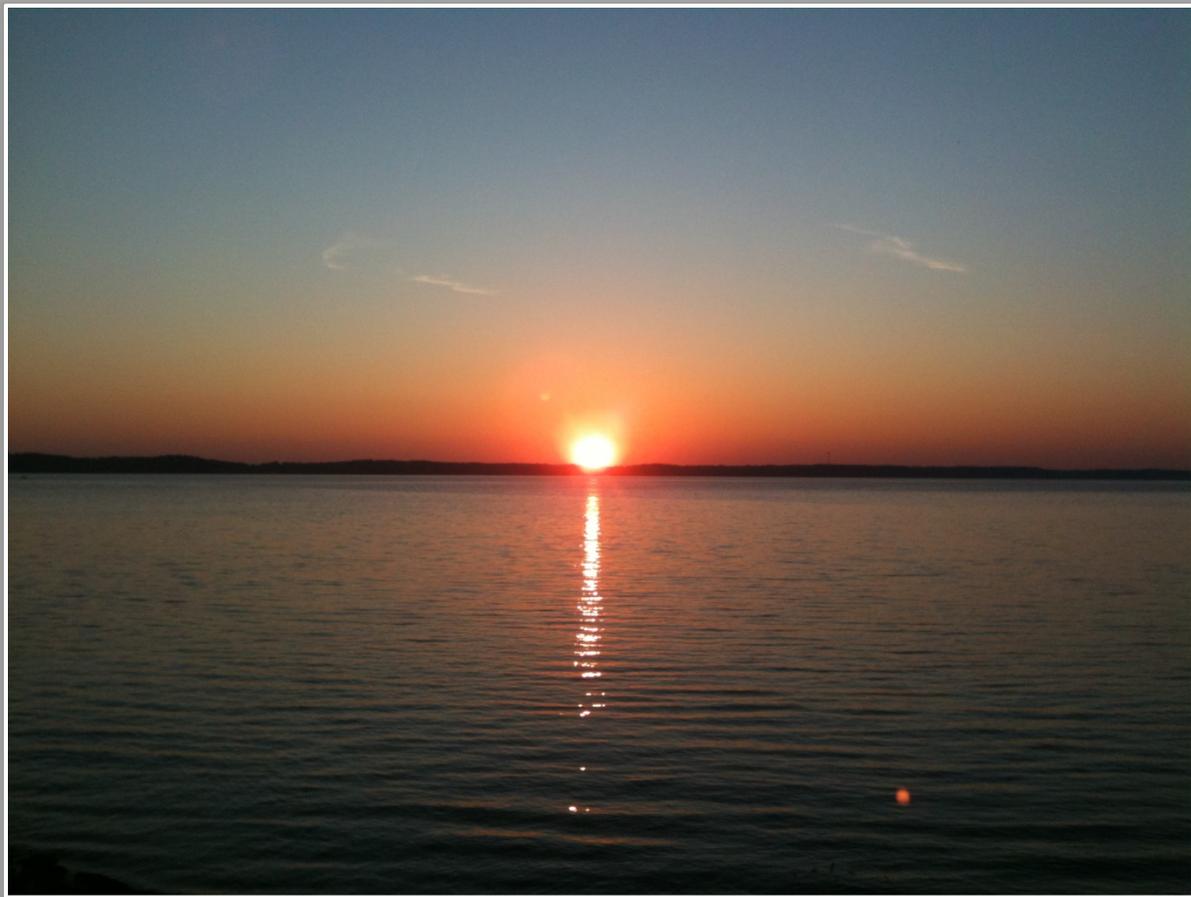


KENTUCKY WATERSHED WATCH VOLUNTEER LAKE MONITORING HANDBOOK

Standard Operating Procedure
WWSOP05000

Effective Date: 10/01/2018



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Cover photograph by DOW, sunrise on Kentucky Lake.

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Document Applicability

This document has been developed by the Kentucky Division of Water (DOW) Water Watch Program as guidance for Watershed Watch Volunteers. The document describes procedures used for uniform and accurate collection and reporting of measurements and observations of the lakes of Kentucky. The methods defined herein are required to ensure the accuracy and quality of data collected.

