2022 Water Quality Report

U.S. Army Corps of Engineers
Saint Louis District

Lake Shelbyville Water Quality Conditions: 1984-2022

November 2023

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Prepared for

United States Army Corps of Engineers
Saint Louis District
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EXECUTIVE SUMMARY

The United States Army Corps of Engineers (USACE) commitment to environmental compliance and protection of estuaries, rivers, lakes, and navigable waters arises from the national policy and directives expressed in Federal Statutes, Executive Orders, and internal regulations. These regulations were designed to minimize pollution, maximize recreation, protect aesthetics, preserve natural resources, and promote the comprehensive planning and use of water bodies to enhance the public interest rather than private gain; therefore, USACE, in the design, construction, management, operation, and maintenance of its facilities, will exert leadership within existing authorities and appropriations in the nationwide effort to protect, enhance, and sustain the quality of the nation's resources. It is USACEs policy to comply with requirements of the Clean Water Act and not to degrade existing water quality conditions to the maximum extent that is practicable, consistent with project authorities, Federal legal and regulatory requirements, the public interest, and water control manuals.

The United States Army Corps of Engineers, Saint Louis District (CEMVS), implemented a water quality monitoring program during the 1970s to evaluate how its civil projects may be affecting water resources. Data collected from this effort serves as an invaluable tool for evaluating the significance of annual water quality measurements and tracking long-term trends. Water quality data is provided to the Missouri Department of Natural Resources and the Illinois Environmental Protection Agency to be used as a screening mechanism for the Missouri and Illinois Water Quality Report which is required every two years by the Clean Water Act Sections 303(d) and 305(b).

The National Water Quality Inventory Report to Congress (305(b) report) is the primary vehicle for informing law makers and the public about general water quality conditions in the United States. This document characterizes our water quality, identifies widespread water quality problems of national significance and describes various programs implemented to restore and protect our waters. Currently the Illinois Environmental Protection Agency (IEPA, 2020) has listed Lake Shelbyville impaired for total suspended solids, total phosphorus, and mercury. The impairments upstream of the lake include pesticides, mercury, PCBs, chloride, dissolved oxygen, bacteria, pH, and sedimentation. The impairments immediately downstream of the lake in the Kaskaskia River include pesticides, mercury, and bacteria. The lists of sources for these impairments are runoff, crop production, shore modifications, and recreational pollution.

Water quality sampling in 2022 revealed the following concerns at Lake Shelbyville: total phosphorus, iron, bacteria, temperature, and chlorophyll_a.

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INTRODUCTION

Lake Shelbyville is located in Shelby and Moultrie Counties of east-central Illinois with the dam site approximately one-half mile east of Shelbyville. Two rivers, the West Okaw and the Kaskaskia, drain into Lake Shelbyville. The Kaskaskia River begins in Champaign County, while the West Okaw headwaters drain farmland from Piatt County southward. At normal recreation pool, the 11,100 acre lake is approximately 20 miles long, varying in width from one-quarter to one mile. Average depth is 19 feet, with depths much deeper in the original river channel. The Kaskaskia River is an important and prominent natural feature in Central and Southwestern Illinois. The watershed, primarily agricultural, is the second largest river system within Illinois, originating in Champaign County and flowing in a southwesterly direction for approximately 292 miles, where it unites with the Mississippi River in Randolph County. The Kaskaskia River Watershed encompasses an area of 5,746 square miles (10.2% of the entire state). The CEMVS manages and operates two large reservoirs on the Kaskaskia River, Lake Shelbyville and Carlyle Lake, as well as the 36 mile long navigable channel and lock and dam at the Kaskaskia River Project.

Shelbyville Lake is managed and operated by the CEMVS for the authorized purposes of flood risk management, recreation, water supply, navigation, and fish and wildlife conservation. The lake serves as a heavy recreational usage lake. The land surrounding the lake is used predominately for agriculture. Surrounding communities have existing industrial/commercial operations and residents which discharge wastewater into municipal wastewater treatment plants that ultimately discharge treated water into the Kaskaskia River basin. Agricultural runoff and municipal wastewater treatment facilities are the primary potential source of pollution into the Lake Shelbyville watershed. Additional sources are marinas, recreational watercraft discharges and wildlife fecal material runoff.

Water quality is of paramount importance for sustaining ecological integrity and services provided by the Kaskaskia River and Lake Shelbyville. Water quality is influenced by a range of both point and nonpoint pollution sources, which may include natural processes, industrial and municipal effluents, and surface runoff from agricultural arenas.

The Saint Louis District USACE has implemented a Water Quality Management Plan (WQMP) as part of the operation and maintenance activities associated with managing USACEs' civil works projects throughout the District which includes, among other reservoirs and rivers, the Kaskaskia River and Lake Shelbyville. The WQMP addresses surface water quality management issues and adheres to the guidance and requirements specified by Clean Water Act (CWA), as well as the self-imposed Engineering Regulation (ER) 1110-2-8154, "Water Quality and Environmental Management for USACE Civil Works Projects" (USACE, 2018). Water quality monitoring is implemented to fulfill five primary objectives that drive the CEMVS WQMP:

1) Establish baseline conditions, identify significant water quality trends, and document problems and accomplishments.
2) Ensure that surface water quality, as affected by CEMVS projects, is suitable for project purposes, existing water uses, public health and safety, and in compliance with applicable state and federal water quality standards.
3) Provide support to water control, project operations, and navigation for regulations and modifications.
4) Investigate special problems, design, and implement modifications, and improve water management procedures
5) Establish and maintain strong working partnerships and collaborations with appropriate entities within and outside USACE regarding water quality.

This report is intended to document and assess water quality conditions occurring at Lake Shelbyville. The report describes conditions observed in 2022, as well as baseline data collected from 1984-2021. Data are available upon request.

LAKE SHELBYVILLE WQMP COVERAGE

The WQMP for Lake Shelbyville includes water samples taken at the following locations: major tributaries (SBV-12 and SBV-13), main body of the lake (SBV-2, SBV-4, SBV-11, and the marinas), and just downstream of the dam (SBV-1). See Table 1 and Figure 1 for site coordinates and a site map.

Sample Location Summary Table

Table 1: Sample Location Summary and Geographic Location (NAD 1983)

Sample Location Type	Abbreviation	Site Name	Latitude	Longitude
Major Tributary	TRIB	SBV-13	39.59417	-88.72651
	TRIB	SBV-12	39.57170	-88.55345
Main Reservoir Surface	RS	SBV-2	39.40947	-88.77614
	RS	SBV-4	39.53397	-88.60528
	RS	SBV-11	39.55269	-88.70556
	RS	SBV-FIN	39.52388	-88.70820
	RS	SBV-LS	39.42802	-88.75728
	RS	SBV-SUL	39.53635	-88.60675
Reservoir Benthic	RB	SBV-2-10	39.40947	-88.77614
Tail Race (below dam)	TR	SBV-1	39.40823	-88.78124

Samples at Marinas are not always taken in the exact same location.

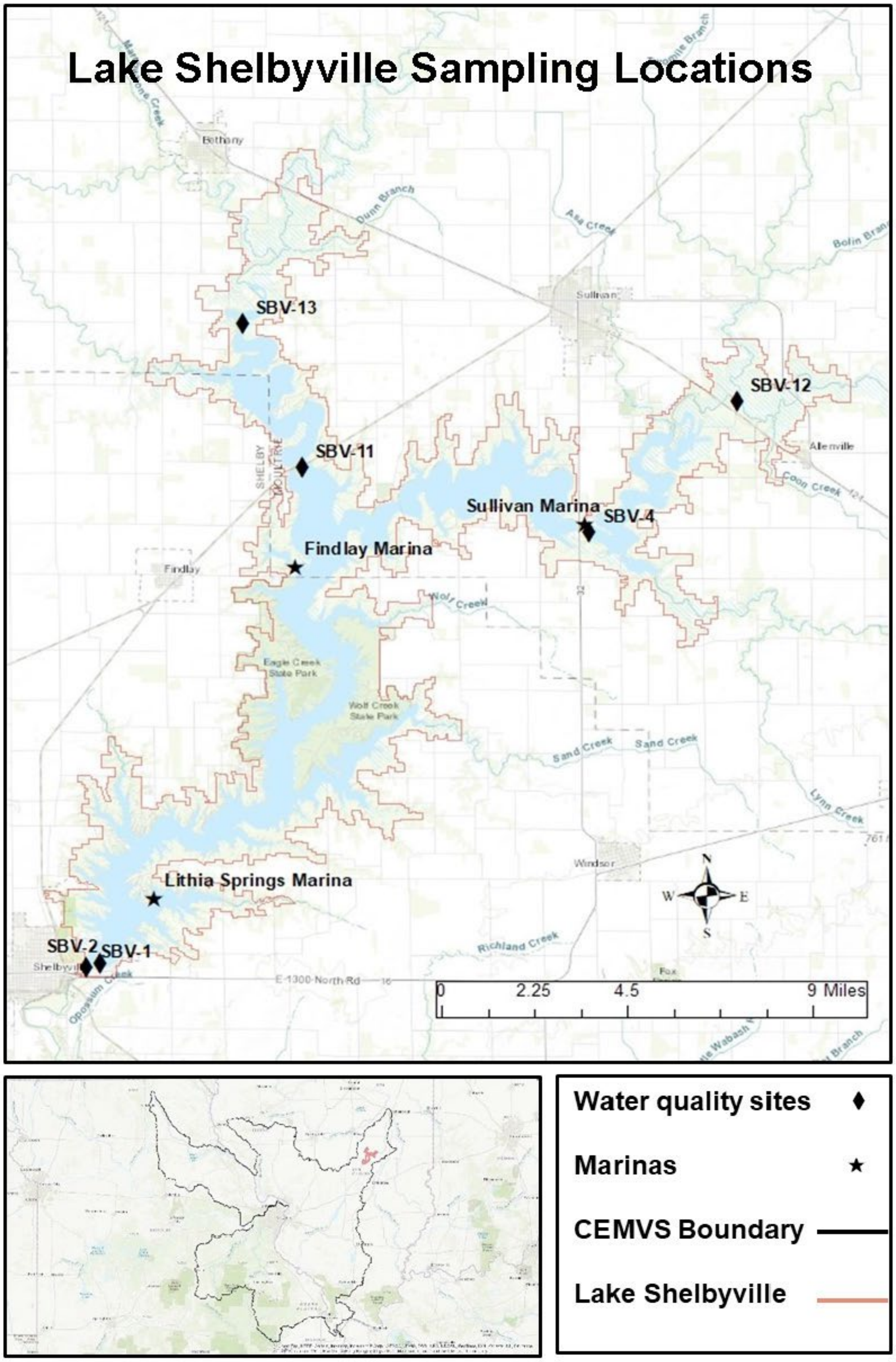


Figure 1. CEMVS District and Lake Shelbyville sampling locations.

METHODS AND ANALYSIS: WATER QUALITY

Data Collection and Historical Reference Data

During 2022, water quality samples were collected and analyzed for 10 locations during four separate sampling events (n=40; Table 1). One duplicate sample was also collected during each sampling event for quality control purposes. Samples were collected from the upper one meter of the water column, preserved, and transported to the Applied Research and Development Laboratory (ARDL) in Mount Vernon, Illinois for analysis.

For the purpose of this report, historical reference data refers to water quality data collected during the previous years ranging as far back as 1984 (parameter dependent) at Lake Shelbyville. Historical reference data are intended to represent the current condition of Lake Shelbyville.

Statistical Summary and Comparison to Applicable Water Quality Standards

Statistical analyses were performed on water quality monitoring data collected for 10 locations, and classified as TRIB (n= 2), RS (n=6), RB (n=1), and TR (n=1). Descriptive statistics were calculated to describe central tendencies and boxplots created to illustrate comparisons between groups. Monitoring results were compared to applicable water quality standard criteria established by the appropriate state agencies pursuant to the Federal Clean Water Act. If a state water quality standard criteria was not available, recommended criteria from the literature were considered.

Seasonal data are classified as: Winter (December 01 - March 14), Spring (March 15 – May 31), Summer (June 1 – September 15), Fall (September 16 – November 30).

