TEXAS
WATER
DEVELOPMENT
BOARD

REPORT 35

QUALITY OF WATER OF BIG MINERAL ARM AND TRIBUTARIES LAKE TEXOMA, TEXAS January 18-20 and February 10-11, 1966

NOVEMBER 1966

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QUALITY OF WATER OF BIG MINERAL ARM AND TRIBUTARIES

LAKE TEXOMA, TEXAS

January 18-20 and February 10-11, 1966

By

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United States Geological Survey

Prepared by the U.S. Geological Survey
in cooperation with the
Texas Water Development Board
and the
City of Sherman

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TABLE OF CONTENTS

TABLES

ILLUSTRATIONS

Figures

QUALITY OF WATER OF
BIG MINERAL ARM AND TRIBUTARIES
LAKE TEXOMA, TEXAS
January 18-20 and
February 10-11, 1966

INTRODUCTION

On January 18-20 and February 10-11, 1966, a quality-of-water survey was made of the Big Mineral Arm and its tributaries, Lake Texoma, Texas (Figure 1). The purpose was to determine suitability of water in the Arm for municipal supply. Water quality was determined at various locations and depths in Big Mineral Arm and was also determined at three verticals in the main body (Red River) of Lake Texoma for comparison with the quality of Big Mineral Arm (Figure 2). Sampling sites on 16 of the largest tributaries to Big Mineral Arm were visited on January 18-19, 1966 (a period of low-flow of the tributaries), and samples were collected at 10 sites where there was flow. Heavy rains in the second week of February caused substantial runoff in the drainage area of Big Mineral Arm. Samples from the 16 inflow sites were collected on February 10-11, 1966, to compare the chemical quality of the water during high runoff with that of low flow.

The quality-of-water survey was done under a cooperative agreement with the city of Sherman and the Texas Water Development Board. Field and laboratory work required to sample and analyze the inflows into Big Mineral Arm during February were done as a part of chemical-quality reconnaissance of the Red River basin, which is a cooperative project of the Texas Water Development Board and the U.S. Geological Survey.

QUALITY OF WATER OF BIG MINERAL ARM

On January 20, 1966, the water in Big Mineral Arm of Lake Texoma was essentially the same in chemical quality from top to bottom (Tables 1 and 2). From the analyses it seems reasonable to infer that complete mixing may be the normal condition during the winter. In winter, the air temperature is usually lower than the temperature of the water in the lake, and thus the top layer of water is cooled, increasing its density. When the density of the lake water near the surface becomes greater than the density of the water at the bottom, the top layer of water moves toward the bottom and ultimately the lake becomes completely mixed.

