

Building Strong Collaborative Relationships for a Sustainable Water Resources Future:

STATE OF OKLAHOMA

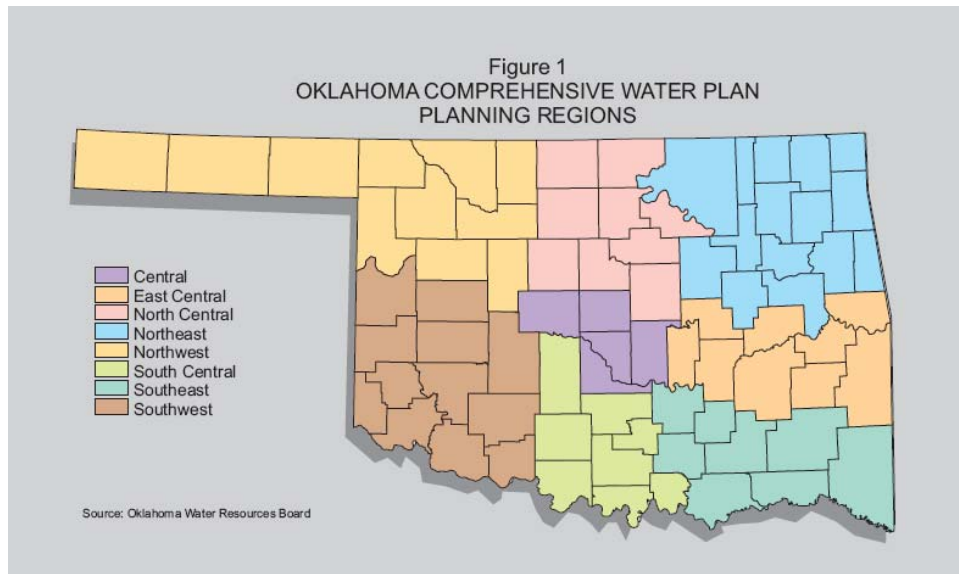
SUMMARY OF STATE WATER PLANNING

U.S. Army Corps of Engineers
Civil Works Directorate
441 G Street NW
Washington, DC 20314-1000

December 2009

The findings contained in this report are based on the information collected from the literature search and interviews for this initiative and should not be construed as an official Department of the Army position, policy or decision unless so designated by other official documentation.

STATE OF OKLAHOMA



Note: The above planning regions were used in the 1995 Plan. The current update to the Plan will focus on supply and demand analysis within watershed sub-basin boundaries.

1. RESPONSIBLE STATE AGENCIES/REGIONAL ENTITIES

The **Oklahoma Water Resources Board (OWRB)** (<http://www.owrb.ok.gov/>) is responsible for Oklahoma's water resource management and planning. The OWRB is "the water agency" for the state and works directly with the Governor's Office and the Legislature to address a number of water resource issues and needs in the state.

Key Agency Contacts at OWRB:

Duane Smith, Executive Director, dasmith@owrb.ok.gov
Kyle Arthur, Director of Water Planning, bkarthur@owrb.ok.gov

Mailing Address/Phone:
Oklahoma Water Resources Board
3800 North Classen
Oklahoma City, OK 73118
Phone: (405)530-8800

The OWRB develops policy and conducts the state's water business through a nine-member Board appointed by the Governor. Members serve staggered seven-year terms and represent all geographic areas of the state and diverse groups of water users.

The OWRB has partnered with numerous state, federal and local agencies in the completion of the 1995 State Water Plan including: U.S. Army Corps of Engineers, Bureau of Reclamation, Natural Resource Conservation Service, U.S. Fish and Wildlife Service, U.S. Geological Survey, National Weather Service, Oklahoma Tourism and Recreation Department, Oklahoma Department of Wildlife Conservation, Oklahoma

Conservation Commission, Oklahoma State Department of Health, Oklahoma Department of Agriculture, Oklahoma Department of Commerce, Office of the State Secretary of Environment, Oklahoma Corporation Commission, Oklahoma Department of Environmental Quality, Oklahoma Department of Transportation, Oklahoma Climatological Survey, Oklahoma Geological Survey, Grand River Dam Authority and Southwestern Power Administration.

The current update to the 1995 Water Plan is being implemented pursuant to a 2008 Programmatic Work Plan. The update will involve partnerships with many of the same agencies identified above; especially, the U.S. Army Corps of Engineers who is assisting with funding of the update through the Planning Assistance to States Program and other authorities. The Oklahoma Water Resources Research Institute, Oklahoma Climatological Survey, Bureau of Reclamation and U.S. Geological Survey will also play key roles in the update.

2. STATE/REGIONAL WATER PLANNING STATUS

The State of Oklahoma established the initial foundation for water planning with the passage of the Water Resources Planning Act of 1965 which was a major contributor to the OWRB efforts in State Water planning due to the federal grants which gave states resources to develop their own state-wide water management and conservation plans. The OWRB published its first comprehensive plan in 1980. In 1992, the Oklahoma Legislature directed the OWRB to update the Oklahoma Comprehensive Water Plan every 10 years. The 1980 Water Plan was updated in 1995 (published in 1997). Oklahoma's 1995 Water Plan provides a detailed inventory of the state's water supplies, projects future needs, and identifies recommendations to address impending water policy questions. Following completion of the 1995 Water Plan, the OWRB recognized that the citizens require a more detailed strategy to meet the many new challenges posed by increased usage and competition for available water supplies.

