

Hazen



**Kickoff Meeting –
Yadkin-Pee Dee/Lumber
River Basin Hydrologic Model**

March 4, 2020

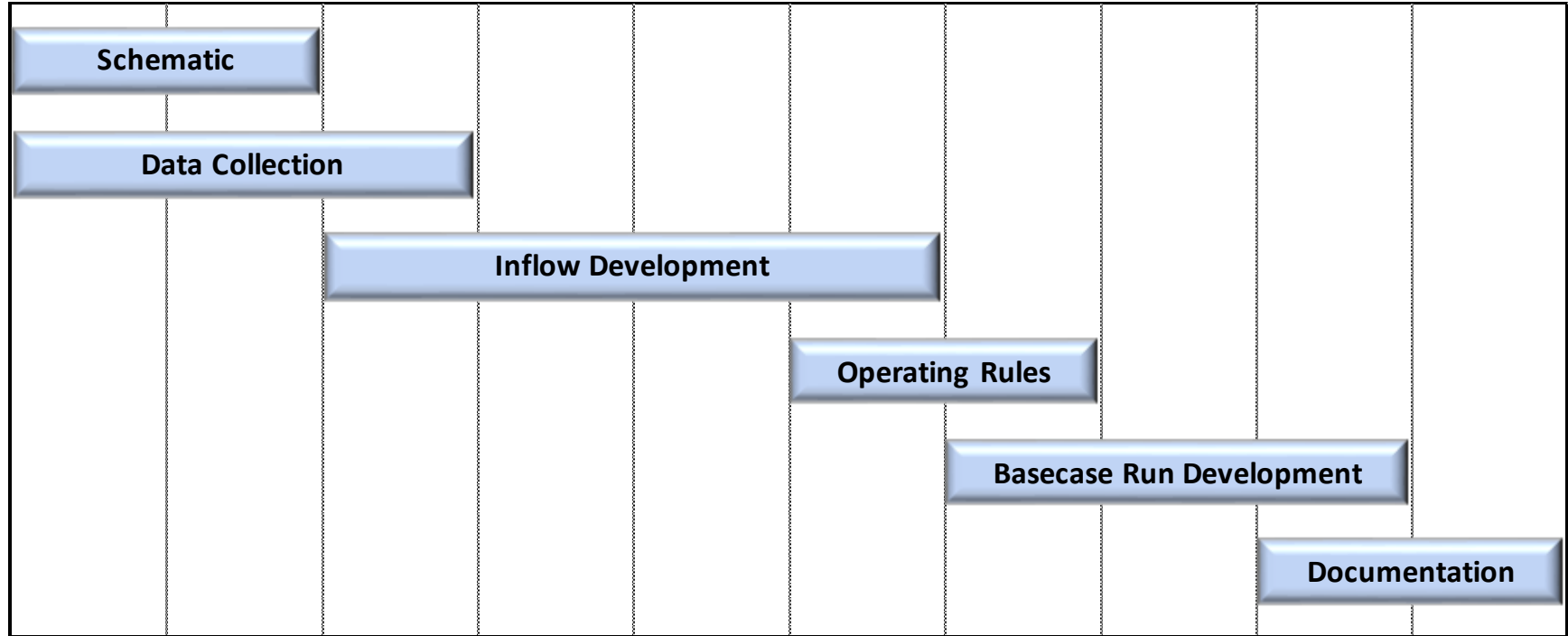
Concept of Basin Hydrologic Model

- River basin model at the finest practical geographic resolution and timestep
 - Nodes for: reservoirs, withdrawals, discharges, USGS gages, minimum instream flows, and other points important to DWR/stakeholders
 - Daily timestep
- Possible Uses
 - Evaluation of the cumulative effects of municipal water supply plans
 - Evaluation of inter-basin transfer permit applications
 - Development of individual water supply plans
 - *Model will be on the DWR server and available to stakeholders and their consultants*
 - A platform for developing risk-based drought plans

Modeling Process

- Develop schematic
- Collect impairment and operating data
- Generate inflows
- Develop performance measures
- Develop “basecase” scenario of current basin conditions
- Provide documentation, set up stakeholder accounts, and train users on model (OASIS)
 - Stakeholder access promotes use of model

