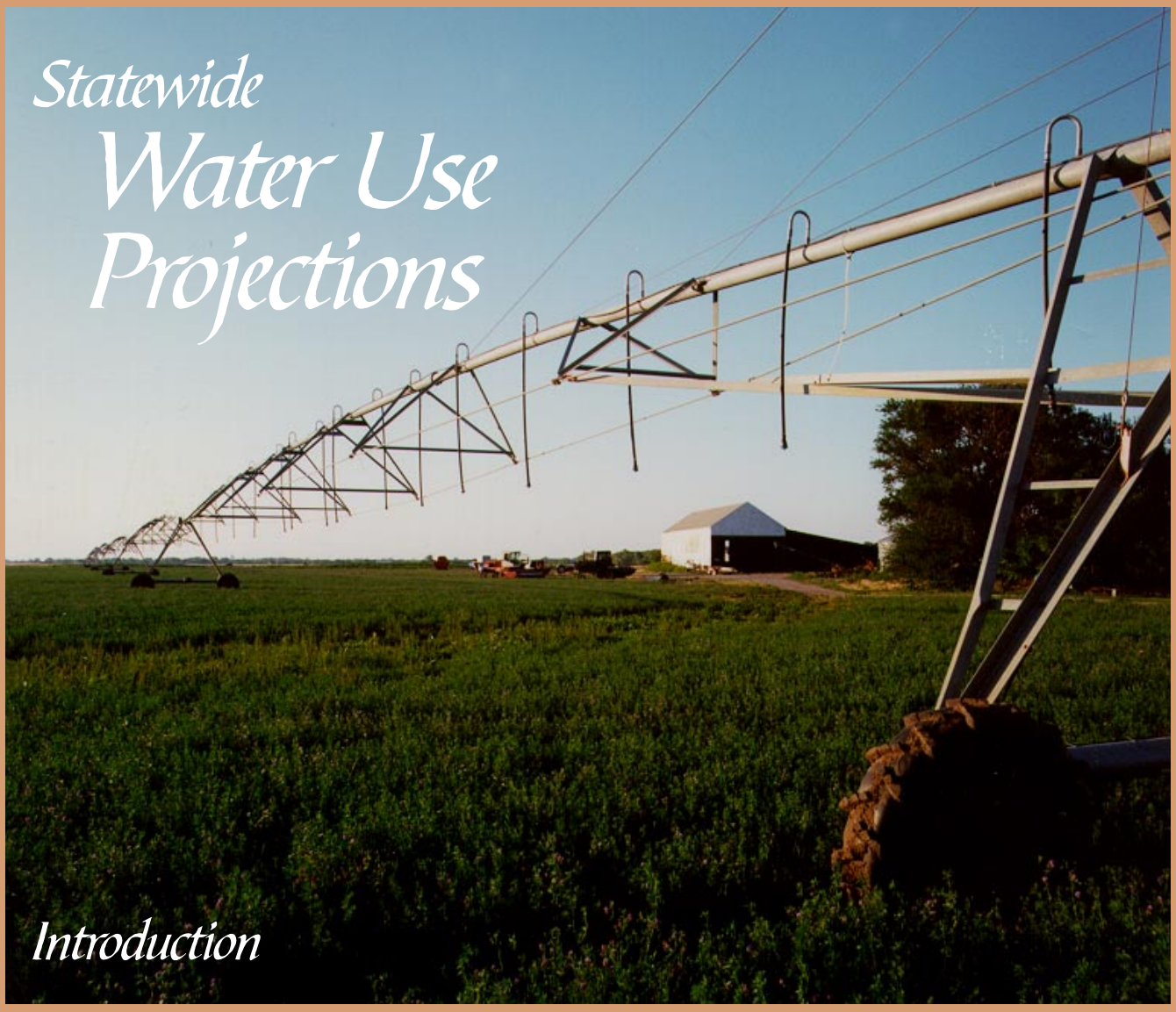


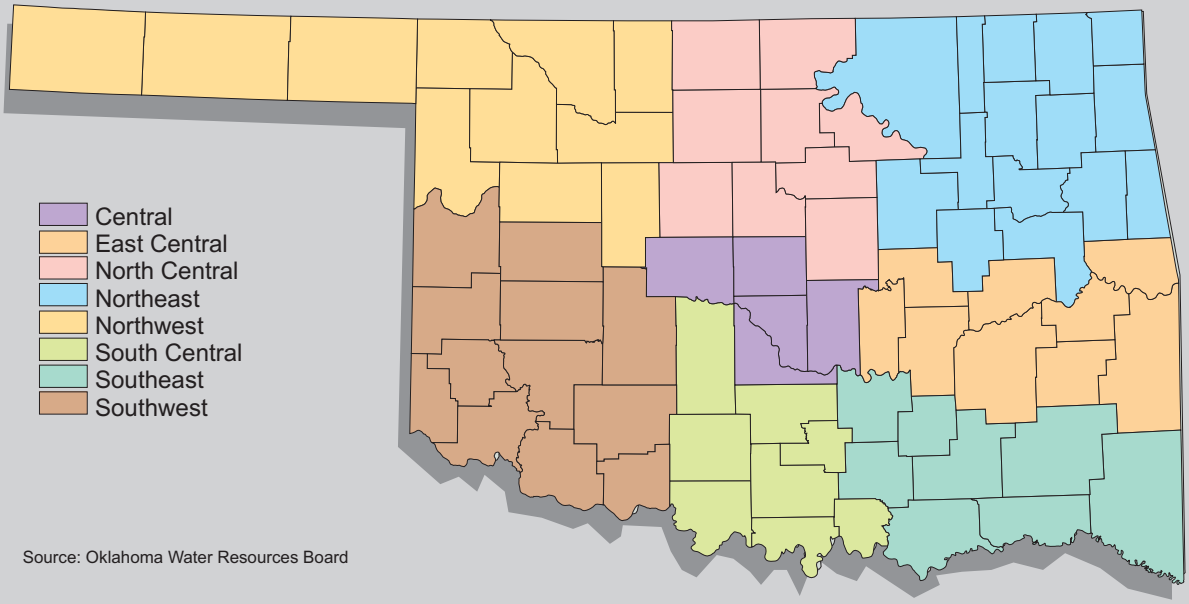
Statewide Water Use Projections

Introduction

Estimating projections of future water requirements is a difficult but necessary task in planning for future water needs. The approach taken in updating water use projections for Oklahoma was a three-part process. Municipal and industrial water demand projections were made in cooperation with the U.S. Army Corps of Engineers, Tulsa District, using the Institute for Water Resources Municipal and Industrial Needs (IWR-MAIN) forecasting model. Agricultural water projections were estimated in cooperation with the Bureau of Reclamation and based upon recent irrigation and livestock watering trends and assumptions of future scenarios in agricultural water demands. Water needed for power generation has been forecasted according to the best available information on the future plans of Oklahoma's power generating companies.

It is obvious that a great deal of uncertainty is inherent in undertaking any type of projection as far as 50 years into the future. The tendency of planners is to take into account the ultimate water needs within reason when attempting to foresee whether future water use and supply can be balanced. Thus, the following water demand projections for the state's eight planning regions are based upon methodologies designed to meet relatively high, yet reasonable, scenarios of projected water use. The planning regions are delineated in Figure 17.

Figure 17
OKLAHOMA COMPREHENSIVE WATER PLAN
PLANNING REGIONS



Source: Oklahoma Water Resources Board

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. The IWR-MAIN model forecasts water use based upon actual and projected socioeconomic characteristics of a study area. Future water use is projected as a function of the most likely determinants of water demand, including (1) number, market value and type of housing units in the residential sector; (2) employment in commercial and manufacturing industries; (3) water pricing; (4) median income; and (5) weather/climate conditions. The analysis includes water use models for each of the 77 counties in Oklahoma. These models can be updated as more current information becomes available.

