
Background Report

Water for 2060 Advisory Council

Prepared for

Oklahoma Water Resources Board



U.S. Army Corps of Engineers, Tulsa District



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Acronyms and Abbreviations

CPUC	California Public Utilities Commission
DWR	Department of Water Resources
EPA	U.S. Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
mgd	million gallons per day
M&I	municipal/industrial water
NRCS	Natural Resources Conservation Service
OCWP	Oklahoma Comprehensive Water Plan
OPAI	Oklahoma Panhandle Agriculture and Irrigation
OSU	Oklahoma State University
PRWP	Panhandle Regional Water Plan
SSR	self-supplied residential water
USBR	U.S. Bureau of Reclamation

1. Introduction

The Water for 2060 Act was passed in the 2012 Oklahoma legislative session and signed into law by Governor Mary Fallin. It sets a goal for the state to use no more “fresh” water in 2060 than it did in 2012 and emphasizes the use of education and incentives, rather than mandates, to achieve this ambitious goal without limiting Oklahoma’s future growth and prosperity. The Act calls for the formation of a Water for 2060 Advisory Council chaired by the Executive Director of the Oklahoma Water Resources Board and comprising of fourteen appointees (five from the Speaker of the House, five from the President Pro Tempore of the Senate, and four from the Governor). The 15-member Advisory Council is tasked with the following:

- Recommend incentives for various water use efficiency measures and programs.
- Make recommendations regarding education programs that modify and improve water consumption practices.
- Enhance existing or develop new financial assistance programs for leak detection/repair programs and encourage consolidation and regionalization of Oklahoma water systems.

Consistent with one of the eight priority recommendations in the *2012 Oklahoma Comprehensive Water Plan Update (OCWP)* and its subsequent implementing legislation, the primary purpose of this Background Report is to provide technical support for the Advisory Council. Specifically, this report summarizes the conservation measures and findings of the *OCWP Water Demand Forecast Report (2011)*. In addition, it summarizes the interview results of conservation programs of selected crop irrigation districts and municipalities in Oklahoma as well as the conservation programs of Colorado and California. The experiences from local and out-of-state programs are used to identify local conservation practices that are being implemented and to demonstrate potential state-level incentives for conservation efforts.

CH2M HILL and Carollo Engineers would like to thank the City of Norman utilities staff, especially Ken Komiske, Mark Daniels, and Chris Mattingly; the City of Shawnee utilities staff, especially Steve Nelms, Greg Price and Jeremy Brown; Tom Buchanan of Lugert-Altus Irrigation District; and Fred Fischer and Roger Fischer of Oklahoma Panhandle Agriculture and Irrigation for providing the information on their conservation programs.

2. Selected Oklahoma Water Use Sectors and OCWP Conservation Scenarios

Technical studies conducted under the OCWP developed water demand estimates for the seven major consumptive water use sector categories in Oklahoma: municipal/industrial (M&I; also referred to as publically supplied water), self-supplied residential (SSR), self-supplied industrial, crop irrigation, livestock, thermoelectric power, and oil and gas. Water demand forecasts were developed in 10-year intervals through 2060 for each water use sector. Forecasts also were prepared to characterize potential water conservation scenarios applied to the previously developed baseline forecasts for Oklahoma’s two largest water use sectors—M&I and Crop Irrigation—and for the smaller SSR use sector. Details are included in the *OCWP Water Demand Forecast Report* (OWRB 2011), available on the OWRB’s OCWP website.¹

2.1 Municipal & Industrial and Crop Irrigation Sectors

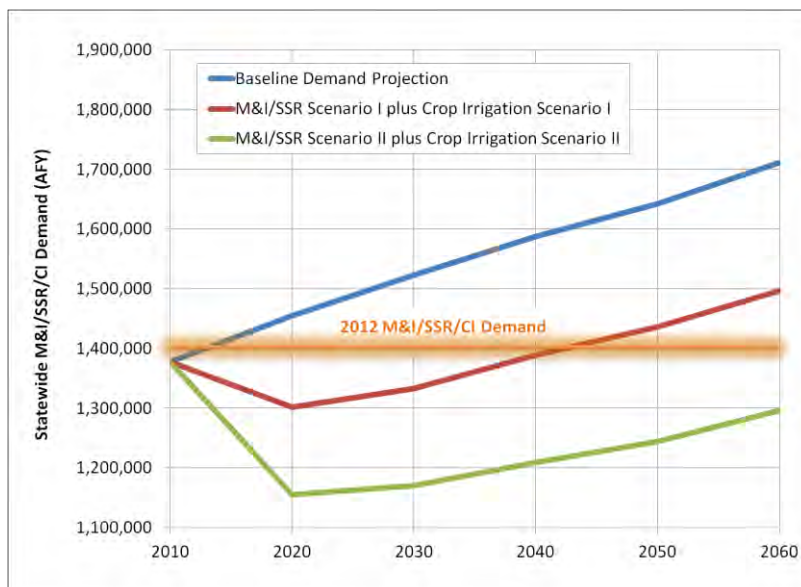
The addendum to the *OCWP Water Demand Forecast Report* (OWRB 2011) includes an assessment of the potential water savings associated with certain types and levels of conservation measures in the M&I and SSR and Crop Irrigation sectors. The potential reductions in water demand were estimated at the county level, then later delineated to the basin level for the state’s 82 OCWP planning basins.

The OCWP evaluated the effects of water conservation on future water demands and shortages under two scenarios for the M&I/SSR and Crop Irrigation sectors:

- Scenario I: Moderately expanded conservation
- Scenario II: Substantially expanded conservation

The conservation measures evaluated include practices that are implemented in some areas of the U.S. However, widespread adoption of these measures across Oklahoma, as contemplated in the OCWP-evaluated scenarios, faces a range of implementation challenges, particularly for Scenario II. Table 2-1 summarizes the water conservation elements of Scenarios I and II for the M&I/SSR and Crop Irrigation sectors. Table 2-2 lists statewide projections of M&I/SSR and Crop Irrigation water demand reductions by 2060 under each OCWP conservation scenario. Projected statewide demands under full implementation of Scenario I and II for M&I/SSR and Crop Irrigation are compared to baseline M&I/SSR and Crop Irrigation projections in Figure 2-1, showing that for these sectors, expanded conservation in Oklahoma could achieve the Water for 2060 goals of using no more fresh water in 2060 than in 2012.

FIGURE 2-1
OCWP M&I, SSR, and Crop Irrigation Water Demand Projections Under Baseline and Conservation Scenarios



Source: Derived from OCWP Water Demand Forecast Report Table 27 and OCWP Demand Addendum, Tables 2 and 6.

¹ <http://www.owrb.ok.gov/supply/ocwp/ocwp.php>

**TABLE 2-1
Summary of OCWP Conservation Scenarios**

Conservation Scenario	Description
M&I/SSR	
Scenario I—Moderately Expanded Conservation	<p>Passive conservation achieved by 2060 for PSR and 2030 for PSNR. Passive conservation is defined as conservation that can be achieved through government plumbing codes as part of the Energy Policy Act.</p> <p>Ninety percent of water providers in each county will meter their customers, unless current metered percentage is greater than 90 percent.</p> <p>Nonrevenue water use (e.g., authorized metered water use that is not billed, unauthorized water use, billing errors, metering errors, line breaks, and system losses) will be reduced to 12 percent, where applicable.</p> <p>Conservation pricing (increasing tiered rate structures) will be implemented by 20 percent of purveyors in rural counties, 40 percent in mostly urban counties, and 60 percent in counties with high metropolitan populations.</p> <p>All providers will implement water conservation educational programs that include billing inserts and conservation tip websites to reduce demands by 3 percent.</p>
	<p>Passive conservation (as in Scenario I).</p> <p>All purveyors will meter their customers.</p> <p>Nonrevenue water use will be reduced to 10 percent where applicable.</p> <p>Conservation pricing will be implemented by 60 percent of purveyors in rural counties, 80 percent in mostly urban counties, and 100 percent in counties with high metro populations.</p> <p>Water conservation education programs will be implemented to reduce demands by 5 percent including school education programs and media campaigns in addition to billing inserts and a conservation tip website.</p> <p>High efficiency plumbing code ordinance will be implemented. This ordinance requires use of high efficiency fixtures with lower maximum flow rates than those required under the Energy Policy Act.</p>
Crop Irrigation	
Scenario I—Moderately Expanded Conservation	<p>The field application efficiency of surface irrigation systems for Harmon, Jackson, Tillman, and Kiowa counties will increase to 80 percent beginning in 2015 (all of Basins 40 and 41, parts of Basins 34, 36, 38, and 42).</p> <p>In Harmon, Jackson, Tillman, and Kiowa counties, 10 percent of the land irrigated by surface irrigation will shift to micro-irrigation beginning in 2015 (all of Basins 40 and 41, parts of Basins 34, 36, 38, and 42).</p> <p>All sprinkler systems will have a field application efficiency of 90 percent beginning in 2015, representing implementation of LEPA nozzles on existing sprinkler systems.</p> <p>Water saved through conservation activities is not applied to a water scheme elsewhere, such as expanding the number of irrigated acres, thus achieving true conservation.</p>
	<p>All assumptions from Scenario I are applicable.</p> <p>All acres of water intensive crops (corn for grain and forage crops, including alfalfa and pasture grass), shift to less water intensive crops (grain for sorghum) beginning in 2015. While it is highly unlikely that all water-intensive crop production will stop, this assumption allows for analysis of full implementation of the what-if scenario.</p>

Source: OCWP Water Demand Forecast Report

**TABLE 2-2
Potential Conservation Savings (AFY)**

	2020	2030	2040	2050	2060
M&I/SSR Scenario I	93,902	128,891	135,194	141,111	147,122
M&I/SSR Scenario II	132,397	178,253	196,007	210,348	219,283
Crop Irrigation Scenario I	59,591	61,600	63,609	65,151	67,628
Crop Irrigation Scenario II	167,514	174,771	182,028	187,597	196,541

Source: OCWP Water Demand Forecast Report Addendum Tables 2 and 6.

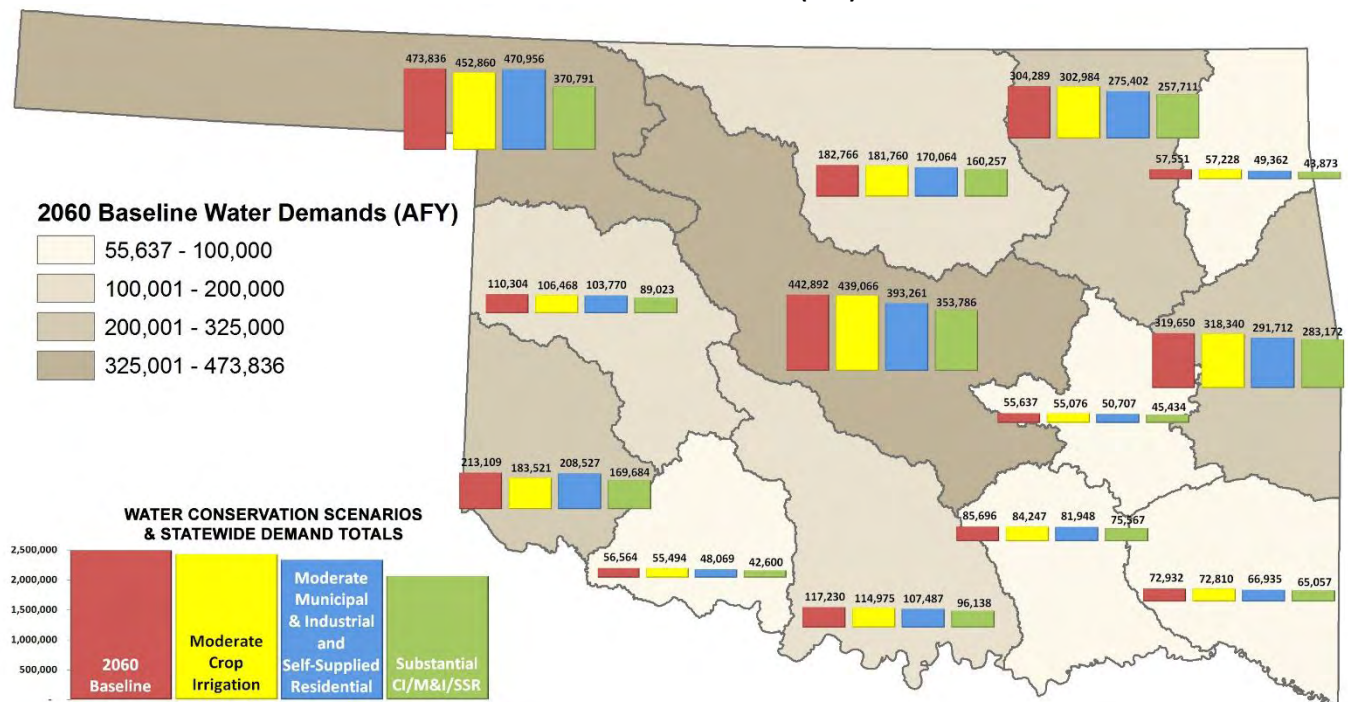
2.2 Potential Reductions in Water Demand

Building on the conservation measures and programs in place today has the potential to reduce future water demands from baseline OCWP projections. A synthesis of data developed for each of the 82 watershed planning basins and aggregated into the 13 OCWP watershed planning regions (Figure 2-2) illustrates how the following conditions could affect 2060 demand for these two major water use sectors:

- 2060 Baseline: No further conservation savings, also referred to as “2060 Baseline” in the figure.
- Moderately expanded conservation in the Crop Irrigation sector (“Moderate Crop Irrigation” in the figure, corresponding to Scenario I, with full realization of Scenario I savings).
- Moderately expanded conservation in the M&I/SSR sectors (“Moderate Municipal & Industrial and Self-Supplied Residential” in the figure, corresponding to Scenario I, with full realization of Scenario I savings).
- Substantially expanded conservation in both the Crop Irrigation and M&I/SSR sectors (“Substantial CI/M&I/SSR” in the figure, corresponding to Scenario II, with full realization of Scenario II savings).

