# CHAPTER 2

## BASIN INFORMATION

The Arkansas River Basin in northeastern Oklahoma and southeastern Kansas, which contains numerous sub-basins, is the area of interest in this report. Lakes, which the U.S. Army Corps of Engineers operates to provide flood control benefits, are located in each of these sub-basins. The location of these projects is shown in **Figure 2-1**. The names of the projects, their owners, and the streams on which they are located are presented in **Table 2-1**.

Except for the five locks and dams, each lake has flood control storage available. The Tulsa District operates the flood control features of all these reservoirs, including those built by the U.S. Department of Interior, Bureau of Reclamation and the State of Oklahoma's Grand River Dam Authority.

The topography of the Arkansas River Basin in Oklahoma and Kansas is a transition between the Great Plains on the west and the Ozark Mountains and central lowlands on the east. The basin has a total drainage area of about 160,000 square miles, of which 150,000 are located above Van Buren, Arkansas.

The Arkansas River runs a distance of approximately 342 miles from the Oklahoma-Kansas state line to the Oklahoma-Arkansas state line. It is characterized by a broad, sandy bed, with long, easy bends and has an average fall, in this reach, of 1.9 feet per mile. Its banks are well-defined, with a height of between 10 and 30 feet. The width of the channel varies from 600 to 3,000 feet.