Project Timeline



March

April

May

June

July

August

September

October

November

December

Meetings



Kickoff



*Data/Inflow
Review*



*Basecase
Review*



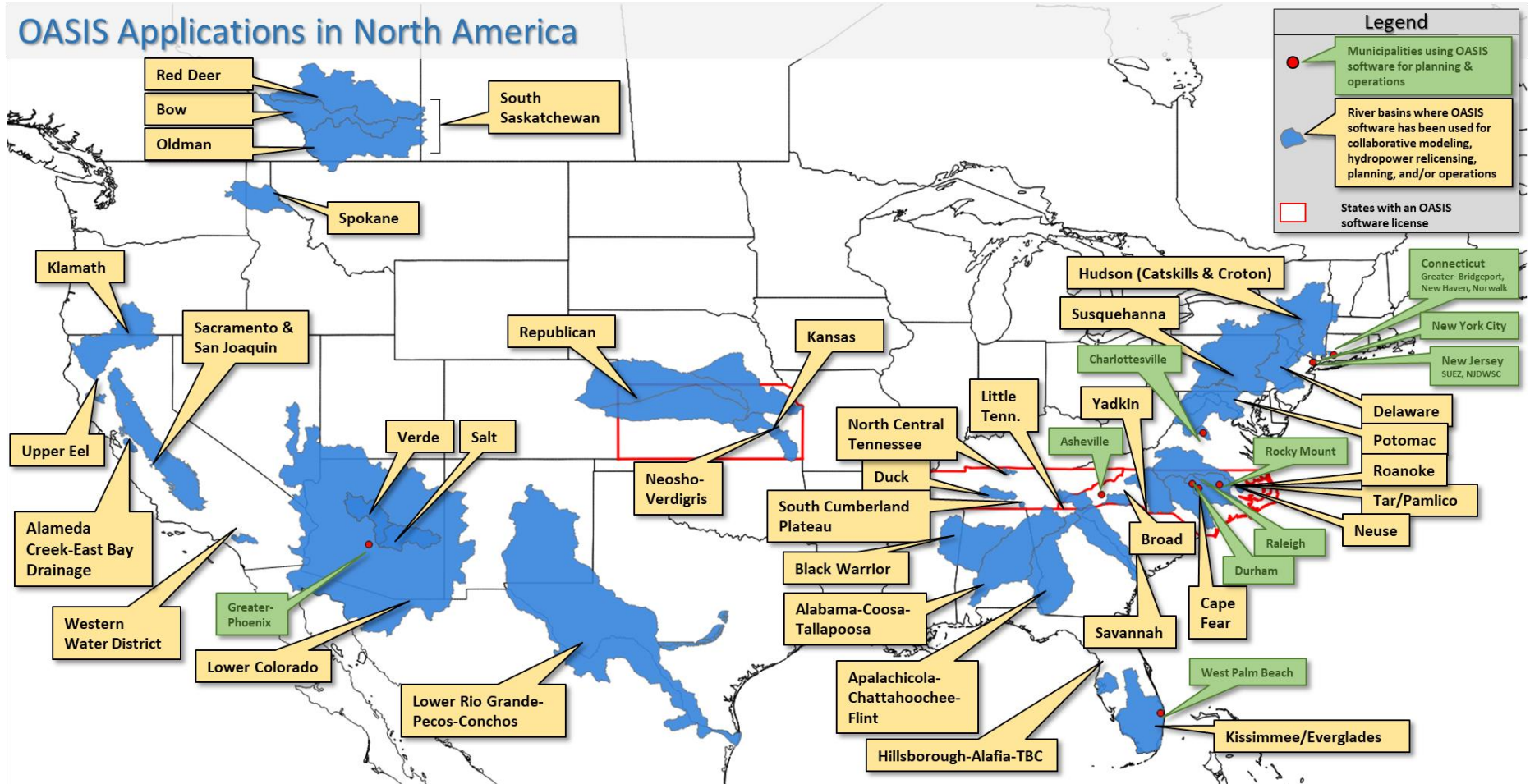
Training

What is OASIS?

Operational Analysis and Simulation of Integrated Systems

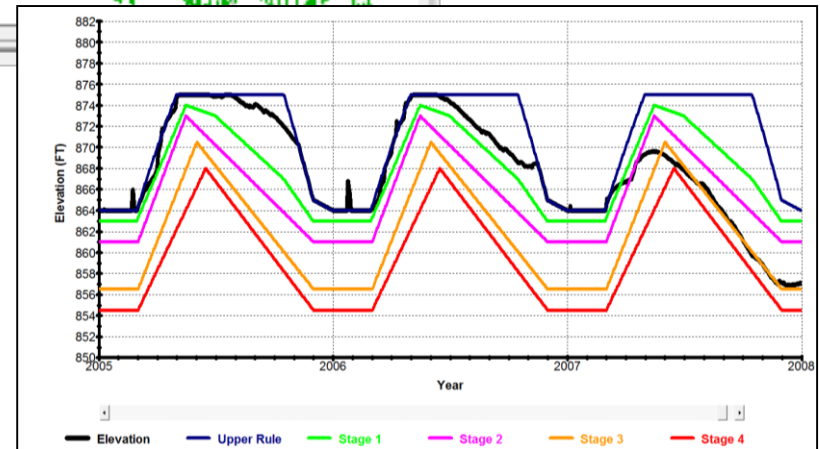
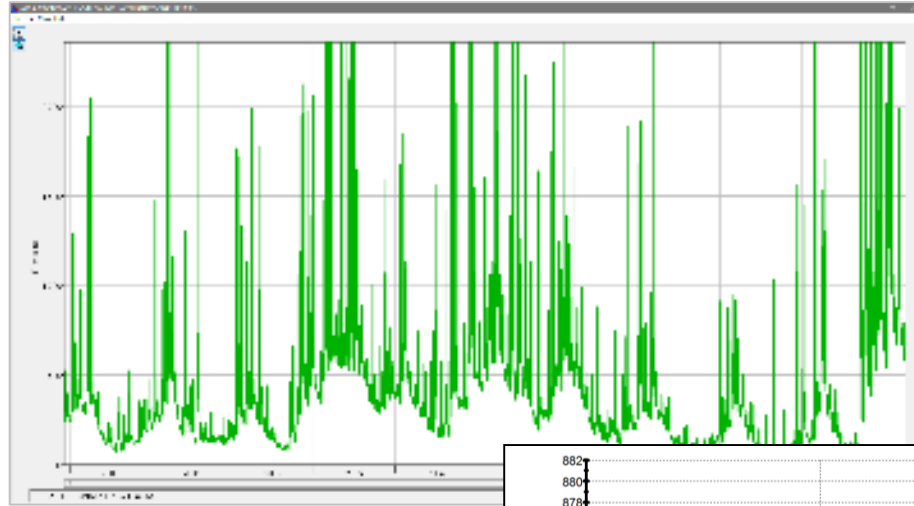
- A patented, mass balance, water resources simulation/optimization model
- Purposes:
 - Alternatives evaluation (planning)
 - Real-time operations
- Used in:
 - Water allocation/conflict resolution (drought management)
 - Water supply planning and operations

