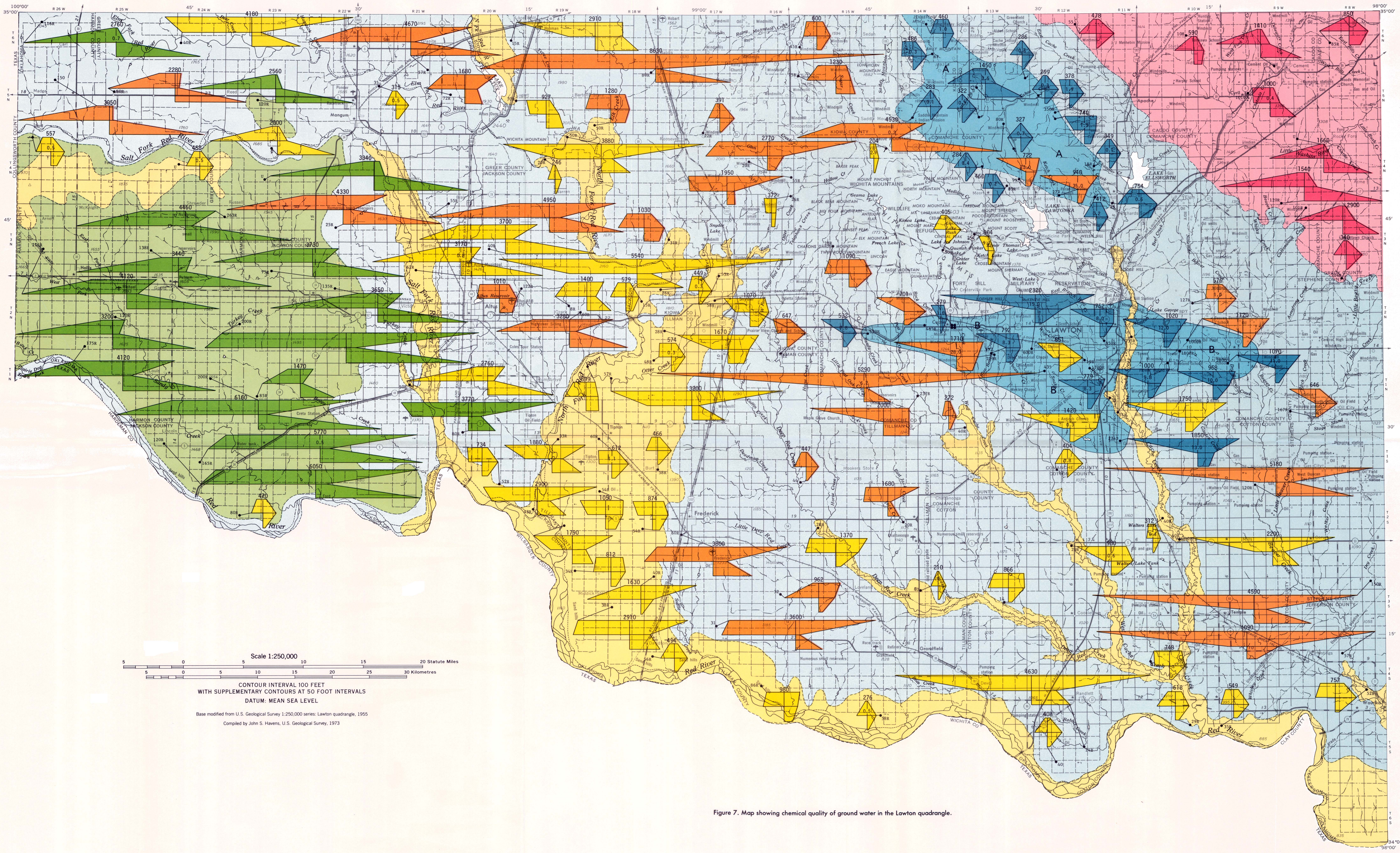


Scale 1:250,000

CONTOUR INTERVAL 100 FEET
WITH SUPPLEMENTARY CONTOURS AT 50 FOOT INTERVALS
DATUM: MEAN SEA LEVEL

Base modified from U.S. Geological Survey 1:250,000 series: Lawton quadrangle, 1955

Compiled by John S. Havens, U.S. Geological Survey, 1973

Figure 7. Map showing chemical quality of ground water in the Lawton quadrangle.

EXPLANATION

Alluvium and terrace deposits

The quality of water from alluvium is extremely variable. Where recharge is derived from bedrock or adjacent streams, water contains more minerals than where recharge is mainly from precipitation.

