# Pre-Meeting Materials for the Fall 2018 UNRBA Stakeholder Meeting

Year Three: Anticipating Stakeholders' Uses for the Modeling Results

October 24, 2018, Butner Town Hall, 9:00 AM to 12:30 PM

The Upper Neuse River Basin Association (UNRBA) is hosting its twice-yearly stakeholder meeting for the Modeling and Regulatory Support Project. The "Year Three: Anticipating Stakeholders' Uses for the Modeling Results" meeting will be held at the Butner Town Hall from 9:00 to 12:30 on October 24th, 2018.

This pre-meeting material is being provided to the stakeholders prior to the meeting. The intent is to provide background information about the UNRBA's re-examination project. A primer for the stakeholder feedback part of the meeting is also provided, as well as sources of additional information.

Please review the materials in advance of the meeting as limited time will be available for each of the four questions posed during the feedback session. Some of these questions ask that you rank your preferences. Reviewing in advance of the meeting will provide more time to consider these questions.

**Contents of Pre-Meeting Materials:**



**Thank you for your interest and participation.**

# Re-examination Background Information

**Why is the re-examination needed?**

The Falls Lake Nutrient Management Strategy was developed by the NC Division of Water Resources (DWR). At the time, limited information was available to develop the models that were used to establish the rules. Because of the uncertainty associated with the modeling, the Falls Lake Nutrient Management Strategy allows for a re-examination of the second phase of nutrient load reduction requirements (Stage II). The Falls Lake Nutrient Management Strategy listed the requirements that any person or group must follow to perform a re-examination. The UNRBA has been working since 2012 to fulfill these requirements and produce an improved set of models and tools.

**What is a model? How are models being used to support the re-examination?**

A model is a representation of a system (like Falls Lake or the Falls Lake watershed) that uses a series of mathematical formulas to explain or predict how the system behaves. These formulas may be based on patterns and mathematical relationships within measured parameters (statistical model) or may use more complex equations to represent the actual physical, chemical and biological processes that occur in the system (mechanistic model). The UNRBA is using both types of model to support their re-examination of Stage II of the Falls Lake Nutrient Management Strategy because using multiple modeling tools is expected to yield more robust and reliable conclusions than relying on a single model.

The UNRBA is developing these models to represent two periods. The first period (2005 to 2007) is consistent with the years simulated by DWR in their modeling effort. Year 2006 was ultimately used by DWR to establish the baseline period for the Falls Lake Nutrient Management Strategy. The second period (2014 to 2018) corresponds with the data collection effort undertaken by the UNRBA.

Once the models are developed, they can be used to test management scenarios and inform decision making. This information will be used to identify cost effective solutions to maintain and improve water quality conditions in Falls Lake.

**Where is the UNRBA in the re-examination process?**

The current focus of the project is development of watershed and lake models. Over the past four years, the UNRBA has been collecting water quality observations in the lake and watershed that will support development of the models. Data from other organizations, including NC Department of Environmental Quality, has been gathered and analyzed to support this process. To develop the models, several types of data are needed in addition to these observations.

**Where can I learn more about the UNRBA re-examination?**

The UNRBA website catalogues the information obtained or evaluated to support the re-examination. Two main tabs house the information related to the Monitoring Program and the Modeling and Regulatory Support (i.e., the Re-examination). Please refer to the following links for additional information:

https://www.unrba.org/monitoring-program

- DWR-Approved documents as required by the Falls Lake Rules
    - UNRBA Monitoring Plan
    - UNRBA Monitoring Quality Assurance Project Plan
    - UNRBA Description of the Modeling Framework
- Interim and annual reports that summarize the data collected with preliminary analyses
- Link to the UNRBA Monitoring Database (open to the public) and User Documentation
- Study plans for the special studies
- Additional analyses
    - Flow estimation methods
    - Model performance and sensitivity

https://www.unrba.org/reexamination

- Data Management Plan and Description of the Modeling Process (posted recently)
- Modeling Quality Assurance Project Plan (Approved by DWR)
- Stakeholder meeting materials including presentations
    - October 2018 (focus on data compilation)
    - October 2017 (focus on watershed modeling); to download a version of this presentation with audio, please use the following link: https://www.dropbox.com/s/4tqlhyi3la3xmc8/Year%202%20Kickoff%20Presentation.mp4?dl=0
    - September 2016 (project kickoff/stakeholder concerns)
- Model selection process and evaluation criteria
- Conceptual modeling plan (how the models will be used together)
- Earlier planning phase of the project (2012 to 2014)
    - Task 1 – Re-examination strategy
    - Task 2 – Review existing data and reports (through 2011)
    - Task 3 – Review methods for estimating nutrient loads
    - Task 4 – Recommend future monitoring and modeling studies
        - UNRBA Monitoring Program
        - UNRBA Modeling and Regulatory Support Project

# Meeting Overview and Questions for Stakeholders

The first part of the Fall 2018 stakeholder meeting will review the status of the modeling work and discuss some of the types of data that have been compiled to support this effort. The modeling team will describe the sources of data and summarize the amount of data compiled. Table 1 lists the data and sources that will be discussed at the meeting. Other data sets will be described at subsequent stakeholder meetings.

