Technical Memorandum

To: *Upper Savannah River Basin Council (RBC)*

From: *CDM Smith*

Date: *April 9, 2024*

Subject: *Demand-side Water Management Strategies*

Following the initial discussion about water management strategies during the March RBC meeting, several RBC members asked for additional information about the strategies being considered, including examples of where they are used. Provided below is a short description of the demand-side strategies considered by other South Carolina RBCs, along with some examples of their use in South Carolina and elsewhere. Demand-side strategies for residential and commercial water users (also called municipal strategies in this context) are described first, followed by strategies applicable to agricultural users. Some of the municipal strategies may also apply to the industrial and energy water use sectors.

Municipal Water Efficiency and Conservation Strategies

Described below are municipal water efficiency practices that may be considered as part of a toolbox of demand side water management strategies.

Development, Update, and Implementation of Drought Management Plans

This strategy is already ongoing in the basin because public suppliers were required to develop drought management plans as part of the Drought Response Act of 2000. Each drought management plan has a set of measurable triggers indicating when conditions have entered one of three phases of drought and corresponding response actions to reduce demand by a target percentage. Chapter 8 of the River Basin Plan will provide a detailed description of the drought management plans in the Upper Savannah River basin. The drought management plans are important for reducing demand and conserving water during critical low-flow periods. Under this strategy, public suppliers would continue to implement their drought management plans during drought conditions as well as keep their plans up to date to reflect any changes to the system.

Public Education of Water Conservation

This strategy would involve expanding existing public education programs or developing new programs as needed. Water conservation education could occur through public schools, civic associations, or other community groups. Water utilities and local governments could create informational handouts and/or include additional water conservation information on water utility bills. For this strategy to remain effective, public outreach would need to continue on a regular basis to maintain public engagement and motivation. The Broad RBC discussed the possibility of larger water utilities sharing staffing or other conservation resources with smaller utilities.

The Upper Savannah RBC could look to the 2014 Water Use Efficiency Plan developed by the Catawba-Wateree Water Management Group (CWWMG) for an example of a basin-wide approach to reduce demand. The Plan includes measures such as a public information campaign, education and outreach, and landscape water management and demonstration gardens.

Conservation Pricing Structures

Conservation pricing structures increase the unit cost of water as consumption increases. Utilities may have pricing structures that have a flat rate for customers, a unit use rate that varies with consumption, or some combination of the two. Conservation pricing sets higher unit price use rates for customers whose usage exceeds set thresholds. This strategy assumes that consumers will curtail their personal use to avoid paying higher prices. The extent of demand reduction depends on the magnitude of the price increase as well as the local price elasticity of demand for water usage.

In the Upper Savannah River basin, Pioneer Water has a flat fee tiered system which increases from $4.25/gallon for the first 3,000 gallons up to $7.50/gallon for all gallons above 8,000.

In the Broad River basin, several utilities including the Inman Campobello Water District (ICWD) and Greer CPW have drought surcharges that may be implemented during severe and/or extreme drought phases. These surcharges are like conservation pricing structures, because the intent is to encourage customers to use less water. If implemented during a drought, ICWD charges the regular water rate for the first 5,000 gallons used in a month, twice the regular water rate for up to 12,000 gallons used, and three times the regular rate for all water used above 12,001 gallons.

Residential Water Audits

Residential water audits allow homeowners to gain a better understanding of their personal water use and identify methods to reduce water use. Homeowners can perform these audits themselves using residential water audit guides, or water utilities may provide free residential water audits to their customers. Residential water audits involve checking both indoor uses, such as toilets, faucets, and showerheads, and outdoor uses, such as lawn sprinklers. Based on the results of the audit, homeowners may invest in low-flow systems, repair leaks, and/or adjust certain personal water–use behaviors.

Landscape Irrigation Program and Codes

Landscape irrigation programs or water-efficient landscaping regulations can encourage or require homeowners to adopt water-efficient landscaping practices. Such practices seek to retain the natural hydrological role of the landscape, promote infiltration into groundwater, preserve existing natural vegetation, and, ultimately, conserve water. Water-efficient landscaping may include the incorporation of native plants or low water–use plants into landscape design (City of Commerce, CA 2021).