With this goal in mind, in June 2006 the OWRB, Governor, and Oklahoma Legislature successfully passed legislation which will provide funding for both the Oklahoma Comprehensive Water Plan and recapitalization of the state water resources Financial Assistance Program - \$1.3 million will be deposited annually through 2010 from gross production tax revenues into a revolving fund for the water plan update.

Today, Oklahomans realize that drought is not an anomaly, but a normal climatic variable that is a constant threat to the welfare of state citizens. The recently initiated update of the Oklahoma Comprehensive Water Plan represents a crucial shift in the state's traditional approach to water planning, one that promotes development of system-level plans to prepare for cyclical drought and provide the most water to the most Oklahomans for 50 years or longer. To accomplish this goal, this new, more ambitious, water planning strategy centers on grass-roots implementation of water policy initiatives and projects.

The initial phase of the five-year Water Plan update will produce projections of water requirements by county and watershed through forecast year 2060 as well as a comprehensive, revised inventory of the state's water supplies.

The foundation of the OWRB's innovative water plan update involves detailed assessments of current water supplies and current and future legal, infrastructure, and water quality challenges in reliably meeting the water needs of all water use sectors. This crucial information will be used to develop local plans aimed at providing dependable and affordable water service to Oklahoma families and thus secure the infrastructure imperative for the state's long-term growth.

Identified water management strategies—including development of additional water supplies, regionalization of facilities, infrastructure upgrades, and management options—will be implemented, wherever feasible, to meet the future needs of citizens, industry, recreation, and the environment, even during drought conditions.

An outline of the major topics address in the Oklahoma Comprehensive Water Plan - 2008 Programmatic Work Plan is provided below.

- Task 1 – Demand Projections
 - Task 1A – Consumptive Demand Projections
 - Task 1B – Non-Consumptive Water Use
- Task 2 – Supply and Gap
 - 2A – Statewide Physical Availability Characterization
 - 2B – Statewide Infrastructure and Legal Availability Characterization
 - 2C – Statewide Screening: GIS Tool Development and Application
 - 2D – Water Allocation Modeling
- Task 3 – Develop and Evaluate Supply Alternatives
 - 3A – Infrastructure and Water Supply Alternatives
 - 3B – Policy and Management Alternatives
- Task 4 – Public/Policy Interaction
 - Task 4A – Technical Interaction with Public/Policy Groups
 - Task 4B – Water User Stakeholder Meetings
 - Task 4C – Technical Evaluation of Public Process Policy Concepts
- Task 5 – Implementation
- Task 6 – Water Plan Documentation
- Task 7 – Project Coordination and QA/QC

3. WATER MANAGEMENT VISION AND GOALS

The mission of the Oklahoma Water Resources Board is to:

Effectively and efficiently manage, protect and improve the water resources of the state and plan for Oklahoma's long-range water needs in a responsive, innovative, and professional manner.

The following goals are identified to help achieve the mission:

- Provide leadership in the development of the State Comprehensive Water Plan to meet Oklahoma’s water resource needs for the next 100 years.
- Maintain and improve water quality.
- Ensure the fair and orderly use of Oklahoma’s water resources through programs that include identification, assessment, allocation, and evaluation.
- Promote sound water policies to protect lives, property, and Oklahoma’s water resources.
- Maintain and enhance financial assistance programs to fund eligible public water supply and wastewater treatment projects.
- Enhance the working environment and facilitate a healthy and safe workplace through management, administrative and legal practices that support personnel and programs.
- Build alliances and increase public awareness of the importance and need for protection of Oklahoma’s surface and groundwater resources.

The OWRB has also adopted specific goal and objectives for the current update to the Comprehensive Water Plan:

- Understanding and addressing municipal and industrial (M&I, often referred to as public water supply) needs, in light of projected growth in population and the fact that some areas have already exhibited limitations in supply. Development of the Water Plan should consider how it can assist public water supply systems that do not have solid plans for meeting future water demands.
- Agricultural demands will continue to comprise a significant portion of the state’s water use, indicating a need to thoroughly understand and project agricultural water demands and the sources of supply that will be used to meet those demands.
- Existing policy and administrative procedures necessarily form the baseline of all analyses. However, technical analyses conducted under the Water Plan will investigate the need for, and potential implications of, policy changes in a number of areas. Policy areas that may be considered in development and execution of the Water Plan include:
 - Conjunctive administration of surface water and groundwater supplies
 - Municipal water system regionalization and the State’s role in regional systems and projects
 - Environmental flow management
 - Other facets of water permitting and administration, such as current permitting practice based on annual average surface water yields
 - Revenue generation and financing sources, instruments and institutions for project implementation
 - Other policy elements identified as part of the ongoing public/policy process
 - Public water supply system’s ability to meet their 50-year demands and supply plans
 - Water demands and needs beyond the base planning horizon (2060), ideally looking ahead 100 years.

- Additional interbasin transfers within the State of Oklahoma to support resolution of any identified (or projected) supply shortfalls.

4. SCOPE OF WATER RESOURCE PLANNING

Population growth trends in metropolitan areas, as well as continuing urban sprawl into rural areas, will continue to place considerable demands on the use, availability, and quality of water throughout Oklahoma. Climate change, drought episodes, environmental regulations, legal considerations, and water requirements for economic development, agriculture, and recreation will result in greater stress on state waters and water managers. These factors are important drivers and consideration in the management of water resources and Oklahoma's water planning process.