The modeling team will also describe how the watershed and the lake have been divided into smaller units. The units allow the models to represent conditions in distinct parts of the lake or watershed, based on measurements, observations, or predictions of the chemical, physical and biological factors affecting nutrient loading from the watershed and water quality in the lake.

The second part of the meeting will provide the stakeholders an opportunity to share their perspective on how they will use, or want to use, the model results. This information will help the modeling team and the UNRBA's Modeling and Regulatory Support Workgroup and Path Forward Committee make informed decisions about how the models should be set up.

Decisions made early in the modeling process affect the types of information that can be generated by the models.

Our goal with this part of the meeting is to gather information before the modeling is conducted to ensure we will be able to answer key questions. The following questions will be asked during the meeting:

**Do you have any input on the data sets that were described today? (See Table 1 below - additional data sets will be covered at future stakeholder meetings.)**

- Additional sources of information?
- Input on assumptions?
- Is there anything that we should know about these data sets as we develop the models?

**Please provide information on the data sets to Alix Matos (amatos@brwncald.com) and Forrest Westall (forrest.westall@unrba.org)**

**What do you want to get out of the watershed model? Rank your top 3 items. [11 minutes]**

- Simulate nutrient concentrations and loading at specific locations (e.g., monitoring stations)
- Understand the relationship between nutrient concentrations and nutrient loads in the watershed.
- Understand how certain storm events affect concentrations and loading
  ______small storms, _______typical storms, ________large storms/hurricanes
- Understand where nutrient loading is highest
  ____by tributary, ______by jurisdiction, _____by soil type
- Understand which land uses or activities contribute to the highest nutrient loads
- Predict the effects of implementing various Best Management Practices on nutrient loading to the lake
- Understand how onsite wastewater treatment systems impact nutrient loading to Falls Lake
- Understand how adjacent wetlands affect water quality in Falls Lake
- Estimate jurisdictional loads (City, County, Utility) as total pounds per unit time
- Compare nutrient loading across jurisdictions (total pounds and pounds per acre)
- Produce nutrient, TSS, and carbon loads at an appropriate time step to provide input to the lake model. Time frame preferred:
  _____ daily, _______ four times per day or every 6 hours, _____ hourly.
- Identify areas needing further exploration because the loads are not well explained by the models.
- Understand the role atmospheric deposition plays in nutrient loads from the landscape.
- Identify unmanageable and manageable sources of nutrient loading for Falls Lake (i.e., what loading is controllable?) and rank them in terms of contribution.
- Ask "What if" questions such as ____________
- Ask "What if" questions such as ____________
- Other ______
- Other _______

**How would you prefer information from the watershed model be summarized and provided to you? [11 minutes]**

**Pick 1 for Spatial and Temporal Scales**

Spatial scale (see Figure 1 through Figure 4)

- At the jurisdictional/utility level
- At the perennial stream level
- At the UNRBA monitoring station level
- At the modeling unit level
- At the locations where streams enter Falls Lake
- Other________
- Other ________

Temporal scale

- Hourly
- Daily
- Monthly
- Seasonal
- Annual

**What do you want to get out of the lake models? (rank top 3)** **[11 minutes]**

- Quantify all of the in-lake sources of nutrients (e.g., nitrogen fixation from the atmosphere, bottom sediment nutrient releases, decomposition of detritus)
- Quantify all of the external sources of nutrients to the lake (e.g., atmospheric deposition, watershed loading)
- Understand the relationship between nutrient loading to the lake and nutrient concentration in the lake, and how each relates to chlorophyll a concentrations
- Quantify the reservoir of nutrients in the Falls Lake sediments and understand how long it will take for those stores to deplete
- Predict differences in water quality in different portions of the lake (e.g., upper lake vs lower lake, tributary arms vs. main stem)
- Predict water quality at beaches and docks
- Predict water quality at the water supply intake
- Predict water quality released to the Neuse River at the dam
- Evaluate a range of weather conditions and long-term response to management
- Understand how seasonal loading and flow patterns affect water quality in the lake
- Understand the variability in water quality from year-to-year
- Understand how rainfall patterns, residence time, and causeways affect water quality
- Understand how lake management/operations affect water quality
- Understand how watershed management affects levels of nutrients, chlorophyll, and carbon in the lake
- Ask "What if" questions such as ____________
- Ask "What if" questions such as ____________
- Other ______
- Other _______
- Other _______

**How would you prefer information from the lake model be summarized and provided to you?** **[11 minutes]**

Lake model, spatial scale (pick 1) (see Figure 2 on the next page)

- For the whole lake (1 summary unit)
- For the upper and lower lake (divided at Hwy 50) (2 summary units)
- For each DWR monitoring station (12 stations)
- For each lake arm and incremental segment (approximately 20 summary units)
- Many locations to demonstrate how much water quality varies across the lake, whilst still maintaining all of the designated uses of the lake
- Other________

Lake model, temporal scale (pick 1)

