Water Resources of De Soto Parish Louisiana

By LELAND V. PAGE *and* HENRY L. PREÉ, JR.

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WATER RESOURCES OF DE SOTO PARISH, LOUISIANA

By LELAND V. PAGE and HENRY L. PREÉ, JR.

ABSTRACT

De Soto Parish, in northwestern Louisiana, has moderate amounts of ground and surface water available for present and future demands. The principal water problems in the parish pertain to water supply for industrial expansion and municipalities, flood control, drainage, irrigation, and navigation.

Only small quantities of surface water have been used for domestic or industrial purposes in De Soto Parish. Use of surface waters for irrigation is increasing. The Sabine River drains approximately 4,830 square miles upstream from the parish and has an average flow of about 3,200 cubic feet per second, or about 2,070 mgd (million gallons per day). The flow of this river provides the most dependable supply of surface water of any river in the parish. The main problems in the use of water from Sabine River are the danger of contamination from upstream sources and the need for proper distribution facilities.

Bayou Pierre has a fairly well sustained base flow and is the second best source of surface water, but at some places the stream has been pumped dry during the irrigation season. During the period 1952–54 the minimum flow at the gaging station on Bayou Pierre near Grand Bayou was 1.9 mgd. Available data indicate that a daily flow of about 4.8 mgd may be expected to be equaled or exceeded 95 percent of the time.

Several of the other streams in the parish would provide a good surface-water supply for a small city if storage facilities were provided. For example, the average flow of Cypress Bayou near Keithville for the period 1939–55 was about 51 mgd, but as there was no flow for short periods in every year except one, proper utilization would require storage facilities.

The rocks of De Soto Parish consist of clay, silt, and fine sand of Paleocene age which unconformably overlie sediments of Cretaceous age. These rocks are overlain by alluvial deposits of Pleistocene and Recent age in the valleys of the Red and Sabine Rivers and their major tributaries and terrace deposits of Pleistocene age on the northeastern and southwestern parts of the parish. The Paleocene rocks dip radially from the Sabine uplift, which is in the east-central part of the parish.

The Naborton formation of Paleocene age is the source of the largest ground-water supplies developed in the parish, although quantities of water adequate for domestic and stock supplies are pumped from the Dolet Hills formation and the overlying part of the Wilcox group. The Quaternary terrace and alluvial deposits have not been developed extensively, chiefly because of their small areal extent. In the flood plain area of the Red River valley, however, relatively large quantities of water are available from these deposits. The maximum yield per well of public-supply and industrial wells in the parish is about 275 gpm (gallons per minute). Drilled and dug wells supplying farms yield 5 to 10 gpm. Wells range in depth approximately from 10 to 400 feet.

Of the nearly 2,500,000 gallons of ground water pumped daily during 1955 in De Soto Parish, about 600,000 gallons was pumped for the Mansfield public supply and the remainder for rural domestic and livestock consumption. Wilcox group furnished about 2,200,000 gallons, or 88 percent of the total daily ground-water pumpage, and the Quaternary deposits furnished about 300,000 gallons, or 12 percent.

The chemical character of the Sabine River water varies considerably throughout the year. The water is generally of excellent quality, but there is danger of periodic contamination from east Texas oil fields. The waters in the smaller streams within the parish are generally low in dissolved solids and low in chloride and sulfate. These waters would be suitable for public supplies without softening but would probably need treatment to remove color and suspended material.

Ground water in De Soto Parish generally is of the sodium bicarbonate type and is suitable for most public-supply and industrial uses. Some is suitable for irrigation. Water from most aquifers has a hardness of less than 200 ppm (parts per million). The iron content ranges from 0.04 to 22 ppm. The dissolved solids vary widely, but most waters contain less than 500 ppm. The pH generally ranges from 6.5 to 8.4. Except for areas of possible contamination, the chloride content of the ground water is less than 250 ppm.

INTRODUCTION

PURPOSE AND SCOPE

The purpose of this investigation was to determine the occurrence, quantity, and quality of ground and surface water in De Soto Parish and to evaluate these resources as to present and potential use. The report presents data that may be used for initial guidance in future development of the water resources of the area. Owing to the general nature of the data, some factors relating to water-supply needs in any specific location will require more detailed local investigation.

This report presents an appraisal of the water resources of De Soto Parish and is based on an analysis of pertinent data that have been collected in cooperation with various State and Federal agencies continuing water-resources investigations for the State. It contains also some special hydrologic and geologic data that have been collected during the period October 1954 to June 1956. This study has been made by the U.S. Geological Survey in cooperation with the Louisiana Department of Public Works and the Louisiana Geological Survey, Department of Conservation.

LOCATION AND EXTENT OF AREA

De Soto Parish is in northwestern Louisiana (see pl. 1) and lies between lat. 31°50′ and 32°20′ N. and long. 93°21′ and 94°03′ W. It is separated on the north from Caddo Parish by Wallace, Cypress and Keatchie Bayous, and an east-west line through the center of T. 14 N., R. 16 W. It is separated from Red River Parish on the east by Bayou Pierre and Wallace Bayou. An east-west line through the center of T. 10 N. is the boundary with Sabine Parish on the south. De Soto Parish is separated from Shelby and Panola Counties, Tex., on the west by the Sabine River and by a north-south line through the western twelfth of R. 16 W. The parish contains 892 square miles and has a maximum east-west length of 39 miles and a maximum north-south length of 34 miles. Mansfield, the parish seat, is near the center.

PREVIOUS INVESTIGATIONS

Streamflow records for streams in this area are published by the U.S. Geological Survey in water-supply papers entitled "Surface-water supply of Lower Mississippi River Basin" and "Surface-water supply of Western Gulf of Mexico Basin." The first streamflow record to be collected in the area is the one which was started in July 1903 for Sabine River at Logansport, La.

The earliest reports on the geology of De Soto Parish were by Hilgard (1869 and 1873), in which he described the geology of the Mansfield area, and by Harris and Veatch (1899), in which they presented only generalized information of the geology of De Soto Parish. The first detailed report on the geology of the parish was by Murray in 1948.

The earliest report on the ground-water resources of De Soto Parish, by A. C. Veatch, was published in 1905. N. H. Darton, in another report (1905), mentioned a deep flowing salt-water well near Frierson. A report by A. C. Veatch (1906) briefly discusses the ground-water conditions in the northern part of the State. Additional data on water wells in De Soto Parish were collected between 1941 and 1954 by the U.S. Geological Survey. The results of these earlier investigations have been used in the preparation of this report.

ACKNOWLEDGMENTS

The author of the surface-water section was assisted in basic analyses and compilation of data and preparation of illustrations by Joseph C. Mehrhoff.

The author of the section on geology and ground-water resources received excellent cooperation and assistance from many persons, industries, city and town officials, and State and Federal agencies, in the collection of field data for this report. Well owners and drillers in the area supplied most of the data on wells and test holes. Water-well contractors, including the B. F. Edington Drilling Co., Inc., G. C. McDaniel, W. C. Barnwell Drilling Co., Louisiana Well Co., Tucker Drilling Co., and Montgomery Drilling Co., provided well logs and other subsurface information and assisted in obtaining drill cuttings and electrical logs. Information on the subsurface geology of the parish was obtained from electrical logs and other well data furnished by Leo W. Hough, State Geologist, from the files of the Louisiana Geological Survey. The author also wishes to thank Mr. Richard Cole of the Ohio Oil Co. for his courteous cooperation in furnishing drillers' logs and other geologic data. Mr. J. H. Lewing, Mayor of Mansfield, and Mr. Murray Pugh, Mayor of Logansport, provided well-construction data and pumpage figures and permitted use of the municipal wells for pumping tests.

Budge Irelan and S. F. Kapustka assisted in the preparation of the section of this report that deals with chemical quality of surface water.

GEOGRAPHY

TOPOGRAPHY AND DRAINAGE

De Soto Parish, in the West Gulf Coastal Plain (Fenneman, 1938) is divided into three topographic units—the alluvial valleys or flood plains, the terraces, and the uplands. It is known as one of the "hill" parishes of north Louisiana because the topography is largely hilly with only scattered areas of bottoms, or flat lands, in the alluvial valleys of the Red and Sabine Rivers and their tributaries.

A small triangular area of about 9 square miles borders the southwestern part of the parish and lies in the Sabine River flood plain, which consists of brown to black and gray Coastal Plain alluvial soils. The altitude of the flood plain ranges from 180 feet in the north to 160 feet in the south. The Red River flood plain, which borders the parish on the east, covers an area of about 38 square miles in De Soto Parish. The altitude of this flood plain ranges from 135 feet in the north, near the Caddo-Red River Parish line, to 125 feet at the southern border of the parish. The relatively steep western wall of the Red River Valley rises 40 to 150 feet within three-fourths of a mile from the edge of the flood plain. There are two flood-plain re-entrants in the east-central and southeastern parts of the parish. One consists of about 13 square miles of bottom-land area along Bayou Pierre east and south of Smithport Lake, and the other consists of about 25 square miles of bottom-land area along the lower reaches of Bayou Pierre. These areas have brownish-red alluvial soils.

The terraces flanking the Red and Sabine Rivers and their major tributaries in De Soto Parish constitute a second topographic unit. The terraces flanking the Sabine River and its tributaries are more numerous and more highly dissected than those bordering the Red River Valley and have a total area of about 41 square miles; those along the Red River total about 35 square miles. The surfaces of the individual terrace segments are flat and relatively undissected. Altitudes of these surfaces range from 180 feet to more than 300 feet. Terraces bordering Edwards and Rambin Bayous and Clear and Bayou Pierre Lakes in the northeastern part of the parish have a total area of about 49 square miles. The altitude of the relatively flat terrace surfaces ranges from 170 feet near Clear Lake to 240 feet near Gloster. Smaller terraces border McGee, Coon, and Buffalo Bayous west of Clear Lake. Small remnants of terraces also border other smaller bayous tributary to Red River.

The remaining 682 square miles of the parish consists of rolling uplands which are considerably dissected near the streams. The general upland slope is to the northeast and to the southwest from a line passing through Mansfield and Keatchie. The average altitude of the upland is about 340 feet; the highest altitude, which occurs at several points just south of the city of Mansfield, is 400 feet.

Three relatively large lakes and numerous small artificial lakes and ponds occur in De Soto Parish. Wallace Lake, which straddles the boundary between Caddo and De Soto Parishes, is formed by a dam on Cypress Creek, 66 miles above the mouth of Bayou Pierre. When filled to spillway crest level (158 feet above mean sea level), the lake has a surface area of 11,800 acres. It is primarily a flood control reservoir, but a conservation pool with a surface area of approximately 2,300 acres at an elevation of 142.0 feet is maintained at all times. Clear Lake and Smithport Lake are formed by Smithport Dam near the mouth of Rambin Bayou, and have a combined surface area of 2,250 acres at the spillway elevation of 129.4 feet above mean sea level. Smithport Dam is owned by Bayou Pierre Game and Fish Commission.

De Soto Parish is drained by the Sabine River and its tributaries and by many streams tributary to Red River. The courses of some of the streams do not conform to the general pattern of southerly flow because they are controlled by geologic structure. For example, Keatchie and Cypress Bayous flow northeastward to Wallace Bayou, which flows southeastward into Bayou Pierre.

Nearly all the streams have their sources within the boundaries of the parish. U.S. Highway 171 approximately follows the drainage divide between the Red River and Sabine River systems. Streams on the east side eventually reach the Red River through Bayou Pierre and its tributaries, and those to the west empty into Sabine River. Plate 1 is a map of De Soto Parish showing the general drainage pattern. Topographic maps are available showing topography and drainage in more detail.

Of the upland areas of De Soto Parish, the western, northern, and central parts, consisting of about 435 square miles, are drained by Keatchie and Cypress Bayous, Bayou Castor, Garrison Creek, Bayou Grand Cane, Bayou Na Bonchassee, Rambin Bayou, and Brushy Bayou. Topsoil is light-brown to gray Coastal Plain soil, underlain by poorly drained plastic subsoils. The south-central and southeastern segment of the upland area, cousisting of about 285 square miles, includes the areas drained by Clement Creek, Cow Bayou, Buffalo Bayou, Bayou San Patricio, and several small bayous in the southeastern corner of the parish. It is covered by fairly friable brownish-gray Coastal Plain soil over a permeable reddish-brown or mottled subsoil.

Although plate 1 shows that there are two Brushy Bayous, two Cypress Bayous, and two Rambin Bayous, the preceding discussion refers to the ones to the north. Bayou Pierre flows along the eastern boundary of the parish and falls about 12 feet in its approximately 39-mile reach. About 10 feet of this fall occurs in the 30-mile reach between the mouth of Wallace Bayou and Evelyn Bridge. In the 9-mile reach from Evelyn Bridge to the Natchitoches Parish boundary, the fall is only about 2 feet when the Red River at the mouth of Bayou Pierre is at average low-water stage. The flatness of the water-surface profile in this reach is due largely to backwater from Red River.

The stream gradient of Sabine River is relatively flat (less than 1 foot per mile) throughout the 23-mile reach that forms the southwestern boundary of De Soto Parish. Keatchie Bayou, which flows along the northwestern boundary of the parish and empties into Cypress Bayou, falls about 150 feet in its 8.5-mile course, or an average of 17.7 feet per mile.

The principal interior streams have relatively steep gradients. Bayou Castor falls about 160 feet, or an average of about 7.5 feet per mile, in its approximately 21-mile course in the western part of the parish. Clement Creek, which rises near the southwest corner of the city of Mansfield and flows southwest into Sabine River, falls about 190 feet, or about 13 feet per mile, in its short course. Bushneck Bayou and Cypress Bayou, which both rise in the southwest corner of Caddo Parish and flow in opposite directions, and Cow Bayou, which flows into Sabine River out of the southwest corner of De Soto Parish, all have stream gradients averaging about 10 feet per mile. Rambin Bayou, which rises in northern De Soto Parish and drains into Bayou Pierre through Clear Lake and Smithport Lake, Bayou San Patricio, and Bayou Grand Cane all have stream gradients averaging about 8.5 feet per mile.

CLIMATE

De Soto Parish lies within the humid climate zone of the United States. The average annual temperature of De Soto Parish is 65°F. Winters are short and mild, and winter temperatures average 49° but may go below freezing for relatively short periods. Considerable rainy weather prevails during winter and spring months. The summer and fall weather is mostly fair. The average length of the growing season is 238 days. The average annual rainfall, based on climatological records ranging in length from 40 years to 80 years, is

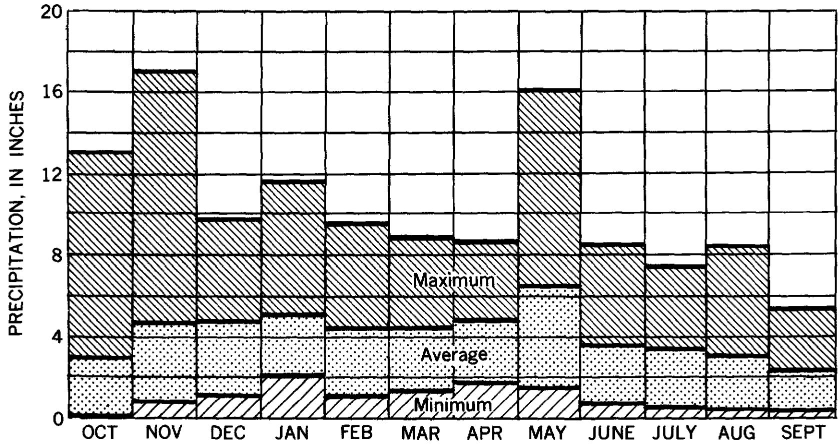

FIGURE 1.—Graph showing monthly precipitation in De Soto Parish area, based on records for Logansport, Shreveport, and Robeline, 1904–55.

about 48 inches. The average annual rainfall for the standard 30-year period 1921–50 is about 50 inches.

The greatest average monthly precipitation occurs in May and the least in the fall. The month to month variation in precipitation is shown in figure 1, and the year to year variation is shown in figure 2. The average precipitation shown in figure 1 is for the period 1938–55, corresponding to the period for which streamflow records are available. The data for figures 1 and 2 were obtained by averaging weighted values for Weather Bureau Stations at Logansport, Shreveport, and Robeline. Relative weights were calculated by the Thiessen polygon method. The variation for a longer period of time (fig. 3) can be shown because continuous records of precipitation at Logansport have been kept since 1903 with the exception of a few months during 1903 and an occasional month during 1918, 1919, and 1920 for which it was possible to estimate the missing data on basis of records obtained at Grand Cane. The record at Logansport indicates that greater extremes occurred in the period prior to 1938. At the Logansport weather station, the average annual precipitation for the standard 30-year period 1921–50 was 49.55 inches as against an average of 49.05 inches for the 53-year period shown in figure 3. The downward trend of the first part of the curve shown in figure 4 represents the cumulative effect of the generally below-normal precipitation during the period 1906–21. The upward trend of the curve during the period 1921–55 represents a period during which precipitation was generally above normal, except for such brief periods as 1930, 1931, and 1936–38. Ground-water levels respond to long-term trends in precipitation.

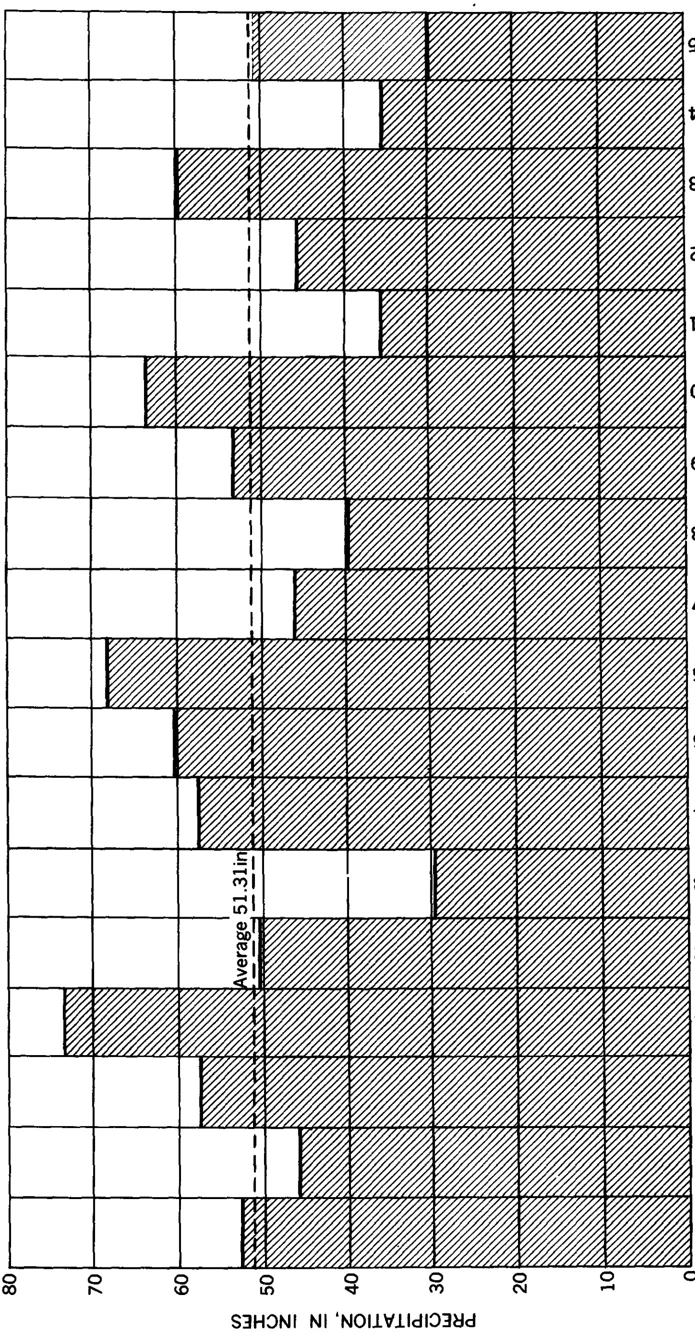

FIGURE 2.—Graph showing annual (water year) precipitation in De Soto Parish area, based on records for Logansport, Shreveport, and Robeline, 1938–55.

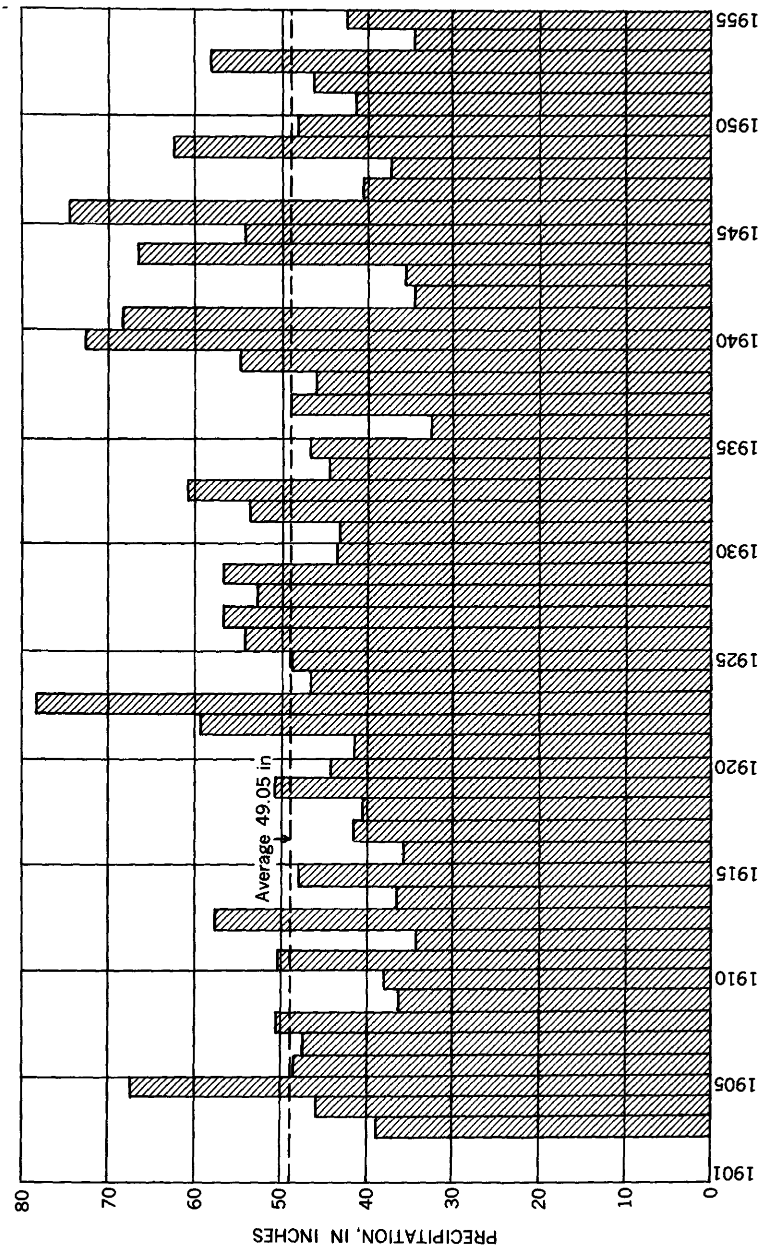

FIGURE 3.—Graph showing annual precipitation at Logansport, La., 1903–55.

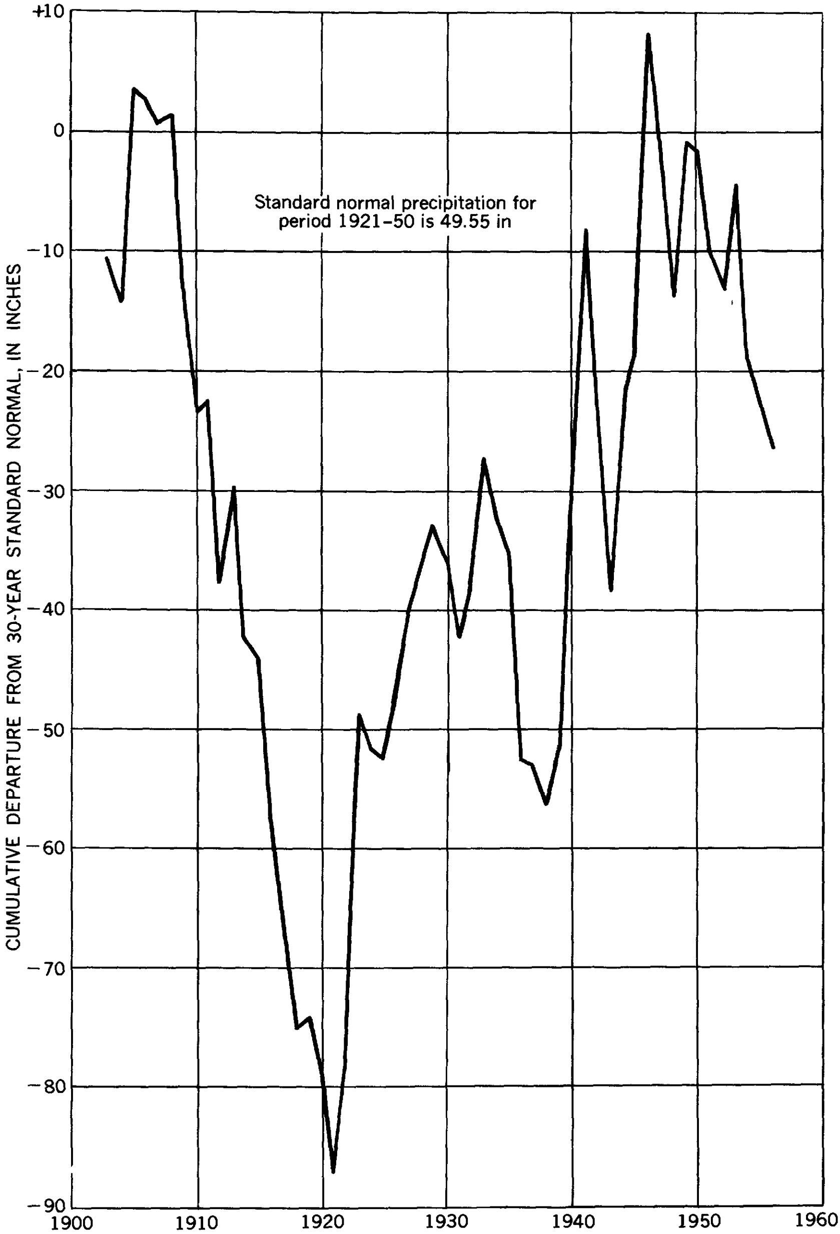

FIGURE 4.—Cumulative departure from standard normal precipitation at Logansport, 1903–55.

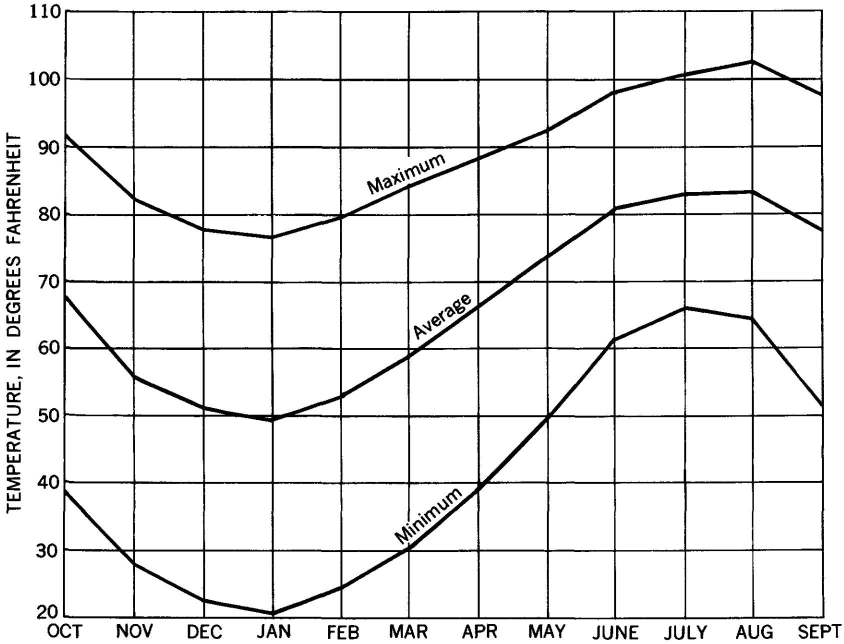

FIGURE 5.—Maximum, average, and minimum monthly air temperature in De Soto Parish area, based on temperature recorded at Natchitoches and Shreveport, 1923-55.

The temperature within a year usually varies about 80°F. Maximum, minimum, and average air temperatures for each month of the year are shown in figure 5. Values used in this figure were obtained by averaging temperature data for Natchitoches and Shreveport. The highest air temperatures occur in August and the lowest in December or January.

VEGETATION

The forests that cover about 57 percent of De Soto Parish may be classified in two broad categories: forests that occupy most of the uplands and forests that occupy the alluvial flood plains. The forests in the upland areas consist predominantly of loblolly-shortleaf pine and a variety of hardwoods including oak, hickory, black walnut, and other species. The forests in the bottom lands of the Red and Sabine Rivers consists largely of cypress, tupelo, black gum, oak, and cottonwood.

A large part of the original forest cover has been removed to make way for farms that occupy approximately 43 percent of the area of the parish. About a fifth of the farm area is used for crops and three-fifths for pasture; the remainder is used for farmyards, roads, and miscellaneous purposes. The three major crops in De Soto Parish are cotton,

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corn, and hay; other important crops include potatoes, oats, and peanuts.

NATURAL RESOURCES

The principal natural resources of De Soto Parish, in addition to water, are oil and gas, timber, sand and gravel, and lignite. The most important of these resources are the oil and gas in the Ajax Benson, Caspiana, De Soto-Red River-Bull Bayou, Grand Cane, Grogan, Holly, Kickapoo, Logansport, Pleasant Hill, Spider, Sutherlin, and Trenton fields. In 1954 about 422,000 barrels of crude oil and condensate and about 31 billion cubic feet of casinghead and natural gas were produced in De Soto Parish. Small deposits of sand and gravel occur in the valley of the Red River and in the terrace deposits bordering the Red and Sabine Rivers. The largest known lignite deposit is at or near the surface throughout a 25-square-mile area in the southeastern part of the parish. The deposit of lignite has been known since 1899, but its commercial development has been small.

DEVELOPMENT

De Soto Parish, named for Hernando de Soto, was established in 1843 by Act 88 of the 16th Legislature of the State of Louisiana. The eastern boundary of the parish, originally near the Red River, has been moved westward to its present position near the western edge of the Red River alluvial valley.

The change in population of De Soto Parish and of the two largest centers of population within it, during the period 1900–50, is shown in the following table.

	1900	1910	1920	1930	1940	1950
De Soto Parish	25,063	27,689	29,376	31,016	31,803	24,398
Mansfield	----------	1,799	2,564	3,837	4,065	4,440
Logansport	----------	420	632	1,040	1,222	1,270

The 1950 census shows the population of De Soto Parish as 24,398, a decrease of 23.3 percent since 1940. The rural farm population accounts for 49.7 percent; rural nonfarm, 32.1 percent; and urban, 18.2 percent of the total.

Most of the business and industrial activities in De Soto Parish are in Mansfield and Logansport. The industries include sawmills, sawmill-equipment manufacturers, sheet-metal works, and manufacturers of trailers, draglines, and clothing. Other industries in the parish include poultry-dressing plants, feed mills and cotton gins.

Agriculture is important to the economy of De Soto Parish. Of the total annual farm income for the entire parish, about 47 percent is derived from crops, 51 percent from livestock and livestock products, and 2 percent from forest products.

A network of highways connects all parts of De Soto Parish with the large centers of population, such as Shreveport to the north, Alexandria to the southeast, and Texas cities to the west and southwest. The parish is served by bus lines and motor-freight lines. Rail service is provided by the Kansas City Southern Lines, Texas and Pacific Railway, and Southern Pacific Lines.

OCCURRENCE AND GENERAL PROPERTIES OF WATER

Precipitation is the source of virtually all fresh-water supply. It is the condensed moisture from the atmosphere falling as rain, snow, hail, or sleet.

Measurements of flow indicate that, of the approximately 50 inches of average annual precipitation over De Soto Parish during the standard 30-year period, about 16 inches becomes runoff and flows to the Sabine River and Bayou Pierre in small streams and bayous. The remainder is lost to evaporation or transpiration or infiltrates to the ground-water zone. The two maps shown in figure 6 illustrate the areal variation in the average annual runoff and standard normal precipitation over the entire State. The isograms on the upper map (fig. 6) connect points of equal runoff based on streamflow records collected over a 15-year period, 1939–53. Lines of equal rainfall, called isohyetals, computed on the basis of averages for the standard 30-year period 1921–50 for weather stations having records ranging in length from 30 to 80 years, are shown on the lower map (fig. 6).

HYDROLOGIC CYCLE

The continual circulation of the earth's water is called the water cycle or hydrologic cycle (fig. 7). This cycle operates in and on the land and water bodies of the earth and in the atmosphere that surrounds the earth. It can be considered as beginning with water evaporating from the surface of the ocean and passing into the atmosphere. This water vapor is lifted in rising masses of warm air to elevations at which it becomes cool enough to condense, first into clouds and then into precipitation, and falls back to the earth's surface as precipitation in the form of rain, hail, snow, or sleet. Some of the water vapor condenses directly on the land as dew. Some of the precipitation runs off the land surface directly into the streams, and the rest seeps into the soil. Part of the water that seeps into the soil is used by growing plants, part evaporates, and the rest replenishes the ground-water reservoirs. Some of the ground water may be close enough to the surface to be evaporated or transpired; the rest slowly percolates from the ground-water reservoir through springs

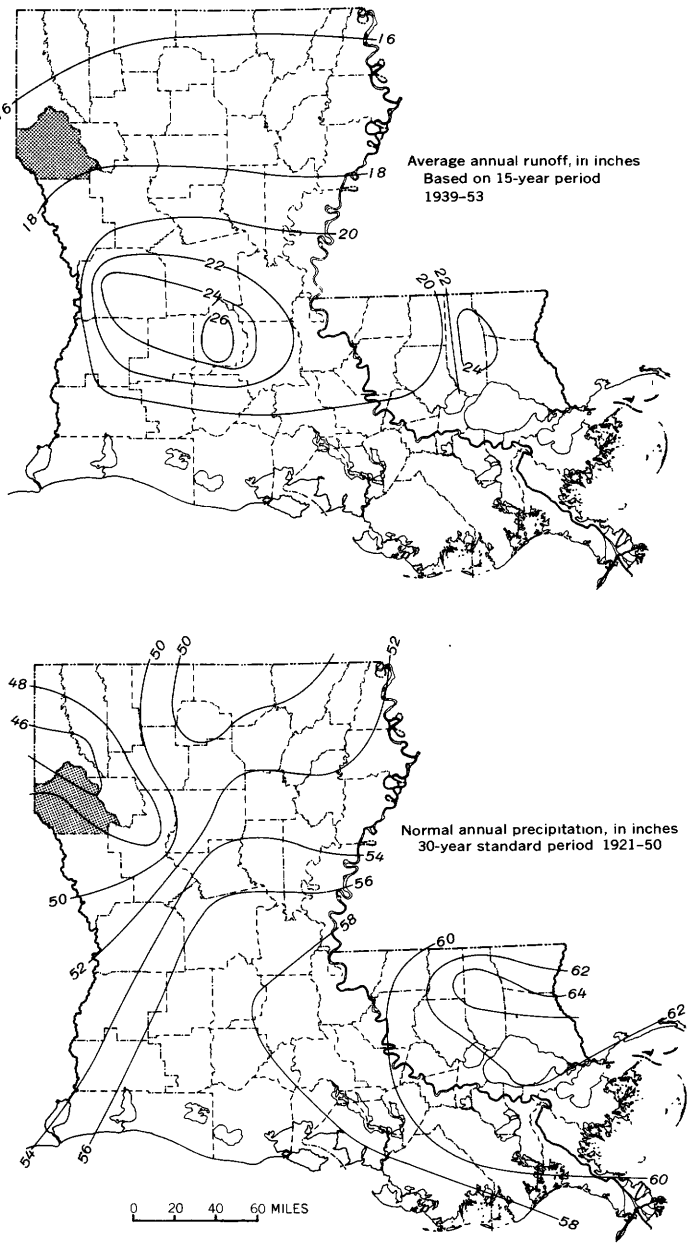

FIGURE 6.—Maps showing areal variation in average annual runoff and standard normal precipitation in Louisiana. De Soto Parish is shaded.

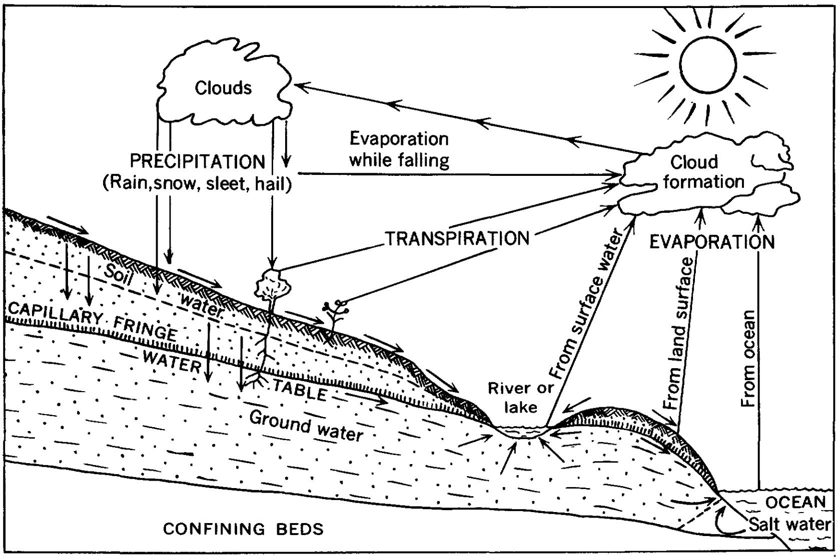

FIGURE 7.—The hydrologic cycle.

and seeps to bodies of surface water; this discharge helps to maintain the flow of streams during dry periods. The streams in turn eventually lead back to the ocean and thus complete the cycle.

SIGNIFICANCE OF CHEMICAL AND PHYSICAL CHARACTERISTICS OF WATER

A single standard that would meet all chemical, physical, or sanitary requirements for the varied uses of water would generally be impossible to evolve. Water that meets the requirements of one user may be unsatisfactory for another. Potential use can conveniently be divided into three broad classes—agricultural, domestic, and industrial.

The total concentration of soluble salts and the type and characteristics of the constituents are essential considerations for water that is used for irrigation, which is the main agricultural use. The domestic consumer is concerned primarily with bacterial quality and hardness and to a lesser extent with iron, manganese, fluoride, sulfate and nitrate content. The mineral content, hardness, alkalinity, hydrogen-ion concentration, organic and inorganic impurities, color, corrosiveness, and temperature determine the value of water for industrial use.

Four major criteria determine quality of water for irrigation: dissolved solids; concentration of sodium and the proportion of sodium to calcium plus magnesium; concentration of bicarbonate; and occurrence of minor elements, such as boron, in amounts that are toxic. Irrigation water with a moderate degree of salinity can be used if leaching and drainage are provided to remove dissolved salts that would otherwise accumulate in the root zone or in the subsoil immediately below. Boron in limited concentrations is necessary for plant growth, but when more than 1 to 3 ppm (parts per million) is present, boron is injurious to most plants. Recommended limit for sodium in irrigation water is less than 60 percent where percent sodium is equal to (Na $\times$ 100) (Ca+Mg+Na+K), where these elements are expressed in terms of milliequivalents per liter (Wilcox, 1948).

The U.S. Salinity Laboratory (1954, p. 80) presents a diagram for classifying irrigation water into four classes with respect to sodium hazard. The classes range from low-sodium water which can be used for irrigation on almost all soils, to very high-sodium water, which is generally unsatisfactory for irrigation.

Recommended concentration limits for chemical constituents commonly found in water have been established by the U.S. Public Health Service (1946). These standards were first adopted in 1914 and were applied to drinking water supplied to the public by common carriers engaged in interstate traffic. Some of these standards are as follows:

	Ppm		*Ppm*
Iron and Manganese (Fe+Mn)	0.3	Fluoride (F)	[1] 1.5
Magnesium (Mg)	125	Nitrate (NO_3)	[2] 44
Sulfate (SO_4)	250	Dissolved Solids	[3] 500
Chloride (Cl)	250		

[1] Mandatory limit.
[2] Maxcy (1950); standard not a part of the 1946 drinking-water standards.
[3] 1,000 ppm permissible when water of better quality is not available.

Iron and manganese in concentrations of more than a few tenths of a part per million (ppm) are objectionable for domestic purposes because they stain porcelain, enamel, clothing, and fabrics. Although iron seldom occurs in solution in surface water in sufficient quantity to cause harm, it often is present in solution in ground water (in the ferrous state) and precipitates as a rust-colored deposit (ferric hydroxide) as it rapidly oxidizes on contact with the air.

High fluoride concentration in water is associated with mottled dental enamel. Water that contains small quantities of fluoride, however, builds stronger and healthier teeth during their period of calcification or formation (Dean, 1936). The U.S. Public Health Service (1946) and many State and local health agencies recommend about 1.0 ppm during the period of calcification of the teeth. The maximum concentration permissible is 1.5 ppm.

Industry is often more concerned with quality of water than with quantity, for it may cost more to treat the water than to develop the original supply. General requirements of water quality for various types of industry are given in table 1.

Hardness of water is the property attributable to the presence of alkaline earth ions, chiefly calcium and magnesium. Iron, manganese, aluminum, and free mineral acids also cause hardness; however, they generally are present in such small quantities that they do not add appreciably to hardness. The hardness property of water is c m-monly recognized by the increased quantity of soap required to produce a lather or by the deposit of insoluble salts formed when the water is heated or evaporated. Hard water is objectionable in the home because it leaves deposits on utensils in which it is used and increases soap consumption.

Carbonate, or temporary, hardness is the hardness that is equivalent to the carbonate and the bicarbonate in water; the remainder of the hardness is noncarbonate, or permanent hardness. Temporary hardness is removed by boiling which precipitates as calcium carbonate. The use of hard water causes objectionable scale in boilers, water heaters, radiators, and pipes and reduction in flow and in heat transfer, and it may cause boiler failure. Theoretically, however, it is advantageous to have a thin deposit of some calcium carbonate on pipes and other equipment as a protective coating against corrosion.

Turbidity of water due to suspended material such as silt, clay, finely divided organic material, microscopic organisms, and similar materials is objectionable in many ways. Besides the aesthetic objections to it, turbid water may cause costly repairs due to its abrasive action on pumps, turbines, blades, and valves.

Color in water is due to dissolved substances of animal, vegetable, or mineral origin. It may be caused by humus material, peat, algae, weeds, protozoa, or metallic substances. Color in water is disadvantageous in many enterprises, particularly food processing, bottled beverage, photographic, laundering, and textile. Color is expressed in units of the platinum-cobalt scale proposed by Hazen (1892, p. 427–428); the unit is 1 ppm of platinum in water. A color less than 10 units on this scale usually passes unnoticed. Some swamp waters have natural color of 200 to 300 units or more.

Dissolved-solids content is a measure of dissolved minerals in the water. Water containing high concentrations of dissolved solids is undesirable for domestic, industrial, and agricultural uses. U.S. Public Health Service (1946) recommends that the maximum concentration of dissolved solids not exceed 500 ppm in drinking and culinary water on carriers subject to Federal quarantine regulations but permits 1,000 ppm if no better water is available. In irrigation water, high concentration of dissolved solids constitutes a salinity hazard; in industrial water, high concentration of dissolved solids cannot be tolerated and must be removed prior to use.

The degree of acidity or alkalinity, of which pH is a measure, is useful as an indication of the scale-forming and corrosive tendencies of water. The pH of most natural waters is between 6.0 and 8.0, although a more acid condition and lower pH will result if the water contains high concentrations of free carbon dioxide. Control of pH is an important factor in such processes as iron removal, recarbonation, acid treatment, and treatment of boiler water for prevention of corrosion. Detailed discussions of the preceding and other chemical constituents and physical properties of water are presented by Rainwater and Thatcher (1960).

EXPRESSION OF RESULTS

The chemical constituents of water are commonly reported as parts per million and equivalent per million. They are defined as follows:

One part per million (ppm) is a unit weight of a constituent present in a million unit weights of water. (Some laboratories report constitutents in grains per gallon, but this practice is gradually being superseded by the more convenient expression of parts per million. Results expressed in part per million can be converted to grains per gallon by multiplying by 0.0584; conversely, grains per gallon can be converted to parts per million by multiplying by 17.)

Equivalents per million (epm) expresses concentration in terms of chemical equivalence. In precise language, these units are milligram equivalents per kilogram when derived from parts-per-million data or milligram equivalents per liter when derived from data expressed in milligrams per liter. The equivalents per million for each constituent are calculated by dividing its concentration in parts per million by its equivalent weight. For example, 100 ppm of calcium divided by its equivalent weight (20.04) amounts to 5 epm of calcium. Equivalents per million are useful in expressing chemical combinations as well as in expressing analyses graphically.

SURFACE WATER RESOURCES

By Leland V. Page

QUANTITATIVE DATA AND ANALYTICAL STUDIES

The principal sources of surface water now used in De Soto Parish are the Sabine River, Bayou Pierre, and rainwater catchment in cisterns and farm ponds. The streams that drain the upland area are not dependable sources of supply without artificial storage because their flows are not well sustained during dry seasons.

Several streams that flow in or near the parish are potential sources of water supply for the parish, and streamflow records available have been compiled and analyzed. These records include stations on the Sabine River, Cypress Bayou, Boggy Bayou, Bayou San Patricio, Bayou Castor, and Bayou Pierre (pl. 2 and fig. 8). A brief description of each stream-gaging station, accompanied by tables of monthly discharge, monthly runoff, and yearly discharge, is given in the section on "Gaging station records," near the end of this report.

If streams in the area are to be used as the source of large additional supplies, water must be held in storage for several months or even several years. The amount of storage required to satisfy a particular need can be computed from the tabulations of monthly discharge. These monthly discharges summarize the daily discharges published in U.S. Geological Survey water-supply papers, parts 7 and 8 of the series "Surface Water Supply of the United States." Similar summaries through the water year 1950 have been published by the U.S. Geological Survey (1955, 1960), and summaries for the water years 1951–60 are planned for publication.

