



# The Emergence of South Carolina's New Tools for Surface Water Availability Assessment

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March 14, 2016



**CDM  
Smith**

WATER + ENVIRONMENT + TRANSPORTATION + ENERGY + FACILITIES



Myrtle Beach, SC

# Presentation Outline

- Project purpose and status
- Surface Water Allocation Model (SWAM) overview
- Project highlights...
  - Comparison of managed and unimpaired flows
  - Aspects of model development, calibration, and verification
- SWAM Demonstration



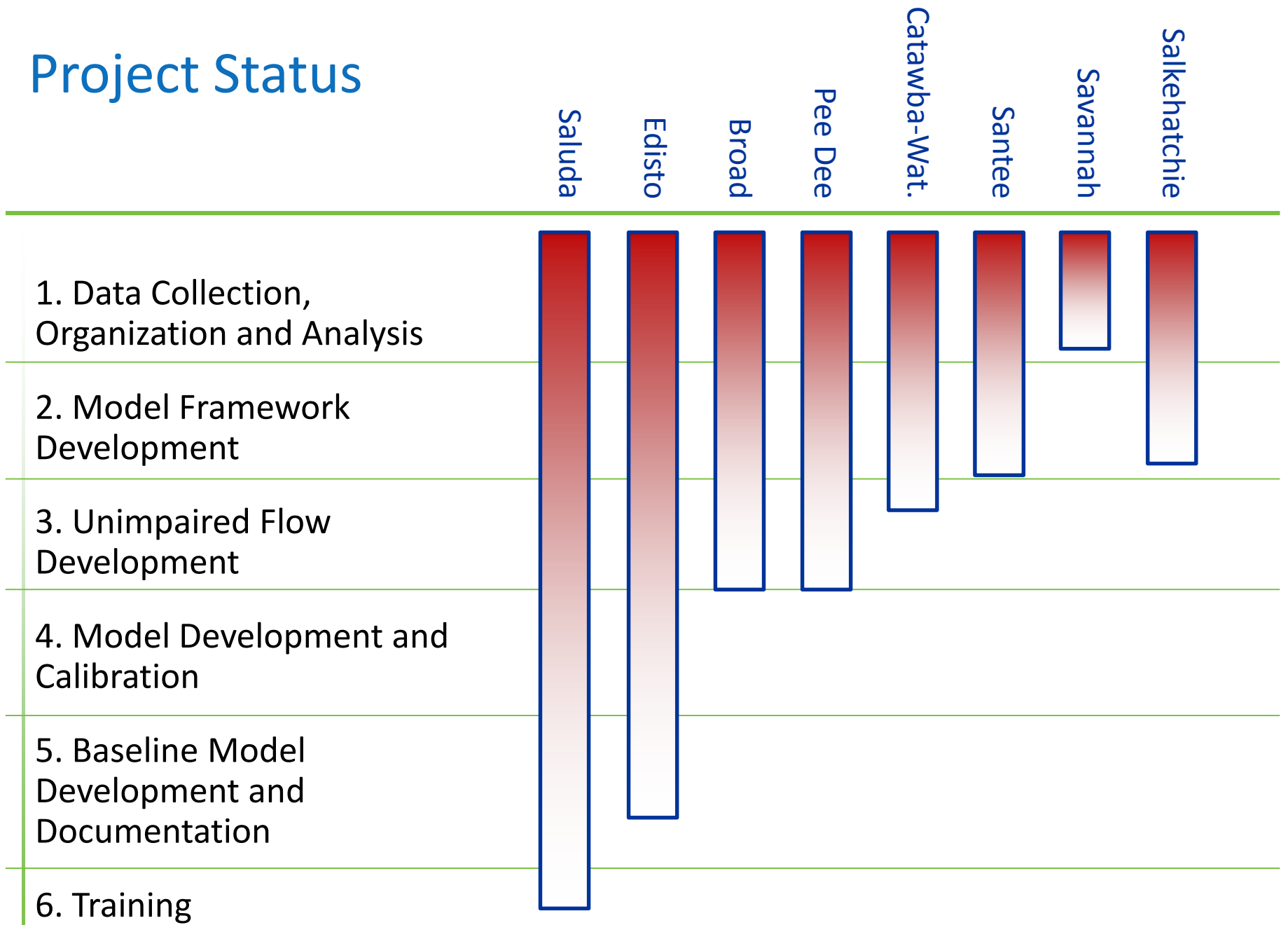
# What is the South Carolina Surface Water Availability Assessment?



**Project Purpose:** Build surface water quantity models capable of...

- Accounting for inflows and outflows from a basin
- Accurately simulating streamflows and reservoir levels over the historical inflow record
- Conducting “What if” scenarios to evaluate future water demands, management strategies and system performance.

# Project Status





# Technical Advisory Committee

- Advisory group consisting of representatives from:
  - Municipalities & industry
  - Non-governmental organizations
  - Energy
  - Agriculture
  - Consultants
- Engage in project meetings and model training
- Provide valuable technical feedback, insight, data analysis, and direction

# Clemson's Stakeholder Outreach Site

- <http://www.scwatermodels.com>

The screenshot shows the website's header with the Clemson University logo and navigation links (A-Z Index, Calendar, Campus Maps, CU Safety, Phonebook, Webcam, Search). The main title is "SOUTH CAROLINA SURFACE WATER AVAILABILITY ASSESSMENT" with "Public Service" on the right. A navigation bar includes "Home", "Process", "Model", "River Basins", and "Resources". The breadcrumb trail reads "CU > Public Service > Water Assessment > Home".

The main content area features a large image of a public meeting with a "GET INVOLVED!" overlay. Below the image is a navigation bar with buttons for "Stakeholders", "Upcoming Meetings", "Get Involved!", "DNR Assessment Site", and "Next".

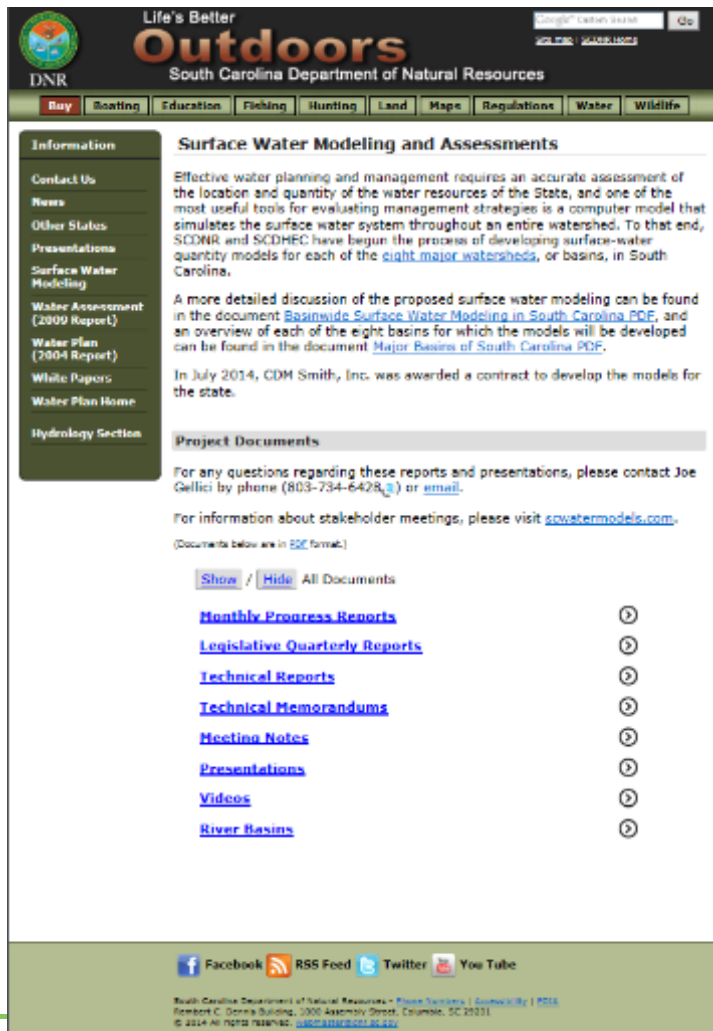
On the right side, there is a "SIGNUP FOR EMAIL NEWS" form with fields for "Email Address", "First Name", "Last Name", "Affiliation", and "Website", and a "Subscribe" button. Above the form is a "PLAYLIST" for "South Carolina" with a video player showing "The Purpose" and a "PLAY ALL" button.

**PROCESS & ASSESSMENT**  
The responsible management of the state's water resources is beyond the scope of any one agency or organization and requires cooperation and shared responsibility amongst all agencies and water users. Stakeholder involvement and feedback is critical to this process. [READ MORE >>](#)

**RIVER BASINS**  
Did you know that only two of South Carolina's eight major river basins are not shared with other states? This is also the first time that South Carolina will have surface water models developed individually for each basin that can work together for a state assessment. [READ MORE >>](#)

# Modeling Report and Other Documents

- <http://www.dnr.sc.gov/water/waterplan/surfacewater.html>



The screenshot shows the website for the South Carolina Department of Natural Resources (DNR). The header includes the DNR logo and the slogan "Life's Better Outdoors". The main navigation menu lists various activities: Boating, Education, Fishing, Hunting, Land, Maps, Regulations, Water, and Wildlife. The page title is "Surface Water Modeling and Assessments".

**Information**

**Surface Water Modeling and Assessments**

Effective water planning and management requires an accurate assessment of the location and quantity of the water resources of the State, and one of the most useful tools for evaluating management strategies is a computer model that simulates the surface water system throughout an entire watershed. To that end, SCDNR and SCDHEC have begun the process of developing surface-water quantity models for each of the eight major watersheds, or basins, in South Carolina.

A more detailed discussion of the proposed surface water modeling can be found in the document [Basinwide Surface Water Modeling in South Carolina PDF](#), and an overview of each of the eight basins for which the models will be developed can be found in the document [Major Basins of South Carolina PDF](#).

In July 2014, CDM Smith, Inc. was awarded a contract to develop the models for the state.

**Project Documents**

For any questions regarding these reports and presentations, please contact Joe Gellici by phone (803-734-6428, [a](#)) or [email](#).

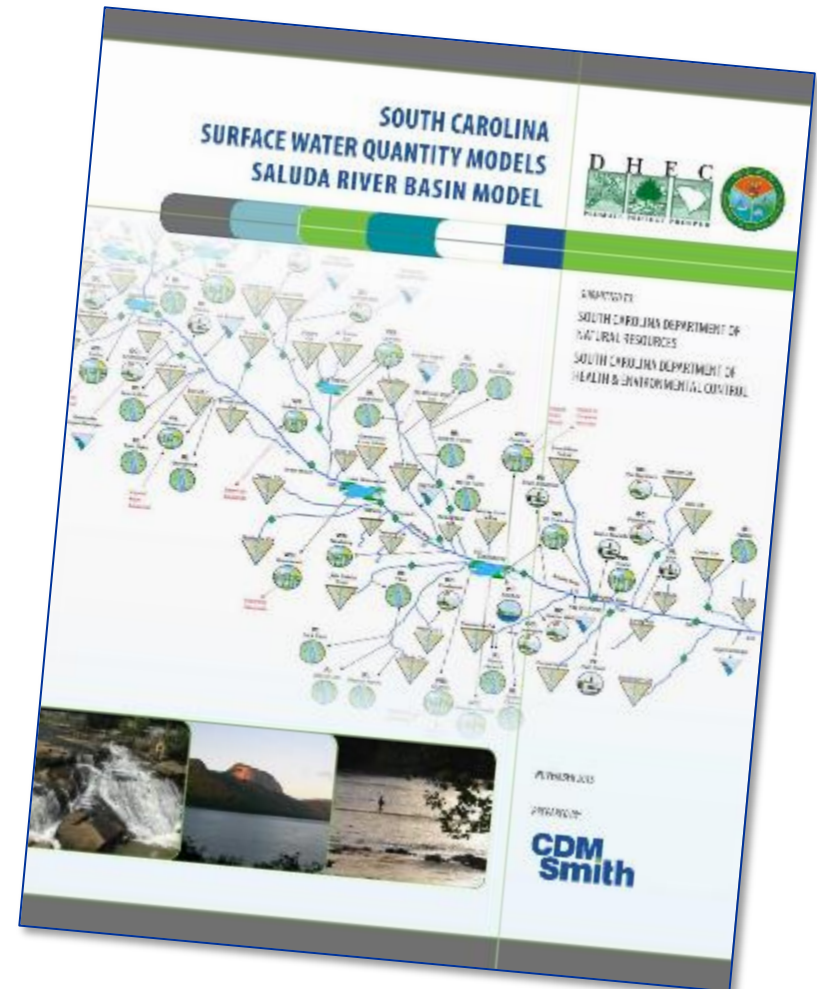
For information about stakeholder meetings, please visit [swwatermodels.com](#).