- Daily
- Monthly
- Seasonal
- Annual
- Other________

**Table 1. Summary of Data, Sources, and Assumptions to be Discussed at the October 24th Meeting; Additional Data Types to Discussed at Subsequent Meetings**

| Data Type | Primary Sources of Information | Resolution of Primary Data Source | Secondary Sources of Information | Key Assumptions or Ongoing Evaluations |
|---|---|---|---|---|
| Meteorological Data | | | | |
| Rainfall | NOAA NEXRAD radar data | Radar data covers the watershed and is available for both modeling periods at hourly increments | NC CRONOS/ ECONet Database (developed by the State Climate Office of North Carolina), USGS, NOAA NCDC, and the Western Regional Climate Center (WRCC) weather stations. | The State Climate Office through a collaboration with the NC DOT has offered to provide these data in a processed format. More information will be provided as it is available. The UNRBA would like to express their appreciation to both organizations for offering to compile and process this very large dataset. A description of the NEXRAD data is available at https://www.ncdc.noaa.gov/data-access/radar-data/nexrad. |
| Air temperature, atmospheric pressure, dew point, wind speed, cloud cover | National Land Data Assimilation System (NLDAS) | 1/8th-degree grid (approximately 60 square mile grid cells) that covers the watershed; provides hourly data for both modeling periods | NC CRONOS/ ECONet Database (developed by the State Climate Office of North Carolina), USGS, NOAA NCDC, and the Western Regional Climate Center (WRCC) weather stations. | Predicted air temperature estimates generated by the NLDAS are being compared to observations at select NOAA NCDC weather monitoring stations. The benefit of using NLDAS is that it provides better spatial coverage than the individual weather monitoring stations. The modeling team is evaluating additional weather parameters to confirm NLDAS will provide accurate inputs for the modeling. More information about NLDAS is available at https://ldas.gsfc.nasa.gov/nldas/. |
| Hydrologic data | | | | |
| Stream Flow and Water Level Data | US Geological Survey (USGS) | Approximately every 15 minutes at monitoring gages | For ungaged locations, flows may be estimated using basin proration with a map correlation modification. | The basin proration with a map correlation modification was evaluated and documented in The Comparison of Flow Estimation Methods TM. This method may be used to approximate flows at ungaged stations for interpretation of model results but will not be used directly for model calibration. |

| Data Type | Primary Sources of Information | Resolution of Primary Data Source | Secondary Sources of Information | Key Assumptions or Ongoing Evaluations |
|---|---|---|---|---|
| Water Quality Observations | | | | |
| In the watershed | UNRBA Monitoring Program (2014 – 2018)<br><br>NC DEQ and local governments (2005 – 2007) | At least monthly with more frequent sampling during high flows during the years 2014 – 2018 | NC DEQ, local governments, USGS, researchers | Most of the data collected from 2014 to 2018 in the watershed has been collected by the UNRBA. This data may be accessed by the public at the UNRBA website: https://www.unrba.org/monitoring-program<br><br>For the historic period, multiple sources of data are available. Raw data access is available through the respective organizations. A summary of this data is available on the UNRBA website in the Task 2 TM. |
| In Falls Lake | NC DEQ | Monthly with twice monthly sampling in 2005 to 2007 | UNRBA, local governments, USGS, researchers | The UNRBA analyzes some parameters in Falls Lake, and this data is housed in the UNRBA database (see row above). DEQ data are available through STORET. The UNRBA Monitoring Program Annual Reports summarize data collected in Falls Lake by multiple organizations. These reports are available at https://www.unrba.org/monitoring-program |
| Wastewater Treatment Plant Effluent Discharges | | | | |
| Major facilities (discharging more than 1 million gallons per day) | Operators | Daily to weekly measurements depending on the parameter | Not applicable | Days with missing values will be filled in using either a step function (model default) or linear interpolation following discussion with the Modeling and Regulatory Support Workgroup. |
| Minor facilities (discharging less than 1 million gallons per day) | DEQ | Daily to weekly measurements depending on the parameter | Not applicable | Days with missing values will be filled in using either a step function (model default) or linear interpolation following discussion with the Modeling and Regulatory Support Workgroup. |

| Data Type | Primary Sources of Information | Resolution of Primary Data Source | Secondary Sources of Information | Key Assumptions or Ongoing Evaluations |
|---|---|---|---|---|
| Watershed Impoundments – Water Withdrawals for Water Supply | | | | |
| Lake Butner | SGWASA (2005 to 2007 and 2014 to 2018) | Daily withdrawal rates for both modeling periods | DEQ WARMF files and OASIS modeling files for 2005 to 2007 | Primary source of daily withdrawal rates will be used to develop the model inputs. |
| Lake Michie | City of Durham (2014 to 2018)<br><br>City of Durham revised WARMF model (2005 to 2007) | Daily withdrawal rates for both modeling periods | OASIS modeling files for 2005 to 2007 | Primary source of daily withdrawal rates will be used to develop the model inputs. |
| Little River Reservoir | City of Durham (2014 to 2018)<br><br>City of Durham revised WARMF model (2005 to 2007) | Daily withdrawal rates for both modeling periods | OASIS modeling files for 2005 to 2007 | Primary source of daily withdrawal rates will be used to develop the model inputs. |
| Lake Orange | Not applicable | Not applicable | Not applicable | Water is not withdrawn from Lake Orange for water supply. Rather, releases from this lake flow to Corporation Lake and Lake Ben Johnson where OAWS and the Town of Hillsborough withdraw water. |
| Compton's Pond | Not applicable | Not applicable | Not applicable | Water is not withdrawn from Compton's Pond for water supply. |
| West Fork Eno River Reservoir | Not applicable | Not applicable | Not applicable | Water is not withdrawn from West Fork Eno River Reservoir for water supply. Rather, releases from this lake flow to Corporation Lake and Lake Ben Johnson where OAWS and the Town of Hillsborough withdraw water. |

