. coli and microcystin (and other harmful algal bloom related parameters) that are generally sampled near shoreline recreational areas (see sections 6.7. and 6.8 of this SOP for more information).

The index sampling site may deviate from the current established lake sampling stations. If this is the case, note in the Comments section of SQUID. The index site is located near the mid-point of the reservoir rather than at the deepest point, which may be near the dam. The index site should be representative of the waterbody. If this would result in an index site that is very shallow or otherwise non-representative of the reservoir as a whole, choose a point near the center of a main basin, where depths and the water column will be more representative of the reservoir.

Next, record wind speed, wind direction, % cloud cover, water color (Forel-Ule Color scale).

At the lake index station, use a calibrated multi-parameter sonde to measure the depth profile for dissolved oxygen (DO) concentration and percent saturation, specific conductance, salinity, temperature, turbidity and pH. Sondes must be calibrated according to SWQB SOP 6.1 Sondes (NMED/SWQB 2024a or current) prior to data collection.

Lake Depth Profile Data Collection Procedure

1. Data are collected beginning at the surface and proceeding at one-meter intervals up to 30 meters (m) depth or the top one third of the lake, whichever is greatest.

2. After 30 meters or the top one third of the lake, collect measurements every five meters.

3. Measurements are taken at the surface to within one meter of the bottom of the lake or to the maximum depth allowed by current equipment (60m).

4. Measurements must be recorded on the Depth Profile section of the Lake and Reservoir Field Sheet prior to finalization of field sheet.

Examination of Lake Depth Profile for Presence of a Thermocline

1. If depth profile measurements are transferable at the time of sample collection the macro enabled field sheet will provide notification of a thermocline. However, this is not always possible due to cell service and space limitations while sampling.

2. If measurements are not transferable at the time of collection results will have to be visually inspected utilizing Steps 3 and 4 of this section.

3. Review temperature results collected in depth profile for greater than one-degree Celsius (C°) change per meter for identifying a thermocline.

4. When determining a thermocline, rapid changes in other parameters, such as pH and DO, also may indicate where stratification is occurring. See Table 1 for example.

> NOTE: One degree or more change in temperature from nonconsecutive measurements is not considered a thermocline. The 1° C change must be observed in successive measurements (e.g., 2 meters to 3 meters).

STATION_NAME	SAMPLE_DATE	Depth	SALINITY	SPECIFIC CONDUCTANCE	PH	TEMPERATURE	% Dissolved Oxygen Local	Dissolved Oxygen (mg/L)	TURBIDITY
Snow Lake at Dam (Deep) - 77SnowLkDamDp	2011-08-16 11:40:00	0	0.08	175	9.21	22.07	122.9	8.16	24
Snow Lake at Dam (Deep) - 77SnowLkDamDp	2011-08-16 11:40:00	1	0.08	174	9.12	20.73	94.5	6.47	13
Snow Lake at Dam (Deep) - 77SnowLkDamDp	2011-08-16 11:40:00	2	0.08	175	9.02	20.35	81.5	5.61	9.4
Snow Lake at Dam (Deep) - 77SnowLkDamDp	2011-08-16 11:40:00	3	0.09	185	8	19.19	3	0.21	12.7
Snow Lake at Dam (Deep) - 77SnowLkDamDp	2011-08-16 11:40:00	4	0.09	192	7.8	18.17	1	0.08	10.2
Snow Lake at Dam (Deep) - 77SnowLkDamDp	2011-08-16 11:40:00	5	0.09	198	7.68	17.57	0.1	0.01	9.6
Snow Lake at Dam (Deep) - 77SnowLkDamDp	2011-08-16 11:40:00	6	0.1	201	7.59	17.07	0	0	10.7
Snow Lake at Dam (Deep) - 77SnowLkDamDp	2011-08-16 11:40:00	6.5	0.1	204	7.47	16.88	0	0	22

Table 1. Example of thermocline present between 2 and 3 meters with sharp decline in dissolved oxygen

Determine Euphotic Zone utilizing Secchi Depth Measurements

The NMED SWQB uses 2.8 times the Secchi depth in meters to estimate euphotic zone (French et al. 1982).

Secchi Depth Measurements

1. Measure Secchi depth on the shaded side of the boat with sunglasses removed and record on Lake and Reservoir Field Sheet.

2. Multiply the Secchi depth (meters) by 2.8 or click on “Calc” button on field sheet.

3. Ensure the euphotic zone has been documented on the Lake and Reservoir Field Sheet.

6.2 Collecting Lake Water Samples for Chemical Analysis

During periods of lake stratification (i.e., when **thermocline is present**) TSS/TDS, nutrients, DOC, dissolved metals, total metals, radionuclides and organics are integrated from the top, middle and bottom of the **entire water column** by taking three Kemmerer samples (Figure 1) and compositing in a 5-gallon carboy (glass or fluoropolymer for collecting organics). If any of the Kemmerer samples fall at the same depth as the thermocline, collect from one meter above. For the bottom sample, keep the Kemmerer at least 1 meter away from the bottom to avoid stirring up sediments.

