

Development of Basinwide Surface-Water Quantity Models in South Carolina

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Surface Water Modeling Project

- Develop surface-water quantity models for each of the State's 8 major river basins
- Models will be an important tool for regional water planning and for updating the State Water Plan:
 - identify potential future water shortages
 - analyze impact of new withdrawals
 - analyze impact of increased water demands
 - evaluate different management strategies
- DNR and DHEC working together
- 2-year project

South Carolina's 8 major river basins



These are the same basins used by DHEC for water-quality assessments and for managing interbasin transfers of water.

Surface Water Modeling Project

- In 2013, DNR and DHEC began preparing a Request for Proposals (RFP) as part of the state procurement process.
- In July 2014, CDM Smith, Inc. was awarded a contract to develop these models using its Simplified Water Allocation Model (SWAM) modeling tool.



Surface Water Modeling Project

- Clemson University is facilitating a stakeholder process, with support from DNR, DHEC, and CDM Smith.
- US Geological Survey is providing streamflow data and is developing a groundwater model.
- US Army Corps of Engineers will be developing water-demand forecasts.



**US Army Corps
of Engineers**

Surface Water Modeling Project

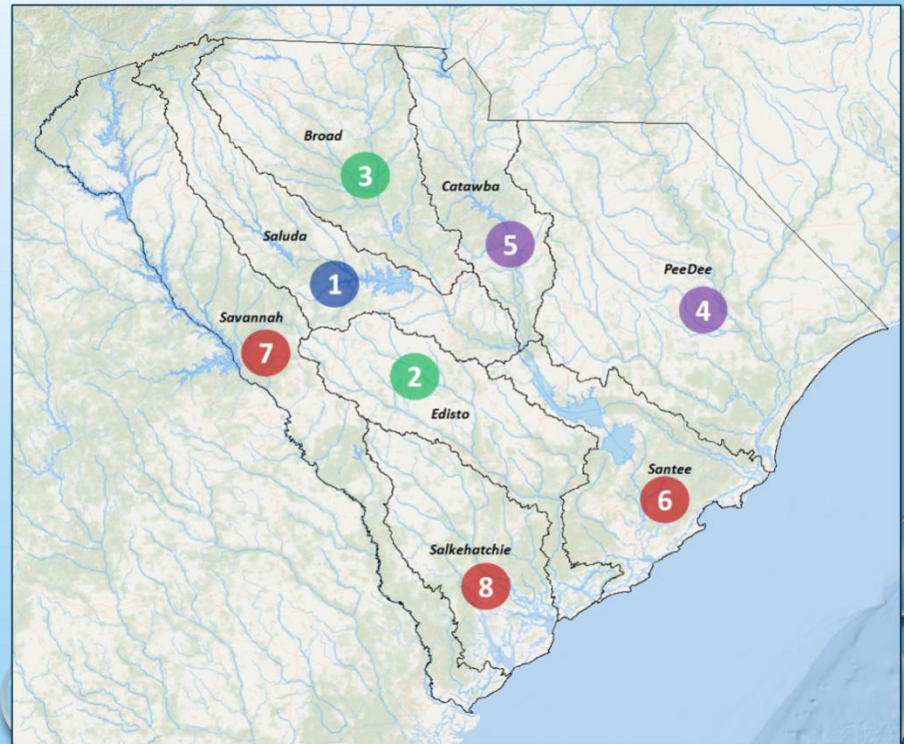
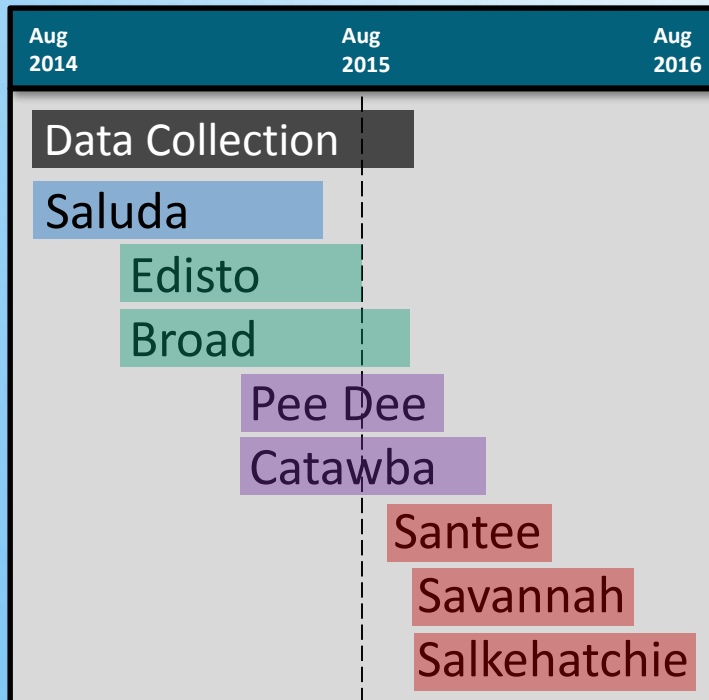
Technical Advisory Committee

Industry • Public Supply • Agriculture • Energy • Environment • Legal

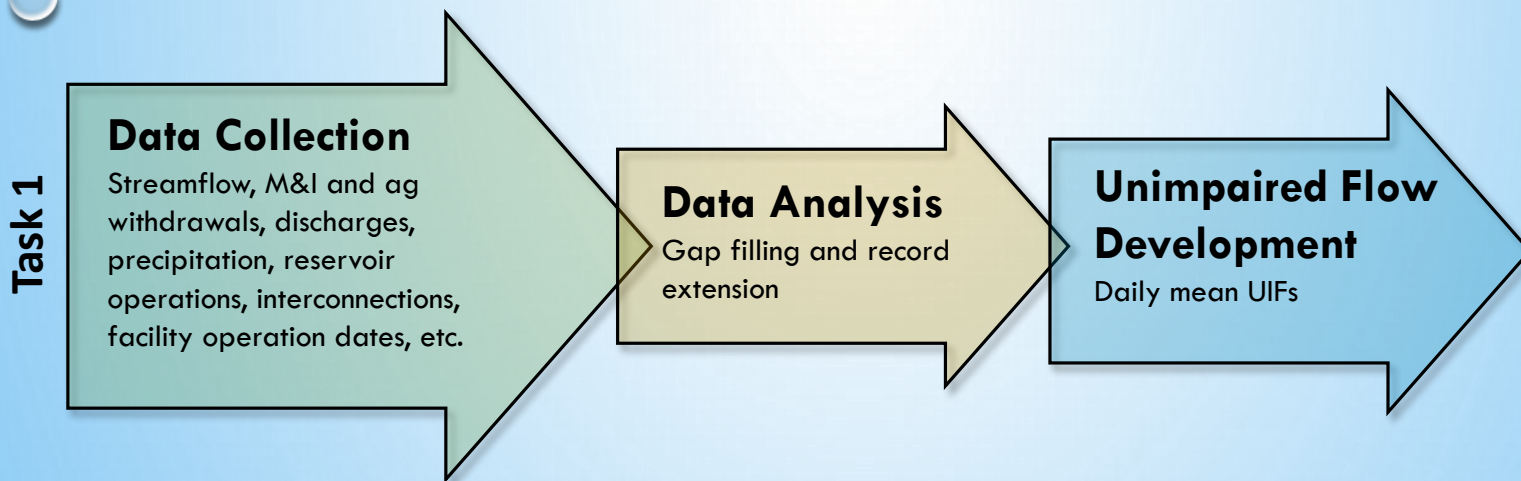
Ruth Albright	<i>Synterra Corporation</i>
Ed Bruce	<i>Duke Energy</i>
Andy Fairey	<i>Charleston Water System</i>
Eric Krueger	<i>The Nature Conservancy</i>
Julie Metts	<i>Santee Cooper</i>
Heather Nix	<i>Upstate Forever</i>
K.C. Price	<i>Greenville Water</i>
Mullen Taylor	<i>Mullen Taylor, LLC</i>
Eddie Twilley*	<i>Twilley, Fondren & Associates</i>
Harrison Watson	<i>Florence Mill</i>
Charles Wingard	<i>Walter P. Rawls and Sons, Inc.</i>

Schedule for Developing the Models

- **Pilot Model** is the Saluda River basin model
- Other models to follow, with order based on data availability
- 2-year schedule requires that groups of models be constructed in parallel