| Data Type | Primary Sources of Information | Resolution of Primary Data Source | Secondary Sources of Information | Key Assumptions or Ongoing Evaluations |
|---|---|---|---|---|
| Lake Ben Johnson | Town of Hillsborough (2005 to 2007 and 2014 to 2018) | Daily withdrawal rates for both modeling periods | WARMF modeling files or OASIS modeling files for 2005 to 2007 | Primary source of daily withdrawal rates will be used to develop the model inputs. |
| Lake Rogers | Population based estimates (2005 to 2007)<br>No water supply withdrawals from 2014 to 2018 | Monthly estimates based on historic withdrawals (1997) and census data. | Not applicable | The 2003 Water Supply Plan for Lake Rogers includes monthly withdrawals for 1997. These values will be scaled by population to estimate monthly withdrawals for 2005, 2006, and 2007 assuming linear population growth between the 2000 and 2010 census data. Lake Rogers ceased use as a water supply in 2012 when SGWASA began to provide water to Creedmoor (Plewah and Richardson 2018). . |
| Corporation Lake | DEQ (2005 to 2017) | Daily withdrawals | OASIS (2005 to 2007) | Primary source of daily withdrawal rates will be used to develop the model inputs. Days with blank values are assumed zero (confirmed with DEQ staff that withdrawals do not occur every day from this impoundment). |
| Teer Quarry | Not available | Not applicable | Not applicable | Teer Quarry is used as a source of water supply during emergency droughts. The quarry was used over a 59-d period during the 2007 to 2008 drought, but specific dates and volumes withdrawn are not available (AECOM 2018). |
| Watershed Impoundments – Releases to Downstream Waters | | | | |
| Lake Butner (storage capacity of 6,331 ac-ft based on OASIS model files) | DEQ WARMF Stage-Release curves | Simulated | OASIS model files (2005 to 2007 time series of releases)<br><br>OASIS model may be updated by DWR to include forecasts for | Use previously developed DEQ WARMF model stage-release curves to simulate outflows. |

| Data Type | Primary Sources of Information | Resolution of Primary Data Source | Secondary Sources of Information | Key Assumptions or Ongoing Evaluations |
|---|---|---|---|---|
| | | | 2014-2018 modeling period. | |
| Lake Michie (storage capacity of 11,584 ac-ft based on OASIS model files) | Flows observed at USGS Gage 02086500 just downstream of the impoundment (2005 to 2007 and 2014 to 2018) | 15 minute | City of Durham revised WARMF model (2005 to 2007)<br><br>WARMF Stage-Release curves | Use primary sources of data to develop model input files. |
| Little River Reservoir (storage capacity of 15,164 ac-ft based on OASIS model files) | Flows observed at USGS Gage 0208524975 just downstream of the impoundment (2005 to 2007 and 2014 to 2018) | 15 minute | City of Durham revised WARMF model (2005 to 2007)<br><br>WARMF Stage-Release curves | Use primary sources of data to develop model input files. |
| Lake Orange (storage capacity of 3,560 ac-ft based on OASIS model files) | OASIS time series of releases (2005 to 2007)<br><br>Orange County time series of releases (2014 to 2017) | Daily | WARMF Stage-Release curves | Use primary sources of data to develop model input files. |
| Compton's Pond (storage capacity of 414 ac-ft based on | This pond is just upstream of Lake Orange. The release data from Lake Orange will | Outflow equals inflow | Not applicable | Rely on the release data from Lake Orange to account for the effects of Compton's Pond. Based on analysis of the OASIS modeling, simulate this pond as a river reach (inflow equals outflow). |

| Data Type | Primary Sources of Information | Resolution of Primary Data Source | Secondary Sources of Information | Key Assumptions or Ongoing Evaluations |
|---|---|---|---|---|
| OASIS model files) | account for storage in this pond. OASIS modeling indicates inflows closely match outflows for this pond. | | | |
| West Fork Eno River (storage capacity of 2,821 ac-ft based on OASIS model files) | Town of Hillsborough (2005 to 2007 and 2014 to 2018) | Daily | WARMF Stage-Release curves | Use primary sources of data to develop model input files. |
| Lake Ben Johnson (storage capacity of 150 ac-ft based on OASIS model files) | Simulate as a river reach based on analysis of OASIS model output (inflow closely matches outflow) | Outflow equals inflow | OASIS time series of releases (2005 to 2007)<br><br>OASIS model may be updated by DWR to include forecasts for 2014-2018 modeling period. | This lake is a run-of-river impoundment with a low head dam. OASIS model output indicates that outflow is similar to inflow for this impoundment. |
| Lake Rogers (storage capacity of 661 ac-ft based on OASIS model files) | Simulate as a river reach based on analysis of OASIS model output (inflow closely matches outflow) | Outflow equals inflow | OASIS time series of releases (2005 to 2007)<br><br>OASIS model may be updated by DWR to include forecasts for 2014-2018 modeling period. | OASIS model output indicates that outflow is similar to inflow for this impoundment. |

| Data Type | Primary Sources of Information | Resolution of Primary Data Source | Secondary Sources of Information | Key Assumptions or Ongoing Evaluations |
|---|---|---|---|---|
| Corporation Lake (storage capacity of 645 ac-ft based on OASIS model files) | Simulate as a river reach based on analysis of OASIS model output (inflow closely matches outflow) | Outflow equals inflow | OASIS time series of releases (2005 to 2007)<br><br>OASIS model may be updated by DWR to include forecasts for 2014-2018 modeling period. | This lake is a run-of-river impoundment with a low head dam. OASIS model output indicates that outflow is similar to inflow for this impoundment. |
| Teer Quarry (storage 7,530 ac-ft based on OASIS model files) | Does not release water downstream; provides offline emergency storage | Not applicable | Not applicable | Teer Quarry is used to store emergency water supply water but does not discharge to downstream waters. |