Streamflow records have been collected on Sabine River at Logansport since July 1903, on Cypress Bayou near Keithville and Boggy Bayou near Keithville since December 1938, on Bayou San Patricio near Noble since October 1952, and on Bayou Castor near Logansport since October 1955. Streamflow records for Bayou Castor near Logansport are not available for publication at this time, but provisional data are available in the files of the U.S. Geological Survey, Baton Rouge, La. Although the gaging station on Bayou Pierre near Grand Bayou has not been operated as a regular daily discharge station previously, the U.S. Army Corps of Engineers have obtained a record of stage and have made miscellaneous discharge measurements at this site from October 1946 to November 1954. From these measurements a record of monthly discharge for the period June 1952 to September 1954 was computed.

The basic surface-water data used in this report have been collected by the U.S. Geological Survey in cooperation with agencies of the State of Louisiana, the Texas State Board of Water Engineers, and the U.S. Army Corps of Engineers. A great part of the data was made available for this report through investigations carried on by the U.S. Geological Survey in cooperation with the Louisiana Department of Public Works. At several locations floodflow data was obtained by the Survey in cooperation with the Louisiana Department of Highways. Other data and information have been taken directly from technical reports of the Corps of Engineers, the U.S. Weather Bureau, and the Louisiana Department of Public Works. These sources of data are indicated through bibliographical references.

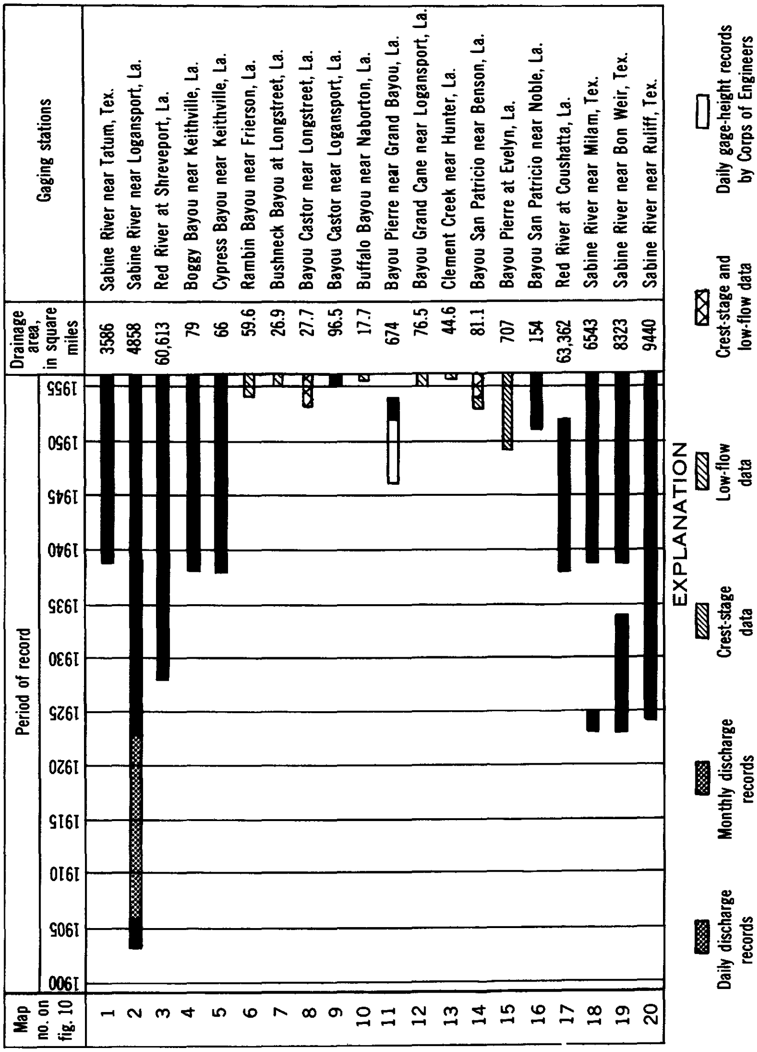

FIGURE 8.—Bar graph showing length of gaging station records in region.

EXPLANATION OF HYDROLOGIC TERMS

Quantities of water, as presented in records shown in this report, are in units of cubic feet per second (cfs); runoff, in inches; and runoff, in acre-feet. Second-feet was formerly used in U.S. Geological Survey reports as an abbreviation of cubic feet per second.

Cubic foot per second (cfs) is the rate of discharge equivalent to that of a stream whose channel is 1 square foot in cross-sectional area and whose average velocity is 1 foot per second.

Cubic feet per second per square mile is the average number of cubic feet of water flowing per second from each square mile of area drained, on the assumption that the runoff is distributed uniformly as regards time and area.

Runoff in inches is the depth to which the drainage area would be covered if all the water flowing from the drainage area in a given period were conserved and uniformly distributed on the surface.

Acre-foot is equivalent to 43,560 cubic feet and is the quantity of water required to cover an acre to the depth of 1 foot.

Equivalent values:

1 cfs=449 gallons per minute (gpm).

1 cfs=646,317 gallons per day (gpd).

1 acre-foot per day=0.504 cfs, or 1 acre-foot=0.504 cfs for 1 day (24 hours).

STREAMFLOW CHARACTERISTICS

Physical variations in the terrain of drainage basins affect the behavior of streamflow. Rates of runoff are probably the most significant differences that result from variations in terrain.

Some areas have a permeable soil mantle and underlying rocks with a large capacity for penetration by, and storage of, ground water, which is later released to the streams at a relatively steady rate. Consequently, the streamflow will be well sustained during the fair-weather periods. On the other hand, in areas with a shallow soil mantle over impermeable rocks or poorly drained subsoils, streamflow will recede rapidly from sharply concentrated flood peaks to low flows, or even no flow, between storms. However, ground storage and timing—that is, the time within which the runoff from a storm is discharged from the basin—appear to influence the long-term total volume of runoff only slightly at most places.

The behavior of the streamflow with respect to timing is illustrated in figure 9. This figure is a hydrograph of daily discharge of Bayou San Patricio near Noble, La.; a plot shows the corresponding mean of daily rainfall at Mansfield and at Converse for the water year 1955. (Runoff amounting to less than 1 cfs is not shown on this figure.) In general, there is about a 2-day lag between the time the center of

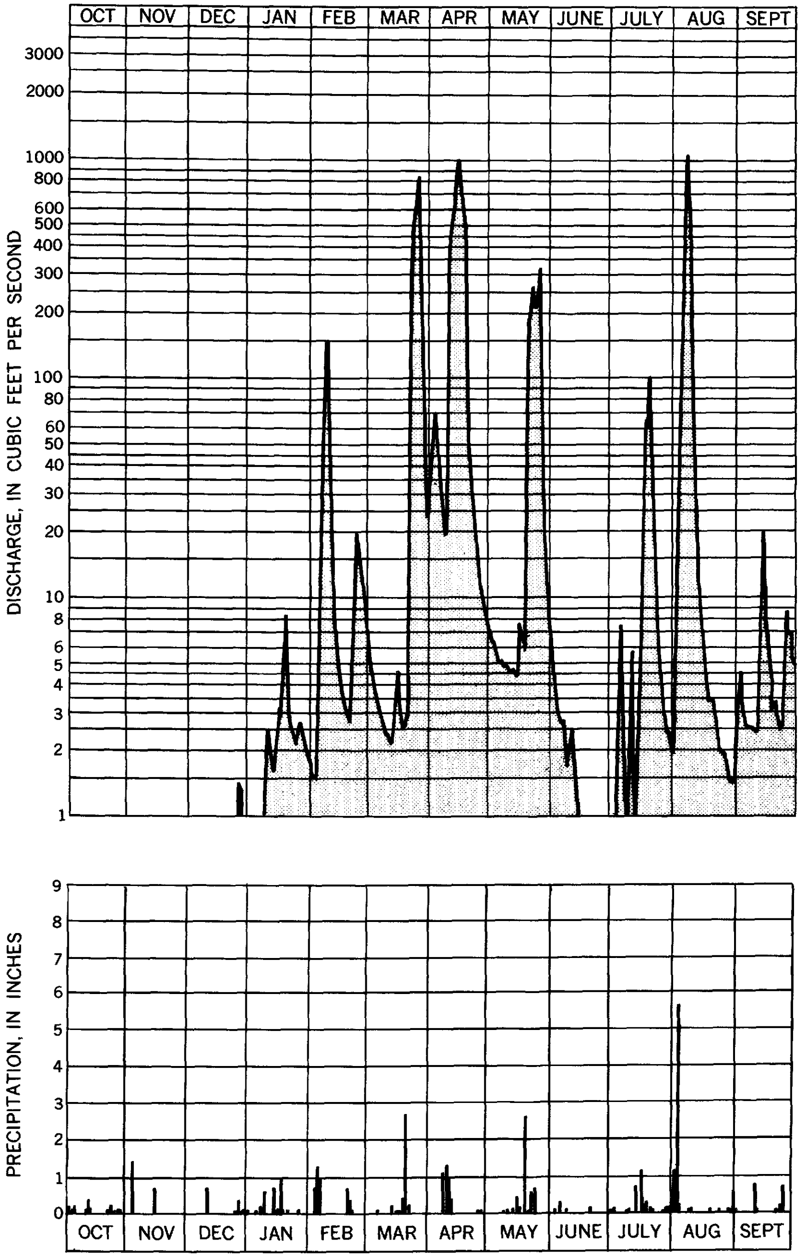

FIGURE 9.—Hydrograph of daily discharge of Bayou San Patricio near Noble, La., and mean of daily precipitation at Mansfield, La., and Converse, La., for water year 1955.

the storm passes over this area and the time the peak discharge passes the gaging station at Noble. The stream is moderately flashy, but high flow persists for a considerable period following storms and can be attributed to the presence of comparatively permeable subsoils in the basin. The combined drainage areas of Cypress Bayou and Boggy Bayou at the gaging stations near Keithville are of comparable size to Bayou San Patricio near Noble. However, the average streambed slopes of Cypress Bayou and Boggy Bayou are considerably steeper than that for Bayou San Patricio, and the Cypress Bayou and Boggy Bayou basins have more impermeable subsoils. Consequently, there is a marked contrast in the streamflow following similar storms over the two areas. The runoff from the Cypress Bayou and Boggy Bayou basins is more rapid and usually reaches a peak rate of flow at the gaging stations near Keithville within a matter of hours after a storm. The rate of flow then recedes almost as quickly to low or to zero flow, as these streams do not have a well sustained base flow.

The regimen of Bayou San Patricio is probably representative of that of Clement Creek, Cow Bayou, Buffalo Bayou, and the several small bayous in the southeastern corner of the parish which drain areas having similar topography and subsoil type. The remaining interior streams of the parish probably behave more nearly like Cypress Bayou and Boggy Bayou, although they are not quite as flashy, as they drain areas which have similar terrain and subsoil type but in which the streambeds do not slope quite as steeply.

To evaluate and compare streamflow characteristics of various streams in or near the report area, records of daily discharges have been analyzed and presented in several different ways. Flow-duration curves (fig. 10) are shown for four streams that are not affected appreciably by regulation—Cypress Bayou, Bayou San Patricio, Sabine River, and Bayou Pierre. Curves of maximum period of deficient discharge (fig. 11) and storage requirements (fig. 12) to maintain various rates of flow are shown for Sabine River. Low-flow frequency curves (figs. 13 and 14) are shown for Cypress Bayou and Sabine River.

A flow-duration curve shows the cumulative frequency of occurrence of different rates of flow at a given point. It indicates the percentage of time, during the period studied, that any given rate of flow was equaled or exceeded. In general, the longer the period of record from which the flow-duration curve data are computed, the more representative of average conditions will be the results.

The slope of the flow-duration curve is a good index of the storage within a basin, including ground-water storage. The flatter the general slope of the curve is, the lower are the flood peaks and the higher is

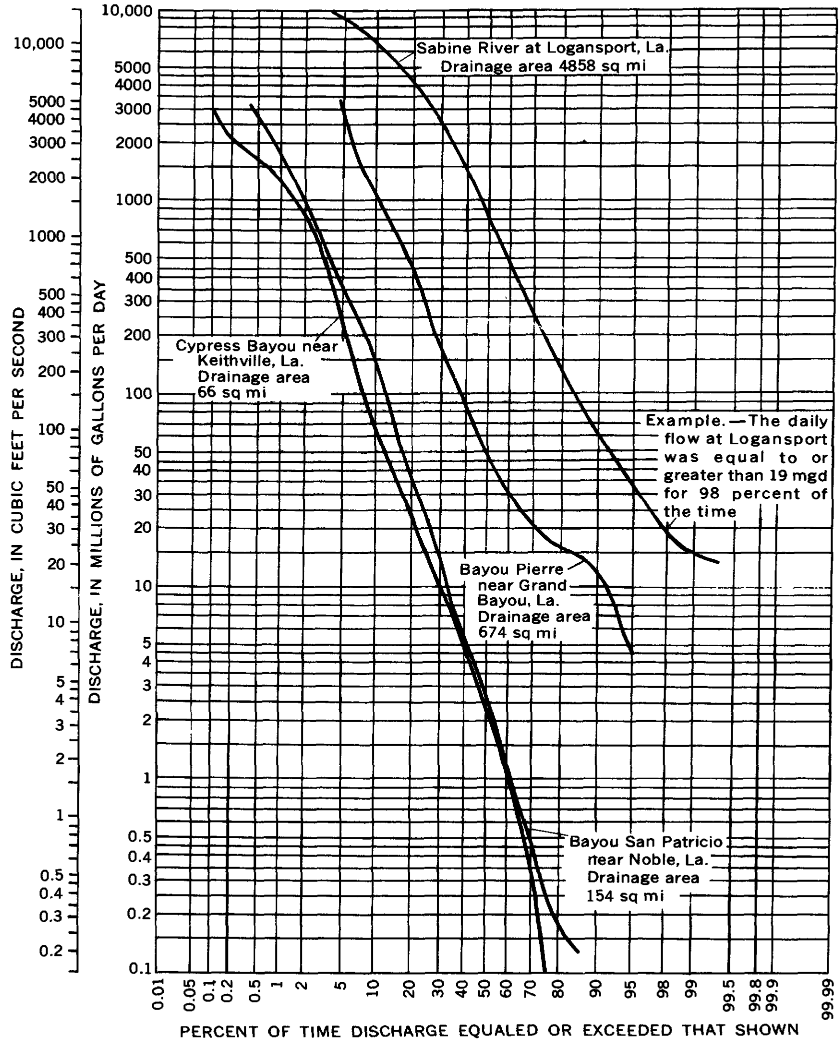

FIGURE 10.—Duration curves of daily flow in and adjacent to De Soto Parish, 1932–55.

the sustained dry-weather flow. A comparison of the low ends of flow-duration curves shows which streams have the highest dry-weather flow and are thus the best source for a water supply without storage.

Flow-duration data in this report are shown in cubic feet per second and in mgd (millions of gallons per day). If one assumes equal yield from all parts of the drainage area and no intervening regulation of flow, these data may be used to estimate flow characteristics at any place on the stream. For example, if information is desired on the Sabine River at a place where the drainage area is 5,000 square miles, flow-duration data can be estimated from data on Sabine River at Logansport which has a drainage area of 4,858 square miles (fig. 10). On the basis of drainage-area proportion a daily flow of 19.6 mgd (19 mgd×5,000÷4,858) may be expected to be equaled or exceeded 98 percent of the time, and daily flow of 835 mgd (810×5,000÷4,858) may be expected to be equaled or exceeded 50 percent of the time. Care should be exercised in using this method because all parts of a drainage basin may not have equal yields or the same runoff characteristics. In general, the possible error increases with an increase in distance upstream or downstream from the gaging station.

The flow-duration curve (fig. 10), the curve showing maximum periods of deficient discharge (fig. 11), the curve showing storage requirements (fig. 12), and the low-flow frequency curves (figs. 13 and 14) can be very useful in the solution of many water-supply design problems. For example, suppose a flow of 20 mgd was required for a hypothetical plant site on Sabine River at Logansport (with a drainage area of 4,858 square miles). If flow conditions in the future are comparable to those experienced during the period of record 1932–54, 20 mgd would be available from Sabine River at Logansport for 97 percent of the time (fig. 10). During unusually dry years, the daily flow at Logansport would be expected to be less than 20 mgd

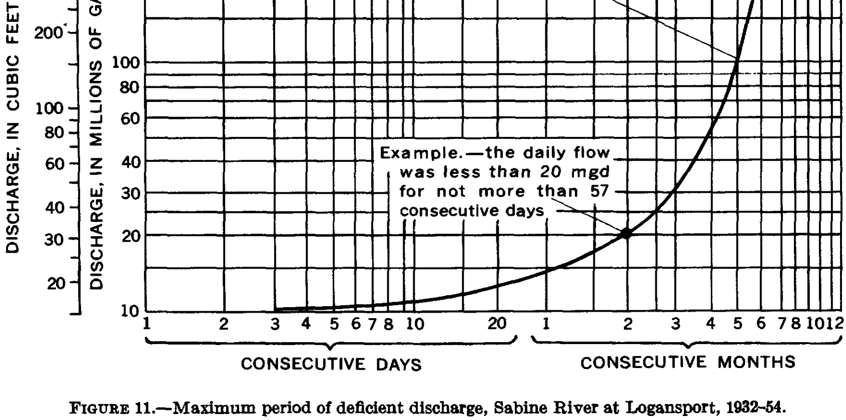

FIGURE 11.—Maximum period of deficient discharge, Sabine River at Logansport, 1932–54.

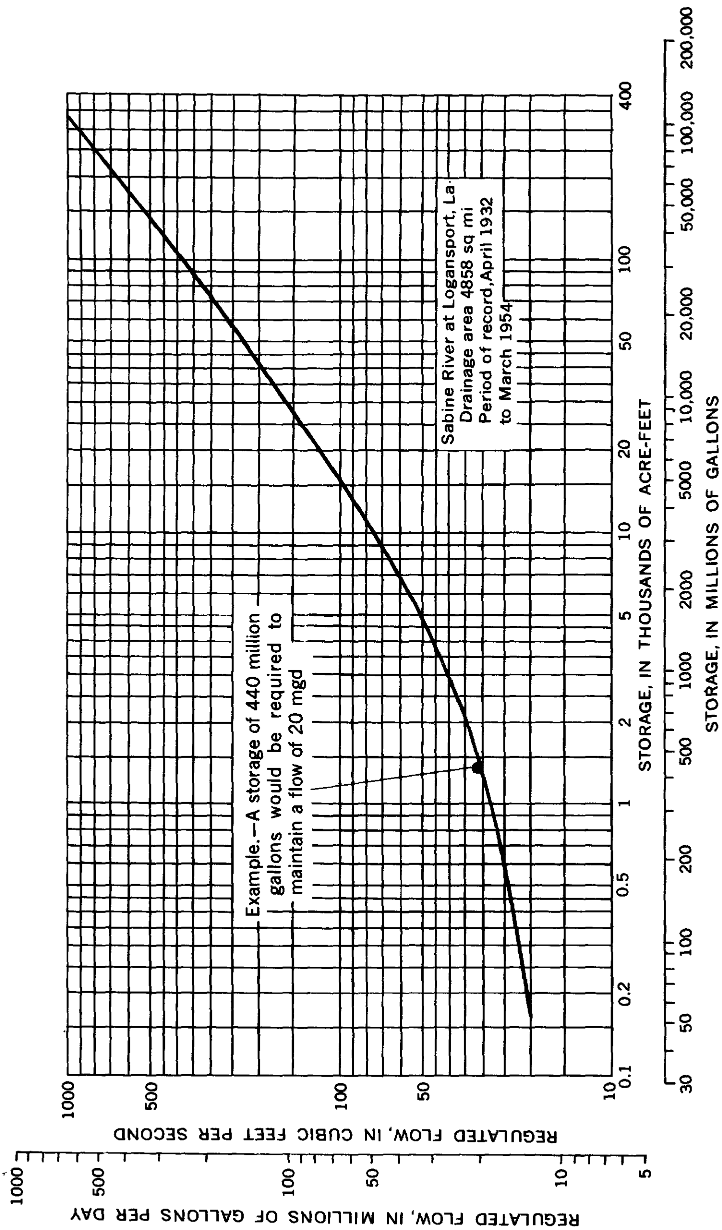

FIGURE 12.—Storage requirements, Sabine River at Logansport, 1932–54.

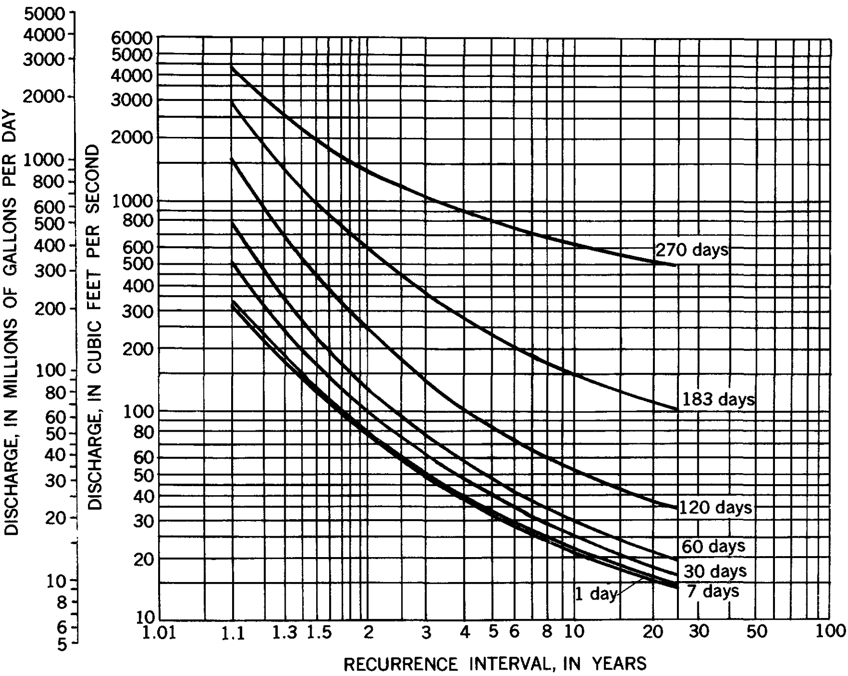

FIGURE 13.—Low-flow frequency curves for Sabine River at Logansport, La., 1932–54.

for not more than 57 consecutive days (fig. 11). During a 23-year period in which the pattern of flow was similar to that in 1932–54, a storage of 4.4 million gallons would be required to maintain a flow of 20 mgd (fig. 12). To this volume must be added the amount of dead storage below the reservoir outlet and an allowance for evaporation and leakage from the reservoir. Without storage, the daily flow would be as low as 20 mgd or less at average intervals of 5.4 years, and the average flow for 30 days would be as low as 20 mgd or less at average intervals of 7.3 years (fig. 13). This statement does not mean that a 30-day flow of as low as 20 mgd would occur at regular intervals of 7.3 years but that over a long period of time the minimum 30-day flow during the year would be expected to be as low as 20 mgd or less about 10 times in 73 years.

Article V of the Sabine River Compact between the States of Texas and Louisiana provides in brief: that all free water in the State line reach shall be divided equally between the two States, this division to be made without reference to the origin; that reservoirs and permits above the State line existing as of January 1, 1953, shall not be liable for maintenance of the flow at the State line; and that reservoirs on which construction is commenced after January 1, 1953, above the

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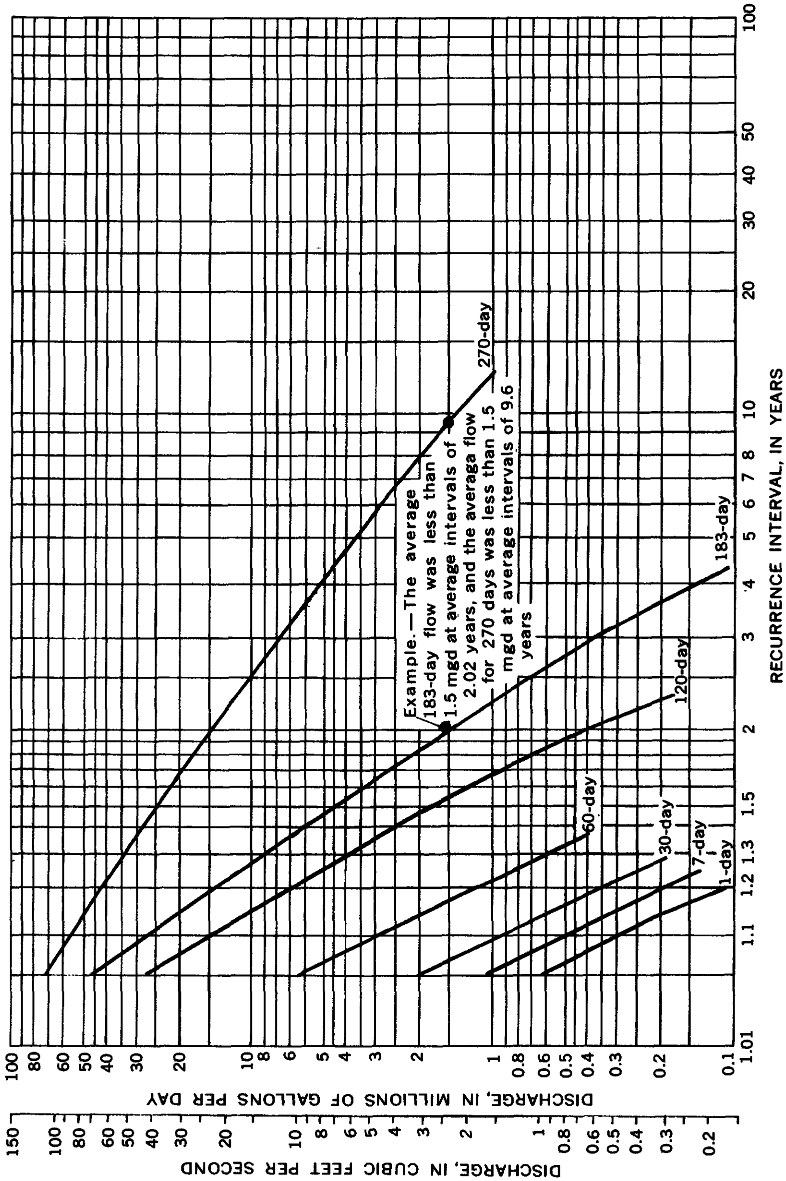

FIGURE 14.—Low-flow frequency curves for Cypress Bayou near Keithville, La., 1939–54.

State line shall be liable for their share of water necessary to provide a minimum flow at the State line of 36 cfs, provided that no reservoir shall be liable for a greater percentage of this minimum flow than the percentage of the drainage area above the State line contributing to that reservoir, exclusive of the watershed of any reservoir on which construction was started prior to January 1, 1953. Water released from reservoirs in Texas to establish the minimum flow of 36 cfs is classed as free water at the State line and divided equally between the two States. The term "free water" means all water other than stored water in the State line reach including, but not limited to, that appearing as natural streamflow and not withdrawn or released from a reservoir for specific uses, and including water released from reservoirs for the purpose of maintaining streamflows provided for in Article V and releases of stored water made in anticipation of spillage.

Curves of discharge available without storage indicate that the flow of Cypress Bayou near Keithville remained below 1 mgd for 6 months at a time and that the flow of Bayou San Patricio near Noble remained below 0.1 mgd for 5.8 months at a time.

LOW FLOWS

A very useful tool in the design of any water-supply development, whether it be a municipal water supply or a supply for an irrigation works, is the low-flow frequency curve. Low-flow frequency curves based on annual flows for the climatic years starting April 1 for Sabine River at Logansport and Cypress Bayou near Keithville are shown in figures 13 and 14. The curves show the recurrence interval of annual minimum flows of several durations. The Sabine River has better sustained flow than does Cypress Bayou, as is shown by the more gradual attenuation of its recurrence interval curves. The curves for Cypress Bayou are fairly representative of Boggy Bayou drainage. It is apparent that in most years flows of 1 cfs or lower for periods of a month or more can be expected at Keithville.

The available record for Bayou San Patricio is too short to develop a representative low-flow frequency curve. Bayou San Patricio drains areas of slightly better sustained flow than do Cypress and Boggy Bayous as is evidenced by figure 10. Because of the great variation possible in flow characteristics from stream to stream, these curves cannot be used indiscriminately to determine the probable frequency of low flows on other streams in the parish.

The combined flow from Boggy Bayou and Cypress Bayou, which flow into Wallace Lake, is a fair indication of the available flow in Bayou Pierre, which flows past De Soto Parish. However, low flows in Bayou Pierre are sustained somewhat by Wallace Lake Reservoir, whereas Boggy and Cypress Bayous go dry nearly every year during periods in the summer and fall.

To appraise the low-flow characteristics of other streams in the parish, special low-flow measurements were made during 1954, 1955, and 1956 on the small ungaged streams listed in table 2. These data are too meager to make reliable correlations with the records for regular gaging stations. However, these measurements verify the well-known fact that most streams that originate in the upland areas of the parish have no flow for at least several successive weeks every year. The length of time that they are dry depends upon the drainage-area size, the type of soil mantle, whether or not there is any sustained base flow from a ground-water table, and the length of time without rainfall. More low-flow measurements will be taken until sufficient data are available to make reliable correlations with records at regular gaging stations.

FLOODS

The floods in July and August 1933, April 1945, and May 1953 were the most notable floods of recent times in De Soto Parish. The flood of April 1945 is the maximum known on the lower reaches of Bayou Pierre and on the Sabine River. The Sabine River reached an elevation of 191.79 feet above mean sea level at Logansport. The maximum known stages, which occurred on the lower reaches of Bayou Pierre during this flood, were caused by diversion from Red River through crevasses in the levee at Grand Bayou, Hammond, and Hanna and were further intensified by backwater from the Red River.

Excessively high stages on Bayou Pierre occurred in early August 1953 following a heavy rain in headwaters in late July. Precipitation at Shreveport totaled 19.08 inches during a 3-day period and caused maximum stages known in the upper reaches of Bayou Pierre. This storm also produced high stages on most of the smaller streams in the parish. Figure 15 shows water-surface profiles for the floods of August 1933, April 1945, February 1950, and April–May 1953 for Bayou Pierre between Shreveport and the mouth. Most of the data for these profiles were furnished by the Corps of Engineers, New Orleans District. The peak discharge for the flood of August 1933 at the gaging station on Cypress Bayou near Keithville is estimated to have been between 30,000 and 35,000 cfs. The threat of future floods in the lower reaches of Bayou Pierre has lessened considerably since the completion of Wallace Lake Reservoir on Cypress Creek, 66 miles above the mouth of Bayou Pierre. Wallace Lake Dam is a part of a comprehensive plan for flood control in Red River basin. Approximately 88,340 acre-feet of capacity is available for flood control storage; this capacity is sufficient to satisfactorily control the maximum flood of record at this site. An outlet conduit in the spillway structure provides a means of regulating the flow from the reservoir. Figure 16 shows curves of discharge through the outlet conduit

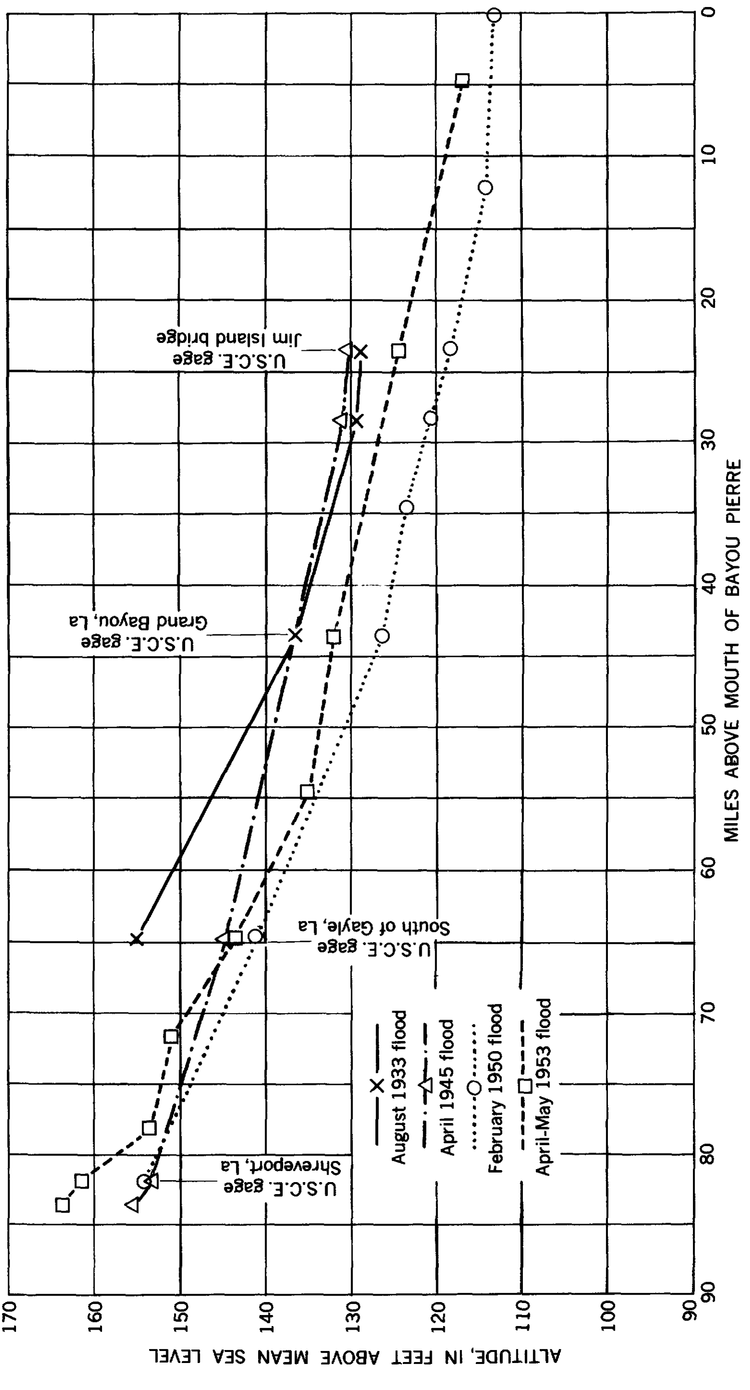

FIGURE 15.—Water-surface profiles for selected floods on Bayou Pierre, Shreveport to mouth.

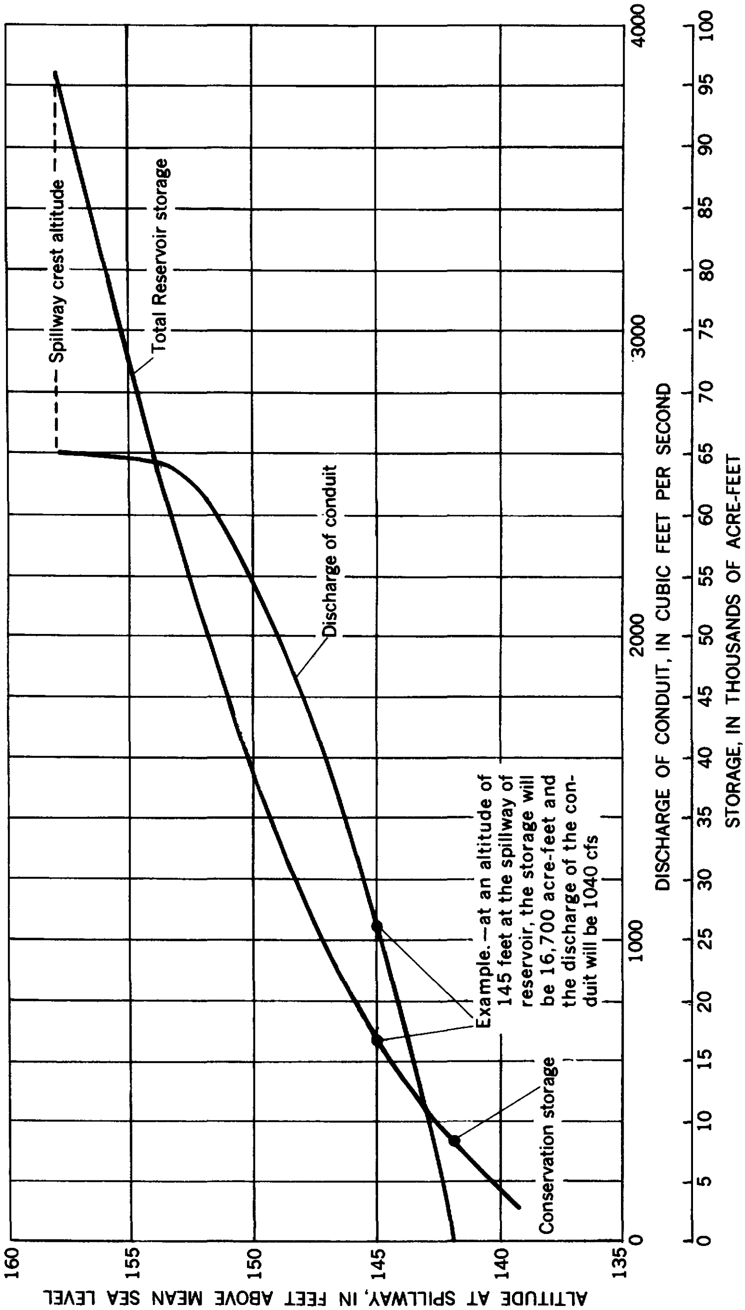

FIGURE 16.—Curves of discharge and total storage for Wallace Lake Reservoir on Cypress Bayou.

and of total reservoir storage for various pool elevations for Wallace Lake Reservoir. These curves are based on data furnished by the Corps of Engineers, New Orleans District.

The flood of April 1945 on the Sabine River ranks first, and the flood of May 1884 ranks second in order of magnitude in the list of known floods at Logansport. The flood of May 1915 ranks second, and the flood of April 1921 ranks third in magnitude during the period of record 1903–56 at Logansport. The more recent flood of May 1953 ranks fifth in magnitude in this period. Figure 17 shows water surface profiles for the floods of April 1945, February 1950, and May 1953 for the Sabine River between Gladewater, Tex., and Ruliff, Tex. Sufficient data are not available to draw profiles for earlier floods. A list of annual maximum stages and discharges for Sabine River at Logansport appears in table 3.

On the basis of the record for Logansport, the highest annual stages on Sabine River in the 52-year period 1903–55 have occurred one or more times in every month except August, September, or October. The highest stage in the year has occurred in either April or May in 46 percent of the years. Figure 18*A* shows the distribution of the maximum annual floods with respect to the months of occurrence.

The probable frequency of floods is an important factor in any project involving drainage, flood control, and protection or in the proper design and location of structures placed in, across, or adjacent to streams. Levees, dams, or like structures that may cause loss of life in the event of failure should be designed to withstand the maximum probable flood. Works of lesser importance, however, where failure would not usually cause the loss of life or would not incur an exceedingly great financial loss usually can be designed for much lesser floods at considerable savings. Consequently, the more economical approach is to design such structures for a flood of some particular recurrence interval rather than for the maximum probable flood. The estimated damage resulting from the occurrence of the design flood, coupled with the probable useful life of the structure, can be weighed against the additional costs of designing the structure to prevent such damage.

To aid in the design of waterway openings, the Louisiana Department of Highways has published a cooperative report (Cragwall, 1952, p. 229–273), prepared by U.S. Geological Survey engineers, that contains much flood data on Louisiana streams and a section on frequency of floods. Figures 18*B* and 19 were constructed from Cragwall's curves for northeastern Louisiana. Figure 18*B* may be used to estimate the probable magnitude of floods having a recurrence interval of 2.33 (mean annual), 5, 10, and 25 years on Bayou San Patricio, Bayou Pierre, and most other smaller streams in De Soto Parish. Although

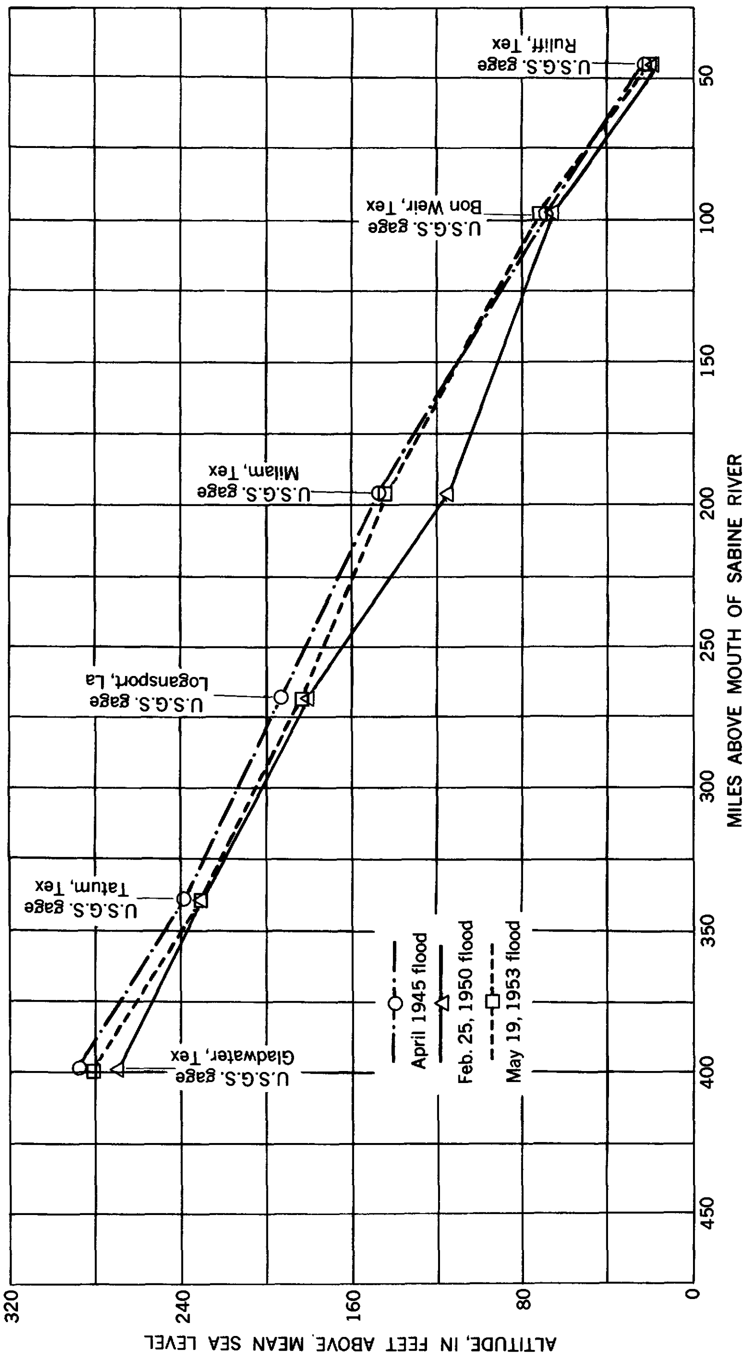

FIGURE 17.—Water-surface profiles for selected floods on Sabine River, Gladewater, Tex. to Ruliff, Tex.

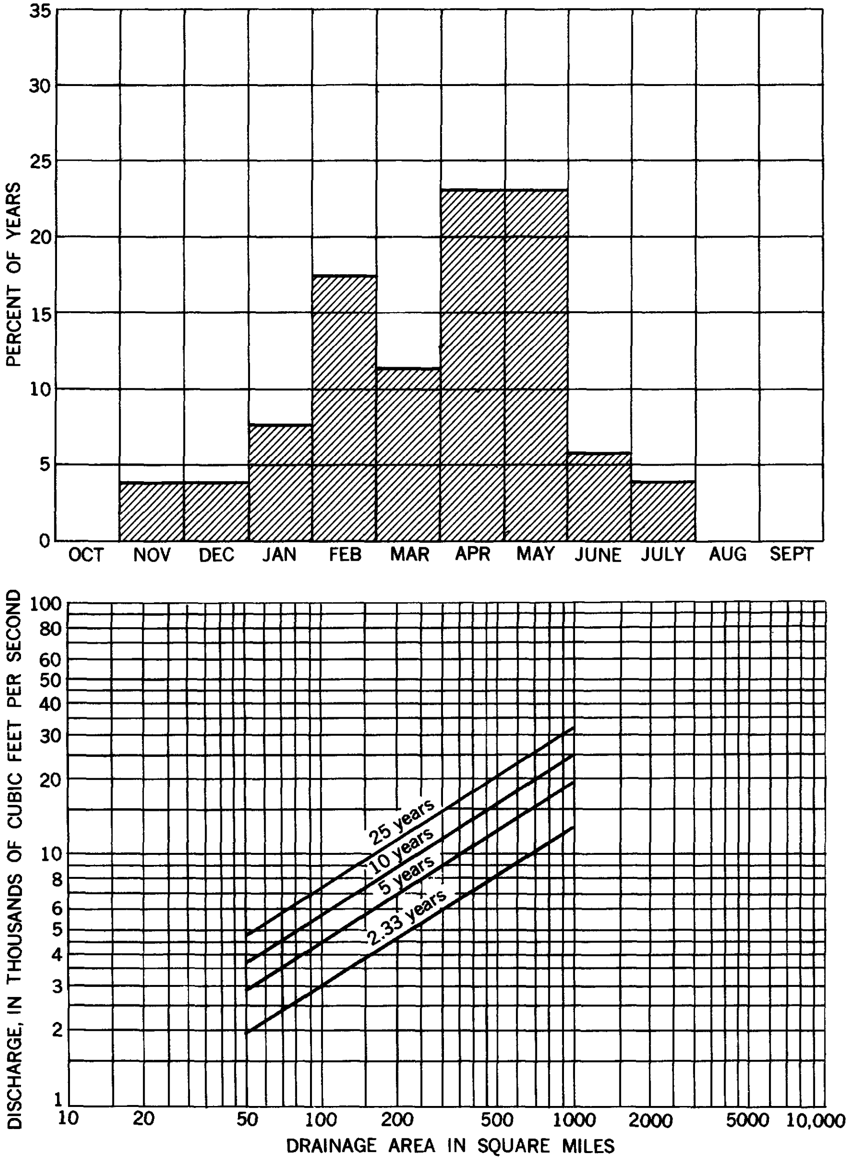

FIGURE 18.—Graphs showing (*A*, upper) occurrence of annual floods on Sabine River, by months, Logansport, La., 1903–55 and (*B*, lower) relation of peak discharge to drainage area (recurrence interval in years)—Bayou San Patricio, Bayou Pierre, and most small streams within De Soto Parish.