Oklahoma is located in an area of the United States where precipitation changes dramatically: some areas of the panhandle receive approximately 16 inches of precipitation while some areas in southeast Oklahoma receive over 50 inches. The Water Plan seeks to address water quantity and quality, including identification of needed infrastructure/storage.

The 1995 Oklahoma Water Plan identifies statewide water supply and demand projections over a 50 years horizon (the year 2000 through 2050). The 50 year planning horizon was selected because it represents a reasonable, foreseeable time period and encompasses the minimum life span of most large water resources projects in Oklahoma. The OWRB is in the process of updating the 1995 Plan, which will extend demands through 2060.

1995 State Water Plan Overview

The first section of the State Plan details the history of Oklahoma's water resource development. Tragic flooding and droughts have been part of Oklahoma's history since the late 1800s. Various pieces of legislation were passed in an effort to conserve and control Oklahoma's water supply. For example, the Reclamation Act helped fund infrastructure projects like dams and reservoirs. The creation of the Oklahoma Water Resources Board in 1957 gave Oklahoma the assets to evaluate and monitor water management and conservation projects throughout the state. The first section of the State Plan also describes the quality of Oklahoma's streams, reservoirs, and groundwater aquifers.

The second section of the State Plan describes variables that impact Oklahoma's surface water and groundwater supplies. It describes the impact of climate and weather patterns, as well as its geography, soils, and geology. Sources of state income include agriculture, mining, and recreation. Population and income statistics are briefed in this section as well.

The Plan then describes the condition of Oklahoma's surface and groundwater supplies based on the eight planning regions. Select information is provided below.

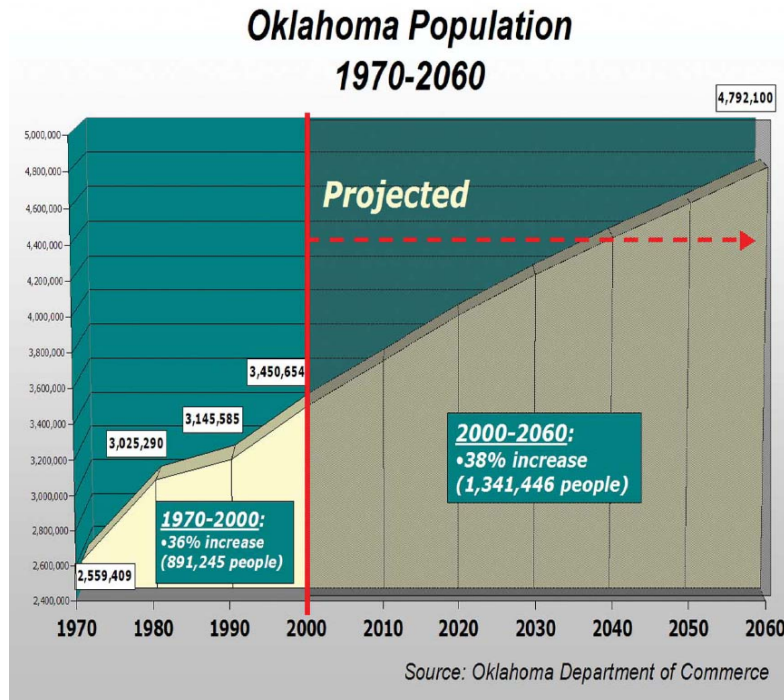
In the next section, the Plan groups water-related needs/issues into 28 categories. These categories are also summarized in the following section.

A detailed recommendations section is presented at the end of the 1995 Plan. The recommendations outline several ways to alleviate the 28 categories of needs/issues. It not only calls on the OWRB to take action, but identifies 22 entities to play a role in the conservation and management of Oklahoma’s water supplies.

Summary of Select Statewide Information/Issues

Demographics

According to the 1995 Water Plan, Oklahoma’s population has increased from 258,657 in 1890 to 3,258,100 in 1994, ranking it below Connecticut but above Oregon in total population by state. The Tulsa and Oklahoma City metropolitan areas account for more than one-half of the state’s population while Norman surpassed Lawton as the state’s third largest city. According to 1994 estimates, the state’s five largest counties, by population, are Oklahoma, Tulsa, Cleveland, Comanche and Canadian; the five smallest are Cimarron, Harmon, Harper, Roger Mills and Ellis. Based on projections from the



Oklahoma Department of Commerce, the state’s population was estimated to reach 3,426,000 in 2000 (3,450,654 actual) and 3,717,500 by 2020. The following figure is from a 2007 fact sheet for the water plan update.

Flooding

The Mississippi River and portions of eastern Oklahoma has a long history of significant flooding. In response to major flooding 34 major Federal and State Water projects (24 built by the U.S. Army Corp of Engineers) were constructed between 1940 and 1985. These projects provide over 13 million acre feet of flood control storage in Oklahoma. Even with significant flood control storage many parts of Oklahoma are subject to localized flooding. In 2007 many areas of the state experience flooding due to higher than average rainfall.

Drought

Oklahoma's exposure to severe drought has been well documented in the literature. The extreme floods observed in the 1920's in eastern Oklahoma were followed by the devastating years of searing drought in the west. By the early 1930's, rural Oklahoma farm families, burned out by drought and hot, dry winds, migrated farther to the west. Meanwhile, dry fields piled up in high sand dunes while lighter silt rose in dust clouds, some five miles high, and swept east to the Atlantic in black blizzards. During a single day in 1934, it is estimated that some 300 million tons of soil were swept from the Great Plains. Droughts have come and gone over the last 80 years with some of the impacts lessened due to the significant storage that has built. In 2006 Oklahoma experienced a severe single year drought which significantly impacted many regions of the state.

