APPENDIX A:

SNOHOMISH COUNTY LAKES VOLUNTEER MONITORING MANUAL

February 2003
Revised January 2011
Revised March 2015

Surface Water Management Division
Public Works Department
Snohomish County

Acknowledgements

Volunteers

To our past, present, and future volunteers, this program would not be possible without your dedication.

Department of Ecology Centennial Clean Water Fund

The Snohomish County Volunteer Lake Monitoring Project was initiated in 1992 with funds from the State of Washington through a Centennial Clean Water Fund Grant.

Washington State Department of Ecology

Washington Department of Ecology. A Citizen's Guide to Understanding and Monitoring Lakes and Streams. November 1999.

The monitoring methods presented in this manual are also patterned after those used in the Department of Ecology's volunteer lake monitoring program during the 1990s.

Table of Contents

Overview of Snohomish County Lake Monitoring Program 5
What is a Volunteer's Role in this Program? 5
General Lake Information 5
Lakes and Watersheds 5
Lake Eutrophication 6
Human Activities That Cause Water Quality Problems 7
Significance of Volunteer Monitoring Data 8
Water Clarity 8
Temperature 8
Dissolved Oxygen 9
Phosphorus 10
Nitrogen 11
Chlorophyll-a 11
pH 12
Lake Level 13
Water Color Observations 13
Water Color Measurements (True Color) 13
Weather and Lake and Watershed Observations 13
Recreational Suitability Observations 14
Monitoring Procedures 15
Monitoring Schedule 15
Check of Weather Conditions 16
Equipment and Monitoring Preparation 16
Location of Monitoring Site 16
Basic Monitoring Activities 17
Temperature and Weather Conditions 17
Water Clarity 18
Algae Observations 18
Water Color 19
Other Observations 19
Water Sampling 20
1 Meter Samples: Total Phosphorus (TP), Total Nitrogen (TPN), Chlorophyll-a (chl-a) 20
Deep Sample (1 meter from lake bottom): Total Phosphorus (TP) 21
Temperature and Dissolved Oxygen Profiles 22
Chain of Custody Form 22

Sample Pick-Up ____ 22
Equipment Storage ____ 22
Data Submittal ____ 23
Generic Lake Monitoring Cheat Sheet ____ 23
Glossary of Terms ____ 23

Figure 1 pH Scale ____ 12
Figure 2 Scum Types ____ 19

Table 1 Comparison of Celsius to Fahrenheit ____ 9
Table 2 Solubility of Dissolved Oxygen in Water ____ 10
Table 3 Equipment Checklist ____ 16
Table 4 Bottom Sample Depths ____ 21

Overview of Snohomish County Lake Monitoring Program

Thank you for participating in Snohomish County's Lake Monitoring Program. Your efforts are essential in helping all of us protect the lakes in Snohomish County. Regular monitoring provides the basic information about the condition of lakes in our county. This information helps the County and the public better manage our lakes.

The goal of the Snohomish County Lake Monitoring Program is to collect data that will support short and long-term management decisions that protect lakes, promote public health and safety, and build a foundation for understanding the nature and character of the county's lakes. Specific objectives of the monitoring program are:

- Assess current water quality status of the county's lakes.
- Identify long-term changes in water quality.
- Identify specific water quality problems at individual lakes.
- Identify lakes that need additional study or specific actions to solve water quality problems.
- Identify toxic algae blooms and notify the public of health risks.
- Involve Snohomish County residents in monitoring their lake's health.

This volunteer manual will cover basic information about lakes and the information volunteers will collect. This manual will also cover detailed instructions on how to collect data.

What is a Volunteer's Role in this Program?

From May to October, volunteers will regularly perform simple scientific measurements at their lakes. Snohomish County staff will provide field equipment and training annually. Measurements include water clarity, temperature, total phosphorus, total nitrogen, chlorophyll a, and lake level. Observations include water color, weather conditions, and other conditions in the lake and watershed. Some volunteers may also measure dissolved oxygen and temperature profiles.

At the end of the year, County staff will prepare a brief report on the status of county lakes based on the results of volunteer monitoring. This report will summarize the general condition of each lake and compare lakes within Snohomish County.

General Lake Information

This section provides basic information about lakes.

Lakes and Watersheds

Lakes are standing bodies of water an acre or more in size. Lakes are closely linked to their surrounding watersheds. A watershed is simply the land area that drains into a lake. Everything that happens in the watershed affects the lake in some way.

The watershed supplies the water that sustains the lake. Water enters the lake from precipitation that falls on the lake surface itself and from precipitation in the watershed that runs off into the lake. Precipitation also percolates through the soil to the groundwater and may ultimately seep into the lake.

Watersheds affect the chemical and biological conditions of the lake water. Water from the watershed carries with it many chemicals and other materials. Runoff washes over plants, dirt, roads, and driveways, picking up materials, dissolved substances, and organic matter. All of these substances are deposited in the lake. Groundwater also transports dissolved chemicals into the lake. The substances transported into the lake by runoff and groundwater affect the clarity of the water, the amount and types of algae and rooted aquatic plants in the lake, and even the abundance of fish in lake. In addition, if pollutants are present in the watershed, the lake is likely to receive some of them and to suffer because of it.

Temperature, oxygen, and other chemical properties of the water also affect the lake condition. During spring and summer, the upper water in a lake is warmed by the sun. Because warmer water is less dense, it tends to float above the cooler and denser water below, forming two distinct layers. During this period of solar warming, the lake may be stratified into two layers that do not mix. Fresh oxygen from the atmosphere is no longer supplied to the bottom waters because of the thermal separation or stratification. If there is an abundance of decaying matter on the lake bottom, the decaying process consumes oxygen, potentially reducing the oxygen content of the lower waters. This can stress fish and introduce nutrients from the lake bottom that stimulates algae production.

In the fall, as the upper waters cool, the temperature difference between the lake layers decreases. Eventually, the wind and waves are able to overcome the density forces separating the two layers and the entire lake mixes again. This phenomenon is called fall turnover. During turnover, dissolved nutrients from the lake bottom are distributed throughout the lake. This can fertilize the growth of algae and cause algae blooms.

Lake Eutrophication

Lakes, like all geologic formations, are not permanent features of the landscape. All lakes move through a cycle, from creation to dry land. This process, similar to aging, happens because of eutrophication. Eutrophication, which literally means "well nourished," occurs as lakes are enriched by excess nutrients and sediment, primarily from the surrounding watershed. The nutrients and sediment nourish plant and algae life in a lake. Given enough nourishment, plants will eventually take over the entire lake. Under natural conditions, this cycle takes tens or hundreds of thousands of years because undisturbed watersheds are relatively stable. However, human activity often dramatically accelerates this process by disturbing the soil and vegetation within the watershed, as well as directly contributing nutrients to the lake.

Most of the lakes in Snohomish County were formed by glaciers. When the lakes were newly formed, they were crystal clear, with little plant or animal life because the level of nutrients was low. Nutrients, such as phosphorus and nitrogen, are the basic food of algae and other plants. A few of the Snohomish County lakes are still at this early stage of life, with very clear water and limited plants. The trophic status of these lakes is called "oligotrophic."

Over time, sediment and nutrients wash into a lake from the surrounding watershed. Algae, which are microscopic plant-like organisms suspended in the water, are the basis of the food pyramid in a lake.

