Exhibit 3: State of Oklahoma, Choctaw Nation of Oklahoma, Chickasaw Nation, City of Oklahoma City Water Settlement

# Memorandum

*To:* *File*
*From:* *Kirk Westphal, P.E.*
*Jenny Bywater, P.E.*
*Date:* *August 2016*
*Subject:* *Kiamichi Basin Hydrologic Model Summary*

This memorandum documents the model initially built by CDM Smith on behalf of the City of Oklahoma City and the Oklahoma City Water Utilities Trust (collectively, "Oklahoma City") to help understand the hydrology and water availability within the Kiamichi River Basin. The model subsequently served as the foundation for the consensus hydrological model Oklahoma City, the State of Oklahoma, the Choctaw Nation of Oklahoma, and the Chickasaw Nation collaboratively developed for purposes of settlement negotiations and future water rights administration in the Kiamichi Basin.

## Overview of Model

A simulation model was developed using the STELLA (Systems Thinking Experimental Learning Laboratory with Animation) modeling interface. The version of the model this memorandum is based on is ***Kiamichi-Atoka Simulation Model_V47.stmx***. It was developed for use with STELLA version 10.1.

STELLA is a graphical system simulation package that allows users to model physical flow systems with operational or planning-level resolution. The rules-based software allows users to develop on-screen control interfaces that facilitate adjustments of system variables for alternatives and sensitivity analyses. The model uses a combination of future water demands and historical hydrological patterns to evaluate various water management strategies and estimate the reliability of satisfying multiple water needs under a wide range of conditions.

**Figure 1-1** shows a schematic of the main physical elements included within the model. The reservoirs simulated explicitly are—Sardis, Hugo, McGee Creek, Atoka, and Stanley Draper. Precipitation, runoff, and evaporation are incorporated into each reservoir. The Kiamichi River is modeled by a series of flow segments.

The model is run on a monthly time step covering the hydrologic period of record from 1926 through 1971 (the record that is unaffected by the presence of Sardis Lake, which was constructed in 1972, and which includes the major droughts of record in Southeast Oklahoma). During a model run, the model determines the percentage of historical hydrologic years in which water would have been available in certain amounts for various consumptive and non-consumptive uses.

## Data Sources

The following are the main data sources used as inputs into the model:

- **Kiamichi River Streamflow**: The USGS streamflow gage at Belzoni (Gage ID: 07336500) was used over other gages since it has a significant timespan (1925 – 1972) covering a wide range of hydrologic conditions including the drought of record. Its records were also not influenced by Sardis Lake operations since the reservoir was operational after 1972 and thus the record represents the natural river conditions. In order to estimate natural flows at locations throughout the basin, the flow record from the Belzoni gage was transposed using drainage area ratios.
    - The subwatershed draining into Sardis Lake is 20 percent of the drainage area measured at the Belzoni gage.
    - Hugo Reservoir is downstream of the Belzoni gage and the subwatershed represented by the Belzoni gage is 83 percent of the total drainage into Hugo Reservoir.
- **Inflow into Atoka Reservoir and McGee Creek Reservoir:** The flow record for the Belzoni gage was also transposed to generate estimates of inflows into Atoka and McGee Creek Reservoirs since available records for those reservoirs were not as extensive as the USGS data in the Kiamichi River Basin, nor did they include the effects of the drought of record. The assumption of hydrologic similarity between the basins was verified through testing the firm yield calculated with the estimated flows and comparing to the published values of 71,800 AFY for McGee Creek Reservoir and 92,067 AFY for Atoka Reservoir in the 2003 Water Master Plan.
    - Inflow into Atoka Reservoir was estimated as 54 percent of the Belzoni gage flow.
    - Inflow into McGee Creek Reservoir was estimated as 60 percent of the Belzoni gage flow.
- **Precipitation and Evaporation:** Rain falling directly on the reservoirs was accounted for based on average monthly historic precipitation for the Southeast Oklahoma region multiplied by the surface area of the reservoir. On average, annual rainfall during the period of record was 47.8 inches. Evaporation rates from reservoir surfaces were based on average monthly values from Broken Arrow Reservoir found in NOAA Technical Report NWS 34 and did not vary in the model year to year. The annual average evaporation was 43.4 inches.
- **Reservoir Storage:** Reservoir storage was determined either from the USACE or OWRB provided data (ultimately, the model relied on the USACE data for Sardis Lake). Stage-Area-Volume tables were input into the model, based on provided records and interpolated where necessary. **Table 1-1** provides the maximum and minimum elevation as well as the total storage that could be physically accessed for the main reservoirs. Potential sedimentation is not considered and the analysis assumes that the physical capacities remain constant throughout the simulation.

**Table 1-1: Modeled Reservoir Storage Volumes and Pool Elevations**

| Reservoir | Max Pool Elevation (ft) | Min Reservoir Elevation for Physical Accessibility* (ft) | Total Storage Volume Above Minimum Elevation** (AF) |
|---|---|---|---|
| Sardis | 599 | 542 | 274,000 |
| Atoka | 590 | 550 | 103,000 (107,940) |
| McGee Creek | 577.1 | 533 | 88,437 (88,445) |
| Stanley Draper | 1191 | 1145 | 72,500 (72,195) |
| Hugo | 410.2 | 390 | 200,000 |

**The model can constrain available storage at the user's discretion for testing management alternatives.*

*** Values listed represent values used in the model to support model simulations during settlement negotiations. Values in parentheses reflect final values in the settlement agreement. The differences between the numbers have no appreciable impact on simulation results, conclusions, or interpretations of results. The model, (version as noted above in this memorandum), has been updated with the numbers per the final settlement agreement.*

- Permitted local water rights within the Kiamichi River Basin, McGee Creek Reservoir, and Atoka Reservoir from the 2009 Regional Raw Water Supply Study are accounted for in the model and held in reserve even if they have not been historically exercised. The rights included are listed in **Table 1-2**.

