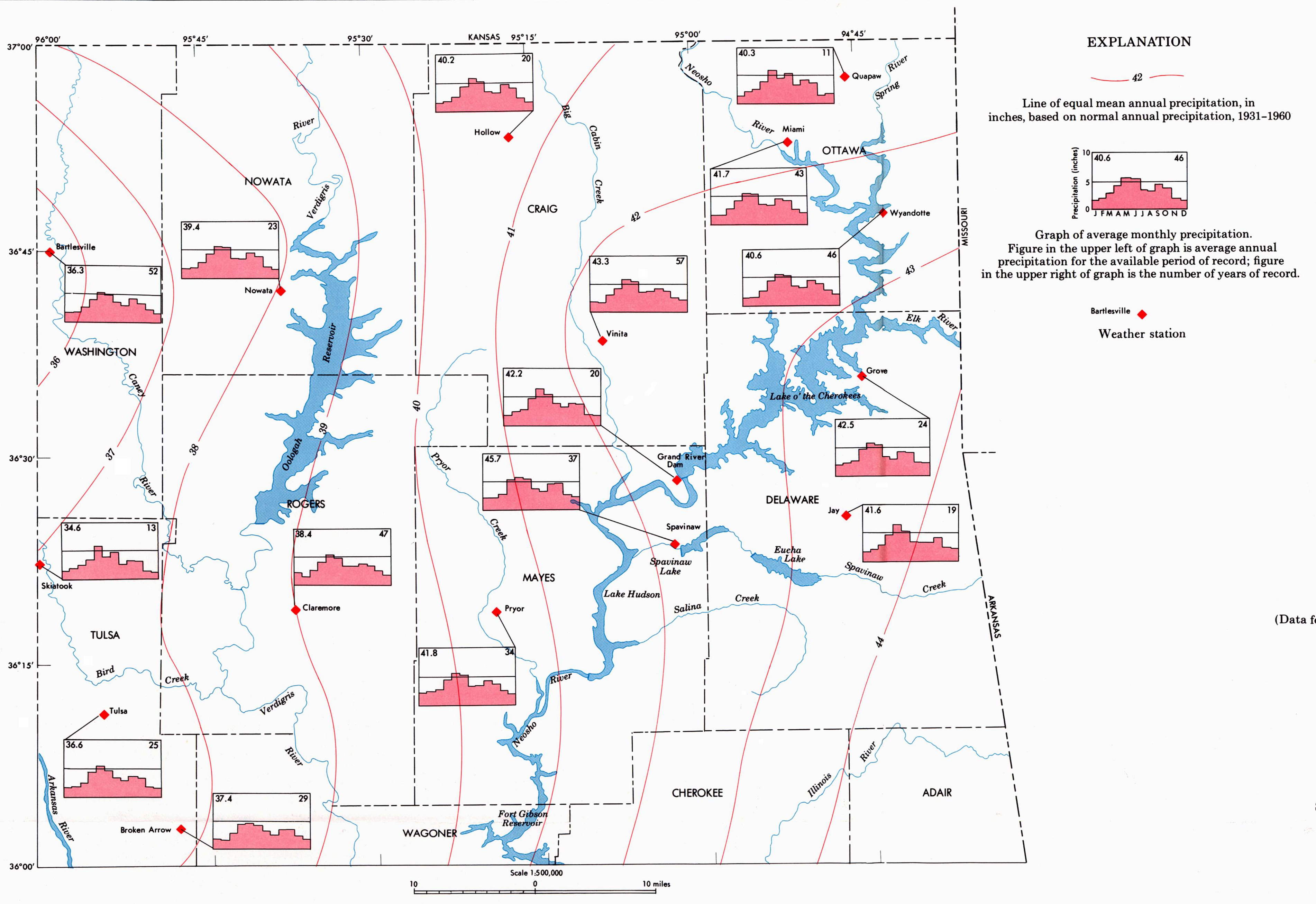
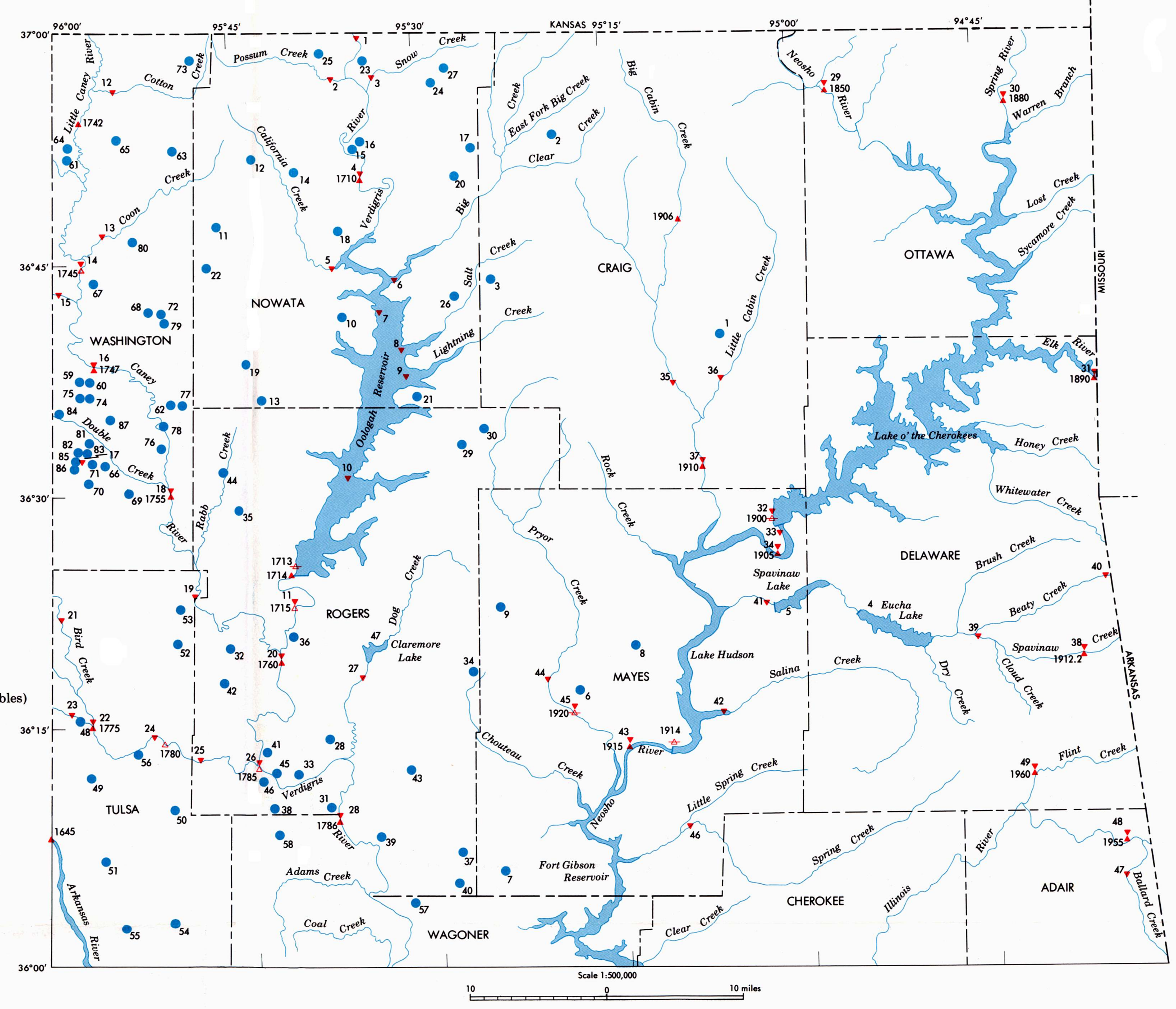


