Surface Water Quantity Models

Progress Meeting Agenda

August 4, 2015 – CDM Smith Columbia Office

Attendees: **CDM Smith**: John Boyer, Kirk Westphal, Tim Cox, Nina Caraway, Lauren Owen, Elizabeth O'Sell
SCDNR: Joe Gellici, Andy Wachob, Scott Harder, Alex Pellet, Ken Rentiers
SCDHEC: David Baize, Chuck Gorman, David Wilson
Clemson University: Jeff Allen
Technical Advisory Committee: Eddie Twilley, K.C. Price, Julie Metts, Andy Fairey, Eric Krueger, Harrison Watson, Ed Bruce, Mullen Taylor

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1. **Saluda Basin Unimpaired Flow Dataset**
   a. Summary of DNR comments and record extension testing
   - Kirk Westphal summarized the effort to address DNR comments on the Draft UIF dataset. The revisions focused on (1) reducing "noise" in the UIFs likely to be related to run-of-river hydropower operations; (2) testing methodology related to log transformations and the use of the pure "MOVE.1" technique for record extensions; (3) revisiting the selection of reference gages; and (4) correcting zero flows that are likely resulting from abrupt monthly differences in withdrawal amounts.
   b. Revisions in Progress
   - Kirk Westphal summarized the results of testing conducted by CDM Smith to further evaluate record extension methodologies and noted that CDM Smith was making minor revisions in UIFs, starting at the top of the basin. Revisions to select UIFs would be forwarded for DNR review and concurrence in groups.
   - K.C. Price indicated that he was still reviewing the Table Rock and North Saluda Reservoir UIF workbooks and that he had some questions regarding evaporation. The questions were tabled until later.

2. **Saluda SWAM Model Update**
    a. Model Setup
    b. Calibration/verification Approach

    - Tim Cox outlined the approach to calibrating/verifying the Saluda SWAM pilot model, discussed the steps involved in verification, and provided preliminary (graphical) results of the calibration [***see attached slides***].

    - TAC members asked what criteria will be considered when deciding that the model is sufficiently calibrated/verified. Tim Cox indicated that unlike models that convert rainfall to runoff, water allocation models (including SWAM) are based on hydrologic records computed from historical measurements. As such, the process of evaluating the performance of these models (their ability to reproduce historical observations) is characterized as a "validation" process, in which the computed flows, once management measures are superimposed on UIFs, are checked against historical records. Calculated downstream flows and reservoir storage levels for a given historical simulation period are compared to observed data. Performance metrics will be used to assess the model's ability to reproduce historical hydrology and water usage such as time-series plots of storage and river flow, annual flow totals (overall water balance), monthly mean-flow values (seasonality), flow and storage percentile plots (range of variability), key statistical low-flow values such as the 7-day and 30-day low flow levels in a given year and/or with a recurrence interval of 10 years.

3. **Draft Broad River Framework and Aug 5th Stakeholder Meeting**
    - Jeff Allen noted that Clemson University has made all necessary preparations for the August 5th stakeholder meeting in Spartanburg.

4. **Data Collection and Analysis**
    a. Broad – Substantially complete
        i. Still contacting golf courses
        ii. Reviewing reservoir data for gaps
    b. Pee Dee – substantially complete
        i. Reviewed golf courses with DHEC; still contacting some
    c. Catawba, Santee, and Salkehatchie – In progress

5. **Schedule Update for Stakeholder Meeting Planning**
    - John Boyer distributed an updated schedule [**attached**] which includes adjusted tentative stakeholder meeting dates for the remainder of the year.

6. **Upcoming Deliverables**
    a. Pee Dee Draft Framework – Week of Aug 31
    b. Edisto UIF Methodology – This week
    c. Draft Saluda Calibration and Baseline Model (and Report) – by Aug 31

7. **Other Items**
    - Scott Harder offered additional observations regarding the Draft UIF dataset for the Saluda basin. The use of SLD02 as a reference gage for computing UIFs at SLD01 and SLD03 was briefly discussed. Noise in the UIFs caused from monthly changes in withdrawal amounts was also briefly discussed.

Calibration Objectives

1. Extend hydrologic inputs (headwater UIFs) spatially to adequately represent entire basin hydrology by parameterizing reach hydrologic inputs
2. Refine initial parameter estimates, as appropriate
   - E.g. reservoir operating rules, %Consumptive Use assumptions, return flow locations
3. Gain confidence in the model as a predictive tool by demonstrating its ability to adequately replicate past hydrologic conditions, operations, and water use
   - without being overly prescriptive

Calibration General Approach

- 1983 – 2013 hindcast period; monthly timestep
- Comparison to gaged (measured) flow data only
  - operations and impairments are implicit in that data
- Assess performance at (subject to gage data availability):
  - multiple mainstem locations
  - all 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)

Calibration Steps

1. Extend tributary headwater flows to confluence points
   - sub-basin flow factors
2. Add new “implicit” tributary objects to the model to capture unmodeled drainage area
   - small tributaries without nodes; point inflows only
3. Adjust mainstem “gain/loss” factor
   - flow gain per unit length
4. As necessary, look at: reservoir operations, assumed %CU, return flow locations, …
5. Verify daily timestep model

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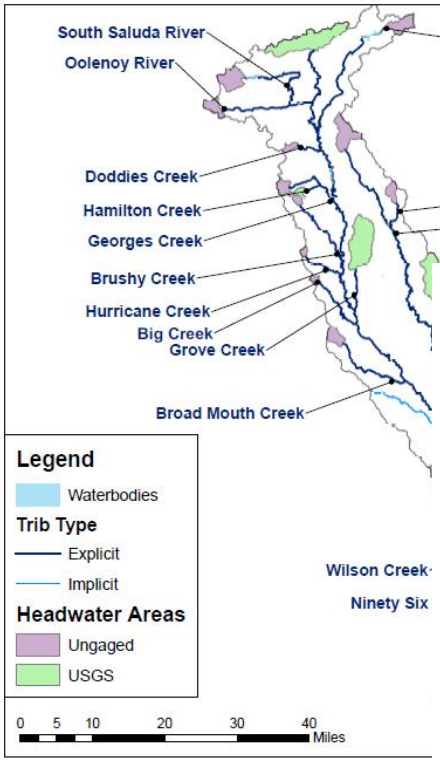
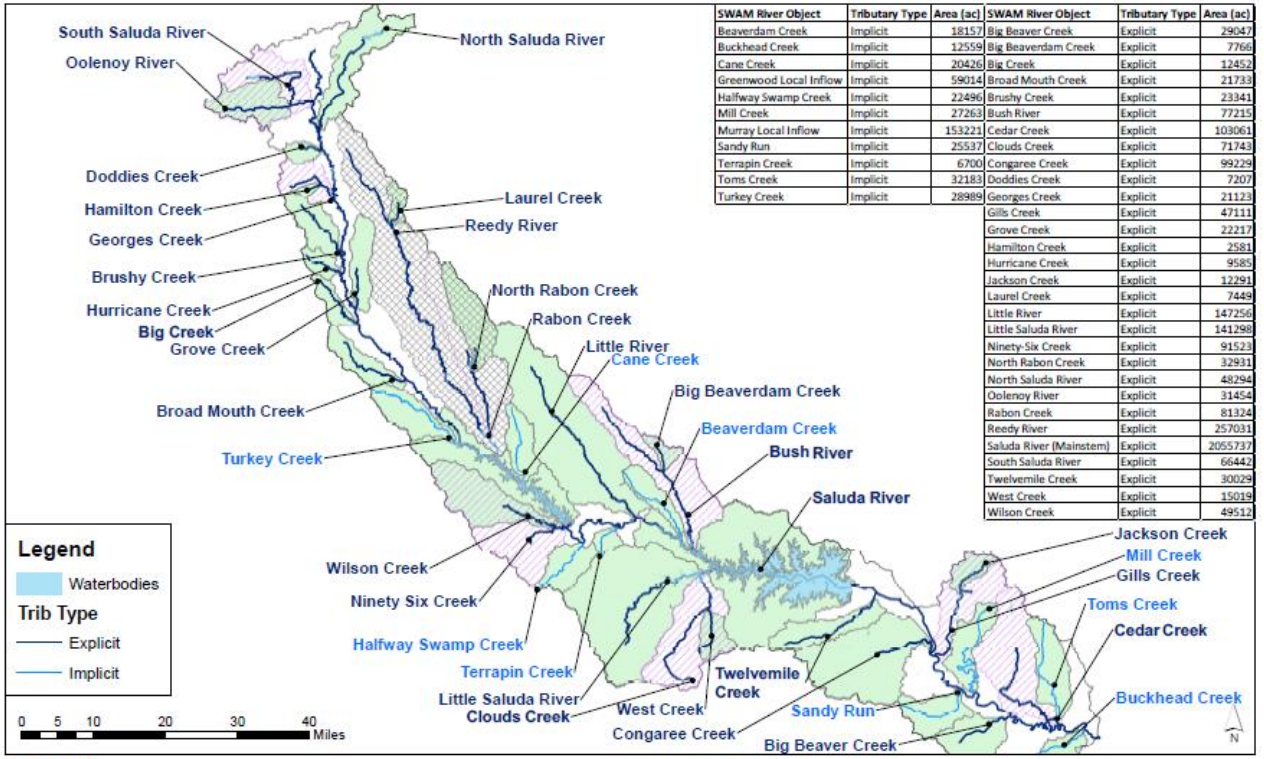
Calibration Steps: Flow Factors