Microscopic animals called zooplankton feed on the algae, and the zooplankton in turn are eaten by fish and other animals. As a lake becomes richer in nutrients, more algae and more floating-leaved plants, such as lily pads, begin to grow in the water. The plants provide food and habitat for fish and other animals.

When the algae and plants die and sink to the bottom, they decompose, adding sediment to the lake. The lake gradually becomes shallower. With more nutrients and plant growth in the lake, the water is no longer as clear. The lake is now in the middle, or “mesotrophic”, stage of eutrophication. Some of our lakes in Snohomish County are at this stage.

When there is an excessive amount of nutrients available for plants, algae blooms may occur. Algae blooms are dramatic explosions of algae that can form scums and cloud the water. This usually happens during summer months when light and temperature are optimal for plant growth. But, blooms can also occur after the lake turns over in the fall or winter and nutrients become mixed throughout the water.

An excessive amount of nutrients in the water may also cause the algae species in a lake to change. Algae species that are eaten by zooplankton and fish are often replaced by blue-green algae species, which are not easily eaten by animals. Large populations of blue-green algae are usually indicators of polluted or threatened lakes.

When lakes reach the stage where they contain excess nutrients, especially phosphorus, and support vigorous growths of algae and plants, the lakes are considered to be “eutrophic.” Eutrophic lakes often exhibit low levels of oxygen. Decomposition of dead plant matter collected on the bottom uses up oxygen. When a lake is stratified, divided into layers by temperature, this lack of oxygen may allow the release of nutrients from the lake bottom back into the water to be used again and again by plants and algae. Some Snohomish County lakes are at this advanced stage of eutrophication.

Human Activities That Cause Water Quality Problems

The natural life cycle of a lake takes thousands of years. However, human activities within a lake’s watershed may introduce excess nutrients and sediment that greatly speed up the process of eutrophication. Activities that can affect lake water quality include:

- use of fertilizers and pesticides, especially in large quantities near the water.
- use of detergents and household products containing phosphates and toxic chemicals.
- excess waterfowl and pet wastes.
- runoff from roads, driveways, rooftops, and other hard or paved surfaces.
- land clearing and development that causes erosion into streams or the lake.
- septic systems that are poorly maintained or improperly designed.
- agricultural practices, inducing animal access to streams or the lake.

All of these activities add nutrients and/or sediment to the lake and hasten the process of eutrophication. These activities are difficult to control, however, because they involve almost every property in a watershed to some degree or another. This is why public stewardship of lake water quality is so important. Unless we all take steps to protect water quality, our lakes will suffer.

Significance of Volunteer Monitoring Data

Volunteers collect a wide variety of data to assist in understanding the condition of Snohomish County lakes. The results of lake monitoring can be used to identify problems and solutions that residents and others can use to protect and improve lakes.

Water Clarity

Volunteers will use a Secchi disk to measure the clarity of the water. A Secchi disk is about 8 inches in diameter and is painted black and white in alternating quadrants. A rope is attached to the disk and marked in tenths of a meter. Volunteers lower the disk into the water and record the depth at which it can no longer be seen. This depth is called the Secchi disk depth or transparency of the lake. An online Secchi reading simulator can be found at http://www.mainevolunteerlakemonitors.org/recertify/disk.php?.

The Secchi disk is a convenient method for determining water quality. It measures how far light can penetrate through the water. Secchi depth readings will vary with the clarity of the water. The more suspended material, such as algae and sediment, in the water, the shallower the Secchi depth reading. The clearer the water, the deeper the Secchi disk can be seen.

The amount of suspended material in the lake may fluctuate during the monitoring season. During periods of heavy rain and runoff, silt and other soil particles may be washed into the lake, clouding the water. During summer, populations of algae may grow in response to the increased light and warmth. Secchi depth readings will be shallower during such periods because of the amount of algae suspended in the water. In some lakes, the water is colored because surrounding wetland and peat soils release natural tannins into the water. This will also reduce the Secchi depth readings.

Poor water clarity affects fish and aquatic life in several ways. Sunlight may be blocked from reaching submersed aquatic plants. These plants need light for photosynthesis. If photosynthesis is restricted, the plants will produce less oxygen for fish and aquatic life. Suspended matter in the water can clog the gills of fish and shellfish and can also interfere with animals that are dependent on visibility to find food.

Water clarity is one of the indicators of the water quality of a lake. Shallow Secchi depth readings may indicate that there is an excess of algae and/or sediment in the water. Progressive declines in Secchi depth may tip us off to problems at a stage when the problems can still be solved. We can also use Secchi depth measurements to scientifically classify the condition of a lake in regard to the eutrophication process. Lakes with poor water clarity are often eutrophic and suffer from nutrient enrichment.

Temperature

Temperature is a simple measurement and one of the most important parameters to monitor in a lake. Temperature dramatically affects the rates of chemical reactions and biological activity in the water, which in turn affect water quality. Warmer water generally increases the rates of plant and algae growth, as well as that of many animals. On the other hand, warm water is able to hold less oxygen than cold water. Cold-water fish, such as trout and salmon, cannot survive in very warm water. Warm water also accelerates the decay of organic matter in a lake, using up more oxygen in the water.

Volunteers will measure the surface temperature of their lakes. This will give an indication of how warm or cool the lake becomes and how quickly the water temperature changes through the seasons.

Some volunteers will have equipment allowing them to measure the temperature at different depths within the lake. This is especially important information for lakes. It provides information about conditions in the lake that may affect oxygen levels and algae growth, as well as how the lakes mix.

During the spring and summer months, the surface waters of a lake will be warmer than deeper waters because of heating by the sun. During this period, the two layers of water will not mix because colder water is more dense than warmer water. The greater the temperature difference, the stronger the separation of water layers. While a lake is stratified, or divided into layers, oxygen from the atmosphere cannot reach the lower waters. If there is sufficient decaying matter in the lake, the oxygen content of the lower waters will soon be depleted. This can threaten fish and animal life. Lack of oxygen can also release nutrients from the bottom sediments that fuel the growth of undesirable algae.

In the fall, the upper waters cool until the entire lake is close to the same temperature. Then, wind and waves will mix and “turn over” the lake from top to bottom. Oxygen will be restored to the bottom waters, but nutrients accumulated during the period of stratification are available for rapid algae growth. Temperature measurements by volunteers will provide information about the timing and strength of lake stratification and turnover.

Volunteers will be measuring temperature with thermometers marked in degrees Celsius or with electronic temperature probes. Using the Celsius scale will make the volunteer-collected data comparable to data from other monitoring programs and more useful for scientists. For reference, Table 1 compares degrees Celsius and Fahrenheit.

Table 1 Comparison of Celsius to Fahrenheit

Celsius (°C)	Fahrenheit (°F)
0	32
1	34
2	36
3	37
4	39
5	41
6	43
7	45
8	46
9	48
10	50
11	52
12	54
13	55
14	57
15	59
16	61
17	63
18	64
19	66
20	68
21	70
22	72
23	73
24	75
25	77
26	79
27	81
28	82
29	84
30	86

Dissolved Oxygen

Dissolved Oxygen is another important measurement for lake water quality. Oxygen dissolved in the water is essential for all plants and animals in the lake. When oxygen levels in the water fall below 3-5 mg/L (milligrams per liter or parts per thousand), many fish and other animals cannot survive. When oxygen levels fall below 2 mg/L, a chemical reaction can occur that releases nutrients from the bottom sediments.