Health and Safety Warning

- Always wear personal floatation devices when conducting work and collecting data from lakes. Boating related laws and regulations are administered by the Kentucky Department of Fish and Wildlife Resources and can be found at <http://fw.ky.gov/FishBoatGuide/Pages/default.aspx>.
- Avoid collecting measurements during hazardous weather conditions, including extreme temperatures.
- All waterbodies have the potential for some contamination. Caution should be taken to avoid water contact with body openings and cuts/sores. In addition, perform thorough hand washing/disinfection after all monitoring activities.

Key Terms

Algae – diverse group of photosynthetic organisms that can range in size from microscopic plankton to large seaweeds.

Chlorophyll – a green pigment present in all green plants and cyanobacteria that absorbs the light necessary to promote photosynthesis.

Cyanobacteria –green to blue-green photosynthetic bacteria; also called blue-green algae.

Photic Zone – the surface layer of a waterbody that receives sunlight sufficient to promote photosynthesis; the Photic Zone in Kentucky is typically 2 to 3 times the Secchi Depth measured.

Photosynthesis – the process by which plants use sunlight to synthesize foods.

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Physiography – physical patterns and processes of the earth’s surface.

Secchi Disk – circular disk used to measure clarity in waterbodies.

Tannic – refers to water that is darkly stained by tannins leached from decaying organic matter; water often appears dark brown to black.

Temporal – of or relating to time; specifically relates to sampling frequency and changes observed across seasons and years.

Trophic State – the density of photosynthetic biomass in a given waterbody, also refers to the waterbody’s *productivity*.

Turbidity – discoloration of water due to suspended material, such as sediment (e.g. muddy)

Introduction and Background

Kentucky has approximately 440,000 acres of lakes within its borders. This amounts to more than one hundred billion gallons of water. Lakes are an integral part of our daily lives and provide wildlife habitat, drinking water supplies, and recreational opportunities. Lakes contribute significantly to the economy of individual communities and the Commonwealth. Adequately evaluating and protecting this resource is a major undertaking that can be greatly improved through volunteer monitoring efforts.

Lakes in Kentucky

Lakes are found all across Kentucky, in each of our river basins and various physiographic regions. The location of a lake imparts unique characteristics based upon the stream that has been impounded, the terrain in which it occurs and the underlying geologic units. These factors strongly influence the basic chemistry and quality of water in the lake, as well as the aquatic species native to each waterbody. The U.S. Geological Survey (2002) has assessed these and other factors to delineate and describe the Ecoregions of Kentucky.

Division of Water Monitoring Programs

The Kentucky Division of Water is charged with monitoring water resources of the Commonwealth. Monitoring programs are maintained for streams, lakes and groundwater across Kentucky. Each of these water monitoring networks includes dedicated permanent stations, as well as rotating and one-time sites to fill data gaps. These data gaps occur spatially, with many water resources unassessed, and

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temporally, with data collection on a limited frequency. Only 50% of the approximately 440,000 acres of lakes have been adequately assessed.

Purpose and Scope

The purpose of the Volunteer Lake Monitoring Program is to involve citizen scientists in expanding water resource monitoring in Kentucky. This will provide a means to address some data gaps and improve upon characterization of water quality in the lakes of Kentucky. The scope is statewide, with emphasis on the nexus of identified monitoring needs and the locations of interest to volunteer participants. This will be accomplished by achieving the goals and objectives described in the following section.

Collection, observation and reporting procedures described in this guide are designed to be low cost, be quickly and easily performed, and provide hands-on experience for volunteers. By conducting field measurements and observations, participants will:

- Develop proficiency in data collection, field observations and reporting.
- Develop a greater sensitivity to the lake(s) they are evaluating.
- Gain further understanding of the importance of Kentucky’s water resources.
- Become part of the growing number of citizens who are concerned with, and dedicated to, the fate of our natural resources.
- Supplement local, state and federal agencies in their efforts to protect and preserve the quality of Kentucky’s lakes and reservoirs.