References to Table 1 that do not have hyperlinks:

AECOM. 2018. Eno River WARMF Update and Calibration. May 2018. Eno River Watershed Improvement Plan, Durham, North Carolina. Prepared for the City of Durham, Stormwater and GIS Services Division Public Works Department.

Plewa, M.J. and S.D. Richardson. 2018. Analysis of Elevated Health Risks for South Granville Water and Sewer Authority System and Potential Association with Drinking Water Disinfection By-Products.

The Wooten Company. 2003. Lake Rogers Lake Management Plan Revised September 2003.

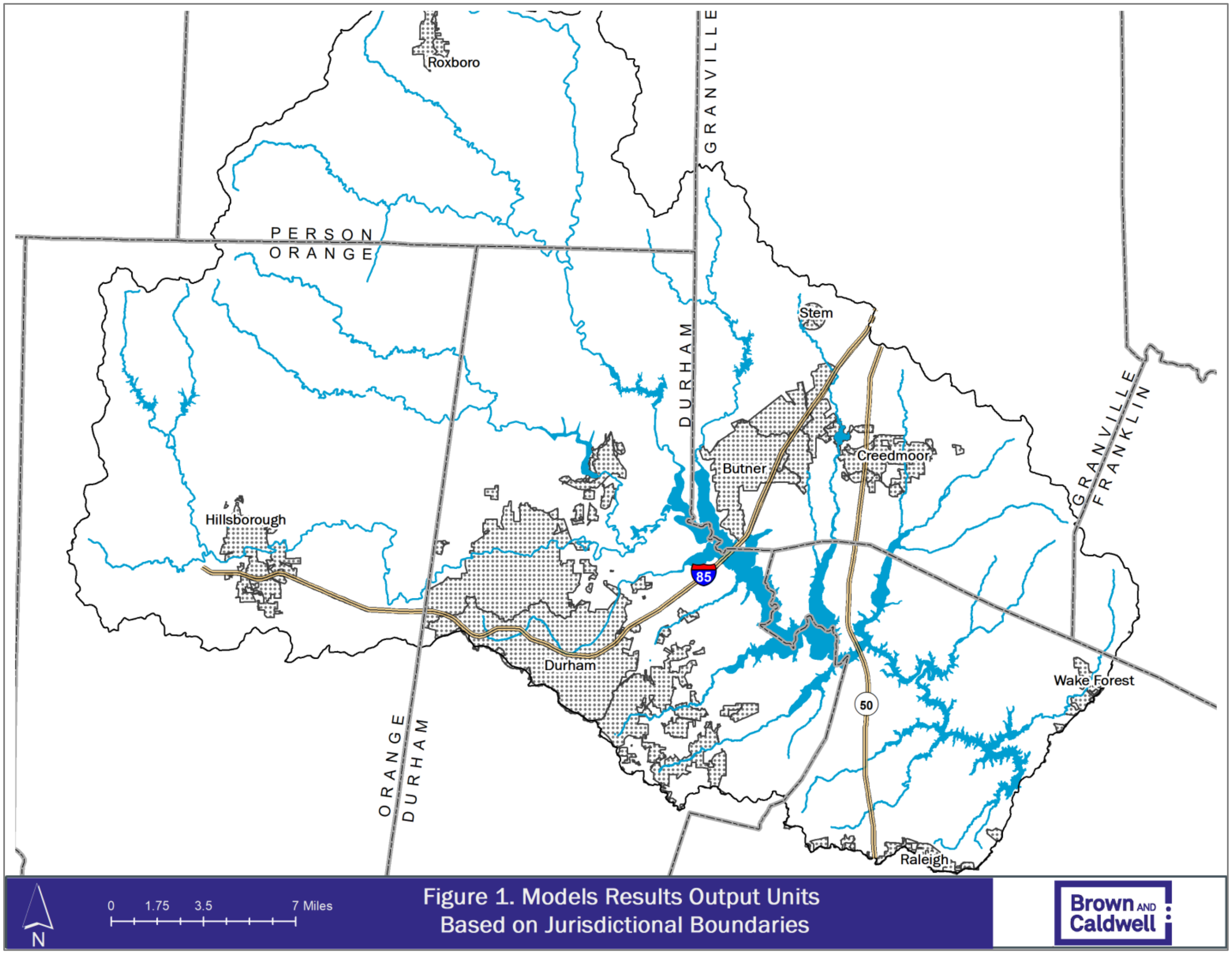


