North Carolina Division of Water Resources Ambient Lakes Monitoring Assessment of the Roanoke River Basin Lakes and Reservoirs

North Carolina Department of Environmental Quality

Division of Water Resources

Water Science Section

Intensive Survey Branch

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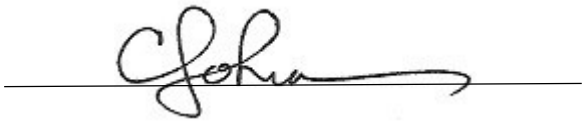

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Date

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Glossary

Algae Small aquatic plants that occur as single cells, colonies, or filaments. May also be referred to as phytoplankton, although phytoplankton are a subset of algae.

Algal Biovolume The volume of all living algae in a unit area at a given point in time. To determine biovolume, individual cells in a known amount of sample are counted. Cells are measured to obtain their cell volume, which is used in calculating biovolume.

Algal Density The density of algae based on the number of units (single cells, filaments and/or colonies) present in a milliliter of water. The severity of an algae bloom may be determined by the algal density as follows:

Mild bloom = 20,000 to 30,000 units/ml

Severe bloom = 30,000 to 100,000 units/ml

Extreme bloom = Greater than 100,000 units/ml

Algal Growth Potential Test (AGPT) A test to determine the nutrient that is the most limiting to the growth of algae in a body of water. The sample water is split such that one sub-sample is given additional nitrogen, another is given phosphorus, a third may be given a combination of nitrogen and phosphorus, and one sub-sample is not treated and acts as the control. A specific species of algae is added to each sub-sample and is allowed to grow for a given amount of time. The dry weights of algae in each sub-sample and the control are then measured to determine the rate of productivity in each treatment. The treatment (nitrogen or phosphorus) with the greatest algal productivity is said to be the limiting nutrient of the sample source. If the control sample has an algal dry weight greater than 5 mg/L, the source water is deemed unlimited for either nitrogen or phosphorus.

ALMP Ambient Lake Monitoring Program.

Centric Diatom Diatoms are photosynthetic algae that have a siliceous skeleton (frustule) found in almost every aquatic environment including fresh and marine waters, as well as moist soils. Centric diatoms are circular in shape and are often found in the water column.

Chlorophyll *a* Chlorophyll *a* is an algal pigment that is used as an approximate measure of algal biomass. The concentration of chlorophyll *a* is used in the calculation of the NCTSI, and the value listed is a lake-wide average from all sampling locations.

Clinograde In productive lakes where oxygen levels drop to zero in the lower waters near the bottom, the graphed changes in oxygen from the surface to the lake bottom produces what's known as a clinograde curve.

Coccoid Round or spherical shaped cell.

Conductivity The measure of the ability for water to conduct an electrical current. This measure increases as water becomes more mineralized. The concentrations listed are the range of values observed in surface readings from the sampling locations.

Dissolved Oxygen The range of surface water concentrations of oxygen found at sampling locations.

Dissolved Oxygen Saturation	The capacity of water to absorb oxygen gas. Often expressed as a percentage, the amount of oxygen that can dissolve into water will change depending on several parameters, the most important being temperature. Dissolved oxygen saturation is inversely proportion to temperature, that is, as temperature increases, water's capacity for oxygen will decrease, and vice versa.
Eutrophic	Describes a lake with high plant productivity and low water transparency.
Eutrophication	The process of physical, chemical, and biological changes associated with nutrients, organic matter, silt enrichment, and sedimentation of a lake.
Limiting Nutrient	The plant nutrient present in lowest concentration relative to need limits growth such that addition of the limiting nutrient will stimulate additional growth. In northern temperate lakes, phosphorus (P) is commonly the limiting nutrient for algal growth.
Manganese	A naturally occurring metal commonly found in soils and organic matter. As a trace nutrient, manganese is essential to all forms of biological life. Manganese in lakes is released from bottom sediments and enters the water column when the oxygen concentration in the water near the lake bottom is extremely low or absent. Manganese in lake water may cause taste and odor problems in drinking water and require additional treatment of the raw water at water treatment facilities to alleviate this problem.
Mesotrophic	Describes a lake with moderate plant productivity and water transparency.
NCTSI	North Carolina Trophic State Index was specifically developed for North Carolina lakes as part of the state's original Clean Lakes Classification Survey (NRCD 1982). It takes the nutrients present along with chlorophyll *a* and Secchi depth to calculate a lake's biological productivity.
Oligotrophic	Describes a lake with low plant productivity and high-water transparency.
pH	The range of surface water pH readings found at sampling locations. This value is used to express the relative acidity or alkalinity of water.
Photic Zone	The portion of the water column in which there is sufficient light for algal growth. DEQ considers 2 times the Secchi depth as depicting the photic zone.
Secchi Depth	This is a measure of water transparency expressed in meters. This parameter is used in the calculation of the NCTSI value for the lake. The depth listed is an average value from all sampling locations in the lake.
Temperature	The range of surface water temperatures found at sampling locations.
Total Kjeldahl Nitrogen	The sum of organic nitrogen and ammonia in a water body. High measurements of TKN typically results from sewage and manure discharges in water bodies.
Total Organic Nitrogen (TON)	Total Organic Nitrogen (TON) can represent a major reservoir of nitrogen in aquatic systems during summer months. Similar to phosphorus, this concentration can be related to lake productivity and is used in the calculation of the NCTSI. The concentration listed is a lake-wide average from all sampling stations and is calculated by subtracting Ammonia concentrations from TKN concentrations.

Total Phosphorus (TP)	Total phosphorus (TP) includes all forms of phosphorus that occur in water. This nutrient is essential for the growth of aquatic plants and is often the nutrient that limits the growth of phytoplankton. It is used to calculate the NCTSI. The concentration listed is a lake-wide average from all sampling stations.
Trophic State	This is a relative description of the biological productivity of a lake based on the calculated NCTSI value. Trophic states may range from extremely productive (Hypereutrophic) to very low productivity (Oligotrophic).
Turbidity	A measure of the ability of light to pass through a volume of water. Turbidity may be influenced by suspended sediment and/or algae in the water.
Watershed	A drainage area or catchment in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

Purpose and Scope

The North Carolina Ambient Lake Monitoring Program (ALMP) originated under the Environmental Protection Agency's (EPA) Clean Lakes Program and is designed to identify long term trends in water quality for lakes and reservoirs across North Carolina. The water quality data collected is used to calculate the state of nutrient enrichment (trophic state) and determine if lakes meet their designated use(s). Lakes are sampled by river basin on a five-year rotation according to the Division of Water Resources (DWR) basin sampling schedule. Lakes of 10 acres or greater, that have either public access and/or are used as a drinking supply qualify for sampling metrics. An interactive map of the state showing the locations of the ALMP sampling locations by DWR may be found here (https://www.deq.nc.gov/about/divisions/water-resources/water-sciences/intensive-survey-branch-isb/ambient-lakes-monitoring)

Overview

The Roanoke River basin extends from its source in the Blue Ridge Mountains of Virginia to the Albemarle Sound in North Carolina, encompassing mountainous, piedmont, and coastal topography as it flows generally east- southeastward. This constitutes 3,503 square miles of drainage area and approximately 2,389 miles of streams and rivers. Fifteen counties and 42 municipalities are also included in the basin. Though the spread of urban and suburban development has occurred in the Roanoke River basin as elsewhere in the state, the greatest portion of land cover in the basin has remained forested and, to a lesser extent, agriculture based. Nonpoint source runoff and numerous small point source dischargers associated with development and agricultural activities have great potential to affect water quality in the basin.

A statewide fish consumption advisory for largemouth bass due to mercury contamination was issued by the NC Department of Health and Human Services, Division of Public Health. This advisory includes lakes in the Roanoke River Basin. Go to https://epi.dph.ncdhhs.gov/oee/fish/advisories.html for specific fish consumption details.

Assessment Methodology

For this report, data from Jan. 1, 2024, through Dec. 31, 2024, were reviewed. Lake monitoring and sample collection activities performed by DWR field staff were in accordance with the Intensive Survey Branch (ISB) Standard Operating Procedures Manual (https://www.deq.nc.gov/water-quality/environmental-sciences/isu/isb-sop-version2-1-final/download)

Generally, ISB samples during the growing season from May through September; however, due to construction upgrades at the DWR Water Quality Laboratory, sampling was postponed and collected from June to October in 2024. Because of these renovations, samples collected for Total Solids (TS) and Chlorophyll *a* (Chl *a*) were sent to a certified third-party laboratory to complete the analysis so that these data points would not be lost. Data was assessed for deviations from the state Class C water quality standards for chlorophyll a, pH, dissolved oxygen, water temperature, and turbidity. Other parameters discussed in this report include Secchi depth and percent dissolved oxygen saturation. Secchi depth provides a measure of water clarity and is used in calculating the trophic or nutrient enriched status of a lake, as well as determining the sampling depth or photic zone. Percent dissolved oxygen saturation gives information on the amount of dissolved oxygen in the water column and may be increased by photosynthesis or depressed by oxygen-consuming decomposition.