Local governments can require the use of these water efficiency measures through municipal codes or encourage them through incentives or educational programs. Potential practices include:

- Smart Irrigation Controller Rebate – Utilities may offer rebates to homeowners who replace their existing irrigation controllers with smart irrigation controllers that adjust irrigation according to soil moisture levels (soil-moisture-based or SMS) and precipitation and/or evapotranspiration rates (weather-based or WBIC). Controllers can be WaterSense-certified by meeting EPA criteria.

- Turf Replacement Rebate – Utilities may offer rebates to homeowners or businesses who replace irrigable turf grass with landscaping that requires minimal or no supplemental irrigation.
- Developer Turf Ordinance – Ordinances can be set that require new developments to have reduced irrigable turf grass area. Such development may be required to have low flow or microirrigation in plant beds, spray or rotor heads in separate zones for turf grass, or smart irrigation controllers to manage remaining turf area.
- Education Programs – Programs could be offered for homeowners to learn about water-efficient landscaping practices. Some examples of landscape irrigation improvements include:
    - Verification of the best irrigation schedule for the climate and soil conditions
    - Verification of the recommended nozzle pressure in sprinklers
    - Adjustments to sprinkler locations to ensure water falls on lawn or garden (not on sidewalk or other impervious surfaces)
    - Use of a water meter to measure water used in landscape irrigation

Water Efficiency Standards for New Construction

Local ordinances can require that all new construction or renovations meet established water efficiency metrics, either set by the local government or by existing water efficiency certifications, such as LEED or EPA's WaterSense. These programs have set water efficiency requirements for all household fixtures, such as a maximum rating of 2.5 gallons per minute flow rate for showers and maximum rating of 1.6 gallons per flush for toilets (Mullen n.d.).

Toilet Rebate Program

Toilet rebate programs offer rebates for applicants who replace old, inefficient toilets with water-efficient ones. For example, if the toilet being replaced uses 3.5 gallons per flush (gpf) and the replacement toilet uses 1.28 gpf, there will be a savings of 2.22 gpf per rebate. Assuming a use rate of five flushes per day per person (DeOreo et al. 2016) and an average of 2.5 persons per household results in savings of 27.8 gallons per household per day for each rebate.

Leak Detection and Water Loss Control Program

A water loss control program identifies and quantifies water uses and losses from a water system through a water audit. Once identified, sources of water loss can be reduced or eliminated through leak detection, pipe repair or replacements, and/or changes to standard program operations or standard maintenance protocols. Following these interventions, the water loss program can evaluate the success of the updates and adjust strategies as needed.

Automated meter reading (AMR) and advanced metering infrastructure (AMI) are technologies that can assist with leak detection. AMR technology allows water utilities to automatically collect water–use data from water meters, either by walking or driving by the property. AMI systems automatically transmit water usage data directly to the utility, without requiring an employee to travel to the property. AMI systems collect data in real time. Both technologies reduce the staff time required to read meters and allow utilities to more frequently analyze actual consumption (as opposed to predicted usage based on less frequent manual meter readings). Higher than expected readings then can be noted and flagged as potential leaks. Because of their ability to collect data more frequently, AMI systems may detect consumption anomalies sooner than AMR. This allows for earlier detection of smaller leaks so that repairs can be made before major pipe breaks. AMI systems are more expensive to install than AMR systems and, therefore, may not be economical for smaller utilities. Hybrid systems on the market allow for future migration from AMR to AMI.

An example of a basin-wide water audit and water loss control program is that of the CWWMG, which is undertaking a significant water audit project to identify real (leaks) and apparent (meter inaccuracy) water losses throughout the basin. This project identified 17 billion gallons of non-revenue water that could be managed to increase utility revenue by $16.8 million (CWWMG no date). Subsequent phases involve conducting economic analyses and identifying water loss goals for each CWWMG member, and the entire group.

