TEXAS WATER DEVELOPMENT BOARD

REPORT 25

BASE-FLOW STUDIES

LITTLE CYPRESS CREEK

UPSHUR, GREGG, AND HARRISON COUNTIES, TEXAS

Quantity and Quality, January and June 1964

By

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Prepared by the U.S. Geological Survey
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TABLE OF CONTENTS

TABLES

TABLE OF CONTENTS (Cont'd.)

Page

ILLUSTRATIONS

Figures

Plates

Follows

B A S E - F L O W   S T U D I E S

L I T T L E   C Y P R E S S   C R E E K

U P S H U R ,   G R E G G ,   A N D

H A R R I S O N   C O U N T I E S ,   T E X A S

Q u a n t i t y   a n d   Q u a l i t y

J a n u a r y   a n d   J u n e   1 9 6 4

INTRODUCTION

The base-flow investigation of Little Cypress Creek in northeast Texas was made by the U.S. Geological Survey under provisions of the 1964 cooperative agreement with the then Texas Water Commission. The agreement provides for the investigation of the water resources of Texas.

Base flow is defined as sustained or fair-weather flow. In most cases the base flow is predominantly ground-water effluent; however, it may include return from bank storage and residual-precipitation runoff in the form of drainage from lakes, swamps, and marshes. Amount of base flow, therefore, may vary with climate, geology, vegetation, and human activities.

Purposes of the base-flow studies were: (1) to determine the source and quantity of the low flow; (2) to determine the chemical quality of the water and its suitability for municipal, industrial, and agricultural use; and (3) to evaluate the effect of geology, vegetation, and human activities on the quantity and chemical quality of the water.

To evaluate the gains and losses of streamflow the tributary inflow, streambed material, and flood-plain vegetation were examined at sites that include the main channel and all defined tributaries, shown in Plate 1. Two field surveys were made for this investigation:

1. In January 1964, a limited survey was made of a channel reach beginning at site 5 (mile 48.0) and ending at site 57 (mile 7.5). Discharge measurements and quality-of-water samples were obtained at only 7 sites on the main channel in this survey.

2. In June 1964, a survey was made of a reach beginning at site 1 (mile 52.1) and ending at site 61 (mile 3.0). Discharge measurements and quality-of-water samples were obtained at 10 sites on the main channel (7 sites of the January survey were remeasured) and at sites on all flowing tributaries.

The reason for selecting the January and June periods was to obtain the maximum annual difference in the effects which vegetal growth, evaporation, and usage have on the streamflow in the reach.

Available in the files of the U.S. Geological Survey in Austin are supporting data for tables and illustrations in this report.

WATERSHED FEATURES

Climate

Average annual precipitation is about 46 inches in the Little Cypress Creek watershed. Eleven inches of this precipitation generally occurs during the months of April and May. The average precipitation for January is about $4\frac{1}{2}$ inches and for June about 3 inches. The average annual temperature is about 66° F.; the coldest month is January and the warmest July. During this investigation the January and June temperatures were less than average, and there was no precipitation. Thus, the climate was favorable for base-flow studies.

General Geomorphology

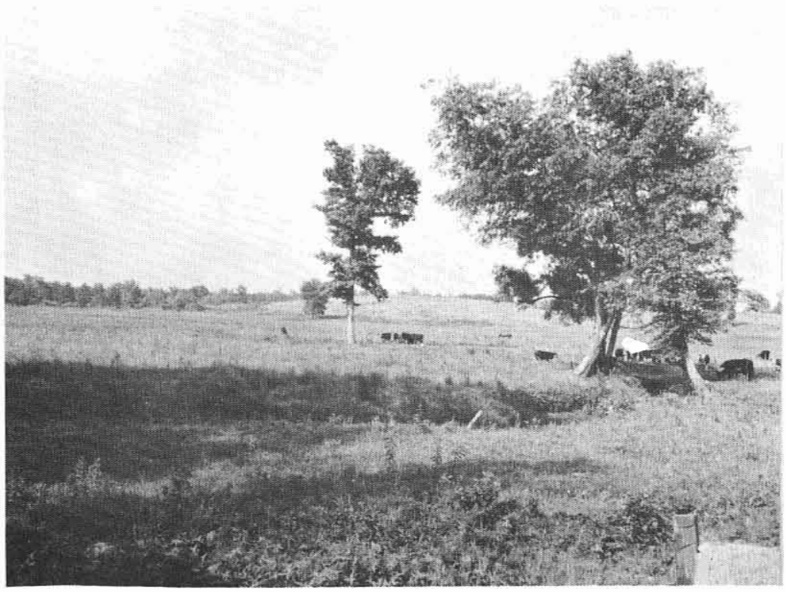
Little Cypress Creek, which has its headwaters in southwestern Camp and northeastern Wood Counties, flows eastward about 70 miles, draining parts of Upshur, Gregg, Marion, and Harrison Counties in northeastern Texas. These counties lie within the northern part of the West Gulf Coastal Plain physiographic province. The drainage areas above the stream-gaging stations at sites 7 and 57 include 383 and 675 square miles respectively. The total drainage area above the mouth is 693 square miles.

The drainage basin is bounded by irregular, rolling, and hilly uplands, many of which are cultivated or cleared for pastureland (Figure 1A). The flood plain forms a flat valley, generally 1 to 2 miles in width. Little Cypress Creek has the characteristics of the typical old-age stream in that it meanders irregularly across the flood plain, forming swamp and marsh areas adjacent to its main channel. The gradient of the streambed is established and only minor degradation takes place. In some oil-field and cleared areas, the natural channel configuration has been straightened by clearing of vegetation by man. Approximately 70 percent of the basin is densely covered with evergreens and deciduous vegetation. Abundant growth of phreatophytes generally is more concentrated on the flood plains and marshlands (Figures 1B and 2A).

GEOHYDROLOGY

Geologic Structure of Little Cypress Creek Watershed

Little Cypress Creek traverses sediments deposited in a synclinal structure known as the East Texas Embayment or Basin. The East Texas Basin trends northeastward, its axis passing through Wood, Upshur, Harrison, Marion, and Cass



A. Cleared productive pastureland area near site 6

B. Timber reforestation and conservation area operated by a private lumber company near site 61

Figure 1

Typical Improved Agricultural and Forested Areas in the Little Cypress Creek Watershed

U.S. Geological Survey in cooperation with the Texas Water Development Board

A. Spring (dashed line) flowing from the Queen City Sand adjacent to Little Cypress Creek near site 27

B. Vegetation (dashed line) in highway cut denotes seepage and spring horizon coincident with the contact. The flood plain of Little Cypress Creek near site 61 is shown at far right.

Figure 2

Typical Occurrences of Seeps and Springs in the Little Cypress Creek Watershed

U.S. Geological Survey in cooperation with the Texas Water Development Board

Counties. This structural basin is bordered by the Sabine Uplift on the southeast and the Luling-Mexia-Talco Fault System on the northwest. The northwestern flank of the Sabine Uplift extends diagonally northeastward across Harrison and Marion Counties.

Within this synclinal structure a great thickness of shoreline sediments was deposited. Subsequent erosion has exposed the bedrock units, all of which belong to the Claiborne and Wilcox Groups. The majority of the outcrops within the Little Cypress Creek watershed is composed of the Weches Greensand, Queen City Sand, Reklaw Formation, and the Wilcox Group. Adjacent to the main channel and larger tributaries are Quaternary terrace and alluvial deposits. Figure 3 is a generalized geologic map showing the distribution of the geologic units in the Little Cypress Creek watershed.