Nutrient data is collected to determine the trophic status of a lake or reservoir and is calculated by the North Carolina Trophic State Index (NCTSI) score. The NCTSI score was specifically developed for North Carolina Lakes as part of the state's original Clean Lakes Classification Survey. It utilizes the nutrients present along with chlorophyll *a* and Secchi depth to calculate a lake's biological productivity. When an analyte was analyzed for but not detected above the PQL (Practical Quantitation Limit), this PQL value was utilized in the NCTSI score calculation. It should be noted that prior to 2023 half of the PQL was utilized in this calculation when an analyte was not detected above the PQL. This decision to use the whole PQL value came out of an abundance of caution to ensure the most conservative estimate of the NCTSI score. The ranges for classification are as follows:

Oligotrophic	< -2.0
Mesotrophic	-2.0 to 0.0
Eutrophic	0.0 to 5.0
Hypereutrophic	> 5.0

For algae collection and assessment, water samples were collected from the photic zone, preserved in the field, and taken concurrently with chemical and physical parameters. Samples were quantitatively analyzed to determine assemblage structure, density (units/ml) and biovolume (m^3/mm^3).

For the purpose of reporting, algal blooms were determined by the measurement of unit density (units/ml). Unit density is a quantitative measurement of the number of filaments, colonies or single celled taxa in a waterbody. Blooms are considered mild if they are between 10,000 and 20,000 units/ml. Moderate blooms are between 20,000 and 30,000 units/ml. Severe blooms are between 30,000 and 100,000 units/ml and extreme blooms are those 100,000 units/ml or greater. An algal group is

considered dominant when it comprises 40% or more of the total unit density or total biovolume. An algal genus is considered dominant when it comprises 30% or more of the total unit density or total biovolume.

Quality Assurance of Field and Laboratory ALMP Data

Data collected in the field via multiparameter water quality meters were uploaded into the Labworks® Database within a week of the sampling date.

Chemistry data from the DWR Water Quality Laboratory were uploaded into Labworks®. If there were data entry mistakes, possible equipment, sampling, and/or analysis errors, these were investigated and corrected, if possible. Chemistry results received from the laboratory that were given a qualification code were entered along with the assigned laboratory code. Laboratory qualification codes are listed in Appendix B.

Information regarding the WSS Chemistry Laboratory Quality Assurance Program is available on the ISB website (https://deq.nc.gov/about/divisions/water-resources/water-resources-data/water-sciences-home-page/microbiology-inorganics-branch/methods-pqls-qa).

The Ambient Lakes Monitoring Program (ALMP) Quality Assurance Project Plan can be found on the Intensive Survey Branch Website (https://www.deq.nc.gov/about/divisions/water-resources/water-sciences/intensive-survey-branch-isb)

Weather Overview for Summer 2024

Weather conditions overall were considered warm and wet for the basin in the sampling season of June-October 2024. Extreme heat arrived early in June of 2024 and stayed through the summer. June and early July were very dry. However, the wet weather returned by mid-July. Tropical storm Debbie brought heavy rains to the region on August 8, 2024. Hurricane Helene brought heavy rains and flooding to the region from September 26- September 27, 2024.

Detailed weather information can be found through the NC State Climate Office Blog (https://climate.ncsu.edu/climateblog) and the Southeast Regional Climate center (https://sercc.com/periodic-reports-monthly)

Lake and Reservoir Assessments
HUC 03010102

John H. Kerr Reservoir

Image Source: Wikipedia

Ambient Lakes Program Name	**John H Kerr Reservoir**	
Season Average Trophic Status (NC TSI)	**Eutrophic (0.2)**	
Mean Depth (meters)	**11.0**	
Volume ($10^6 m^3$)	**448.0**	
Watershed Area (mi^2)	**7800**	
Classification	**B**	
Stations	**ROA037A**	**ROA037B**
Number of Times Sampled	**5**	**5**
Stations Cont'd	**ROA037E**	**ROA037I**
Number of Times Sampled	**5**	**5**
Stations Cont'd	**ROA037IJ**	**--**
Number of Times Sampled	**5**	**--**

John H Kerr Reservoir Monthly Snapshot		
Sample Period	**Monthly NC TSI Score**	**Trophic State**
June	0.0*	Eutrophic
July	0.4	Eutrophic
August	0.0	Eutrophic
September	0.5	Eutrophic
October	0.2	Eutrophic

*TKN for ROA037E was qualified – this site was removed from the June monthly average

The John H. Kerr Reservoir is a large impoundment constructed and operated by the US Army Corps of Engineers to provide flood control, recreation and hydroelectric power. The reservoir crosses the North Carolina-Virginia state line. Kerr Reservoir is the first of three-chain lake impoundments on the Roanoke River in North Carolina and has a mean hydraulic retention time of 124 days. Major tributaries to Kerr Lake include the Dan River, the Hyco River, and the Roanoke River. Sampling of the lake is confined to North Carolina (the Nutbush Creek Arm).

Kerr Lake was sampled monthly from June through October in 2024. Secchi depths ranged from 1.0 to 2.2 meters. Surface dissolved oxygen ranged from 7.0 to 8.9 mg/L. pH values ranged from 6.2 to 8.2 s.u. Total phosphorus ranged from <0.03 to 0.03 mg/L and total Kjeldahl nitrogen ranged from <0.40 to 0.51 mg/L. Ammonia ranged from <0.05 to 0.06 mg/L and Nitrate plus nitrite ranged from <0.03 to 0.04 mg/L. Chlorophyll *a* ranged from 7.7 to 30.0 µg/L. Turbidity ranged from 1.6 to 5.5 NTU.

Based on the calculated NCTSI scores for June through October, John H. Kerr Reservoir was determined to exhibit mildly Eutrophic conditions in 2024. This represents an increase from previous calculations. Starting in 2023, NCTSI scores are calculated using the more conservative whole PQL substitution method for values below the detection limit, aligning with other DWR branches. This shift to a more conservative approach may partly explain the change in trophic status.

HUC 03010103

Hanging Rock Lake

Image Source: NC Parks

Ambient Lakes Program Name	**Hanging Rock Lake**
Season Average Trophic Status (NC TSI)	**Mesotrophic (-0.5)**
Mean Depth (meters)	**1.0**
Volume ($10^6 m^3$)	**0.003**
Watershed Area (mi^2)	**2.1**
Classification	**B**
Stations	**ROA003A**
Number of Times Sampled	**5**

Hanging Rock Lake Monthly Snapshot		
Sample Period	**Monthly NC TSI Score**	**Trophic State**
June	-0.4	Mesotrophic
July	-0.7	Mesotrophic
August	-0.8	Mesotrophic
September	--	--
October	-0.2	Mesotrophic

--Chl a qualified – J2 value failed to meet the established quality control criteria for either precision or accuracy – no NC TSI calculated.

Hanging Rock Lake is a 12-acre impoundment located within Hanging Rock State Park. The original earthen and concrete dam was built in 1938 as a Civilian Conservation Corps project. The 445-acre watershed is primarily forested. Hanging Rock Lake has a classification of B (suitable for swimming).

DWR field staff monitored Hanging Rock Lake monthly from June through October 2024. Surface dissolved oxygen in this lake ranged from 6.7 to 8.1 mg/L and surface pH ranged from 5.5 to 7.5 s.u. (Appendix A). Secchi depths, ranged from 1.7 to 2.5 meters.

Total phosphorus remained below the 0.03 mg/L detection limit. Total Kjeldahl nitrogen also remained below the 0.4 mg/L detection limit. Ammonia and nitrogen plus nitrite (NOx) remained under the 0.05 mg/L and 0.03 mg/L detection limits, respectively. Chlorophyll *a* values ranged from 6.0 to 12 *u*g/L, which remained below the state water quality standard of 40 *u*g/L. Hanging Rock Lake was determined to exhibit moderate biological productivity (mesotrophic conditions) during the growing season of 2024. Starting in 2023, NCTSI scores are calculated using the more conservative whole PQL substitution method for values below the detection limit, aligning with other DWR branches. Before 2023, a less conservative half PQL substitution method was used. This shift to a more conservative approach may partly explain the change in trophic status.

Kernersville Reservoir

Image Source: https://forsyth.cc/Parks/K

Ambient Lakes Program Name	**Kernersville Reservoir**
Season Average Trophic Status (NC TSI)	**Eutrophic (1.7)**
Mean Depth (meters)	**5.0**
Volume ($10^6 m^3$)	**0.4**
Watershed Area (mi^2)	**9.1**
Classification	**WS-IV B**
Stations	**ROA0092A**
Number of Times Sampled	**5**

Kernersville Reservoir Monthly Snapshot		
Sample Period	**Monthly NC TSI Score**	**Trophic State**
June	0.5	Eutrophic
July	2.2	Eutrophic
August	2.2	Eutrophic
September	--	--
October	1.8	Eutrophic

Kernersville Reservoir, an impoundment of Belews Creek constructed in 1952, serves as a back-up water supply for the Town of Kernersville. Since 1984, Kernersville has been buying potable water from the City of Winston-Salem. Upstream land use within the watershed has become industrialized.

This reservoir was sampled monthly from June through October 2024. Surface dissolved oxygen ranged from 5.4 to 8.0 mg/L (Appendix A). Surface pH values ranged from 6.3 to 7.4 s.u. Secchi depths for Kernersville Reservoir ranged from 1.7 meter to 2.5 meters.

Total phosphorus concentrations remained below the 0.03 mg/L detection limit. Total Kjeldahl nitrogen ranged from 0.41 to 0.64 mg/L (Appendix A). Ammonia and nitrite plus nitrate (NOx) values were consistently below the DWR water quality laboratory detection level of 0.05 and 0.03 mg/L respectively. Chlorophyll *a* values were less than the state water quality standard of 40 *u*g/L and ranged from 11 to 30 *u*g/L. Based on the calculated NCTSI scores, Kernersville Reservoir was determined to exhibit elevated biological productivity or eutrophic conditions. This reservoir has been eutrophic since it was first monitored in 1998 by DWR.