Oxygen enters the water at the surface of a lake from the atmosphere. The mixing action of wind and waves assists oxygen transfer from the atmosphere to the water. Oxygen is introduced into lake water also by aquatic plants and algae as a by-product of photosynthesis.

Dissolved oxygen levels in a lake will vary over time and with depth. For example, in a productive lake, oxygen levels increase during the daytime as aquatic plants and algae release oxygen during photosynthesis. During the night, the plants and algae take up oxygen as they respire, lowering oxygen levels in the water. Oxygen levels increase after storm events, strong winds and waves, and during the winter when the entire lake is well-mixed.

In the spring and summer, oxygen levels will decrease in bottom waters because stratification prevents oxygen from being re-supplied from the atmosphere. Oxygen is also consumed by the bacteria that decompose organic matter on the lake bottom. This low oxygen condition persists throughout the summer until fall turnover provides fresh oxygen from the atmosphere. However, in some lakes, oxygen levels may actually decrease after fall turnover because of the huge oxygen deficit that has been created through the rapid decomposition of organic matter in the lake bottom during the summer.

Another fact to know is that warm water holds less oxygen than cold water. Table 2 shows the maximum amount of oxygen that water can hold at different water temperatures, also known as 100% saturation.

Table 2 Solubility of Dissolved Oxygen in Water

Temperature (°C)	Dissolved Oxygen (mg/L)
0	14.6
4	13.1
8	11.9
12	10.9
16	10.0
20	9.2
24	8.6
28	7.9

Snohomish County staff will visit each lake at least once during the year to measure dissolved oxygen and temperature levels. Some volunteers will also be given instruments to measure the amount of oxygen at different depths in the lake. Together with temperature information, data on dissolved oxygen will provide an indication of the biological and chemical conditions in each lake.

Phosphorus

Phosphorus is an essential nutrient for the growth of both plants and animals. Phosphorus occurs naturally in the soil and rocks and can be found in all plant and animal tissue, as well as attached to particles in the atmosphere.

Phosphorus may enter a lake in multiple ways. Phosphorus can be deposited from the atmosphere as dust directly onto the surface of the lake. It can be released from the watershed by the weathering of rocks and soils, and transported by surface runoff and streams to the lake. Human impacts in the watershed can increase the amount of phosphorus in runoff. Sources of phosphorus include lawn fertilizers, agricultural fertilizers, wastes from pets and farm animals, runoff from roads, roofs, and paved areas, land clearing and soil erosion, and poorly maintained or failing septic systems.

Phosphorus is important to algae growth and is usually the limiting factor in biological productivity in a lake. Phosphorus is usually measured in two components—soluble phosphorus and total phosphorus. Soluble or dissolved phosphorus is that portion of the phosphorus that is immediately available for use by algae. Total phosphorus includes both soluble phosphorus and other forms of phosphorus that may be attached to soil particles or contained within the cells of algae and zooplankton.

Too much phosphorus in a lake can lead to nuisance algae blooms, and lake eutrophication. A eutrophic lake can have multiple water quality issues associated with the excess amount of algae growth caused by too much phosphorus. These could include toxic algae blooms, interference with recreational activities and boating, decline in fish and wildlife habitat, and aesthetic problems.

It is important to know the concentration of phosphorus in a lake to assess the degree of eutrophication. Snohomish County staff or volunteers will collect monthly samples at different depths in each lake to measure the phosphorus concentrations.

Nitrogen

Nitrogen is also an essential nutrient for the growth of plants and algae. Various forms of nitrogen can be found in water, including organic and inorganic forms. Organic forms of nitrogen are derived from living organisms and include amino acids and proteins. Inorganic forms are composed of materials other than plants or animals and include nitrate, nitrite, ammonia, and nitrogen gas. Total nitrogen is a measure of all the various forms of nitrogen found in a water sample, except for nitrogen gas. In general, algae and aquatic plants directly utilize inorganic forms of nitrogen.

Like phosphorus, nitrogen can enter the lake in multiple ways. Some algae can “fix” or pull gaseous nitrogen from the atmosphere and convert it to a usable form. It can be transported by surface runoff and streams to the lake. Human impacts in the watershed can increase the amount of nitrogen in runoff. Sources of nitrogen include lawn fertilizers, agricultural fertilizers, wastes from pets and farm animals, runoff from roads, roofs, and paved areas, and poorly maintained or failing septic systems.

It is useful to know total nitrogen concentrations in a lake to assess the ratio between phosphorus and nitrogen. This ratio is a useful tool to understand the relative importance of these nutrients and algae abundance in a lake. Snohomish County staff or volunteers will collect monthly samples at different depths in most lakes to measure the total nitrogen concentrations.

Chlorophyll-a

Chlorophyll-*a* is a photosynthetic pigment present in all algae and aquatic plants. In the process of photosynthesis, chlorophyll captures light energy, using it to combine carbon dioxide and water into sugar, and storing the energy as chemical energy. Because chlorophyll-*a* is present in all algae and is such an important component of algae growth, it is used as a measure of algae biomass in lakes.

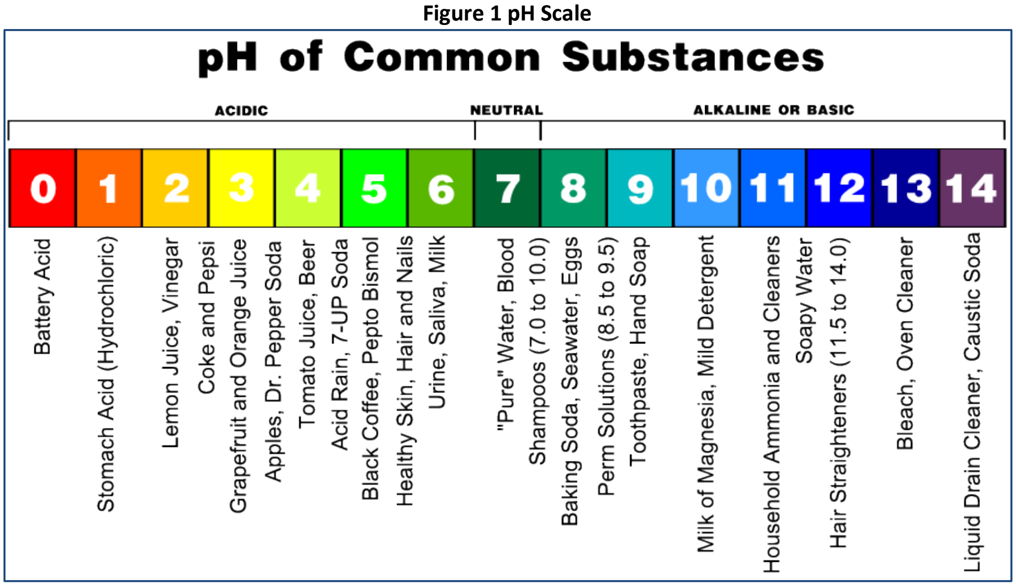
Knowing the concentration of chlorophyll-*a* in a lake provides a good estimation of the amount of algae in the water column. Chlorophyll-*a* concentrations are usually high in the spring and summer months when there is a lot of light and nutrients are available for growth. Chlorophyll-*a*, like phosphorus, is an indicator of the condition of the lake and is used to determine the trophic status. Snohomish County staff or volunteers will collect monthly samples near the surface in most lakes to measure chlorophyll-*a* concentrations.

pH

Hydrogen ion activity, or pH, is a measure of the relative acidity of a liquid. The pH of water is measured on a scale of 0 to 14. A pH of 0 is extremely acidic and a pH of 14 is extremely alkaline or basic. A pH of 7 is considered neutral. Distilled water has a pH of about 7 and rainwater is closer to 6.