Figure 1. Models Results Output Units Based on Jurisdictional Boundaries

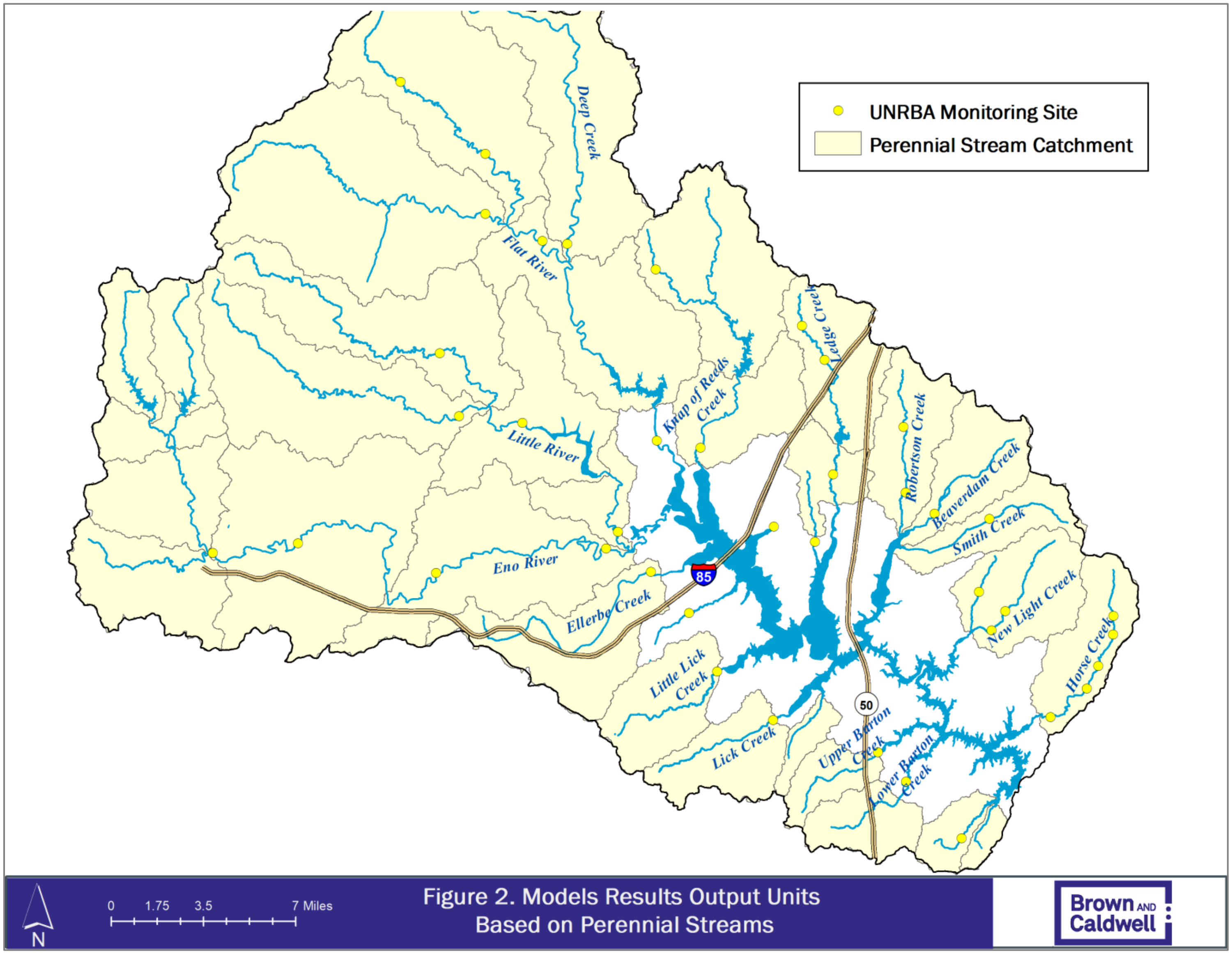


Figure 2. Models Results Output Units Based on Perennial Streams

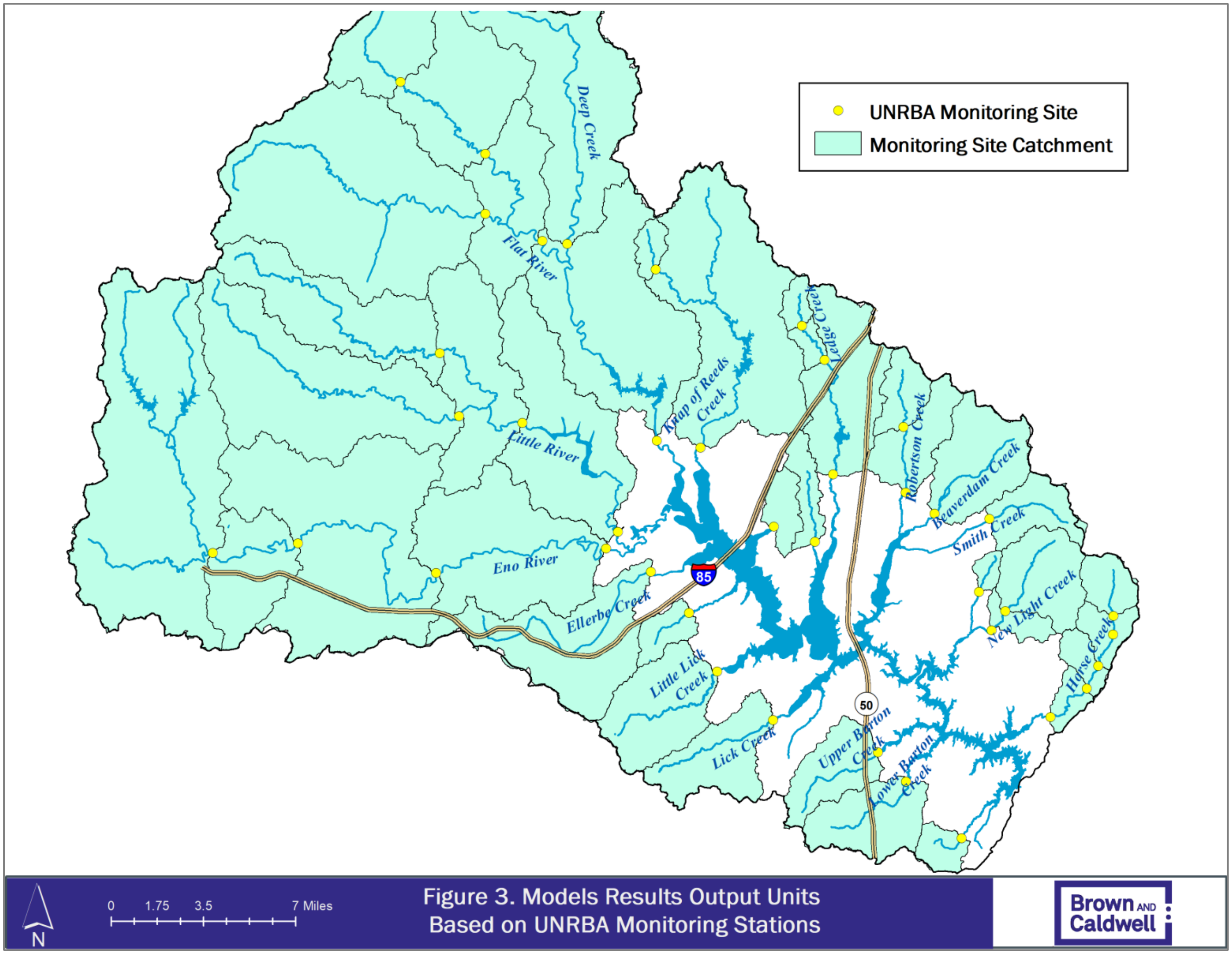


Figure 3. Models Results Output Units Based on UNRBA Monitoring Stations