Belews Lake

Image Source: Carolina Marina/Facebook

Ambient Lakes Program Name	**Belews Lake**	
Season Average Trophic Status (NC TSI)	**Mesotrophic (-1.7)**	
Mean Depth (meters)	**15.0**	
Volume ($10^6 m^3$)	**228.0**	
Watershed Area (mi^2)	**120.0**	
Classification	**WS-IV C**	
Stations	**ROA009E**	**ROA009G**
Number of Times Sampled	**5**	**5**
Stations Cont'd	**ROA009H**	**ROA009J**
Number of Times Sampled	**5**	**5**

Belews Lake Monthly Snapshot		
Sample Period	**Monthly NC TSI Score**	**Trophic State**
June	-1.9	Mesotrophic
July	-1.2	Mesotrophic
August	-1.5	Mesotrophic
September	--	--
October	-2.1	Oligotrophic

--All September Chl *a* data qualified – J2 – value failed to meet the established quality control criteria for either precision or accuracy – No NC TSI calculated.

Belews Lake is located on Belews Creek, a tributary of the Dan River in the northern Piedmont of the state. Construction of the dam was completed in 1973. The lake was constructed by Duke Energy to provide a source of condenser cooling water for the Belews Creek Steam Station. The maximum depth of Belews Lake is approximately 144 feet (44 meters). The watershed is mostly forested and agricultural with some urban areas. Retention time of Belews Lake is approximately 4.1 years.

Belews Lake was sampled by DWR field staff monthly from June through October 2024. Secchi depths during the summer sampling period ranged from 2.5 to 4.5 meter (Appendix A). Surface dissolved oxygen ranged from 6.6 mg/L to 7.7 mg/L. Surface water temperatures ranged from 25.7 °C to 34.1 °C. Surface pH values ranged from 6.0 to 8.0 s.u.

Total phosphorus concentrations in Belews Lake remained below the lab detection limit of 0.03 mg/L (Appendix A). Total Kjeldahl nitrogen ranged from below the detection limit of 0.4 mg/L to 0.51 mg/L. Ammonia and nitrite plus nitrate values were consistently below the DWR laboratory detection levels of 0.05 mg/L and 0.03 mg/L respectively at each of the three lake sampling sites. Chlorophyll *a* values ranged between 2.2 to 5.9 *u*g/L. Based on the calculated NCTSI scores in 2024, Belews Lake was determined to exhibit moderate to low biological productivity (oligotrophic and mesotrophic conditions) from June through October.

HUC 03010104

Farmer Lake

Image Source: NC Triad Outdoors

Ambient Lakes Program Name	**Farmer Lake**	
Season Average Trophic Status (NC TSI)	**Eutrophic (3.4)**	
Mean Depth (meters)	**6.0**	
Volume ($10^6 m^3$)	**6.5**	
Watershed Area (mi^2)	**125**	
Classification	**WS-II HQW CA**	
Stations	**ROA027G**	**ROA027J**
Number of Times Sampled	**5**	**5**
Stations Cont'd	**ROA027L**	**--**
Number of Times Sampled	**5**	**--**

Farmer Lake Monthly Snapshot		
Sample Period	**Monthly NC TSI Score**	**Trophic State**
June	3.3	Eutrophic
July	3.3	Eutrophic
August	3.3	Eutrophic
September	--	--
October	3.5	Eutrophic
--September Total phosphorous data was missing or qualified due to lab errors – no NC TSI score calculated		

Farmer Lake, a water supply reservoir for the City of Yanceyville, was built in 1983. The reservoir is an impoundment of Country Line Creek in Caswell County. Farmer Lake is also used extensively for recreational fishing. The land uses within the watershed include agricultural and forested lands.

In 2024, surface dissolved oxygen ranged from 4 to 10.5 mg/L and surface pH ranged from 6.2 to 8.8 s.u. Secchi depths ranged from 0.1 to 0.8 meters (Appendix A). Total phosphorus was greatest at the upper end of the reservoir, ranging overall from <0.03 mg/L near the dam throughout the summer to 0.08 mg/L at the upper end in August. Ammonia and nitrite plus nitrate values were consistently below the DWR laboratory detection levels of 0.05 mg/L and 0.03 mg/L respectively at each of the three lake sampling sites with the exception of the September sampling round at ROA027G where the nitrite plus nitrate was 0.09 mg/L. Chlorophyll *a* ranged from 12 to 140 µg/L. Turbidity ranged from 3.9 to 340 NTU. The state water quality standard for Turbidity (25 NTU) was exceeded twice at site ROA027G in June (40 NTU) and September (340 NTU) (Appendix A). Field notes indicated heavy rains had fallen in the 24 hours prior to the extremely high turbidity reading of 340 NTU.

Farmer Lake was determined to exhibit elevated biological productivity (eutrophic conditions) in 2024. Apart from 2002 when low rainfall conditions contributed to mesotrophic conditions, Farmer Lake has been consistently eutrophic since it was first monitored by DWR in 1991.

Hyco Lake

Ambient Lakes Program Name	**Hyco Lake**	
Season Average Trophic Status (NC TSI)	**Eutrophic (0.7)**	
Mean Depth (meters)	**20.0**	
Volume ($10^6 m^3$)	**99.0**	
Watershed Area (mi^2)	**256.0**	
Classification	**WS-V B**	
Stations	**ROA030C**	**ROA030E**
Number of Times Sampled	**5**	**5**
Stations Cont'd	**ROA030F**	**ROA030G**
Number of Times Sampled	**5**	**5**

Hyco Lake Monthly Snapshot

Sample Period	Monthly NC TSI Score	Trophic State
June	0.1*	Eutrophic
July	-0.1	Mesotrophic
August	0.8	Eutrophic
September	--	--
October	1.8	Eutrophic

*All June Chl *a* data qualified with Q2 (exceeded hold time in the lab); however, values were consistent with what would be expected for Hyco Lake in June. – NC TSI calculated

--All Sept. Chl *a* data qualified with J2 (failed to meet established quality control criteria for either precision or accuracy in the lab) – No NCTSI calculated.

Hyco Lake is located on the Hyco River approximately three miles south of the North Carolina-Virginia State line in Person and Caswell Counties. This reservoir was constructed in 1965 to provide cooling water for the Duke Energy Roxboro Steam Plant. Hyco Lake has maximum depth of 49 feet (15 meters) and a mean hydraulic retention time of 180 days. The drainage area for Hyco Lake is characterized by rolling hills and land use along the 159 mile (256 kilometer) shoreline is primarily residential, forested, and agriculture.

DWR field staff sampled Hyco Lake monthly from June through October 2024. Secchi depths ranged from 0.9 to 2.4 meters (Appendix A). Surface dissolved oxygen ranged from 6.1 to 8.7 mg/L and surface pH ranged from 6.1 to 7.4 s.u. Surface water temperature ranged from 20.3 °C to 32.8 °C and surface conductivity in Hyco Lake ranged from 84 to 183 µmhos/cm in 2024.

Total phosphorus values were consistently below laboratory detection limits of 0.03 mg/L. Total Kjeldahl nitrogen ranged from 0.42 to 0.80 mg/L (Appendix A). Nitrate plus nitrite in Hyco Lake in 2024 ranged from <0.03 to 0.04 mg/L. Chlorophyll *a* values ranged from 8.4 to 29 µg/L. Hyco Lake was determined to exhibit mildly eutrophic conditions in 2024 based on the calculated NCTSI scores. This represents an increase from previous calculations. Starting in 2023, NCTSI scores are calculated using the more conservative whole PQL substitution method for values below the detection limit, aligning with other DWR branches. This shift to a more conservative approach may partly explain the change in trophic status.

Lake Roxboro (South Hyco Creek)

Image Source: Linda Elliott

Ambient Lakes Program Name	**Lake Roxboro**	
Season Average Trophic Status (NC TSI)	**Eutrophic (3.4)**	
Mean Depth (meters)	**6.1**	
Volume ($10^6 m^3$)	**11.0**	
Watershed Area (mi^2)	**62**	
Classification	**WS-II B HQW**	
Stations	**ROA030DA**	**ROA030DC**
Number of Times Sampled	**5**	**5**
Stations Cont'd	**ROA030DE**	**--**
Number of Times Sampled	**5**	**--**

Lake Roxboro Monthly Snapshot		
Sample Period	**Monthly NC TSI Score**	**Trophic State**
June	2.9	Eutrophic
July	3.0	Eutrophic
August	3.4	Eutrophic
September	5.8	Eutrophic
October	1.8	Eutrophic

Lake Roxboro (also called South Hyco Creek) is located in Caswell and Person Counties near the Town of Roxboro and covers 195 acres. The lake, which is an impoundment of South Hyco Creek, was filled in 1978 and is owned by the Town of Roxboro, which uses the lake as a source of drinking water. Land uses in the watershed include agriculture, forest, and residential areas.

DWR field staff sampled Lake Roxboro monthly from June through October 2024. Surface dissolved oxygen ranged from 4.3 to 9.9 mg/L and surface pH values ranged from 5.8 to 8.2 s.u. (Appendix A). The Secchi depth measurements were lowest in early October (September sampling) following hurricane Helene and highest in July (average 1.07 meters).