The IWR-MAIN model was used to estimate water use for 1990 and project water needs, by decade, from 2000 through 2040. The trend developed in IWR-MAIN projections for 2000 to 2040 is used to derive figures for the year 2050. County-level data required by the IWR-MAIN model were aggregated for each of the eight planning regions as delineated in the 1980 Oklahoma Comprehensive Water Plan. The IWR-MAIN model requires four basic parameters to estimate and project water use: population, income, housing and employment. The model uses these basic parameters in conjunction with water use data imbedded within the model. Values for each parameter, along with average water pricing information, are required to determine estimated water use for the base year. Water pricing information (marginal price and bill difference) for each county in Oklahoma was based upon a 1985 study conducted by Planning Associates for the U.S. Army Corps of Engineers Institute for Water Resources. An estimate of actual water use is required not as an input parameter, but as an external check for how well the model simulates base-year usage. Since the projection frame for this analysis is the decades between 1990 and 2050, external projection data for three parameters -- population, income and employment -- were required for each decade between 1990 and 2050. Housing projections were determined internally by the model.

POPULATION

Population data for this update 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

To account for water demand by industry, the model requires information on employment in commercial and manufacturing industries by place of employment. Consequently, U.S. Bureau of Census County Business Patterns non-farm employment data were used for the base-year estimates. 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 the projected population figures identified above. During the verification process, IWR-MAIN appeared to "under-pre-

dict" consumption in several counties where a large amount of self-supplied industrial water use existed. More specific information was obtained on these industries and the appropriate water use coefficients were adjusted accordingly.

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.

RESULTS

Table 3 presents municipal and industrial water projections by decade for each of the eight delineated planning regions. This table displays the 1990 demands estimated by IWR-MAIN. These 1990 estimates are used as a gauge for the model's ability to project demands. As shown in Figure 18, comparisons to actual 1990 water use figures, derived from several sources (in-

Table 3
COUNTY/REGIONAL MUNICIPAL & INDUSTRIAL
WATER USE PROJECTIONS 1990-2050

(IN 1,000AC-FT PER YEAR)

PLANNING REGION & COUNTY	*YEAR*						
	1990	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*
CENTRAL							
Canadian	15.2	18.8	18.9	19.7	20.2	20.6	21.1
Cleveland	31.6	38.9	41.7	43.2	44.0	44.5	44.9
McClain	5.2	6.2	6.6	6.8	7.1	7.2	7.3
Oklahoma	140.6	164.4	180.3	188.6	195.4	197.5	199.5
Pottawatomie	12.4	14.9	16.0	17.0	17.6	18.4	19.2
Total	**205.0**	**243.2**	**263.5**	**275.3**	**284.3**	**288.2**	**292.0**
EAST CENTRAL							
Haskell	2.4	2.5	2.5	2.5	2.6	2.6	2.6
Hughes	2.8	3.1	3.5	3.7	3.9	4.0	4.1
Latimer	2.4	2.6	2.7	2.8	2.8	2.9	3.0
LeFlore	10.3	11.5	12.5	13.0	13.6	14.2	14.9
McIntosh	5.0	5.3	5.3	5.3	5.3	5.4	5.5
Okfuskee	2.6	2.7	2.8	2.9	2.9	3.0	3.1
Pittsburg	9.1	9.7	10.1	10.2	10.5	10.9	11.2
Seminole	5.7	6.2	6.5	6.7	6.8	7.1	7.3
Sequoyah	8.2	9.2	10.2	10.4	10.6	11.0	11.3
Total	**48.5**	**52.9**	**56.1**	**57.5**	**59.0**	**61.1**	**63.0**
NORTH CENTRAL							
Garfield	15.3	18.1	20.9	22.7	24.5	24.8	25.1
Grant	1.6	1.8	1.9	2.0	2.1	2.2	2.2
Kay	15.8	18.4	20.2	21.2	21.5	21.7	22.0
Kingfisher	3.0	3.2	3.5	3.6	3.6	3.7	3.8
Lincoln	5.2	6.3	6.9	7.3	7.7	8.2	8.6
Logan	7.1	7.6	8.2	9.0	9.4	9.6	9.7
Noble	1.5	1.6	1.7	1.8	1.9	2.0	2.1
Pawnee	3.5	3.9	4.3	4.5	4.7	4.9	5.2
Payne	16.5	19.3	19.9	20.0	20.5	21.1	21.4
Total	**69.5**	**80.2**	**87.5**	**92.1**	**95.9**	**98.2**	**100.1**

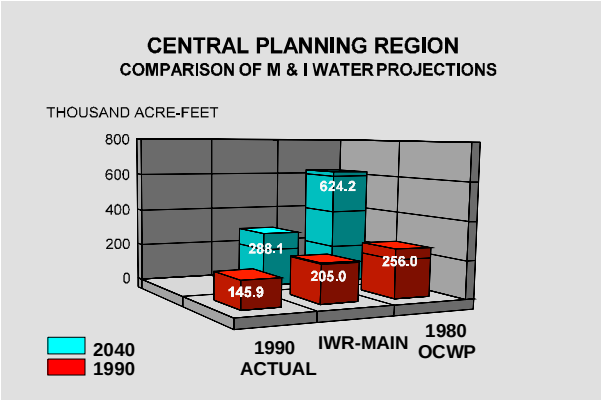
Continued

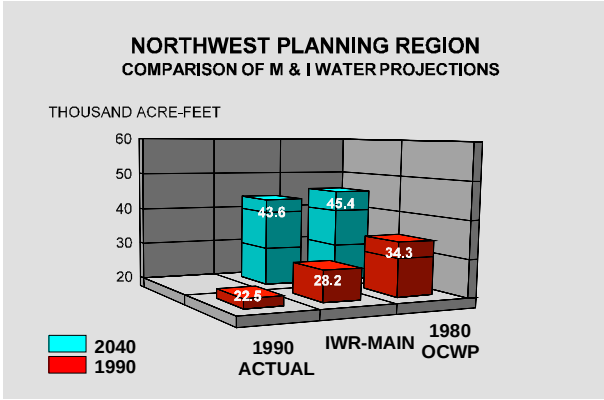
Table 3 (Continued)
COUNTY/REGIONAL MUNICIPAL & INDUSTRIAL
WATER USE PROJECTIONS 1990-2050

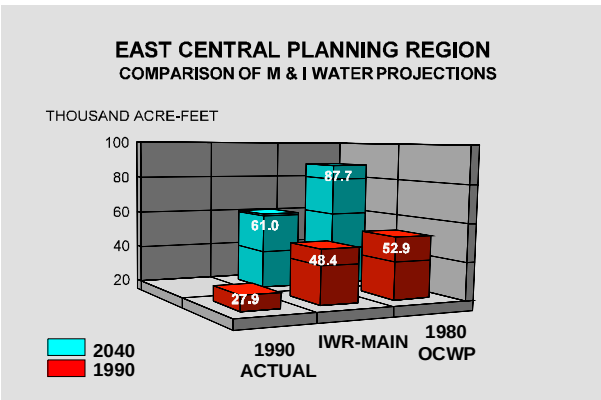
(IN 1,000 AC-FT PER YEAR)

