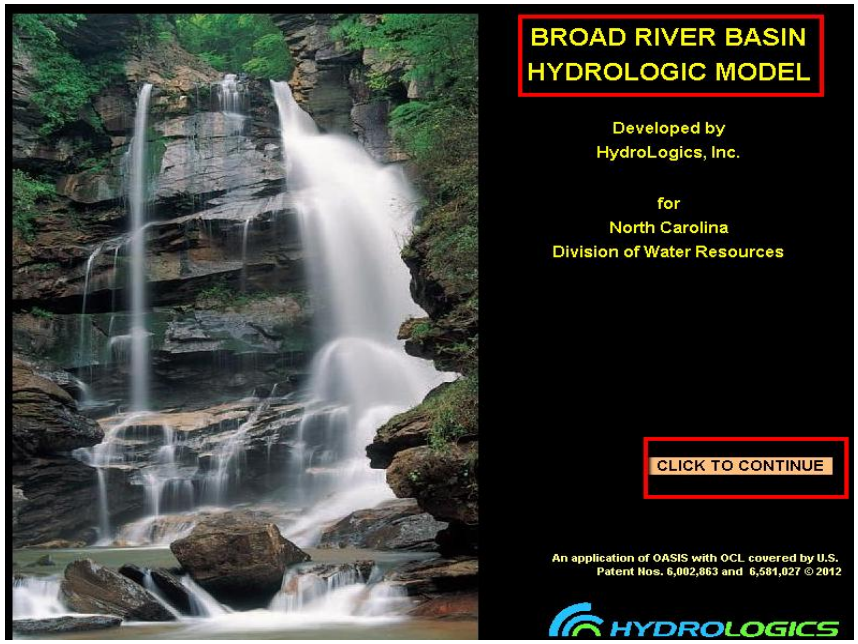
Broad River Basin Model



July 11, 2012

Water Allocation Committee

Tom Fransen
Division of Water Resources
NC Department of Environment and Natural Resources

Agenda

- Background
- Process
- Model Basics
- Validation
- Next Steps
- Questions

Improve River Basin Modeling – SL 2010-143

(3) Model. – Each basinwide hydrologic model shall:

a. Include surface water resources within the river basin, groundwater resources within the river basin to the extent known by the Department, transfers into and out of the river basin that are required to be registered under G.S. 143-215.22H, other withdrawals, ecological flow, instream flow requirements, projections of future withdrawals, an estimate of return flows within the river basin, inflow data, local water supply plans, and other scientific and technical information the Department deems relevant.

b. Be designed to simulate the flows of each surface water resource within the basin that is identified as a source of water for a withdrawal registered under G.S. 143-215.22H in response to different variables, conditions, and scenarios. The model shall specifically be designed to predict the places, times, frequencies, and intervals at which any of the following may occur:
   1. Yield may be inadequate to meet all needs.
   2. Yield may be inadequate to meet all essential water uses.
   3. Ecological flow may be adversely affected**.**

c. Be based solely on data that is of public record and open to public review and comment.

(6) Approval and modification of hydrologic models.

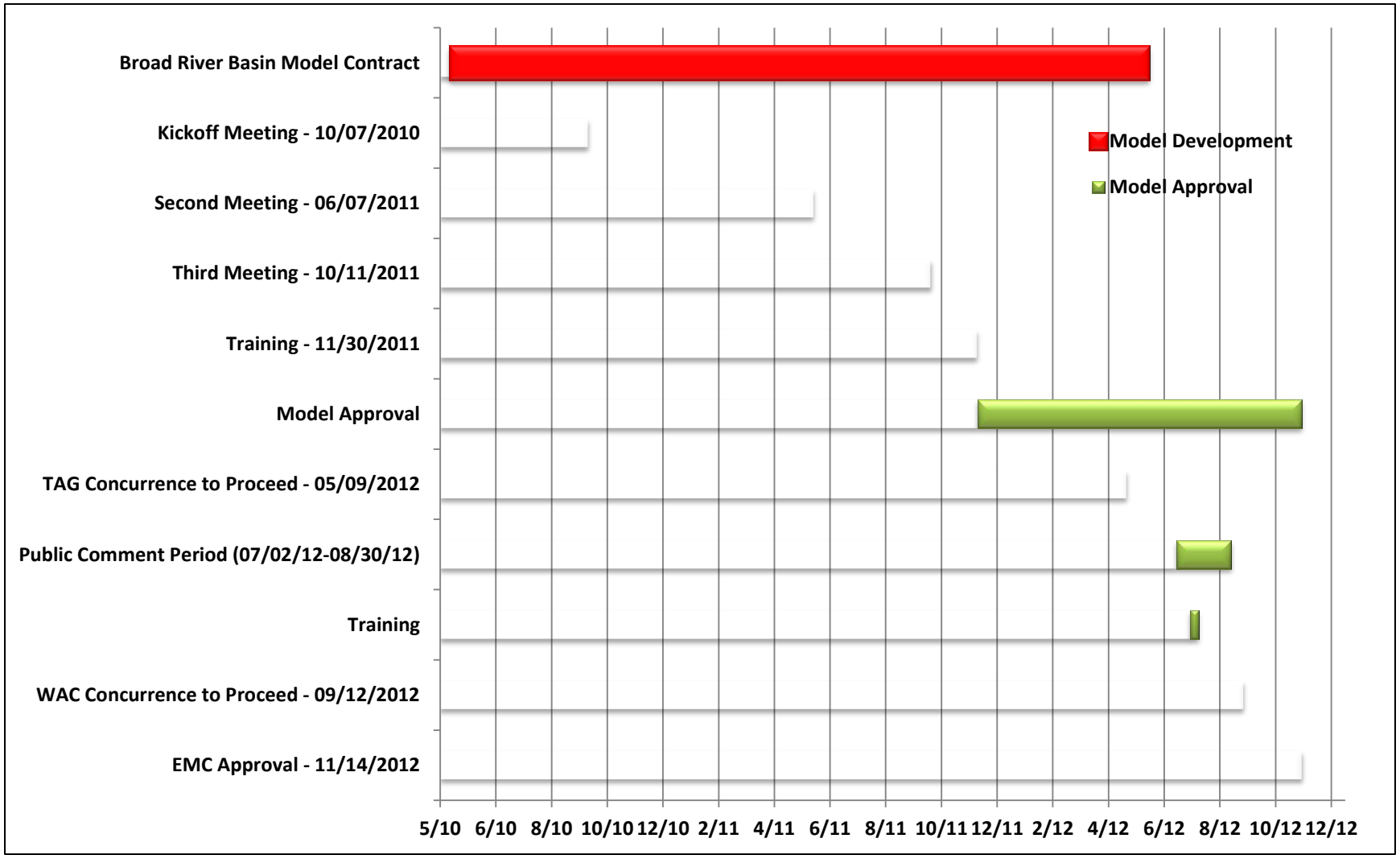
Broad Hydrologic Model

- Basin models required by Session Law 2010-143 (G.S. §143.355(o))
- DWR uses OASIS for meeting the requirements of SL2010-143.
  - OASIS is a patented, mass balance, water resources simulation/optimization model.
  - ***Change-in-Storage = Inflow - Outflow***
- Uses Operations Control Language (OCL) to communicate operating policies to the model

Applications of Broad OASIS Model Alternatives Evaluation – "What if?"