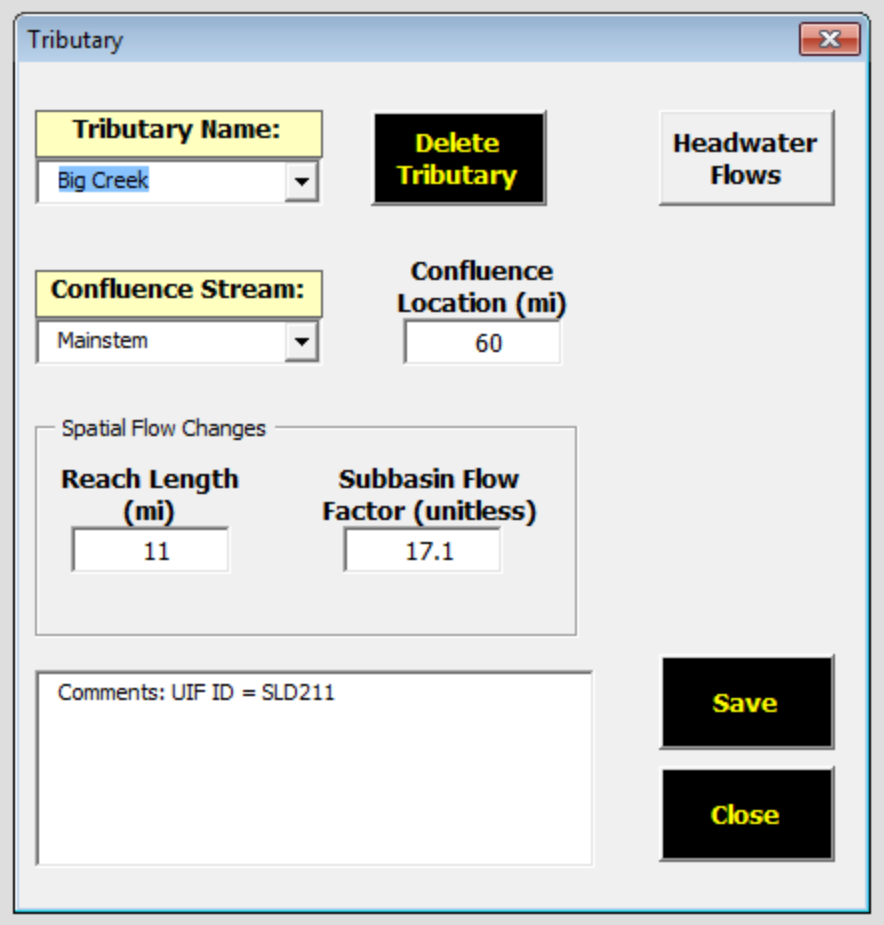
ID	Type	Model Trib	Area (ac)
SLD31	USGS	Big Beaver Creek	6342
SLD218	Ungaged	Big Beaverdam Creek	2020
SLD211	Ungaged	Big Creek	728
SLD213	Ungaged	Broad Mouth Creek	2622
SLD207	Ungaged	Brushy Creek	1280
SLD34	USGS	Bush River	9921
SLD225	Ungaged	Cedar Creek	16269
SLD221	Ungaged	Clouds Creek	1234
SLD139	Ungaged	Congaree Creek	22615
SLD204	Ungaged	Doddies Creek	1031
SLD206	Ungaged	Georges Creek	1987
SLD227	Ungaged	Gills Creek	12330
SLD08	USGS	Grove Creek	12267
SLD05	USGS	Hamilton Creek	1050



SWAM River Object	Tributary Type	Area (ac)
Beaverdam Creek	Implicit	18157
Buckhead Creek	Implicit	12559
Cane Creek	Implicit	20426
Greenwood Local Inflow	Implicit	59014
Halfway Swamp Creek	Implicit	22496
Mill Creek	Implicit	27263
Murray Local Inflow	Implicit	153221
Sandy Run	Implicit	25537
Terrapin Creek	Implicit	6700
Toms Creek	Implicit	32183
Turkey Creek	Implicit	28989

SWAM River Object	Tributary Type	Area (ac)
Big Beaver Creek	Explicit	29047
Big Beaverdam Creek	Explicit	7766
Big Creek	Explicit	12452
Broad Mouth Creek	Explicit	21733
Brushy Creek	Explicit	23341
Bush River	Explicit	77215
Cedar Creek	Explicit	103061
Clouds Creek	Explicit	71743
Congaree Creek	Explicit	99229
Doddies Creek	Explicit	7207
Georges Creek	Explicit	21123
Gills Creek	Explicit	47111
Grove Creek	Explicit	22217
Hamilton Creek	Explicit	2581
Hurricane Creek	Explicit	9585
Jackson Creek	Explicit	12291
Laurel Creek	Explicit	7449
Little River	Explicit	147256
Little Saluda River	Explicit	141298
Ninety-Six Creek	Explicit	91523
North Rabon Creek	Explicit	32931
North Saluda River	Explicit	48294
Oolenoy River	Explicit	31454
Rabon Creek	Explicit	81324
Reedy River	Explicit	257031
Saluda River (Mainstem)	Explicit	2055737
South Saluda River	Explicit	66442
Twelvemile Creek	Explicit	30029
West Creek	Explicit	15019
Wilson Creek	Explicit	49512

Calibration Steps: Flow Factors



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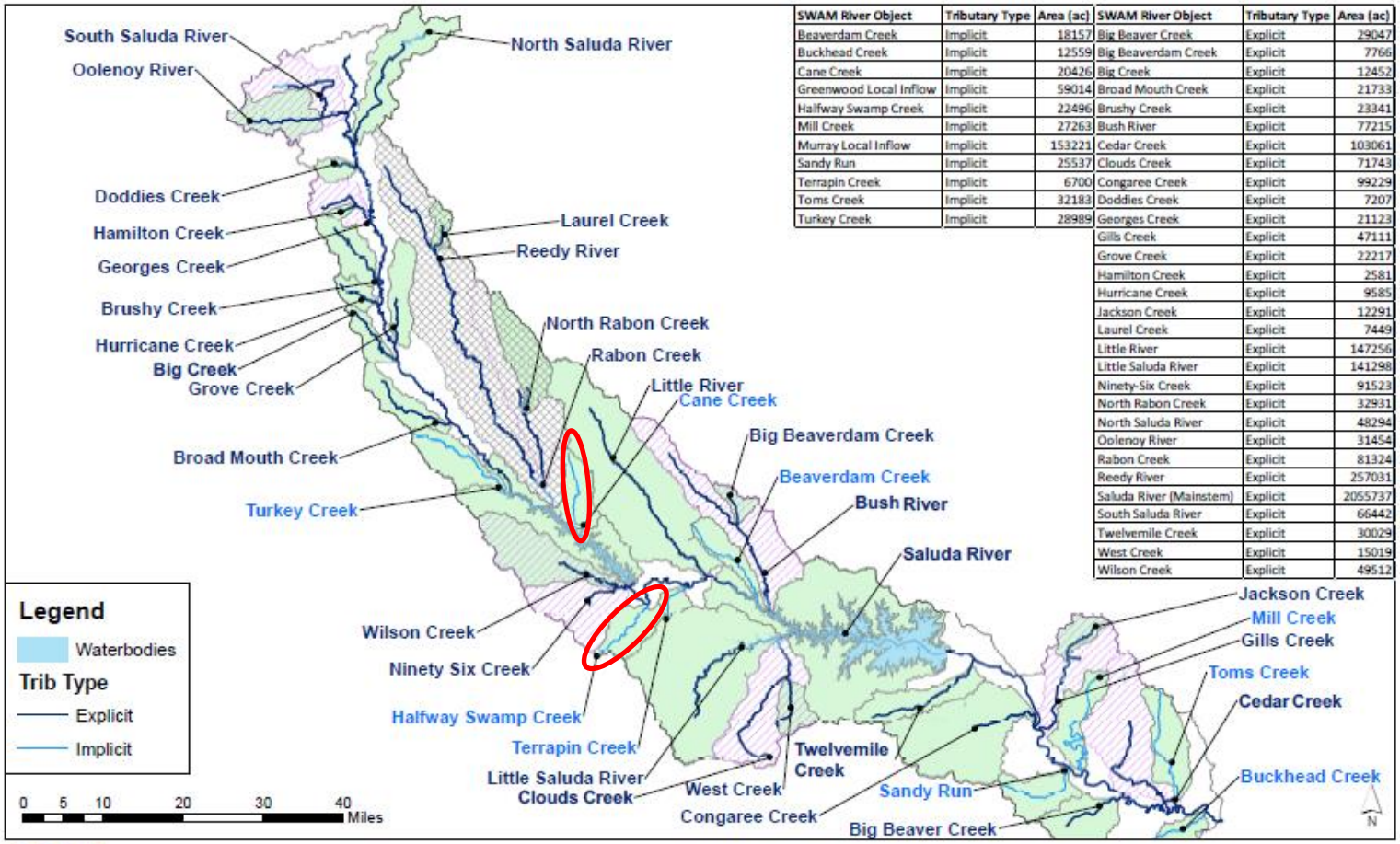
Calibration Steps: Implicit Tribs