Total phosphorus ranged from below detection limit of 0.03 to 0.11 mg/L. Total Kjeldahl nitrogen concentrations ranged from 0.58 to 1.2 mg/L. Ammonia stayed below laboratory detection rates (0.05mg/L) throughout much of the summer, however elevated ammonia levels were noted in October with a maximum value of 0.18 mg/L. Nitrate plus nitrite values were consistently below the DWR laboratory detection level of 0.03 mg/L. Chlorophyll *a* values ranged from 5.9 to 80 µg/L. Four of the 15 chlorophyll samples collected in 2024 exceeded the state water quality standard of 40 µg/L.

Based on the calculated NCTSI scores for 2024, Lake Roxboro was determined to exhibit elevated biological productivity or eutrophic conditions.

Mayo Reservoir

Image Source: Mayo Lake Park / Facebook

Ambient Lakes Program Name	**Mayo Reservoir**	
Season Average Trophic Status (NC TSI)	**Mesotrophic (-0.1)**	
Mean Depth (meters)	**9.0**	
Volume ($10^6 m^3$)	**105.0**	
Watershed Area (mi^2)	**133**	
Classification	**WS-V**	
Stations	**ROA0341A**	**ROA0342A**
Number of Times Sampled	**5**	**5**
Stations Cont'd	**ROA0343A**	**--**
Number of Times Sampled	**5**	**--**

Mayo Reservoir Monthly Snapshot		
Sample Period	**Monthly NC TSI Score**	**Trophic State**
June	-0.1	Mesotrophic
July	0.4	Eutrophic
August	0.0	Eutrophic
September	-0.2	Mesotrophic
October	-0.4	Mesotrophic

Mayo Reservoir is located on Mayo Creek in Person County just south of the Virginia border and covers 2,800 acres (1,133 hectares). Owned by Duke Energy, the reservoir was completed in 1983 to provide cooling water for the Mayo Electric Generating Plant. Mayo Reservoir has an average retention time of 36 months. The drainage area is characterized by rolling hills with forests and agriculture.

Mayo Reservoir was sampled monthly from June through October by DWR field staff. Secchi depths for this reservoir ranged from 1.5 to 3.6 meters (Appendix A). Surface dissolved oxygen ranged from 6.9 to 8.9 mg/L and surface water temperatures ranged from 20.2 °C to 30.5 °C. Surface pH values varied from 5.5 to 8.3 s.u. and surface conductivity ranged from 46 to 97 µmhos/cm.

Total phosphorus in Mayo Reservoir was predominantly below the DWR Laboratory detection level (Appendix A). Total Kjeldahl nitrogen ranged from 0.42 to 0.54 mg/L and nitrate plus nitrite values were all below the detection limit. Chlorophyll a ranged from 5 to 30 µg/L. Overall, Mayo reservoir was determined to exhibit moderate biological productivity or mesotrophic conditions in 2024 based on the calculated NCTSI scores for June through October. Trophic conditions in Mayo Reservoir have varied between mesotrophic and oligotrophic since 1983 when monitoring by DWR began.

Lake Isaac Walton (Roxboro City Lake)

Ambient Lakes Program Name	**Lake Isaac Walton**	
Season Average Trophic Status (NC TSI)	**Eutrophic (2.0)**	
Mean Depth (meters)	**3.5**	
Volume ($10^6 m^3$)	**0.3**	
Watershed Area (mi^2)	**508**	
Classification	**WS-II HQW CA**	
Stations	**ROA031C**	**ROA031E**
Number of Times Sampled	**5**	**5**
Stations Cont'd	**ROA031H**	**--**
Number of Times Sampled	**5**	**--**

Lake Isaac Walton Monthly Snapshot		
Sample Period	**Monthly NC TSI Score**	**Trophic State**
June	1.8	Eutrophic
July	2.2	Eutrophic
August	2.3	Eutrophic
September	--	--
October	1.5	Eutrophic

--All Sept. Chl *a* data qualified with J2 (failed to meet established quality control criteria for either precision or accuracy in the lab) – No NCTSI calculated.

Lake Isaac Walton (also called Roxboro City Lake) is located in Person County near the Town of Roxboro and is the primary water supply for the town. The lake was built in the 1930's and Satterfield and Storys Creek are the main tributaries. Maximum depth is about 23 feet (seven meters) and retention time is approximately 30 days. The watershed is comprised of agricultural land, pastures, and residential areas.

This lake was sampled monthly from June through October in 2024. Surface dissolved oxygen ranged from 5.1 to 9.5 mg/L and surface water temperatures ranged from 16.6 °C to 28.4°C (Appendix A). Surface pH values ranged from 5.8 to 7.7 s.u. Secchi depths in Lake Isaac Walton ranged from 0.7 to 1.3 meters in 2024.

Total phosphorus ranged from <0.03 to 0.05 mg/L and total Kjeldahl nitrogen ranged from 0.57 to 0.86 mg/L. Ammonia ranged from <0.03 to 0.25 mg/L and nitrate plus nitrate was below detection limits for in all 2024 samples. Chlorophyll *a* in Lake Isaac Walton ranged from 13 to 47.6 µg/L. Chlorophyll a exceeded the state water quality standard of 40 µg/L on three occasions at site ROA031C. Based on the calculated NCTSI scores, Lake Isaac Walton was determined to have elevated biological productivity or eutrophic conditions.

HUC 03010106

Lake Gaston

Ambient Lakes Program Name	**Lake Gaston**	
Season Average Trophic Status (NC TSI)	**Eutrophic (0.2)**	
Mean Depth (meters)	**29.0**	
Volume ($10^6 m^3$)	**512.0**	
Watershed Area (mi^2)	**21340.0**	
Classification	**WS-IV, V B**	
Stations	**ROA0382A**	**ROA038A**
Number of Times Sampled	**5**	**5**
Stations Cont'd	**ROA039**	**ROA039B**
Number of Times Sampled	**5**	**5**

Lake Gaston Reservoir Monthly Snapshot		
Sample Period	**Monthly NC TSI Score**	**Trophic State**
June	-0.5	Mesotrophic
July	-0.4	Mesotrophic
August	0.7*	Eutrophic
September	0.6**	Eutrophic
October	0.4***	Eutrophic

*ROA0382A – elevated Chl *a* PQL
**ROA0382A – elevated Chl *a* PQL and all TP samples exceeded the hold time following lab receipt
***All Chl a data qualified with V1 – analyte detected in both the sample and the method blank.

Lake Gaston is located on the North Carolina - Virginia border just downstream from the John H. Kerr Reservoir dam on the Roanoke River. The lake was built in 1962 by the Virginia Electric and Power Company for generating hydroelectric power. The drainage area of the lake is comprised of forested land with some agriculture, residential development and urbanized areas.

DWR staff monitored Lake Gaston monthly from June through October 2024. Secchi depths ranged from 0.8 to 2.1 meters (Appendix A). Surface dissolved oxygen concentrations ranged from 4 mg/L to 9.5 mg/L. Surface water temperatures ranged from 22.9 °C in May at the upper end of the reservoir to 32.3 °C near the dam (ROA039B) in July. Surface pH values in 2014 ranged from 6.2 to 7.7 s.u.

Total phosphorus concentrations were below laboratory detection limits during the sampling period. Total Kjeldahl nitrogen ranged from <0.4 to 1.0 mg/L. Ammonia ranged from <0.05 to 0.18 mg/L and nitrate plus nitrite ranged from 0.03 to 0.18 mg/L. Chlorophyll a values ranged from <1.2 to 21.0 µg/L. In 2024, Lake Gaston demonstrated mildly eutrophic conditions. This represents an increase from previous calculations. Starting in 2023, NCTSI scores are calculated using the more conservative whole PQL substitution method for values below the detection limit, aligning with other DWR branches. Before 2023, a less conservative half PQL substitution method was used. This shift to a more conservative approach may partly explain the change in trophic status.

Roanoke Rapids Lake

Ambient Lakes Program Name	**Roanoke Rapids Lake**	
Season Average Trophic Status (NC TSI)	**Mesotrophic (-0.4)**	
Mean Depth (meters)	**5.0**	
Volume ($10^6 m^3$)	**96.0**	
Watershed Area (mi^2)	**124819**	
Classification	**WS-IV B CA**	
Stations	**ROA039C**	**ROA039D**
Number of Times Sampled	**5**	**5**
Stations Cont'd	**ROA039E**	**--**
Number of Times Sampled	**5**	**--**

Roanoke Rapids Lake Monthly Snapshot		
Sample Period	**Monthly NC TSI Score**	**Trophic State**
May	-1.1	Mesotrophic
June	-0.5	Mesotrophic
July	-0.3	Mesotrophic
August	0.0	Mesotrophic
September	0.1	Eutrophic

Roanoke Rapids Lake, located on the Roanoke River immediately downstream from Lake Gaston, is owned by the Virginia Electric and Power Company and used for hydropower generation as well as public recreation and as a water supply. Maximum depth of this reservoir is 89 feet (27 meters). The Roanoke River is the major tributary to the reservoir and drains nearly all of its 8,294 mi^2 (21,482 km^2) watershed. Releases from Lake Gaston located directly upstream account for almost all of the inflow into Roanoke Rapids Lake.

