

Expanding a USACE-SWD RiverWare Model for Municipal Water Supply Planning: *The LRR-SA Model for Oklahoma City*

RiverWare User Group Meeting

August 26, 2026

Amber Spriggs

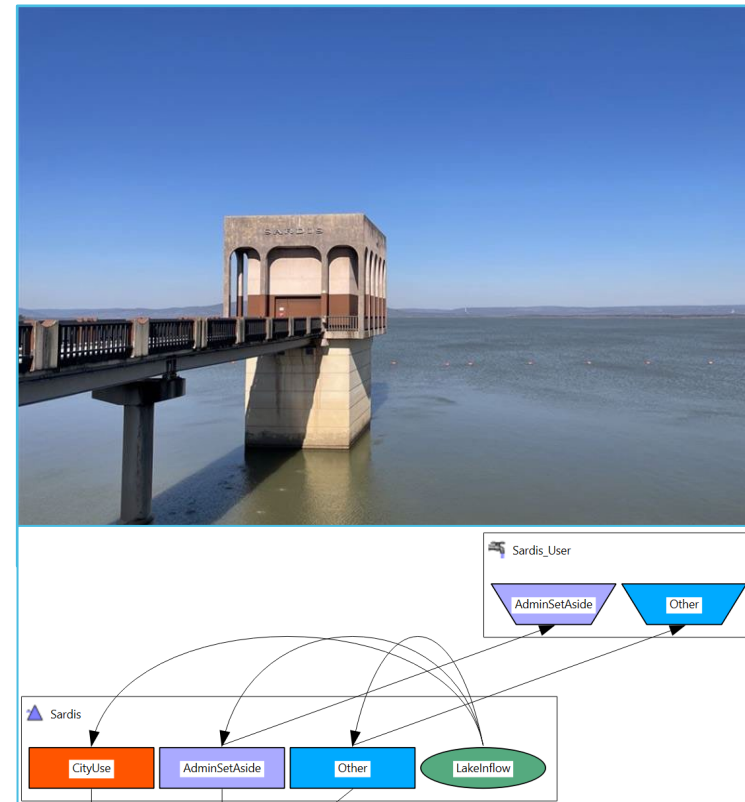
Water Resources Engineer

Patrick Noe, PE

Water Resources Engineer



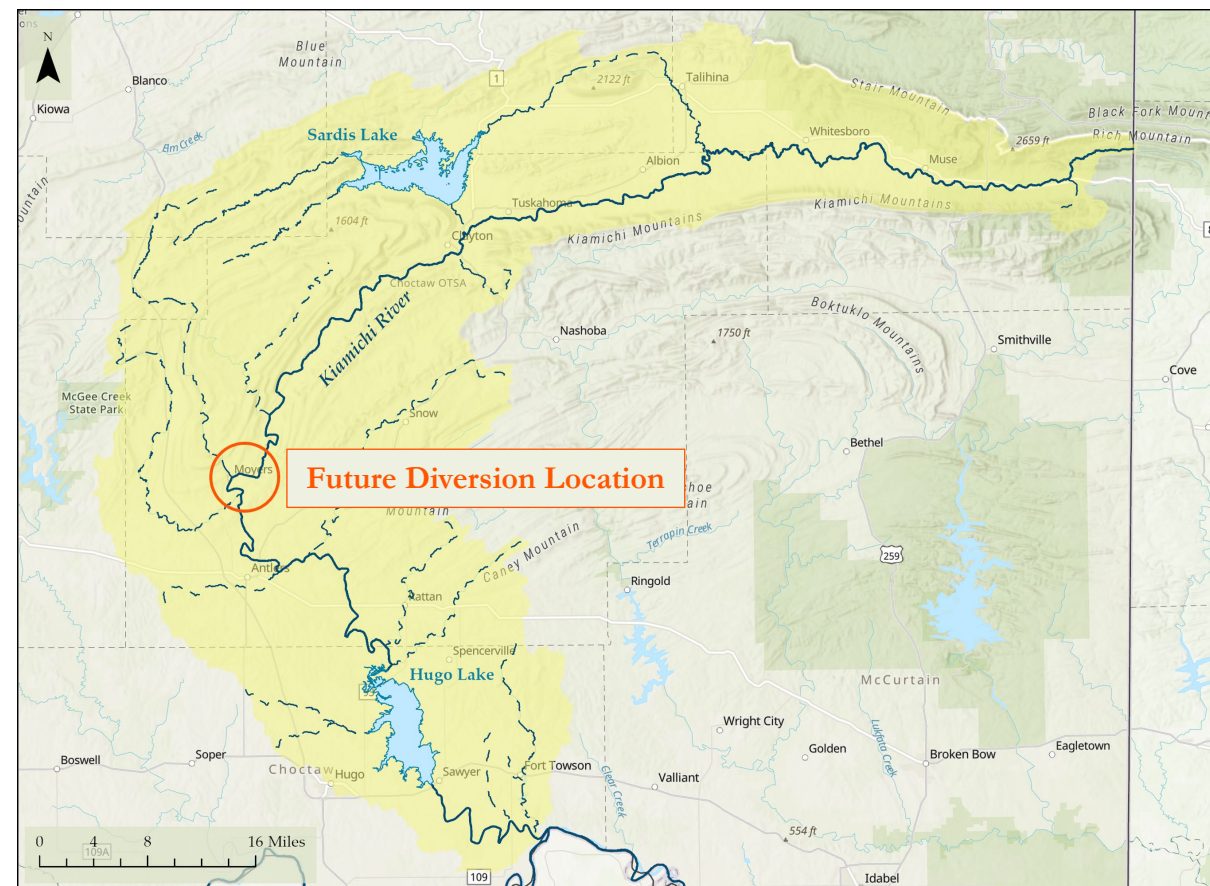
PRECISION
WATER RESOURCES ENGINEERING



The 2016 Water Settlement Agreement

State of Oklahoma, Choctaw Nation of Oklahoma, Chickasaw Nation, and City of Oklahoma City

- Establishes guidelines and criteria for future use of Sardis Lake storage and Kiamichi River flows for water supply in Oklahoma City, including:
 - Sardis Lake storage and release restrictions
 - Oklahoma City Reservoir drought conditions
- Establishes guidelines for diversions from the Kiamichi River into the City's new pipeline, including:
 - Maximum diversion rate
 - Minimum bypass
- PWRE has been working with Oklahoma City on development of a RiverWare model to simulate these rules for a variety of planning and administrative efforts.

