Overview of the Work of the Upper Neuse River Basin Association to Support Implementation and Re-examination of the Falls Lake Rules

November 2021

The Upper Neuse River Basin Association (UNRBA) was formed in 1996 to examine water quality conditions and regulatory controls within the Falls Lake watershed. The UNRBA's principal focus is to develop pollution reduction and management strategies that efficiently and effectively provide a sustainable water supply for the region. Seven municipalities, six counties, and local Soil and Water Conservation Districts voluntarily formed the UNRBA.

Background

The Falls Lake project was authorized by Congress as part of the Flood Control Act in 1965. The reservoir began filling in January 1983. The designated uses of Falls Lake include drinking water supply, recreation, fishing, aquatic life, and wildlife. Design and construction of the impoundment were conducted by the USACE, which continues to manage the reservoir today.

Pre-impoundment studies predicted that Falls Lake would be highly eutrophic, especially in the upper end of the lake (DNER 1973[1], USACE 1974[2], NCDEM 1983[3]). These studies predicted that that dissolved oxygen would be depleted in deeper portions of the lake during thermally stratified conditions. Despite the predicted high chlorophyll-a concentrations and the low dissolved oxygen concentrations in deep waters, each study indicated that the uses of Falls Lake would be met. Conditions in the lake today based on monitoring by the NC Division of Water Resources are much better than predicted. For example, the earlier studies predicted summer average chlorophyll-a concentrations of 110 µg/L while data collected from August 2014 to October 2018 show a summer average concentration of 41 µg/L in the upper part of the lake. These data are summarized in the UNRBA 2019 Monitoring Report.

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Because Falls Lake was listed as impaired in 2008 for exceedances of the 40 µg/L chlorophyll-a criterion, in 2011 the EMC passed the Falls Lake Nutrient Management Strategy (the Rules) which requires two stages of nutrient reductions for Falls Lake. The Stage I goal is to achieve compliance with the chlorophyll-a standard in the lower half of the lake (below Highway 50). While the Stage II goal is to comply with the chlorophyll-a standard everywhere in the lake at all times. The current Management Strategy dictates load reduction requirements for local governments and other entities based on a lake nutrient response model developed by the Division of Water Resources (DWR). Based on DWR's fiscal analysis of the Management Strategy, the cost of Stage I is expected to exceed $500 million and implementation costs for Stage II are expected to approach $1 billion or more.

The UNRBA is in the process of its re-examination of Stage II of the Rules. The UNRBA began planning for the re-examination in 2011 in accordance with the procedures and requirements outlined in the Rules (15A NCAC 02B.0275 Section (5)(f)). This section of the rules is generally referred to as the adaptative management provision. The UNRBA supports its members in the implementation of Stage I of the Management Strategy however, the UNRBA believes that the reduction goals for Stage II are infeasible and beyond the limits of technology. This conclusion is supported based on a technical review of the Stage II provisions (see Section 3 of Framework for Reexamination of Stage II).

Stage I Implementation Support

UNRBA Stage I efforts to reduce nutrient loading have already contributed to water quality improvements in Falls Lake. Based on DWR's 2016 Status Report for Falls Lake, agriculture, wastewater treatment plants exceeding 1 million gallons per day, and NC Department of Transportation have all met or exceeded Stage I load reduction targets. New development regulations were adopted in 2012 by all local governments in the watershed to reduce loading from development activities. Though the Stage I load reduction targets for existing development have not been set by DWR and the EMC, the UNRBA has worked to develop actions and program proposals to reduce loading from existing development. This effort involves two initiatives: the Nutrient Credit Development Project and the Stage I existing development Interim Alternative Implementation Approach (IAIA). These two initiatives are summarized on the following page.

[1]North Carolina Department of Natural and Economic Resources (DNER) Office of Water and Air Resources. 1973. North Carolina Water Plan – Progress Report Chapter 34 – Neuse River Basin Special Annex. Special Analysis of the Falls of the Neuse Project.
[2]United States Army Corps of Engineers (USACE). 1974. Final Environmental Impact Statement (Revised) Falls Lake Neuse River Basin North Carolina. U.S. Army Corps of Engineers Wilmington District. March 1974.
[3]North Carolina Division of Environmental Management (NCDEM). 1983. Water Quality Discussions of Falls of the Neuse and B. Everett Jordan Lakes. North Carolina Department of Natural Resources and Community Development, Division of Environmental Management, Water Quality Section. 94 pp.

