Ecological Solutions Inc. tests the following highlighted 'Water Quality' parameters.

Water Quality Parameters

A FACT SHEET OF THE PENNSYLVANIA LAKE MANAGEMENT SOCIETY

Managing a lake requires a basic understanding of an extensive set of constituents that affect water quality. The purpose of this fact sheet is to provide an explanation of the most important parameters, to present typical or acceptable values, and to provide established criteria where appropriate. An explanation of units and sources for additional information and assistance are included at the bottom of page 2.

PARAMETER	LAKES	STREAMS	EXPLANATION
Alkalinity		20 to 200 mg/L PA standards require 20	Usually expressed in terms of calcium carbonate Carbonate compounds are abundant in nature & provide natural buffering Optimal is 100-200 ppm Low alkalinity cannot mediate low pH events
Calcium (Ca)	< 11 mg/L = oligotrophic > 24 mg/L usually are eutrophic	In limestone areas, typically 30 - 100 mg/L	Leached from nearly all rocks but most prevalent in regions with limestone, dolomite & gypsum deposits Low calcium in areas with granite or siliceous deposits Important for biological activity - plant cell walls, bony tissue & shells
Chlorine, total residual		4 day average not to exceed 0.011 mg/l and 1 hr maximum not to exceed 0.019 mg/l	Used for disinfection Does not occur naturally
Chlorophyll a (mean growing season limit)	<2.0 µg/L = oligotrophic 2.0 - 6.0 µg/L = mesotrophic 6.0 - 40.0 µg/L = eutrophic > 40.0 = hypereutrophic	Recreation / aesthetics: < 0.025 mg/L	0-10 µg/L - no problems evident; no water discoloration 10-20 µg/L - algal scums evident; some discoloration 20-30 µg/L - nuisance conditions encountered >30 µg/L - severe conditions encountered; very deep discoloration
Dissolved Oxygen	Same as streams 4 - 5 mg/L minimum	< 3 - 4 mg/L is stressful to aquatic life 6 mg/L is best for coldwater fishes	O_2 levels controlled by photosynthetic & respiratory activity & diffusion Higher late in the day; lowest early AM
Fecal coliform bacteria	< 200/100 ml (summer months)		Not necessarily bad in itself, but may indicate presence of pathogens
Hardness		0 - 60 mg/l = soft 61 - 120 = mod. hard 121 - 180 = hard >180 = very hard 100-200 mg/L optimal	Due to dissolved salts of calcium, magnesium & sometimes aluminum, manganese and iron Usually expressed in mg/L as $CaCO_3$ >250 mg/L $CaCO_3$ can precipitate out to stream bottom May affect fish tolerance to toxic metals, toxicity of mercury, copper, lead, ammonia, phenols increases with lower alkalinity
Iron (Fe)	Will be higher near lake bottom	Not to exceed 1500 µg/L Acceptable level: 0.3 mg/l	At pH > 3, iron precipitates out in water as "yellow boy" (ferric hydroxide) Can clog gills & smother habitats
Manganese (Mn)	Similar to iron		Mostly a color problem
Magnesium (Mg)		In areas with source, 5 - 50 mg/L	Mainly from leaching of igneous & carbonate rocks; essential micronutrient in plants for chlorophyll production
Nitrogen (N)			Present in several forms - organic nitrogen, ammonia (the product of decomposition), nitrate and nitrite. Occasionally it is the nutrient that limits algae growth.
Ammonia nitrogen (NH3-N)	May reach 5 to 10 mg/L in anoxic bottom waters in a eutrophic lake	Non polluted: <1 mg/L	EPA's recommended criteria is 0.02 mg/L for freshwater aquatic life with caution against using with temp. < 5 °C & pH > 8.5 (Toxicity affected by temp. & pH) Acute lethal levels for fish ranges 0.2 to 2.0 mg/L Sources - wastewater, agricultural runoff, decay of organisms
Nitrate nitrogen (NO3-N)	Relatively "Healthy" lake = <0.05mg/L in summer, top layers of eutrophic lake has low levels due to plant uptake; bottom higher due to decay	Rarely exceeds 10 mg/L Frequently < 1 mg/L during high primary production	The most abundant inorganic form of nitrogen Drinking water standard is 10 mg/L. Algae can use nitrate as nitrogen source for growth
Nitrite N (NO2-N)		Typically present in extremely low concentrations	Rarely measurable in unpolluted natural waters; generally <1 mg/L High concentrations may be indicative of septic or sewage

