May 2, 2019

Ms. Pam Behm
Chief, Water Planning Section
Division of Water Resources
N.C. Dept. of Environment and Natural Resources
1611 Mail Service Center
Raleigh, North Carolina 27699-1611

RE: Proposal to Develop Hydrologic Models
of the Yadkin and Lumber River Basins

Dear Ms. Behm:

This letter constitutes a proposal to the North Carolina Department of Environment and Natural Resources to develop applications for the referenced basins using HydroLogics' OASIS water resources modeling software. Similar applications have been developed for the major river basins of the state, including the Cape Fear and Neuse.

This proposal consists of the following parts, each of which is covered in more detail in the attachments.

1. Hydrologic Models. The models will be developed by HydroLogics and are described in more detail in Exhibit 1. They will run on a daily time step and have all the features and functionality of the other OASIS river basin models, including the capability to generate and use statistical hydrologic forecasts for drought management purposes.

2. Impairment Data. A subcontractor to HydroLogics will develop historical municipal, industrial, and agricultural demand and discharge data for the period of record (1930 through 2019). These data will be used by HydroLogics to develop a data set of daily historic, unregulated inflows at selected points in the system for the same period of record. With these inflows, the user can simulate the operation of the basin for any set of actual or proposed facilities, demands, and operating policies.

HydroLogics would be pleased to undertake this work for a firm, fixed fee of $340,000, allocated as follows:

Hydrologic Models	$210,000
Impairment Data (Subcontractor)	$130,000

I will serve as the principal-in-charge for the project. I will be assisted in the development of the applications by my colleague Casey Caldwell, who has been involved in previous modeling efforts for the state. Our resumes and additional information about HydroLogics are available on our website at www.hydrologics.net.

This offer will remain firm for acceptance through September 30, 2019. If accepted, the proposed work can be accomplished within nine months of the notice to proceed. I look forward to hearing from you regarding this proposal. Should you have questions, you may direct them to me at (919) 260-1457 or via email at snebiker@hydrologics.net.

Sincerely yours,
HydroLogics, Inc.

Steven Nebiker, P.E.
Vice President

encl.

Exhibit 1

HydroLogics' SCOPE OF WORK

HydroLogics will be responsible for developing an OASIS application of the Yadkin and Lumber River Basins. HydroLogics will also coordinate with the project partners, organize project meetings, assist in data collection, and maintain overall responsibility to deliver the project in accordance with schedule and cost.

TASK 1: Develop inflow data from 1930 to September 2019

- Unimpair daily streamflow data. This will require collecting data on reservoir operations, water withdrawals and discharges, evaporation, precipitation, and streamflows. A subcontractor will provide data on withdrawals and discharges as a time series for historical adjustments to streamflows. Data will be collected for up to 30 irrigation withdrawals, 30 municipal withdrawals, 30 industrial withdrawals, 10 reservoirs, and 30 streamflow gages. Wastewater discharges will be mostly linked to water withdrawals, but provision will be made for up to 25 discharge-only nodes not associated with water withdrawals.
- Use a statistical hydrology program called *Fillin* to complete missing flow records for up to 30 gages. The inflow development process will ensure that flows match the unimpaired gage flow on a monthly basis.
- Provide DSS script files to simplify future updates of the inflow data set.

  Schedule: A draft of the inflow data set will be completed no later than four months following the Notice to Proceed (NtP), or one month after receiving the demand and discharge data being assembled by the subcontractor. In coordination with the project's Technical Advisory Committee, verification efforts will be undertaken in months four and five, leading to a final inflow data set no later than five months following the NtP.

TASK 2: Build an OASIS application of the Yadkin and Lumber River Basins with the following features:

- A clickable, map-based schematic with up to 125 nodes representing reservoirs, withdrawals, discharges, stream gages, and other inflow locations. The map will be provided electronically by DWR. The geographic reach of the model will extend from the headwaters of the Yadkin down to the Pee Dee at Rockingham gage and the headwaters of the Lumber River down to the border with South Carolina.
- Monthly patterns for all withdrawal and discharge nodes (with data provided by the subcontractor).
- Up to 50 inflow nodes including long-term USGS gages.
- Time of travel equations for flow routing provided by DWR.

- Operating rules for reservoirs (minimum releases, power generation, flood control), system interconnections, interbasin transfers, and drought management protocols.
- Position analysis mode for real-time reservoir operations. An inflow update table will be offered from the model interface to enable the user to quickly update the inflows for conducting real-time runs.
- Model run that includes a basecase representing existing conditions. DWR will be responsible for modifying this run to look at future conditions. The future conditions runs will consist primarily of increased demand levels consistent with DWR's 50-year basin planning studies, and as such, will rely on data supplied by DWR.
- A customized model interface containing many of the components found in the other DWR OASIS models, including an irrigation withdrawal update table, automated safe yield analysis, uniform demand multiplier, and drought plan activation switch.
- Output options including xQy statistics such as 7Q10.

  Schedule: The model will be completed within four months of the NtP so that it can be used in the verification effort outlined in Task 1. Completion of the basecase scenario is dependent upon having an agreed-upon inflow data set and will be provided no later than month six following the NtP.

TASK 3: Organize and conduct meetings (one day each)

- One kickoff meeting to present project methodology for review and comment, including schematic and inflow development.
- One meeting for showing and reviewing system data and operating rules and to show preliminary model results, including inflow verification.
- One meeting for showing finalized model results (basecase simulation and position analysis runs).

  Schedule: The project kickoff meeting will be scheduled within 30 days of the NtP or as soon as the participants' schedules permit. The meeting for reviewing system data and preliminary model results will occur in month four. Finalized model results will be shown no later than month seven.

TASK 4: Deliverables (electronic)

- Written documentation of inflow development methodology, with companion data files.
- A user manual of the OASIS model.
- A user manual containing specifics of the Yadkin/Lumber OASIS application.

  Schedule: Drafts of all deliverables will be submitted no later than 6 months following the Notice to Proceed. Final deliverables will be provided no later than

7 months from the Notice to Proceed and at least one month prior to the training detailed in Task 5.

TASK 5: Training and Installation

- A 2-day training session for users of the Yadkin/Lumber River Basin model.
- Installation of the model on the DWR server to include user accounts and access privileges.

Training will be provided for up to 20 people working two per computer at a location of DWR's choosing. DWR will be responsible for providing the facility and the ten desktop or laptop computers. HydroLogics will require access to the facility and computers the day prior to the training to load the model and ancillary software onto the computers and verify proper operation.

Schedule: The training will be conducted no later than 8 months following the NtP.