Modeling Experience



Model Input

- Time series data
 - Unregulated inflows
 - Evaporation
 - Precipitation
- Static data
 - Physical data
 - Reservoir SAE, turbine characteristics, channel capacities, etc.
 - Withdrawals, discharges, demands
- Operating Data, e.g.
 - Rule curves
 - Minimum releases/environmental flows
 - Drought and flood management policies

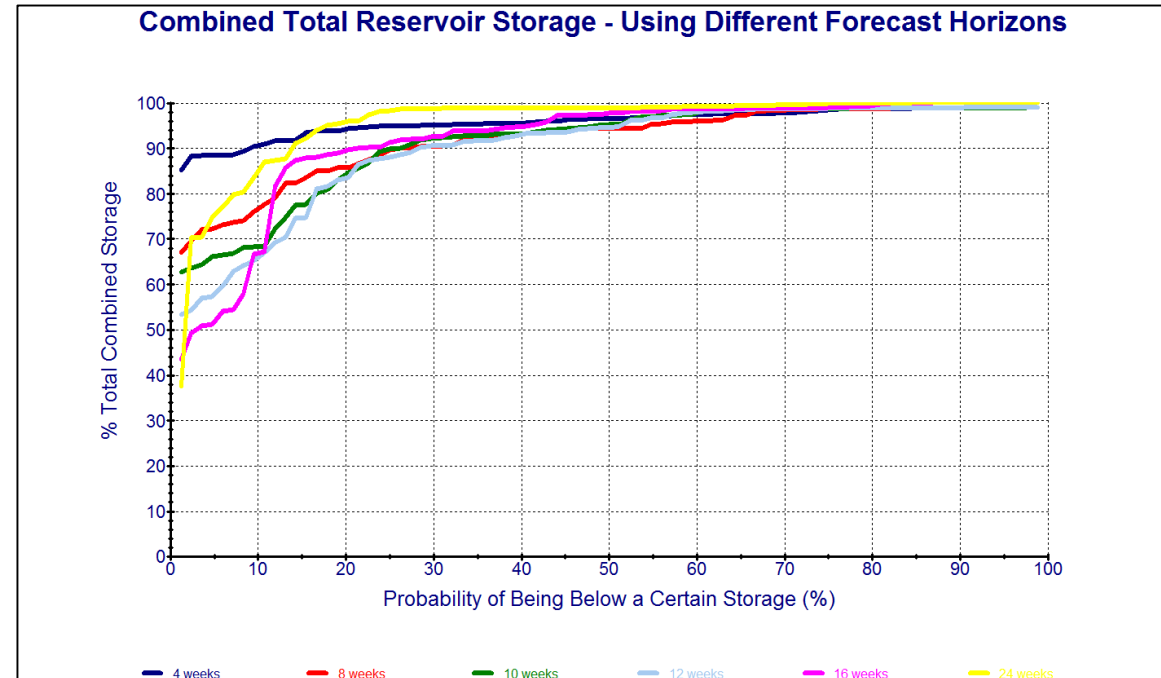


Model Output

- Tables and graphs of
 - Flow
 - Storage, and
 - *Derived attributes*, e.g. habitat availability, energy, revenue, water supply shortages, recreation days, etc.

for every time step

at every point in the system



Examples

- Yadkin – Pee Dee
 - Alcoa (APGI) relicensing
 - Coordinated with Progress Energy and DTA (CHEOPS)
- Broad
 - Coordinated with Duke Energy and HDR (CHEOPS)
- Roanoke
 - Dominion Energy
 - Corps of Engineers
 - American Electric Power

Examples: New York City

NYC DEPARTMENT OF ENVIRONMENTAL PROTECTION Operations Support Tool

Hazen and Sawyer led development of the Operations Support Tool (OST) to help NYCDEP meet the challenges of operating its 19-reservoir water supply system. OST is a data and modeling system that integrates near-real time data and ensemble inflow forecasts with reservoir operating rules and simulation modeling. NYCDEP uses OST to guide reservoir system operations decisions that reliably deliver 1.1 billion gallons of high quality water daily to over 9 million people.

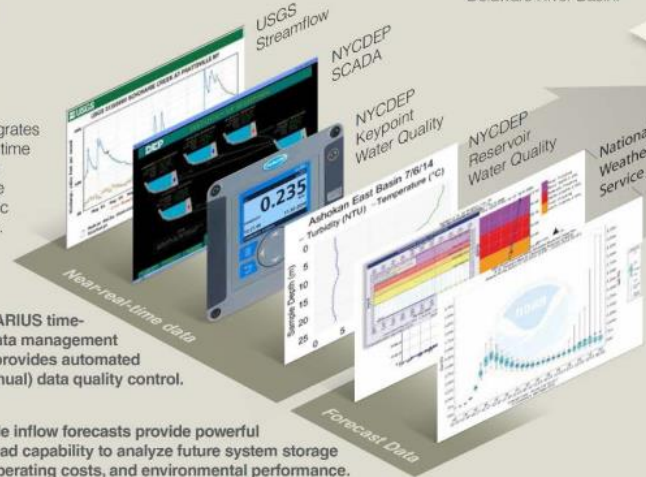
How it works

1 Data feeds

OST integrates near-real time data and ensemble hydrologic forecasts.