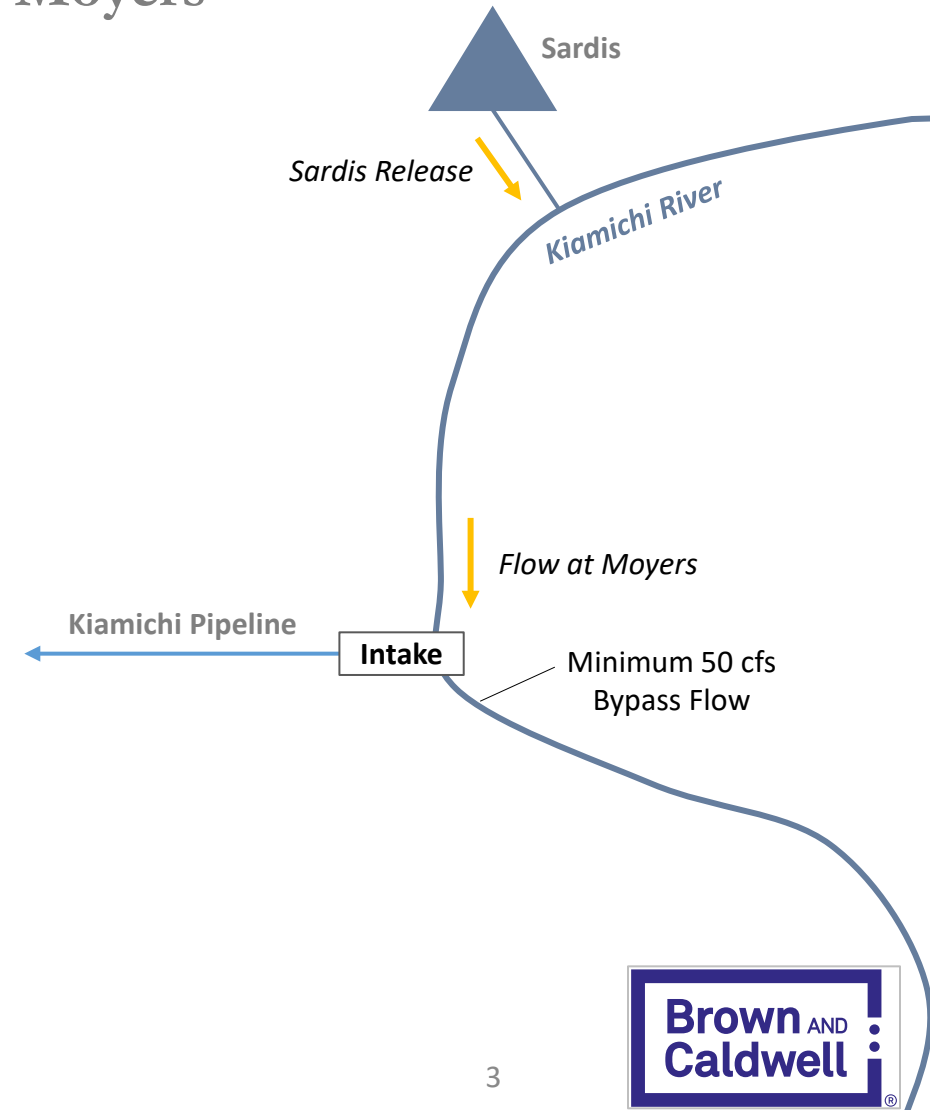


Kiamichi River Basin

The 2016 Water Settlement Agreement

Diversion and Minimum Bypass at Moyers

- Oklahoma City can divert both:
 - “Natural flow” from the Kiamichi River (which includes upstream reservoir releases for flood management), and
 - Water supply releases from the City’s storage account in Sardis Lake.
- The City is permitted to divert water only when a minimum bypass of 50 cfs is met at Moyers.



The 2016 Water Settlement Agreement

Definition of City Reservoir Drought Conditions

SA defines drought condition based on Hefner Storage, Draper Storage, **AND** Cumulative City Storage.

Cumulative City Storage - Draper, Hefner, Canton, Overholser, McGee Creek, and Atoka Reservoirs.

Extreme Drought Condition

- Draper Storage, Hefner Storage **AND** Cumulative City Storage below 50%

Advanced Drought Condition