The procedures outlined in this guide are not intended to identify subtle changes in water quality or fully assess a waterbody for all potential uses. However, the data and observations obtained will show the general condition of the lake. This information can be used in tandem with other data to evaluate the need for increased monitoring and to serve as field verification of remote sensing models.

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Goals and Objectives

Three main goals have been identified for the Volunteer Lake Monitoring Program:

- 1) Provide citizen scientists research opportunities to learn more about their local waterbodies, and use their efforts to increase public awareness of water quality issues and environmental protection.
- 2) Provide easily accessible, quality data that can be utilized by citizen scientists, DOW, other government agencies and researchers to characterize water quality in lakes.
- 3) Augment work conducted by DOW and other government agencies by expanding lake monitoring efforts. These measurements and observations will also provide field verification to improve remote sensing models employed by DOW to rapidly assess large areas of lakes across Kentucky.

Citizen Research and Public Awareness

Public involvement and awareness is key in protecting and enhancing the water resources of Kentucky. Citizen scientists' research can help characterize the quality of local waterbodies. This information can be used to help identify, prioritize and address potential threats to the waterbody. Through their monitoring efforts, volunteers will also have the opportunity to engage the public and spread awareness about activities that promote clean water, pollution control and wildlife conservation.

Provide Accessible Quality Data

Providing access to quality data to each stakeholder is paramount for the success of any monitoring program. This goal will be achieved by incorporating lake data and observations into the Watershed Watch database that has been developed by the Kentucky Geological Survey. Data management and dissemination, and communication amongst stakeholders are key objectives to the success of this goal.

Expand Lake Monitoring and Evaluation Efforts

Many of Kentucky's lakes are not adequately monitored and assessed due to limited resources. Expanding lake monitoring efforts by volunteers will allow for spatial and temporal data gaps to be filled. The objective to achieve this goal will be prioritizing target lakes based on overlap between volunteer availability and identified data gaps. A

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secondary objective will be to create a GIS layer to identify active lake monitoring stations and priority targets not yet monitored.

Kentucky Division of Water environmental biologists utilize remote sensing imagery from Landsat to model and evaluate basic water quality indicators. Remote sensing models utilize Landsat images (satellite imagery collected for the joint NASA-USGS Landsat Program) to evaluate basic water quality indicators, such as chlorophyll concentrations. These water quality indicators can be used for rapid cursory evaluations of large areas of lakes across the state. Those evaluations can identify waterbodies that may be impacted by various problems, such as algal blooms. Field measurements and observations are necessary to properly calibrate this remote sensing model. The field verification activities and remote sensing model both serve as forecasting and early warning for potential water quality problems, such as Harmful Algal Blooms. For these reasons, data collection will be scheduled to coincide with the Landsat flyovers to the extent practicable.

Understanding Secchi Depth

Secchi Depth¹ is a measure of the transparency of water that relates to sunlight penetration and the productivity, or *trophic state*, of a waterbody. Secchi Depth is affected by characteristics such as turbidity, biomass and surface conditions (e.g. cloud cover, glare, and water turbulence). Secchi Depth is determined by lowering a disk into the waterbody until it disappears from sight, raising the disk to the point it reappears, and then averaging those two depth measurements. Detailed procedures are described later in this document. Long term Secchi Depth monitoring by volunteers provides valuable information for detecting trends in lake water quality.



¹ In 1865, Angelo Secchi created a plain white circular disk to measure water transparency in the Mediterranean Sea. Many years later the disk was redesigned to be smaller and painted into black and white quadrants for use in freshwater (*limnology*) systems.

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Photic Zone and Photosynthesis

Trends in lake water quality, good or bad, can be tracked using Secchi Depth. The clarity and transparency of water affects how deep sunlight can penetrate into a waterbody. The upper layer of the water column that can be penetrated by sunlight in sufficient quantity to allow photosynthesis is referred to as the *Photic Zone*. The energy derived from sunlight influences water temperature and movement, and is utilized by aquatic photosynthetic organisms (e.g. phytoplankton) to process nutrients. The photic zone typically extends about 2 to 3 times the measured Secchi Depth in lakes located in Kentucky. Water clarity and the photic zone depth can vary seasonally and following storm or runoff events.