Cragwall's curves for the small streams in northwest Louisiana were based on data collected in the Red River basin, streams in De Soto Parish tributary to Sabine River, like Bayou San Patricio, would probably show somewhat the same characteristics as the other small

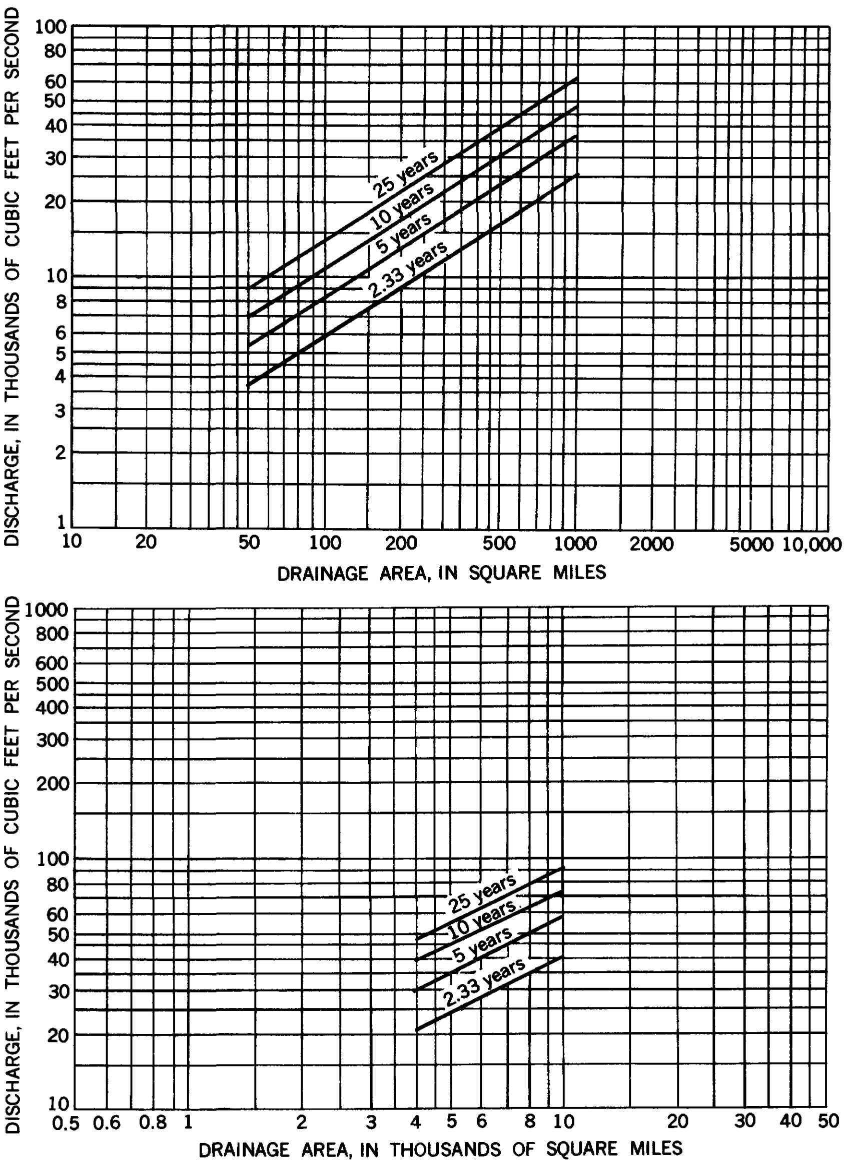

FIGURE 19.—Graphs showing relation of peak discharge to drainage area (recurrence interval in years) *A* (upper), Cypress Bayou; *B* (lower), Sabine River.

streams, excluding Cypress Bayou, inasmuch as the drainage patterns and topography of the areas are similar. Figure 19*A* may be used for Cypress Bayou drainage basin which has characteristics somewhat different from those for most other streams within De Soto Parish.

Figure 19*B* may be used to estimate the probable magnitude of floods of the indicated recurrence intervals on the mainstream of Sabine River. For example, a peak discharge of 7,200 cfs may be expected from a drainage area of 100 square miles on the average of once in 25 years for any small stream in the parish, excepting Cypress Bayou (fig. 18*B*), but a discharge of about 13,000 cfs may be expected from the same size area on the average of once in 25 years for Cypress Bayou (fig. 19*A*). However, the recurrence interval does not imply any regularity of occurrence but is the probable average interval between floods of a given magnitude in a long period of time. Two 25-year interval floods could conceivably occur in consecutive years or even in the same year.

CHEMICAL AND PHYSICAL CHARACTERISTICS

CHEMICAL QUALITY

Water falling upon the earth in the form of rain contains little or no dissolved matter. Its chemical constituents consist primarily of the normal gaseous constituents of the air—nitrogen, oxygen, and carbon dioxide. Once the water comes in contact with soils or rocks, it dissolves mineral matter. The amount of mineral matter that is dissolved depends largely on the type of rock or soil over, or through, which the water flows and the length of time the water has been in contact with that medium. The chemical character of water is continually changing, not only because of natural processes but also because of activities of man. Drainage from mines and oil fields or the addition of municipal or industrial wastes increases the concentration of mineral matter in many rivers.

In contrast to ground water, surface water may change in chemical quality from day to day. Therefore, daily records of chemical analyses at strategically located points within each large river system are desirable. Unfortunately, this information is not available for De Soto Parish; however, daily samples have been taken continuously from the Sabine River near Ruliff, Tex., since 1947, and from the Sabine River near Tatum, Tex., since February 1952. Results of analyses for two typical years, 1954 and 1955, for these sampling stations are shown in tables 4, 5, 6, and 7. Analyses of several samples collected at sites in or near the parish during the 2 years from October 1954 to September 1956 give an indication of the quality of water. The mineral constituents and physical properties of the surface waters in or near De Soto Parish that have practical bearing on the uses of surface water for most purposes are given in table 8. Also, results of chloride determinations of surface water in or near the parish at selected points on Bayou Pierre are shown in table 9.

All the analyses tabulated in table 8, with the exception of those representing sampling stations at times of extremely low flow, are low in dissolved solids and are low in chloride and sulfate. The hardness of most of the water samples in table 8 is less than 60 ppm, and on the basis of commonly used classifications the surface water in and near De Soto Parish is soft. However, treatment would be necessary to remove color and suspended material, as water with a color of more than 15 or 20 units on the standard cobalt-platinum scale is not very acceptable for public use. If these analyses are representative, a storage of several hundred acre-feet of water on any of the small streams probably would provide a good surface supply for a small city in the parish.

Tabulated analyses of Sabine River water collected during the water years 1954 and 1955 at Tatum and Ruliff, Tex., appear in tables 4, 5, 6, and 7. These analyses show the quality of water that could be pumped from the Sabine River at any point in De Soto Parish. This water is generally of excellent quality, but there is danger of periodic contamination from east Texas oil fields. Chloride concentrations of more than 250 ppm are not recommended for public water supplies, and dissolved solids preferably should not be greater than 500 ppm, although 1,000 ppm can be accepted when better water is not available. Data listed in tables 4, 5, 6, and 7 show that the concentrations of chemical constituents in the Sabine River water are generally well below the limits recommended by the U.S. Public Health Service (1946).

A considerable variation in the chemical character of the Sabine River during the year is indicated graphically by the values of specific conductance in figure 20. This figure also shows the relation of hardness, dissolved solids, and specific conductance of the Sabine River near Tatum, Tex., to the streamflow at that point during the 1955 water year. Figure 21 shows the relation of chloride concentration of Sabine River near Tatum, Tex., to specific conductance for the same period. It is apparent from this graph that the relation between conductivity and chloride content is linear except for the very high and very low concentrations of chloride.

TEMPERATURE

The temperature of surface water varies with air temperature, usually reaching a maximum in July and August and a minimum in December and January. During the winter months when the streamflow is greatest, the monthly average surface-water temperature is

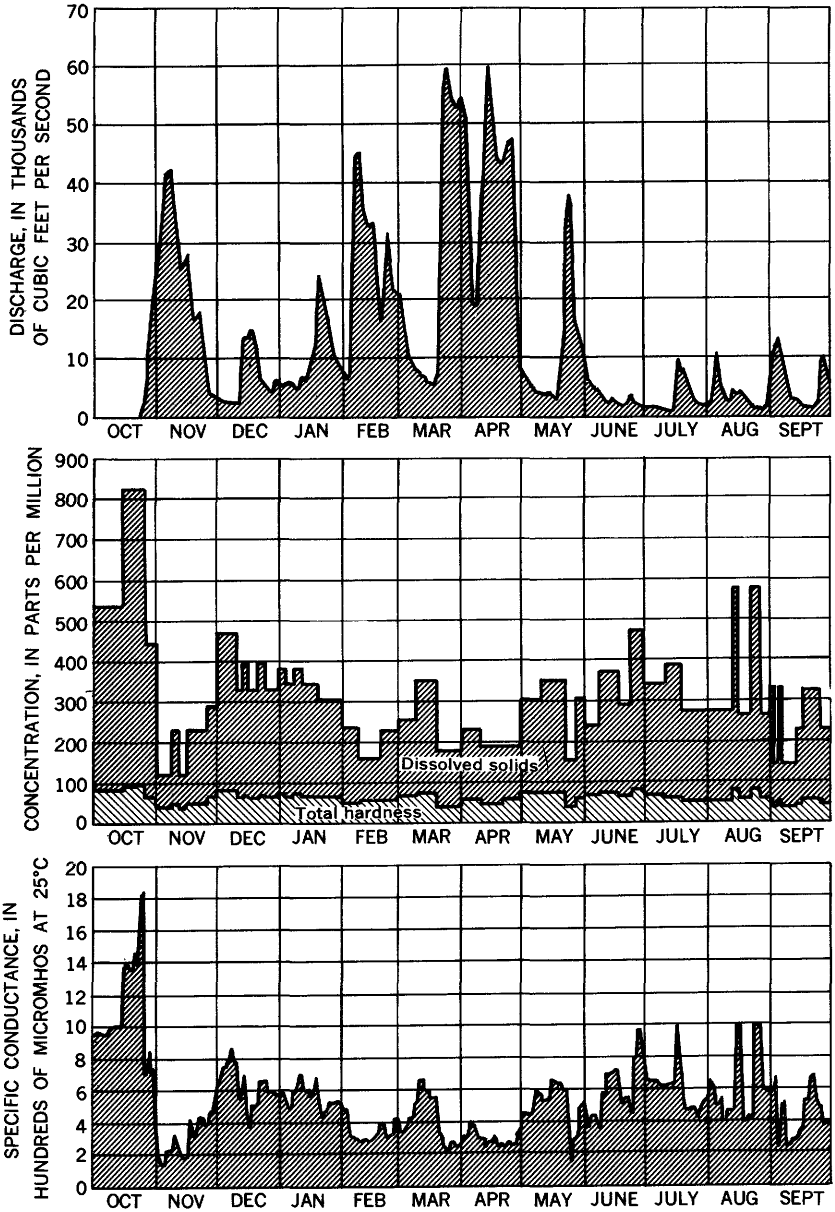

FIGURE 20.—Graphs showing relation of hardness, dissolved solids, and specific conductance to streamflow, Sabine River near Tatum, Tex., water year 1955.

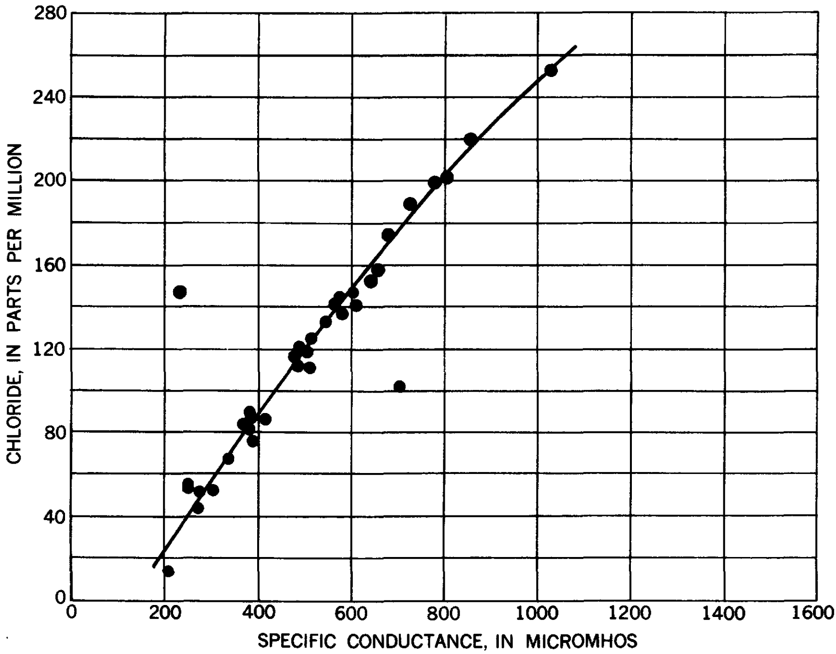

FIGURE 21.—Graph showing relation of chloride concentration to specific conductance, Sabine River near Tatum, Tex., water year 1955.

nearly the same as the monthly average air temperature. During the months of low flow the monthly average surface-water temperature is several degrees higher than the monthly average air temperature. Figure 22*A* shows the maximum, average, and minimum monthly temperature of Sabine River near Tatum, Tex., for the water year ending September 20, 1955. Also shown on this figure for comparison is a graph of monthly average air temperature for Longville, Tex., for the same period. Longville, which is about 18 miles upstream from Tatum, has the nearest climatological station having a complete period of daily air temperatures. Figure 22*B* shows a graph of daily water temperatures for Sabine River near Tatum, Tex., for water year October 1954 to September 1955.

Observations of water temperature have been made of Bayou San Patricio near Noble, La., since December 1951, of Cypress Bayou near Keithville since January 1955, and of Wallace Lake since October 1954. The results of these observations follow.

Observations of water temperature, in degrees Fahrenheit, of Bayou San Patricio, Cypress Bayou, and Wallace Lake

Bayou San Patricio near Noble, La.

1951	
Dec. 13	49
1952	
Feb. 14	61
Apr. 10	62
May 15	72
June 19	89
Aug. 20	79
Oct. 30	48
Dec. 18	49
1953	
Jan. 29	47
July 6	80
Oct. 18	66
Dec. 18	42
1954	
Jan. 13	42
Feb. 16	64
Mar. 16	52
Apr. 21	67
May 20	69
June 23	83
Nov. 16	67
Dec. 17	49
1955	
Jan. 12	51
Feb. 9	49
Mar. 9	54
Apr. 1	59
Apr. 29	75
May 24	71
June 21	75
June 30	74
July 27	85
Aug. 14	76
Sept. 14	74
Oct. 18	63
Nov. 30	40
1956	
Jan. 5	46
Jan. 31	55
Feb. 29	60
Mar. 27	65
Apr. 25	66
May 23	62
June 20	78
July 18	84

Cypress Bayou near Keithville, La.

1955	
Jan. 1	44
Feb. 7	51
Apr. 12	64
May 17	74
June 7	72
July 14	75
Aug. 16	76
Oct. 18	57
Nov. 17	66
Dec. 9	45
1956	
Jan. 19	38
Feb. 8	48
Mar. 6	66
Apr. 3	67
Apr. 30	68
June 6	80
July 10	84

Wallace Lake

1954	
Oct. 21	71
Nov. 19	57
Dec. 7	50
1955	
Jan. 14	46
Feb. 8	49
Apr. 13	68
May 17	82
June 7	82
July 19	83
Aug. 16	92
Sept. 22	89

USES OF SURFACE WATER

The city of Logansport, which was dependent upon five wells for its domestic water supply, has recently converted to a surface-water supply. Logansport has been allocated 4 mgd by the Sabine River Compact Administration and has constructed a plant capable of handling 1 mgd. The plant takes water directly from Sabine River a short distance upstream from the city. The city of Mansfield, which is the only other municipality in the parish having a public water system, obtains its water from wells which are adequate to satisfy present demands; however, future large industrial expansion will require the development of a surface-water supply. Clear Lake

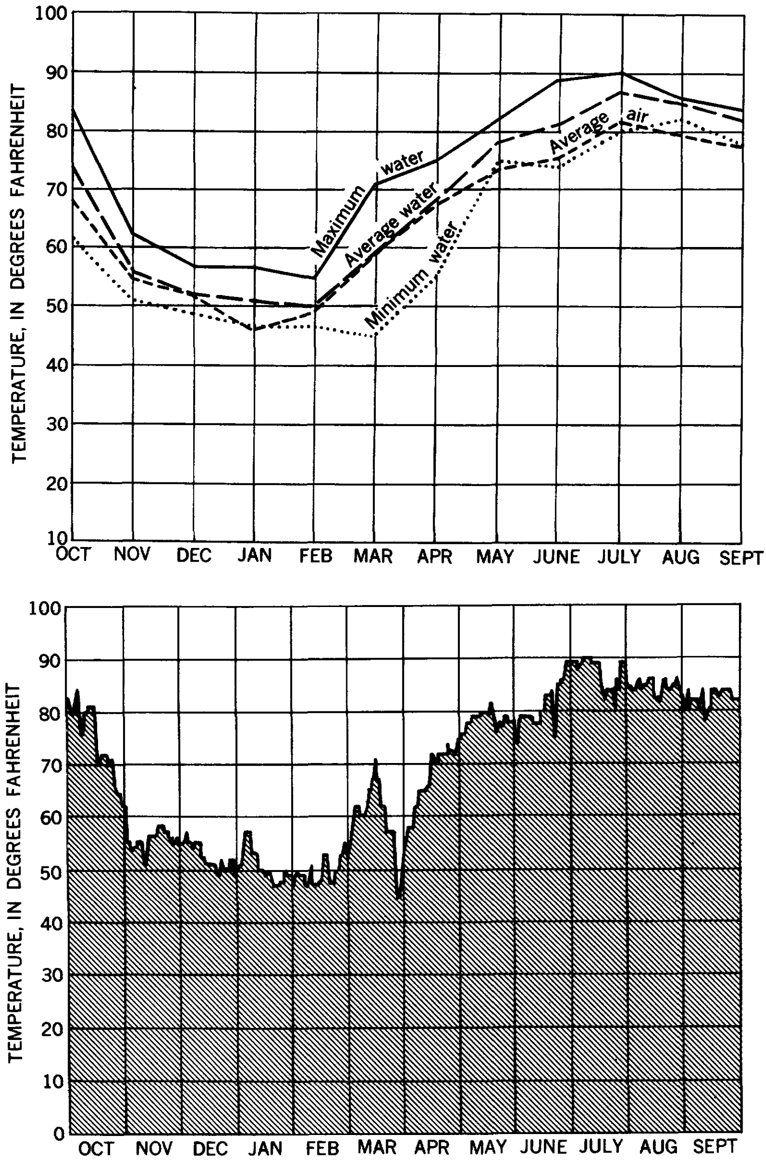

FIGURE 22.—Graphs for water year October 1954 to September 1955. *A* (upper), Monthly maximum, average, and minimum water temperature for Sabine River near Tatum, Tex., compared to monthly average air temperature for Longville, Tex.; *B* (lower), Daily water temperature, Sabine River near Tatum, Tex.

has been considered as a possible future surface-water source for the city of Mansfield, and more recent studies have indicated the possibility of developing a closer supply by building a reservoir on Bayou Na Bonchasse.

During dry periods more and more use is being made of surface water in the parish for irrigation. Even though the parish is in the humid zone, where the normal precipitation is usually adequate during the growing season for most agricultural pursuits, comparatively short periods of drought that adversely affect crops are not uncommon. Several private irrigation systems have been installed along Bayou Pierre in the past few years. Several private sprinkler-type irrigation projects that draw water from stock ponds have also been installed in the parish in the past year or two.

The city of Logansport has relied largely on Sabine River for disposal of its wastes. Untreated sewage and the effluent from numerous septic tanks empties either directly into the river or indirectly through local natural drainage tributary to the river. The city of Mansfield also relies on local surface-water channels for disposal of its sewage, some of which enters the streams directly as raw sewage and some in the form of effluent from private septic tanks. Plans are underway for improving the sewage disposal facilities of both Logansport and Mansfield.

Streams in De Soto Parish do not play an important role in navigation at the present time, owing to their inability to accommodate large, modern craft. Sabine River and Bayou Pierre have played important roles in earlier times when they were used by small craft. The authorized project for the Overton-Red River Waterway (pl. 2) will provide for 9-foot draft navigation from the Mississippi River to Shreveport. The proposed waterway is expected to provide low-cost transportation to move local agricultural products to markets. Inbound traffic serving commercial activities and consumer goods requirements of the area are also expected to use the waterway.

WATER PROBLEMS

The principal water problems in the parish pertain to water supplies for industrial and municipal expansion, flood control, drainage, irrigation, and navigation. Other problems are sewage disposal and contamination from salt water encountered in oil-drilling operations.

The demand on the water system for the city of Logansport exceeded the capacity of the old plant, which depended on ground-water wells for its source of supply. A new water plant for Logansport has been constructed that uses Sabine River water and will doubtless satisfy the needs for the foreseeable future. If any industrial expansion requiring moderate to large supplies of water occurs in the Mansfield area, it will be necessary to consider the development of a surface-water supply to replace or supplement the present ground-water supply.

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Channel improvements on Bayou Pierre and the completion of Wallace Lake Reservoir on Cypress Bayou and levees on Red River have alleviated the flood problems considerably.

Wet lands along Bayou Pierre are very fertile and productive when properly drained and protected from floods. The impermeable nature of the subsoils, the flat topography, and the large percentage of clay in their structure, along with the heavy rainfall of the area, make the soils soggy. Considerable work has been done by the Louisiana Department of Public Works and the Corps of Engineers in clearing and enlarging old bayous and constructing new ditches and levees. Additional flood protection would be required, however, to permit drainage of some areas.

Many present as well as potential problems arise with irrigation. For example, Bayou Pierre has been pumped dry at times by those using the water for irrigation. Also, even though the Sabine River can provide ample quantities of water suitable in quality for irrigation, the main problem is to distribute the water to the irrigable lands on the east side of the parish.

The extreme lower reaches of the Sabine River have been improved for navigation, but De Soto Parish is more than 200 miles above any practical improvement for navigation on this river. The construction of the proposed Overton-Red River Waterway along the route of Bayou Pierre would provide a 9-foot channel from the Mississippi River to Shreveport, as well as improve the drainage of wet lands adjacent to the waterway.

No serious pollution problems presently exist within the parish, although minor pollution problems arise occasionally from releases of oil-field brine. Even so, pollution caused by oil-field operations must not be overlooked when needs arise to develop water supplies, particularly on some of the interior streams.

FUTURE NEEDS

The population of De Soto Parish has been comparatively static or slightly declining with a shift from rural farm to rural nonfarm, and there has been no appreciable increase in demand for water for domestic use. However, there has been an appreciable increase in the demand for water for industrial use by light industires. Much of this increase has been dependent on the municipal supply in Logansport, and to meet this demand it has been necessary to resort to a surface-water supply to replace the overtaxed ground-water supply. The new surface-water supply, which utilizes Sabine River water, promises to be adequate to meet the demands which would result from any foreseeable future industrial expansion in Logansport. Mansfield's present water supply from wells is considered adequate to meet present and expected future demands of domestic users, but a significant increase in demands for industrial use will necessitate resorting to development of a surface-water supply.

The demand for suitable water for irrigation is increasing rapidly. Present sources drawing on smaller streams with better quality water are already overtaxed in dry years. The available ground water is variable in quality and in some areas is unsuitable for irrigation. Additional surface-water supplies, particularly in the area now served by Bayou Pierre water, could be obtained from Wallace Lake and Clear Lake, which contain waters of reasonably good quality. Sabine River offers a plentiful source of water suitable for irrigation except for short periods during extremely dry years when daily flows at Logansport may be as low as 10 mgd; however, without expensive pumping and distribution works, the water is inaccessible to most areas of the parish now engaged in agricultural pursuits that might benefit by irrigation. Half of the flow at the Logansport State line station is available to Louisiana users.

GEOLOGY

By Henry L. Preé, Jr.

STRATIGRAPHY

The bedrock in De Soto Parish consists of clay, marl, silt, and fine sand of Paleocene age. These sediments are overlain in the northeastern and southwestern parts of the parish by terrace deposits of Pleistocene age and are composed of sand and some gravel generally overlain by silt and clay. The bedrock is overlain in the Red and Sabine River valleys by alluvial deposits of Quaternary age and is composed of sand, silt, and clay. These rocks have been classified in different ways, as discussed in the following sections and shown on table 11.

PREVIOUS CLASSIFICATION

The classification of the Tertiary sediments of De Soto and Red River Parishes has been revised several times (table 11). The Midway group of the Paleocene series, as used in earlier studies, included all the marine sediments stratigraphically above the Arkadelphia formation of the Gulf series and below the abandoned Sabine group of the Eocene series. Howe and Garrett (1934) divided the Sabine group of Louisiana into the Mansfield and Wilcox subgroups. The name Mansfield was restricted to the pre-*Ostrea thirsae* (Marthaville) sediments, and the name Wilcox (not shown in table 11 because of its absence in De Soto Parish) designated sediments between the base of the *Ostrea thirsae* beds and the Claiborne group.

Murray (1948, p. 83), on the basis of the discovery of what he considered to be diagnostic Midway fossils in the sediments stratigraphically above the Porters Creek clay and below the *Ostrea thirsae* zone of his Marthaville formation, placed the Midway-Wilcox contact about 800 feet higher than had been designated in the earlier studies. On the basis of detailed field mapping, he divided his Midway sediments above the Porters Creek clay into three formations, each representing a depositional cycle that includes a basal sand phase, a middle carbonaceous and lignitic shale phase, and an upper calcareous shale and silt phase. Murray (1948) named the formations, in their order of deposition, the Naborton (p. 94–101), Logansport (p. 101–127), and Hall Summit (p. 127–135). He applied the name Marthaville formation (p. 135–140) to the deposits immediately overlying the Hall Summit formation and considered them to represent the basal sediments of the Wilcox group. Neither the Hall Summit nor the Marthaville formation is present in De Soto Parish.

Murray (1948, p. 94–101) did not name the three depositional phases within the Naborton formation. However, he recognized and named the Chemard Lake lignite lentil of the Naborton formation and divided the overlying Logansport formation into three members which, in the order of deposition, are the Dolet Hills, Cow Bayou, and Lime Hill. These members represent his depositional cycle—the basal sand, the carbonaceous and lignitic shale, and the calcareous shale and silt. He further divided the Cow Bayou into the Benson and Lula facies—beds composed principally of clay and sand, respectively.

Murray (1955, p. 685) later proposed the adoption of Midway and Sabine as stage names to be used as time designations and of Wilcox to be used as a group name for the sand, lignitic shale, and calcareous shale and silt included within these two stages. The relation of Murray's formation names to the Midway stage is shown in table 11. His Sabine stage is not present in De Soto Parish and is not shown in this table.

CLASSIFICATION USED IN THIS REPORT

In this report the correlation of rock units is based largely on their stratigraphic position as shown by electrical logs of oil- and gas-test wells, samples from three test holes, and drillers' logs of water wells. The stratigraphic columns given in table 11 under "This report" show the series, groups, and formations which can be mapped in the subsurface in De Soto Parish. The subsurface relationships of the rock units are shown diagramatically on plate 8.

The contact between the calcareous and sandy beds of the Cretaceous system and the thick clay beds representing the Clayton formation and the Porters Creek clay of the Midway group is recognizable on electrical logs and is easily correlated throughout large areas. (See pl. 5.) The stratigraphic position of the overlying beds was determined primarily on the basis of this contact. With the exception of the Naborton formation and Dolet Hills member of the Logansport formation, Murray's formations are not readily identified in the subsurface in De Soto Parish. The base of the Naborton formation is defined by Murray (1948, p. 98) as the base of the lowest sandy sequence above the Porters Creek. The Naborton-Porters Creek contact is shown commonly on electrical logs by a decrease in the resistivity and a positive deflection on the spontaneous-potential curve. Plate 4 is a contour map showing the altitude of the top of the Porters Creek clay in De Soto Parish.

The sand directly overlying the Porters Creek clay forms the lower part of the Naborton formation, and the first massive sand above the clayey upper part of the Naborton is the Dolet Hills member. As these beds are traceable in De Soto and Red River Parishes, they have been assigned formational status (Newcome, 1957). However, the other members—Lime Hill and Cow Bayou—of Murray's Logansport formation cannot be distinguished readily in the subsurface. Therefore, the Tertiary sediments above the Dolet Hills sand in De Soto Parish are referred to as undifferentiated Wilcox group.

The Clayton formation and the Porters Creek clay are distinctive as they are composed primarily of clay. These formations of Paleocene age are assigned to the Midway group because they constitute a single rock type. The formations overlying the Midway group (Naborton, Dolet Hills, and undifferentiated Wilcox group) are composed typically of lignitic fine-grained sand, clay, and silt of both Paleocene and Eocene age and belong to the Wilcox group. This difference in age can be determined only on the basis of the fossil content and not on the composition of the sediments. Wilcox sediments of Eocene age are not present in De Soto Parish.

STRUCTURE

The dominant structural feature in De Soto Parish is a part of the flat-topped asymmetrical dome known as the Sabine uplift, which extends from northwestern Louisiana into easternmost Texas. The geologic map (pl. 3) indicates that the structurally highest part of the Sabine uplift is the De Soto-Red River-Bull Bayou uplift in the east-central part of De Soto Parish. The Naborton formation, surrounded by the sediments of the younger Wilcox group, is exposed in the central part of the dome. The contour map in plate 4 shows the configuration of the top of the Porters Creek clay and the location of the principal dome and its associated structures. Although the general trend of the axes of this structural complex is northeast, many minor folds such as those in the vicinity of Naborton are nearly at right angles to the general trend. The two principal structures in the northern part of the parish are the anticline near Frierson and the syncline near Gloster, which trend approximately northeast. The small domal structure on the northwest flank of the principal dome shown by the dashed contour in plate 4 is inferred from the structure of the underlying deposits of Cretaceous age and from the geologic map, as no subsurface information on the top of the Porters Creek clay is available at this locality. The top of the Porters Creek slopes generally southward from the central part of the principal dome. The irregularity of the contours reflects the minor structures around the uplift. The geologic sections (pl. 5), constructed on lines radiating from the top of the dome, show the dip of the formations away from the center of the uplift and the effect of the associated structures.

Although surface evidence of faulting is slight, Murray (1948, pl. 12) reported considerable faulting in the subsurface. About 1 mile east of Bayou Pierre in Red River Parish a 200-foot displacement of the deposits of Cretaceous age was reported along the principal fault in the De Soto-Red River-Bull Bayou field; however, the faulting does not seem to displace the Porters Creek clay of Paleocene age. Thus, displacement along these faults either increases with depth or it may have occurred partly in Cretaceous and pre-Porters Creek time. The trend of the principal faults is to the northeast, whereas the trend of the secondary, or minor, faults is generally to the northwest. These faults are not considered to have a great effect on the movement of ground water in De Soto Parish.

GROUND WATER RESOURCES

By Henry L. Preé, Jr.

METHOD OF STUDY

Nearly all geologic and hydrologic data presented in this report were collected from October 1954 to June 1956, although a few records of water wells were collected between 1941 to 1954. Geologic studies consisted mainly of the interpretation and correlation of subsurface data obtained from electrical logs and drillers' logs and by examination of samples of well cuttings. These data were supplemented by the examination of outcrops. The hydrology was studied to determine the occurrence and availability of fresh water. The 322 wells listed in table 10 and located on plate 6 are considered to be representative. The pertinent available data regarding these wells, including well depths, static and pumping water levels, well-casing and screen records, yields, and pump settings were recorded. The depths to water in these wells were measured where possible; however, reported water levels are given for wells in which the water levels could not be measured. Records were obtained of water-level fluctuations in 10 wells. Periodic water-level measurements were made in 8 of the wells, and continuous records of water-level fluctuations were made by recording gages installed on the other 2 wells. Pumping tests were made on municipal wells at Mansfield and Logansport to determine the capacity of the aquifer to store and transmit water.

Chemical analyses were made of 31 water samples collected from 29 wells; the results are given in table 13 and shown graphically on plate 7.

WELL-NUMBERING SYSTEM

Water wells and geologic test holes are numbered with reference to the parish in which they are situated and generally in the numerical order in which they were inventoried. For example, DS–1, located in Stonewall, in the northern part of De Soto Parish, is the first well in the parish inventoried by the U.S. Geological Survey. One geologic test hole augered by the U.S. Geological Survey in Shelby County, Texas, has been assigned number A–1. The location of a few borings made by the U.S. Army Corps of Engineers are shown on plate 6 and identified by the prefix E.

PRINCIPLES OF OCCURRENCE

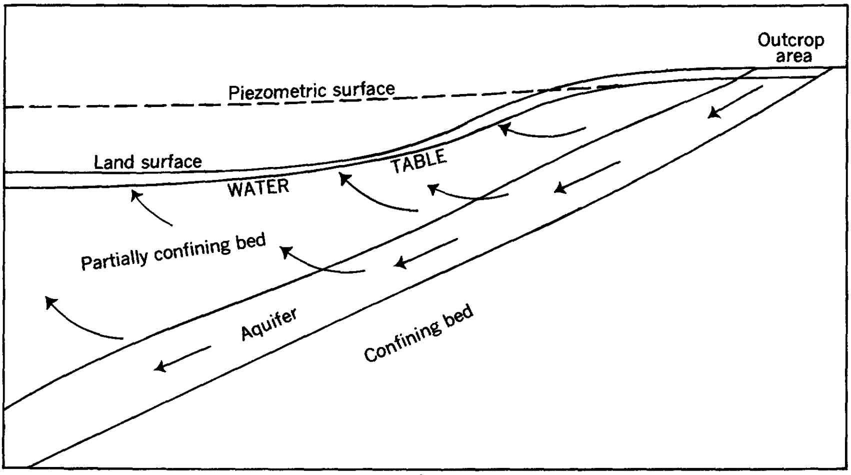
The main supplies of ground water in De Soto Parish occur in the pore spaces of the permeable sands that underlie most of the parish. Ground water generally is considered to occur under either water-table (unconfined) or artesian (confined) conditions. Under water-table conditions water occurs in porous and permeable rocks not overlain by impervious beds. As a result, water from precipitation may enter the water-bearing bed or aquifer by direct downward percolation. Water-table conditions may exist also where porous and permeable rocks are overlain by relatively impervious rocks but where the upper part of the permeable rock is not saturated. The position of the water table, the upper surface of the zone of saturation (zone saturated with water under hydrostatic pressure), is generally marked by water levels in wells tapping the aquifer. As the water moves through the zone of saturation it may pass beneath a relatively impermeable bed and become confined. Water in a well penetrating such a confined aquifer will rise above the bottom of the confining bed, and artesian conditions are said to exist. The height to which the water level rises above the base of the confining bed is contingent on the hydrostatic head. The head may be sufficient to raise the water level near to or above the land surface. If the water level rises in a well above the land surface, the well has a natural flow. Thus, there are two general types of artesian wells, flowing and nonflowing. Because the water is confined by relatively impermeable beds, the artesian aquifer is completely filled with water, and there is no water table; an imaginary plane, called the piezometric surface, is defined by the level to which the confined water will rise under its full head.

There are several distinct differences between water-table and artesian aquifers. Water-table aquifers are chiefly storage reservoirs in which the water is replenished by direct downward percolation from precipitation. As the water table declines, the pore spaces are drained, and large quantities of water, equivalent to several percent or tens of percent of the total volume of aquifer drained, are removed from the water-bearing materials. Artesian aquifers, unlike water-table aquifers, act chiefly as conduits to transmit water from the outcrop or water-table area and from other areas of recharge to areas of natural or artificial discharge. Water is discharged naturally by seepage and artificially through wells. Artesian aquifers contain large amounts of water; but, because they are filled with water so long as they remain artesian, the water they yield from storage when the head is lowered represents principally the water squeezed out of storage in fine-grained material plus the small amount contributed by expansion of the water itself and contraction of the aquifer skeleton. The water represented by this "coefficient of storage" is many times smaller than the amount that will drain out under water-table conditions.

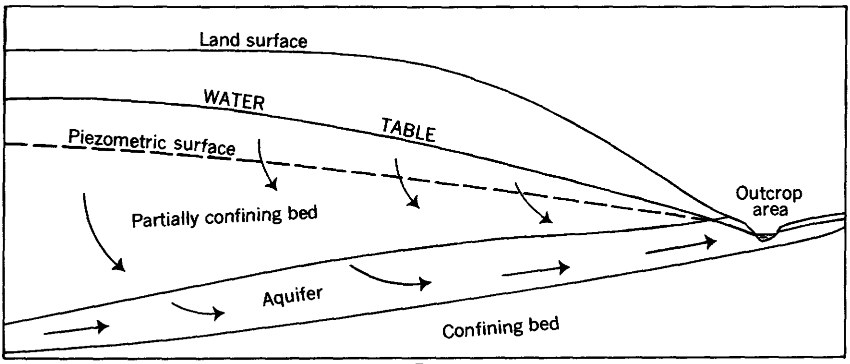
MOVEMENT

The rate of movement of ground water is controlled chiefly by the porosity and permeability of the sediments and the difference in head, or hydraulic gradient, from place to place. Under natural conditions the movement is generally slow and ranges from a few feet to a few hundred feet per year. Near points of natural discharge the rate of movement generally increases slightly. Near a discharging well, however, velocities are much greater and may be measured in feet per minute.

Ground water moves from points of high head to points of low head—from areas of recharge to areas of discharge. The path of flow is generally in the direction of the steepest hydraulic gradient—at right angles to lines joining points of equal altitude of the water table or piezometric surface. However, the paths of flow are not uniform because of the heterogeneity of the rocks, changes in the lithologic and hydraulic characteristics of the rocks, and leakage from or recharge to the aquifer. Under water-table conditions the direction of movement is controlled principally by the topography of the area—in general, the movement is from the hills to the ad-



A



B

FIGURE 23.—Diagrams showing relation of ground-water movement to head. *A*, Piezometric surface above local water table; *B*, Piezometric surface below local water table.

jacent streams. Under artesian conditions the movement is controlled by the difference in head between aquifers, as well as the distribution of head within the artesian aquifer.

Figure 23*A* shows the direction of movement of water in an artesian aquifer in which the artesian head is above the local water table. The water in the artesian aquifer moves slowly downdip from the outcrop area and then upward through the confining bed into the body of unconfined ground water; from this zone of saturation it moves upward into the unsaturated zone and thence into the atmosphere by evapotranspiration or into surface streams by seepage.

Figure 23*B* shows the direction of ground-water movement in an artesian aquifer in which the artesian head is below the local water table. Water in the zone of saturation moves slowly downward through the confining bed into the artesian aquifer and up the dip of the aquifer toward the outcrop area where it is discharged. The distribution of ground-water movement in the Naborton formation, one of the principal aquifers in De Soto Parish, is similar in many respects to that shown in figure 23*B*.

The flow paths shown in figures 23*A* and *B* are simplified for the purpose of illustration; under actual conditions the flow paths may be very complex and depend on local changes in the permeability of sediments and on head relationships.

RECHARGE

The part of the precipitation that moves downward and enters the zone of saturation constitutes the principal source of recharge. If no replenishment of the ground-water reservoirs occurred, the movement of water resulting from the previously established differences in hydraulic head would ultimately cease. However, in De Soto Parish the water in the ground-water reservoirs is being replenished almost constantly by direct infiltration from precipitation, by influent seepage from streams, or by flow from other aquifers. In humid areas such as Louisiana the potential recharge usually exceeds the amount of water withdrawn from the ground-water reservoirs by pumping from wells, artesian flow, or leakage into adjacent beds. In the recharge area the amount of water available for recharge may be greater than the capacity of the aquifer to transmit the water toward areas of discharge. This excess water is rejected (rejected recharge) from the water-bearing beds in the outcrop area by increased evapotranspiration or by effluent seepage to streams.

As precipitation is the chief source of recharge, variations in daily and annual precipitation generally have distinct effects on the water table. In water-table aquifers the water table may rise rapidly in response to precipitation. In artesian aquifers, however, there is a less immediate response to precipitation, as changes in the altitude of the water table in the outcrop area have a rapidly diminishing effect on the piezometric surface downdip. Thus, under artesian conditions it may be necessary to collect records over a period of many years to determine the effect of the long-term cycles of precipitation shown in figure 4.

DISCHARGE

Under natural conditions there is a hydraulic balance between recharge and discharge, and over a long period the ground water discharged by natural means is equal to the recharge. This natural discharge takes place by flow from the zone of saturation to streams or springs (effluent seepage), by evaporation or transpiration of ground water from the soil zone, and by leakage into adjacent beds. Evapotranspiration is particularly effective in removing ground water from the reservoir where the water table or the capillary fringe above it is within reach of plant roots. The amount of water lost by this process, which in De Soto Parish is probably greater than that withdrawn through wells and lost by leakage into adjacent beds, varies seasonally and is greatest during the growing season. Most water evaporated and transpired, however, is soil moisture that has never become ground water.

Although the amount of water discharged by individual wells appears to the casual observer to be large, the aggregate amount withdrawn by wells in De Soto Parish is small in comparison to the total quantity discharged by natural means.

HYDRAULIC CHARACTERISTICS OF AQUIFERS

Water in both unconfined and artesian aquifers behaves in accordance with fundamental hydraulic principles. Before pumping, the water in a well stands at a height equal to the static water level. When a pump begins discharging water from a well, a hydraulic gradient is established toward the well, and the water table or piezometric surface assumes a form similar to an inverted cone. In homogeneous materials this cone of depression will be circular if the initial static water table or piezometric surface is horizontal; it will be somewhat elliptical if the initial water surface has a slope. As long as the well is pumped, the water table or piezometric surface will continue to decline, though at a decreasing rate, and the cone of depression will eventually extend to the limits of the formation. In aquifers of similar permeability the drawdown of the water level and development of the cone of depression under artesian conditions is much more rapid than under water-table conditions. Recharge to the aquifer, however, will retard or stop the growth of the cone of depression.

After the discharge of a well is stopped, water continues to move toward the well under the established hydraulic gradient, replaces the water previously withdrawn from storage, and restores the water table or piezometric surface to about its original position. As the hydrostatic head recovers, the hydraulic gradient is decreased, and the rate of return to static conditions, or recovery, becomes progressively slower.

A term commonly used in evaluating the relation between the yield of and drawdown in a well is the term "specific capacity," which is defined as the yield per unit of drawdown and is generally expressed as gallons per minute per foot of drawdown at the end of a specified period. The specific capacity is affected not only by the water-bearing properties of the aquifer but also by other factors, such as the diameter, method of construction, and efficiency of development of the well.

The ability of an aquifer to store and transmit water is dependent chiefly on two fundamental characteristics—the coefficients of storage and permeability. The capacity of an aquifer to store water is termed the "coefficient of storage" (S), and is expressed as the volume of water the aquifer releases from or takes into storage per unit surface area of the aquifer per unit change in the component of head normal to that surface. The storage coefficient of a water-table aquifer is generally 100 to 1,000 times greater than that of an artesian aquifer. Although rigid limits cannot be established, water-table aquifers generally have a coefficient of storage of 0.10 or greater and artesian aquifers 0.001 or less. The ability of a material to transmit water, called the permeability, is usually expressed as a coefficient and designated by the letter P. This quantity is expressed in meinzer units, or meinzers (Wenzel, 1942), as the rate of flow of water, in gallons per day, through a cross-sectional area of 1 square foot under a hydraulic gradient of 1 foot per foot at a temperature of 60° F. In field practice the coefficient of permeability is expressed as the field coefficient of permeability (P_f), which denotes the rate of flow at the prevailing water temperature. The transmissibility (Theis, 1935), also expressed as a coefficient (T), is defined as the flow of water at the prevailing water temperature, in gallons per day, through a vertical strip of the aquifer 1 foot wide extending the full height of the aquifer under a hydraulic gradient of 1 foot per foot. It is equal to the field permeability (P_f) multiplied by the thickness of the aquifer (m), in feet. This relationship commonly is expressed in the equation:

$$T = P_f m \tag{1}$$

The hydraulic properties of an aquifer may be determined by either laboratory or field methods. The results obtained from laboratory methods are generally considered less accurate than those obtained from field methods, owing to inherent limitations in obtaining representative samples of the water-bearing materials and the need for application of theoretical corrections. The hydraulic characteristics may be determined in the field by pumping tests. In such tests, measurements are made of the relation between water-level fluctuations and the rate and duration of discharge from the aquifer. Thus, the principal prerequisites are (1) a well that can be pumped at a measureable and relatively constant rate, and (2) one or more observation wells tapping the same aquifer as the pumped well.

The results of pumping tests may be interpreted in one of several ways, according to the existing geologic and hydrologic conditions. The nonequilibrium formula developed under the direction of Theis (1935) may be used to compute the results of a pumping test and determine the hydraulic characteristics of an aquifer. The formula is:

$$S=\frac{114.6q}{T}\int_{1.87r^2S/Tt}^{\infty}\frac{e^{-u}}{u}\,du, \tag{2}$$

where

$u=1.87r^2\,S/Tt$;

s=the drawdown (or recovery) of the water level, in feet, at any point in the vicinity of a well pumped at a uniform rate;

q=the discharge of the well, in gallons per minute;

T=the coefficient of transmissibility of the aquifer, in gallons per day per foot;

r=the distance, in feet, from the pumped well to the point of observation;

S=the coefficient of storage of the aquifer; and

t=the time, in days, that the well has been pumped; or, for recovery, the time in days since it was shut off.

Values of T and S may be determined by substitution in the following equations, which are derived from equation (2):

$$T=\frac{114.6qW(u)}{S} \tag{3}$$

and

$$S=\frac{uTt}{1.87r^2}. \tag{4}$$

$W(u)$ is defined as the "well function" of u and is given in a table by Wenzel (1942).

The original formula (eq 2) is based on the following assumptions: (1) the aquifer is homogeneous and isotropic (transmits water equally well in all directions), (2) the aquifer has an infinite areal extent, (3) the discharging well penetrates and receives water from the entire thickness of the aquifer, (4) the coefficient of transmissibility is constant at all times and at all places, (5) the well has an infinitesimal diameter, and (6) water removed from storage is discharged instantaneously with the decline in head. Although the conditions specified in these assumptions are ideals and never fully represent actual conditions, this formula can be applied unmodified to many problems of ground-water flow in extensive aquifers and can be modified to account for boundary conditions where there is a reasonable understanding of the geologic conditions in the vicinity of the wells tested.

The amount and rate of decline of water levels caused by pumping from wells at a given rate and for a given time depends upon the transmissibility and storage coefficients of the aquifer. Thus, if these are known it is possible to predict the drawdown in the aquifer for a given amount of discharge from the aquifer.