PRECIPITATION MAP



LOCATION MAP OF GAGING STATIONS, WATER-QUALITY SAMPLING SITES, AND LAKES

Summary of Chemical Analyses of Surface Water

(Results in milligrams per liter except sodium adsorption ratio and specific conductance)

Location number	Name of stream and location	Type of sampling,[1] water year, and (number of analyses)	Sulfate Maximum	Sulfate Minimum	Chloride Maximum	Chloride Minimum	Total dissolved solids Maximum	Total dissolved solids Minimum	Hardness Maximum	Hardness Minimum	Sodium adsorption ratio Maximum	Sodium adsorption ratio Minimum	Specific conductance[2] Maximum	Specific conductance[2] Minimum
1	Verdigris River near South Coffeyville	M, 52(9), 53(3)	70	43	192	56	618	344	296	208	4.1	3.5	1,130	584
2	Possum Creek near Lenapah	M, 52(4)	54	45	118	59	434	314	211	167	---	---	727	520
3	Snow Creek near Lenapah	M, 59(4)	37	33	34	8.0	337	302	230	122	.7	.6	485	266
4	Verdigris River near Lenapah	D, 52–64	150	5.6	375	14	937	114	370	48	5.6	.3	1,620	126
5	California Creek near Nowata	M, 52(8), 53(1), 59(9)	78	33	1,750	78	3,380	440	1,230	114	8.0	2.7	5,500	426
6	Big Creek near Nowata	M, 52(8), 53(3), 59(10)	60	27	860	5.0	1,880	201	714	104	5.7	.3	3,020	229
7	Verdigris River near Nowata	M, 52(9), 53(5)	61	37	348	60	848	359	332	223	4.3	3.1	1,470	604
8	Salt Creek near Alluwe	M, 52(8), 53(2), 59(10)	34	10	1,240	4.0	2,480	154	734	90	8.9	.2	4,190	182
9	Lightning Creek near Alluwe	M, 52(8), 53(3), 59(10)	155	67	3,960	28	7,190	328	1,370	164	24	.9	11,700	388
10	Verdigris River near Talala	M, 52(8), 53(3)	55	37	252	58	694	348	298	214	3.5	2.9	1,260	573
11	Verdigris River at State Highway 88 bridge near Claremore	M, 52(8), 53(3), 59(15)	58	18	172	24	544	185	288	112	2.7	.7	971	286
12	Cotton Creek near Copan	M, 52(8), 53(1), 67(11)	89	23	2,850	104	5,650	294	1,460	90	18	2.5	8,360	478
13	Coon Creek near Dewey	M, 52(8), 53(3)	115	66	468	170	1,190	586	448	224	5.4	1.1	1,990	1,000
14	Little Caney River near Bartlesville	M, 52(8), 53(3), 67(23)	89	10	367	23	931	199	345	112	4.3	1.0	1,450	330
15	Sand Creek near Bartlesville	M, 52(8), 53(3)	27	12	1,940	31	3,730	217	944	99	13	7.4	6,180	286
16	Caney River near Ochelata	M, 60(10), 61(9)	67	8.2	415	8.0	1,150	127	410	60	4.2	.4	1,700	205
17	Double Creek Watershed site 5 near Ramona	M, 54(1), 55(3), 57(11), 65(3)	25	22	152	7.1	214	170	210	74	1.9	.2	783	176
18	Caney River near Ramona	M, 52(14), 53(11), 55(1), 57(3), 58(3), 59(16), 69(12), 61(8), 62(9), 65(20), 66(29); D, 67	112	9.1	610	11	1,380	90	490	58	5.7	.4	2,310	159
19	Caney River near Collinsville	M, 49(2), 50(4), 51(4), 52(8), 53(3), 59(9)	91	16	305	22	1,000	132	472	86	3.6	.9	1,630	263
20	Verdigris River near Claremore	D, 48–54; M, 59(15)	66	8.2	292	13	747	126	406	50	4.0	.8	1,330	130
21	Bird Creek near Skiatook	M, 49(3), 50(4), 51(4), 52(8), 53(3)	49	16	212	34	740	173	462	108	1.3	.6	1,250	287
22	Bird Creek near Sperry	D, 52–53; M, 60(10), 61(5), 62(9); D, 65–67	42	6.0	1,050	20	3,590	76	924	32	9.6	.7	6,050	115
23	Delaware Creek near Sperry	M, 52(8), 53(1)	123	25	2,400	290	4,740	616	1,760	162	9.0	---	7,350	1,040