1. Evaluation of the combined basinwide effects of current and future water supply demands.
2. Evaluation for Interbasin transfer permit applications.
3. Model will be on the DWR server and available to stakeholders and their consultants.
   - Development of individual water supply plans.
   - A platform for developing risk-based triggers for water shortage response plans.
   - SEPA impact analysis.

Broad River Basin Modeling Process



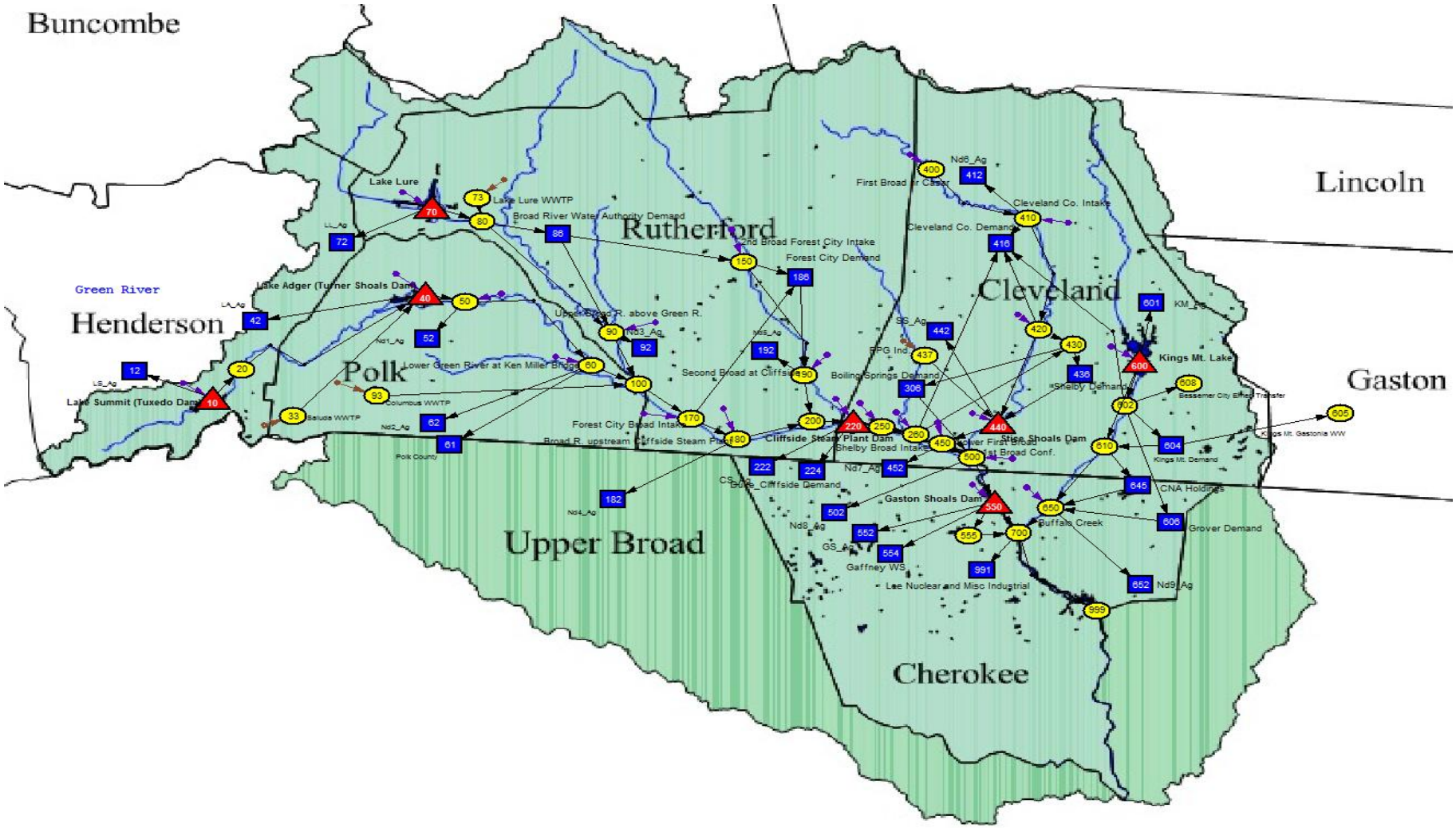
Model Basics

- Models water quantity as water moves downstream considering additions and deletions at specified locations.
- Built on OASIS with OCL™ platform developed by HydroLogics, Inc.
- Not for flood analysis
- Does not model water quality
- Does not directly model ground water

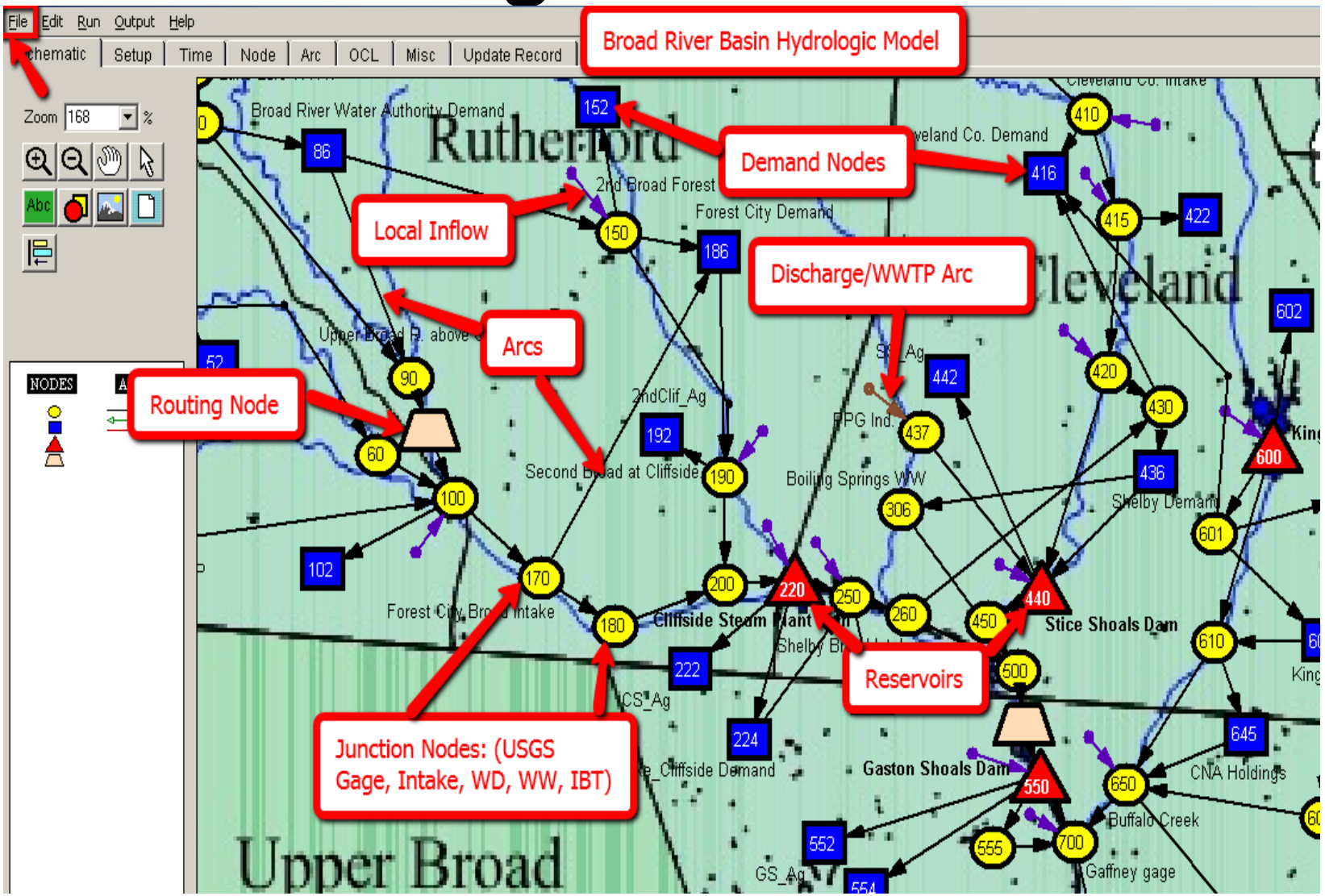
Overview of Broad River Basin Hydrologic Model

