

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

North Carolina Department of Environmental Quality
Division of Water Resources
Water Science Section
Intensive Survey Branch
2025

This report has been approved for release by:



Chris Johnson
Chief, Water Science Section

May 8, 2026

Date

Table of Contents

Glossary 3

Purpose and Scope 6

Overview 6

Assessment Methodology 6

Quality Assurance of Field and Laboratory ALMP Data 7

Weather Overview for Summer 2025 8

Lake and Reservoir Assessments 9

 Lake Phelps 9

Appendix A 10

Appendix B 11

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
AGPT	Algal Growth Potential Test 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 period 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 considered to be 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 <i>a</i>	Chlorophyll <i>a</i> is an algal pigment that is used as an approximate measure of algal biomass. The concentration of chlorophyll <i>a</i> 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.
Cocoid	Round or spherical shaped cell.

Conductivity	This is a measure of the ability of 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 concentrations of oxygen found at the sampling locations.
DO 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 proportional 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 <i>a</i> 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 pH readings found at the 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 the sampling locations.

TKN	Total Kjeldahl Nitrogen (TKN) 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.
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.
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 on the ISB website.

Overview

The Pasquotank River Basin consists of 3,697 square miles of flat lands and vast open waters of the northeastern portion of the state. The Pasquotank River is freshwater upstream of Elizabeth City and becomes brackish and tidally influenced downstream. The Alligator River near Lake Phelps is a large blackwater river that is designated as an Outstanding Resource Water. The Alligator National Wildlife Refuge extends along the entire eastern shore of the Alligator River. Lake Phelps is owned by the NC State Parks and is also designated as an Outstanding Resource Water. The lake shore of Lake Phelps consists of wooded swampland transitioning to agricultural land.

A statewide fish consumption advisory for multiple fish species 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 Pasquotank River Basin. Visit the [North Carolina Fish Consumption Advisories webpage](#) for specific fish consumption advisory details.

Assessment Methodology

For this report, data from May 2025 through September 2025 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](#).

All lakes were sampled during the growing season from May through September. Data were assessed for excursions of the state's Class C water quality standards for chlorophyll α , 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 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 came out of an abundance of caution to ensure the most conservative estimate of the NCTSI score. The ranges for classification are as follows:

Trophic Level Classifications	NC TSI Score
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. A 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 month 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 DEQ website.

The [Ambient Lakes Monitoring Program \(ALMP\) Quality Assurance Project Plan](#) can be found on the Intensive Survey Branch Webpage.

Weather Overview for Summer 2025

Weather conditions were considered relatively dry for the basin during the sampling season of May-September 2025, highlighted by Tropical Storm Chantal passing through the central piedmont of North Carolina. A dry winter led to a soaking and warm May to start off the sampling season, with wetter than normal conditions lasting through the summer. This soggy and steamy weather ended in August with a statewide average precipitation of 4.5 inches of rain by the end of the summer. August was an overall dry month, with dry weather returning and persisting into the fall and winter. The drought conditions were especially pronounced in several western counties of the state. The average temperature for 2025 was the 22nd warmest year on record with an average temperature of 59.9°F

Detailed weather information can be found through the [NC State Climate Office Blog](#) and the [Southeast Regional Climate Center](#).

Lake and Reservoir Assessments

Lake Phelps



<i>ALMP Lake Information</i>	<i>Lake Phelps</i>	
Season Average Trophic Status (NC TSI)	Eutrophic	
Mean Depth (meters)	2.0	
Volume (10⁶ m³)	98.7	
Watershed Area (mi²)	N/A	
Classification	B Sw ORW	
Stations	PAS012C	PAS012D
Number of Times Sampled	5	

Lake Phelps Monthly Snapshot:

<i>Sample Period</i>	<i>Monthly NC TSI Score</i>	<i>Trophic State</i>
May	2.5	Eutrophic
June	1.3	Eutrophic
July	1.4	Eutrophic
August	---	---
September	---	---

*The monthly NCTSI Score may not have been calculated due to laboratory or sampling-related qualifiers. Please see Appendices A and B for specific details.

A season average NCTSI is not calculated for lakes with less than three months of usable NCTSI data.

Lake Phelps, the second largest natural lake in North Carolina, is located in Washington and Tyrrell Counties. Much of the region has been cleared of vegetation, drained, and put into large scale agricultural use. Lake Phelps is recharged by natural precipitation with a small fraction coming from underground aquifers. There is no known overland flow into the lake as it occupies the highest elevation in the area. Lake Phelps has an average retention time of 1161 days, and, because of its shallow depth and wind mixing, the water column does not stratify. Lake Phelps is a Carolina Bay Lake. These lakes are characteristically shallow, oval in shape with a northwest to southeast orientation, and have low pH waters that are usually tea-colored from tannins leached from underlying peat beds. This lake is owned by the State of North Carolina and is associated with Pettigrew State Park and is used for recreational activities such as fishing and boating. Historically, Lake Phelps has been used as a water source for fighting local peat fires in the immediate region.

Lake Phelps was monitored five times in 2025 by DWR field staff. Secchi depths ranged from 0.5 to 1.5 meters (Appendix A). Surface dissolved oxygen ranged from 7.9 to 8.9 mg/L and surface pH ranged from 6.0 to 6.9 s.u. Total phosphorus in Lake Phelps remained below the detection limit of <0.05 mg/L and total kjeldahl nitrogen ranged from below detection at 0.06 to 0.78 mg/L. Chlorophyll a values ranged from 2.4 to 8.1 ug/L.

The water in Lake Phelps is clearer than that of typical Carolina Bay Lakes, which allows for more accurate secchi depth measurements and calculation of NC Trophic State Index Score (NCTSI). In 2025, the trophic status of this lake was eutrophic. NCTSI scores from previous monitoring efforts by DWR field staff have indicated shifts between oligotrophic and mesotrophic conditions in Lake Phelps beginning in 1981 when this lake was first monitored. It first showed eutrophic conditions in the 2021 cycle.

Appendix A

**Data for the Pasquotank River Basin Lakes from
January 1, 2025 through December 31, 2025 is now available for
download as an Excel file using the link below
([Accessible Appendix A Table](#))**

Appendix B

Qualifier codes used at the time of the publication of this report can be found at the link below.

[DWR Chemistry Laboratory Data Qualifier Codes](#)

[NCDEQ WSS Laboratory Quality Assurance Webpage](#) has additional and up to date information on qualifier codes.