In the vicinity of Kelsey, approximately 6 miles west of Gilmer (Plate 1 and Figure 3) is a structural uplift known as the Kelsey Anticline. The Kelsey Anticline is a broad, bilobate, wedge-shaped structure. The configuration of Kelsey Creek shows a large curve southward on the southern flank of the anticline. This curve indicates that the southern end of the anticline has undergone the more recent uplift, the anticlinal folding apparently having diverted Kelsey Creek from the normal northeasterly course. On the northern flank of the anticline Little Cypress Creek shows similar initial lateral dislocation northward, but has since become incised into the Claiborne and Wilcox Groups contemporaneously with uplift. No evidence of faulting is discernible at the surface in the vicinity of the Kelsey Anticline.

A fault approximately 1 mile southwest of Jefferson (Plate 1 and Figure 3), trending southward, probably intersects Little Cypress Creek near its junction with Grays Creek. Southward from Little Cypress Creek the fault is not discernible on the surface, but electric logs from oil and gas wells in the vicinity indicate that it extends downward into the Wilcox Group. Hydrologically, this fault seems to have no noticeable effect upon the normal flow or quality of the surface water traversing the area.

Hydrologic Properties of the Geologic Units

The Weches Greensand consists of glauconite, glauconitic sand and silt, and iron ore. It forms a highly erosion-resistant, reddish-black sandstone about 40 feet thick. Only small outliers of the Weches Greensand are found capping the more prominent hills within the Little Cypress Creek watershed. Since the sandstone is known to yield only minor quantities of water to wells, rejected recharge in the form of streamflow probably is minor.

The Queen City Sand, which underlies the Weches Greensand, consists of over 200 feet of interbedded fine to medium quartz sand, sandy and silty clay, and impure lignite. The sand and clay beds are typically lenticular and crossbedded. These alternating sand, clay, and shale beds form many seeps and springs that leach and redeposit limonite on weathered outcrops of the Queen City Sand. In general, the Queen City Sand is relatively porous, permeable, and friable, weathering readily into a light colored sandy loam. About 80 percent of the Little Cypress Creek watershed is in the outcrop area of the Queen City Sand (Figure 3); therefore, it is the major contributor of ground water to the base flow.

The Reklaw Formation, about 100 feet thick, consists mainly of laminated sandy clay, but commonly contains beds of glauconitic sand and crossbedded sandstone. Most of the irregular outcrop area is characterized by a distinctive reddish silty-clay soil. The Reklaw yields small amounts of water to wells and contributes minor amounts to base flow.

The Wilcox Group crops out in a small area in the extreme eastern end of the basin. It consists mostly of fine to medium sand interbedded with clay lenses and lignite seams. The Wilcox Group was found to yield a small amount of base flow at sites 56 and 58 (Plate 1).

Alluvial deposits are adjacent to the main channel of Little Cypress Creek and along many of the larger tributaries. They comprise the flood plains and consist of silt and clay, reaching a maximum thickness of about 50 feet. The alluvium yields only small quantities of water to wells because of its very low transmissibility. In the extreme eastern portion of the basin, terrace deposits (Figure 3) are associated with the alluvium and consist of fine to coarse sand. These alluvial and terrace deposits may contribute a small amount of base flow, but are not nearly so important as the Queen City Sand.

From the foregoing descriptions of the geologic units, it can be seen that they have similar lithologic properties and, therefore, probably are interconnected hydraulically. This condition allows the Wilcox Group and these formations in the Claiborne Group to function as a single aquifer, named the Cypress aquifer (Broom, Alexander, and Myers, 1965).

The main source of ground water and, therefore, base flow within Little Cypress Creek watershed is the large amount of precipitation (about 46 inches annually) on the extensive outcrop of the Queen City Sand. Because of the topography, the dense vegetal growth, and the high ground-water table, only a small part of the annual precipitation becomes permanent ground-water recharge. Much of the precipitation that falls within the basin is absorbed by the exposed sand, only to become rejected ground water further down the topographic slope. This rejected ground water is discharged from springs and seeps (Figure 2A and B) into the dendritic tributaries and the channel of Little Cypress Creek to become base flow. Seeps and springs commonly appear along the contacts of sand beds with the underlying thin clay beds. In the Queen City Sand, these alternating lithological contacts form numerous seeps and springs.

A loss of ground water and surface water is caused by transpiration from the dense phreatophytes in the flood plain of Little Cypress Creek and its tributaries. Diurnal fluctuations of a few hundredths of a foot have been detected by the recorders at the stream-gaging stations. These minor fluctuations result from evaporation and transpiration, which are larger during the summer months. Density of vegetation adjacent to the Little Cypress Creek channel is illustrated by Figures 1B and 2A and B.

CHARACTER OF STREAMFLOW

The Water Resources Division of the U.S. Geological Survey has been collecting streamflow data on Little Cypress Creek near Jefferson (site 57) since December 11, 1963, and near Ore City (site 11) since December 16, 1962. The U.S. Army Corps of Engineers has obtained daily water stages and made occasional discharge measurements, chiefly at medium and high stages, on Little Cypress

Creek at State Highway 154 (Survey site 7; Corps of Engineers station 45-B) and at U.S. Highway 59 (Survey site 57; Corps of Engineers station 45). The Corps of Engineers has published stage records at sites 7 and 57 since 1946, and stage records and discharge measurements since 1951. Monthly discharges for site 57 for the period 1946-63 are available in the U.S. Geological Survey's Surface Water Records of Texas, 1965.

At the stream-gaging station near Ore City (site 11) the creek ceased flowing after continued dry hot periods in 1963 and in July and August 1964. Periods of no flow also have been experienced at the stream-gaging station near Jefferson (site 57). Characteristic base-flow recessions occurred at these two stream-gaging stations during the investigations and are shown by the discharge hydrographs in Figure 4.

January Study

The field survey made January 2-3, 1964, followed a year of drought conditions and a cold December. In 1963 the U.S. Weather Bureau stations at Jefferson, Longview, and Marshall recorded rainfalls, respectively, of 27.66 inches (18.34 inches under normal), 32.85 inches (13.31 inches under normal), and 33.17 inches (13.79 inches under normal). The 1963 rainfall at Gilmer was only 26.13 inches (about 20 inches below normal). Extremely cold weather caused evapotranspiration to be at a minimum. December 1963 produced an average temperature of 38.6° F. (10.4° F. below normal) at nearby Marshall.

Seven water-discharge measurements and chemical-quality samples were taken at sites on the main channel, January 2-3, 1964 (Table 1 and Figure 5). No discharge measurements or chemical-quality samples were taken on tributaries. Site numbers in Table 1 correspond with those on Plate 1, as do those in Table 2, which gives extensive data on the June 1964 study.

Water discharge was found to increase at each successive downstream site in conformity with the increase in drainage area. The discharge increased about 250 percent from 9.5 cubic feet per second (cfs) at mile 48.0 (site 5) to 33.6 cfs at mile 7.5 (site 57). In this overall reach, the total dissolved-solids concentration increased from 103 to 344 parts per million (ppm), or about 230 percent.

From mile 48.0 (site 5) to mile 39.6 (site 11), water discharge increased 6.8 cfs or 72 percent but the quality remained uniform in this subreach. Dissolved-solids concentrations for sites 5, 7, and 11, respectively, were 103, 93, and 107 ppm (Table 1 and Figure 4).