- Draper Storage, Hefner Storage **AND** Cumulative City Storage below 65% **AND** conditions for Extreme Drought Condition not met.

Moderate Drought Condition

- Draper Storage, Hefner Storage **AND** Cumulative City Storage below 75% **AND** conditions for Extreme and Advanced Drought Condition not met.

Baseline Condition

- Conditions for Extreme, Advanced, **AND** Moderate Drought Condition not met.

The 2016 Water Settlement Agreement

Sardis Lake Elevation Thresholds

Baseline Condition

- 4/1 through 8/31, Sardis to 599' MSL.
- 9/1 through 3/31, Sardis to 595' MSL.

Moderate Drought Condition

- 7/5 through 8/31, Sardis to 597' MSL.

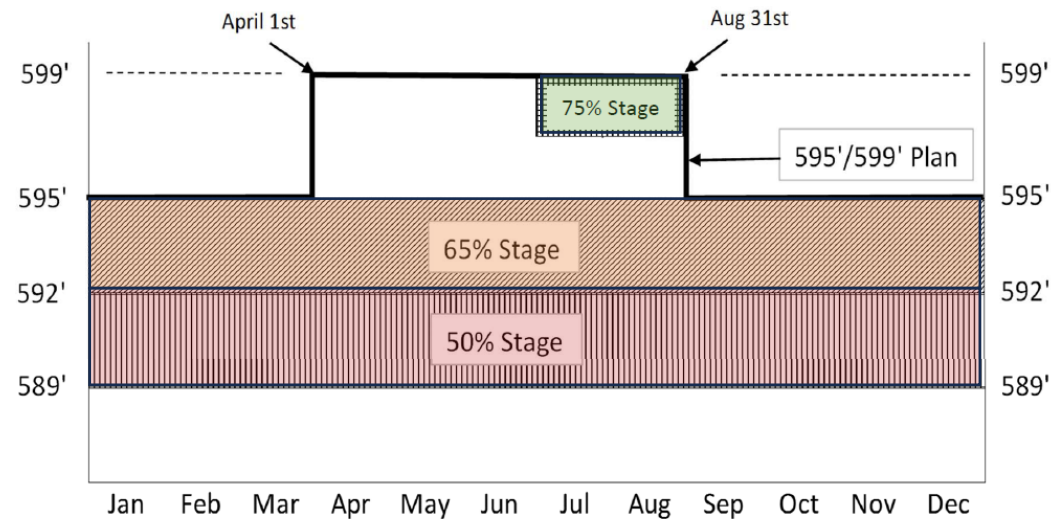
Advanced Drought Condition

- Sardis to 592' MSL all year

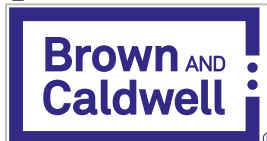
Extreme Drought Condition

- Sardis to 589' MSL all year

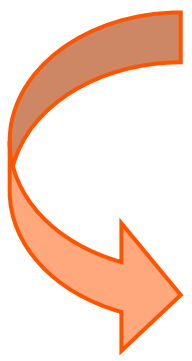
Drought Conditions - Impact on Sardis Drawdown Ability