Summary of Regional Information

Oklahoma's 1995 Water Plan divided the state into eight planning regions to better facilitate water planning for a 50 year period. The counties in each region exhibit common characteristics — such as homogeneity of climate, geography, hydrology, economics and demography — that meld them into functional planning units. However, each region is unique in its water resources and requirements.

For water demand analyses, the OWRB categorizes the individual planning regions water usage by consumptive uses which are municipal and industrial, irrigation, and thermoelectric. Each planning region has its own water demand calculations as shown in the following Table. As previously mentioned the update to the 1995 Water Plan will summarize demand, supply and water supply gaps/issues at the subbasin level. Therefore, the information provided in the following regions is also likely to change significantly once the data and information for the Water Plan update is collected and analyzed.

OKLAHOMA

Planning Region and Use	1990	2000	2010	2020	2030	2040	2050
CENTRAL							
M&I	205	243.2	263.5	275.3	284.3	288.2	292
Agricultural	26.4	28.1	30	31.9	33.7	35.7	37.4
Power	8.4	10.3	12.7	15.6	19.2	23.6	29
Total	239.8	281.6	306.2	322.8	337.2	347.5	358.4
EAST CENTRAL							
M&I	48.5	52.8	56.1	57.5	59	61.1	63
Agricultural	31.5	32.8	34.2	35.9	37.1	38.6	40
Power	21.8	26.8	33	40.6	50	61.5	75.6
Total	101.8	112.4	123.3	134	146.1	161.2	178.6
NORTH CENTRAL							
M&I	69.5	80.2	87.5	92.1	95.9	98.2	100.1
Agricultural	36.6	38	39.4	40.7	42	43.5	44.8
Power	21.5	26.4	32.5	40	49.2	60.5	74.4
Total	127.6	144.6	159.4	172.8	187.1	202.2	219.3
NORTHEAST							
M&I	267.2	291.1	311.1	323.5	336.1	348.7	361.8
Agricultural	36.4	37.8	39.7	41.3	43.1	44.8	46.6
Power	64.9	79.8	98.2	120.8	148.5	182.7	224.7
Total	368.5	408.7	449	485.6	527.7	576.2	633.1
NORTHWEST							
M&I	28.2	34.1	37.4	40.3	42	43.6	45.5
Agricultural	694.7	755.1	815.7	876.2	936.7	997.2	1057.7
Power	1.2	1.5	1.8	2.2	2.7	3.3	4.1
Total	724.1	790.7	854.9	918.7	981.4	1044.1	1107.3
SOUTH CENTRAL							
M&I	44.3	51.9	57.1	61	64.4	69.2	74.6
Agricultural	46.9	49.2	51.6	54.1	56.4	58.8	61.3
Power	0	0	0	0	0	0	0
Total	91.2	101.1	108.7	115.1	120.8	128	135.9
SOUTHEAST							
M&I	79.5	86.9	94.6	100.8	102.4	104	105.5
Agricultural	31.6	33.8	36	38.3	40.6	43	45.1
Power	4.6	5.7	7	8.6	10.5	13	15.8
Total	115.7	126.4	137.6	147.7	153.5	160	166.4
SOUTHWEST							
M&I	74.6	90.5	104.7	116.2	119.9	122.8	125.4
Agricultural	417.5	736.5	455.4	474.3	493.5	512.4	631.5
Power	3.4	4.2	5.2	6.4	7.9	9.7	11.8
Total	495.5	531.2	565.3	596.9	621.3	644.9	668.7

Units are 1000 acre feet per year

Central Planning Region

The Central Planning Region consists of five counties — Canadian, Cleveland, McClain, Oklahoma, and Pottawatomie — primarily in the North Canadian and Canadian River Basins. This region benefits from the convergence of coast-to-coast and border-to-border interstate highways, including I-40 and I-35.

The Central Region is the smallest of the eight planning regions, comprising only 3,544 square miles. However, Oklahoma County is projected to account for more than 17 percent of the total projected municipal and industrial (M&I) water demand for the entire state, and more than 68 percent of the total M&I water demand for the region in the year 2050.

The climate is generally pleasant with annual mean temperatures ranging between 60 and 62 degrees. Annual evaporation within the region ranges from 63 inches per year in western areas to 57 inches per year in the east. Rainfall averages vary from 28 inches per year in western Canadian County to more than 34 inches in southeastern Pottawatomie County. As with most of the state, thunderstorms are a frequent occurrence during much of the spring and summer and are often accompanied by heavy rain, lightning, hail and tornados. In addition, these storms may generate flash floods, making flood control storage a critical element in most reservoirs in the region.

East Central Planning Region

Covering approximately 11.2 percent of the state (7,829 square miles), Haskell, Hughes, Latimer, LeFlore, McIntosh, Okfuskee, Pittsburg, Seminole and Sequoyah Counties comprise the East Central Planning Region. The region's terrain varies from the forested Kiamichi Mountains to the rolling river basin plains of the Arkansas River, to the foothills of the Ozark Mountains. Stream and surface water sources are abundant within the region.

The East Central Region has one of the lowest projected M&I water demands for the year 2050. The region is lightly populated with McAlester as the largest city. Projected 2050 agricultural demands are the lowest of any planning region.