Trophic State

Trophic State is a classification of lakes based on how productive they are in relation to aquatic life. Trophic state refers to the amount of nutrients and photosynthetic biomass (phytoplankton) in a waterbody. Photosynthetic organisms, such as algae, form the foundation of the food web and are integral to lake health. Lakes in a lower trophic state have fewer nutrients and lower biological growth, while lakes in a higher trophic state have high nutrient amounts and increased biological growth. Generally, as lakes age and the contributing watershed matures, the trophic state increases. The main factors that influence trophic state are nutrient supply, climate and lake shape (depth and size).

Factors Affecting Water Clarity

Many factors influence the water clarity of a waterbody. Sediment suspended in water will decrease its clarity. This may range from very minor impacts to extremely turbid water. Sources of sediments in lakes include storm runoff through streams and overland, bank erosion due to wave action or lake bottom sediments being stirred up by various means. The clarity is also influenced by the abundance of algae. There are many types of algae and they play an important role in the food web. However, an overabundance of algae can be detrimental to the lake ecosystem and create dangerous conditions for animals and humans. If a lake has low suspended sediment, Secchi Depth can provide a relative estimate of the amount of algae present. Water color may vary based on inputs to the waterbody. Tannic, or tea colored, water occurs when tannic acid is released from decaying organic matter. Light will not penetrate dark-colored water as well, and Secchi Depth will be reduced.

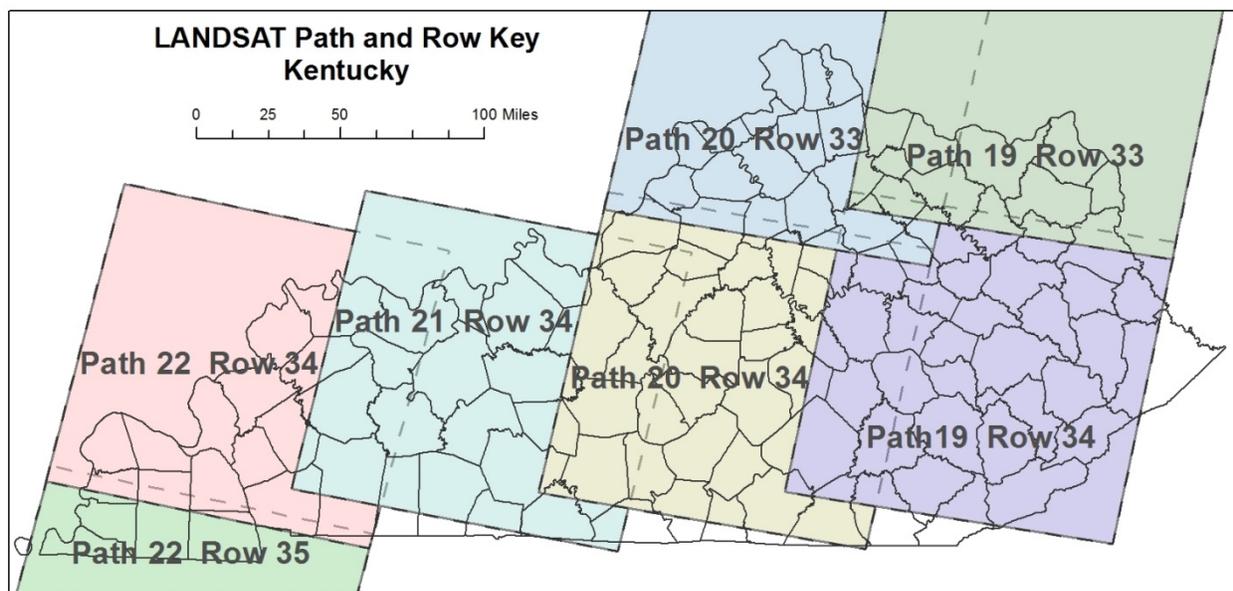
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Monitoring Secchi Depth

Monitoring Secchi Depth is extremely useful as a water quality indicator and is relatively easy to accomplish. The section below describes the preparation, procedures and documentation required.