(Documents below are in PDF format.)

[Show](#) / [Hide](#) All Documents

- [Monthly Progress Reports](#)
- [Legislative Quarterly Reports](#)
- [Technical Reports](#)
- [Technical Memorandums](#)
- [Meeting Notes](#)
- [Presentations](#)
- [Videos](#)
- [River Basins](#)

At the bottom of the page, there are social media icons for Facebook, RSS Feed, Twitter, and YouTube. The footer contains the address: South Carolina Department of Natural Resources - P.O. Box 10000 | Columbia, SC 29210, and the date: © 2014 All rights reserved. | [www.dnr.sc.gov](#)



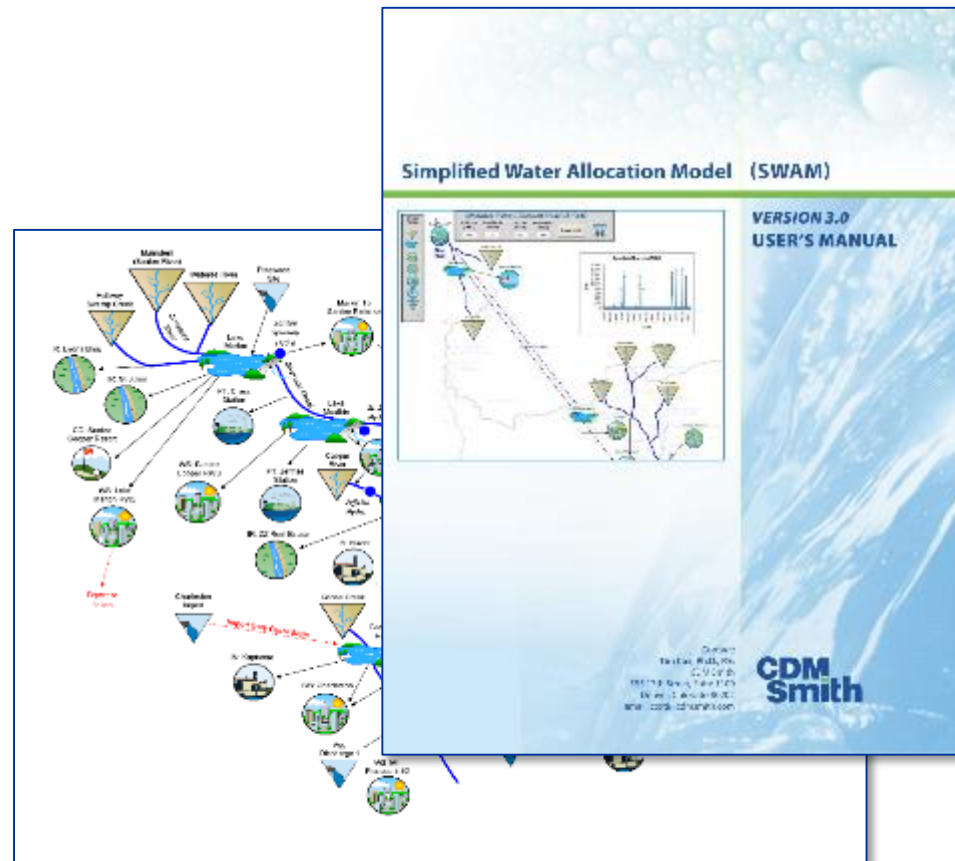


# Simplified Water Allocation Model (SWAM)



# Simplified Water Allocation Model (SWAM)

- Developed in response to an increasing need for a desktop tool to facilitate regional and statewide water allocation analysis
- Calculates physically and legally available water, diversions, storage, consumption and return flows at user-defined nodes
- Used to support large-scale planning studies in Colorado, Oklahoma, Arkansas, and Texas



# The Simplified Water Allocation Model is...

- A water accounting tool
- A WHAT-IF simulation model
- A network flow model that traces water through a natural stream network, simulating withdrawals, discharges, storage, and hydroelectric operations
- Not precipitation-runoff model (e.g., HEC-HMS)
- Not a hydraulic model (e.g. HEC-RAS)
- Not a water quality model (e.g., QUAL2K)
- Not an optimization model
- Not a groundwater flow model (e.g., MODFLOW)



## The Models Can Be Used To...

- Determine surface-water availability
- Predict where and when future water shortages would occur
- Test alternative water management strategies, new operating rules, and “what-if” scenarios
- Consolidate hydrologic data
- Evaluate the impacts of future withdrawals on instream flow needs
- Evaluate interbasin transfers
- Support development of Drought Management Plans
- Compare managed flows to natural flows
- Evaluate and test complex reservoir operating rules



# Unimpaired Flows and Model Development

# UIF Definition and Uses

- Definition: Estimate of natural historic streamflow in the absence of human intervention

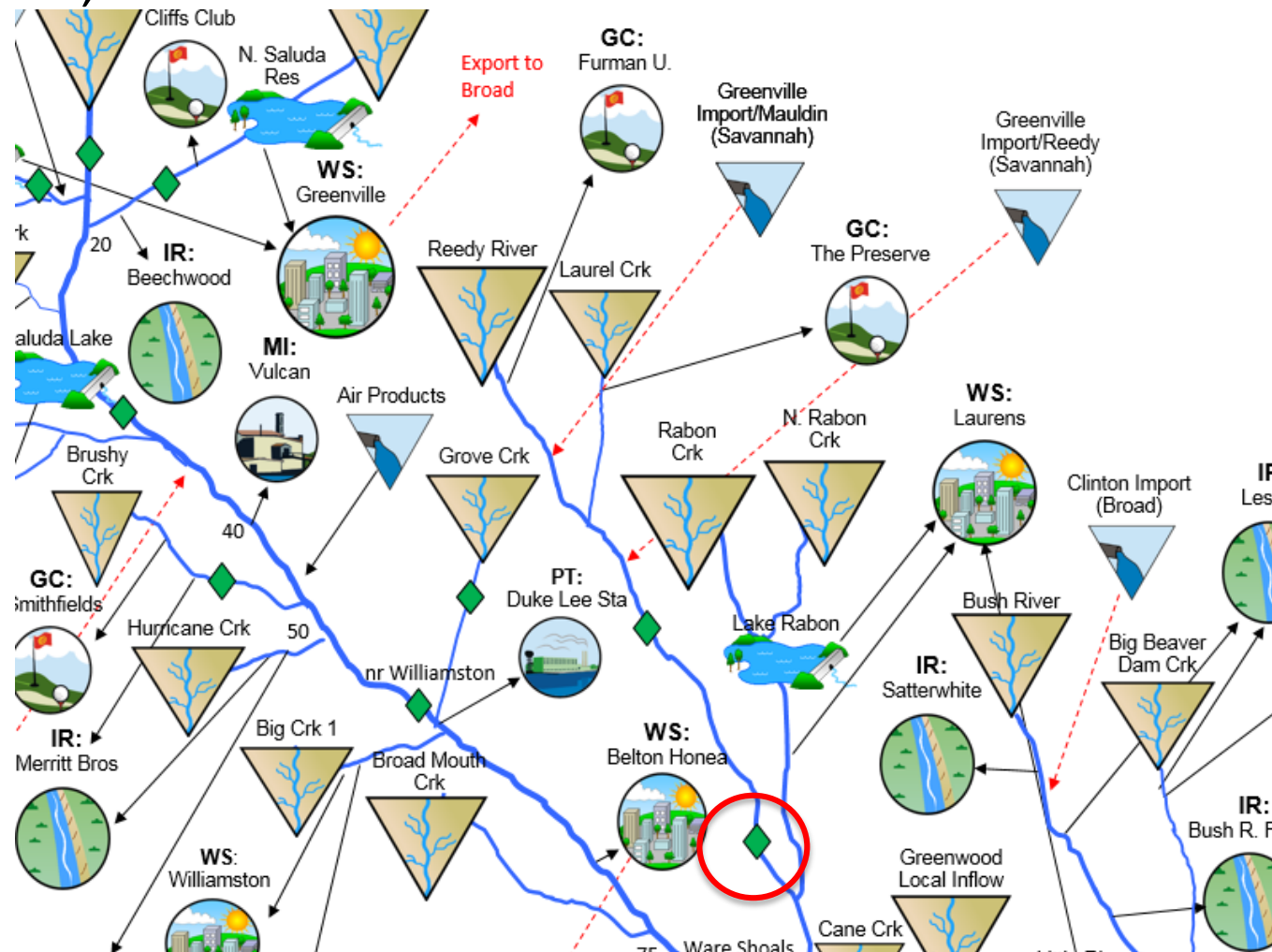
- Unimpaired Flow =

*Measured Gage Flow + River Withdrawals + Reservoir Withdrawals – Discharge to Reservoirs – Return Flow + Reservoir Surface Evaporation – Reservoir Surface Precipitation + Upstream change in Reservoir Storage + Runoff from Previously Unsubmerged Area*

- Fundamental input to the model at headwater nodes and tributary nodes
- Comparative basis for model results