24	Bird Creek near Owasso	M, 49(3), 50(3), 51(4), 52(8), 53(3)	47	10	960	35	1,940	204	552	114	3.1	1.5	3,380	404
25	Bird Creek near Catoosa	M, 65(29), 66(16), 67(17)	135	8.0	265	4.0	740	114	290	56	3.6	.2	1,130	214
26	Verdigris River at U.S. Highway 66 bridge near Claremore	M, 52(8), 53(3)	54	15	278	30	704	250	275	131	3.5	1.5	1,270	401
27	Dog Creek near Claremore	M, 52(5), 53(1)	129	23	64	6.0	348	127	192	48	1.1	---	557	144
28	Verdigris River near Inola	D, 48–67	116	8.3	1,700	12	3,060	91	580	48	17	.1	6,030	127
29	Neosho River near Commerce	D, 48–54; M, 60(9), 61(5), 62(8), 63(8), 64(15), 65(19), 66(14), 67(15)	405	12	158	3.4	690	83	462	51	2.7	.1	1,140	126
30	Spring River near Quapaw	D, 48–49; M, 52(12), 53(9), 54(5), 55(7), 56(6), 57(5), 58(2), 60(12), 61(5), 62(5), 63(8)	188	25	30	2.0	375	93	270	48	.6	.1	654	137
31	Elk River near Tiff City, Mo.	D, 48–49; M, 52(12), 53(13), 54(8), 55(9), 56(3), 57(2), 58(5), 60(11), 61(6)	8.2	1.6	11	2.2	178	123	140	84	.2	.1	281	183
32	Lake o' the Cherokees near Langley	M, 48(1), 49(2)	48	45	14	8.8	204	163	149	116	---	---	325	281
33	Neosho River (Lake o' the Cherokees) at Langley	D, 52–54; M, 55(8)	61	30	19	6.0	240	155	177	104	.5	.3	409	234
34	Neosho River near Langley	M, 50(4), 51(4); D, 56–59	53	21	66	4.8	293	128	170	78	1.2	.1	508	148
35	Big Cabin Creek near Vinita	M, 49(1), 50(4), 51(4)	115	30	8.0	4.0	302	78	185	52	---	---	437	146
36	Little Cabin Creek near Vinita	M, 49(3), 50(4), 51(4)	123	20	122	3.0	395	109	144	51	---	---	707	96
37	Big Cabin Creek near Big Cabin	M, 52(10), 53(15), 54(9), 55(9), 56(5), 57(8), 58(5), 59(2), 60(4), 64(12), 65(17), 66(14), 67(13)	142	11	325	2.6	396	48	220	28	5.6	.2	1,410	77
38	Spavinaw Creek near Row	M, 59(4), 60(25), 61(2)	9.5	1.6	13	3.0	144	102	124	81	.2	.1	245	168
39	Spavinaw Creek near Jay	M, 58(4), 59(8), 61(2)	4.5	.8	10	2.4	127	122	126	80	.2	0	243	165
40	Beaty Creek near Maysville, Ark.	M, 59(3)	4.1	.8	11	4.7	176	---	144	116	.3	.2	292	243
41	Spavinaw Creek near Spavinaw	M, 49(3), 50(4), 51(4)	7.2	3.1	13	4.0	122	98	109	59	---	---	221	165
42	Salina Creek near Salina	M, 48(1), 49(1), 51(4), 52(9), 53(5), 58(2), 59(8)	6.7	2.1	7.5	1.5	139	89	110	64	.2	0	221	132
43	Neosho River near Chouteau	D, 51; M, 52(9), 53(8), 54(11), 55(10), 56(9), 57(10), 58(7), 60(2)	48	13	26	4.0	215	134	180	68	.7	.2	400	145
44	Pryor Creek at State Highway 69A bridge	M, 64(2), 63(8)	104	20	16	3.1	306	98	120	36	.8	.1	487	110
45	Pryor Creek near Pryor	M, 49(3), 50(3), 51(4), 52(12), 53(12), 54(9), 55(7), 56(5), 57(10), 58(6), 59(2), 60(2), 61(3), 62(4), 63(8)	87	22	2,160	3.5	4,400	54	670	20	13	.6	6,780	77.3
46	Spring Creek near Locust Grove	M, 58(2), 59(7)	3.3	1.6	6.0	2.6	115	111	90	68	.2	0	179	146
47	Ballard Creek at Ballard	M, 58(5), 59(8)	4.9	1.6	4.6	2.5	162	138	124	56	.2	0	242	124
48	Illinois River near Watts	M, 55(1), 56(10), 57(4), 58(4), 59(21), 60(25), 61(5), 63(4)	44	1.6	12	3.3	152	119	140	48	.4	.1	290	125
49	Flint Creek near Kansas	M, 55(1), 56(9), 57(4), 58(2), 59(5), 60(29), 61(3), 63(3)	5.8	1.2	10	3.7	139	98	116	42	.5	.1	278	96