Thermocline Present – Sampling Procedure for TSS/TDS, Anions, Nutrients, DOC, Metals, Radionuclides

1. Begin by reviewing the depth profile for determining sample location, see Figure 1.

2. Next, double rinse the Kemmer (i.e., acrylic, polyethylene, or fluoropolymer) and 5-gallon polyethylene carboy (or polyethylene bucket).

3. Proceed with collecting surface (i.e., top) sample and deposit in carboy.

4. Next, collect sample from the middle of water column and deposit in carboy.

5. Last, collect water sample from the bottom of the water column at least 1 meter from bottom of lake and deposit in carboy.

6. Pour water quality samples off composited sample into their respective containers; 1-liter Cubitainers® or other containers as prescribed per the analysis to be performed.

7. Next, preserve samples as prescribed by applicable method.

Thermocline Present – Sampling Procedure for Organics
Same as above, however a fluoropolymer (i.e., PTFE, Teflon®) Kemmerer must be used and samples must be composited in a glass or fluoropolymer carboy.

Thermocline Present – Sampling Procedure for Chlorophyll a and Phytoplankton
Follow Figure 1 below and Section 6.3 of this SOP for the collection of chlorophyll a and phytoplankton samples. Samples should be taken from the top, middle and bottom of the euphotic zone and composited into a polyethylene carboy (or polyethylene bucket) and then processed according to their respective procedures prescribed in this SOP.

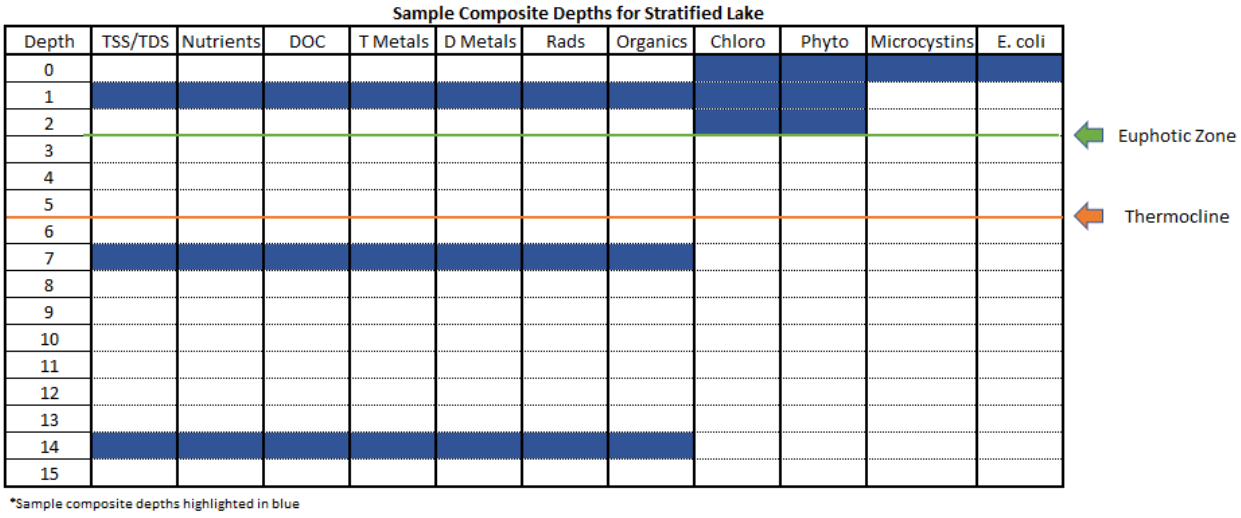

Figure 1. Sample collection methods when a thermocline is present.

Absence of Thermocline (no epilimnion)
When the lake is well mixed (i.e. **thermocline is not present**), all samples except microcystins and *E. coli* are collected from the top, middle, and bottom of the **euphotic zone** (Figure 2), or the upper 1/3 of the water column, whichever is shallowest. If the lake max depth is 3 meters or less, samples must be collected at two meters or less from the surface of lake. If the lake is one and a half meters or less the vertical Kemmerer cannot be used and water samples must be taken from just below the surface.

Thermocline Absent – Sampling Procedure for TSS/TDS, Anions, Nutrients, DOC, Metals, Radionuclides, Chlorophyll a and Phytoplankton

1. Begin by reviewing depth profile for determining sample location within the euphotic zone, see Figure 2

2. Next, double rinse the Kemmer (i.e., acrylic, polyethylene, or fluoropolymer) and 5-gallon polyethylene carboy (or polyethylene bucket).

3. Proceed with collecting lake sample from top of euphotic zone and depositing into carboy.

4. Next, collect lake sample from middle of euphotic zone and deposit in carboy.

5. Last, collect water sample from bottom of euphotic zone (must be at least 1 meter from bottom of lake) and deposit in carboy.

6. Pour water quality samples off composited sample into their respective containers; 1-liter Cubitainers® or other containers as prescribed per the analysis to be performed.

7. Next, preserve samples as prescribed by applicable method.

Thermocline Absent – Sampling Procedure for Organics

Same as above, however a fluoropolymer (i.e., PTFE, Teflon®) Kemmerer must be used and samples must be composited in a glass or fluoropolymer carboy.