Preparation

Sample scheduling will vary according to individual volunteer availability and field conditions. As much as practicable, scheduling should include consideration of the Landsat flyover schedule for your area. Secchi Depth measurements and field observations that coincide with Landsat data acquisition can be utilized to calibrate the DOW remote sensing models. As previously mentioned, Landsat is a joint NASA/USGS program that uses satellites to collect images of the earth's surface. Flyovers occur on a roughly two-week interval and the images collected can be used to identify natural changes and human alterations on the earth. Use the map below to determine the Path and Row in which your site falls, then visit <https://landsat.usgs.gov/landsat-8-acquisition-calendar> to determine upcoming flyover dates.



Consult the pre-sampling checklist included with the Field Guide for Volunteer Lake Monitoring Secchi Depth Measurements received during training to ensure that you are prepared. Check that all safety gear needed is in your boat and in good repair. Verify that you have a Watershed Watch – Lakes Measurement and Observation Record

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(shown below) for each site that you plan to visit and that it contains the correct site and sampler information. Consult the lake sample site(s) map(s) provided to you and make sure that it agrees with your Lakes Measurement and Observation Record(s). Inspect the Secchi disk and line/tape to ensure that all connections are secure. Consider the time of day that you will be collecting measurements to ensure adequate natural light; 9:00 AM to 3:00 PM is ideal and mid-day is optimal.

Procedure

Use the monitoring site(s) map provided for your lake to ensure that you have reached the correct location. Follow the steps below to measure the Secchi Depth:

- a) Anchor boat
- b) Remove sunglasses, allowing eyes a couple of minutes to adjust
- c) Measure Secchi Depth off of the shady side of the boat
- d) Lower Secchi disk slowly until it is just out of sight – Record Depth on Field Form to the nearest fraction of a meter
- e) Slowly lower Secchi disk a little further to insure it is out of sight
- f) Raise Secchi disk slowly until it reappears and you can see the black and white indicators – Record Depth on Field Form to the nearest fraction of a meter
- g) Repeat (d) through (f) as necessary to minimize error
- h) Note if Secchi disk is on lake bottom
- i) Retrieve and secure Secchi disk inside boat, wipe clean if needed

Recording Measurements and Field Observations

The header information on your Watershed Watch – Lakes Measurement and Observation Record (or Chain of Custody) will come pre-populated with the Site #, Lake Name, Basin, Sampling Location and County, Name of Supervising Sampler, Associate ID Number and Telephone Number. Please double check all of this information prior to collecting measurements in the field.

The following instructions correspond to individual sections of the Observation Record, which are highlighted on the following page:

- 1) **Site Visit** – provide the date, time (24 hr. clock, e.g. 3:00 is reported as 1500) and Time Zone. Since measurements will occur across two time zones and recorded in a central location it is very important to note this on your form.
- 2) **48-hr Rainfall** – this information can be obtained from a number of websites such as www.kymesonet.org/ or <http://hdsc.nws.noaa.gov/hdsc/pfds/>; excessive

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rainfall can cause or increase turbidity, which affects Secchi Depth measurements.

- 3) **Lake Conditions** – relatively calm conditions are best for Secchi Depth measurements, but ideal conditions may not be present. Choppy water can create unsteady measurements and reflect more light, limiting Secchi Disk visibility. Noting the lake’s surface conditions at the time of measurement will indicate the potential for variation.
- 4) **Lake Appearance** – indicate how the lake appears; utilize the Comments/Observations section if further description is necessary.
- 5) **Current Weather** – make a note of the weather conditions at the time of Secchi Depth measurement. The amount of sunlight available to penetrate into the waterbody will greatly influence the Secchi Depth.
- 6) **Photo** – whenever possible, take photos. Indicate if a photograph was taken; submittal information provided.
- 7) **Secchi Depth Measurements** – check box to indicate if measurement was from a boat or a dock. Record Secchi Depths 1 (lowered) and 2 (raised), noting if disk is on bottom. These values will be averaged to determine the actual Secchi Depth. Note total depth of lake at that site if it is known.
- 8) **Comments/Observations** – record any other pertinent information that has not been captured elsewhere. A check box is included to note if a water quality sample is collected, and there are blanks to indicate Analysis Requested, Container Type and Preservation – this will not typically be used.
- 9) **Chain of Custody Signature Area** – used only if water quality samples are collected and submitted to the laboratory.