[1]D, daily; M, monthly.
[2]Micromhos per centimeter at 25°C.

The usability of surface water for municipal, industrial, and irrigation requirements depends chiefly upon its quality. Available information on the chemical quality of surface water in the Tulsa quadrangle is summarized above. The U.S. Geological Survey has published an annual series of Water-Supply Papers, "Quality of Surface Waters of the United States," from 1941 through 1963. Records for streams in the Tulsa quadrangle are in Part 7 of this series. Beginning with the 1964 water year, water-quality data were published annually on a Statewide basis. These data also are published every 5 years in the U.S. Geological Survey Water-Supply Paper series. Chemical-quality data published in these reports include concentrations of total dissolved solids and individual constituents, such as sodium, calcium, sulfate, and chloride, and such characteristics as hardness, sodium adsorption ratio, specific conductance, and pH. Fluvial-sediment information is included for suspended-sediment discharges and concentrations and for partial-size distribution of suspended and bed material. Water-temperature data are given only for daily observations.

Data collected by the U.S. Geological Survey provide a general picture of the chemical quality of stream waters in the Tulsa quadrangle. Except in parts of Ottawa County, water of the eastern tributaries of the Neosho River is of excellent quality, seldom having dissolved-solids concentrations greater than 200 mg/l. Some of the streams in Ottawa County, notably Tar Creek, have excessive amounts of sulfate, iron, zinc, and lead derived largely from mine-waste water. With cessation of mine dewatering as the ores are depleted, the quality of water in these streams can be expected to improve. Big Cabin Creek in Craig and Mayes Counties has a moderate sulfate content derived from waste piles left by coal-mining activities. Coal-mining waste piles also contribute sulfate to some small streams in the upper reaches of the Verdigris River. In addition, the Verdigris River above Oologah Reservoir has an above normal content of chloride, indicating contamination by oil-field brines. Oil-field brines have also contaminated Caney River and its tributaries above the confluence with Double Creek near Ramona.