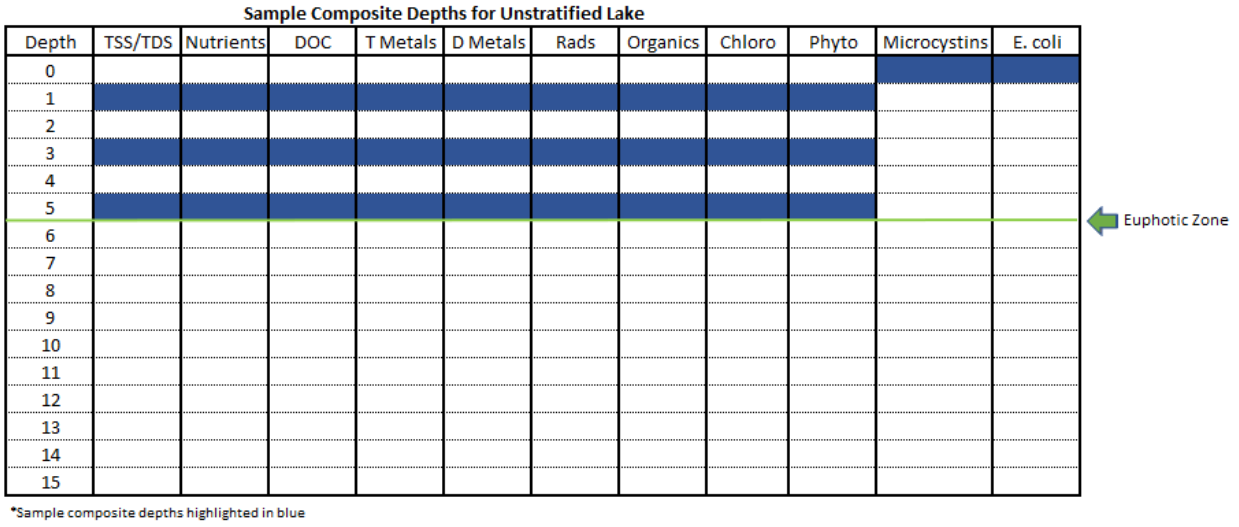

Figure 2. Sample collection methods when a thermocline is not present

6.3. Sampling for Phytoplankton and Chlorophyll a

Phytoplankton and chlorophyll a samples are composited from the top, middle, and bottom of the euphotic zone in **both** stratified and mixed lakes (Figures 1 & 2).

1. Begin by determining sample locations within the euphotic zone.

> If the lake max depth is 2 meters or less, samples must be collected at one meter or less from the surface. If the lake is one and a half meters or less in depth, the Kemmerer cannot be and water samples must be taken just below the surface as a grab sample using a Cubitainer®.

2. Composite samples from the appropriate depths with a clean Kemmerer (acrylic, fluoropolymer or glass) and fill a 1-liter Cubitainer® for phytoplankton and 1-gallon Cubitainer® for chlorophyll a. Samples can be poured off from TSS/TDS, anions, nutrients, DOC, metals, and radionuclides composite if the lake is **well mixed (no thermocline).**

6.4 Phytoplankton sample Preservation

1. Preserve sample within 2 hours of collection using approximately 10 milliliters of Lugol's solution until the sample appearance looks like a weak tea color.

2. Store samples in the dark and on ice or under refrigeration (EPA 2012).

3. At the end of the sampling season after all samples are collected (but no longer than one year from earliest sample collection) ship samples to the contracted lab for identification and enumeration.

6.5 Chlorophyll *a* Preservation and Processing

Confirm sample processing methods from selected lab prior to processing. If processing methods differ from below, follow instructions provided by the contract lab.

The 1-gallon Cubitainer® must be stored on ice and out of sunlight and filtered as soon as possible after collection.

Filtering procedure for chlorophyll a processing is described below.

Processing of Chlorophyll a Samples

1. Begin by double rinsing the chlorophyll flask and funnel with DI water.

2. Filter sample water through a Whatman Glass Fiber Grade GF/F or GF/C filter until substantial color development is on the filter medium, indicating adequate chlorophyll pigment is present. Volume of sample filtered must be documented.

> NOTE: If clogging or filtering time is a concern, use the larger retention of the GF/C filter. It has been shown that there is no difference between chlorophyll concentrations collected on Whatman GF/F of GF/C filters (Prepas et al. 1988).

3. Do not exceed a vacuum pressure of 6in. Hg (20kPa) during filtration.

> If filtering must be delayed, hold sample water on ice or at 4°C and protect from exposure to light by using opaque bottles and storing in the dark.

4. Excessively long filtration times (>10 min) and high pressures may damage cells and result in a loss of chlorophyll (EPA 1997).

5. Remove the filter from the filtering apparatus, fold it in half, place it in a petri dish labeled with sample identification and filter volume

6. Then wrap the petri dish with aluminum foil, put in a zip lock bag and place on dry ice.

7. Record the volume of water filtered on the field sheet

8. Upon returning to the SWQB lab, store samples in a freezer until they are shipped to the contract lab.

Samples should be sent to the laboratory for processing as soon as possible after collection; however, samples on filters taken from water having pH 7 or higher can be frozen for up to 28 days before analysis, if necessary. Samples from acidic water (< pH 7) should be processed promptly after filtration to prevent possible chlorophyll degradation from residual acidic water on filter.