Major Steps in Model Development

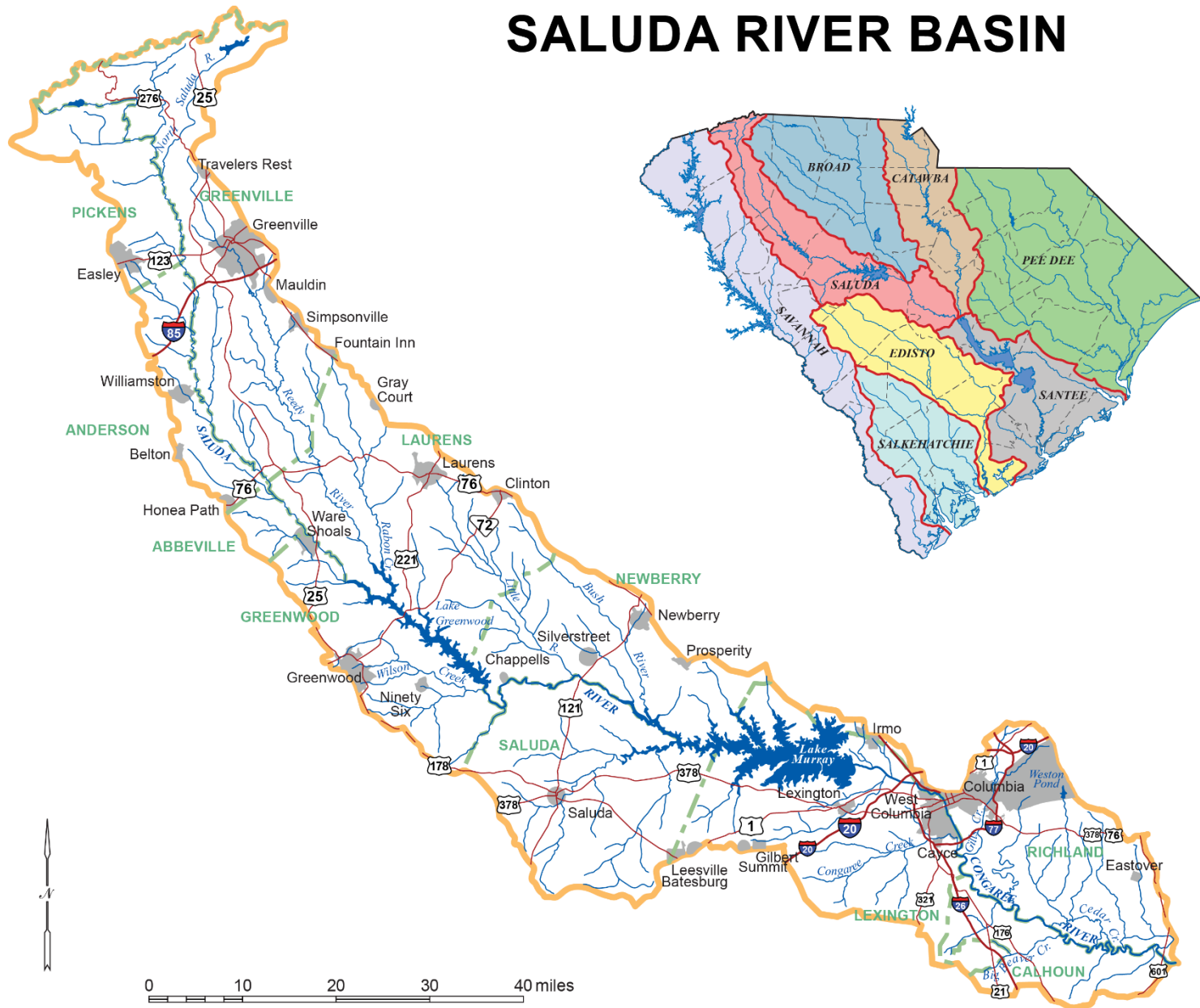


Data collection and processing

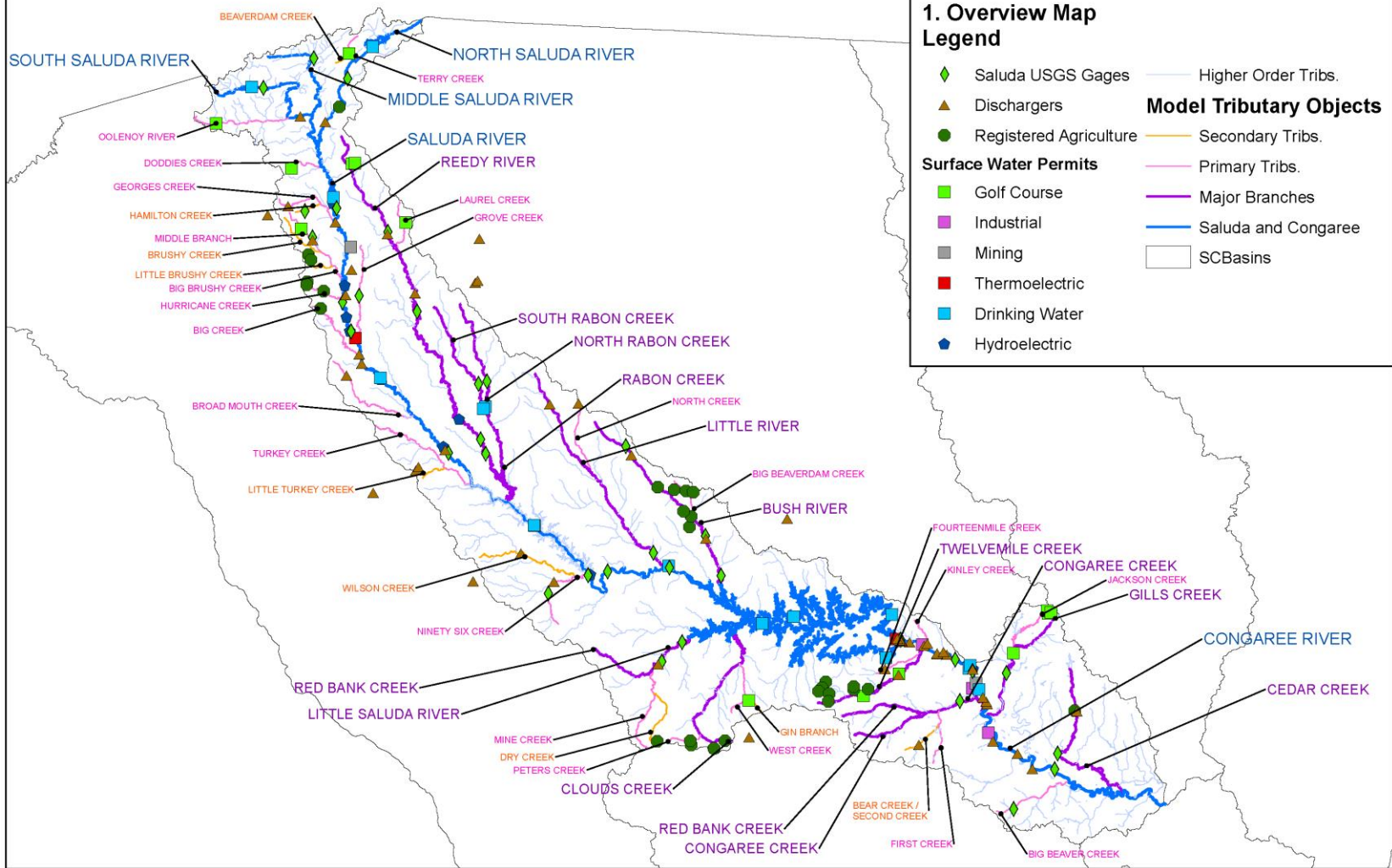
Data extension/gap filling to produce complete daily data sets for 80-year period for all stream gages and water withdrawals and discharges

Unimpaired Flow is the flow in a river as it would be in a completely unaltered state