Quality Assurance

The United States Army Corps of Engineers, Saint Louis District quality assurance procedures considers two primary focus areas: (1) those that involve laboratory analysis of samples, and (2) those concerning the collection and processing of the water samples in the field.

Since 2012, ARDL has analyzed water quality samples for CEMVS. Their quality assurance program includes the use of quality control charts, check standards, field and in-house matrix spikes, laboratory blanks and performance evaluation samples. In addition, one blind duplicate sample is submitted for at least every 20 samples, or, in this case, every sampling event (one event/day at Lake Shelbyville has 6 samples and one duplicate).

Internal checks are also used for field sampling. This includes adherence to operating procedures for data collection and periodic evaluation of sampling personnel. Field sampling equipment and multimeters are calibrated/serviced in accordance with factory recommendations.

Water Quality Parameters and Criteria

Parameters used to characterize water quality have been generally accepted criteria for assessing aquatic life and human health include:

Temperature (Temp) is important because it controls several aspects of water quality. Colder water holds more dissolved oxygen which is required by aquatic organisms. Plants grow more rapidly and use more oxygen in warmer water. Decomposition of organic matter which uses oxygen is accelerated in warmer water. Temperature can also determine the availability of toxic compounds such as ammonia. Since aquatic organisms are cold blooded, water temperature regulates their metabolism and ability to survive. The number and kinds of organisms that are found in streams or lakes is directly related to temperature. Certain organisms require a specific temperature range, such as Salmonids, which require water temperatures below 20°C. Water temperature criteria for warm water bodies in Illinois is within 2.8°C of the seasonal norm.

Dissolved Oxygen (DO) refers to the measurement of free oxygen molecules (O_2) that are not bonded to any other elements; thus, oxygen bonded in water (H_2O) would not be considered in a measurement of dissolved oxygen. Oxygen is dissolved in surface waters through interactions with the atmosphere and as a waste product of photosynthesis (CO_2 + H_2O (CH_2O) + O_2) from phytoplankton and aquatic vegetation. Additional factors influencing DO include temperature, pressure, and salinity.

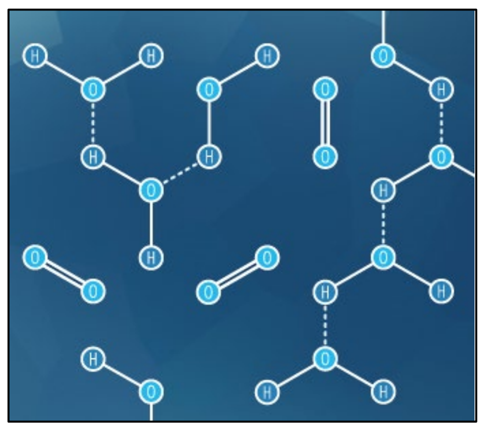


Figure 1: Dissolved oxygen (O_2) vs oxygen bonded in water (H_2O).

Dissolved oxygen is required for most aquatic life including fish, invertebrates, bacteria, and plants. Fish and invertebrates utilize DO for respiration through gills and cutaneous breathing, and plants require dissolved oxygen for respiration when photosynthesis is not possible. Smaller microbes and bacteria utilize DO for decomposition of organic material; a process essential for nutrient cycling. Bottom feeders such as worms and mussels can persist when DO is ≥1mg/L, while most inland fish species require a minimum DO of 4mg/L. The DO water quality criteria for Illinois is ≥5mg/L.

Potential of Hydrogen (pH) is a measure of how acidic or basic water is. Potential of Hydrogen is reported on a logarithmic scale ranging from 0 – 14, with 7.0 being neutral. As pH increases from 7.0, water increases in alkalinity, whereas a decrease from 7.0

indicates an increase in acidity. Since pH is measured on a logarithmic scale, every one-unit change in pH indicates a 10-fold change in acidity; thus, a pH of 6.0 is ten times more acidic than a pH of 7.0 and a pH of 4.0 would be one-thousand times more than a pH of 7.0.

The pH of water varies considerably beyond the local level. Natural variation in bedrock and soil composition through which water moves has been reported as one of the most influential factors. Additional factors include decomposition of organic materials, acidity of local precipitation, discharge of effluents and chemicals, and mining operations.

Most freshwater streams and rivers have a natural pH ranging from 6 to 8. As pH approaches 5 (acidic), less tolerant fish and aquatic invertebrate assemblages may be extirpated, and a pH below 4.5 would be without most desired aquatic life. Conversely, when pH exceeds 9.5 (alkaline), aquatic fish and invertebrates begin to rapidly decrease and beyond 10, fish become extirpated. The pH water quality criteria for Illinois ranges from 6.5 – 9.0.

Conductivity is a measure of water's ability to conduct electrical current. In its purist form, water has a *near* neutral charge, indicating that it is an inefficient conductor of electrical current. Thus, the ability to carry electrical current is driven by water soluble ions (atoms and molecules with a charge) such as salts and other inorganic materials. Conductivity is also influenced by water temperature; as temperature increases, conductivity increases. For this reason, conductivity is commonly reported as Specific Conductivity (SpCond), which is the measurement of conductivity at 25 degrees Celsius.

Conductivity in streams and rivers is affected by the geology of the area. Streams running through granite tend to have lower conductivity due to granite being composed of inert material; materials that do not ionize or dissolve into ionic compounds in water. Conversely, streams that run through areas of limestone or clay soils tend to have higher conductivity readings because of the presence of materials that ionize. Conductivity is useful as a general measure of water quality. A stream tends to have a relatively constant range of conductivity that, once established, can be used as a baseline. Significant changes, either increases or decreases, might indicate a source of pollution has been introduced into the water. The pollution source could be a treatment plant, which raises the conductivity, or an oil spill, which would lower the conductivity. In general, there are no water quality criteria for SpCond. The District threshold of 500 µS/cm is a rule of thumb value that is often associated with some form of biological impairment.

Oxidation Reduction Potential (ORP) is a measurement of the net status of all the oxidation and reduction reactions in a given water sample. Oxidation involves an exchange of electrons between 2 atoms. The atom that loses an electron is oxidized and the one that gains an electron is reduced. Oxidation reduction potential sensors measure the electrochemical potential between the solution and a reference electrode. Readings are expressed in millivolts. Positive readings indicate increased oxidizing potential and negative readings increased reduction. Oxidation reduction potential values are used much like pH values to determine water quality. While pH readings characterize the state of a system relative to the receiving or donating hydrogen ions (base or acid), ORP readings characterize the relative state of losing or gaining electrons. Generally, ORP readings above 400mV are harmful to aquatic life; however, ORP is a non-specific measurement, which is a reflection of a combination of effects of all the dissolved materials in the water. Therefore, the measurement of ORP in relatively clean water has only limited utility unless a predominant redox-active material is known to be present.

Total Suspended Solids (TSS) concentrations, which cause the photosynthetic activity to be reduced by more than 10% from the seasonably established norm, can have a detrimental effect on aquatic life. Soil particles, organic material, and other debris comprise suspended solids in the water column. **Turbidity (FNU)** measurements are inverse to suspended solid measurements. As TSS increases, the FNU or water transparency decreases. Total suspended solids can be an important indicator of the type and degree of FNU. Total Suspended Solids measurements represent a combination of **Volatile Suspended Solids (VSS)**, which consist of organic material, and **Nonvolatile Suspended Solids (NVSS)**, which is comprised of inorganic mineral particles in the water. In order to more accurately determine the types and amounts of suspended solids, VSS are analyzed. Volatile suspended solid concentration represents the organic portion of the total suspended solids. Organic material often includes plankton, and additional plant and animal debris present in water. Total VSS indicates the presence of organics in suspension; and, therefore, show additional demand levels of oxygen. The Illinois Environmental Protection Agency suggests that generally NVSS above 15 mg/L could highly impair recreational lake use while NVSS of 3 to 7 mh/L may cause slight impairment (Hudson, 1998).

Total Organic Carbon (TOC) is a measure of the amount of organic carbon in a water body. In addition to natural organic substances, TOC includes insecticides and herbicides, as well as domestic and industrial waste. Industrial waste effluent may include carbon-containing compounds with various toxicity levels. Further, a high organic content means an increase in the growth of microorganisms which contribute to the depletion of oxygen supplies.

Currently, there are no state or federal water quality standard criteria set for TOC. Because carbon occurs naturally, its concentration varies based on physical and chemical attributes in a watershed; thus, this study relies on historical reference conditions to identify unfavorable conditions.

Metals Iron (TFe) and Manganese (TMn) (T=total) are nutrients for both plants and animals. Living organisms require trace amounts of metals. However, excessive amounts can be harmful to the organism. Heavy metals exist in surface waters in three forms, colloidal, particulate, and dissolved. Water chemistry determines the rate of adsorption and desorption of metals to and from sediment. Metals are desorbed from the sediment if the water experiences increases in salinity, decreases in redox potential, or decreases in pH. Metals in surface waters can be from natural or human sources. Metal levels in surface water may pose a health risk to humans and the environment.

Pesticides are commonly used throughout much of the agricultural landscape that the Big Muddy River flows. This study considers one insecticide and seven herbicides. Atrazine and Alachlor herbicides are commonly used agricultural chemicals which can be readily transported by rainfall runoff. Both compounds are suspected of causing cancer; and therefore, were monitored for the protection of human and aquatic health. Herbicides which are pesticides used to kill vegetation are the most widely used and sampled. Two of the most widely used herbicides are Atrazine and Alachlor. Atrazine is a preemergence or postemergence herbicide use to control broadleaf weeds and annual grasses. Atrazine is most commonly detected in ground and surface water due to its wide use, and its ability to persist in soil and move in water. Alachlor is a Restricted Use Pesticide (RUP) due to the potential to contaminate groundwater. The water quality standards for the pesticides sampled are located in Table 2.

Nitrogen occurs naturally in water through several forms including nitrogen (N2), nitrite (NO2-N), nitrate (NO3-N), ammonia (NH3), and ammonium (NH4). Nitrates are the most commonly reported form of nitrogen and may have a meaningful influence on a water body's trophic status. Algae and other plants use NO3-N as a food source, thus excess levels of NO3-N can promote increases in algae production and hypereutrophic conditions.

In general, NO3-N does not have a *direct* effect on fish or aquatic insects. Illinois has set criteria standards for NO3-N to 10 mg/L to accommodate safe drinking waters for human and livestock; however, this threshold likely exceeds the concentration that is appropriate for assessing ecosystem health.

Total Ammonia Nitrogen (TAN) includes NH3 and NH4. Total ammonia nitrogen is a colorless gas with a strong pungent odor. Ammonia occurs naturally and is a biological requirement for aquatic life, however elevated concentrations can be toxic to freshwater organisms. Unnatural sources of ammonia include, accidental releases of ammonia rich fertilizer, effluent from sewage treatment plants, improper disposal of ammonia products, and livestock waste.

Toxic concentrations for freshwater organisms range from 0.53 – 22.8 mg/L, and are strongly dependent on both pH and temperature. In general, an increase in pH and/or temperature corresponds with an increase in toxicity. Additional information regarding the relationship between pH, temperature, and ammonia, as it relates to toxicity, can be reviewed in Aquatic Life Ambient Water Quality Criteria for Ammonia – Freshwater (USEPA 2013).

Total Phosphorus (TP) is analyzed as phosphorus and has been monitored due to the potential for uptake by nuisance algae. Levels of phosphate can indicate the potential for rapid growth of algae (algae bloom) which can cause serious oxygen depletion during the algae decay process. Phosphorous is typically the limiting nutrient in a water body; therefore, any addition of phosphorous to the ecosystem stimulates the growth of plants and algae. Phosphorous is delivered to lakes and streams by way of runoff from agricultural fields and urban environments. Other sources of phosphorous are anaerobic decomposition of organic matter, leaking sewer systems, and point source pollution. The general Illinois standard for phosphorous is (shall not exceed) 0.05 mg/L. Dissolved phosphorous, also called **Orthophosphate (PO_4-P)** is generally found in much smaller concentrations than total phosphorous and is readily available for algal uptake. Orthophosphate concentrations in a water body vary widely over short periods of time as plants take it up and release it.