Rush Springs-Chickasha-Duncan aquifer

Water from this aquifer typically contains calcium sulfate or calcium carbonate.

Dog Creek-Blaine-Flowerpot aquifer

Water from this aquifer contains either calcium sulfate or, more commonly, a mixture of calcium sulfate and sodium chloride.

A B

Arbuckle-Timbered Hills aquifer

In the Limestone Hills area (labeled A), water is commonly of the calcium carbonate type, but mixtures with calcium sulfate and sodium chloride waters occur locally, and the water may contain fluoride exceeding standards set by the Oklahoma State Department of Health. In the area south of the Wichita Mountains (labeled B), water is mainly the sodium chloride type, with some carbonate and sulfate waters. It generally contains fluoride in excess of Oklahoma State Department of Health standards.

Minor aquifers

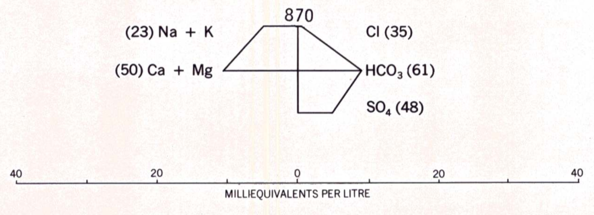
The quality of water from minor aquifers is extremely variable.

Approximate boundary for principal aquifer.

Water-Quality Diagrams

Water-quality diagrams show the general character of ground water. The size of the diagram indicates the dissolved-solids concentration of water – the larger the area the more dissolved solids. The shape of the diagram is a general indication of the chemical content. Constituents are plotted in milliequivalents per litre. The figure above the diagram denotes the quantity of dissolved solids, expressed in milligrams per litre. The figure in the center of diagram, where shown, denotes fluoride content, in milligrams per litre.

The diagram below shows factors that can be used to convert the ionic concentration from milliequivalents per litre to milligrams per litre. The scale can be used to read the value of milliequivalents per litre of a particular ion, or combination of ions. Multiply the value by the number beside the ion. The resulting number for Cl, HCO_3, or SO_4 ions indicates concentration in milligrams per litre, and the resulting number for Na + K is the concentration as Na. The resulting number of Ca + Mg is the hardness as $CaCO_3$.

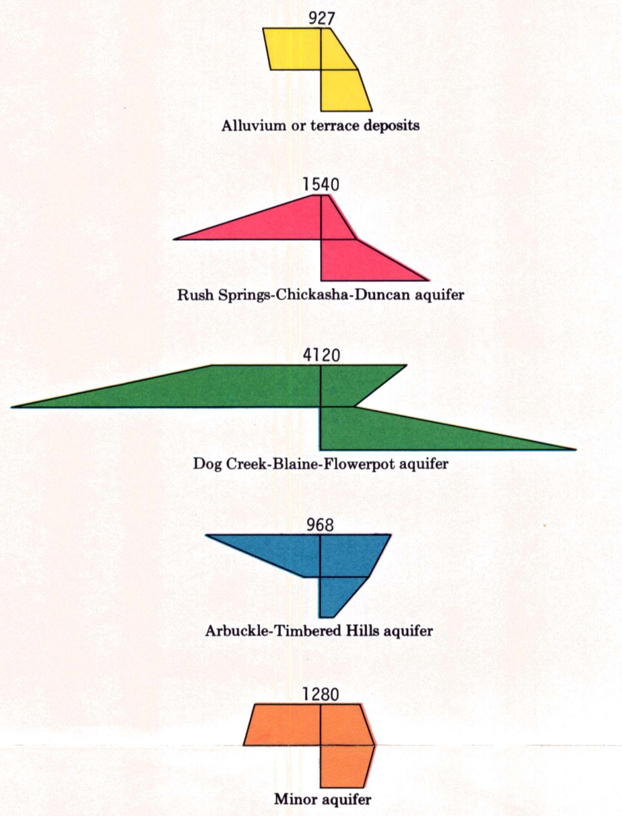


60 Well from which water sample was collected; number indicates well depth, in feet; U=unknown; R=reported

3 Well field from which sample was collected; figure indicates number of wells in field; diagram is based on average for all wells in field

Spring from which water sample was collected

Geologic Sources of Water



CHEMICAL QUALITY OF GROUND WATER

Chemical analyses of water samples from 130 wells and 14 springs in the Lawton quadrangle were used in preparing figure 7. Most of these analyses were made by the U.S. Geological Survey; some analyses were from reports and analyses by State or private agencies. Laboratory determinations by the U.S. Geological Survey included calcium and magnesium hardness, bicarbonate, carbonate, sulfate, chloride, nitrate, dissolved solids, and, for some samples, fluoride content. The amount of sodium and potassium was calculated for most older analyses and analyzed in more recent ones.