An AQUARIUS time-series data management system provides automated (and manual) data quality control.

Ensemble inflow forecasts provide powerful look-ahead capability to analyze future system storage levels, operating costs, and environmental performance.



2 Operations Model

The core of OST is an OASIS model of New York City's water supply system and the Delaware River Basin.

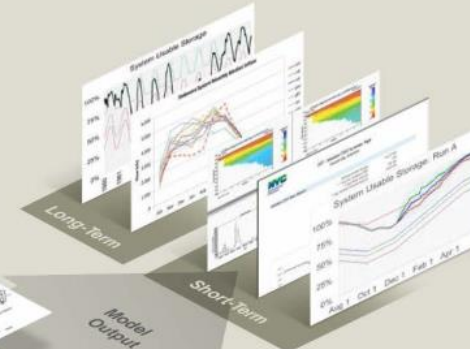


OASIS is dynamically linked to CE-QUAL-W2 models of key reservoirs to capture the impact of water quality on system operations.

The OASIS-W2 model simulates daily reservoir operations and water quality. Operators run what-if scenarios to select operations that best meet reliability, quality, environmental, and cost objectives.

3 Planning, Operations Support

Create short-term ensemble simulations for operational guidance, or long-term runs for capital planning, rule testing, and climate change assessment.



At the helm

Multiple users can access the system concurrently to review data inputs, create simulations, and analyze results through a user-friendly interface and interactive dashboard.



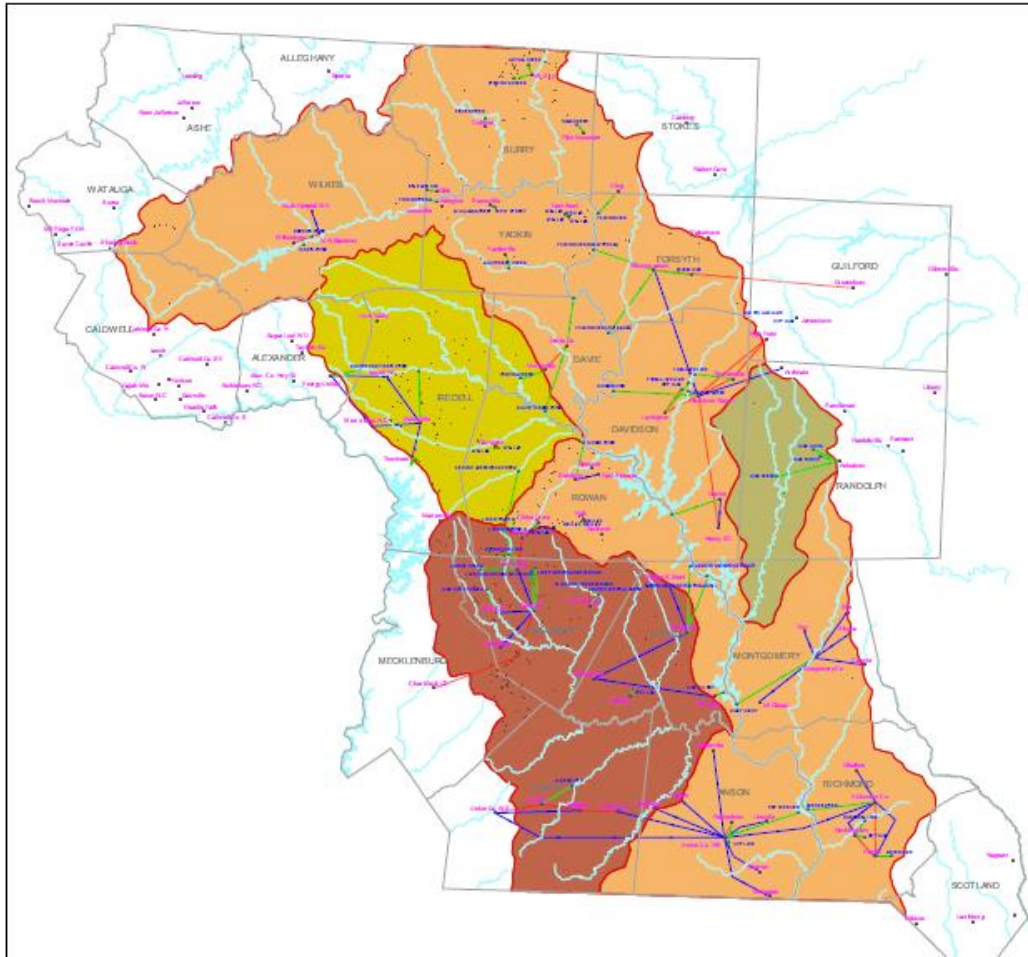
Demonstration of OASIS (Using Classic)