The pH scale is exponential. That is, a change of one whole number on the scale is a ten-fold change in acidity. So a pH change of one whole number would mean significant change in the chemical composition of the lake water. Figure 1 shows the relative pH of common substances.

Figure 1 pH Scale



Measurement of pH is important because pH affects biological and chemical activity in a lake. Extremes of acidic or basic conditions may threaten living organisms. Most animals cannot survive if pH is less than 5 or greater than 9. Measurement of pH is also important because pH can be an indicator of water quality. Lake pH can be affected by activities within the lake and the watershed. Photosynthesis by aquatic plants and algae increases pH. Sediment from soil erosion can change pH depending on the types of soils and rocks found in the watershed. Agricultural practices, fertilizers, pesticides, septic system effluent, and runoff from developed areas can affect the pH of the water.

Another property of lake water quality that is related to pH is alkalinity. Alkalinity is a measure of a lake's ability to resist changes in pH. This is known as the buffering capacity of the lake. Low alkalinity reduces a lake's resistance to changes. A lake with low buffering capacity (soft water) is more susceptible to pollution than one with a high buffering capacity (hard water) because only small changes in chemistry are needed to affect the lake water quality. Volunteers are not asked to measure pH, but County staff will measure pH in most lakes whenever they perform the monitoring, usually at least once a year.

Lake Level

Volunteers will also measure the water level of their lakes. This indicates both the amount of water in the lake and the balance between water flowing in from precipitation or groundwater and water leaving by evaporation or outflow. Lake levels in our region will be highest in early spring and lowest in late summer and fall. The importance of lake level is to indicate the seasonal effects of the water balance in the lake. Several factors may contribute to changes in lake level, including; rainfall, sedimentation, surrounding topography, beaver activity, and plugged outlets.

Water Color Observations

Volunteers will observe and describe the apparent water color of their lakes each time they take a Secchi disk measurement. Apparent color is the color of the water as seen by the human eye. Because observation of water color is a subjective judgment, volunteers will choose from a list the color that best matches their perception of the lake water color.

Water color is generally not a water quality concern. However, color can be a factor influencing the interpretation of other data collected on a lake. For example, the water in some lakes may be brown, or amber because of the lake's proximity to natural wetlands that release tannins into the water. The color does not indicate pollution, but does reduce the ability of light to penetrate the water.

Natural water color affects the Secchi readings and may complicate the interpretation of the relationship between Secchi depth and lake water quality. In other cases, water color may indicate the presence of suspended algae (which come in various colors) or fine silt in the water. Accordingly, the color of the water may change based on the amount of algae production and the recent history of rainfall and erosion.

Water Color Measurements (True Color)

True color is the color of water after all suspended substances that could influence the color, like algae and suspended sediment, have been removed. True color is determined by first filtering a water sample to remove all suspended substances. After the samples have been filtered, they are compared to a specific color scale. This comparison is generally done in a laboratory with a spectrophotometer.

The most commonly used color scale is the platinum-cobalt color scale. This system is comprised of 1,000 color units or platinum-cobalt units (PCU or Pt-Co units). If one were to use the platinum-cobalt color scale to measure lake water that is especially clear (colorless), the color readings would probably be less than 10 PCU, whereas lakes that have a little color will have a true color measurement ranging from 20 to 50 PCU. On the far end of the spectrum, lake water that is extremely dark in color will have a color reading of 500 PCU or higher.

Snohomish County staff or volunteers will collect true color samples every five to ten years.

Weather and Lake and Watershed Observations

Weather conditions will affect measurements of Secchi depth, temperature, dissolved oxygen, lake level, and other aspects of lake condition. Therefore, volunteers will record recent weather conditions when they collect monitoring data.

Since Secchi measurements rely on light and the eyesight of the volunteer, the amount of cloud cover, smoothness of the water surface, and time of day will affect the readings. In addition, recent storms may have washed sediment into the lake, creating temporary turbidity (cloudiness) in the water.

Water temperature and dissolved oxygen are also affected by weather. Windy, rainy conditions will add oxygen to the water and may mix the lake unless the lake is strongly stratified. In contrast, a succession of warm, sunny, calm days provides conditions that are ideal for algae and plant growth.

Volunteers are asked to record other observations about the lake and the watershed. This includes floating algae, odors, muddy water, waterfowl, oil on the water surface, land clearing, rapid increases in the abundance of aquatic plants, or any other conditions that the volunteers consider significant.

These observations, though sometimes subjective, provide clues about possible water quality problems and may indicate potential causes of the problems. Observant and concerned residents serve a valuable role in protecting lakes and alerting the community to water quality problems. If agencies and residents learn about problems in time, there are greater opportunities to address the problems before they permanently damage the lake.

Recreational Suitability Observations

Lakes are used for a wide variety of recreational opportunities. Therefore, another perspective on lake condition is the quality of a lake in terms of its suitability for recreational use. Some microbial organisms, algae toxins, and other contaminants may be present in lakes and can even make people sick.

Volunteers are asked to record other observations about the extent of recreation that occurs at their lakes. This includes the number of boats, number of fishermen on the lake, the number of people swimming or wading, as well as a subjective ranking of their lake's recreational suitability.

This suitability ranking is focused on nuisance algae and its effect on recreational activities. The ranking is from one to five, one being the best, and five being the worst. Current weather conditions and temperature should not factor into the ranking. The descriptions of the recreational suitability are;

1. beautiful could not be nicer.
2. minor aesthetic concerns - still good for swimming and boating.
3. swimming, boating and aesthetic enjoyment slightly impaired.
4. swimming, boating and aesthetic enjoyment substantially impaired (would not swim, but boating is ok).
5. swimming, boating and aesthetic enjoyment are severely limited (would not swim or boat in lake).

Monitoring Procedures

The following sections describe lake monitoring procedures in detail. Please read these pages over before you begin monitoring, and please carry out the monitoring in the order described. The instructions are broken down into major activities that you are to complete and procedures necessary to measure each parameter. The major activities include;

- Monitoring Schedule
- Check of Weather Conditions
- Equipment and Monitoring Preparation
- Location of Monitoring Site
- Basic Monitoring Activities
- Water Sampling
- Temperature and Dissolved Oxygen Profiles
- Chain of Custody Form
- Sample Pick-up
- Equipment Storage
- Data Submittal

County staff will also provide a two-page waterproof "monitoring cheat sheet" specific to your lake. An example of this monitoring cheat sheet is available at the end of this appendix. Please refer to the annual monitoring schedule for your lake and instructions from Snohomish County staff to confirm the monitoring you will perform.

Monitoring Schedule

County staff will prepare a monitoring schedule at the beginning of each monitoring season. This schedule will include basic monitoring activities, water sampling dates, and sample pick-up dates. All monitoring must be done between 9:00AM and 4:00PM.