Nutrient Credit Development Project

In 2014, the UNRBA invested approximately $310,000 on a Nutrient Credit Development Project to expand the list of state-approved nutrient-reducing practices in North Carolina. DWR contributed an additional $70,000 through a 319 grant to support this project which furthered research and supported development of nutrient credits for three practices that are now managed under the Stormwater Program of the Division of Energy, Mineral and Land Resources. Crediting information and minimum design criteria for design variants associated with bioretention cells, level spreader filter strips, and infiltration devices are available online at https://deq.nc.gov/about/divisions/energy-mineral-and-land-resources/stormwater/stormwater-program/stormwater-design. Credits for three practices were developed with the DWR and subject matter experts. These three crediting documents for remedying illicit discharges, soil improvement, and cattle exclusion (contingent on approval of a trading framework by the Falls Lake Watershed Oversight Committee) are available online at https://www. unrba.org/nutrient-credit-program. Two additional practices were submitted for credit by the UNRBA to DWR, and the agency has since taken over developing the crediting document for one of these (buffer restoration in developed areas). Credit development for land conservation has been postponed, but land conservation has been included as an approved practice under the IAIA.

Stage I Existing Development Interim Alternative Implementation Approach (IAIA)

Since 2018, the UNRBA has been exploring an alternative option for achieving compliance with Stage I existing development nutrient load reductions requirements to overcome some of the obstacles present in the current Rules. This concept was originally brought forth by environmental advocacy groups active in the watershed. The UNRBA has worked with its members, representatives from environmental groups, conservation organizations, staff at DWR, other interest groups and regulated entities to develop an alternative approach for complying with the Rules that uses financial investment in projects and actions that benefit water quality and encourage water management in the watershed. This approach does not rely on counting pounds of nutrient reductions associated with individual projects. This innovative approach promotes actions that provide “on-the-ground” benefits to the watershed and lake. A frequently asked questions document provides an overview of the IAIA program.

This program is considered interim because it would apply only until the Falls Lake Rules are readopted as required by the NC General Assembly (expected in 2025 or later). It is anticipated that the IAIA experience will help inform the development of a revised nutrient management strategy for Falls Lake.

This approach is based on the voluntary participation of individual UNRBA members. The IAIA program allows participating jurisdictions to achieve compliance using a joint compliance approach as outlined in the revised Model

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Program developed by DWR (approved by the EMC in January 2021). If a jurisdiction chooses not to participate in the Stage I IAIA, that local government has to comply by developing a Stage I existing development local program. This local program must include a determination of the load reduction requirement and identify the projects to be implemented to meet the required load reduction. The UNRBA finalized the IAIA approach, and implementation under this framework began in July 2021.

Re-examination of Stage II

The Stage II requirements represent very large and costly additional reductions in nutrient loading from developed lands in the watershed. The technical feasibility of meeting these reductions are beyond the capability of available technology and are therefore infeasible. The DWR predictive modeling used to develop the Falls Rules was developed on a compressed time schedule with limited data, thus there is a lot of uncertainty in the nutrient load reduction targets and the ability of the lake to meet chlorophyll-a water quality standards regardless of the load reductions achieved. For these reasons, the Rules allow for a “re-examination” of the required nutrient load reductions (adaptive management provision). The UNRBA developed a plan for conducting the re-examination in 2013 that included four components:

- review of historic data
- review of previously developed models
- recommended additional monitoring and modeling to support the re-examination
- framework for conducting the re-examination

Monitoring

In 2014, the UNRBA initiated a Monitoring Plan that described the locations, parameters, frequencies, and other program elements. As established in Section 5 (f) of the Falls Lake Nutrient Management Strategy, the UNRBA Monitoring Plan was approved by DWR on July 16, 2014. The UNRBA Monitoring Quality Assurance Project Plan (QAPP) was developed specifically for the program to ensure that data are reliable and suitable for consideration for regulatory purposes. The QAPP was approved by the North Carolina Division of Water Resources (DWR) on July 30, 2014 and again on January 18, 2017.