Summary of Surface-Water Records

Stream	Station number	Drainage area (square miles)	Period of record	Discharge (cubic feet per second) Maximum	Discharge Minimum	Discharge Average	Remarks
Arkansas River at Tulsa	7–1645	74,615	1925–	246,000	27	6,387	Flow regulated since 1964.
Verdigris River near Lenapah	1710	3,639	1938–	137,000	0	2,022	Flow partly regulated. No flow at times in 1939–1940, 1956.
Verdigris River near Oologah	1714	4,339	1961–	27,900	0	1,609	Flow regulated by Oologah Reservoir. No flow Mar. 16–26, 1967.
Verdigris River near Sageeyah	1715	4,402	1938–1945	138,000	0	3,368	No flow at times in 1939–1940.
Little Caney River near Copan	1740	424	1943–1958	36,400	0	238	No flow at times in 1946, 1952–1957.
Little Caney River below Cotton Creek near Copan	1742	502	1958–	23,700	0	200	No flow at times in 1962–1966.
Caney River at Bartlesville	1745	1,465	1949–1956	26,400	.1	494	
Caney River near Ochelata	1747	1,753	1956–	33,800	.4	814	
Caney River near Ramona	1755	1,955	1935–1939, 1945–	38,500	0	829	No flow at times in 1936, 1956.
Verdigris River near Claremore	1760	6,534	1935–	182,000	0	3,373	Flow partly regulated since May 1963. No flow at times in 1936, 1939–1940, 1956.
Bird Creek near Sperry	1775	905	1938–	90,000	0	436	No flow at times in 1939, 1954–1957, 1964–1966.
Bird Creek near Owasso	1780	1,022	1935–1939	19,700	2	---	
Verdigris River near Inola	1786	7,911	1944–	118,000	5.9	3,898	Flow partly regulated in recent years.
Neosho River near Commerce	1850	5,876	1939–	267,000	0	3,292	No flow at times in 1953–1954, 1956.
Spring River near Quapaw	1880	2,510	1939–	190,000	5.8[1]	1,830	Flow partly regulated.
Lost Creek at Seneca, Mo.	1885	42	1948–1959	5,760	0.1	28.1	
Elk River near Tiff City, Mo.	1890	872	1939–	137,000	5.1[1]	755	
Neosho River near Grove	1895	10,000	1925–1939	133,000	32	6,283	
Neosho River near Langley	1905	10,335	1939–	300,000	9[1]	6,524	Flow regulated by Lake o' the Cherokees.
Big Cabin Creek near Pyramid Corners	1906	71.1	1963–	4,710	0	24.2	No flow at times each year.
Big Cabin Creek near Big Cabin	1910	466	1947–	52,000	.1	291	
Spavinaw Creek near Row	1912	127	1959–1962	15,000	0	---	No flow for many days each year.
Spavinaw Creek near Sycamore	1912.2	133	1961–	4,240	1.2	67.0	
Pryor Creek near Pryor	1920	229	1947–1963	32,000	0	131	No flow at times in most years.
Neosho River near Chouteau	1915	11,546	1937–1950, 1963–	400,000	12[1]	7,797	Flow regulated by Lake Hudson.
Illinois River near Watts	1955	635	1955–	68,000	8.6	503	Low flow partly regulated.
Flint Creek near Kansas	1960	110	1955–	23,600	.6[1]	90.9	

[1]Minimum daily discharge.

Streamflow data are available at 27 sites in the quadrangle and are published in reports of the U.S. Geological Survey. Two of the gaging stations are in Missouri, each about 1 mile east of the Oklahoma State line. The locations of the gaging stations are shown on the map, and selected data from the records are given in the tabulation.

Prior to 1961, the records of streamflow and of reservoir contents were published in the annual series of U.S. Geological Survey Water-Supply Papers entitled "Surface Water Supply of the United States." The records for Oklahoma are contained in Part 7 of that series. The records for the 5-year period 1961–65 are contained in a 2-volume publication of the same series.

Beginning with the 1961 water year, streamflow records also have been issued by the U.S. Geological Survey in annual reports on a State-boundary basis. These basic-data reports are released by the district offices primarily for local needs.

The summary of surface-water records gives the station location, station number, drainage area, period of published record available through 1968, the maximum, minimum, and average discharge for the complete years of record, and remarks on no-flow occurrences and on flow regulation. The average discharge is not given for stations having less than 5 complete years of record.

Streamflow in the Tulsa quadrangle is highly variable because precipitation and runoff are not uniformly distributed throughout the year. Annual runoff averages about 7 inches in the western part of the area and about 12 inches in the eastern part. The greatest amount of runoff occurs during the spring months when rainfall is greatest and evaporation and transpiration are relatively low. High runoff may occur during any month of the year, depending upon storm occurrence, but streamflow is generally lowest in the summer or early fall.

Because of the variability of runoff, the development of storage is usually necessary to provide a dependable water supply. There are four major reservoirs in the quadrangle, the largest being Lake o' the Cherokees on the Neosho River. This reservoir was completed in 1940 and has a regulated water supply averaging 4.7 million acre-feet per year.