FIGURE 2-2

2060 Water Demands under OCWP Baseline and Conservation Scenarios (AFY)



Source: Prepared by the OWRB using OCWP data analyzed and synthesized by Carollo Engineers.

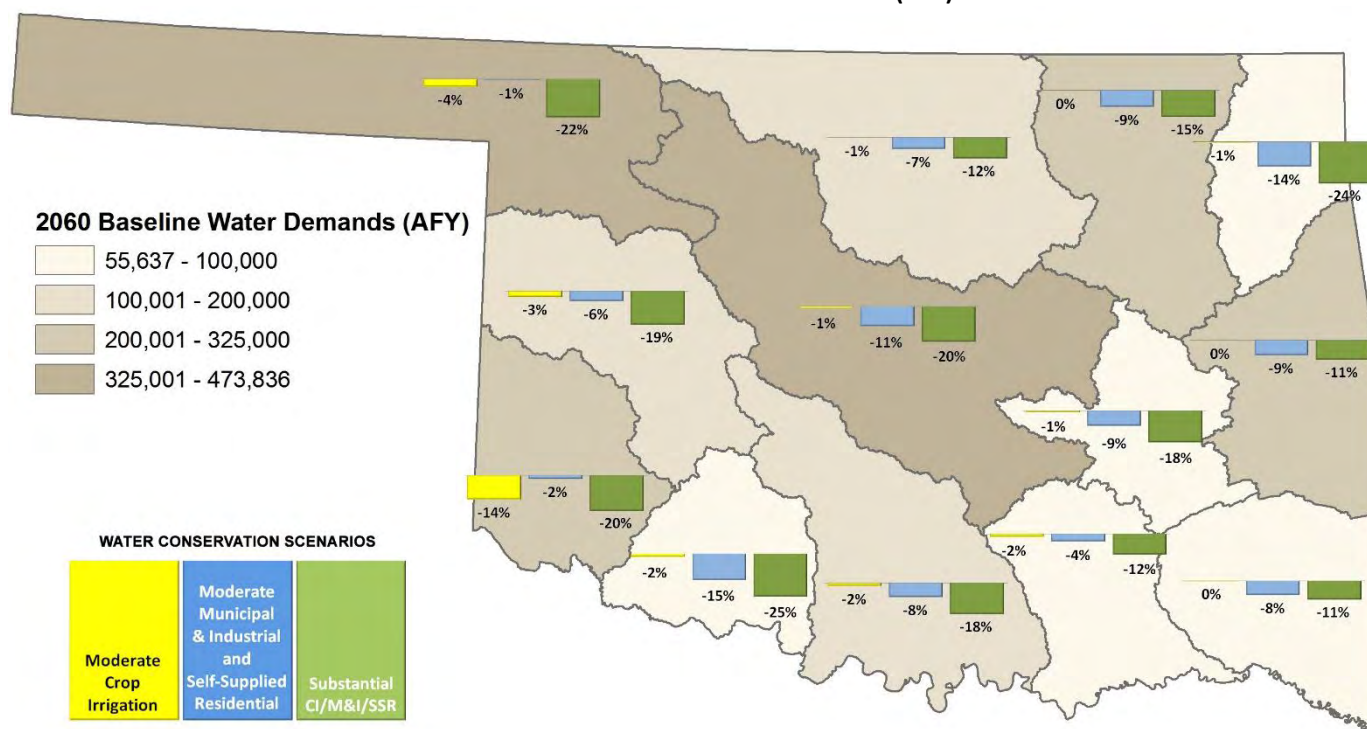
The figure shows the overall trend of savings associated with each package of conservation measures. Statewide, about 2.5 million acre-feet per year (AFY) of baseline demand for all use sectors is projected in 2060, with potential reductions in demand under the three conservation scenarios for Crop Irrigation and M&I/SSR as follows:

- Moderately expanded conservation in the Crop Irrigation sector:
68,000 AFY reduction in 2060 demand (about 3 percent of 2060 total statewide demand)
- Moderately expanded conservation in the M&I/SSR sectors:
174,000 AFY reduction in 2060 demand (about 7 percent of 2060 total statewide demand)
- Substantially expanded conservation in both the Crop Irrigation and M&I/SSR sectors:
439,000 AFY reduction in 2060 demand (about 18 percent of 2060 total statewide demand)

Demands in each water use sector vary significantly from one region to another. For example, the magnitude of conservation savings in the Crop Irrigation sector would be expected to be larger in areas where there is significant crop irrigation demand, but less where there is minimal crop irrigation demand. To illustrate this, Figure 2-3 depicts the percent reduction in demands by OCWP watershed planning region under the same three conservation scenarios. On a region level, the range of potential savings in total regional demand includes:

- Moderately expanded conservation in the Crop Irrigation sector:
Reduction in total regional demand ranging from 0 to 14 percent per region
- Moderately expanded conservation in the M&I/SSR sectors:
Reduction in total regional demand ranging from 1 to 15 percent per region
- Substantially expanded conservation in both the Crop Irrigation and M&I/SSR sectors:
Reduction in total regional demand ranging from 11 to 25 percent per region

FIGURE 2-3
Percent Reduction of 2060 Demand under OCWP Water Conservation Scenarios (AFY)



Source: Prepared by the OWRB using OCWP data analyzed and synthesized by Carollo Engineers.

2.3 Potential Reductions in Water Shortages

2.3.1 Statewide

Reductions in future water demand may or may not reduce the magnitude and/or frequency of anticipated future water shortages in a basin, depending on relative basin-specific conditions. For example, a reduction in peak seasonal crop irrigation demand would only reduce shortages if the supply availability issues occur during the peak demand season. While this is often the case, there are situations where water supply availability is lowest during off-demand seasons. An analysis of the potential impact of OCWP Scenario I and II conservation savings on shortages in the Crop Irrigation and M&I/SSR demand sectors was conducted at a basin level, then aggregated to the regional level.

Statewide, expanded conservation could reduce surface water gaps and groundwater storage depletions, as summarized in Table 2-3. The effectiveness of conservation in reducing the number of basins with surface water gaps and/or groundwater storage depletions is summarized in Table 2-4.

TABLE 2-3

Potential Reduction in Gaps/Storage Depletions with Expanded Conservation (2060)

Source	Baseline Gap/Storage Depletion	Total and Percent Reduction from Baseline Shortage/Depletion Amount			
		M&I, SSR, and Crop Irrigation Scenario I – Moderately Expanded Conservation		M&I, SSR, and Crop Irrigation Scenario II – Substantially Expanded Conservation	
Surface Water	75,240 AFY	-18,810 AFY	-25%	-23,980 AFY	-32%
Alluvial Groundwater	38,980 AFY	-12,474 AFY	-32%	-22,554 AFY	-59%
Bedrock Groundwater	92,710 AFY	-13,906 AFY	-15%	-73,784 AFY	-78%

Source: Adapted from OCWP Water Demand Forecast Report Addendum Tables 2 and 6. Negative values indicate amount of reduction from baseline conditions.

TABLE 2-4

Number of Basins with Gaps and/or Storage Depletions (2060)

	Number of Basins with Surface Water Gaps	Number of Basins with Alluvial Groundwater Storage Depletions	Number of Basins with Bedrock Groundwater Storage Depletions
Baseline	55	63	34
M&I, SSR, and Crop Irrigation Scenario I – Moderately Expanded Conservation	42	51	26
M&I, SSR, and Crop Irrigation Scenario II – Substantially Expanded Conservation	33	41	23

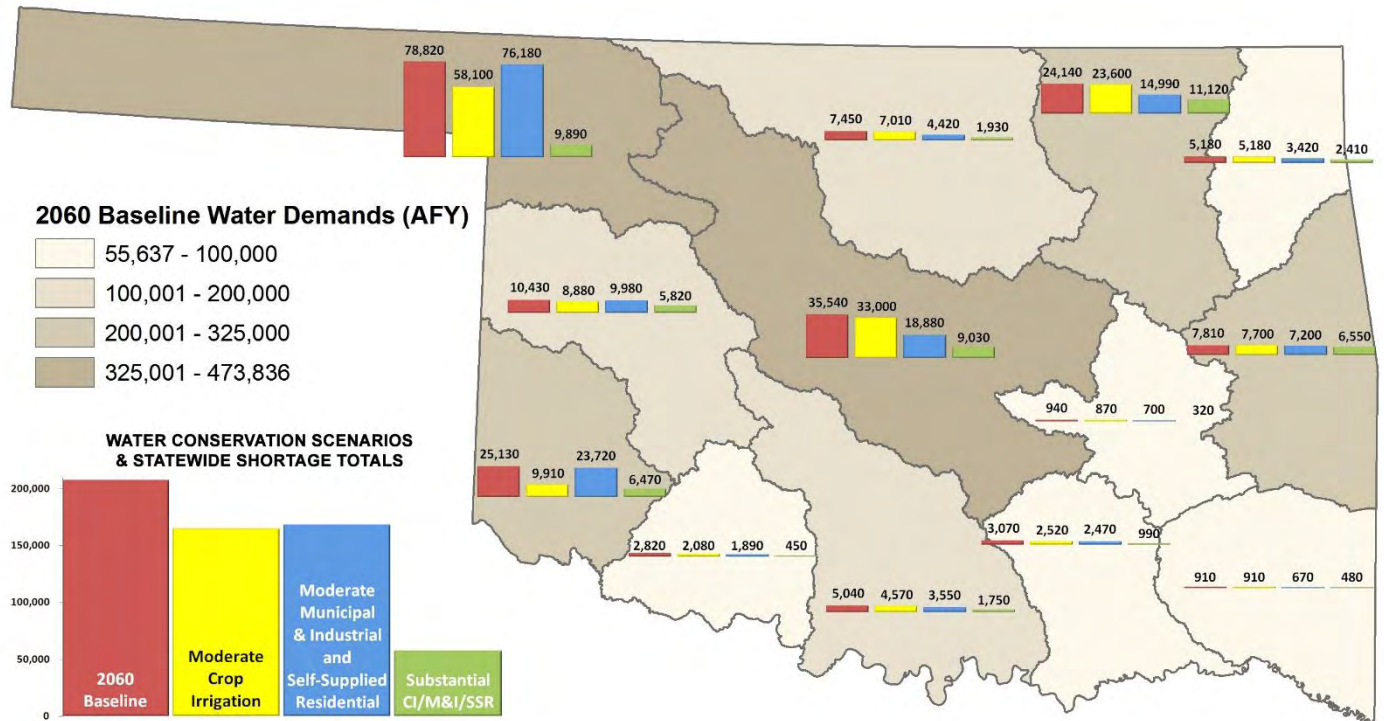
Source: Adapted from OCWP Water Demand Forecast Report Addendum.

Figure 2-4 illustrates the total water supply shortages by region under the same scenarios analyzed above for reductions in demand.