Chlorophyll a (CHL_a) is a measure of the amount of algae growing in a waterbody, and therefore can be used to classify trophic status. Although algae are a natural part of freshwater ecosystems, too much algae can cause aesthetic problems such as green scums and bad odors and can result in decreased levels of DO.

Pheophytin a (PHEO a) is a natural degradation product or digestion of CHL_a. The ratio of PHEO_a to CHL_a can provide an indication of the decline or growth in eukaryotic algae and cyanobacteria populations.

Trophic Status is determined using a modified **Trophic State Index (TSI)**, as described by Carlson (1977). Trophic State Index is calculated from secchi-depth transparency, total phosphorus, and chlorophyll-a measurements. Values for these three parameters are converted to an index number ranging from 0-100 according to the following equations:

$$\text{TSI (Secchi Depth)} = 10(6 - (\ln SD/\ln 2))$$
$$\text{TSI (Chlorophyll-}a\text{)} = \text{TSI(Chl)} = 10(6 - ((2.04 - 0.68 \ln Chl)/\ln 2))$$
$$\text{TSI (Total Phosphorus)} = \text{TSI(TP)} = 10(6 - (\ln (48/TP)/\ln 2))$$

where ln indicates the Natural Logarithm

A TSI average value, calculated as the average of the three individually determined TSI metrics, is used as an overall indicator of a water body's trophic state. The relationship between TSI and trophic condition according to the IEPA is defined as follows:

TSI	Trophic Condition
0-40	Oligotrophic
40-50	Mesotrophic
50-70	Eutrophic
70-100	Hypereutrophic

Laboratory Methods and Water Quality Criteria Summary Table

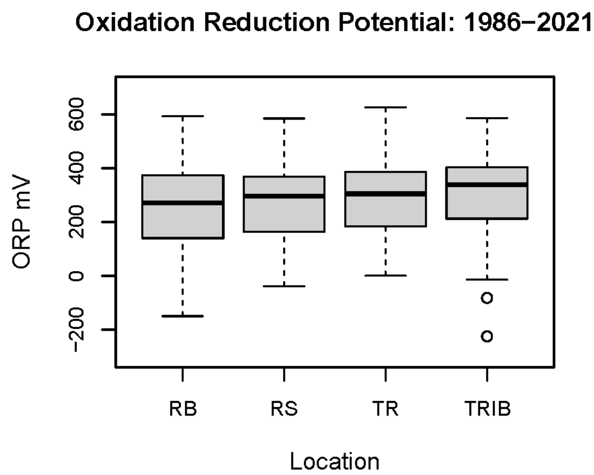
Table 2: Metrics, Methods, and Water Quality Criteria Used for Evaluating Water Quality

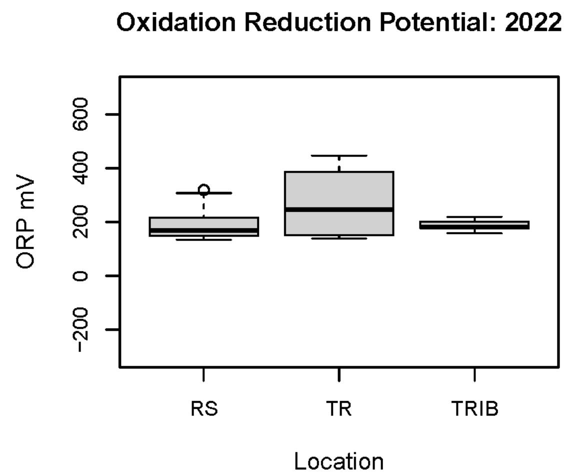
Metric	Abbreviation	Analysis Method	Water Quality Criteria	Source
Alachlor		EPA Method 8270C	< 2µg/L PWS or <1100 µg/L: aquatic life	Illinois EPA
Ammonia Nitrogen	NH_3	EPA Method 350.1	<15 mg/L	Illinois EPA
Atrazine	Atrazine	EPA Method 8270C	9 µg/L: Chronic or 82 µg/L: Acute or 3 µg/L DWS	Illinois EPA
Bacteria: E. Coliform	E Col	EPA Method 1604	< 235 E. Col per 100/mL for single sample	Illinois EPA
Chlorophyll a	Chl_a	SM Method 10200H	< 25mg/cm^3 (Eutrophic Upper Limit)	Carlson 1977
Cyanazine		EPA Method 8270C	< 30 µg/L: chronic or < 370 µg/L acute (aquatic life)	Illinois EPA
Depth	Depth	Multiparameter Meter	Measurements reported at ~1 meter	-----
Dissolved Oxygen	DO	Multiparameter Meter	Greater than 5.0mg/L	Illinois EPA
Metolachlor		EPA Method 8270C	30.4 µg/L: Chronic or 380 µg/L: Acute	Illinois EPA
Metribuzin		EPA Method 8270C	8.4 mg/L: aquatic life or 8.3 mg/L: human health	Illinois EPA
Nitrate as Nitrogen	NO_3	Green Method	< 10 mg/L	Illinois EPA
Non-Volatile Suspended Solids	NVSS	TSS - VSS	-----	-----
Orthophosphate	Ortho	EPA Method 365.2	-----	-----
Pendmethalin		EPA Method 8270C	< 30 µg/L: chronic or < 350 µg/L acute (aquatic life)	Illinois EPA
Pheophytin a	Phpy_a	SM Method 10200H	-----	-----
Potential of Hydrogen	pH	Multiparameter Meter	Range: 6.5 – 9.0pH	Illinois EPA
Specific Conductivity	SpCond	Multiparameter Meter	500 uS/cm	-----
Temperature	Temp	Multiparameter Meter	Less than rise of 2.8°C above normal seasonal temperature	Illinois EPA
Total Dissolved Solids	TDS	Multiparameter Meter	< 500 mg/L	Illinois EPA
Total Manganese	TMn	EPA Method 6010C	< 1 mg/L	Illinois EPA
Total Organic Carbon	TOC	EPA Method 415.1	-----	-----

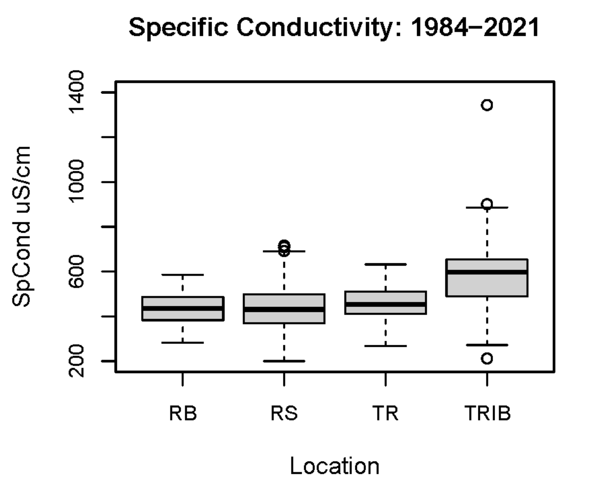
Metric	Abbreviation	Analysis Method	Water Quality Criteria	Source
Total Iron	TFe	EPA Method 6010C	< 1 mg/L	Illinois EPA
Total Phosphorus	TP	EPA Method 365.2	Less than 0.05 mg/L	Illinois EPA
Total Suspended Solids	TSS	EPA Method 160.2	-----	-----
Trifluralin		EPA Method 8270C	< 1.1 µg/L: chronic or < 26 µg/L acute (aquatic life)	Illinois EPA
Turbidity	Turb	Multiparameter Meter	-----	-----
Volatile Suspended Solids	VSS	EPA Method 160.4	-----	-----

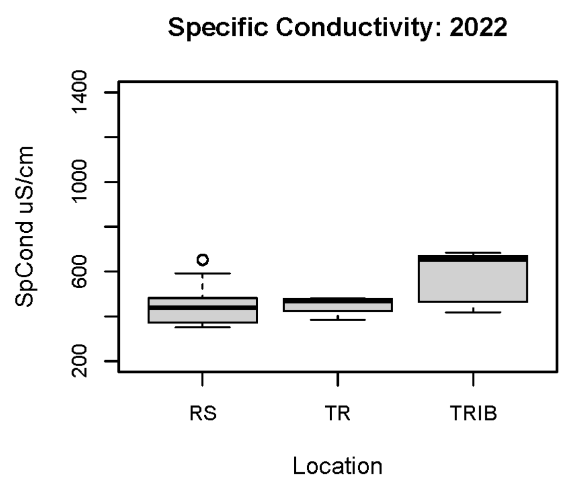
**1 mg/L is equivalent to 1 drop in two bathtubs and 1 ug/L is equivalent to 1 drop in an Olympic size swimming pool. PWS is public water supply. DWS is drinking water standard. WBC is whole body contact recreation. SCR is secondary contact recreation. USEPA* refers to the Federal EPA reference nutrient conditions for level III ecoregion 72 lakes and rivers.*

RESULTS AND SUMMARY STATISTICS: WATER QUALITY



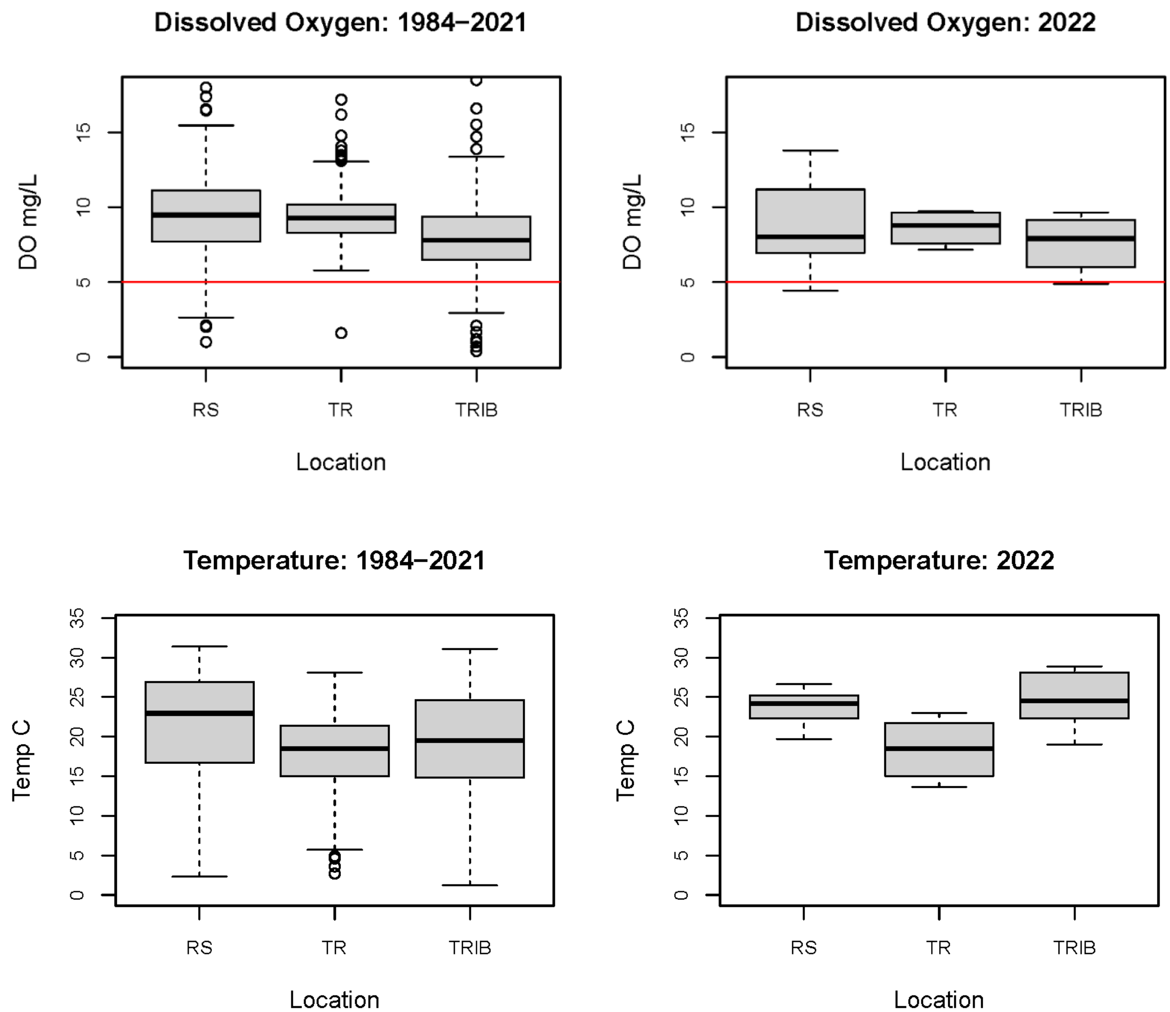






	Historical Reference 1984-2021				**2022**		
	Location	Mean	Median	n	Mean	Median	n
ORP	RB	259.07	271.50	94	----	----	----
	RS	272.90	297.00	321	191.60	169.30	23
	TR	283.52	305.00	129	269.18	245.65	4
	TRIB	310.28	339.50	196	186.99	181.25	8
SpCond	RB	436.54	435.00	99	----	----	----
	RS	440.58	431.00	347	451.20	439.10	23
	TR	454.06	454.20	146	450.35	468.30	4
	TRIB	575.76	597.00	207	575.09	655.80	8