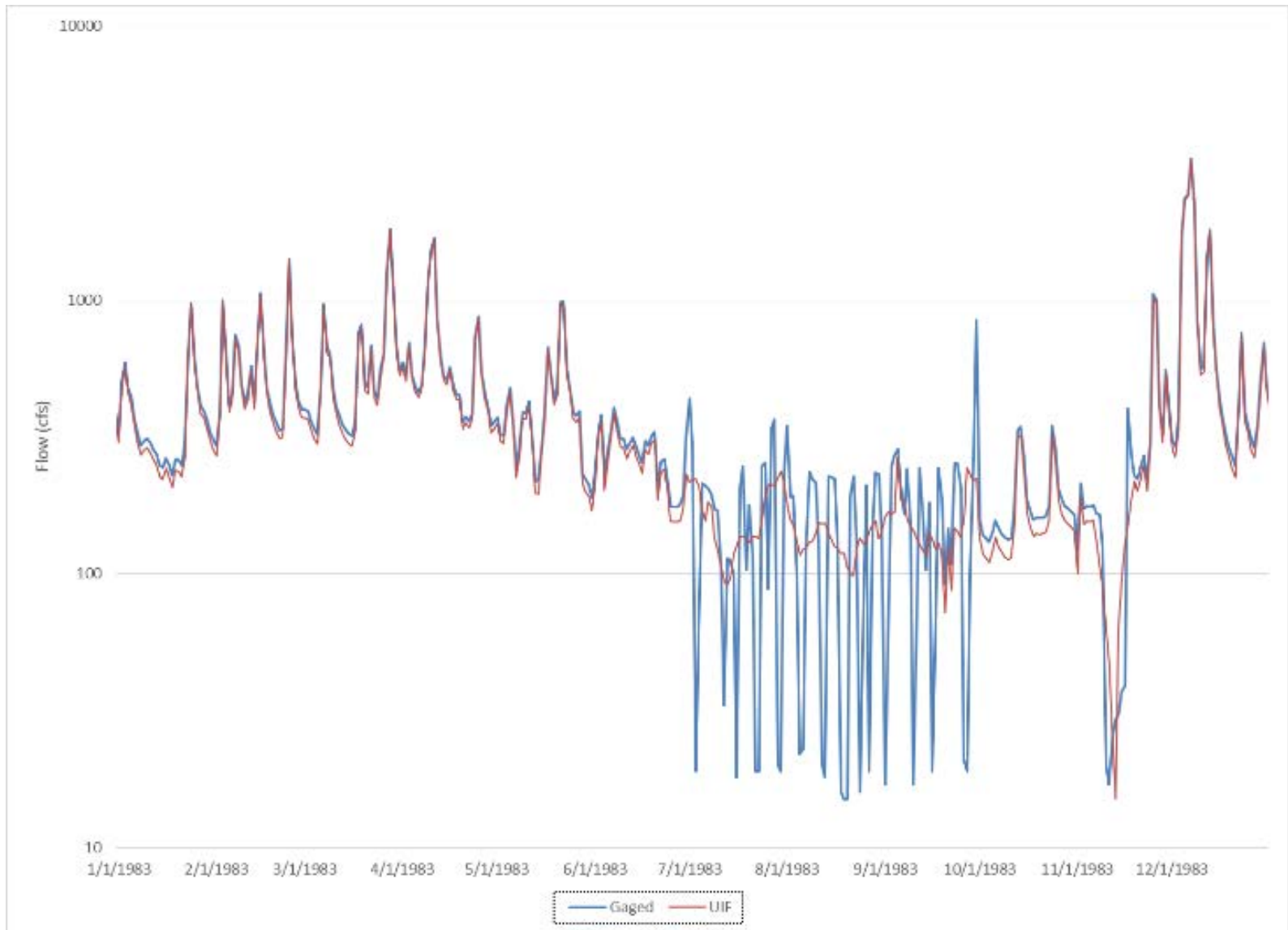
# Saluda UIF Example

- USGS streamflow gage 02165000 on Reedy River near Ware Shoals, SC



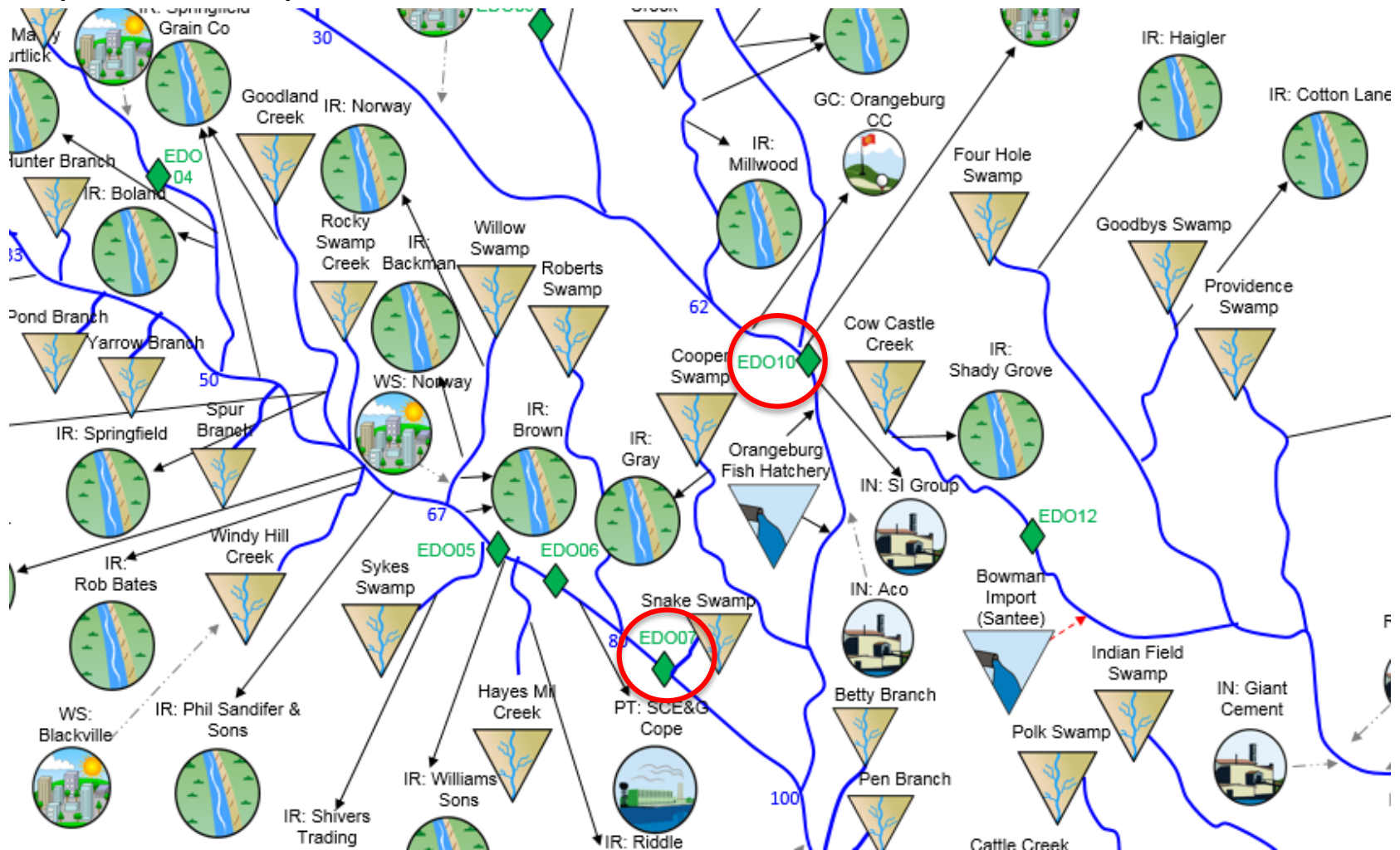


# Saluda UIF Example



# Edisto UIF Examples

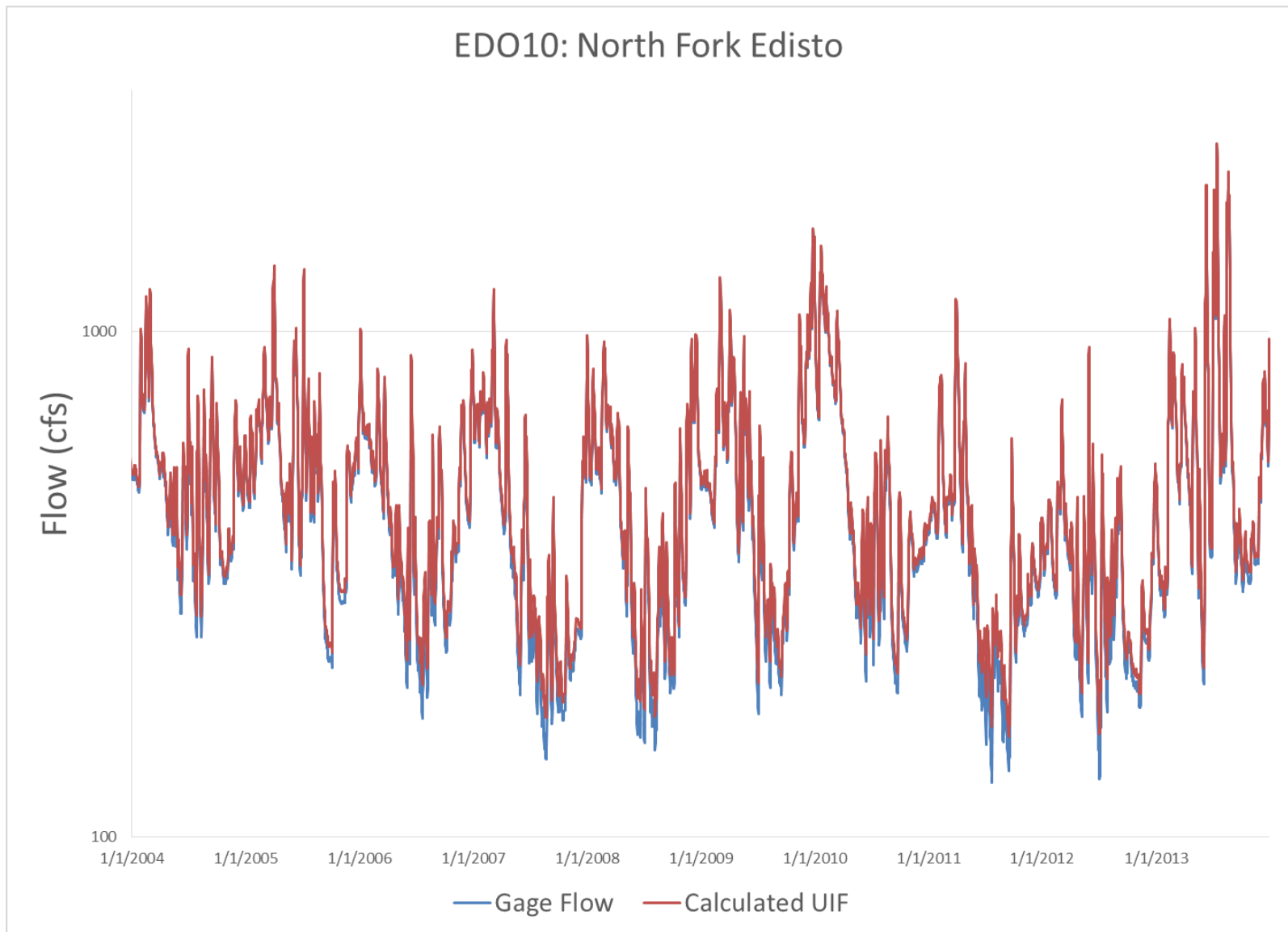
- USGS gages on North Fork (02173500) and South Fork (02173051) Edisto Rivers