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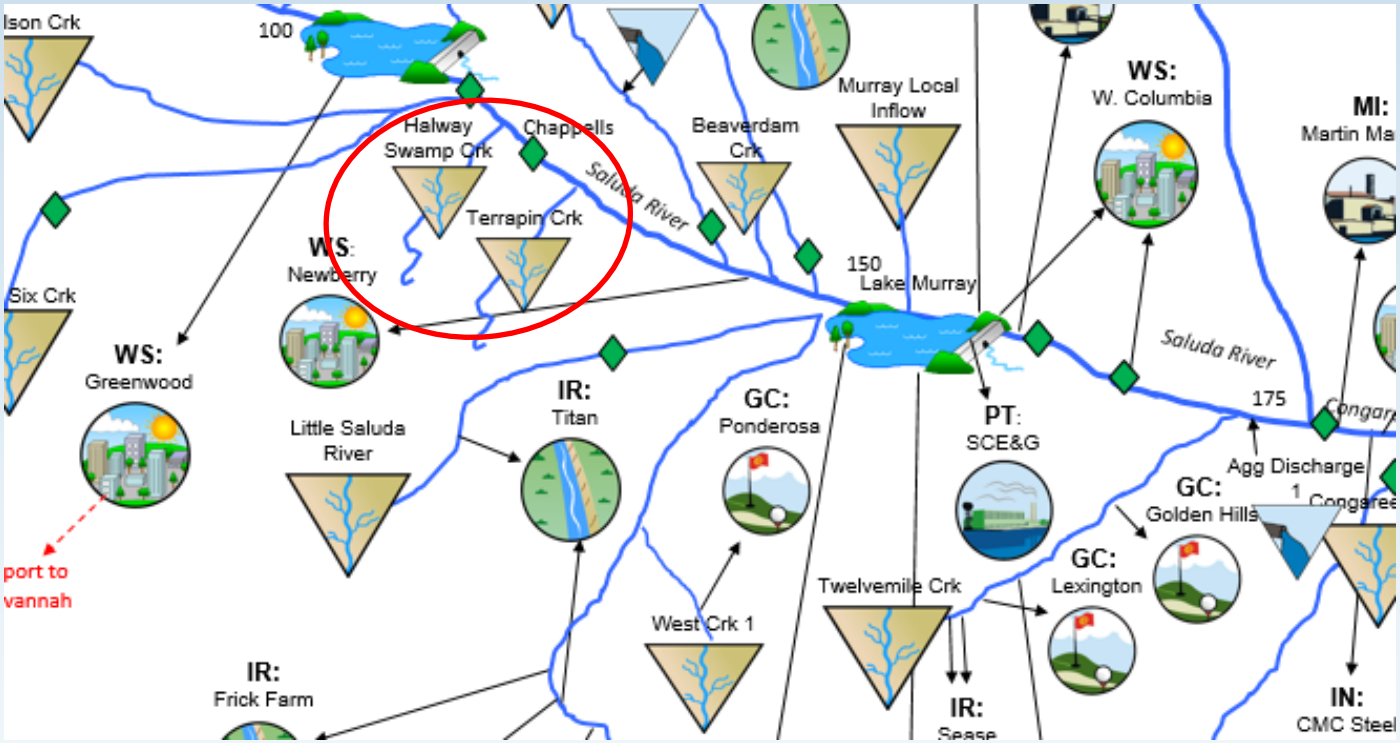

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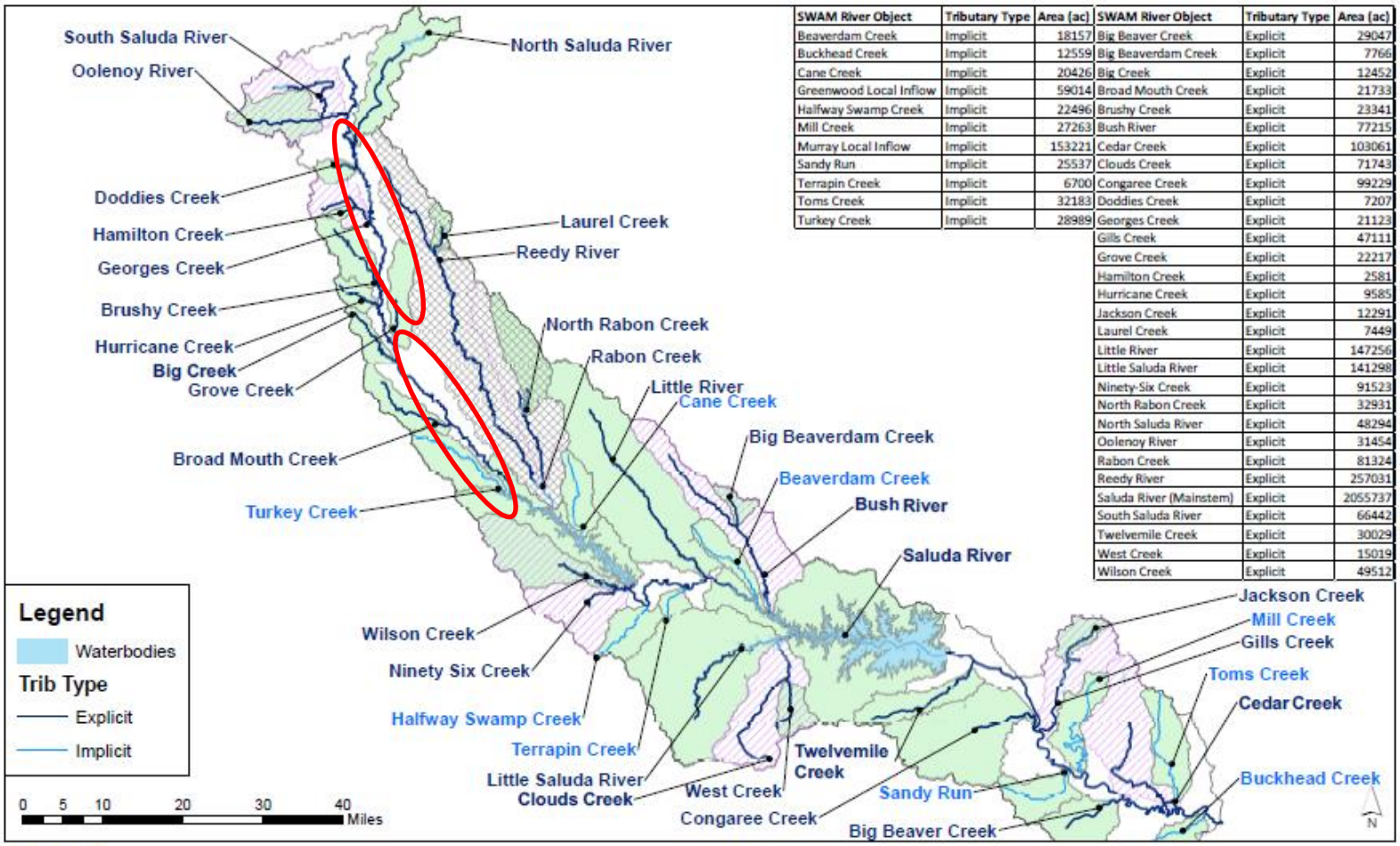