- Model schematic
- Model inputs
- Model outputs
- Run configurations
- Key graphics, validation plots
- Systems Drought Plan
- Model report

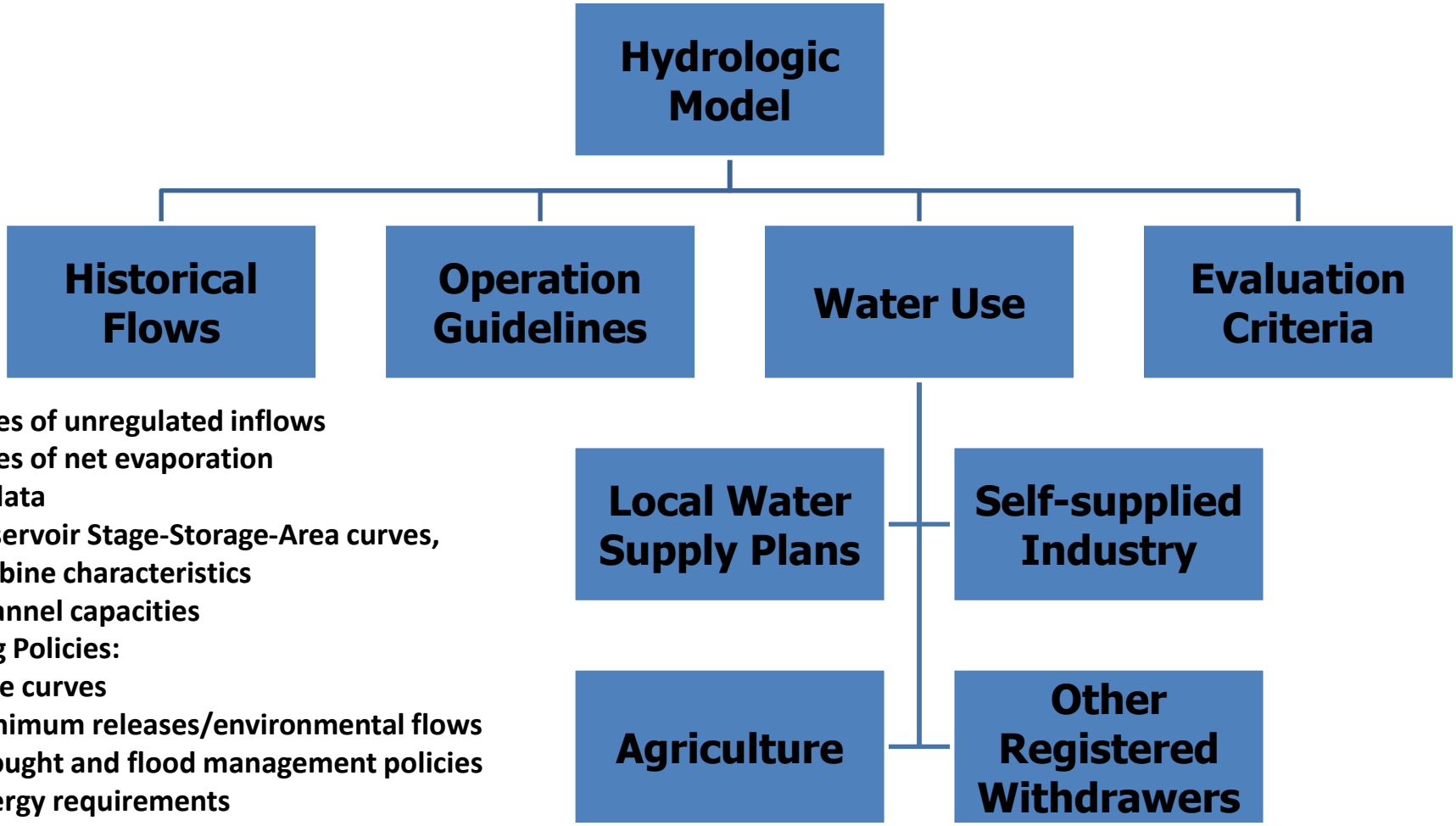
Model Schematic



Reading The Schematic



Model Input



Time series of unregulated inflows
Time series of net evaporation
Physical data
- **Reservoir Stage-Storage-Area curves,**
- **Turbine characteristics**
- **Channel capacities**

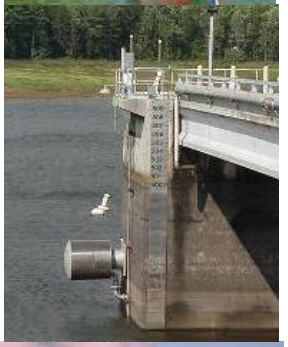
Operating Policies:
- **Rule curves**
- **Minimum releases/environmental flows**
- **Drought and flood management policies**
- **Energy requirements**

Operations Guidelines

Examples

- **Quantity and timing of specific flows**
  - Aquatic habitats
  - Water quality protection
  - ✓ Intake coverage
  - Recreation