TYPES OF WELLS

Of the 322 wells described in this report 148 were drilled, 134 were dug, 38 were bored, and 2 were driven. The drilled wells may be divided into three general types: open-end wells, perforated-casing wells, and screened wells. An open-end well is one in which no screen is installed, and the water enters the well through the open hole at the bottom of the casing. The casing, commonly 4 to 6 inches in diameter, in this type of well may extend only far enough below the surface to prevent caving of the upper less consolidated materials, or it may extend nearly to the bottom of the well. Because, in most of the parish, holes drilled below depths of 100 to 125 feet will remain open without casings, open-end wells are common and are used primarily for domestic and stock purposes. The second type of drilled well commonly used in this area is cased to the bottom of the formation, the last few feet of casing being slotted opposite the aquifer. Because the slots in the casing generally are too large to prevent fine sand from entering the well, sanding is a continuous problem. The most successful type of drilled well in De Soto Parish is screened in the aquifer. The screen design and size of apertures are generally determined on the basis of the grain size of the sand and gravel penetrated during the drilling of the well. Wells drilled for domestic purposes may or may not have an envelope of gravel surrounding the screen. Public-supply and industrial wells are constructed with "pit" casings 10 to 20 inches in diameter (to accommodate the pump) and finished as "gravel-packed" wells with casings and screens 8 to 12 inches in diameter. The "gravel pack" that envelops the screen generally consists of coarse sand grading to fine gravel. Coarse gravel is generally not used because of the fine texture of the water-bearing materials in De Soto Parish.

Dug wells in De Soto Parish, usually excavated with pick and shovel, generally range in diameter from 24 to 36 inches, extend only a short distance below the water table, and are curbed with wood, concrete, glazed tile, stone, or brick. These wells are common in rural areas because, in comparison to drilled wells, their construction is less expensive. However, they have certain disadvantages that limit their use. It is difficult to dig the wells very far below the water table; consequently, they are likely to go dry when large amounts of water are pumped from them or during extended periods of drought when the water table declines. Furthermore, protection of dug wells against contamination is generally more difficult than protection of drilled wells.

Bored wells, constructed by hand- or power-driven augers, are generally finished with vitrified clay pipe or concrete tile ranging from 4 to 12 inches in diameter. They are used where the material penetrated is relatively unconsolidated but will stand up without caving for a short time and where the water table is shallow. Water enters these wells through the open bottoms and unsealed joints of the tile casings.

Driven wells generally are constructed with casings 1¼ to 2 inches in diameter and drivepoint screens 3 to 5 feet long. This type of well is generally constructed where the water table is relatively near the surface, the material to be penetrated is unconsolidated, and the water-bearing material yields water freely. Most driven wells in De Soto Parish are in the flood plain of the Red River and range in depth from 50 to 75 feet.

METHODS OF LIFT

The methods used to bring ground water to the surface include air-lift, suction, jet, and turbine pumps and buckets. Of the 283 inventoried wells that are in use, 89 are equipped with hand-operated buckets, 2 with an air-lift pump, 45 with suction pumps, 109 with jet pumps, and 36 with turbine pumps, and 2 are flowing wells. All pumps are operated electrically. All the large-capacity wells in the parish are equipped with deep-well turbine pumps. Some of the turbine pumps used for public supply are of the submersible type, in which both the pump and the motor are below the water level in the well.

UTILIZATION OF WATER

The amount of ground water in De Soto Parish used for domestic, stock, public, industrial, and irrigation water supplies is about 550 million gallons per year, or about 1.5 mgd. Mansfield, one of the largest communities in the parish, has the only public water-supply system using ground water. The total annual pumpage of this system, which serves about 18 percent of the population of the parish, is about 220 million gallons or about 0.6 mgd. Most of the industries, which are in or near Mansfield or Logansport, obtain water from the public supplies of these towns. Residents of most of the rural areas obtain water from individual wells or, where ground water of good quality is not readily available, from cisterns or tanks.

Records of 317 wells and 1 spring in De Soto Parish and 5 wells in Shelby County, Tex. (listed in table 10), were obtained during this investigation, but not all wells in the parish were inventoried. Of these 322 wells, 260 are used for domestic or stock purposes, 10 for public supplies, 11 by industries, and 2 for irrigation. Of the remainder, 14 were drilled as test wells, and 35 are abandoned or not in use.

Most of the water used for domestic and stock purposes is obtained from wells. Although pumpage from domestic and farm wells is not measured, it is estimated that about 600,000 gallons of water is pumped from these wells daily. This figure is based on an estimated daily consumption on the farm and in the home of 50 gallons for each member of a family. Although the use of ponds for watering stock is increasing, the present withdrawal of ground water for this purpose is estimated to be 200,000 gpd. This figure is based in part on the number of livestock reported for De Soto Parish in 1950 (Northwest Regional Development Board and State of Louisiana Department of Public Works, p. 26–27).

The Mansfield water supply, which serves about 5,000 people, is pumped from five wells ranging in depth from 220 to 270 feet. Yields of the wells range from about 110 to 200 gpm. Water from wells DS–15, –17, –18, and –20 is pumped into two 250,000-gallon surface reservoirs. After being chlorinated the water is pumped into the mains and into a 100,000-gallon elevated steel tank used for storage and for maintenance of line pressure. Water from well DS–183, which contains an objectionable amount of hydrogen sulfide, is used only when line pressures in the southeastern part of Mansfield are low. The pumpage figures in table 12, which include only the water that passes through the surface reservoirs, show that the average pumpage is about 220 million gallons per year, or about 600,000 gpd. The additional amount of water pumped from well DS–183, which is small, is not metered.

Industries in De Soto Parish that do not obtain their water from either the Mansfield or the Logansport public supply include sawmills, cotton gins, and high-pressure gas-line booster stations. The principal use of the water is for washing, cooling, and sanitary purposes. As the water is not metered, it is necessary to estimate the quantity of water used from the reported yields of wells. On this basis, the total withdrawal by these industries is about 100,000 gpd.

Irrigation in De Soto Parish is not widespread; however, supplemental irrigation is anticipated to expand in the future because the area has an average of more than two droughts per growing season (Louisiana Department of Public Works, 1956). A drought in Louisiana is defined as any period of 20 days or more in which less than a half inch of rain occurs in each 10-day period. Several farmers have reported supplemental irrigation of small areas (generally less than 15 acres), but the total amount of water used for this purpose so far is negligible.

The daily pumpage from the aquifers in the Wilcox group is estimated to be about 2,200,000 gallons, or 88 percent of the total daily pumpage, and the Quaternary deposits furnish about 300,000 gallons, or 12 percent.

CHEMICAL CHARACTER OF GROUND WATER

This report includes the analyses of 29 samples of water from 25 wells in De Soto Parish, 2 wells west of the Sabine River in Texas, and 2 wells in Red River Parish. (See table 13.) Table 14 lists the constituents commonly found dissolved in water and summarizes their sources and significance to the water user.

The chemical character of ground water in each geologic unit is described under the section on water-bearing rock units. In general, however, ground water in the older deposits may be classified as the sodium bicarbonate type and water in the Pleistocene alluvium as the sodium-magnesium bicarbonate type. As shown in table 13, the iron content of water varies greatly, not only in different aquifers but within a single aquifer. The iron content in 15 of the analyses given in table 13 is high (more than 0.3 ppm) and would be objectionable for most uses. Dissolved solids range from 110 to 1,870 ppm, and in 10 of the analyses given in table 13 the dissolved solids are higher than the generally recommended limit of 500 ppm.

Plate 7 illustrates the areal distribution of water quality in each water-bearing rock unit. The chemical constituents illustrated in the columns are plotted in equivalents per million. When parts per million are converted to equivalents per million, the sum of all the cations should equal the sum of all the anions, within limits of practical analytical procedure, because these ions are in equilibrium. Thus, in the graphic plots on plate 7 the left-hand column of cations and the right-hand column of anions have the same height. In these diagrams the cations are shown in the following order from the bottom to the top: calcium, magnesium, sodium and potassium together, and aluminum. The anions are shown in the following order: bicarbonate (including carbonate), sulfate, and chloride (including fluoride and nitrate). The hardness of a water as calcium carbonate, in parts per million, is shown by a figure at the top of the magnesium block. Silica also occurs in most waters; it probably does not occur in ionic form and, therefore, is not included in the ionic calculations.

The pH values included in table 13 may not indicate the pH at the time of collection of the samples because this characteristic of the water may change slightly between collection and analysis of the sample. They do provide, however, an indication of the approximate range of pH values of the water samples.

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TEMPERATURE OF GROUND WATER

The temperature of ground water varies slightly throughout the year and is generally slightly higher than the mean annual temperature of the air. It rises with increasing depth in the earth's crust in conformity with the geothermal gradient. The temperature of the earth generally rises 1° F for each 40 to 90 feet of depth (Stearns, Stearns, and Waring, 1937, p. 68). The temperature of ground water in De Soto Parish ranges from 65° to 71° F. Temperature data on water pumped from wells in De Soto Parish show the temperature increasing with increasing depth. Although the temperatures obtained have a considerable variation at each depth, the data indicate that the temperature of water increases about 1° F for each 50-foot increase in depth.

WATER-BEARING ROCK UNITS

By Henry L. Preé, Jr.

TERTIARY SYSTEM

PALEOCENE SERIES—MIDWAY GROUP

CLAYTON FORMATION AND PORTERS CREEK CLAY

The Clayton formation was named for exposures near Clayton, Barbour County, Ala. It is correlative with the Kincaid formation, which was named by Gardner (1933) for exposures on the old Kincaid ranch (Lewis ranch) on the Frio River in Texas and which includes the basal limy sediments of the Midway group in Texas. Alexander (1935) proposed including in the formation the basal marl of the Midway group in northwestern Louisiana. Even though the Clayton formation is not exposed at the surface in Louisiana, its thickness and composition were obtained from a study of cores and electrical logs. In De Soto Parish the thickness of the Clayton formation ranges from 15 to 50 feet, and the formation consists of gray calcareous generally fossiliferous shale or clay containing a few chalk lenses, calcareous concretions, and glauconite grains (Murray, 1948, p. 92). On electrical logs it cannot be readily distinguished from the overlying Porters Creek clay. The Clayton formation contains no fresh water in De Soto Parish.

The Porters Creek clay was named by Safford (1864) for exposures along Porters Creek, Hardeman County, Tenn., where the formation is a very fine textured micaceous clay which is dark gray when wet and grayish white when dry. Alexander (1935) included in the Wills Point formation lignitic and limy shales that overlie sediments containing a Kincaid (Clayton) microfauna in the subsurface of northwestern Louisiana. He considered these sediments to be equivalent to the Wills Point formation in Texas. The entire sequence of beds between the top of the Clayton formation and the top of the Logansport formation of Murry contains a fauna correlated with the Wills Point formation in Texas and the Porters Creek formation in Alabama. The Porters Creek has been traced (Murray, 1948, p. 92) from its outcrop in Alabama and Mississippi to De Soto Parish by means of paleontological, lithological, and electrical-log data.

The contact between the Porters Creek clay and the overlying Naborton formation, which is transitional from silty and lignitic clay into lignitic silt and fine sand, is generally drawn at the base of the lowest dominantly sandy stratum above the thick clay of the Porters Creek. On electrical logs this contact is commonly marked by a pronounced positive deflection in the spontaneous-potential curve and a decrease in the resistivity curve.

Electrical logs of oil- and gas-test wells in De Soto Parish show a definite, though only slight, increase in resistivity in the upper part of the Porters Creek clay. This increase or bulge in the resistivity curve, which extends downward for about 100 feet from the top of the Porters Creek clay in most parts of the parish, can be traced on electrical logs of many wells throughout the parish. Several examples of this increase in resistivity are shown in plate 5. This bulge is possibly caused by the occurrence of lignite in the upper part of the Porters Creek clay. For example, during the drilling of test well DS–315, about 15 miles northwest of Mansfield, a deposit of lignite about 100 feet thick was penetrated at a depth of 452 feet in the Porters Creek. Only small amounts of gray silt, very fine gray sand, and light-gray clay were mixed with the lignite. Most of the lignite brought to the surface was hard and black and contained little or no pyrite or marcasite. The bed of lignite at the top of the Porters Creek clay in this test well apparently is thicker than that in the same stratigraphic position in several other parts of the parish, and the lignite was probably deposited in a localized pocket. No evidence of thick beds or lenses of lignite was found in a microscopic examination of the drill cuttings from a test well (DS–183) in Mansfield or recorded in the driller's log of a test well (DS–192) 3 miles southeast of Mansfield. The lenticular form of many of the lignite beds and the relationship between these beds and the associated clays and shales indicate that at least some of the lignite was formed in fresh-water swamps (Meagher and Aycock, 1942, p. 9).

The Porters Creek clay in De Soto Parish, except for the lignite beds that generally mark the top of the formation in most of the parish, consists of light- to dark-gray tough clay and various amounts of lignite, calcareous materials, fine sand, and silt.

The Porters Creek clay underlies all De Soto Parish (pls. 4, 5, and 8) at depths ranging from a few feet on the highest part of the Sabine uplift to more than 400 feet downdip from that area. Data from electrical logs and drillers' logs indicate that the thickness of this formation ranges from about 650 to 1,000 feet. As shown in the geologic section (pl. 5) and in the fence diagram (pl. 8), erosion has thinned this formation near the center of the Sabine uplift. The Porters Creek clay is not considered a source of fresh water in De Soto Parish.

PALEOCENE SERIES—WILCOX GROUP

NABORTON FORMATION

STRATIGRAPHY

The Naborton formation, named by Murray (1948, p. 94–101) for the town of Naborton, De Soto Parish, includes all the strata between the Porters Creek clay and the overlying Dolet Hills formation. The type locality is along a local road between Naborton and Goss, in secs. 3 and 4, T. 12 N., R. 12 W. The exposures of the formation at the type locality, as described by Murray (1948), consist chiefly of gray and buff sandy, clayey lignitic silts containing some lignitic clay and lignite beds. Irregularly shaped limonitic concretions are reported to be more abundant in this formation than in any other part of the Wilcox group. Large limonitic and calcareous concretions may be the hard "rock" reported by many well drillers at frequent intervals in this formation. Samples of the Naborton formation collected from test wells DS–183 and –315 are predominantly composed of very fine light-olive-gray to light-gray quartz sand and variable amounts of fine sand, silt, and clay and much lignite. Detailed descriptions of these samples are presented in table 15. Mechanical analyses of sand samples from these test wells (fig. 24*A* and *B*) show that most of the material in the aquifer ranges in grain size from very fine sand to silt. Even though the sand is very fine, it has a relatively uniform grain size and, consequently, the permeability probably is correspondingly high. The coefficients of permeability of the sand in which well DS–183 is screened, as determined in the laboratory and from analyses of pumping tests, are 375 meinzers (gpd per sq ft) and 300 meinzers respectively. Grain size does not seem to change in an orderly or systematic manner with depth such as would be expected in cyclic deposition (Murray, 1948, p. 85), in which case the coarse material would have been concentrated near the base of the deposit. The resistivity curve on the electrical log of test well DS–315 shows thin beds of silty sand or silt alternating with beds of sand containing little or no silt or clay. Therefore, the electrical logs also do not indicate a cyclic pattern of deposition but rather a complex depositional interval.

Murray's Chemard Lake lignite lentil (1948, p. 98), which marks the contact of the Naborton formation with the overlying Dolet

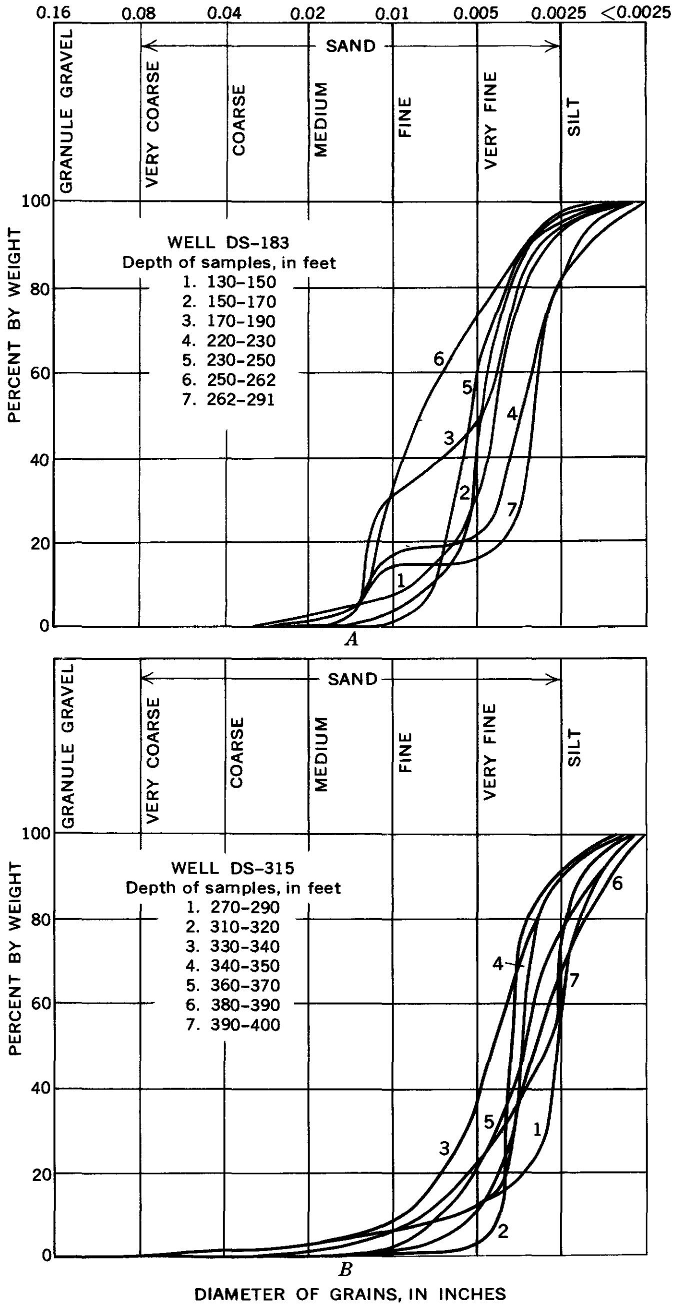

FIGURE 24.—Cumulative curves showing grain sizes of material from the Naborton formation. *A*, Well DS-183; *B*, Well DS-315.

Hills, consists of lignite and lignitic clays having a maximum known thickness of 10 feet (Meagher and Aycock, 1942). The type locality is an exposure 1 mile northwest of Chemard Lake at Coal Bed Springs in the bluffs facing Dolet Brake and Dolet Bayou, in the NW¼ sec. 3, T. 11 N., R. 11 W. The absence of animal fossils, the abundance of well-preserved fossil flora, and the lenticularity of the sediments suggested to Murray (1948, p. 100) that the Naborton formation was fluviatile and deltaic.

The Naborton formation crops out over an area of about 55 square miles in the east-central part of De Soto Parish. (See pls. 3 and 8.) Although this area is relatively rugged, it contains several small sections of low, flat land.

The aggregate thickness of the Naborton formation is variable, as shown on plate 9. The total thickness of the formation, as indicated by electrical logs, ranges from 140 to 330 feet and averages about 215 feet. It is thickest in the southeastern corner of the parish and thinnest in the eastern part of the parish, near the center of the Sabine uplift.

WATER-BEARING PROPERTIES

Water in the Naborton formation occurs under artesian conditions in most of the parish except in the area of outcrop, where it occurs generally under water-table conditions. The altitude of water levels in this formation (pl. 10) is generally highest in the northwestern and southwestern parts of the parish, where the formation is overlain by the undifferentiated part of the Wilcox group, and lowest in the southeastern part of the parish, where the formation crops out or is overlain by alluvium of the Red River. This evidence indicates that recharge occurs where the Naborton is overlain by the undifferentiated Wilcox group and that discharge occurs in the areas where it crops out or is overlain by alluvium. Thus, the aquifer is recharged by water moving through about 200 feet of overlying clay and sand. The idealized section in figure 23*A* illustrates this type of recharge. Natural discharge of water to Clear Lake in the east-central part of the parish is shown by the slope of the piezometric surface toward the lake. The effect of artificial discharge at Mansfield and Logansport is shown by the configuration of the contours in plate 10.

Figure 25 shows a comparison of the fluctuations of water levels in the Naborton formation in areas of relatively large and small withdrawals. Water levels in well DS–177, 2 miles north of Longstreet, do not reflect nearby pumping and fluctuated only slightly during a period of almost 15 months. Comparison of this hydrograph with the accompanying precipitation record shows that in this area water levels in artesian wells respond slowly and slightly to variations in

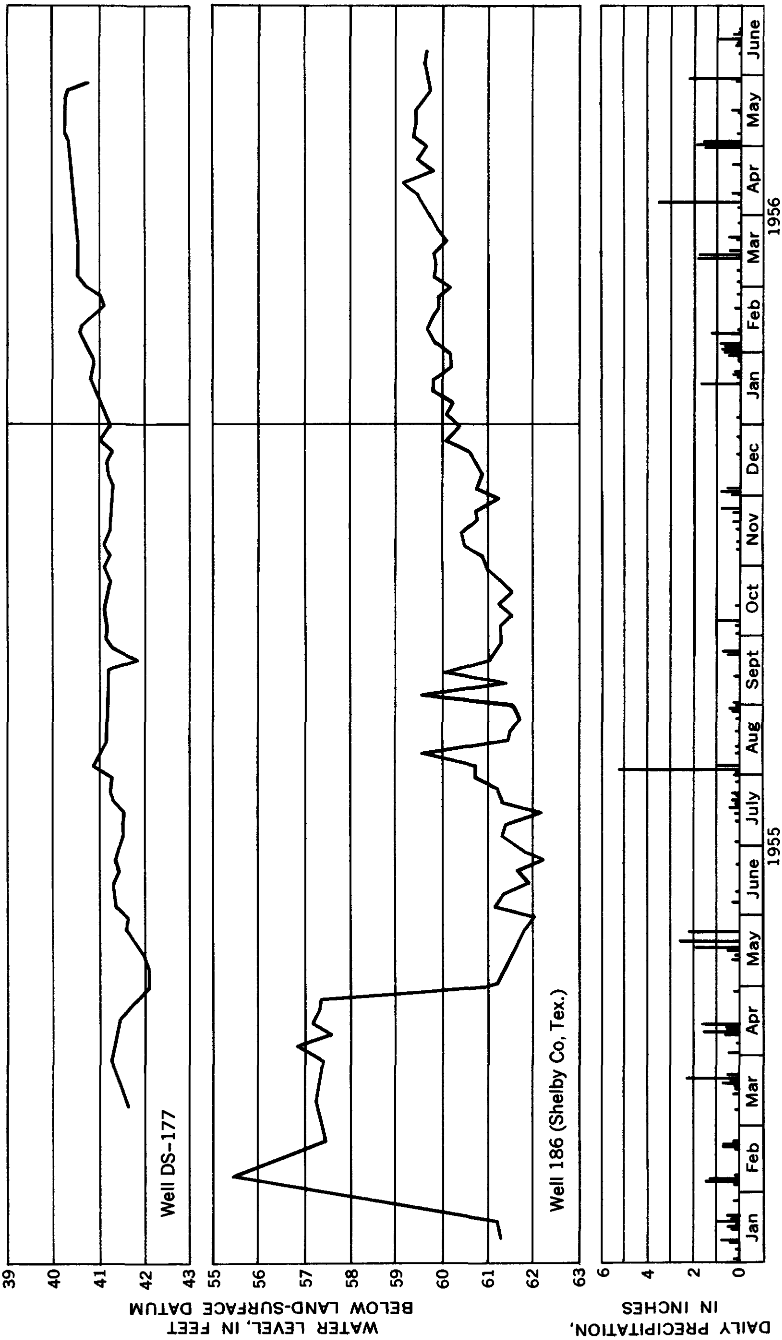

FIGURE 25.—Hydrographs of well DS-177 and well 186, Shelby County, Tex., and daily precipitation at Logansport, La., 1955–56.

rainfall. For example, during the period July 31 to August 5, 1955, the water level rose only about 4.8 inches in response to a total rainfall of about 6.2 inches. Water-level measurements made in well DS–59, 4 miles northwest of Mansfield (table 16), show fluctuations similar to those in well DS–177. The effect of pumping on water levels in the Naborton formation is shown in figure 25 by the hydrograph of well 186 in Shelby County, Tex., an unused well near the production wells owned by the town of Logansport, La. Because of nearby pumping the fluctuations of water level in this well are generally greater than those in well DS–177.

Of the 322 wells inventoried for this report, 103 yield water from the Naborton formation. In the area where this formation crops out (pl. 3), the wells range in depth from about 10 to 50 feet. Most of the remaining wells are in the northern two-thirds of the parish and range in depth from 135 to 400 feet. Yields of wells range from a few gallons a minute to about 280 gpm. Most wells in the parish that are used for domestic and stock purposes are pumped at only a few gallons per minute. The wells of largest yield are public-supply and industrial wells, which range in yield from about 20 to 280 gpm. The public-supply wells at Mansfield are the largest-capacity wells in the parish and have an average yield of about 120 gpm. However, well DS–13 in Mansfield was reported to have a yield of about 280 gpm when it was drilled in 1929, and well DS–20 had a yield of about 200 gpm during a pumping test in 1954. The yields of the largest-capacity wells in the Logansport area range from 22 to 55 gpm. Well DS–282, between Logansport and Mansfield, reportedly yields about 50 gpm, the largest yield reported for any industrial well in the Naborton formation. The measured specific capacities of wells DS–15 and –18 in the city of Mansfield are 4.2 and 2.4 gpm per foot of drawdown, respectively, after pumping about 120 gpm continuously for 5 hours. Although only these two reliable specific-capacity determinations are available, they probably represent generally the specific capacities that can be expected in this area. Although most of the larger capacity wells in the parish are in the Mansfield area, wells yielding as much as 200 gpm can probably be developed in other parts of the parish where adequate thicknesses of sand are present in the Naborton formation.

To determine the water-bearing properties of the Naborton formation, pumping tests were made at Mansfield in October 1954 and June 1955, and a test was made at Logansport in June 1955. The October test is used as an example of the procedure followed in obtaining data by pumping tests and the analyses of these data. Well DS–20 was the pumped well, and wells DS–15 and –16 were the observation wells at Mansfield. Only the records obtained for well DS–15 will be used to illustrate the procedure followed during the pumping test and the subsequent analyses of the data obtained. The same procedure was followed in analyzing the test data from the other observation well (DS–16). Figure 26 is a rectangular coordinate plot of the depths to water in well DS–15 from 1:50 p.m. on October 6 to 7:40 p.m. on October 7, 1954, and in well DS–16 from 1:40 p.m. October 6 to 8:00 p.m. October 7, 1954.

Measurements of the discharge rate of the pump were made by means of a flowmeter installed in the discharge line. Water-level measurements were made with a steel tape for a period of about 6 hours and 10 minutes before the test started to determine the residual effect of previous pumping for use in projecting the trend of the water level. (See fig. 26.) Because of the short duration of the test and the relative stability of the atmospheric pressure, no corrections were needed for barometric-pressure changes.

The recovery phase of the test, which lasted for 12 hours, was followed by the drawdown phase, which also lasted 12 hours. The water levels observed in well DS–15 were corrected to take into account the water-level trend and were plotted in relation to time (in minutes) on logarithmic graph paper. For computation, the graph of the data observed during the recovery phase of the test was superposed on the type curve as shown in figure 27. The coordinate axes of the two curves were oriented so that they would be parallel, and the position at which most of the points on the curve representing the observed data coincided with those on the type curve was found by trial. With the curves in this position, an arbitrary point—generally where $W(u)=1.0$ and $u_r=1.0$, for convenience in subsequent computations—was chosen on the type curve. From the point on the data curve that coincided with this point, values of drawdown (s) and time (t_r) were obtained for use in computing the coefficients of transmissibility (T) and storage (S).

These coefficients, determined from data collected during the recovery phase, were 13,000 gpd per ft and 0.00009, respectively, for well DS–15, and 15,000 gpd per ft and 0.00024, respectively, for well DS–16. The data obtained during the June 1955 test and the drawdown phase of the October 1954 test were analyzed in the same way and the values determined were similar. (See fig. 28.)

If the data curve obtained during a pumping test coincides throughout its length with the type curve, the assumptions upon which equation 2 is based can be considered to be fulfilled. In many tests, however, as in the pumping test in Mansfield, the later points on the test curve fall either above or below the type curve. This divergence from the type curve indicates an increase or a decrease from the theoretical rate at which the water level would change if

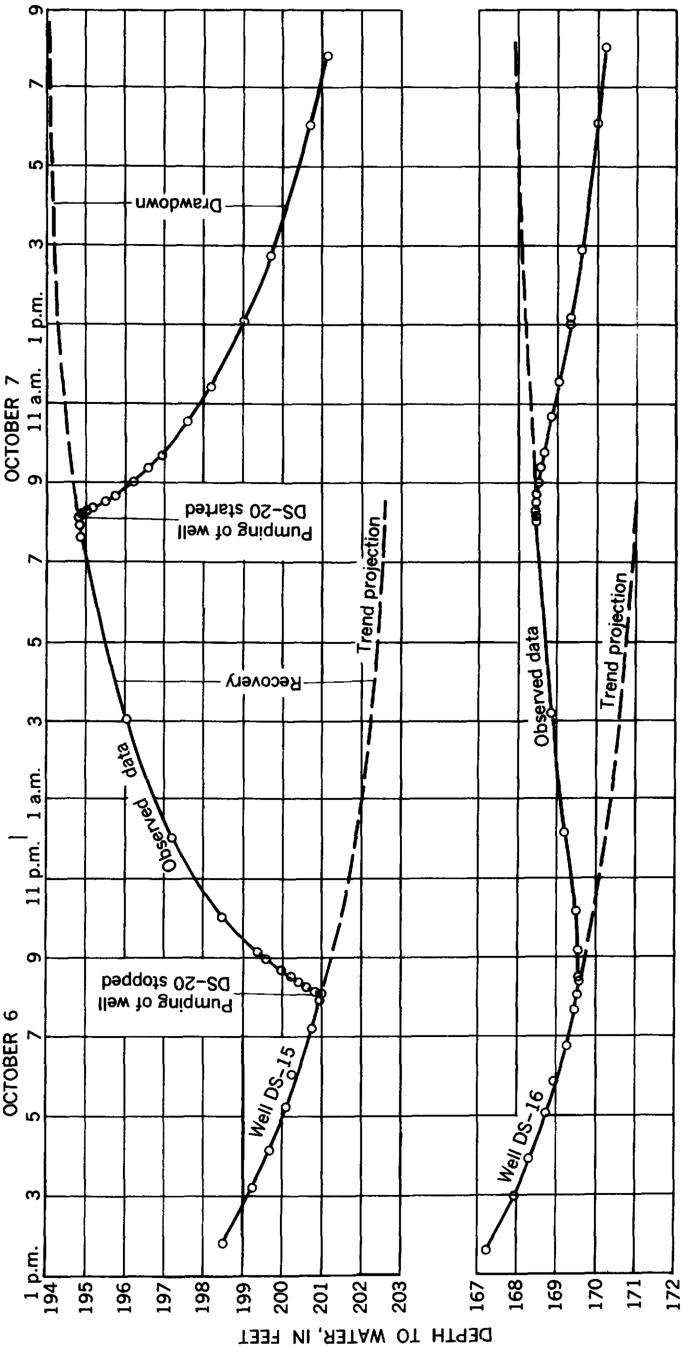

FIGURE 26.—Graphs showing recovery and drawdown in wells DS-15 and -16 during pumping test at Mansfield, La., October 1954.

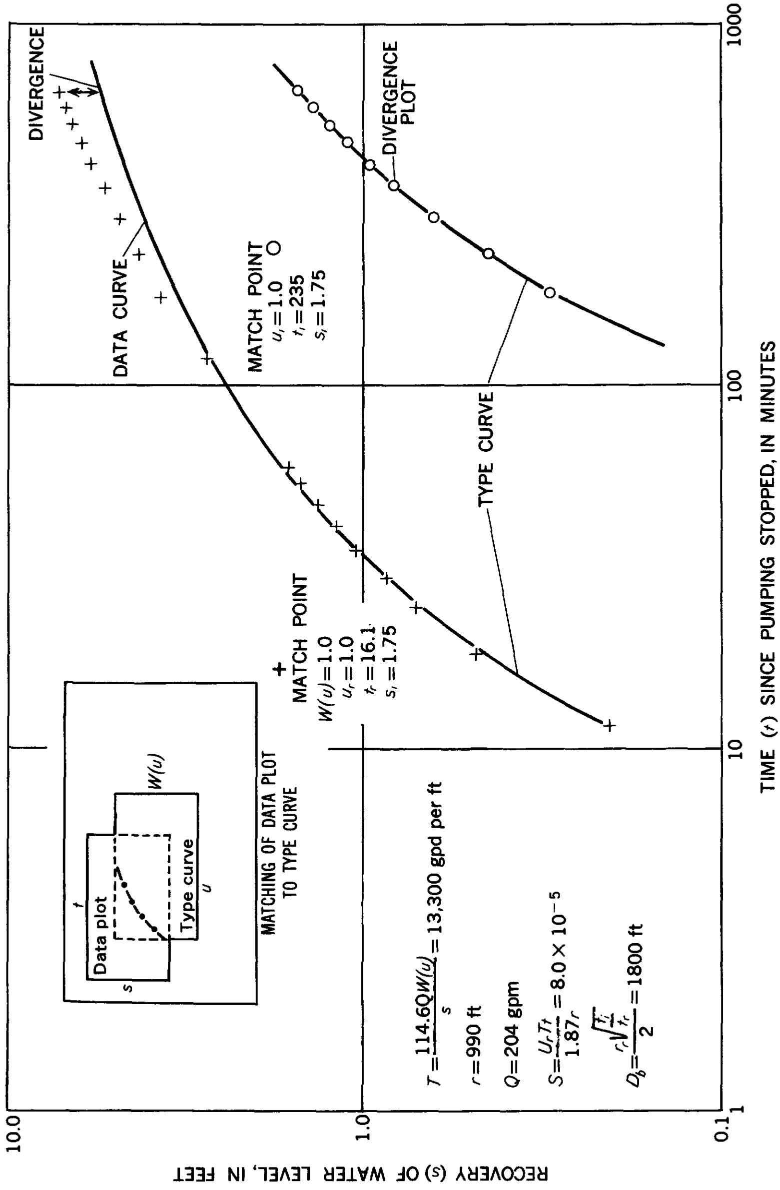

FIGURE 27.—Logarithmic plot of recovery data obtained from well DS-15 during pumping test at Mansfield, La., October 1954.

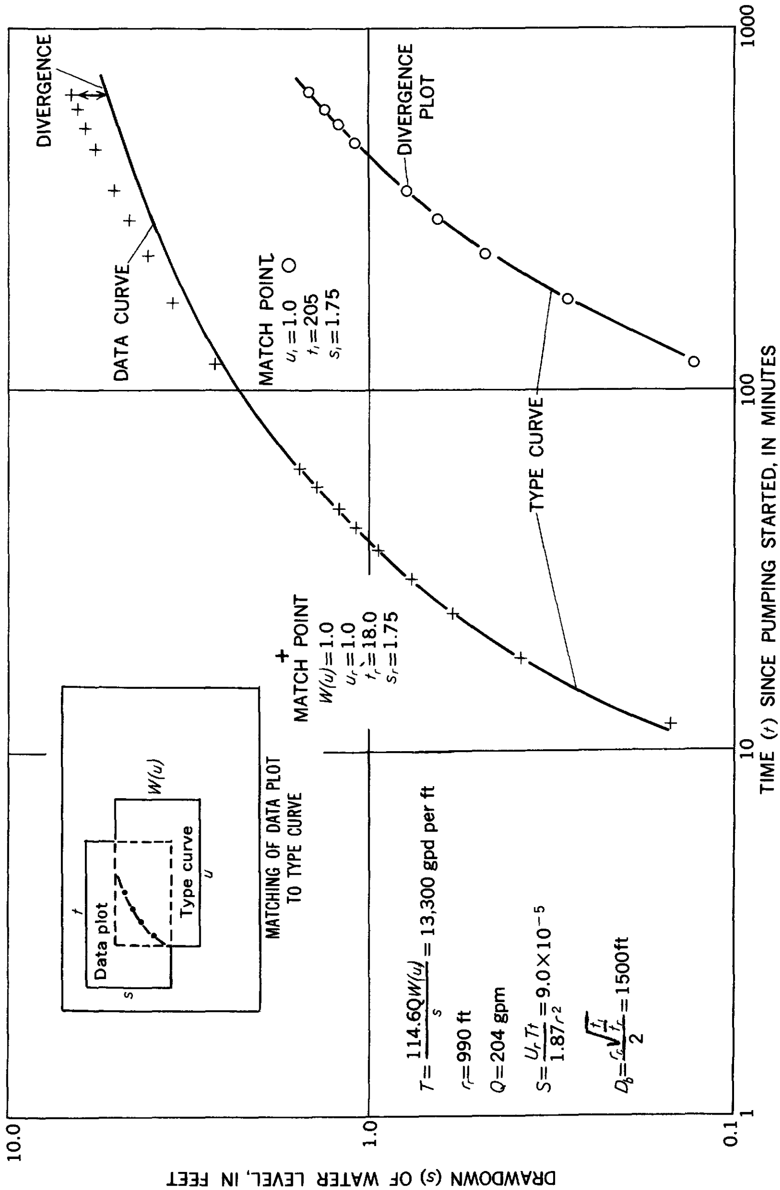

FIGURE 28.—Logarithmic plot of drawdown data obtained from well DS-15 during pumping test at Mansfield, La., October 1954.

conditions were ideal. The divergence may be caused by a recharging or discharging boundary in the hydraulic system being tested. Streams and lakes hydraulically connected with the aquifer, a thickening or an increase in permeability of the aquifer, recharging wells, and leakage from other aquifers are examples of recharging boundaries. Thinning or a decrease in permeability of the aquifer, discharge through springs and wells, leakage to other aquifers, and truncation of the aquifer by faults or other barriers are examples of discharging boundaries.

To determine the distance to the indicated barrier, the amount of divergence of the plotted data from the type curve is plotted in the same manner as the original data. If the curve resulting from the divergence plot coincides with the type curve throughout its entire length, only one boundary is present. (See figs. 27 and 28.) After agreement of the divergence plot with the type curve, a point on the graph is selected where u is the same on both the data curve and the divergence plot ($u_i=u_r$), and the value of t_i is obtained. The distance to the boundary may be computed by the following formula, using the values of t_i and t_r obtained from the original data curve.

$$D_b=\frac{r_r\sqrt{\frac{t_i}{t_r}}}{2},$$

in which

D_b=distance to boundary,
r_r=distance between observation and pumped well,
t_i=time on divergence plot where $u_i=u_r$, and
t_r=time on data curve where $u_i=u_r$.

The distances to the discharging boundaries computed on the recovery and drawdown curves for well DS–15 in figures 27 and 28 were 1,800 and 1,500 feet, respectively. The boundary distance determined on the recovery and drawdown curves in the test on well DS–16 was 1,900 feet. Because of the lenticularity of the bedding, the boundaries indicated in this test are probably the result of local thinning of the aquifer.

In using these data to estimate water-level declines caused by pumping or interference between wells, the effect of boundary conditions must be considered. For example, the discharging boundaries indicated in figures 27 and 28 would cause the actual water-level decline to be greater than the theoretical decline computed by using the average coefficients of transmissibility and storage of 14,000 gpd per ft and 0.00016, respectively. Based upon the aquifer's thickness at the site of the pumped well (DS–20) and the average coefficient of

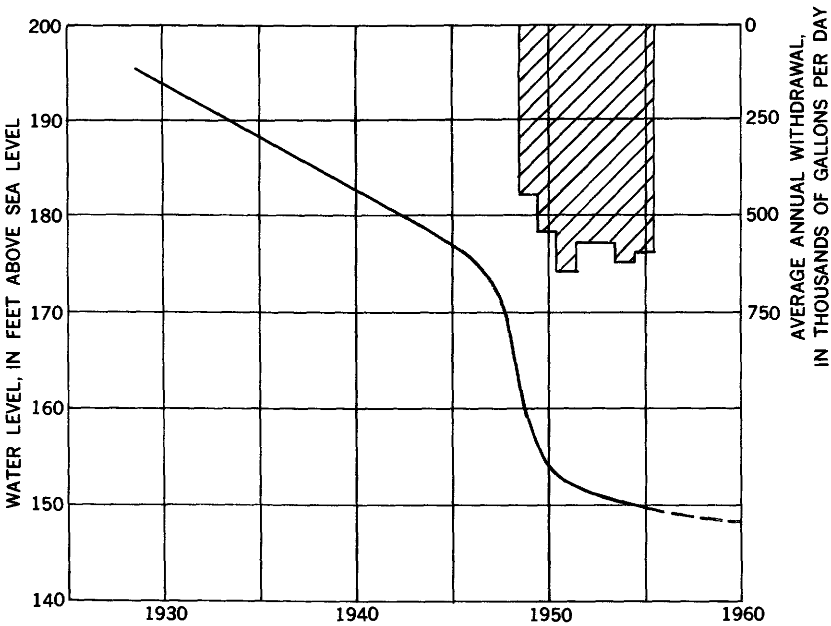

FIGURE 29.—Graphs showing the relation of pumping to average water level in wells screened in the Naborton formation at Mansfield, La.

transmissibility, the coefficient of permeability of the Naborton formation at Mansfield is about 300 meinzers. In June 1955 a drawdown-interference test was made at Logansport using wells 75 and 186, Shelby County, Texas. Because of the difficulty of controlling the rate of pumping, the duration of the test was only 480 minutes, and accurate measurements could not be made during the recovery phase of the test. The coefficients of transmissibility and storage, determined from data collected during this test, were 8,200 gpd per ft and 0.00032 respectively. The aquifer's thickness at the site of the pumped well (well 75) is 113 feet. Based upon the coefficient of transmissibility and the aquifer's thickness, the coefficient of permeability of the Naborton formation at Logansport is about 70 meinzers. Because of the irregular thickness of the Naborton formation and the wide variation of its permeability, the hydraulic characteristics determined at any one site could not with confidence be applied throughout the parish.

Figure 29 shows the general water-level decline near the center of the cone of depression caused chiefly by pumping from public-supply wells in Mansfield. From 1929, when the water levels were about 195 feet above sea level, to 1946 there was a relatively constant water-level decline to an altitude of 176 feet. After 1946, the water level declined rapidly in response to increased pumping. This increase in pumping coincides with the construction of five new wells used for public supply since 1945. The relatively large water-level decline is the result of the close spacing of wells in an area where the transmissibility is low. As the water level is approaching the top of the artesian aquifer, it may be necessary to obtain additional supplies of water away from the present center of the cone of depression. Water levels in wells 3 to 4 miles from the center of pumping have not been seriously affected by the pumping and are at altitudes comparable to those in the center of the cone of depression in the 1940's. Thus, the drawdown of water levels in wells drilled in these peripheral areas would not result in dewatering of the aquifer as rapidly as would drawdown of water levels in additional wells constructed near the center of the present cone of depression. Estimated yields of at least 200 gpm could be obtained from properly constructed and developed wells in these areas where the aquifer is of adequate thickness.

CHEMICAL QUALITY OF THE WATER

The Naborton is the deepest formation containing fresh water in De Soto Parish. (See pl. 5.) Water from the Naborton formation is of the sodium bicarbonate type and is suitable for most domestic, commercial, and industrial uses. (See table 13.) The range in concentration and the median concentration of each constituent is given in table 17. Water from this formation, as shown on plate 7 by the combined concentrations of calcium and magnesium, is generally softer than water from the Dolet Hills and slightly harder than water from the undifferentiated beds of the Wilcox group. Although the hardness of the 20 samples analyzed ranges from 2 to 990 ppm, the hardness of 17 of the samples is less than 60 ppm. The wide range in total iron content, from 0.04 to 4.8 ppm, indicates the difficulty in predicting the presence of objectionable amounts of iron in the water. No apparent relation exists between the amount of iron and the depth or location of the wells.

The dissolved-solids content of water from the Naborton formation, although generally less than 500 ppm, is greater than that of water from the other aquifers. The pH of water from the Naborton formation, ranging from about 7.0 to 8.4, is slightly higher than that of water from the other water-bearing formations. The chloride content of the water is generally less than 250 ppm, although the chloride content of water from the Logansport public-supply wells is as high as about 410 ppm. (See analyses for well 187, Shelby County, Tex., in table 13.) The high chloride content, as well as the high concentration of dissolved solids shown by some analyses, indicates contamination, possibly from nearby oil or gas wells. This contamination is illustrated by the analyses of samples from well 75, Shelby County, Tex., collected in 1937 and 1955.

Hydrogen sulfide, although not common in most water from the Naborton formation, locally is present in objectionable quantities. Water pumped from well DS–183, a public-supply well at Mansfield, is reported to contain 8 ppm of hydrogen sulfide. Water from the Naborton formation is characterized by relatively low calcium, magnesium, and sulfate contents and dissolved solids of less than 1,000 ppm; however, the water from well DS–80 at Stonewall (see pl. 7) may be contaminated because the major constituents are present in much greater amounts than are generally found in water from this formation.

DOLET HILLS FORMATION

STRATIGRAPHY

The Dolet Hills formation was originally described by Murray (1948, p. 105–110) as a member of his Logansport formation for exposures in the Dolet Hills area of southeastern De Soto Parish. He described type localities in the NW¼ sec. 6, T. 11 N., R. 11 W., the NE¼ sec. 1, T. 11 N., R. 12 W., and the SW¼ sec. 36, T. 12 N., R. 12 W., along the road from Grove Hill church and cemetery to Naborton, on the north side of the first large hill and 1¼ miles northeast of the church. Murray (1948) did not map the Dolet Hills as a separate unit, and as time was not available during this study to map geologic formations exposed at the surface, the Dolet Hills is included with the undifferentiated Wilcox group in plate 3.