SALUDA RIVER BASIN



SWAM Model – Saluda basin framework



SWAM Model – Edisto basin framework

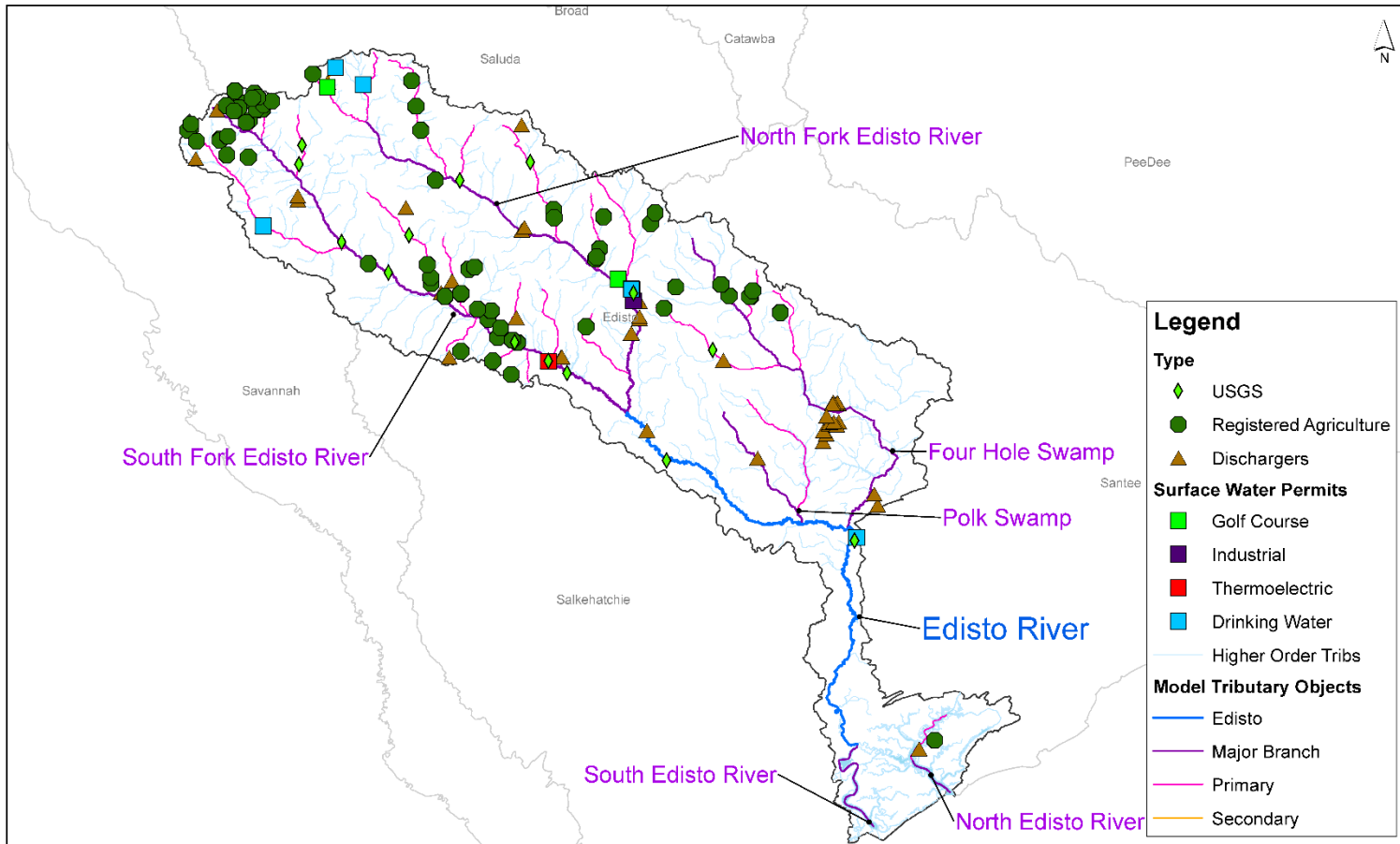


Figure 1: Overview Map

SWAM Model – Broad basin framework

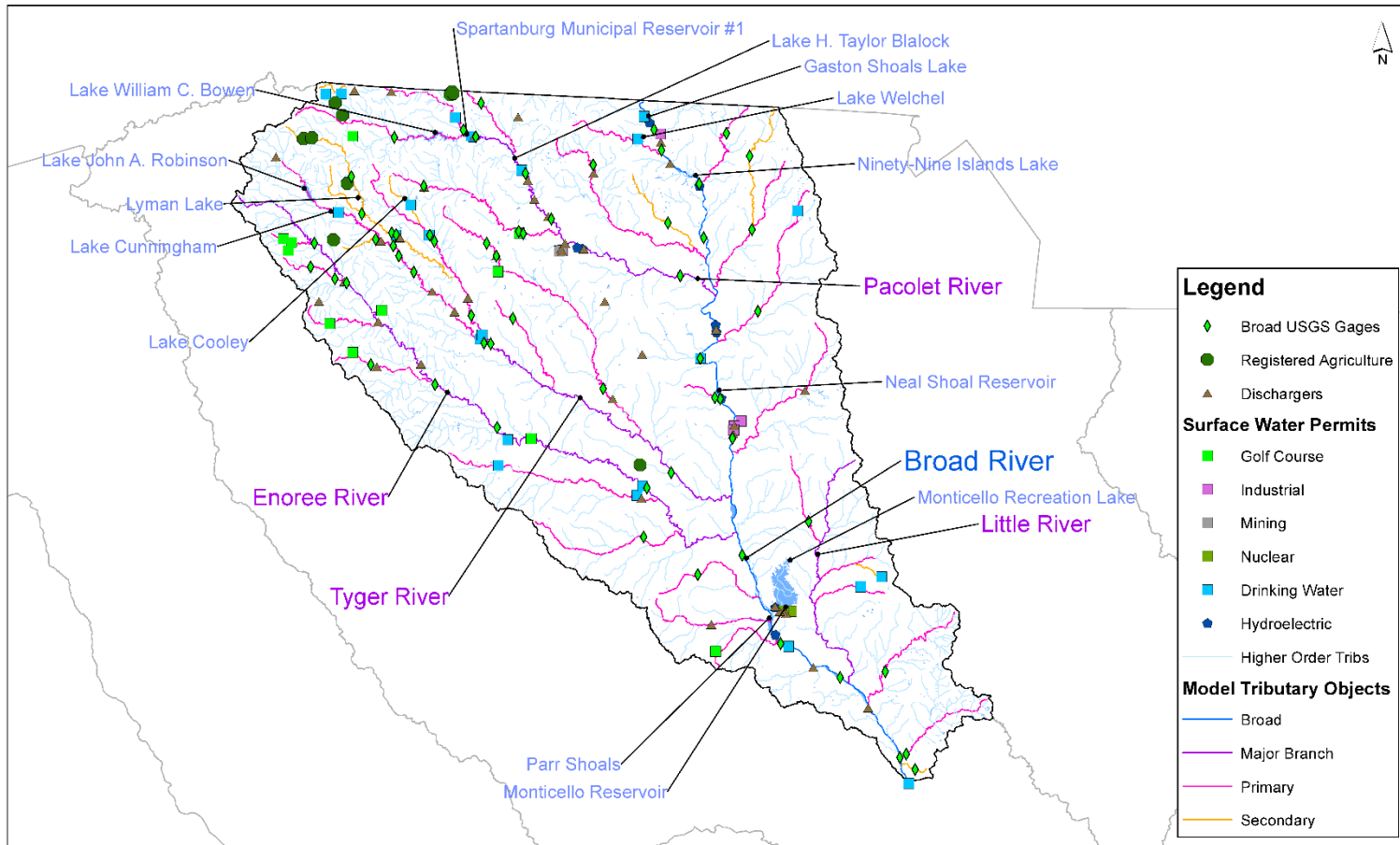


Figure 1: Overview Map