Roanoke Rapids Lake was sampled monthly from June through October 2024. Secchi depths ranged from 1 to 2.3 meters (Appendix A). Surface dissolved oxygen ranged from 4.7 to 11.5 mg/L and surface water temperature ranged from 21.2 °C to 29.4 °C. Surface pH values were within state water quality standards and ranged from 6.2 to 8.7 s.u.

The concentration of total phosphorus in Roanoke Rapids Lake was consistently <0.03 mg/L (Appendix A). Total Kjeldahl nitrogen ranged from <0.4 to 0.44 mg/L and nitrate plus nitrite ranged from <0.03 to 0.16 mg/L. Chlorophyll *a* values ranged from 3.0 µg/L in June to 18 µg/L in September. In 2024, Roanoke Rapids demonstrated moderate productivity or mesotrophic conditions. Hydrilla (*Hydrilla verticillata*), Eurasian milfoil (*Myriophyllum spicatum*) and Brazilian elodea (*Egeria densa*) are the dominant aquatic weeds in this lake.

Appendix A –Roanoke River Basin Data

January 1, 2024 Through December 31, 2024

Lake	SURFACE PHYSICAL DATA								PHOTIC ZONE DATA								
	Date	Sampling Station	DO mg/L	Temp Water °C	pH s.u.	Cond. µmhos/cm	Depth Secchi meters	DO SAT %	TP mg/L	TKN mg/L	NH3 mg/L	NOx mg/L	Chla µg/L	Total Solids mg/L	Total Suspended Solids mg/L	Turbidity NTU	Total Hardness mg/L
HUC 03010102																	
JOHN H. KERR RESERVOIR	June 5, 2024	ROA037A	8.7	26.8	7.1	53	1.3	110.5	0.03	0.4 U	0.05 U	0.03 U	13.3	63	4.5 J2	3.4	
	June 5, 2024	ROA037B	8.7	26.6	7.6	92	1.4	109.3	0.03 U	0.4 U	0.05 U	0.03 U	9.1	50	3.8 J2	2.9	28.0
	June 5, 2024	ROA037E	8.9	26.0	7.8	93	1.5	110.3	0.03 U	0.51 U,J2,J3,P	0.05 U	0.03 U	11.0	57	3.1 J2	2.7	
	June 5, 2024	ROA037I	8.9	26.0	8.0	92	1.6	110.7	0.03 U	0.4 U	0.05 U	0.03 U	9.9	53	2.8 J2	2.3	
	June 5, 2024	ROA037IJ	8.8	26.0	8.1	92	1.8	110.2	0.03 U	0.4 U	0.05 U	0.03 U	12.7	50	2.8 J2	2.1	
	July 23, 2024	ROA037A	8.0	29.2	7.5	95	1.0	104.4	0.03	0.51	0.05 U	0.03 U	30.0	104	7.0	5.5	
	July 23, 2024	ROA037B	7.5	29.5	7.0	92	1.5	98.4	0.03 U	0.40	0.05 U	0.03 U	16.0	120	15.0	2.7	28.0
	July 23, 2024	ROA037E	7.5	29.2	7.3	98.5	1.5	98.5	0.03 U	0.4 U	0.05 U	0.03 U	17.0	113	3.7	2.5	
	July 23, 2024	ROA037I	7.8	30.1	7.3	91	1.7	104.1	0.03 U	0.4 U	0.05 U	0.03 U	9.7	103	2.8	2.2	
	July 23, 2024	ROA037IJ	7.6	30.1	7.1	92	2.2	101.3	0.03 U	0.4 U	0.05 U	0.03 U	11.0	98	4.2 U, Y	1.6	
	August 28, 2024	ROA037A	8.9	28.8	8.2	86	1.4	115.4	0.03	0.45	0.05	0.03	18.0	60.0	3.6	2.9	
	August 28, 2024	ROA037B	8.4	30.0	7.2	85	1.8	112.1	0.03 U	0.42	0.05 U	0.03 U	12.0	71	2.8	2.2	28.0
	August 28, 2024	ROA037E	8.7	29.2	7.9	85	1.7	113.5	0.03 U	0.41	0.05 U	0.03 U	14.0	69	2.6	2.0	
	August 28, 2024	ROA037I	8.4	29.2	7.7	85	2.2	110.5	0.03 U	0.4 U	0.05 U	0.03 U	11.0	53	2.5	1.7	
	August 28, 2024	ROA037IJ	8.0	29.2	7.4	90	2.0	105.7	0.03 U	0.4 U	0.05 U	0.03 U	9.0	61	2.5	1.7	
	September 19, 2024	ROA037A	8.6	24.7	6.2	84	1.1	104.2	0.03 U	0.44	0.05 U	0.03 U	23	70	4.9	3.8	
	September 19, 2024	ROA037B	8.4	24.8	7.2	83	1.3	101.8	0.03 U	0.4 U	0.05 U	0.03 U	19	69	4.1	2.7	25.0
	September 19, 2024	ROA037E	7.9	24.5	7	84	1.2	96	0.03 U	0.42	0.05 U	0.03 U	22	67	4	3.2	
	September 19, 2024	ROA037I	7.4	24.5	7.2	85	1.5	89.9	0.03 U	0.4 U	0.05 U	0.03 U	12	64	3.4	2.2	
	September 19, 2024	ROA037IJ	7.2	24.9	7.1	88	1.95	88.2	0.03 U	0.4 U	0.06	0.03 U	8.6	67	2.5 U	1.7	
	October 7, 2024	ROA037A	8.5	24.4	6.2	82	1.3	102.7	0.03 U	0.48	0.05 U	0.03 U	25	65	4.1	3.4	
	October 7, 2024	ROA037B	7.5	24.5	7.1	83	1.6	91.4	0.03 U	0.4 U	0.05 U	0.03 U	16	27 Q2	3.4	2.6	25.0
	October 7, 2024	ROA037E	8	24.4	6.9	82	1.6	96.5	0.03 U	0.42	0.05 U	0.03 U	15	62	3.4	2.5	
	October 7, 2024	ROA037I	7.1	24.4	7.1	84	2	85.9	0.03 U	0.4 U	0.05 U	0.03 U	9.2	58	2.6	2.2	
	October 7, 2024	ROA037IJ	7	23.8	7	86	2.1	83.6	0.03 U	0.4 U	0.05	0.04	7.7	64	2.5 U	2.1	
HUC 03010103																	
HANGING ROCK LAKE	June 25, 2024	ROA003A	7.4	27.7	5.5	13	1.8	100.1	0.03 U	0.4 U	0.05 U	0.03 U	8.0	14	5.0 U,Y	3.0	
	July 30, 2024	ROA003A	7.6	26.2	7.5	14	>1.8	99.9	0.03 U	0.4 U	0.05 U	0.03 U	6.0	14 J2	2.5 U	1.2	
	August 20,2024	ROA003A	7.8	25.2	6.5	11	2.5	100.6	0.03 U	0.4 U	0.05 U	0.03 U	7.5	20 J2	3.5	2.7	
	September 24, 2024	ROA003A	8.1	22.7	6.1	12	1.7	99.5	0.03 U	0.4U	0.05U	0.03U	6.0 J2	29 J2	3.1 U,Y	3.5	
	October 15, 2024	ROA003A	6.7	17.4	5.7	11	2.0	73.6	0.03 U	0.4U	0.05 U	0.03 U	12.0	25	2.8 U	1.8	
KERNERSVILLE RESERVOIR	June 25, 2024	ROA0092A	6.3	29.3	6.3	145	1.0	85.2	0.03 U	0.41	0.05 U	0.03 U	11.0	88	8.6	5.3	
	July 30, 2024	ROA0092A	5.4	28.0	7.2	159	0.8	70.6	0.03 U	0.64	0.05 U	0.03 U	24.0	114	5.4 J2	7.0	
	August 20,2024	ROA0092A	7.2	26.8	7.4	92	0.7	92	0.03 U	0.61	0.05 U	0.03 U	22.0	107 J2	6.8	9.3	
	September 24, 2024	ROA0092A	8.0	24.4	7.0	120	1.2	98.5	0.03 U	0.49	0.05 U	0.03 U	30 J2	35 J2	4.2	4.7	
	October 15, 2024	ROA0092A	6.8	19.3	7.2	105	0.8	75.8	0.03 U	0.58	0.05 U	0.03 U	18.0	95	6.1	6.8	
BELEWS LAKE	June 25, 2024	ROA009E	7.2	33.3	6.9	95	3.8	103.6	0.03 U	0.4 U	0.05 U	0.03 U	3.1	48	2.5 U,Y	1.0	
	June 25, 2024	ROA009G	7.5	32.0	7.2	95	3.6	104.8	0.03 U	0.4 U	0.05 U	0.03 U	2.8	63	2.5 U,Y	1.2	
	June 25, 2024	ROA009H	7.5	31.3	6.0	95	4.1	103.9	0.03 U	0.4 U	0.05 U	0.03 U	2.8	53	2.5 U,Y	1.0	26.0
	June 25, 2024	ROA009J	7.0	35.3	6.4	96	3.7	103.8	0.03 U	0.4 U	0.05 U	0.03 U	4.2	36	2.5 U,Y	1.5	
	July 30, 2024	ROA009E	7.4	31.7	7.4	99	3.0	103.3	0.03 U	0.51	0.05 U	0.03 U	5.9	70	2.5 U,J2	1.3	
	July 30, 2024	ROA009G	7.7	30.3	7.4	99	3.3	104.6	0.03 U	0.4 U	0.05 U	0.03 U	5.5	80	2.9 U,J2,Y	1.2	
	July 30, 2024	ROA009H	7.6	30.3	7.3	99	3.3	103.4	0.03 U	0.4 U	0.05 U	0.03 U	4.8	66	2.9 U,J2,Y	1.2	30.0
	July 30, 2024	ROA009J	7.3	33.3	7.4	100	2.9	105	0.03 U	0.4 U	0.05 U	0.03 U	5.7	61	3.3 U,J2,Y	1.6	
	August 20, 2024	ROA009E	7.2	32.4	7.8	88	2.7	102.3	0.03 U	0.4 U	0.05 U	0.03 U	4.7	69 J2	2.5 U	1.4	
	August 20, 2024	ROA009G	7.5	31.4	8.0	88	2.7	103.6	0.03 U	0.4 U	0.05 U	0.03 U	3.9	72 J2	2.5 U	1.1	
	August 20, 2024	ROA009H	7.5	30.7	7.9	86	3.5	103.3	0.03 U	0.4 U	0.05 U	0.03 U	3.3	66 J2	2.5 U	1.0	29.0
	August 20, 2024	ROA009J	6.9	34.1	7.6	88	2.5	99.7	0.03 U	0.4 U	0.05 U	0.03 U	3.5	72 J2	2.5 U	1.6	
	September 24, 2024	ROA009E	6.8	29.8	7.4	46	4.0	92.1	0.03 U	0.4 U	0.05 U	0.03 U	4.1 J2	72 J2	2.5 U	1.0 U	
	September 24, 2024	ROA009G	7.4	28.5	7.5	94	4.0	97.7	0.03 U	0.4 U	0.05 U	0.03 U	5.0 J2	67 J2	2.5 U	1.0 U	
	September 24, 2024	ROA009H	7.5	29.0	7.9	95	4.0	100	0.03 U	0.4 U	0.05 U	0.03 U	5.0 J2	67 J2	2.5 U	1.0 U	27.0
	September 24, 2024	ROA009J	6.9	32.5	7.5	96	4.0	97.4	0.03 U	0.4 U	0.05 U	0.03 U	3.6 J2	48 J2	2.5 U	1.0 U	
	October 15, 2024	ROA009E	6.7	26.7	7.3	84	3.8	85.9	0.03 U	0.4 U	0.05 U	0.03 U	2.2	64	2.5 U	1.0 U	
	October 15, 2024	ROA009G	7.0	25.8	7.3	84	4.5	87.4	0.03 U	0.4 U	0.05 U	0.03 U	2.9	52	2.5 U	1.0 U	
	October 15, 2024	ROA009H	7.1	25.7	7.5	84	4.2	89.6	0.03 U	0.4 U	0.05 U	0.03 U	2.6	63	2.5 U	1.0 U	24.0
	October 15, 2024	ROA009J	6.6	28.8	7.4	85	3.4	88.3	0.03 U	0.4 U	0.05 U	0.03 U	3.2	65 J2	2.5 U	1.1	