Data Collection

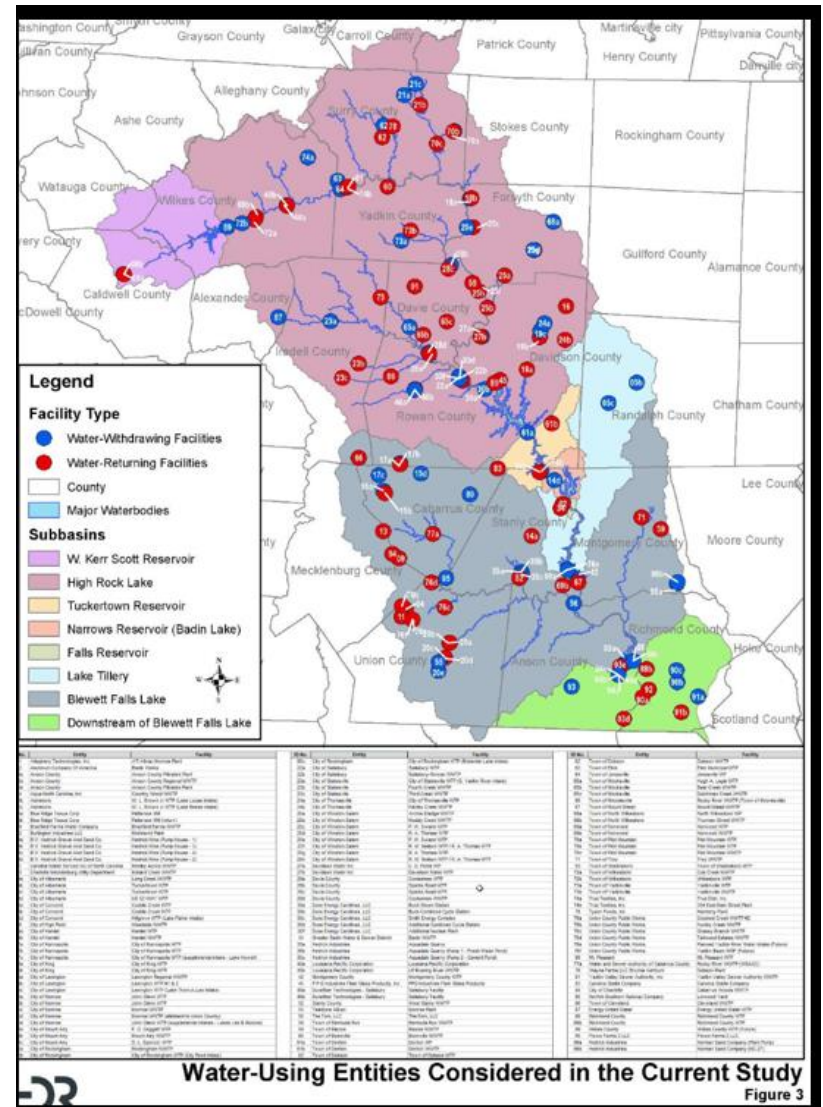
- Use to develop daily inflow record extending from 1930 to 2019
- Geographic scope from headwaters to state line (or the nearest gage)

Water withdrawal and wastewater returns

- Water withdrawals for municipal and industrial (over 100,000 gpd)
 - DWR databases for Water Withdrawals and Transfers and Local Water Supply Plans
 - Water withdrawals are net of any groundwater use
 - Contact facilities for additional data
- Wastewater returns for municipal and industrial (over 100,000 gpd)
 - Include those users that rely on groundwater for water supply
 - NPDES databases
 - Contact facilities for additional data
- Agricultural use: surface water irrigation based on acreage, net of rainfall, and livestock counts, both net of groundwater use
 - Ag extension agencies; USGS and others
- Extrapolate back in time (factoring in facility starts)
 - Based on population, economic, and power generation data (municipal and industrial)
 - Based on historic acreage, livestock, and climate (agricultural)
- Coordinate with YRBWVG in terms of data collected



Lumber not included yet



Water-Using Entities Considered in the Current Study

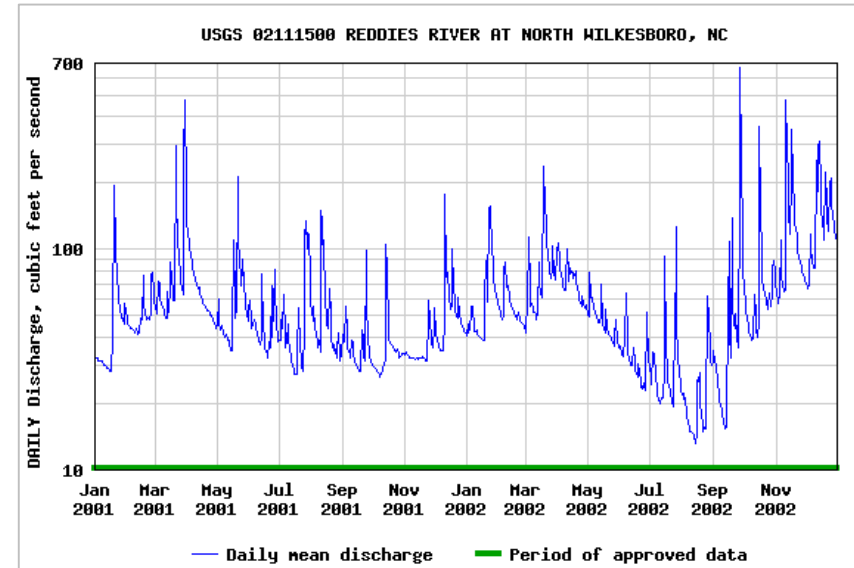
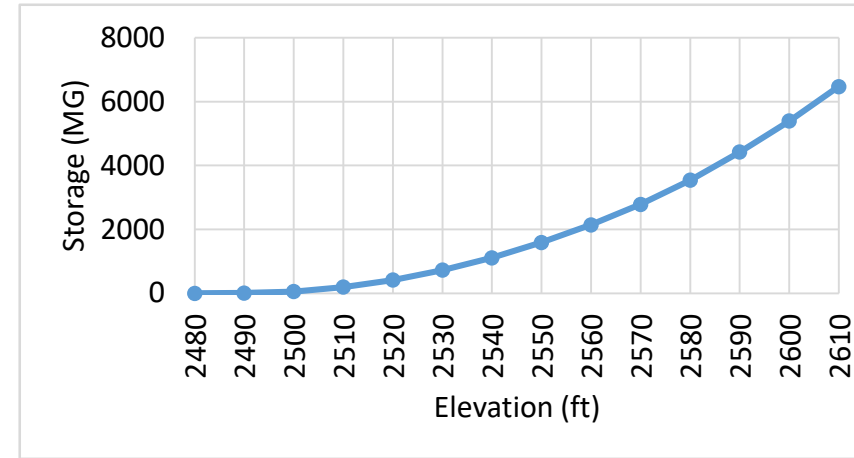
Figure 3

