



Surface Water Quantity Models Progress Meeting Notes

April 4, 2016 – Teleconference

Attendees: **CDM Smith:** John Boyer, Tim Cox, Nina Caraway
SCDNR: Joe Gellici, Andy Wachob, Scott Harder, Alex Pellet, Bill Clendenin
DHEC: Leigh Anne Monroe, Chuck Gorman, Rob Devlin
Clemson: Jeff Allen
Technical Advisory Committee: Eddie Twilley, Ed Bruce, K.C. Price, Heather Nix, Mike Harrelson, Charles Wingard
Guest: William Gaither and Joey Henderson (Santee Cooper)

1. Scheduling of Upcoming Stakeholder Meetings & Training

- a. Broad
 - Jeff Allen noted that Clemson is attempting to reserve a room at the USC Upstate Campus for May 1, 2 or 3.
- b. Pee Dee
 - Jeff Allen noted that Clemson is attempting to reserve a room at Francis Marion University for May 1, 2 or 3, since the previously used venue is being renovated.
- c. Training
 - John Boyer indicated that once the stakeholder meeting dates are set, a date for additional DNR and DHEC SWAM training will be selected. The training will focus primarily on the new reservoir enhancements.

2. Update on UIFs and Model Development

- a. Broad and Pee Dee
 - i. Draft UIFs (completed)
 - ii. Calibration Models (in development)
 - John Boyer indicated that the draft UIF datasets for the Broad and Pee Dee basins have been completed, and the accompanying technical



memoranda were provided to DNR and DHEC for review. The technical memoranda were also made available for TAC download.

b. Edisto

i. Finalizing report and baseline model

- John Boyer noted that the Edisto baseline model and report are being finalized. Earlier in the month, DNR had reviewed the results of the verification exercise and calibration results using different headwater inputs, and had settled on the headwater inputs used in the calibration model that was presented during the December 8th Progress Meeting.

c. Saluda

i. Updating report and baseline model

- John Boyer noted that the updated calibration and baseline models were provided to DNR and DHEC. The baseline model includes the new reservoir enhancements, and provides an opportunity for DNR and DHEC staff to become familiar with and test the enhancements.

3. SWAM Reservoir Enhancements (refer to attached slides)

- Tim Cox reviewed the enhancements made to the SWAM model to provide more user flexibility when adjusting reservoir operating rules. Tim noted that these are considered “advanced” options, and will require more training and understanding by the user.
- K.C. Price asked if it could be made clearer which units (CFS and MG) listed under the “Target” Column, where applicable. Tim Cox responded that since CFS is a unit of flow and MG is a unit of volume, the user should understand if they are entering a value associated with a unit of flow or volume.
- Scott Harder asked if SWAM interpolates between the set reservoir storage targets, and releases an incremental amount between targets, such that a gradual change is realized, or if SWAM tries to meet the next storage target as quickly as possible, and considering any other criteria. Tim Cox responded that the model will attempt to meet the storage target as quickly as possible; however, the user can specify a “maximum release” amount that allows for a gradual decline in reservoir storage and level. Tim noted that alternatively, or in addition, the user can add more storage targets. Since there are five “Rule Sets” in SWAM, and each can support up to 12 targets, a total of 60 targets could be established (if no other rules were used). Tim noted that the maximum release of 2,500 cfs set for Lake Murray worked well in matching

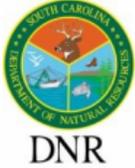


the typical decline in lake levels, when there was a drop in the target storage/elevation from one period to the next.

- Ed Bruce noted that a lot of the South Carolina reservoirs have reduced level/storage targets for winter, and their highest targets appear in summer.
- Scott Harder questioned whether the maximum release associated with the rule curve prevents the model from passing a large volume of water that is associated with a flood event. Tim Cox indicated that it does not affect flood releases, but he would double check to be sure.
- Ed Bruce noted that most stakeholders associate with reservoir elevation targets, not storage targets and asked if SWAM could be adapted so that elevation targets were used. John Boyer clarified that SWAM had been adapted to generate reservoir output in terms of both storage and elevation. For input of targets, the user must think in terms of storage. Ed Bruce suggested that it would be useful if the stage-storage curve and/or table for each reservoir could be easily accessed in the model. John Boyer indicated that will be considered and noted that the user would also be able to reference the modeling report, which will contain a table and/or curve of the storage targets.