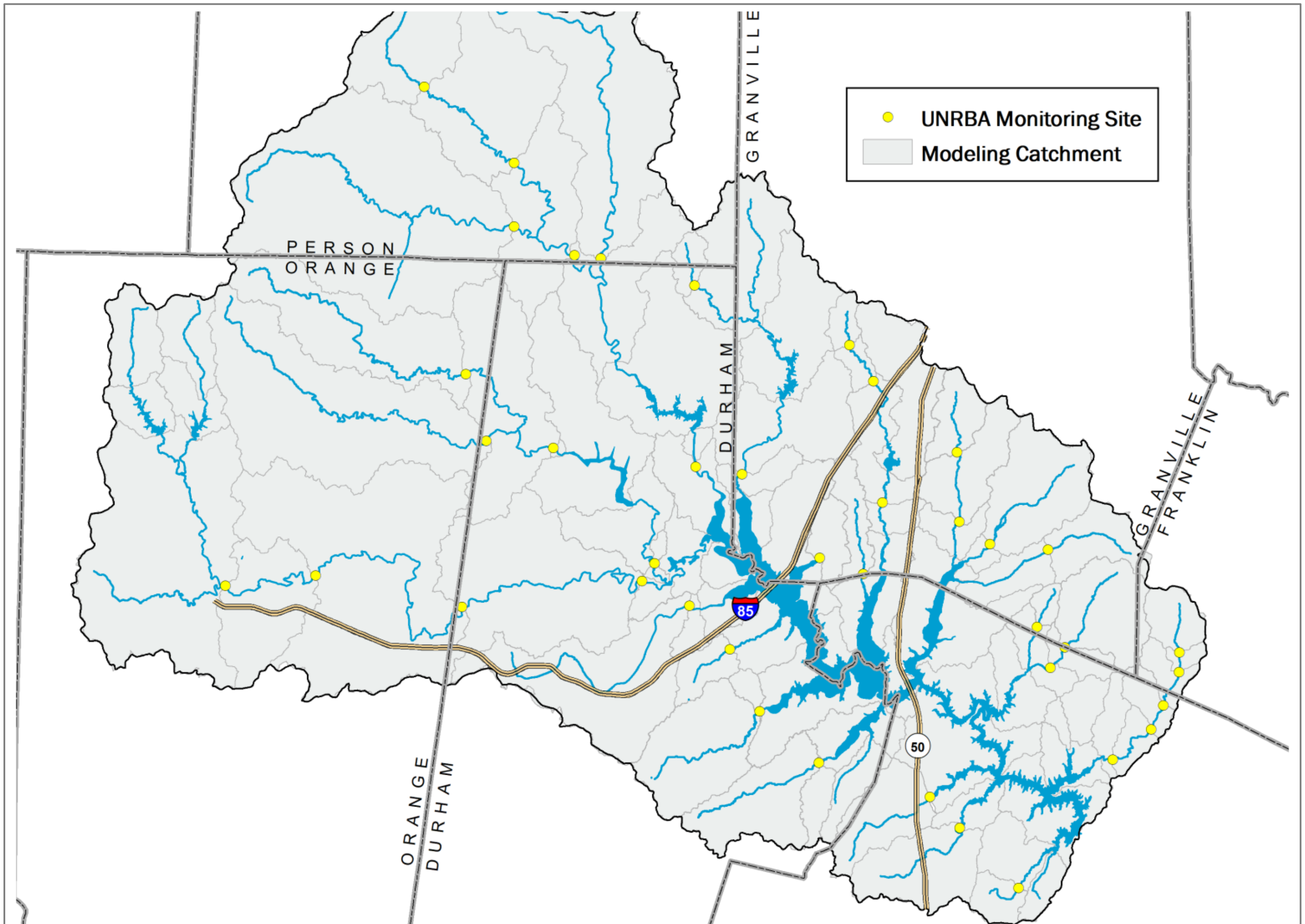


Figure 4. Models Results Output Units Based on Watershed Modeling Units

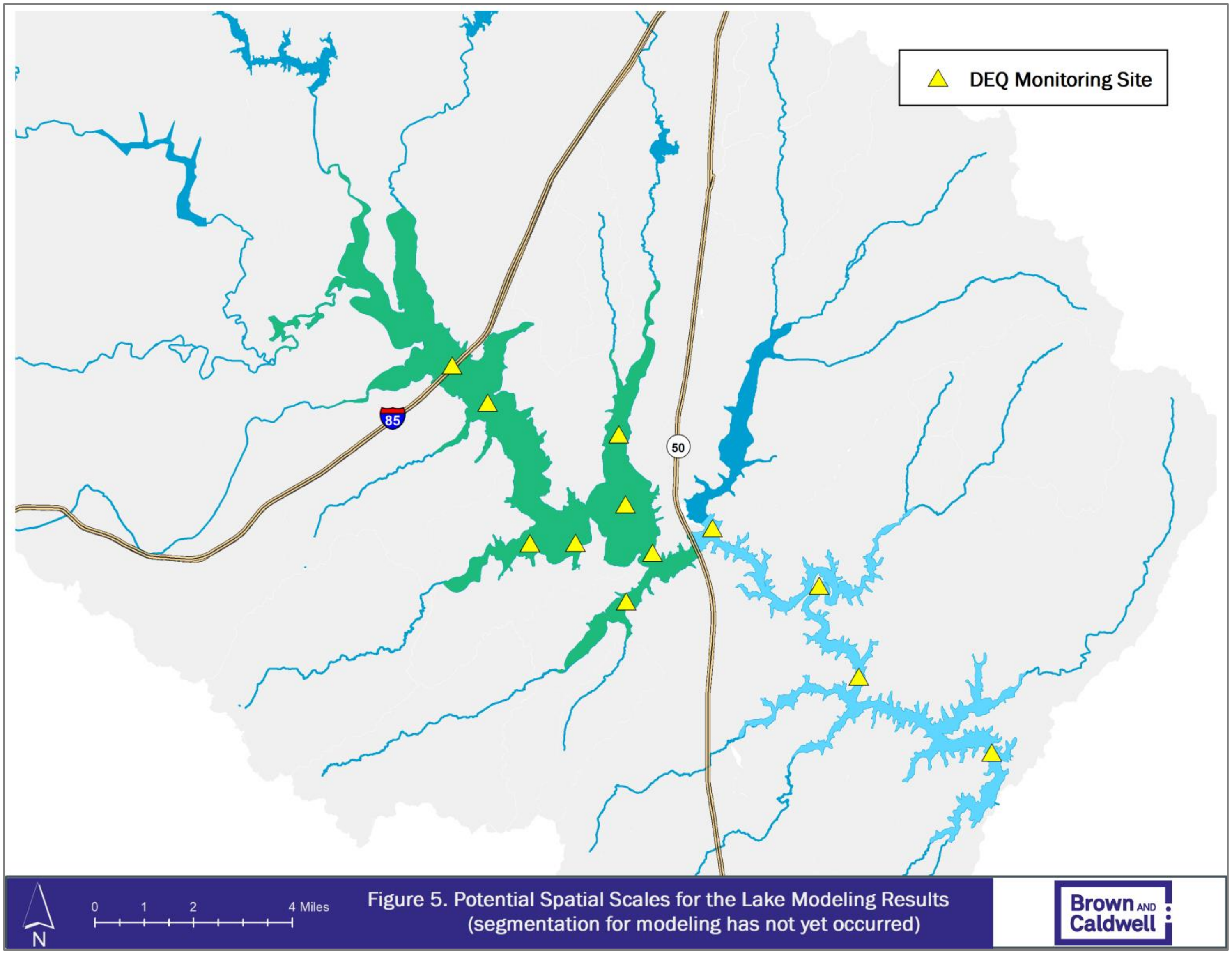


Figure 5. Potential Spatial Scales for the Lake Modeling Results
(segmentation for modeling has not yet occurred)