SARDIS_EXH_010178



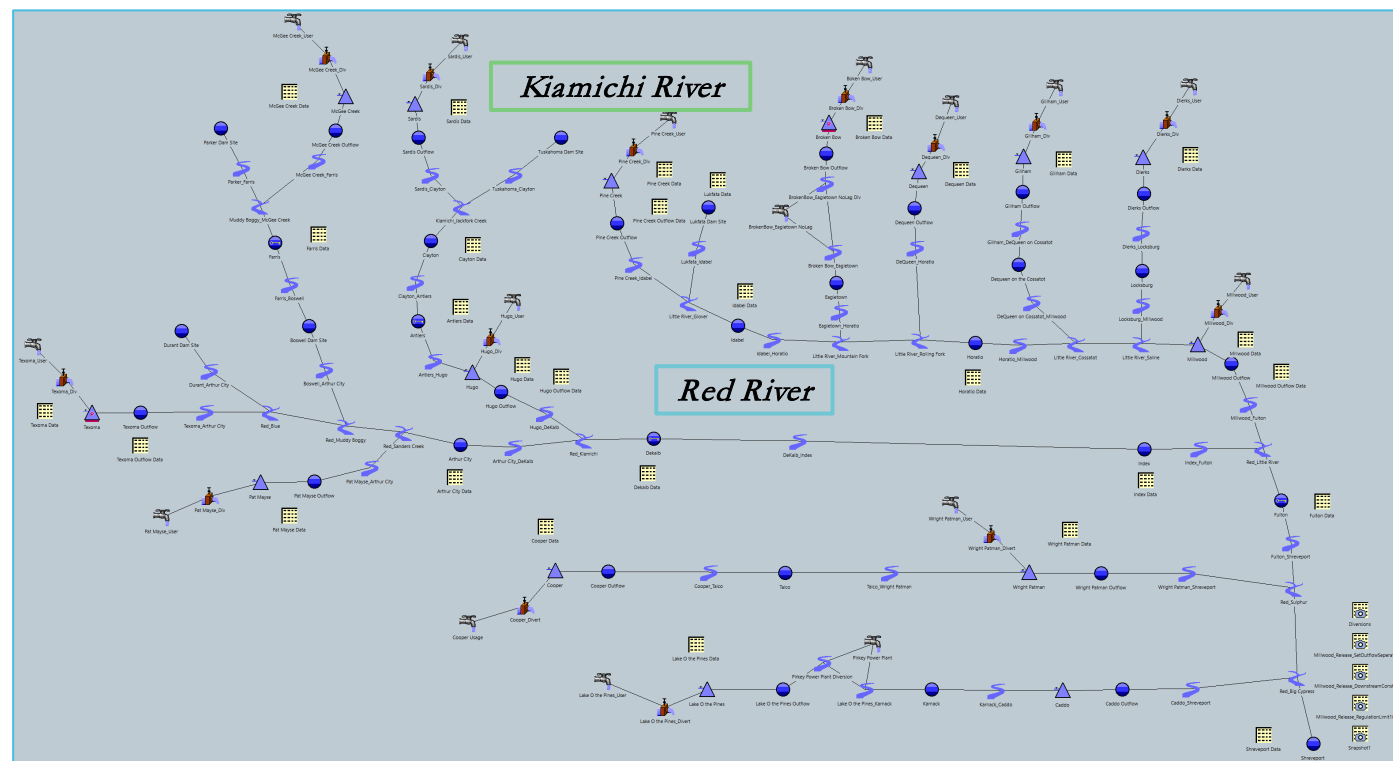
In short, the Settlement Agreement clearly defines a RiverWare model extent required for the City's planning purposes.

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- We need to accurately simulate mass balance to capture daily elevations on Sardis and all City Reservoirs (Atoka, Canton, Draper, Hefner, McGee Creek, and Overholser).
 - This requires us to model both USACE flood management (applicable to McGee, Canton, and Sardis) and Oklahoma City water supply operations.