- **Reservoir water level limits and timing**
  - Structural limits
  - Aquatic habitat protection
  - ✓ Intake coverage
  - Boat ramp access
  - Authorized purposes and storage allocations



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Principle Data

Water Use

- **Water Withdrawal Registrations**
  - Agriculture > 1,000,000 gallons per day
  - Non-agriculture > 100,000 gallons per day
- **Local Water Supply Plans**
  - Local Government Water Systems
  - Other Large Community Water Systems

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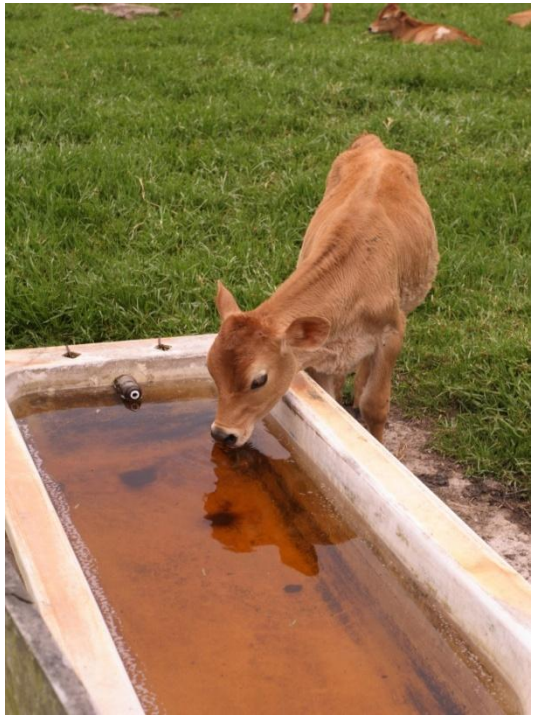
Data Sources

- Municipal & Industrial Withdrawals
  - DWR
  - Water Users
- Wastewater Discharges (NPDES)
  - DWQ
  - Dischargers
- Agricultural Water Use
  - National Agricultural Statistics Service
  - Ag Statistics from NC Dept. of Agriculture (NCDA)
  - Ag Extension Agents and Questionnaire



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Municipal & Industrial Data Analysis

- Withdrawals & Discharges
  - 1930s to 2008
  - Monthly Time Series
- Fill Gaps in Series
  - Linear Interpolation – Census Data
  - User Records of Facility Start/Stop Dates

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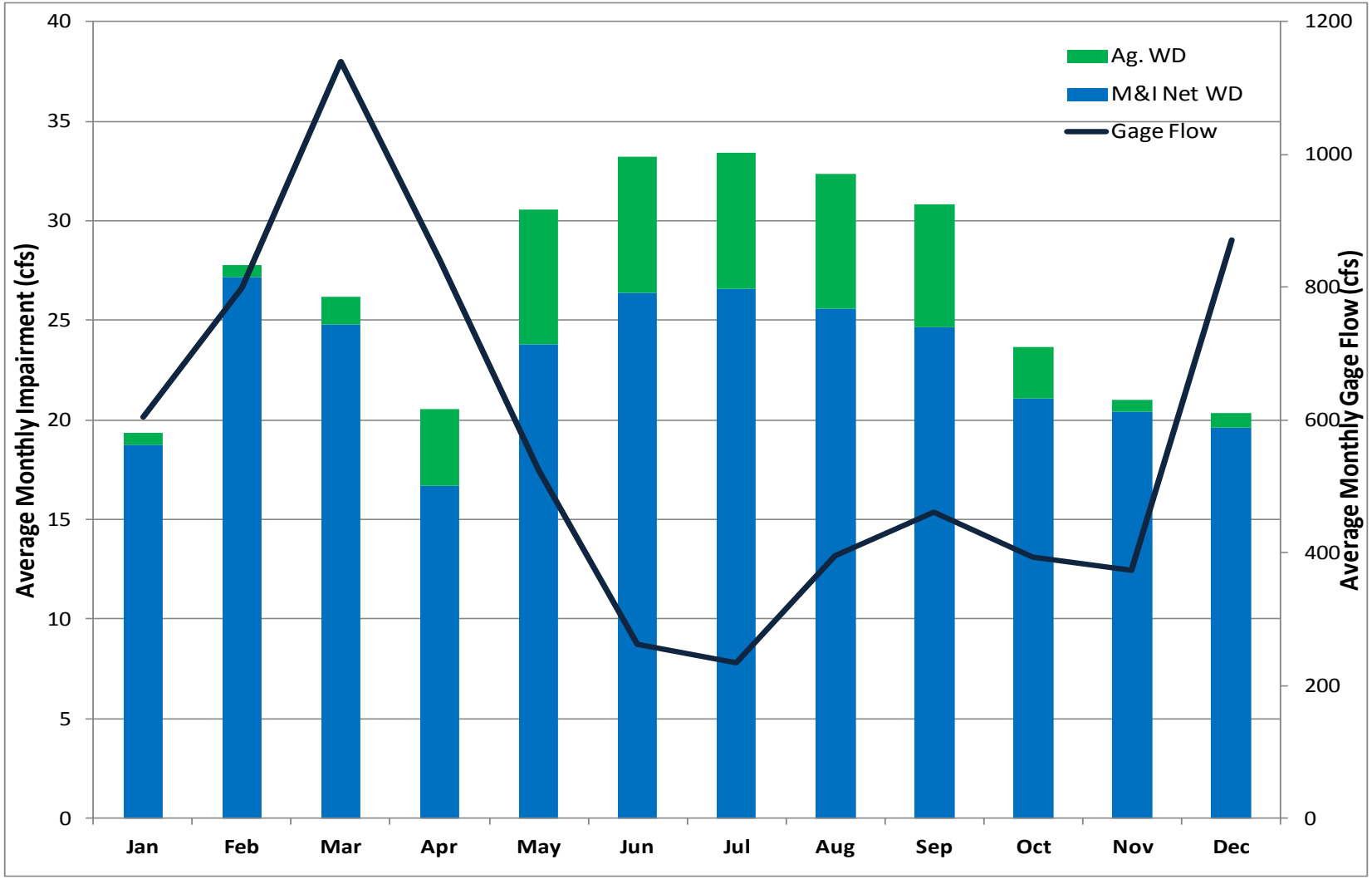
Water use data is used to create unimpaired streamflows. Monthly Impairments at Boiling Springs (2008)



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Validation of Broad River Basin Hydrologic Model

Assumptions:

- Demand 2007 – historic monthly or daily values as available
- Discharge 2007
  - Historic monthly pattern [using actual monthly average discharge / demand ratios] for dependent discharge nodes
  - Historic daily discharge for independent discharge nodes
- Beginning of 2007 reservoir levels (or year levels)
- Drought operation of the systems
- No historic agricultural demand – used as calculated by the model
- No historic evaporation from reservoir – used as calculated by the model