SWAM Model – Pee Dee basin framework

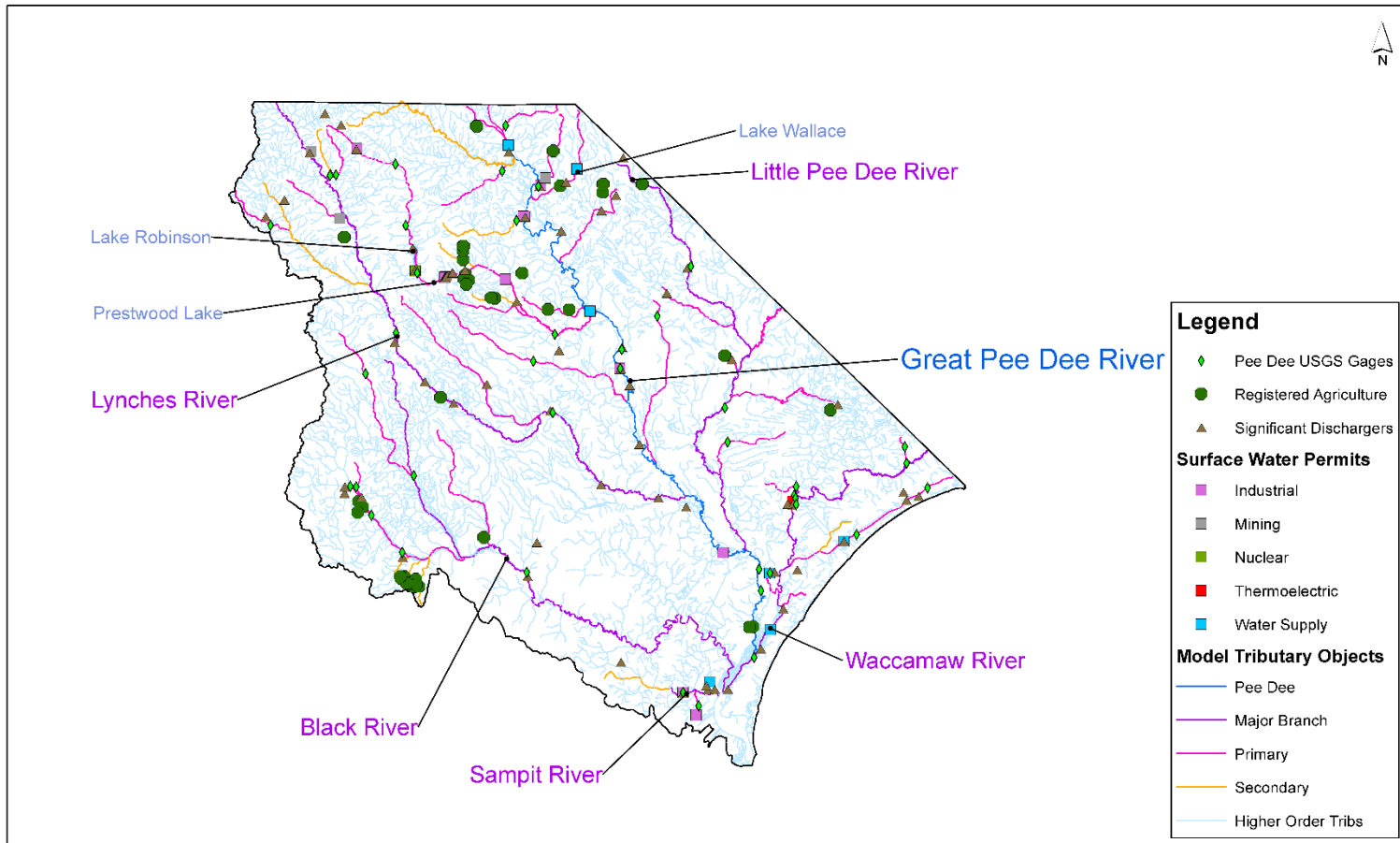


Figure 1: Overview Map

SWAM Model – Catawba basin framework

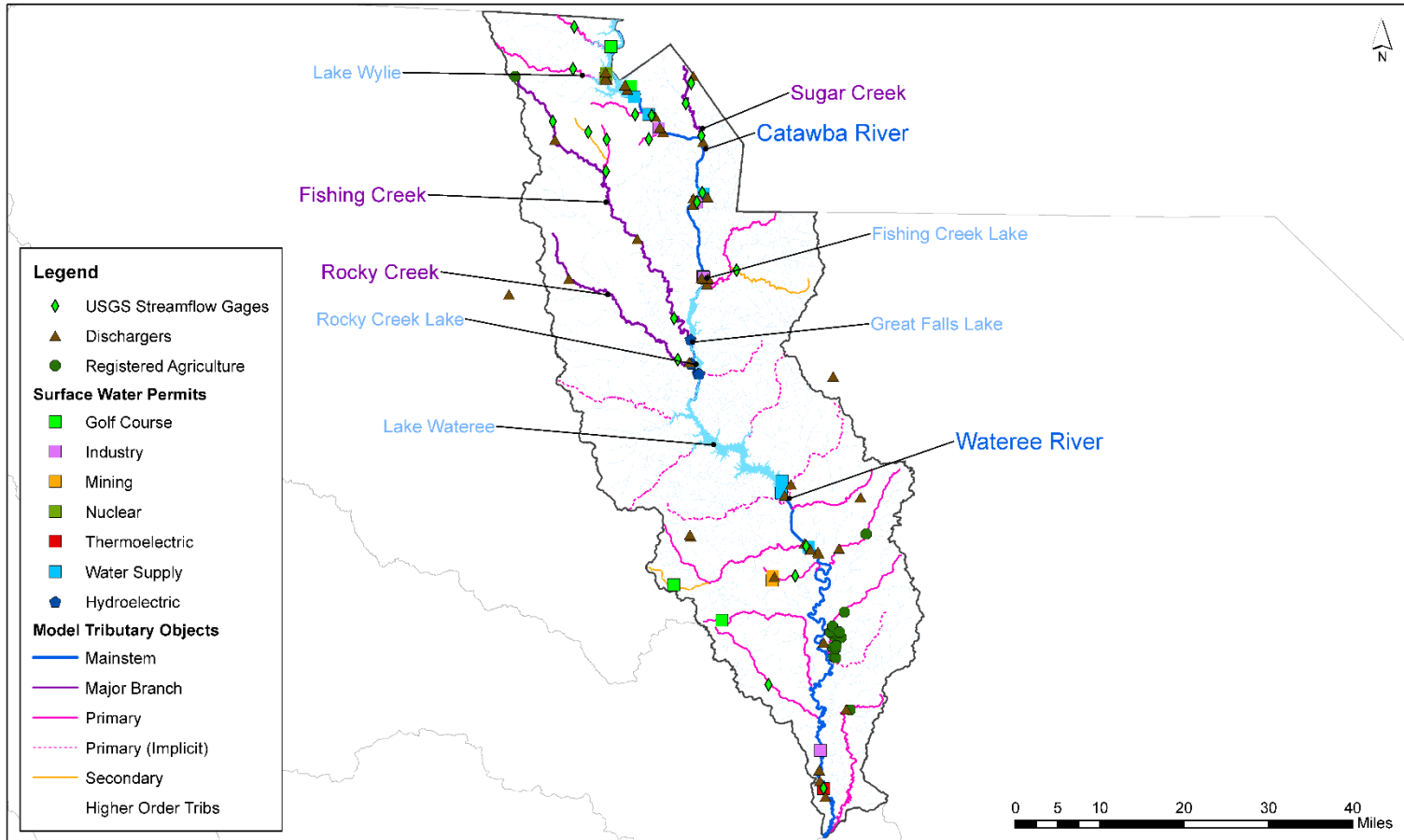
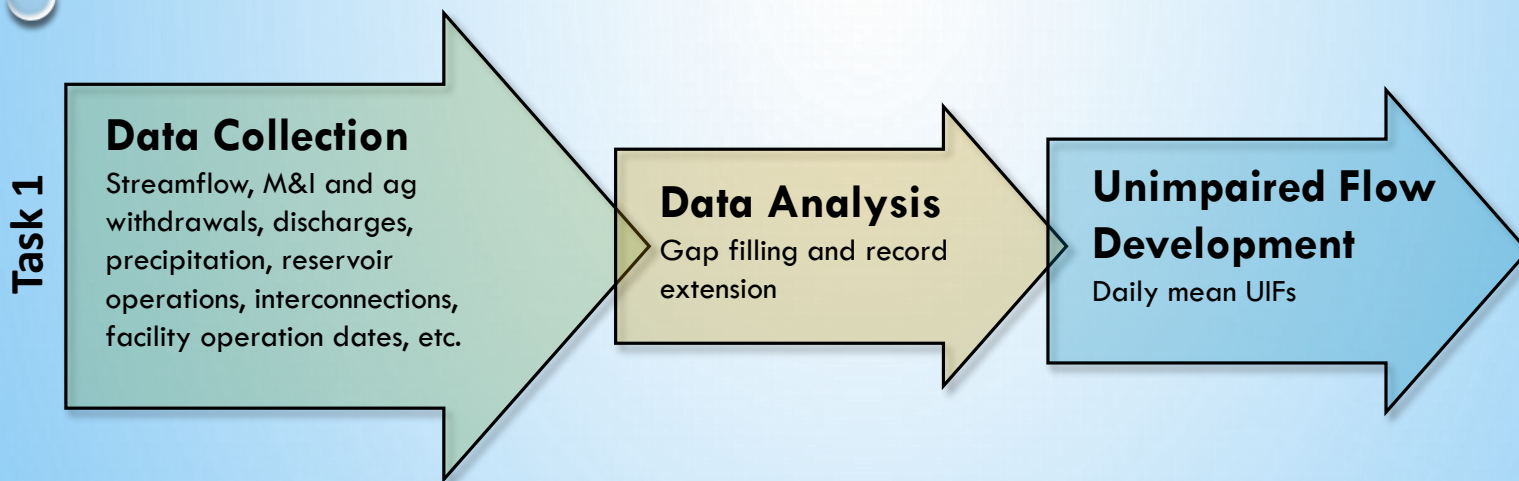
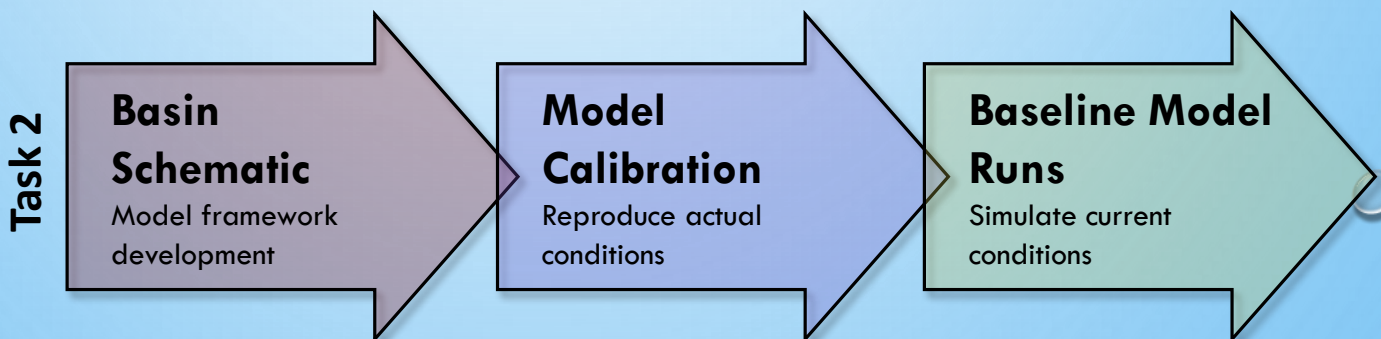