PARAMETER	LAKES	FLOWING	EXPLANATION
pH	6.0 to 9.0 ideal range for aquatic organisms	6.5 - 8.2 optimal	7.0 is neutral 8.5 and above may result from biological productivity (CO_2) 5.5 and below is stressful to organisms, may indicate acid rain/acid mine drainage; low pH can release metals into water
Phosphorus (P)	TP (total P) - below 0.01 mg/L (<10µg/L) provides a high level of protection; oligotrophic <0.02 mg/L avoids nuisance algal growth >0.03 mg/L = likely to experience problem weed and algae growth; eutrophic	Non polluted waters - total phosphorus usually < 0.1 mg/L	Present in several forms - organic bound, inorganic polyphosphates and inorganic orthophosphates Very biologically active and cyclic Sources - leaching from phosphate bearing rocks; fertilizers; sewage; detergents; septic tanks; soil erosion; agriculture; development The element most likely to cause stimulation of plant production (Aglae and aquatic plants use only the orthophosphate (PO_4) form of phosphorus)
Ortho - Phosphorus	In unproductive lakes, ortho-P <0.005 - 0.007 mg/L	Ortho-phosphorus < 0.01mg/L	Soluble Ortho-Phosphorus is the form most available to plants
Silica (Si)	Lakes can have a silica cycle	Natural waters - 1 to 10 mg/L Rarely >60 mg/L	Common in nature from igneous rocks, quartz & sand Principle component of diatoms (silica-shelled algae); use by diatoms influences silica cycle
Sulfate (SO4)	Much higher in saline lakes Conc. cyclic in lakes	5 - 50 mg/L in natural waters Not to exceed 250 mg/L	Usually the 2nd most common anion; from sedimentary rocks; in lakes is cyclic - organically reduced forms & free Sulfate is taken up by higher plants and algae
Specific conductance (conductivity)		Usually between 50-1500 µmhos	In natural waters, unit is micromho (µmho) Affected by temperature Indicator of the amount ot total dissolved solids
Temperature	Above 30 °C (88 °F) can be stressful to fish	Up to 66 F for coldwater fish Up to 87 F for warmwater fish	Maximum allowable temperature varies by season and water body
Total Dissolved Solids	Unpolluted = 17 - 30mg/L Polluted = 400 mg/L	Maximum = 1500 mg/L	The total amount of solids that are in solution in water; total dissolved solids consist of the anions and cations that are dissolved in water and include sodium, calcium, sulfates, orthophosphate, and other dissolved chemicals.
Total Suspended Solids (TSS)	Clear water = <25mg/L Intermediate = 25-100 mg/L Muddy = >100 mg/L TSS of 25mg/L produces a "turbid" appearance generally perceived as a water quality problem	High level of protection = < 25 mg/L Moderate protect. = 80 mg/L Low level protect. = 400 mg/L Very Low protect. = > 400 mg/L Harmful to fish eggs = 75 - 100mg/L	Not all kinds of TSS are equally harmful Walleye are sensitive to TSS with death rates at > 200 mg/L (reduced sight affects feeding ability) Good to moderate fisheries - 25 to 80 mg/L 80 to 400 mg/L unlikely to support good fishery but could get by at lower end AFS suggests limit of 100 mg/L to prevent aquatic life mortality, but concentrations can be greater without adverse effects
Turbidity		>100 NTU is excessive 50 NTU is considered turbid	Turbidity is caused by the presence of suspended matter in water such as clays, mud, algae, silica, and bacteria.
Visibility - Secchi Disk	Excellent = 15 - 20+ feet Poor = < 2 feet Oligotrophic = > 8 meters Mesotrophic = 4 - 8 meters Eutrophic = 2 - 4 meters		20 cm (8") diameter standard Secchi disk, black and white; Used to measure the clarity of lake water; Excellent, inexpensive measurement of lake water quality condition.

EXPLANATION OF UNITS

Typical units of concentration used in water chemistry are milligrams per liter (mg/L) which is equivalent to parts per million (ppm), and micrograms per liter (µg/L) which is equivalent to parts per billion (ppb). The units are related in the following ways:

1 mg/L = 1 ppm; 1 ppm = 1,000 ppb 1 µg/L = 1 ppb; 1 ppb = 0.001 mg/L

Lake Management References

- *Nutrient Criteria Technical Guidance Manual-Lakes and Reservoirs, EPA-822-B00-001, April 2000; Nutrient Criteria Technical Guidance Manual-Rivers and Streams, - EPA Water Resource Center, 202-260-7786, center.water-resource@epa.gov*
- *US Environmental Protection Agency (EPA): **www.epa.gov***
- *PA Department of Environmental Protection (DEP): **www.state.pa.us***
- *National Resource Conservation Service (NRCS): www.nrcs.gov*

FOR MORE INFORMATION, CONTACT

The Pennsylvania Lake Management Society (PALMS)

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Lansdale, PA 19446

Table discussing common water quality parameters and their role in maintaining "healthy" conditions in your lake. (Provided by the Pennsylvania Lake Management Society)

Ecological Solutions Inc.

Bacteria: Types, Sources, Testing, Impact on Water Quality

BACTERIA SOURCES The following highlighted 'Bacteria Tests' are conducted.

Bacteria are common single-celled organisms: a natural component in humans, animals, plants, soil, lakes, rivers, and streams. Most bacteria are beneficial, serving as food for larger organisms, enabling organic matter decomposition, fixation of nitrogen, and digestion of food.

Coliform bacteria are characterized by their rod-like shape and their ability to produce gas from the fermentation of lactose sugar.

They are critical indicators of water quality. Increased levels of coliform bacteria may originate from a variety of sources, including human and animal waste, soil, vegetation, papermill discharge, animal carcasses, rainwater runoff, agricultural runoff, septic tanks, and wastewater discharge.