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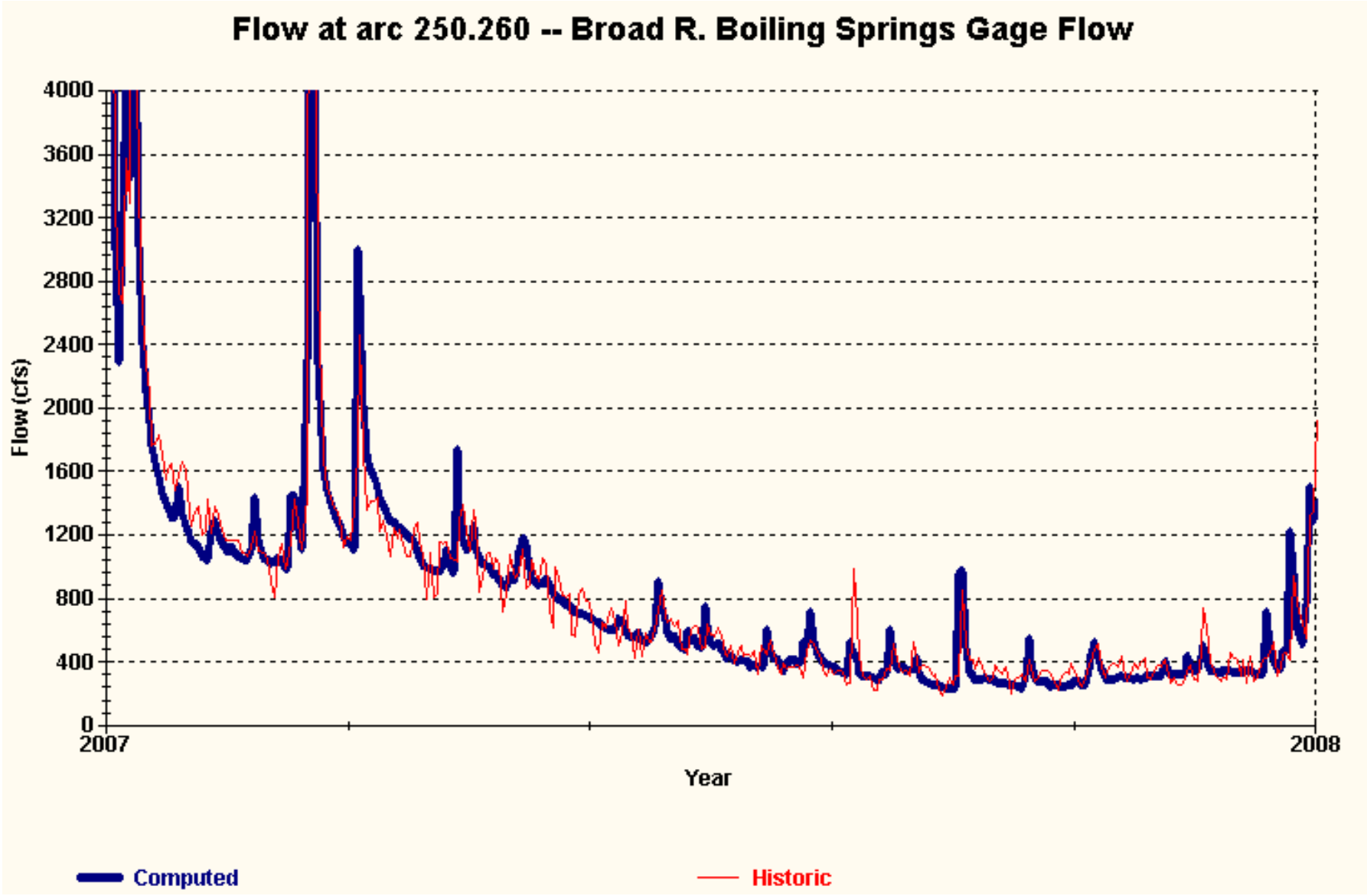