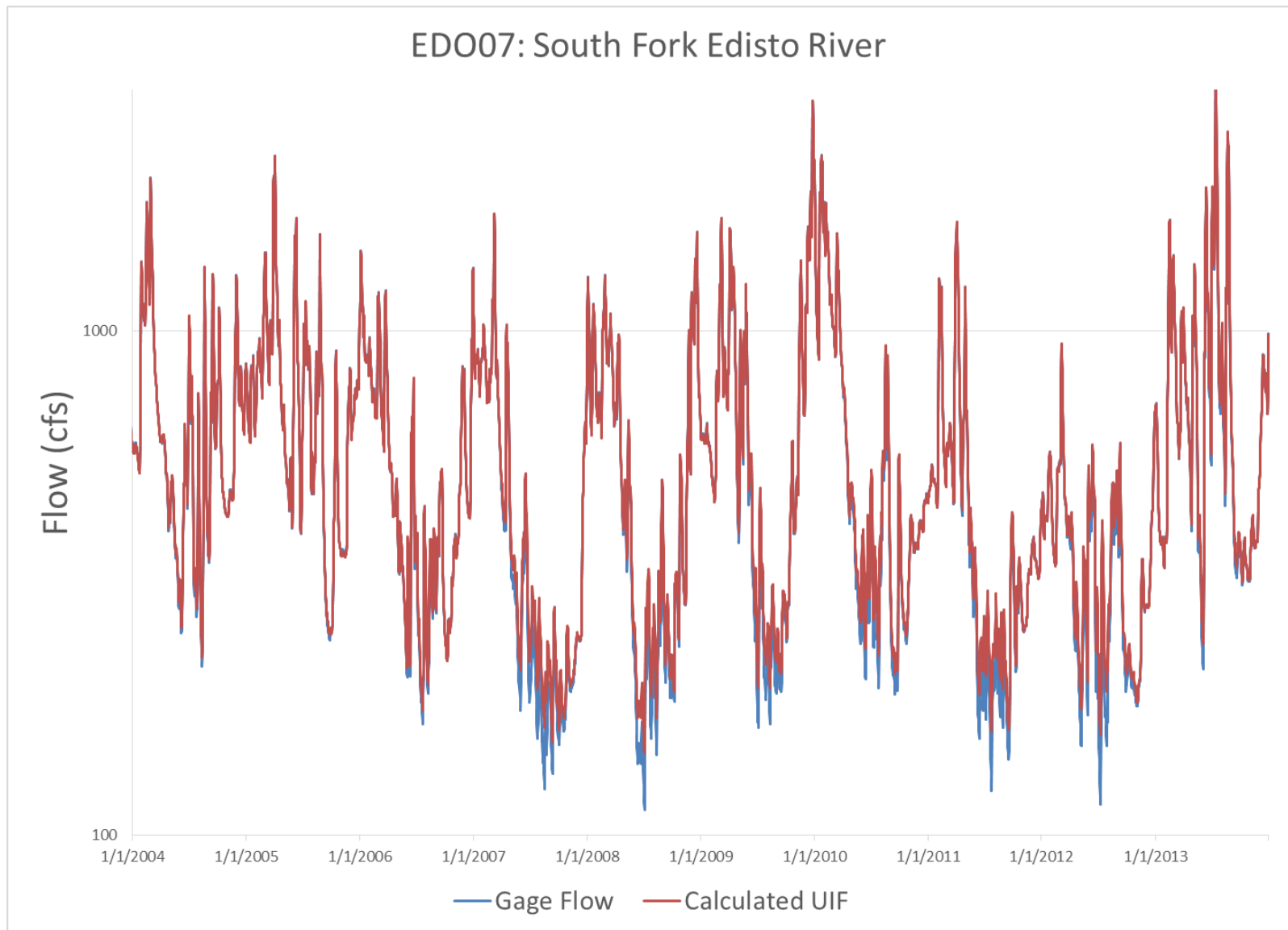


# Edisto UIF Examples

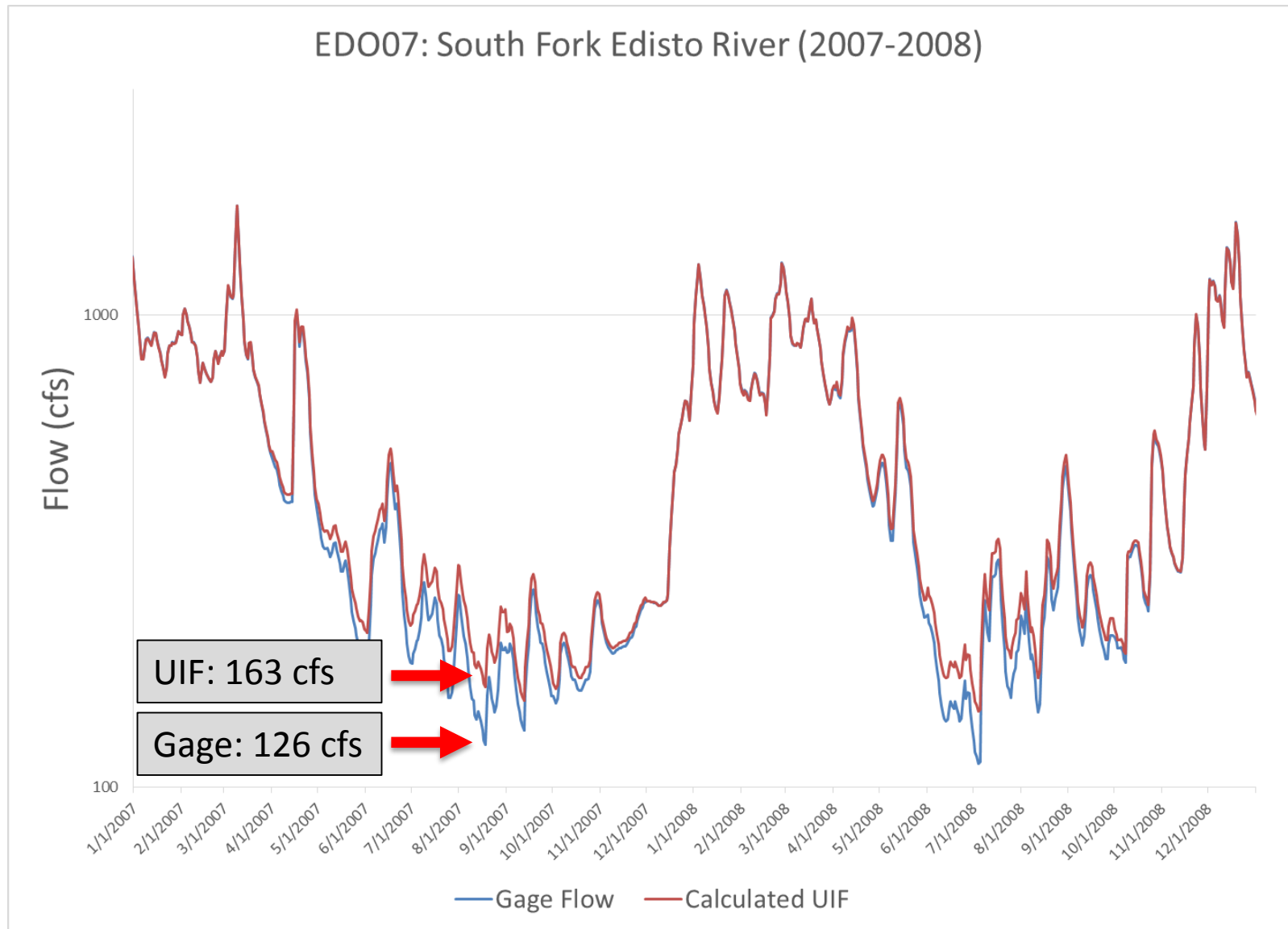




# Edisto UIF Examples



# Edisto UIF Examples



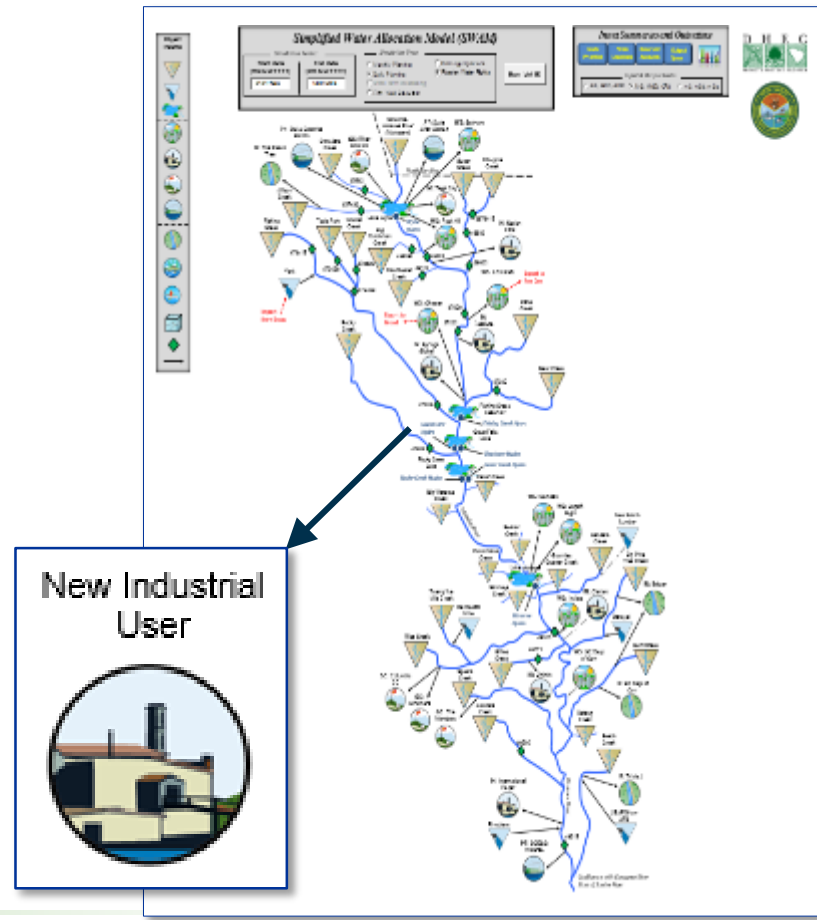
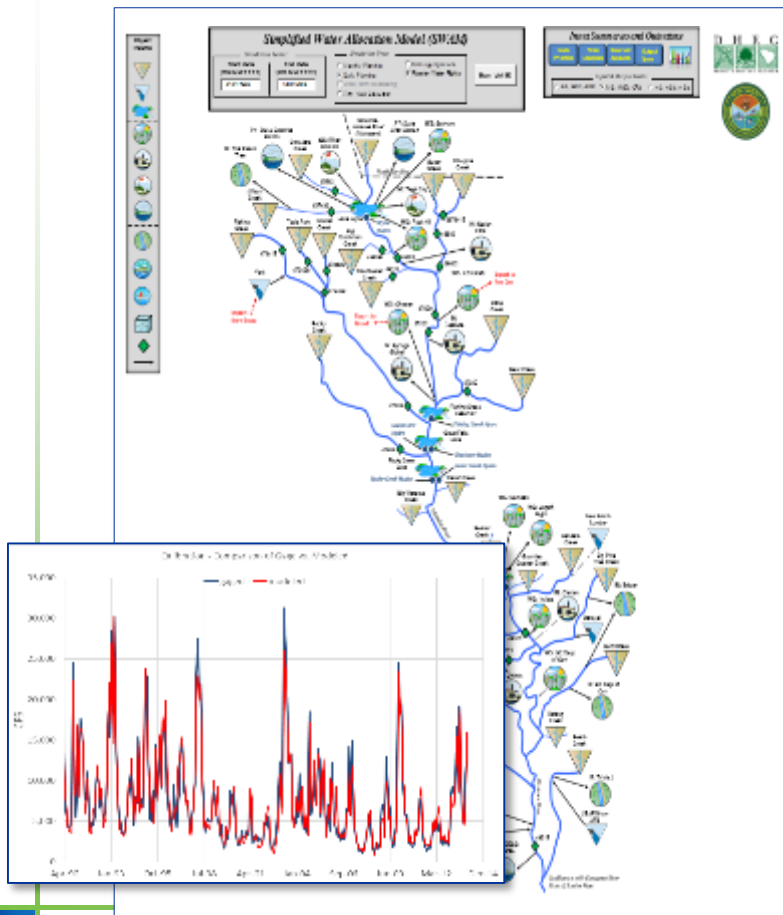