Figure 1: Overview Map

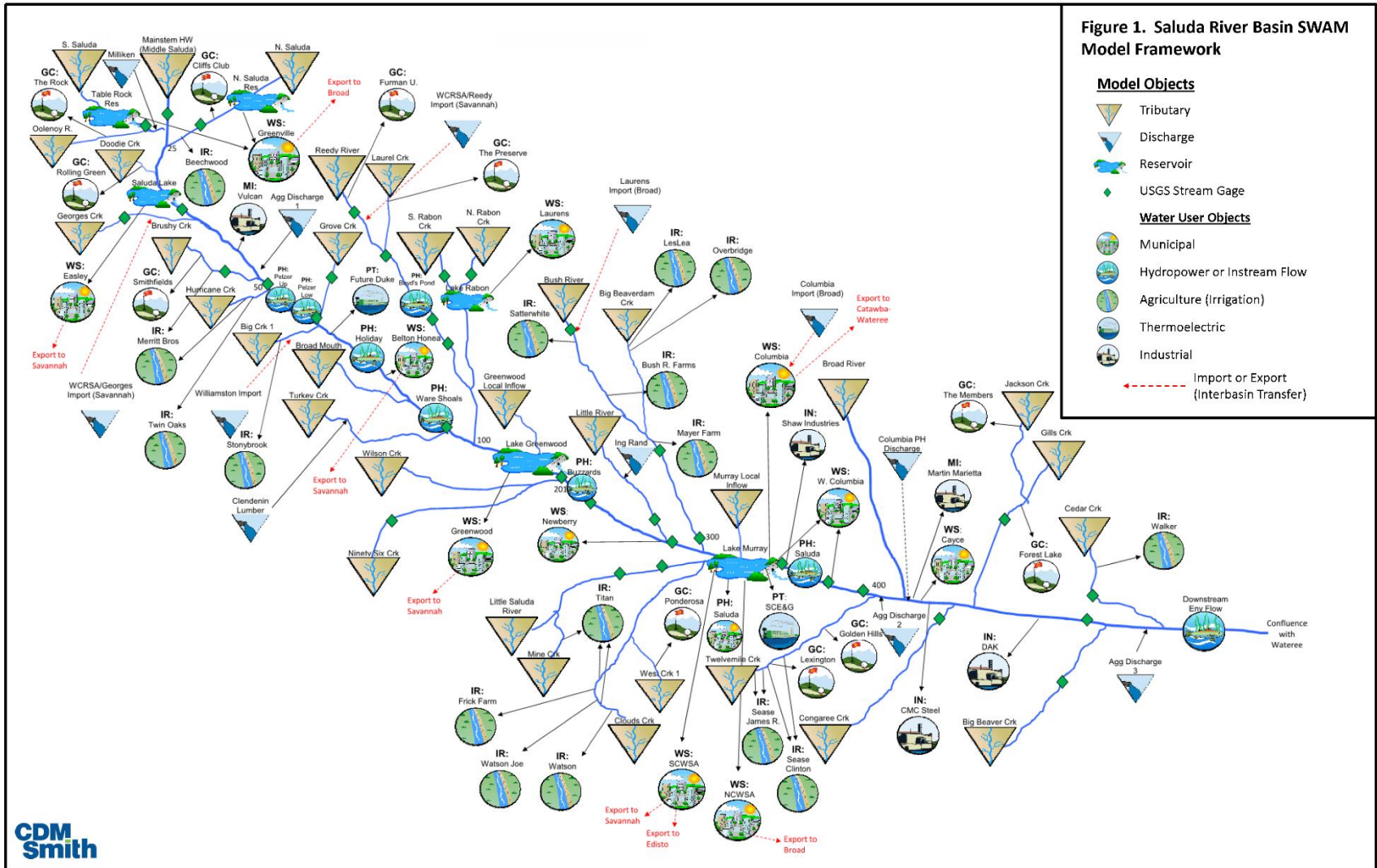
Major Steps in Model Development



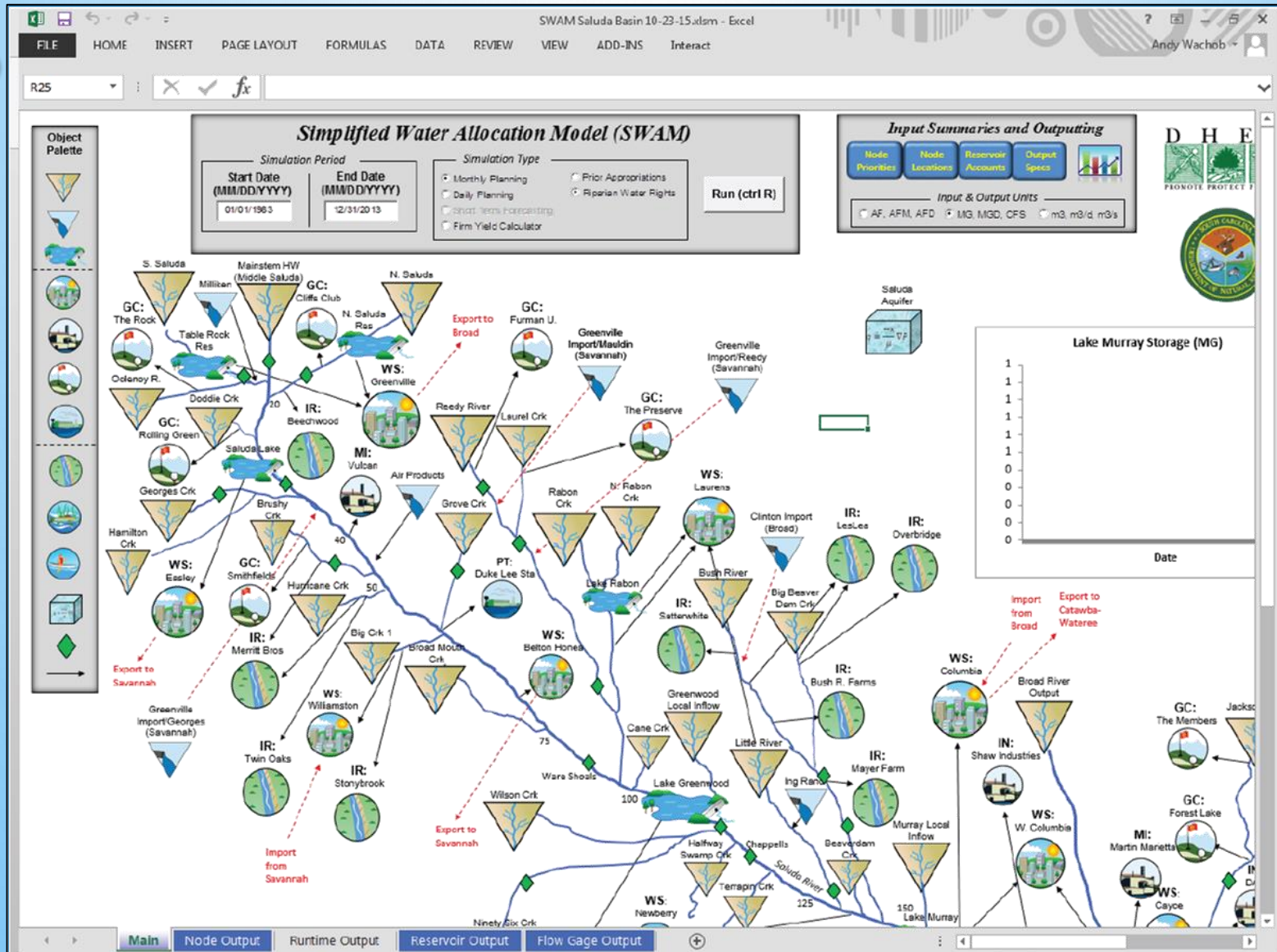
Model development and calibration



SWAM Model – Saluda basin framework



SWAM Model – Saluda basin



SWAM Model – Saluda basin

Simplified Water Allocation Model (SWAM)

Simulation Period: Start Date (MM/DD/YYYY) 01/01/1983, End Date (MM/DD/YYYY) 12/31/2013

Simulation Type: Monthly Planning, Daily Planning, Short-Term Forecasting, Firm Yield Calculator, Prior Appropriations, Riparian Water Rights

Run (ctrl R)

Input Summaries and Outputting

Node Priorities, Node Locations, Reservoir Accounts, Output Specs

Input & Output Units: AF, AFM, AFD, MG, MGD, CFS, m3, m3/d, m3/s

Water User

Main | Water Usage | Source Water | Return Flows

Water User Name: [Dropdown]

Delete Node

Multiple Sources of Water?