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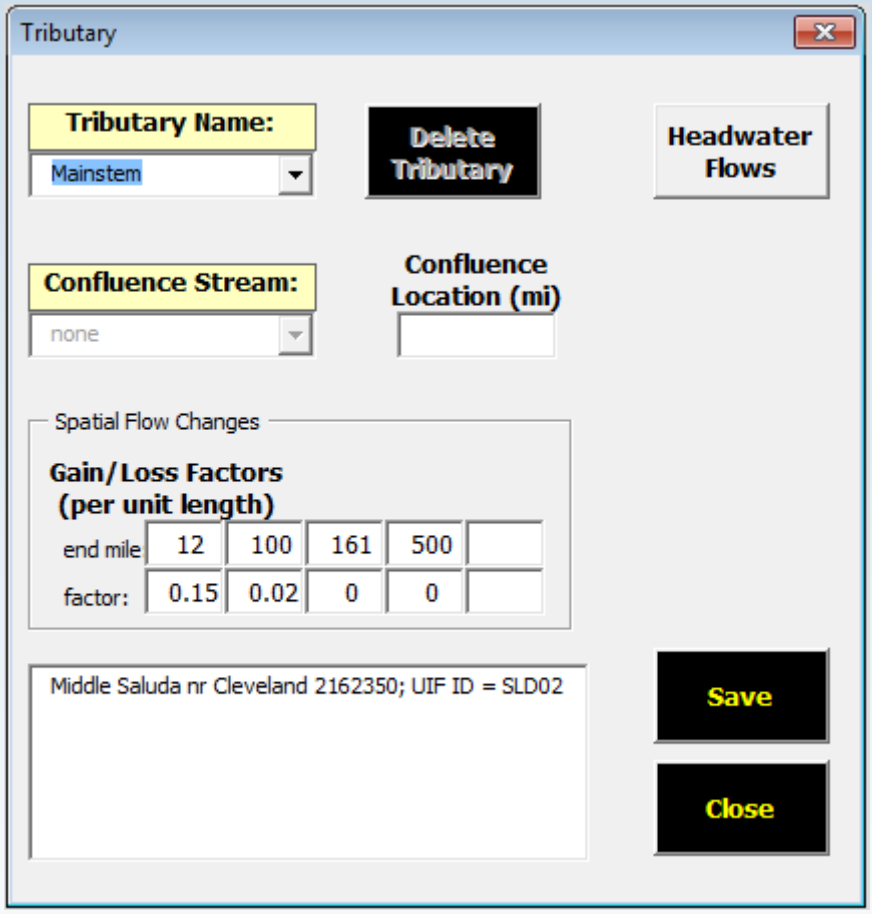

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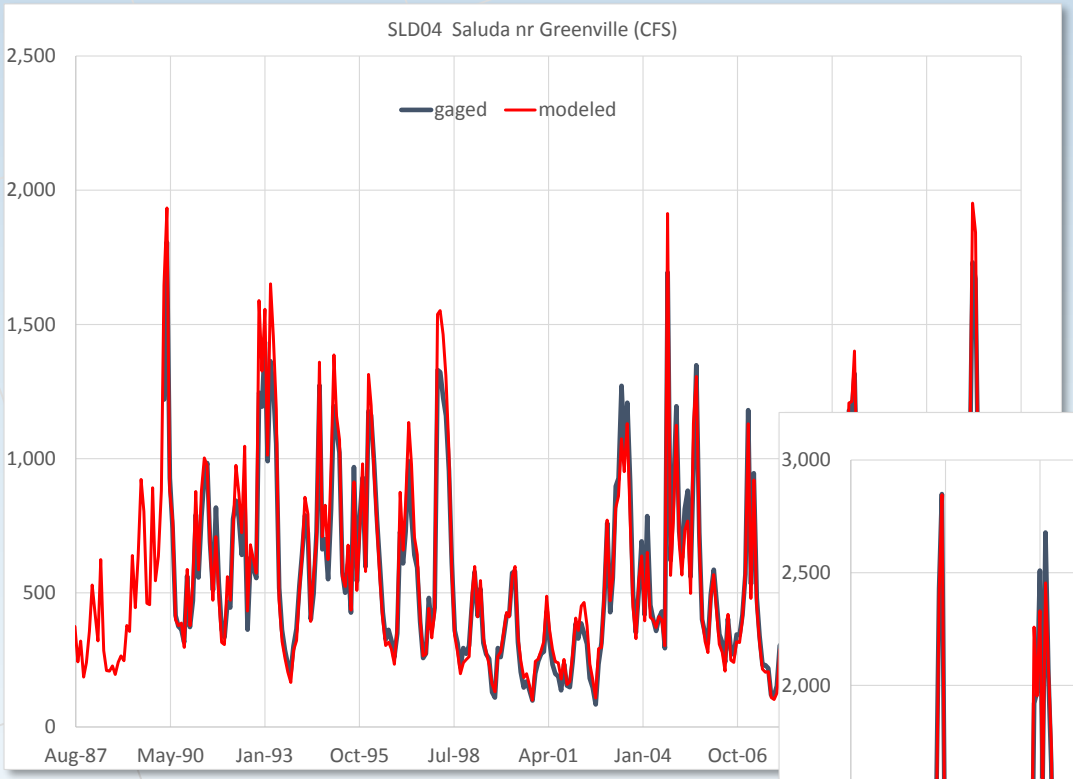