4. Catawba-Wateree Basin LIP Considerations (refer to attached e-mail)

- John Boyer presented the proposed approach to incorporating the Catawba-Wateree Basin's Low Inflow Protocol (LIP). Since the SWAM model will begin at Lake Wylie, the flows into Lake Wylie will originate from the Catawba-Wateree CHEOPS model. In support of the Catawba-Wateree Basin Master Plan, a number of future scenarios were developed and run using the CHEOPS model. Flows into Lake Wylie from these scenarios can serve as inputs into the SWAM model. Alternatively, the user would use the CHEOPS model to develop a different set of flows that would serve as inputs into the SWAM model.
- John Boyer noted that SWAM would use the time series of LIP stages and implement the rules (actions) associated with each stage.
- John Boyer noted that since one of the LIP triggers is related to the Storage Index (SI), it is possible that the calculated total storage values may differ between models, and thus there is the potential for a total system storage that suggests a different LIP stage than what is specified in the input LIP time series.



- Ed Bruce recognized that this is possible, but noted that it is unlikely since the North Carolina Reservoirs tend to have more influence in setting the total system storage. Ed noted that the proposed approach sounded reasonable.
- Ed Bruce noted that there are two inputs into Lake Wylie: (1) the discharge from Mountain Island Reservoir and (2) unregulated flow. Both would need to be included as flow inputs into Lake Wylie in the SWAM model.

5. Upcoming Deliverables

- a. Draft Broad and Pee Dee Models (April 15)
 - John Boyer noted that CDM Smith is working on developing and performing an initial calibration of the Broad and Pee Dee models. April 15th was set as the target for distributing the draft calibration models and draft modeling reports to DNR and DHEC for review.
- b. Final Edisto UIF Memorandum, Model Report, and Baseline Model (April 22)
 - John Boyer noted that CDM Smith is currently finalizing the Edisto UIF Results Technical Memorandum, the Model Report and Baseline Model. April 22nd was set as the target date for distribution to DNR and DHEC.

6. Other Items

- Scott Harder indicated that DNR was still reviewing the Saluda calibration and baseline model and may have additional questions.
- John Boyer asked if DNR had discussed and settled on recommended potential adjustments to how SWAM output is presented, and what output is provided. Joe Gellici noted that an e-mail was forthcoming summarizing their thoughts.

Model Enhancements

- Provide greater flexibility with respect to simulating reservoir operations and decision making
- Particularly focused on FERC licensing requirements, past or future, for many of S.C. reservoirs
- User-defined prioritized rule sets that are date-specific
- Considered an “advanced user” feature in SWAM

Model Enhancements

- Conditional or unconditional targets involving:
 - Minimum releases (as in previous version)
 - Storage curve targets
 - Minimum instream flow (ISF) targets.
- Conditions based on (<, >, =):
 - Flows at flow gage
 - Reservoir storage
 - Specific water user account storage
 - Combinations of above (AND / OR).
- Multiple and flexible date ranges (rather than just calendar month)
- Rule sets written in order of priority (as in prev. version).

Model Enhancements

- Additional layers of sophistication:
 - Moving average calculations for conditions
 - “Composite” flow gage conditions
 - “Moving Target”: multiplier applied to a dynamic flow target (rather than prescribed static target)

SWAM Enhanced Reservoir Operations: Lake Greenwood

Reservoir

Main | Rule Set 1 | Rule Set 2 | Rule Set 3 | Rule Set 4 | Rule Set 5

Minimum Releases
 Storage Curve
 Instream Flow

Priority #4
 Include Rule

Maximum Release
1000000 (CFS)

Description: Normal operating storage curve.