From mile 39.6 (site 11) near Ore City to mile 26.0 (site 31) near Harleton, the water discharge increased 62 percent (16.3 to 26.5 cfs). In this subreach the dissolved-solids concentration increased 160 percent (107 to 282 ppm) and the chloride concentration increased 600 percent (17 to 120 ppm). The chloride concentration of the 10.2 cfs inflow in this reach averaged 285 ppm. Glade Creek probably contributed most of the inflow.

In the subreach from mile 26.0 (site 31) near Harleton to mile 13.1 (site 45) near Woodlawn, the water discharge increased slightly (3.7 cfs) and the water quality was slightly improved.

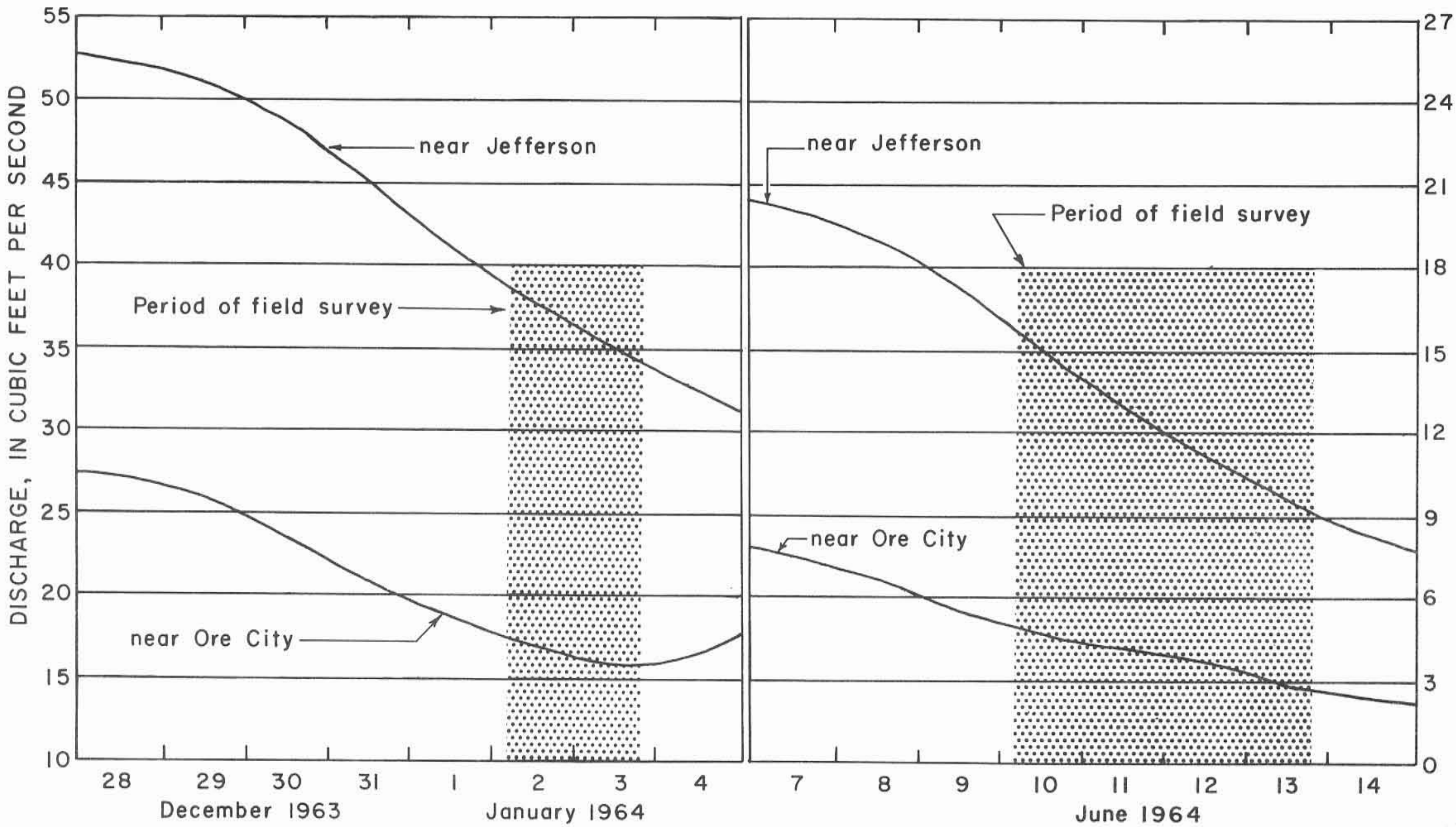


Figure 4

Discharge Hydrographs for Stream-Gaging Stations on Little Cypress Creek Near Ore City and Near Jefferson, Showing Streamflow Conditions During January and June 1964 Field Surveys

U.S. Geological Survey in cooperation with the Texas Water Development Board

Table 1.--Water discharge and chemical analyses, Little Cypress Creek, January 1964

(Analytical results in parts per million except as indicated)

Site No.	Date	Discharge (cfs)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (calculated)		Hardness as $CaCO_3$		Percent sodium	Sodium adsorption ratio	Specific conductance (micromhos at 25° C)	pH
													Parts per million	Tons per day	Calcium, magnesium	Noncarbonate				
AT BRIDGE ON FARM ROAD 555, NEAR GILMER																				
5	Jan. 2	9.51	27	5.8	1.8	17		5	35	11	0.0	3.0	103	2.64	22	18	63	1.6	142	5.8
AT BRIDGE ON STATE HIGHWAY 154, NEAR GILMER																				
7	Jan. 2	10.7	27	5.2	2.0	14		4	30	12	0.0	1.0	93	2.69	21	18	59	1.3	130	5.7
AT GAGING STATION NEAR ORE CITY																				
11	Jan. 2	16.3	27	5.8	2.3	16	2.8	2	35	a17	0.0	0.2	107	4.71	24	22	56	1.4	156	5.2
AT BRIDGE ON FARM ROAD 450, NEAR HARLETON																				
31	Jan. 3	26.5	27	14	3.7	74	3.0	3	39	b120	0.1	0.0	282	20.2	50	48	75	4.6	506	5.4
AT BRIDGE ON STATE HIGHWAY 154, NEAR HARLETON																				
37	Jan. 3	30.0	28	13	3.8	75		3	36	121	0.1	0.0	278	22.5	48	46	77	4.7	500	5.3
AT BRIDGE ON COUNTY ROAD, 4.6 MILES WEST OF WOODLAWN																				
45	Jan. 3	30.2	27	14	3.2	71		3	38	113	0.1	0.0	267	21.8	48	46	76	4.5	484	6.0
AT GAGING STATION NEAR JEFFERSON																				
57	Jan. 3	33.6	26	20	4.9	92		3	41	159	0.1	0.0	344	31.2	70	68	74	4.8	642	5.4

a Includes 0.4 ppm bromide (Br) and 0.0 ppm iodide (I).
b Includes 1.0 ppm bromide (Br) and 0.4 ppm iodide (I).