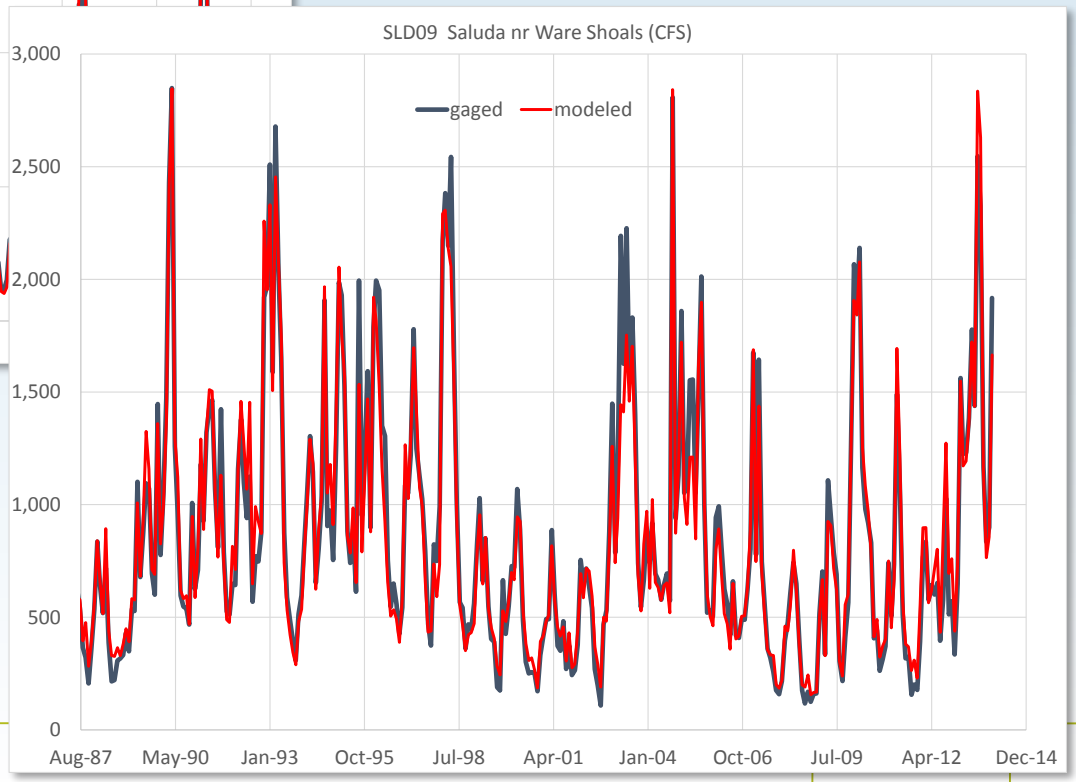

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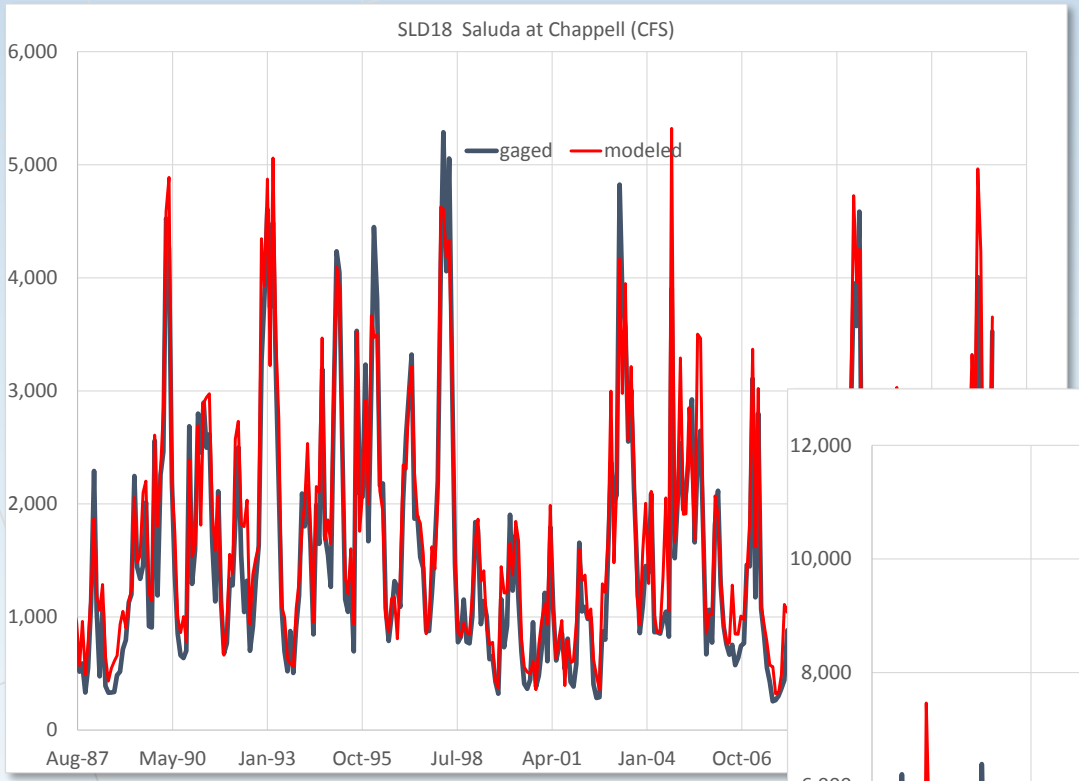

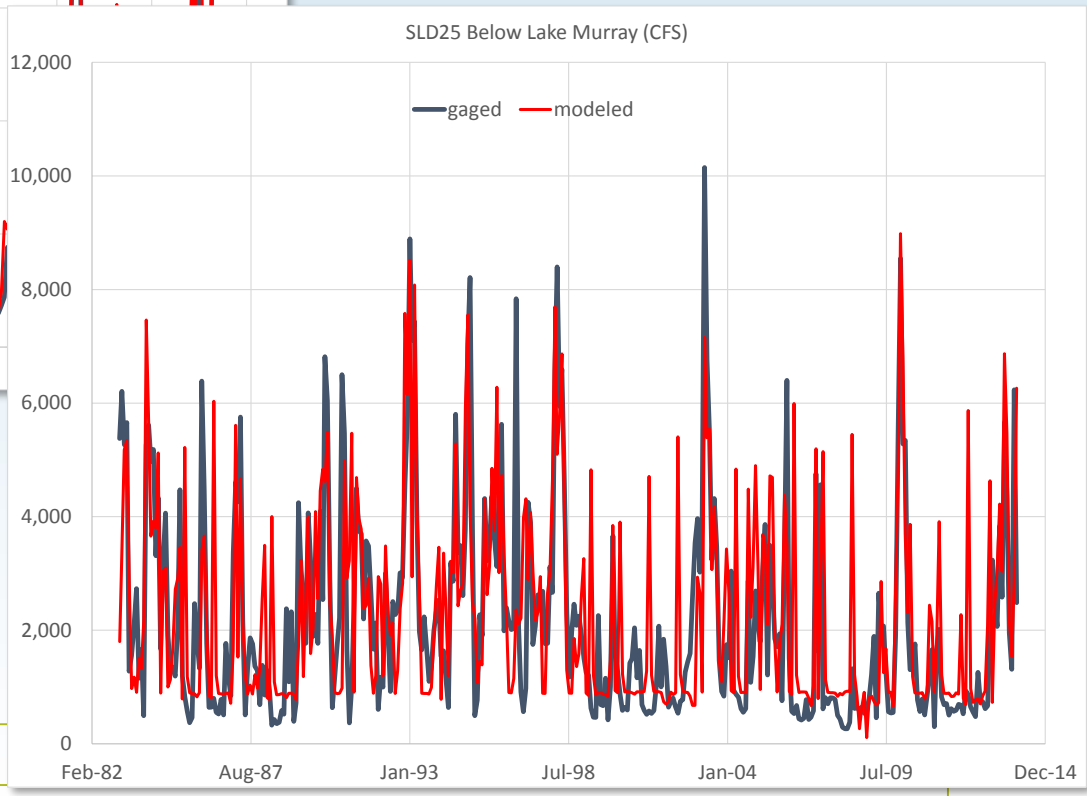

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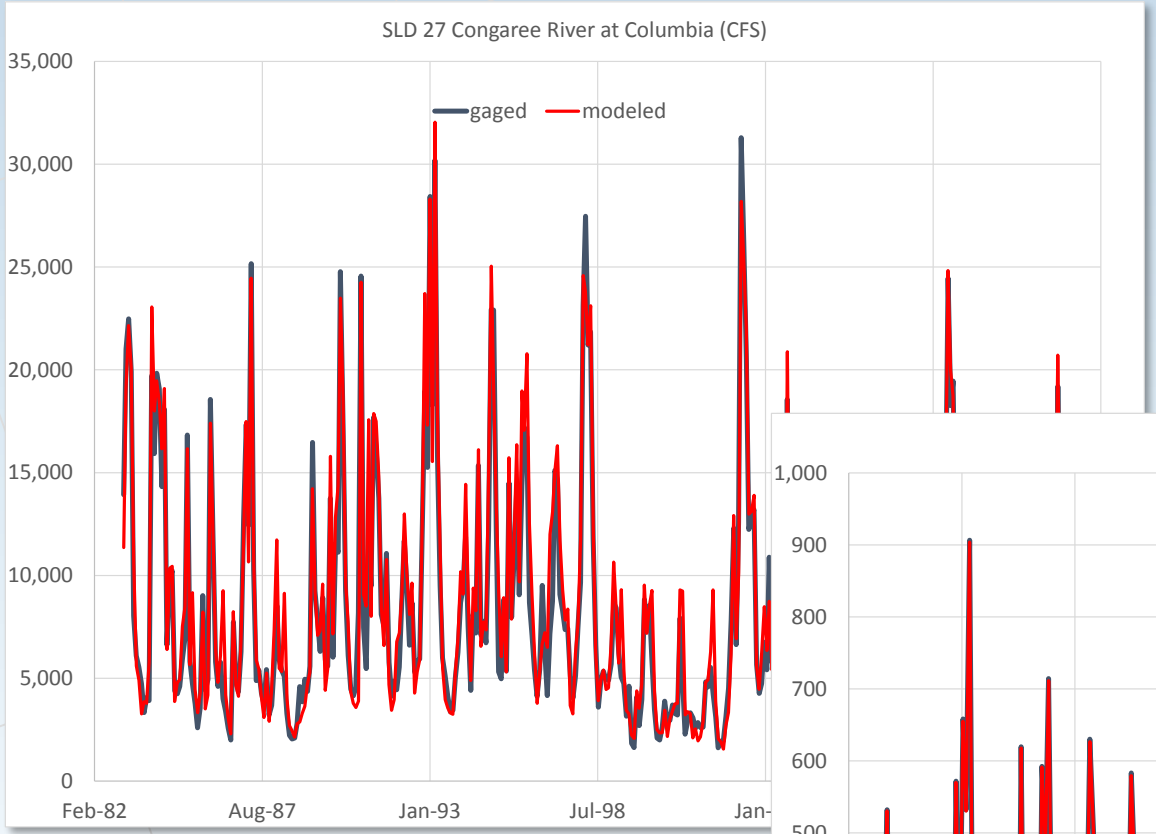