- Basic monitoring activities are scheduled twice a month between May and October. This monitoring can be performed any time during that week or weekend.
- Water sampling is scheduled once a month between June and September. Water sampling must be performed on a Saturday or Sunday, and should be done along with the basic monitoring activities.
- Sample pick-up times are scheduled for Monday mornings following a water sampling weekend. County staff will begin to pick up water samples at 8:00AM.

Because of weather conditions or other time commitments, it may not always be possible for you to monitor on the day you have planned. Try to complete the monitoring within two days of your scheduled date. Even if you miss the date by more than two days, you should still perform the monitoring. Late or early data are better than no data.

The only exception is for phosphorus and chlorophyll *a* sampling. If you cannot collect these samples on the designated weekend, please contact County staff. Please remember that regular monitoring is needed to accurately document any changes in lake condition. Please call County staff if you have questions about scheduling.

Check of Weather Conditions

Check the current and forecasted weather conditions and decide if conditions allow for safe monitoring. Check the lake for waves and rough water. Do not go out in stormy or dangerous conditions. No data are worth your safety.

Equipment and Monitoring Preparation

Ensure that you have all equipment for the monitoring to be performed that day. Table 3 lists all of the equipment necessary to perform basic monitoring, water sampling, and dissolved oxygen and temperature profiles.

Table 3 Equipment Checklist

Basic Monitoring		Water Sampling	Dissolved Oxygen
☐ Instruction Sheet	☐ Life jacket	☐ Water sampler	☐ YSI meter
☐ Data Sheet	☐ Anchor	☐ 1 TP/TPN bottle	☐ DO Instructions
☐ Clipboard	☐ Algae Sample Kit	☐ 1 TP bottle	
☐ Pencil & Sharpie	☐ Hat (optional)	☐ 1 Chl-*a* bottle (public)	
☐ Thermometer	☐ Towel (optional)	☐ Cooler with ice	
☐ Secchi Disk	☐ Boat (not optional)	☐ Extra Bottle Set	

<u>Before</u> going out on the lake;

1. Please label your sample bottles with Sharpie or other permanent marker, to include the following information:
    a. Lake name and depth.
    b. Date and approximate time the sample will be collected (use the same time for all bottles).
2. If you are assigned a dissolved oxygen meter, calibrate the instrument (see specific instructions).

Location of Monitoring Site

Monitoring locations for all Snohomish County lakes are found in Appendix B of the *Quality Assurance Plan: Snohomish County Lake Management Program*.

Use the following steps to locate the monitoring location for your lake:

1. Monitoring should be performed at the deepest point in the lake. This location provides the best indication of the overall condition of the lake. Be sure to conduct your monitoring at the same spot in the lake every time. This will provide consistency in the data and make the results more scientifically valid.
2. Your map indicates the approximate location of the deepest spot in the lake. County staff will also help you locate this point before you begin the monitoring and will mark your map with shoreline landmarks. These landmarks will consist of two sets of features that line up together and form an imaginary "X" when you are at the correct location in the lake. (An alternative method is to anchor a buoy at the appropriate location. A buoy works best in small, shallow lakes with little boat traffic.

3. Once you have located the correct spot, anchor your boat. Anchoring will keep the boat from drifting into shallow water while you monitor.
4. If your lake is shallow, avoid re-positioning the anchor once it is dropped. Moving the anchor may stir up sediment and affect your monitoring results.

Basic Monitoring Activities

Basic monitoring is done twice a month from May through October. Begin filling in the monitoring datasheet with lake name, volunteer name(s), and monitoring date and time. The specific monitoring procedures for each parameter are located in the following sections. Only follow those procedures for parameters that have been assigned to you, in the order in which they appear in the following pages. Some volunteers in the program may monitor and collect samples for more or less parameters than you will be doing for your lake.

Temperature and Weather Conditions

Complete the temperature and weather conditions section of the field form. Use the thermometer provided to you by County staff for measuring temperature. (Be sure to take the thermometer out of its case.) The weather conditions should be the conditions that are present when you are doing your Secchi disk measurement.

Air Temperature

1. Measure the air temperature. First, dry the thermometer and place it in your boat out of the direct sun (or you can hang it under a shady tree or bush away before you go out in the boat). Keep the thermometer away from any large objects that can radiate heat.
2. Wait two to three minutes to allow the thermometer to stabilize at the correct temperature.
3. Read the thermometer and record the value on the data sheet to the nearest ½ degree C, which is the smallest division on the thermometer. The next longer marks are for each degree. The longest marks are for every five degrees. Please note that the “5” between 10 and 20 is for 15 degrees and the “5” between 20 and 30 is for 25 degrees.

Surface Water Temperature

1. Measure the water temperature. Be sure the string is attached securely to the cork float.
2. Hold the thermometer about 6 to 12 inches below the surface of the lake. Wait two minutes for the thermometer to stabilize.
3. Pull the thermometer out of the water and read the temperature quickly but accurately. It is important to read the temperature quickly because the thermometer will start changing immediately in response to air temperature and wind.
4. Record the surface temperature to the nearest ½ degree C. That is the smallest division on the thermometer. The next longer marks are for each degree. The longest marks are for every five degrees. Please note that the “5” between 10 and 20 is for 15 degrees and the “5” between 20 and 30 is for 25 degrees.

Weather Conditions

1. Record the percentage of cloud cover. “0%” means the sky is completely sunny. “100%” means the sky is completely overcast. Choose the cloud cover percentage that best describes conditions at the time of the Secchi reading.

2. Describe the extent of rain within the last two days. If there has been rain, use your judgment to determine how much rain there was. You may also write in observations about recent weather, such as describing a brief but heavy downpour that produced lots of runoff.
3. Describe the current wind conditions. Windy conditions will disturb the lake surface and affect the monitoring results. Choose the wind conditions that best describe conditions at the time of the Secchi reading.

Water Clarity

1. Remove your sunglasses and lean over the shaded side of the boat. This is important to reduce sun glare and provide optimum conditions for looking into the water.
2. Lower the Secchi disk into the water slowly until the disk just disappears from view. Then, slowly raise the disk until you can barely see it again. Move the disk carefully up and down a few inches until the exact vanishing/re-appearing point is found. Make sure the rope is vertical when you take the reading. Take your time because your view of the disk will be very faint.
3. Without moving the disk again, record the depth where the rope touches the water surface as the "1st Secchi Reading."
    a. Please record the Secchi reading to the nearest tenth (0.1) of a meter. If it is exactly on the meter mark, record "0" tenths, such as "4.0" meters.
    b. If the disk hits the lake bottom before disappearing from view, write down the depth and check the appropriate box on the form.
    c. If the disk disappears into the weeds, move a short distance away from the weeds. If you have to move more than a few feet because of weeds, take the Secchi reading at the new location, note the problem, and call County staff.
4. Repeat the Secchi disk depth measurement by following steps 2-3. If the second reading is more than one tenth (0.1) meter different from the first, please do a third reading.
5. Record the second reading on the data sheet as the "2nd Secchi Reading".
6. If you had to do three or more readings to get two within 0.1 meters, please enter the two readings that were within one tenth of a meter.

Algae Observations

1. Lower the Secchi disk 6 inches below the water on the sunny side of the boat and observe the small particles (the algae) over the disk. If there are too many particles to count in an area the size of a half dollar, select "Yes" for Heavy Algae.
2. Look for mats of stringy filamentous algae throughout your monitoring trip and note if observed. Filamentous algae will not break apart when disturbed with a stick and look like long strands or dense mats of "hair".