In the hydrologic cycle, water falls as precipitation on the land surface, where it dissolves soluble minerals from the soil. As water percolates downward below the soil zone to the aquifer or water table, it leaches additional minerals. The chemical concentration of ground water thus reflects the mineral character of the soil and rocks with which the water has been in contact.

Sodium and potassium are dissolved from most rocks and are found in most ground water, but small to moderate quantities have little effect on the usefulness of water. Sodium generally predominates as the amount of dissolved sodium plus potassium increases. The ratio of sodium content to that of calcium plus magnesium in water is expressed as SAR (sodium-adsorption ratio); water with high SAR values may be unsatisfactory for irrigation.

Calcium is dissolved from many rocks, but higher concentrations generally are found in water that has been in contact with limestone, dolomite, or gypsum; magnesium is dissolved primarily from dolomitic rocks. Calcium and magnesium hardness is expressed in terms of an equivalent quantity of calcium carbonate. The U.S. Geological Survey classifies water having a hardness of less than 60 mg/l (milligrams per litre) as soft; 61 to 120 mg/l, moderately hard; 121 to 180 mg/l, hard; and more than 180 mg/l, very hard.

Chloride is present in many rocks and is a major constituent of some evaporite deposits, such as halite or rock salt. Rocks that have been under the sea at some stage of their formation generally contain some chloride. Chloride is a major constituent of most oil-field brines. Some chloride is present in almost all water, and small quantities are desirable for human consumption, but excessive chloride renders water unpalatable and tends to accelerate corrosion of metal.

Water that has been in contact with limestone and dolomite dissolves carbonate and bicarbonate through the action of carbon dioxide and organic acids in the water. Bicarbonate and carbonate in moderate concentrations have little effect on the use of water for most purposes, and most natural water does not contain large amounts of carbonate.

Sulfate is most plentiful in gypsum and shale but can be formed by the oxidation of iron sulfides. Gypsum and anhydrite, when dissolved, contribute to the sulfate concentration of ground and surface waters. Excessive amounts of sulfate in waters containing calcium and magnesium tend to form hard scale in boilers. Sulfates have a cathartic effect on many people, particularly those unaccustomed to using water with a high sulfate concentration.

Nitrate in water generally is considered a final oxidation product of nitrogenous material and may indicate possible pollution and contamination by sewage, organic waste, or nitrate fertilizers.

Small amounts of fluoride have been recognized for many years to be necessary and desirable for development of healthy teeth and prevention of tooth decay in children; however, excessive fluoride in drinking water produces fluorosis (tooth mottling and staining and bone damage), which increases with fluoride concentration (Oklahoma State Department of Health, 1964, p. 7). Optimum fluoride levels for a community depend on the average annual temperature, as an index of the quantity of water children drink; for the Lawton area (Oklahoma State Department of Health, 1964, p. 7), the greatest acceptable concentration of naturally occurring fluoride is 1.6 mg/l at the average annual temperature of 75.5°F (24.2°C).

Some mineralization of water in the Lawton quadrangle may be from contamination by oil-field brines, particularly in the vicinity of oil fields in the eastern part of the quadrangle. Such contamination may result from seepage of waste pits, defective well casing, defective well plugging, waterflooding operations, or improper brine disposal.

The dissolved solids reported in this study consist of the solid residue left after evaporation of a water sample. Water containing 500 mg/l or less of dissolved solids is generally considered satisfactory for most domestic and industrial uses; 500 mg/l is considered the maximum recommended for drinking water. Water quality is so variable in the Lawton quadrangle, even within short distances, that it is impossible to delineate quality by geographical area. The following tables summarize results of laboratory analyses of ground water collected from wells and springs throughout the quadrangle.