# Model Development, Calibration, and Verification

# Two Versions of Every Model

- Calibration with UIFs and historic use records

- Baseline: planning with UIFs, current uses, and user-defined future uses



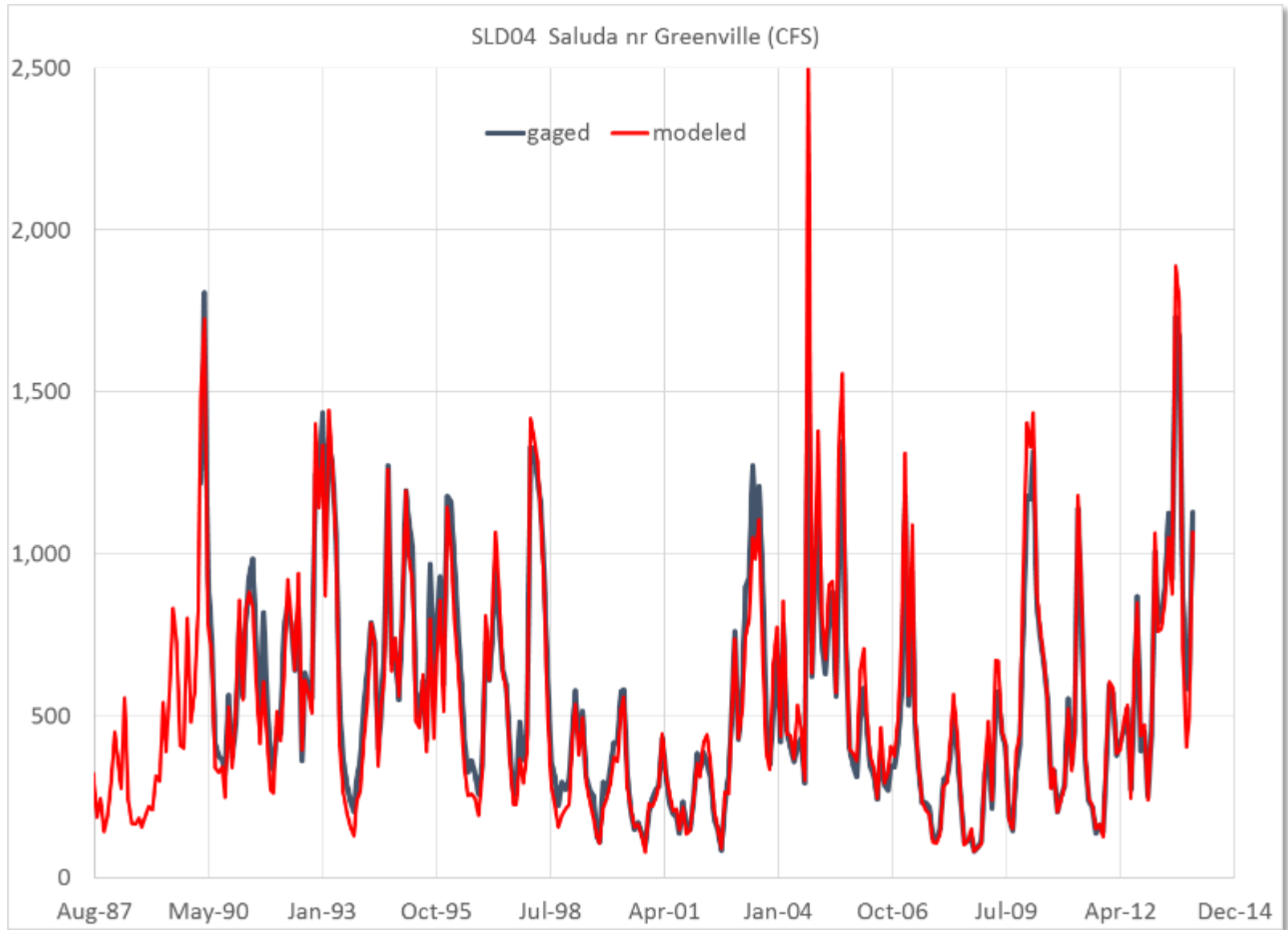
# Calibration/Validation General Approach

- 1983 – 2013 hindcast period; monthly timestep first
  - Includes droughts in both early and late 2000's
- Comparison to gaged (measured) flow data
  - Operations and impairments are implicit in that data
- Assess performance at (subject to gage data availability):
  - Multiple mainstem locations
  - Tributary confluence locations
  - Major reservoirs
- Multiple model performance metrics, including:
  - Timeseries plots (monthly and daily variability)
  - Annual and monthly means (water balance and seasonality)
  - Percentile plots (extremes and frequency)

# Potential Sources of Model Error & Uncertainty

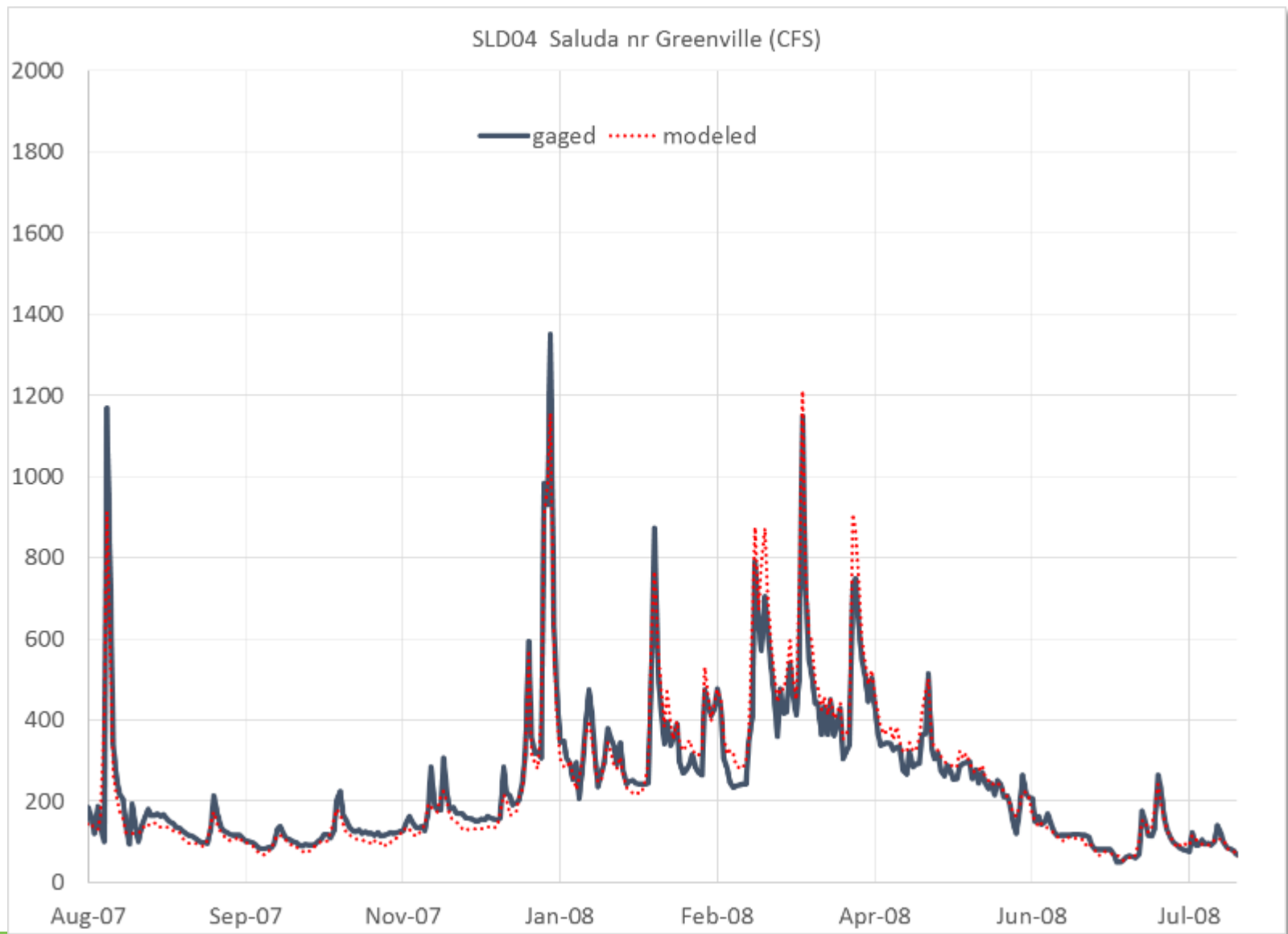
- Gaged flow data
- Gaged reservoir levels
- Basin climate and hydrologic variability
- Reported withdrawal and discharge data
- Hindcasted withdrawal and discharge data
- Return flow locations and lag times (if applicable, e.g. outdoor use)
- Reservoir operations (operator decision making)
- Reach hydrology: gains, losses, local runoff and inflow