The region's climate is mild, with annual mean temperatures varying from 51 to 62 degrees. Annual evaporation ranges from 56 inches per year in the western portion of the region to 48 inches per year in the east. Rainfall averages closely approximate evaporation rates, making the region well-suited for reservoirs.

North Central Planning Region

Garfield, Grant, Kay, Kingfisher, Lincoln, Logan, Noble, Pawnee and Payne County comprise the North Central Planning Region. Covering 7,689 square miles, the region is drained by the Cimarron, Chikaskia, Salt Fork of the Arkansas and the Arkansas Rivers. The topography of this region ranges from the densely forested east to the sand hills of

the western portion of the region. Elevations range from 850 to 1,100 feet above mean sea level.

This region encompasses 10.8 percent of the total land area of the state, with approximately one-half of the region consisting of pastureland or cropland. Annual lake evaporation, which exceeds precipitation, ranges from 62 inches in the west to 55 inches in the east. Annual precipitation ranges from 28 inches in the west to 36 inches in the east portion of the region, including an average annual snowfall of 14 inches. Frequent droughts cause severe crop damage while severe flooding occurs as a result of concentrated, heavy precipitation. Thunderstorms — accompanied by high winds, hail and heavy rain — increase the likelihood of flash flooding and emphasize the need for watershed protection and flood prevention projects.

Northeast Planning Region

Fifteen counties form the Northeast Planning Region — Adair, Cherokee, Craig, Creek, Delaware, Mayes, Muskogee, Nowata, Okmulgee, Osage, Ottawa, Rogers, Tulsa, Wagoner and Washington. Stream and surface water sources are abundant in the region. The Northeast Region has abundant oil and gas supplies and strong industrial development aided, in part, by barge traffic of the Mc-Clellan-Kerr Navigation System. The region is predicted to have the highest overall M&I and power demands for water by 2050. Annual evaporation within the region ranges from 56 inches in the west to 46 along the Arkansas and Missouri borders. Rainfall averages 34 to 44 inches per year.

Northwest Planning Region

The Northwest Planning Region covers 11 counties totaling 14,339 square miles. The counties include Alfalfa, Beaver, Blaine, Cimarron, Dewey, Ellis, Harper, Major, Texas, Woods and Woodward. The Panhandle counties of Cimarron, Texas and Beaver are generally flat while the remainder of the region is characterized by rough terrain marked with high sand hills and deep erosion. This region contains 20.2 percent of the state's total land area and supports the most extensive agricultural activities in Oklahoma. The Northwest Planning Region accounts for approximately 59 percent of the total statewide projected agricultural water demand.

The climate is semi-arid in the Panhandle and sub-humid in the remainder of the region. Thunderstorms producing high winds and damaging hail are a common occurrence throughout the region. Annual evaporative losses from lakes in the region range from 56 to 64 inches and greatly exceed precipitation. These losses create critical and persistent water problems and greatly affect the design of reservoirs in the region. Droughts are fairly common and mean annual temperatures range from 54 degrees in the Panhandle to 60 degrees in the southeast corner of the region. While flooding is relatively uncommon in the Northwest Region, four large flood control reservoirs and a few smaller watershed protection structures protect the area from widespread agricultural and property losses.

Total 2050 demands for municipal and industrial, agricultural, and power uses in the Northwest are projected to reach 1,107,300 af/yr, substantially higher than any other planning region. Preliminary analysis indicates that these demands can be met with existing surface and groundwater sources. Due to the uncertainty associated with long-term reliability of groundwater supplies, the development of new surface water sources, either inside or outside the region, may be necessary to satisfy future demands.

South Central Planning Region

Covering approximately 8.3 percent of the state (5,799 square miles), Carter, Garvin, Grady, Jefferson, Love, Marshall, Murray and Stephens Counties comprise the South Central Planning Region. Lying at the eastern edge of the Southern Great Plains, the region varies from lush pastures in the river bottoms to sparsely vegetated oilfields to the rugged foothills of the Arbuckle Mountains. Stream and surface water sources are abundant in the eastern portion of the region; however, they are relatively scarce in the west.

The South Central Region is projected to have the lowest overall water demand of any region for the year 2050. The region is sparsely populated, with the largest cities being Ardmore, Duncan and Chickasha. The projected 2050 agricultural demand is estimated to account for only 3.2 percent of the total statewide agricultural demand.

The region's climate is mild with annual mean temperatures varying from 61 to 64 degrees. Annual evaporation within the region ranges from 63 inches in the west to 55 inches in the east. Rainfall averages 30 inches per year in the west and approaches 39 inches per year in the east.

Southeast Planning Region

Atoka, Bryan, Choctaw, Coal, Johnston, McCurtain, Pontotoc and Pushmataha are the eight counties that comprise the Southeast Planning Region. The region's terrain varies from the rugged Kiamichi Mountains to the rolling, alluvial plains of the Red River. Stream and surface water sources are abundant in the region which is noted for its vast timber resources.

The Southeast Region is projected to have the second lowest overall water demand of any planning region in the year 2050. McCurtain County, with its large timber and related industry, is a county specific exception. Ada, Durant, Hugo and Idabel are the largest cities in the region.

The region's climate is mild with annual mean temperatures varying from 62 to 64 degrees. Rainfall is abundant, ranging from 40 inches per year in the west to more than 56 inches in northern McCurtain County. Annual evaporation ranges from 56 inches in western areas to 48 inches in the east.