Operating Protocols

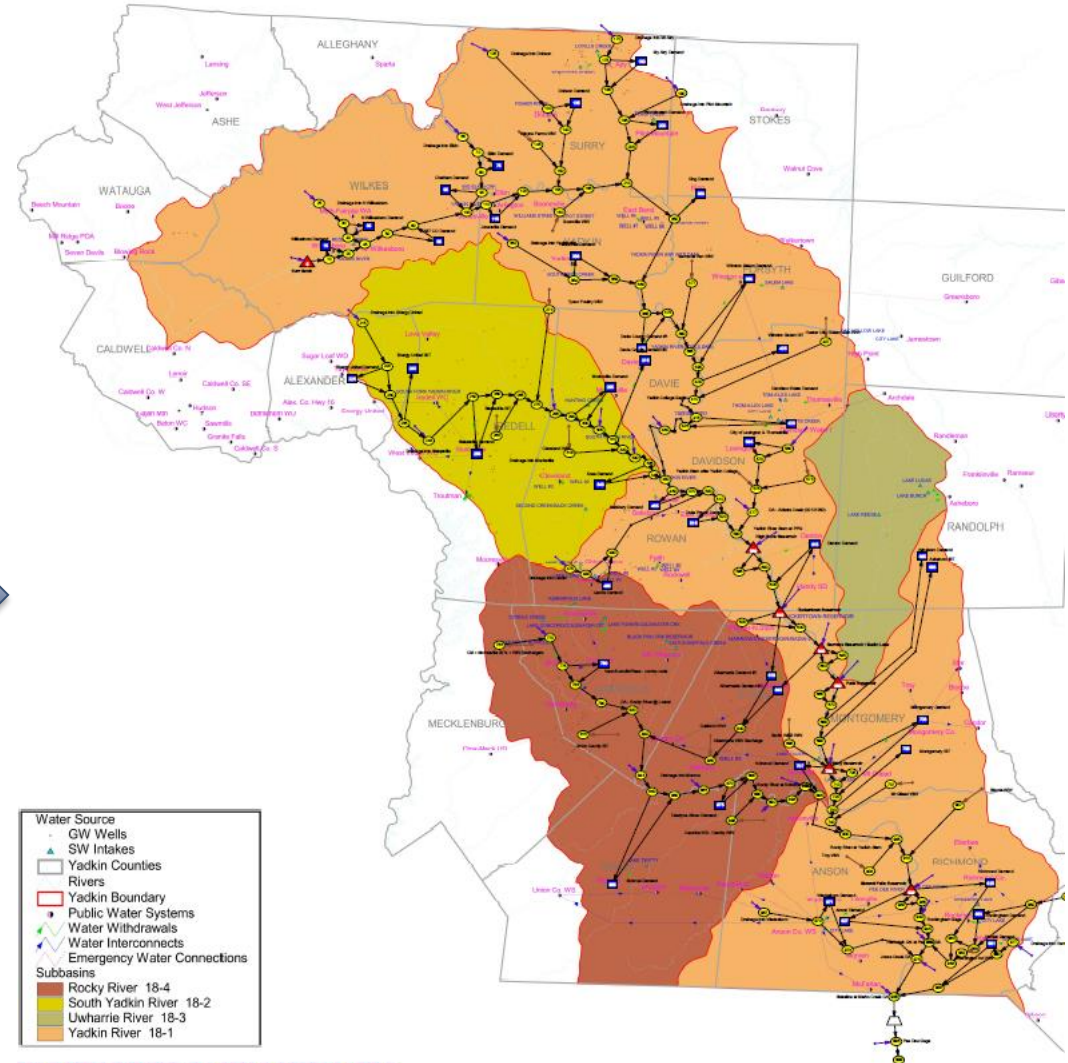
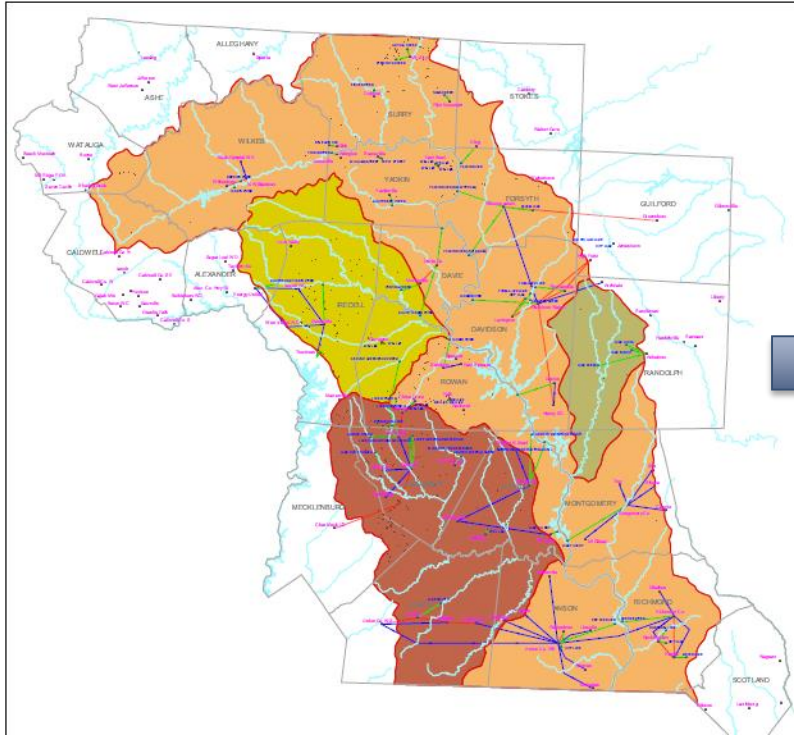
- FERC license agreements, including minimum releases and drought response plans
 - **Coordinate with HDR on hydropower operations in CHEOPS model**
- Utility drought plans (Water Shortage Response Plans)
- Facility operations, including hydro facilities (e.g., rule curves)
- Annual average and monthly patterns for municipal and industrial demands and discharges
- Additional system information from Local Water Supply Plans