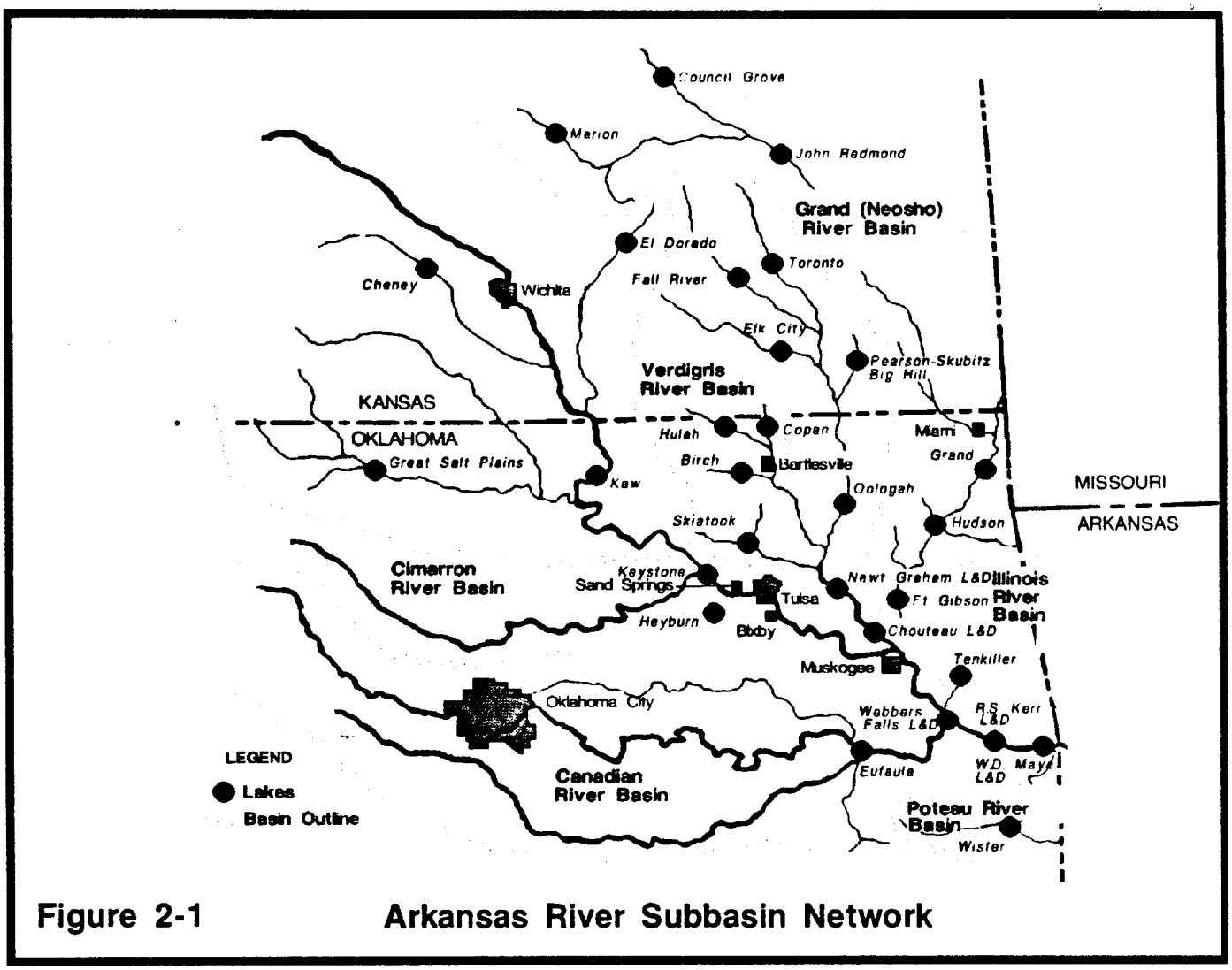



**Figure 2-1** **Arkansas River Subbasin Network**

TABLE 2-1

MAJOR LAKES IN THE ARKANSAS RIVER BASIN

| Construction Agency/Reservoir | Major Stream |
|---|---|
| Bureau of Reclamation | |
| Cheney | North Fork Ninnescah River |
| Meredith | Canadian River |
| Thunderbird | Little River |
| Grand River Dam Authority | |
| Grand (Pensacola Dam) | Grand (Neosho) River |
| Hudson | Grand (Neosho) River |
| US Army Corps of Engineers | |
| Arcadia | Deep Fork River |
| Birch | Birch Creek |
| Canton | North Canadian River |
| Chouteau Lock and Dam | Verdigris River |
| Copan | Little Caney River |
| Council Grove | Grand (Neosho) River |
| El Dorado | Walnut River |
| Elk City | Elk River |
| Eufaula | Canadian River |
| Fall River | Fall River |
| Fort Gibson | Grand (Neosho) River |
| Fort Supply | Wolf Creek |
| Great Salt Plains | Salt Fork of Arkansas River |
| Heyburn | Polecat Creek |
| Hulah | Caney River |
| John Redmond | Grand (Neosho) River |
| Kaw | Arkansas River |
| Keystone | Arkansas River |
| Marion | Cottonwood River |
| Newt Graham Lock and Dam | Verdigris River |
| Oologah | Verdigris River |
| Optima | North Canadian River |
| Pearson-Skubitz Big Hill | Big Hill River |
| Robert S. Kerr Lock and Dam | Arkansas River |
| Skiatook | Hominy Creek |
| Tenkiller Ferry | Illinois River |
| Toronto | Verdigris River |
| W. D. Mayo Lock and Dam | Arkansas River |
| Webbers Falls Lock and Dam | Arkansas River |
| Wister | Poteau River |

Much of the Arkansas River channel has been straightened from the mouth of the Verdigris River to the Mississippi River to shorten the overall length and create the McClellan-Kerr Arkansas River Navigation channel. The banks have been stabilized to aid in the maintenance of depth and alignment of the navigation channel.

## MAJOR TRIBUTARIES

### Canadian River

The Canadian River rises in northeastern New Mexico, flows southerly and then easterly across New Mexico, Texas, and Oklahoma. It enters the Arkansas River at mile 423. The basin is 560 miles long in an east-west direction, about 85 miles in average width, and drains 47,705 square miles. Topography of the basin varies from gently sloping plains in the Texas and Oklahoma panhandle areas to rough, hilly terrain in eastern Oklahoma. Total length of the Canadian River is 906 miles, with an average fall of 8.3 feet per mile. The river banks in Texas and western Oklahoma are, on the average, very low but reach a height of 20 to 30 feet in eastern Oklahoma.