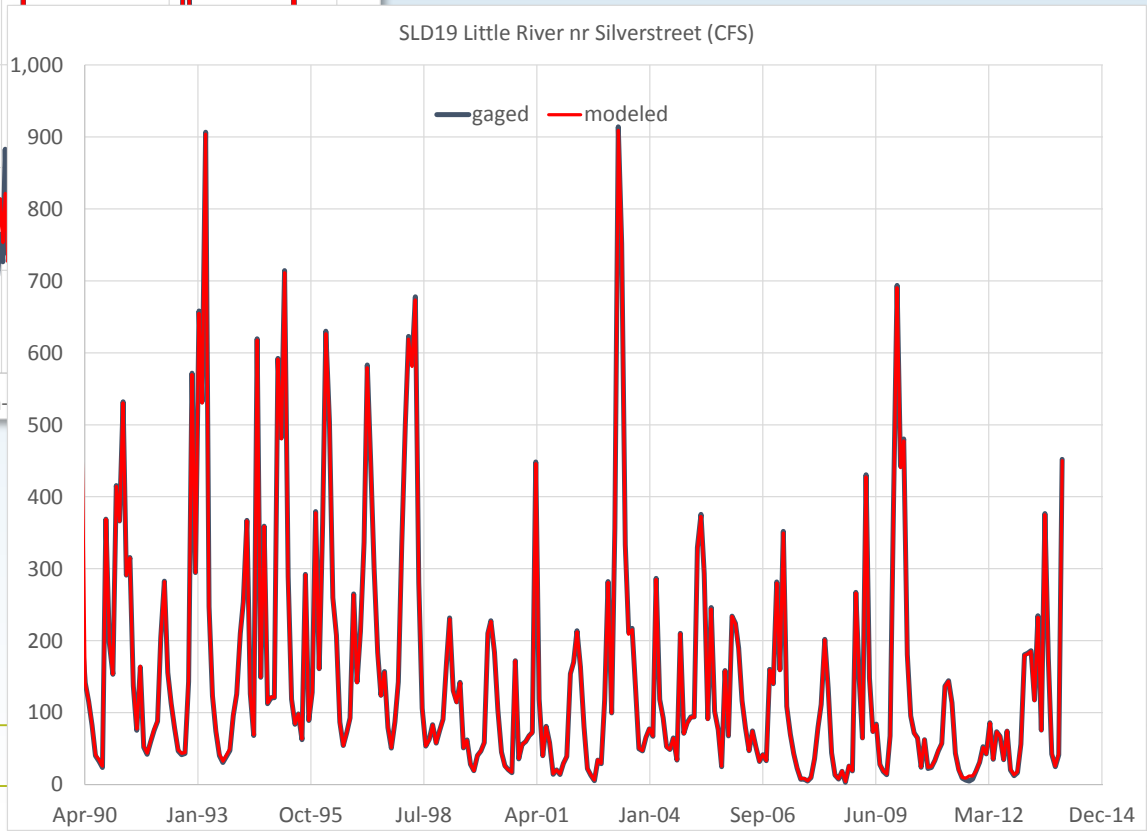

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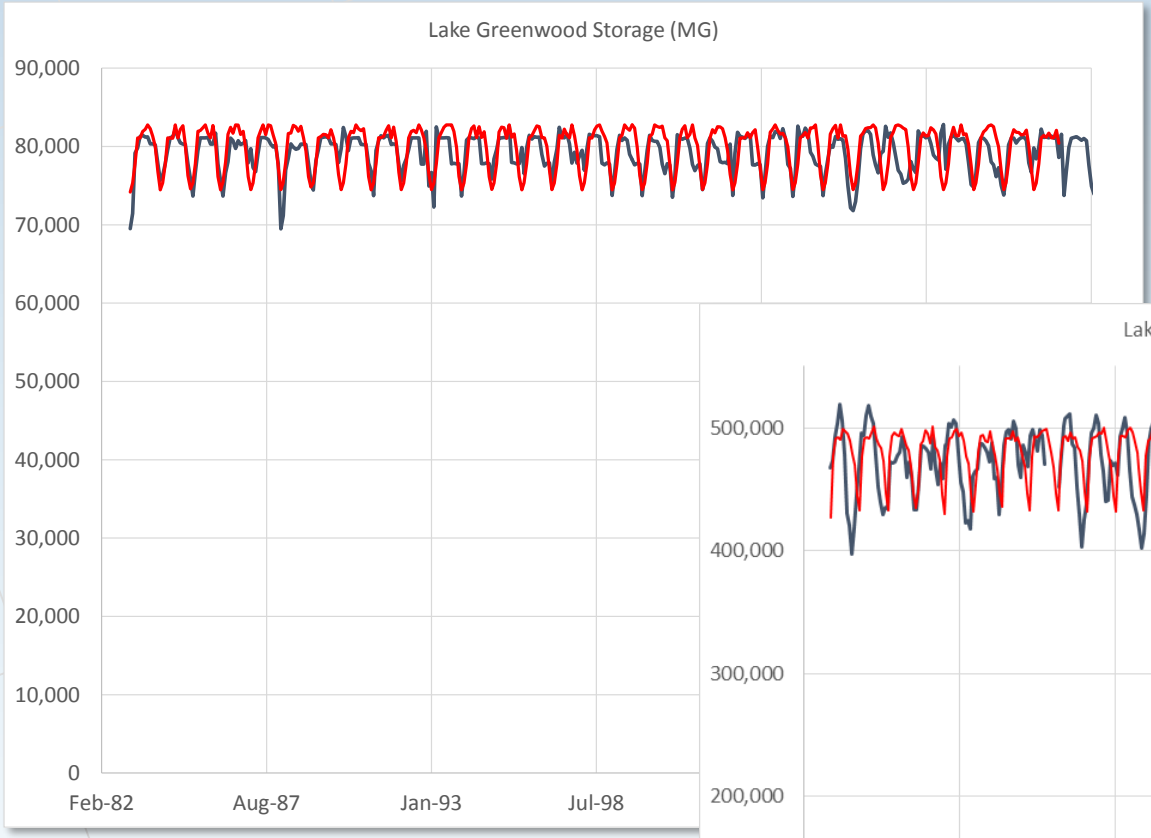