6.6 Zooplankton Sample Collection

The objective of zooplankton sample collection is to sample a sufficient volume of water to obtain at least 300 organisms per sample from oligotrophic lakes. Oligotrophic lakes are low in nutrient concentrations, low plant growth and contain abundant oxygen in the deeper parts. This will be verified with the depth profile measurements, visual examination of lake for excessive plant growth and reviewing historical sampling events. Zooplankton sample collection is completed by collecting two vertical samples using fine mesh (50 µm) and coarse mesh (150 µm) Wisconsin style nets with collection bucket attached at the cod end following the Sample Collection Procedure below. Figure 3 provides the equipment and supplies needed for the collection of zooplankton. Figure 4 is an illustration of the zooplankton nets and collection buckets required for sampling.

Type	**Item**	**Quantity per site**
Form	-Lake Field Sheet	1
Collection	-Plankton net fine (50µm) and collection bucket	1
	- Plankton net course (150 µm) and collection bucket	1
	- Calibrated line (30 m, calibrated, marked in .5 m intervals)	1
	- Funnel	1
	- Squirt bottle – de-ionized (DI) water	1
	- Squirt bottle- lake water	1
	- Effervescent sodium bicarbonate (e.g., Alka seltzer) tablets	1
	- Pail (for narcotization and concentration of samples)	1
Storing and Preservation	- HDPE bottle (125ml or 250 ml)	2

	- Ethanol (95%) - Labels for fine and course samples	1 As needed

Figure 3. Equipment and supplies for Zooplankton Sample Collection

National Lakes Assessment 2022

Version 1.2, May 2022

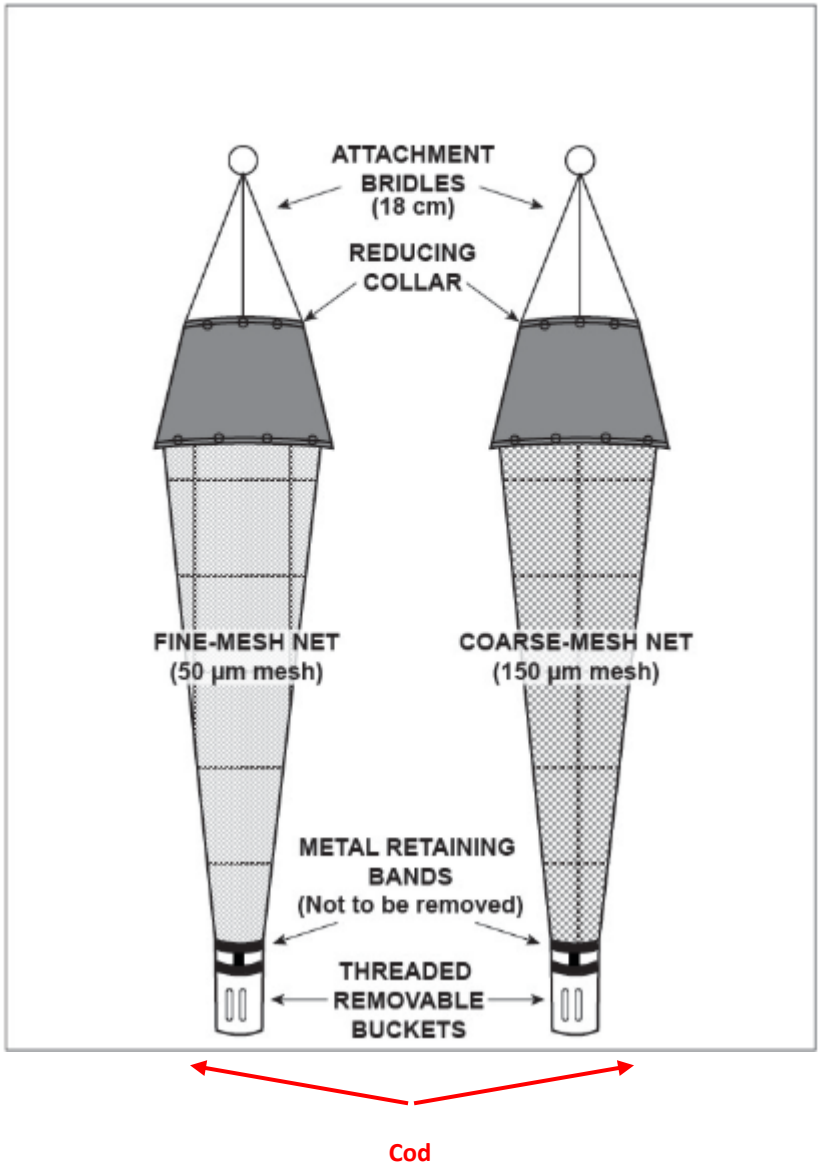

Figure 4. Wisconsin Net and Collection Diagram for Zooplankton

The procedures for collecting and processing zooplankton samples are presented below.