The exposures of this formation in the type locality described by Murray (1948, p. 106) consist chiefly of gray to brown fine to medium massive lignitic sand and gray silt and clay lenses. The only fossils reported by Murray are sparse fragments of plants or leaves. Samples of the Dolet Hills collected from test wells DS–175, –183, and –315 consist of very fine to fine olive-gray quartz sand with large amounts of silt and lignite and variable amounts of clay. (See table 15.) The thickness of the sand beds as shown by both electrical logs and drillers' logs is variable. The electrical logs of test wells DS–183 and –315 show 10-foot beds of relatively clean sand separated by 10 to 20 feet of silty and clayey sand. The electrical log of test well DS–175, however, shows a 96-foot thickness of sand and many thin, closely spaced silt or clay layers. The percentage of silt in samples from this test hole was small in comparison with the percentage of silt and clay in samples from DS–183 and –315. Mechanical analyses of formation samples from wells DS–175 and –183 (fig. 30) show the similarity in texture of sands from these wells. The samples of the Dolet Hills range in texture from fine sand to silt, as do the samples of the Naborton formation. A comparison of figure 30 with figure 24, however,

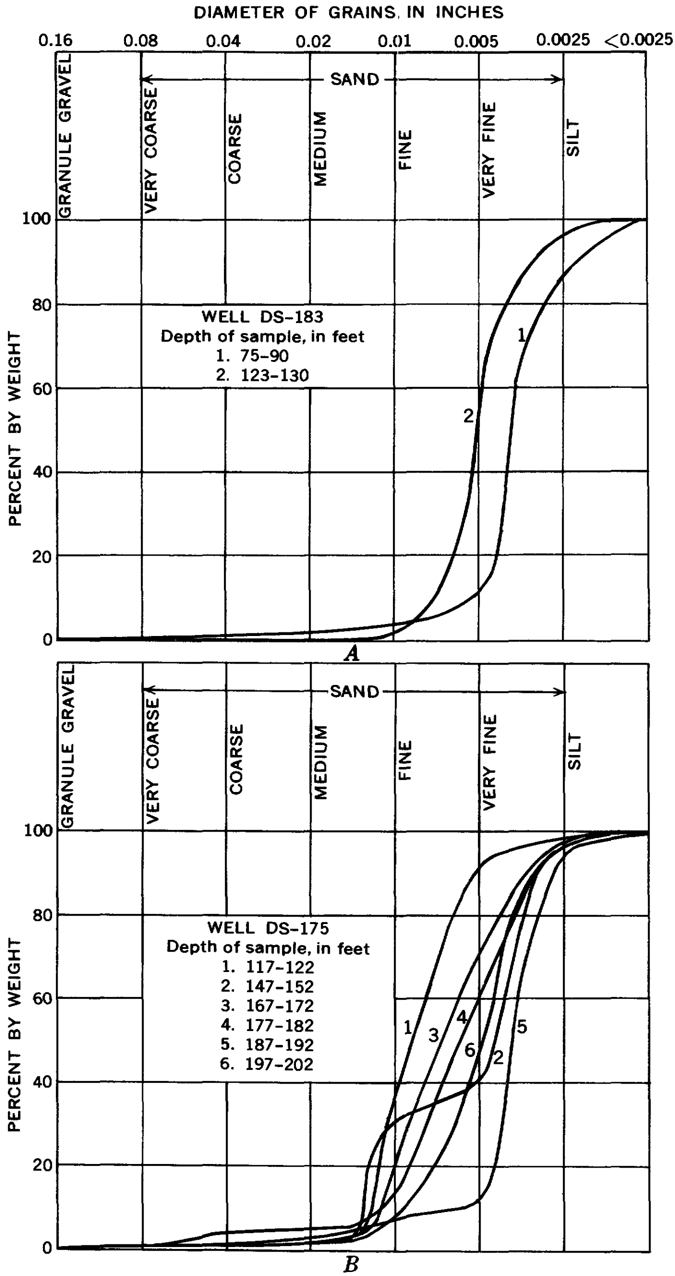

FIGURE 30.—Cumulative curves showing grain sizes of material from the Dolet Hills formation. *A*, Well DS-183; *B*, Well DS-175.

shows that the samples of the Dolet Hills contain a larger percentage of fine sand than the samples of the Naborton.

The Dolet Hills is exposed at the surface in the Logansport, Spider, De Soto-Red River-Bull Bayou, Sutherlin, and Benson oil-field structures. The largest area of outcrop is in the Dolet Hills of southeastern De Soto Parish. (See pls. 3 and 8.) The Dolet Hills in that area is deeply dissected and forms the most rugged topography in De Soto Parish.

The thickness of the Dolet Hills in De Soto Parish, as indicated by electrical logs and drillers' logs, ranges from about 40 to 175 feet. Plates 8 and 11 indicate that this member is thickest in the southeastern part of the parish and thins to the west and the northwest. The map indicates also that the Dolet Hills is thicker in the vicinity of Grand Cane and to the north of Mansfield than it is in the northwestern part of the parish.

WATER-BEARING PROPERTIES

Water in the Dolet Hills, like that in the Naborton formation, occurs under both artesian and water-table conditions. It occurs under artesian conditions throughout most of the area where the Dolet Hills is overlain by other formations, and under water-table conditions in the areas where the aquifer crops out or is near the surface. Water levels in this aquifer are highest, about 330 feet above sea level, about 7 miles southeast of Mansfield (pl. 12) in the outcrop area receiving the most recharge. Except for this area, water levels are generally highest in the western third of the parish. Recharge to the aquifer occurs in the northwestern part of the parish, where the aquifer is overlain by younger sediments, as well as in the outcrop area to the southeast of Mansfield. The slope of the piezometric surface indicates that natural discharge is toward Bayou Pierre in the northeastern part of the parish and toward the Sabine River in the southwestern part.

Figure 31, a hydrograph of the water level in well DS–69, which is 8 miles northwest of Mansfield, shows the fluctuations of the water levels in the Dolet Hills in an area not affected by heavy withdrawals. The hydrograph shows that the water level in this well rises rather rapidly in response to precipitation. The rise in water level in the early spring, a period of much precipitation, is followed by a drop in water level from June to the last of January, a period of less rainfall. The rise in water level from late January to late May reflects increased precipitation during this period. Well DS–69 is 137 feet deep and is in the outcrop area of the undifferentiated upper part of the Wilcox group (pl. 3); thus, water from precipitation apparently reaches the

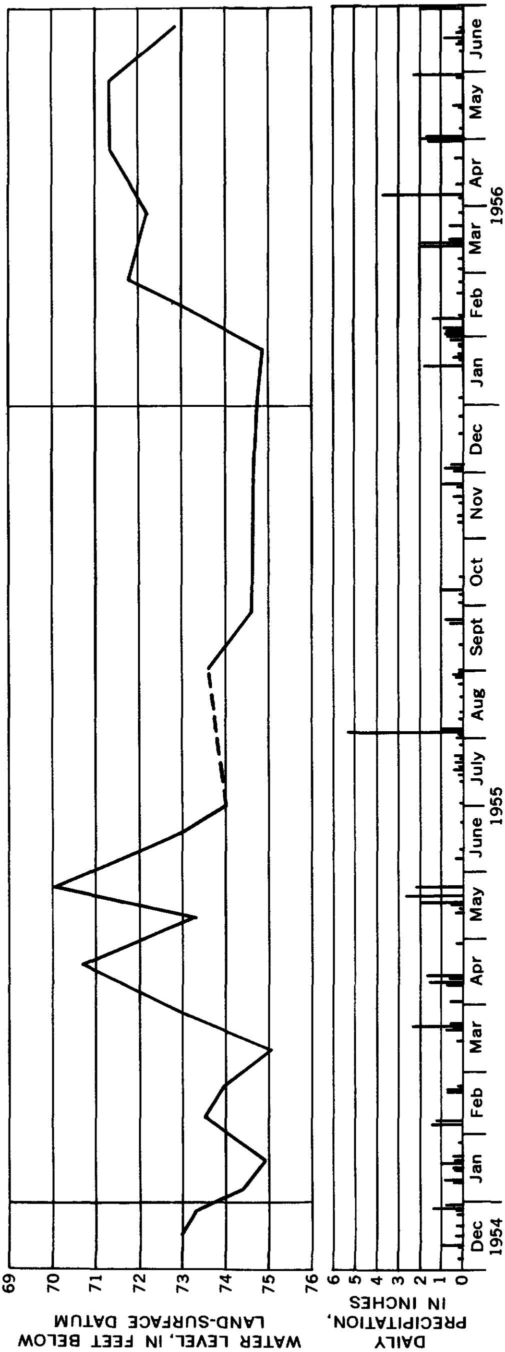

FIGURE 31.—Hydrograph showing water-level fluctuations in well DS-69 and daily precipitation at Logansport, La., 1954–56

Dolet Hills by passing through the undifferentiated beds. Measurements of water levels in wells DS–69 and –175 are listed in table 16.

The Dolet Hills formation is the source of water for 38 of the 322 wells listed in this report. The wells in the area, where this aquifer is at or near the surface, range in depth from 100 to 286 feet. Most of the wells in the Dolet Hills are in the northern half of the parish and do not have large yields because they are used mainly to supply domestic and stock needs. Well DS–175, which was drilled in 1955 as a supplemental source of water for irrigation, yields 50 gpm.

CHEMICAL QUALITY OF THE WATER

The analyses of seven water samples (table 13) indicate that water from the Dolet Hills is of good quality and is suitable for most domestic, commercial, and industrial uses. It can be classified, generally, as a sodium bicarbonate water. Table 17 gives the range in concentration and the median concentration of each of the determined constituents. Water from this aquifer is generally harder than water from either the Naborton formation or the undifferentiated Wilcox group. Hardness of water from this formation ranges from 27 to 194 ppm. The water from wells DS–22 and –238, whose water samples had hardnesses of 27 and 56 ppm, is not considered typical of water from the Dolet Hills because the water may be obtained in part from the Naborton formation. Water from the Dolet Hills contains objectionable amounts of iron, which generally are larger than those in water from the Naborton formation or the undifferentiated upper part of the Wilcox group. Water from the Dolet Hills has a dissolved-solids content ranging from 212 to 530 ppm and a pH ranging from 6.6 to 8.0, which are generally lower than those of water from the Naborton formation and higher than those of water from the overlying undifferentiated beds. Water from the Dolet Hills contains only small amounts of chloride.

UNDIFFERENTIATED WILCOX GROUP

STRATIGRAPHY

The rocks of Tertiary age above the Dolet Hills in De Soto Parish were assigned by Murray (1948) to the Cow Bayou and Lime Hill members of his Logansport formation. These members are difficult to trace in the subsurface solely on the basis of lithologic and electrical logs, as they are not composed of distinctive sediments. Therefore, in this discussion the rocks of the Wilcox group in the interval between the top of the Dolet Hills and the base of the Quaternary deposits are not differentiated. (See table 11.)

The outcrop areas of the undifferentiated Wilcox group, primarily in the western and southwestern part of the parish (pls. 3, 5, and 8),

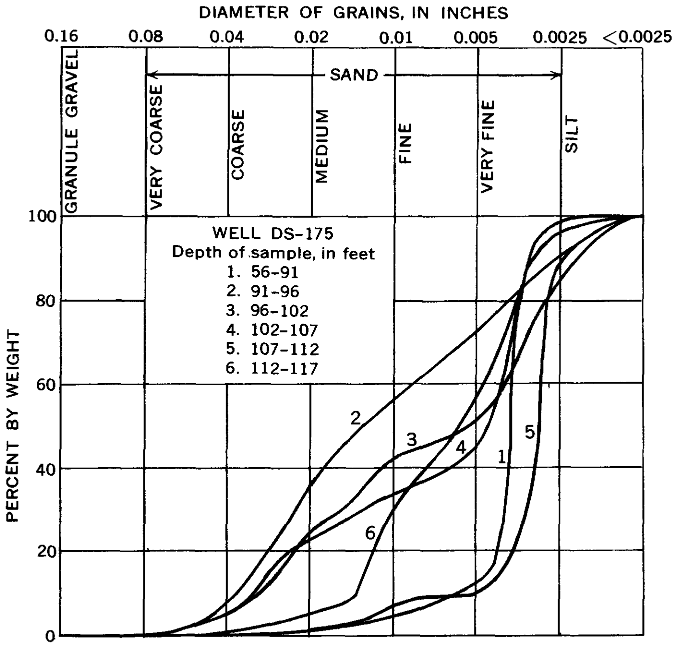

FIGURE 32.—Cumulative curves showing grain size of material from the undifferentiated Wilcox group.

are hilly with narrow divides and relatively deep, steep-sided valleys. Drillers' and electrical logs of wells indicate several thin sand beds in the undifferentiated Wilcox group. However, these beds thicken and thin considerably within a small area. (See pl. 8.) The beds dip radially from the structural high in the east-central part of the parish; the steepest dip is southward, and at the southern boundary of the parish the base of the beds is at a depth of 400 feet below land surface. (See pl. 5.)

These beds consist of alternating thin layers of very fine to fine grayish sand, silt, and clay. Variations within this formation in different parts of the parish are shown by formational samples collected from test wells DS–175, –183, and –315. (See table 15.) Samples from test well DS–315 contain a larger percentage of gray silty clay and silt than sand; on the other hand, samples from test wells DS–175 and –183 contain a larger percentage of gray silty and clayey sand than clay and silt. Mechanical analyses of samples from well DS–175 (fig. 32) indicate that the largest percentage of grains range in size from very fine sand to silt. At this site the undifferentiated beds contain a much larger proportion of very fine to coarse sand than the deeper aquifers sampled in the parish.

WATER BEARING PROPERTIES

Water in the undifferentiated beds of the Wilcox group occurs under both artesian and water-table conditions. Generally, water-table conditions exist where the sands are at or near the surface, and artesian conditions exist at greater depths. These sands are the source of water for 143 of the 322 wells listed in this report. (See table 10.) Shallow dug or bored wells, rarely more than 50 feet deep, are common in the outcrop areas, and yield sufficient water for domestic purposes. Deeper wells, as much as 250 feet deep, yield water for domestic and industrial uses. The only wells from which water is pumped for industrial use are DS–280 and –281, at the compressor station of the Southern Natural Gas Co., 4 miles east of Logansport. The yields of these wells are about 90 gpm.

Water levels in the shallow wells are generally within 40 feet of the land surface and fluctuate with seasonal variations in precipitation. The altitudes of water levels (pl. 13) indicate that the principal area of recharge for the undifferentiated part of the Wilcox group is a belt extending from the southeastern part to the northwestern part of the parish. This area coincides with a topographic high extending throughout the parish. The general direction of flow is to the northeast and southwest away from the central area of high water levels. Static-water levels range in altitude from about 140 feet in the northeastern part of the parish to about 360 feet in the southeastern part of the parish. (See pl. 13.) Most of the natural discharge from the aquifer, with the exception of evapotranspiration, is to local streams. The contours on plate 13 have been generalized and do not show the effect of discharge into the local streams.

Water-level fluctuations in a well unaffected by nearby pumping are shown on figure 33. The fluctuations of water levels in this well, DS–68, result principally from seasonal variations in (1) recharge from precipitation, (2) discharge by evaporation and transpiration of plants, and (3) discharge to local streams. As indicated by the hydrograph, an abrupt rise in water level of about 37 feet occurs in the early spring and is the result of increased precipitation; the rapid decline of water level during the summer and fall is the result of a decrease in precipitation and the increased demands for water by vegetation. The large magnitude of these fluctuations in response to precipitation reflects the fineness and low permeability of the sand in the undifferentiated beds of the Wilcox group. Measurements of water levels in well DS–68 are listed in table 16.

CHEMICAL QUALITY OF THE WATER

Analyses of two samples of water from the undifferentiated Wilcox group indicate soft water comparatively low in dissolved solids.

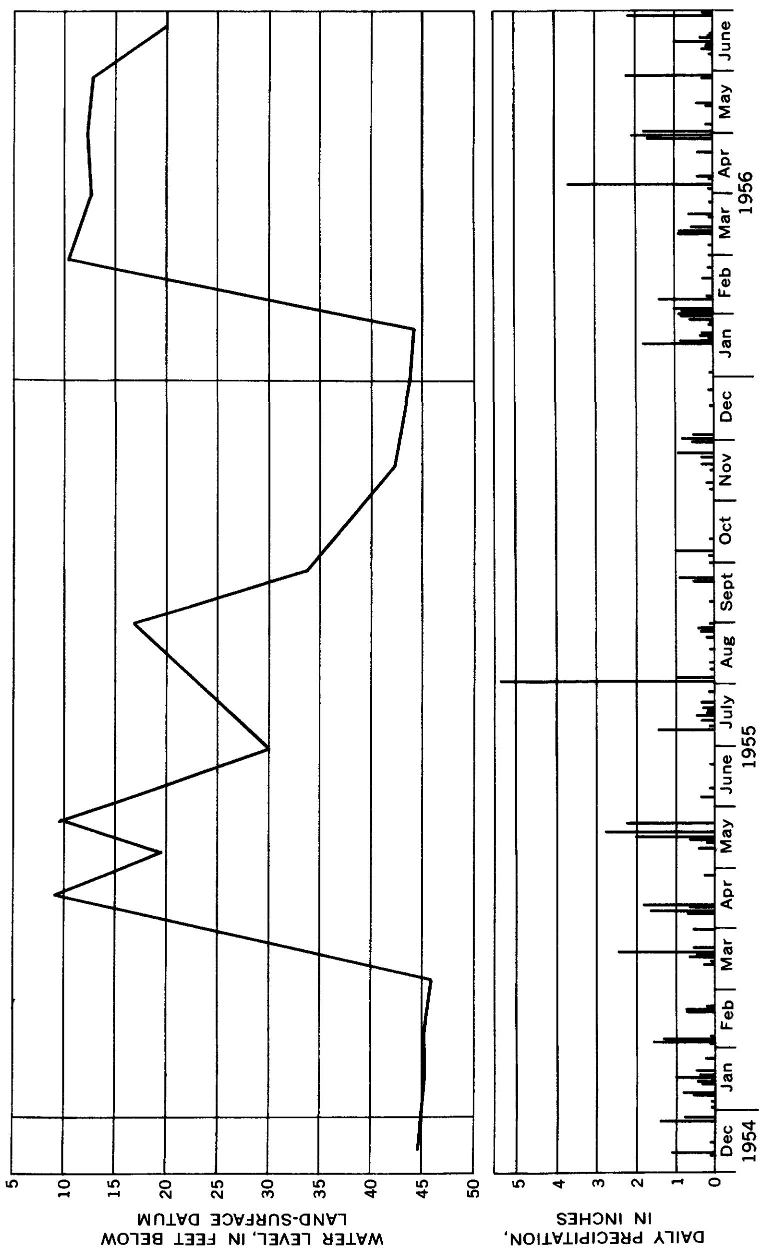

FIGURE 33.—Hydrograph showing water-level fluctuations in well DS-68 and daily precipitation at Logansport, La., 1954-56.

Verbal reports and analyses of the samples from wells DS–29 and –281 indicate the water has a wide range in iron content.

QUATERNARY SYSTEM

PLEISTOCENE SERIES

TERRACE DEPOSITS

STRATIGRAPHY

Terrace deposits of Pleistocene age unconformably overlie the Tertiary deposits in De Soto Parish. Fisk (1938, p. 51–75) first mapped the Williana, Bentley, Montgomery, and Prairie terrace surfaces in Louisiana and later (1940, p. 53–112) gave formational rank to the sedimentary sequences underlying the terrace surfaces. Trowbridge (1954, p. 793–812) reviewed disagreements regarding the time and method of deposition of these sediments, and Doering (1956, p. 1816–1862) presented a new and different interpretation in which he mapped five terraces in the Louisiana gulf coast. These terraces do not coincide with those mapped by Fisk. Because the thickness and areal extent of these deposits are small in De Soto Parish, it was not possible to resolve their geologic history; consequently, for the purposes of this report they have not been differentiated and are referred to simply as terrace deposits.

The Pleistocene terrace deposits in De Soto Parish generally consist of basal sand and some gravel grading upward through silt into silty clay. According to Murray (1948, p. 144) the terrace deposits in the northeastern part of the parish reach a maximum known thickness of 118 feet in the NW cor. sec. 5, T. 13 N., R. 11 W. Test hole DS–322 penetrated only 28 feet of terrace material near the headwaters of Edwards Bayou in T. 14 N., R. 14 W. Test hole DS–323, in the same drainage basin (T. 14 N., R. 13 W.), penetrated 75 feet of yellow, red, and gray clay of the terrace deposits, which were underlain by Murray's Cow Bayou member of the Logansport formation. However, east of Clear Lake only the top 13.5 feet of test hole DS–324 penetrated clay; the remaining 86.5 feet penetrated very fine to medium yellowish-brown to reddish-brown sand of the terrace deposits.

WATER-BEARING PROPERTIES

The water in the terrace deposits occurs under water-table conditions throughout most of the area of Pleistocene exposure. These deposits form an aquifer which is utilized by only a small percentage of the wells in De Soto Parish. The 19 wells in the terrace deposits listed in table 10 range in depth from 12 to 84 feet. All except well DS–125, which is east of Clear Lake, are less than 55 feet deep. The wells provide sufficient water during periods of normal precipitation to meet the needs of an average household and a few head of livestock.

They furnish only meager quantities of water during periods of below-normal precipitation. Well DS–125, which is 84 feet deep, penetrates the zone of saturation sufficiently to provide a constant and plentiful supply of water for domestic and stock use. The water table in the terrace deposits ranges in altitude from about 125 feet north of Clear Lake to about 250 feet at a location 8 miles southeast of Logansport.

CHEMICAL QUALITY OF THE WATER

Because the areal extent of the terrace deposits is small and the quantities of water available from them are not so large, no samples of water were collected for complete chemical analysis. However, reports by well owners indicate that the water is generally soft and contains only small amounts of iron. Elsewhere in the State, water from these deposits contains objectionable quantities of iron, and such water may occur in some areas not yet developed in De Soto Parish.

PLEISTOCENE AND RECENT SERIES

ALLUVIUM

STRATIGRAPHY

Because the deposits in the valleys of the Red and Sabine Rivers contain materials of both Pleistocene and Recent age which are not readily differentiated, these deposits will be referred to collectively as of Pleistocene and Recent age. The alluvial deposits in De Soto Parish in both the Red and Sabine River valleys are similar in texture, grading from coarse sand at the base upward through progressively finer sand and silt into clay. The most obvious difference between the alluvium of the Red and Sabine Rivers is in their color. In the Red River valley the lower sand is brown and gray, and the upper silt and clay are predominantly red. In the Sabine River valley the deposits are generally brown, yellow, and gray throughout.

The alluvial deposits are found in narrow belts underlying and flanking the Red River along the eastern edge of the parish and the Sabine River along the southwestern edge of the parish. The total area of alluvial deposits in De Soto Parish is about 70 square miles. About 60 square miles of this area is occupied by alluvium of the Red River, the largest area of which is in the southeastern part of the parish near Evelyn, where the alluvium reaches its greatest thickness. Borings indicate that the alluvium is about 100 feet thick along Bayou Pierre. This deep part of the buried channel was probably occupied at one time by the Red River. The alluvium is thin along the remainder of the eastern border of De Soto Parish, owing to the nearness of the valley wall. Alluvium of the Sabine River within the boundaries of De Soto Parish covers an area of about 9 square miles. Test boring Texas (Shelby County) A–1 indicates that the alluvium is about 30 feet thick at Logansport. Other test borings made in the northern part of Sabine Parish indicate that the alluvium is not more than 50 feet thick in that vicinity.

WATER-BEARING PROPERTIES

Water in the alluvial deposits in De Soto Parish occurs generally under water-table conditions. In the Red River valley, however, the water level is near the base of the silt, which acts as a confining layer; consequently, the water is under artesian conditions during the initial stage of pumping from wells.

These deposits are the source of water for only a small number of driven and dug domestic wells in De Soto Parish. Static water levels in the alluvium of the Red River are about 110 feet above mean sea level. No wells have been constructed in other areas of alluvial deposits in the parish.

Although no large-capacity wells have been drilled in the alluvium in De Soto Parish, data obtained from a well 105 feet deep (RR–50) in Red River Parish, in sec. 29, T. 14 N., R. 11 W., about 14 miles northeast of Mansfield, indicate that wells of large capacity may be constructed in parts of the Red River alluvial valley where there is sufficient permeable water-bearing material. During a pumping test on well RR–50 the measured yield was 1,160 gpm and the drawdown was 48.5 feet. Thus, the specific capacity of the well was 24 gpm per foot of drawdown. As determined from analyses of data obtained during the pumping test, the coefficients of transmissibility and permeability of the alluvial deposits at the site of well RR–50 are 95,000 gpd per ft and 1,900 meinzers, respectively (Newcome, 1960). Newcome reported the alluvial deposits to be hydraulically connected with the Red River and Bayou Pierre throughout the length of the valley in Red River Parish. He also stated that except during short periods of high river stage, water from the alluvial aquifer is discharging into the streams. Thus, these streams are a large potential source of recharge that would tend to prevent excessive water-level declines.

CHEMICAL QUALITY OF THE WATER

Water from the Pleistocene and Recent alluvium is generally of the calcium-magnesium bicarbonate type. The water, which is used to some extent for domestic use, is very hard and contains large amounts of iron, as shown by analyses of water from wells RR–50 and –85 in Red River Parish. (See table 13.) The pH of the two samples are 7.2 and 7.3, and the chloride content was 62 and 39 ppm, respectively.

CONCLUSIONS

The occurrence of ground water in De Soto Parish is closely related to geologic conditions. All fresh water occurs above the top of the

Porters Creek clay. The calcareous clay and lignite of the Porters Creek clay has an average thickness of about 800 feet and is the chief marker bed on which correlations in the area can be made. In this report, the Porters Creek clay is considered to be in the Midway group of Paleocene age; the overlying Naborton formation, Dolet Hills, and the undifferentiated part of the Wilcox are included in the Wilcox group of Paleocene age. The principal structural feature in the area is an asymmetrical dome, the Sabine uplift. Near the center of the uplift, in the east-central part of the parish, part of the Naborton formation has been removed by erosion, and little or no potable ground water is available.

In the shallow aquifers of the undifferentiated part of the Wilcox group, ground water occurs generally under water-table conditions. Except in the central part of the structural dome, the Dolet Hills and the Naborton formation contain water under artesian conditions. However, these artesian aquifers receive recharge not from their outcrop areas but through the confining beds from the overlying water-table aquifers. In general, the natural discharge from these aquifers is in their outcrop areas in the northeastern part of the parish and along the Sabine River at the southwestern margin of the parish.

Since 1956 in De Soto Parish only about 895 million gallons of ground water a year has been pumped for all purposes. The largest developments are for public-supply, domestic, and stock uses. There is no large industrial development in the area and no extensive irrigation, and consequently use for these purposes is small.

The principal aquifer developed in De Soto Parish is the Naborton formation. The water is soft and is of the sodium bicarbonate type; however, it generally contains objectionable quantities of iron and is rather high in dissolved solids. The yields of large-diameter wells range from about 20 to 276 gpm but are generally about 125 gpm. Where the aquifer is of adequate thickness and outside areas of present development, yields of at least 200 gpm can probably be obtained from properly constructed and developed wells.

Only small supplies have been developed from aquifers in the Dolet Hills and the undifferentiated Wilcox group and in the terrace deposits. In some places the Dolet Hills seems to have an adequate thickness to yield moderate supplies to wells; however, only small supplies are generally available from these beds.

Water from the alluvial deposits has been developed only for domestic and stock purposes. In the Red River valley, however, the permeable sand and gravel is of adequate thickness to yield relatively large quantities of water to wells. In Red River Parish, wells having a maximum yield of 1,160 gpm have been constructed where these sediments have a thickness comparable to that in De Soto Parish.

In the Sabine River valley, these deposits are relatively thin and of small areal extent and are apparently capable of producing only small quantities of water.

Periodic measurements of water levels have been made in De Soto Parish since 1955. Thus, determinations of water-level fluctuations in this report were based on only 1½ years of record. The collection of data should be continued so that a better evaluation of ground-water conditions in the area can be made. Information on newly drilled wells (including well logs, construction data, well performance, and water levels), water-bearing properties of the aquifers, salt-water contamination, and detailed geologic conditions should be incorporated in the continuing program of data collection in this area.

GAGING-STATION RECORDS

A brief description of each gaging station in or near the area, accompanied by tables of monthly discharge, monthly runoff, and yearly discharge follows.

SABINE RIVER AT LOGANSPORT, LA.

Location.—Lat 31°58′, long 94°00′, in NE¼ sec. 4, T. 11 N., R. 16 W., at bridge on U.S. Highway 84, 200 ft upstream from Texas and New Orleans Railroad bridge at Logansport, De Soto Parish, 3 miles upstream from Bayou Castor, and at mile 267.

Drainage area.—4,858 sq mi.

Supplemental records available.—Gage height records collected at same site since 1903 are contained in reports of U.S. Weather Bur.; used by U.S. Geol. Survey 1903–05, corrected to datum of U.S. Geol. Survey gage.

Gage.—Wire-weight gage read twice daily. Datum of gage is 147.72 ft above mean sea level, datum of 1929. July 1, 1903, to Dec. 31, 1906, chain gage at present site at datum 2.0 ft lower. Jan. 1, 1907, to Aug. 23, 1934, chain gage at present site and datum. Aug. 24, 1934, to Feb. 14, 1941, chain gage 200 ft downstream at present datum.

Average discharge.—49 years (1903–19, 1922–55), 3,226 cfs.

Extremes.—1903–55: Maximum discharge, 92,000 cfs Apr. 8, 1945 (gage height, 44.07 ft, from floodmark); minimum observed during periods of daily records, 16 cfs Sept. 26–28, Oct. 3, 4, 1939.

Maximum stage known prior to 1945, 39.4 ft in May 1884, present datum.

Remarks.—Small diversions above station. January 1907 to September 1923, monthly records only.

Cooperation.—Gage-height record collected in cooperation with U.S. Weather Bur.

Monthly and yearly mean discharge, in cubic feet per second

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1903										3,590	1,430	242	
1904	1,170	558	465	470	893	988	4,570	2,060	1,940	884	345	196	1,210
1905	104	107	2,012	2,770	6,280	7,374	9,650	19,350	10,590	13,270	4,139	441	6,352
1906	610	3,130	6,406	12,650	5,300	4,330	7,978	3,590	3,700	1,130	2,000	955	4,311
1907	1,350	429	3,980	5,710	1,520	3,210	1,980	8,120	7,440	932	161	85.6	2,930
1908	127	4,090	7,050	4,690	7,550	4,000	3,380	14,410	5,327	456	622	763	4,366
1909	527	337	823	827	2,700	2,140	1,120	507	450	111	63.6	45.1	792
1910	105	86.1	1,060	1,020	1,620	2,280	3,400	2,230	505	494	73.3	43.6	1,070
1911	33.9	35.5	97.6	313	348	502	3,350	2,020	132	1,010	187	84.0	675
1912	80.8	83.6	1,430	1,830	1,110	6,780	9,138	2,900	522	447	5,100	680	2,515
1913	97.6	94.5	225	824	1,740	6,760	3,740	1,070	439	3,750	193	2,140	1,760
1914	4,450	668	9,240	3,610	4,880	4,020	8,010	17,470	3,260	240	642	503	4,767
1915	237	300	3,060	6,210	8,501	7,630	4,199	15,950	1,260	2,170	6,250	4,620	5,030
1916	831	1,930	1,660	3,610	7,824	1,130	3,770	7,270	991	702	274	207	2,497
1917	132	390	699	1,190	2,420	2,040	1,340	868	1,120	1,170	427	631	1,030
1918	307	143	230	457	379	356	2,393	4,530	859	175	183	337	865
1919	197	1,150	3,190	6,530	4,990	4,220	3,720	1,790	2,280	4,590	3,630	2,300	3,210
1920	10,680	16,790	7,120	10,370	6,090	6,300	4,990	3,880	3,520	1,130	2,000	1,600	6,200
1921	800	1,200	2,500	6,275	4,057	5,249	10,900	8,663	2,063	3,673	329	252	3,830
1922	124	154	546	1,250	2,520	9,300	17,760	12,340	2,602	1,262	432	192	4,040
1923	96.6	688	539	1,118	6,180	6,193	7,491	3,157	2,575	475	86.7	881	2,421
1924	504	494	5,610	8,780	5,510	8,020	4,490	4,040	4,590	155	122	174	3,540
1925	124	99.6	216	821	521	542	498	1,820	219	78.5	47.3	100	425
1926	386	5,180	734	3,190	2,170	7,360	10,500	7,540	1,680	2,930	1,630	174	3,830
1927	263	510	2,970	4,720	5,310	8,870	11,500	5,970	1,810	1,520	1,260	118	3,720
1928	1,790	354	738	887	1,520	4,480	4,360	3,180	2,310	1,560	699	75.1	1,830
1929	190	1,450	4,670	9,420	5,870	5,440	2,840	4,990	7,470	573	80.0	338	3,800
1930	104	550	996	6,090	6,360	3,470	938	10,300	8,010	219	102	89.9	3,080
1931	500	470	3,060	3,000	2,410	5,040	2,130	3,890	756	363	183	164	1,840
1932	40.6	300	7,540	20,600	19,400	11,500	3,100	1,810	368	503	110	142	5,420
1933	95.2	103	724	7,000	5,280	7,480	6,100	5,060	2,160	5,730	2,260	406	3,530
1934	244	263	628	4,680	3,140	9,570	9,260	1,260	450	92.9	29.2	34.6	2,470
1935	39.8	663	2,693	2,883	6,835	3,009	2,143	17,490	5,364	2,680	205	234	3,678
1936	515	2,143	3,840	1,006	1,084	1,281	465	2,352	421	639	68.0	39.6	1,159
1937	1,044	603	1,344	7,874	4,972	6,632	4,226	648	401	122	103	167	2,334
1938	177	1,287	3,115	10,150	13,140	6,314	11,220	6,044	606	347	547	67.7	4,358
1939	41.0	409	460	3,842	6,500	6,636	2,346	1,297	491	209	38.4	23.3	1,831
1940	19.5	87.4	1,677	800	4,176	935	3,505	2,402	4,226	2,301	453	1,168	1,795

1941	223	7,123	15,890	12,600	5,498	9,297	4,444	8,676	8,316	6,689	736	1,018	6,735
1942	1,767	5,150	4,449	2,754	2,991	4,703	12,250	16,590	7,305	909	1,910	2,467	5,273
1943	498	915	1,185	4,107	1,427	1,558	3,105	1,554	12,490	1,540	131	82.2	2,371
1944	990	347	1,116	6,315	7,066	10,460	9,517	25,470	7,044	379	132	375	5,776
1945	140	570	3,646	14,620	6,049	21,400	34,410	2,829	5,021	9,470	936	308	8,282
1946	4,431	1,958	3,403	12,280	15,620	11,730	5,631	8,673	19,930	1,082	350	885	7,096
1947	572	11,220	6,868	7,758	4,884	7,488	8,176	5,320	1,361	754	142	601	4,585
1948	201	1,154	5,391	6,857	10,090	9,497	3,390	6,816	2,652	424	183	99.8	3,885
1949	91.9	360	548	3,117	6,395	7,143	4,509	3,580	1,714	1,981	1,465	556	2,600
1950	4,276	3,593	1,727	10,680	17,950	7,704	2,229	11,380	6,953	1,601	1,703	1,107	5,836
1951	527	540	495	1,535	4,279	3,848	2,021	1,216	1,930	678	105	193	1,427
1952	94.6	253	843	1,458	5,997	4,331	6,447	6,451	4,000	227	102	40.8	2,500
1953	37.1	119	2,214	2,232	3,816	6,997	2,626	22,310	4,892	1,270	546	496	3,993
1954	97.0	370	2,071	2,771	2,972	1,182	1,476	4,914	852	83.1	34.5	22.3	1,399
1955	142	2,592	1,056	1,860	4,640	3,632	7,193	2,981	679	418	1,948	554	2,284

Monthly and yearly runoff, in thousands of acre-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Yearly runoff
1903	------	------	------	------	------	------	------	------	------	221.0	87.90	14.40	------
1904	71.90	33.20	28.60	28.90	51.40	60.80	272.0	127.0	115.0	54.40	21.20	11.70	876.0
1905	6.40	6.37	123.7	170.0	349.0	453.4	574.0	1,189	629.9	816.2	254.5	26.20	4,599
1906	37.50	186.0	393.9	778.1	294.0	266.0	474.7	221.0	220.0	69.50	123.0	56.80	3,120
1907	83.00	25.50	245.0	351.0	84.40	197.0	118.0	499.0	443.0	57.30	9.90	5.09	2,120
1908	7.81	243.0	433.0	288.0	434.0	246.0	210.0	885.9	317.0	28.00	38.20	45.40	3,167
1909	32.40	20.10	50.60	50.80	150.0	132.0	66.60	31.20	26.80	6.82	3.91	2.68	574.0
1910	6.46	5.12	65.20	62.70	90.00	140.0	202.0	137.0	30.00	30.40	4.51	2.59	776.0
1911	2.08	2.11	6.00	19.20	19.30	30.90	199.0	124.0	7.86	62.10	11.50	5.00	489.0
1912	4.97	4.97	87.90	113.0	63.80	416.9	543.8	178.0	31.10	27.50	314.0	40.50	1,826
1913	6.00	5.62	13.80	50.70	96.60	416.0	223.0	65.80	26.10	231.0	11.90	127.0	1,270
1914	274.0	39.70	568.1	222.0	271.0	247.0	477.0	1,074	194.0	14.80	39.50	29.90	3,451
1915	14.60	17.90	188.0	382.0	472.1	469.0	249.9	981.0	75.00	133.0	384.3	275.0	3,642
1916	51.10	115.0	102.0	222.0	450.1	69.50	224.0	447.0	59.00	43.20	16.80	12.30	1,812
1917	8.12	23.20	43.00	73.20	134.0	125.0	79.70	53.40	66.60	71.90	26.30	37.50	742.0
1918	18.90	8.51	14.10	28.10	21.00	21.90	142.0	279.0	51.10	10.80	11.30	20.10	627.0
1919	12.10	68.40	196.0	402.0	277.0	259.0	221.0	110.0	136.0	282.0	223.0	137.0	2,320
1920	656.6	999.1	438.0	637.5	350.0	387.0	297.0	239.0	209.0	69.50	123.0	95.20	4,501
1921	49.20	71.40	153.7	385.8	225.3	322.8	648.5	532.7	122.8	225.8	20.21	15.00	2,773
1922	7.62	9.18	33.54	76.87	140.0	572.0	1,057	758.6	154.8	77.59	26.58	11.44	2,925
1923	5.94	40.95	33.17	68.74	343.2	380.8	445.7	194.1	153.2	29.18	5.33	52.45	1,753
1924	31.00	29.40	345.0	540.0	317.0	493.0	267.0	248.0	273.0	9.53	7.49	10.30	2,570
1925	7.63	5.93	13.30	50.50	29.00	33.30	29.60	112.0	13.00	4.82	2.91	5.95	308.0
1926	23.70	308.0	45.10	196.0	120.0	453.0	627.0	464.0	100.0	180.0	100.0	10.40	2,630
1927	16.20	30.40	182.0	290.0	295.0	545.0	684.0	367.0	107.0	93.20	77.30	7.01	2,690
1928	110.0	21.10	45.40	54.50	87.40	275.0	259.0	196.0	137.0	95.90	43.00	4.47	1,330
1929	11.70	86.30	287.0	579.0	326.0	334.0	169.0	307.0	444.0	35.20	4.92	20.10	2,600
1930	6.40	32.70	61.20	374.0	353.0	213.0	55.80	633.0	477.0	13.50	6.27	5.35	2,230
1931	30.70	28.00	188.0	184.0	134.0	310.0	127.0	239.0	45.00	22.30	11.30	9.76	1,330
1932	2.50	17.90	464.0	1,270	1,120	707.0	184.0	111.0	21.90	30.90	6.76	8.45	3,940
1933	5.85	6.13	44.50	430.0	293.0	460.0	363.0	311.0	129.0	352.0	139.0	24.20	2,560
1934	15.00	15.60	38.60	288.0	174.0	588.0	551.0	77.50	26.80	5.71	1.80	2.06	1,780
1935	2.45	39.42	165.6	177.3	379.6	185.0	127.5	1,075	319.2	164.8	12.58	13.91	2,662
1936	31.67	127.5	236.1	61.84	62.33	78.79	27.69	144.6	25.06	39.29	4.18	2.36	841.4
1937	64.17	35.88	82.63	484.1	276.1	407.8	251.5	39.82	23.83	7.52	6.35	9.96	1,690
1938	10.85	76.56	191.6	624.3	729.5	388.2	667.4	371.7	36.05	21.33	33.64	4.03	3,155
1939	2.52	24.34	28.30	236.2	361.0	408.0	139.6	79.78	29.21	12.88	2.36	1.39	1,326
1940	1.20	5.20	103.1	49.19	240.2	57.49	208.6	147.7	251.5	141.5	27.83	69.48	1,303

1941	13.73	423.8	976.9	774.9	305.4	571.6	264.4	533.5	494.8	411.3	45.26	60.59	4,876
1942	108.6	306.5	273.6	169.3	166.1	289.2	729.1	1,020	434.7	55.86	117.4	146.8	3,817
1943	30.63	54.42	72.84	252.5	79.26	95.80	184.7	95.56	743.3	94.68	8.04	4.89	1,717
1944	60.88	20.64	68.64	388.3	406.5	642.9	566.3	1,566	419.2	23.29	8.12	22.30	4,193
1945	8.63	33.92	224.2	899.1	335.9	1,316	2,048	174.0	298.8	582.3	57.54	18.34	5,997
1946	272.5	116.5	209.2	754.9	867.6	721.2	335.1	533.3	1,186	66.56	21.50	52.64	5,137
1947	35.17	667.9	422.3	477.0	271.3	460.4	468.5	327.1	80.99	46.38	8.71	35.77	3,320
1948	12.38	68.67	331.5	421.6	580.6	583.9	201.7	419.1	157.8	26.06	11.27	5.94	2,821
1949	5.65	21.43	33.70	191.7	355.2	439.2	268.3	220.2	102.0	121.8	90.08	33.07	1,882
1950	262.9	213.8	106.2	656.5	997.1	473.7	132.6	699.6	413.7	98.47	104.7	65.86	4,225
1951	32.42	32.14	30.42	94.40	237.6	236.6	120.3	74.76	114.9	41.70	6.45	11.47	1,033
1952	5.82	15.07	51.86	89.65	344.9	266.3	383.6	396.6	238	13.96	6.27	2.43	1,814
1953	2.28	7.07	136.1	143.4	211.9	430.2	156.2	1,372	291.1	78.07	33.57	29.51	2,891
1954	5.96	22.03	127.4	170.4	165.1	72.69	87.84	302.1	50.69	5.11	2.12	1.32	1,013
1955	8.76	154.3	64.94	114.4	257.7	223.3	428.0	183.3	40.38	25.7	119.8	32.99	1,654

Yearly discharge

Water year	Water-supply paper	Water year ending Sept. 30							Calendar year		
		Momentary maximum		Minimum day (cfs)	Mean (cfs)	Square mile	Runoff		Mean (cfs)	Runoff	
		Discharge (cfs)	Date				Inches	Acre-feet		Inches	Acre-feet
1903	850										
1904	850	6,090	Apr. 13, 1904		1,210	0.249	3.37	876,000	1,211	3.37	878,900
1905	850	33,600	May 26, 1905		6,352	1.31	17.74	4,599,000	7,017	19.60	5,080,000
1906	850	20,000	Jan. 5, 1906		4,311	.887	12.04	3,120,000	3,946	11.07	2,857,000
1907	850	10,800	May 31, 1907		2,930	.603	8.18	2,120,000	3,385	9.46	2,448,000
1908	850	30,100	May 18, 1908		4,366	.899	12.24	3,167,000	3,564	10.01	2,587,000
1909	850	6,330	Feb. 19, 20, 1909		792	.163	2.24	574,000	756	2.12	547,600
1910	850	7,540	May 24, 25, 1910		1,070	.220	3.00	776,000	980	2.75	709,400
1911	850	6,980	Apr. 29, May 4, 1911		675	.139	1.89	489,000	796	2.22	576,700
1912	850	16,200	Apr. 9, 1912		2,515	.518	7.06	1,826,000	2,415	6.77	1,754,000
1913	850	11,900	Mar. 18, 1913		1,760	.362	4.89	1,270,000	2,940	8.20	2,130,000
1914	850	36,000	May 10, 1914		4,767	.981	13.33	3,451,000	3,854	10.78	2,790,000
1915	850	47,000	May 5, 1915		5,030	1.04	14.05	3,642,000	5,096	14.24	3,689,000
1916	850	13,800	Feb. 3, 1916		2,497	.514	7.01	1,812,000	2,229	6.25	1,618,000
1917	850	5,100	Mar. 11, 12, 1917		1,030	.212	2.85	742,000	981	2.64	709,100
1918	850	8,890	May 11, 1918		865	.178	2.41	627,000	1,190	3.33	861,800
1919	850	10,700	Jan. 6, 1919		3,210	.661	8.96	2,320,000	5,720	15.97	4,141,000
1920	850	31,600	Jan. 27, 1920		6,200	1.28	17.37	4,501,000	3,690	10.35	2,682,000
1921	850	41,600	Apr. 29, 1921		3,830	.788	10.71	2,773,000	3,521	9.85	2,549,000
1922	850	32,800	Apr. 2, 1922		4,040	.832	11.35	2,925,000	4,080	11.46	2,955,000
1923	850	12,200	Apr. 8, 9, 1923		2,421	.498	6.75	1,753,000	2,870	8.00	2,078,000
1924	588	14,000	June 3, 4, 1924	43	3,540	.729	9.91	2,570,000	3,021	8.45	2,192,000
1925	608	3,100	May 25, 1925		425	.087	1.17	308,000	909	2.52	657,900
1926	628	23,000	Apr. 25, 1926	33	3,630	.747	10.13	2,630,000	3,425	9.56	2,479,000
1927	648	20,900	Apr. 19, 1927	60	3,720	.766	10.64	2,690,000	3,650	10.44	2,642,000
1928	668	9,860	Apr. 29, 1928	47	1,830	.377	5.12	1,330,000	2,117	5.92	1,537,000
1929	688	25,000	June 1, 1929	47	3,600	.741	10.06	2,600,000	3,206	8.97	2,320,000
1930	703	34,800	May 29, 1930	58	3,080	.634	8.60	2,230,000	3,286	9.16	2,378,000
1931	718	10,800	May 4, 1931	68	1,840	.379	5.13	1,330,000	2,164	6.04	1,567,000
1932	733	41,000	Feb. 23, 1932	34	5,420	1.12	15.17	3,940,000	4,829	13.52	3,516,000
1933	748			58	3,530	.727	9.86	2,560,000	3,550	9.92	2,570,000
1934	763	17,400	Mar. 8, 1934	23	2,470	.508	6.88	1,780,000	2,657	7.41	1,923,000
1935	788	36,000	May 8, 1935	34	3,678	.757	10.26	2,662,000	3,937	10.98	2,850,000

1936	808	8,400	Dec. 14, 1935	24	1,159	.238	3.25	841,400	866	6.88	628,800
1937	828	11,800	Jan. 29, 1937	24	2,334	.480	6.51	1,690,000	2,467	11.32	1,786,000
1938	858	25,700	Feb. 7, 1938	52	4,358	.897	12.19	3,155,000	4,049	5.32	2,931,000
1939	878	13,600	Mar. 4, 1939	16	1,831	.377	5.10	1,326,000	1,906	10.07	1,380,000
1940	898	8,060	Feb. 7, 1940	16	1,795	.369	5.04	1,303,000	3,592	10.07	2,608,000
1941	928	38,800	Nov. 27, 1940	94	6,735	1.39	18.82	4,876,000	5,733	16.02	4,150,000
1942	958	27,000	Apr. 24, 1942	144	5,273	1.09	14.74	3,817,000	4,540	12.69	3,286,000
1943	978	31,400	June 21, 1943	70	2,371	.488	6.63	1,717,000	2,361	6.59	1,709,000
1944	1008	34,300	May 6, 1944	74	5,776	1.19	16.18	4,193,000	5,937	16.64	4,310,000
1945	1038	92,000	Apr. 8, 1945	118	8,282	1.70	23.14	5,997,000	8,740	24.42	6,328,000
1946	1058	37,000	June 13, 1946	228	7,096	1.46	19.82	5,137,000	7,824	21.86	5,664,000
1947	1088	25,400	Nov. 22, 1946	106	4,585	.944	12.82	3,320,000	3,601	10.06	2,607,000
1948	1118	13,200	Feb. 15, 16, 1948	71	3,885	.800	10.88	2,821,000	3,401	9.52	2,469,000
1949	1148	9,380	Mar. 16, 1949	66	2,600	.535	7.26	1,882,000	3,321	9.28	2,404,000
1950	1178	28,900	Feb. 25, 1950	251	5,836	1.20	16.30	4,225,000	5,162	14.42	3,737,000
1951	1212	7,620	Feb. 22, 1951	59	1,427	.294	3.97	1,033,000	1,396	3.88	1,011,000
1952	1242	13,000	Feb. 17, 1952	36	2,500	.514	7.00	1,814,000	2,601	7.29	1,887,000
1953	1282	40,900	May 19, 1953	36	3,993	.822	11.15	2,891,000	4,007	11.17	2,901,000
1954	1342	11,500	May 18, 1954	18	1,399	.288	3.91	1,013,000	1,499	4.20	1,085,000
1955	1392	12,600	Apr. 18, 1955	28	2,284	.470	6.38	1,654,000			

BAYOU SAN PATRICIO NEAR NOBLE, LA.