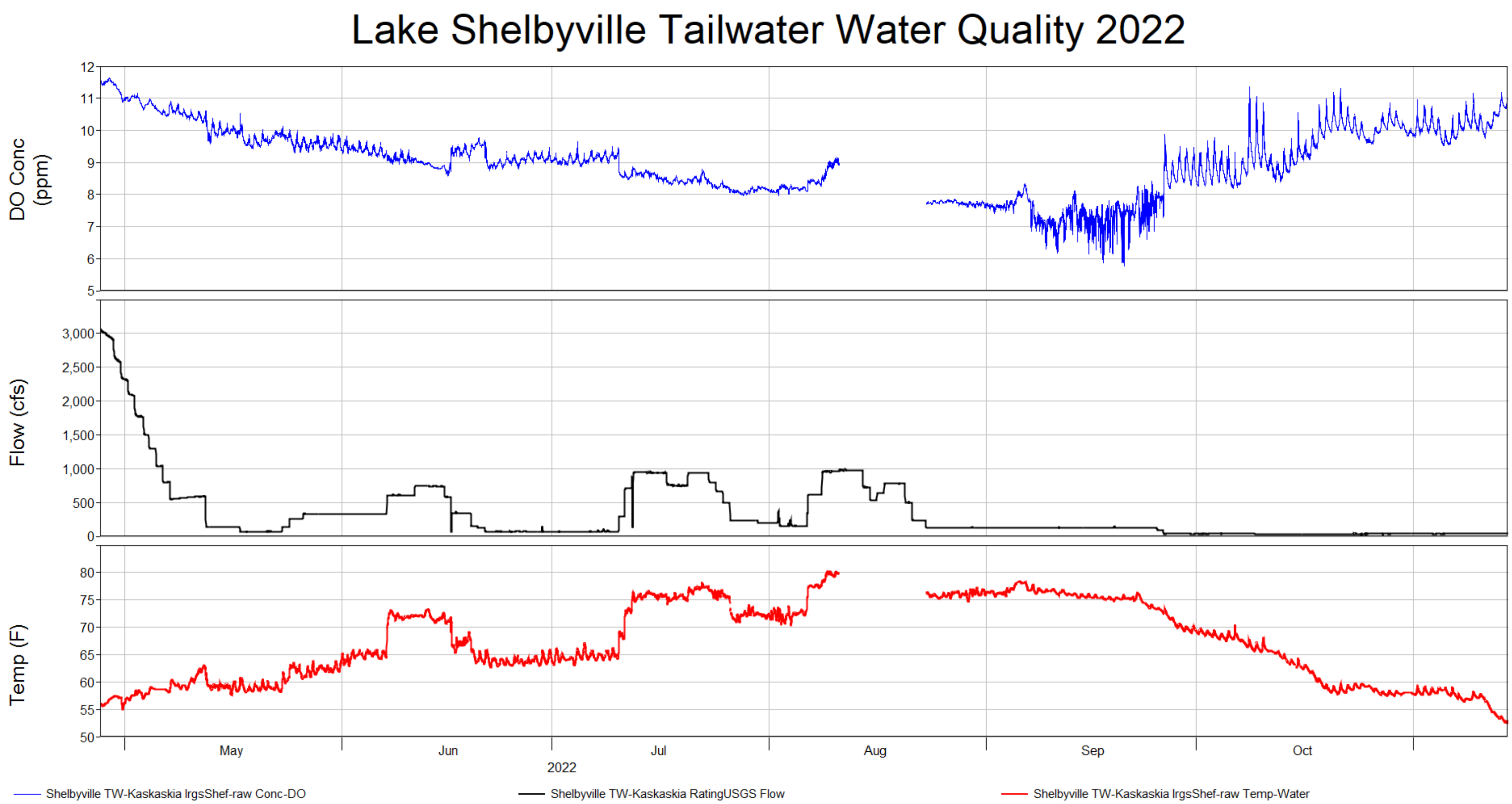
**This report does not acknowledge a water quality criteria for SpCond or ORP.*



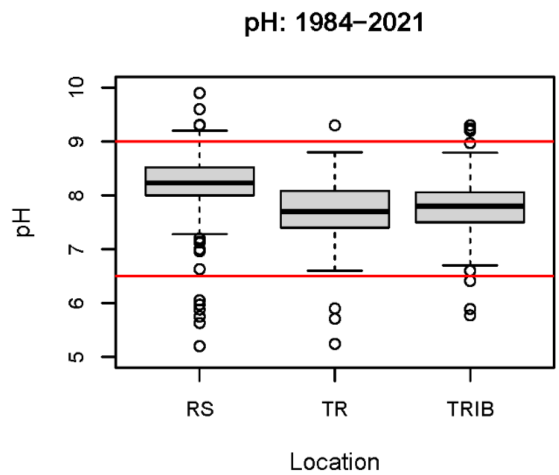
Red line placed at the 5 mg/L level for DO.

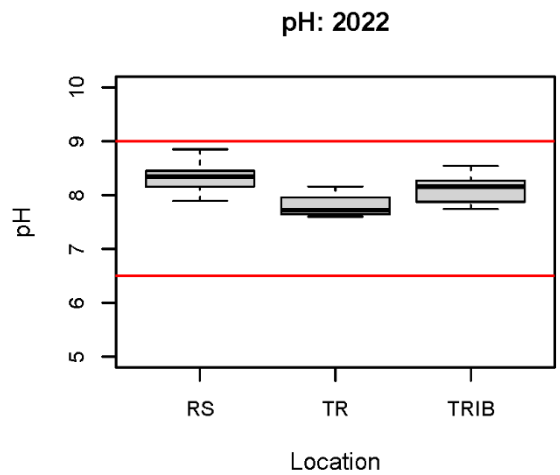
	Historical Reference 1984-2021				**2022**		
	Location	Mean	Median	n	Mean	Median	n
DO	RS	9.51	9.50	338	8.73	8.02	23
	TR	9.47	9.29	146	8.62	8.79	4
	TRIB	8.00	7.82	204	8.87	7.92	8
Temp	RS	20.94	22.95	350	23.83	24.19	22
	TR	17.81	18.50	149	18.39	18.47	4
	TRIB	19.22	19.50	212	24.75	24.50	7

** During the four sampling events the DO standard was exceeded three times. In 2022 temperature was recorded above the standard (rise of 2.8° C above the natural temperatures) for RS in the spring and TRIB in the summer. The historical average temperature by season per class was used as the natural temperature.*



**Data recorded by multi-parameter sonde at Lake Shelbyville Dam. There were no DO exceedances in 2022. Data was not reliable from August 11 through August 23, 2022.*

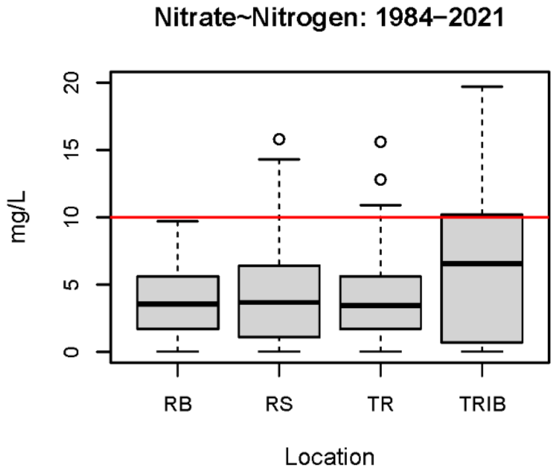


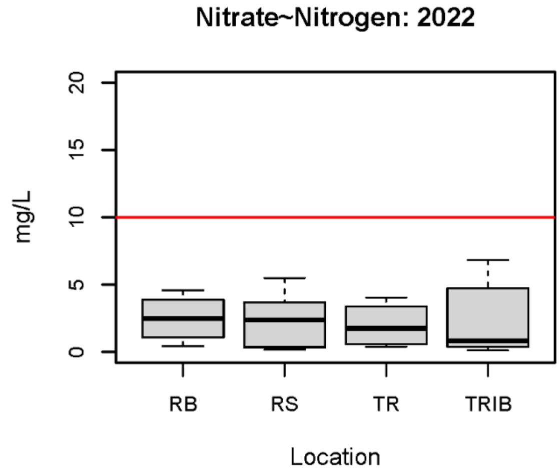


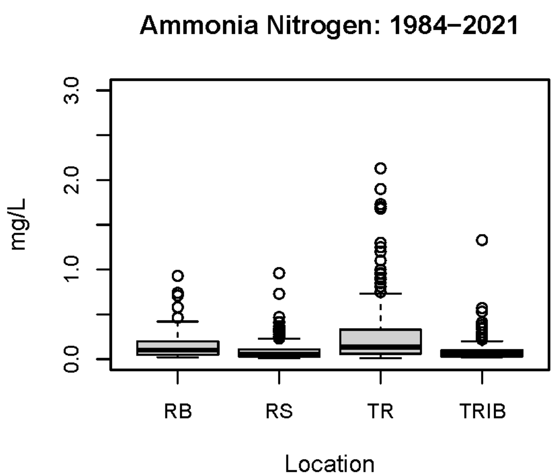
**Red lines indicate the upper and lower water quality criteria standards (between 6.5 and 9).*

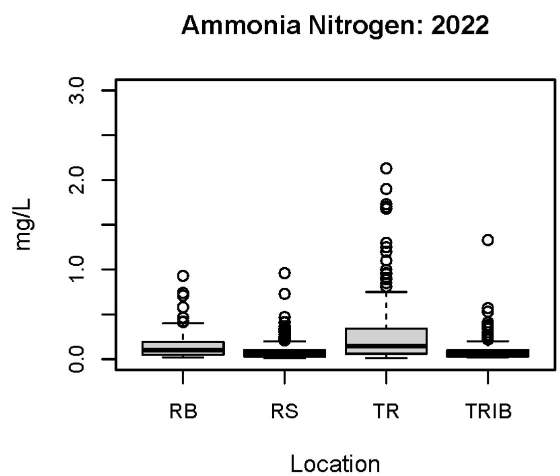
	Historical Reference 1984-2021				2022		
	Location	Mean	Median	n	Mean	Median	n
pH	RS	8.21	8.23	341	8.34	8.34	23
	TR	7.72	7.70	145	7.80	7.72	4
	TRIB	7.79	7.80	208	8.11	8.16	8