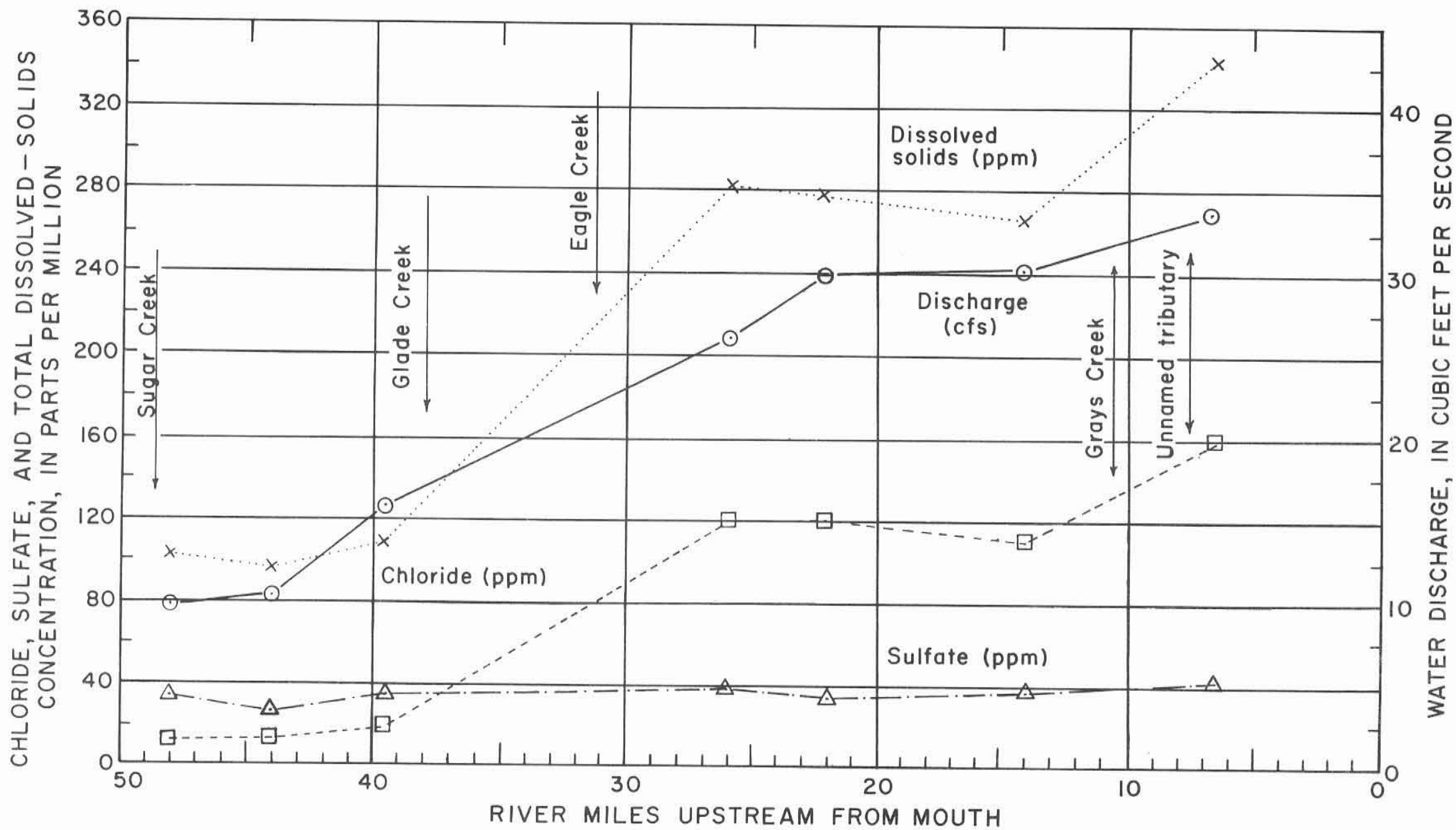


Figure 5

Changes in Chemical Character and Water Discharge, Little Cypress Creek, January 2-3, 1964

U.S. Geological Survey in cooperation with the Texas Water Development Board

From mile 13.1 (site 45) to mile 7.5 (site 57) at the gaging station near Jefferson, the water discharge increased from 30.2 to 33.6 cfs (11 percent), the dissolved-solids concentration increased from 267 to 344 ppm (29 percent), and the chloride concentration increased from 113 to 159 ppm (41 percent). The 3.4 cfs increase in discharge in this reach had a weighted-average concentration of 568 ppm chloride. The majority of this pollution was attributed to inflow from Grays Creek at mile 10.5.

June Study

The field survey made June 10-13, 1964, followed a 5-week period of steadily diminishing streamflow. Hot summer weather kept evapotranspiration at a maximum. Water-discharge measurements and/or chemical-quality samples were taken at 61 sites (Plate 1). Table 2 gives pertinent data in downstream order obtained at each main channel site and at those tributary sites with flow. The increase in the main channel discharge also is shown graphically in Figure 6.

Numerous springs and seeps (Figure 2) contributed some inflow to Little Cypress Creek throughout the study reach during June 10-13, 1964. The only appreciable inflows, however, were from the municipal sewage plant and a pipe-manufacturing plant, both in the city of Gilmer. Gilmer uses an average of 1.0 cfs of water, of which an estimated 1/2 to 3/4 cfs is returned as sewage effluent. The pipe-manufacturing company's effluent was 0.84 cfs at the time of the discharge measurement on June 10, 1964. Both the city and the pipe-manufacturing plant obtain water from wells. Effluents from the city and the plant eventually are discharged into Sugar Creek (Figure 7B), a tributary of Little Cypress Creek. This effluent accounts for about 50 percent of the increase in discharge in the main channel between sites 1 and 5 during this study. The dissolved-solids concentration of the 2.0 cfs flow at mile 52.1 (site 1) was 69 ppm (Table 3 and Figure 6). Four miles downstream at mile 48.0 (site 5) the water discharge was 4.2 cfs and the dissolved-solids concentration was 190 ppm. The increase in dissolved solids resulted from polluted inflow from Sugar Creek (mile 48.5) immediately above measuring and sampling site 5.

Three samples were collected in the Sugar Creek watershed. At site 2, on Sugar Creek south of Gilmer, the dissolved-solids concentration was 85 ppm; but at site 3, in Gilmer, a sample from a stream being fed entirely by effluent from a pipe (Figure 7B) had a dissolved-solids concentration of 980 ppm. The dissolved constituents were mostly sulfuric acid, and the pH of the sample was 2.4. A sample collected from Sugar Creek at site 4 east of Gilmer had a dissolved-solids concentration of 810 ppm and also was highly acidic (pH 2.6).

Although little change in water discharge occurred between sites 5 and 7 (miles 48.0 to 43.8), the dissolved-solids concentration decreased from 190 to 119 ppm. Fluctuating chemical discharge from Sugar Creek could have resulted in the better water at site 7 when the sample was collected. Part of the changes in quality in this reach and throughout the study reach may be the result of density stratification. The channel of Little Cypress Creek is characterized by deep, low-velocity pools (Figures 2A and 7D). Saline inflows may lie on the bottom of these pools, while the fresher water on top moves downstream with an apparent loss in dissolved solids.

Table 2 .--Summary of water discharge measurements, Little Cypress Creek base-flow investigation, June 1964

(All tributaries were inspected; many with no flow are not listed in this table.)