Additional analyses were conducted by summing the magnitude of OCWP-projected 2060 surface water gaps and groundwater depletions (including alluvial and bedrock groundwater sources) for each OCWP basin, then aggregating those values for each of the 13 OCWP watershed planning regions. Statewide, the total water shortage would be 207,000 AFY under the 2060 baseline conditions. If fully implemented statewide, total shortages in 2060 for all water use sectors in Oklahoma under the M&I/SSR and Crop Irrigation conservation scenarios would be as follows:

- Moderately expanded conservation in the Crop Irrigation sector: 164,000 AFY, reflecting regional-level shortages that range from 0 to 61 percent less than the baseline scenario
- Moderately expanded conservation in the M&I/SSR sectors: 168,000 AFY, reflecting regional-level shortages that range from 3 to 47 percent less than the baseline scenario
- Substantially expanded conservation in both the Crop Irrigation and M&I/SSR sectors: 57,000 AFY, reflecting regional-level shortages that range from 16 to 87 percent less than the baseline scenario

FIGURE 2-4
Projected 2060 Water Shortages under OCWP Baseline and Conservation Scenarios (AFY)



Source: Prepared by the OWRB using OCWP data analyzed and synthesized by Carollo Engineers.

The OCWP also evaluated the probability of shortages occurring in each basin in 2060 expressed as a percent frequency in time. Shortages in surface water and alluvial groundwater are driven by drought cycles whereas bedrock groundwater—which lacks a direct connection to surface waters—is not directly affected. Thus, shortage frequencies at the regional level is represented in this analysis as a combination of surface water and alluvial groundwater shortage frequencies in 2060. Figure 2-5 summarizes the remaining shortages for those supply sources by OCWP watershed planning region.

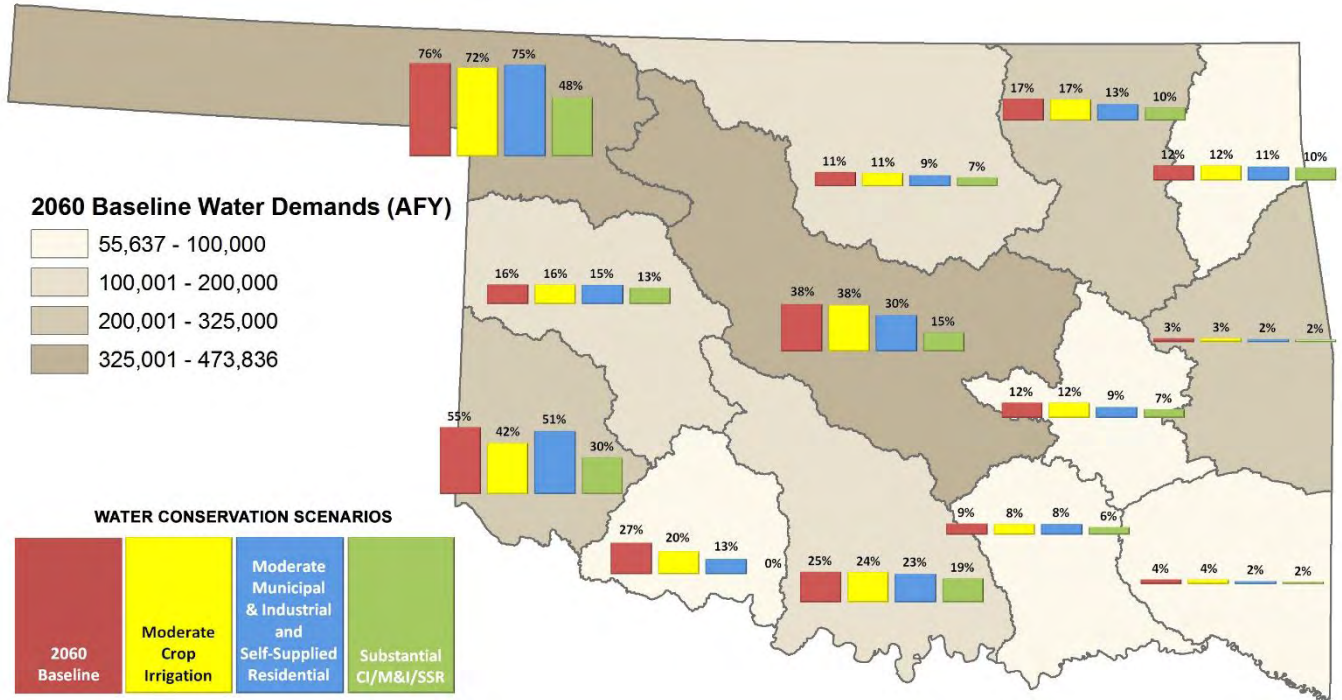
Frequency of regional shortages under baseline conditions range from 3 to 76 percent. Shortages in 2060 under the three conservation scenarios described above vary from one region to another, as follows:

- Moderately expanded conservation in the Crop Irrigation sector: Frequency of regional shortages ranging from 3 to 72 percent
- Moderately expanded conservation in the M&I/SSR sectors: Frequency of regional shortages ranging from 2 to 75 percent
- Substantially expanded conservation in both the Crop Irrigation and M&I/SSR sectors: Frequency of regional shortages ranging from 0 to 48 percent.

These analyses demonstrate the degree to which various levels of additional conservation could address future water shortages. In addition, they illustrate the specific regions of the state where additional conservation efforts could have the most significant impacts on projected water demands and supply shortages.

FIGURE 2-5

2060 Water Shortage Frequency under OCWP Baseline and Conservation Scenarios



Source: Prepared by the OWRB using OCWP data analyzed and synthesized by Carollo Engineers.

2.3.2 Conservation Effectiveness in OCWP Hot Spots

OCWP analyses included a ranking of the state’s 82 planning basins to determine the relative significance of water supply issues statewide. The 12 basins with the most significant water supply challenges, referred to as hot spots, were identified in the OCWP. Potential solutions for addressing the water supply issues in those basins were analyzed in further detail in the OCWP. Across all 12 hot spot basins, expanded conservation could reduce surface water gaps and groundwater storage depletions, as summarized in Table 2-5. Figure 2-6 depicts the location of the 12 OCWP hot spot basins.

TABLE 2-5

Potential Reduction in Hot Spot Basin Gaps/Depletions with Conservation (2060)

Source	Baseline Shortage/ Depletion	Total and Percent Reduction from Baseline Shortage/Depletion Amount			
		Moderately Expanded Conservation		Substantially Expanded Conservation	
Surface Water	14,590 AFY	-7,440 AFY	-51%	-8,676 AFY	-60%
Alluvial Groundwater	12,070 AFY	-6,036 AFY	-50%	-9,036 AFY	-75%
Bedrock Groundwater	69,000 AFY	-24,080 AFY	-35%	-61,320 AFY	-89%

Source: Adapted from OCWP Water Demand Forecast Report Addendum Tables 2 and 6.

FIGURE 2-6
OCWP Hot Spot Basins

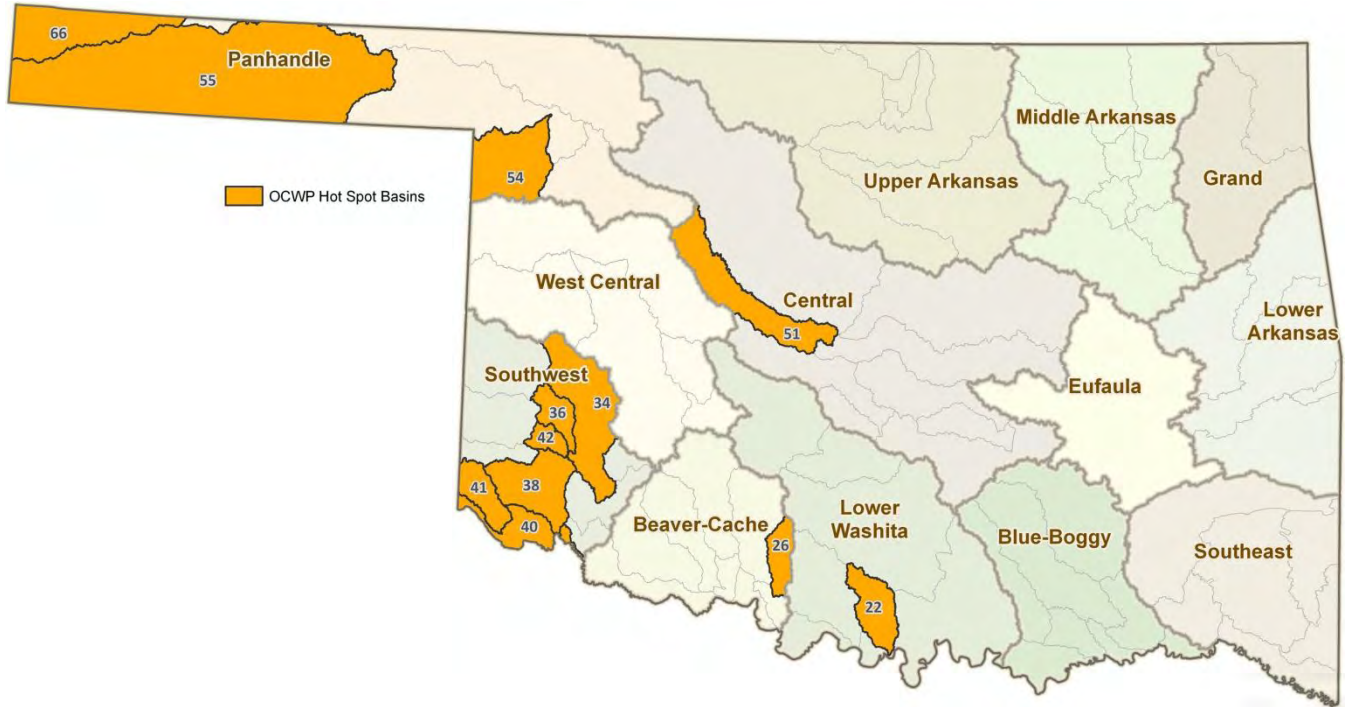


Table 2-6 shows the effectiveness of full implementation of Crop Irrigation and M&I/SSR Scenario I and II conservation for each of the hot spot basins, in terms of reduction in the size of 2060 shortages. In addition to reducing the size of the shortages, additional conservation could also reduce the frequency under which each of the hot spot basins would encounter a shortage. In a few of the hot spot basins, moderately expanded conservation could eliminate or nearly eliminate shortages. Substantially expanded conservation could result in significantly greater reduction in hot spot basin shortages and assist in addressing those basins’ future water supply issues.

TABLE 2-6
Reduction in 2060 Hot Spot Basin Shortages Under Conservation Scenarios I and II

Hot Spot Basin	Crop Irrigation and M&I/SSR Scenario I (Moderately Expanded Conservation)			Crop Irrigation and M&I/SSR Scenario II (Substantially Expanded Conservation)		
	Surface Water	Alluvial Groundwater	Bedrock Groundwater	Surface Water	Alluvial Groundwater	Bedrock Groundwater
22	44%	38%	18%	72%	69%	37%
26	100%	NA	14%	100%	NA	52%
34	36%	55%	NA	48%	74%	NA
36	0%	15%	NA	100%	46%	NA
38	100%	100%	100%	100%	100%	100%
40	73%	90%	100%	77%	91%	100%
41	100%	100%	100%	100%	100%	100%
42	19%	11%	9%	41%	33%	34%
51	78%	73%	82%	97%	96%	100%
54	6%	13%	15%	31%	84%	97%
55	38%	29%	33%	81%	84%	87%
66	18%	0%	20%	93%	100%	89%

Source: OCWP updated models of basin shortages; table values may not match values in OCWP Executive Report. Values indicate the percent reduction in shortages relative to baseline conditions (i.e., no additional conservation). NA (not applicable) indicates no shortage in that supply source for that basin.

3. Examples of Oklahoma Water Conservation Practitioners

Selected Oklahoma water users and providers with conservation programs and practices were characterized to provide a baseline understanding of some of the types of conservation and water efficiency measures already in use in Oklahoma. This effort focused on public water supply systems and crop irrigation water uses. These two water use sectors constitute about 70 percent of the consumptive water use in Oklahoma. Moreover, unlike many industrial uses unique to specific sites and types of industry, practices employed in the public water supply and crop irrigation sectors are potentially applicable to similar users throughout the state.

Two irrigation associations and two public water supply providers were interviewed and have been characterized in this section. The intent was to obtain examples of some of the leading conservation practices in Oklahoma, to identify additional water efficiency practices that might be feasible for similar users in Oklahoma, and to spur the generation of additional strategies that the Water for 2060 Advisory Council could consider during its review and consideration of incentives to promote water efficiency in Oklahoma.

3.1 Crop Irrigation

3.1.1 Oklahoma Panhandle Agriculture and Irrigation

3.1.1.1 Introduction

On January 15, 2013, the project team interviewed members of Oklahoma Panhandle Agriculture and Irrigation (OPAI). The input received was used to characterize water conservation efforts by crop irrigators, recommendations for other irrigators interested in expanding their conservation efforts, and suggestions for state-level incentives for implementing additional water efficiency measures for the Crop Irrigation sector.