**The pH standard was not exceeded in 2022.*



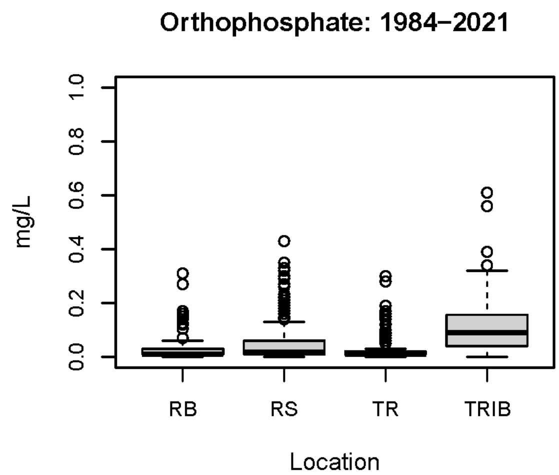


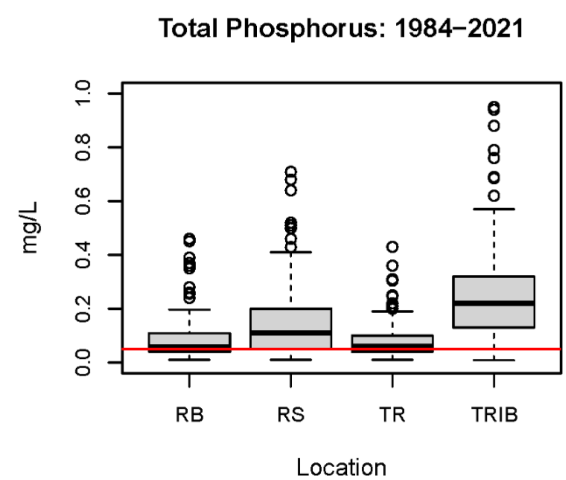


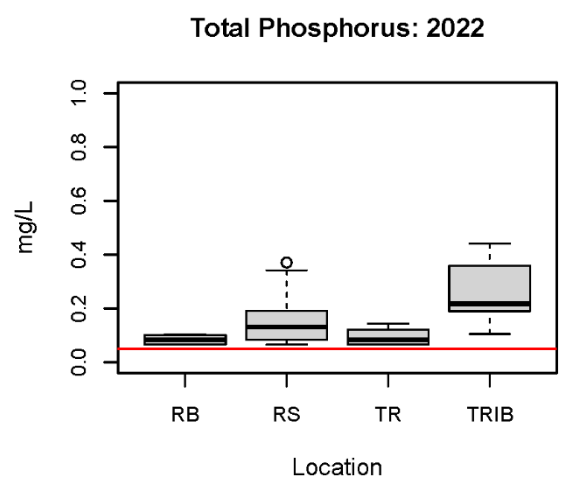


Historical Reference 1984-2021					2022		
	Location	Mean	Median	n	Mean	Median	n
NO3-N	RB	3.79	3.55	110	2.48	2.46	4
	RS	4.18	3.69	345	2.31	2.36	11
	TR	3.87	3.45	160	1.98	1.75	4
	TRIB	6.24	6.55	230	2.34	0.83	8
NH3N	RB	0.16	0.10	110	0.15	0.10	114
	RS	0.09	0.05	343	0.09	0.06	354
	TR	0.29	0.14	162	0.29	0.15	166
	TRIB	0.09	0.06	230	0.09	0.06	238

**The nitrate standard of 10 mg/L was not exceeded in 2022. All observations of ammonia nitrogen were within the water quality standard during 2022.*



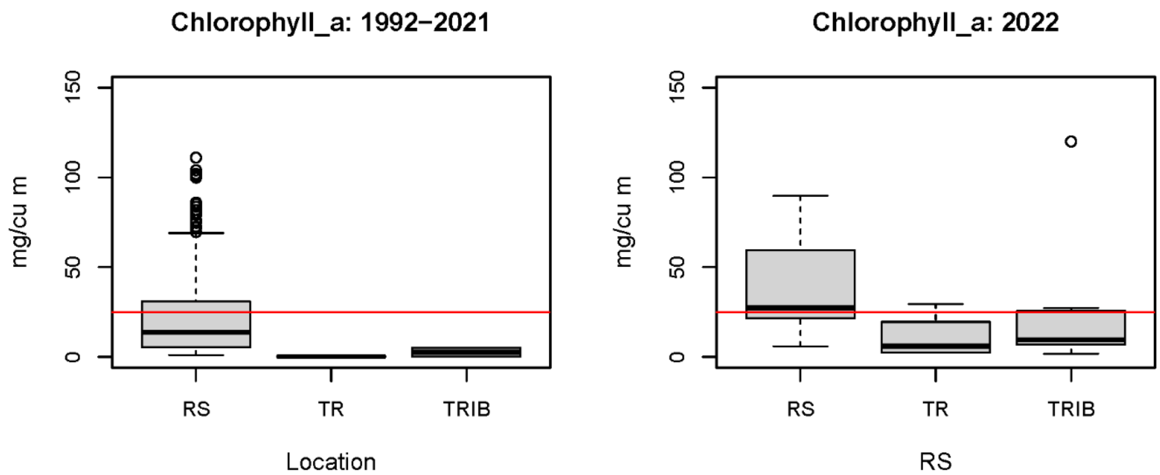




**Red line indicates the TP water quality screening value of 0.05 mg/L.*

	Historical Reference 1984-2021				2022		
	Location	Mean	Median	n	Mean	Median	n
PO4	RB	0.03	0.01	106	----	----	----
	RS	0.05	0.02	333	----	----	----
	TR	0.03	0.01	157	----	----	----
	TRIB	0.11	0.09	226	----	----	----
TP	RB	0.09	0.06	111	0.08	0.08	4
	RS	0.14	0.11	349	0.16	0.13	11
	TR	0.08	0.06	162	0.09	0.08	4
	TRIB	0.25	0.22	234	0.26	0.22	8

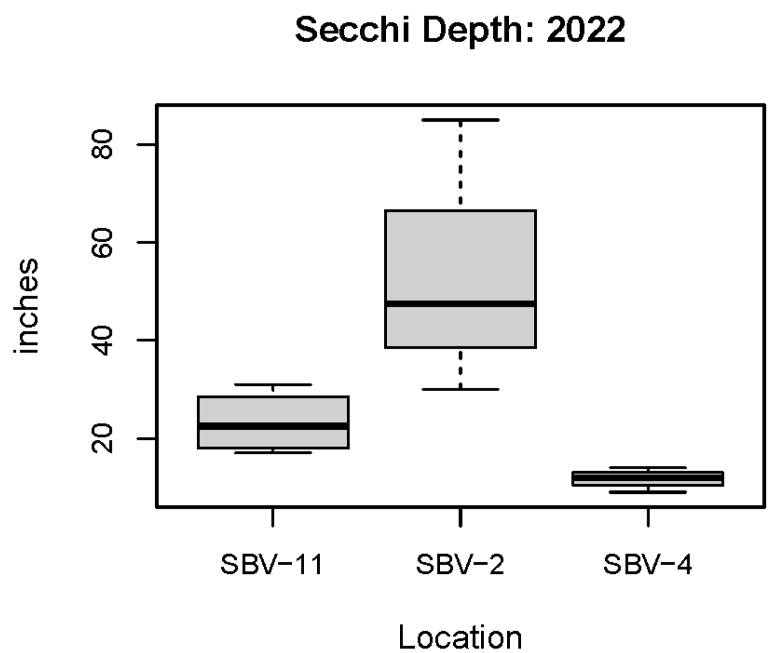
**TP exceeded the standard of 0.05 mg/L at all locations during multiple events in 2022. This study does not acknowledge a water quality standard for PO4. PO4 was not sampled in 2022.*

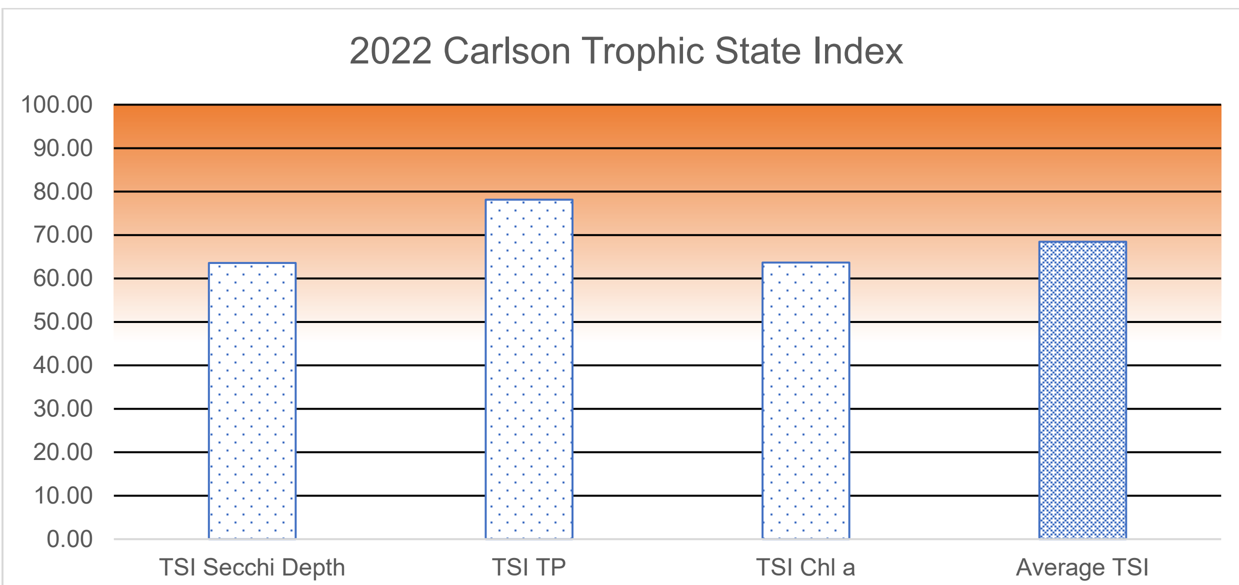


**Red line indicates the reference standard of 25 mg/cu m.*

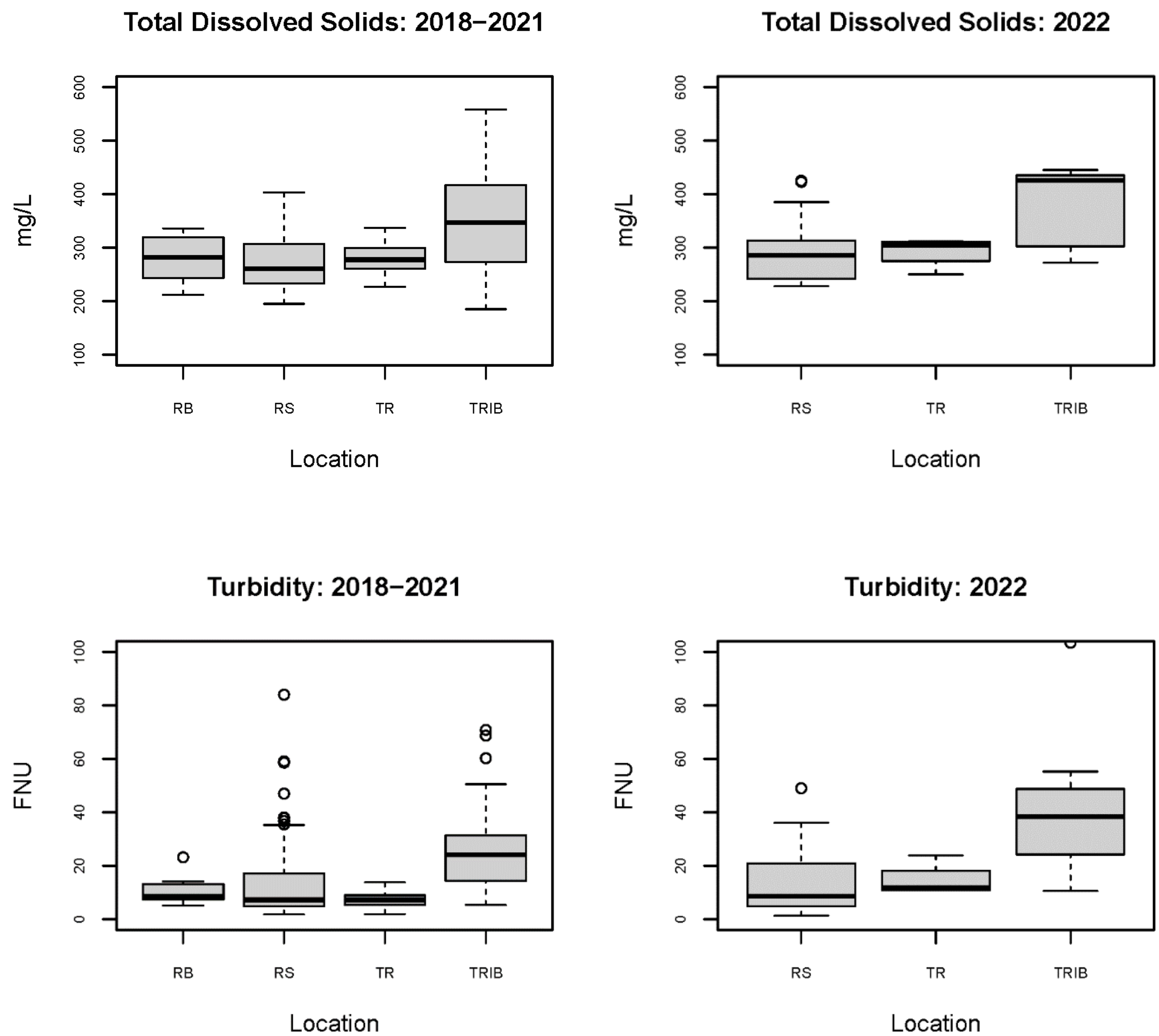
	Historical Reference 1984-2021				2022		
	Location	Mean	Median	n	Mean	Median	n
Chl_a	RS	21.94	13.70	321	37.32	27.35	12
	TR	0.22	0.22	1	10.98	6.00	4
	TRIB	2.61	2.61	2	25.78	9.70	8