### Cimarron River

The Cimarron River rises in the high plateau of northeastern New Mexico. It flows in a northeasterly direction across the Oklahoma panhandle and the extreme southeastern corner of Colorado into southwestern Kansas. Its course then changes to a southeasterly direction and flows into and across north-central Oklahoma to its junction with the Arkansas River in Keystone Lake, about 17 miles above Tulsa, Oklahoma. The fall of the river varies from

50 feet per mile near the headwaters to about 1.5 feet per mile near the mouth. The basin is approximately 500 miles in length, 50 miles in width, and has a total drainage area of 18,900 square miles.

Grand (Neosho) River

The Grand (Neosho) River drains an area of 12,520 miles in southeastern Kansas, northeastern Oklahoma, southwestern Missouri, and northwestern Arkansas. Its basin is approximately 260 miles long, 80 miles wide in the upper reach, and widens to about 90 miles near the Oklahoma-Kansas state line. The river flows a total of 480 miles, has an average fall of 2 feet per mile, and enters the Arkansas River at mile 459.5. Its meandering, well-defined channel varies in width from 50 feet in Kansas to about 400 feet in the lower reaches in Oklahoma. The banks vary in height from 15 to 30 feet. The terrain varies from rough, hilly country in the upper reaches and eastern portions of the basin to a rolling contour over the remainder of the watershed.

Illinois River

The Illinois River drains an area of about 1,660 square miles in northwestern Arkansas and northeastern Oklahoma. The drainage basin is approximately 80 miles long and averages about 20 miles in width. The northeastern part of the basin is rough and mountainous; central portion, tablelands; and the southwestern area is rugged and hilly. The river flows in a general southwesterly direction and joins the Arkansas River at mile 426.7. Total length of the river is approximately 150 miles, with an average fall of about 8 feet per mile.

Poteau River

The Poteau River drains an area of 1,888 square miles in southeastern Oklahoma and western Arkansas. The entire basin is generally mountainous. The river rises in the rugged area of west-central Arkansas. It flows westerly in western Arkansas and southeastern Oklahoma, for a distance of 65 miles, then flows in a general northeasterly direction to join the Arkansas River just west of the Oklahoma-Arkansas state line at mile 362. Total length of the river is 128 miles, with an average fall of 5.2 feet per mile.

Verdigris River

The Verdigris River watershed is about 180 miles long, 75 miles wide, and comprises an area of 8,303 square miles. The river flows in a general southerly direction 350 miles from its source in southeastern Kansas to its confluence with the Arkansas River at mile 460 near Muskogee, Oklahoma. Average fall throughout the length of the river is 2.6 feet per mile. The channel width varies from 150 to 500 feet and the banks are from 10 to 40 feet high.

## PRECIPITATION

Storms of long duration, producing large total amounts of rainfall, often cover great areas of the Arkansas River Basin. The average annual rainfall in this area varies from 32 inches at Wichita, Kansas and Oklahoma City, Oklahoma to 44 inches near the Oklahoma-Arkansas state line. Average annual precipitation amounts at National Weather Service stations in the storm area are shown in **Table 2-2**.

TABLE 2-2

AVERAGE ANNUAL PRECIPITATION

| National Weather Service Station | Precipitation (inches) |
|---|---|
| Elgin, Kansas | 35.50 |
| Sedan, Kansas | 36.91 |
| Chanute Airport, Kansas | 39.10 |
| Toronto Dam, Kansas | 36.07 |
| Spavinaw, Oklahoma | 40.89 |
| Stilwell, Oklahoma | 43.79 |
| Tahlequah, Oklahoma | 43.18 |
| Newkirk, Oklahoma | 33.94 |
| Redrock, Oklahoma | 31.90 |
| Perry, Oklahoma | 32.82 |
| Guthrie, Oklahoma | 31.12 |
| Oologah Dam, Oklahoma | 38.03 |
| Wetumka, Oklahoma | 40.31 |
| Dewar, Oklahoma | 38.47 |
| Poteau, Oklahoma | 43.79 |
| Webbers Falls, Oklahoma | 41.05 |
| Fort Smith, Arkansas | 42.27 |

## RUNOFF

Runoff is rainfall which does not enter the ground, does not evaporate, follows a downhill path to streams and rivers, and is a primary factor in flooding. If streams and rivers cannot contain the amount of runoff, flooding results along those rivers.