Sample Collection

1. Determine and record the number of tows required to achieve the standard cumulative 5-meter(m) tow on the Lake field sheet.
    a. For lakes deeper than 7 m, you will take a single 5 m tow with each net.
    b. For lakes with a depth less than 7 m, you will determine and record the number of tows that will be required to achieve a standard cumulative 5 m tow for each net (Figure 5). For example, if the lake is 6 m deep, you will take two 2.5 m tows with each net. All lakes less than 7 m deep require at least two tows because the collection bucket should never touch the sediment due to potential fouling.

Depth of lake (m)	Length of Tow	Number of Tows
7 or more	5 m	1
4 to <7	2.5 m	2
2 to <4	1 m	5
less than 2	0.5 m	10

Figure 5. Lengths and numbers of zooplankton tows based on lake depth.

    c. The zooplankton collection methods vary slightly depending on the number of tows required to achieve a standard cumulative 5 m tow.
        i. If the number of tows = 1: follow steps 2 through 13 described below.
        ii. If the number of tows ≥ 2, follow steps 2 through 12 described below. After step 12, pour the contents of the collection bucket into a clean (i.e., DI rinsed) 1- gallon pail. Rinse the collection bucket with DI. While taking care not to tip the zooplankton sample in the pail, repeat steps 2 through 12 for the second tow. Add the contents of the collection bucket from the second tow to the pail. Continue to take zooplankton tows and add samples from the collection bucket into the pail until the target number of tows (2, 5, or 10) is reached. On the last tow, pour the contents of the pail into the collection bucket to filter the excess water. Rinse the bucket with DI water and pour the contents of this rinse into the collection bucket with the zooplankton sample. Once the zooplankton sample has been filtered down to an appropriate volume in the collection bucket, continue on to step 13.

2. Prior to each use, carefully clean and thoroughly rinse the interior of the nets and buckets with DI water.

3. Carefully inspect the nets and buckets for holes or tears.

4. Attach the collection buckets to the “cod” end of the nets and secure. Make sure the correct bucket is attached to the correct net (i.e., the mesh sizes match).

5. Attach the bridled end of the net to a calibrated line with markings every 0.5 m.

6. Carefully and slowly lower the first net in a constant upright position over the side of the boat.

7. Continue lowering the net to the correct depth (remember to account for the length of the bridle). If more than one tow is needed, be sure to take additional tows from different locations around the boat.

8. Retrieve the net by pulling back to the surface at a steady rate (0.3 m/s or 1 ft/s) without stopping.

9. Once at the surface, slowly dip the net up and down in the water without submersing the net mouth to rinse contents into the collection bucket.

10. Complete the rinsing of the net contents by spraying lake water against the outside of the net with a squirt bottle or similar tool (a peristaltic pump may be used at low speed). Be careful not to splash or squirt lake water into the net mouth, or additional organisms may be collected.

11. If additional rinsing is needed on the interior of the net, use a squirt bottle or similar tool with DI water to avoid introducing additional organisms.

12. Once all organisms have been rinsed into the collection bucket, hold the collection bucket in a vertical position, and carefully remove the bucket from the net.

13. Repeat steps 5-12 with the second net on the opposite side (or end) of the boat.

Sample Processing

1. Set the collection buckets in a pail filled half full of lake water, inset two (2) CO_2 (e.g., Alka-Seltzer) tablets outside of the collection buckets. Wait 30 to 60 seconds for the CO2 tablets to dissolve.

2. Ensure that the organisms in the collection buckets are submerged in the water but be careful not to submerge the top of the collection buckets, or sample loss will occur. Wait until zooplankton movement has stopped (usually about one-two minute)

> Note: The CO_2 narcotizes the zooplankton to relax their external structure to facilitate identification

3. Raising and lowering the collection buckets in the pail can help water exchange within the bucket to disperse CO_2 tablets.

4. Check the sample label on the collection buckets to verify which sample has been collected (coarse or fine mesh).

5. Use small volumes of DI water from a squirt bottle to rinse the contents of the mesh net collection bucket into the 125 or 250 mL polyethylene bottle. Rinse the collection bucket with DI water three to four times or until the majority of zooplankton have been removed without allowing the bottle to fill more than half full (~60-70 mL or 120-130 mL of sample and rinse water combined).

6. After the zooplankton have been transferred and the sample bottle is half full of sample and rinsate, fill the bottle to the shoulder with 95% ethanol. Use a funnel, if necessary, when transferring the sample, rinsate or ethanol to the sample bottle.

7. In some cases, the volume of zooplankton collected in the collection bucket may exceed 125-250 mLs. Under this scenario do not try to force the entire sample into a single bottle, or the preservative will not function properly, and the sample may be lost. In such cases, fill the first bottle half full, and then use a second bottle to preserve the additional amount of sample. Complete the label on second bottle. Ensure the Lake field sheet is properly labeled.