Rule Details

Moving Averages | Composite Metrics

Start Date	End Date	Target	Condition Type	Conditional Object 1:	Criteria1:	Cond. 1:	Conditional Object 2:	Criteria2:	Cond. 2:
01/01	01/31	69808	None						
02/01	02/28	71562	None						
03/01	03/31	76978	None						
04/01	04/30	84568	None						
05/01	05/31	84568	None						
06/01	06/30	84568	None						
07/01	07/31	84568	None						
08/01	08/31	84568	None						
09/01	09/30	84568	None						
10/01	10/31	84568	None						
11/01	11/30	80720	None						
12/01	12/31	73341	None						

(CFS or MG) (CFS or MG) (CFS or MG)

Save Close

SWAM Enhanced Reservoir Operations: Lake Murray

Reservoir
X

Main Rule Set 1 Rule Set 2 Rule Set 3 Rule Set 4 Rule Set 5

Minimum Releases

Storage Curve

Instream Flow

Priority #1

Include Rule Moving Target?

Description: Striped Bass Rule.

Rule Details

Moving Averages
Composite Metrics

Start Date	End Date	Target	Condition Type	Conditional Object 1:	Criteria1:	Cond. 1:	Conditional Object 2:	Criteria2:	Cond. 2:
04/01	05/10	1300	Flow Gage AND Flow Gag	Broad at Alston	<	3000	Broad at Alston	>	2500
04/01	05/10	1500	Flow Gage AND Flow Gag	Broad at Alston	<	3500	Broad at Alston	>	2999
04/01	05/10	1700	Flow Gage AND Flow Gag	Broad at Alston	<	4000	Broad at Alston	>	3499
04/01	05/10	1900	Flow Gage AND Flow Gag	Broad at Alston	<	4500	Broad at Alston	>	3999
04/01	05/10	2100	Flow Gage AND Flow Gag	Broad at Alston	<	5000	Broad at Alston	>	4499
04/01	05/10	2300	Flow Gage AND Flow Gag	Broad at Alston	<	5500	Broad at Alston	>	4999
04/01	05/10	2500	Flow Gage AND Flow Gag	Broad at Alston	<	6000	Broad at Alston	>	5499
04/01	05/10	2700	Flow Gage AND Flow Gag	Broad at Alston	<	6500	Broad at Alston	>	5999
04/01	05/10	2300	Flow Gage AND Flow Gag	Broad at Alston	<	7000	Broad at Alston	>	6499
04/01	05/10	1900	Flow Gage AND Flow Gag	Broad at Alston	<	7500	Broad at Alston	>	6999
04/01	05/10	1500	Flow Gage AND Flow Gag	Broad at Alston	<	8000	Broad at Alston	>	7499
04/01	05/10	1000	Flow Gage OR Flow Gage	Broad at Alston	>	7999	Broad at Alston	<	1000

(CFS or MG)
(CFS or MG)
(CFS or MG)

Save
Close

SWAM Enhanced Reservoir Operations: Moving Averages

The screenshot displays the 'Reservoir' software interface. At the top, there are tabs for 'Main', 'Rule Set 1', 'Rule Set 2', 'Rule Set 3', 'Rule Set 4', and 'Rule Set 5'. The 'Rule Set 4' tab is active, showing 'Priority #4'. Below this, there are radio buttons for 'Minimum Releases', 'Storage Curve', and 'Instream Flow'. The 'Minimum Releases' option is selected. There are checkboxes for 'Include Rule' (checked) and 'Moving Target?' (unchecked). A large empty text box is present on the right side of the 'Rule Details' section.

The 'Rule Details' section has two tabs: 'Moving Averages' (highlighted with a red circle) and 'Composite Metrics'. Below these tabs is a table with the following columns: 'Start Date', 'End Date', 'Target', 'Condition Type', 'Conditional Object 1:', 'Criteria 1:', 'Cond. 1:', 'Conditional Object 2:', 'Criteria 2:', and 'Cond. 2:'. The first row of the table contains the following data: '1/1', '1/31', '100', 'Flow Gage Only', 'Saluda nr Ware Sh', '>', '1000', and empty cells for the remaining columns.

A red arrow points from the 'Moving Averages' tab to a dialog box titled 'Moving Averages'. This dialog box is divided into two columns: 'Condition 1' and 'Condition 2'. Each column contains a list of 12 rules. Each rule has a 'Moving Avg.' checkbox and an 'Averaging Period' input field. Rule 1 and Rule 11 have their 'Moving Avg.' checkboxes checked. Rule 1's 'Averaging Period 1' is set to '6'. A 'Close' button is located at the bottom right of the dialog box.