Transbasin Import

Water Exchange

Save Close

Map Labels: S. Saluda, Mainstem HW (Middle Saluda), GC: Cliffs Club, N. Sal. Res., Table Rock Res, Oolenoy R., Doddie Crk, GC: Rolling Green, Georges Crk, Hamilton Crk, WS: Easley, GC: Smithfields, Hurricane Crk, IR: Merritt Bros, WS: Williamston, IR: Twin Oaks, IR: Stonybr, Greenville Import/Georges (Savannah), Export to Savannah, Import from Savannah

Object Palette: [Icons for various water features]

Footer: Main | Node Output | Runtime Output | Reservoir Output | Flow Gage Output

SWAM Model – Saluda basin

SWAM Saluda Basin 10-5-15.xlsm - Excel

FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW ADD-INS Interact

Simplified Water Allocation Model (SWAM)

Simulation Period: Start Date (MM/DD/YYYY) 01/01/1983, End Date (MM/DD/YYYY) 12/31/2013

Simulation Type:

- Monthly Planning
- Daily Planning
- Short-Term Forecasting
- Firm Yield Calculator
- Prior Appropriations
- Riparian Water Rights

Run (ctrl R)

Water User

Main | Water Usage | Source Water | Return Flows

Water User Name: [Dropdown]

Buttons: Delete Node, Multiple Source

Options:

- Transbasin Import
- Water Exchange

Water User List:

- IN: CMC Steel
- IN: DAK
- IN: Shaw Industries
- MI: Martin Marietta
- MI: Vulcan Mining
- PT: Duke Lee Station
- PT: SCE&G
- WS: Belton Honea Path
- WS: Cayce
- WS: Columbia
- WS: Easley
- WS: Greenville
- WS: Greenwood
- WS: Laurens
- WS: Newberry
- WS: Newberry County
- WS: SCWSA
- WS: West Columbia
- WS: Williamston

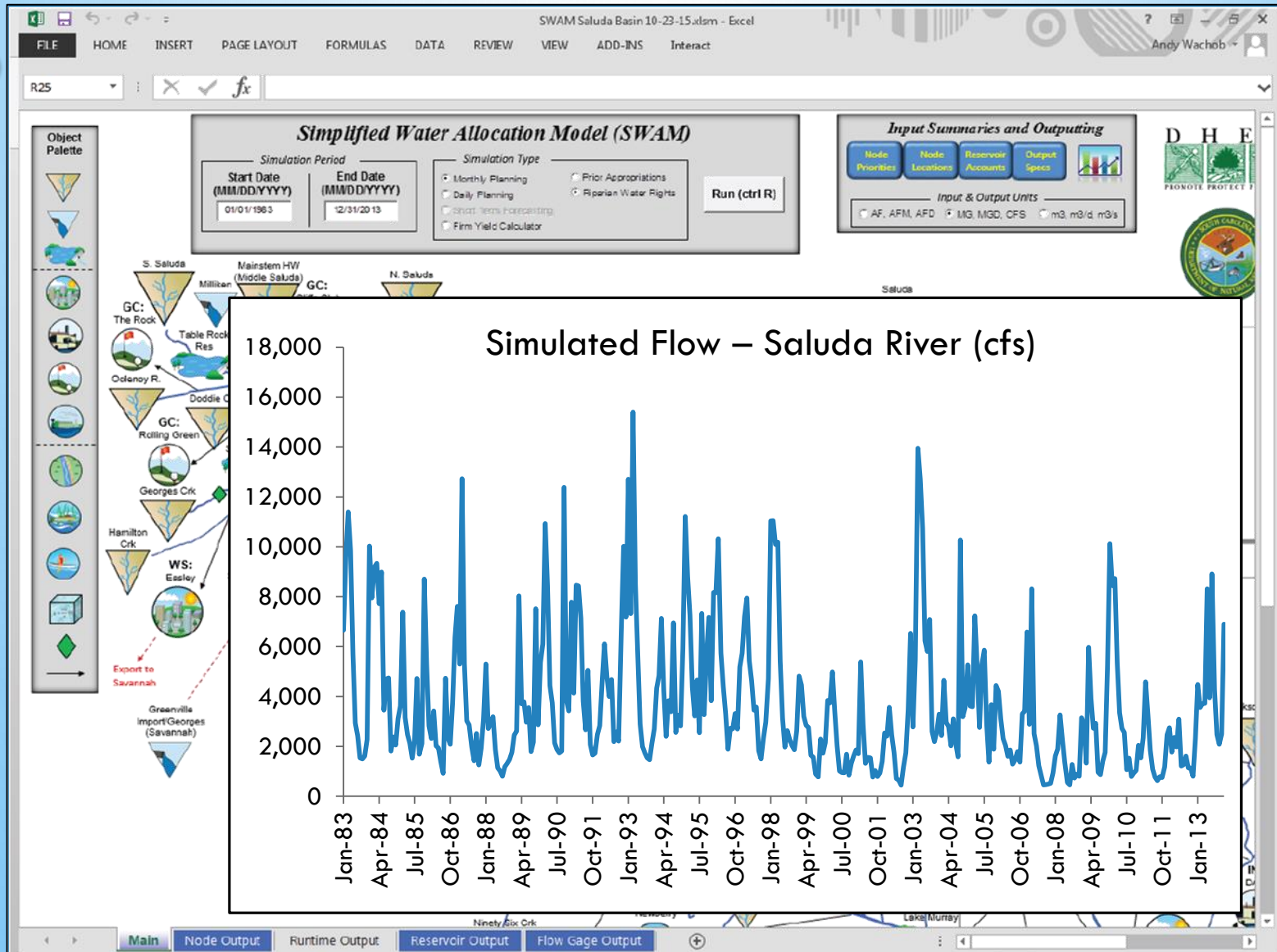
Export to Savannah

Import from Savannah

Year (YYYY)	Month (MMM)	Monthly Demand (MGD)	% CU
1983	Jan	38.3	9
1983	Feb	38.1	7
1983	Mar	38.5	6
1983	Apr	43.9	19
1983	May	50.1	31
1983	Jun	52.7	34
1983	Jul	54.6	37
1983	Aug	53.3	29
1983	Sep	49.6	29
1983	Oct	46.1	27
1983	Nov	41.9	19
1983	Dec	38.4	11
1984	Jan	38.3	9
1984	Feb	38.1	7
1984	Mar	38.5	6
1984	Apr	43.9	19
1984	May	50.1	31
1984	Jun	52.7	34
1984	Jul	54.6	37
1984	Aug	53.3	29
1984	Sep	49.6	29
1984	Oct	46.1	27
1984	Nov	41.9	19
1984	Dec	38.4	11
1985	Jan	40.2	9
1985	Feb	40.0	7
1985	Mar	40.4	6
1985	Apr	46.1	19
1985	May	52.6	31
1985	Jun	55.3	34
1985	Jul	57.3	37
1985	Aug	56.0	29
1985	Sep	52.0	29
1985	Oct	48.4	27
1985	Nov	43.9	19
1985	Dec	40.3	11
1986	Jan	40.2	9
1986	Feb	40.0	7
1986	Mar	40.4	6
1986	Apr	46.1	19
1986	May	52.6	31
1986	Jun	55.3	34

Main Node Output Runtime Output Reservoir Output Flow Gage Output

SWAM Model – Saluda basin



Model Calibration

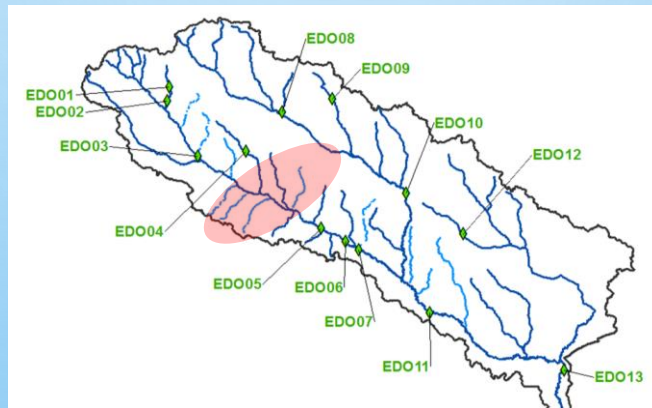
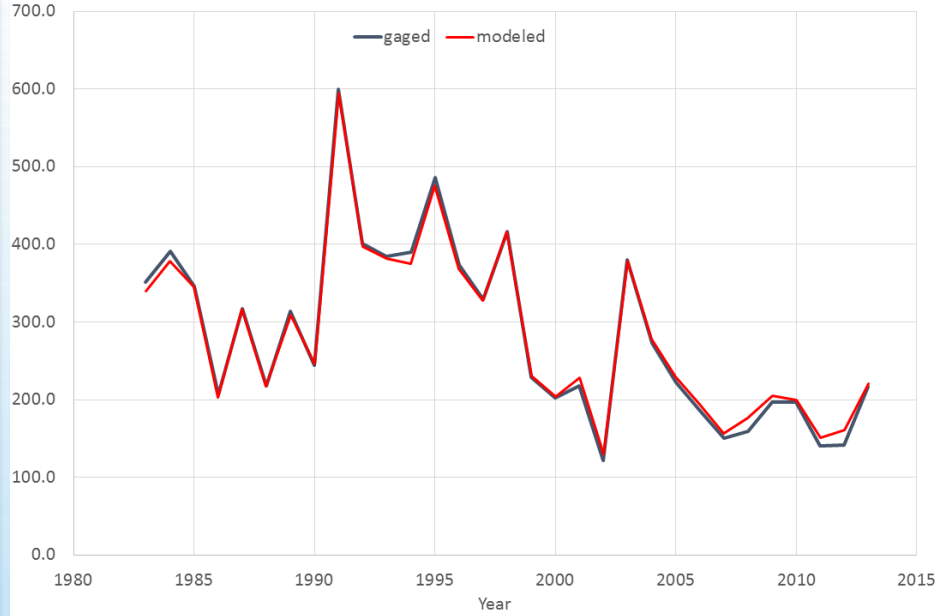
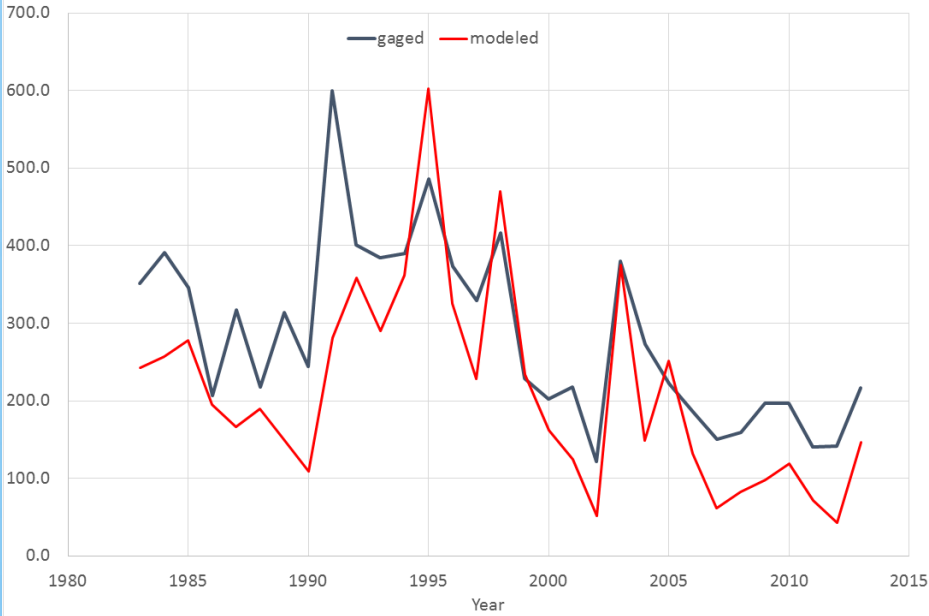
North Fork Edisto River at Orangeburg