8. Seal sample bottles with electrical tape.

9. On the Lake Field Sheet, indicate that the sample is preserved.

10. Verify that all information on the labels and the form is complete and correctly recorded.

11. Repeat steps 2-9 for the second sample collected.

Sample Storage
Zooplankton samples should be stored in a secure location while awaiting delivery to the laboratory for analysis, samples may remain at room temperature. Contact the contract laboratory for transportation requirements. Samples should be analyzed within 1 year of sample collection, if sealed properly as described sample processing.

Storage and Cleaning of Zooplankton Nets
Briefly soak zooplankton nets in a 1% bleach solution and dry after each use. Do not dry in sunlight because the mesh is photosensitive.

6.7 *E. coli* Sampling

Collect *E. coli* samples from the surface of the water at lake sampling location in accordance with the procedures in Bacteriological Sampling SOP 9.1 (NMED/SWQB 2023c or current). Lake sampling stations sampled for E. coli should be conducted at high recreational areas along beaches/shore. Record the GPS coordinates of the monitoring site on the field form if differs from index site.

6.8 Microcystin Samples

Microcystin samples are collected to identify Harmful Algal Blooms (HABs) in areas of a lake where HABs have been observed or are of concern due to heavy recreation (swim beach, boat launch, etc.). Record the GPS coordinates of the monitoring site on the field form if differs from index site. Sampling should be performed from mid-summer to late-fall when HABs are most likely.

1. Begin by collecting surface grab samples using a 1-liter Cubitainer™.
   Note: If long, filamentous algae are present, leave headspace in Cubitainer™ and shake vigorously to ensure sample is homogenized.

2. Immediately store sample on ice away from sunlight.

3. Samples must be maintained at 0-10° C until arrival at lab.

4. If samples are not processed by laboratory within 5 days of collection samples must be maintained at -20 ° C until sent to laboratory for processing.

Maximum hold time for samples is not to exceed 14 days after collection unless stored at -20 ° C, however, most laboratories requires samples to be delivered within 5 days of collection. Be sure to notify the laboratory as soon as possible prior to sampling to ensure they are prepared for sample processing and relay any additional requirements for sample collection and processing.

At sites where E. coli and microcystin samples are collected, record the water color using the Forel-Ule Color scale, collect grab data using a calibrated sonde and a Secchi depth as outlined in this SOP. If samples are taken from the shore/beach a Secchi depth may not be collected. Ensure GPS location is recorded. A nutrient and phytoplankton sample at each microcystin location may also be collected dependent on project objectives.

6.9 Sampling Harmful Algal Blooms (HAB) at Recreational Stations

See SWQB SOP on HABs, under Specialized Monitoring.

6.10 Deployment of Bouy in New Mexico Lakes

The SWQB deploys buoy(s) at priority lakes within New Mexico. Buoy deployment is highly specialized and requires assistance from the SWQB Monitoring Team. Loggers are attached to buoys and are deployed to collect long-term data in lakes. At the time of deployment and retrieval a lake profile is required using a calibrated sonde. All required quality control processes detailed in SWQB SOPS are adhered to so that the data can be used for its intended purpose(s). For more information contact the Monitoring Team Supervisor. Please be sure to take extra caution when deploying buoys from the Jon Boat or rafts due to safety concerns.

7.0 Data and Records Management

All field data and samples collected following the procedures outlined in this SOP are entered in SWQB's water quality database as part of a Lake Sampling Event. A second staff member verifies that the data are entered correctly. Date of entry and verification are noted on the field sheet.

Sampling events and data are stored in the SQUID database. Hard copy forms are stored in the project binder located in the SWQB file storage cabinets. Electronic forms are stored within the project file within the shared server. Per 1.21.2.436 NMAC, water quality records are to be maintained for five years from the close of file.

Enter all field form data into appropriate electronic Lake Field Sheet (form can be found on the SWQB SOP website). Save these forms in the project folder on the SWQB network. Open a blank/new electronic SLD Submittal Auto form and follow the instructions to create submittals. Copy and save the combined data tab into its own Excel file. In the electronic field form, copy the profile tab into its own Excel file and save within the project file.

Uploading field sampling event data into the SQUID database:

- Select the Data Management tab.
- Select Imports.
- Select Sampling Event Data.
- Navigate to the project file and select the file with the combined data and import.

Uploading Depth Profile into the SQUID database:

- In SQUID under the Projects tab locate the project and sampling event you want to add a depth profile to.
- Select “Add Depth Profile” located in the same row as the Lake-Chemical sampling event
- Choose the appropriate .csv or .xlsx file and click “Upload File”

Phytoplankton and Zooplankton Data Upload

Data received from the contracted lab must be formatted properly in new Excel upload sheet in order to be entered into SQUID. Copy and paste lab data received from the contracted lab into the appropriate columns of the upload spread sheet. Follow the format presented in Figure 6. For taxon data you must combine the genus and species columns from the lab spread sheet. The easiest way to do this is to use the Excel formula (=GENUS&” “&SPECIES). For example: (=J2&” “&K2). Copy and re-paste cells values to remove the formula but keep text. In SQUID, under the Data Management Tab, select imports then biological results. Select appropriate file and select “insert” then select “process results”. Make sure both columns match (for “count” row select “number of natural units”). Click process results and ensure there are no import errors. Click “Import Results” to finish upload process.