Appendix A – Roanoke River Basin Data

Lake	Date	Sampling Station	DO mg/L	Temp Water °C	pH s.u.	Cond. µmhos/cm	Depth Secchi meters	DO SAT %	TP mg/L	TKN mg/L	NH3 mg/L	NOx mg/L	Chla µg/L	Total Solids mg/L	Total Suspended Solids mg/L	Turbidity NTU	Total Hardness mg/L
SURFACE PHYSICAL DATA									**PHOTIC ZONE DATA**								
HUC 03010104																	
FARMER LAKE	June 26, 2024	ROA027G	10.5	32.5	8.2	110	0.25	148.5	0.04	0.91	0.05 U	0.03 U	63	142	21	40	
	June 26, 2024	ROA027J	10.3	32.5	8.8	85	0.75	146	0.03	0.78	0.05 U	0.03 U	27	69	6.6	5.4	
	June 26, 2024	ROA027L	8.9	32.2	8.3	71	0.8	124.3	0.03 U	0.67	0.05 U	0.03 U	19	60	6	4.6	21.0
	August 1, 2024	ROA027G	9.4	30.7	8.6	102	0.3	128.2	0.08	0.78	0.05 U	0.03 U	69	112 J2	17 J2	18	
	August 1, 2024	ROA027J	8.6	29.3	7.4	86	0.8	113.7	0.03 U	0.64	0.05 U	0.03 U	22	77 J2	4.0 J2	4.1	
	August 1, 2024	ROA027L	7.9	30.1	7	73	0.8	106.7	0.03 U	0.6	0.05 U	0.03 U	12	80 J2	3.5 J2	3.9	25.0
	August 28, 2024	ROA027G	9.7	29	8.6	82	0.4	128.2	0.07	0.75	0.05 U	0.03 U	46	98	16	17	
	August 28, 2024	ROA027J	9.8	29	8.8	67	0.7	128.8	0.03 U	0.71	0.05 U	0.03 U	28	76	7.2	7.4	
	August 28, 2024	ROA027L	9	29.2	8.5	64	0.7	118.4	0.03 U	0.73	0.05 U	0.03 U	17	77	6.2	7.1	24.0
	September 18, 2024	ROA027G	5.7	21.6	6.6	42	0.1	65.2	**	1.5	0.05 U	0.09	140	352	230 Q2	340	
	September 18, 2024	ROA027J	5.7	23.2	7.1	71	0.6	67.2	0.03 U,Q2	0.79	0.05 U	0.03 U	44	77	11	12	
	September 18, 2024	ROA027L	6.7	23.1	7.2	62	0.6	79.8	0.03 U,Q2	0.63	0.05 U	0.03 U	31	77	7.1	7.6	26.0
	October 9, 2024	ROA027G	8.5	21.4	6.8	86	0.3	97.8	0.06	0.74	0.05 U	0.03 U	47	63	21	22	
	October 9, 2024	ROA027J	4.1	22.5	6.4	70	0.45	48.2	0.03 U	0.68	0.05 U	0.03 U	26	82	17	23	
	October 9, 2024	ROA027L	4	22.1	6.2	63	0.5	46.7	0.03 U	0.64	0.05 U	0.03 U	21	84	12	20	21.0
HYCO LAKE	June 26, 2024	ROA030C	6.1	32.8	6.5	150	1.55	86.1	0.03 U	0.43	0.05 U	0.03 U	11 Q2	105	3.6 U,Y	2.6	
	June 26, 2024	ROA030E	7.6	31.6	7.2	140	1.65	104.8	0.03 U	0.47	0.05 U	0.03 U	12 Q2	86	2.5 U,Y	2.3	
	June 26, 2024	ROA030F	6.5	32.5	6.7	148	1.7	91.5	0.03 U	0.44	0.05 U	0.03 U	10 Q2	104	13	2.4	
	June 26, 2024	ROA030G	7.2	31.7	7.1	145	1.7	100.3	0.03 U	0.42	0.05 U	0.03 U	8.5 Q2	81	2.5 U,Y	1.9	
	July 29 2024	ROA030C	6.1	31.7	6.7	171	1.8	83.2	0.03 U	0.46	0.05 U	0.03 U	9.9	157	2.5 U	2.1	
	July 29 2024	ROA030E	7.6	29.9	7.3	154	2	100.8	0.03 U	0.54	0.05 U	0.03 U	13	120	2.7	3.2	
	July 29 2024	ROA030F	6.2	31.1	6.9	172	2	84.7	0.03 U	0.4 U	0.05 U	0.03 U	8.4	159 J2	2.5 U	2	
	July 29 2024	ROA030G	7	29.2	7.2	84	2.4	92.3	0.03 U	0.46	0.05 U	0.03 U	9.9	158	2.5 U	1.6	
	August 20, 2024	ROA030C	6.4	30.8	6.3	159	1.2	86.8	0.03 U	0.52	0.05 U	0.03 U	22	151	2.9	3.3	
	August 20, 2024	ROA030E	7.7	30.3	7	150	1.25	103.3	0.03 U	0.57	0.05 U	0.03 U	21	115	3.4	3	
	August 20, 2024	ROA030F	6.9	30.9	6.7	161	1.6	94	0.03 U	0.43	0.05 U	0.03 U	12	143	2.5 U	2.4	
	August 20, 2024	ROA030G	7.5	30.6	7.4	164	1.7	102.2	0.03 U	0.45	0.05 U	0.03 U	12	137	2.5 U	1.8	
	September 23, 2024	ROA030C	8.5	27.1	7	183	1.8	108.3	0.03 U	0.53	0.05 U	0.03 U	16 J2	162	2.7	2	
	September 23, 2024	ROA030E	8.7	25.2	7.3	146	1.5	107.2	0.03 U	0.6	0.05 U	0.03 U	42 J2	128	3.7	2.4	
	September 23, 2024	ROA030F	7.9	25	6.7	168	2.1	97.3	0.03 U	0.71	0.05 U	0.03 U	19 J2	152	2.5 U	1.7	
	September 23, 2024	ROA030G	7.7	24.9	7.2	163	2.3	93.7	0.03 U	0.47	0.05 U	0.03 U	10 J2	147	2.5 U	1.6	
	October 23 2024	ROA030C	6.6	20.3	6.1	144	1	73.2	0.03 U	0.62	0.05 U	0.04	14.0	136	4.3	4.7	
	October 23 2024	ROA030E	8.3	20.4	6.7	114	0.9	92.9	0.03 U	0.8	0.05 U	0.03 U	29.0	111	5.1	5	
	October 23 2024	ROA030F	6.6	20.8	6.8	142	1	74.7	0.03 U	0.6	0.05 U	0.04	21.0	136	5	5.1	
	October 23 2024	ROA030G	6.8	21	6.8	139	1	76.7	0.03 U	0.52	0.05 U	0.03 U	15.0	134	3.7	4.5	
LAKE ROXBORO	June 20, 2024	ROA030DA	9.1	28.6	6.8	82	0.70	118.3	0.03 U	1.00	0.05 U	0.03 U	33.3	60	9.6	7.9	
	June 20, 2024	ROA030DC	9.3	29.5	6.6	73	0.95	122.5	0.03 U	0.91	0.05 U	0.03 U	24.1	43	6.0	5.0	
	June 20, 2024	ROA030DE	9.1	29.4	6.1	72	0.90	119.7	0.03 U	0.92	0.05 U	0.03 U	23.4	65	5.3	4.8	
	July 18, 2024	ROA030DA	9.2	31.1	7.8	76	0.60	125.9	0.07	0.94	0.05 U	0.03 U	71.0	132	10.0	9.1	
	July 18, 2024	ROA030DC	8.2	30.6	8.2	71	1.10	111.6	0.03 U	0.67	0.05 U	0.03 U	31.0	74	3.6	3.5	
	July 18, 2024	ROA030DE	7.7	31.5	8.2	71	1.50	106.8	0.03U	0.58	0.05U	0.03U	25.0	67	2.9	2.9	
	August 6, 2024	ROA030DA	9.9	29.8	7.5	76	0.60	132	0.07	0.97	0.05 U	0.03 U	44.0	70	8.6	7.7	
	August 6, 2024	ROA030DC	9.2	29.8	8.4	70	0.80	123.3	0.03 U	0.82	0.05 U	0.03 U	27.0	68	5.0	4.4	
	August 6, 2024	ROA030DE	8.9	30.6	7.6	71	0.90	121	0.03 U	0.87	0.05 U	0.03 U	22.0	40	4.1	4.1	
	October 2, 2024	ROA030DA	9	24.7	6.7	54	0.35	110	0.11	1.1	0.05U	0.03U	77	102	20	35	
	October 2, 2024	ROA030DC	8.2	23.6	6.4	53	0.4	97.7	0.1	1.2	0.05U	0.03U	80	113	18	30	
	October 2, 2024	ROA030DE	5.2	23.6	6	54	0.45	61.8	0.07	0.86	0.05U	0.03	13	41	10	29	
	October 22, 2024	ROA030DA	7	18.7	6.6	67	0.7	75.3	0.04	0.83	0.13	0.03 U	18	81	8.3	10	
	October 22, 2024	ROA030DC	4.8	18.2	6.4	33	1	51.5	0.04	0.84	0.18	0.03 U	9	76	3.9	8.6	
	October 22, 2024	ROA030DE	4.3	18.1	5.8	67	1.1	46	0.03 U	0.78	0.17	0.03 U	5.9	84	3	7.3	