Georgia is one of the few states that have implemented statewide water loss control requirements. In 2010, the Georgia Water Stewardship Act was signed into law. The Act set water loss control requirements that apply to public water systems serving populations over 3,300, which include:

- Completion of an annual water loss audit using American Water Works Association (AWWA) M36 Methodology
- Development and implementation of a water loss control program
- Development of individual goals to set measures of water supply efficiency
- Demonstration of progress toward improving water supply efficiency

Reclaimed Water Programs

Reclaimed water programs reuse highly treated wastewater for other beneficial purposes, reducing demands on surface water and groundwater. Water can be reclaimed from a variety of sources then treated and reused for beneficial purposes such as irrigation of crops, golf courses, and landscapes; industrial processes including cooling water; cooling associated with thermoelectric plants; and environmental restoration. The quality of reuse water would need to be matched with water quality requirements of the end use, and emerging contaminants of concern (e.g., per- and polyfluoroalkyl substances [PFAS] and microplastics) would need to be considered.

Car Wash Recycling Ordinances

In-bay automatic car wash systems use approximately 35 gallons of water per vehicle. A touch-free car wash (one that relies solely on chemicals and high-pressure spray rather than on the gentle friction of a soft-touch wash) uses approximately 70 gallons per vehicle. Assuming one-bay and 100 customers per day, these two common types of systems use between 3,500 and 7,000 gallons of water per day. To reduce water usage, car wash recycling ordinances require all new car washes to be constructed to include recycled water systems. Recycled water systems allow for water used in washing or rinsing to be captured and reused. Ordinances can set a percentage of recycled water to total water used. Typical ordinances require at least 50 percent use of recycled water.

Water Waste Ordinance

Local governments can establish a water waste ordinance to prohibit the watering of impervious surfaces, such as sidewalks or driveways, and/or prohibit runoff from private properties onto public streets.

Time-of-Day Watering Limit

A time-of-day watering limit prohibits outdoor watering during the hottest part of the day, usually 10:00 a.m. to 6:00 p.m. This practice reduces water loss from evaporation.

Agriculture Water Efficiency Demand-Side Strategies

Following is a description of the agricultural water efficiency practices that may be considered as part of the toolbox of demand-side strategies.

Water Audits and Nozzle Retrofits

Water audits monitor water use in an agricultural irrigation system to identify potential opportunities for water efficiency improvements. Water audits consider water entering the system, water uses, water costs, and existing water efficiency measures. They gather information on the size, shape, and topography of the agricultural field, depth to groundwater, vulnerability to flooding, pumping equipment, irrigation equipment, and past and present crop use and water use (Texas Water Development Board 2013).

Across the state, Clemson University Cooperative Extension Service specialists and researchers have held meetings to talk with farmers about center pivot irrigation and discuss the Clemson Center Pivot Irrigation Test Program, a type of water audit offered by the Clemson Extension Water Resources, Agronomic Crops, and Horticulture Teams. These audits measure irrigation uniformity—the consistency of irrigation depth across the irrigated area. Without irrigation uniformity, some crops may experience overirrigation and some may experience underirrigation, leading to wasted water and profit losses. The Center Pivot Irrigation Test Program can provide growers with a map of irrigation depths, observed issues such as leaks and clogs, estimated costs of over- or underwatering, estimated costs for nozzle retrofits, and design versus observed flow rates and system pressure (Clemson Cooperative Extension 2022a). After the audit, a report is provided that includes an estimated cost of under- and overirrigation based on crop types. This cost of suboptimal irrigation is compared to the estimated cost of a sprinkler retrofit.

The South Carolina Mobile Irrigation Laboratory pilot project is another example water audit program. This project is the result of a partnership with South Carolina Department of Agriculture (SCDA) and Aiken Soil and Water Conservation District. The audits identify areas of over- and underwatering, suggest energy savings opportunities, and recommend upgrades or operational changes (SCDNR 2019). The project is providing no-cost water and energy audits on 24 agricultural center pivot irrigation systems throughout South Carolina over 3 years (SCDNR 2020). Following the 3-year pilot program, the feasibility of expanding the pilot to a statewide project will be assessed (SCDNR 2020).