Overview of the Lower Red River (LRR) Model

USACE Southwest Division (SWD) RiverWare Modeling

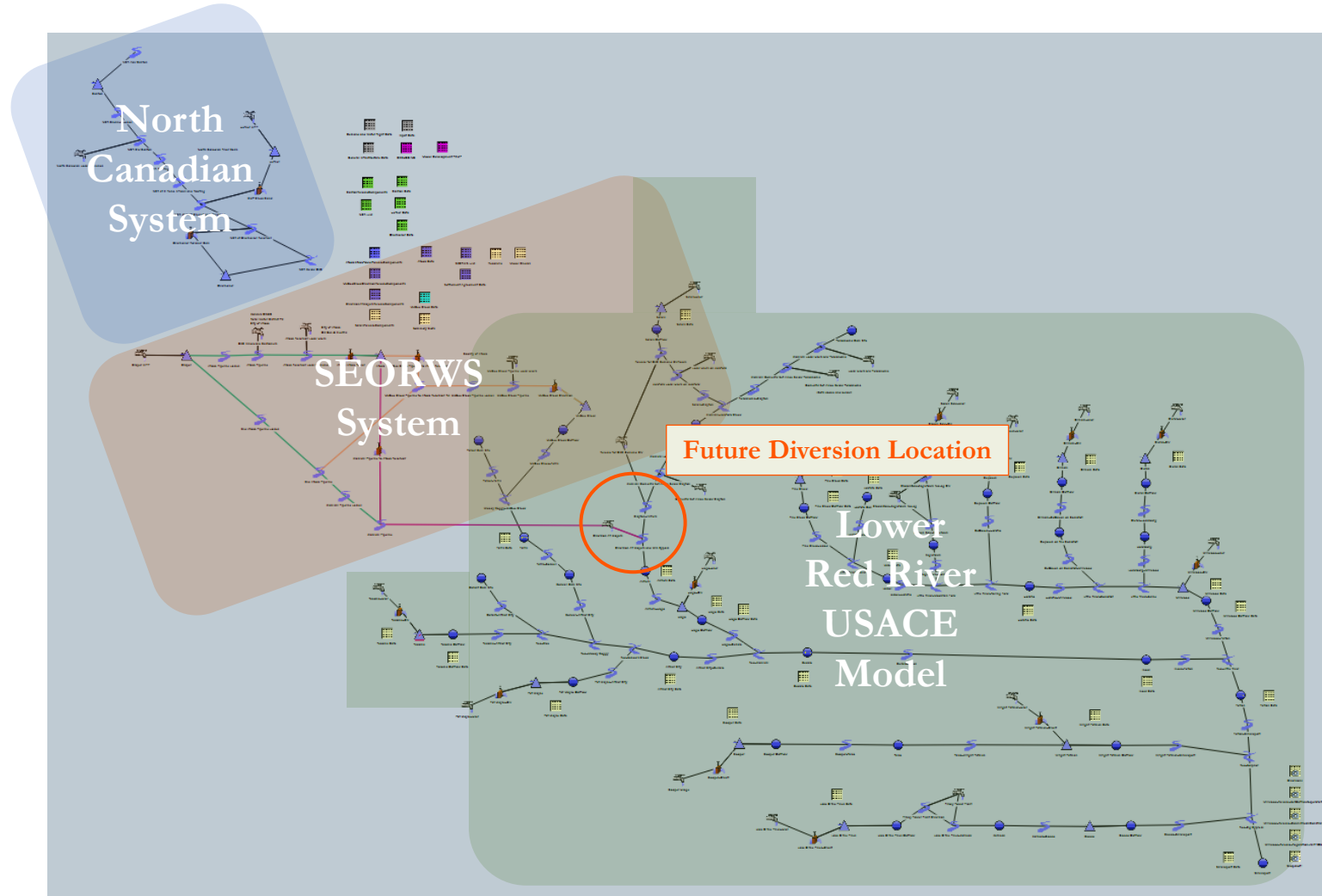
- USACE – SWD worked with CADSWES to develop a suite of generic rules and functions that simulate the Corps' flood operations criteria for large basins in RiverWare.
- The LRR Basin model was developed as part of this effort.
 - The LRR simulates operations on 15 Reservoirs on the Red River and tributaries, including Sardis and Hugo on the Kiamichi River.
 - Operates under USACE-prescribed criteria (i.e., surcharge releases, flood control releases, low-flow and hydropower, etc.).