Routine Monitoring began in August 2014 and continued through October 2018. The Routine Monitoring obtained data on 20 water quality parameters from 38 tributary stations on a monthly basis (51 months) resulting in more than 38,000 measurements. In addition to routine

monitoring, special studies were conducted to provide a detailed understanding of the functions of Falls Lake's physical, chemical, biological, and geological characteristics. These special studies included storm event sampling, high flow event sampling, lake sediment depth and quality, lake bathymetry, constriction point monitoring of water movement and water quality, and light extinction data. **The UNRBA invested approximately $3.5 million in this effort to fill data gaps and improve the understanding of the lake and the watershed.**

The UNRBA developed a comprehensive monitoring report in 2019 that summarizes the monitoring data, provides nutrient loading summaries by source and through time, and evaluates lake residence time, dissolved oxygen concentrations, and algal toxin data. This monitoring data, along with data collected by other organizations (DWR, NC State University Center for Applied Aquatic Ecology, and the cities of Durham and Raleigh), is being used to calibrate watershed loading and lake water quality simulation models. The UNRBA also coordinated with researchers through the UNC Collaboratory on additional studies to inform water quality simulation models.

Key findings from the monitoring studies provide insights into the behavior of the lake and also provide model inputs for the watershed and lake models being developed to support the re-examination. For example, when the original models were developed by DWR to establish the Rules, no measurements of chlorophyll-a concentrations were available in the tributaries filling Falls Lake. DWR assumed tributary concentrations were equivalent to those in the lake. **The UNRBA monitoring study included chlorophyll-a in tributaries, and concentrations are typically much lower in the streams than those in the lake.**

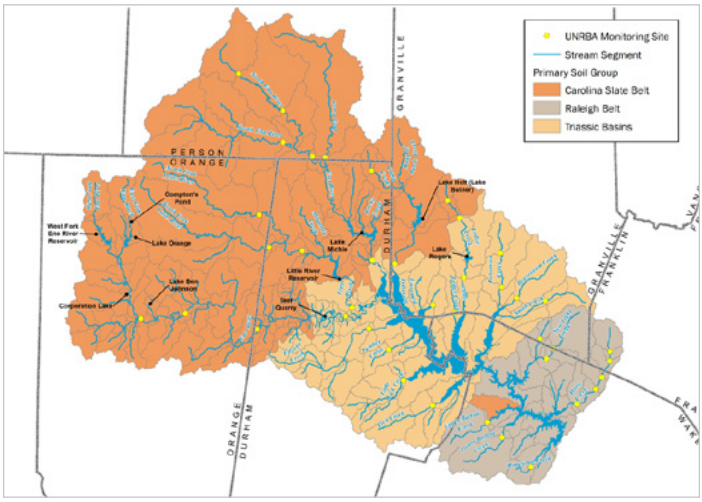
Another key finding of the monitoring study is that nutrient loading is not the only driver of algal growth in the lake. Chlorophyll-a concentrations in Falls Lake were highest in 2017 compared to other UNRBA monitoring years, but nutrient loads that year were approximately half. High nutrient loading corresponds with high inflow volumes which result in increased flushing and reduced residence times. Periods of low loading correspond to small inflow volumes and longer residence times when algae are provided longer periods of growth. The hydrology, morphology, retention time, depth, and characteristics of the different areas of the lake are just as important as nutrient loading. While the UNRBA aims to manage nutrient loading in the watershed, it recognizes it is not the only factor to consider in developing a revised nutrient management strategy.

Modeling

Predictive simulation models provide useful tools to understand how conditions in the watershed affect lake water quality and to evaluate potential changes in lake water quality due to proposed future management actions taken in the watershed. In 2017, the UNRBA worked with internal and external stakeholders to screen and select four models to support the re-examination. The Association also developed a Conceptual Modeling Plan to describe how different types of models would be used to provide multiple lines of evidence for a revised strategy. As required by the Rules, DWR approved the Description of the Modeling Framework and the Modeling QAPP that specifies how the models should be developed and assessed for performance. Following completion of the monitoring program in 2018, the UNRBA membership has been providing $800,000 in annual funding to support this modeling and regulatory support effort.

There are four types of models being developed to support the re-examination of Stage II. The first is a watershed model to estimate sources of nutrients from the watershed to Falls Lake. The UNRBA has selected the Watershed Analysis Risk Management Framework (WARMF) to conduct the watershed modeling. This model is driven by weather, land use, and soils data and includes atmospheric deposition, nutrient application, wastewater treatment, etc. Many organizations have provided information to assist with development of the watershed model: UNRBA member local governments and utilities, NC Department of Agriculture, NC Department of Transportation, NC State Climate Office, Wildlife Resources Commission, US Geologic Survey, DWR, CAAE, and the UNC Collaboratory.