Water supply and use is critical to all residents and businesses in the Panhandle. In addition to meeting the daily needs of the region's citizens and industries, access to reliable water supplies is vital to maintaining the Panhandle as Oklahoma's most productive crop producing region and one of the country's foremost producers of key crops. Water supply is thus very closely interlinked with the economic productivity of the Panhandle. OPAI advocates for research and development, conservation, and less governmental regulation.

In 2012, OPAI partnered with the Panhandle Regional Economic Development Coalition, Inc., in an unprecedented collaboration to prepare a comprehensive evaluation of water use and water supplies in the Panhandle, along with water management strategies that will extend the life of the Ogallala Aquifer and provide continued economic growth and development. That partnership drove the development of the December 2012 Panhandle Regional Water Plan (PRWP),¹ covering Beaver, Cimarron, and Texas counties. The PRWP data and projections were founded on OCWP information, with minor modifications as described in the PRWP. Because of significant limitations in the availability of alternate water supplies in and around the Panhandle, the PRWP focused primarily on strategies to build upon existing water use efficiencies. The data cited in this section were drawn from the PRWP and augmented by subsequent interviews of crop irrigators.

3.1.1.2 Water Supply Sources

Crop irrigators in the Panhandle nearly exclusively use Ogallala bedrock aquifer supplies, primarily because of the lack of alternative supply sources. According to the PRWP, 98.5 percent of water demands in the 3 Panhandle counties are met with bedrock groundwater supplies, and crop irrigation comprises some 90 percent of Panhandle demands. There are no major interbasin infrastructure systems in the Panhandle that transfer water into the Panhandle region from other sources.

¹ *Panhandle Regional Water Plan*, Oklahoma Panhandle Agriculture and Irrigation, and the Panhandle Regional Economic Development Coalition, Inc., December 2012.

Predominant crops vary from year to year and decade to decade based on market conditions. Recent years have seen irrigated acreage in the Panhandle dominated by corn and wheat crops, with those crops making up about three-quarters of the irrigated acres in the Panhandle counties. The PRWP evaluated alternative crop mixes and equipment for irrigated agriculture in the Panhandle and analyzed the potential economic implications in terms of expenditures and revenues of each.

3.1.1.3 Current Water Conservation Programs

Inherent to the use of bedrock groundwater supplies is the decentralized, “well by well” nature of the supply. That fact, coupled with independent farming operations, results in conservation practices that are often unique to an individual farming operation or even to an individual irrigated property. OPAI serves as a central forum for farmers in the Panhandle for a broad range of irrigation and other issues. However, there are no broadly adopted, standard approaches for water management, nor are there conservation measures that would be practical and effective on every farm across the state. Examples of the types of water conservation practices commonly employed by crop irrigators in the Panhandle are described below.

Irrigation Equipment. Crop irrigation in the Panhandle has evolved over the years, with accompanying changes in water use. The widespread adoption of center pivot sprinkler irrigation systems in the 1970s reduced water use from peak usage (including significant amounts of flood irrigation) in the late 1960s, as further detailed in the PRWP. Today, sprinkler irrigation is the predominant technology in use, with about 95 percent of irrigated acreage using sprinkler systems. Although there can be significant variability in application efficiencies, sprinkler systems are around 85 percent efficient (measured as the amount of water applied that is available to the crop). In contrast, surface irrigation is about 64 percent efficient, and drip irrigation (sometimes referred to as micro-irrigation) is about 89 percent efficient. Modern crop-height sprinkler systems reduce evaporation and other losses; advances in sprinkler system and technologies, such as the low energy precision application (“LEPA”) technologies commonly in use today, have contributed to more efficient use of water for crop irrigation.

Evolving technology has benefited irrigation systems in many ways. For example, the use of cell phone–based information systems on center pivot arms provides instantaneous feedback on center pivot operations. Previously, a major leak or “stuck” center pivot arm would go unnoticed until farm staff made daily physical inspections. With the use of current technologies, alerts are instantly sent to farm staff by cell phone, text, or e-mail to alert them to low pressure conditions (indicative of a leak) or stationary center pivot arms. Left in a single stuck position, continued irrigation not only uses excessive water on a single area, it causes operational problems for farm staff in freeing the equipment to resume operations and wastes well pump fuel. Irrigators have observed higher crop yields using these monitoring systems. Real-time information allows farmers to respond quickly to major leaks and to minimize overirrigation of concentrated areas, while reducing the need for daily inspection. Thus, there are multiple benefits to irrigators in the use of such technologies.

Regular replacement of nozzles and regulators in sprinkler systems contributes to uniformity of application. In turn, that uniformity and application efficiency not only affects water use efficiency, but also has been shown to result in better crop yield. Past practices, where aging nozzles might only be replaced after they fail, can lead to water loss. Additional research to evaluate the uniformity of application and optimum timing for nozzle/regulator replacement would be supported by and valuable to OPAI members.

Drip irrigation is being considered and gradually implemented in the Panhandle. OPAI estimates that less than 1,000 of the 230,000 acres of irrigated cropland in the Panhandle are served by drip irrigation today. Capital costs to implement a drip irrigation system are substantially higher than sprinkler systems, at around \$2,000 to \$2,400 per acre as compared to about \$500 to \$800 per acre for conventional sprinkler systems. Various sizes of drip systems are being installed, and it is expected that five or six systems will be in place by spring of 2013. Some reductions in labor costs may be recognized by replacing sprinkler systems with drip systems, but those savings have generally not been quantified. The increases in efficiency relative to sprinkler systems are not trivial (89 percent, compared to 85 percent for sprinklers), but to date, many irrigators employing drip technologies have not observed significant reductions in the amount of water needed to raise and yield a crop.

Two drip irrigation installations were cost-shared with Natural Resources Conservation Service (NRCS) assistance

and participation through the Environmental Quality Incentives Program (EQIP).² Those systems may not have been financially feasible without the federal cost-share, but local irrigators and NRCS sought to gain experience in the use and management of drip systems. The first drip system in the Panhandle has been in operation for 2 years, and farmers are working on managing the operation of the system to improve crop yields.

Irrigation Practices. The EQIP program offers technical support to irrigators for management and conservation of resources by several different avenues. Irrigators generally support EQIP, as it uses common sense approaches with adaptations to climate as required. Examples of water-saving practices promoted by NRCS under EQIP are leaving residue after harvest, tillage options, and the Conservation Stewardship Program. Previously, innovators and early adopters were not eligible to participate in NRCS programs, since they were already implementing practices NRCS sought to promote. More recently, a two-part approach has been in place, with a baseline for ongoing stewardship and separate incentives for new ideas. Among the NRCS grant programs that incentivize efficient water practices is the Conservation Innovation Grants for Development of Novel Agricultural Practice.³

Farmers continue to drive the testing and adaptation of strip till and no-till methods of growing corn. Growing corn with 100 percent ground cover can help increase water efficiency. Irrigators and universities recognize the value in ongoing research regarding the timing of irrigation throughout the growing season. For example, pre-irrigation before planting can have significant benefits throughout the season in terms of both crop yield and water use.

Seed Research. Drought resistant crop seed research holds significant promise as a method for reducing water use and managing crop yields, particularly in water supply-limited situations. Research is ongoing at universities (e.g., Oklahoma Panhandle State University and Oklahoma State University (OSU)), at Oklahoma Cooperative Extension Service, and in the private sector (e.g., crop seed manufacturers). Development of seed technologies that allow a shorter crop maturation time can also provide water savings. For example, a crop seed mix that reduces the time to maturity by one week can provide a significant water savings. On a ½-mile lateral center pivot system irrigating two inches per week, one week less irrigation saves about 84 acre-feet (more than 27 million gallons) of water.

3.1.1.4 Alternative Water Supplies

Stream flows typically are intermittent in the Panhandle, and most streams can experience extended periods of no flow. Accordingly, there are also minimal supplies of alluvial groundwater. Thus, local alternatives to Ogallala bedrock groundwater are minimal and unreliable for water supply. Concepts for transbasin water supply projects have been contemplated in the OCWP and previous planning documents, but generally are found to be cost-prohibitive. Communities in the Panhandle, such as Guymon, reuse parts of their treated wastewater effluent, and many seek to expand their reuse programs. The PRWP characterized the lack of alternate supplies, and as a result, focused on conservation and reuse as primary strategies toward meeting future water needs.

3.1.1.5 Education and Outreach

OPAI supports ongoing education and outreach to irrigators in the Panhandle and throughout Oklahoma. Part of OPAI's value to its members and the agricultural community as a whole is the collection and dissemination of information regarding water efficiency. For example, networking opportunities in forums, such as OPAI meetings and stakeholder meetings that were held in conjunction with development of the PRWP, have helped irrigators learn from others' experiences and advanced the use of efficient irrigation practices. OPAI supports the ongoing efforts of NRCS and Oklahoma Panhandle State University to provide education and outreach opportunities.

3.1.1.6 Performance Measurement

Water efficiency can be measured in many ways. For many irrigators in the Panhandle, the ultimate measure is crop yield. As part of the development of the PRWP, OPAI members expressed support for considering water efficiency in terms of gallons used to create a given yield, or gallons per acre. Other measures also can be used to gauge progress in water efficiency in agriculture, such as the number or percent of irrigated acreage on sprinkler

² <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/eqip/?&cid=stelprdb1044009> (accessed January 2013).

³ <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/newsroom/?cid=STELPRDB1048666> (accessed January 2013).

and drip irrigation systems, the prevalence of higher-technology center pivot irrigation monitoring systems, and the degree to which drought-tolerant seed technologies are in use.

3.1.1.7 Recommendations

The PRWP concluded that the following strategies can help to increase efficiencies in the Crop Irrigation sector:

- Research and development (drought-tolerant crops, alternative crops, efficient irrigation technologies)
- Invasive species eradication
- University research priorities
- Additional groundwater data collection
- Regulatory relief
- Water reuse programs and incentives
- Cost share partnerships and opportunities
- Information sharing and education opportunities for irrigators

The PRWP analyzed the economic implications of changing crop types toward lower water-use crops, as well as the economic costs and returns of retrofitting additional lands from sprinkler irrigation equipment to drip irrigation systems. Both approaches were found to have unacceptable economic impacts, such that economics could not provide the sole justification for either approach to reducing water use.

For other irrigators wishing to increase their permanent conservation measures, and for consideration of incentives for water efficiency enhancements, OPAI members offered the following supplementary suggestions:

- Use incentives, rather than mandates, leaving local control that can best apply those incentives to suit individual and site-specific needs
- Address insurance practices, such as the need to irrigate a crop during drought to demonstrate efforts to raise the crop, even when supply and demand conditions clearly point to a failed crop
- Consider the end user when developing incentives. Certain federal incentives pose significant challenges for complying with their requirements, serving as a disincentive for participation.
- If state incentive funds are administered through the Oklahoma Conservation Commission, consider how best to coordinate those programs with existing NRCS programs.
- Consider the operational implications of mandates; for example, limitations on individual well use in neighboring states caused farmers to stop irrigating 90 percent of the way through the season, such that they could not finish the crop and wasted almost an entire season's water use.
- Provide incentives both for expanding existing practices and implementing new practices.
- Consider financial support for initial and annual expenses of sprinkler system operational monitoring technology.
- Fund an irrigation engineer from OSU full time in the Panhandle at the OSU Research Center in Goodwell to promote better onsite testing and adaptation of technologies. This could also be a partnership where the staff time is split between the Panhandle and southwest Oklahoma.
- Provide support on a watershed basis for eradicating salt cedar and other invasive species.
- Provide support for well rehabilitation, to optimize and modernize existing infrastructure.

3.1.1.8 Conservation Program Costs

Because of the decentralized nature of farming operations and groundwater well supplies, there is no centralized database of the costs of conservation measures. Federal programs, such as NRCS EQIP, have not published a database of costs. However, some data are available to support such an analysis. As noted, equipment changes can trigger significantly higher capital costs.

3.1.2 Lugert-Altus Irrigation District

3.1.2.1 Introduction

On February 6 and 12, 2013, the project team members interviewed Tom Buchanan, manager of the Lugert-Altus Irrigation District. The Lugert-Altus Irrigation District is the only true irrigation district in Oklahoma. It is governed by a Board and provides water to approximately 50,000 acres of irrigated land through open-channel delivery systems. Every acre the District serves has been assessed and designated as an authorized recipient.

3.1.2.2 Water Supply Sources

Lugert-Altus Reservoir is the District's sole water supply source. The District's irrigated land area primarily overlies minor aquifers, which generally do not have sufficient yield for irrigation purposes. Localized water quality issues also deter use of groundwater in some areas. Consequently, surface water is critical to The District.