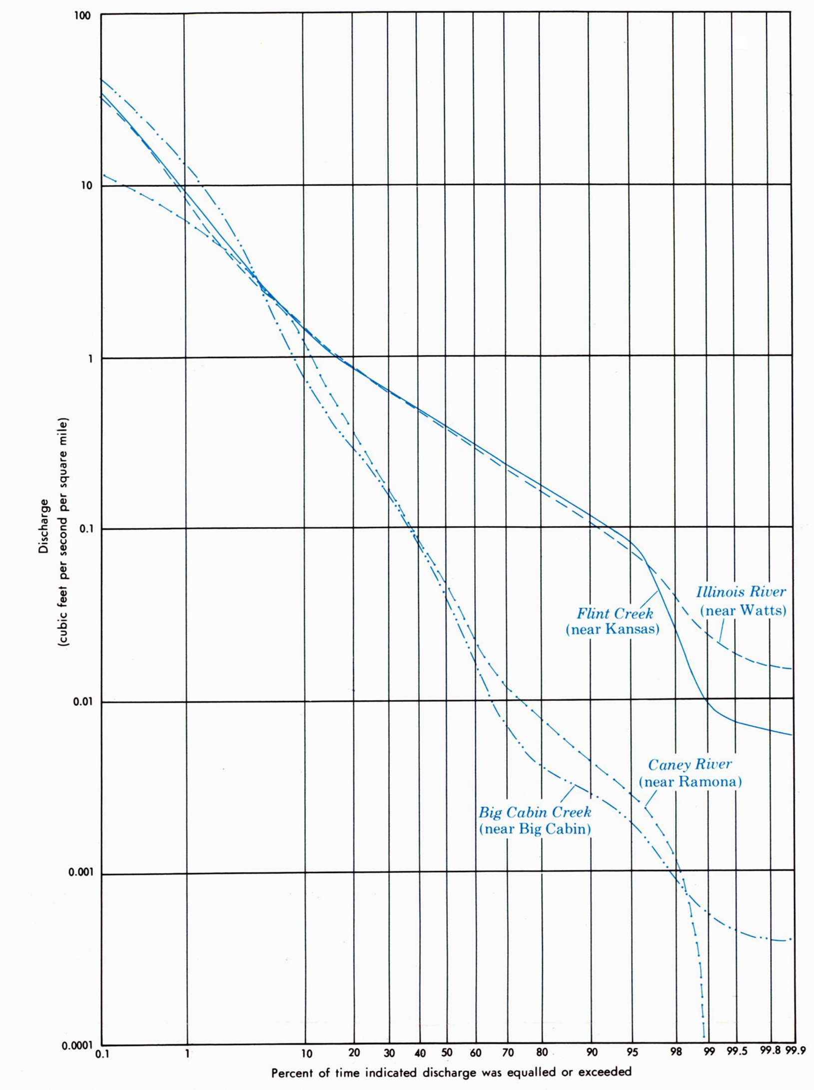
Lakes in the Tulsa Quadrangle[1]

Map number	Designation	Use	Area (acres)	Capacity (acre-feet)
	Craig County			
1	Eastern Oklahoma Hospital	Ir	50	150
2	Snedden	P	13	65
3	Hartley	P	12	75
	Delaware County			
4	Eucha Lake	M	2,880	69,567
	Mayes County			
5	Spavinaw Lake (partly in Delaware County)	M	1,638	30,590
6	Scarbow	P	23	168
7	C. M. Livingston	P	10	60
8	Satterfield	P	15	51
9	Polone	P	10	38
	Nowata County			
10	City of Nowata	M	65	200
11	Montgomery Ranch	P	11	84
12	Glenn Webster	P	10	264
13	Stande Ranch	P	21	147
14	Skimmerhorn Oil Co.	I	21	90
15	Wettack Estate	P	13	40
16	Wettack Estate	P	16	50
17	Halsell Ranch	P	10	50
18	Lee Berry	P	11	88
19	Lawrence Brown	P	22	105
20	A. G. Cranor	P	14	70
21	R. F. Denton	P	62	400
22	Bill Doenges	P	21	100
23	W. M. Gillispie	P	14	84
24	Lee Milligan	P	20	100
25	Henry Pahmeyer	P	10	50
26	Bill Parrott	P	22	105
27	Sunrise, Sunset Club	P	15	85
	Rogers County			
28	Canyon Lake	I	17	120
29	Chelsea Lake 1	M	14	210
30	Chelsea Lake 2	M	25	100
31	Fin and Feather	P	126	504
32	Nichols Lake	P	14	81
33	Horseshoe Lake	P	145	725
34	Lewis Lake	P	20	100
35	Sooner Coal Lake	P	25	105
36	Lawson Lake	P	10	50
37	Duan Lake	P	19	100
38	Indian Hills Lake	P	14	84
39	Diem Lake	P	11	66
40	Bull Creek Lake	Ir	10	100
41	Yonkinpin Lake	R	80	240
42	Malchi Lake	P	10	100
43	Inola Lake	P	70	700
44	Wagner Lake	P	20	100
45	Howell Lake	P	18	90
46	Henreid Lake	P	18	72
47	Claremore	M	431	2,586
	Tulsa County			
48	Owasso	P	18	144
49	Yohola	M	425	7,000
50	Vettie Cooley	P	30	180
51	W. Marvell Coats	P	10	50
52	Maude Grazier	P	15	75
53	W. J. Pattison	P	15	75
54	Carl Porter	P	20	100
55	Jay L. Smith	P	15	75
56	Murray Lake	R	80	240
	Wagoner County			
57	V. L. Colerige	P	20	100
58	L. D. Robson	P	20	100
	Washington County			
59	Burlingame Lake	P	35	350
60	Burlingame Lake	P	61	900
61	Long Lake	P	45	400
62	Mallard Club Lake	P	33	396
63	Scudder Lake	P	15	75
64	Youngs Lake	P	57	322
65	O. A. Partridge	P	12	60
66	Ramona Reservoir	M	14	70
67	R. R. Wilson	P	12	60
68	Orval Guinn	P	22	220
69	Ernest L. Rowe	I	22	180
70	E. G. Todd (site 5)	R	17	155
71	W. N. Sears (site 4)	I	16	90
72	Willis Jardot	P	12	90
73	Elmer Gallery	P	18	137
74	Ochelata City Reservoir	M	15	---
75	Ochelata Sportsman Club	R	10	---
76	Bartlesville Gun Club	R	50	---
77	Tie-In Club	R	20	---
78	Bacon Lake	P	20	---
79	Silver Lake	P	20	---
80	Turkey Creek (site 1)	F	20	---
81	Double Creek (site 1)	F,R	73	353
82	(site 2)	F	15	64
83	(site 3)	F	52	219
84	(site 6)	F,R	9	39
85	(site 4)	F	21	104
86	(site 5)	F	25	89
87	Thomas Lake	P	13	156