# Monthly Flow Comparison



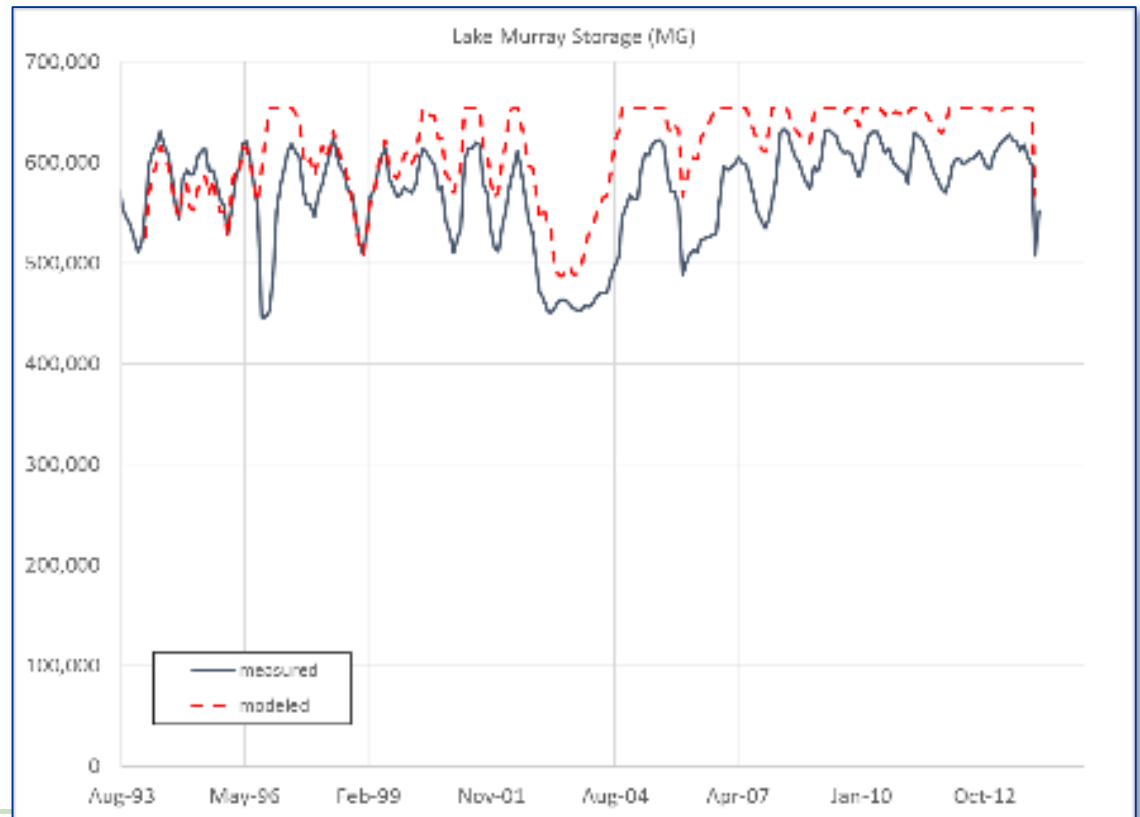


# Daily Flow Comparison – Drought Period



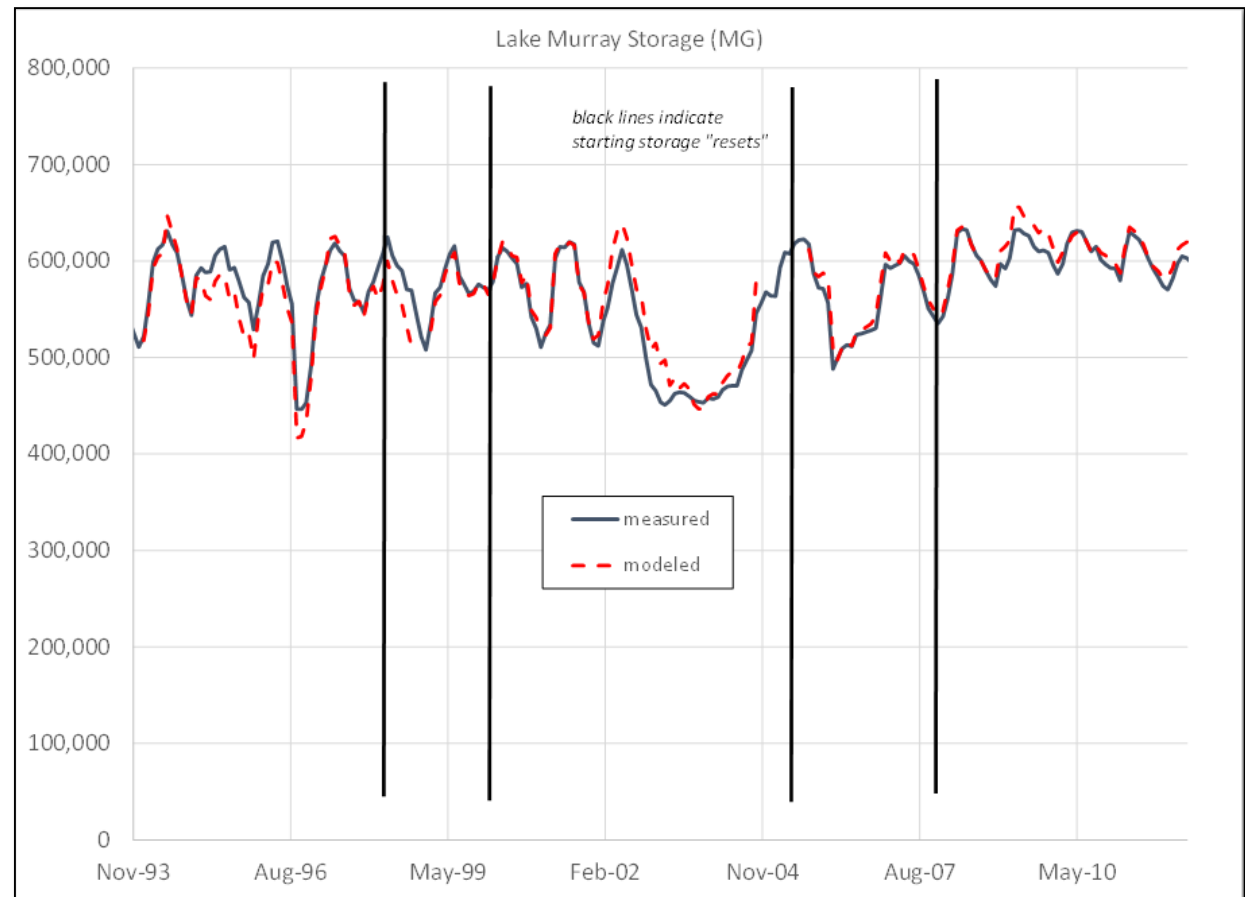
# Lake Murray Verification Exercise

- **Approach:** Set the Lake Murray release equal to the historical release, then run the model to check that the combination of inflow, evaporation, and withdrawals/discharges result in a reasonable match of historical lake levels/storage.
- **Observations:** Modeled lake storage was higher than observed storage for certain years



# Lake Murray Verification Exercise

- **Adjustments:** Adjust inflow by selecting alternative reference gages for headwater inputs at select, ungaged tributaries
- **Results:** Better match of modeled and measured Lake Murray storage



# Baseline Model

- Represents current demands and operations combined with an extended period of estimated hydrology
  - Most demands reflect 2005-2013 averages
  - Estimated hydrology from 1920's-30's to 2013
  - Current reservoir rules, guide curves, minimum releases
  - Rules can be adjusted
  - Inactive users are not included
- The baseline model serves as the starting point for future predictive simulations



# Example Use

## *Assessing a New M&I User – Edisto Example*

- Add model flow gage at proposed withdrawal location
  - Calculate minimum instream flows (20/30/40 Rule)
  
- Add a new M&I permittee
  - Demand = 500 MGY (0.6-2.6 MGD)
  - *Can the river sustain the new user?*
  
- Enter minimum instream flows in user object
  - *Are there shortages, i.e. does the withdrawal cause streamflow to drop below the minimum instream flow?*

***Note that this example does not necessarily represent how DHEC will use the model to evaluate a proposed withdrawal***

# Add Flow Gage from Palette

**Object Palette**

**Simplified Water Allocation Model (SWAM)**

Simulation Period

Start Date (MM/DD/YYYY): 1/1/1932

End Date (MM/DD/YYYY): 12/1/2013

Simulation Type

Monthly Planning     Prior Appropriations

Daily Planning         Riparian Water Rights

Short Term Forecasting

Firm Yield Calculator

Run (ctrl R)

**Input Summaries and Outputting**

Node Priorities

Node Locations

Reservoir Accounts

Output Specs

Input & Output Units

AF, AFM, AFD     MB, MBD, CFS     m8, m8/d, m3/s

Main | 
 Node Output | 
 Reservoir Output | 
 Flow Gage Output | 
 Aquifer Output

# Add Industrial Water User Object from Palette

**Object Palette**

### Simplified Water Allocation Model (SWAM)

Simulation Period

Start Date (MM/DD/YYYY): 1/1/1932

End Date (MM/DD/YYYY): 12/1/2013

Simulation Type

Monthly Planning     Prior Appropriations

Daily Planning         Riparian Water Rights

Short Term Forecasting

Firm Yield Calculator

**Run (ctrl R)**

### Input Summaries and Outputting

Node Priorities

Node Locations

Reservoir Accounts

Output Specs

Input & Output Units

AF, AFM, AFD     MB, MBD, CFS     m3, m3/d, m3/w

Location of new user

Export to

Edisto Aquif

Main

Node Output

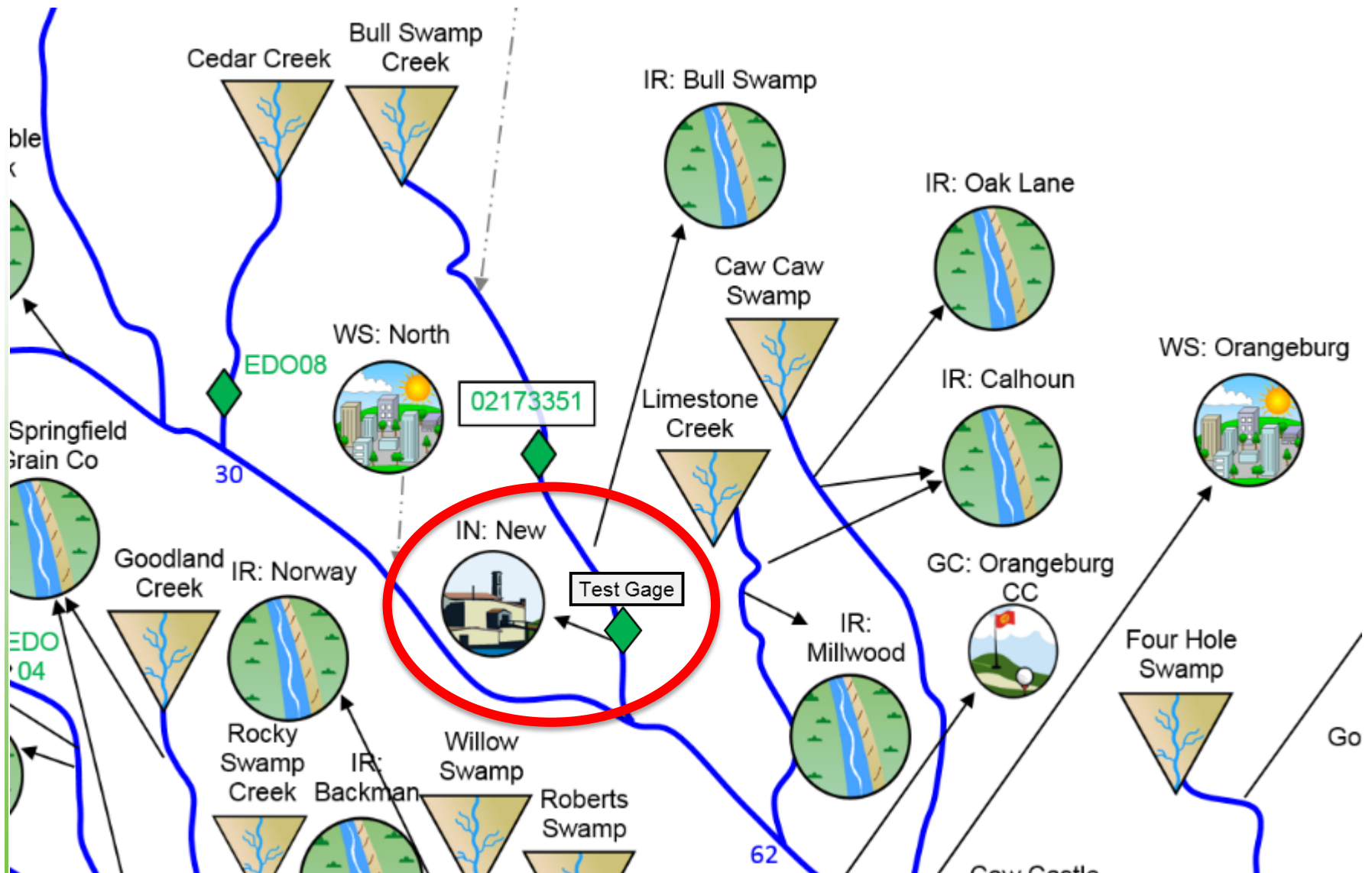
Reservoir Output

Flow Gage Output

Aquifer Output

+

# Add Flow Gage & Industrial Water User Objects





# Specify Flow Gage Location

The image displays a map of a stream network with several gages. A dialog box titled "Flow Gage" is open, showing the configuration for a gage named "Test Gage". The "Target Stream" is set to "Bull Swamp Creek" and the "Downstream Location (mi)" is 15. The dialog also includes a "Delete Gage" button, a "Comments" text area, and "Save" and "Close" buttons. On the map, the "Test Gage" location is highlighted with a red circle. Other gages shown include "EDO08" (WS: North), "EDO04" (Goodland Creek), "IR: Norway", "IR: Backman", "IR: Millwood", "GC: Orangeburg CC", and "Four Hole Swamp". Stream names include Cedar Creek, Bull Swamp Creek, Rocky Swamp Creek, Willow Swamp, and Roberts Swamp. The map also shows "Springfield Grain Co" and "Go".

# Run the Model over the Entire Period of Record

The image displays the user interface of the Simplified Water Allocation Model (SWAM). At the top left is an 'Object Palette' with various icons. The main window is titled 'Simplified Water Allocation Model (SWAM)' and contains the following elements:

- Simulation Period:** Start Date (MMDDYYYY) set to 1/1/1992, End Date (MMDDYYYY) set to 12/1/2013.
- Simulation Type:** Includes checkboxes for Monthly Planning, Daily Planning, Short Term Forecasting, Firm Yield Calculator, Prior Appropriations, and Riparian Water Rights.
- Run (ctrl R):** A button highlighted with a red circle.
- Input Summaries and Outputting:** A section with buttons for Node Priorities, Node Locations, Reservoir Accounts, and Output Specs, along with a bar chart icon.
- Input & Output Units:** Checkboxes for AF, AFM, AFD; MD, MDD, CFS; and m0, m0d, m3k.

Below the main window is a network diagram showing various nodes and reservoirs, including IR: Titan (Chinquapin), IR: Walter P. Rawl & Sons, IR: Kyzer, IN: Gaston, Cedar Creek, Bull Swamp Creek, IR: Bull Swamp, IR: Oak Lane, IR: Celhoun, WS: Crangeburg, IR: Halgier, IR: Smith WG III, IR: Titan (Shaw), WS: North, Limestone Creek, IR: Millwood, GC: Crangeburg, IR: Aiken, KY-TN Clay, Rocky Spring Creek, Hunter Branch, IR: Boland, IR: Walther, IR: Norway, Goodland Creek, Rocky Swamp Creek, Willow Swamp, IR: Beokman, IR: Roberts, and Four Hole Swamp. A 'Test Gage' is also indicated. The CDM Smith logo is visible in the bottom right of the main window.

At the bottom of the interface is a navigation bar with tabs: Main, Node Output, Reservoir Output, Flow Gage Output, and Aquifer Output. The 'Main' tab is currently selected.

Logos for DHEC (Department of Health and Environmental Control) and the University of North Carolina are visible in the top right corner. A small box labeled 'Edisto Aquifer' with a mathematical equation is also present on the right side.