Lugert-Altus Reservoir is a U.S. Bureau of Reclamation (USBR) project constructed in the mid-1940s for the purpose of irrigation water supply, municipal water supply, and flood control. The lake's capacity is 132,830 acre-feet with a surface area of 6,260 acres (OWRB, 2010). Since the Reservoir is currently fully allocated, growth of the Lugert-Altus Irrigation District is constrained by water availability.

3.1.2.3 Current Water Conservation Programs

Each acre of irrigated land served by the District receives an annual assessment tax for water supply, currently \$12.50 per irrigated acre. The fee is administered and paid at the beginning of each year by the users. Every June, the Board reviews the available water supply in the reservoir (1) to determine the water allocation to each user (based on the volume of available water) and (2) to define the current price of water per acre-foot. For example, in 2010, the rate was set at \$45 per acre-foot. Because all the irrigated acres are designated and assessed, the Board is able to track payment status and water use by user.

The District meters water supply and reports actual use. In a vein similar to that reported by the OPAI (see Section 3.1.1.3), conservation practices implemented by water users in the District are often unique to the individual farming operations; however, water conservation in the District is facilitated by metered flow delivery systems, flow control structures, and some automated delivery equipment. With accurate accounting and metering of water delivery within their system, the District is able to identify water losses within their system and remedy the problem. The accounting system tied to the assessed acreage provides a means of tracking water use among the different users; therefore, the District is managing known quantities of water, which allows it to monitor trends in water use and to communicate effectively with its users.

Most of the 50,000 acres irrigated by the District employ flood irrigation. Many farmers being served by the District use tailwater pits at the downstream end of their fields to collect and reuse irrigation water. Many farmers are converting from flood irrigation to more efficient subsurface (drip) irrigation. The conversion from flood to subsurface irrigation presents some logistical challenges to the District in terms of water delivery schedules and rotation among the farms; however, the challenges are steadily being resolved, and the resulting on-field water efficiency gains are welcomed and encouraged by the District.

3.1.2.4 Alternative Water Supplies

No alternative water supplies are available to the District, but the District is working with the USBR to investigate the feasibility of implementing chloride controls to develop another potential surface water source. An additional water source would allow the District to augment its water supply. Whether because of recent drought conditions or increased withdrawals of surface water or groundwater upstream of Lugert-Altus Reservoir, or both, the volume of the water supply has diminished in recent years. Augmenting the existing supply would increase the reliability of the water yield, thus allowing for an increase in irrigated acres.

3.1.2.5 Education and Outreach

Roughly 20 producers represent the nearly 50,000 acres of irrigated land served by the District. Therefore, education and outreach is achieved primarily by word of mouth. Because there is a legacy of people in the District working together as farmers and neighbors, education and outreach occurs readily through frequent

communication. Given the small communities in which the District operates, word-of-mouth education and outreach have proven effective.

3.1.2.6 Performance Measurement

As a water supplier rather than end user, the primary measure of importance for the District in terms of water conservation is the efficiency of water delivery. The District has invested significant capital in recent years to modernize and improve its infrastructure to better conserve water. Technical upgrades, including automated gate controls and meters to measure water volume and velocity, provide a more efficient and quantifiable means of tracking water delivery. As such, the District quantifies the amount of water that enters its canal system at the reservoir and the amount of water delivered to each farm. Quantifying inflow and outflow not only provides the District a means to track water demand and use, it also is an effective means of detecting water losses in the canals should it occur. Because the point of water delivery is essentially “on the farm,” there are no significant areas of infrastructure that go unmetered; thus, the accounting system is robust with few unknowns.

Because on-field water use practices are implemented, operated, and managed at the discretion of the individual producers, the District does not establish performance measures for the end users. For example, many farmers are converting from flood to subsurface irrigation, but because such practices are at the discretion of the producer, the District does not establish associated criteria or goals.

3.1.2.7 Recommendations

The following recommendations were offered to help support increased efficiencies in the Crop Irrigation sector:

- The need to conserve surface water and groundwater resources is important. To do so, financial incentives of some type, such as matching funds or tax credits, are needed. Farmers have every incentive to do what they can within their own means to conserve water, so farmers are already implementing the easier measures. The resource constraints suppliers and users face warrant and require programmatic financial incentives to conserve water beyond measures already taken.
- Consider forming new irrigation districts across the state to provide a form of regulatory structure that ensures more surface water and groundwater supplies (levels) are monitored routinely and water allocations are prescribed based on quantitative data that are proactively managed. This would reduce the potential of overdrafting water supplies. For example, in the absence of an irrigation district (or similar model), the amount of water withdrawn from an aquifer by any given user is more likely tied to the user’s willingness to pay the electric utility bill rather than a predetermined sustainable yield from the aquifer. Some form of regulatory structure such as an irrigation district would help prevent such problems.
- There needs to be greater effort to educate the public and all water use sectors that overdrafting surface water and groundwater resources affects all users, including municipal suppliers, and not just agricultural suppliers.
- All water use sectors need to do a better job of measuring their water use. Water supplies cannot be managed effectively if the amount of water actually being used across all sectors is unknown.

3.1.2.8 Conservation Program Costs

There are significant capital investment costs incurred by the District to maintain the water supply and delivery infrastructure, including the Lugert-Altus Reservoir dam and dikes. Even though the lake is a USBR project, the District is responsible for operating and maintaining the dam and dikes. The District’s infrastructure has operated with great success for over 60 years, but it is beginning to deteriorate and improvements are needed. For example, nine flood gates are slated for repair or replacement at an estimated cost of \$1.0 million to \$1.25 million. These costs are significant considering the District’s annual operating budget is \$2.1 million.

Water efficiency grants, such as the USBR WaterSMART Grant, provide a 50/50 cost share to help fund irrigation and water districts. Such programs are essential to the District’s operations. The District levies a tax against itself from acreage assessments and water allocations and uses the money to match the federal funds.

Although the Lugert-Altus Reservoir project was dedicated for irrigation, flood control, and water supply, recreational uses such as fishing, swimming, water skiing, and camping have benefited from the project. Recreational uses occur without fees for ramping or docking boats for example, so the cost of operating and maintaining the dam and dikes remains the sole responsibility of the District through contracts with the federal government.

3.2 Public Water Supply

3.2.1 City of Norman

3.2.1.1 Introduction

Project team members interviewed members of the City of Norman's utilities staff on January 10, 2013. Located in Cleveland County, the City serves a population of around 100,000 people.

Norman meets its average annual potable water demand of 14 million gallons per day (mgd) through use of 36 groundwater wells and an annual allocation averaging 8.4 mgd from Lake Thunderbird. When peak demand exceeds Norman's water supply, Norman purchases treated water from the Oklahoma City Water Utilities Trust through an interconnection between the two utilities' water systems.

3.2.1.2 Current Water Conservation Programs

Norman adopted its current Water Conservation Plan⁴ in May 2011. The plan provides information on Norman's water system and current permanent conservation programs, as well as temporary demand reducing methods (such as watering restrictions) that are used during drought conditions. Norman most recently employed temporary drought measures when drought conditions triggered a temporary 10 percent reduction in allocations available from Lake Thunderbird in early 2013. Norman implements several permanent conservation programs, some of which affect all users (like rate structures), while others are targeted to specific user categories.

Rate Structures. Norman established an inclining block rate structure with base rate for residential customers in 2006. Under an inclining block rate structure, each "block" of water use above base monthly usage costs more on a per-thousand-gallons used basis than the previous block of usage. Any change in Norman's water rates requires a majority vote of the public.

Municipal Activities to Promote Conservation. Norman employs a "lead by example" approach for water conservation. For example, the City uses drip irrigation on medians and in other applicable areas to minimize overspray.

Norman meters all its customers (even water used at City facilities) and periodically tests and replaces meters. In a recent large commercial meter testing/replacement program, Norman recognized an increase in revenue due to more accurate water use measurements. Through leak detection training of meter readers, customer service staff, and public works staff, water loss has been reduced significantly. Overall, Norman's nonrevenue water (which includes losses, leakage, and water not sold through meters, such as firefighting) has been reduced to 8 to 9 percent of total water production. The City has considered ways of implementing further reductions in water loss and leakage.

Norman implemented design standards requiring strategically located isolation valves in addition to a valve exercising and replacement program. Both activities reduce water lost during leaks. Building upon historical leak tracking, Norman has stopped using ductile iron pipe and carbon steel bolts (which can be prone to leaks under corrosive soil conditions) and executes a hot soil and urban pipe replacement program to reduce the occurrence of future water leaks.

Norman is planning for long-range water supplies. As part of this process, representatives from the community weighed in on criteria that would be used to evaluate supply options. Several of the criteria weighted highest by the representatives centered on efficient water use and maximizing the use of local supplies (including reuse). Norman will continue to implement and promote conservation, because it is highly important to community

⁴ <http://www.normanok.gov/sites/default/files/Utilities/images/2011%20Water%20Conservation%20Plan.pdf> (accessed January 2013).

members. Numerous alternate sources of water are being evaluated. This includes consideration of several approaches for increased reuse of treated wastewater effluent, along with use of urban stormwater runoff for potable and nonpotable supply augmentation. Estimated capital costs for regional freshwater supply options in the hundreds of millions of dollars provide further incentive for identification of local sources and efficient use of water supplies.

Residential and Commercial/Industrial Water Conservation. In 2005, Norman passed an ordinance that requires all new automatic irrigation systems to have a rain sensor and freeze gauges installed. This promotes water conservation by shutting off irrigation systems when irrigation water demand is low or nonexistent. Norman city codes require low flow fixtures in new construction (under Norman's adoption of the 1997 International Plumbing Code for nonresidential construction and 1995 Council of American Building Officials for residential construction).

During construction of new water transmission lines, Norman encourages efficient water use by limiting contractors on how much free water they can use for flushing of new mains; if additional flushes are required, contractors are charged for water used. Norman provides and requires the use of hydrant meters by contractors. The City imposes fines for nonuse. Farmers and smaller contractors have access to a coin-operated system for water truck filling.

3.2.1.3 Alternative Water Supplies

Norman has switched to nonpotable water wells for irrigation of certain parks, street sweeping, and similar uses. It uses treated effluent for nonpotable water at the wastewater treatment plant (both process water and irrigation). Similarly, the City provides treated effluent to the University of Oklahoma for irrigation use on its golf course. Norman is evaluating expanded reuse through indirect potable reuse (Lake Thunderbird augmentation) or direct nonpotable reuse (purple pipe system for large landscape irrigators and industrial users) as part of its ongoing long-range water supply planning.

3.2.1.4 Education and Outreach

Norman maintains a water conservation website⁵ that provides tips for customers to reduce both outdoor and indoor water use. Visitors can link to other conservation resources—such as the Simple Irrigation Plan website developed by Oklahoma State University Division of Agriculture and Natural Resources Team Initiative Grant and the Oklahoma Mesonet—that provide more information on efficient water use.

In addition, Norman actively educates its customers. Norman provides the previous day's water use and trends to the newspaper for publication, and occasionally includes with its water bills "bill stuffer" pamphlets that focus on conservation. The effectiveness of bill stuffers is not easily documented. In the past, Norman sent water conservation flyers home with students in Norman's public schools. This program was discontinued based on feedback indicating that those flyers were not widely read.

Norman tested a program whereby it purchased water conservation kits containing a low-flow showerhead, kitchen and bathroom sink aerator, toilet bank, and leak detection tables. The City made these available to customers at low to no cost in exchange for customers' consent to monitor water use. Norman staff noted that public interest in the conservation kits was low and that they still had many kits, even after making them available to the public for no cost.

Norman hosts an Environmental Control Advisor Board made up of citizen representatives. While it does not focus only on water conservation, the Board frequently participates in public education and outreach on water quality and conservation. These activities include an annual clean water poster competition, rain barrel and other conservation themed workshops, and promotion of "smart irrigation month."

3.2.1.5 Program Implementation

Norman began actively to pursue conservation activities in 2004. The promulgation of lower arsenic standards for drinking water (which resulted in the shutdown of about 16 wells) and subsequent water supply studies showing

⁵ <http://www.ci.norman.ok.us/content/water-conservation> (accessed January 2013).

very high costs to replace and expand Norman's raw water supplies resulted in more aggressive promotion of water use efficiency.

Norman considered reducing systemwide water pressure as a way to save water during peak demand periods, but this was not implemented. Customers did not view this short-term water saving strategy favorably.

Norman would like to expand its limited meter testing and replacement program to include more frequent testing and replacement of nonresidential meters and also residential meters. The program has not been expanded, however, because of lack of funds.