Southwest Planning Region

Twelve counties, covering approximately 15.7 percent of the state, comprise the Southwest Planning Region. They are Beckham, Caddo, Comanche, Cotton, Custer, Greer, Harmon, Jackson, Kiowa, Roger Mills, Tillman and Washita Counties. The region lies at the center of the Southern Great Plains and normally experiences mild winters and long, hot summers. The region's terrain includes vast farming areas with rolling river bottoms and the rocky Wichita Mountains. Stream and surface water sources are relatively scarce in the region.

The Southwest Region is projected to have approximately 17 percent of the overall statewide water demand for the year 2050. The region is sparsely populated and its projected 2050 agricultural demand is estimated to be the second highest in the state, behind the Northwest Planning Region.

The region's climate is mild with annual mean temperatures varying from 59 to 64 degrees. Annual evaporation within the region ranges from 62 to 65 inches. Rainfall averages 22 inches per year in western areas to almost 32 inches per year in the east. These factors, along with the existence of numerous natural chloride deposits in southwest Oklahoma, lead to water quality problems in many of the region's stream systems.

The Southwest Planning Region's extensive agricultural demand may pose serious water problems in some areas, including Jackson and Tillman Counties, which are projected to have substantial shortages. These problems could be compounded by the current overdevelopment of groundwater in those areas. Water quality is also a problem in the west. Existing reservoirs in the region are fully allocated with no surplus water available. The long-range projection of M&I water demand in the year 2050 is 125,400 af/yr (111.5 mgd). The agricultural demand of 531,500 af/yr (473 mgd) is projected to be the second highest of any planning region.

Methodology

Completion of the 1995 Water Plan involved the use of numerous methodologies and technical tools some of which are described below. These and other tools will be utilized for the Ongoing Comprehensive Update to the Plan.

Municipal and Industrial Water Use Projections

The U.S. Army Corps of Engineers, under authority of their Planning Assistance to States Program, cooperated with the Oklahoma Water Resources Board in identifying future municipal and industrial water needs in the state using the Corps' Institute for Water Resources Municipal and Industrial Needs (IWR-MAIN) model. The model is a computerized forecasting system that contains a range of forecasting models, parameter-generating procedures and data management techniques.

Population - Population data for the 1995 Plan for the years 2000 to 2020 were derived from Oklahoma Department of Commerce (ODOC) projections published in April 1993. For projected figures beyond the year 2020, the rates of change for 2020 to 2040 were developed by applying the U.S. Bureau of Economic Analysis county-level projections to ODOC's 2020 figures while a straight-line extrapolation was used to project figures for the year 2050.

Employment- Employment projections were based primarily upon the projected labor force participation rates in the U.S. Bureau of Economic Analysis county-level projections (adjusted for non-farm labor participation) and projected population figures.

Income - The IWR-MAIN model requires median household income data for both the base year and projected years. The 1990 census data provided base-year household income data. The rate of change from the U.S. Bureau of Economic Analysis was applied to the base year to derive projected household income figures. The rate of change between 2030 and 2040 was held constant to derive the 2050 figure.

Housing - The 1990 Census of Population and Housing provides the number of housing units by type of unit and value categories. These categories were used for the base year data. The census data provides the percentage of homes attached to a public sanitary sewer. This percentage was used to estimate the number of unsewered homes, an optional input for the model. No external housing projections were used. The IWR-MAIN model applied the 1990 housing/ population ratio to the projected population figures.

Forecast Assumptions - The estimates of future water derived by the IWR-MAIN model were based upon the following assumptions:

- The water use forecast values will follow the trend in explanatory variables, including population, number and type of housing units, employment and median household income.
- Future estimates of water demand reflect normal weather conditions based upon the latitude and longitude of each study area and climatic variables obtained from the IWR-MAIN Library of Climatic Conditions.
- The forecasts of residential water use assume that future prices of water will be maintained at current price levels in real terms; therefore, no increases in the real price of water are assumed.
- The estimates of water use do not account for current or planned water conservation activities.
- All estimates of water use are calculated from the IWR-MAIN actual and revised computational equations and water use coefficients adjusted to water use patterns in Oklahoma.

Agricultural Water Demand

Agricultural water demand forecasts were developed in cooperation with the Bureau of Reclamation's Oklahoma City Project Office under authority of their Technical

Assistance to States Program. Agricultural projections include both irrigation and livestock water demands by decade for the forecast period 1990 through 2050.

Livestock

Data from the Oklahoma Agricultural Statistics Service were used to estimate historical trends of livestock production (manufacturing and processing aspects are addressed under M&I projections). Estimates derived from conversations with the American Society of Agricultural Engineers, Corps of Engineers and Oklahoma Department of Commerce indicate that the livestock population is expected to remain relatively stable throughout the 50-year planning horizon, thus a relatively modest increase of 15 percent was used to project future livestock production over the planning period.

Irrigation

Oklahoma State University compiled biennial irrigation surveys, including information on the number of acres actually irrigated versus acres potentially available for irrigation, in 1983, 1985 and 1987. For the purpose of estimating current irrigation patterns, it was assumed that the report figures are valid and representative of recent (from 190 Water Use Report) irrigation patterns.