Before Model Calibration

After Model Calibration

EDO10 NORTH FORK EDISTO RIVER AT ORANGEBURG, SC
Annual 7 Day Low Flow (CFS)

EDO10 NORTH FORK EDISTO RIVER AT ORANGEBURG, SC
Annual 7 Day Low Flow (CFS)



Status Update

Progress of each basin model (as of 12/8/2015)

BASIN	% COMPLETE	STATUS OF MODEL DEVELOPMENT
Saluda	99	Draft Baseline model complete
Edisto	99	Draft Calibration model complete
Broad	79	Draft UIF data mostly complete
Pee Dee	69	Draft UIF data mostly complete
Catawba	35	Data collection mostly complete
Santee	19	Data collection mostly complete
Savannah	9	Data collection ongoing
Salkehatchie	19	Data collection mostly complete

After baseline models are complete

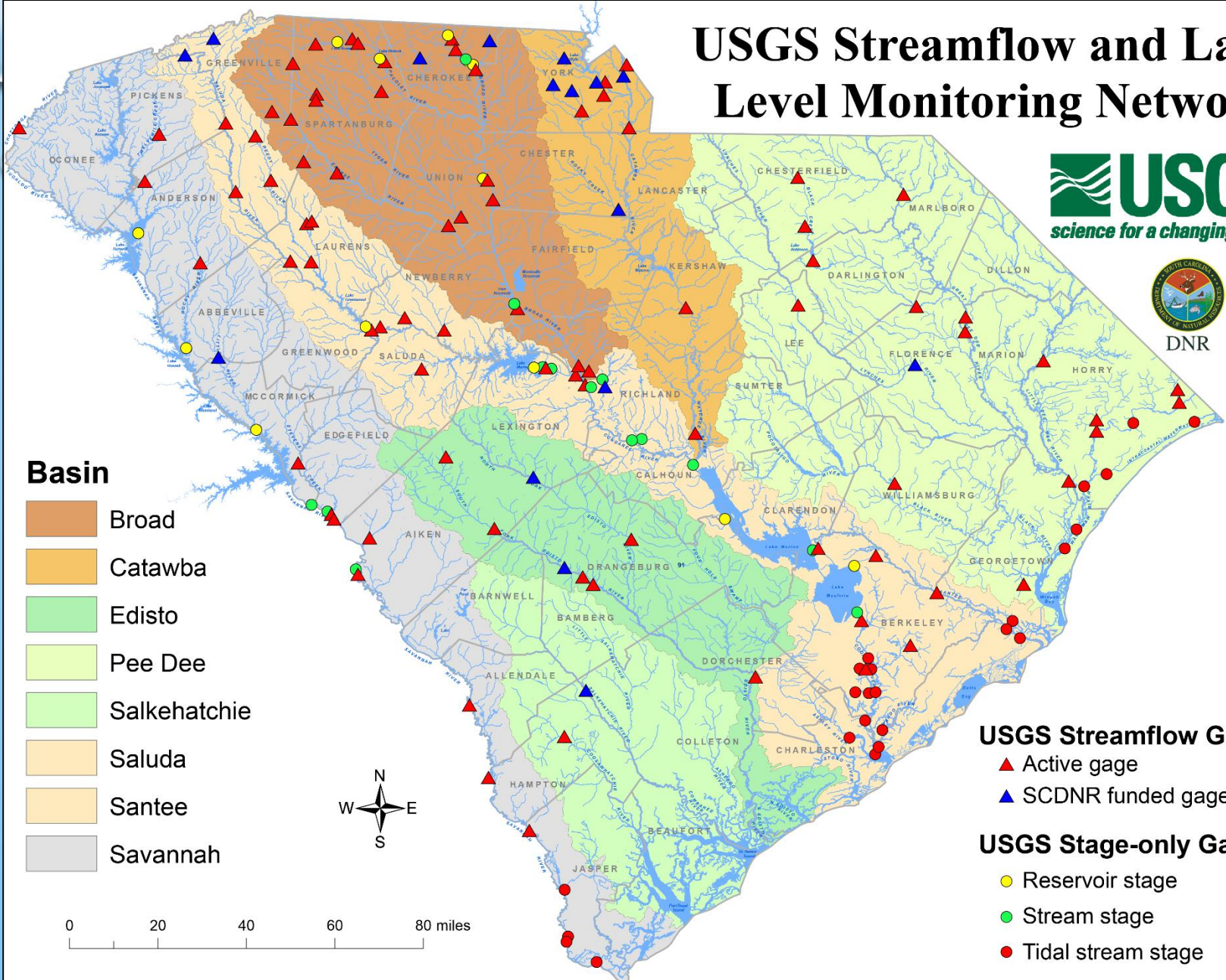
DHEC

- Can start using models to analyze withdrawal permit applications

DNR

- Development of groundwater model
- Develop water-demand forecasts
- Use models to identify potential water-supply shortages
- Form basin planning groups
- Develop basin water plans
- Update State water plan
- Update model UIF data every 5-10 years