Average annual runoff in the Arkansas River Basin in eastern Oklahoma and Kansas varies from about 2 inches near Oklahoma City to nearly 15 inches near the Oklahoma-Arkansas state line. **Figure 2-2** shows the annual recorded streamflow at Lock and Dam 13 near Van Buren, Arkansas from 1923 through 1986. Runoff from the September-October 1986 flood accounted for approximately 45 percent of the total for 1986 and was about 80 percent of the median annual flow.

## DESCRIPTION OF A FLOOD CONTROL DAM

A typical allocation of storage in a multiple-purpose lake is shown on **Figure 2-3**. The conservation pool contains storage for various purposes such as hydropower generation and water supply. Water from the conservation pool is withdrawn or released to achieve those purposes for which the storage is provided. Inflows into the lake allow the lake level to generally be maintained at or near the top of the conservation pool.

The flood control pool provides temporary storage for floodwaters. River flows entering the lake during a flood are held back from downstream areas and stored in the flood control pool. Lake releases are not normally made if the releases would cause or increase flooding downstream. When downstream

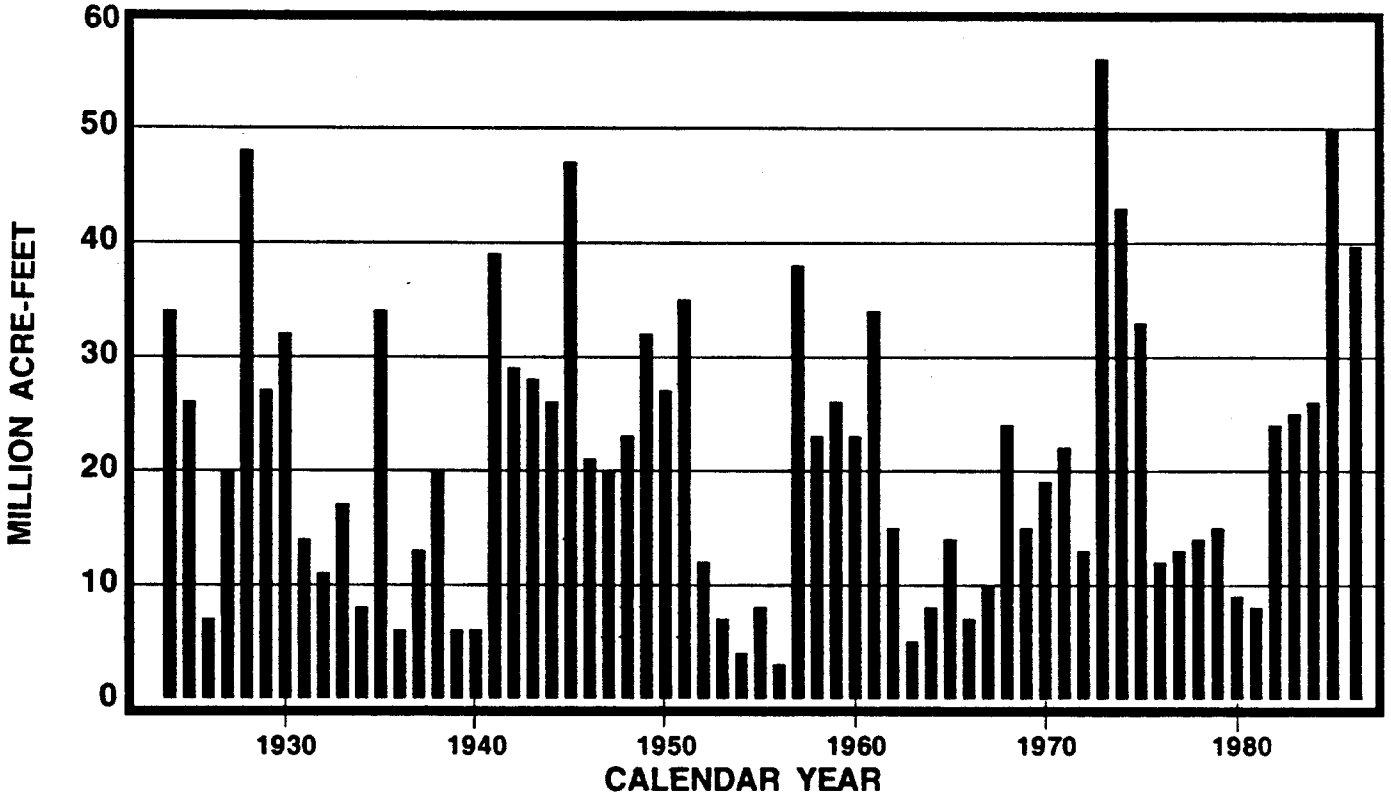
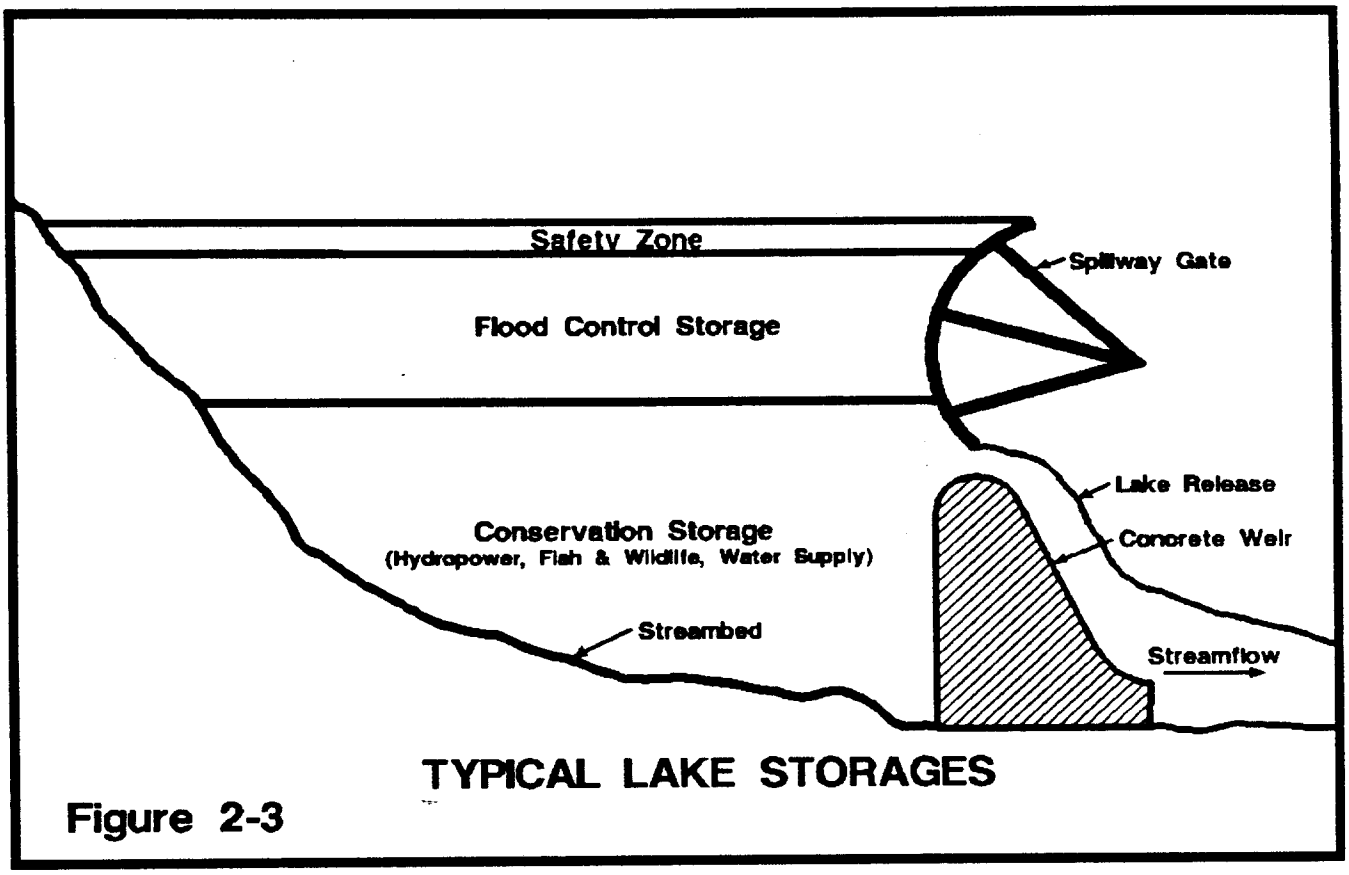