Thermoelectric Power

The 1990 estimates of water withdrawals for power generation were derived from three sources: (1) 1990 OWRB water use reports; (2) background data compiled for U.S. Geological Survey Circular 1080, *Estimated Use of Water in the United States, 1990*; and (3) U.S. Department of Energy Form EIA-767, *1989 Cooling System Design Parameters and 1989 Cooling System Annual Operations*. Projections of future water use for power generation were based upon projections of power generation from the October 1991 Fourth Biennial Electric System Planning Report prepared by Decision Focus Incorporated for the Oklahoma Corporation Commission. Statewide forecasts through the year 2000 were generated by summing the values for the individual utilities. Statewide energy demand is forecasted to grow at 2.3 percent annually through the year 2000; values for individual utilities ranged from 1.3 percent to 3.3 percent. The 2.3 percent annual growth rate was applied to 1990 county water use estimates for electric power generation and a straight-line extrapolation was used to project figures through the year 2050.

5. PARTNERSHIPS, STAKEHOLDER, AND PUBLIC INVOLVEMENT

The State of Oklahoma has developed a robust stakeholder and public involvement process as part of their State Water Plan development and update. They have also embarked upon several collaborative partnerships. The agencies that participated in the 1995 Water Plan were discussed earlier. These agencies will also participate in the Water Plan update with several of entities playing key roles as outlined below.

The U.S. Army Corps of Engineers, through its Planning Assistance to the States program and other authorities are providing cost share funding for the Water Plan update. In addition, the Corps and OWRB are cooperating in various water planning projects to investigate future water supply alternatives for growing communities in Oklahoma, including Bartlesville and Bristow. A related ongoing study in western Oklahoma is researching potential construction of a reservoir to provide the region with water supply and recreational benefits.

The U.S. Geological Survey will be assisting in identifying and describing trends in base and total flow. Currently there is no analysis of long-term base and total flow trends for streams in the major watersheds of Oklahoma. USGS researchers will analyze flow data collected at streamflow-gaging stations in Oklahoma to construct a trend analysis to determine when and where base and total flow has changed in Oklahoma and interpret causes for significant flow trends. Researchers will also use recent streamflow data to update summaries of streamflow statistics in Oklahoma. Useful information describing gaging station streamflow data includes: mean annual and monthly flow, low- and high-flow frequency statistics, peak-flow statistics, and annual flow-duration statistics.

Oklahoma Climatological Survey (OCS) will evaluate the potential impacts of climate and climate change on water resources and management in Oklahoma, both on a seasonal and regional scale.

Oklahoma's update to the Water Plan will include more than a dozen research projects that will answer many important water management questions and provide necessary data for decisions in the water planning process. Many of these studies also serve to accomplish early implementation of Water Plan initiatives.

Finally, the Oklahoma Water Resources Research Institute, established in 1965 at Oklahoma State University but serving the entire State, is leading the effort to urge Oklahomans from all across the state to contribute to the current update to the Water Plan. The goals of the public participation process are to produce a water resource management plan that is (1) based on the best available science and (2) enjoys broad public support.

Local Input Meetings

During 2007, the Institute sponsored 42 local input meetings across the State, which allow Oklahomans to:

1. Identify the issues that should be considered.
2. Voice concerns about these issues.
3. Specify the questions that should be answered in considering these issues.
4. Offer suggestions about how the issues should be addressed in the plan.

Regional Input Meetings

In 2008, the Institute sponsored 11 regional input meetings, one in each of the 11 sub-state planning regions of Oklahoma, to group the issues raised in local input meetings into similar categories and to rate the categories as to their relative importance. The results of the local and regional input meetings will form the agenda for all meetings to follow.

Planning Workshops

The Institute will sponsor a series of workshops, in 2009, to formulate alternative water resource management strategies. These workshops will be organized around the issues and issue categories that were identified in the input meetings. Each of the workshops will be repeated twice (three in all) so that experts can respond to questions raised by the participants. Approximately 20 Oklahomans will be invited to participate in each of the workshops.

Town Hall Meeting

During 2010, the Institute will work with the Oklahoma Academy for State Goals to host a 3-day town hall meeting, in Norman. Approximately 150 Oklahomans will be invited to consider the alternative water resource management strategies that were formulated in the planning workshops and reach agreement on a series of recommendations for inclusion in the comprehensive water plan. The recommendations will be delivered to the OWRB for its use in preparing a draft of the water plan.

Comment and Implementation Meetings

During 2011, the Institute will return to the 11 sub-state planning regions to review and discuss the draft water plan. Participants will be encouraged to offer suggestions about how the plan should be carried out. Participants will be encouraged to offer their comments on the draft plan as well as the implementation suggestions originating from the afternoon sessions. All comments and implementation suggestions will be communicated to the OWRB for its use in developing the final water plan that will be delivered to the Governor and Legislature in 2011.

6. PLAN IMPLEMENTATION STRATEGY/OUTCOMES ASSESSMENT PROCESS

Because the OWRB is the entity which implements actions for water resources planning and management, the recommendations of the Water Plan are/will be directed toward the actions and responsibilities of the Board. In general the State Water Plan is used for:

- Shaping Policy
- Establishing/Revising Regulations
- Local Problem Solving

- Prioritizing Budget Recommendations
- Problem Prevention

Assessing progress toward meeting the recommendations of past water plans and the current water plan update will be done both qualitatively and quantitatively based on the above actions and responsibilities of the Board.

There are a number of specific topics/categories and/or issues/needs (presented below, not listed in order of importance) that are discussed in the 1995 State Water Plan that have been or will continue to be addressed as the planning process moves forward. In many cases the OWRB is addressing specific recommendations which can be found in the 1995 Plan utilizing existing financial resources and they are also seeking new state and federal partnerships.