Location.—Lat 31°43′15″, long 93°42′25″, in lot 38, T. 9 N., R. 13 W., in Sabine Parish, at bridge on U.S. Highway 171, 1.6 miles downstream from Kansas City Southern Railroad bridge and 2.5 miles northwest of Noble.

Drainage area.—154 sq mi.

Gage.—Wire-weight gage and crest-stage indicator; gage read twice daily. Datum of gage is 169.73 ft above mean sea level, datum of 1929, supplementary adjustment of 1941.

Extremes.—1951–55: Maximum discharge, 9,330 cfs Apr. 30, 1953 (gage height, 14.75 ft); no flow for many days in 1954, 1955.

Monthly and yearly mean discharge, in cubic feet per second

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1952	0.49	1.52	60.6	78.9	237	228	408	87.5	13.1	12.7	4.37	0.18	93.4
1953	.10	1.07	4.70	24.6	294	891	484	1,414	3.84	8.13	4.84	.54	262
1954	.14	.54	10.3	52.8	28.7	8.84	70.7	344	1.51	.04	0	0	43.5
1955	0	.02	.18	2.13	25.5	126	223	64.5	1.50	14.4	115	5.41	48.3

Monthly and yearly runoff, in acre-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Yearly runoff
1952	30	90	3,730	4,850	13,630	14,010	24,260	5,380	782	783	269	11	67,820
1953	6.1	63	289	1,510	16,300	54,760	28,790	86,960	229	500	298	32	189,700
1954	8.3	32	636	3,250	1,590	544	4,200	21,150	90	2.6	0	0	31,500
1955	0	1.2	11	131	1,420	7,770	13,290	3,970	89	883	7,090	322	35,000

Yearly discharge

Water year	Water-Supply Paper	Water year ending Sept. 30							Calendar year		
		Momentary maximum		Minimum day (cfs)	Mean (cfs)	Square mile	Runoff		Mean (cfs)	Runoff	
		Discharge (cfs)	Date				Inches	Acre-feet		Inches	Acre-feet
1952	1242	1,380	Apr. 14, 1952	0.1	93.4	0.606	8.26	67,820			
1953	1282	9,330	Apr. 30, 1953	.1	262	1.70	23.10	189,700	88.6	7.85	64.330
1954	1342	2,900	May 13, 1954	0	43.5	.282	3.84	31,500	263	23.14	190,100
1955	1392	1,200	Aug. 6, 1955	0	48.3	.314	4.26	35,000	42.6	3.75	30,800

BAYOU PIERRE NEAR GRAND BAYOU, LA.

Location.—Lat 32°04′40″, long 93°30′40″, in SE¼ sec. 29, T. 13 N., R. 11 W., at bridge on U.S. Highway 84, 2.8 miles west of Grand Bayou, Red River Parish, and 43.4 miles above mouth.

Supplemental records available.—Oct. 1946 to Nov. 1954, stage records and occasional discharge measurements in reports of Corps of Engineers, New Orleans District.

Drainage area.—674 sq. mi.

Gage.—Water-stage recorder. Datum of gage is 101.13 ft above mean sea level, datum of 1929 (levels by Corps of Engineers). Prior to July 15, 1952, staff gage at same site and datum.

Extremes.—1946–1954: Maximum stage, 30.8 ft May 19, 1953; minimum stage, 4.57 ft Sept. 5, 1954.

Monthly and yearly mean discharge, in cubic feet per second

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1952									358	51.5	50.2	30.5	
1953	15.9	19.0	71.6	277	1,370	2,360	625	4,540	236	64.2	105	70.0	467
1954	14.3	17.8	76.7	194	197	81.7	492	1,660	83.5	18.4	5.06	4.30	238

Monthly and yearly runoff, in acre-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Yearly runoff
1952									21,300	3,160	3,090	1,820	
1953	976	1,130	4,400	17,000	75,980	144,800	37,170	27,900	14,040	3,950	6,470	4,160	338,000
1954	879	1,060	4,720	11,940	10,940	5,020	29,310	102,000	4,970	1,130	311	256	172,500

Yearly discharge

[Data not previously published]

Water year	Water year ending Sept. 30							Calendar year		
	Momentary maximum		Minimum day (cfs)	Mean (cfs)	Square mile	Runoff		Mean (cfs)	Runoff	
	Discharge (cfs)	Date				Inches	Acre-feet		Inches	Acre-feet
1952										
1953			7.8	467	0.693	16.47	438,000	467	16.38	338,100
1954			3.0	238	.353	4.80	172,500			

CYPRESS BAYOU NEAR KEITHVILLE, LA.

Location.—Lat 32°18′00″, long 32°49′40″, in SW¼ sec. 8, T. 15 N., R. 14 W., at bridge on U.S. Highway 171, immediately downstream from Texas and Pacific Railroad bridge, 2 miles south of Keithville, Caddo Parish, and 6 miles upstream from mouth of Boggy Bayou.

Drainage area.—66 sq mi.

Gage.—Water-stage recorder. Datum of gage is 162.13 ft above mean sea level, datum of 1929, supplementary adjustment of 1941 (levels by Corps of Engineers). Prior to Dec. 28, 1929, staff gage at same site and datum.

Average discharge.—16 years (1939–55), 78.6 cfs.

Extremes.—1938–55: Maximum discharge, 23,700 cfs Aug. 3, 1955 (gage height, 13.62 ft), from rating curve extended above 8,000 cfs by logarithmic plotting and velocity-area studies; no flow during long periods.

Maximum stage known, 18.0 ft, from floodmarks, in 1933.

Monthly and yearly mean discharge, in cubic feet per second

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1939	----------	----------	7.87	99.7	394	38.1	10.1	31.9	2.53	1.13	0.161	0	----------
1940	0	0	142	36.0	255	31.0	197	45.9	77.2	10.4	32.7	.6	68.0
1941	.061	437	534	154	186	145	25.9	208	293	34.5	4.18	.897	168
1942	125	269	97.9	72.2	40.9	144	155	147	23.4	.787	.671	.600	89.8
1943	.03	.32	3.78	5.01	5.72	15.5	5.20	5.13	2.36	.12	0	0	3.60
1944	0	0	13.3	213	292	203	166	472	6.23	.60	.62	1.97	114
1945	0	2.87	115	286	119	325	119	58.8	2.54	96.9	1.66	.02	94.4
1946	100	24.4	72.4	649	346	277	45.0	210	107	2.39	.26	.58	152
1947	1.49	21.3	23.8	242	208	233	61.3	9.39	2.01	.23	.10	.02	66.2
1948	0	.93	29.0	144	278	73.4	24.5	96.4	.58	4.55	0	0	53.6
1949	0	3.64	24.7	209	94.4	62.6	48.2	7.21	26.2	9.45	2.06	5.46	40.9
1950	370	6.88	72.1	281	223	29.2	35.3	167	63.2	57.9	3.33	2.87	109
1951	5.04	5.84	4.46	34.6	150	111	21.7	5.48	1.97	.72	.05	1.33	27.7
1952	.20	1.81	126	65.5	223	124	112	62.7	2.41	.98	2.66	0	59.6
1953	0	.39	12.0	36.0	157	234	292	517	.53	.45	.07	0	104
1954	0	.10	4.67	47.6	15.9	5.06	53.0	196	.72	0	0	0	27.1
1955	0	.02	2.60	15.6	78.9	81.6	162	140	3.56	17.1	454	.18	80.0

Monthly and yearly runoff, in acre-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Yearly runoff
1939	----------	----------	484	6,130	21,910	2,340	599	1,960	151	69.4	9.92	0	----------
1940	0	0	8,750	2,220	14,670	1,910	11,750	2,820	4,590	639	2,010	34	49,390
1941	3.8	25,980	32,800	9,500	10,360	8,930	1,540	12,800	17,410	2,120	257	53	121,800
1942	7,660	15,990	6,020	4,440	2,270	8,830	9,220	9,050	1,390	48	41	36	65,000
1943	1.8	19	233	308	318	951	309	316	140	7.5	0	0	2,600
1944	0	0	819	13,080	16,820	12,460	9,860	29,000	371	37	38	117	82,600
1945	0	171	7,090	17,590	3,320	19,990	7,090	3,620	151	5,960	102	1.2	68,390

1946	6,180	1,450	4,450	39,880	19,210	17,030	2,680	12,920	6,350	147	16	35	110,300
1947	91	1,270	1,460	14,860	11,570	14,320	3,650	578	120	14	6.1	1.2	47,940
1948	0	55	1,780	8,870	15,990	4,510	1,460	5,930	35	280	0	0	38,910
1949	0	217	1,520	12,880	5,240	3,850	2,870	443	1,560	581	127	325	29,610
1950	22,750	410	4,430	17,300	12,360	1,800	2,100	10,270	3,760	3,560	205	171	79,120
1951	310	348	274	2,130	8,330	6,820	1,290	337	117	44	28	79	20,080
1952	12	108	7,770	4,030	12,820	7,620	6,660	3,860	143	60	164	0	43,250
1953	0	23	735	2,220	8,700	14,370	17,380	31,780	31	27	4.6	0	75,270
1954	0	6.1	287	2,930	882	311	3,150	12,040	43	0	0	0	19,650
1955	0	1.4	160	958	4,380	5,020	9,620	8,580	212	1,050	27,900	11	57,890

Yearly discharge

Water year	Water Supply Paper	Water year ending Sept. 30							Calendar year		
		Momentary maximum		Minimum day (cfs)	Mean (cfs)	Square mile	Runoff		Mean (cfs)	Runoff	
		Discharge (cfs)	Date				Inches	Acre-feet		Inches	Acre-feet
1939	877	7,720	Feb. 3, 1939	0	------	------	------	------	57.9	11.90	41,920
1940	897	5,170	Dec. 23, 1939	0	68.0	1.03	14.04	49,390	137	28.25	99,430
1941	927	8,050	Dec. 27, 1940	0	168	2.55	34.58	121,800	128	26.31	92,640
1942	957	6,970	Oct. 31, 1941	0	89.8	1.36	18.47	65,000	49.2	10.12	35,580
1943	977	220	May 31, 1943	0	3.60	.055	.75	2,600	4.38	.90	3,170
1944	1007	8,250	Apr. 30, 1944	0	114	1.73	23.47	82,600	123	25.30	89,040
1945	1037	7,050	Mar. 4, 1945	0	94.4	1.43	19.42	68,390	101	20.78	73,200
1946	1057	14,700	Jan. 5, 1946	0	152	2.30	31.34	110,300	140	28.72	101,100
1947	1087	4,840	Mar. 13, 1947	0	66.2	1.00	13.63	47,940	64.9	13.35	46,950
1948	1117	3,200	May 12, 1948	0	53.6	.812	11.05	38,910	53.5	11.01	38,810
1949	1147	3,200	Jan. 28, 1949	0	40.9	.620	8.41	29,610	76.6	15.76	55,470
1950	1177	8,010	Oct. 5, 1949	0.4	109	1.65	22.49	79,120	72.5	14.92	52,460
1951	1211	1,130	Mar. 28, 1951	0	27.7	.420	5.71	20,080	37.4	7.68	27,040
1952	1241	3,700	Feb. 12, 1952	0	59.6	.903	12.29	43,250	49.7	10.27	36,120
1953	1281	13,900	Apr. 29, 1953	0	104	1.58	21.38	75,270	103	21.25	74,810
1954	1341	7,450	May 12, 1954	0	27.1	.411	5.58	19,650	27.0	5.55	19,520
1955	1391	23,700	Aug. 3, 1955	0	80.0	1.21	16.45	57,890	------	------	------

BOGGY BAYOU NEAR KEITHVILLE, LA.

Location.—Lat 32°22′35″, long 93°49′20″, in NW¼SE¼ sec. 17, T. 16 N., R. 14 W., near right bank on downstream side of bridge on U.S. Highway 171, 0.4 mile downstream from Gilmer Bayou, 3 miles north of Keithville, Caddo Parish, and 5 miles upstream from mouth.

Drainage area.—79 sq mi.

Gage.—Water-stage recorder. Datum of gage is 145.13 ft above mean sea level, datum of 1929 (levels by Corps of Engineers). Prior to August 31, 1949, wire-weight gage: Jan. 19 to April 7, 1954 staff gage at same site and datum.

Average discharge.—16 years (1939–55), 90.4 cfs (65,450 acre-ft per year).

Extremes.—1938–55: Maximum discharge, 14,800 cfs Jan. 5, 1946 (gage height, 20.2 ft from graph based on gage readings), from rating curve extended above 5,200 cfs by velocity-area studies; no flow during long periods in most years.

Maximum stage known, 26.7 ft from floodmark, in 1933.

Monthly and yearly mean discharge, in cubic feet per second

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	The year
1939	------	------	20.5	397	684	51.0	6.32	48.0	2.50	0.56	0.57	0	------
1940	0	1.60	173	49.1	252	62.4	204	30.2	17.4	8.19	21.5	2.51	67.6
1941	.19	423	729	212	334	154	22.1	259	212	20.8	1.47	3.09	197
1942	53.5	314	126	51.1	65.0	191	252	321	26.0	.93	39.6	8.93	121
1943	.38	.96	7.64	10.7	9.34	45.1	17.8	2.38	4.11	.52	0	0	8.26
1944	0	.31	36.4	229	365	261	112	411	36.2	.11	.04	1.80	121
1945	0	3.61	148	476	199	578	246	72.3	2.15	87.1	4.87	.36	152
1946	297	47.3	215	900	459	335	58.3	393	153	4.89	1.80	1.08	239
1947	3.98	32.3	49.9	197	138	232	163	8.70	2.43	.19	0	.01	68.6
1948	0	1.47	10.5	104	288	85.1	26.5	72.3	1.22	1.23	0	0	48.3
1949	0	2.18	5.57	179	118	42.0	61.3	6.34	1.31	1.33	.62	4.54	34.7
1950	326	7.08	35.8	497	243	53.4	66.0	181	55.7	32.5	1.86	4.50	125
1951	3.98	5.71	4.72	35.7	189	85.3	29.9	5.23	8.39	.57	.05	.60	29.6
1952	.15	1.12	67.5	145	378	123	156	49.8	3.87	.43	.42	0	75.9
1953	0	.27	7.29	22.2	68.6	126	271	393	.75	.47	.12	0	74.3
1954	0	1.14	4.55	12.7	10.1	3.99	6.66	136	1.29	.08	0	0	14.9
1955	0	.98	4.55	19.3	85.8	75.1	160	203	23.7	6.17	243	.89	68.7

Monthly and yearly runoff, in acre-feet

Water year	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Yearly runoff
1939	----------	----------	1, 260	24, 430	37, 990	3, 130	376	2, 950	149	34	35	0	----------
1940	0	95	10, 610	3, 020	14, 510	3, 840	12, 120	1, 860	1, 040	503	1, 320	149	49, 070
1941	12	25, 160	44, 850	13, 050	18, 580	9, 470	1, 320	15, 930	12, 610	1, 280	90	184	142, 500
1942	3, 290	18, 710	7, 720	3, 140	3, 610	11, 730	14, 980	19, 720	1, 590	57	2, 430	531	87, 470
1943	23	57	470	660	519	2, 770	1, 060	146	245	32	0	0	5, 980
1944	0	18	2, 240	14, 080	21, 000	16, 030	6, 680	25, 250	2, 150	6. 9	2. 2	107	87, 560
1945	0	215	9, 090	29, 250	11, 040	35, 560	14, 660	4, 450	128	5, 350	300	22	110, 100
1946	18, 280	2, 820	13, 190	55, 340	35, 480	20, 600	3, 470	24, 170	9, 080	301	111	64	172, 900
1947	245	1, 920	3, 070	12, 140	7, 650	14, 250	9, 690	535	144	12	0	. 8	49, 660
1948	0	87	645	6, 390	16, 550	5, 230	1, 580	4, 450	73	75	0	0	35, 080
1949	0	130	343	11, 930	6, 530	2, 580	3, 650	390	78	82	38	270	25, 120
1950	20, 070	421	2, 200	30, 540	13, 470	3, 280	3, 920	11, 120	3, 310	2, 000	114	268	90, 710
1951	245	340	290	2, 200	10, 480	5, 240	1, 780	321	499	35	3. 0	36	21, 469
1952	9. 3	66	4, 150	8, 890	21, 770	7, 560	9, 290	3, 060	230	26	26	0	55, 077. 3
1963	0	16	448	1, 370	3, 810	7, 760	16, 120	24, 160	45	29	7. 1	0	53, 765. 1
1954	0	68	280	783	560	245	396	8, 350	77	4. 8	0	0	10, 763. 8
1955	0	58	280	1, 190	4, 770	4, 620	9, 550	12, 470	1, 410	379	14, 960	53	49, 740

Yearly discharge

Water year	Water-Supply Paper	Water year ending Sept. 30: Momentary maximum: Discharge (cfs)	Water year ending Sept. 30: Momentary maximum: Date	Water year ending Sept. 30: Minimum day (cfs)	Water year ending Sept. 30: Mean (cfs)	Water year ending Sept. 30: Square mile	Water year ending Sept. 30: Runoff: Inches	Water year ending Sept. 30: Runoff: Acre-feet	Calendar year: Mean (cfs)	Calendar year: Runoff: Inches	Calendar year: Runoff: Acre-feet
1939	877	----------	----------	0	----------	----------	----------	----------	110	18.95	79,800
1940	897, 1211	3,360	Dec. 23, 1939	0	67.6	.856	11.65	49,070	149	25.72	108,400
1941	927, 1211	8,380	Dec. 27, 1940	0	197	2.47	33.81	142,500	141	24.25	102,200
1942	957, 1211	8,370	May 18, 1942	0	121	1.53	20.77	87,470	80.5	13.85	58,300
1943	977, 1211	435	Mar. 26, 1943	0	8.26	.105	1.41	5,980	10.6	1.82	7,690
1944	1007, 1211	5,670	May 2, 1944	0	121	1.53	20.78	87,560	130	22.45	94,610
1945	1037, 1211	7,430	Mar. 4, 1945	0	152	1.92	26.12	110,100	189	29.45	136,800
1946	1057	14,800	Jan. 5, 1946	.3	239	3.03	41.05	172,900	199	34.16	143,900
1947	1087	4,030	Apr. 8, 1947	0	68.6	.868	11.79	49,660	62.4	10.71	45,150
1948	1117	1,610	Feb. 9, 1948	0	48.3	.611	8.33	35,080	48.0	8.27	34,820
1949	1147	1,610	Jan. 27, 1949	0	34.7	.439	5.96	25,120	65.4	11.23	47,340
1950	1177	5,100	Oct. 5, 1949	.1	125	1.58	21.53	90,710	95.2	16.36	68,897
1951	1211	845	Mar. 29, 1951	0	29.6	.375	5.10	21,469	34.3	5.90	24,819.3
1952	1241	6,930	Feb. 12, 1952	0	75.9	.961	13.08	55,077.3	70.7	12.19	51,316
1953	1281	7,320	Apr. 29, 1953	0	74.3	.941	12.75	53,765.1	74.1	12.73	53,649.1
1954	1341	2,780	May 12, 1954	0	14.9	.189	2.56	10,763.8	14.9	2.55	10,753.8
1955	1391	6,840	Aug. 4, 1955	0	68.7	.870	11.80	49,740	----------	----------	----------

TABLE 1.—*Suggested water-quality tolerances in industry*

[Allowable limits in parts per million except as indicated. After Moore (1940, p. 271)]

Industry or use	Turbidity	Color [1]	Hardness as $CaCO_3$	Iron as Fe	Manganese as Mn	Iron and manganese	Total solids	Alkalinity as $CaCO_3$	Odor taste	Hydrogen sulfide	Other requirements [2]
Air conditioning				0.5					Low		No corrosiveness, slime formation.
Baking	10	10		.2					do	0.2	Potable water.
Brewing:											
Light beer	1–10		200–300	0.1–1.0			500	75–80	do	.2	Potable water. NaCl less than 527 ppm (pH 6.5–7.0).
Dark beer	1–10		200–300	0.1–1.0			1,000	80–150	do	.2	Potable water. NaCl less than 275 ppm (pH 7.0 or more).
Canning:											
Legumes	10		25–75	.2	0.2	0.2			do	1	Potable water.
General	10			.2	.2	.2			do	1	Do.
Carbonated beverages	1–2	5–10	200–250	0.1–0.2	.2	.2	850–885	30–170	do	0–0.2	Potable water. Organic color units plus oxygen consumed in ppm should be less than 10.
Confectionery				.2	.2	.2	100		do	.2	Potable water. pH above 7.0 for hard candy.
Cooling	50		50	.5	.5	.5			do		No corrosiveness slime formation.
Food, general	10	10	50–85	0.2–0.3	.2	.2		30–250	do		Potable water.
Ice	1–5	5	70–72	0.03–0.2	.2	.2		30–50	do		Potable water. SiO_2 less shan 10 ppm.
Laundering (diapers)			0–50	.2	.2	.2		60			Potable water.
Plastics, clear uncolored				.02	.02	.02	200				
Paper and pulp:											
Groundwood	50	≤35	200	.3	0	1.0	500	150			No grit, corrosiveness.
Kraft pulp		≤25	100	.2	.1	.2	500	150			
Soda and sulfite		10	100	N.1	.05	.1	250	75			
High-grade light papers	5–25	≤5	100	.1	.05	.1	200	45–75			
Rayon (viscose), pulp production.		5	8	0–0.05	.03	.05	100–200				Al_2O_3 less than 8 ppm, SiO_2 less than 24 ppm, Cu less than 5 ppm.
Manufacture			50–55	0	0	0					pH 7.8 to 8.3.
Tanning	20	10–100	50–135	0.1–2.0	.2	.2		135			
Textiles: General dyeing		5–70			.25	.25					Constant composition. Residual alumina less than 0.5 ppm.
Wool scouring					1.0	1.0					
Cotton bandage					.2	.2			Low		

[1] Hazen scale units. [2] Portable water, as used here, conforms to U.S. Public Health Service standards (U.S. Public Health Service, 1946).

TABLE 2.—*Miscellaneous low-flow measurements*

[Discharge, in cubic feet per second. Asterisk indicates no flow]

Date of measurement	Measured discharge at low-flow station	Concurrent gaging-station discharge: 5. Cypress Bayou near Keithville, La. (drainage area, 66 sq mi)	Concurrent gaging-station discharge: 16. Bayou San Patricio near Noble, La. (drainage area, 154 sq mi)
	6. Rambin Bayou near Frierson, La. (drainage area, 59.6 sq mi)		
Aug. 20, 1954	(*)	(*)	(*)
Sept. 22	(*)	(*)	(*)
Oct. 21	(*)	(*)	(*)
Nov. 19	(*)	(*)	(*)
Dec. 7	(*)	(*)	(*)
Aug. 16, 1955	2.21	2.0	4.5
Nov. 8	[1] .02	(*)	.2
Apr. 4, 1956	6.66	6.5	17.4
Aug. 15	(*)	(*)	(*)
Dec. 4	(*)	(*)	[1] .02
	7. Bushneck Bayou near Longstreet, La. (drainage area, 26.9 sq mi)		
Oct. 17, 1955	.045	.1	9.9
Dec. 9	.06	.8	4.7
Jan. 4, 1956	[1] .02	.9	1.0
Apr. 4	2.22	6.5	17.4
Aug. 15	(*)	(*)	(*)
Dec. 4	(*)	(*)	[1] .02
	8. Bayou Castor near Longstreet, La. (drainage area, 27.7 sq mi)		
Oct. 17, 1955	.045	.1	9.9
Dec. 9	.06	.8	.2
Jan. 4, 1956	[1] .02	.9	1.0
Apr. 4	2.22	6.5	17.4
Aug. 15	(*)	(*)	(*)
Dec. 4	(*)	(*)	[1] .02
	10. Buffalo Bayou near Naborton, La. (drainage area, 17.7 sq mi)		
Sept. 26, 1956	(*)	(*)	(*)
Dec. 3	(*)	(*)	[1] .02
	12. Bayou Grand Cane near Logansport, La. (drainage area, 76.5 sq mi)		
Aug. 16, 1955	3.41	2.0	4.5
Sept. 22	.096	(*)	2.7
Oct. 17	(*)	.1	9.9
Apr. 3, 1956	6.32	6.9	16.6
Aug. 15	(*)	(*)	(*)
Dec. 3	(*)	(*)	[1] .02

[1] Discharge estimated.

TABLE 2.—*Miscellaneous low-flow measurements*—Continued

[Discharge, in cubic feet per second. Asterisk indicates no flow]

Date of measurement	Measured discharge at low-flow station	Concurrent gaging-station discharge: 5. Cypress Bayou near Keithville, La. (drainage area, 66 sq mi)	Concurrent gaging-station discharge: 16. Bayou San Patricio near Noble, La. (drainage area, 154 sq mi)
	13. Clement Creek near Hunter, La. (drainage area, 44.6 sq mi)		
Sept. 26, 1956	(*)	(*)	(*)
Dec. 3	.040	(*)	[1] .02
	14. Bayou San Patricio near Benson, La. (drainage area, 81.1 sq mi)		
Sept. 29, 1954	(*)	(*)	(*)
Aug. 14, 1955	4.16	10	6.8
Sept. 22	[1] .2	(*)	2.7
Apr. 4, 1956	6.29	6.5	17.4
Aug. 15	(*)	(*)	(*)
Dec. 3	(*)	(*)	[1] .02

[1] Discharge estimated.

TABLE 3.—*Maximum stages and discharges for each water year for period of record for Sabine River at Logansport, La.*

Water year	Date	Gage height (feet)	Water-surface elevation above mean sea level (feet)	Discharge (cfs)
1884	May	39.4	187.1	60,000
1904	Apr. 13	18.6	166.3	6,090
1905	May 26	33.8	181.5	33,600
1906	Jan. 5	29.6	177.3	20,000
1907	May 31	24.5	172.2	10,800
1908	May 18	32.9	180.6	30,100
1909	Feb. 19, 20	19.0	166.7	6,330
1910	Mar. 24, 25	20.8	168.5	7,540
1911	Apr. 29	20.0	167.7	6,980
1912	Apr. 9	27.7	175.4	16,200
1913	Mar. 18	25.5	173.2	11,909
1914	May 10	34.4	182.1	36,000
1915	May 5	36.9	184.6	47,000
1916	Feb. 3	26.4	174.1	13,800
1917	Mar. 11, 12	16.8	164.5	5,100
1918	May 11	22.5	170.2	8,890
1919	Jan. 6	24.4	172.1	10,700
1920	Jan. 27	33.3	181.0	31,600
1921	Apr. 29	35.7	183.4	41,600
1922	Apr. 2	33.6	181.3	32,800
1923	Apr. 8	25.9	173.6	12,200
1924	Dec. 26	27.2	174.9	[1] 14,000
1925	May 25	12.24	159.96	3,100
1926	Apr. 25	29.6	177.3	23,000
1927	Apr. 19	29.1	176.8	20,900
1928	Apr. 29	22.4	170.1	9,860
1929	June 1	(2)		25,000
1930	May 29	34.1	181.8	34,800
1931	May 4	24.6	172.3	10,800
1932	Feb. 23	35.6	183.3	41,100
1933	July 25	34.6	182.3	[3] 29,400
1934	Mar. 8	28.4	176.1	17,400
1935	May 8	34.4	182.1	36,000
1936	Dec. 14	21.7	169.4	8,400
1937	Jan. 29	24.6	172.3	11,800
1938	Feb. 7	31.36	179.08	25,700
1939	Mar. 4	25.98	173.70	13,600
1940	Feb. 11	23.28	171.00	[4] 8,060
1941	Nov. 27	35.91	183.63	38,800
1942	Apr. 24	31.98	179.70	27,000
1943	June 21	33.40	181.12	31,400
1944	May 6	35.05	182.77	34,300
1945	Apr. 8	44.07	191.79	92,000
1946	June 13	35.15	182.87	37,000
1947	Nov. 22	32.17	179.89	25,400
1948	Feb. 15, 16	25.16	172.88	13,200
1949	Mar. 16	21.08	168.80	9,380
1950	Feb. 25	32.70	180.42	28,900
1951	Feb. 22	18.75	166.47	7,620
1952	Feb. 17	24.00	171.72	13,000
1953	May 19	35.98	183.70	40,900
1954	May 18	23.47	171.19	11,500
1955	Apr. 18	24.60	172.32	12,600

[1] Occurred June 3, 4, 1924, gage height, 26.90 ft.
[2] No gage height record; discharge computed on basis of record for stations near Longview and near Bon Wier.
[3] Occurred July 27, gage height, 32.7 ft.
[4] Occurred Feb. 7, gage height, 20.57 ft.

TABLE 4.—*Chemical analyses of Sabine River near Tatum, Tex., water year 1954*

[Chemical analyses, in parts per million, except as indicated. Percent sodium includes sodium plus potassium. Analyses by U.S. Geol. Survey]

Location.—At gaging station at bridge on State Highway 43, 5 miles upstream from Potters Creek, 5.2 miles northeast of Tatum, Rusk County, 7 miles downstream from Cherokee Bayou, and at mile 339.

Drainage area.—3,586 square miles.

Records available.—Chemical analyses: February 1952 to September 1954.

Water temperatures: February 1952 to September 1954.

Extremes, 1953–54.—Dissolved solids: Maximum, 682 ppm Dec. 7–10, 13; minimum, 178 ppm Jan. 22–31.

Hardness: Maximum, 106 ppm Sept. 1–10; minimum, 39 ppm May 12–23.

Specific conductance: Maximum daily, 1,200 micromhos Dec. 7–10; minimum daily, 187 micromhos May 15.

Water temperatures: Maximum observed, 95°F July 7, 13; minimum observed, 45°F on several days during December and January.

Extremes, 1952–54.—Dissolved solids: Maximum, 682 ppm Dec. 7–10, 13, 1953; minimum, 82 ppm May 10–20, 1953.

Hardness: Maximum, 106 ppm Sept. 1–10, 1954; minimum, 29 ppm Sept. 9–10, 12–18, 1953.

Specific conductance: Maximum daily, 1,200 micromhos Dec. 7–10, 1953; minimum daily, 123 micromhos May 10–11, 1953.

Water temperatures: Maximum observed, 95°F July 7, 13, 1954; minimum observed, 45°F on several days during December 1953 and January 1954.

Remarks.—Records of specific conductance of daily samples available in district office at Austin, Tex. Records of discharge for water year October 1953 to September 1954 given in Water-Supply Paper 1242.

TABLE 4.—*Chemical analyses of Sabine River near Tatum, Tex., water year 1954*—Continued

[Chemical analyses, in parts per million, except as indicated. Percent sodium includes sodium plus potassium. Analyses by U.S. Geol. Survey]

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180°C): Parts per million	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Percent sodium	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
1953																			
Oct. 1-11	91.4	15	16	6.0	126		38	16	205	1.5	432	0.59	107	64	34	81	6.8	786	7.2
Oct. 12-23, 27-28	80.6	14	15	5.8	105		47	18	165	0.8	367	.50	79.9	62	23	79	5.8	664	7.5
Oct. 24-26, 29-31	126	13	18	6.9	144		47	19	232	1.0	470	.64	160	74	35	81	7.3	869	7.3
Nov. 1-7, 20-23	360	11	17	6.0	144		40	19	232	1.2	480	.65	467	67	34	82	7.7	802	7.0
Nov. 8-11, 14-19	289	14	12	4.6	66		32	17	104	1.0	255	.35	199	49	23	74	4.1	446	7.0
Nov. 12-13, 24-30	520	14	14	5.0	78		29	18	129	1.2	302	.41	424	56	32	75	4.6	524	6.8
Dec. 1-5, 18-19, 29-31	1,401	18	14	4.6	78		25	25	125	1.2	318	.43	1,200	54	33	76	4.6	521	6.8
Dec. 6, 11-12, 14-17, 20-28	1,944	17	14	4.1	42		30	22	67	1.0	228	.31	1,200	52	27	64	2.5	323	7.0
Dec. 7-10, 13	1,956	18	20	4.9	207		18	38	330	.8	682	.93	3,600	70	56	87	11	1,200	6.6
1954																			
Jan. 1-15	815	28	16	5.2	77		18	34	126	1.2	301	.41	662	61	47	73	4.3	529	6.8
Jan. 16-21	3,247	18	13	4.5	52		12	30	86	1.2	236	.32	2,070	51	41	69	3.2	381	6.9
Jan. 22-31	4,639	17	11	3.2	28		26	21	40	1.5	178	.24	2,230	41	19	60	1.9	225	7.2
Feb. 1-9	3,608	23	19	5.3	43		46	34	62	2.0	230	.31	2,240	69	32	57	2.2	358	7.5
Feb. 10-25	1,239	24	17	6.4	64		28	39	102	1.2	287	.39	960	69	46	67	3.4	479	7.4
Feb. 26-28, Mar. 1-5	2,046	18	14	4.9	45		28	33	67	2.2	231	.31	1,280	55	32	64	2.7	346	7.2
Mar. 6-15	652	28	16	6.4	64		26	35	104	1.5	281	.38	495	66	45	68	3.4	476	7.2
Mar. 16-23	613	23	16	6.8	72		25	37	117	1.8	310	.42	513	68	47	70	3.8	512	7.2
Mar. 24-31	694	23	17	7.4	71		23	39	118	1.0	314	.43	588	73	54	68	3.6	529	7.2
Apr. 1-15	588	18	20	8.2	95		29	46	154	1.0	380	.52	603	84	60	71	4.5	665	7.2
Apr. 16-19, 26-30	1,141	19	21	5.9	55		1	35	83	2.0	263	.36	810	77	35	61	2.7	440	7.3
Apr. 20-25	2,253	17	20	4.5	32		64	26	40	3.0	197	.27	1,200	68	16	51	1.7	296	7.5
May 1-11	1,095	20	14	4.1	56		33	24	84	2.5	236	.32	698	52	25	70	3.3	399	7.4
May 12-23	4,520	15	11	2.8	37		25	20	54	3.5	192	.26	2,340	39	18	68	2.6	274	7.3

May 24–31	1,926	20	18	3.7	46	51	20	67	3.0	210	.29	1,090	60	18	62	2.6	346	7.8
June 1–10	1,108	22	15	5.1	54	38	22	85	1.5	226	.31	676	58	27	67	3.0	390	7.1
June 11–22	430	24	25	5.3	52	86	20	74	1.5	244	.33	283	84	14	57	2.5	432	7.7
June 23–30	113	23	26	6.7	88	84	18	139	0.5	348	.47	106	92	24	67	4.0	641	7.6
July 1–10	53.5	24	25	7.3	100	91	11	158	1.8	398	.54	57.5	92	18	70	4.5	694	7.7
July 11–20	30.0	22	24	8.0	111	96	8.4	174	2.0	420	.57	34.0	93	14	72	5.0	747	7.7
July 21–31	27.5	21	25	8.1	123	99	6.4	195	1.5	460	.63	34.1	96	15	74	5.5	825	7.6
Aug. 1–10	22.6	19	23	7.2	116	93	13	176	1.5	416	.57	25.4	87	11	74	5.4	761	7.8
Aug. 11–20	14.1	15	23	7.2	117	92	16	176	.8	416	.57	15.8	87	12	74	5.4	764	7.9
Aug. 21–31	13.9	14	24	8.2	138	95	15	212	1.0	469	.64	17.6	94	16	76	6.2	864	7.6
Sept. 1–10	10.8	18	28	8.7	163	98	12	260	2.0	553	.75	16.1	106	26	77	6.9	1,060	8.1
Sept. 11–20	11.1	16	27	8.6	158	100	13	248	1.8	526	.72	15.8	103	21	77	6.8	1,020	8.1
Sept. 21–30	10.3	14	25	8.4	153	108	9.7	235	.8	509	.69	14.2	97	8	77	6.8	984	8.1
Weighted averages	1,004	19	15	4.6	55	32	27	85	1.9	252	0.34	683	56	30	68	3.2	398	----

TABLE 5.—*Chemical Analyses of Sabine River near Tatum, Tex., water year 1955*

[Chemical analyses, in parts per million, except as indicated. Percent sodium includes sodium plus potassium. Analyses by U.S. Geol. Survey]

Location.—At gaging station at bridge on State Highway 43, 5 miles upstream from Potter's Creek, 5.2 miles northeast of Tatum, Rusk County, 7 miles downstream from Cherokee Bayou, and at mile 339.

Drainage area.—3,586 square miles.

Records available.—Chemical analyses: February 1952 to September 1955.

Water temperatures: February 1952 to September 1955.

Extremes, 1954–55.—Dissolved solids: Maximum, 823 ppm Oct. 16–25; minimum, 119 ppm Oct. 31, Nov. 1–8, 12–15.

Hardness: Maximum, 94 ppm Oct. 16–25; minimum, 32 ppm Sept. 3–4, 7–13.

Specific conductance: Maximum daily, 1,850 micromhos Oct. 25; minimum daily, 154 micromhos Nov. 4.

Water temperatures: Maximum observed, 90°F July 7–11; minimum observed, 45°F Mar. 26–28.

Extremes, 1952–55.—Dissolved solids: Maximum, 823 ppm Oct. 16–25, 1954; minimum, 82 ppm May 10–20, 1953.

Hardness: Maximum, 106 ppm Sept. 1–10, 1954; minimum, 29 ppm Sept. 9–10, 12–18, 1953.

Specific conductance: Maximum daily, 1,850 micromhos Oct. 25, 1954; minimum daily, 123 micromhos May 10–11, 1953.

Water temperatures: Maximum observed, 95°F July 7, 13, 1954; minimum, observed, 45°F on several days during winter months.

Remarks.—Records of specific conductance of daily samples available in district office at Austin, Tex. Records of discharge for water year October 1954 to September 1955 given in Water-Supply Paper 1392.

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na) and Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180°C): Parts per million	Dissolved solids: Tons per acre-foot	Dissolved solids: Tons per day	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Percent sodium	Sodium adsorption ratio	Specific conductance (micromhos at 25°C)	pH
1954																		
Oct. 1–15	27.3	12	22	7.1	174	121	7.9	252	0.8	[1] 536	0.73	39.5	84	0	82	8.3	1,020	7.7
Oct. 16–25	80.0	7.8	24	8.4	262	69	20	415	1.0	823	1.12	178	94	38	86	12	1,510	7.8
Oct. 26–30	916	8.8	17	5.7	124	26	30	199	2.8	446	.61	1,100	66	44	80	6.6	787	6.8
Oct. 31, Nov. 1–8, 12–15	3,200	11	13	2.1	25	37	15	33	2.0	[1] 119	.16	1,030	40	10	57	1.7	211	7.2
Nov. 9–11, 16–26	2,057	13	14	3.4	54	28	24	84	1.2	231	.31	1,280	50	27	70	3.3	381	7.3
Nov. 27–30	408	16	18	4.8	77	31	29	124	3.0	294	.40	324	65	40	72	4.2	523	7.3
Dec. 1–10	250	20	25	5.2	122	28	38	202	2.0	461	.63	311	83	60	76	5.8	803	6.7
Dec. 11–12, 15–20, 25–31	802	18	18	4.5	81	17	36	133	1.5	326	.44	706	63	49	74	4.5	553	6.4
Dec. 13–14, 21–24	841	16	20	4.9	105	16	37	175	.8	399	.54	906	70	57	77	5.5	686	6.4

1955																		
Jan. 1-3, 8-11	527	20	17	7.1	97	18	43	158	1.2	386	.52	549	72	58	75	5.0	658	6.9
Jan. 4-7, 12-20	992	18	15	6.8	84	16	41	136	1.2	342	.47	916	66	53	73	4.5	582	6.8
Jan. 21-31	1,398	17	16	6.2	71	18	44	112	1.2	304	.41	1,150	65	50	70	3.8	509	7.0
Feb. 1-8	2,168	16	13	4.5	53	15	28	87	1.0	236	.32	1,380	50	38	70	3.3	387	6.7
Feb. 9-19	3,193	14	15	4.0	36	31	29	53	2.5	[1] 168	.23	1,450	55	30	58	2.1	302	7.0
Feb. 20-28	3,422	16	14	4.7	49	15	32	81	1.0	228	.31	1,490	54	42	66	2.9	375	6.7
Mar. 1-9	1,308	17	17	5.5	56	30	37	87	2.0	255	.35	901	65	40	65	3.0	426	7.3
Mar. 10-19	637	20	18	6.9	87	22	42	141	1.8	352	.48	605	73	55	72	4.4	608	7.1
Mar. 20-31	4,723	10	9.5	3.0	35	15	19	55	1.8	178	.24	2,270	36	24	68	2.5	263	7.0
Apr. 1-10	3,339	15	15	4.4	46	35	31	67	1.0	229	.31	2,060	56	27	64	2.7	343	7.3
Apr. 11-20	4,845	15	12	3.9	35	23	26	52	1.0	187	.25	2,450	45	26	63	2.2	272	7.0
Apr. 21-29	4,053	16	14	4.1	31	43	21	44	1.5	187	.25	2,050	53	18	56	1.9	271	7.2
Apr. 30, May 1-10	626	22	18	6.5	68	36	31	111	2.0	302	.41	510	71	42	68	3.5	515	7.4
May 11-22	464	20	17	6.7	90	35	28	147	1.5	352	.48	441	71	42	73	4.6	607	7.1
May 23-27	2,618	12	9.1	3.0	31	19	17	48	1.5	157	.21	1,110	35	19	66	2.3	235	7.0
May 28-31	1,298	16	16	5.3	74	31	25	119	2.0	307	.42	1,080	61	36	72	4.1	511	7.1
June 1-7	558	22	17	5.2	49	47	24	75	2.8	238	.32	359	64	26	63	2.7	390	7.5
June 8-17	282	22	19	6.6	98	46	28	157	1.5	374	.51	285	75	38	74	4.9	650	7.5
June 18-23	258	19	17	5.2	72	48	20	112	1.8	290	.39	202	64	25	71	3.9	503	7.4
June 24-30	188	17	21	7.1	134	51	19	220	1.0	475	.65	241	81	39	78	6.5	858	7.3
July 1-10	93.2	18	18	5.6	98	59	16	153	1.0	340	.46	85.6	68	20	76	5.2	643	7.9
July 11-18	229	15	16	5.3	118	42	15	189	1.2	389	.53	241	62	28	80	6.5	730	7.1
July 19-31	377	15	13	4.5	74	32	18	117	1.2	274	.37	279	50	24	76	4.6	487	7.1
Aug. 1-13	452	13	14	3.4	75	28	16	121	1.8	274	.37	334	48	25	77	4.7	499	7.1
Aug. 14-16, 23-26	235	14	20	7.0	181	38	21	298	1.8	580	.79	368	80	49	83	8.8	1,110	7.5
Aug. 17-22, 27-31	214	16	13	4.9	73	39	19	112	1.2	264	.36	153	53	21	75	4.3	493	7.3
Sept. 1-2, 5-6	1,028	13	14	3.8	192	27	20	145	2.0	332	.45	922	50	28	80	5.6	575	7.0
Sept. 3-4, 7-13	670	14	8.9	2.4	37	27	13	53	2.5	[1] 144	.20	260	32	10	72	2.8	254	7.3
Sept. 14-16, 26-30	601	12	11	3.4	58	28	14	90	2.0	229	.31	372	41	18	75	3.9	380	7.1
Sept. 17-25	171	13	15	4.3	89	38	16	141	1.5	322	.44	149	55	24	78	5.2	571	7.4
Weighted averages	1,291	14	14	4.1	51	29	26	79	1.6	226	.31	788	52	28	68	3.1	370	----

[1] Sum of determined constituents.

TABLE 6.—*Chemical analyses of Sabine River near Ruliff, Tex., water year 1954*

[Chemical analyses, in parts per million, except as indicated. Percent sodium includes sodium plus potassium. Analyses by U.S. Geol. Survey]

Location.—At gaging station at bridge on State Highway 235, 2.4 miles north of Ruliff, Newton County, 4.2 miles upstream from Kansas City-Southern Railway bridge, 4.5 miles downstream from Cypress Creek and at mile 40.