Figure 2-2 ANNUAL RECORDED FLOW
ARKANSAS RIVER AT LOCK AND DAM NO. 13, NEAR FORT SMITH, ARKANSAS




TYPICAL LAKE STORAGES

Figure 2-3

flooding subsides, water is released to drain the flood control pool as quickly as downstream conditions permit. If, however, the inflow forecast indicates that the flood control pool will completely fill before downstream flooding subsides, releases **must** be made to prevent overfilling of the lake. In this case, releases are made in a manner to minimize downstream flooding. The top of the flood control pool in a lake with a gated spillway is usually the same elevation as the top of the spillway gates in a closed position.

Several large projects with gated spillways have additional storage above the top of the flood control pool. This additional storage area is referred to as an "**induced surcharge pool**" or "**safety zone**". Since this storage lies above the top of the spillway gates, the only way it can be utilized is to raise the top of the gates. Hoisting the top of a gate into the safety zone obviously means raising the bottom of the gate as well, resulting in outflows from the lake. If the lake level rises to the top of the safety zone, releases, equal to the lesser of the lake inflow or the spillway capacity, must be made to avoid compromising the stability of the dam.

## DESCRIPTION OF THE FLOOD CONTROL SYSTEM

The Tulsa District operates 35 lakes in the Arkansas River Basin. They are operated for multiple purposes: flood control, hydroelectric power, navigation, water supply, water quality, recreation, irrigation, and fish and wildlife management. Authorized purposes for each lake are shown in **Table 2-3**.

TABLE 2-3

PROJECT PURPOSES

| Project | FC | HP | Rec | WQ | WS | F&WL | Nav |
|---|---|---|---|---|---|---|---|
| Arcadia Lake | X | | X | | X | | |
| Birch Lake | X | | X | X | X | X | |
| Canton Lake | X | | | | X* | | |
| Cheney Lake | X | | X | | X | X | |
| Chouteau Lock and Dam | | | | | | | X |
| Copan Lake | X | | X | X | X | X | |
| Council Grove Lake | X | | X | X | X | | |
| El Dorado Lake | X | | X | X | X | | |
| Elk City Lake | X | | | X | X | | |
| Eufaula Lake | X | X | | | X | | X |
| Fall River Lake | X | | | X | | | |
| Fort Gibson Lake | X | X | | | | | |
| Fort Supply Lake | X | | | | X | | |
| Grand Lake | X | X | | | | | |
| Great Salt Plains Lake | X | | X | | | X | |
| Heyburn Lake | X | | X | | X | X | |
| Hulah Lake | X | | | X | X | | |
| John Redmond Reservoir | X | | X | X | X | | |
| Kaw Lake | X | | X | X | X | X | |
| Keystone Lake | X | X | | | X | X | X |
| Lake Hudson | X | X | | | | | |
| Lake Meredith | X | | X | | X* | X | |
| Lake Thunderbird | X | | | | X | | |
| Marion Lake | X | | X | X | X | | |
| Newt Graham Lock and Dam | | | | | | | X |
| Oologah Lake | X | | | | X | | X |
| Optima Lake | X | | X | | X | X | |
| Pearson-Skubitz Big Hill Lake | X | | X | | X | | |
| Robert S. Kerr Lock and Dam | | X | X | | | | X |
| Skiatook Lake | X | | X | X | X | X | |
| Tenkiller Ferry Lake | X | X | | | X | | |
| Toronto Lake | X | | | X | X | | |
| W.D. Mayo Lock and Dam | | | | | | | X |
| Webbers Falls Lock and Dam | | X | | | | | X |
| Wister Lake | X | | | | X | | |