Irrigation Scheduling

Irrigation scheduling refers to the process of scheduling when and how much to irrigate crops based on the needs of the crops and the climatic/meteorological conditions. It ensures that crops are receiving the correct amount of water at the right time. The three main types of irrigation scheduling methods include soil water measurement, plant stress sensing, and weather-based methods. To measure soil water, farmers can use soil moisture probes at varying depths. For weather-based methods, farmers can research regional crop evapotranspiration reports to develop an irrigation schedule. Additionally, farmers can use thermal sensors to detect plant stress (Freese and Nichols, Inc. 2020). The use of thermal and/or moisture sensors to automatically schedule irrigation is referred to as smart irrigation.

A 2021 Clemson study on Intelligent Water and Nutrient Placement (IWNP) combines smart watering strategies with smart fertilizer applications. IWNP will use smart sensing with model-based decision support systems to determine the irrigation water and nutrient application required by crops at a given time (Clemson College of Agriculture, Forestry and Life Sciences 2021). The IWNP systems would be installed on existing overhead irrigation systems as a retrofit. The program first seeks to develop the system, then develop a training program to teach farmers how to use the system.

Soil Management

Soil management includes land management strategies such as conservation tillage, furrow diking, and the use of cover crops in crop rotations. The USDA defines conservation tillage as “any tillage or planting system that covers 30 percent or more of the soil surface with crop residue, after planting, to reduce soil erosion by water” (USDA 2000). Conservation tillage can conserve soil moisture, increase water–use efficiency, and can decrease costs for machinery, labor, and fuel. Types of conservation tillage include:

- No-Till – The soil is left undisturbed from harvest to planting except for nutrient injection. With this type of practice, planting is done in narrow seedbeds and a press wheel may be used to provide firm soil–seed contact (Janssen and Hill 1994).
- Strip Till – This practice involves tilling only the seed row prior to planting, disturbing less than one-third of the row width.
- Ridge Till – This practice involves planting into a seedbed prepared on ridges using sweeps, disk openers, coulters, or row cleaners. Residue is left on the surface between ridges to reduce soil loss (Janssen and Hill 1994).
- Mulch Till – This practice uses chisel flows, field cultivators, disks, sweeps, or blades to till soil in such a way that it does not invert the soil but leaves it rough and cloddy (Janssen and Hill 1994).
- Furrow Diking – The practice of creating small dams or catchments between crop rows to slow or prevent rainfall runoff and increase infiltration. Increased water capture reduces supplemental irrigation needed, resulting in a direct water savings.
- Cover Crops – This practice involves planting cover crops, such as cereal grains or legumes, following the harvest of summer crops. Such cover crops use unused nutrients and protect

against nutrient runoff and soil erosion. They can increase infiltration and water-holding capacity of the soil, which may indirectly result in water savings.

Crop Variety, Crop Type, and Crop Conversion

Changing crop type from those that require a relatively large amount of water to crops that require less water use can save significant amounts of irrigation water. In South Carolina, transitioning away from corn and small grains, such as wheat, rye, oats, and barley, and increasing cotton crops can reduce water use. However, because the choice of crops is market-driven and certain machinery, infrastructure, and skills are specific to different crops, changing crop type may not make economic sense for growers. Conversion programs that offer growers incentives may be necessary. Switching the variety of a particular crop may also act as a water conservation strategy. For example, switching from full/mid-season corn to short-season corn could result in a 3.7 acre-inches per acre savings. However, such a change could also result in substantial yield loss, making it an unviable option for some growers (Freese and Nichols, Inc. 2020).

Converting from irrigated crops to dryland crops can have substantial water saving benefits. Exact savings vary by crop but potentially could be on the order of 15.8 acre-inches per acre (Freese and Nichols, Inc. 2020).

Irrigation Equipment Changes

Changing from low-efficiency irrigation equipment to higher-efficiency equipment can reduce water use but requires significant financial investment. Irrigation methodologies may include mid elevation, low elevation, low-elevation precision application, or drip irrigation. These methodologies have application efficiencies of 78, 88, 95, and 97 percent, respectively (Amosson et al. 2011).

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