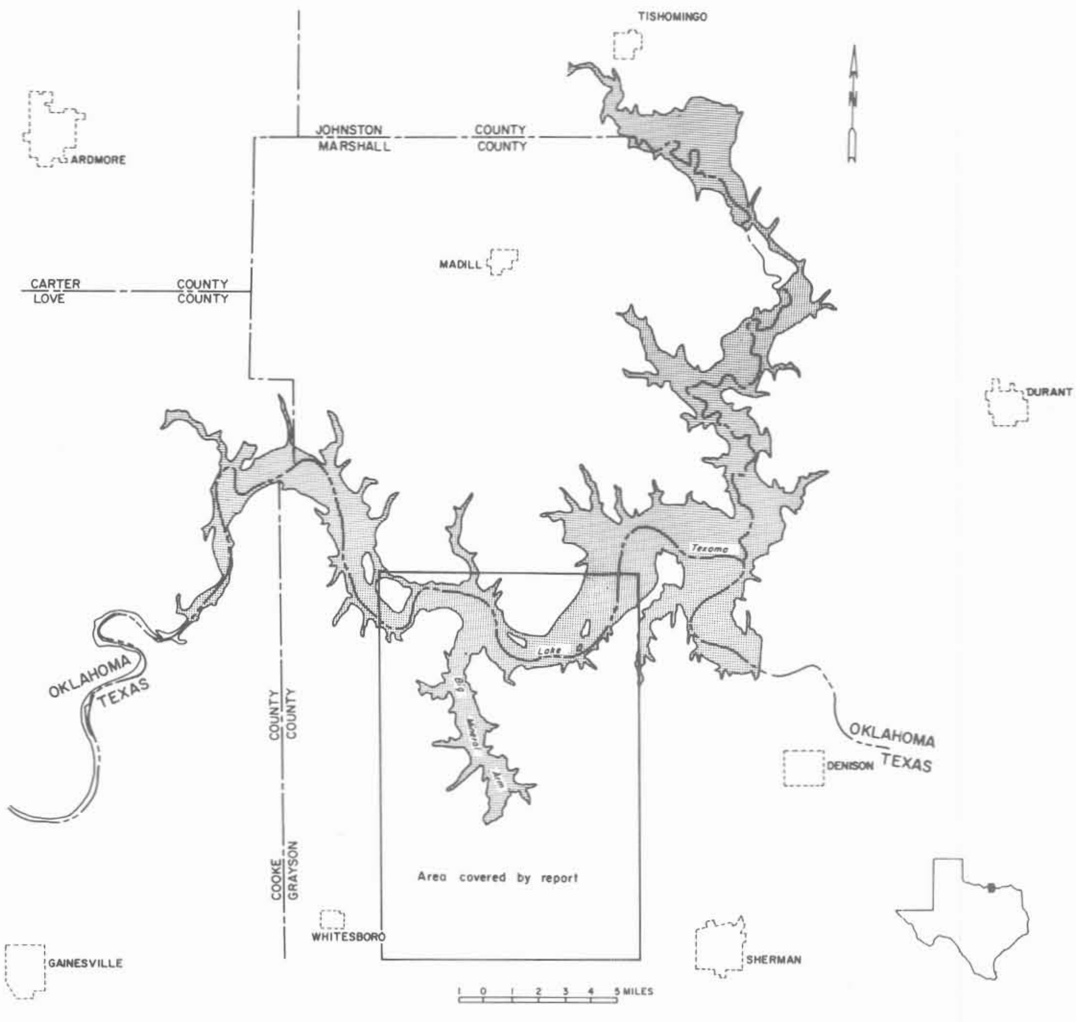

Figure 1

Lake Texoma and Vicinity Showing Location of Report Area

U. S. Geological Survey in cooperation with the Texas Water Development Board and the City of Sherman

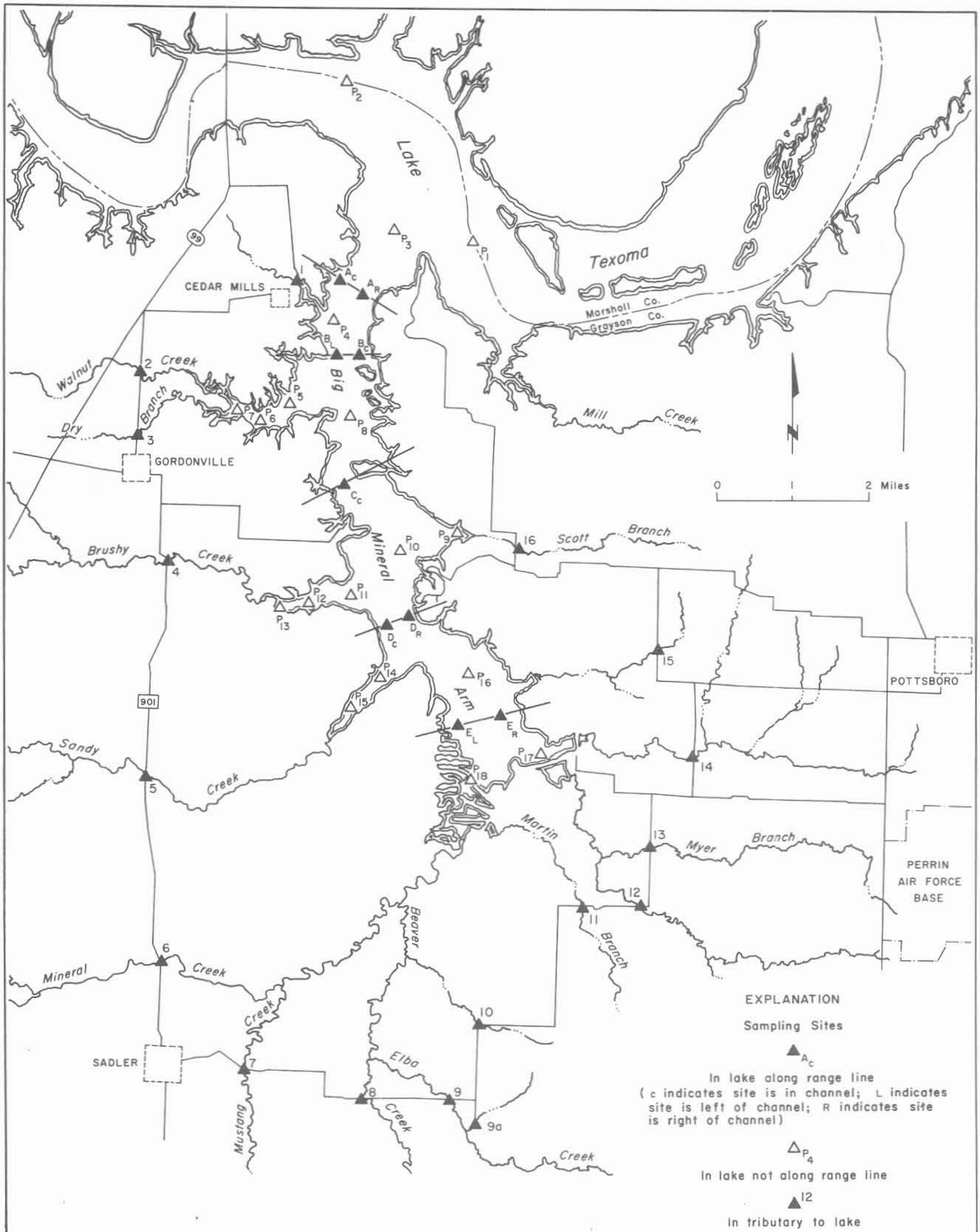

Figure 2

Locations of Sampling Sites

U. S. Geological Survey in cooperation with the Texas Water Development Board and the City of Sherman

Base compiled from USGS topographic quadrangles

Table 1.--Diagrammatic table showing depths, specific conductances, and chlorides in that order for sampling sites in Big Mineral Arm, January 20, 1966

[Exact location of sampling points shown on Figure 2. Specific conductance in micromhos at 25°C and chloride in parts per million.]