3. Look for algae scums throughout your monitoring trip and note if they are present and the scum type. Algae scum is an accumulation of algae cells that often looks like spilled paint.
    a. Figure 2 shows the difference between small clumps, thin film, and thick scum types.
4. Indicate if an algae sample was taken during the monitoring event. Write down the location on the lake where the sample was taken.

Algae Sampling

Algae Sample kits will provided by County staff to sample scums.

1. Put on nitrile gloves provided before sampling algae scums.
2. Fill out the sample bottle label with lake name, sampling date, and sampling location.
3. Collect the algae scum using a skimming motion across the lake surface. The skimming motion will ensure that scum will enter the bottle.
4. Place sample in cooler.

Water Color

1. Lower the Secchi disk to ½ the Secchi depth reading for that day and look at the white part of the disk to determine the water color.
2. Select the color on the datasheet that best matches the color you observe. If none of the colors on the datasheet is close, write in your own description.
3. Choose the intensity that best matches the water color you observe. The options are light, moderate and dark.
    a. Light intensity is a faint wash of color.
    b. Moderate intensity is vivid color.
    c. Dark intensity is when the color appears murky.

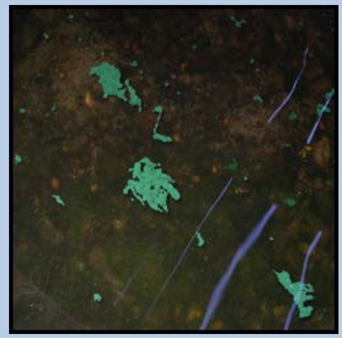
Other Observations

1. Record the lake level at the lake staff plate or a pre-determined location and circle inches or feet. If you don't have a location set up to record lake level, please contact County staff.
2. Record numbers of ducks, geese, and other waterfowl seen throughout monitoring trip. Write in names of other waterfowl seen on the lake.
3. Record numbers of the following seen throughout the monitoring trip;
    a. boats.
    b. people fishing.
    c. swimmers or people wading in the water.

Figure 2 Scum Types

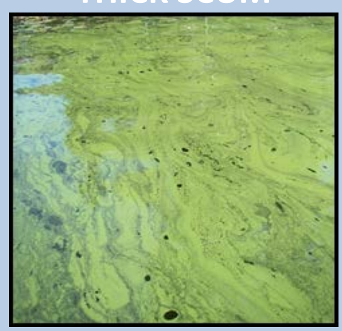
FILAMENTOUS ALGAE

SMALL CLUMPS



THIN FILM

THICK SCUM



4. Select the option that best describes your perception of the lake recreational suitability from one to five (1=best, 5=worst). Please disregard poor weather conditions (such as cold weather) when selecting one of the following options;
    a. 1- beautiful could not be nicer
    b. 2 - minor aesthetic concerns - still good for swimming/boating
    c. 3 - swimming, boating & aesthetic enjoyment slightly impaired
    d. 4 - swimming, boating & aesthetic enjoyment substantially impaired (would not swim, but boating ok)
    e. 5 - swimming, boating & aesthetic enjoyment are severely limited (would not swim or boat in lake)
5. Note other observations from your monitoring trip, or that have taken place on or around your lake, e.g. aquatic plants, odors, wildlife, pollution, land clearing, or equipment issues. There is additional space for notes and comments on the back side of the field sheet.

Water Sampling

Water sampling is done once a month from June through September.

- Check the provided monitoring schedule to verify that it is a water sampling weekend.
- Label sample bottles and prepare a cooler with ice before going out on the lake.
- Please conduct your regular monitoring and temperature/dissolved oxygen profiles on the same day that you collect samples.

1 Meter Samples: Total Phosphorus (TP), Total Nitrogen (TPN), Chlorophyll-a (chl-a)

Prior to collecting the 1-meter samples, review the following guidelines:

- If collecting field duplicates, please follow the procedures "Sample Procedures for Collecting Field Duplicates" located immediately following these procedures.
- Conduct all other monitoring (except chlorophyll *a*) before you collect the TP and TPN samples.

Collect TP/TPN sample at 1 meter

1. Open the sampler and rinse three times with lake water.
2. Obtain a water sample from 1 meter deep.
3. Collect the TP/TPN Sample:
    a. Rinse the 1 meter TP/TPN bottle and cap **three times** with water from the sampler, being careful not to touch the inside of the cap or bottle with your hands.
    b. Fill the 1 meter TP/TPN bottle to the shoulder, being careful not to touch the bottle with the sampler tube.
4. Immediately place the sample in the cooler.
5. Refrigerate all samples immediately after returning to your home.

Collect Chlorophyll-a sample (public lakes only) at 1 meter

1. Obtain a water sample from 1 meter deep.
    a. **DO NOT RINSE** the Chl-*a* sample bottle. This bottle has a small amount of preservative inside.
    b. **DO NOT POUR OUT**. If by accident you rinse it, use your extra Chl-*a* bottle instead and return the empty rinsed bottle with your samples.

2. Fill the bottle to the shoulder.
3. Immediately place the sample in the cooler. It is important to keep the Chl-*a* sample cold and dark to prevent the sample from degrading.
4. Refrigerate all samples immediately after returning to your home.

Deep Sample (1 meter from lake bottom): Total Phosphorus (TP)

Prior to collecting deep sample, review the following guidelines:

- If collecting field duplicates, please follow the procedures "Sample Procedures for Collecting Field Duplicates" located immediately following these procedures.
- Be sure you know the depth of the lake at the sampling site. This is important because the hypolimnion sample should be taken about 1 to 1.5 meters above the bottom of the lake.
- Do not measure the lake depth when you collect samples. The bottom sediments could be stirred up and are likely to contaminate the sample.

Collect TP Sample at X meters

Specific sample depths for each lake are located in Table 4 and are also provided on the "cheat sheet" for your lake.

2. Obtain a water sample from X meters.
    a. If the water sample is cloudy with sediments, dump it out and sample again on other side of the boat.
    b. Rinse the X meter TP bottle and cap **three times** with water from the sampler, being careful not to touch the inside of the cap or bottle with your hands.
    c. Fill the X meter TP bottle to the shoulder, being careful not to touch the bottle with the sampler tube.
3. Record if there is a rotten egg odor in the remaining sample water within the sampler.
4. Immediately place the sample in the cooler.
5. Refrigerate all samples immediately after returning to your home.

Table 4 Bottom Sample Depths

Lake	Sample Depth (m)
Armstrong	7.0
Beecher	2.0
Blackmans	6.0
Bosworth	20.0
Bryant	6.0
Cassidy	6.0
Chain	5.0
Cochran	15.0
Crabapple	12.0
Crystal	9.0
Echo	13.0
Flowing	18.0
Gissberg N.	6.5
Gissberg S.	---
Goodwin	13.0
Hilton N.	2.0
Hilton S.	3.0
Howard	14.0
Kayak	4.0
Ketchum	5.0
Ki	18.0
L. Martha	5.0
Loma	7.0
Lost	11.0
Martha N.	19.0
Martha S.	10.0
Meadow	5.0
Nina	10.0
Panther	10.0
Riley	9.0
Roesiger N.	30.0
Roesiger S.	20.0
Rowland	6.0
Ruggs	3.0
Serene	5.0
Shoecraft	9.0
Spring	---
Stevens	40.0
Stickney	9.0
Storm	12.0
Sunday	4.5
Wagner	5.0

Temperature and Dissolved Oxygen Profiles

Some volunteers will be assigned a YSI dissolved oxygen (DO) and temperature instrument during the monitoring season. Dissolved oxygen and temperature profiles should be measured during each monitoring trip after the basic monitoring activities are completed. The directions for instrument calibration and use will vary by the instrument model number. Specific instructions and training will be provided to volunteers prior to the monitoring season. If you are interested in taking dissolved oxygen and temperature profiles for your lake, please contact County staff.