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Watershed Watch – Lakes Measurement and Observation Record

Pre-populated with Site and Sampler information

Sections (1) through (6) above

Section (7) above, record measurements

Sections (8) and (9) above, record other pertinent info. Indicate if sample was collected and provide details and signature, if required

Site #		Lake Name			
Basin					
Sampling Location and County (correct or add info if necessary)					
Name of "Supervising Sampler" collecting sample:					Associate ID Number
Use comments box to correct					
Telephone(s):					
Site Visit	48 Hr Rainfall	Lake Conditions	Lake Appearance	Current Weather	Photo
Date:	<input type="checkbox"/> Zero <input type="checkbox"/> .1" <input type="checkbox"/> .5"	<input type="checkbox"/> Calm <input type="checkbox"/> Ripples	<input type="checkbox"/> Clear/Natural <input type="checkbox"/> Tannic/Tea Color <input type="checkbox"/> Turbid/Muddy	<input type="checkbox"/> Sunny <input type="checkbox"/> Partly Cloudy <input type="checkbox"/> Mostly Cloudy	<input type="checkbox"/> Yes <input type="checkbox"/> No
Time (24hr):	<input type="checkbox"/> 1.0" <input type="checkbox"/> 1.5"	<input type="checkbox"/> Small waves <input type="checkbox"/> Choppy waves	<input type="checkbox"/> Discolored-Algae <input type="checkbox"/> Other:	<input type="checkbox"/> Overcast <input type="checkbox"/> Rain	Email to: Ollie.otter@ky.gov
Time Zone:	<input type="checkbox"/> > 1.5 "	<input type="checkbox"/> Crested Waves			
Secchi Depth Measurements					
Collected from: <input type="checkbox"/> Boat or <input type="checkbox"/> Dock (mark one)					
Secchi Depth 1 (disk lowered until it disappears): _____ meters				Disk on Bottom: Yes / No	
Secchi Depth 2 (disk raised until it reappears): _____ meters				Disk on Bottom: Yes / No	
Total Depth of Lake at site (if known): _____ meters					
** If Harmful Algal Bloom (HAB) or other water quality issues suspected report immediately to the Kentucky Division of Water, Complaints Coordinator at 502-564-3410					
Comments/Observations:					
<input type="checkbox"/> Sample Collected – Analysis Requested:		Container:		Preservation:	
When transporting samples to the lab, it is necessary to have each person that controls the sample to sign and record date and time as to when they receive it AND when they relinquish it.					
Relinquished By:		Time/Date		Received By:	
LAB NOTES:					
<u>This form must accompany your sample to the lab. The first signature in the "relinquished by" column must match the supervising sampler's name!</u>					
NOTICE TO LAB: Mail a copy of this form to: Joann Palmer, KY Water Watch, 300 Sower Blvd, 3 rd Floor, Frankfort, KY 40601.					
Please correct errors on the pre-printed part of this record. If you have questions or difficulties, please contact us at (502) 782-7032.					

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Data Management

Each Watershed Watch – Lakes Measurement and Observation Record will be generated using the KY Watershed Watch database at DOW. After completing a monitoring event, submit field forms to the KY Water Watch Coordinator at DOW, 300 Sower Blvd, 3rd Floor, Frankfort, KY 40601; this address is provided on each field form. The KY Water Watch coordinator will enter these data into the database, and they will be available through the Watershed Watch in Kentucky Data Portal (<http://kgs.uky.edu/wwky/main.htm>) where they can be queried by interested parties.