Summary of chemical analyses of water from alluvium

	Concentrations (in milligrams per litre)					Number of samples
	Maximum	Upper quartile[1]	Median[2]	Lower quartile[3]	Minimum	
Hardness as $CaCO_3$	1,720	650	375	160	64	30
Sulfate (SO_4)	1,330	535	84	41	8.1	30
Chloride (Cl)	1,800	500	205	37	8.0	30
Nitrate (NO_3)	56	37	6.8	.5	0	25
Dissolved solids (Residue on evaporation at 180°C)	4,630	1,880	882	408	240	30

Summary of chemical analyses of water from terrace deposits

	Concentrations (in milligrams per litre)					Number of samples
	Maximum	Upper quartile[1]	Median[2]	Lower quartile[3]	Minimum	
Hardness as $CaCO_3$	1,880	575	315	276	150	26
Sulfate (SO_4)	1,840	405	124	44	9.5	26
Chloride (Cl)	2,300	415	70	38	7.5	26
Nitrate (NO_3)	280	36	24	3.5	.1	21
Dissolved solids (Residue on evaporation at 180°C)	5,540	1,790	843	494	210	26

Summary of chemical analyses of water from the Rush Springs-Chickasha-Duncan aquifer

	Concentrations (in milligrams per litre)					Number of samples
	Maximum	Upper quartile[1]	Median[2]	Lower quartile[3]	Minimum	
Hardness as $CaCO_3$	1,870	1,058	640	380	284	9
Sulfate (SO_4)	1,560	838	504	118	17	9
Chloride (Cl)	44	30	21	9.4	7.0	9
Nitrate (NO_3)	80	53	15	7.5	.7	6
Dissolved solids (Residue on evaporation at 180°C)	2,900	1,548	1,000	562	340	9

Summary of chemical analyses of water from the Dog Creek-Blaine-Flowerpot aquifer

	Concentrations (in milligrams per litre)					Number of samples
	Maximum	Upper quartile[1]	Median[2]	Lower quartile[3]	Minimum	
Hardness as $CaCO_3$	3,020	2,320	2,135	1,906	780	16
Sulfate (SO_4)	2,570	2,075	1,895	1,735	535	16
Chloride (Cl)	1,950	1,370	425	174	8.8	16
Nitrate (NO_3)	27	24	10	4.9	3.0	11
Dissolved solids (Residue on evaporation at 180°C)	6,800	4,375	3,730	3,235	1,470	16

Summary of chemical analyses of water from the Arbuckle-Timbered Hills aquifer in the Limestone Hills

	Concentrations (in milligrams per litre)					Number of samples
	Maximum	Upper quartile[1]	Median[2]	Lower quartile[3]	Minimum	
Hardness as $CaCO_3$	800	280	260	245	150	15
Sulfate (SO_4)	770	50	27	18	12	15
Chloride (Cl)	190	52	26	6.8	2.5	15
Nitrate (NO_3)	38	4.9	1.7	.8	.2	15
Fluoride (F)	2.5	.8	.4	.2	.1	15
Dissolved solids (Residue on evaporation at 180°C)	1,450	473	378	310	283	15

Summary of chemical analyses of water from the Arbuckle-Timbered Hills aquifer south of the Wichita Mountains

	Concentrations (in milligrams per litre)					Number of samples
	Maximum	Upper quartile[1]	Median[2]	Lower quartile[3]	Minimum	
Hardness as $CaCO_3$	34	27	21	16	6	11
Sulfate (SO_4)	220	114	72	64	19	11
Chloride (Cl)	880	358	320	180	55	11
Nitrate (NO_3)	.9	.4	.1	.1	0	9
Fluoride (F)	15	11.5	9.8	8.2	1.6	11
Dissolved solids (Residue on evaporation at 180°C)	2,320	1,058	968	759	279	11

Summary of chemical analyses of water from minor aquifers

	Concentrations (in milligrams per litre)					Number of samples
	Maximum	Upper quartile[1]	Median[2]	Lower quartile[3]	Minimum	
Hardness as $CaCO_3$	3,690	1,380	520	198	4	37
Sulfate (SO_4)	2,200	1,150	295	79	21	37
Chloride (Cl)	3,290	900	375	92	14	37
Nitrate (NO_3)	970	26	10	1.9	.2	29
Dissolved solids (Residue on evaporation at 180°C)	8,630	3,800	1,680	940	272	37

[1]Upper quartile—25 percent of the samples had a concentration greater than the amount shown and 75 percent had less.

[2]Median—50 percent of the samples had a concentration greater than the amount shown and 50 percent had less.

[3]Lower quartile—25 percent of the samples had a concentration less than the amount shown and 75 percent had more.

Reference Cited

Oklahoma State Department of Health, 1964, Standards for public water supply facilities: Oklahoma Department of Health Engineering Bulletin 0589, 58 p.

RECONNAISSANCE OF THE WATER RESOURCES OF THE LAWTON QUADRANGLE, SOUTHWESTERN OKLAHOMA

By
John S. Havens
U.S. Geological Survey

1977