1. Calibrate the DO instrument according to specific instructions provided to you by County staff. This step should be completed before you go out on the lake.
2. Record the temperature, DO in mg/L, and %DO on the back side of the data sheet at the surface, 0.5 meters, and each meter down to the lake bottom.
    a. Keep the probe at the desired depth for at least a minute to allow for the meter to stabilize. You will need to "jiggle" the probe up and down to ensure that water is flowing past the membrane so that you can get an accurate DO reading.
    b. Jiggle the probe by holding the cord and lifting it up and down about 1 to 2 inches at a rate of approximately 100 times per minute.
3. Record the lake depth in meters by lowering the instrument probe to the lake bottom.
4. Record the instrument name.
5. Note any comments specific to the DO instrument.

Chain of Custody Form

Fill out the Chain of Custody (COC) form with the following information:

1. Date and time of the sampling, just as written on the sample bottles.
2. "Sample ID," write the lake name and depth just as it appears on each bottle.
3. Mark the parameter for each sample:
    a. 1 meter samples will have TP, TPN, and Chl-a marked.
    b. Bottom samples will have TP marked.
4. Sign your name in the space labeled "Sampled by" near the bottom of the sheet
5. Write the date and time that you will set out the samples for pick-up.

Sample Pick-Up

County staff will schedule sample pick-ups for the Monday following the water sampling weekend.

1. Place samples in a cooler with ice at your designated pick-up location by 8:00AM.
2. Include the COC and monitoring datasheets with your sample.
    a. Make sure your forms are in a Ziploc bag.

Equipment Storage

Once you have completed your lake monitoring activities for the day, you will need to rinse and dry the monitoring equipment and store it in a dry spot.

- Make sure that fragile equipment, such as the thermometer, will not be crushed in the storage location.
- Please store thermometers in an upright position. This will prevent the liquid inside the thermometers from separating.
- Do not leave the vertical samplers in an open position. This will stretch the internal tubing and make the sampler leak and become difficult to close in the future.

- If you are assigned a dissolved oxygen meter, make sure that the sponge in the probe sleeve is moistened. This will prevent the membrane from drying out.

Data Submittal

County staff will provide pre-addressed and stamped envelopes to mail in your completed monitoring datasheets.

Generic Lake Monitoring Cheat Sheet

Please find a generic lake monitoring cheat sheet that summarizes all the monitoring methods and procedures at the end of Appendix A. You will also be given a monitoring cheat sheet tailored to your specific lake. Please take that cheat sheet with you every time you do the monitoring.

Glossary of Terms

The following terms are used throughout this monitoring manual and in other lake reports.

Acre-Foot – The volume of water that would cover an area of one acre to a depth of one foot; equivalent to 43,560 cubic feet, or 325,850 gallons of water.

Algae – Small plant-like organisms occurring as single cells, multi-celled colonies, or filaments. Algae contain chlorophyll and form the base of the food web in lakes.

Algae (or Algal) Bloom – A heavy growth of algae in a lake resulting from high nutrient concentrations and favorable weather conditions.

Alkalinity – The capacity of water to neutralize acids; the buffering capacity of water to resist a change in pH.

Anoxia – A condition where no dissolved oxygen remains in the water, usually occurring near the bottom in stratified lakes which have large amounts of decomposing organic matter in the lake sediments.

Bathymetric Map – A map showing the depth contours of the bottom of a lake.

Benthic – Referring to the bottom of a lake, which supports a community of small organisms that live on or in the sediment and are important in decomposing organic matter.

Blue-green Algae – One of the main groups of algae that are responsible for many of the unpleasant algae blooms in lakes. More properly known as Cyanobacteria, blue-green algae are physically like bacteria, but function more like plants.

Chlorophyll *a* – A type of green pigment found in all algae. It plays an essential role in photosynthesis.

Conductivity –A measure of the capacity of water to conduct an electrical current; an indicator of the amount of dissolved ions in the water.

Dissolved Oxygen – The oxygen gas that is dissolved in water and available for use by microorganisms and fish.

Emergent – Aquatic plants that have their roots and lower stems in the water while the upper portions of the plants stand above the water surface.

Epilimnion – The uppermost, warm, well-mixed layer of water in a lake during stratification.

Eutrophic – Description of a lake that is rich in nutrients and highly productive of plants and algae.

Eutrophication – The natural process of lake enrichment caused by accumulating nutrients and sediment that results in increased growth of plants and algae, reduced water clarity, and lake filling. Human activities that add nutrients and sediment to a lake can greatly accelerate this process.

Filamentous Algae – types of green algae that grow as long, thin filaments in a lake. Filamentous algae usually grow in shallow water attached to aquatic plants or the lake bottom.

Food Web – The system of feeding interactions occurring among the organisms in a lake.

Hypolimnion – The deep, cooler layer of water in a lake isolated from surface influences during stratification.

Limnology – The study of fresh waters, especially lakes.

Loading (External and Internal) – The total amount of nutrients added to the water of a lake. External loading comes from sources outside the lake, such as streams, direct runoff, pipes, ground water, and the air; internal loading comes from sources within the lake itself, such as recycling from the bottom sediments and release from decaying plants and animals.

Macrophytes – Another term for aquatic plants, either rooted or floating, that grow in lakes.

Mesotrophic – Description of a lake that contains moderate levels of nutrients and produces moderate amounts of plants and algae.

Metalimnion – The layer of lake water between the epilimnion and hypolimnion during stratification, where water temperature and density change rapidly with depth.

Nitrogen – One of the nutrients essential for plant and algae growth. Nitrogen is present in several forms, and some algae can take it directly out of the atmosphere. The relative abundance of nitrogen and phosphorus is a key indicator of lake conditions.

Nutrient – Any chemical element, ion, or compound that is essential for life and growth, such as nitrogen, phosphorus, carbon, and oxygen.

Oligotrophic – Description of a lake that contains few nutrients and produces little algae and aquatic plants.

Periphyton – Algae that grow attached to underwater surfaces, such as rocks, pilings, and aquatic plants. Periphyton do not float freely in a lake as phytoplankton do.

pH – A measure of the concentration of hydrogen ions in a substance such as water. Values go from 0 to 14; a pH of 7 is neutral; values below 7 are increasingly more acidic, while values greater than 7 are increasingly more basic (alkaline). Each increment represents a ten-fold change in acidity.

Phosphorus – One of the nutrients essential for plant and algae growth. Phosphorus availability often limits algae growth in a lake because it is the nutrient in shortest supply.

Photosynthesis – The process by which chlorophyll-containing cells in plants and algae produce organic matter from carbon dioxide and water using light energy.