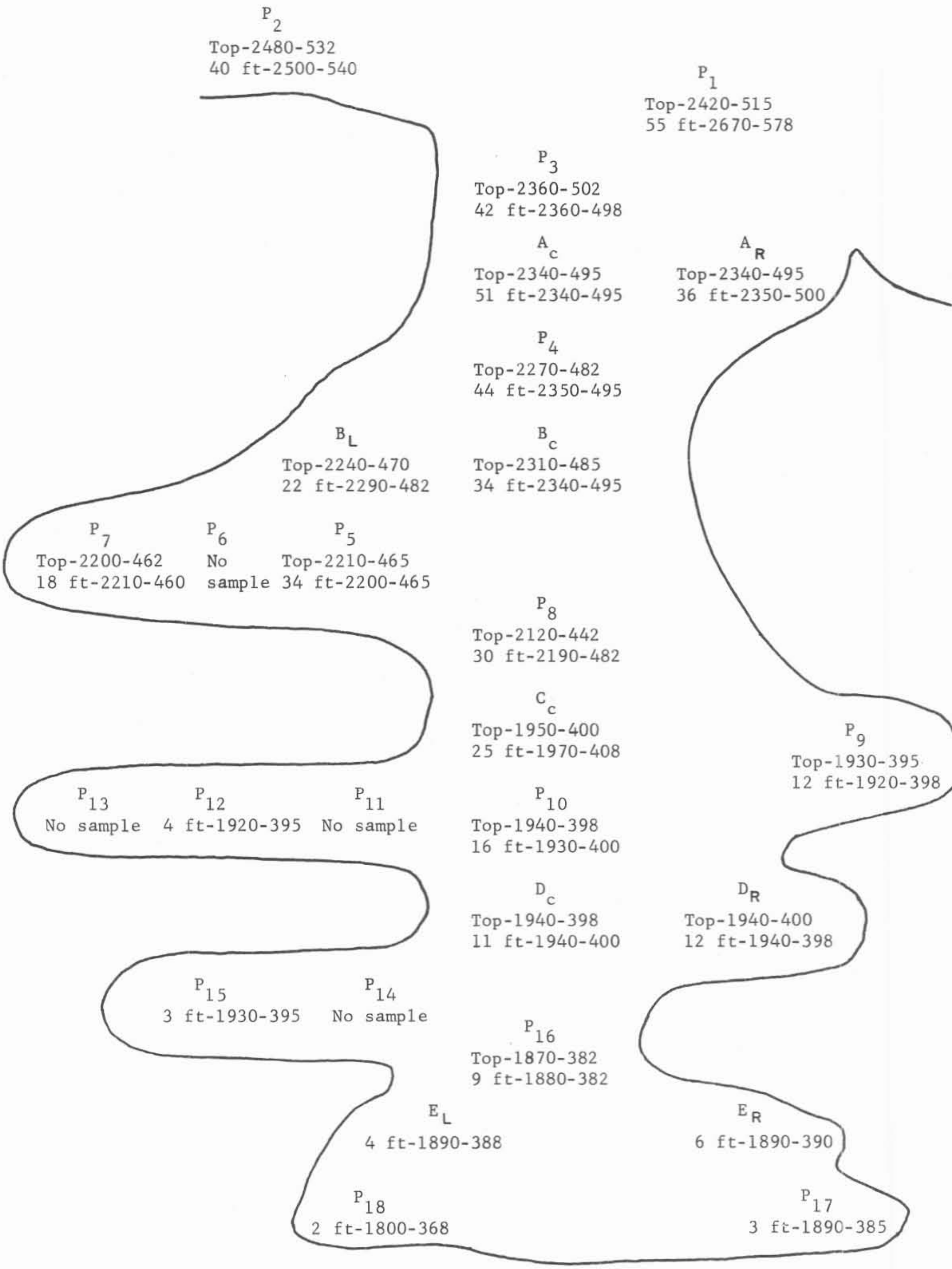

Table 2.--Chemical analyses of water from Big Mineral Arm and main body of Lake Texoma, January 20, 1966

Lake surface elevation 613.2 feet

Results in parts per million except as indicated

Site of collection	Depth in feet	Temp. (°F)	Silica (SiO_2)	Iron (Fe) Solution	Iron (Fe) Total	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved oxygen (DO)	Dissolved solids (calculated) Parts per million	Dissolved solids (calculated) Tons per acre-foot	Hardness as $CaCO_3$ Calcium, Magnesium	Hardness as $CaCO_3$ Non-carbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH	Field pH
P_1	Top	48	--	--	--	--	--	--		134	0	316	515	--	--	11.5	--	--	476	366	--	2,420	7.5	8.2
	55	50	--	--	--	--	--	--		--	--	--	578	--	--	11.3	--	--	--	--	--	2,670	--	8.2
P_2	Top	48	2.8	--	--	134	36	328		136	0	320	532	0.3	1.8	11.5	1,420	1.93	484	372	6.5	2,480	7.6	8.1
	40	49	--	--	--	--	--	--		136	0	332	540	--	--	11.5	--	--	482	370	--	2,500	7.5	8.1
P_3	Top	48	--	--	--	--	--	--		--	--	--	502	--	--	11.6	--	--	--	--	--	2,360	--	8.1
	42	48	--	--	--	--	--	--		--	--	--	498	--	--	11.9	--	--	--	--	--	2,360	--	8.1
A_c	Top	48	2.8	--	--	127	33	307		132	0	300	495	.2	1.2	11.6	1,330	1.81	452	344	6.3	2,340	7.6	8.0
	51	48	--	--	--	--	--	--		128	0	302	495	--	--	11.6	--	--	458	353	--	2,340	7.4	8.0
A_R	Top	48	--	--	--	--	--	--		--	--	--	495	--	--	11.6	--	--	--	--	--	2,340	--	8.0
	36	48	--	--	--	--	--	--		--	--	--	500	--	--	11.6	--	--	--	--	--	2,350	--	8.0
P_4	Top	48	--	0.01	0.01	--	--	--		--	--	--	482	--	--	11.6	--	--	--	--	--	2,270	--	7.9
	44	48	--	.01	.01	--	--	--		--	--	--	495	--	--	11.6	--	--	--	--	--	2,350	--	7.9
B_c	Top	48	3.0	--	--	125	35	295		132	0	292	485	.4	1.2	11.5	1,300	1.77	456	348	6.0	2,310	7.5	8.0
	34	48	--	--	--	--	--	--		--	--	--	495	--	--	11.5	--	--	--	--	--	2,340	--	8.0
B_L	Top	48	--	--	--	--	--	--		--	--	--	470	--	--	11.5	--	--	--	--	--	2,240	--	7.9
	22	48	--	--	--	--	--	--		--	--	--	482	--	--	11.5	--	--	--	--	--	2,290	--	7.9
P_5	Top	48	--	--	--	--	--	--		--	--	--	465	--	--	11.6	--	--	--	--	--	2,210	--	7.9
	34	48	--	--	--	--	--	--		--	--	--	465	--	--	11.6	--	--	--	--	--	2,200	--	7.9
P_7	Top	47	--	--	--	--	--	--		--	--	--	462	--	--	11.8	--	--	--	--	--	2,200	--	7.9
	18	45	--	--	--	--	--	--		--	--	--	460	--	--	11.8	--	--	--	--	--	2,210	--	7.9
P_8	Top	48	--	--	--	--	--	--		--	--	--	442	--	--	11.5	--	--	--	--	--	2,120	--	7.9
	30	48	--	--	--	--	--	--		--	--	--	482	--	--	11.5	--	--	--	--	--	2,190	--	7.8
C_c	Top	45	--	--	--	--	--	--		--	--	--	400	--	--	12.0	--	--	--	--	--	1,950	--	7.6
	25	45	--	--	--	--	--	--		--	--	--	408	--	--	12.0	--	--	--	--	--	1,970	--	7.8
P_9	Top	46	--	--	--	--	--	--		124	0	240	395	--	--	12.0	--	--	384	282	--	1,930	7.4	7.7
	12	45	--	--	--	--	--	--		--	--	--	398	--	--	12.0	--	--	--	--	--	1,920	--	7.7
P_{10}	Top	45	--	--	--	--	--	--		--	--	--	398	--	--	12.0	--	--	--	--	--	1,940	--	8.1
	16	45	--	--	--	--	--	--		--	--	--	400	--	--	12.0	--	--	--	--	--	1,930	--	8.1
P_{12}	4	43	--	--	--	--	--	--		--	--	--	395	--	--	12.3	--	--	--	--	--	1,920	--	8.1
D_c	Top	45	--	.01	.01	--	--	--		--	--	--	398	--	--	12.0	--	--	--	--	--	1,940	--	8.1
	11	45	--	.01	.02	--	--	--		--	--	--	400	--	--	12.0	--	--	--	--	--	1,940	--	8.1
D_R	Top	45	--	--	--	--	--	--		--	--	--	400	--	--	12.0	--	--	--	--	--	1,940	--	8.1
	12	45	--	--	--	--	--	--		--	--	--	398	--	--	12.0	--	--	--	--	--	1,940	--	8.1
P_{15}	3	41	--	--	--	--	--	--		122	0	238	395	--	--	12.6	--	--	396	296	--	1,930	7.3	8.0
P_{16}	Top	43	--	--	--	--	--	--		--	--	--	382	--	--	12.4	--	--	--	--	--	1,870	--	8.1
	9	43	--	--	--	--	--	--		--	--	--	382	--	--	12.4	--	--	--	--	--	1,880	--	8.1
E_L	4	43	2.8	--	--	106	27	235		122	0	226	388	.3	1.5	12.4	1,050	1.34	374	274	5.3	1,890	7.4	8.1
E_R	6	44	--	--	--	--	--	--		--	--	--	390	--	--	12.3	--	--	--	--	--	1,890	--	8.1
P_{17}	3	43	--	--	--	--	--	--		--	--	--	385	--	--	12.4	--	--	--	--	--	1,890	--	8.1
P_{18}	2	40	--	.00	.01	--	--	--		130	0	224	368	--	--	12.8	--	--	374	268	--	1,800	7.3	8.0