Appendix A – Roanoke River Basin Data

Lake	SURFACE PHYSICAL DATA								PHOTIC ZONE DATA								
	Date	Sampling Station	DO mg/L	Temp Water °C	pH s.u.	Cond. µmhos/cm	Depth Secchi meters	DO SAT %	TP mg/L	TKN mg/L	NH3 mg/L	NOx mg/L	Chla µg/L	Total Solids mg/L	Total Suspended Solids mg/L	Turbidity NTU	Total Hardness mg/L
MAYO RESERVOIR	June 20, 2024	ROA0341A	8.4	29.5	5.5	89	1.50	110.8	0.03 U	0.48	0.05 U	0.03 U	9.8	56	5.0 U,Y	2.7	
	June 20, 2024	ROA0342A	8.6	29.8	6.5	93	1.80	112.9	0.03 U	0.44	0.05 U	0.03 U	9.0	24	5.0 U,Y	2.2	
	June 20, 2024	ROA0343A	8.3	30.5	7.3	95	2.00	111.7	0.03 U	0.4 U	0.05 U	0.03 U	8.3	48	5.0 U,Y	1.8	
	July 18, 2024	ROA0341A	8.2	30.5	7.5	88	1.5	110.6	0.03 U	0.54	0.05 U	0.03 U	30.0	81	7.8	5.5	
	July 18, 2024	ROA0342A	7.4	30.1	8.0	87	1.8	99.9	0.03 U	0.4 U	0.05 U	0.03 U	8.6	222	2.5 U	1.6	
	July 18, 2024	ROA0343A	7.7	30.5	7.4	94	1.9	104	0.03 U	0.4 U	0.05 U	0.03 U	8.9	80	2.8 U, Y	1.6	
	August 6, 2024	ROA0341A	8.9	29.8	8.2	80	1.7	118.9	0.03 U	0.53	0.05 U	0.03 U	14.0	72	2.7	2.7	
	August 6, 2024	ROA0342A	8.3	29.6	7.7	90	2.0	110.5	0.03 U	0.42	0.05 U	0.03 U	9.5	61	2.5	2.0	
	August 6, 2024	ROA0343A	8.6	30.2	8.3	96	2.0	116.1	0.03 U	0.42	0.05 U	0.03 U	9.7	64	3.1 U,Y	1.9	
	October 2, 2024	ROA0341A	8.4	24.8	6.1	84	1.65	102.6	0.03 U	0.4 U	0.05 U	0.03 U	16	62	3.5	3.8	
	October 2, 2024	ROA0342A	8	24.8	6.7	87	2	97.9	0.03 U	0.4 U	0.05 U	0.03 U	13	65	2.5 U	2.5	
	October 2, 2024	ROA0343A	8.1	24.8	6.7	97	2.4	99.4	0.03 U	0.4 U	0.05 U	0.03 U	7.3	71	2.5 U	1.7	
	October 22, 2024	ROA0341A	7.8	20.7	6	81	1.5	87.2	0.03 U	0.54	0.05 U	0.03 U	17	60	3.8	3.1	
	October 22, 2024	ROA0342A	6.9	20.8	6.7	85	2.4	77.7	0.03 U	0.4 U	0.05 U	0.03 U	6.7	72	2.5 U	2.1	
	October 22, 2024	ROA0343A	7.9	20.2	6.7	46	3.6	88	0.03 U	0.4 U	0.05 U	0.03 U	5	67	2.5 U	1.5	
LAKE ISAAC WALTON	June 3, 2024	ROA031C	9.5	26.3	6.2	65	0.80	119.6	0.03 U	0.60	0.05 U	0.03 U	47.6	67	6.8 J2	7.3	20.0
	June 3, 2024	ROA031E	8.7	25.4	6.4	66	1.10	107.2	0.03 U	0.58	0.05 U	0.03 U	15.5	60	4.0 J2	4.2	
	June 3, 2024	ROA031H	8.6	25.6	6.1	60	1.10	107.5	0.03 U	0.57	0.05 U	0.03 U	13.9	51	2.9 J2	3.6	
	July 29, 2024	ROA031C	9.1	27.3	7.0	62	0.7	116.9	0.04	0.65	0.05 U	0.03 U	41.0	76	7.3	9.4	23.0
	July 29, 2024	ROA031E	7.9	28.3	6.7	60	1.1	102.3	0.03 U	0.61	0.05 U	0.03 U	22.0	56	3.3 U,Y	3.6	
	July 29, 2024	ROA031H	8.2	28.4	7.1	61	1.1	106.7	0.03 U	0.60	0.05 U	0.03 U	21.0	58	3.3 U,Y	3.2	
	August 20, 2024	ROA031C	7.9	27.2	7.0	63	0.8	101.2	0.05	0.78	0.05 U	0.03 U	43.0	82	5.9	6.5	30.0
	August 20, 2024	ROA031E	8.2	27.9	7.2	60	1.3	106.3	0.03 U	0.62	0.05 U	0.03 U	22.0	74	2.9	3.2	
	August 20, 2024	ROA031H	8.3	27.9	7.7	60	1.3	107.4	0.03 U	0.66	0.05 U	0.03 U	22.0	59	3.1	3.5	
	September 23, 2024	ROA031C	7.2	23.9	6.4	73	0.7	86.2	0.03 U	0.70	0.07	0.03 U	43 J2	74	8.3	7.1	33.0
	September 23, 2024	ROA031E	8.4	24.3	6.6	62	1	101.6	0.03 U	0.63	0.05 U	0.03 U	37 J2	49	4.5	4.1	
	September 23, 2024	ROA031H	8.7	24.5	6.8	62	1	105.4	0.03 U	0.59	0.05 U	0.03 U	30 J2	63	3.2	3.9	
	October 23, 2024	ROA031C	8	16.6	5.8	64	1.1	83.1	0.03	0.8	0.18	0.03 U	19	46	4.8	7	100.0
	October 23, 2024	ROA031E	4.4	18.4	6.3	69	1	46.9	0.03 U	0.86	0.25	0.03 U	17	78	5.1	5.2	
	October 23, 2024	ROA031H	5.1	18.6	6.5	69	1	55.6	0.03 U	0.71	0.25	0.03 U	13	76	3.8	4.2	