3.2.1.6 Performance Measurement

Norman tracks the effectiveness of conservation programs using several metrics. Generally, city staff uses overall trends in per capita water use to evaluate long-term effectiveness of conservation programs. Staff tracks monthly water losses and metrics associated with leak repairs. Together these work to minimize the amount of water lost.

Although it is difficult to quantify the effectiveness of the conservation programs individually, Norman generally has seen a decline in dry year per capita water use and a fairly stable per capita water use in other years. Over the last 10 years, Norman also has experienced a measurable decrease in peak day demands because of permanent conservation measures combined with treated effluent reuse and conversion of some demands from potable supply to nonpotable wells.

Norman has found nearly all conservation programs to be valuable. Training of key staff to recognize possible leaks, tracking of water loss, and monitoring the amount of time elapsed in responding to leak repairs were identified as programs that had immediate results with minimal effort or expense to implement. The programs associated with new construction were successful, but they had some initial capital costs associated with purchasing fire hydrant meters. Costs for the rain and freeze sensors on new irrigation systems generally are borne by the owner of the system.

Norman has found the inclining block rate structure with base rate to be somewhat effective. City staff noted that it could be more effective by having steeper increases in the per-thousand-gallon rate between blocks or by having a variable base rate based on meter size to encourage further efficient water use.

3.2.1.7 Recommendations

For public water supply providers wishing to expand their permanent conservation programs, Norman staff offered the following supplementary suggestions:

- Include ongoing maintenance as part of private irrigation systems.
- Consider more aggressive water loss/leakage evaluation and mitigation.
- Adequately fund an annual meter testing and replacement program, especially for nonresidential meters.
- Use nonpotable water or reuse water when possible.
- Show customers the utility's commitment to efficiency and conservation by adopting permanent conservation methods early.

For state-level programs, Norman staff offered the following suggestions:

- Encourage regionalization of water systems.
- Consider increasing fees or prohibiting drilling irrigation wells when a potable supply is readily available.
- Work within and between state agencies to develop rules that promote efficient use of water resources and encourage reuse.
- Consider having state funding contingent on having an approved conservation plan, provided reasonable standards are established for compliance.
- Continue to work with state and federal regulators to implement reuse regulations and standards that are practical and implementable, encouraging reuse without undue regulatory burden.

- Provide direct financial support for conservation programs, such as cost sharing in rebates for high efficiency appliances or construction of direct nonpotable reuse system.

3.2.1.8 Conservation Program Costs

The City of Norman funds its conservation programs through its operational budget and has no staff members dedicated solely to conservation. Programs funded through this revenue include bill stuffers, fire hydrant meters, water conservation kits, and website maintenance. The Environmental Control Advisor Board has a budget of roughly \$5,000 per year for activities, some of which promote water conservation. Additional conservation programs likely would be implemented if funds were made available. Norman is considering enhancements to its water conservation program as part of its 2060 Strategic Water Supply Plan.

3.2.2 City of Shawnee

3.2.2.1 Introduction

Project team members interviewed City of Shawnee utilities staff on February 26, 2013. Located in Pottawatomie County, the City serves roughly 30,000 people.

Shawnee's water supply consists of three surface water reservoirs. The Twin Lakes were built in 1935 (no. 1) and 1960 (no. 2) for water supply and recreation. Wes Watkins Reservoir was built in 1997 for flood control, water supply, and recreation. Water from the three reservoirs is used on a rotating basis to protect water rights and to provide for the needs of Shawnee, the Pottawatomie County Development Authority, and other users.

Shawnee's water treatment plant produces an average 4.4 million gallons of potable water each day. The plant capacity is 8.5 mgd. The City owns four water storage towers with a total capacity of 2.5 million gallons. The City's Water Distribution Division maintains more than 15 miles of raw water lines, 150 miles of water main, and more than 10,000 water meters on ¾-inch to 6-inch pipes.

A recent multi-reservoir yield and operations analysis concluded that Shawnee has enough raw water from its reservoirs under a balanced surface water elevation operations scenario (firm yield of 8.2 mgd based on physical availability, 4.7 mgd available to Shawnee when limited by permit constraints) to meet the current projections for 2060 average annual day water demands of 4.7 mgd (CDM Smith 2012).

In addition to the reservoirs, Shawnee has several groundwater wells from which it may withdraw water should the need arise. It also has rights to withdraw water from the North Canadian River and Atoka water line.

3.2.2.2 Current Water Conservation Programs

Shawnee adopted a drought management plan in 2012 using data developed through its multi-reservoir yield analysis (CDM Smith 2012). The plan can be viewed on the City's Water and Wastewater Services website.⁶ Voluntary restrictions, or conservation measures, as well as four levels of increasingly stringent mandatory restrictions, are included in the plan. The plan is designed to balance water withdrawals from the reservoirs so as to avoid withdrawing from the Wes Watkins Reservoir recreation pool (elevation 1,062 feet) unless necessary.

Voluntary water restrictions are initiated when the supply reservoirs fall to a predetermined elevation. Mandatory restrictions begin when the reservoirs continue to fall to lower elevations or the average weekly water treatment plant production exceeds a certain rate. The trigger-point elevations and water treatment plant production rates are outlined in the plan and made available to the public on the Water and Wastewater Services website. Also posted on the website are real-time lake level (pool elevation) charts based on U.S. Geological Survey data, including direct links to relevant websites of the U.S. Geological Survey.

Voluntary restrictions outlined in the plan include turning off the tap while shaving or brushing teeth; showering rather than bathing; using a dishwasher only when fully loaded; washing only full loads of clothes and using the appropriate water level or load size selection; and using water-saving features when replacing fixtures.

⁶ <http://www.shawneeok.org/PublicWorks/Water> (accessed February 2013).

A Level 1 mandatory restriction limits outside water usage for both residential and commercial customers to certain days between 6:00 PM to 10:00 AM. Outside water usage can only occur at odd-numbered addresses on Monday and Thursday, and even-numbered addresses on Tuesday and Friday. During a Level 2 mandatory restriction, the time slot remains the same, but residential outside water usage is reduced to only 1 day: Monday for odd-numbered properties and Tuesday for even. Commercial users must reduce water usage by 10 percent as compared to the previous year's usage figures.

During a Level 3 mandatory restriction the allowable days for residential outside water usage remains the same as Level 2, but the time slot is reduced to 7:00 PM to 8:00 PM. Outside water usage is limited to watering shrubs and young trees only. Commercial users are required to reduce water usage by 15 percent as compared to the previous year's usage figures. Lawn watering, automobile washing, and refilling or adding water to public and private swimming pools are forbidden. During a Level 4 mandatory restriction, there is no usage authorized for residences other than for household purposes. Commercial users must reduce water usage by 25 percent as compared to the previous year's usage figures.

The City Code provides for penalties for violations of a proclamation designating a water emergency. A warning is issued for the first violation. Subsequent violations result in fines, ranging from \$150 to \$500 depending upon the number of violations, plus costs. In addition to such penalties, water, sewer, and garbage services furnished by the City to any person who violates any of the provisions of the proclamation are subject to suspension.

Another conservation measure Shawnee oversees and manages is the amount of water allowed for flushing new lines. To tap into the City's water line, contractors must obtain a permit from the City. There is a tap fee for all new taps made on main lines. The Utility Department will make taps on lines only 1 inch or less once the tap fee has been paid. A certified tapping company is required for lines larger than 1 inch. The City inspects all taps. Standard practice is to limit flush times to 1 hour or less, commonly 30 minutes.

Shawnee uses an inclining block rate structure with a base rate specific to residential and commercial customers inside and outside city limits. Under an inclining block rate structure, each "block" of water use above base monthly usage costs more on a per-thousand-gallons used basis than the previous block of usage. The base rate for users inside city limits is slightly higher for commercial users compared to residential; however, the inclining block rates are identical. The same relationship is true for residential and commercial users outside the city limits, but the rates are higher in comparison to those paid by customers within city limits.

3.2.2.3 Alternative Water Supplies

Shawnee is not exploring alternative water supplies, primarily because of the favorable results of its recent reservoir yield study (CDM Smith 2012), as well as rights to several surface water and groundwater sources.

3.2.2.4 Education and Outreach

Shawnee maintains a Water and Wastewater Services website⁷ that promotes water conservation measures and includes information on water quality. The amount (volume or flow rate) of water used during common household activities, such as flushing the toilet and taking a shower, is presented on the website under the heading "Every Drop Counts!"

The website outlines Shawnee's commitment to protecting water supply through water-efficient practices, products, and services. Through a partnership with the U.S. Environmental Protection Agency (EPA), Shawnee's customers can participate in the national program WaterSense, which offers people a simple way to make product choices that use less water and thereby save money on utility bills. Shawnee's website provides links to EPA's "Test Your Water Sense" and "WaterSense Product Index." WaterSense labeled products are backed by independent third party certification and meet EPA's specifications for water efficiency and performance.

To notify the public when water restrictions are required, media outlets such as the local newspaper and television stations, as well as mail flyers and bulletin postings, are used. A web-based outreach tool, *CityNews*, provides

⁷ <http://www.shawneeok.org/PublicWorks/Water> (accessed February 2013)

automated e-mail notifications to those who have provided their e-mail address to the City. Notifications are sent when the City's website is updated with new postings such as meeting agendas, minutes, and other notifications.

If emergency notifications are required, Shawnee uses its "Blackboard Connect" program to leave an automated telephone voicemail message with users in any given area. The system is linked to the City's emergency management program, so rapid and automated communication is provided.

The City provides colored tablets to the public upon request if a customer wishes to determine if a toilet tank is leaking to the bowl. A slow leak from the tank to the bowl can be difficult to see or hear, so the colored tablets are a useful detection device that can help direct repairs and save water.

3.2.2.5 Program Implementation

The City has been using its website to educate and inform customers of water-related information at least as far back as 2003. The City adopted the drought management plan in June 2012. The City is also working with other communities in their region to identify action plans to increase and/or implement supplemental long-term conservation efforts. In addition to these conservation-oriented activities, Shawnee's conservation endeavors have been ongoing through planning, maintenance, operation, management, and tracking of all system elements from the supply side through distribution and ultimately consumer use.

3.2.2.6 Performance Measurement

Shawnee's drought management plan is relatively new, but thus far it has been well received. With an established plan, the City is able to communicate its needs and to enforce the various levels of restrictions. The City often receives calls from the public notifying it of observed violations by neighbors. Because the police are responsible for code enforcement and perform daily patrols as part of their routine duties, they play an important role in community outreach and reporting observed violations associated with outdoor watering.

When Level 1 and Level 2 restrictions have been implemented, the City has notified the largest water users directly and in short order. To date, there has been great cooperation from such customers to conserve and minimize their use as much as possible. That kind of cooperation is expected to continue.

The City maintains a water utility crew of 5 people who are on call 24 hours a day, 365 days a year. Water withdrawals from the reservoir are tracked daily. Leaks in the distribution system most often are detected by members of the public; however, the City also monitors the water level in the storage towers using an automated supervisory control and data acquisition (SCADA) system. Response time to shut valves in the event of a leak is on the order of minutes. In addition to the automated monitoring equipment, the City maintains two telephone hotlines available to the public to report utility problems during and after regular hours of business. So, the water utility is operated, maintained, and managed with resource conservation and efficiency in mind, but no specific or unique performance measures have been established.

3.2.2.7 Recommendations

The primary recommendation from staff at the City's utility department is to encourage each municipality and all major water providers to develop, adopt and implement a drought management plan. Shawnee benefits from long-term water supply planning and encourages water users to begin long-term planning if they have not already done so.

3.2.2.8 Conservation Program Costs

The City of Shawnee funds its conservation programs through its operational budget and has no staff members dedicated solely to conservation. Programs funded through this revenue include website maintenance, toilet leak-detection tablets, bill stuffers, and all monitoring and notification requirements associated with the drought management program.

4. Water Conservation Programs in Colorado and California

State-level water efficiency programs in other states were investigated as part of the current studies. This information is provided to support Water for 2060 Advisory Council dialogue regarding potential state-level programs that could be considered for implementation in Oklahoma. Each state is unique in terms of its specific water use types and characteristics, political drivers and issues, funding resources, and water efficiency needs. Thus, it is unlikely that any other state's program would be ideal for Oklahoma to implement. By learning about other state programs, the Advisory Council will have examples of programs that are in place elsewhere that can in turn be used to foster discussion and generation of ideas for programs that might be modified to suit Oklahoma's needs.

This section characterizes the state programs in Colorado and California. Those states are recognized leaders in developing incentives for water efficiency in crop irrigation, the public water supply sector, and other water use sectors, and they have water use sectors similar to those in Oklahoma.