FC = Flood Control HP = Hydropower Rec = Recreation
WQ = Water Quality WS = Water Supply F&WL = Fish and Wildlife
Nav = Navigation

* - Includes irrigation

The Arkansas River system has very limited flood control storage and can only partially control larger floods. The projects have a total of approximately 11 million acre-feet of flood control storage. The flood control storage for each reservoir, drainage area, and inches of runoff from the drainage area required to fill the flood storage are shown in **Table 2-4**.

Eleven lake projects (see **Figure 2-4**) have primary control of flows on the main stem of the Arkansas River downstream from Keystone Dam in Oklahoma and account for approximately 75 percent of the total flood control storage available in the basin. The average frequency of filling of the flood control storage in the 11 lakes varies from once in 10 years to once in 30 years. Downstream from these lakes, there is an area of about 7,000 square miles of uncontrolled drainage area in Oklahoma (**Figure 2-4**).

TABLE 2-4

ARKANSAS RIVER BASIN FLOOD CONTROL STORAGE

| Project | Contributing Drainage Area (square miles) | Flood Control Storage | |
|---|---|---|---|
| | | Acre-Feet | Inches of Runoff |
| Cheney | 664 | 80,700 | 2.3 |
| El Dorado | 234 | 79,200 | 6.4 |
| Kaw | 6,652 | 919,400 | 2.6 |
| Great Salt Plains | 3,200 | 240,000 | 1.4 |
| Keystone | 22,351 | 1,180,000 | 1.0 |
| Heyburn | 123 | 48,290 | 7.4 |
| Toronto | 730 | 179,800 | 4.6 |
| Fall River | 585 | 234,500 | 7.5 |
| Elk City | 634 | 239,500 | 7.1 |
| Big Hill | 37 | 13,100 | 6.6 |
| Oologah | 4,339 | 965,600 | 4.2 |
| Hulah | 732 | 258,900 | 6.6 |
| Copan | 505 | 184,300 | 6.8 |
| Birch | 66 | 39,000 | 11.1 |
| Skiatook | 354 | 178,000 | 9.4 |
| Council Grove | 246 | 63,800 | 4.9 |
| Marion | 200 | 60,200 | 5.6 |
| John Redmond | 3,015 | 559,000 | 3.5 |
| Grand | 10,298 | 525,000 | 1.0 |
| Hudson | 11,533 | 244,200 | 0.4 |
| Fort Gibson | 12,492 | 919,200 | 1.4 |
| Tenkiller | 1,610 | 576,700 | 6.7 |
| Meredith | 16,000 | 462,200 | 0.5 |
| Thunderbird | 256 | 76,600 | 5.6 |
| Optima | 2,341 | 100,500 | 0.8 |
| Fort Supply | 1,494 | 86,800 | 1.1 |
| Canton | 7,600 | 265,800 | 0.7 |
| Arcadia | 105 | 64,430 | 11.5 |
| Eufaula | 8,405 | 1,468,000 | 3.3 |
| Wister | 993 | 386,800 | 7.3 |