Site No.	Date	Stream	Location	River Mile	Water Temp. (°F)	Discharge in cfs Main Stream	Discharge in cfs Tributary	Streambed Material a/	Remarks
	1964 June								
1	10	Little Cypress Creek	At bridge on State Highway 155, 3.0 miles NE of Gilmer.	52.1	86	b 2		Sandy loam	
2	10	Sugar Creek	At bridge on Farm Road 1403, 1.0 mile SE of Gilmer.	48.5	65		b 0.01	Shale and silt	
3	11	Sugar Creek tributary	In ditch along St. Louis Southwestern Railway tracks at Pittsburg Standard Pipe Company, Gilmer.	--	88		.84	Silt	Industrial waste; adjacent vegetation dead.
4	10	Sugar Creek	At bridge on State Highway 154, 0.2 mile east of Gilmer.	48.5	82		b 1	Sand and silt	
5	10	Little Cypress Creek	At bridge on Farm Road 555, 4.2 miles east of Gilmer.	48.0	83	4.18		Sand and silt	January measurement site.
6	11	Gum Creek	At bridge on Farm Road 1649, 3.0 miles NW of Diana.	44.2	88		0	Silt	
7	11	Little Cypress Creek	At bridge on State Highway 154, 8.0 miles east of Gilmer.	43.8	83	4.14		Silt	Corps of Engineers gaging station 45-B. January measurement site.
8	10	Barton Lake	At bridge on Farm Road 1650 below lake, 4.3 miles east of Gilmer.	43.6	82		.02	Sand	
9	11	Clear Creek	At bridge on Farm Road 1973, 7.0 miles SE of Gilmer.	42.3	81		.16	Silt	
10	11	Clear Creek	At bridge on Farm Road 1650, 3.5 miles SW of Diana.	42.3	80		b .2	Sand	
11	10	Little Cypress Creek	At bridge on U. S. Highway 259, 9.0 miles south of Ore City.	39.6	81	4.45		Sand	USGS stream-gaging station 7-3460.5. January measurement site.
12	11	Private reservoir on Little Cypress Creek tributary	At low-water crossing, 6.0 miles NW of Judson.	39.1	90		0	--	
13	10	Walnut Creek	At bridge on U. S. Highway 259, 2.6 miles west of Ashland.	38.5	--		0	Sand	
14	11	Glade Creek tributary	At bridge on Farm Road 1650, 10.0 miles south of Ore City.	--	78		b .1	Silt	Drainage from East Texas Oil Field area.
15	11	Glade Creek	At bridge on Farm Road 1650, 4.5 miles north of Judson	37.7	82		--	Sand	Discharge measured downstream at site 16. This area polluted by oil field brines.
16	10	Glade Creek	At bridge on U. S. Highway 259, 9.5 miles south of Ore City.	37.7	80		.17	Fine sand	
17	11	Glade Creek tributary	At bridge on North Ridge Road, 0.2 mile east of U. S. Highway 259 junction, 4.0 miles north of Judson.	--	84		b .005	Silt	Flow sustained by ground-water effluent.
18	11	Glade Creek tributary	At culvert on North Ridge Road, 0.5 mile east of U. S. Highway 259 junction, 4.0 miles north of Judson	--	78		.15	Fine sand	Oil slick noted on water surface.
19	11	Glade Creek tributary	Seepage across North Ridge Road, 1.4 miles east of U. S. Highway 259 junction, 4.0 miles north of Judson.	--	75		b .003	Sand	Flow sustained by ground-water effluent.
20	10	Little Cypress Creek tributary	At collapsed bridge on abandoned county road, 1.8 miles south of Ashland.	36.3	--		0	Silt and clay	
21	10	Little Cypress Creek tributary	At collapsed bridge on abandoned county road, 1.7 miles south of Ashland.	36.3	--		0	Sand	

Table 2.--Summary of water discharge measurements, Little Cypress Creek base-flow investigation, June 1964--Continued

(All tributaries were inspected; many with no flow are not listed in this table.)

Site No.	Date	Stream	Location	River Mile	Water Temp. (°F)	Discharge in cfs Main Stream	Tributary	Streambed Material a/	Remarks
	1964 June								
22	10	Caney Creek	At bridge on State Highway 154, 1.2 miles SE of Ashland.	35.2	--		--	Silt	Discharge measured downstream at site 23.
23	10	Caney Creek	0.1 mile above mouth and 2.5 miles south of Ashland.	35.2	81		0.11	Silt	
24	11	Little Cypress Creek tributary	At culvert on North Ridge Road, 2.6 miles east of U. S. Highway 259 junction and 4.3 miles NE of Judson.	35.0	76		.02	Sand and gravel	Flow sustained by ground-water effluent.
25	11	Panther Creek	0.2 mile above mouth and 4.5 miles NE of Judson.	34.6	79		.06	Sand	Drainage from North Lansing Gas Field area.
26	10	Little Cypress Creek tributary	At culvert on county road, 4.8 miles south of Ashland.	33.0	--		0	Silt	Ponded oil field drainage and seepage.
27	10	Little Cypress Creek	At bridge on county road, 4.2 miles SE of Ashland.	32.4	82	5.70		Fine sand and silt	
28	10	Eagle Creek tributary	At culvert on county road, 3.5 miles west of Harleton.	--	80		b .01	Silt and clay	
29	10	Eagle Creek	At bridge on county road, 4.0 miles west of Harleton.	31.0	79		.18	Clayey silt	
30	11	Moccasin Creek	At bridge on Farm Road 449, 5.8 miles south of Harleton.	28.3	85		.03	Sand and silt	USGS partial-record station 7-3460.6 Drainage is from North Lansing Gas Field area.
31	11	Little Cypress Creek	At bridge on Farm Road 450, 3.7 miles south of Harleton.	26.0	85	5.93		Sand and silt	January measurement site.
32	12	Page Creek	At bridge on Farm Road 449, 5.3 miles south of Harleton.	25.2	77		.23	Sand and silt	
33	12	Gum Creek	0.5 mile below Farm Road 449, 5.5 miles south of Harleton.	24.0	75		.26	Fine sand and silt	
34	13	Lick Creek	0.2 mile above mouth and 4.3 miles south of Harleton.	23.6	75		b .04	Sand	
35	12	Caney Creek	At bridge on county road, 5.5 miles south of Harleton.	22.5	82		.50	Silty clay, sand and shale	Drainage from Petit Oil Field area.
36	12	Little Cypress Creek tributary	At bridge on county road, 4.2 miles SE of Harleton.	22.2	75		b .005	Sand	Flow lost into alluvium near junction with Little Cypress Creek.
37	12	Little Cypress Creek	0.3 mile below bridge on State Highway 154, 4.9 miles SE of Harleton.	22.0	87	5.79		Sand and silt	Corps of Engineers gaging station 45-A. January measurement site.
38	13	Lawrence Creek	At bridge on State Highway 154, 4.5 miles NW of Marshall.	20.5	84		b .04	Sand	Flow sustained by ground-water effluent.
39	13	Lawrence Creek tributary	At bridge on State Highway 154, 5.4 miles NW of Marshall.	--	78		b .001	Silt	Flow sustained by ground-water effluent.
40	12	Little Cypress Creek tributary	At bridge on county road, 4.0 miles east of Harleton.	18.7	76		b .01	Fine sand	Drainage from Harleton East Gas Field.
41	12	Little Cypress Creek tributary	At bridge on county road, 6.5 miles east of Harleton.	16.4	75		b .01	Sand and silt	Flow sustained by ground-water effluent.
42	13	Ray Creek	0.7 mile above mouth and 7.0 miles north of Marshall.	16.0	77		.05	Fine sand	
43	12	Little Cypress Creek tributary	At bridge on county road, 6.0 miles west of Woodlawn.	15.0	76		.12	Sand and gravel	
44	12	Little Cypress Creek tributary	At bridge on county road, 5.8 miles west of Woodlawn.	14.8	75		.03	Sand and gravel	
45	13	Little Cypress Creek	0.1 mile below bridge on county road and 4.6 miles west of Woodlawn.	13.1	84	7.75		Sand	January measurement site.

Table 2.--Summary of water discharge measurements, Little Cypress Creek base-flow investigation, June 1964--Continued

(All tributaries were inspected; many with no flow are not listed in this table.)