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Symbol		Definition
A		Value reported is the mean (average) of two or more determinations. This code is to be used if the results of two or more discrete and separate samples are averaged. These samples shall have been processed and analyzed independently (e.g. field duplicates, different dilutions of the same sample). This code is not required for BOD, coliform or acute/chronic metals reporting since averaging multiple results for these parameters is fundamental to those methods or manner of reporting.
	1	The reported value is an average, where at least one result is qualified with a "U". The PQL is used for the qualified result(s) to calculate the average.
B		Results based upon colony counts outside the acceptable range and should be used with caution. This code applies to microbiological tests and specifically to **membrane filter (MF)** colony counts. It is to be used if less than 100% sample was analyzed and the colony count is generated from a plate in which the number of colonies exceeds the ideal ranges indicated by the method. These ideal ranges are defined in the method as: *Fecal coliform or Enterococcus bacteria: 20-60 colonies Total coliform bacteria: 20-80 colonies*
	1	Countable membranes with less than 20 colonies. Reported value is estimated or is a total of the counts on all filters reported per 100 ml.
	2	Counts from all filters were zero.
	3	Countable membranes with more than 60 or 80 colonies. The value reported is calculated using the count from the smallest volume filtered and reported as a greater than ">" value.
	4	Filters have counts of both >60 or 80 and <20. Reported value is estimated or is a total of the counts on all filters reported per 100 ml.
	5	Too many colonies were present; too numerous to count (TNTC). TNTC is generally defined as >150 colonies. The numeric value represents the maximum number of counts typically accepted on a filter membrane (60 for fecal or enterococcus and 80 for total), multiplied by 100 and then divided by the smallest filtration volume analyzed. This number is reported as a greater than value.
	6	Estimated Value. Blank contamination evident.
	7	Many non-coliform or non-enterococcus colonies or interfering non-coliform or non-enterococcus growth present. In this competitive situation, the reported value may under-represent actual density.
		Note: A "B" value shall be accompanied by justification for its use denoted by the numbers listed above (e.g., B1, B2, etc.). Note: A "J2" should be used for spiking failures.
C		Total residual chlorine was present in sample upon receipt in the laboratory; value is **estimated**. Generally applies to cyanide, phenol, NH3, TKN, coliform, and organics.
G		A single quality control failure occurred during biochemical oxygen demand (BOD) analysis. The sample results should be used with caution.
	1	The dissolved oxygen (DO) depletion of the dilution water blank exceeded 0.2 mg/L.
	2	The bacterial seed controls did not meet the requirement of a DO depletion of at least 2.0 mg/L and/or a DO residual of at least 1.0 mg/L.
	3	No sample dilution met the requirement of a DO depletion of at least 2.0 mg/L and/or a DO residual of at least 1.0 mg/L.
	4	Evidence of toxicity was present. This is generally characterized by a significant increase in the BOD value as the sample concentration decreases. The reported value is calculated from the highest dilution representing the maximum loading potential and should be considered an **estimated** value.
	5	The glucose/ glutamic acid standard exceeded the range of 198 ± 30.5 mg/L.
	7	Less than 1 mg/L DO remained for all dilutions set. The reported value is an **estimated** greater than value and is calculated for the dilution using the least amount of sample.
	8	Oxygen usage is less than 2 mg/L for all dilutions set. The reported value is an **estimated** less than value and is calculated for the dilution using the most amount of sample.
	9	The DO depletion of the dilution water blank produced a negative value.
	10	The cBOD value is greater than the BOD value.
		Note: A "G" value shall be accompanied by justification for its use denoted by the numbers listed above (e.g., G1, G2, etc.).

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J		**Estimated** value; value may not be accurate. This code is to be used in the following instances:
	1	Surrogate recovery limits have been exceeded.
	2	The reported value failed to meet the established quality control criteria for either precision or accuracy.
	3	The sample matrix interfered with the ability to make any accurate determination.
	4	The data is questionable because of improper laboratory or field protocols (e.g., composite sample was collected instead of grab, plastic instead of glass container, the sample's extraction batch did not include a LCS/MS/MSD, etc.).
	5	Temperature limits exceeded (samples frozen or >6°C) during transport or not verifiable (e.g., no temperature blank provided): non-reportable for NPDES compliance monitoring.
	6	The laboratory analysis was from an unpreserved or improperly chemically preserved sample. The data may not be accurate.
	7	This qualifier is used to identify analyte concentration exceeding the upper calibration range of the analytical instrument/method. The reported value should be considered estimated.
	8	Temperature limits exceeded (samples frozen or >6°C) during storage, the data may not be accurate.
	9	The reported value is determined by a one-point estimation rather than against a regression equation. The estimated concentration is less than the laboratory PQL and greater than the laboratory method detection limit.
	10	Unidentified peak; estimated value.
	11	The reported value is determined by a one-point estimation rather than against a regression equation. The estimated concentration is less than the laboratory PQL and greater than the instrument noise level. This code is used when an MDL has not been established for the analyte in question.
	12	The calibration verification did not meet the calibration acceptance criterion for **field parameters**.
	13	Standards used for this analyte are from an uncertified source. These are the only standards currently available for the analyte.
	14	Blank surrogate(s) percent recovery failed low. Potential contamination cannont be ruled out. This means assocated sample results may be biased high. This qualifier is only to be used for samples which have target analyte results ≥PQL.
	15	This result has no supporting QA/QC data.
		Note: A "J" value shall be accompanied by justification for its use denoted by the numbers listed above (e.g., J1, J2, etc.).
M		Sample and duplicate results are "out of control". The sample is non-homogenous (e.g., VOA soil). The reported value is the lower value of duplicate analyses of a sample.
N		Presumptive evidence of presence of material; **estimated** value. This code is to be used if:
	1	The component has been tentatively identified based on mass spectral library search.
	3	This code shall be used if the level is too low to permit accurate quantification, but the estimated concentration is less than the laboratory PQL and greater than the laboratory method detection limit. This code is not routinely used for most analyses.
P		Sample dilution occurred due to either matrix interference or target analytes being present at concentrations greater than the calibration curve. Reported target analyte values are obtained from results which were bracketed by the calibration curve. For example, "P10" in sample comments would indicate that a 10x dilution was performed to obtain the reported result.
Q		Holding time exceeded. These codes shall be used if the value is derived from a sample that was received, prepared and/or analyzed after the approved holding time restrictions for sample preparation and analysis. The value does not meet NPDES requirements.
	1	Holding time exceeded prior to receipt by lab.
	2	Holding time exceeded following receipt by lab.
S		Not enough sample provided to prepare and/or analyze a method-required matrix spike (MS) and/or matrix spike duplicate (MSD).
U		Indicates that the analyte was analyzed for, but not detected above the reported PQL. The number value reported with the "U" qualifier is equal to the laboratory's PQL*. If the "P" qualifier is reported with this "U" qualifier, then the reported PQL is elevated.
UU		Indicates that the analyte result was generated from a screen analysis (i.e., does not have supporting QA/QC data). The value reported with the "UU" qualifier is equal to the laboratory's PQL. The number value was determined by a one-point estimation at the PQL, rather than against a regression equation.

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V	Indicates the analyte was detected in both the sample and the associated blank. Note: The value in the blank shall not be subtracted from the associated samples. 1 The analyte was detected in both the sample and the method blank. 2 The analyte was detected in both the sample and the field blank.
X	Sample not analyzed for this constituent. This code is to be used if: 1 Sample not screened for this compound. 2 Sampled, but analysis lost or not performed-field error. 3 Sampled, but analysis lost or not performed-lab error. Note: an "X" value shall be accompanied by justification for its use by the numbers listed.
Y	Elevated PQL due to insufficient sample size.
Z	The sample analysis/results are not reported due to: 1 Inability to analyze the sample. 2 Questions concerning data reliability. Note: The presence or absence of the analyte cannot be verified.

Supporting Definitions listed below

MDL	A Method Detection Limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the true value is greater than zero and is determined in accordance with 40 CFR Part 136, Appendix B.
ML	Minimum Levels are used in some EPA methods. A Minimum Level (ML) is the lowest level at which the entire analytical system must give a recognizable signal and acceptable calibration point for the analyte. It is equivalent to the concentration of the lowest calibration standard, assuming that all method - specified sample weights, volumes, and cleanup procedures have been employed. The ML is calculated by multiplying the MDL by 3.18 and rounding the result to the nearest factor of 10 multiple (i.e., 1, 2, or 5). For example, MDL = 1.4 mg/L; ML = 1.4 mg/L x 3.18 = 4.45 rounded to the nearest factor of 10 multiple (i.e., 5) = 5.0 mg/L
PQL	The Practical Quantitation Limit (PQL) is defined as the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. PQLs are subjectively set at some multiple of typical MDLs for reagent water (generally 3 to 10 times the MDL depending upon the parameter or analyte and based on the analyst's best professional judgement, the quality and age of the instrument and the nature of the samples) rather than explicitly determined. PQLs may be nominally chosen within these guidelines to simplify data reporting and, where applicable, are generally equal to the concentration of the lowest non-zero standard in the calibration curve. PQLs are adjusted for sample size, dilution and % moisture. For parameters that are not amenable to MDL studies, the PQL may be defined by the sample volume and buret graduations for titrations or by minimum measurement values set by the method for method-defined parameters (e.g., BOD requires a minimum DO depletion of 2.0 mg/L, fecal coliform requires a minimum plate count of 20 cfu, total suspended residue requires a minimum weight gain of 2.5 mg, etc.). Additionally, some EPA methods prescribe Minimum Levels (MLs) and the lab may set the PQL equal to this method-stated ML. Determination of PQL is fully described in the laboratory's analytical Standard Operating Procedure (SOP) document.