M, municipal; P, private; R, recreation; I, industrial; F, flood control (may be used to some extent for recreation); Ir, irrigation.

[1]Data provided by the Oklahoma Water Resources Board and U.S. Department of Agriculture Soil Conservation Service.

Development of storage is necessary to provide dependable water supplies in the western two-thirds of the Tulsa quadrangle because of limited availability of ground water and because of the lack of sustained flow in the small streams. Man-made ponds and lakes provide water for stock and other farm uses. Most of the ponds and lakes of 10 acres or more are listed in the table above.



FLOW-DURATION CURVES OF SELECTED STREAMS

During dry periods, streams are fed by ground water draining from rocks underlying the stream basins. The streams west of the Neosho River are underlain mainly by Pennsylvanian shale, siltstone, and sandstone. The Pennsylvanian rocks have limited storage capacity and thus cannot provide water to maintain streamflow during dry periods. Streams east of the Neosho River are in the Ozark region, which is underlain mostly by Mississippian chert and limestone. The Mississippian rocks have a much greater capacity for storing water and thus can provide water to maintain streamflow most of the time.

Streams draining into Oklahoma from the Ozark region in western Arkansas are perennial and tend to have substantial base flows. For example, flow-duration curves show that Flint Creek and the Illinois River each have a median daily flow (the flow available 50 percent of the time) of at least 0.3 cfs per sq mi (cubic feet per second per square mile) upstream from the gaging stations in Oklahoma. Miscellaneous measurements of base flow obtained in 1968 in the lower reaches of other streams east of the Neosho River indicate that median daily flows probably exceed 0.25 cfs per sq mi in Beaty, Brush, Honey, and Spring Creeks. In contrast, low flows are not dependable in most of the watersheds west of the Neosho River. Caney River and Big Cabin Creek, for example, have a median flow of less than 0.05 cfs per sq mi, and they have periods of little or no flow during many summers.

Measurements of base flow obtained in October 1968 indicate that the low flows at that time were about 0.2 cfs per sq mi in several streams east of the Neosho River. These flows are similar to the median value of the seasonal duration curve of October runoffs for the 32-year period 1936–67 of the Illinois River near Tahlequah about 10 miles downstream from the edge of the Tulsa quadrangle. Because the streamflow in the Ozark region probably was in the normal range during October, the flows during drought periods could be expected to be smaller than the figures given. Many of the smaller springs in the region probably cease flowing in a dry year.

Summary of Major Reservoirs in the Tulsa Quadrangle

Reservoir	Station number	Maximum capacity (acre-feet)	Maximum contents (acre-feet)	Date	Minimum contents (acre-feet)	Date
Oologah Reservoir near Oologah	7–1713	1,020,000	345,800	4– 8–65	37,270	1–25–67
Lake o' the Cherokees at Langley	1900	2,197,000	2,213,000[1]	5–25–57	642,900	9–28–54
Lake Hudson	1914	444,500	282,000	3–21–68	183,100	12–24–67
Fort Gibson Reservoir near Fort Gibson	1930[2]	1,284,000	1,278,000	5–12–61	303,800	5–26–55

[1]Gage height 0.27 foot above top of spillway gates.
[2]Gaging station outside Tulsa quadrangle.

Surface reservoirs constitute the major part of the water resources in the area and are the prime source of water for municipal and industrial use. Although the prime purpose of the large reservoirs is to impound water for flood control, power generation, and water supply, recreation is an important secondary benefit.

Reservoir data are available at three sites in the quadrangle and are published annually by the U.S. Geological Survey. The locations of the reservoir gaging stations are shown on the map, and pertinent data from the records are summarized above.