The second model, WARMF Lake, receives direct input from the watershed model. It is a less complex model and is linked directly to the watershed model, so it can be used to quickly evaluate the impacts of nutrient loading

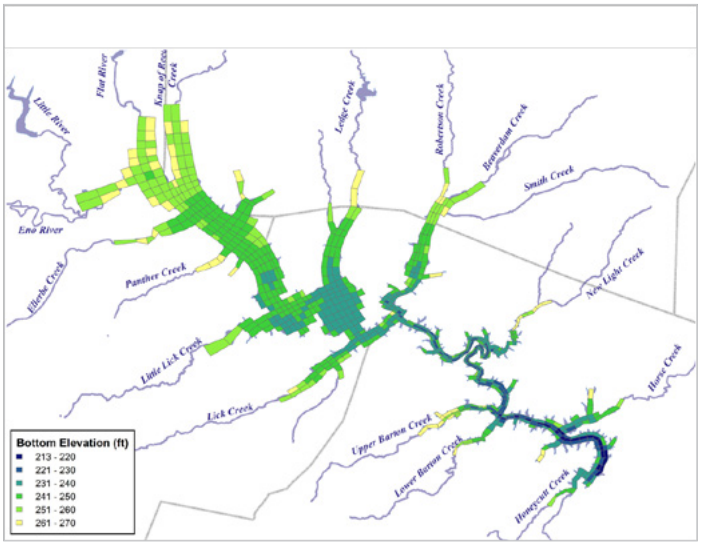


reduction scenarios on lake water quality. The third model is a hydro-dynamic water quality model of Falls Lake using the Environmental Fluid Dynamics Code (EFDC). This model provides spatially refined water quality information and includes a sediment diagenesis module to simulate nutrient releases from lake sediments over time. Both of these Falls Lake water quality models will simulate concentrations of nutrients, carbon, and algae in Falls Lake that result from hydrologic and loading inputs from the watershed.

The UNRBA re-examination includes the development of a fourth model to evaluate how designated uses are affected by lake water quality. This statistical model will be primarily data driven (empirical). This model will incorporate Bayesian techniques that allow expert opinion to be considered when relationships between parameters and uses are difficult to

quantify or costly to measure. The UNRBA has identified experts in the fields of water chemistry, lake processes, drinking water treatability, and evaluation of impacts to recreational uses to provide this expertise.

In addition to the UNC Collaboratory research studies that the UNRBA will consider in its re-examination, the UNC Col- laboratory is also providing third party review of the UNRBA modeling efforts. This invaluable contribution is occurring while the models are being developed to provide input and feedback on the model development processes being used by the UNRBA. Third party reviews increase transparency and provide an extra layer of assurance that the models can be relied upon to support regulatory and policy decisions.



After the predictive models are developed, they will be used to evaluate the impacts of different management options on lake water quality and designated uses. A cost benefit analysis will also be conducted to assess the technical and financial feasibility of the various management options. The re-examination will integrate the model results of various management options and cost benefit information to develop recommendations for a revised nutrient management strategy for Falls Lake. This approach may also include the evaluation of regulatory options such as site-specific chlorophyll-a criteria, sub-classifications of designated uses, or other regulatory options.

Stakeholder Involvement

The UNRBA membership has consistently used consensus to reach its decisions based on input from its members and representatives. External stakeholders participate through attendance and participation at UNRBA meetings which are open to the public. External stakeholders also have access to review UNRBA project activities, materials developed to describe and present

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its work, and documents generated by the UNRBA and its contractors in support of its objectives. Stakeholders are invited to comment on these materials during meetings and in writing to provide input to the work of the UNRBA. The UNRBA has and will continue to provide and enhance input opportunities during stakeholder meetings and workshops. The UNRBA encourages timely input from external stakeholders as this input is critical to the success of implementing a revised nutrient management strategy for Stage II. Input from the NC Department of Environmental Quality, including specifically the DWR, as the regulatory agency is especially important for successful development and adoption of a revised strategy.