USGS Streamflow and Lake Level Monitoring Network



Basin

- Broad
- Catawba
- Edisto
- Pee Dee
- Salkehatchie
- Saluda
- Santee
- Savannah

USGS Streamflow Gages

- ▲ Active gage
- ▲ SCDNR funded gage

USGS Stage-only Gages

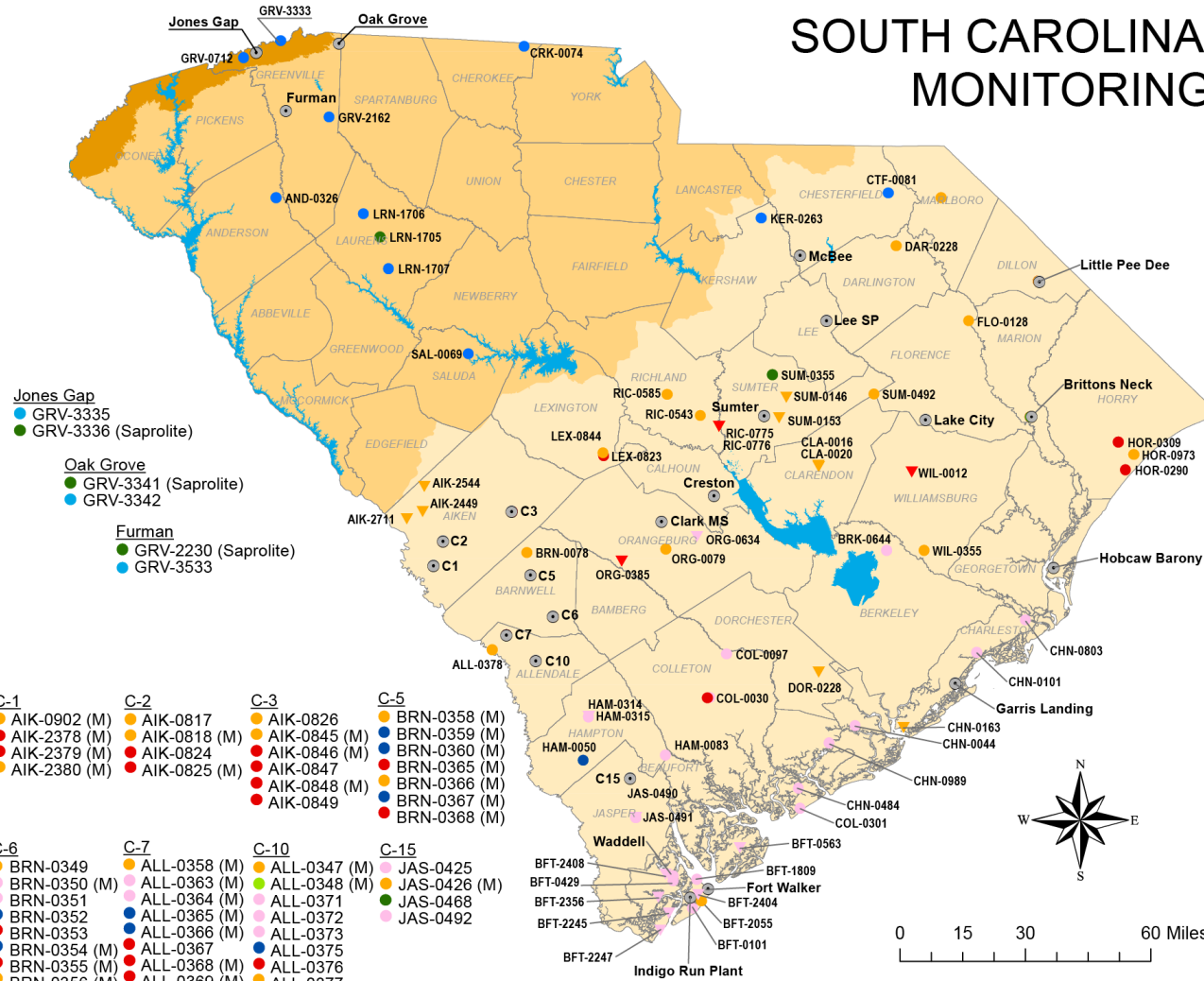
- Reservoir stage
- Stream stage
- Tidal stream stage

Groundwater Monitoring Network

SOUTH CAROLINA GROUNDWATER MONITORING NETWORK



DNR



- Lee**
 - LEE-0075
 - LEE-0179
 - LEE-0180
 - LEE-0181
- Brittons Neck**
 - MRN-0077
 - MRN-0078
- Little Pee Dee**
 - DIL-0121
 - DIL-0171
 - DIL-0172
 - DIL-0173
 - DIL-0174
 - DIL-0175
- McBee**
 - CTF-0221
 - CTF-0222
- Lake City**
 - FLO-0274
 - FLO-0276
- Sumter**
 - SUM-0488
 - SUM-0497
- Hobcaw Barony**
 - GEO-0381 (C)
 - GEO-0382
 - GEO-0383 (C)
- Clark Middle**
 - ORG-0393
 - ORG-0430
 - ORG-0431
- Creston**
 - CAL-0192
 - CAL-0193
 - CAL-0194
 - CAL-0195
- Garris Landing**
 - CHN-0990 (C)
 - CHN-0991 (C)
- Waddell**
 - BFT-1845 (C)
 - BFT-1846
- Indigo Run**
 - BFT-1820
 - BFT-1822
- Ft. Walker**
 - BFT-1813 (C)
 - BFT-1814

Agency

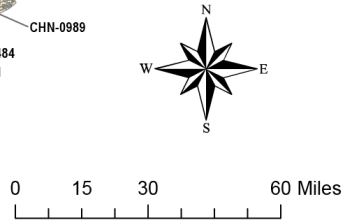
- SCDNR
- SCDNR Well Cluster
- ▼ SCDNR/SCDHEC

Aquifer

- Shallow Aquifer System
- Tertiary Sand
- Floridan
- Black Creek
- Middendorf
- Cape Fear
- Crystalline Rock

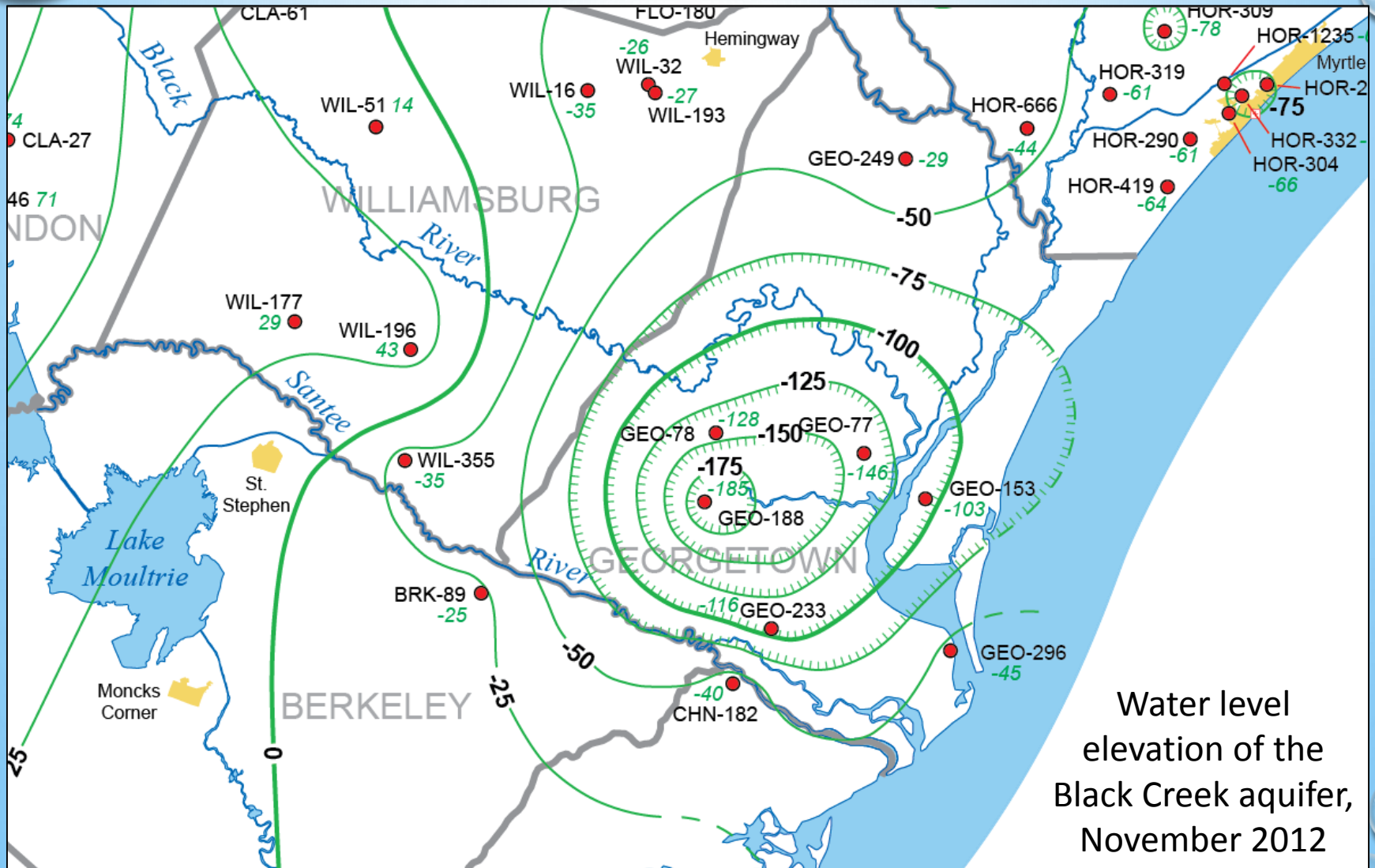
(M) - Manual water level measurement
(C) - Conductivity Monitoring Site

Mountain
 Piedmont
 Upper Coast



Map prepared by the Land, Water & Conservation Division of the South Carolina Department of Natural Resources: January, 2015

Potentiometric mapping



Water level elevation of the Black Creek aquifer, November 2012

Real-time groundwater monitoring



FOR MORE INFORMATION

On the Web

- DNR: <http://www.dnr.sc.gov/water/waterplan/surfacewater.html>
- Clemson: www.scwatermodels.com

Contacts

- Joe Gellici, DNR
 - gellicij@dnr.sc.gov
- David Baize, DHEC
 - baized@dhec.sc.gov
- John Boyer, CDM Smith
 - boyerjd@cdmsmith.com

SOUTH CAROLINA
SURFACE WATER
AVAILABILITY ASSESSMENT

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Project Documents

Effective water planning and management requires an accurate location and quantity of the water resources of the State, and most useful tools for evaluating management strategies is a computer model that simulates the surface water system throughout an entire watershed. 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 model is in the document [Basinwide Surface Water Modeling in South Carolina](#). 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](#).

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

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

(Documents below are in PDF format.)

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[Legislative Quarterly Reports](#)
[Technical Reports](#)