LRR RiverWare Model Extent

Overview of the Lower Red River-Settlement Agreement (LRR-SA) Model

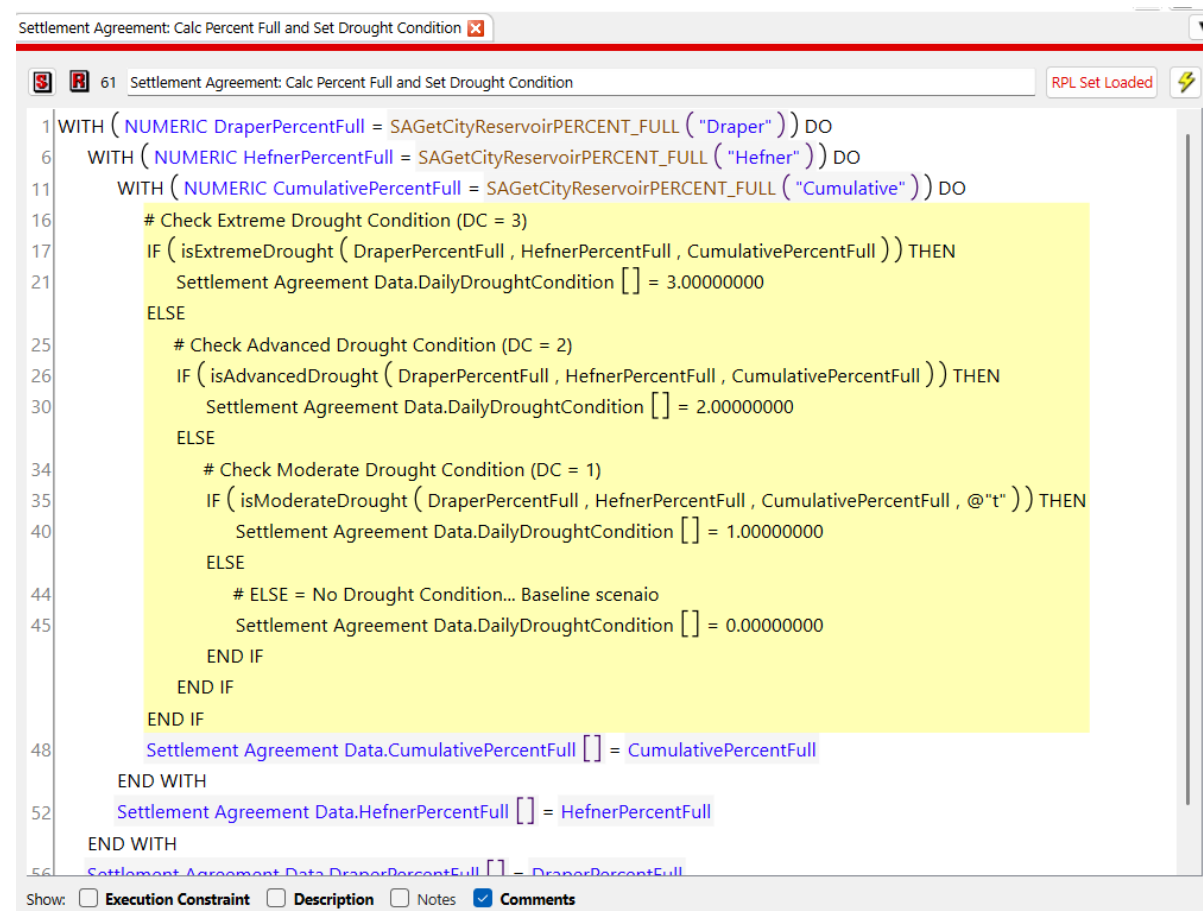
Extension of the USACE-SWD LRR RiverWare Model



Key Modifications to LRR Model

Settlement Agreement Rules and Operational Logic

- City Reservoir Drought Condition determination:
 - On every day in the run period, the model computes 1.) Draper's percent full, 2.) Hefner's percent full, and 3.) the City Reservoir Cumulative percent full.
 - These percentages are checked against thresholds defined by the Settlement Agreement and assigned as an integer to a "Daily Drought Condition" slot.
 - Sardis's water supply operations fire later and check this slot for drawdown conditions.
- Minimum bypass is added to release requests from Sardis when necessary.