# Calculate the Minimum Instream Flows

Model Output:

	<u>Reach / mi</u>
	<i>Bull Swamp Creek / 15</i>
Date	Test Gage Flow (CFS)
<b>Min</b>	<b>5</b>
<b>Max</b>	<b>96</b>
<b>Avg</b>	<b>25</b>
1/1/32	34.7
1/2/32	34.7
1/3/32	34.7
1/4/32	37.8
1/5/32	34.7
1/6/32	34.7
1/7/32	37.8
1/8/32	43.7
1/9/32	50.3
1/10/32	53.4
1/11/32	50.3
1/12/32	50.3
1/13/32	50.3
1/14/32	53.4
1/15/32	50.3
1/16/32	46.9
1/17/32	40.6
1/18/32	37.8
1/19/32	34.7



Minimum Flow Calculations:

	: 40%
	: 30%
	: 20%
Month	Instream Flow (cfs)
Jan	10.3
Feb	10.3
Mar	10.3
Apr	10.3
May	7.7
Jun	7.7
Jul	5.2
Aug	5.2
Sep	5.2
Oct	5.2
Nov	5.2
Dec	7.7

# Add the New User in the Water User Dialogue

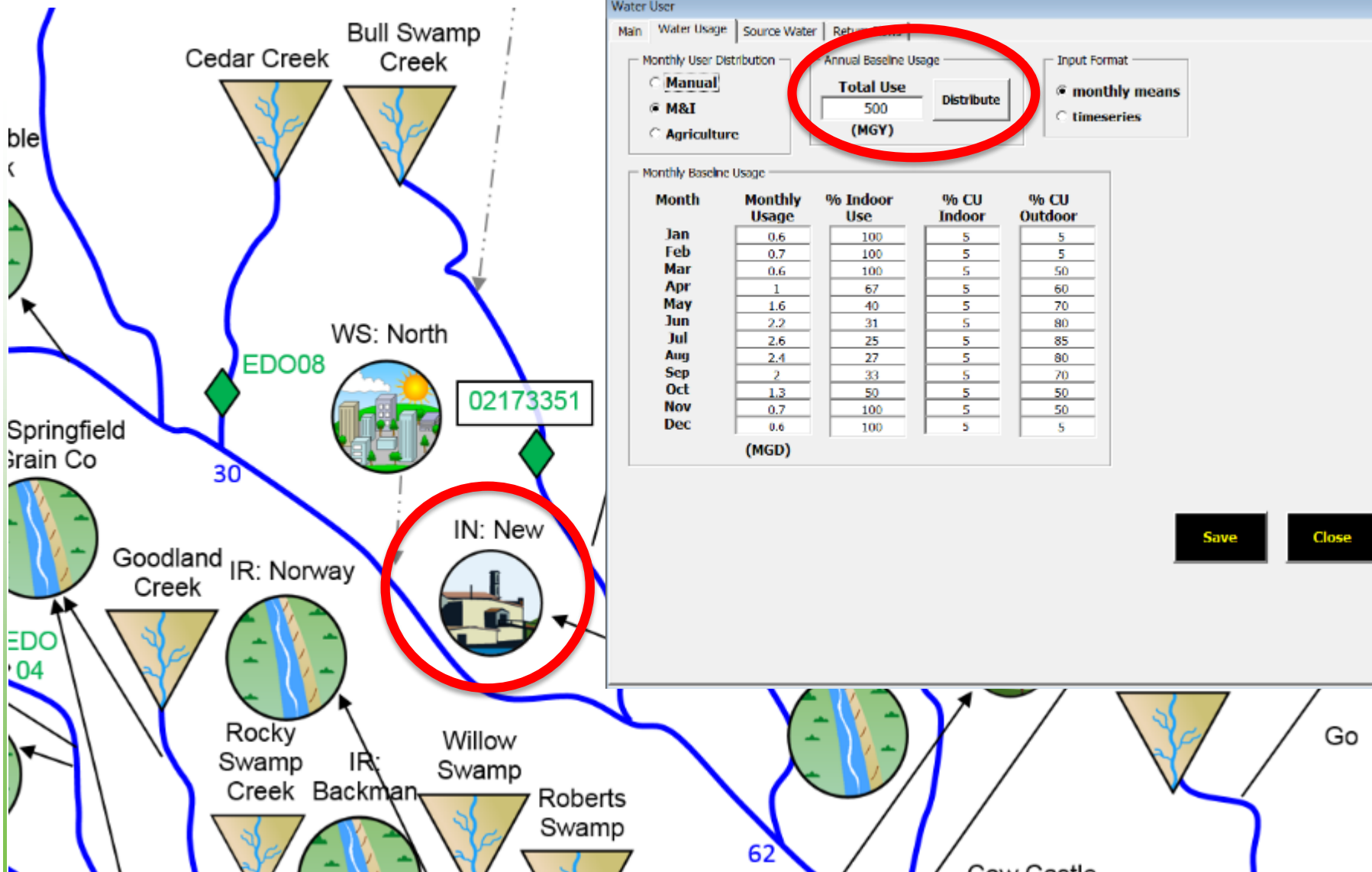
The image displays a water management software interface. On the left, a map shows a network of blue waterways. Key features include:

- Cedar Creek** and **Bull Swamp Creek** at the top.
- Springfield Grain Co** and **Goodland Creek** on the left side.
- Rocky Swamp Creek** and **Willow Swamp** at the bottom.
- Roberts Swamp** at the bottom right.
- A central node labeled **WS: North** with a city icon and ID **02173351**.
- A node labeled **IR: Norway** with a dam icon and ID **EDO08**.
- A node labeled **IR: Backman** with a dam icon and ID **EDO04**.
- A node labeled **IN: New** with a factory icon, circled in red.
- Other labels include **30**, **62**, and **Go**.

On the right, the **Water User** dialog box is open, showing the following details:

- Water User Name:** IN: New (circled in red)
- Delete Node** button
- Multiple Sources of Water?**
- Supplemental Supply/Demand Alternatives:**
  - Conservation
  - Transbasin Import
  - Recapture Reuse
  - Water Exchange
  - Ag Transfer
- Comments:** (empty text area)
- Save** and **Close** buttons at the bottom right.

# Specify Water Use



# Specify the Source and Diversion Location

The map displays a network of waterways including Cedar Creek, Bull Swamp Creek, Goodland Creek, Rocky Swamp Creek, Willow Swamp, and Roberts Swamp. A red circle highlights a location labeled 'IN: New' on the river. An inset window titled 'Water User' is overlaid on the map, showing configuration options for a water user. The 'Source Stream' is set to 'Bull Swamp Creek' and the 'Diversion Location (mi)' is set to '14.9'. Other options include 'Direct River', 'Reservoir', and 'Groundwater' for source water type, and 'Permit Limit', 'Seasonal Permit', and 'Minimum Flow' for diversion capacity and permit settings.

**Water User**

Man | Water Usage | Source Water | Return Flows

**Source Stream:** Bull Swamp Creek

Source Water Type:  Direct River  Reservoir  Groundwater

**Diversion Location (mi):** 14.9

Priority Date: 4/1901

Diversion Capacity: 1000 (CFS)

Permit Limit: 1000 (MGM)

Seasonal Permit

Minimum Flow

Identifying Notes:

Save

Close

# Designate the Return Location

The map displays a network of waterways including Cedar Creek, Bull Swamp Creek, Goodland Creek, Rocky Swamp Creek, Willow Swamp, and Roberts Swamp. A specific location, 'IN: New', is circled in red. The 'Water User' window is open, showing the 'Return Flows' tab. The 'Return Flow Locations' section has 'single point' selected. The 'Receiving Stream' dropdown is set to 'Bull Swamp Creek', and the 'RF Location (mi)' is set to 15.5. The 'Save' and 'Close' buttons are visible.

Return Flow Locations	Receiving Stream	RF Location (mi)	RF Lag (months)
<input checked="" type="radio"/> single point	Bull Swamp Creek	15.5	
<input type="radio"/> multiple			

# Run the Model over the Entire Period of Record

The image displays the user interface of the Simplified Water Allocation Model (SWAM). At the top left is an 'Object Palette' with various icons. The main window is titled 'Simplified Water Allocation Model (SWAM)' and contains the following elements:

- Simulation Period:** Start Date (MMDDYYYY) set to 1/1/1992, End Date (MMDDYYYY) set to 12/1/2013.
- Simulation Type:** Includes checkboxes for 'Monthly Planning', 'Daily Planning', 'Short Term Forecasting', 'Firm Yield Calculator', 'Prior Appropriations', and 'Riparian Water Rights'.
- Run (ctrl R):** A button highlighted with a red circle.
- Input Summaries and Outputting:** A panel with buttons for 'Node Priorities', 'Node Locations', 'Reservoir Accounts', and 'Output Specs', along with 'Input & Output Units' options (AF, AFM, APD; MD, M3D, CFS; m0, m0d, m3k).

The central window shows a 'Run' button and a 'Cancel' button. Below the buttons, it says 'Simulation Year ='. The background features a network diagram with nodes such as 'IR: Titan (Chinquapin)', 'IR: Walter P. Rawl & Sons', 'IR: Kyzer', 'IN: Gaston', 'Cedar Creek', 'Bull Swamp Creek', 'IR: Bull Swamp', 'Caw Caw Swamp', 'IR: Oak Lane', 'IR: Celhoun', 'WS: Crangeburg', 'IR: Halgier', 'IR: Smith WG III', 'IR: Titan (Shaw)', 'WS: Aiken', 'KY-TN Clay', 'Rocky Spring (Imp) Creek', 'IN: JM Huber', 'Cedar Creek (IR: M...)', 'Grain Co', 'Hunker Branch', 'IR: Boland', 'IR: Walther', 'Goodland Creek', 'IR: Norway', 'Rocky Swamp Creek', 'Willow Swamp', 'IR: Beekman', 'Roberts', 'Limestone Creek', 'IR: Millwood', 'GC: Crangeburg', 'Four Hole Swamp', and 'Goodbys Swamp'. A 'Test Gage' is also indicated. The bottom of the interface has a navigation bar with 'Main', 'Node Output', 'Reservoir Output', 'Flow Gage Output', and 'Aquifer Output' tabs.





# Build a Shortage Plot for the New User

The screenshot displays the **Simplified Water Allocation Model (SWAM)** interface. At the top left is an **Object Palette** with various icons. The main window is divided into several panels:

- Simulation Period:** Start Date (MM/DD/YYYY) is 1/1/1992, and End Date (MM/DD/YYYY) is 12/1/2013.
- Simulation Type:** Includes checkboxes for Monthly Planning, Daily Planning, Short Term Forecasting, Firm Yield Calculator, Prior Appropriations, and Riparian Water Rights.
- Run (ctrl R):** A button to execute the simulation.
- Input Summaries and Outputting:** A panel with buttons for Node Priorities, Node Locations, Reservoir Accounts, and Output Specs. A red circle highlights the **Output Specs** button.
- Input & Output Units:** Includes checkboxes for AF, AFM, AFD, MD, MGD, CFS, and m8, m8/d, m3/s.

The central part of the interface shows a network map with nodes and links. A **Test Gage** is highlighted at the **IN: New** node. An **Output Plotting** dialog box is open, showing:

- Node:** IN: New
- Output Parameter:** Shortage (MGD)
- Plot Type:** Time Series (selected) and Exceedance.
- Buttons: Clear Exceedance Links, Create Dynamic Plot, and Close.

Below the map, a **Shortage Plot** is displayed. The y-axis is labeled **IR: New Shortage (MGD)** and ranges from 0.0 to 1.0. The x-axis is labeled **Date** and shows a timeline from Jan-32 to May-10. The plot shows a constant shortage of 0.0 MGD throughout the period.

At the bottom, there is a navigation bar with tabs: **Main**, **Node Output**, **Reservoir Output**, **Flow Gage Output**, and **Aquifer Output**.



# Add Minimum Flows

**Water User**

Main | Water Usage | Source Water | Return Flows

**Source Stream:** Bull Swamp Creek

Source Water Type:
 

- Direct River
- Reservoir
- Groundwater

Diversion Location (mi): 14.9

Priority Date: 3/4/1901

Diversion Capacity (CFS): 1000

Permit Limit (MGM): 1000

Seasonal Permit  
 Minimum Flow

**Monthly Minimum Flow Requirements**

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10.3	10.3	10.3	10.3	7.7	7.7	5.2	5.2	5.2	5.2	5.2	7.7

CFS

Identifying Notes:

# Re-Run the Model

The image displays the user interface of the Simplified Water Allocation Model (SWAM). At the top, a control panel titled "Simplified Water Allocation Model (SWAM)" contains simulation parameters. The "Simulation Period" section shows a Start Date of 1/1/1992 and an End Date of 12/1/2013. The "Simulation Type" section includes options for Monthly Planning, Daily Planning, Short Term Forecasting, Firm Yield Calculator, Prior Appropriations, and Riparian Water Rights. A "Run (ctrl R)" button is highlighted with a red circle.