TYPES

Coliform bacteria are always present in the digestive tracts of animals, including humans, and are found in their wastes. They are often referred to as "indicator organisms" because they indicate the potential presence of disease-causing bacteria in water. Their presence indicates that a contamination pathway exists between a source of bacteria and a water body.

Testing - The most basic test for bacterial contamination of a water supply is the test for Total Coliform bacteria. Total coliform counts give a general indication of water quality. If a total coliform bacteria test is positive, then specific tests for the subgroups of coliform bacteria (Fecal coliform and E. coli) should be conducted.

Fecal coliform is a subset group of total coliform bacteria, present specifically in the intestinal tract of warm-blooded animals. There are also natural, non-fecal sources of fecal indicator bacteria, including plants, sand, soil and sediments. In addition to the possible health risk associated with the presence of elevated levels of fecal bacteria, they can also cause cloudy water, unpleasant odors, and an increased oxygen demand.

Testing - The origins of fecal coliforms are more specific than the origins of the more general total coliform group of bacteria, therefore fecal coliforms are considered a more accurate indication of sewage or animal waste contamination.

E. coli is a subset group of fecal coliform bacteria. There are hundreds of strains of E. coli. Although most strains are harmless and live in the intestines of healthy humans and animals. Of the groups of coliforms, only E. coli is generally not found growing and reproducing in the environment. E. coli is a species of fecal coliform bacteria that is specific to fecal material from humans and other warm-blooded animals The most common issues with E.coli ingestion is gastrointestinal distress – stomach flu-type symptoms. These are typically not life threatening, although more serious issues could arise.

Testing - A positive E. coli test result is much more serious than total coliform bacteria, because it indicates that human or animal waste is entering the water supply. According to EPA guidelines, E. coli bacteria levels measured above 235 colonies/100 ml are considered a higher risk for illness when swimming.

Algae and Cyanobacteria Fact Sheet

'Algal Tests' find anatoxins and microcystins in algae.

Name	Description	Signs	Control	Image
Algae	Primitive organisms which live in surface water. Algae play a fundamental role in the health of any body of water - the base of the food web in lakes. Small animals, called zooplankton, feed on algae, subsequently, zooplankton become food for fish. Algae also produce some of the oxygen found in lake water and in the atmosphere. Green and golden-brown algae are usually inconspicuous and not harmful to humans or animals, but problems arise when it grows/blooms or cyanobacteria begins to grow.	Planktonic: Green hue in water. Filamentous: String-like, floating in mats	Monitor algae from early Spring and limit excessive build-up with: aquatic herbicides/ copper sulphate applications, aerators, and control of the sources of nutrients entering the lake.	 
Algae bloom	A dense growth of long, stringy, and slimy algae forming mats, covering large areas of the water surface. Normally harmless, however, large blooms are dangerous to fish because they block sunlight from entering the water and deplete oxygen levels. Blooms can cover the top of aquatic plants or be below the surface in billowing clouds. Fortunately, these algae do not produce toxins. The amount of algae tends to be high in spring and summer because of increasing water temperature, more sunlight, abundant nutrients from winter rains, and low amounts of grazing by zooplankton.	Thick unpleasant scums. on a lake's surface. When a stick is dipped into the middle of a bloom and then lifted out, long green strings are left clinging to it. (As a precaution - Use protective clothing, gloves etc.)	All the above, plus planting a buffer of native plants next to the lake shore, whereby preventing nutrients from reaching the water.	

Algae and Cyanobacteria Fact Sheet

Name	Description	Signs	Control	Image
Cyanobacteria (Often called blue-green algae)	A group of photosynthetic bacteria that lives in surface waters. These single-cell organisms clump together to mimic the appearance of algae, photosynthesizing sunlight to produce nutrients.	Too small to be seen by the naked eye until it reproduces and grows into a bloom.	Monitor algae from early Spring and limit excessive build-up with: aquatic herbicide/ copper sulphate applications, aerators, and control of the sources of nutrients entering the lake.	N/A
Cyanobacteria bloom	Like algae, cyanobacteria can rapidly multiply, forming thick blooms, especially in warm, eutrophic (rich in nutrients) waters. When cyanobacteria blooms are large and produce chemicals, or toxins, the event is called a harmful algal bloom (HAB). HABs can occur in lakes, reservoirs, rivers, ponds, bays, and coastal waters. Some strains of cyanobacteria can produce toxins (cyanotoxins) in concentrations that are harmful to humans, pets, fish, and wildlife. Cyanobacterial blooms can also produce secondary compounds, which can cause taste-and-odor problems in public water systems.	It has a bluer color - forming foam, scum, mats, or paint on the surface and will discolor the water around it, turning it blue, green, or purple. It has a strong unpleasant odor. Cyanobacteria testing kits are available. Dipping a stick into the middle of a bloom will reveal a paint-like or granular substance left clinging to it. (As a precaution - Use protective clothing, gloves etc.)	All the above, plus planting a buffer of native plants next to the lake shore, whereby preventing nutrients from reaching the water.