	A	B	C	D	E	F	G	H	I
1	LAB ID	Sample ID	Water Body	Collection Date	Status	Taxon	Life Stage	Exclude	Number of Natural Units
2	Water Quality Lab	2530652	Snow Lake	9/3/2019	Final	Achnanthidium minutissimum	Adult	N	1
3	Water Quality Lab	2530652	Snow Lake	9/3/2019	Final	Cylotella striata	Adult	N	77
4	Water Quality Lab	2530652	Snow Lake	9/3/2019	Final	Plagioselmis nannoplanctica	Adult	N	35
5	Water Quality Lab	2530652	Snow Lake	9/3/2019	Final	Rhodomonas lacustris	Adult	N	2
6	Water Quality Lab	2530660	Bill Evans Lake	9/4/2019	Final	Cryptomonas erosa	Adult	N	4
7	Water Quality Lab	2530660	Bill Evans Lake	9/4/2019	Final	Plagioselmis nannoplanctica	Adult	N	71
8	Water Quality Lab	2530660	Bill Evans Lake	9/4/2019	Final	Chroococcus microscopicus	Adult	N	9

Figure 6. Proper phytoplankton spreadsheet formatting for data upload

***E. Coli* Data Upload**

See SWQB SOP 9.1 Bacteriological Sampling and Analysis (NMED/SWQB 2023c or current) for upload instructions into SQUID.

Chlorophyll *a* Data Upload

Results from the laboratory are uploaded to SQUID using the *Chlorophyll a Analysis Sheet*.
Uploading data into the SQUID database:

- Select the Data Management tab.
- Select Imports.
- Select Biological Results.
- Navigate to the project file and select the file with the combined data
- Click upload

Water Chemistry, Metals, Organics, Radionuclides and Microcystin data Upload
Data are received electronically from applicable laboratories and are uploaded to SWQB SQUID database. For most analytical analysis of samples, the SWQB uses the Air and Heavy Metals, Organics, Water, and Radiochemistry Sections of SLD Chemistry Bureau. SLD uses a software-based Laboratory Information Management System (LIMS) to issue standardized result reports which include detection limits, quantitation limits, and data qualifiers. For more information on the upload process contact the Monitoring Team Supervisor or the SWQB QAO.

8.0 Quality Control and Quality Assurance

The SWQB controls the quality of lake sampling data by using standardized methods that are documented in this SOP. All personnel who conduct lake sampling must be familiar with these protocols, sign the acknowledgment form associated with this specific SOP and collect data in accordance with the procedures as they are defined in this SOP. In addition to standardized methods, proper training of field personnel represents a critical aspect of meeting the data quality objectives in order to fulfill the goals of the SWQB's QAPP (NMED/SWQB 2024).

QA/QC activities for sampling (bacteriological, water chemistry, metals, organics, radionuclides and microcystin) are the same as described in the Chemical Sampling SOP in Lotic Environments (SOP 8.2) and Bacteriological Sampling (SOP 9.1).

Any SWQB personnel who conduct lake sampling are required to receive training in the field and be supervised by MASS Monitoring Team Supervisor for all aspects of sample collections. Any MASS Monitoring staff who conduct training in the field must have conducted at least 1 field season of lake sampling prior to training of other staff or unsupervised sampling. Once training has occurred and all aspects of lake sampling procedures have been observed as correct, personnel may conduct unsupervised lake sampling for the SWQB with approval from Monitoring Team Supervisor. This process will ensure comparability and accuracy of data used for water quality assessments, refinement of water quality standards and TMDL development.

Assurance of field data collection for lake sampling are done through adherence to the processes outlined in this and other applicable SOPs and oversight of the process by the QAO. If at any time the QAO determines this process is not being adhered to, the QAO has the authority to cease activities specific to this SOP with prior support and approval by the SWQB Bureau Chief and MASS Program Manager, until such a time that the issue can be resolved.

9.0 Related Forms

- Lake/Reservoir Sampling Equipment Checklist
- Lake/Reservoir Field Sheet
- Chlorophyll *a* Analysis Sheet
- Upload form for Phytoplankton and Zooplankton

10.0 Revision History

Originally modified from SOP 2007.

Revision 1 – March 2012 –clarified sampling procedures for conditions with a thermocline present (stratified) and when a thermocline is absent (mixed); added guidance on sampling lakes where low DO is a suspected water quality concern

Revision 2 – March 2013 – added information regarding compliant and non-compliant sampling equipment for organic samples to be consistent with SOP 8.2 Chemical Sampling and 40 CFR Part 136; added clarification for sampling in shallow lakes (≤ 3 meters in depth) and use of larger filters for chlorophyll

Revision 3 – March 2014 – revised language and figures to clarify sampling depths during different mixing conditions. Added the use of either a contract lab or in-house analysis.