**The reference standard of 25 mg/cu m was exceeded on multiple occasions in the lake as well as in the tailrace and tributaries in 2022.*



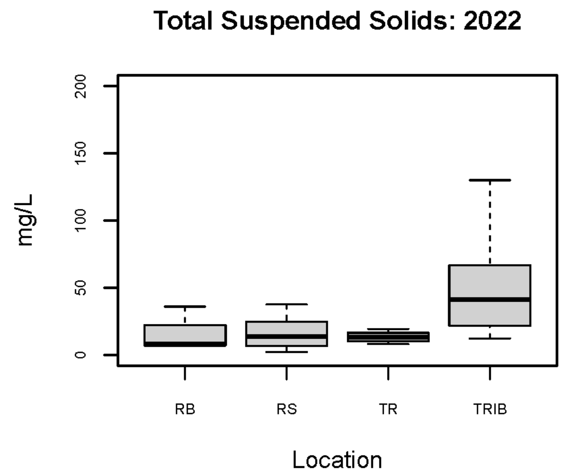


<40 = Oligotrophic __ 40-50 = Mesotrophic __ 50-70 = Eutrophic __ >70 Hypereutrophic



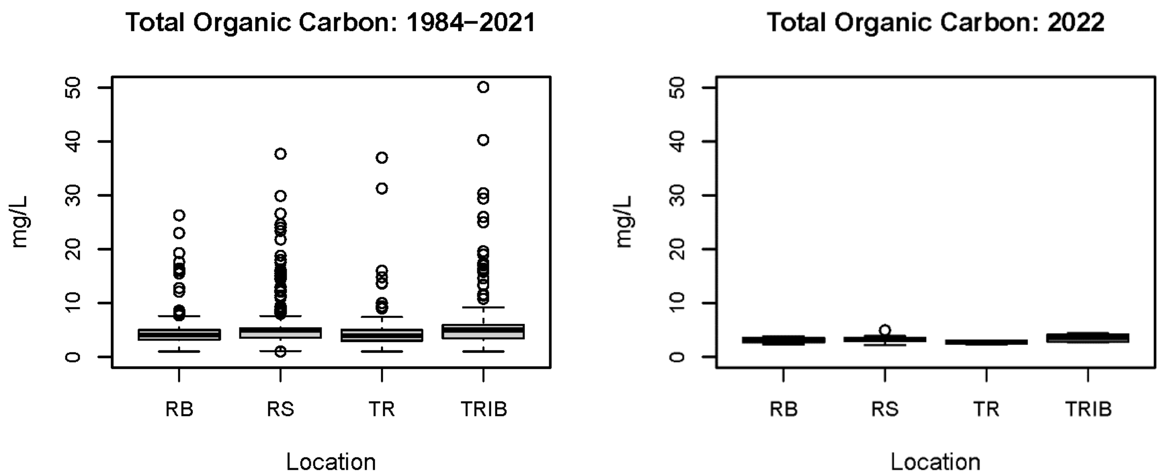
	Historical Reference 2018-2021				2022		
	Location	Mean	Median	n	Mean	Median	n
TDS	RB	279.87	281.50	12	----	----	----
	RS	274.18	260.50	84	293.23	285.50	22
	TR	281.52	277.50	16	292.75	304.50	4
	TRIB	343.24	346.50	32	374.00	426.00	7
FNU	RB	10.42	8.69	12	----	----	----
	RS	15.07	7.27	84	14.54	8.65	23
	TR	7.37	7.25	16	14.55	11.75	4
	TRIB	27.07	24.13	32	42.09	38.34	8

* *All TDS observations were below the standard in 2022. This study does not recognize a standard for turbidity.*



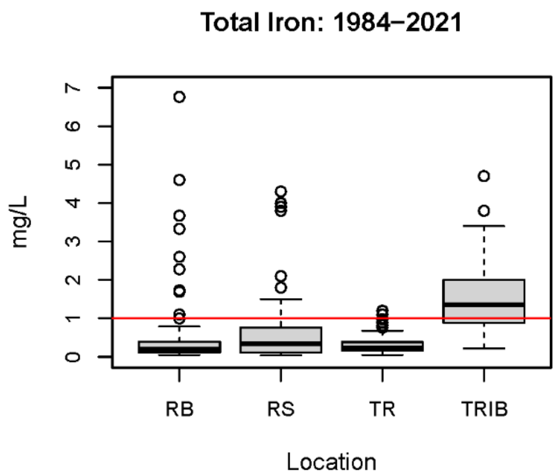
	Historical Reference 1984-2021				2022		
	Location	Mean	Median	n	Mean	Median	n
TSS	RB	18.42	8.00	104	14.88	8.06	4
	RS	18.82	13.20	349	16.19	13.85	12
	TR	9.29	8.00	160	13.48	13.20	4
	TRIB	42.48	36.00	230	50.33	41.40	8

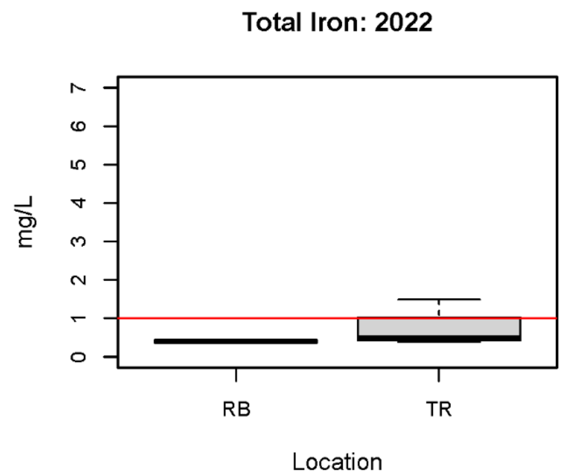
** This study does not recognize a standard for TSS.*



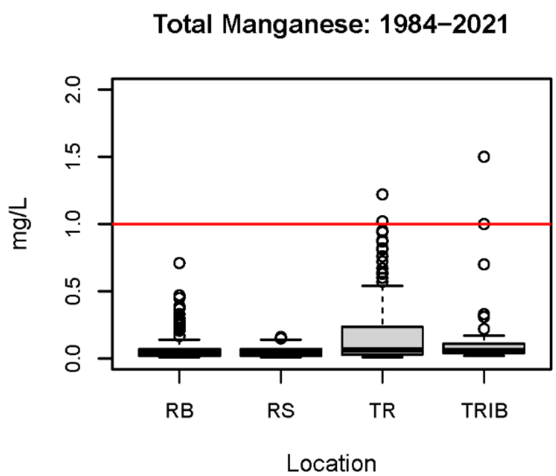
Historical Reference 1984-2021					2022		
	Location	Mean	Median	n	Mean	Median	n
TOC	RB	5.20	4.10	111	3.14	3.23	4
	RS	5.50	4.90	349	3.30	3.27	11
	TR	4.62	3.90	162	2.76	2.80	4
	TRIB	5.91	5.00	233	3.53	3.56	8

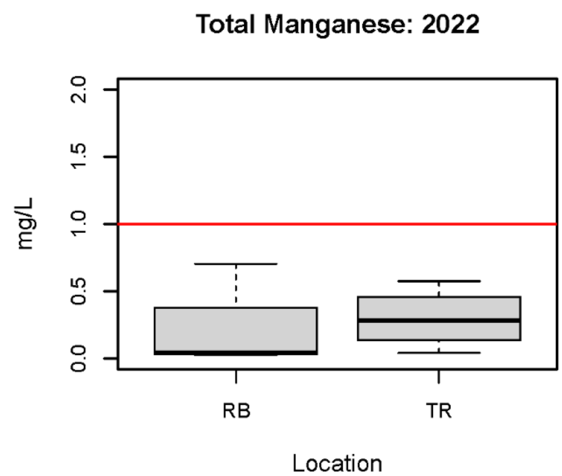
**This study does not recognize a standard for TOC.*





**Red line indicates the water quality standard of 1 mg/L.*

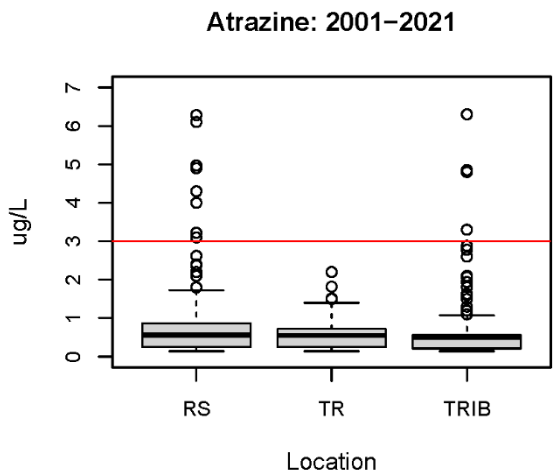


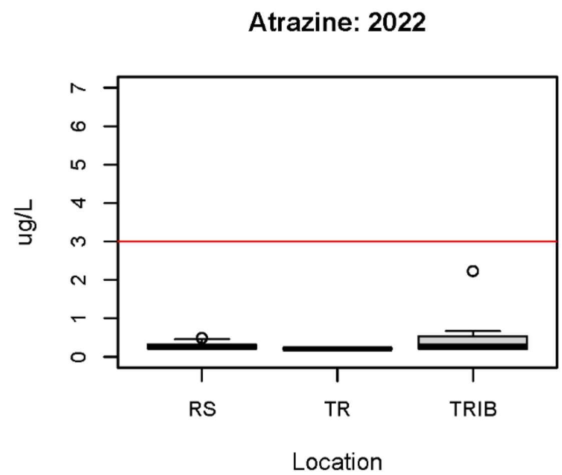


**Red line indicates the standard for manganese of 1 mg/L.*

	Historical Reference 1984-2021				**2022**		
	Location	Mean	Median	n	Mean	Median	n
TFe	RB	0.48	0.20	110	0.40	0.40	3
	RS	0.64	0.34	100	----	----	----
	TR	0.30	0.24	160	0.72	0.50	4
	TRIB	1.49	1.35	68	----	----	----
TMn	RB	0.08	0.04	110	0.20	0.04	4
	RS	0.05	0.04	95	----	----	----
	TR	0.18	0.07	160	0.30	0.28	4
	TRIB	0.13	0.06	68	----	----	----