From: Scott Harder <HarderS@dnr.sc.gov>
Sent: Friday, March 18, 2016 1:47 PM
To: Boyer, John
Cc: Joe Gellici
Subject: RE: Catawba-Wateree SWAM Model - LIP Considerations

Follow Up Flag: Follow up
Flag Status: Flagged

Hi. Your summary below, I believe, is consistent with what we talked about doing a while back. However, I would assume that the way the model is calibrated or verified, in South Carolina, may have to be adjusted somewhat. That probably needs to be discussed, but I would think that the next progress call could cover that. Though, I'm open for a separate meeting if others are.
scott

From: Boyer, John [<mailto:BoyerJD@cdmsmith.com>]
Sent: Friday, March 18, 2016 11:43 AM
To: Joe Gellici <GelliciJ@dnr.sc.gov>; Scott Harder <HarderS@dnr.sc.gov>; Alex Pellett <PellettC@dnr.sc.gov>; Andy Wachob <WachobA@dnr.sc.gov>; David Baize <baizedg@dhec.sc.gov>; Gorman, Chuck (GORMANCM@dhec.sc.gov) <GORMANCM@dhec.sc.gov>; Devlin, Rob (DEVLINRJ@dhec.sc.gov) <DEVLINRJ@dhec.sc.gov>; monroela@dhec.sc.gov
Cc: Westphal, Kirk <WestphalKS@cdmsmith.com>; Cox, Timothy J. <CoxTJ@cdmsmith.com>; Caraway, Nina M. <carawaynm@cdmsmith.com>
Subject: Catawba-Wateree SWAM Model - LIP Considerations

DNR and DHEC Team -

As we will be building the Catawba-Wateree SWAM model only for the SC portion of the basin, we wanted to discuss the proposed approach for incorporating the C-W LIP stages into the model. The point of this e-mail is to introduce the approach and identify some specific nuances and one limitation; however, it may be worthwhile to ultimately schedule a call to discuss this further.

- The SWAM model will be relying on input flows (to Lake Wylie) from the C-W CHEOPS model. The CHEOPS model will need to be run prior to running the SWAM model. Ultimately, it may be useful to have CHEOPS output available for a suite of future scenarios (as completed for the C-W Master Plan), for use as input into the SWAM model. The user would pick and choose from one of the standard CHEOPS output sets that have been pre-generated.
- The CHEOPS model runs will be associated with a time series of LIP stages (No LIP, 0, 1, 2, 3, or 4). SWAM will read-in this time series of LIP stages and the associated rules (actions) for each stage will be implemented by SWAM.
- The LIP has three trigger points: (1) The Storage Index (SI); (2) 3-month avg. Drought Monitor; and (3) 6-month avg. streamflow. Only the SI can be calculated within the model; however, since the CHEOPS run will already specify the LIP stage, SWAM will not perform the SI calculation, nor will it compare the SI (in South Carolina) to the Total Storage Index (TSI) value.

- Although SWAM will not be calculating the SI, it is possible that SWAM's overall calculations will result in total storage values for lakes Wylie, Fishing Creek, Great Falls, Cedar Creek and Wateree that is different than those calculated in the CHEOPS model. The differences could be for one of two reasons: different model assumptions/data, or the simulation of future water uses and management practices in South Carolina that may not be replicated in the CHEOPS LIP determinations. Those differences could be significant enough that, if the SI was calculated and compared to the TSI, it would suggest that a different LIP stage should be in effect, compared to what the CHEOPS model is suggesting.

We just wanted to bring this minor limitation to your attention. At this point, we don't think this limitation is significant; however, until the SWAM model is built and running, we won't know what differences exist between the two models. We simply want to advocate this approach as a practical combination of two tools with different attributes: CHEOPS includes both North and South Carolina and can therefore simulate LIP stages in their totality, while SWAM provides a platform for South Carolina stakeholders and decision makers to evaluate the potential impacts of a broad range of future water uses and policies that is consistent with the rest of the state.

We can discuss this further in a separate call, or perhaps during the next Progress Call (April 4th). Although we're mostly working on the Pee Dee and Broad right now, we wanted to bring this to your attention in light of our current testing of the reservoir enhancements to SWAM. I think we will be in a position provide an introduction and/or demo the reservoir enhancements during the next Progress Call.

Thanks,
John

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