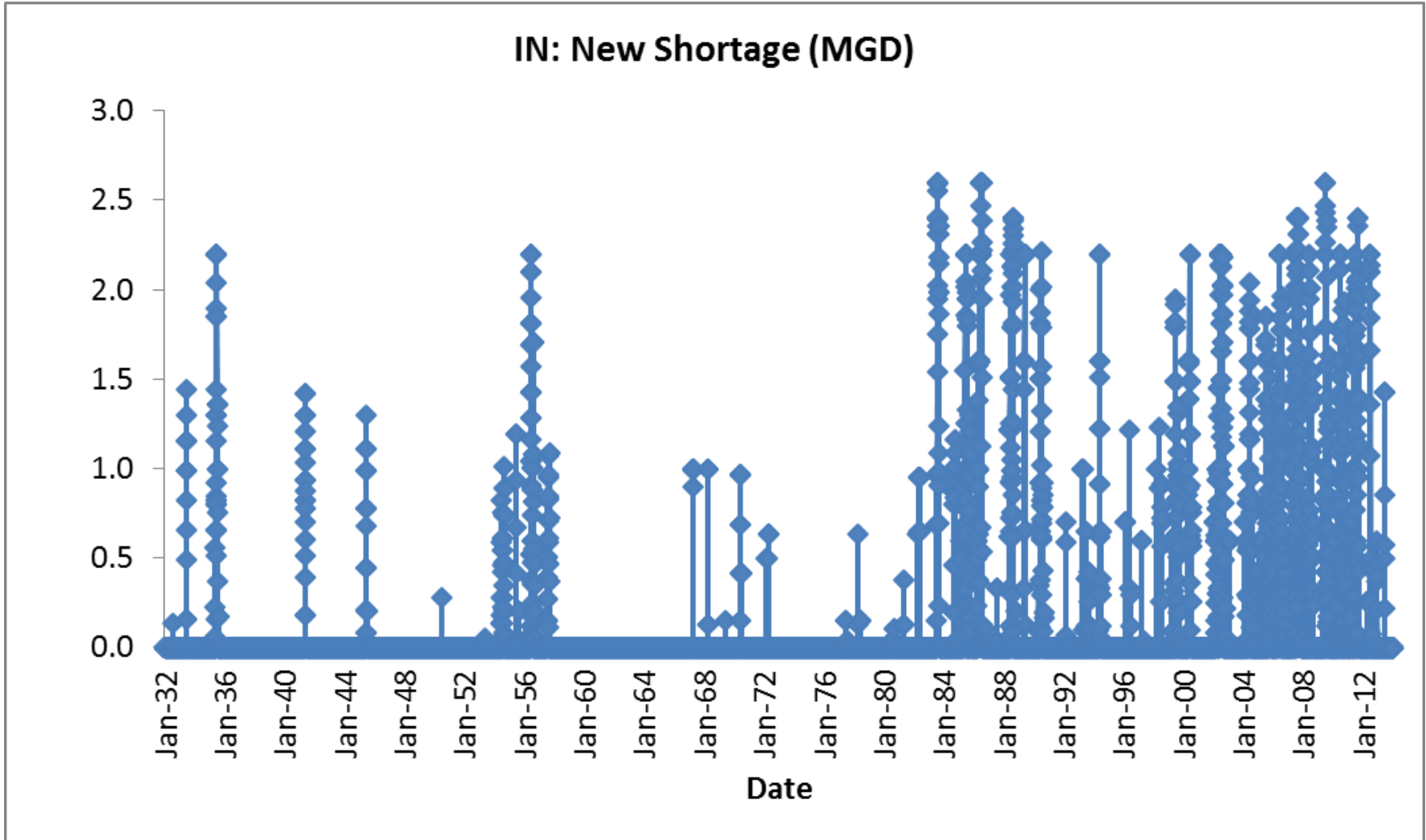
To the right, the "Input Summaries and Outputting" panel features buttons for Node Priorities, Node Locations, Reservoir Accounts, and Output Specs, along with a bar chart icon. Below these are "Input & Output Units" options: AF, AFM, APD; MD, MDD, CFS; and m0, m0d, m0k.

In the center, a modal dialog box titled "Simplified Water Allocation Model (SWAM)" prompts the user to "Click on button:" with two large buttons: "Run" and "Cancel". Below the buttons, it says "Simulation Year =" and includes the CDM Smith logo.

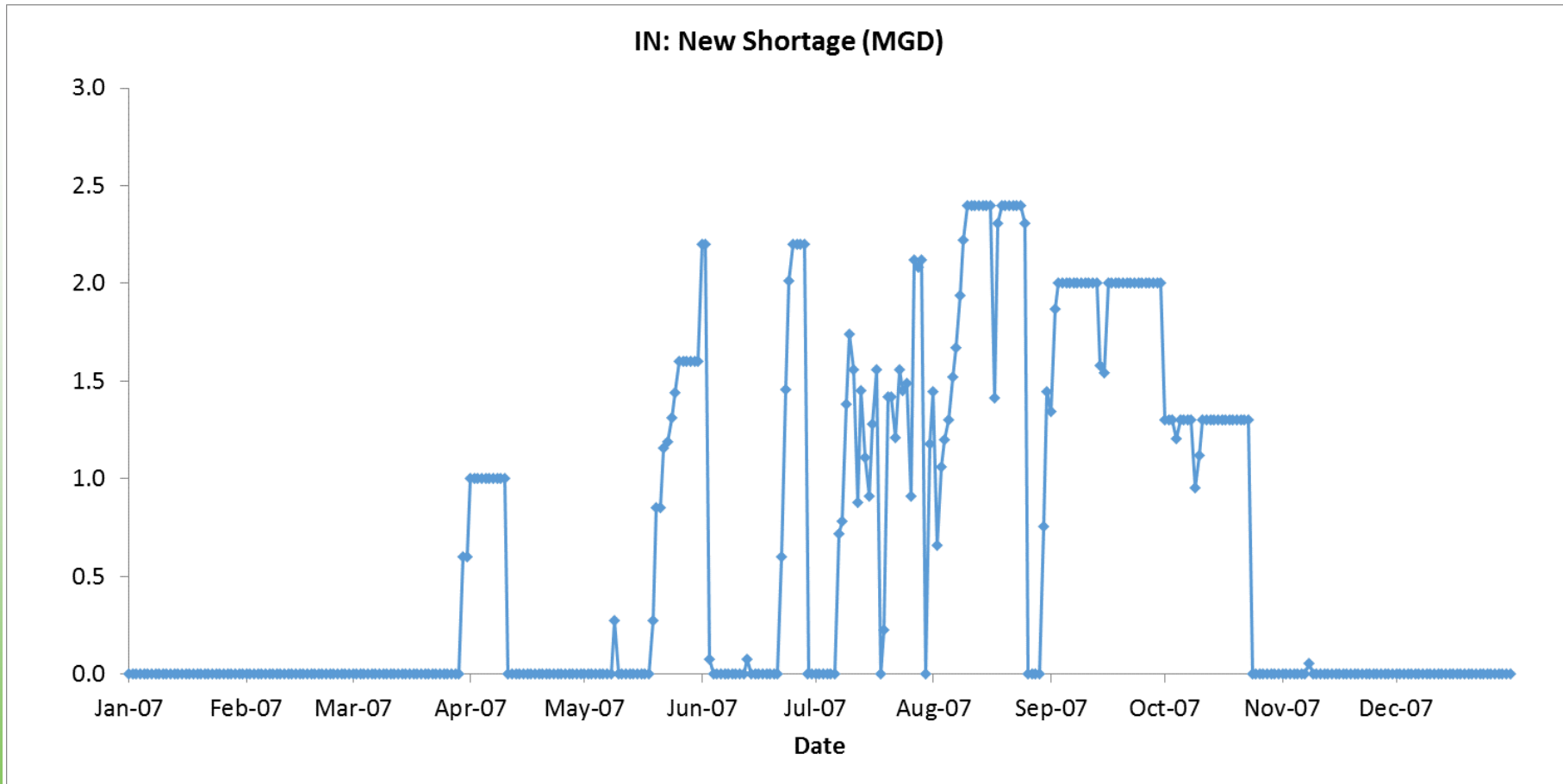
The background shows a network diagram of water resources, including various Inflow Reservoirs (IR), Reservoirs (R), and Swamps (WS). A "Test Gage" is also indicated. The interface includes an "Object Palette" on the left and a bottom navigation bar with tabs for Main, Node Output, Reservoir Output, Flow Gage Output, and Aquifer Output.



# Shortages with Min. Instream Flows Enforced



# Shortages with Min. Instream Flows Enforced: 2007



# Shortages also Available in Node Output Table

		<u>Priority Rank</u>	<u>Reach</u>	<u>Location</u>	<u>Permit Limit (MGM)</u>	<u>Ditch Capacity (CFS)</u>	<u>Storage Capacity (MG)</u>	<u>Storage Withdrawal Permit (MGM)</u>			
	<i>IN: New</i>	49	<i>Bull Swamp Creek</i>	15	1000	1000	0	325829			
<u>Date</u>	<u>Physically Avail. (MGD)</u>	<u>Legally Avail. (MGD)</u>	<u>Diverted (MGD)</u>	<u>Storage (MG)</u>	<u>GW Pumping (MGD)</u>	<u>Demand (MGD)</u>	<u>Shortage (MGD)</u>	<u>Return Flow (MGD)</u>	<u>Release (MGD)</u>	<u>Evap Losses (MGD)</u>	
<b>Min</b>	2	0	0	0	0	1	0	0	0	0	
<b>Max</b>	67	36	3	0	0	3	2	1	0	0	
<b>Avg</b>	17	11	1	0	0	1	0	1	0	0	
1/31/06	17	8	1	0	0	1	0	1	0	0	
2/28/06	15	5	1	0	0	1	0	1	0	0	
3/31/06	10	0	0	0	0	1	1	0	0	0	
4/30/06	8	0	0	0	0	1	1	0	0	0	
5/31/06	5	1	1	0	0	2	1	0	0	0	
6/30/06	17	13	2	0	0	2	0	1	0	0	
7/31/06	7	4	3	0	0	3	0	1	0	0	
8/31/06	11	9	2	0	0	2	0	1	0	0	
9/30/06	11	8	2	0	0	2	0	1	0	0	
10/31/06	9	6	1	0	0	1	0	1	0	0	
11/30/06	17	14	1	0	0	1	0	1	0	0	
12/31/06	16	10	1	0	0	1	0	1	0	0	
1/31/07	20	11	1	0	0	1	0	1	0	0	
2/28/07	18	8	1	0	0	1	0	1	0	0	
3/31/07	17	6	1	0	0	1	0	1	0	0	
4/30/07	10	0	0	0	0	1	1	0	0	0	
5/31/07	7	2	2	0	0	2	0	1	0	0	
6/30/07	11	7	2	0	0	2	0	1	0	0	
7/31/07	6	4	3	0	0	3	0	1	0	0	
8/31/07	5	3	2	0	0	2	0	1	0	0	
9/30/07	2	0	0	0	0	2	2	0	0	0	
10/31/07	5	2	1	0	0	1	0	1	0	0	
11/30/07	6	3	1	0	0	1	0	1	0	0	
12/31/07	17	11	1	0	0	1	0	1	0	0	



## Other Example Uses

- Determine surface water availability
- Predict where and when future water shortages would occur
- Test alternative water management strategies, new operating rules, and “what-if” scenarios
- Evaluate the impacts of future withdrawals on instream flow needs
- Evaluate interbasin transfers
- Consolidate hydrologic data



Questions?

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