Other

- “Static”
 - Storage, area, elevation curves for reservoirs
 - Maximum pumping and treatment capacity
 - Turbine curves
- Timeseries
 - Precipitation and evaporation
 - Gaging data
 - Historic reservoir storage/elevation and outflows



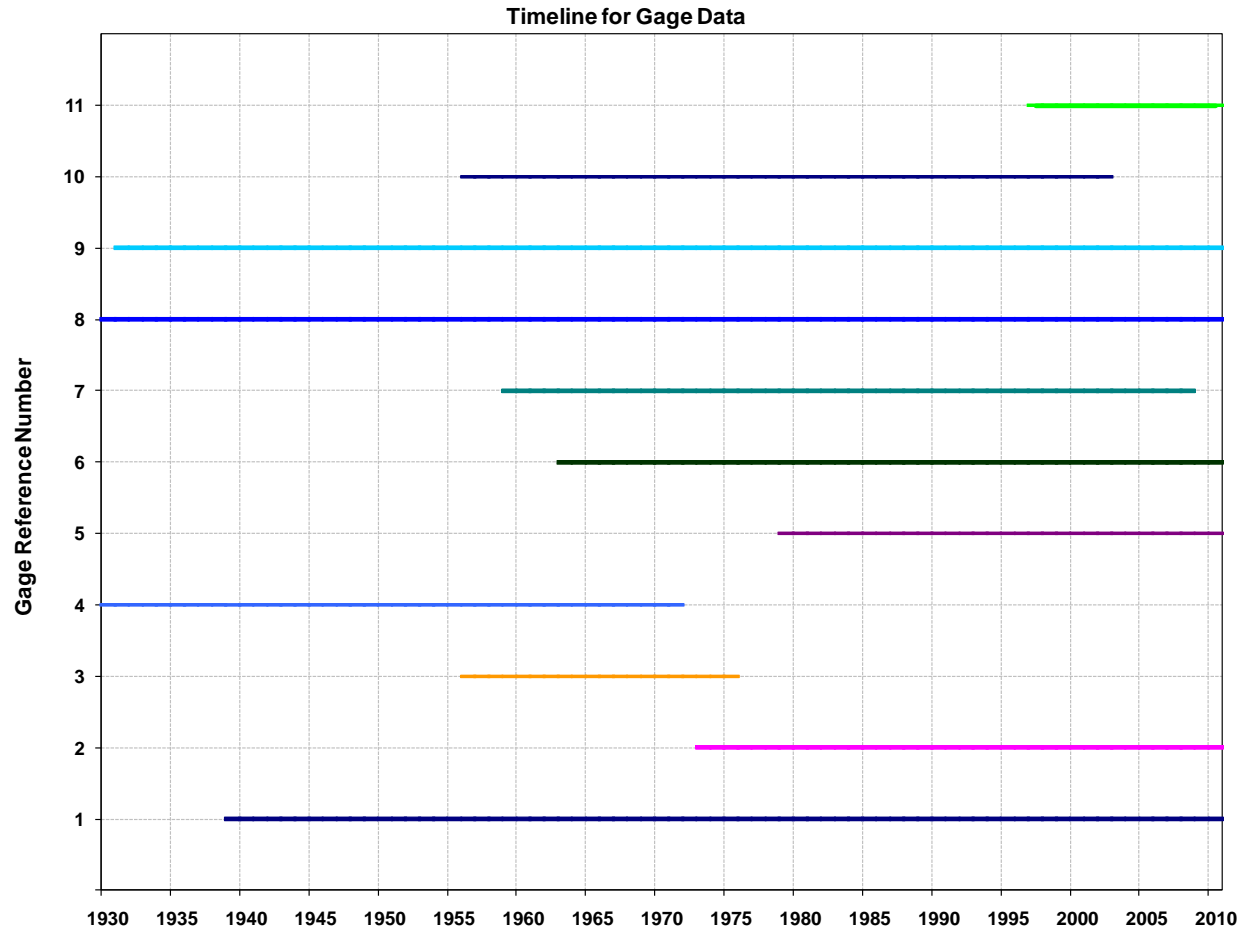
Schematic Development



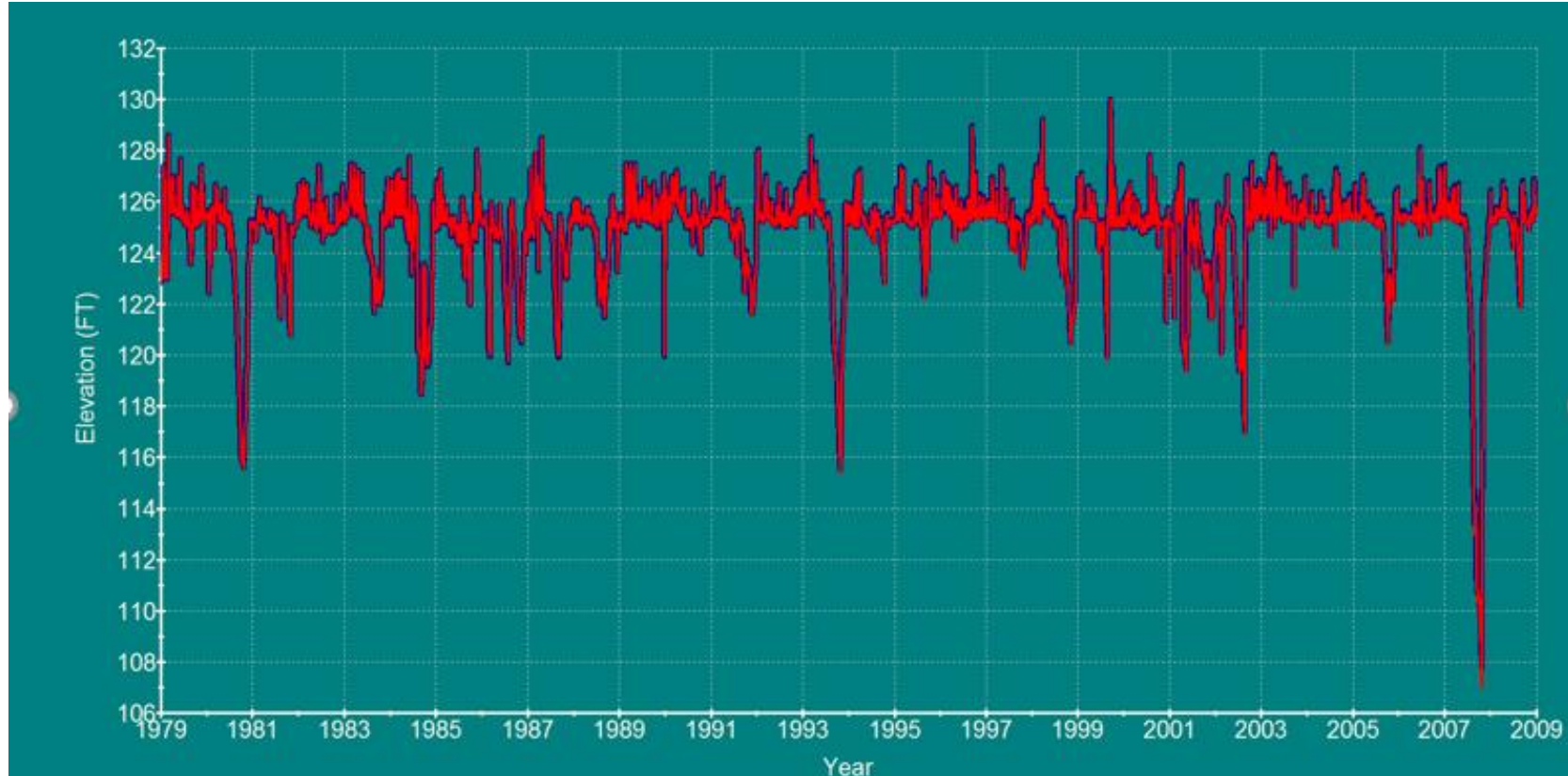
- Water Source
- GW Wells
- SW Intakes
- Yadkin Counties
- Rivers
- Yadkin Boundary
- Public Water Systems
- Water Withdrawals
- Water Interconnects
- Emergency Water Connections
- Subbasins
- Rocky River 18-4
- South Yadkin River 18-2
- Uwharrie River 18-3
- Yadkin River 18-1

YADKIN RIVER BASIN SCHEMATIC

Inflow Development (Matching at Gages)



Model Development (Sample of Output)



Next Steps

- Coordinate with Technical Review Committee
- Send out data request (in coordination with DWR) and follow-up with users for additional information
- Develop model schematic
- Optional: set up a data repository on SharePoint
- Next meetings
 - **Data collection and inflows (summer)**
 - **Preliminary review of basecase model run (fall)**
 - **Training (winter)**