Phytoplankton – Microscopic algae that float freely in open water.

Productivity – The rate at which aquatic plants and algae create organic matter through photosynthesis.

Secchi Disk – A black and white disk (usually 8 inches in diameter) used to measure light transparency (water clarity) in a lake.

Stratification – The layering of lake water caused by differences in temperature and density. Layers are called the epilimnion, the metalimnion, and the hypolimnion. Stratification is typical of deeper lakes during the warm summer months.

Submersed – Rooted aquatic plants that grow entirely, or almost entirely, under the water.

Trophic State – The degree of eutrophication of a lake. Lakes may be classified as oligotrophic, mesotrophic, or eutrophic.

Turnover – The mixing of lake water from top to bottom that usually occurs in the fall and is caused by the cooling of surface waters and wind energy.

Watershed – The land area that drains to or contributes water to a lake or other waterbody.

Zooplankton – Microscopic animals that float in open water and feed on bacteria, algae, and organic matter and may be consumed by fish.

GENERIC LAKE MONITORING INSTRUCTIONS

1. **PREPARE FOR MONITORING**
   - Check monitoring calendar to confirm monitoring activities and dates.
   - Check weather and lake conditions; DO NOT monitor in bad weather.
   - Monitor between 9:00 am and 4:00 pm (Secchi readings after 5:00 pm cannot be accepted).
   - Ensure that you have all equipment for the monitoring to be performed that day.

Basic Monitoring		Water Sampling	Dissolved Oxygen
☐ Instruction Sheet	☐ Life jacket	☐ Water sampler	☐ YSI meter
☐ Data Sheet	☐ Anchor	☐ 1 TP/TPN bottle	☐ DO Instructions
☐ Clipboard	☐ Algae Sample Kit	☐ 1 TP bottle	
☐ Pencil & Sharpie	☐ Hat (optional)	☐ 1 Chl-*a* bottle (public)	
☐ Thermometer	☐ Towel (optional)	☐ Cooler with ice	
☐ Secchi Disk	☐ Boat (not optional)	☐ Extra Bottle Set	

2. **LABEL SAMPLE BOTTLES (IF MONITORING ON A WATER SAMPLING DATE)**
   - Before heading out label the water sample bottles with date, collection time, and sample ID as follows:

Sample Type	Sample ID	Bottle Description
Chlorophyll *a*	Lake Name - 1 meter	Large Brown bottle
TP/TPN	Lake Name - 1 meter	Clear 125 mL bottle
TP	Lake Name - X meter (varies by lake)	Clear 50 mL bottle

3. **LOCATE YOUR MONITORING SITE**
   - Find the monitoring location at the deepest part of the lake using the bathymetric map provided to you.
   - Always monitor in the same location and anchor your boat.

4. **RECORD WEATHER CONDITIONS**
   - Record air temperature in the shade to nearest ½ ˚C (before getting the thermometer wet).
   - Record near surface water temperature to nearest ½ degree ˚C by holding thermometer 6-12 inches under the water surface for 2 minutes (read temperature quickly).
   - Choose the cloud cover percentage that best describes conditions at the time of the Secchi reading.
   - Choose the amount of rain that best describes the recent rainfall in the area.
   - Choose the wind conditions that best describe conditions at the time of the Secchi reading.

5. **MEASURE WATER CLARITY**
   - Remove sunglasses and use shady side of boat.
   - Lower the Secchi disk until it just disappears; raise disk until it re-appears; move disk slowly up and down until you find the exact vanishing point.
   - Measure and record depth of the Secchi disk to the nearest 0.1 meter.
   - Repeat until you get two readings within 0.1 meters (data cannot be accepted if more than 0.1 m apart).
   - If the Secchi disk hits the lake bottom or enters weeds, check the appropriate box.

6. **ASSESS ALGAE CONDITIONS**
   - Lower the Secchi disk 6 inches below the water on the sunny side of the boat and observe the small particles (the algae) over the disk. If there are too many particles to count in an area the size of a half dollar, select "Yes" for Heavy Algae.
   - Look for mats of stringy filamentous algae throughout your monitoring trip and note if observed.

6. **ASSESS ALGAE CONDITIONS (continued)**

- Look for algae scums throughout your monitoring trip especially along the shoreline. If a scum is present:
  - Choose the term that best describes the algae scum type.
  - Label your algae screening sample bottle and collect a sample of the scum while wearing gloves.
  - Take a photo of the scum if possible.
  - If you take a sample, please call 425-388-3464 to arrange a pick-up if not a scheduled pick-up date.

7. **IDENTIFY WATER COLOR AND ODOR**

- Lower the Secchi Disk to ½ the Secchi depth taken that day (e.g. if Secchi was 4 meters, lower disk to 2 meters)
- Choose the Intensity and Tint that best describes the color of the water over the white portion of the disk.

8. **RECORD OTHER OBSERVATIONS**

- Record the lake level at the lake staff gage or a pre-determined location and circle inches or feet.
- Record the numbers of ducks, geese, and other waterfowl seen throughout monitoring trip.
- Record the number of boats, people fishing, and swimmers/waders seen throughout monitoring trip.
- Select the option that best describes your perception of the lake recreational suitability (1 = best; 5 = worst).
- Note other observations: aquatic plants, odors, wildlife, pollution, land clearing, equipment issues, etc.

9. **COLLECT WATER SAMPLES (IF WATER SAMPLING DATE)**

COLLECT 1 METER SAMPLE(S)

- Open the sampler and rinse three times with lake water.
- Obtain a water sample from 1 meter deep.
- Collect the TP/TPN Sample:
  - Rinse the 1 meter TP/TPN bottle and cap three times with water from the sampler, being careful not to touch the inside of the cap or bottle with your hands
  - Fill the 1 meter TP/TPN bottle to the shoulder, being careful not to touch the bottle with the tube.
- Collect the Chlorophyll a sample (only public lakes):
  - DO NOT RINSE the Chl-a sample bottle - it has a small amount of preservative - DO NOT POUR OUT. If by accident you rinse it, use your extra Chl-a bottle instead and return rinsed bottle with samples.
  - Fill the bottle to the shoulder (obtain more water if needed).
- Immediately place the samples in the cooler – keep cold and dark.

COLLECT BOTTOM SAMPLE

- Obtain a water sample 1 meter from the bottom (see specific depth for your lake).
- If the water sample is cloudy with sediments, dump it out and sample again on other side of the boat.
- Collect the TP Sample
  - Rinse the bottom TP sample bottle and cap three times with water from the sampler, being careful not to touch the inside of the cap or bottle with your hands
  - Fill the bottom TP sample bottle to the shoulder being careful not to touch the bottle with the tube.
- Record if there is a rotten egg odor in the remaining sample water (means no oxygen at bottom).
- Immediately place the sample in the cooler – keep cold and dark.

10. **CONDUCT DISSOLVED OXYGEN PROFILE MONITORING**

- If you have volunteered to take dissolved oxygen profiles, refer to Dissolved Oxygen Profile Instructions.

11. **SUBMIT DATA, CHAIN OF CUSTODY FORM, AND SAMPLES**

- Mail in the original data sheet with the provided envelope or submit with water samples.
- Store water samples in fridge, complete the Chain of Custody Form and submit with samples.
- Put cooler with ice and samples on porch or at end of driveway by 8:00 am Monday.