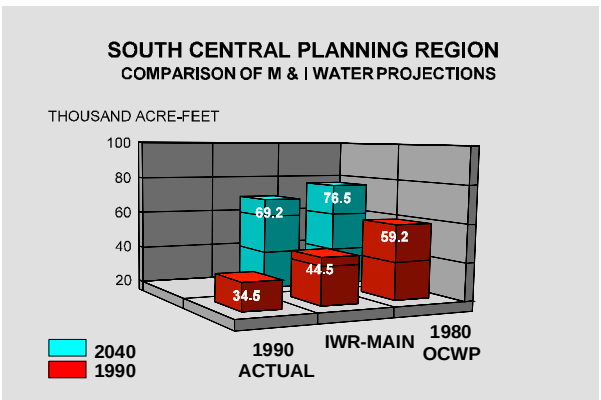
PLANNING REGION & COUNTY	YEAR						
	1990	2000	2010	2020	2030	2040	2050
NORTHEAST							
Adair	3.7	3.8	4.3	4.8	4.9	5.0	5.2
Cherokee	9.9	10.3	11.4	12.0	12.5	13.3	14.2
Craig	3.1	3.4	3.6	3.7	3.8	3.9	4.0
Creek	12.8	14.9	16.9	18.5	20.8	21.7	22.7
Delaware	6.6	6.8	6.9	6.9	7.2	7.3	7.4
Mayes	9.9	10.9	11.8	12.5	13.6	15.2	17.1
Muskogee	28.4	30.1	31.0	31.7	33.0	33.7	34.4
Nowata	2.0	2.2	2.4	2.4	2.5	2.6	2.7
Okmulgee	7.3	8.2	8.8	9.3	9.5	9.7	10.0
Osage	7.6	8.8	10.0	10.3	11.1	11.4	11.8
Ottawa	6.4	7.1	7.5	7.7	7.8	8.1	8.3
Rogers	9.2	10.9	12.0	12.5	12.9	13.1	13.3
Tulsa	139.0	149.4	159.0	164.2	168.3	174.6	181.1
Wagoner	8.8	10.2	10.5	10.8	11.1	11.3	11.6
Washington	12.5	14.1	15.0	16.2	17.1	17.8	18.0
Total	**267.2**	**291.1**	**311.1**	**323.5**	**336.1**	**348.7**	**361.8**
NORTHWEST							
Alfalfa	1.8	1.9	2.0	2.0	2.1	2.2	2.4
Beaver	1.8	2.0	2.2	2.4	2.4	2.5	2.6
Blaine	3.0	3.6	4.0	4.5	4.7	4.9	5.2
Cimarron	1.0	1.1	1.1	1.1	1.1	1.2	1.4
Dewey	1.2	1.3	1.3	1.5	1.6	1.6	1.6
Ellis	1.3	1.6	1.6	1.7	1.7	1.8	1.9
Harper	0.7	0.8	0.8	0.9	0.9	0.9	1.0
Major	1.9	2.0	2.0	2.1	2.1	2.2	2.4
Texas	5.4	7.3	8.3	8.8	9.2	9.3	9.4
Woods	2.9	3.0	3.1	3.4	3.5	3.6	3.8
Woodward	7.2	9.5	11.0	11.9	12.9	13.4	13.8
Total	**28.2**	**34.1**	**37.4**	**40.3**	**42.2**	**43.6**	**45.5**
SOUTH CENTRAL							
Carter	10.4	13.7	15.9	17.8	19.7	22.4	25.5
Garvin	8.6	9.7	10.3	11.0	11.1	11.4	11.8
Grady	8.7	9.9	10.5	11.0	11.2	12.1	13.1
Jefferson	1.3	1.6	1.7	1.8	1.9	2.0	2.1
Love	1.2	1.3	1.5	1.6	1.6	1.7	1.8
Marshall	2.0	2.4	2.7	2.7	2.9	3.1	3.4
Murray	3.1	3.8	4.3	4.6	5.0	5.4	5.7
Stephens	9.0	9.5	10.2	10.5	11.0	11.1	11.2
Total	**44.3**	**51.9**	**57.1**	**61.0**	**64.4**	**69.2**	**74.6**
SOUTHEAST							
Atoka	2.7	3.1	3.4	3.5	3.6	3.7	3.8
Bryan	7.7	8.7	9.1	9.5	9.5	9.9	10.2
Choctaw	3.2	3.6	4.0	4.6	4.7	4.8	4.9
Coal	1.5	1.9	2.0	2.2	2.5	2.6	2.7
Johnston	2.4	2.5	2.6	2.6	2.6	2.7	2.8
McCurtain	49.1	52.0	58.2	62.9	63.8	64.3	64.7
Pontotoc	10.2	12.2	12.3	12.5	12.7	12.9	13.1
Pushmataha	2.7	2.9	3.0	3.0	3.0	3.1	3.3
Total	**79.5**	**86.9**	**94.6**	**100.8**	**102.4**	**104.0**	**105.5**
SOUTHWEST							
Beckham	4.9	5.6	5.9	6.3	6.5	6.6	6.7
Caddo	6.3	7.2	8.0	8.6	8.7	9.1	9.4
Comanche	37.0	44.8	52.4	58.2	59.6	60.6	61.6
Cotton	1.5	1.8	2.1	2.2	2.5	2.9	3.4
Custer	8.0	8.4	8.6	8.6	8.7	8.7	8.7
Greer	1.3	1.7	1.9	2.1	2.2	2.5	2.7
Harmon	1.5	1.6	1.6	1.7	1.7	1.7	1.7
Jackson	5.9	10.5	14.8	18.6	20.0	20.3	20.5
Kiowa	2.1	2.4	2.5	2.5	2.5	2.5	2.5
RogerMills	1.1	1.2	1.3	1.5	1.6	1.7	1.8
Tillman	2.2	2.4	2.5	2.7	2.7	2.8	2.9
Washita	2.8	2.9	3.1	3.2	3.2	3.4	3.5
Total	**74.6**	**90.5**	**104.7**	**116.2**	**119.9**	**122.8**	**125.4**
GRAND TOTAL	**816.8**	**930.7**	**1012.0**	**1066.7**	**1104.2**	**1135.8**	**1167.9**

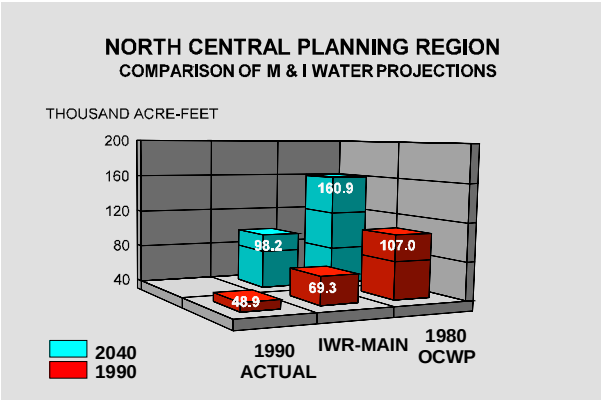
Figure 18
COMPARISON OF MUNICIPAL AND INDUSTRIAL
WATER USE PROJECTIONS

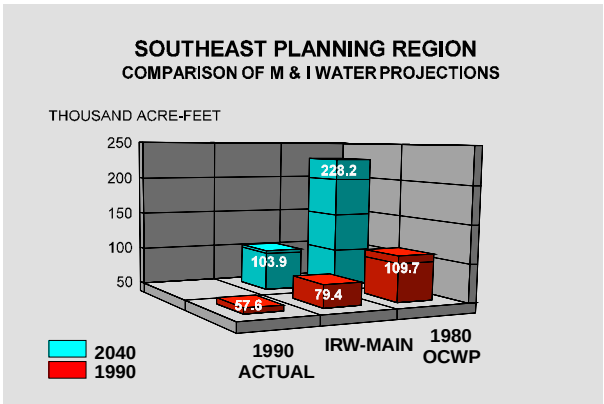


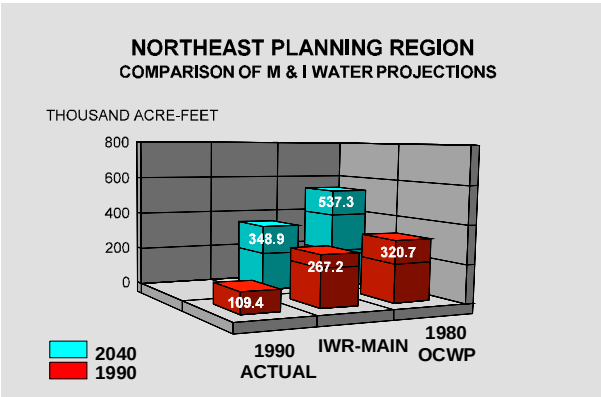


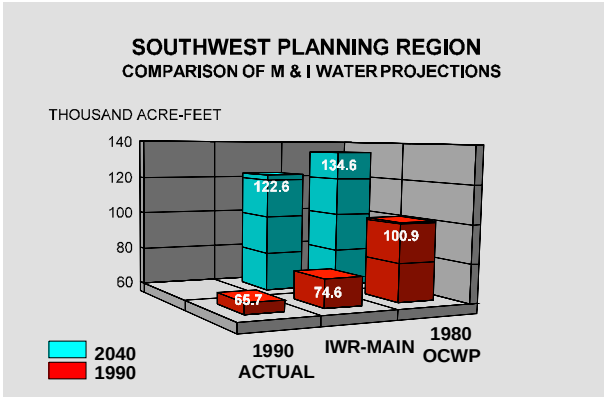












cluding OWRB water use reports), indicate that the IWR-MAIN 1990 estimates are reasonable.