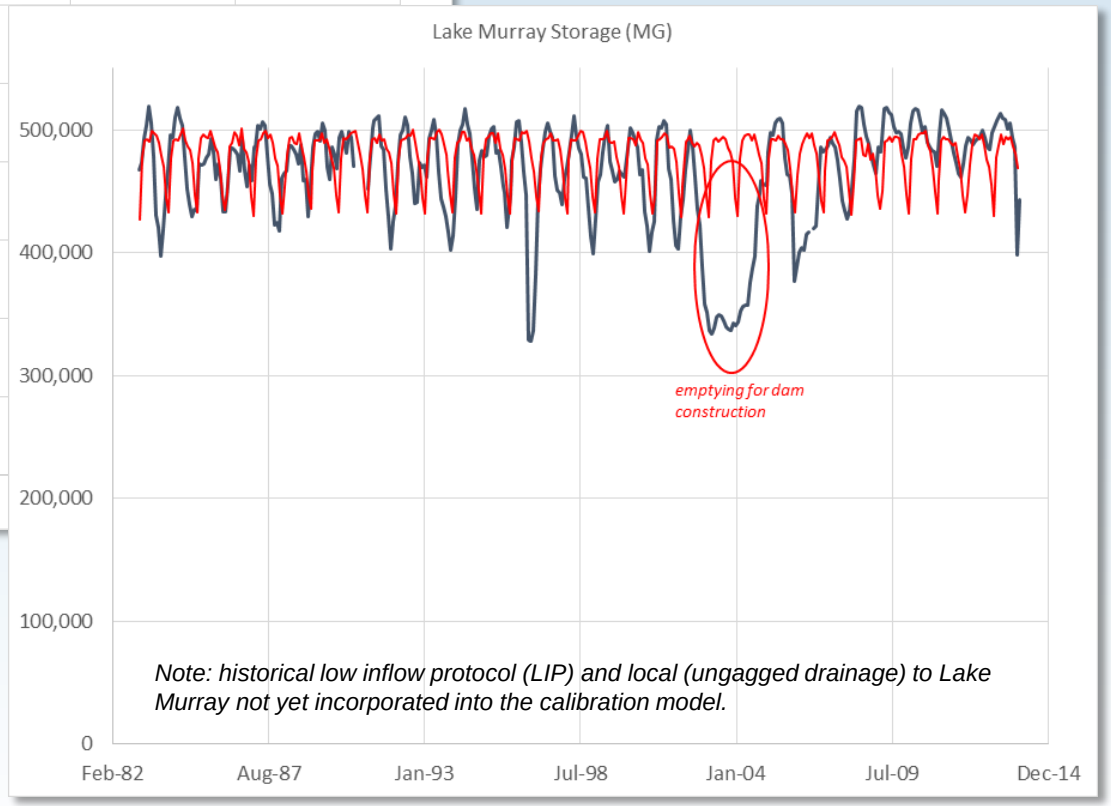

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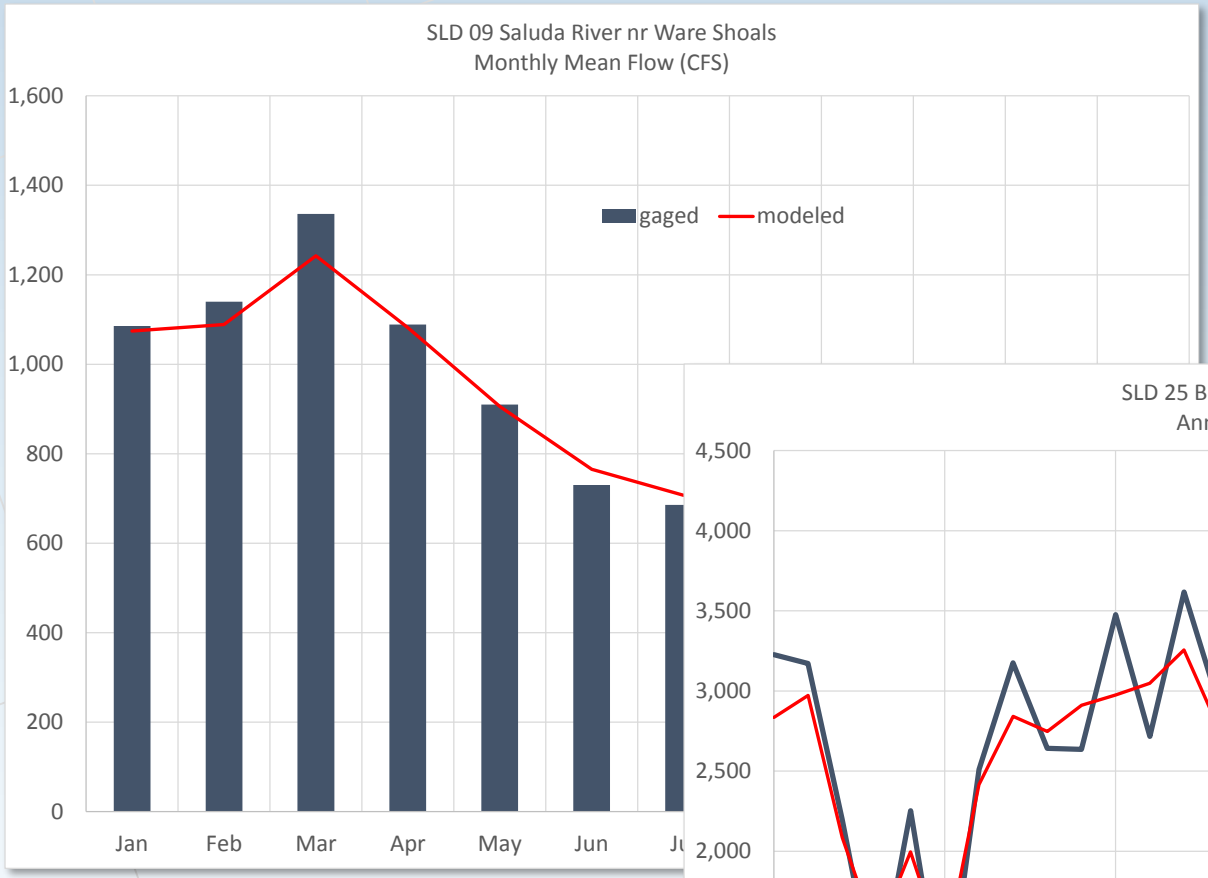

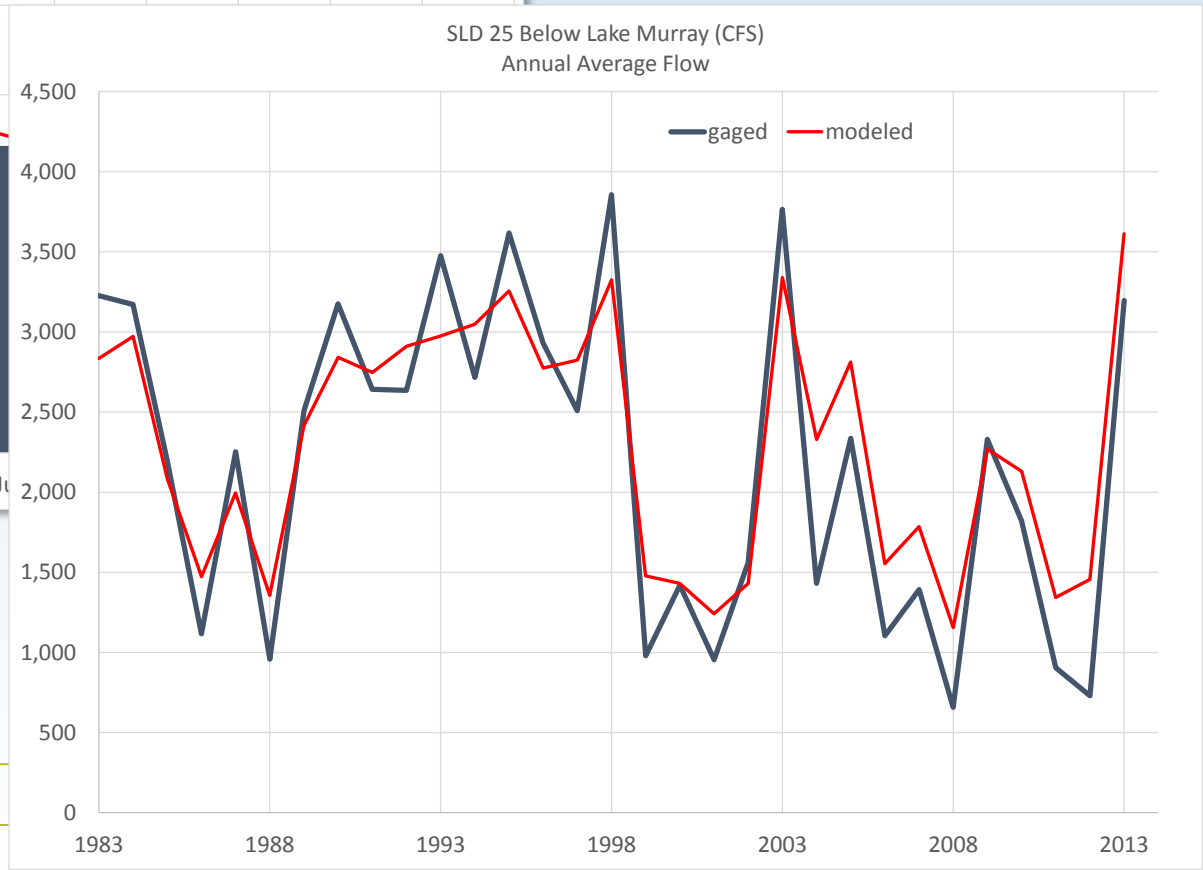

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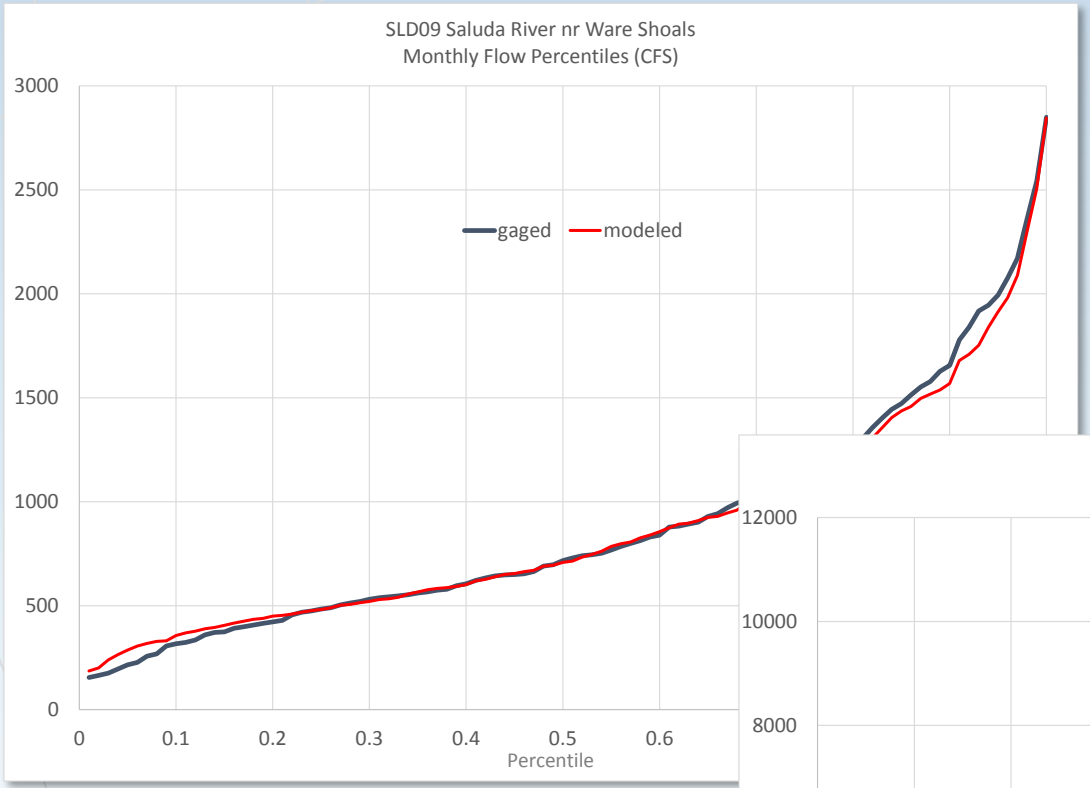