Drainage area.—9,440 square miles.

Records available.—Chemical analyses: October 1945 to September 1946, October 1947 to September 1954.

Water temperatures: October 1947 to September 1954.

Extremes, 1953–54.—Dissolved solids: Maximum, 326 ppm Dec. 16–22; minimum, 57 ppm May 4–10, 15.

Hardness: Maximum, 52 ppm Dec. 16–22; minimum, 16 ppm May 4–10, 15.

Specific conductance: Maximum daily, 588 micromhos Dec. 21; minimum daily, 61.6 micromhos May 6.

Water temperatures: Maximum opserved, 89°F June 9; minimum observed, 50° F Jan. 20–23.

Extremes, 1945–46, 1947–54.—Dissolved solids: Maximum, 411 ppm Dec. 26–27, 1948; minimum, 35 ppm June 5–11, 1950.

Hardness: Maximum, 64 ppm Aug. 1, 11, 16–19, 21–23, 1948; minimum, 8 ppm May 20–24, 1953.

Specific conductance: Maximum daily, 774 micromhos Dec. 26, 1948; minimum daily, 32.9 micromhos May 22, 1953.

Water temperatures (1947–54): Maximum observed, 95°F Aug. 12, 1953; minimum observed, 34°F Jan. 24, 1948.

Remarks.—Records of specific conductance of daily samples available in district office at Austin, Tex. Records of discharge for water year October 1953 to September 1954 given in Water-Supply Paper 1342.

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180 °C)			Hardness as $CaCO_3$		Percent sodium	Sodium adsorption ratio	Specific conductance (micromhos at 25 °C)	pH
											Parts per million	Tons per acre-foot	Tons per day	Calcium, magnesium	Noncarbonate				
1953																			
Oct. 1–2, 10–20	9,784	23	7.3	3.0	29		36	6.7	40	1.0	134	0.18	3,540	30	1	68	2.3	211	7.2
Oct. 3–9	1,141	21	9.1	3.3	54		32	8.6	83	0.5	196	.27	604	36	10	76	3.9	346	7.1
Oct. 21–31	9,192	22	6.5	2.5	24		34	5.7	31	1.2	114	.16	2,830	26	0	66	2.0	178	7.0
Nov. 1–10	1,001	20	6.4	2.4	28		31	6.1	38	1.2	139	.19	376	26	0	70	2.4	193	6.9
Nov. 11–20	1,067	21	6.9	2.8	37		33	6.6	53	.5	147	.20	423	28	2	74	3.0	247	7.1
Nov. 21–30	1,419	20	6.9	2.8	41		32	8.4	59	.2	156	.21	598	28	2	76	3.3	266	6.9
Dec. 1–15	4,799	11	7.0	2.5	29		18	11	46	1.5	146	.20	1,890	28	14	70	2.4	219	6.9
Dec. 16–22	4,977	14	13	4.9	86		18	25	141	1.0	326	.44	4,380	52	38	78	5.2	543	6.6
Dec. 23–31	5,233	13	8.2	2.8	21		22	14	31	1.5	[1] 102	.14	1,440	32	14	58	1.6	182	6.6

1954																		
Jan. 1-11	5,112	14	7.0	2.5	20	18	13	31	.8	[1] 97	.13	1,340	28	14	61	1.7	186	7.2
Jan. 12-14, 18-23	6,182	15	7.7	3.8	37	16	21	56	1.0	[1] 150	.20	2,500	34	22	70	2.7	278	6.8
Jan. 24-31	7,670	13	8.0	3.7	30	14	22	46	.8	[1] 130	.18	2,690	35	24	65	2.2	243	7.1
Feb. 1-8	7,972	12	9.7	3.7	26	26	20	36	1.0	[1] 121	.16	2,600	39	18	59	1.8	218	7.1
Feb. 9-18	5,990	15	13	4.1	30	31	26	44	1.2	[1] 148	.20	2,390	50	24	57	1.9	269	7.2
Feb. 19-28	3,750	16	12	4.5	35	32	25	51	.8	[1] 160	.22	1,620	48	22	61	2.2	288	7.3
Mar. 1-9	4,444	16	11	4.8	39	23	26	61	.8	201	.27	2,410	47	28	65	2.5	305	7.2
Mar. 10-20	2,754	19	11	4.8	27	30	21	42	1.0	170	.23	1,260	47	22	56	1.7	245	7.2
Mar. 21-31	2,433	20	11	4.2	36	32	20	54	1.5	177	.24	1,160	45	19	64	2.4	286	7.2
Apr. 1-10	2,229	18	11	5.0	38	34	21	57	.5	182	.25	1,100	48	20	63	2.4	305	7.3
Apr. 11-16, 26-30	4,071	14	9.8	4.3	39	27	24	56	.5	176	.24	1,930	42	20	67	2.6	285	7.0
Apr. 17-25	1,281	9.0	5.0	1.8	20	17	11	26	.5	[1] 81	.11	280	20	6	68	1.9	145	6.6
May 1-3, 11-14, 16-20	12,550	11	5.4	2.2	17	12	10	26	3.5	[1] 81	.11	2,740	22	12	62	1.6	133	6.4
May 4-10, 15	20,380	9.6	3.8	1.7	11	12	6.4	16	2.5	[1] 57	.08	3,140	16	6	60	1.2	84	6.4
May 21-31	15,640	12	6.2	2.2	17	14	12	26	1.8	[1] 84	.11	3,550	24	13	60	1.5	138	6.5
June 1-10	6,428	20	10	3.0	25	37	14	31	2.8	136	.18	2,360	38	7	59	1.7	201	7.4
June 11-20	2,830	24	11	2.1	40	39	15	52	1.5	182	.25	1,390	36	4	70	2.9	273	7.3
June 21-30	1,759	24	11	4.0	34	42	14	49	1.2	161	.22	765	44	10	63	2.3	272	7.2
July 1-10	1,039	22	11	4.5	32	50	12	44	1.2	159	.22	446	46	5	61	2.1	269	7.6
July 11-20	749	22	11	4.3	30	53	9.2	39	2.5	153	.21	309	45	2	59	1.9	243	7.4
July 21-31	601	21	10	4.2	31	51	8.4	40	2.5	149	.20	242	42	0	61	2.1	243	7.2
Aug. 1-10	693	20	9.0	3.2	29	44	7.2	38	.8	[1] 129	.18	241	36	0	64	2.1	223	7.0
Aug. 11-20	438	20	9.4	3.4	30	48	7.5	38	1.0	[1] 133	.18	157	38	0	63	2.1	223	6.9
Aug. 21-31	421	20	9.1	3.2	30	47	6.7	38	1.0	134	.18	152	36	0	64	2.2	225	6.9
Sept. 1-10	371	21	8.8	3.3	32	48	6.1	42	1.0	141	.19	141	36	0	67	2.4	231	7.4
Sept. 11-20	344	22	8.8	3.3	34	48	6.1	44	1.0	147	.20	137	36	0	67	2.5	242	7.5
Sept. 21-30	329	20	7.1	2.8	33	49	5.4	39	1.0	138	.19	123	29	0	71	2.7	225	7.7
Weighted average	4,097	14	8.3	2.9	26	22	14	38	1.6	121	.16	1,340	32	14	63	2.0	202	----

[1] Sum of determined constitutents.

TABLE 7.—*Chemical analyses of Sabine River near Ruliff, Tex., water year 1955*

[Chemical analyses, in parts per million, except as indicated. Percent sodium includes sodium plus potassium. Analyses by U.S. Geol. Survey]

Location.—At gaging station at bridge on State Highway 235, 2.4 miles north of Ruliff, Newton County, 4.2 miles upstream from Kansas City Southern Railway bridge, 4.5 miles downstream from Cypress Creek and at mile 40.

Drainage area.—9,440 square miles.

Records available.—Chemical analyses: October 1945 to September 1946, October 1947 to September 1955.

Water temperatures: October 1947 to September 1955.

Extremes 1954–55.—Dissolved solids: Maximum, 318 ppm Dec. 21–22; minimum, 37 ppm Aug. 5–13.

Hardness: Maximum, 65 ppm Dec. 21–22; minimum, 10 ppm May 22.

Specific conductance: Maximum daily, 612 micromhos Aug. 9.

Water temperatures: Maximum observed, 88°F July 11–12, 24; minimum observed, 42°F Jan. 31, Feb. 13.

Extremes, 1945–46, 1947–55.—Dissolved solids: Maximum, 411 ppm Dec. 26–27, 1948; minimum, 35 ppm June 5–11, 1950.

Hardness: Maximum, 65 ppm Dec. 21–22, 1954; minimum, 8 ppm May 20–24, 1953.

Specific conductance: Maximum daily, 774 micromhos Dec. 26, 1948; minimum daily, 33 micromhos May 22, 1953.

Water temperatures (1947–54): Maximum observed, 95°F Aug. 12, 1953; minimum observed, 34°F Jan. 28, 1948.

Remarks.—Records of specific conductance of daily samples available in district office at Austin, Tex. Records of discharge for water year October 1954 to September 1955 given in Water-Supply Paper 1392.

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180 °C) Parts per million	Tons per acre-foot	Tons per day	Hardness as $CaCO_3$ Calcium, magnesium	Noncarbonate	Percent sodium	Sodium adsorption ratio	Specific conductance (micromhos at 25 °C)	pH
1954																			
Oct. 1-10	333	21	7.7	2.8	33		47	6.2	40	1.0	142	0.19	128	30	0	70	2.6	223	6.9
Oct. 11-20	391	21	7.2	2.6	32		43	5.3	40	1.0	142	.19	150	28	0	71	2.6	222	7.2
Oct. 21-31	446	19	7.3	2.4	35		40	6.5	45	1.0	148	.20	178	28	0	73	2.9	231	7.1
Nov. 1-6	690	18	7.2	3.6	40		40	9.8	55	.8	158	.21	294	33	0	73	3.1	270	7.3
Nov. 7-12	2,910	13	11	4.3	84		28	20	129	2.0	294	.40	2,310	45	22	80	5.4	520	7.1
Nov. 13-20	4,220	11	10	3.5	22		32	17	31	1.2	[1]112	.15	1,276	40	14	55	1.5	197	7.0
Nov. 21-30	2,931	12	11	3.6	31		32	19	45	1.2	[1]139	.19	1,100	42	16	62	2.1	249	6.9
Dec. 1-10	1,452	16	14	2.6	43		28	22	66	1.2	206	.28	808	46	23	67	2.8	318	7.3
Dec. 11-20	1,278	17	13	2.6	43		27	19	66	1.5	194	.26	669	43	21	68	2.8	311	7.4
Dec. 21-22	2,940	19	19	4.0	80		32	30	123	1.0	318	.43	2,520	65	39	73	4.3	534	7.4
Dec. 23-31	2,070	14	10	2.6	43		18	18	68	1.5	191	.26	1,070	36	22	72	3.1	305	6.5

1953																	
Jan. 1-7	1,570	17	7.4	3.8	35	20	19	52	1.0	159	.22	674	34	18	69	2.6	261	7.0
Jan. 8-11	2,040	16	8.4	4.1	52	17	22	80	1.8	209	.28	1,150	38	24	75	3.7	351	7.0
Jan. 12-20, 22, 29-31	3,830	14	6.4	2.9	33	14	16	50	1.0	148	.20	1,530	28	16	72	2.7	232	6.6
Jan. 21, 23-28	6,370	14	8.8	4.1	46	12	23	74	1.8	207	.28	3,560	39	29	72	3.2	334	6.5
Feb. 1-6, 16-23, 27-28	8,300	11	6.6	3.1	30	14	21	42	1.5	148	.20	3,320	29	18	69	2.4	218	6.9
Feb. 7-11, 24, 26	17,420	7.4	4.0	1.5	14	11	10	19	1.2	[1] 62	.08	2,920	16	7	66	1.6	109	6.5
Feb. 12-15	16,420	9.0	5.0	1.8	18	10	14	26	1.0	[1] 80	.11	3,550	20	12	67	1.8	144	6.8
Mar. 1-8	8,260	14	9.2	2.9	24	15	21	36	1.8	[1] 116	.16	2,590	35	22	60	1.8	201	6.7
Mar. 9-17	3,710	17	11	4.0	35	24	27	51	1.0	[1] 158	.21	1,580	44	24	63	2.3	271	7.0
Mar. 18-26	3,330	19	13	3.9	37	30	24	56	1.5	[1] 169	.23	1,520	49	24	62	2.3	292	7.1
Mar. 27-31, Apr. 1-12	10,520	10	8.8	2.2	22	18	16	33	1.8	[1] 103	.14	2,930	31	16	61	1.7	188	6.7
Apr. 13-22	23,880	8.8	4.6	1.6	12	13	9.3	16	1.5	[1] 60	.08	3,870	18	7	59	1.2	107	6.8
Apr. 23-30	13,610	13	7.8	2.6	23	24	17	29	2.2	[1] 107	.15	3,930	30	10	62	1.8	178	6.5
May 1-10	5,980	15	12	3.7	26	36	18	36	1.2	156	.21	2,520	44	14	56	1.7	231	7.0
May 11-20, 23-25	5,560	16	11	3.5	31	34	17	44	1.5	154	.21	2,310	42	14	61	2.1	247	6.7
May 22	9,600	----	----	----	----	7	----	10	----	----	----	----	10	4	----	----	59	6.7
May 21, 26-31	9,630	9.0	5.6	1.9	20	17	9.6	29	1.0	[1] 84	.11	2,180	22	8	67	1.9	151	6.6
June 1-6	9,080	12	6.6	2.3	16	21	12	22	1.5	[1] 82	.11	2,010	26	9	58	1.4	145	6.8
June 7-14	3,430	17	9.2	3.2	24	28	13	36	1.2	139	.19	1,290	36	13	59	1.8	206	6.9
June 15-30	1,740	22	11	3.9	34	42	14	48	1.0	167	.23	785	44	10	63	2.2	268	7.3
July 1-10	1,450	18	10	3.7	35	40	13	49	1.0	162	.22	634	40	7	66	2.4	267	7.0
July 11-17	1,500	17	10	3.5	46	37	9.6	69	1.5	184	.25	745	40	10	71	3.1	316	7.4
July 18-23, 30-31	3,090	9.0	4.2	1.8	17	20	5.9	22	0.8	[1] 71	.10	592	18	2	67	1.7	127	6.7
July 24-29	3,390	11	7.0	2.6	35	26	8.9	51	.8	[1] 129	.18	1,180	28	6	73	2.9	238	6.7
Aug. 1-3	3,010	12	7.8	2.5	28	31	5.6	42	.8	[1] 114	.16	926	30	4	67	2.2	206	7.5
Aug. 4, 14-20, 30-31	8,300	11	4.8	1.5	12	19	5.2	16	1.0	[1] 60	.08	1,340	18	2	60	1.2	101	6.8
Aug. 5-13	22,280	6.2	3.2	.7	5.7 2.0	10	3.2	10	1.0	[1] 37	.05	2,230	11	3	48	.8	57	6.5
Aug. 21-29	2,610	16	7.0	2.6	22	30	7.3	30	1.5	112	.15	789	28	4	63	1.8	168	6.9
Sept. 1-9	5,220	12	4.2	1.3	14	20	3.9	18	1.2	[1] 65	.09	916	16	0	66	1.6	106	6.4
Sept. 10-11, 13-14, 21-22	2,180	18	8.2	2.6	34	35	7.7	48	.8	[1] 136	.18	800	31	2	70	2.6	240	7.3
Sept. 12, 15-20	2,120	15	11	3.3	52	30	12	82	1.5	208	.28	1,190	41	16	73	3.5	356	6.6
Sept. 23-30	2,350	14	5.6	1.4	20	22	5.5	28	1.5	[1] 87	.12	552	20	2	69	2.0	141	6.7
Weighted average	5,574	11	6.9	2.3	22	19	13	32	1.4	104	0.14	1,570	26	11	64	1.9	174	----

[1] Sum of determined constituents.

TABLE 8.—*Chemical analyses of surface waters at selected sites in or near De Soto Parish, La., October 1954 to September 1955*

[Chemical analyses, in parts per million, except as indicated. Color in Hazen scale units. Analyses by U.S. Geol. Survey]

Date of collection	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Calculated dissolved solids	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Percent sodium	Specific conductance (micromhos at 25° C)	pH	Color
Bayou Castor near Longstreet, La.																		
1955																		
Oct. 17	0.157	32	0.73	7.5	2.5	16		46	2.0	16	1.0	101	29	0	54	141	6.9	70
Dec. 9	.314	24	.70	8.6	3.3	17		57	1.5	16	0.5	100	35	0	51	154	7.0	35
1956																		
Apr. 4	2.98	20	.58	16	8.5	43		60	30	62	.6	211	75	26	56	359	7.0	55
Bayou Pierre West of Westdale, La.																		
1955																		
Feb. 9	----------	7.0	0.19	9.7	4.1	16		36	18	18	1.8	93	41	12	45	178	6.8	50
Bayou San Patricio near Benson, La.																		
1955																		
Aug. 14	3.98	19	1.4	7.4	2.6	10		34	7.1	11	0.5	76	29	1	43	126	6.6	130
Bayou San Patricio near Noble, La.																		
1955																		
Oct. 18	5.90	30	0.85	3.2	0.7	5.3	2.7	20	4.2	4.0	0.2	61	11	0	44	55	6.5	90
Nov. 30	.62	15	.06	13	6.1	52		59	2.3	84	.2	216	57	9	66	380	7.3	35
1956																		
Jan. 5	.89	14	.09	11	5.0	95		40	7.0	152	.2	318	48	15	81	577	6.6	25
Feb. 29	18.8	15	.72	9.6	4.6	53		26	18	84	.7	199	43	22	73	360	6.5	80
Mar. 27	27.0	14	.65	10	6.0	46		30	24	70	.9	186	50	25	67	338	6.5	80
Apr. 25	13.0	16	.78	11	5.3	85		30	16	137	.7	287	49	25	79	542	6.5	65
May 23	5.10	15	.92	9.1	3.7	39		38	11	56	1.3	155	38	7	69	273	6.6	90

Cypress Bayou near Keithville, La.

1955																		
Jan. 14	1.82	27	0.41	16	8.0	33		93	15	38	0.2	184	74	0	49	302	7.3	60
Feb. 7	686	8.8	.17	4.0	2.5	6.6	1.9	18	9.8	8.5	.8	52	20	6	39	85	6.5	80
Apr. 12	1,290	4.1	.20	2.3	1.5	3.9	2.2	14	4.3	5.2	.8	32	12	1	36	56	6.1	80
May 17	1.00	13	.14	32	17	67		170	29	89	.5	349	150	10	49	618	7.5	70
June 7	25.6	14	.27	11	6.1	21		53	17	26	.8	122	53	9	47	211	6.9	80
July 14	46.2	5.0	.12	3.7	2.0	5.0	2.3	20	3.7	6.5	1.0	39	17	1	35	68	6.3	45
Aug. 16	2.0	18	.34	21	10	33		95	24	44	.2	212	94	16	43	348	7.2	40

Wallace Lake at Dam near Shreveport, La.

1954																		
Oct. 21		4.0	0.03	13	5.8	17		[1] 77	3.5	18	0.2	[2] 111	56	0	39	190	9.0	15
Nov. 19		0.8	.05	13	5.9	16		67	10	19	.5	[2] 109	57	2	39	192	7.1	25
Dec. 7		1.4	.04	13	6.5	17		69	10	20	.2	[2] 115	59	3	38	208	8.5	30
1955																		
Jan. 14		.7	.01	12	5.8	17		55	16	22	.2	[2] 112	55	10	41	199	7.1	15
Feb. 8		4.7	.26	7.5	3.5	18		36	14	20	.8	87	33	4	55	160	7.4	55
Apr. 13		3.2	.38	5.7	2.9	6.9	2.9	30	6.9	9.2	.8	54	26	0	34	102	6.5	70
May 17		2.9	.39	6.4	2.9	6.9	1.4	37	4.7	6.5	1.2	51	28	0	34	96	6.7	55
June 7		4.8	.31	5.6	2.7	5.4	2.4	27	5.4	7.5	.8	48	25	3	29	87	6.5	80
July 19		2.1	.06	7.0	3.2	9.3	3.6	36	4.6	13	1.2	62	31	1	36	121	6.2	30
Aug. 16		6.3	.10	9.6	4.1	4.6		50	2.4	5.5	.5	[2] 76	41	0	20	119	6.4	40
Sept. 22		4.1	.11	12	6.3	18		58	20	17	3.0	[2] 121	55	7	42	206	6.9	30

[1] Includes equivalent of 7 ppm. of carbonate (CO_3).

[2] Residue on evaporation at 180° C.

TABLE 9.—*Chloride content of Bayou Pierre at selected points in or near De Soto Parish, La.*

Sampling point	Date	Chloride (Cl) (ppm)	Sampling point	Date	Chloride (Cl) (ppm)
West of Armstead	12-15-55	144	West of Lake End	2-14-55	24
Do	12-28-55	112	Do	12-15-55	96
West of Grand Bayou	12- 9-55	18	West of Westdale	12-15-55	64
Do	12-15-55	72	West of Williams	12-15-55	64

TABLE 10.—*Description of water wells*

Type: B, bored; D, drilled; Dr, driven; Du, dug well.
Stratigraphic unit: Al, Quaternary alluvium; TD, Quaternary terrace deposits; U, undifferentiated Wilcox group; DH, Dolet Hills formation; and N, Naborton formation.

Method of lift: A, airlift; B, bucket; C, centrifugal; J, jet; S, suction; T, turbine pump.
Use: A, abandoned; D, domestic; I, industrial; Ir, irrigation; N, none; O, observation; P, public supply; S, stock; T, test well.
Remarks: C, chemical analysis; L see log.

USGS well	Location: Section	Location: Township N.	Location: Range W.	Owner	Driller	Year completed	Type	Altitude (feet)	Depth (feet)	Casing diameter (inches)	Screened interval (feet)	Stratigraphic unit	Depth to water level below land surface (feet)	Date	Method of lift	Use	Remarks
De Soto Parish, La.																	
1	20	15	14	H. H. Goldsby	Hunt & White		D	205	256	6		N	34.90	1-27-41	J	D	Reported yield 20 gpm.
2	16	15	14	H. J. Cathey			D	210	180			N	20	1934	J	D, S	
3	20	14	15	S. E. Johnson	A. C. Morgan	1938	D	345	181	5	120–140 160–180	U	32	2- -38	J	D, S	
4	17	15	14	De Soto Parish Board of Education Stonewall School.	M. C. Forsong	1938	D	220	161	4	140–161	N			J	D	C. Gravel reported 119–161 ft.
5	17	15	14	do	do	1940	D	220	290			N				A	
6	19	13	15	Y. V. Headrick		1925	D	325	365	5		N	32	6- -55	J	I	
7	22	14	15	Southern Pacific Lines.	W. J. Swinehart & Son.	1941	D	330	181	8	138–158	U	20	2-2 -42		N	L. Maximum yield reported 100 gpm. Screen opening: 0.012 in.
8	4	11	16	Stubblefield Chevrolet Co., Inc.		1956	D	180	205	4		N	78	6- -56	J	D	
10	9	12	13	City of Mansfield	Louisiana Well Co.		D	340	284	6	247–267	N				A	L.
11	21	14	15	De Soto Parish Board of Education Keatchie School	C. O. Bolt		D	335	248		230–248	U				N	
12	22	14	15	Edith Patterson	do		D	320	245	4		DH			J	D	

				City of Mansfield:													
13	9	12	13	Old Cowley	Layne-Louisiana Co.	1929	D	310	252	16-10		N	115 133	1929 1940		A	L; C. Temp 68° F. Reported (1929) to pump 276 gpm.
14	8	12	13	Old Hewitt	do	1932	D	320	276	16-10		N	133	1940		A	Reported (1941) to pump 200 gpm.
15	9	12	13	Old Nabors	do	1940	D	325	253	20-12	223-253	N	204.25	6-19-55	T	P	L. Pump discharge (11-3-55) 110 gpm at 50 psi line pressure, with 46.5 feet drawdown. Specific capacity 2.4.
16	9	12	13	New Cowley	Louisiana Well Co.	1946	D	320	225	18-12	195-225	N	166.20	6-19-55		N	L. Temp 69° F.
17	8	12	13	New Hewitt	Layne-Louisiana Co.	1945	D	330	226	18-12	232-262	N			T	P	Pump discharge (10-6-54) 115 gpm; pump discharge (8-29-56) 121 gpm. Temp 69° F.
18	9	12	13	Town	G. C. McDaniel	1949	D	330	245	16-12	213-243	N	183.51	11-2-55	T	P	L; C. Pump discharge (8-29-56) 120 gpm at 20 psi. Temp 69° F. Specific capacity 4.4.
19	9	12	13	KCS Well	Louisiana Well Co.	1952	D	345	223	12-8	181-221	N	167.17	6-29-55		N	L. Pump discharge (10-5-54) 25 gpm at 25 psi.
20	9	12	13	New Nabors	do	1952	D	280	220	12-8	184-220	N			T	P	L. Pump discharge (8-28-56) 204 gpm at 50 psi. Temp 69° F.
21	22	14	14	J. G. Burford	Thorn Oil Co.	1929	D	205	250(?)	6		N	Flowing			S, Ir	C. Water level (1-6-55) 8 feet above land surface. Original depth 3,020 ft.
22	28	14	14	do	Ed Smith	1931	D	280	255	3	235-255	DH			S	D, S	C.
23	3	10	12	De Soto Parish Board of Education Pelican High School.	G. C. McDaniel	1950	D	320	377	6-3	357-377	N			T	D	L; C. Temp 71° F.
24	21	14	15	E. F. Schuler, Sr.	H. L. Simons	1950	D	335	336	4		N			J	D	C. Temp 65° F.
25	36	12	11	Howard Rascoe	M. Reisinger	1940	D	125	300	5		N			J	D	
26	29	15	14	R. C. Russell	Caddo Drilling Co.	1954	D	240	204	6		DH	33.38	10-28-54	T	D	C.
27	30	13	14	J. M. Ford	A. L. Robbins	1954	D	340	246	4		N			S	D	
28	20	14	15	S. E. Johnson, Jr.	W. M. Brummett	1954	D	350	197	4		U			J	D, S	
29	28	14	15	G. I. Bazemore	R. L. Weeks	1953	D	340	186	4	182-186	U	27.04	11-4-54	J	D, S	C.
30	29	14	15	S. F. Talbert	G. C. McDaniel	1954	D	315	350	12-8		N				T	L.

TABLE 10.—*Description of water wells*—Continued

USGS well	Location: Section	Location: Township N.	Location: Range W.	Owner	Driller	Year completed	Type	Altitude (feet)	Depth (feet)	Casing diameter (inches)	Screened interval (feet)	Stratigraphic unit	Depth to water level below land surface (feet)	Date	Method of lift	Use	Remarks
De Soto Parish, La.—Continued																	
31	19	14	13	De Soto Parish Board of Education Second Ward School.	Houston Drilling Co.	1953	D	240	294	4	272–294	N	52.80	11- 5-54	T	D	
32	10	11	15	De Soto Parish Board of Education Oak Grove High School.	A. C. Morgan	1954	D	300	380	6	337–380	N	28	4 6-54	T	D	Pump discharge (4-6-54) 27 gpm.
33	11	11	14	De Soto Parish Board of Education Spider School.	G. C. McDaniel	1952	D	320	379	6		N			S	D	
34	35	16	14	C. E. Richardson		1920	Du	190	33	36		U	24.79	11-11-54	B	D, S	
35	21	15	13	Mrs. Georgia Wright.			Du	220	26	30		U	17.85	11-12-54	B	D, S	
36	17	15	13	Gene Dunn			Du	225	28	36		U	24.80	11-18-54		N	
37	7	15	13	G. A. Strong	A. C. Morgan	1953	D	205	235	6		N			J	D, S	
38	7	15	13	do			D	205	87	8		U			J	D	
39	18	15	13	H. T. Perrin			D	240	210	8		DH	43.17	11-18-54	J	D	
40	19	15	13	John N. Scott	M. C. Forsong	1946	D	250	169	4		DH			J	D, S	
41	13	15	14	W. B. Roach	A. L. Robbins	1954	D	250	204	6-4		DH			J	D, S	
42	14	15	14	Stuart S. Hill	Willie William	1953	B	250	34	8		U	29.38	11-18-54	B	D	
43	14	15	14	Ruben Hall	Ruben Hall	1954	B	230	42	8		U	34.90	11-18-54	B	D	
44	22	15	14	John Taylor	R. L. Weeks	1952	B	235	37	8		U	14.35	11-18-54	B	D	
45	22	15	14	Dr. E. A. Sartor	McBryde	1954	D	250	192	4		DH	55	6- -54	J	D	
46	15	15	14	Gerald Holmes	Caddo Drilling Co.	1953	D	245	160	4		DH	40	5- -53	J	D, S	Top of sand reported at 160 ft.
47	21	15	14	A. B. Summers	Barnwell Drilling Co.	1953	D	265	284	4	218–244	N	30	1953	J	D	
48	16	15	14	R. N. Hall, Jr	Baborn & Laborde.	1949	D	255	196	6		DH	45–50	1949	J	D, S	
49	15	15	14	Otis Rambin		1945	Du	225	31	36		U	25.08	11-19-54	B	D	
50	15	15	14	P. J. Loftus	Wm. S. Boone	1952	D	240	280	4		N	40	7- -52	J	D	Pump discharge (reported 1952) 4 gpm.
51	15	15	14	J. D. Penywell	R. L. Weeks	1951	B	230	67	8		U	33.84	11-19-54	B	D	
52	15	15	14	do	J. D. Penywell	1945	Du	230	37	24		U	33.11	11-19-54	B	D	
53	10	15	14	M. J. Andrews	R. L. Weeks	1939	B	220	60	8		U	45	1954	J	D, S	
54	10	15	14	E. H. Powell	A. L. Robbins	1951	D	230	180	5		DH			J	D	

55	10	15	14	do		1935	B	230	59	10		U	17.38	12- 7-54		N, O	Water levels in table 16.
56	3	15	14	Amos Jenkins			B	180	27	8		U	18.19	12- 7-54	B	D	
57	13	15	14	Henry Marshall, Jr.	Rabon	1948	D	250	318	6		N	55	1948	J	D, S	
58	21	15	14	Otis Rambin	R. L. Weeks	1949	B	265	80	10		U	9	1949	J	D, S	
59	36	13	14	De Soto Parish Police Jury and De Soto Parish Airfield.	Layne-Louisiana Co.		D	320	300	12-8		N	127.06	12- 6-54	T	N, O	Water levels in table 16.
60	28	15	14	T. E. Hall	Hunt	1944	D	260	194	6		DH	45	1944	J	D, S	
61	20	15	13	Warren Thomas		1934	Du	210	25	36		U	19.75	12- 8-54	J	D	
62	34	15	13	J. E. Scott	W. M. Brummett	1952	D	170	204	3		N			S	D	
64	34	15	13	W. A. Lincoln			Du	190	29	30		U	22.64	12- 8-54	S	D	
65	34	15	13	The Frierson Co., Inc.			Du	180	20	30		U	12.78	12- 8-54	B	D	
66	5	14	14	W. J. Williamson	G. C. McDaniel	1947	D	265	166	6	80-100 146-166	DH	13	1947	J	S	
67	26	15	13	C. A. Goldsberry	do	1954	D	205	135	4	125-135	N	60	8-14-54	J	D, S	L; C.
68	30	13	14	J. M. Ford			Du	340	51	30		U	44.85	12-16-54	B	N, O	Water levels in table 16.
69	30	13	14	do		1936	D	340	137	4		DH	73.99	12-16-54		N, O	Do.
70	19	13	15	Guy McMichael	Pridgem	1955	D	310	84	4		U	32.35	1- 6-55	J	D, S	
76	3	11	16	Town of Logansport.	W. C. Barnwell Drilling Co.	1951	D	220	227	8	205-227	N	62.18	1- 6-55		N, O	Well drilled to 292 ft. Electrical log available. Water levels in table 16.
77	3	11	16	do	B. F. Edington	1954	D	220	224			N				T	
78	19	15	14	Charles B. Berry	Weeks Water Well Service.	1953	D	250	189	4		DH	43	1953	J	D, S	
79	30	15	14	Mrs. M. C. Middleton.	B. F. Edington	1952	D	280	230	4		DH	80	1952	S	D, S	L.
80	20	15	14	R. E. Nicholson	L. E. Simmons Drilling Co.	1952	D	260	320	8-6	275-320	N	60.30	3-30-55	T	D, S, Ir.	C. Pump discharge (1-13-55) 100 gpm. Temp 68°F. Water levels in table 16.
81	28	13	14	J. M. Ford		1936	D	300	290	4		N	50	1954	S	D	
82	2	12	14	W. R. Smith	G. C. McDaniel	1949	D	330	398	6		N	132	5- -49	T	D	C.
83	8	12	13	W. C. Nabors	do	1949	D	300	255	6		N	174	1954	T	D	
84	19	12	13	L. E. Colvin	do	1952	D	360	321	4	300-321	N	138	4-16-52	T	D	L.
85	16	14	15	Mrs. Virginia Burford.			Du	360	26	36		U	19.13	1-20-55	B	D	
86	17	14	15	Clayton T. Rushing		1947	Du	345	20	30		U	16.67	1-20-55	J	D	
87	26	14	16	John T. & Tom Moseley.	R. L. Weeks	1948	B	325	47	8		U	22	1948	J	D	
88	34	14	16	H. B. Thompson	do	1953	B	340	161	6		U			J	D, S	
89	33	14	16	W. H. Bagley	do	1942	B	280	190	4		DH			J	D, S	
90	29	14	16	H. H. Timmons	do	1954	B	300	156	4		DH	45-50	1954	J	D, S	
91	30	14	16	E. E. Bagley	do	1953	B	280	160	4		N			J	D	
92	20	14	16	J. F. Bagley	J. G. Spurlock	1952	Du	305	86	36		U			J	D, S	
93	28	14	16	R. L. Holmes	R. L. Weeks	1950	B	280	160	6		N	20	1950	J	D, S	
94	26	14	16	J. B. Hassell	do	1951	B	330	61	6		U	20	1951	J	D, S	

TABLE 10.—*Description of water wells*—Continued

USGS well	Location: Section	Location: Township N.	Location: Range W.	Owner	Driller	Year completed	Type	Altitude (feet)	Depth (feet)	Casing diameter (inches)	Screened interval (feet)	Stratigraphic unit	Depth to water level below land surface (feet)	Date	Method of lift	Use	Remarks
De Soto Parish, La.—Continued																	
95	10	14	15	Dr. J. F. Fisher			Du	340	26	30		U	23.41	1-25-55	B	D, S	
96	22	14	15	Tom McCann			Du	335	15	24		U	10.68	1-25-55	S	D	
98	18	14	14	M. G. Howe	W. S. Boone	1953	D	320	286	4		DH	90	1953	S	D, S	
99	18	14	14	Herman Crawford	Ed Smith	1950	D	310	380	4		N	50	1940	J	D, S	
100	7	14	14	Mrs. M. S. Garland		1948	D	300	185	6		U			S	D, S	
101	32	15	14	S J. Lacobee	R. L. Weeks	1954	D	270	171	4		DH	15	1954	J	D, S	
102	29	15	14	M. O. Carney	B. F. Edington	1948	D	275	225			DH			S	D, S	
103	25	15	14	J. A. DeWitt		1884	Du	240	21	36		U	16.66	1-25-55	B	D	
104	2	14	14	J. E. Tyler	J. E. Tyler	1950	D	220	220	4	198–218	DH	30	1950	S	D	
105	3	14	14	B. Witherspoon	L. E. Simmons Drilling Co.	1946	D	260	400	9⅝		N	60	1946	J	D, S	
106	8	14	14	James U. Burford		1951	Du	300	32	30		U	29.69	1-26-55	J	D, S	
107	27	15	13	A. S. Rambin	Thomas	1954	D	190	146	4		N	50	1954	J	D	
108	29	13	12	Fergia C. Lafitte	A. L. Robbins	1954	D	225	200	4		N	80	1954	J	D	
109	29	13	12	E. A. Lafitte	E. A. Lafitte	1927	D	230	210	6		N	30	1927	S	I	
110	22	13	12	Joe Pratt	A. L. Robbins	1955	D	230	204	4		N	80-100	1955	S	D	
111	9	13	12	Herbert De Soto	do	1954.	D	170	204	4		N	38	4- -54	S	D	
112	22	13	12	John De Soto	do	1954	D	220	185	4		N	70	7- -54	J	D	C.
113	9	13	12	Dr. Bell Hewett				160				TD				D	Spring.
114	6	13	12	Harold C. Skidmore		1933	D	205	226	6		N	33.42	2- 4-55		N	
115	12	13	13	Mrs. Robert L. Smith.	A. C. Morgan	1954	D	225	213	6		N	70	9- -54	J	D, S	C.
116	14	13	13	C. A. Shepherd	A. L. Robbins	1954	D	225	200	4		N			J	D, S	
117	23	14	15	Glen E. Martin	L. E. Simmons	1955	D	340	360	4		N	92	2- -55	T	D, S	
118	23	14	15	do		1947	D	330	276	4		N	73.71	2- 8-55		N	
119	36	15	14	Hal Means			Du	220	33	30		U	30.56	2- 9-55	J	D	
120	36	15	13	E. R. Nelson		1940	B	195	19	6		U	16.11	2- 9-55	S	D, S	
121	6	14	12	Mrs. Clyde Prudhome.	W. Williams	1954	B	180	44	6		TD	39.53	2- 9-55	B	D	
122	11	14	13	Wayne Douglas, Jr.			Du	160	20	24		U	18.60	2- 9-55	B	D, S	
123	28	14	12	Moses Draughn	W. Williams	1950	B	165	45	12		TD	41.78	2- 9-55	B	D, S	
124	35	14	12	Lonnie Thomas		1950	B	175	40	6		TD	36.02	2- 9-55	B	D	
125	3	13	12	Robert Samuel		1955	D	175	84	2		TD	41	1- -55	J	D, S	
126	11	13	12	John D. Lane	John D. Lane	1938	Du	170	52	24		TD	45.91	2-10-55	B	D, S	
127	18	13	12	J. T. Daw		1950	Du	155	15	36		U	11.70	2-10-55	B	D	
128	30	13	12	Frank Lee		1932	Du	230	20	40		N	14	1932	S	D	
129	29	13	12	E. A. Lafitte	Caddo Drilling Co.	1955	D	210	142	4		N	65.21	2-10-55	S	I	C. Temp 69°F.

130	36	13	13	Mrs. Jesse Porter			Du	230	15	36		N	13.02	2-10-55	B	D	
131	26	13	13	Don Jenkins	Hunt	1946	D	225	220	4		N	65	1946	S	S	
132	27	13	13	Mrs. R. W. Greening.	R. W. Greening	1945	Du	275	18	24		U	14.48	2-10-55	J	D	
133	27	13	13	A. C. Mobley			Du	259	34	28		U	29.34	2-10-55	B	D	
134	12	13	13	J. G. Melder	A. L. Robbins	1954	D	180	190	4	127–190	N	20	11- -54	J	D	
135	22	13	13	Major Davis		1952	Du	250	26	36		U	25.61	2-10-55	B	D, S	
136	36	13	13	James Calhoun	Lewis A. Brooks	1954	D	270	220	4	200–220	N	100-150	1954	T	D, S	
137	2	12	13	James Guy	Caddo Drilling Co.	1954	D	270	140	4		N	45-50	1954	J	S	
138	3	12	13	Glen English	W. M. Brummett.	1951	D	320	225	4	183–225	N	147	1951	S	D	
139	22	13	13	Horace Dinkins			Du	240	30	30×36		U	26.00	2-17-55	B	D	
140	16	13	13	C. L. Boyd	C. L. Boyd	1918	Du	205	23	26		U	19.18	2-17-55	B	D	
141	9	13	13	W. W. Dill	W. C. Barnwell	1954	D	180	187	4		N	65	10- -54	J	D	
142	9	13	13	Stanley Whittaker, Jr.	Standard Oil Co	1930	D	180	33	6		U	18.15	2-17-55	B	D	
143	4	13	13	M. F. Jones		1910	Du	200	20	30		U	15.71	2-17-55	B	D	
144	5	13	13	C. R. Smith	M. C. Fairweather.	1945	Du	245	21	24		U	8.85	2-18-55	B	D	
145	33	14	13	A. A. Gilbert		1952	D	240	170	4		DH			J	D	
146	21	14	13	H. E. L. Scott		1947	Du	210	33	28		U	10.60	2-18-55	B	D	
147	21	14	13	Justin Scott	B. F. Edington	1944	D	210	196	4		N	30	1944	J	D	Sand reported: 172-196 ft. C. Temp 68°F.
148	16	14	13	B. A. Martin	Sam Murray	1950	B	210	38	6		U	7.10	2-18-55	B	D	
149	9	14	13	Kager Atkin		1954	B	185	36	6		U	24.35	2-18-55	B	D	
150	4	14	13	Mrs. Hazlett		1950	B	160	17	6		TD	10.52	2-18-55	B	D	
151	22	14	13	J. Moran		1950	D	200	179	5		DH	60	1950	J	D,S	Sand reported: 159-179 ft.
152	15	14	13	Richard Carroll		1920	Du	220	37	36		U	34.73	2-24-55	B	D	
153	24	14	13	Nettie Belle Alexander.	Willie Williams	1954	B	200	28	6		U	21.41	2-24-55	B	D	
154	24	14	13	Jessie B. Grant	do	1954	B	206	47	6		U	41.35	2-24-55	B	D	
155	19	14	12	Mrs. Sarah Freeman.	do	1953	B	175	34	6		U	29.01	2-24-55	B	D	
156	36	14	13	Tom Fuller		1945	B	160	29	12		DH	16.20	2-24-55	B	D	
157	2	13	13	Walter Davis	Willie Williams	1948	B	170	28	6		DH	24.24	2-24-55	B	D	
158	3	13	13	M. F. Jones		1946	Du	200	20	24		U	15.30	2-24-55	B	D	
159	6	12	12	E. T. Goldsby		1920	Du	275	16	24		N	13.04	2-24-55	J	D	
160	6	12	12	L. P. Smith		1921	Du	280	17	48		N	15.02	2-25-55	S	D	
161	3	12	12	Albert Washington	Albert Washington.	1950	Du	240	13	30		N	10.93	2-25-55	B	D	
162	32	13	11	W. C. Nabors		1951	Du	180	40	36		N	36	1955	J	D	
163	36	15	15	Mrs. E. E. Johnson			D	220	249	4		N	1.00	3- 3-55		A	
164	10	12	12	L. E. Smith			Du	220	15	36		N	9.75	3-11-55	B	D	
165	21	12	12	Truevine Church	Odie Washington	1950	Du	365	47	48		DH	31.75	3-11-55	B	D	
166	20	12	12	Huey Jones		1952	Du	340	19	42		U	7.80	3-30-55	B	D	
167	19	12	12	J. S. Howell		1913	Du	320	18	30		U	5.94	3-30-55	J	D	
168	24	12	13	Raymond Calhoun			Du	340	27	36		DH	21.60	3-30-55	J	D	
169	25	12	13	O. E. Bufkin		1955	D	330	300	4	252–269	N	60-70	1955	J	D	
170	11	11	12	Addie Taylor		1955	Du	385	47	30		U	46.36	4- 1-55	B	D	
171	19	12	12	T. E. Roberts		1938	Du	320	16	30		U	14.30	4- 1-55	J	D	

TABLE 10.—*Description of water wells*—Continued

USGS well	Location: Section	Location: Township N.	Location: Range W.	Owner	Driller	Year completed	Type	Altitude (feet)	Depth (feet)	Casing diameter (inches)	Screened interval (feet)	Stratigraphic unit	Depth to water level below land surface (feet)	Date	Method of lift	Use	Remarks
De Soto Parish, La.—Continued																	
172	7	12	12	F. N. Evans	A. C. Morgan	1954	D	290	255	4		N	80	1954	J	D	
173	21	14	14	S. W. Long	W. C. Barnwell	1955	D	250	278	4	228–278	DH	20	3– –55	J	D,S	L.
174	9	14	14	W. A. Long		1930	Du	280	30	30		U	26	1955	J	D,S	
175	2	14	14	J. E. Tyler	W. C. Barnwell	1955	D	220	210	8	168–210	DH	21.96	4–22–55	T	Ir	L; C. Gravel-walled well. Temp 68°F. Water levels in table 1b.
176	27	13	15	P. A. Frederick	L. E. Simmons	1949	D	310	237	4		DH	60	8– –49	J	D	C.
177	7	13	15	Howard Dennison	L. E. Simmons	1949	D	300	350	4	290–350	N	41.67	3–10–55		A, O	
178	7	13	15	do	C. G. Vaught	1955	D	300	345	7	320–345	N	34.87	3–10–55	J	D, S	L; C. Drawdown 15.55 ft after 8 hrs. pumping 8 gpm. Gravel packed well. Temp 71° F.
179	10	12	13	F. E. Bufkin	R. P. Bufkin	1955	D	345	326	8		N	156	4–27–55	T	D	
180	27	14	14	C. L. Reed			Du	260	18	30		U	9.60	4–28–55–	B	D, S	
181	3	13	14	Bethlehem Church			Du	330	41	30		U	27.05	4–28–55	B	D	
182	26	14	14	David Means, Jr	Wm. S. Boone	1954	D	285	280	4		N			J	D, S	
183	9	12	13	City of Mansfield	B. F. Edington	1955	D	320	270	10–8	183–211 231–260	N	139.06	6– 2–55	T	P	L. Pump discharge (8–31–56) 202 gpm at 80 psi; 257 gpm at 0 psi.
184	22	12	13	B. R. Guinn	C. G. Vaught	1953	D	320	312	7	252–272	N	123	12– –53	S	N	L. Pump discharge (by air lift) reported 26 gpm.
185	10	11	10	U. K. Isbell	U. K. Isbell		Dr	128	59	1¼	48–59	Al	17	1955	A	S	
186	23	12	13	Henry P. Fleniken, Jr.	L. E. Simmons	1951	D	310	152	4	132–152	N	65	1951	J	D	
187	10	12	13	Matthews Lumber Co.	B. F. Edington	1955	D	345	220	10	170–210	N	174.37	6–10–55	T	I	L.
188	22	14	15	Southern Pacific Lines.		1942	D	330	172	8		U			T	N	L of test hole to 714 ft 7 in.
189	22	14	15	do		1942	D	330	178	8		U	20.76	6–28–55	T	N	
190	3	11	16	Town of Logansport		1944	D	170	275			N				T	L.
191	33	12	16	do		1944	D	190	245			N				T	L.