Site No.	Date	Stream	Location	River Mile	Water Temp. (°F)	Discharge in cfs Main Stream	Discharge in cfs Tributary	Streambed Material a/	Remarks
	1964 June								
46	13	Holmes Lake	2.0 miles north of Marshall.	10.3	89		0		No outflow.
47	13	Grays Creek tributary	2.6 miles north of Marshall.	--	79		b .02	Sand and silt	200 feet above junction with Grays Creek.
48	13	Grays Creek	At bridge on county road, 2.8 miles north of Marshall.	10.3	80		b .1	Sand and gravel	Designated as Morriss Creek on county maps.
49	13	Grays Creek tributary No. 2	At bridge on county road, 3.0 miles north of Marshall.	--	76		b .01	Sand and gravel	
50	13	Grays Creek tributary No. 3	At bridge on U. S. Highway 59, 3.2 miles north of Marshall.	--	78		0	Sand	
51	13	Grays Creek tributary No. 4	At bridge on county road, 3.0 miles SW of Woodlawn.	--	74		b .006	Sand	
52	13	Grays Creek tributary No. 5	At bridge on U. S. Highway 59, 1.8 miles south of Woodlawn.	--	88		b .005	Sand and gravel	
53	13	Grays Creek tributary No. 6	On private road 2.3 miles SW of Woodlawn.	--	92		.03	Sand, silt and clay	Refinery effluent. Measured 0.5 mile east of U. S. Highway 59.
54	13	Grays Creek tributary No. 7	At bridge on county road, 2.6 miles SW of Woodlawn.	--	78		0	-	
55	13	Grays Creek tributary No. 8	At bridge on county road, 2.4 miles west of Woodlawn.	--	78		0	-	
56	13	Grays Creek	At bridge on Farm Road 1997, 1.9 miles west of Woodlawn	10.3	78		.12	Sand and silt	Designated as Morriss Creek on county maps.
57	12	Little Cypress Creek	At bridge on U. S. Highway 59, 3.5 miles south of Jefferson.	7.5	90	10.6		Sand and silt	USGS stream-gaging station 7-3460.7. Corps of Engineers gaging station 45. January measurement site.
58	12	Little Cypress Creek tributary	At bridge on county road, .4 mile east of U. S. Highway 59, 5.0 miles south of Jefferson.	7.3	79		.24	Sand and silt	
59	12	Little Cypress Creek tributary	At bridge on U. S. Highway 59, 1.8 miles north of Woodlawn.	7.3	90		0	-	
60	12	Little Cypress Creek tributary	500 feet south of Farm Road 134, 2.5 miles east of Jefferson.	5.3	78		0	Silt	Ponded water hole below dam.
61	12	Little Cypress Creek	At bridge on Farm Road 134, 4.4 miles SE of Jefferson.	3.0	84	11.6		Sand and silt	

a Order in which streambed material is listed indicates degree of prominence.
b Estimated
Note: River mile shown for tributaries is that for main stem at mouth of tributary.

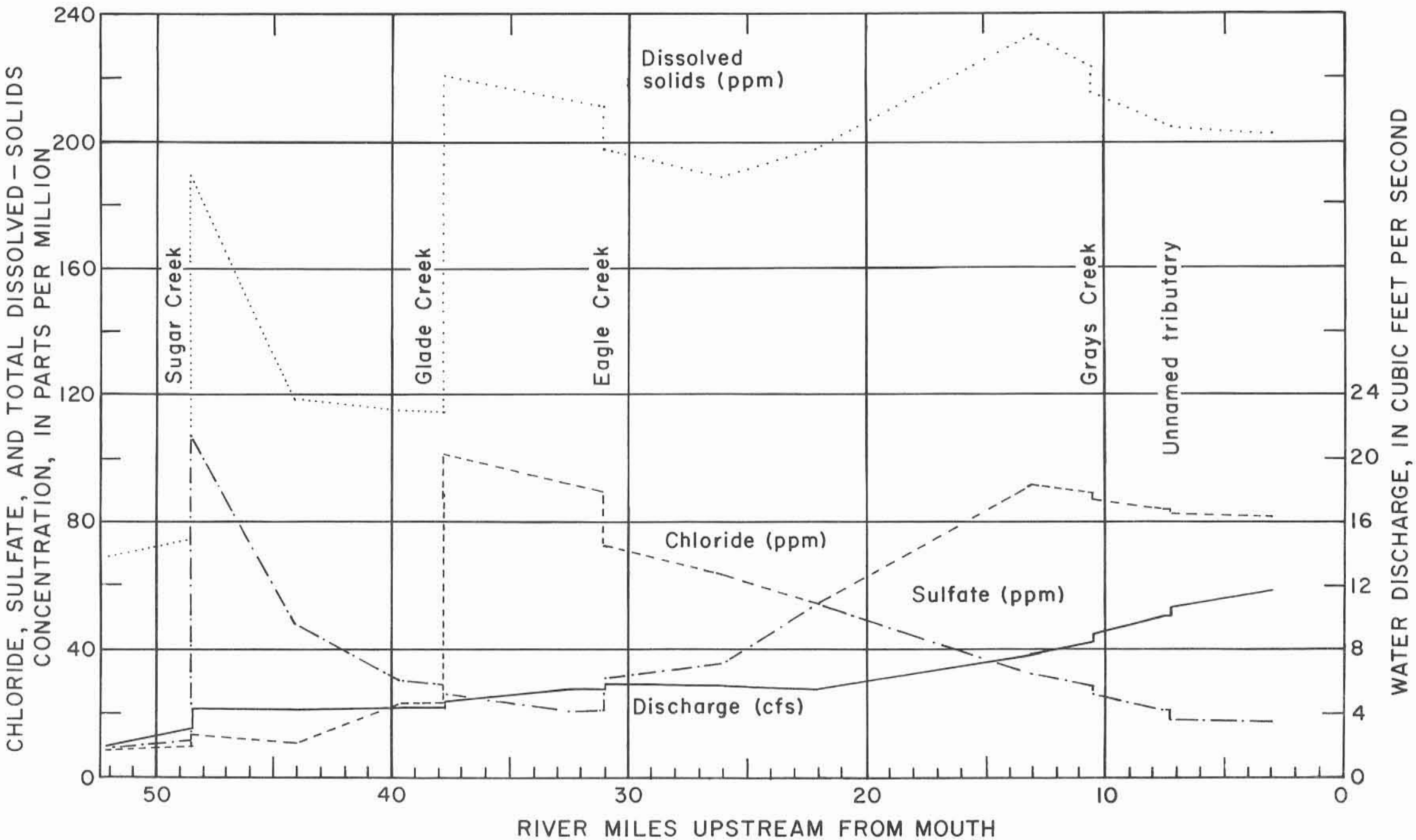


Figure 6

Changes in Chemical Character and Water Discharge, Little Cypress Creek, June 10-13, 1964

U.S. Geological Survey in cooperation with the Texas Water Development Board

A. Oil well site showing brine pollution which is killing vegetation and contributing to soil erosion (East Texas oil field near site 15)

B. Municipal and industrial effluent carried by Sugar Creek, site 3 near Gilmer

Figure 7

Effects of Industrial, Oil-Field, and Municipal Effluent Pollution in the Little Cypress Creek Watershed

U.S. Geological Survey in cooperation with the Texas Water Development Board

C. Brine disposal pond adjacent to Glade Creek showing the devastating effects of polluted surface water which may enter the ground-water supply (East Texas oil field near site 15)