The greatest difference of specific conductance and chloride from the top to the bottom in Big Mineral Arm was at sampling sites P_4 and P_8, where the conductance ranged from 2,120 to 2,190 micromhos at 25°C at P_4 and the chloride concentration ranged from 442 to 482 ppm (parts per million) at P_8. The difference in dissolved-solids concentration, inferred from the specific conductances, from top to bottom was negligible at most points throughout the lake (Tables 1 and 2).

Although all the water in Big Mineral Arm was slightly saline (slightly less than 1,050 to 1,330 ppm dissolved solids), the dissolved-solids concentration decreased toward the upstream sampling sites (Table 2). The most saline water in Big Mineral Arm was at sampling site A_R near the main body of Lake Texoma (Figure 2), where the specific conductance was 2,350 micromhos at 25°C and the chloride concentration was 500 ppm at a depth of 36 feet. This water was less mineralized than the water in the main body of the lake. The least saline water in Big Mineral Arm was at sampling site P_{18}, the most upstream sampling site, where the specific conductance was 1,800 micromhos at 25°C and the chloride concentration was 368 ppm. Thus, the water in Big Mineral Arm largely was diluted by tributary inflow into the Arm.

Although the water in Big Mineral Arm was somewhat less mineralized than that of the main body of Lake Texoma, the water in Big Mineral Arm had the same proportion of dissolved constituents as shown by diagrammatic representations of both waters (Figure 3). The discharge-weighted average analysis for the Red River near Gainesville, Texas, for the 1963 water year, the last year of complete record, also shows about the same concentration and characteristic proportions as found during the lake survey.

In summary, the study of January 20, 1966, shows that the water in Big Mineral Arm was well mixed, was the same type water as that in the main body of Lake Texoma, and was diluted by tributary inflow into the Arm. Because of its salinity at the time of the survey, the water in Big Mineral Arm would not meet the standards of the U.S. Public Health Service (1962) for municipal supplies. However, the water was of better quality than that used by some municipalities in West Texas.

QUALITY OF WATER OF TRIBUTARIES TO BIG MINERAL ARM

During the quality-of-water survey of the tributaries, January 18-19, 1966, a period of low flow, there was flow at only 10 of the 16 inflow sampling sites visited. A water sample was collected at site 9_a on a tributary to Elba Creek a short distance upstream from site 9 on Elba Creek because the water in the tributary to Elba Creek appeared to be an oily emulsion and was directly downstream from producing oil wells. Only five of the samples of inflow had dissolved-solids concentrations low enough to meet the U.S. Public Health Service Standards for municipal supplies (Table 3). The water of the other tributaries was too highly mineralized to meet the standards for municipal use. Also, the concentrations of some individual dissolved constituents in water in five of the tributaries were too high to meet the standards. The highest concentration of any individual constituent was the 2,520 ppm chloride in Sandy Creek (site 5).