Revision 4 – August 13, 2020 – revised language and figures to include organics sampling. Clarified sampling depths in compliance with 20.6.4.14(C)(3). Added Lugol's solution formula. Added microcystin sampling. Added process for depth profile data upload into SQUID. Added DOC sampling. Updated sampling location figures. Added sampling at recreational sites. Added phytoplankton and chlorophyll-*a* lab result upload instructions. Added boating safety section. Standard Operating No. changed from 12.0 to 12.1.
Miguel Montoya, QAO; Jonathan Celmer, SME; Kris Barrios, MASS Program Manager

Revision 5 – May 22, 2025 – addition of zooplankton sample collection and processing. Updated *E. coli* sample location. Deleted duplicative language on processes.
Emily Miller, QAO; Lynette Guevara, MASS Program Manager

11.0 References

New Mexico Environment Department / Surface Water Quality Bureau (NMED/SWQB). 2024a. Standard Operating Procedure 6.1 Sondes. Available at: https://www.env.nm.gov/surface-water-quality/sop/

NMED/SWQB. 2024b. Standard Operating Procedure 8.2 Chemical Sampling in Lotic Environments. Available at: https://www.env.nm.gov/surface-water-quality/sop/

New Mexico Administrative Code (NMAC). 2023. *State of New Mexico Standards for Interstate and Intrastate Surface Waters.* 20.6.4. As amended through February 8, 2023. Santa Fe, NM. Available at: https://www.env.nm.gov/surface-water-quality/wqs/

NMED/SWQB. 2023b. Comprehensive Assessment and Listing Methodology (CALM). Available at: https://www.env.nm.gov/surface-water-quality/calm/

NMED/SWQB. 2023c. Standard Operating Procedure 9.1 Bacteriological Sampling and Analysis. Available at: https://www.env.nm.gov/surface-water-quality/sop/

NMED/SWQB. 2021. Quality Assurance Project Plan for Water Quality Management Programs. Available at: https://www.env.nm.gov/surface-water-quality/protocols-and-planning

NMED/SWQB. 2021b. Standard Operating Procedure 6.4 Long-term Deployment Data Logger QA & Upload. Available at: https://www.env.nm.gov/surface-water-quality/sop/

NMED/SWQB. 2020. Standard Operating Procedure 1.1 Creation and Maintenance of SOPs. Available at: https://www.env.nm.gov/surface-water-quality/sop/

American Public Health Association (APHA). 2017. Standard methods for the examination of water and wastewater, 23rd Edition. Washington, D.C. 1504 p.

Blake A. Schaeffer, Sean W. Bailey, Robyn N. Conmy, Michael Galvin, Amber R. Ignatius, John M. Johnston, Darryl J. Keith, Ross S. Lunetta, Rajbir Parmar, Richard P. Stumpf, Erin A. Urquhart, P. Jeremy Werdell, Kurt Wolfe ; *Mobile device application for monitoring cyanobacteria harmful algal blooms using Sentinel-3 satellite Ocean and Land Colour Instruments*.; Environmental Modelling & Software Volume 109, November 2018, Pages 93-103

Cole, G.A. 1983. Textbook of Limnology – 3rd edition. The C.V. Mosby Company. St. Louis, MO.

Cole, G.A. 1994. *Textbook of Limnology – 4th edition*. The C.V. Mosby Company. St. Louis, MO.

French RH, Cooper JJ, Vigg S. 1982. Secchi disc relationships. Water Resources Bulletin 18: 121-123. https://ksuweb.kennesaw.edu/~jdirnber/limno/LecPhy/secchi%20photic%20depth.pdf

Ohio EPA Total (Extracellular and Intracellular) Microcystins - ADDA by ELISA Analytical Methodology Ohio EPA DES 701.0 Version 2.3

Prepas, E.E., M.E. Dunnigan, and A.M. Timbee. 1988. Comparison of *in situ* estimates of chlorophyll *a* obtained with Whatman GF/F and GF/C glass-fiber filters in mesotrophic to hypereutrophic lakes. Can. J. Fish. Aquat. Sci. 45: 910-914.

United States Environmental Protection Agency (USEPA). 1980. Clean Lakes Program Guidance Manual. EPA 440/5-81-003. Office of Water, Washington, DC.

United States Environmental Protection Agency (USEPA). 1997. EPA 445 Method In Vitro Determination of Chlorophyll *a* and Pheophytin *a* in Marine and Freshwater Algae by Fluorescence

United States Environmental Protection Agency (USEPA). 2004. Test Method for Evaluating Solid Waste (SW-846) Method 9060A Total Organic Carbon. Revision 1. 9060A-1. https://www.epa.gov/hw-sw846/sw-846-test-method-9060a-total-organic-carbon

United States Environmental Protection Agency (USEPA). 2012. National Lakes Assessment 2012 Field Operation Manual. https://www.epa.gov/national-aquatic-resource-surveys/national-lakes-assessment-2012-field-operations-manual

United States Environmental Protection Agency (USEPA). 2022. National Lakes Assessment 2022 Field Operation Manual. Zooplankton sample procedure. https://www.epa.gov/national-aquatic-resource-surveys/national-lakes-assessment-2022-manuals

United States Environmental Protection Agency (USEPA). 2016. EPA Method 546: Determination of Total Microcystins and Nodularins in Drinking Water and Ambient Water by Adda Enzyme-Linked Immunosorbent Assay. Office of Water (MS-140). EPA 815-B-16-011. EPA contract EP-C-12-013.