D. Oil-field brine and scum contaminating the surface water, killing aquatic life in Glade Creek (site 15)

Figure 7-- Continued

Effects of Industrial, Oil-Field, and Municipal Effluent Pollution in the Little Cypress Creek Watershed

U S Geological Survey in cooperation with the Texas Water Development Board

Table 3.--Water discharge and chemical analyses, Little Cypress Creek, June 1964

(Analytical results in parts per million except as indicated)

Site No.	Stream	Date	Discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Acidity (H)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (calculated)[1]: Parts per million	Dissolved solids (calculated)[1]: Tons per acre-foot	Hardness as $CaCO_3$: Calcium, Magnesium	Hardness as $CaCO_3$: Noncarbonate	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
1	Little Cypress Creek----	June 10	a2.0	22	0.15	--	0.00	4.2	2.1	8.3	2.7	20	9.4	8.7	0.1	1.2	b69	0.09	19	4	0.8	84	5.8
2	Sugar Creek------------	do.	a .01	27	--	--	--	--	--			26	--	11	--	--	85	--	24	3	--	113	5.9
3	Sugar Creek tributary	June 11	.84	19	--	11	--	--	--	125	1.5	0	780	21	--	18	c980	--	22	22	12	2,980	2.4
4	Sugar Creek------------	June 10	a 1.0	21	--	5.8	--	--	--	--		0	526	21	--	13	c810	--	24	24	--	1,770	2.6
5	Little Cypress Creek----	do.	4.18	21	--	.4	--	8.8	3.7	34		0	106	13	.3	2.8	b190	.26	37	37	2.4	323	4.2
6	Gum Creek--------------	June 11	0	--	--	--	--	--	--	--		23	--	13	--	--	99	--	30	11	--	134	5.8
7	Little Cypress Creek----	do.	4.14	22	--	--	--	5.8	2.3	23		8	48	11	.3	2.2	b119	.16	24	17	2.0	179	5.4
8	Outflow from Barton Lake	June 10	.02	--	--	--	--	--	--	--		20	--	17	--	--	88	--	24	8	--	118	5.9
9	Clear Creek------------	June 11	.16	--	--	--	--	--	--	--		14	--	16	--	--	93	--	24	13	--	124	5.6
10	-----do.---------------	do.	a .2	--	--	--	--	--	--	--		16	--	12	--	--	81	--	24	11	--	108	5.8
11	Little Cypress Creek----	June 10	4.45	--	--	--	--	--	--	--		14	31	21	--	--	b115	--	28	17	--	182	5.6
12	Private reservoir on Little Cypress Creek tributary -----------	June 11	0	--	--	--	--	--	--	--		10	--	7.1	--	--	57	--	16	8	--	76	5.8
14	Glade Creek tributary---	do.	a .1	30	--	1.4	--	--	--	--		0	--	332	--	--	--	--	81	81	--	1,390	2.7
15	Glade Creek------------	do.	--	--	--	.2	--	--	--	--		0	--	1,110	--	--	--	--	184	184	--	3,510	4.2
16	-----do.---------------	June 10	.17	--	--	.3	--	--	--	--		0	.0	1,200	--	--	b1,980	--	187	187	--	3,730	3.7
18	Glade Creek tributary	June 11	.15	--	--	--	--	--	--	--		14	--	5.6	--	--	48	--	16	5	--	64	6.0
23	Caney Creek------------	June 10	.11	33	--	--	--	--	--	--		18	--	8.4	--	--	70	--	21	6	--	84	6.3
24	Little Cypress Creek tributary------------	June 11	.02	--	--	--	--	--	--	--		21	--	7.2	--	--	61	--	19	2	--	81	5.9
25	Panther Creek----------	do.	.06	--	--	--	--	--	--	--		10	--	7.5	--	--	50	--	12	4	--	66	5.9
27	Little Cypress Creek----	June 10	5.70	22	--	--	--	8.5	3.6	59		16	20	91	.2	1.0	b213	.29	36	23	4.3	392	5.8
28	Eagle Creek tributary---	do.	a .01	--	--	--	--	--	--	--		14	--	9.4	--	--	64	--	16	5	--	85	5.7
29	Eagle Creek------------	do.	.18	--	--	--	--	--	--	--		9	--	5.1	--	--	39	--	10	3	--	52	5.8
30	Moccasin Creek---------	June 11	.03	--	--	--	--	--	--	--		24	--	12	--	--	81	--	24	4	--	108	5.7
31	Little Cypress Creek----	do.	5.93	--	--	--	--	--	--	--		14	36	63	--	--	186	--	36	25	--	338	5.8
32	Page Creek-------------	June 12	.23	--	--	--	--	--	--	--		20	--	7.2	--	--	74	--	19	3	--	98	5.7
33	Gum Creek--------------	do.	.26	--	--	--	--	--	--	--		10	--	5.1	--	--	46	--	13	5	--	62	5.6
35	Caney Creek------------	do.	.50	--	--	--	--	--	--	--		16	--	6.7	--	--	56	--	12	0	--	74	5.9
37	Little Cypress Creek----	do.	5.79	--	--	--	--	--	--	--		15	56	56	--	--	195	--	43	31	--	355	5.9
38	Lawrence Creek---------	June 13	a .04	--	--	--	--	--	--	--		15	--	7.1	--	--	63	--	16	4	--	84	6.1
39	Lawrence Creek tributary	do.	a .001	--	--	--	--	--	--	--		5	--	8.1	--	--	44	--	6	2	--	59	5.2
42	Ray Creek--------------	do.	.05	--	--	--	--	--	--	--		27	--	5.1	--	--	81	--	31	9	--	108	5.9
43	Little Cypress Creek tributary------------	June 12	.12	--	--	--	--	--	--	--		14	--	7.3	--	--	78	--	14	3	--	104	6.2
44	-----do.---------------	do.	.03	--	--	--	--	--	--	--		13	--	5.1	--	--	46	--	10	0	--	61	6.2
45	Little Cypress Creek	June 13	7.75	21	--	--	--	10	5.1	62		17	33	93	.3	.2	b233	.32	46	32	4.0	428	6.0
46	Holmes Lake------------	do.	0	--	--	--	--	--	--	--		20	--	7.8	--	--	68	--	26	10	--	91	6.3
48	Grays Creek------------	do.	a .1	12	--	--	--	--	--	--		21	--	7.7	--	--	63	--	24	7	--	84	6.5
51	Grays Creek tributary #4	do.	.006	--	--	--	--	--	--	--		4	--	1.9	--	--	15	--	4	1	--	20	5.8
52	Grays Creek tributary #5	do.	a .005	--	--	--	--	--	--	--		36	--	5.9	--	--	75	--	39	10	--	100	6.3
53	Grays Creek tributary #6	do.	.03	--	--	.0	--	--	--	--		0	281	21,200	--	--	--	--	9,560	9,560	--	d47,300	4.5
56	Grays Creek------------	do.	.12	--	--	--	--	--	--	--		24	11	970	--	--	--	--	450	430	--	3,080	6.0
57	Little Cypress Creek----	June 12	10.6	22	--	--	--	12	3.7	52		20	22	83	.2	.5	b205	.28	45	29	3.4	373	5.8
58	Little Cypress Creek tributary------------	do.	.24	--	--	--	--	--	--	--		10	--	4.6	--	--	37	--	10	2	--	49	6.5
61	Little Cypress Creek----	do.	11.6	21	.04	--	.00	13	3.3	51		24	18	82	.3	1.8	b202	.27	46	26	3.3	362	6.3
62																							

1 Calculated from specific conductance.
a Estimated.
b Calculated.
c Residue at 180°C.
d Density (g/ml) 1.025.

Several tributaries had flow into Little Cypress Creek in the reach between sites 7 and 27 (miles 43.8 to 32.4). All the tributary inflows, except the saline water from Glade Creek, were low in dissolved solids. A sample collected from Glade Creek at site 16 (mile 37.7) had a dissolved-solids concentration of 1,980 ppm and a chloride concentration of 1,200 ppm. The saline flows in Glade Creek apparently resulted from oil-field activity in the watershed (Figure 7A, C, and D). The increase in dissolved-solids and chloride concentration in Little Cypress Creek between sites 7 and 27 doubtless is due to Glade Creek inflow because the dissolved-solids concentration in Little Cypress Creek increased here from 119 to 213 ppm, and the chloride concentration increased sharply from 11 to 91 ppm (Table 3 and Figure 6).