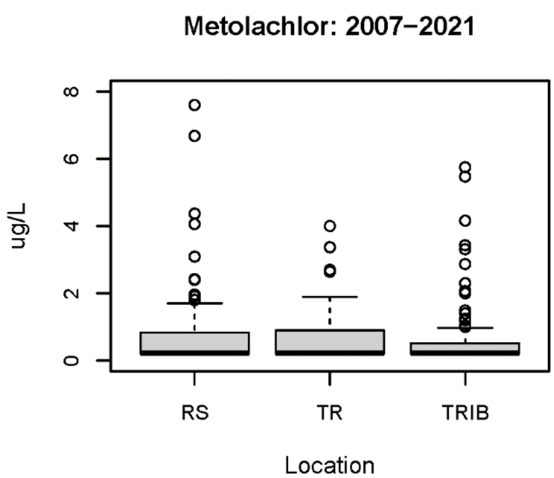
**Fe exceeded the standard of 1 mg/L in the tailrace once in September 2022. The standard for Mn was not exceeded in 2022.*

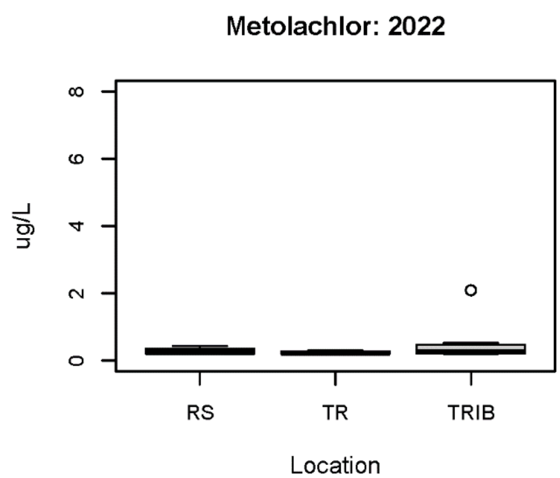




	Historical Reference 1996-2021				**2022**		
	Location	Mean	Median	n	Mean	Median	n
Atrazine	RS	0.78	0.56	213	0.28	0.23	12
	TR	0.59	0.55	72	0.21	0.21	4
	TRIB	0.70	0.50	137	0.56	0.29	8

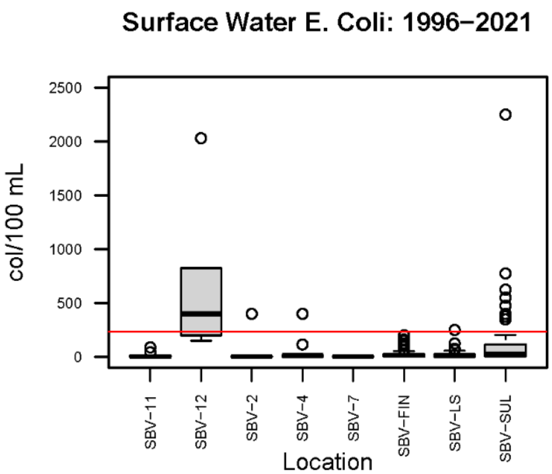
**The standard of 3 ug/L for Atrazine was not exceeded 2022.*

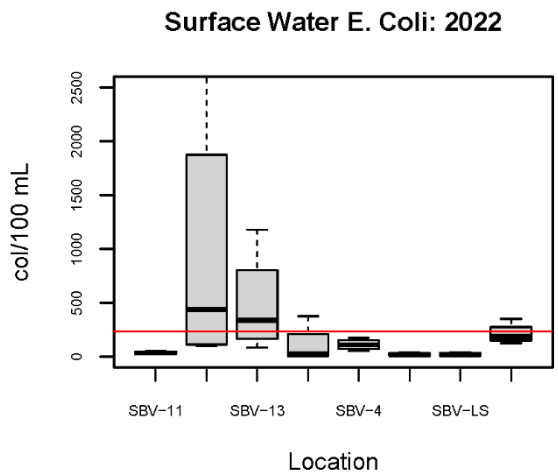




	Historical Reference 1984-2021				**2022**		
	Location	Mean	Median	n	Mean	Median	n
Metolachlor	RS	0.70	0.22	136	0.28	0.25	12
	TR	0.72	0.22	45	0.23	0.21	4
	TRIB	0.67	0.22	88	0.53	0.27	8

**The standard of 30.4 ug/L for Metolachlor was not exceeded in 2022.*





The standard <235 colonies/100 mL is indicated with a red line.

	Historical Reference 2001-2021				2022			
	Location	Mean	Median	n	Location	Mean	Median	n
E col	SBV-11	15.91	3.00	11	SBV-11	36.50	34.50	4
	SBV-12	667.50	400.00	6	SBV-12	993.75	437.50	4
	SBV-2	40.00	3.00	11	SBV-2	109.00	28.00	4
	SBV-4	48.62	13.00	13	SBV-4	112.25	111.50	4
	SBV-7	4.00	4.00	1	SBV-13	484.25	337.50	4
	SBV-FIN	33.36	17.00	56	SBV-FIN	20.75	18.00	4
	SBV-LS	23.16	10.00	55	SBV-LS	20.50	15.50	4
	SBV-SUL	146.32	25.00	53	SBV-SUL	212.50	187.50	4

**Bacteria levels exceed the standard of 235 colonies/100 mL at in the tributaries and in the lake multiple times in 2022.*

2022 Lake Shelbyville Swimming Beach Bacteria Levels (E. Coli / 100 mL)

Date	Coon Creek		Dam West		Lithia Springs		Sullivan Beach		Wilborn Creek	
	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep	Shallow	Deep
5/16/2022	2	1	6.3	1	1	1	3	3	6.3	1
6/1/2022	3.1	2	2	1	1	1	1	3.1	1	2
6/14/2022	1	1	2	1	2	1	12.1	8.4	1	1
6/27/2022	5.2	1	1	3.1	1	1	13.5	10.8	2	4.1
7/13/2022	3.1	1	6.3	6.3	1	1	152.9	5.2	47.3	3.1
7/27/2022	3.1	2	8.6	1	1	1	686.7	6.3	17.3	6.3
8/3/2022				Re-test from 7/27/2022			83.6	113.7		
8/8/2022	1	1	2	2	1	1	14.4	5.2	27.5	6.3
8/24/2022	1	1	1	1	1	1	1	1	1	4.1

**Beach bacteria levels exceeded the standard of 235 col/100mL once at Sullivan Beach on July 27, 2022.*

DISCUSSION: WATER QUALITY

Water quality metrics assessed by CEMVS can be sporadic and highly variable from year to year, thus long-term data collection using consistent and comparable methodology is critical to identify trends or patterns. In general, conditions observed during 2022 did not deviate far from conditions observed during the reference period (1984-2020); nevertheless, concerns regarding TP, TFe, bacteria, and temperature were evident. In addition, CHL_a and subsequent TSI levels were indicative of a eutrophic system.

TP levels have surpassed the 0.05 mg/L criterion for several years. In 2022 the TP criterion was exceeded at all locations with a mean concentration across all sites of 0.169 mg/L, which is 8.9% greater than the historical average of 0.154 mg/L. Phosphorus is a limiting nutrient for primary producers (algae and plants) due to its relatively low amount in the environment. Higher inputs of TP and NO3-N into the lake contribute to a highly productive environment which stimulates algal growth that can lead to blooms that deplete the oxygen levels during die off. In addition, blooms can sometimes contain toxins which may be harmful to humans and wildlife.

Living organisms require trace amounts of metals, excessive levels can be harmful. TFe exceeded the criterion of 1 mg/L one time at the tailrace with a concentration of 1.49 mg/L. The 2022 mean TFe was 0.584 mg/L compared to 0.606 mg/L for the historical mean (3.6% less). Iron cycling is a function of oxidation-reduction processes. Elevated levels of iron near the bottom of a lake is not immediately detrimental to the overall lake system. Iron oxidizes relatively rapidly (minutes to hours); therefore, any iron released through the spillway will be oxidized in a short period of time.

Fecal coliform bacteria is monitored for the protection of human health as it relates to full body contact of recreational waters. People can be exposed to disease-causing organisms, such as bacteria, viruses and protozoa in beach and recreational waters mainly through accidental ingestion of contaminated water or through skin contact. These organisms, called pathogens, usually come from the feces of humans and other warm-blooded animals. If taken into the body, pathogens can cause various illnesses and on rare occasions, even death. Waterborne illnesses include diseases resulting from bacterial infection such as cholera, salmonellosis, and gastroenteritis, viral infections such as hepatitis, gastroenteritis, and intestinal diseases, and protozoan infections such as amoebic dysentery and giardiasis. The most commonly monitored recreational water indicator organisms are fecal coliform, Escherichia coli, (E. coli) and enterococci. Fecal coliform are bacteria that live in the intestinal tracts of warm-blooded animals. The Environmental Protection Agency (EPA) currently recommends E. coli or enterococci as an indicator organism for fresh waters. The standard for E. coli is less than 235 colonies per 100ml per single sample water or geometric mean of 126 colonies per 100ml. Swimming beaches (monitored by Lake Shelbyville staff) and surface water in the lake and in some of the tributaries are monitored for E. coli. In 2022 the water quality standard was exceeded in the tributaries and lake. Bacteria sampling in the tributaries was added in recent years to get a better understanding of bacteria levels coming into the lake. Recent investigations in this arm of the lake suggest an increasing trend for bacteria and recent observations reinforce this finding.

Temperature is important because it controls several aspects of water quality. Colder water holds more dissolved oxygen which is required by aquatic organisms. Plants grow more rapidly and use more oxygen in warmer water. Decomposition of organic matter which uses oxygen is accelerated in warmer water. Temperature can also determine the availability of toxic compounds such as ammonia. Water temperature criteria for warm water bodies in Illinois is within 2.8°C of the seasonal norm. Observations in 2022 were compared to the USACE seasonal historical means. This comparison revealed that average observed temperature exceeded the standard in the surface water (RS) during spring and in the tributaries (TRIB) during summer.

Although there is not a state criterion for CHL_a, the proposed standard of 25 ug/L was exceeded at multiple locations in the lake and in the tailrace and tributaries throughout 2022. The 2022 mean CHL_a concentration of 29.1 ug/L is 25.3 % greater than the historical mean of 21.75 ug/L. CHL_a is an indicator of the abundance of phytoplankton. Any water environment with a level recorded above 25 ug/L is considered to be eutrophic (nutrient enrichment increases algal and plant growth and negative effects). The 2021 TSI level, an average of the individual trophic state indexes for secchi depth, CHL_a, and TP, for Lake Shelbyville is 67.25. Lake Shelbyville is considered eutrophic based on this TSI level. This does not necessarily mean the water quality is poor, but that its trophic level indicates nutrient levels are abundant, which can support an abundance of plants and algae. Long term monitoring and analyses are important to assess changes over time.

Total suspended solids can affect water quality by increasing temperature through the absorption of sunlight by suspended particles in the water column, and consequently reduce DO. Total suspended solids are also strongly correlated with water clarity and the presence of Macrophytes. Though there are no numeric water quality standards for TSS, Lake Shelbyville is listed by IEPA as impaired by TSS. The 2022 TSS levels were comparable to the historical levels and show the same spatial patterns by occurring in higher concentrations in the tributaries and trending down near the dam and discharge. Mean 2022 TSS levels were 25.4 mg/L compared to 23.4 mg/L historical levels.

All remaining parameters evaluated during the 2022 water quality monitoring effort were within designated criteria or within historical reference norms.