Figure 18 also indicates that IWR-MAIN estimates for 1990 and projections for 2040 are lower than those projected in the 1980 Oklahoma Comprehensive Water Plan. This is largely attributed to shifts in actual and projected population and economic growth for Oklahoma.

Agricultural Water Use Projections

Agriculture is one of the most important segments of Oklahoma's economy. It is a rapidly expanding industry despite declining numbers of farms and farm operations. Its expansion is measured in terms of total value of production as well as product diversification. The paradoxical relationship between increased production and declining farm numbers may stem largely from an increase in farm efficiency, use of conservation programs, resource developments, improved technology, feed additives, fertilizers, insecticides and more efficient farm machinery.

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

Livestock water demands were based upon the estimated and projected water use for cattle, hogs, sheep and poultry. 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

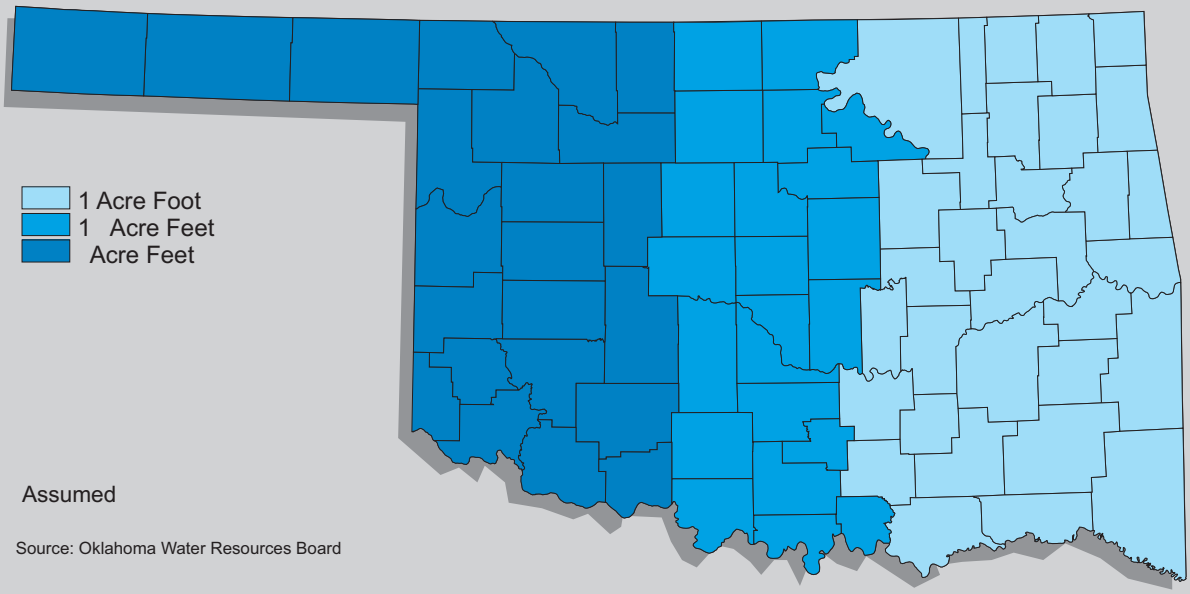
Contacts with various authorities indicate that it is virtually impossible to accurately forecast the need for irrigation water in the future for specific years. Variations in weather, politics and socioeconomic forces cause significant swings in demand. Nonetheless, it is necessary to adopt plausible guidelines to be used in planning for future demands for irrigation water.

The state's water needs and application rates for irrigation vary from county to county. For purposes of estimating present and future irrigation water demands, it was assumed that cultivated lands in the east require one acre-foot of irrigation water per acre of farmed land, increasing to a need of 1.5 acre-feet in the mid-region counties and two acre-feet in the western counties (see Figure 19). These general irrigation water rates, adopted by the Planning Committee in developing the 1980 Oklahoma Comprehensive Water Plan, take into account climate, geology, soil and surface and groundwater availability.

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 irrigation patterns. These figures on actually irrigated acres were also compared to irrigation information from OWRB 1990 water use reports.

In order to provide a buffer against both over-reporting and under-reporting of irrigated lands, the number of acres actually irrigated in 1990 was estimated based upon a county-by-county average of the highest irrigated acreage for any one OSU report

Figure 19
AMOUNT OF WATER REQUIRED PER ACRE OF LAND IRRIGATED*



Source: Oklahoma Water Resources Board

survey year and irrigated acreage from 1990 water use reports. For example, the OSU reports indicated that the number of acres irrigated in Texas County was 172,500 acres in 1983; 177,315 acres in 1985; and 176,450 acres in 1987. The 1990 water use reports indicated that 133,725 acres were under irrigation in Texas County. Therefore, 1990 water use for Texas County irrigation was determined to be 155,520 acres -- calculated by taking the average of 177,315 and 133,725 acres. Irrigation water use for 1990 was estimated by applying the county water requirements, as shown in Figure 19, to the number of acres irrigated, as estimated above.

While water withdrawals for irrigation have historically comprised the largest portion of statewide water use, irrigation water use peaked in the early 1980's. Due primarily to improved conservation, more efficient irrigation practices and better technology, irrigated farmlands are not expected to expand beyond that acreage which is potentially available for irrigation; water use per irrigated acre is expected to decrease 20 percent by the year 2050. The number of acres (by county) potentially available for irrigation was based upon the highest reported potential irrigated acres for any one survey year from OSU's 1981 through 1987 biennial irrigation surveys. It should be noted that potential irrigated acres include not only acres currently being irrigated, but also those lands that have been irrigated or are accessible by developed irrigation systems. By basing projections upon potential irrigated acres, future irrigation of lands that may come out of the Conservation Reserve Program (CRP) will likely be encompassed in the water use projections. (The CRP, authorized by the conservation title of the Food Security Act of 1985, encourages farmers, through 10-15 year contracts with USDA, to stop growing crops on land subject to excessive erosion or land that contributes to a significant water quality problem and, instead, plant it to a protective cover of grass or trees.) Therefore, projections of acres irrigated by 2050 were based upon a straight-line extrapolation of the 1990 actual acres irrigated increased to the number of potential irrigated acres identified in the OSU reports. Projections of irrigation water demands were made by applying the water rates (Figure 19) with the 20 percent conservation efficiency decrease over time.

RESULTS

Based upon the methodologies and assumptions described above, Table 4 presents agricultural water demand projections by decade for each planning region. As shown in Figure 20, comparisons to actual 1990 water use figures derived from OWRB water use reports show that the above methodology results in water use estimates which are higher than the total reported for each region. Figure 20 also indicates that the updated agricultural water demand projections are substantially lower that those projected in the 1980 Oklahoma Comprehensive Water Plan. This is largely attributed to the highly optimistic perspective in 1980 of Oklahoma's role in national food production as well as on the future economy of the farming sector in general.