**Table 1-2: Modeled Local Water Needs**

| Location | Annual Water Needs (AFY) |
|---|---|
| Atoka Local | 2,315 |
| Hugo Local | 62,029 (plus 90 mgd required release) |
| Kiamichi River Local | 9,700 |
| McGee Local | 20,000 (rights senior to OKC) |
| Sardis Local | 20,000 |

- A domestic use set aside of 6 AFY for each 160 acres in the upstream drainage area is accounted for within the model. Above Sardis Lake 6,600 AFY is reserved for this set aside by being subtracted from the runoff entering the reservoir. At Moyers another 20,720 AFY is reserved from the natural streamflow in the Kiamichi River.

- No seepage from the reservoirs or river bed is explicitly accounted for within the model. This assumption was verified through a literature search and an analysis of USGS streamflow records that indicated no significant seepage.

## Operational Considerations

- The model includes a user-defined bypass flow requirement at a simulated point of withdrawal from the basin. This was configured in accordance with the values specified in the settlement agreement.

- The model allows the specification of monthly peaking factors and maximum flow for future withdrawals from the basin. These were configured in accordance with the values specified in the settlement agreement.

- The model includes rules that restrict withdrawals from the basin based on monthly variable lake elevation levels at Sardis Lake, as well as the relative drawdown levels of

other Oklahoma City reservoir levels. These operating rules were incorporated into the model in accordance with the values specified in the settlement agreement.

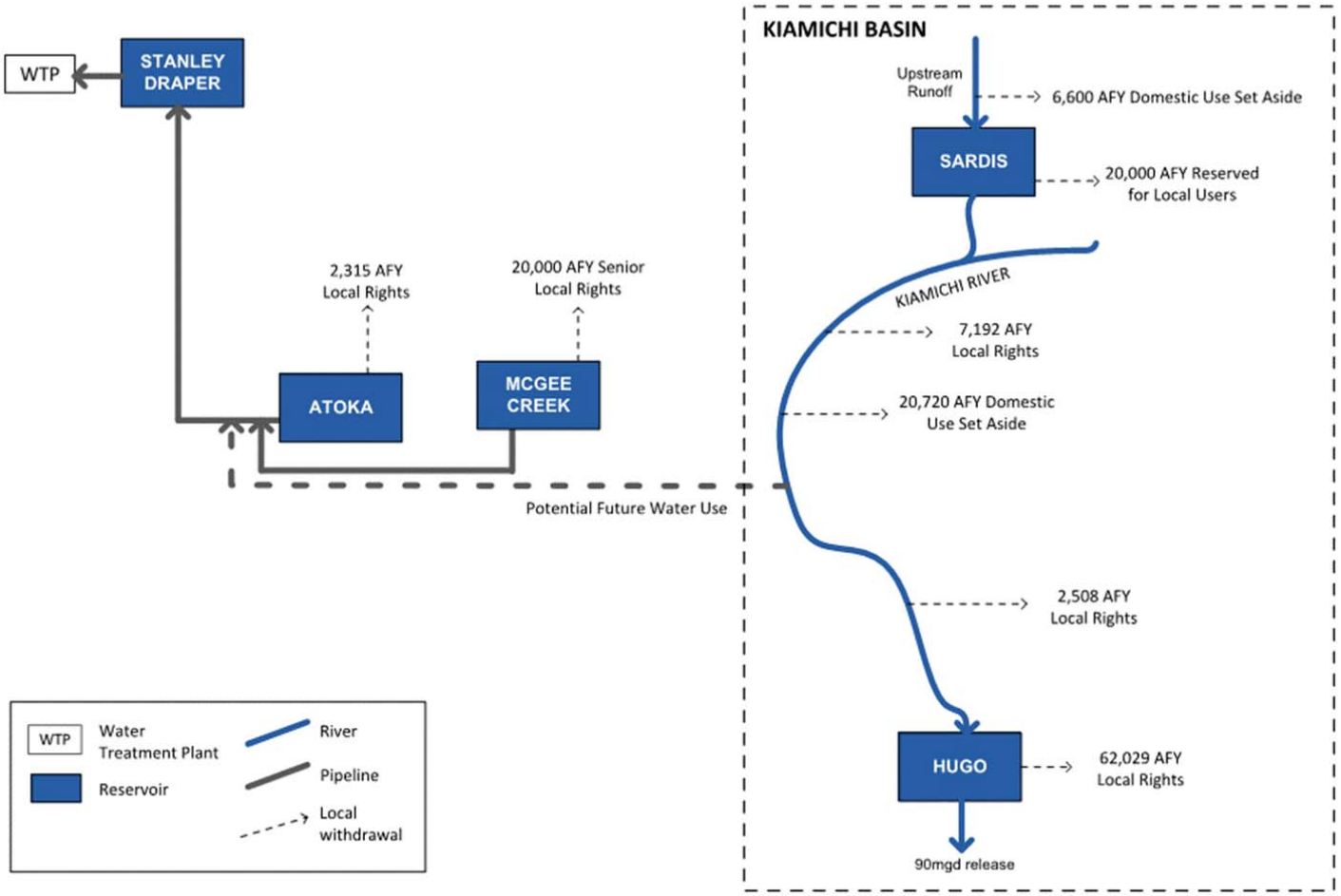


**Figure 1-1: Model Schematic**