Colorado has diverse water uses and users, many of which are in urban and agricultural settings similar to those found in Oklahoma. Like Oklahoma, Colorado's programs for planning assistance and incentives for implementation of water efficiency measures were founded largely in state legislation, prompted at least in part by increasing constraints on water supplies in the state. Colorado has taken an incentive-based approach to encouraging conservation at the local level, rather than mandates and enforcement. This general approach is what was envisioned by Oklahoma's Water for 2060 Act.

California's most consumptive water use sector is agriculture, as is the case in Oklahoma. California ranks first of all the states in terms of irrigated acreage.¹ California places great emphasis on water conservation in both agricultural and urban water use sectors. California provides some interesting comparisons and insights to water conservation planning and management as it is the most populous state, third largest in land area, and like Oklahoma, spans more than 10 ecoregions, each representing differences in geology, climate, soils, land use, wildlife, fish, hydrology and vegetation.

Other states also have innovative programs. This section is not intended to be a comprehensive investigation of all state programs. Rather, it provides examples that can help provide for an informed dialogue and further generation of ideas for potential Oklahoma programs. Additional information on state-level water efficiency programs in each of the 50 states is documented in such publications as the Alliance for Water Efficiency's *Water Efficiency and Conservation State Scorecard: An Assessment of Laws and Policies* (September 2012).

4.1 State of Colorado Water Efficiency Programs

4.1.1 Agencies Involved

Several state agencies are involved in Colorado municipal and agricultural water planning and water conservation programs. This subsection summarizes their roles and responsibilities.

4.1.1.1 Role and Authority

The Colorado Water Conservation Board (CWCB) is the key state agency focused on water use and conservation in Colorado. Its mission is to conserve, develop, protect, and manage Colorado's water for current and future generations. The board comprises nine geographic gubernatorial appointees and the Executive Director of the Department of Natural Resources. Nonvoting members include directors and commissioners of various state agencies. CWCB's responsibilities include protecting Colorado's streams and lakes, water conservation, flood mitigation, watershed protection, stream restoration, drought planning, water supply planning, and water project financing. Water conservation falls under CWCB's Water Supply Planning Section, which is responsible for

¹ <http://ga.water.usgs.gov/edu/wuir.html>

statewide water supply planning. A Statewide Water Supply Initiative planning study reviews statewide water resources and water demand through 2050.

Several other state agencies have a connection to water conservation. The State Water Court issues surface water and groundwater rights based on an appropriation doctrine (first in time, first in right). The Colorado Water Resources and Power Development Authority (CWRPDA) provides low-cost financing for water and wastewater infrastructure projects, including administration of the federal state revolving fund loan program in Colorado.

4.1.1.2 Funding Sources

The CWCB is predominantly self-funded through the CWCB Construction Fund, a low-cost revolving fund focused on water supply and management. No general fund monies are used to support the CWCB's activities, but transfers from the state's Severance Tax Trust Fund to the Construction Fund can be made to support specific projects through annual legislation. Severance tax funds cannot roll over from one fiscal year to the next. The Construction Fund was created in 1971 with state general fund monies, but all interest, income, and excess is maintained in the control of the CWCB. Expenditures from the Construction Fund are set by annual legislative appropriations. By statute, the CWCB must have cash in hand before loans, grants, and operational expenses are authorized or appropriated.

4.1.1.3 Staffing

The CWCB has a staff of about 40, with 10 in the Water Supply Planning Section and 2 of those focused on water conservation in the public water supply sector. The two positions did not exist before 2008. There is a position related to water conservation in the agricultural irrigation sector, but it is vacant. The public water supply conservation personnel are responsible for setting water conservation standards, reviewing submitted local and regional water conservation plans, and administering water conservation grant funding.

4.1.2 Regulations and Standards

4.1.2.1 Mandates

Colorado has no specific mandates or specific goals for water conservation. However, municipal water providers with more than 2,000 acre-feet of annual water demand (defined as "covered entities" in statute) are required to submit water conservation plans and have them approved by the CWCB. The enforcement mechanism for this requirement is that an entity must have an approved water conservation plan to be considered eligible for any CWCB or CWRPDA grants or loans for water projects. State legislation has defined the minimum required water conservation plan elements.² While the approved water conservation plan must evaluate these elements, there is no requirement for implementation of any particular conservation measure or program.

4.1.2.2 Permitting

There is no specific, regulated link between water conservation and water permitting and water rights. However, political pressure between regions can affect water management decisions. For example, there is significant pressure for east slope water providers to use water very efficiently (including water reuse, where allowed by water rights constraints) before making further diversions from the west slope. Many in the agricultural community expect providers to optimize water efficiency as part of making agricultural-to-urban water rights transfers.

4.1.2.3 Standards

Fixtures and Appliance Standards. The CWCB has not established a published policy on water efficiency standards but provides guidance as to what will be funded for implementation. The CWCB seeks the highest impact of efficiency program grant funding. For instance, the CWCB will not provide grant funding for implementation of a rebate program for 1.6 gallon-per-flush (gpf) toilets, instead focusing on 1.28 gpf toilet rebates. CWCB follows nationally established efficiency standards that are continually updated as minimum standards for grant-funded rebate programs. These include EPA WaterSense³ for fixtures and the Consortium for Energy Efficiency for clothes

² <http://cwcb.state.co.us/water-management/waterEfficiency/Documents/MinReqWaterConservePlanElements.pdf> (accessed January 2013).

³ <http://www.epa.gov/watersense/> (accessed January 2013).

washers and dishwashers.⁴ Concepts for requiring toilet and fixture retrofits as part of the sale of any property, up to current water efficiency standards, proved unpopular with the real estate industry and were not implemented. Denver Water sought legislation in the 2012 legislative session for ultra-high efficiency water fixtures, but that legislation did not move forward. The state’s Interbasin Compact Commission convened a subcommittee that has called for certain recommendations for indoor water use efficiency, but those recommendations are not enforceable or binding. However, the state is promoting and implementing the use of efficient water use fixtures and practices at all state-owned facilities.

Water Provider Standards. CWCB encourages water providers to evaluate rate programs, stressing the use of inclining block rate structures that strongly reinforce conservation practices (e.g., those with significant increases from one rate block to the next). CWCB recommends use of the American Water Works Association Water Audit method⁵ to track and reduce water loss. CWCB is giving consideration to development or adoption of landscaping standards.

Irrigated Agriculture Standards. CWCB has no specific standards for crop irrigation equipment or irrigation practices. Generally, CWCB supports federal agencies’ programs and practices such as the U.S. Department of Agriculture’s EQIP. EQIP is a voluntary program that provides financial and technical assistance to agricultural producers through contracts that provide financial assistance to help plan and implement conservation practices.

4.1.3 Implementation Approaches

4.1.3.1 Incentives for Water Efficiency

Colorado water management agencies generally rely on incentives rather than mandates, to drive water efficiency at the local level. As noted, state legislation⁶ requires major water providers (“covered entities” with demands greater than 2,000 acre-feet per year) to submit water conservation plans and update them at least every 7 years. Practically speaking, there is no direct mechanism for the state to enforce the requirements for submitting conservation plans.

Rather, Colorado encourages development and submittal of local conservation plans—and thereby, drives implementation of local conservation measures and programs—through financial incentives. Application for state funding from CWCB or CWRPDA requires an approved Water Conservation Plan filed with the CWCB.

Within the CWCB budget, water conservation receives about \$500,000 annually from severance tax revenues, subject to annual appropriations. The budget is distributed to an account set aside for water conservation program implementation. The money is distributed in grants for water conservation planning studies and water efficiency initiatives within an approved study, such as a high-efficiency fixture rebate. All grants require a minimum 25 percent local match in kind or in cash, but expectations are for some or all matches to be in cash. The water conservation fund rolls over year to year.

CWCB’s primary grant and loan programs include the following:

Water Conservation Planning Grants. Planning grants are available to covered entities, noncovered entities, and other governmental entities that are developing or updating water conservation plans. No minimum or maximum grant amounts are specified, but grants are limited to available funds.

Water Conservation Implementation Grants. Implementation grants are available to assist covered entities⁷ and smaller water providers who have a CWCB-approved water conservation plan. Conservation measures or programs included in an approved conservation plan are candidates for state implementation grant funding, with a goal of helping to achieve the plan’s stated water conservation goals. These grants can be used to support public education and outreach programs.

⁴ <http://www.cee1.org/resid/seha/seha-main.php3> (accessed January 2013).

⁵ http://www.awwa.org/Portals/0/files/resources/water%20knowledge/water%20loss%20control/iwa-awwa%20method_awwa.pdf (accessed January 2013).

⁶ <http://cwcbweblink.state.co.us/weblink/docview.aspx?id=111879&searchhandle=25493&dbid=0> (accessed January 2013).

⁷ <http://cwcb.state.co.us/Pages/WaterEfficiencyGrantFrequentlyAskedQuestions.aspx> (accessed January 2013).

Water Supply Reserve Account Grants. Reserve account grants are an additional source of funding for local implementation projects. Project funding requests are developed by the state’s Basin Roundtables and Interbasin Compact Committee process.⁸ The program typically is funded at \$7 million to \$10 million each year, contingent on annual appropriations. Projects are funded in support of several different water use sectors, with those related to public water supply and crop irrigation often receiving most of the available grant funding. CWCB and the Basin Roundtables frequently seek to fund projects that have multiple benefits to users, and that improve water quality and the environment.

Water Project Loan Program. CWCB’s low-interest loan program is focused on the design and construction of raw water projects in Colorado. Water efficiency projects could, for example, include lining of agricultural ditches to reduce transit losses, or other municipal or agricultural water management modernization improvements. Roughly \$20 million is available annually from the program for agricultural, municipal, and commercial borrowers. As of January 2013, rates range from 2 percent for agricultural loans to around 3 percent for municipal borrowers and 6 percent for commercial borrowers.

Observations and experience of CWCB staff indicate that these financial assistance programs have served as effective incentives for water users to implement water conservation measures that they otherwise would not have been implemented, or that might have been deferred to later implementation. The effectiveness of resulting projects, individually or collectively, is not routinely monitored.

4.1.3.2 Planning

The CWCB provides technical assistance to water providers (covered entities) largely through review of conservation plans submitted by providers. The CWCB also has developed a guidance document for water conservation plan development.⁹ The CWCB prepared a sample plan for a fictitious city. CWCB assisted the nonprofit Colorado WaterWise in the development of a *Guidebook of Best Practices for Municipal Water Conservation in Colorado*.¹⁰ Approved plans are publicly available on the CWCB’s website, serving as examples of approved plans and providing programs and measures for consideration by other providers. CWCB notes that the plans can be significantly different for an older community than for a newer community that installed higher efficiency fixtures as part of original construction. However, even communities built primarily in the 1990s and 2000s can be candidates for higher-efficiency retrofit and rebate programs, targeting installation of fixtures and appliances that go beyond today’s minimum federal requirements.

Although water conservation plans typically have been developed by individual entities, regionalized planning has been conducted as well. Joint regional plans have been developed for cities with multiple water providers or within a watershed or along a river, and for other political regions.

CWCB assists providers with guidance on water leakage tracking and recommends American Water Works Association and various tools and resources to providers. CWCB sees the potential value in recurring systemwide nonrevenue water audits for public water supply providers, beyond simple leak detection and seeking out sources of losses. However, funding for such an initiative has not been identified.

Agricultural water use planning is coordinated primarily through the Basin Roundtable and Interbasin Compact Committee process. CWCB has not directly engaged in agricultural water conservation planning or incentives, but it participates in helping the agricultural community maintain water supplies through near-term droughts and long-term competition for water rights throughout the state. To some degree, the state’s prohibition against holding speculative water rights (i.e., purchasing water rights for unspecified potential future use or sale) serves as a disincentive for efficient water use, imposing a “use it or lose it” requirement for all water rights holders. CWCB is the lead agency that facilitates Basin Roundtable dialogue and analysis of alternatives to transfers of water rights from agriculture to municipal use.

⁸ <http://cwcb.state.co.us/about-us/about-the-ibcc-brts/Pages/main.aspx> (accessed January 2013).

⁹ <http://cwcb.state.co.us/technical-resources/water-conservation-plan-development-guide/Pages/main.aspx> (accessed January 2013).

¹⁰ See <http://coloradowaterwise.org/BestPractices> (accessed January 2013).

For example, this includes assessment of rotating fallowing programs, drought-year interruptible supply agreements between agricultural and municipal providers, and related management programs. Some areas have seen municipal entities provide financial assistance for efficient agricultural water use practices (e.g., drip irrigation systems) as part of transactions involving agricultural-to-urban water rights transfers. Another approach being investigated by CWCB, universities, and municipal and agricultural partners is one of “deficit irrigation.” In deficit irrigation, crop watering is reduced, for example, to 70 percent of historical use, and crops have been found to yield as much as 85 percent of their typical yield. Coupled with research regarding the timing of when water is applied to a crop, this practice has been found to show some promise in reducing water use while managing impacts on farming operations and economics.