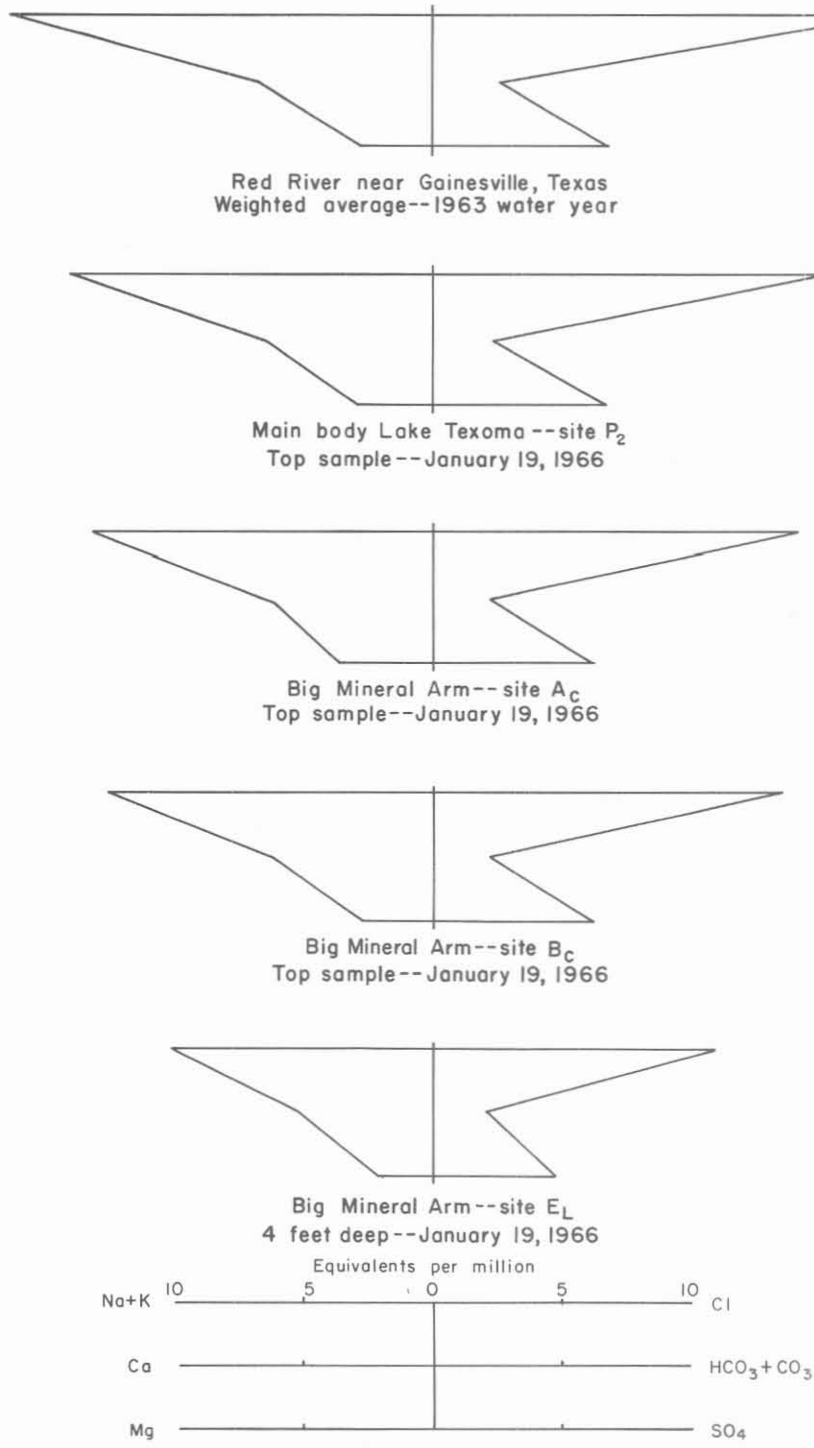

Figure 3

Selected Chemical Analyses of Lake Texoma and Red River Waters

U. S. Geological Survey in cooperation with the Texas Water Development Board and the City of Sherman

Table 3.--Chemical analyses of inflow water during low and high flows into Big Mineral Arm, January 18-19 and February 10-11, 1966

Results in parts per million except as indicated

Date of collection	Discharge (cfs)	Temp. (°F)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Nitrite (NO_2)	Dissolved solids (calculated) Parts per million	Dissolved solids (calculated) Tons per acre-foot	Hardness as $CaCO_3$ Calcium, Magnesium	Hardness as $CaCO_3$ Non-carbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
SITE 1. CEDAR CREEK 0.5 MILE NORTH OF CEDAR MILLS																					
Jan. 19, 1966.........	A0.05	35	5.5	45	20	27		204	0	49	24	0.2	0.0		271	0.37	193	26	0.8	493	7.4
Feb. 10...............	2.3	60	.0	54	8.8	19		170	0	51	14	.2	.2		231	.31	171	32	.6	411	6.9
SITE 2. WALNUT CREEK 1.4 MILES NORTH OF GORDONVILLE																					
Jan. 19, 1966.........	A0.02	37	2.5	66	32	31		164	0	186	24	0.4	0.2		423	0.58	296	162	0.8	709	7.5
Feb. 10...............	2.1	56	.0	40	16	14		88	0	105	10	.3	.5		229	.31	167	95	.5	398	6.6
SITE 3. DRY BRANCH 0.5 MILE NORTH OF GORDONVILLE																					
Jan. 19, 1966.........	A0.01	38	34	268	73	118		0	0	1,180	22	2.6	0.0		1,700	2.31	970	970	1.7	1,940	4.4
Feb. 10...............	A1.2	53	.0	107	40	42		2	0	480	14	1.0	.0		685	.93	432	430	.9	957	4.8
SITE 4. BRUSHY CREEK AT FM ROAD 901, 1.5 MILES SOUTH OF GORDONVILLE																					
Jan. 19, 1966.........	0																				
Feb. 10...............	22.8	54	8.8	26	8.5	14		36	0	62	24	0.3	1.2		163	0.22	100	70	0.6	287	6.2
SITE 5. SANDY CREEK AT FM ROAD 901, 3.9 MILES NORTH OF SADLER																					
Jan. 19, 1966.........	A0.05	42	20	972	334	180		192	0	460	2,520				4,580	6.23	3,800	3,640	1.3	9,940	6.1
Feb. 10...............	28.1	55	.0	59	15	103		40	0	42	251	0.3	1.2		492	.67	209	176	3.1	983	6.2
SITE 6. MINERAL CREEK AT FM ROAD 901, 1.4 MILES NORTH OF SADLER																					
Jan. 19, 1966.........	A1.2	40	5.2	119	27	340		338	0	131	515	0.4	9.3		1,310	1.78	410	133	7.3	2,380	7.6
Feb. 10...............	27.5	55	.0	42	9.7	65		86	0	61	106	.3	1.0		327	.44	145	74	2.3	613	6.4
SITE 7. MUSTANG CREEK 1.2 MILES EAST OF SADLER																					
Jan. 19, 1966.........	B0	33	9.1	66	5.0	65		122	0	103	75	0.4	0.8	0.10	384	0.52	185	85	2.1	547	6.9
Feb. 10...............	23.8	55	10	47	6.7	19		74	0	84	24	.5	3.2		230	.31	145	84	.7	398	6.4
SITE 8. BEAVER CREEK 3.1 MILES EAST OF SADLER																					
Jan. 19, 1966.........	A0.3	33	11	32	10	139		388	0	76	18	0.7	0.8		478	0.65	122	0	5.5	808	7.7
Feb. 10...............	26.8	55	10	46	4.7	13		99	0	71	3.8	.5	1.2		199	.27	134	53	.5	332	6.7
SITE 9. ELBA CREEK 4.8 MILES EAST OF SADLER																					
Jan. 19, 1966.........	A0.001	33	6.5	54	4.7	16		188	0	24	5.8	0.4	0.8		204	0.28	154	0	0.6	363	7.2
Feb. 10...............	13.7	55	7.0	36	4.9	11		90	0	51	4.3	.4	.2		159	.22	110	36	.5	277	6.7

A Estimated.
B Ponded.