Schedule

The UNRBA completed its four-year monitoring program in 2018 and is currently focused on development of models to evaluate nutrient loading from the watershed and water quality in the lake. These models will be calibrated in 2021 after which they will be used to test nutrient management scenarios. The UNRBA will work internally and with external stakeholders including the UNC Collaboratory to evaluate the predictions for nutrient management actions and to consider feasibility and costs in the revised strategy. The UNRBA will propose a revised strategy in 2023, considering the work of UNC Collaboratory. The Collaboratory's final report on Falls Lake is due later that year. Figure 1 provides an overview of the UNRBA re-examination schedule.

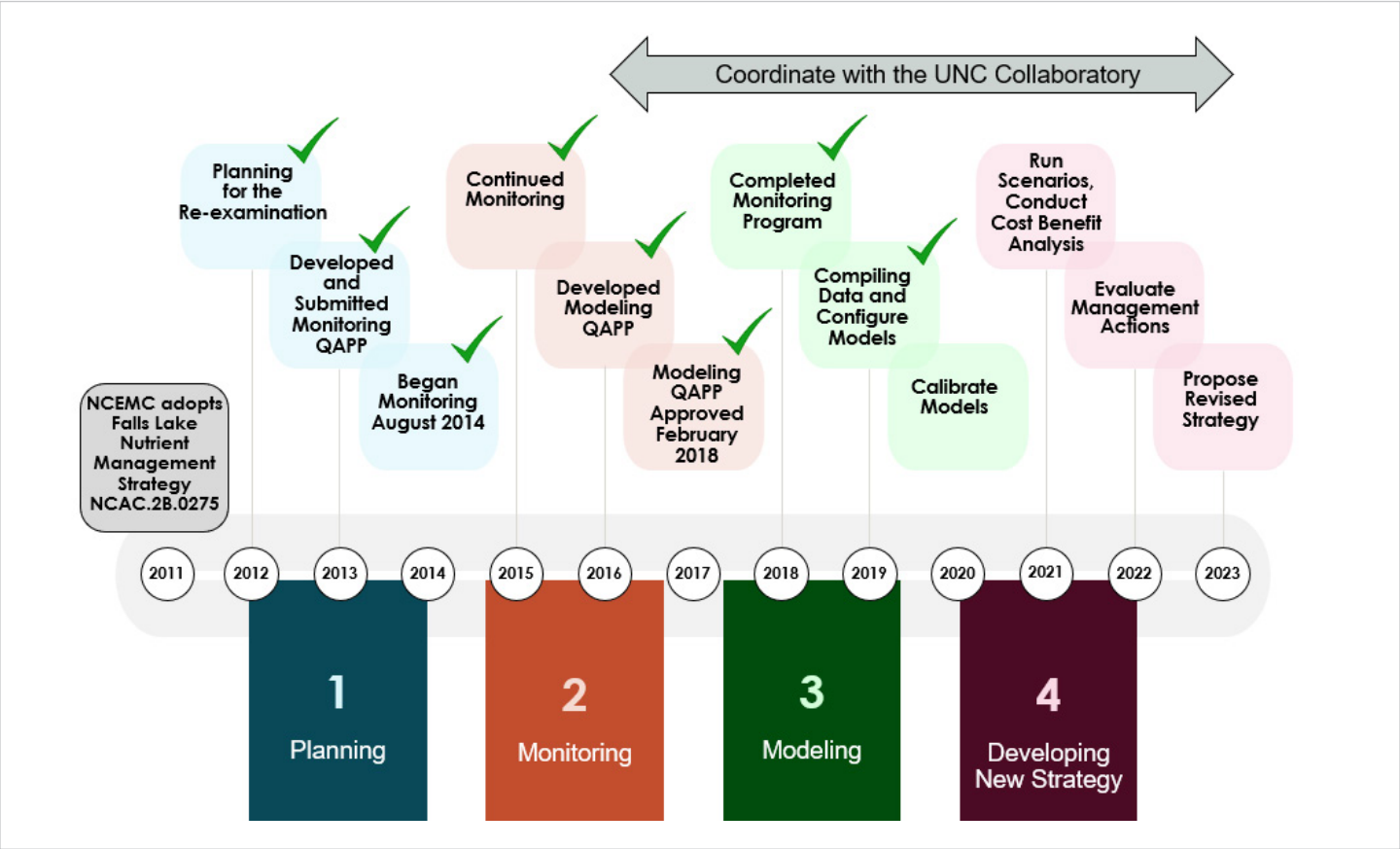

Figure 1. Schedule for the UNRBA Re-examination of Stage II Requirements