4.1.3.3 Monitoring

In 2010, the Colorado legislature enacted House Bill 1051,¹¹ requiring annual reporting of water use and conservation savings by covered entities. Reporting requirements start with 2013 data, which must be submitted by June 30, 2014. The database of statewide water use and effectiveness of water conservation measures will allow better characterization of water conservation potential in the next update to the Statewide Water Supply Initiative (scheduled for 2016). CWCB has convened a water conservation technical advisory group of providers, nongovernmental organizations, and consultants that is assisting CWCB with implementation of House Bill 1051. This includes developing requirements and tools (such as web-based portals) that facilitate data reporting and minimize burden on those submitting annual data.

In addition, providers’ water conservation plans must be renewed every 7 years, at which time the covered entity will review and update its progress in water conservation.

Agricultural water efficiency projects are not monitored through a central tracking system, but their effectiveness often is monitored on a project-by-project basis. For example, limited analyses and anecdotal evidence suggest that the state’s efforts to control phreatophytes (i.e., deep-rooted plants that draw water from the groundwater table, such as tamarisk) is providing water supply benefits.

4.1.3.4 Compliance Mechanisms

Colorado has no direct compliance mechanisms in place regarding implementation of water conservation measures. The state relies on self-reported monitoring results and the 7-year water conservation plan renewal cycle to encourage covered entities to implement water conservation measures. Colorado’s legislature and state agencies promote a voluntary, incentive-based approach to conservation, with financial incentives and technical planning support as the primary means for providing incentives.

4.1.3.5 Recommendations

CWCB has successfully implemented its water conservation planning requirements for water providers and is initiating a program to more closely monitor the effects of water conservation in the public water supply sector. CWCB has found that linking its financial programs (grants and loans) for water projects to water conservation planning is a strong incentive for local water conservation. CWCB staff indicated that these programs have been well received and could be strong candidates for implementation elsewhere. Additional recommendations from CWCB, in considering expansion of state programs for water efficiency, include the following:

- Recognize passive conservation savings. Consider how new development can contribute to savings (e.g., through ultrahigh efficiency standards). Consider the timing for those reductions as well.
- State level standards would help institutionalize higher savings that are happening in an ad hoc manner to date. Landscapers are seeking statewide common certification for outdoor standards to “level the playing field” from one community to another in terms of attracting development.
- Consider developing and incentivizing adoption of standards for landscaping that will be able to survive future droughts.

¹¹ http://www.leg.state.co.us/CLICS/CLICS2010A/csl.nsf/fsbillcont3/68D1C9003815AB67872576A8002A2E45?Open&file=1051_enr.pdf (accessed January 2013).

- Consider conservation implications and benefits to the water/energy connection.

For the agricultural sector, CWCB staff suggest that limitations in data availability, and a lack of authority to prioritize improvements, can hamper efforts to incentivize and measure progress in crop irrigation water efficiency. Centralized planning for optimization of which crops to plant in certain areas (considering water availability, climate, marginal lands, etc.) could be effective in increasing efficient water use, but these approaches are inherently decentralized and driven by private property interests. CWCB would, however, recommend loan and grant programs such as those in place in Colorado for consideration in other states. CWCB staff sees clear evidence of projects moving forward that would not be implemented without the incentives.

4.2 State of California Water Efficiency Programs

4.2.1 Agencies Involved

4.2.1.1 Role and Authority

The California Department of Water Resources (DWR) is responsible for managing and protecting California's water resources. DWR's Office of Water Use Efficiency provides technical assistance to local agencies and individuals for agricultural and urban water conservation and provides financial assistance, in the form of loans and grants, for water conservation efforts. In accordance with the California Water Plan Update 2009, DWR provides assistance for actions implemented under the California Urban Water Conservation Council's "Memorandum of Understanding Regarding Urban Water Conservation in California" and the Agricultural Water Management Council's "Memorandum of Understanding" (DWR 2009).

The State Water Resources Control Board, under the California Environmental Protection Agency, and the nine Regional Water Quality Control Boards (regional boards) protect water quality and allocate surface water rights. Along with DWR, the State Water Board administers grant funding programs for water resources programs.

The California Public Utilities Commission (CPUC) regulates water utilities that provide water to roughly 20 percent of California residents. The CPUC has developed a Water Action Plan with water conservation as a primary goal and is addressing water conservation rate structure design (<http://www.cpuc.ca.gov/puc/>).

4.2.1.2 Funding

California does not have a sufficient funding mechanism for implementation of water management strategies outlined in the State's Water Conservation Plan (20x2020). At present, state-issued bonds provide financial assistance for water efficiency programs (see Section 2.2.3.4).

4.2.2 Regulatory Drivers

In 2009, California's Legislature put into law the Water Conservation Act of 2009 (Senate Bill X7-7 [SBX7-7]), which required all water suppliers to increase water use efficiency. The following are specific requirements of SBX7-7:

- All water suppliers must reduce urban per capita consumption 10 percent by 2015 and a total of 20 percent by 2020.
- The DWR must develop a standardized water use reporting form for urban and agricultural water agencies.
- Urban retail water suppliers must develop water use targets.
- Each urban water supplier must develop an Urban Water Management Plan.
- A Commercial, Institutional, Industrial task force must be established to develop and implement urban best management practices for statewide water savings.
- Suppliers of agricultural water must prepare and adopt agricultural water management plans and update them on a 5-year cycle.
- Each agricultural water supplier must measure the volume of water delivered to customers.

- DWR must adopt regulations that provide for a range of options that agricultural water suppliers may use to comply with the measurement requirement.
- Agricultural water suppliers must adopt a pricing structure for water customers based at least in part on quantity delivered.
- Agricultural water suppliers must implement mandatory efficient water management practices on measurements, pricing, and implementation reporting.
- Agricultural water suppliers must implement additional efficient management practices, as outlined in their agricultural water management plans.

The Agricultural Efficient Water Management Act of 1990 requires agricultural water suppliers to post their agricultural water management plans and plan updates online.

The Agricultural Water Measurement Regulation requires all agricultural water suppliers to measure and report the volume of water delivered to customers (2012).

Executive Order S-06-08, issued in 2008, set forth requirements addressing water shortages in California, including coordination between the DWR and CPUC.

4.2.3 Implementation Approaches

The California Water Plan Update 2009 outlines water resource management strategies under the following overarching categories: reduce water demand, increase water supply, reduce flood risk, improve water quality, and enhance environmental and resource stewardship. Toward the goal of implementing recommendations in the Water Plan, the Office of Water Use Efficiency does the following:

- Provides expertise to local agencies and individuals regarding agricultural and urban water and energy conservation, reclamation and reuse of water, land and water use, and drainage management.
- Manages the California Irrigation Management Information System (CIMIS), which collects data from more than 140 automated weather stations throughout the state. CIMIS provides reference evapotranspiration and weather data to the public for irrigation scheduling and other purposes such as water balance analyses, pest management, energy generation, firefighting, weather forecasting, and scientific research.
- Assists in establishing mobile laboratories that conduct irrigation system evaluations.
- Carries out data analysis, demonstration projects, and research to achieve energy and water use efficiency.
- Provides loans and grants to make more efficient use of water and energy resources.¹²

4.2.3.1 Agricultural Water Conservation Strategies

As noted, SBX7-7 includes specific requirements related to agricultural water use efficiency. The Agricultural Water Management Council nonprofit organization was established in 1996 and helps water districts with agricultural water supply requirements. The Council receives technical, financial and administrative assistance through the Agricultural Water Management Planning and Implementation Program. Agricultural water suppliers must implement mandatory Efficient Water Management Practices and additional efficient management practices, as outlined in their agricultural water management plan.

The following are on-farm conservation strategies commonly used in California:

- Irrigation Scheduling—Use of soil-, plant-, or atmosphere-based irrigation schedules developed to optimize crop watering times and volumes.
- Tailwater Return Systems—In surface irrigation, collecting tailwater from lower areas of a field for reuse

¹² <http://www.water.ca.gov/wateruseefficiency/>

- Irrigation System Improvements—Includes changing the method being used or minimizing water losses in the existing method. In California, many irrigators have switched from surface irrigation to pressurized systems to reduce the amount of water needed.

The following are commonly used irrigation district-level conservation strategies:

- Canal lining, including canals that have high seepage rates or that overlie highly saline groundwater that requires desalination for reuse.
- Canal structure improvements, which include improving structures to reduce water spillage
- Remote monitoring and control, which use remote systems to measure flow or water depth and remotely operate hydraulic structures or devices.

4.2.3.2 Urban Water Conservation Strategies

SBX7-7 outlined measures required for urban water suppliers, including the development of Urban Water Management Plans and reduction in per capita consumption by 20 percent by 2020. DWR has an urban planning assistance program to assist urban water suppliers to meet the requirements of SBX7-7. The 20x2020 Plan, a collaborative effort between state and federal agencies, developed a “road map to maximize the state’s urban water efficiency and conservation opportunities between 2009 and 2020” and to achieve the goal of 20 percent per capita reduction in urban water demand by 2020.

California has implemented the following regulatory initiatives focused on urban water use efficiency:

- State mandates that all water connections be metered by 2025.
- State mandates that new significant landscaped areas use efficient irrigation systems and low water-using plants.
- Coordination is required between land use and water use planning agencies (20x2020).

4.2.3.3 Economic Incentives

A key economic incentive for water conservation is cost savings. Tiered water rate structures, where the unit cost of water increases as water use increases, are a common way to promote water conservation. In California, some agricultural agencies and most urban water suppliers have adopted a tiered rate structure (CWP 2009, 2013).

While costs of residential wastewater service most often are not linked to volume of wastewater, some commercial and industrial facilities are charged based on the volume of wastewater, thus promoting water conservation ideals (2009).

The Metropolitan Water District of Southern California provides a local example of a water conservation incentive program. The District provides incentives to member agencies for water recycling, groundwater recovery, and seawater desalination. Incentives include economic incentives and other assistance, such as rebates for installation of low-flush toilets, water audits for residential landscapes, and mobile lab services for increasing on-farm water use efficiency at no charge to customers as well as other innovative programs (Update 2009).

4.2.3.4 Financial Assistance Incentives

The DWR, State Water Board, and California Department of Public Health administer bond programs that have provided more than \$18.4 billion in grants and low-interest loans for water resources programs, including integrated regional water management, water conservation, and water recycling (Update 2009). The DWR administers a grant funding programs authorized under SBX2 1 Water Bill (2008) for Integrated Regional Water Management. The state recently offered about \$15 million in grant funds for agricultural water use efficiency projects under Proposition 50 (The Water Security, Clean Drinking Water, Coastal and Beach Protection Act of 2002; draft update 2013). Senate Bill SBX7-7 provides additional incentives by prohibiting urban retail and agricultural water suppliers that do not meet water conservation requirements established by the bill from receiving future state water grants or loans.

5. References

- City of Norman. 2013. Personal communication Ken Komiske, Mark Daniels, and Chris Mattingly, January 10.
- City of Shawnee. 2013. Personal communication with Steve Nelms, Greg Price, and Jeremy Brown, February 26.
- CDM Smith. 2012. Multi-Reservoir Yield and Operations Analysis Report. City of Shawnee, Oklahoma.
- Colorado Water Conservation Board. 2013. Personal communication with Kevin Reidy, January 11 and with Todd Doherty, January 22.
- Lugert-Altus Irrigation District. 2013. Personal communication with Tom Buchanan, February 6 and 12.
- Natural Resources Conservation Service. 2013. Personal communication with Alan Messenger, January 15.
- Oklahoma Panhandle Agriculture and Irrigation. 2013. Personal communication with Fred Fischer and Roger Fischer, January 15.
- Oklahoma Panhandle Agriculture and Irrigation, and the Panhandle Regional Economic Development Coalition, Inc. *Panhandle Regional Water Plan*. December 2012.
- Oklahoma Water Resources Board (OWBR). 2010. *Lakes of Oklahoma*. Ed. Brian Vance. Published by the Oklahoma Water Resources Board and Oklahoma Department of Wildlife Conservation.
- Oklahoma Water Resources Board. 2011. OCWP Water Demand Forecast Report. In, *Oklahoma Comprehensive Water Plan Update (2012)*.
- Oklahoma Water Resources Board. 2012. *Oklahoma Comprehensive Water Plan Update*.
- State of California, Department of Water Resources. 2009. *California Water Plan Update*.
- State of California. 2010. *20x2020 Water Conservation Plan*.