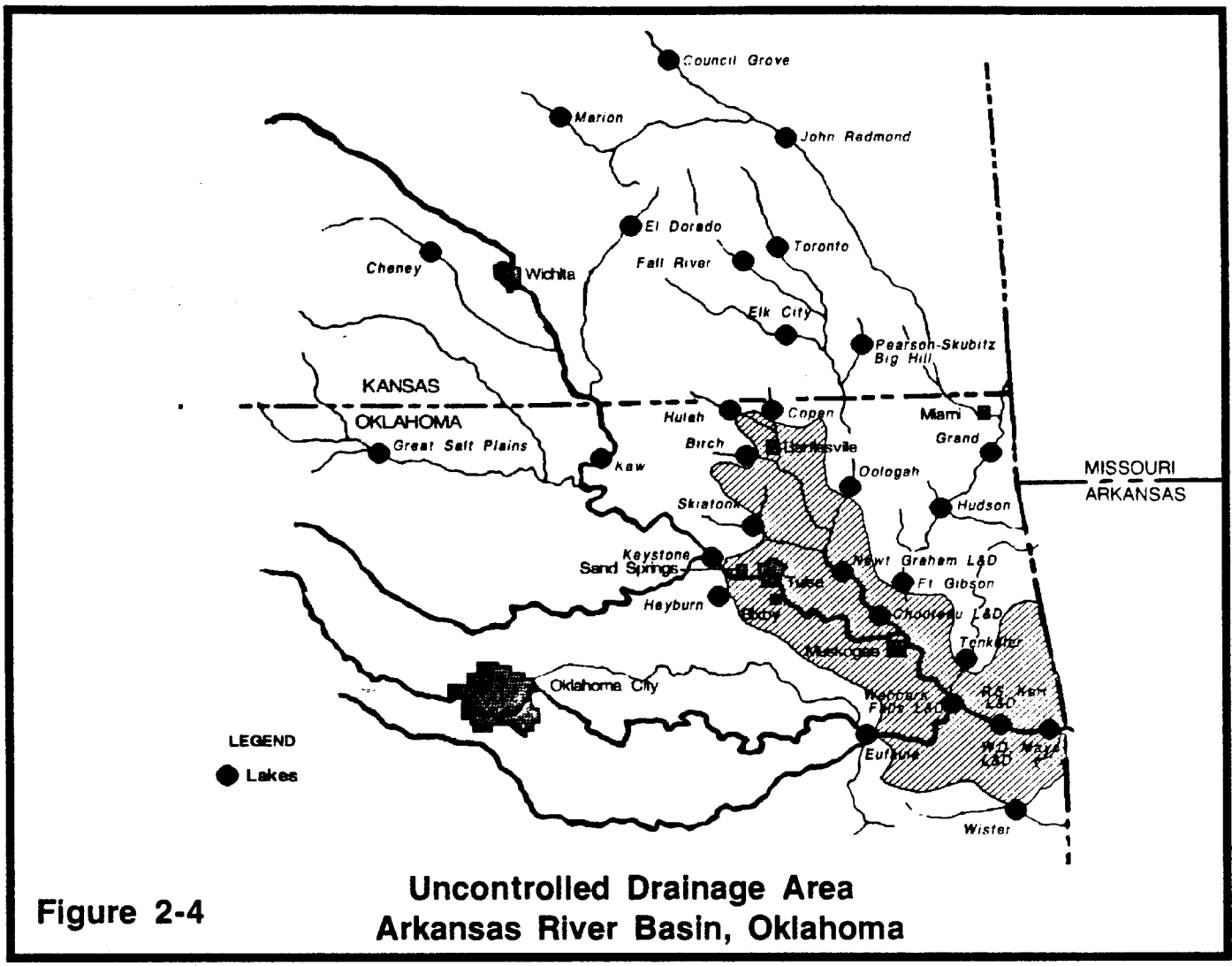



**Figure 2-4**

**Uncontrolled Drainage Area**
**Arkansas River Basin, Oklahoma**