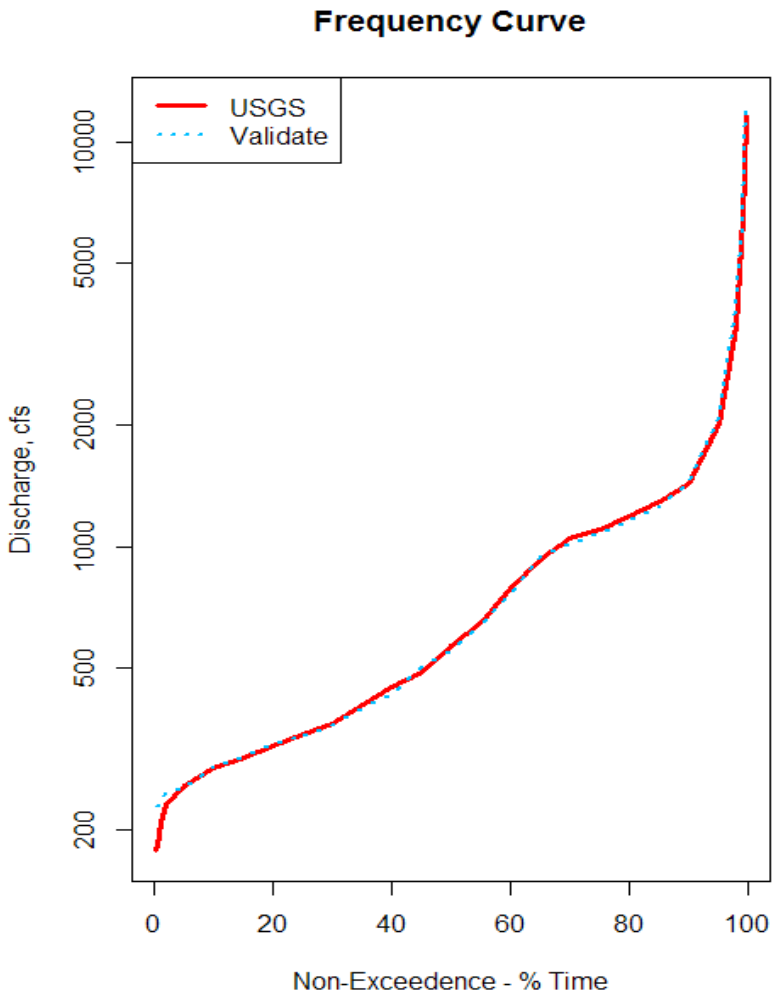
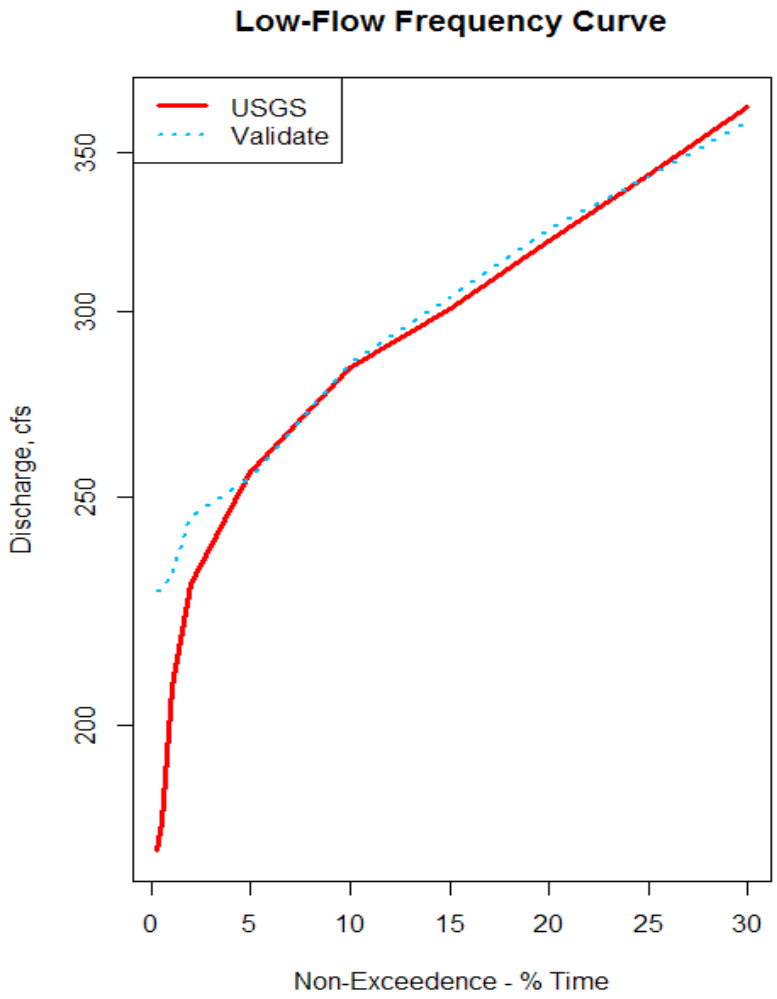
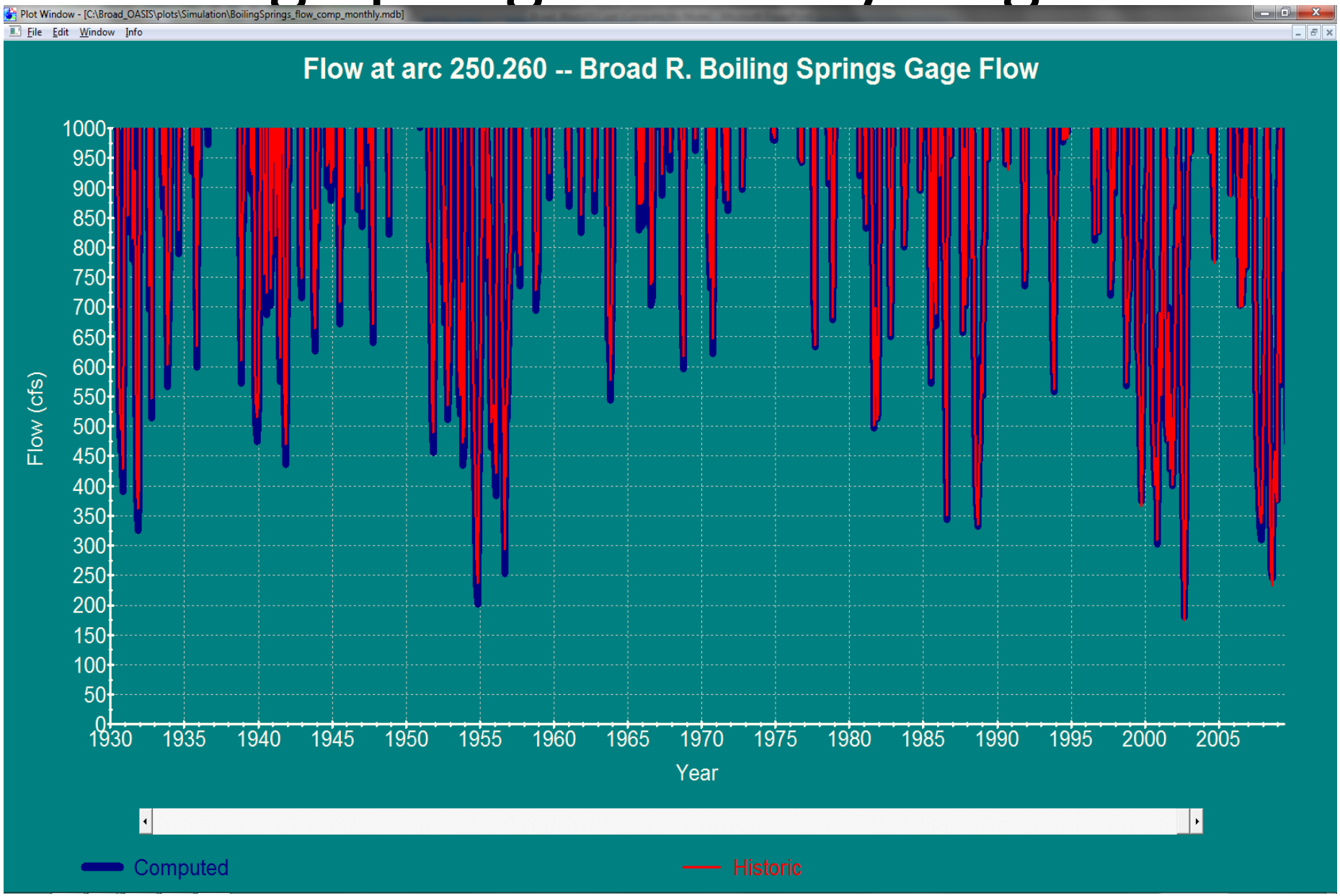