- Municipal & Rural Water/Wastewater Systems
- Financing
- Allocation & Control
- Maintenance & Renovation
- Water Transfer
- Weather Modification
- Groundwater Recharge
- Reclamation & Reuse
- Water Conservation
- Basin/Watershed Management
- Drought Preparedness
- Wetlands Protection & Management
- Endangered Species
- Floodplain Protection & Preservation
- Water Resource Dispute Resolution
- Local Empowerment
- Interstate Water Disputes
- Stream Gaging Network
- Water Well Measurement
- Water Quality Sampling & Monitoring
- Water Resource Data Management
- Instream Flow Protection
- Indian Water Rights
- Groundwater/Stream Water Relationships
- Groundwater Protection
- Groundwater Quality Standards
- Nonpoint Source Pollution
- Stream Water Quality Standards

Specific projects approved for implementation are financed through the Statewide Water Development Fund. The Statewide Water Development Revolving Fund, currently responsible for more than \$1.7 billion in state water/wastewater financing, will provide

the essential mechanism to implement long-term water supply strategies that arise from the OCWP process. However, federal money for water infrastructure has fallen significantly over the last few decades. The Clean Water and Drinking Water State Revolving Funds, administered by the U.S. Environmental Protection Agency and managed by individual states, have been particularly hard-hit. SRF loans, which provide about 70 percent of Oklahoma's water and sewer infrastructure financing, play a vital role in community water quality improvement.

In light of an anticipated \$5.4 billion water/wastewater infrastructure funding gap in Oklahoma over the next 20 years, the OWRB continues to explore new avenues to replenish the dwindling Revolving Fund so that it can remain a viable tool for Oklahoma's water future. The OWRB is investigating opportunities through the state's existing SRF programs to expedite the planning, prioritization, and implementation of community water resource projects in Oklahoma.

7. NEEDS, CHALLENGES AND CRITICAL PRIORITIES - INTERVIEW INSIGHTS

As discussed earlier in this summary, population growth trends in metropolitan areas, as well as continuing urban sprawl into rural areas, will continue to place considerable demands on the use, availability, and quality of water throughout Oklahoma. Climate change, drought episodes, environmental regulations, legal considerations, and water requirements for economic development, agriculture, and recreation will result in greater stress on state waters and water managers. These factors are important drivers and consideration in the management of water resources and Oklahoma's water planning process (please see the planning region summaries for additional insights).

Oklahoma is located in an area of the United States where precipitation changes dramatically: some areas of the panhandle receive approximately 16 inches of precipitation while some areas in southeast Oklahoma receive over 50 inches. The Water Plan seeks to address water quantity and quality, including identification of needed infrastructure/storage.

In light of these factors perhaps the single most significant challenge facing the state is infrastructure. This includes:

- Developing the infrastructure needed to move water from the location of supply to the location of need (overall water supply is not major issue on a statewide bases but localized shortages to current and future needs exist/may exist pending further analysis).
- Maintenance or existing infrastructure.
- Replacement of aging infrastructure both storage and distribution systems.

Oklahoma's Demographic trends indicate that a large portion of growth will be in the current urban and along southern boundary with Texas. Western Oklahoma has less available water but is not expected to see the same level of growth. Meeting urban

growth needs will require infrastructure to store and convey water supplies. Funding water supply options will be a future challenge.

Future challenges and needs to address priority water resource issues fall into two major categories: (1) Technical; and (2) Financial as discussed below.

Technical

Water resource planning support - it would be valuable to have federal agency resources available to assist the states in implementing planning. This assistance should be flexible and fit the states approach to planning; some states will effectively utilize integrated water resource planning while others may have effective planning that meets their states needs. The decision of what works best is best left up to the state, and the state should be the entity that sets the priorities.

Financial

Funding is needed for implementation

It was noted that the permitting process should recognize the state plan and bring issues into the planning process early so they can be dealt with during the state planning process.

Energy Trends – Oklahoma is a recognized leader and has a strong history in the field of energy production, including oil and gas exploration and development. Looking forward the state is well positioned to continue as a leader exploring both emerging and known technologies. In this effort that state will examine its role in new power including nuclear; biofuels; and alternate fuel and energy (i.e., wind, solar etc.) and the corresponding energy water nexus.

Finally, the state, through the Comprehensive Water Planning process is looking at climate change relative to changing demand patterns, land use change and changes in the water budget, specifically ET rates.

8. REFERENCES

Much of the language and information in this summary comes directly from reports published by the Oklahoma Water Resources Board.

Oklahoma Water Resources Board, Oklahoma Comprehensive Water Plan, 2007 Status Report. Available at http://www.owrb.ok.gov/supply/ocwp/pdf_ocwp/WaterPlanUpdate/OCWPStatusReport2007.pdf

Oklahoma Water Resources Board, Oklahoma Comprehensive Water Plan, 2008 Status Report. Available at

http://www.owrb.ok.gov/supply/ocwp/pdf_ocwp/WaterPlanUpdate/OCWPStatusReport2008.pdf

Oklahoma Water Resources Board, Programmatic Work Plan, May 2008. Available at http://www.owrb.ok.gov/supply/ocwp/pdf_ocwp/WaterPlanUpdate/OWCP_PWP_workplan.pdf

Oklahoma Water Resources Board, Strategic Plan, FY 2008-2012. Available at <http://www.owrb.ok.gov/about/management/OWRBStrategicPlanFY2008.pdf>

Warren Viessman, Jr. and Timothy D. Feather. State Water Resources Planning in the United States. United States: American Society of Civil Engineers, 2006.