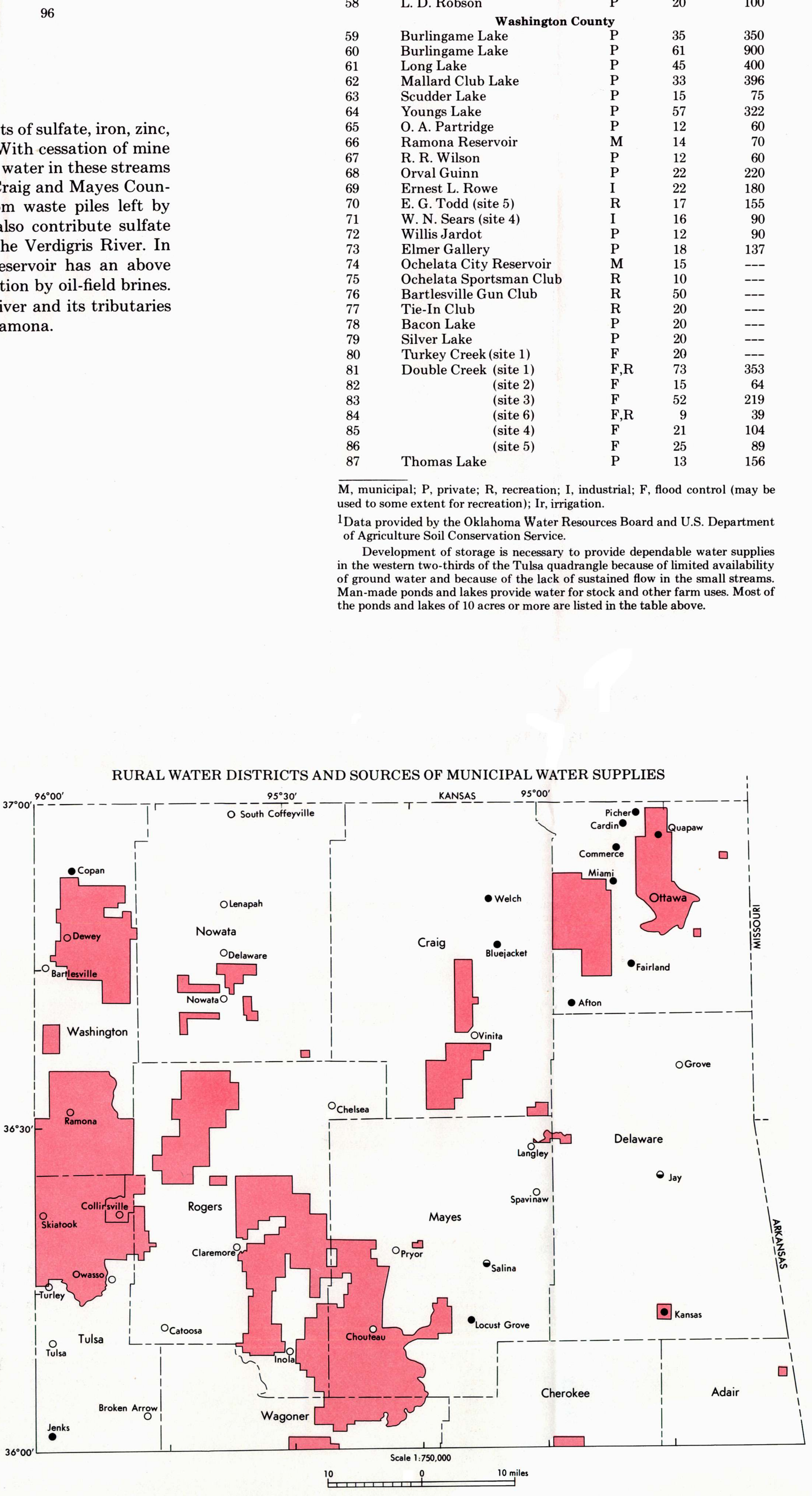
Water Use

Surface water is the major source of water used in the Tulsa quadrangle. The total amount of water used in 1968 is estimated at 25.4 billion gallons. Approximately 86 percent of this amount, or about 21.8 billion gallons, was taken from the lakes and rivers of the area; the remaining 3.6 billion gallons was provided by ground-water development. The major use of water was for municipal and industrial purposes, which accounted for about 24 billion gallons; rural domestic use accounted for the remaining 1.4 billion gallons.

The most intensive area of ground-water development is in Ottawa County, where, in 1968, about 1.7 billion gallons was pumped from deep aquifers for municipal and industrial use.

Because of the difficulty in obtaining sufficient water of good quality in many parts of the area, 33 rural water districts had been established by the end of 1967. These districts supplied an estimated 0.2 billion gallons of water to approximately 15,000 people; all the water was taken from surface-water sources. Many of the districts will be expanded and new ones established, particularly in the western two-thirds of the area, to meet the increasing rural demand for good-quality water.

RURAL WATER DISTRICTS AND SOURCES OF MUNICIPAL WATER SUPPLIES



EXPLANATION

Rural water districts

Sources of municipal water supplies
- Ground water
- Surface water
- Combined ground and surface water

RECONNAISSANCE OF THE WATER RESOURCES OF THE TULSA QUADRANGLE, NORTHEASTERN OKLAHOMA

Melvin V. Marcher and Roy H. Bingham

1971