Flow at arc 250.260 -- Broad R. Boiling Springs Gage Flow
Flow (cfs)
4000
3600
3200
2800
2400
2000
1600
1200
800
400
0
2007
2008
Year
Computed
Historic

Broad River near Boiling Springs Arc250.260 2007 Validation Scenario

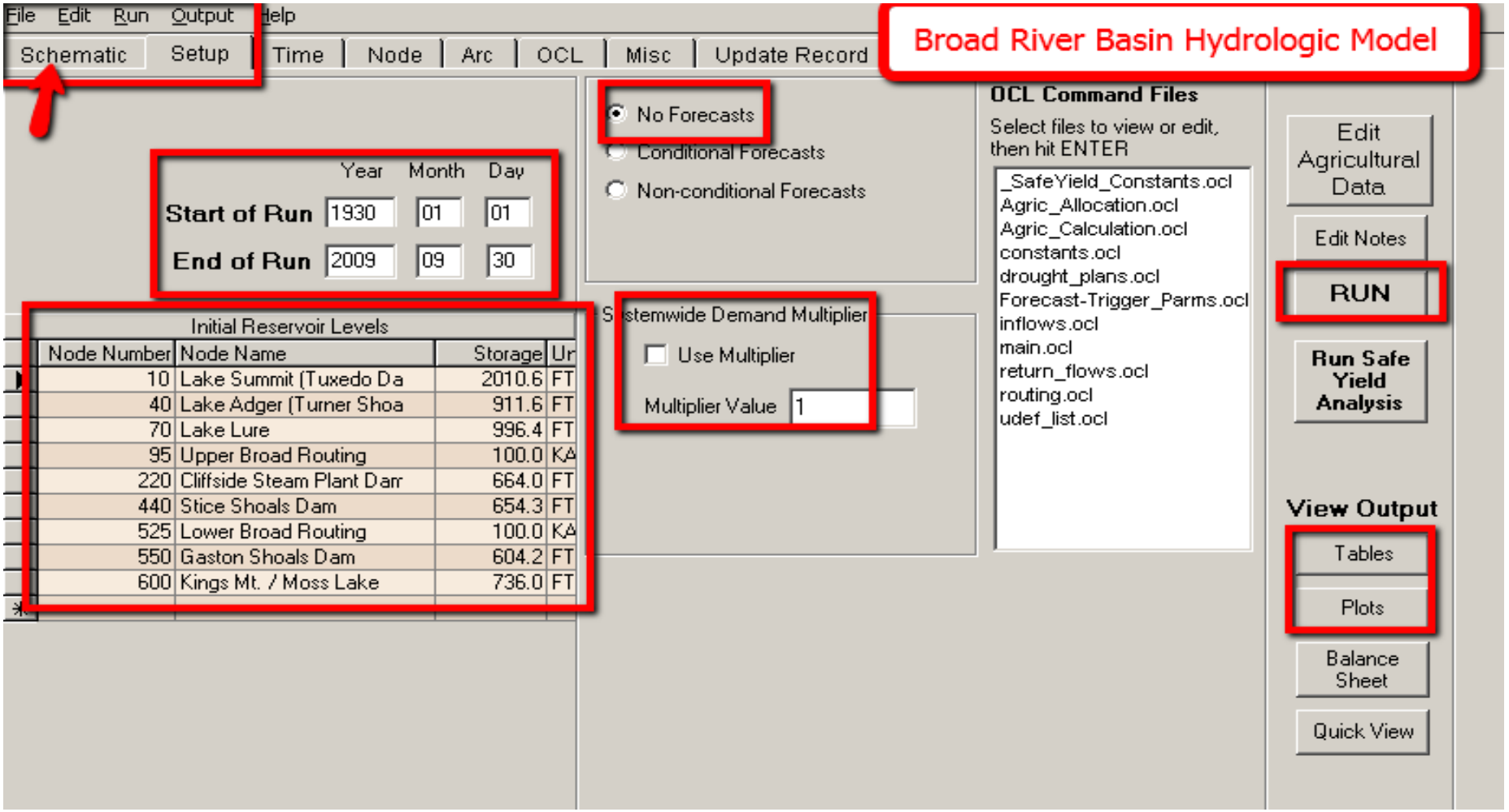




Boiling Springs Monthly Gage Flow



Using the Broad River Basin Model



Major Systems Current Demands & Future Demands Projections

Utility	2010 Average Annual Demand (MGD)	2060 Average Annual Demand (MGD)
BRWA	5.7	3.9*
Polk Co.	2.5	3.5
Forest City	1.8	2.6
Cliffside Steam (Net WD)	11.4	20.7
Cleveland Co.	4.2	7.9**
Shelby	3.8	5.4
Kings Mtn.	2.4	2.0
Gaffney (SC)	8.3	14.6

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Current & Future Projections of Wastewater Returns

Utility	2010 Average Annual Return (MGD)	2060 Average Annual Return (MGD)
Lake Lure	0.07	0.2
Rutherfordton	0.5	0.9
Spindale	1.2	1.5
Saluda	0.05	0.2
Columbus	0.3	0.5
Boiling Springs	0.3	0.5
PPG Industries	0.7	2.9
Grover	0.05	0.2

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Broad River Water Authority (BRWA) Simplified

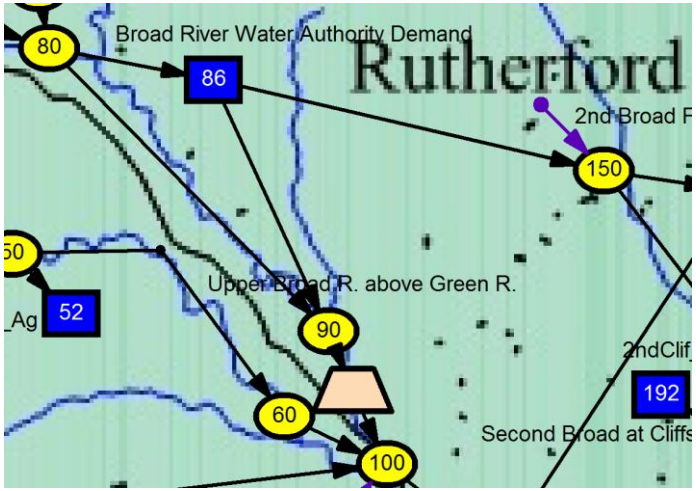
Flow from upstream Broad River

BRWA total withdrawal

Spindale sales/wastewater discharge to 2nd Broad

Rutherfordton sales/wastewater discharge

Broad River flow



Broad River Water Authority

- Primary source – Broad River
- Sells water to Spindale, Rutherfordton
  - Wastewater treated in these towns
- Annual Average Demand = 5.17 MGD
  - Assume 2.5 is for Polk county in current scenario
- Treatment capacity = 8 MGD
- Drought Plan
  - Stage 1 – Flow at Intake < 65 MGD for 7 days
    - Voluntary – 5% reduction
  - Stage 2 – Flow at Intake < 20 MGD for 7 days
    - Mandatory I – Shortage – 10% reduction
  - Stage 3 – Flow at Intake < 18 MGD for 7 days
    - Mandatory II – Emergency – 20% reduction
  - Stage 4 – Flow at Intake < 15 MGD for 7 days
    - Mandatory III – Crisis – 25% reduction

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BRWA Demand Pattern

Demand Pattern at Node 86, 'Broad River Water Authority Demand'

	Month	Day	Demand
▶	1	1	0.983
	1	31	0.983
	2	1	0.942
	2	29	0.942
	3	1	0.942
	3	31	0.942
	4	1	0.970
	4	30	0.970
	5	1	1.021
	5	31	1.021
	6	1	1.081
	6	30	1.081
	7	1	1.069
	7	31	1.069
	8	1	1.113
	8	31	1.113
	9	1	1.047
	9	30	1.047
	10	1	1.007
	10	31	1.007
	11	1	0.929
	11	30	0.929
	12	1	0.896
	12	31	0.896
*			