Table 3.--Chemical analyses of inflow water during low and high flows into Big Mineral Arm, January 18-19 and February 10-11, 1966--Continued

Results in parts per million except as indicated

Date of collection	Discharge (cfs)	Temp. (°F)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Nitrite (NO_2)	Dissolved solids (calculated)		Hardness as $CaCO_3$		Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
															Parts per million	Tons per acre-foot	Calcium, Magnesium	Noncarbonate			
SITE 9a. TRIBUTARY TO ELBA CREEK, 0.6 MILE SOUTHEAST OF SITE 9																					
Jan. 18, 1966	A0.001	39	14	63	52	648		676	0	166	745	0.5	0.2		2,020	2.75	370	0	15	3,200	7.8
SITE 10. UNNAMED CREEK 6.2 MILES EAST OF SADLER																					
Jan. 19, 1966	0																				
Feb. 11	.07	44	7.6	46	4.0	9.5	3.9	98	0	64	4.6	0.3	0.5		188	0.26	131	52	0.4	312	6.5
SITE 11. MARTIN BRANCH 8.7 MILES SOUTHWEST OF POTTSBORO																					
Jan. 19, 1966	0																				
Feb. 11	3.4	44	0.0	74	6.4	19		100	0	158	2.5	0.3	0.5		310	.42	211	129	0.6	490	6.7
SITE 12. HARRIS CREEK 7.9 MILES SOUTHWEST OF POTTSBORO																					
Jan. 19, 1966	0																				
Feb. 11, 1966	2.9	49	0.0	87	8.0	23		99	0	198	8.6	0.4	0.8		375	0.51	250	169	0.6	573	6.6
SITE 13. MYER BRANCH 7.0 MILES SOUTHWEST OF POTTSBORO																					
Jan. 19, 1966	0																				
Feb. 11	1.7	45	0.0	72	6.4	18		125	0	127	6.1	0.4	0.2		291	0.40	206	104	0.5	483	6.7
SITE 14. UNNAMED CREEK 6.3 MILES WEST SOUTHWEST OF POTTSBORO																					
Jan. 19, 1966	A0.5	39	5.1	48	18	233		298	0	198	148	0.8	48		846	1.15	194	0	7.3	1,400	7.4
Feb. 11	3.8	48	.0	65	9.2	28		114	0	140	14	.4	1.8		314	.43	200	106	.9	506	6.7
SITE 15. UNNAMED CREEK 4.6 MILES WEST OF POTTSBORO																					
Jan. 19, 1966	0																				
Feb. 11	.1	47	0.0	109	10	17		103	0	242	9.4	0.3	0.5		439	0.60	314	230	0.4	665	6.8
SITE 16. SCOTT BRANCH 6.8 MILES WEST OF POTTSBORO																					
Jan. 19, 1966	0																				
Feb. 11	.3	49	0.0	65	31	33		3	0	335	5.8	0.4	1.5		473	0.64	290	288	0.8	631	5.2

A Estimated.

The dissolved-solids concentration of inflow during January 18-19 is about the maximum to be expected because the flows at all sites except site 6 (Big Mineral Creek) were relatively small. The total amount of salts contributed to the lake during these low flows would obviously be small.

Water samples collected at the same inflow sites on February 10-11, 1966, during high flows, were of much better quality than the low-flow samples collected in January. Only at site 3 (Dry Branch), did the dissolved-solids concentration exceed 500 ppm. Here the concentration of dissolved solids on February 10 was 685 ppm, of which 480 ppm was sulfate (250 ppm sulfate is the upper limit established by the U.S. Public Health Service). The concentration of chloride (251 ppm) at site 5 (in Sandy Creek) exceeded only slightly the U.S. Public Health Service limit of 250 ppm. The water at all other sites met the U.S. Public Health Service Standards. The diagrammatic representation of the chemical analyses of inflow water during high and low flows (Figure 4) shows that the dominant type water was calcium sulfate and shows that this is in contrast to the dominant sodium chloride water in Big Mineral Arm, main body of Lake Texoma, and Red River (Figure 3).

CONCLUSIONS

A review of the analyses of water samples from the 16 sampling sites and the diagrammatic representation of these analyses (Figure 4 and Table 3) give an indication of the tributaries that may be sources of good water and also show problem areas and possible sources of contamination.

The quality of water at sites 1 and 2 was good at low and high flows, but at site 3 the concentration of sulfate is high (1,180 and 480 ppm) at low and high flows, respectively. Baker (1960) shows that some areas of the Woodbine Formation yield ground water of high sulfate concentration. Well A-16, which is described in the above report, is near site 3. This well, producing from the Woodbine, had a sulfate concentration of 1,050 ppm. Water from site 16 had similar ratios of constituents to water from site 3, although the water contained a much lower concentration of dissolved solids during high flow.

Site 4 had water of good quality during high flow. There was no flow at this site during the January survey.

At sites 5 and 6 the water had a high chloride content during low and high flows; sodium plus potassium and calcium were the predominant dissolved cations. The persistence of a sodium or potassium chloride type water even during high flows may be an indication of contamination by oil-field brines. A report of oil-field brine disposal by the Texas Water Commission and Texas Water Pollution Control Board (1963) shows that in 1961 most of the brine disposal in the oil fields of the area was by open surface pits.

The water at sites 7, 8, and 9 was of good quality during low and high flows. A saline tributary (site 9_a), probably was affected by oil-field waste, but its flow was not large enough to increase appreciably the salinity of the water at site 9.

There was no flow at sites 10, 11, and 12 during the survey in January, but during the February survey the water at all three sites was of good quality.