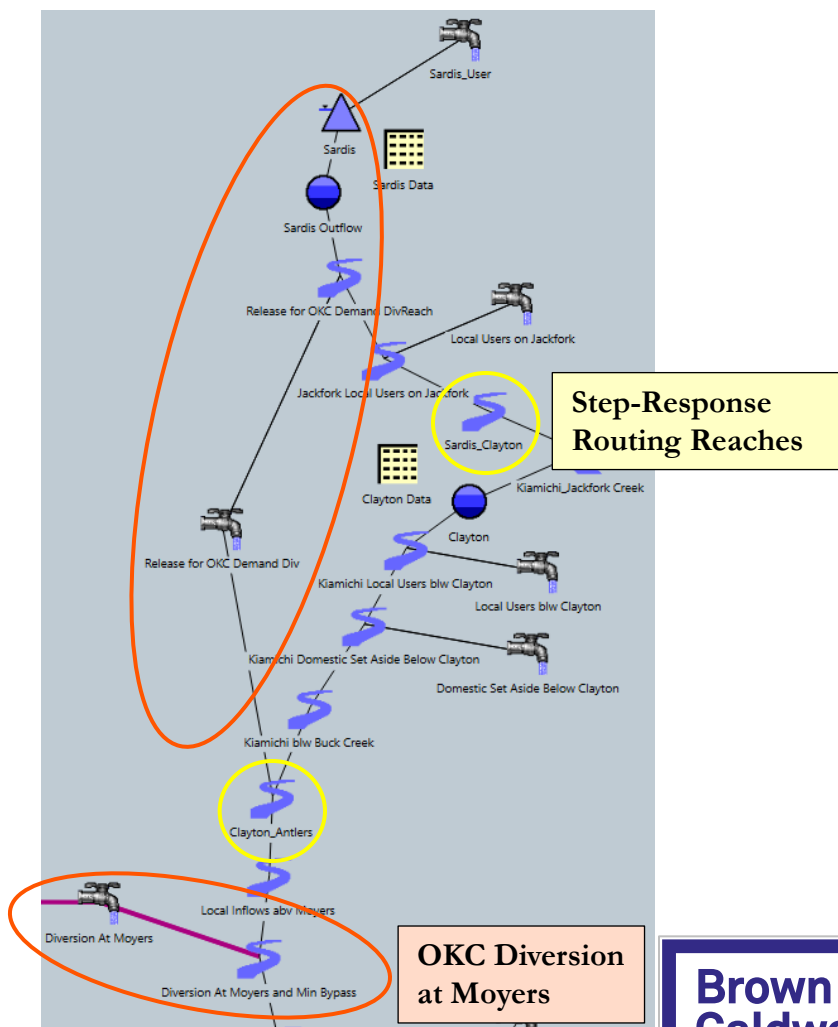


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1 WITH ( NUMERIC DraperPercentFull = SAGetCityReservoirPERCENT_FULL ( "Draper" ) ) DO
6   WITH ( NUMERIC HefnerPercentFull = SAGetCityReservoirPERCENT_FULL ( "Hefner" ) ) DO
11     WITH ( NUMERIC CumulativePercentFull = SAGetCityReservoirPERCENT_FULL ( "Cumulative" ) ) DO
16       # Check Extreme Drought Condition (DC = 3)
17       IF ( isExtremeDrought ( DraperPercentFull , HefnerPercentFull , CumulativePercentFull ) ) THEN
21         Settlement Agreement Data.DailyDroughtCondition [ ] = 3.00000000
25       ELSE
26         # Check Advanced Drought Condition (DC = 2)
27         IF ( isAdvancedDrought ( DraperPercentFull , HefnerPercentFull , CumulativePercentFull ) ) THEN
30           Settlement Agreement Data.DailyDroughtCondition [ ] = 2.00000000
34         ELSE
35           # Check Moderate Drought Condition (DC = 1)
36           IF ( isModerateDrought ( DraperPercentFull , HefnerPercentFull , CumulativePercentFull , @"t" ) ) THEN
40             Settlement Agreement Data.DailyDroughtCondition [ ] = 1.00000000
44           ELSE
45             # ELSE = No Drought Condition... Baseline scenario
46             Settlement Agreement Data.DailyDroughtCondition [ ] = 0.00000000
47           END IF
48         END IF
49       END IF
50       Settlement Agreement Data.CumulativePercentFull [ ] = CumulativePercentFull
51     END WITH
52   Settlement Agreement Data.HefnerPercentFull [ ] = HefnerPercentFull
53 END WITH
54 Settlement Agreement Data.DraperPercentFull [ ] = DraperPercentFull
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Key Modifications to LRR Model

Alternate Flow Path for Sardis Releases

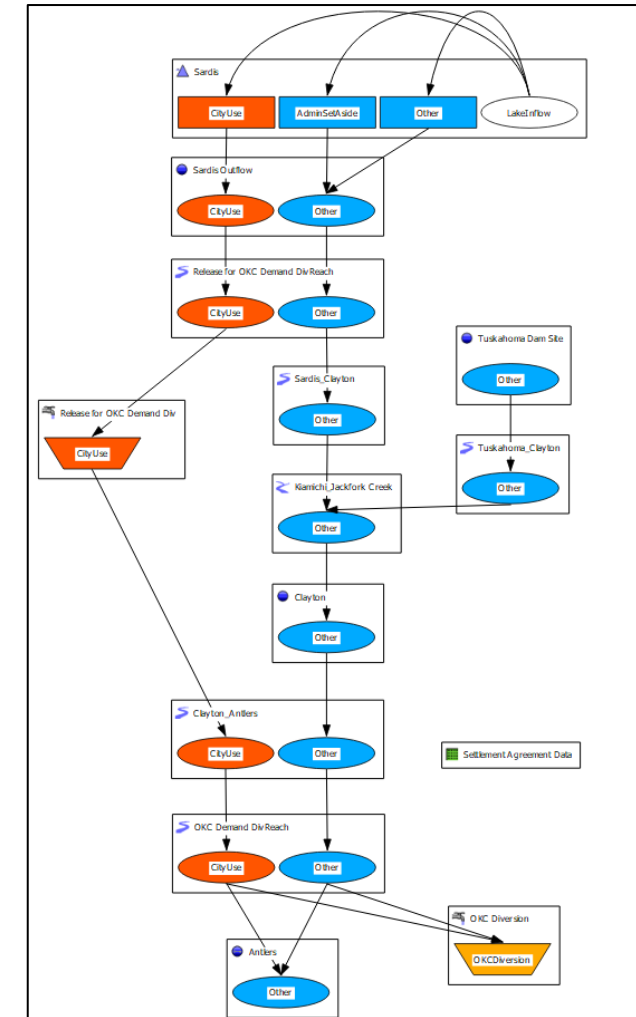
- The LRR model incorporates a step-response routing method through the mainstem Kiamichi River.
 - This method is designed and works well for routing flood flows downstream.
 - This method makes it impossible to make precise releases at Sardis Reservoir to hit specific diversion targets downstream at Moyers, which is a critical part of this modeling effort.
- We created an alternate flow branch with a simple lag routing method for OKC Sardis storage releases.
 - When releases of the City's water are made from Sardis for diversion through the pipeline or for SA-mandated bypass, they are routed through this branch.