Auxiliary Sample Collection

Water samples will not be collected as a normal part of the volunteer lake monitoring program. However, occasions may arise when water sample collection will be needed. The following basic protocols for water sample collection and preservation are derived from DOWSOP02000, *Kentucky Watershed Watch Stream Grab Sample Collection*. The procedures will be slightly different because sampling locations will typically be in areas with little or no current. Additionally, monitoring points will be focused on locations most likely for human contact, such as shorelines, beaches and boat ramps.

E. coli Grab Sample Procedure

Turn boat off. When collecting an *E. coli* grab sample remember to put on disposable gloves to avoid any potential contamination from your skin. Do not rinse out the bottle when collecting *E. coli* grab samples; the bottles used for bacteria sample collection are sterilized. Point the mouth of the bottle directly over the surface of the water. Next, dip to one foot deep and scoop the bottle away from you and toward the point of access (shoreline or boat ramp), beneath the water surface and through the water column in one swift motion to fill above the line marked on the bottle. If a preservative tablet is in the bottle, alter the grab sample procedure and angle the mouth of the bottle so as not to spill the preservative while collecting the sample. Cap the bottle, leaving at least a small airspace at top to allow lab mixing. Place in wet ice immediately.

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Other Grab Samples Procedures

Turn boat engine off to prevent sample contamination. Remember to put on your disposable gloves to protect the sample from any contaminants. Rinse the bottle with lake water three times – each time, fill bottle approximately $\frac{1}{4}$ full of lake water, cap, shake, and then discard rinse water away from grab sample point. Be sure to discard the rinse water away from the sample point to avoid any potential contamination. Point the mouth of the bottle away from you and toward the point of access (shoreline or boat ramp), submerge the entire bottle to one foot deep and fill. Cap bottle. Add preservative, if necessary, and then place in wet ice. Preservatives are usually strong acids that can be very damaging to your skin, eyes and clothing. The use of gloves and eye protection are required for this procedure. Use extreme caution when handling these chemicals and avoid contact with exposed areas of your body. Should accidental contact with body tissue occur, flush the affected area with large amounts of clean water and seek immediate medical attention.

Preservation

Samples must be kept immersed in wet ice – but not frozen – until received by the laboratory. Wet ice is prepared by mixing clean water with ice cubes to produce a “slurry”. This ensures constant contact with all parts of the sample bottle(s) and an assurance of consistent cooling of all samples at required temperatures without fear of freezing. Ice cubes or blocks alone, or blue ice, are not adequate because they may leave air spaces and cooling may not be consistent. The ice works as a preservative by cooling the sample to a temperature that effectively slows any biological or chemical activity that could skew the sample results. Each sample parameter has a specific holding time, which is the amount of time you have to deliver samples to the laboratory. The shortest holding time is for bacteria (*E. coli*), which is 6 hours. Prior to a sampling event, the Science Advisor should confer with the Lab Manager where samples will be processed to determine any changes in procedural requirements.

If grab samples are collected, always remember to check the box and complete the sample information in the Comments/Observations box, which serves as the Chain of Custody (COC). Make sure that you fill in the blanks to indicate the Analysis Requested, Container Type and Preservation method(s). The Date and Time recorded in the Site Visit section will also serve for purposes of noting sample collection date and time.

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References and Resources

Carlson, R. and Simpson, J., 1996, A Coordinator's Guide to Volunteer Lake Monitoring Methods, NALMS: <http://www.nalms.org/home/nalms-reports/>

Woods, A.J., et al, 2002, Ecoregions of Kentucky (color poster with map, descriptive text, summary tables, and photographs): Reston, VA, U.S. Geological Survey (map scale 1:100,000)

Understanding Lake Ecology: A primer on limnology, US Environmental Protection Agency: <https://cfpub.epa.gov/watertrain/pdf/limnology.pdf>

Secchi Disk Reading Simulator from Maine Volunteer Lake Monitoring Program: <http://www.minelakedata.org/recertify/disk.php>

The Secchi Dip-In: Volunteer Monitoring Methods (North American Lake Management Society): <http://www.secchidipin.org/index.php/monitoring-methods/>

US Environmental Protection Agency, Lakes: <https://www.epa.gov/lakes>