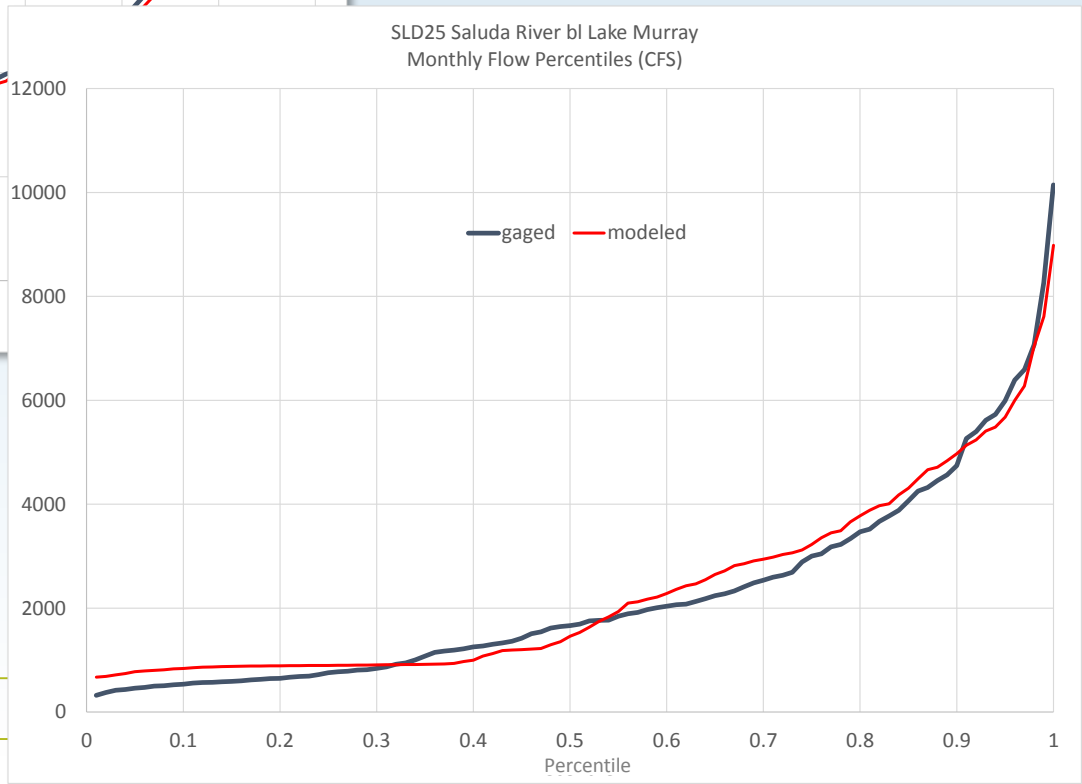

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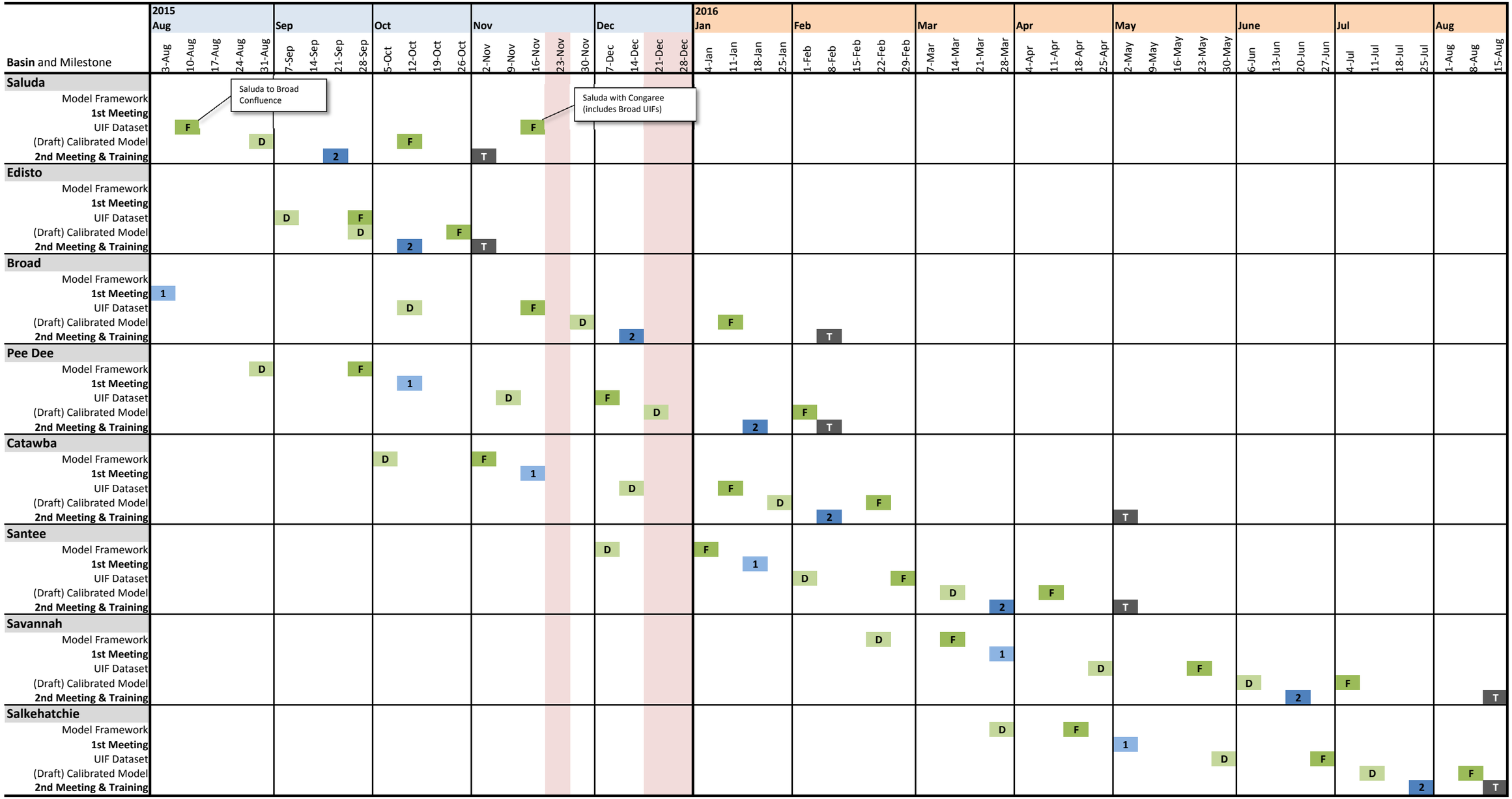
South Carolina Surface Water Quantity Assessment

Schedule

Updated August 4, 2015



Constraints and Rules:

1. Final model framework needs to be made available at least two weeks before 1st stakeholder meeting.
2. Draft calibrated model needs to be made available at least two weeks before 2nd stakeholder meeting.
3. Avoid meetings during holiday weeks in Nov and Dec.
4. Broad UIFs need to be completed before finalizing Saluda UIFs.

Key

1 = First Meeting
2 = 2nd Meeting
D = Draft Comlpetion Date
F = Final Completion Date
T = Training

Holiday Weeks