Table 4
COUNTY/REGIONAL AGRICULTURAL
WATER USE PROJECTIONS
1990-2050

(IN 1,000 AC-FT PER YEAR)

PLANNING REGION & COUNTY	YEAR						
	1990	2000	2010	2020	2030	2040	2050
CENTRAL							
Canadian	10.1	11.5	12.9	14.4	15.8	17.3	18.7
Cleveland	2.7	2.9	3.1	3.3	3.5	3.7	3.8
McClain	3.0	3.0	3.1	3.1	3.1	3.2	3.2
Oklahoma	3.7	3.7	3.8	3.8	3.9	3.9	4.0
Pottawatomie	6.9	7.0	7.1	7.3	7.4	7.6	7.7
Total	**26.4**	**28.1**	**30.0**	**31.9**	**33.7**	**35.7**	**37.4**
EAST CENTRAL							
Haskell	1.6	1.6	1.7	1.8	1.8	1.9	1.9
Hughes	12.5	12.8	13.2	13.6	13.9	14.3	14.6
Latimer	0.8	0.8	0.8	0.9	0.9	0.9	0.9
LeFlore	6.0	6.1	6.2	6.3	6.4	6.5	6.6
McIntosh	1.1	1.2	1.4	1.5	1.6	1.7	1.9
Okfuskee	1.9	2.0	2.0	2.1	2.2	2.2	2.3
Pittsburg	2.5	2.6	2.6	2.7	2.8	2.9	3.0
Seminole	1.8	2.2	2.6	3.0	3.3	3.7	4.1
Sequoyah	3.3	3.5	3.7	4.0	4.2	4.5	4.7
Total	**31.5**	**32.8**	**34.2**	**35.9**	**37.1**	**38.6**	**40.0**
NORTH CENTRAL							
Garfield	2.9	3.0	3.1	3.2	3.3	3.4	3.5
Grant	2.1	2.3	2.5	2.7	2.9	3.1	3.3
Kay	2.0	2.1	2.1	2.2	2.2	2.3	2.3
Kingfisher	19.8	20.2	20.6	21.0	21.5	21.9	22.3
Lincoln	1.2	1.2	1.3	1.3	1.3	1.4	1.4
Logan	3.8	4.0	4.2	4.3	4.5	4.7	4.9
Noble	1.4	1.5	1.6	1.7	1.7	1.8	1.9
Pawnee	1.7	1.9	2.2	2.5	2.7	3.0	3.3
Payne	1.7	1.8	1.8	1.8	1.9	1.9	1.9
Total	**36.6**	**38.0**	**39.4**	**40.7**	**42.0**	**43.5**	**44.8**

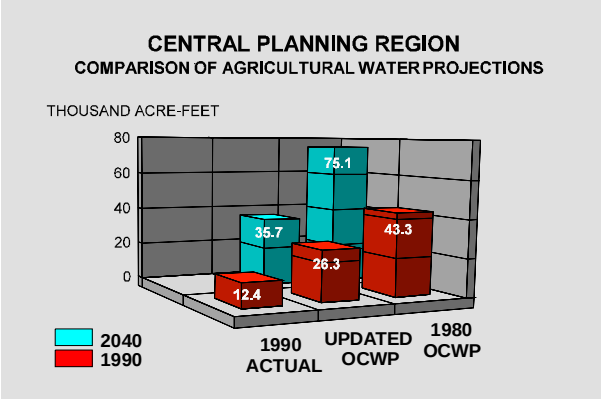
(Continued)

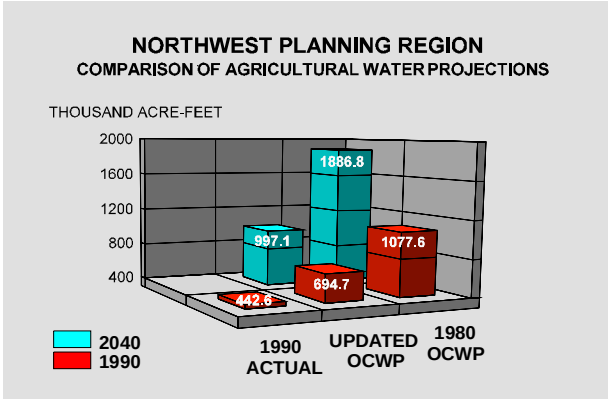
Table 4 (Continued)
COUNTY/REGIONAL AGRICULTURAL
WATER USE PROJECTIONS 1990-2050

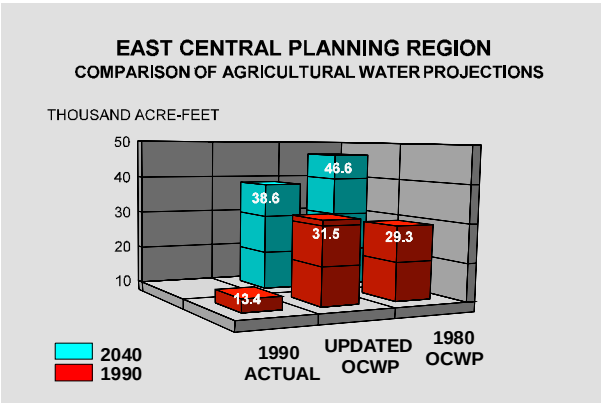
(IN 1,000 AC-FT PER YEAR)

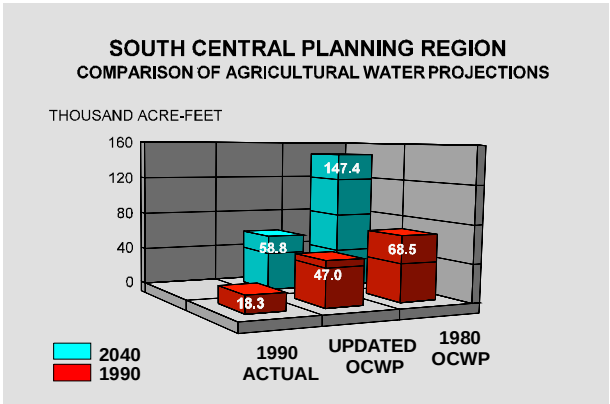
PLANNING REGION & COUNTY	YEAR						
	1990	2000	2010	2020	2030	2040	2050
NORTHEAST							
Adair	3.0	3.0	3.1	3.2	3.3	3.3	3.4
Cherokee	2.3	2.4	2.5	2.6	2.7	2.7	2.8
Craig	2.4	2.5	2.7	2.8	2.9	3.0	3.2
Creek	1.1	1.1	1.2	1.2	1.3	1.3	1.4
Delaware	1.4	1.4	1.4	1.5	1.6	1.6	1.7
Mayes	2.1	2.2	2.3	2.4	2.5	2.7	2.8
Muskogee	6.2	6.6	7.0	7.4	7.8	8.2	8.7
Nowata	1.0	1.1	1.3	1.4	1.5	1.7	1.8
Okmulgee	1.4	1.4	1.4	1.5	1.5	1.5	1.6
Osage	2.8	2.8	2.9	3.0	3.1	3.2	3.3
Ottawa	1.4	1.5	1.5	1.6	1.6	1.7	1.7
Rogers	1.9	2.0	2.1	2.1	2.2	2.3	2.3
Tulsa	4.5	4.7	5.0	5.2	5.4	5.7	5.9
Wagoner	2.8	2.9	3.0	3.1	3.3	3.4	3.5
Washington	2.1	2.2	2.3	2.3	2.4	2.5	2.5
Total	**36.4**	**37.8**	**39.7**	**41.3**	**43.1**	**44.8**	**46.6**
NORTHWEST							
Alfalfa	7.3	7.7	8.2	8.7	9.2	9.7	10.1
Beaver	60.7	70.1	79.5	88.9	98.3	107.7	117.1
Blaine	4.3	4.8	5.3	5.8	6.3	6.8	7.2
Cimarron	173.2	195.5	217.9	240.2	262.6	284.9	307.3
Dewey	5.6	5.7	5.8	5.9	6.0	6.1	6.2
Ellis	44.7	45.4	46.1	46.8	47.4	48.1	48.8
Harper	32.2	32.5	32.8	33.1	33.4	33.7	34.0
Major	18.1	20.0	21.9	23.8	25.7	27.6	29.5
Texas	317.9	340.9	363.9	386.9	409.9	432.9	455.9
Woods	8.5	8.8	9.0	9.3	9.5	9.8	10.1
Woodward	22.2	23.7	25.3	26.8	28.4	29.9	31.5
Total	**694.7**	**755.1**	**815.7**	**876.2**	**936.7**	**997.2**	**1057.7**
SOUTH CENTRAL							
Carter	5.0	5.1	5.2	5.3	5.5	5.6	5.7
Garvin	6.4	7.6	8.8	10.1	11.3	12.5	13.7
Grady	17.5	17.8	18.1	18.3	18.6	18.9	19.2
Jefferson	3.3	3.5	3.7	4.0	4.2	4.4	4.7
Love	4.0	4.2	4.3	4.5	4.6	4.8	4.9
Marshall	5.7	5.8	6.0	6.2	6.4	6.6	6.8
Murray	1.8	1.9	2.1	2.2	2.3	2.4	2.6
Stephens	3.2	3.3	3.4	3.5	3.5	3.6	3.7
Total	**46.9**	**49.2**	**51.6**	**54.1**	**56.4**	**58.8**	**61.3**
SOUTHEAST							
Atoka	2.5	3.3	4.1	5.0	5.8	6.7	7.5
Bryan	11.9	12.4	12.9	13.5	14.0	14.6	15.1
Choctaw	2.5	2.6	2.6	2.6	2.7	2.7	2.7
Coal	2.5	2.7	2.9	3.0	3.2	3.4	3.5
Johnston	3.1	3.3	3.6	3.9	4.1	4.4	4.7
McCurtain	4.3	4.5	4.8	5.0	5.3	5.5	5.7
Pontotoc	3.6	3.7	3.7	3.8	3.9	4.0	4.1
Pushmataha	1.2	1.3	1.4	1.5	1.6	1.7	1.8
Total	**31.6**	**33.8**	**36.0**	**38.3**	**40.6**	**43.0**	**45.1**
SOUTHWEST							
Beckham	6.7	7.4	8.0	8.7	9.3	10.0	10.7
Caddo	140.4	141.6	142.8	144.0	145.2	146.4	147.6
Comanche	5.9	5.9	5.9	6.0	6.0	6.0	6.1
Cotton	2.5	3.0	3.6	4.1	4.6	5.2	5.7
Custer	9.6	13.7	17.8	21.9	26.0	30.1	34.1
Greer	15.4	17.2	19.1	20.9	22.8	24.6	26.5
Harmon	40.6	40.7	40.7	40.7	40.8	40.8	40.9
Jackson	113.7	117.4	121.2	125.0	128.8	132.5	136.3
Kiowa	9.6	9.9	10.2	10.5	10.9	11.2	11.5
RogerMills	13.6	14.3	15.0	15.7	16.4	17.1	17.8
Tillman	44.7	48.6	52.6	56.5	60.5	64.4	68.4
Washita	14.8	16.8	18.5	20.3	22.2	24.1	25.9
Total	**417.5**	**436.5**	**455.4**	**474.3**	**493.5**	**512.4**	**531.5**
GRAND TOTAL	**1321.6**	**1411.3**	**1502.0**	**1592.7**	**1683.1**	**1774.0**	**1864.4**