The dissolved-solids concentrations fluctuated moderately in the remaining 27 miles of the study reach as the chloride-sulfate ratio changed from one sampling site to the next. The chloride-sulfate ratio was affected more by the fluctuation of tributary inflow and stratification of pools than by the geology. For example, a brine sample was collected near an oil refinery north of Marshall (site 53). The brine flow (in a tributary to Grays Creek) had a chloride concentration of 21,200 ppm (Table 3). A sample collected downstream on Grays Creek (site 56) likewise showed the effects of this brine inflow (970 ppm chloride). The highly saline water from Grays Creek was not present, however, at the downstream site (57) on Little Cypress Creek at the time of the sampling.

If the conditions in the Little Cypress Creek watershed would remain as they were during the June study, the creek's outflow generally should be of good but inconsistent quality. Conversely, if the polluted inflows from Sugar, Glade, and Grays Creeks were eliminated, the waters of Little Cypress Creek would be of excellent quality.

WATER USES

Municipal

Drinking water used on common carriers in interstate traffic should not exceed standards published by the U.S. Public Health Service (1962). These standards usually are accepted as a basis for determining the suitability of waters for municipal and domestic use. The recommended maximum limits are 250 ppm chloride, 250 ppm sulfate, and 500 ppm total dissolved solids.

Water samples collected in Little Cypress Creek during January and June had chloride, sulfate, and dissolved-solids concentrations well below the recommended maximum limits; however, inflows from some of the tributaries were acid waters and brines. These polluted waters are very corrosive, and an increase in the percentage of these inflows compared to that of the good quality water from the watershed could make the Little Cypress Creek water undesirable for domestic use.

Based on the following tabulation used by the U.S. Geological Survey in classifying water hardness by numerical ranges, Little Cypress Creek water is soft to moderately hard, but the hardness will change with the percentage of tributary inflow.

Hardness range (ppm)	Rating
60	Soft
61-120	Moderately hard
121-180	Hard
181	Very hard

Industrial

The Little Cypress Creek water was of good quality during the study. For use by most industries, a continuous supply of this quality water should be satisfactory without extensive treatment.

Irrigation

The two most important characteristics in determining water quality of irrigation, according to the U.S. Salinity Laboratory Staff (1954, p. 69), are the total concentration of soluble salts and the relative proportion of sodium to the other cations. Based on these standards, the water from Little Cypress Creek would be in the medium-salinity and low-sodium classification. With an average annual rainfall of about 46 inches in this study area, the water should be excellent for irrigation.

COMPARISON OF THE JANUARY AND JUNE STUDIES

The streamflow was much higher during January than during June. Water discharge increased from 9.51 cfs at mile 48.0 (site 5) to 33.6 cfs at mile 7.5 (site 57) during the January study, and from 4.18 cfs to 10.6 cfs during the June study. The dissolved-solids concentration increased from 103 ppm (site 5) to 344 ppm (site 57) in January, and from 190 ppm to 205 ppm in June (Tables 1 and 3 and Figures 5 and 6).

Although the dissolved-solids concentration of Little Cypress Creek streamflow in June almost tripled from mile 52.1 (site 1) near Gilmer to mile 3.0 (site 61) near Jefferson, the flow at site 61 was still of good quality (Table 3 and Figure 6). Most of the samples collected during this study of Little Cypress Creek showed the water to be of excellent quality. Except for pollution in three tributaries (Sugar, Glade, and Grays Creeks), the low flows of all tributaries were low pH waters of less than 100 ppm dissolved solids. The chemical quality of the unpolluted base flows is similar to that of the water from three shallow wells shown on Plate 1.

Chloride concentration increased between sites 11 and 31 in January and in June. The increases apparently resulted from oil-field brine inflows from Glade Creek. The chloride concentration also increased between sites 45 and 57 during the January study. This increase probably was caused by saline refinery effluent from Grays Creek. In June the sample at site 57 showed a decrease in chloride from that at site 45 (93 to 83 ppm), despite the fact that brines and saline waters were sampled in the Grays Creek watershed and apparently flowed intermittently into Little Cypress Creek.

In the reach between mile 48.0 (site 5) and mile 22.0 (site 37), the inflow exceeded the evapotranspiration by only 1.61 cfs during the June study. In the reach from mile 22.0 (site 37) to mile 3.0 (site 61), the discharge increased 5.8 cfs.

SUMMARY AND CONCLUSIONS

Streamflow in Little Cypress Creek during periods of low flow generally is sustained by ground-water effluent. Results of base-flow studies for two periods were compared for a 45-mile reach of Little Cypress Creek extending upstream from near its junction with Big Cypress Bayou to the town of Gilmer. Periods in January and June 1964 were selected in order to obtain the maximum variance in evapotranspiration in the densely-vegetated basin.

Streamflow in the January study ranged from 9.51 cfs to 33.6 cfs at the ends of the study reach. Comparable values of streamflow in the June study were 4.18 and 10.6 cfs. In general, streamflow increased with drainage area throughout the reach. In June, approximately 10 percent of the increased flow was found to be industrial and municipal effluent and the remaining 90 percent was attributed to ground-water effluent, mainly from the Queen City Sand.

Numerous swampy, marshy, and heavily-vegetated areas within the drainage basin are evidence of a relatively high and stable ground-water table within the Queen City Sand and alluvium. This condition is the result of the abundant precipitation that saturates the Queen City Sand and the generally low transmissibility of the Cypress aquifer; therefore, Little Cypress Creek is an effluent (gaining) stream throughout most of its reach, despite the high evapotranspiration that causes rapid depletion of streamflow during the hot summers. Except for the reach between sites 5 and 7, the numerous small seepage inflows along the main channel in the overall study reach exceeded this large evapotranspiration.

Water pollution principally was due to effluents in tributaries from manufacturing plants, oilfields, and a refinery. The main channel and some of the tributaries to Little Cypress Creek contain numerous, deep, wide pools with connecting riffles. These pools apparently collect the polluted water during low-flow periods and subsequent rises flush out this stratified and polluted water. Pollution in the main channel of Little Cypress Creek was not excessive during the periods studied.

In both the January and June studies, the dissolved-solids concentration increased downstream by approximately 200 percent. Except for industrial and oilfield-brine pollution in three tributaries (Sugar, Glade, and Grays Creeks), the water in all tributaries had dissolved-solids concentrations less than 100 ppm. The pH was low in the unpolluted tributaries and extremely low (acidic) in Sugar, Glade, and Grays Creeks. The chemical content of the unpolluted surface water was similar to that of the ground water in shallow wells tapping the Queen City Sand exposed in the watershed.

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