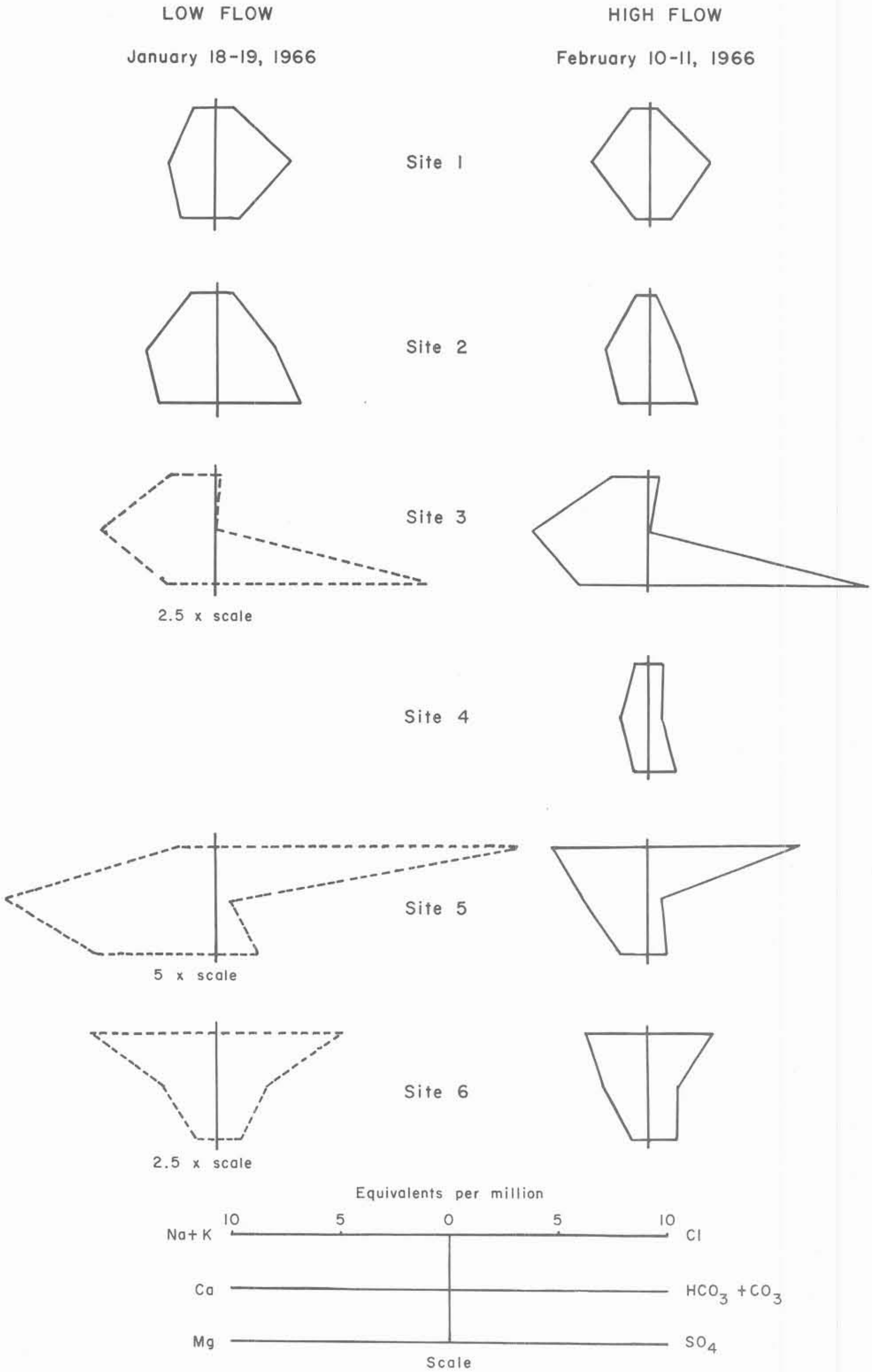

Figure 4

Chemical Analyses of Inflow Water During Low and High Flows into Big Mineral Arm

U. S. Geological Survey in cooperation with the Texas Water Development Board and the City of Sherman

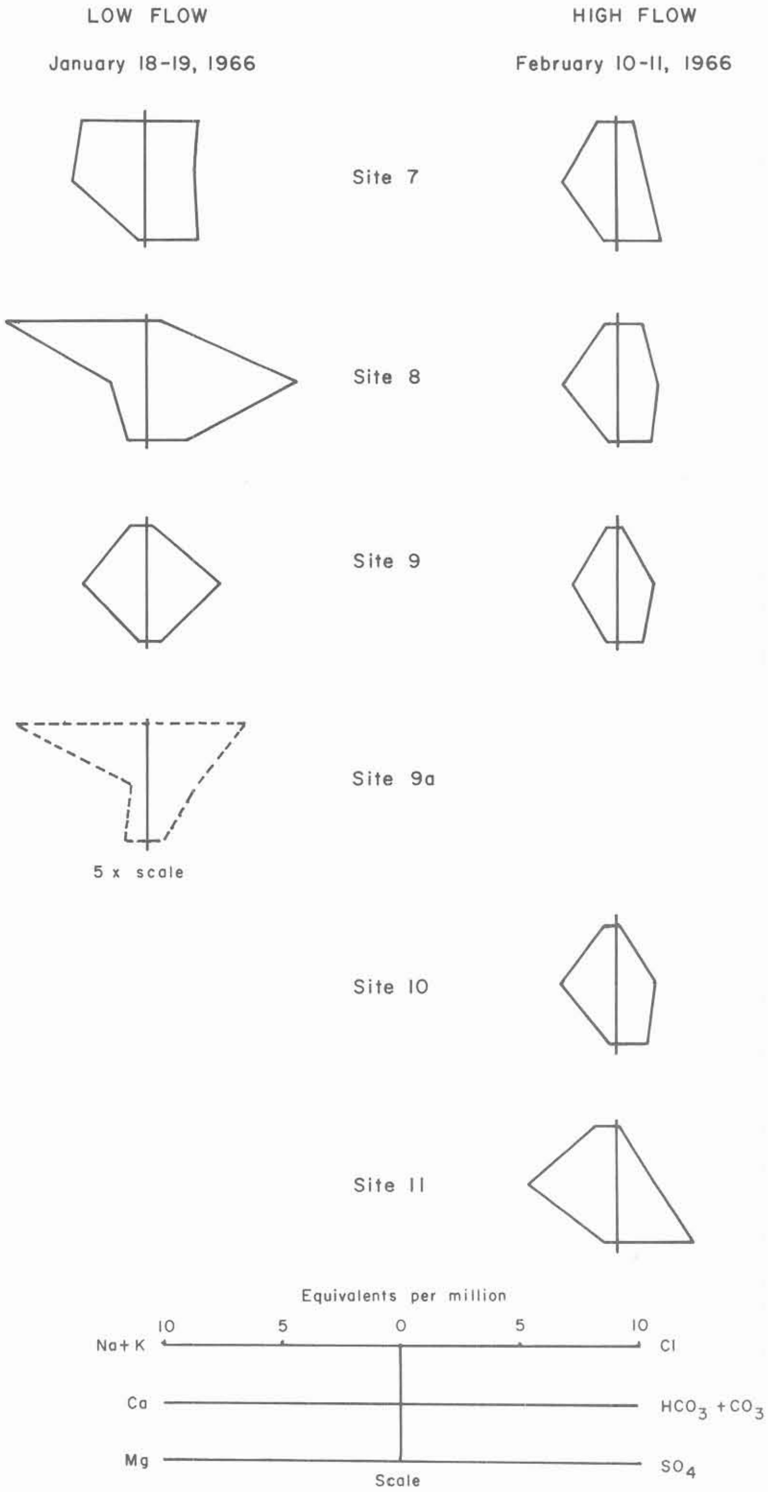

Figure 4-- Continued
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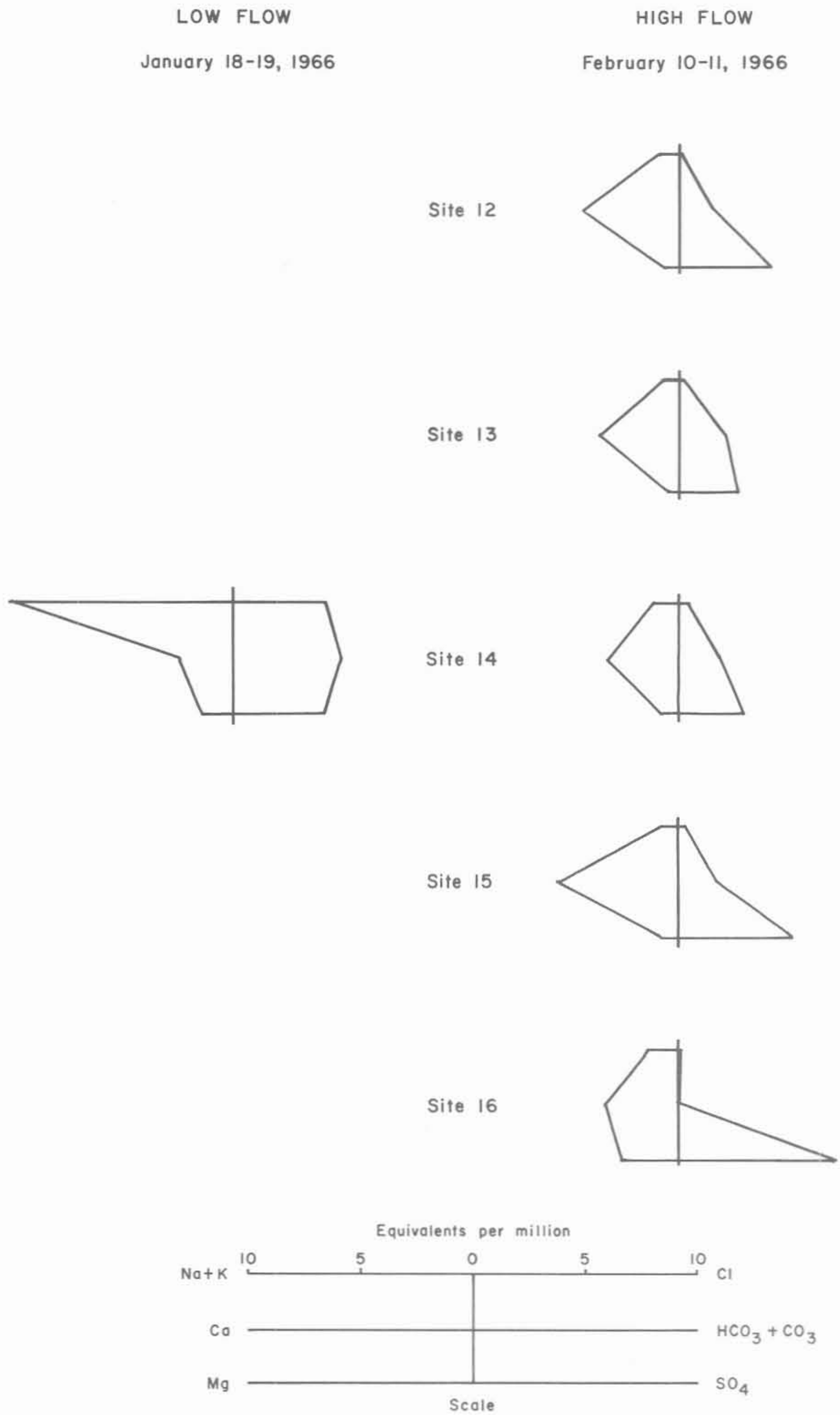

Figure 4-- Continued

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The low flow at site 14 was low in dissolved-solids content and only one of the dissolved constituents, nitrate, exceeded the maximum permitted by the U.S. Public Health Service Standards. Nevertheless, the high nitrate (48 ppm) and the proportions of the dissolved constituents point to possible contamination by sewage. During the high flows of February, the quality of the water at this site was excellent.

The water at sites 15 and 16 was of good quality (except for a high sulfate concentration at site 16) after the high flows in February. There was no flow at sites 15 and 16 during the survey in January.

In summary, the analyses of inflow water into Big Mineral Arm of Lake Texoma show that most of the inflow water was of acceptable quality for municipal supplies. Some of the water of tributary streams was of good quality even during the period of low flow, but the amounts of flow were too small to affect appreciably the quality of the water in the Arm. The water in Big Mineral Creek, the only tributary with significant low flow, 1.2 cfs (cubic feet per second), was slightly saline.

At high flow, all but two of the inflow samples (at sites 3 and 16) were of good quality. These more mineralized waters came from smaller watersheds whose contribution would be only a small part of the total inflow into Big Mineral Arm.

RECOMMENDATIONS