Key Modifications to LRR Model

Kiamichi River System Accounting

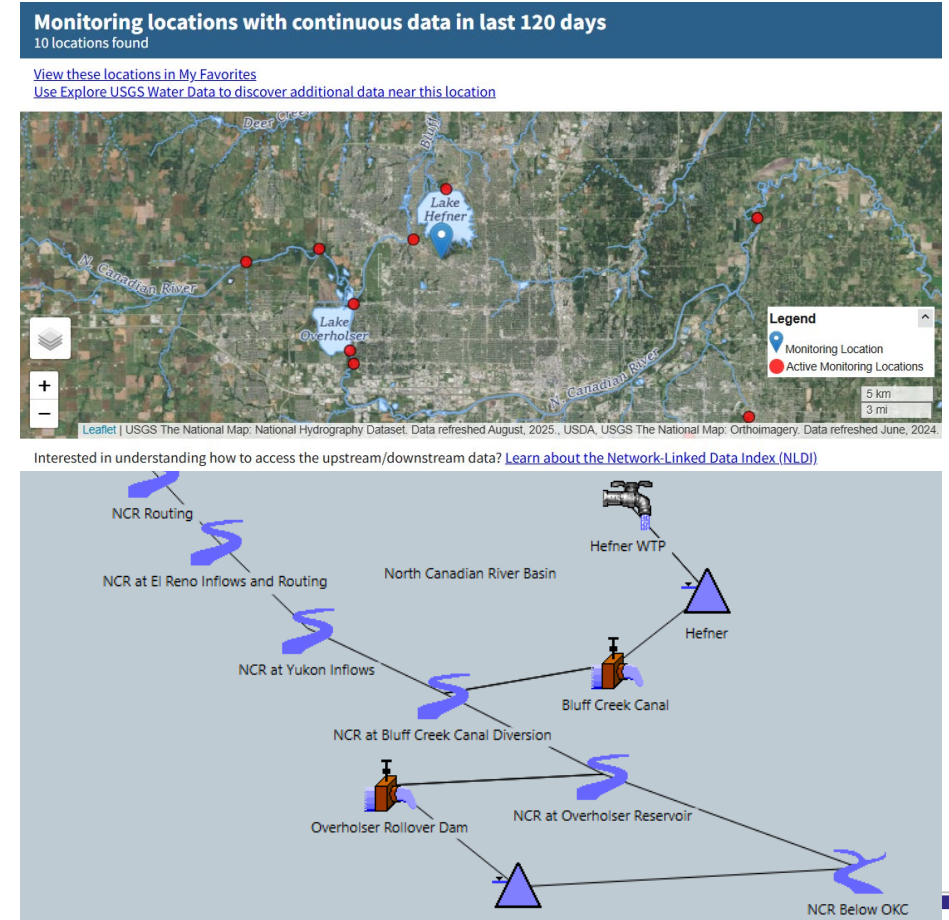
- The provisions of the Settlement Agreement necessitated the implementation of water accounting in the Kiamichi section of the model.
- The Settlement Agreement establishes unique rules for three storage accounts in Sardis:
 - Oklahoma City Storage
 - Administrative Set Aside
 - Other (Lake Level Management)
- Passthrough accounts are used to track Oklahoma City Storage and Other flows in the Kiamichi River for enforcement of the City's minimum bypass.



Lessons Learned and Conclusions

Model Development

- In any basin, a RiverWare model built for one purpose often cannot serve a different one. Things to consider:
 - What questions does this model need to answer?
 - How much of the existing model should be kept or modified?
 - What assumptions were made in development of the existing model?
- The RiverWare framework is flexible and continues to allow for complex, multi-purpose water management.
 - Frequent communication with USACE modelers and CADSWES documentation of USACE-SWD Modeling Techniques were critical to our success.



How is the LRR-SA Model Being Used?

Model Applications

- The LRR-SA is being used for numerous planning and administrative efforts by the City, including:
 - Assessing impacts of future diversions from the Kiamichi River on instream flows for endangered species.
 - Allowing the City to ask “what if” questions and explore operational strategies for their future water supply system.
 - Collaborating on Kiamichi Basin administrative planning with the Chickasaw and Choctaw Nations.