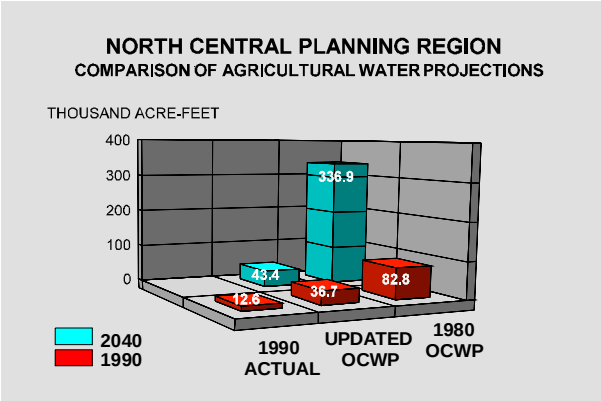
Figure 20
COMPARISON OF AGRICULTURAL
WATER USE PROJECTIONS

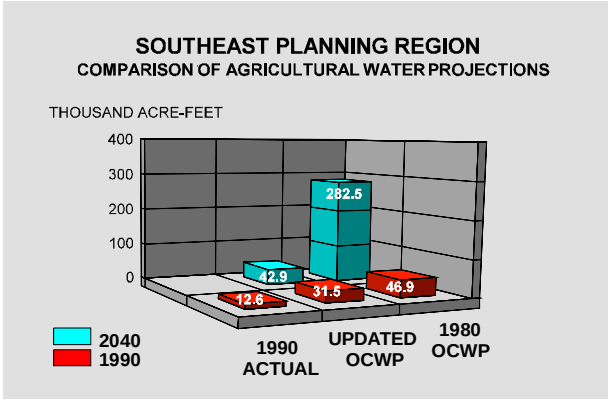


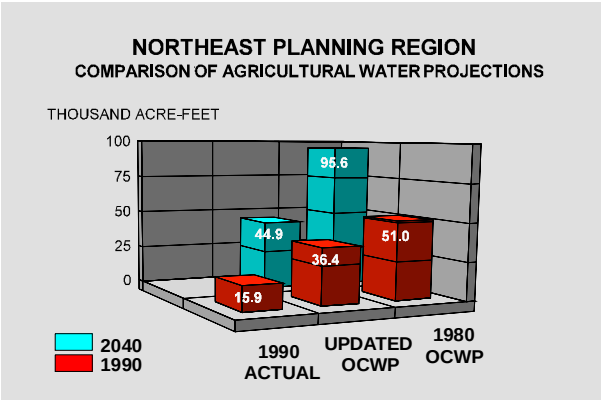


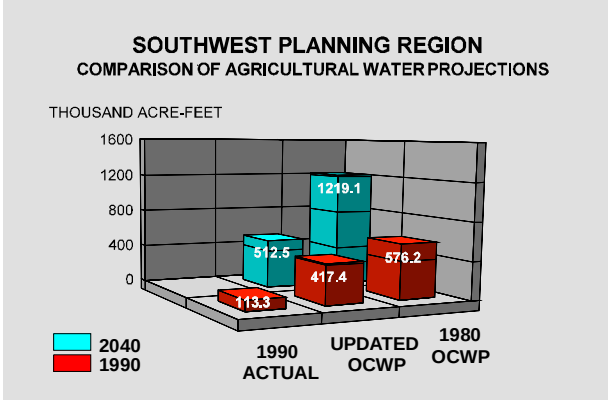












Electric Power Generation Water Use Projections

Water used for electric (thermoelectric) power generation is defined as the amount of water withdrawn in the production of electric power generated with fossil fuels, such as coal, oil and natural gas.

The 1990 estimates of water withdrawals for power generation were derived from three sources: 1990 OWRB water use reports; background data compiled for U.S. Geological Survey Circular 1080, Estimated Use of Water in the United States, 1990; and 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.

RESULTS

Table 5 displays the power water demand projections by decade for each county and planning region. A regional comparison between the updated power demand figures and those contained in the 1980 Oklahoma Comprehensive Water Plan for years 1990 and 2040 is shown in Figure 21.

Table 5
COUNTY/REGIONAL ELECTRIC POWER GENERATION (COOLING WATER)
WATER USE PROJECTIONS 1990-2050

(IN 1,000 AC-FT PER YEAR)

PLANNING REGION & COUNTY	*YEAR*						
	1990	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
CENTRAL							
Canadian	2.0	2.5	3.0	3.7	4.6	5.6	6.8
Cleveland	---	---	---	---	---	---	---
McClain	---	---	---	---	---	---	---
Oklahoma	6.4	7.9	9.7	12.0	14.7	18.1	22.2
Pottawatomie	---	---	---	---	---	---	---
Total	**8.4**	**10.3**	**12.7**	**15.6**	**19.2**	**23.6**	**29.0**
EAST CENTRAL							
Haskell	---	---	---	---	---	---	---
Hughes	---	---	---	---	---	---	---
Latimer	---	---	---	---	---	---	---
LeFlore	---	---	---	---	---	---	---
McIntosh	---	---	---	---	---	---	---
Okfuskee	---	---	---	---	---	---	---
Pittsburg	---	---	---	---	---	---	---
Seminole	21.8	26.8	33.0	40.6	50.0	61.5	75.6
Sequoyah	---	---	---	---	---	---	---
Total	**21.8**	**26.8**	**33.0**	**40.6**	**50.0**	**61.5**	**75.6**
NORTH CENTRAL							
Garfield	---	---	---	---	---	---	---
Grant	---	---	---	---	---	---	---
Kay	---	---	---	---	---	---	---
Kingfisher	---	---	---	---	---	---	---
Lincoln	---	---	---	---	---	---	---
Logan	---	---	---	---	---	---	---
Noble	---	---	---	---	---	---	---
Pawnee	21.5	26.4	32.5	40.0	49.2	60.5	74.4
Payne	---	---	---	---	---	---	---
Total	**21.5**	**26.4**	**32.5**	**40.0**	**49.2**	**60.5**	**74.4**
NORTHEAST							
Adair	---	---	---	---	---	---	---
Cherokee	---	---	---	---	---	---	---
Craig	---	---	---	---	---	---	---
Creek	---	---	---	---	---	---	---
Delaware	---	---	---	---	---	---	---
Mayes	9.3	11.4	14.1	17.3	21.3	26.2	32.2
Muskogee	42.0	51.7	63.5	78.2	96.1	118.2	145.4
Nowata	---	---	---	---	---	---	---
Okmulgee	---	---	---	---	---	---	---
Osage	---	---	---	---	---	---	---