At the time of the survey in January, the water in Big Mineral Arm of Lake Texoma was slightly saline and essentially the same as that in the main body of Lake Texoma. If the water in the Arm is to be used for municipal supply, it would be desirable to provide for some dilution with water of better quality, or to devise some means of preventing free mixing of water from Big Mineral Arm with that of Red River.

A more intensive investigation is needed to isolate the specific sources of contamination and to determine remedial measures to reduce the salt load in Sandy and Big Mineral Creeks. This study is needed because: (1) the poor quality of the low flows at sites 5 and 6 (in Sandy and Mineral Creeks, respectively) and a comparison of constituents of the water at these sites at both low and high flows indicate that much of the mineralization of the water on these tributaries is probably due to contamination by oil-field brines, and (2) these two tributaries are probably the largest contributors of inflow to Big Mineral Arm.

Although the high sulfate of both low and high flows on Dry Branch (site 3) and the similarity of dissolved constituents of the high flow at site 3 and site 16 on Scott Branch indicate that the probable cause of mineralization is natural, more studies should be made to confirm this indication.

Because part of the mineralization of the low flow at site 14 may be caused by man's activities, further work must be done to determine exact sources of contamination and to determine remedial measures.

With the reconnaissance-type data collected in this investigation--a lake survey and samples of high and low inflows of the tributaries--the future quality of inflow into Big Mineral Arm can be predicted only in broad terms; that is, the weighted-average concentration of dissolved solids probably will be less than 500 ppm. So that more exact quantitative predictions of both the quantity and the quality of water of inflows into the Big Mineral Arm can be determined, more intensive studies should be made. A good record of quantity and quality should involve years of above and below normal rainfall as well as average years.

REFERENCES CITED

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