MGD Units

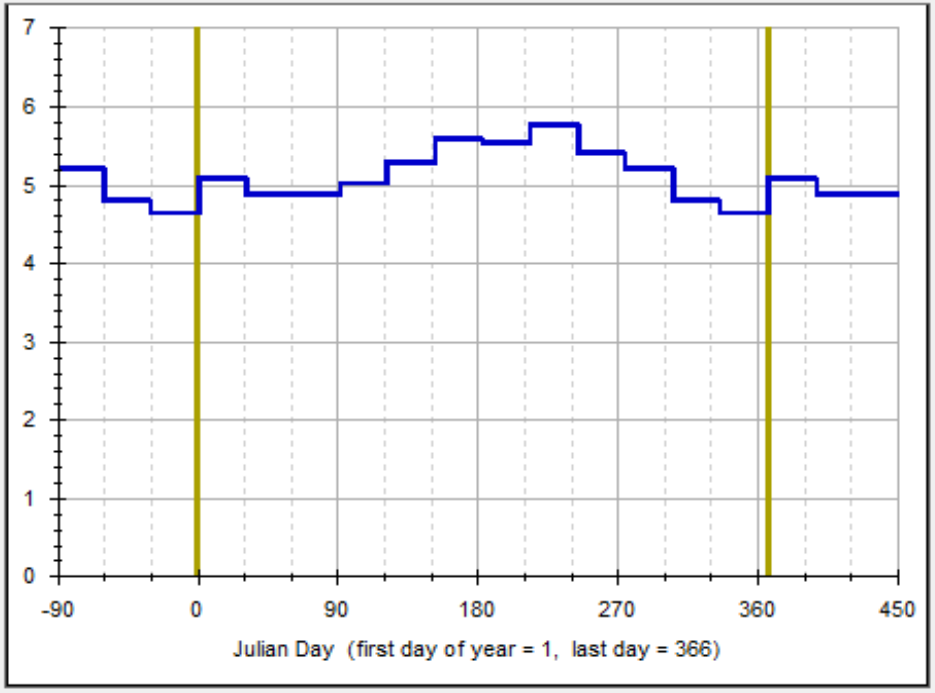
5.17 Multiplication Factor

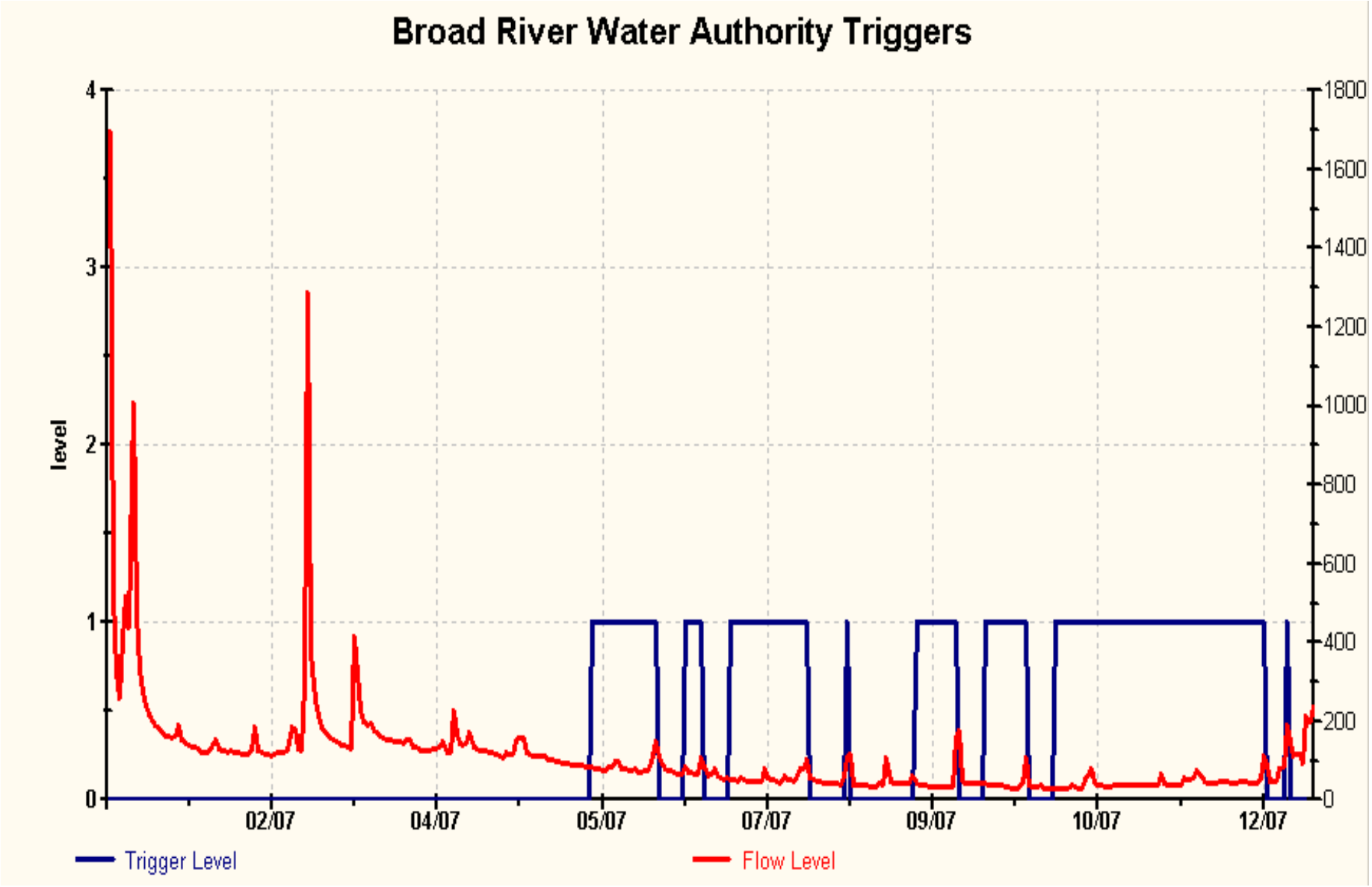
Change Node

Import Data

OK

Cancel





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Next Steps

- 60 Day Comment Period (7/2/12 – 8/30/12)
  - Model Training - 1 or 2 days based on requests
    Potential dates - 7/17, 7/19, 7/24, 7/26
- WAC Concurrence – September
- EMC Approval – November
- *Use the model to assist in the management of the Broad River Basin water resources.*

Questions?

- **Broad Model Website -** http://www.ncwater.org/Data_and_Modeling/Broad/
- **Broad Model Report -** http://www.ncwater.org/Data_and_Modeling/Broad/background/03_BRBM_Modeling_the_Broad_River_Basin_Operations_with_OASIS.pdf
- **Model Training Signup -** http://www.ncwater.org/Data_and_Modeling/Broad/training.php

Contact Information

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