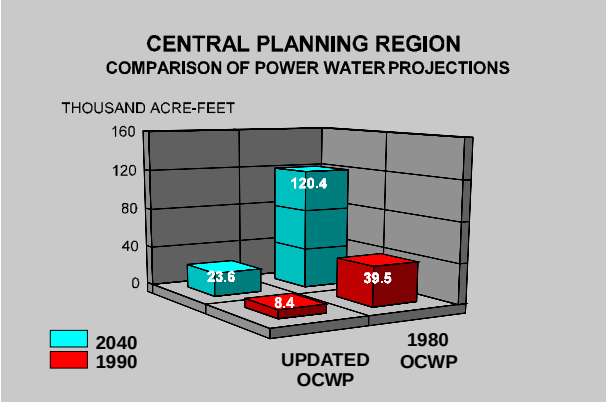
(Continued)

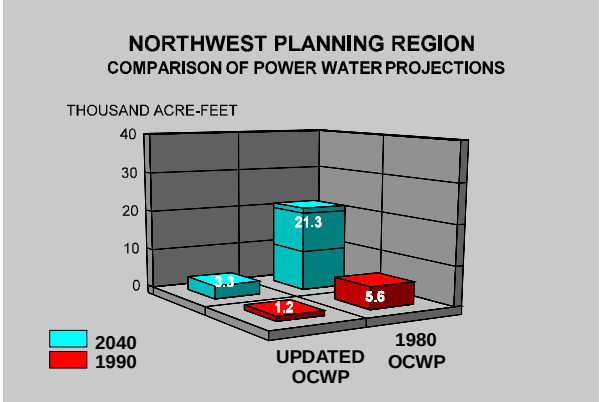
Table 5 (Continued)
COUNTY/REGIONAL ELECTRIC POWER GENERATION (COOLING WATER)
WATER USE PROJECTIONS 1990-2050

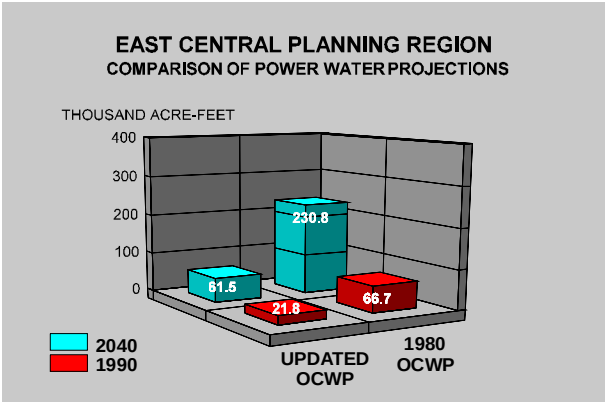
(IN 1,000 AC-FT PER YEAR)

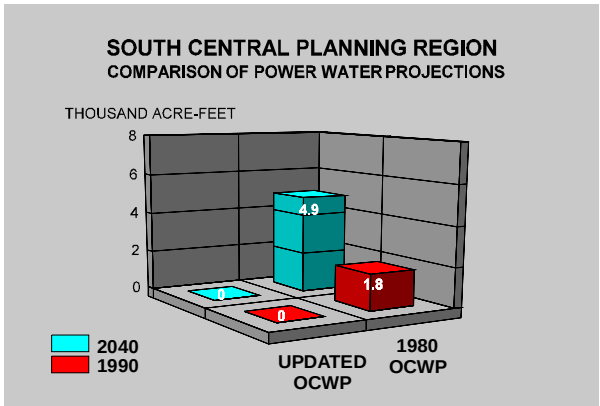
PLANNING REGION & COUNTY	YEAR 1990	2000	2010	2020	2030	2040	2050
Ottawa	---	---	---	---	---	---	---
Rogers	10.0	12.3	15.1	18.6	22.9	28.2	34.6
Tulsa	3.6	4.4	5.4	6.7	8.2	10.1	12.5
Wagoner	---	---	---	---	---	---	---
Washington	---	---	---	---	---	---	---
Total	**64.9**	**79.8**	**98.2**	**120.8**	**148.5**	**182.7**	**224.7**
NORTHWEST							
Alfalfa	---	---	---	---	---	---	---
Beaver	---	---	---	---	---	---	---
Blaine	---	---	---	---	---	---	---
Cimarron	---	---	---	---	---	---	---
Dewey	---	---	---	---	---	---	---
Ellis	---	---	---	---	---	---	---
Harper	---	---	---	---	---	---	---
Major	---	---	---	---	---	---	---
Texas	---	---	---	---	---	---	---
Woods	---	---	---	---	---	---	---
Woodward	1.2	1.5	1.8	2.2	2.7	3.3	4.1
Total	**1.2**	**1.5**	**1.8**	**2.2**	**2.7**	**3.3**	**4.1**
SOUTH CENTRAL							
Carter	---	---	---	---	---	---	---
Garvin	---	---	---	---	---	---	---
Grady	---	---	---	---	---	---	---
Jefferson	---	---	---	---	---	---	---
Love	---	---	---	---	---	---	---
Marshall	---	---	---	---	---	---	---
Murray	---	---	---	---	---	---	---
Stephens	---	---	---	---	---	---	---
Total	**---**	**---**	**---**	**---**	**---**	**---**	**---**
SOUTHEAST							
Atoka	0.1	0.1	0.2	0.2	0.2	0.3	0.3
Bryan	---	---	---	---	---	---	---
Choctaw	4.4	5.4	6.7	8.2	10.1	12.4	15.2
Coal	---	---	---	---	---	---	---
Johnston	---	---	---	---	---	---	---
McCurtain	---	---	---	---	---	---	---
Pontotoc	0.1	0.1	0.2	0.2	0.2	0.3	0.3
Pushmataha	---	---	---	---	---	---	---
Total	**4.6**	**5.7**	**7.0**	**8.6**	**10.5**	**13.0**	**15.9**
SOUTHWEST							
Beckham	---	---	---	---	---	---	---
Caddo	1.7	2.1	2.6	3.2	3.9	4.8	5.9
Comanche	1.7	2.1	2.6	3.2	3.9	4.8	5.9
Cotton	---	---	---	---	---	---	---
Custer	---	---	---	---	---	---	---
Greer	---	---	---	---	---	---	---
Harmon	---	---	---	---	---	---	---
Jackson	---	---	---	---	---	---	---
Kiowa	---	---	---	---	---	---	---
Roger Mills	---	---	---	---	---	---	---
Tillman	---	---	---	---	---	---	---
Washita	---	---	---	---	---	---	---
Total	**3.4**	**4.2**	**5.2**	**6.4**	**7.9**	**9.7**	**11.9**
GRAND TOTAL	**125.8**	**154.7**	**190.4**	**234.2**	**288.0**	**354.3**	**435.6**

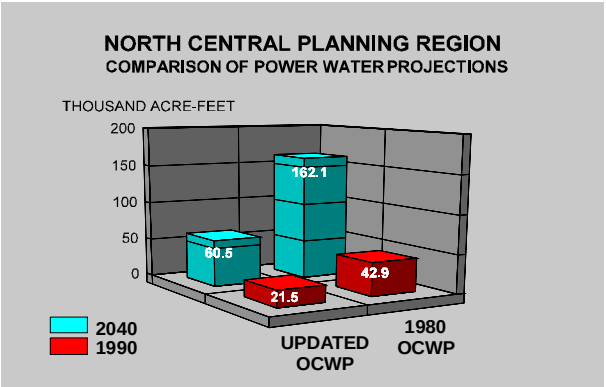
Figure 21
COMPARISON OF ELECTRIC POWER GENERATION
WATER USE PROJECTIONS