MONITORING PROGRAM RECOMMENDATIONS

In accordance with EM-1110-2-1201, sediment samples should be taken to monitor and assess potential impacts to aquatic and human health. Routine sediment sampling and analyses occurred at Lake Shelbyville in 2018, and prior to that in 2007. During these last analyses multiple exceedances over the recommended criteria were observed. There were two non-routine sediment sampling efforts carried out by USACE which were executed due to upcoming dredge work in the Sullivan arm of the lake. The first sampling occurred in April 2022 and found that no analytes exceeded IEPA's elevated levels. The second sampling occurred in October/November 2022 and revealed all analytes of concern would fall below the criteria and/or historical background levels after twenty-four hours of settling. Both of these events in 2022 were geared towards meeting a 401 water quality certification for the upcoming dredging project and only focused on a small portion of the lake. Identifying trends over time is much more achievable with more consistent data. Contaminated sediments may have negative impacts on ecological processes. It is recommended to sample and analyze for sediment metals and nutrients, as well as grain size analyses yearly or every two years at all lake sites.

It is recommended to maintain a minimum of 4 seasonal routine water quality sampling events at all established locations to monitor conditions and conduct trend analyses as needed on parameters of concern such as nutrients, bacteria, temperature, pesticides, chlorophyll_a, and total suspended solids.

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APPENDIX A: FIELD DATA

Date	Site	Depth (m)	DO (mg/L)	pH	ORP (mV)	Temp (C)	Sp Cond (µS/cm)	TDS (mg/L)	Turbidity (FNU)	Secchi (in)
5/19/2022	SBV-1	1.56	9.72	8.16	164.5	13.64	474.8	309	12.5	
5/19/2022	SBV-1	0.75	10.01	8.23	163.3	13.55	467.6	304	23.93	
5/19/2022	SBV-2	0.57	13.87	8.83	143.9	20.02	410.4	267	2.27	48
5/19/2022	SBV-2	1.12	13.8	8.81	146.4	19.69	412.5	268	2.74	
5/19/2022	SBV-2	2.13	11.55	8.58	157.5	19.21	425.5	277	2.95	
5/19/2022	SBV-2	3.04	8.08	8.22	169.8	18.14	444.6	289	3.28	
5/19/2022	SBV-2	3.08	8.28	8.22	170.9	18.22	443.1	288	3.23	
5/19/2022	SBV-2	4.17	5.35	8.1	177	16.13	463.8	301	3.48	
5/19/2022	SBV-2	5.30	5.13	8.13	179	15.26	467.9	304	4	
5/19/2022	SBV-2	6.39	5.44	8.23	178.1	14.35	468.5	304	5.08	
5/19/2022	SBV-2	7.79	6.1	8.29	177.2	13.95	467.5	304	4.77	
5/19/2022	SBV-2	9.44	5.79	8.25	179	13.49	467.2	304	5.75	
5/19/2022	SBV-2	10.56	5.32	8.2	181	13.38	467.4	304	7.66	
5/19/2022	SBV-2	11.58	4.78	8.13	182.9	13.20	467.7	304	11.06	
5/19/2022	SBV-LS	1.00	13.57	8.85	214	20.97	394.5	256	4.73	
5/19/2022	SBV-LS	5.44	4.85	8.08	229.4	15.51	472.1	307	4.63	
5/19/2022	SBV-LS	9.68	4.26	8.09	226.7	13.64	470.4	306	17.81	
5/19/2022	SBV-13	0.68	7.52	8.22	172.8	19.01	663.9	432	36.82	
5/19/2022	SBV-FIN	1.06	12.54	8.62	196	21.41	481.9	313	6.59	
5/19/2022	SBV-FIN	2.34	12.51	8.57	190.8	20.93	486.9	317	6.86	
5/19/2022	SBV-FIN	3.81	8.45	8.11	116.8	20.35	506.7	329	36.31	
5/19/2022	SBV-11	1.08	12.12	8.57	152.3	21.71	499.4	325	5.13	31
5/19/2022	SBV-11	2.03	12.33	8.57	152.6	21.66	499.3	325	5.27	
5/19/2022	SBV-11	3.09	12.34	8.55	155	21.37	500.5	325	5.15	
5/19/2022	SBV-11	4.18	11.11	8.37	159.8	20.86	510.5	332	6.73	
5/19/2022	SBV-11	5.01	5.63	8.01	174.8	18.21	563.5	366	29.15	
5/19/2022	SBV-4	1.16	8.18	8.39	195.9	22.59	654	425	21.71	12
5/19/2022	SBV-SUL	1.12	8.02	8.37	218.8	22.29	651.4	423	25.89	
5/19/2022	SBV-12	0.65	8.69	8.26	157.9	20.76	655.8	426	10.59	
6/21/2022	SBV-1	0.88	9.6	7.69	446.9	16.44	480.3	312	10.86	
6/21/2022	SBV-2	1.08	8.71	8.1	227.2	24.28	448.2	291	1.36	85
6/21/2022	SBV-2	2.02	8.3	8.08	225.2	23.94	448.4	291	1.49	
6/21/2022	SBV-2	3.30	6.89	7.95	224.2	23.73	451.2	293	1.49	
6/21/2022	SBV-2	4.27	4.54	7.72	226	23.24	455	296	1.59	
6/21/2022	SBV-2	5.16	3.1	7.6	227.3	22.87	456.7	297	1.92	
6/21/2022	SBV-2	5.15	3.12	7.6	227.1	22.87	456.7	297	1.96	
6/21/2022	SBV-2	6.25	0.8	7.45	229.1	21.67	460.3	299	3.02	
6/21/2022	SBV-2	7.23	0.41	7.42	230.2	20.24	462.9	301	4.9	
6/21/2022	SBV-2	8.05	0.32	7.41	230.7	18.87	467.1	304	9.11	
6/21/2022	SBV-2	9.09	0.29	7.43	228.8	17.67	470.5	306	7.46	
5/19/2022	SBV-1	1.56	9.72	8.16	164.5	13.64	474.8	309	12.5	
5/19/2022	SBV-1	0.75	10.01	8.23	163.3	13.55	467.6	304	23.93	

Date	Site	Depth (m)	DO (mg/L)	pH	ORP (mV)	Temp (C)	Sp Cond (µS/cm)	TDS (mg/L)	Turbidity (FNU)	Secchi (in)
6/21/2022	SBV-2	10.10	0.28	7.44	227	16.82	474.5	308	9.29	
6/21/2022	SBV-LS	10.11	0.86	7.51	283.9	17.31	473.9	308	17.22	
6/21/2022	SBV-LS	5.17	3.2	7.62	273.8	23.17	451.1	293	2.66	
6/21/2022	SBV-LS	0.97	10.98	8.34	253	25.19	430.4	280	3.14	
6/21/2022	SBV-13	0.20	19.83	8.54	219.4	28.87	488.6	318	39.86	
6/21/2022	SBV-FIN	1.00	12.32	8.36	148.7	25.74	447.8	291	7.36	
6/21/2022	SBV-FIN	3.01	7.52	7.99	168.6	24.73	461.6	300	7.13	
6/21/2022	SBV-11	1.29	10.42	8.29	307.5	26.61	460.1	299	8.65	26
6/21/2022	SBV-11	2.12	9.45	8.22	294.9	25.78	462.2	300	12.9	
6/21/2022	SBV-11	3.15	7.93	8.07	290.8	25.23	465.1	302	21.58	
6/21/2022	SBV-11	4.16	7.56	8.03	286.5	25.05	465.1	302	33.56	
6/21/2022	SBV-11	5.18	3.27	7.64	287.4	24.92	477.1	310	22.2	
6/21/2022	SBV-11	5.95	2.55	7.58	286.9	24.84	478.8	311	28.15	
6/21/2022	SBV-4	1.17	6.88	8.03	319.1	25.23	592.6	385	49	14
6/21/2022	SBV-SUL	1.15	7.4	8.08	252.4	25.47	592	385	33.75	
6/21/2022	SBV-12	0.83	9.66	8.09	196.9	27.44	684.2	445	14.45	
8/3/2022	SBV-1	0.65	7.98	7.6	326.8	20.50	461.8	300	10.99	
8/3/2022	SBV-2	1.02	4.8	7.89	169.3	24.70	390.8	254	4.36	47
8/3/2022	SBV-2	2.07	4.26	7.78	174.7	24.60	392	255	4.36	
8/3/2022	SBV-2	2.99	3.27	7.71	178	24.60	393.3	256	4.52	
8/3/2022	SBV-2	4.17	3	7.69	179.5	24.50	393	255	4.74	
8/3/2022	SBV-2	4.96	2.64	7.65	181.6	24.50	393.5	256	4.96	
8/3/2022	SBV-2	6.07	1.87	7.59	183.3	24.40	395.4	257	10.02	
8/3/2022	SBV-2	7.03	2.01	7.58	183.5	24.30	394.5	256	8.72	
8/3/2022	SBV-2	8.21	0.54	7.52	184.9	23.90	399.6	260	11.73	
8/3/2022	SBV-LS	1.04	7.19	8.23	164.6	25.20	378	246	6.48	
8/3/2022	SBV-LS	10.23	1.16	7.47	85.1	22.80	325.6	212	103.16	
8/3/2022	SBV-LS	5.00	5.33	7.99	125.6	24.90	383.6	249	5.93	
8/3/2022	SBV-13	0.05	8.3	8.28	182.7	28.80	440.9	287	79	
8/3/2022	SBV-13	0.05	8.31	8.28	180.9	28.80	441.2	287	103.44	
8/3/2022	SBV-FIN	1.01	7.76	8.41	214.1	25.70	372.6	242	12.46	
8/3/2022	SBV-FIN	2.98	5.91	8.16	61.4	25.00	371	241	17.65	
8/3/2022	SBV-FIN	1.87	6.57	8.3	83.7	25.30	372	242	14.85	
8/3/2022	SBV-11	1.10	11.43	8.79	187.5	26.50	357.7	233	14.15	19
8/3/2022	SBV-11	2.08	11.43	8.78	183.4	26.50	358.1	233	14.61	
8/3/2022	SBV-11	3.12	7.61	8.52	181.7	25.50	363.1	236	17.63	
8/3/2022	SBV-11	4.08	5.63	8.35	182	25.10	364.6	237	18.57	
8/3/2022	SBV-11	5.14	5.08	8.29	181.7	24.90	364.9	237	20.27	
8/3/2022	SBV-11	6.16	4.54	8.21	181.6	24.90	365.4	238	24.91	
8/3/2022	SBV-4	1.16	7.71	8.4	157.4				20.01	
8/3/2022	SBV-4	2.06	7.77	8.4	158.8				19.52	
8/3/2022	SBV-12	0.05	4.9	7.78	181.1				42.26	

Date	Site	Depth (m)	DO (mg/L)	pH	ORP (mV)	Temp (C)	Sp Cond (µS/cm)	TDS (mg/L)	Turbidity (FNU)	Secchi (in)
9/7/2022	SBV-13	0.17	6.18	7.85	184.8		417.2	271	49.22	
9/7/2022	SBV-13	0.52	5.06	7.74	181.4		418	272	55.25	
9/7/2022	SBV-12	0.93	6.96	7.97	205.5		673.9	438	34.03	
9/7/2022	SBV-1	2.30	7.18	7.75	138.5	23	384.5	250	23.86	
9/7/2022	SBV-2	1.07	8.72	8.49	134.6	24.4	353.6	230	4.88	30
9/7/2022	SBV-2	6.97	7.87	8.4	146.1	24.2	354.7	231	5.09	
9/7/2022	SBV-2	3.83	8.14	8.44	151.4	24.2	354.4	230	5.29	
9/7/2022	SBV-LS	1.04	7.06	8.34	140.4	24.1	356.6	232	4.66	
9/7/2022	SBV-FIN	1.07	6.21	8.32	143.1	23.8	351.2	228	10.4	
9/7/2022	SBV-11	1.05	5.21	8.22	149	23.8	354.1	230	14.98	17
9/7/2022	SBV-11	5.39	3.43	7.97	48.7	23.3	356.5	232	30.78	
9/7/2022	SBV-11	3.02	3.22	7.96	96.2	23.5	356.6	232	13.54	
9/7/2022	SBV-SUL	1.05	4.44	7.93	146.6	22.5	472.5	307	36.03	
9/7/2022	SBV-4	1.04	5.38	7.98	168.9	22.3	474.4	308	35.94	9
9/7/2022	SBV-4	1.41	4.66	7.9	157.1	22.3	477.8	311	61.72	

APPENDIX B: LABORATORY DATA