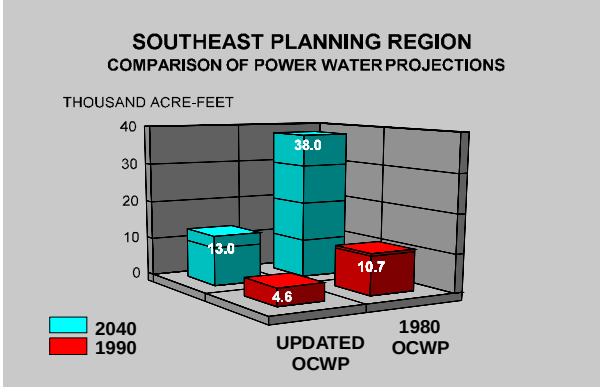


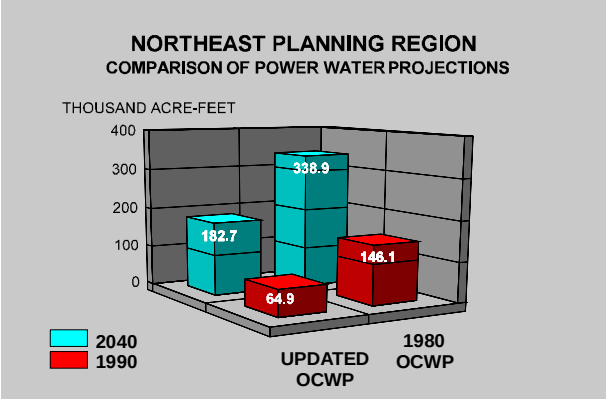


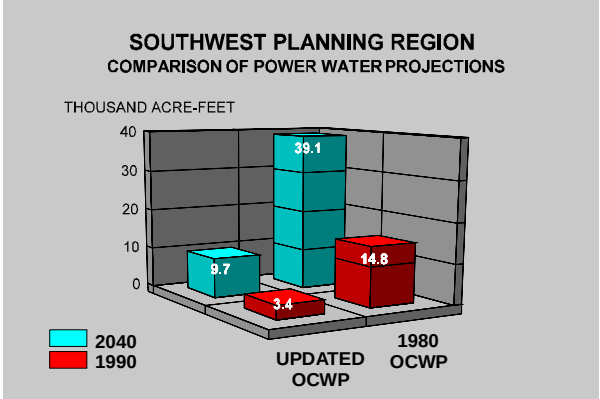












Total Water Use Projections

The ultimate goal in developing water use projections is to determine the amount of water needed to meet future consumptive water demands of municipal, industrial, agricultural and power sectors in Oklahoma. In turn, these projections provide the basis for estimating the adequacy of existing water sources in meeting water demands through the year 2050 and determining whether alternatives for additional supplies should be pursued.

Table 6 summarizes 1990-2050 water use projections by category (municipal and industrial, agricultural and power) for each of the eight planning regions and the state. Figure 22 shows total state water demands for centennial years 1990-2050. The estimated 1990 water use of almost 2.26 million acre-feet annually is projected to increase to almost 3.47 million acre-feet per year by 2050, more than a 52 percent increase in projected water demand over the 50-year planning horizon.

Figure 22
STATEWIDE WATER USE PROJECTIONS

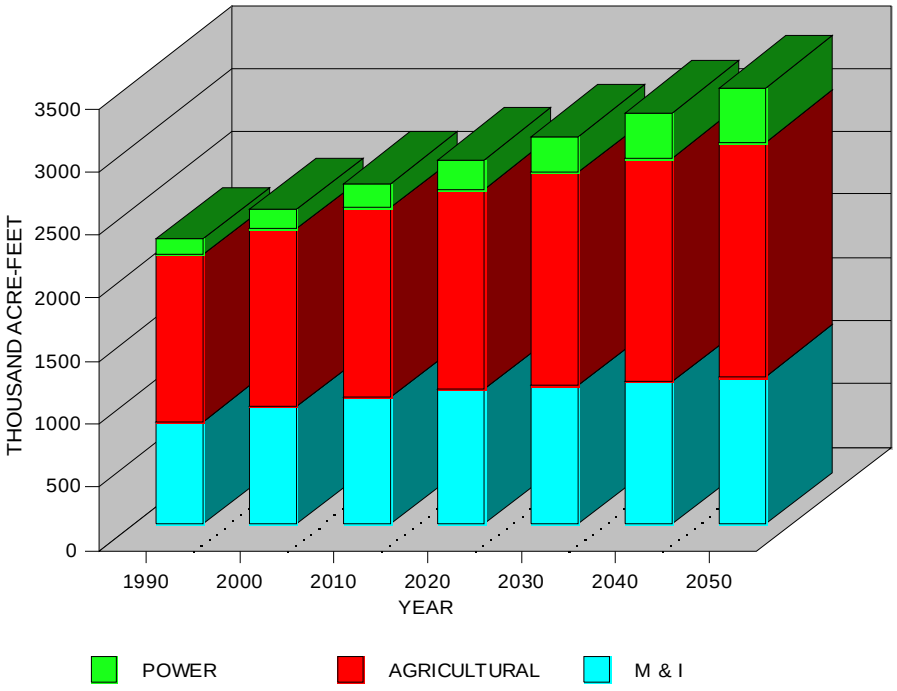


Table 6
REGIONAL/STATEWIDE WATER USE PROJECTIONS
BY CONSUMPTIVE WATER USE CATAGORY

(IN 1,000 AC-FT PER YEAR)

PLANNING REGION & USE	*YEAR*						
	1990	*2000*	*2010*	*2020*	*2030*	*2040*	*2050*
CENTRAL							
M&I	205.0	243.2	263.5	275.3	284.3	288.2	292.0
Agricultural	26.4	28.1	30.0	31.9	33.7	35.7	37.4
Power	8.4	10.3	12.7	15.6	19.2	23.6	29.0
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	59.0	61.1	63.0
Agricultural	31.5	32.8	34.2	35.9	37.1	38.6	40.0
Power	21.8	26.8	33.0	40.6	50.0	61.5	75.6
Total	**101.8**	**112.4**	**123.3**	**134.0**	**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	38.0	39.4	40.7	42.0	43.5	44.8
Power	21.5	26.4	32.5	40.0	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**	**449.0**	**485.6**	**527.7**	**576.2**	**633.1**
NORTHWEST							
M&I	28.2	34.1	37.4	40.3	42.0	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**

Continued

Table 6 (Continued)
REGIONAL/STATEWIDE WATER USE PROJECTIONS
BY CONSUMPTIVE WATER USE CATAGORY

(IN 1,000 AC-FT PER YEAR)

PLANNING REGION & USE	***YEAR***						
	1990	***2000***	***2010***	***2020***	***2030***	***2040***	***2050***
SOUTH CENTRAL							
M&I	44.3	51.9	57.1	61.0	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	0.0	0.0	0.0	0.0
Total	**91.2**	**101.1**	**108.7**	**115.1**	**120.8**	**128.0**	**135.9**
SOUTHEAST							
M&I	79.5	86.9	94.6	100.8	102.4	104.0	105.5
Agricultural	31.6	33.8	36.0	38.3	40.6	43.0	45.1
Power	4.6	5.7	7.0	8.6	10.5	13.0	15.8
Total	**115.7**	**126.4**	**137.6**	**147.7**	**153.5**	**160.0**	**166.4**
SOUTHWEST							
M&I	74.6	90.5	104.7	116.2	119.9	122.8	125.4
Agricultural	417.5	436.5	455.4	474.3	493.5	512.4	531.5
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**
STATEWIDE							
M&I	816.8	930.7	1012.0	1066.7	1104.2	1135.8	1167.9
Agricultural	1321.6	1411.3	1502.0	1592.7	1683.1	1774.0	1864.4
Power	125.8	154.7	190.4	234.2	288.0	354.3	435.4
TOTAL	**2264.2**	**2496.7**	**2704.4**	**2893.6**	**3075.3**	**3264.1**	**3467.7**