192	23	12	13	Louisiana State Parks & Recreation Commission.	B. F. Edington	1955	D	340	503	6	------	N	------	------	------	T	L.
193	30	12	12	W. K. Williams	------	1905	Du	325	31	30	------	DH	27.47	7-13-55	J	D	
194	32	12	12	E. B. Egbert	------	1955	Du	300	47	30	------	DH	41	1955	J	D	
195	9	11	12	Betty W. Jones	------	------	Du	310	9	42	------	U	7.84	7-13-55	B	D, S	
196	15	11	12	Roy C. Bice	------	1950	Du	330	28	30	------	U	25	6- -55	S	D	
197	23	11	12	B. H. Smith	------	1905	Du	320	21	36	------	U	19.16	7-14-55	S	D	
198	35	11	12	J. M. Adams	------	1923	Du	340	25	36	------	U	19.74	7-14-55	B	D	
199	2	10.	12	V. M. Chamberlin	------	1954	Du	360	27	36	------	U	16.13	7-14-55	J	D	
200	2	10	12	Rochelle Turner	------	1955	Du	360	26	36	------	U	23.81	7-14-55	B	D	
201	18	10	11	F. N. Gillespie	------	1950	D	360	284	3-2	------	U	140	1950	J	S	
202	17	10	11	W. C. Lee	------	------	Du	340	34	24	------	U	28.75	7-14-55	J	D	
203	17	10	11	John Collum	------	------	Du	345	17	30	------	U	7.08	7-14-55	B	D	
204	15	10	11	John Cates	------	1950	Du	300	25	36	------	U	22.5	9- 2-55	J	D	
205	10	10	11	O. H. Hinkie	------	1922	Du	260	42	30	------	U	38	9- 2-55	B	D	
206	13	10	11	J. L. Wilson	------	1874	Du	275	18	30	------	U	13.70	9- 2-55	B	D	
207	37	10	11	Wiley Boone	Wayne Hightower.	1955	D	210	268	6	------	N	52	1955	J	D	
208	35	11	11	District 8 Baptist Convention.	G. C. McDaniel	1953	D	230	217	6	------	N	85.69	9- 9-55	T	D	L; C. Pump capacity (reported) 40 gpm.
209	36	11	11	J. W. Ramsey	------	1912	Du	220	46	30	------	U	20.15	9- 2-55	J	D	
210	24	11	11	H. S. Rambin	------	1939	Du	230	16	30	------	U	10.99	9- 8-55	J	D	
211	12	11	11	J. J. Rambin	------	1936	D	135	148	4	------	N	80	1936	J	D, S	
212	7	11	10	W. B. Flores	W. B. Flores	------	Dr	130	65	2	------	Al	18	1955	J	S	
213	29	11	11	John E. Young	------	------	Du	220	17	30	------	U	15.87	9- 9-55	J	D	
214	30	11	11	J. B. Bice	------	------	Du	265	20	36	------	U	17.43	9- 9-55	J	D	
215	24	11	12	Clyde Russell	------	------	Du	305	21	30	------	U	24.07	9- 9-55	B	D	
216	12	11	12	E. T. Polk Estate	------	1881	Du	370	19	36	------	U	11.83	9- 9-55	B	D	
217	38	10	12	W. E. Risher	------	1943	Du	360	31	36	------	U	23.70	9-12-55	S	D	
218	38	10	12	W. A. Stennett	J. G. Spurlock	1955	D	380	240	4	------	DH	40	6- -55	J	D	C. Temp 68° F.
219	38	10	12	Jack Fisher	------	1930	Du	310	25	30	------	U	19.90	9-12-55	S	D	
220	39	10	12	Willie Carter	------	1940	Du	305	38	36	------	U	29.12	9-12-55	J	D	
221	38	10	13	D. H. Sebastian	------	1901	Du	300	17	36	------	U	12.40	9-12-55	B	D	
222	38	10	13	F. M. Anderson	------	1945	Du	250	18	30	------	U	6.85	9-13-55	J	D	
223	38	10	13	Aud Smith	George Brazier	1955	D	270	137	3	------	DH	30.74	9-13-55	J	D	C.
224	38	10	13	Mrs. Sally Hill	------	1915	Du	280	22	36	------	U	16.82	9-13-55	B	D	
225	37	11	13	Bryan B. Norwood	------	------	Du	290	16	36	------	U	9.66	9-13-55	J	D	
226	17	11	13	Roy L. Flores	------	------	Du	330	23	24	------	U	10.40	9-13-55	B	D	
227	33	12	13	Mrs. Maddie Gillespie.	------	1950	Du	345	14	36	------	U	10.52	9-13-55	S	D	
228	37	11	13	Hudson Darby	------	1951	Du	300	19	36	------	U	18.60	9-13-55	B	D	
229	37	11	13	Mrs. Mary M. Price.	------	------	Du	310	20	30	------	U	16.16	9-13-55	B	D	
230	37	11	13	Henry Jacob	------	1947	Du	260	16	36	------	U	13.89	9-13-55	B	D	
231	37	11	13	John Owens	------	1955	Du	260	14	30	------	U	11.66	9-13-55	B	D	
232	37	11	13	Henry Johnson	------	------	Du	290	20	36	------	U	14.20	9-13-55	S	D	
233	38	10	13	Allen Norwood	------	1915	Du	330	31	36	------	U	17.11	9-13-55	S	D	
234	38	10	13	Ken Wilcox	------	------	Du	330	18	30	------	U	12.42	9-13-55	B	D	
235	37	11	13	Billy Pilot	------	------	Du	300	14	30	------	U	9.89	9-13-55	------	N	
236	28	12	13	Mrs. W. Y. Metcalf.	------	------	Du	320	19	36	------	U	13.96	9-14-55	J	D	

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TABLE 10.—*Description of water wells*—Continued

USGS well	Location: Section	Location: Township N.	Location: Range W.	Owner	Driller	Year completed	Type	Altitude (feet)	Depth (feet)	Casing diameter (inches)	Screened interval (feet)	Stratigraphic unit	Depth to water level below land surface (feet)	Date	Method of lift	Use	Remarks
De Soto Parish, La.—Continued																	
237	3	11	13	Mount Olive Baptist Church.			Du	345	18	30		U	16.84	9-14-55	B	D	
238	37	11	12	Syracuse Enterprises.	W. C. Barnwell	1954	D	270	223	12¾	202-223	DH	35	1954	T	I	C. Well drilled to 250 ft. Well test pumped at 100-125 gpm when completed.
239	37	11	12	Archie Griffin		1925	Du	270	20	30		U	16.25	9-14-55	B	D	
240	37	11	12	Larry West		1921	Du	290	16	36		U	9.61	9-14-55	B	D	
241	37	11	12	Mrs. Frances Raborn.			Du	325	31	30		U	24.86	9-14-55	B	D	
242	6	11	12	C. L. Franklin			Du	330	28	30		U	17.19	9-14-55	B	D	
243	37	11	12	Bailey Franklin		1900	Du	240	11	30		U	8.32	9-14-55	B	D	
244	31	13	13	Ben Renois		1949	Du	290	17	36		U	13.05	9-15-55	B	D	
245	29	13	13	George Hunt, Jr			Du	240	26	72		U	13.84	9-15-55	J	D	
246	6	13	13	Asmus Fuller			Du	260	8	30		U	1.89	9-14-55	B	D	
247	16	13	14	Alton Perry			Du	345	23	30		U	16.40	9-14-55	B	D	
248	28	13	14	Lewis Richardson	Lewis A. Brooks	1954	D	325	238	4	228-238	N	80	1954	J	D, S	
249	5	13	15	C. P. Shows	Wm. S. Boone	1950	D	310	284	4		N	50	1950	J	D	
250	5	13	15	do		1950	B	320	60	8		U	22	1950	J	S	
251	1	12	16	Willie Barnes			Du	240	30	30		U	23.18	9-15-55	B	N	
252	14	12	16	Thomas Fern			Du	230	13	30		U	9.31	9-15-55	B	D	
253	23	12	16	J. R. Stelle	Woodfin	1954	D	240	100	4		DH	70	1954	J	D	
254	20	13	14	John Abington		1850	Du	310	21	30		U	16.91	9-16-55	S	D, S	
255	7	13	14	Dr. A. V. Young	Arkansas Fuel Oil Co.	1943	D	360	160	6		U			T	D	
256	6	13	14	M. Moran	Wm. S. Boone	1952	D	350	207	4		U	80	1952	J	D	
257	19	14	14	J. G. O'Brien	A. C. Morgan	1950	D	280	120	4		U	100	1950	J	D, S	
258	36	14	15	Victory Herbert	Victory Herbert		Du	305	22	30		U	15.00	9-16-55	B	D	
259	35	14	15	Marie Graves		1954	Du	320	44	36		U	37.79	9-16-55	J	D	
260	14	13	15	Mrs. Jonnie S. Rodger.		1800	Du	320	33	24		U	29.63	9-16-55	B	S	
261	25	13	15	Roy Gamble			Du	320	20	24		U	16.94	9-19-55	B	D	
262	27	13	15	Turner Mason		1945	D	290	250	4		N			T	D, S	
263	29	13	15	Miss Minnie Ward		1942	Du	285	31	30		U	25.60	9-19-55	B	D	
264	22	13	14	Claude Dance	W. C. Brummett	1950	D	340	256	4		DH	100	1950	S	D	
265	31	13	15	J. W. Moncrief		1935	Du	305	40	30		U	37.18	9-20-55	B	D	
266	4	12	15	Herman D. Gamble		1954	Du	310	23	30		U	21.01	9-20-55	S	D	

267	2	12	15	Mrs. Ed Brown	Ed Brown	1917	Du	310	15	30		U	9.30	9-20-55	B	D	
268	9	12	15	R. S. Horn		1905	B	290	20	36		U	16	1955	S	D	
269	10	12	15	L. C. Blunt	Woodfin	1923	D	240	39	7		U	13.13	9-20-55	J	I	Well reported to be 112 ft deep originally.
270	20	12	15	R. D. Register		1953	Du	260	24	30		U	17.94	9-20-55	B	N	
271	27	12	16	S. L. Scarber		1920	Du	240	17	30		TD	12.62	9-20-55	S	D	
272	15	12	15	C. L. Caldwell		1933	Du	275	15	36		U	12.88	9-20-55	S	D	
273	14	12	15	Merle L. Barnett			Du	300	14	30		U	11.20	9-20-55	B	D	
274	6	12	14	Mrs. Bertha Hall		1955	Du	305	34	30		U	27.00	9-20-55	B	D	
275	9	12	14	Wallace Wagner			Du	270	17	24		U	6.87	9-21-55	S	D, S	
276	29	12	14	Richard Johnson, Sr.			Du	310	18	24×34		U	13.04	9-21-55	B	D	
277	14	12	14	H. Pinkerson		1950	Du	290	13	30		U	8.74	9-21-55	B	D	
278	33	12	14	Morris Lee			Du	300	29	24		U	8.91	9-21-55	B	D	
279	33	12	14	S. H. Bates	B. F. Edington	1948	D	300	220	6		N	80	1948	T	D	Formerly (1948) used for industrial cooling system.
280	32	12	15	Southern Natural Gas Co.	Louisiana Well Co.	1952	D	210	92	10-6	52-92	U	11	1952	T	1	Pump capacity (reported) 87 gpm. Total of 75,000 gpd (reported) pumped from DS-280 and DS-281; 100,000 gal storage at station; 10,000 gal storage in village for domestic use. C.
281	31	12	15	Southern Natural Gas Co.	Louisiana Well Co.	1952	D	200	99	10-6	68-98	U	8	1952	T	1	Pump capacity (reported) 93 gpm. Temp 68° F. C.
282	33	12	14	do	do	1951	D	300	175	8	155-175	N			T	1	Pump capacity (reported) 52 gpm. Total of 12,000 gpd (reported) pumped. Temp 68° F.
283	26	12	16	C. E. Bogle			Du	220	21	30		TD	12.88	9-22-55	B	D	
284	36	12	16	H. L. Billingsley	J. G. Spurlock		D	280	180	6		N	55-60		J	D	
285	31	12	15	O. L. Morris	O. L. Morris	1943	D	230	35	2½		TD	Flowing	9-22-55	S	D	
286	31	12	15	do	do		D	230	33	6		TD	16.62	9-22-55		N	
287	20	12	15	Bethel Methodist Church.	do	1950	D	245	86	6		U			J	D	
288	6	11	15	S. H. Cox	S. H. Cox	1940	Du	200	17	30		TD	15.40	9-22-55	S	D	
289	9	11	15	Mrs. M. L. Mullen			Du	290	17	24		U	8.95	9-22-55	S	D	
290	3	11	15	McCoy Bros. Lumber Co.	A. C. Morgan		D	300	320	6		N			T	I	
291	3	11	15	H. H. Creech			Du	280	25	30		U	24.10	9-22-55	B	N	
292	3	11	15	Mrs. E. T. Rich	J. C. Spurlock	1955	D	280	135	4		N			J	D	
293	29	12	15	D. S. Gurley			Du	225	14	30		U	9.18	9-22-55	S	D	
294	1	11	15	J. V. Christian			Du	290	25	24		U	19.81	9-22-55	B	D	

TABLE 10.—*Description of water wells*—Continued

USGS well	Location: Section	Location: Township N.	Location: Range W.	Owner	Driller	Year completed	Type	Altitude (feet)	Depth (feet)	Casing diameter (inches)	Screened interval (feet)	Stratigraphic unit	Depth to water level below land surface (feet)	Date	Method of lift	Use	Remarks
De Soto Parish, La.—Continued																	
295	11	11	16	Blanton Boyd		1940	Du	205	15	36		TD	11.02	9-23-55	S	D	
296	18	11	15	W. M. Stephens			Du	200	13	30		TD	11.15	9-23-55	B	D	
297	20	11	15	W. C. Weir		1950	Du	240	12	30		TD	9.20	9-23-55	B	D	
298	27	11	15	Olin Mathieson			Du	270	31	36		TD	18.79	9-23-55	B	D	
299	36	11	15	N. L. Rogers		1950	Du	270	28	36		U	26.44	9-23-55	S	D	
300	36	11	15	Roy F. Flint			Du	270	26	30		U	20.40	9-23-55	S	D	
301	38	10	14	Mrs. Eunice McDonald.			Du	260	19	60		U	11.87	9-23-55	J	D	
302	35	12	14	Mrs. M. M. Hicks		1935	Du	292	18	36		U	13.47	9-26-55	S	D	
303	14	11	14	M. Johnson			Du	320	20	30		U	7.84	9-26-55	B	D	
304	27	11	14	W. H. Norris		1930	Du	230	20	30		U	16.46	9-26-55	B	D	
305	30	11	14	Mrs. F. M. Smith		1907	Du	285	20	30		U	8.38	9-27-55	S	D	
306	28	12	16	W. R. Spraggins			Du	230	24	30		TD	20.50	9-27-55	S	D, S	
307	9	12	16	T. G. Chandler			Du	270	26	30		U	16.48	9-27-55	T	D	
308	27	13	16	E. J. Ramsey			Du	305	21	30		U	16.61	9-27-55	J	D, S	
309	16	13	16	M. R. Speights		1940	B	315	53	8		U	20.60	9-27-55	J	D, S	
310	15	13	16	E. D. McFadden			Du	310	38	30		U	35.91	9-27-55	J	D, S	
311	29	14	15	S. F. Talbert	W. C. Barnwell	1955	D	330	288	3	245-288	N			A	I	Oil field supply (temporary).
312	34	13	14	E. S. Tatman	C. H. Chambers	1955	D	305	271	3	251-271	N	70	9- 7-55	J	D	
313	16	12	13	O. H. P. Sample		1954	D	350	247	6		N			T	D	
314	5	13	15	Frank Scheller	Quad Drilling Co.	1950	D	320	333	4½	318-333	N	62.71	11-18-55	T	D	
315	5	13	15	U.S. Geol. Survey	Tucker Drilling Co.	1955	D	325	577			DH				T	L. Electrical log available.
316	30	12	13	Mack M. Spears	do	1955	D	345	310	4	297-310	N	133	1955	T	D	L.
317	10	12	13	Mrs. Farmer	Montgomery Drilling Co.	1956	D	345	308	4-2	298-308	N	130	3- 3-56	T	D	
318	27	12	11	U.S. Geol. Survey		1954	B	135	48	1½	45-48	Al	25.95	10-21-54		T, O	L.
319	25	12	11	do		1954	B	135	43	1½	40-43	Al	29.73	10-21-54		T, O	L.
320	10	13	12	do		1955	B	135	98			N				T	L.
321	10	13	12	do		1955	B	165	60			TD				T	L.
322	11	14	14	do		1956	B	215	65			U				T	L
323	2	14	13	do		1956	B	165	100			U				T	L.
324	34	14	12	do		1956	B	176	100			TD				T	L.
325	31	12	15	do		1956	B	228	100			U				T	L.
326	5	13	15	Frank Scheller	Tucker Drilling Co.	1955	D	325	324	4-2	210-220 232-242 270-280 310-320	N	56.85	12-29-55	J	D, S	

75				Town of Logansport (1)	Town of Logansport.	1936	D	170	208	12-4	128-208	N	19.1	4-14-37	T	P	L;C. Chloride content (6-9-55) 200 ppm. Pump discharge (6-8-55) 55.1 gpm at 12 psi line pressure. Temp 67°F.
185				Town of Logansport (2)	Hogan	1941	D	170	196	12-8	136-196	N			J	P	Choride content (6-9-55) 32 ppm. Pump discharge (6-7-55) 21.7 gpm at 81 psi line pressure. Temp 68°F.
186	(1)			Town of Logansport (3)	A. C. Morgan	1948	D	170	217	12-8	157-217	N	61.31	1-12-55		N, O	Well unused since 1950 because of objectionable chloride content of water.
187				Town of Logansport (4)	Louisiana Well Co.	1951	D	170	154	12-6	100-154	N			T	P	C. Chloride content (6-9-55) 420 ppm. Pump discharge (6-7-55) 54.4 gpm at 21 psi line pressure. Temp 69°F.
188				Town of Logansport (5)	do	1952	D	170	156	12-6	102-156	N			T	P	Chloride content (6-9-55) 316 ppm. Pump discharge (6-7-55) 30.6 gpm at 12 psi line pressure. Temp 68°F.

[1] See plate 6.

TABLE 12.—*Pumpage record of the City of Mansfield, La.*

[Millions of gallons]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total annual
1948			9.134	10.339	12.172	15.451	16.619	18.516	15.842	14.766	14.594	13.927	
1949	11.838	11.337	11.617	11.155	13.635	17.548	18.580	15.961	13.627	12.281	12.676	12.579	162.834
1950	13.468	13.018	14.222	13.102	16.061	17.101	20.829	22.719	16.223	16.497	16.024	16.461	195.725
1951	17.458	17.306	17.298	17.054	21.356	20.231	22.815	27.612	19.025	18.895	17.508	18.018	234.576
1952	18.589	13.891	14.938	15.155	16.459	22.153	22.038	19.713	18.508	18.241	14.452	13.407	207.544
1953	12.912	11.442	13.717	13.623	14.574	24.049	21.673	21.858	22.120	20.344	16.322	15.230	207.864
1954	16.615	13.875	16.724	17.926	19.811	25.346	24.494	22.070	20.882	17.686	15.948	15.634	227.011
1955	15.782	14.551	16.819	17.231	20.845	22.260	19.476	19.651	19.134	18.007	17.962	17.035	218.753
1956	17.659	15.942	16.845	16.384	19.152	20.879	23.801						

TABLE 13.—*Chemical analyses of water from wells in De Soto and Red River Parishes, La., and Shelby County, Tex.*

[Unless otherwise indicated, analyses by U.S. Geol. Survey. Stratigraphic unit: Al, alluvium; U, undifferentiated Wilcox group; DH, Dolet Hills formation; N, Naborton formation]

USGS well	Depth of well (feet)	Strati-graphic unit	Date of collec-tion	Tem-pera-ture (°F)	Parts per million																		Specific conductance (micromhos at 25°C)	pH	Color	Remarks
					Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Boron (B)	Dissolved solids residue on evaporation at 180°C	Hardness as $CaCO_3$	Free carbon dioxide				
												De Soto Parish, La.														
DS-4	160	N	4-30-41	------	------	------	------	------	------	------	------	401	----	10	8	0.0	2.3	------	------	------	12	------	------	------	----	
13	252	N	4-29-41	68	24	0.04	------	20	5.5	146	2.4	325	0	35	66	.1	2.4	------	------	467	73	------	------	------	----	
18	245	N	3- 3-55	69	23	.72	0.00	20	5.4	154	2.7	334	0	37	70	.2	1.8	0.53	0.42	485	72	11	805	7.7	5	
21	250	N	4-30-41	------	------	------	------	------	------	------	------	296	----	8	18	.6	------	------	------	------	33	------	------	------	----	
21	250	N	1- 6-55	67	20	.04	.02	7.6	1.9	112	2.5	291	0	8.1	20	.2	.0	------	.06	305	27	5.8	510	7.9	5	
22	255	DH	4-30-41	------	------	------	------	------	------	------	------	289	----	10	18	.2	------	------	------	------	27	------	------	------	----	
23	377	N	3- 4-55	71	36	4.8	.10	5.2	2.6	38	1.5	87	0	15	16	.2	.2	.08	.11	159	24	------	228	7.0	15	Precipitated Fe 4.6 ppm.
24	336	N	2- 3-54	65	17	.60	.02	13	2.2	94	2.0	271	0	10	12	.1	1.2	.36	.19	284	42	8.6	468	7.7	5	
26	204	DH	3- 3-55	------	32	1.3	.20	36	14	38	2.3	244	0	10	14	.2	1.2	.25	.03	255	147	9.7	432	7.6	0	
29	186	U	3- 3-55	------	68	.26	.01	5.0	1.1	8.3	.8	36	0	1.8	4.2	.1	.8	1.2	.07	116	17	18	83	6.5	0	
67	135	N	4-22-55	------	16	.04	.01	11	3.7	98	2.1	256	0	8.9	29	.3	2.0	.3	.34	302	43	------	505	7.7	0	
80	320	N	4-27-55	68	28	------	.43	224	105	168	4.3	256	0	568	395	.2	2.2	.00	.18	1,870	990	------	2,490	8.1	5	
82	398	N	4-28-55	------	16	.12	.02	2.1	.3	474	2.2	828	19	.4	220	1.8	.0	3.7	2.3	1,160	6	------	1,930	8.4	45	
112	185	N	4-27-55	------	22	.04	.02	5.8	2.4	301	3.1	525	0	106	90	.1	2.8	.4	.60	795	24	------	1,280	8.0	10	
115	213	N	3- 4-55	------	14	.22	.00	2.6	.4	247	1.4	524	18	20	45	.4	3.5	1.5	.08	613	8	------	1,020	8.3	20	
129	142	N	3- 4-55	69	15	------	.05	11	3.3	326	3.3	535	0	1.0	226	.8	4.0	.12	1.7	878	41	------	1,490	8.0	5	
147	196	N	3- 4-55	68	12	.62	.00	6.8	1.9	154	2.2	368	0	5.9	35	.2	2.8	.78	.56	406	25	------	681	8.1	5	
175	213	DH	4-27-55	68	21	------	.10	31	7.0	39	2.1	207	0	2.7	13	.1	1.2	.3	.01	216	106	------	360	8.0	10	
176	237	DH	3- 4-55	------	40	5.9	.10	50	13	110	3.8	255	0	78	98	.1	3.2	.07	.24	530	178	------	874	7.7	0	
178	345	N	3-31-55	71	9.5	.10	.00	.4	.2	136	1.3	341	0	.8	15	.1	2.0	.6	.51	350	2	------	559	7.9	30	
208	220	N	11- 4-55	------	14	.52	.02	4.2	.1	175	1.4	375	0	45	30	.2	2.2	.9	.40	462	11	4.7	748	8.1	15	
218	240	DH	11- 3-55	68	40	21	.39	23	13	22	1.8	135	0	16	26	.3	.0	.00	.18	212	112	34	336	6.8	0	

223	137	DH	11- 3-55	------	31	2.6	.10	45	20	93	5.0	238	0	123	64	.1	2.5	.01	.46	500	194	19	803	7.3	0	Al, 1.2 ppm.
238	223	DH	11- 4-55	------	59	22	.04	18	2.6	45	1.7	88	0	44	47	.1	.0	.01	.41	278	56	35	383	6.6	0	Al, 4.8 ppm.
281	99	U	11- 4-55	68	60	5.4	.10	2.9	2.1	17	2.2	50	0	2.6	8.5	.1	.0	.01	.10	121	16	10	115	6.9	5	
282	175	N	11- 4-55	68	11	.61	.00	1.8	.1	153	.9	328	4	12	37	.2	1.2	.8	.60	388	5	2.7	638	8.3	20	
Red River Parish, La.																										
RR-50[1]	105	Al	2- 9-55	67	26	4.4	-----	102	55	56	1.6	545	0	73	62	0.3	3.0	0.01	0.00	657	480	-----	1,080	7.2	0	
85[2]	78	Al	5- 5-55	67	25	5.9	0.07	111	54	34	1.4	617	0	21	39	.3	2.0	.2	.16	591	499	-----	1,030	7.3	0	
Shelby County, Tex.																										
75[3]	208	N	4-30-37	------	------	------	-----	11	1.0	30		43	----	19	28	----	----	-----	-----	110	31	-----	------	-----	----	
75	208	N	11- 3-55	67	16	0.43	0.02	8.2	.8	288	2.0	440	0	3.7	208	1.0	0.0	2.3	1.0	756	24	-----	1,300	7.9	30	Gas in water.
187	154	N	11- 3-55	69	12	.10	.00	3.2	1.0	546	3.2	775	0	1.8	410	3.6	.0	2.2	1.8	1,420	12	-----	2,400	8.0	35	Do.

[1] Well RR-50 is in sec. 29, T. 14 N., R. 11 W., in Red River Parish.
[2] Well RR-85 is in sec. 7, T. 14 N., R. 11 W., in Red River Parish.
[3] Analyses by Works Progress Administration.

TABLE 14.—*Constituents commonly found in ground water*

Constituent	Source	Significance
Silica (SiO_2)	Siliceous minerals present in essentially all rocks.	Forms hard scale in pipes and boilers. Inhibits deterioration of zeolite-type water softeners.
Iron (Fe)	The common iron-bearing minerals present in most formations.	Oxidizes to a reddish-brown precipitate which discolors water. More than about 0.3 ppm stains laundry and utensils reddish brown; source of deposits in water lines and boilers; objectionable for food processing, beverages. Larger quantities impart taste and favor growth of iron bacteria.
Manganese (Mn)	Manganese-bearing minerals, generally associated with iron.	Less common than iron; in general has same objectionable features; brown to black stain. Total iron and manganese content should not exceed 0.3 ppm for public water supply.
Calcium (Ca) and magnesium (Mg).	Minerals that form limestone and dolomite and are present in essentially all rocks. Gypsum also a common source of calcium.	Cause most of the hardness and scale-forming properties of water; soap consuming. Recommended limit of magnesium for potable waters, 125 ppm.
Sodium (Na) and Potassium (K).	Feldspars and other common minerals; sea and connate water; industrial brines, sewage.	As chlorides in large amounts give salty taste; objectionable for irrigation water and specialized industrial water uses. Recommended limit for percent sodium in irrigation water less than 60.
Bicarbonate (HCO_3) and carbonate (CO_3).	Action of carbon dioxide in water on carbonate minerals.	In combination with calcium and magnesium forms carbonate hardness; decomposes in boiling water with attendant formation of scale and release of corrosive carbon dioxide gas.
Sulfate (SO_4)	Gypsum, iron sulfides	Sulfates of calcium and magnesium give bad taste, form hard scale. Recommended limit for potable waters not more than 250 ppm.
Chloride (Cl)	Found in small to large amounts in all soils and rocks; sewage, artificial brines, sea and connate water.	Adds to content of solids and increases corrosive character of water; objectionable for various specialized industrial uses of water; may indicate the presence of animal pollution.
Fluoride (F)	Various minerals of widespread occurrence, in minute amounts.	Not generally of significance industrially. In water consumed by children, about 1.5 ppm or more may cause mottling of the tooth enamel; about 1.0 ppm seems to lessen the incidence of tooth decay.
Nitrate (NO_3)	Decayed organic matter; sewage, nitrate fertilizers, nitrates in soil.	Values higher than the local average may suggest pollution. High concentrations may cause methemoglobinemia in infants. Useful in control of boiler embrittlement.

TABLE 15.—*Description of samples from geologic and hydrologic test holes*

Material	Thickness (feet)	Depth (feet)
Well DS-175		
[Location: Sec. 2, T. 14 N., R. 14 W.; alt: 220 ft]		
Paleocene series—Wilcox group undifferentiated:		
Clay (no sample)	26	26
Shale (no sample)	30	56
Sand, quartz, rounded to subrounded, fine, light-olive-gray; large percentage lignite and small percentage dark minerals	35	91
Sand, quartz, rounded to subrounded, fine, light-olive-gray; large percentage of silt and clay	5	96
Sand, quartz, rounded to subrounded, very fine to fine, light-olive-gray; large percentage lignite and small percentage dark minerals; large percentage of silt and calcareous clay	6	102
Sand, quartz, rounded to subrounded, very fine to fine, light-olive-gray; large percentage lignite and small percentage dark minerals; large percentage of silt and small percentage of calcareous clay	5	107
Sand, quartz, rounded to subrounded, fine to very fine, light-olive-gray; large percentage lignite and small percentage dark minerals; large percentage of calcareous clay	5	112
Sand, quartz, rounded to subrounded, fine, olive-gray; large percentage lignite and dark minerals; large percentage of slightly calcareous clay	5	117

TABLE 15.—*Description of samples from geologic and hydrologic test holes*—Con.

Material	Thickness (feet)	Depth (feet)
Well DS-175—Continued		
Paleocene series—Wilcox group—Dolet Hills formation:		
Sand, quartz, rounded to subrounded, fine to medium, olive-gray; large percentage lignite and small percentage dark minerals; small percentage of gray clay	5	122
Sand, quartz, rounded to subrounded, fine, light-olive-gray; large percentage lignite and dark minerals; small percentage of gray calcareous clay	10	132
Sand, quartz, rounded to subrounded, fine, light-olive-gray; large percentage lignite and dark minerals; small percentage of light-gray silt	5	137
Sand, quartz, rounded to subrounded, fine, light-olive-gray; large percentage lignite and dark minerals; small percentage of light-gray slightly calcareous silt	5	142
Sand, quartz, rounded to subrounded, fine, light-olive-gray; large percentage lignite and dark minerals	5	147
Sand, quartz, rounded to subrounded, fine, light-olive-gray; large percentage lignite and dark minerals; small percentage of light-gray silt	15	162
Sand, quartz, rounded to subrounded, fine, light-olive-gray; large percentage lignite and dark minerals; small percentage of light-gray slightly calcareous silt	5	167
Sand, quartz, rounded to subrounded, fine, light-olive-gray; large percentage lignite and dark minerals; small percentage of light-gray silt	5	172
Sand, quartz, rounded to subrounded, fine, light-olive-gray; large percentage lignite and dark minerals; small percentage of light-gray silt (large pieces lignite)	5	177
Sand, quartz, rounded to subrounded, fine, light-olive-gray; large percentage lignite and dark minerals; large percentage of silt	5	182
Sand, quartz, rounded to subrounded, fine, light-olive-gray; large percentage lignite and dark minerals; small percentage of light-gray silt (small fragments of siltstone)	5	187
Sand, quartz, rounded to subrounded, fine, light-olive-gray; large percentage lignite and dark minerals; small percentage of light-gray slightly calcareous silt	5	192
Sand, quartz, rounded to subrounded, fine, light-olive-gray; large percentage lignite and dark minerals; small percentage of light-gray silt (small fragments of siltstone)	5	197
Sand, quartz, rounded to subrounded, fine, light-olive-gray; large percentage lignite and dark minerals; small percentage of light-gray silt (several large fragments of lignite)	5	202
Well DS-183		
[Location: Sec. 9, T. 12 N., R. 13 W.; alt: 320 ft]		
Paleocene series—Wilcox group undifferentiated:		
Clay, red (no sample)	8	8
Sand, quartz, very fine to fine, rounded to subrounded, grayish-orange, iron-stained, silty; small percentage of dark minerals (magnetite, amphiboles, pyroxenes)	22	30
Sand, quartz, fine, rounded to subrounded, light-gray; large percentage of dark minerals	5	35
Sand, quartz, fine to very fine, rounded to subrounded, gray, small percentage iron-stained, silty; small amount of gray clay; large percentage of dark minerals	15	50
Clay, olive-gray, silty and slightly sandy (fine to very fine rounded to subrounded, quartz sand)	25	75
Paleocene series—Wilcox group—Dolet Hills formation:		
Sand, quartz, fine to very fine, rounded to subrounded, light-olive-gray (very little iron stain); small amount of gray clay; large percentage of dark minerals, lignite	15	90
Shale, hard (no sample—driller's description)	10	100
Sand, quartz, very fine to fine, rounded to subrounded, olive-gray, silty; gray clay; large percentage of dark minerals; lignite	23	123
Sand, quartz, fine to medium, rounded to subrounded, light-gray; large percentage of lignite; small percentage of dark minerals	10	133
Shale, brown (driller's description—no sample)	7	140
Rock (no sample)	1	141
Paleocene series—Wilcox group—Naborton formation:		
Sand, quartz, fine to medium, rounded to subrounded, light-olive-gray; small amount of silt and clay; large percentage of lignite; small percentage of dark minerals; scattered mica flakes	14	155
Sand, quartz, fine to very fine, rounded to subrounded, light-olive-gray; large percentage of lignite	15	170
Sand, quartz, medium to fine, rounded to subrounded, light-olive-gray, slightly silty; large percentage of lignite	36	206
Shale, sandy (driller's description—no sample)	18	224
Sand, quartz, very fine to medium, rounded to subrounded, light-olive-gray (very little iron stain), slightly silty; large percentage of lignite	6	230
Sand, quartz, fine, rounded to subrounded, light-gray; small percentage of lignite	32	262
Lignite, shale, and fine to very fine (small percentage of medium), rounded to subrounded light-olive-gray quartz sand containg a large percentage of lignite, some silt and calcareous clay	29	291
Rock (no sample)	2	293
Sand, quartz, very fine to fine (some medium), rounded to subrounded, light-olive-gray, silty, calcareous; large percentage of lignite	17	310

TABLE 15.—*Description of samples from geologic and hydrologic test holes*—Con.

Material	Thickness (feet)	Depth (feet)
Well DS-183—Continued		
Paleocene series—Wilcox group—Naborton formation—Continued		
Clay, medium-gray, silty and slightly sandy; small spots of yellow and tan silt; large amount of lignite	18	328
Rock (no sample)	1	329
Clay, medium-gray, slightly silty; small percentage of lignite	31	360
Rock (no sample)	1	361
Clay, medium-gray, slightly silty; small percentage of lignite	7	368
Rock (no sample)	1	369
Clay, medium-gray, slightly silty; small percentage of lignite	42	411
Rock (no sample)	1	412
Clay, medium-gray, slightly silty; small percentage of lignite	17	429
Rock (no sample)	3	432
Clay, medium-gray; thin layers of light-gray silt	30	462
Rock (no sample)	2	464
Clay, medium-gray, slightly silty; small pockets of yellow to very light-gray silt	6	470
Clay, medium-gray, very slightly silty	20	490
Clay, medium-gray, slightly silty; small amount of lignite	20	510
Clay, medium-gray; small amount of yellowish-gray silt	26	536
Rock (no sample)	2	538
Clay, medium-gray, very slightly silty	12	550
Clay, medium-gray	25	575
Rock (no sample)	1	576
Clay, medium-gray	27	603
Well DS-315		
[Location: Sec. 5, T. 13 N., R. 15 W.; alt: 325 ft]		
Paleocene series—Wilcox group undifferentiated:		
Topsoil (no sample)	2	2
Silt, quartz, rounded to subrounded, yellowish-gray (slight iron stain); a few pink quartz grains	12	14
Sand, quartz, rounded to subrounded, fine, yellowish-gray; small percentage of dark minerals	17	31
Sand, quartz, rounded to subrounded, fine to medium; large percentage of gray clay	13	44
Silt, quartz, rounded to subrounded, yellowish-gray, iron-stained, very sandy	3	47
Sand, quartz, rounded to subrounded, very fine, gray; large percentage of gray clay and silt	20	67
Sand, quartz, rounded to subrounded, very fine to fine, gray; large percentage of light-gray clay and small percentage of dark minerals (chiefly lignite)	3	70
Clay, light-gray, silty and slightly sandy (very fine to fine, rounded to subrounded, quartz sand)	10	80
Clay, silty, calcareous light-gray; large percentage of lignite	10	90
Lignite (no sample)	1	91
Sand, quartz, rounded to subrounded, very fine to fine, light-gray; large percentage of gray clay and calcareous silt	9	100
Silt, quartz, rounded to subrounded, light-gray, sandy (most of sand very fine); small percentage of calcareous clay	10	110
Clay, medium-gray; large percentage of lignite and medium-gray calcareous silt (quartz)	6	116
Lignite and gray clay (no sample)	3	119
Clay, medium-gray, silty, slightly calcareous; small percentage of lignite	6	125
Clay, medium-gray, silty, slightly calcareous; small percentage of lignite	5	130
Clay, medium-gray, silty, slightly calcareous; large percentage of lignite	10	140
Clay, medium-gray, calcareous, slightly silty; small percentage of lignite	10	150
Clay, medium-gray, calcareous, slightly silty; small percentage of lignite	10	160
Sand, quartz, rounded to subrounded, very fine to fine, light-olive-gray; gray silt and small amount of gray clay; small amount of lignite	10	170
Sand, quartz, rounded to subrounded, fine to very fine, light-olive-gray; small amount of lignite and slightly calcareous gray silt	10	180
Clay, medium-gray, slightly calcareous, silty, slightly sandy; large percentage of lignite	10	190
Paleocene series—Wilcox group—Dolet Hills formation:		
Clay, light-olive-gray, silty; large percentage of lignite; small percentage of very fine gray quartz sand	10	200
Clay, light-olive-gray, slightly silty; small percentage of lignite	14	214
Sand, quartz, rounded to subrounded, fine, light-olive-gray; small amount of silt and lignite	6	220
Sand, quartz, rounded to subrounded, fine to very fine, light-olive-gray; large percentage of silt; small percentage of lignite	10	230
Sand, quartz, rounded to subrounded, fine to very fine, medium-gray; large percentage of light-gray clay and lignite	12	242
Hard layer (rock?)	.5	242.5

TABLE 15.—*Description of samples from geologic and hydrologic test holes*—Con.

Material	Thickness (feet)	Depth (feet)
Well DS-315—Continued		
Paleocene series—Wilcox group—Naborton formation:		
Sand, quartz, rounded to subrounded, fine, medium-gray; small percentage of light-gray clay; large percentage of lignite	9.5	252
Rock, thin (no sample)	.5	252.5
Sand, quartz, rounded to subrounded, fine to very fine, medium-gray; large percentage of lignite	7.5	260
Sand, quartz, rounded to subrounded, very fine, light-gray; large percentage of light-gray silt and lignite	20	280
Sand, quartz, rounded, very fine, light-gray; large percentage of lignite	6	286
Lignite, hard (no sample)	.5	286.5
Sand, quartz, rounded, very fine, light-gray; large percentage of lignite	3.5	290
Sand, quartz, rounded to subrounded, very fine, light-gray; large percentage of lignite	30	320
Sand, quartz, rounded to subrounded, very fine, light-gray; small percentage of light-gray silt; large percentage of lignite	6	326
Lignite	3	329
Sand, quartz, rounded, very fine, light-olive-gray; large percentage of lignite (from 3-ft lignite bed above)	11	340
Sand, quartz, rounded, very fine, light-gray; small percentage of lignite	16	356
Sand, quartz, rounded to subrounded, fine to very fine, light-olive-gray; small percentage of silt; large percentage lignite	4	360
Sand, quartz, rounded to subrounded, very fine, light-olive-gray; small percentage silt and lignite	8	368
Lignite	1	369
Sand, quartz, rounded, very fine to fine, light-olive-gray; small percentage silt; large percentage lignite	11	380
Sand, quartz, rounded, very fine to fine, light-gray; large percentage lignite	10	390
Sand, quartz, rounded, very fine to fine, light-olive-gray; large percentage of calcareous silt; small percentage lignite	6	396
Rock (no sample)	1.3	397.3
Sand, quartz, rounded, very fine to fine, light-olive-gray; large percentage of calcareous silt; small percentage lignite	2.7	400
Sand, quartz, rounded to subrounded, fine to very fine, yellowish-gray; large percentage calcareous silt; large percentage lignite	8	408
Rock (no sample)	.7	408.7
Sand, quartz, rounded to subrounded, fine to very fine, yellowish-gray; large percentage calcareous silt; large percentage lignite	2.3	411
Lignite (no sample)	2	413
Sand, quartz, rounded to subrounded, fine to very fine, light-olive-gray; large percentage light-olive-gray calcareous silt; small percentage lignite	4	417
Rock (no sample)	1	418
Sand, quartz, rounded to subrounded, fine to very fine, light-olive-gray; large percentage light-olive-gray calcareous silt; small percentage lignite	18	436
Rock (no sample)	.7	436.7
Sand, quartz, rounded to subrounded, fine to very fine, light-olive-gray; large percentage light-olive-gray calcareous silt; small percentage lignite	15.3	452
Paleocene series—Midway group—Porters Creek clay:		
Lignite	4	456
Lignite; small amount of gray silt and very fine gray sand	4	460
Lignite (no sample)	10	470
Lignite	3	473
Lignite; small percentage of light-gray silt and sand	2	475
Lignite	5	480
Lignite; small percentage of light gray silt	10	490
Lignite; small percentage of light-gray clay	30	520
Lignite (no sample)	26	546
Lignite, hard (driller reported rock); coarse to very coarse sand; large percentage dark minerals	1.5	547.5
Lignite; small percentage silt	4.5	552
Silt, quartz, rounded, light-olive-gray; small percentage very fine light-gray sand	18	570
Clay, tough, light-olive-gray, slightly calcareous; small percentage silt and lignite (sample taken from bottom of bit)	----------	570

TABLE 15.—*Description of samples from geologic and hydrologic test holes*—Con.

Material	Thickness (feet)	Depth (feet)
Well DS-318		
[Location: Sec. 25, T. 12 N., R. 11 W.; alt: 135 ft]		
Recent and Pleistocene series—Alluvium:		
Silt, red	4	4
Clay, silty, red	1	5
Sand, fine, red	3	8
Sand, fine, red, water-saturated	4	12
Clay, stiff, gray to green	15	27
Clay, red	1	28
Silt and sand, fine, reddish-brown	10	38
Sand, fine to medium, reddish-brown	5	43
Well DS-319		
[Location: Sec. 27, T. 12 N., R. 11 W.; alt: 135 ft]		
Recent and Pleistocene series—Alluvium:		
Silt, red	1	1
Clay, silty, hard, red	2	3
Silt, red	2	5
Clay, silty, soft, red	2	7
Silt, red, and fine sand	6	13
Silt, red, water-saturated	17	30
Sand, fine to medium, red-brown	10	40
Sand, medium, red-brown	18	58
Paliocene series—Wilcox group—Naborton formation:		
Clay, tough	5	63
Well DS-320		
[Location: Sec. 10, T. 13 N., R. 12 W.; alt: 135 ft]		
Pleistocene series—Terrace deposits:		
Sand, quartz, rounded to subrounded, very fine to fine, yellowish-red, iron-stained (scattered fine grains of clear quartz)	5	5
Sand, quartz, rounded to subrounded, very fine to fine, yellowish-red, iron-stained; large percentage of silt	5	10
Clay, gray and red (no sample)	1	11
Clay, silty (no sample)	8	19
Paleocene series—Wilcox group—Naborton formation:		
Clay, olive-gray, slightly sandy; small amount of lignite	31	50
Clay, olive-gray; thin silt laminae and very small amount of very fine sand and lignite (very hard 78–80; soft 80–81)	31	81
Clay, tough, light-olive-gray (reported as rock); small amount of silty and slightly sandy gray clay	6	87
Clay, hard (no sample)	3	90
Clay, soft	8	98
Well DS-321		
[Location: Sec. 10, T. 13 N., R. 12 W.; alt: 165 ft]		
Pleistocene series—Terrace deposits:		
Silt, slightly sandy, red	27	27
Sand, quartz, rounded to subrounded, fine to very fine, yellowish-red, iron-stained	6	33
Sand, quartz, rounded to subrounded, fine to very fine (few medium grains), yellowish-red, iron-stained; small percentage of dark minerals	17	50
Clay, yellow, silty and sandy	10	60
Well DS-322		
[Location: Sec. 11, T. 14 N., R. 14 W.; alt: 215 ft]		
Pleistocene series—Terrace deposits:		
Clay, tough, light-gray; yellow and red iron stains	28	28
Paleocene series—Wilcox group undifferentiated:		
Clay, tough, dark-gray; small amount of mica (in small flakes)	2	30
Clay, tough, dark-gray; scattered small flakes of mica; thin layers of fine sand near bottom	33	63

TABLE 15.—*Description of samples from geologic and hydrologic test holes*—Con.

Material	Thickness (feet)	Depth (feet)
Well DS-323		
[Location: Sec. 2, T. 14 N., R. 13 W.; alt: 165 ft]		
Pleistocene series—Terrace deposits:		
Clay, gray and yellow	13	13
Clay, yellow	15	28
Clay, red	47	75
Paleocene series—Wilcox group undifferentiated:		
Sand, clear quartz, rounded to subrounded, fine, silty, gray; noncalcareous small percentage of lignite	3	78
Clay, brownish-gray, silty; small percentage of very fine to medium quartz sand	22	100
Well DS-324		
[Location: Sec. 34, T. 14 N., R. 12 W.; alt: 176 ft]		
Pleistocene series—Terrace deposits:		
Clay, slightly silty, light-brown (red and yellow when fresh)	13	13
Clay, gray	.5	13.5
Sand, quartz, very fine to fine, reddish-brown (iron-stained), some clear, subrounded to rounded	56.5	70
Sand, quartz, fine to medium, rounded to subrounded, reddish-brown (iron-stained)	2	72
Sand, quartz, medium to fine, rounded to subrounded, light-yellowish-brown (iron-stained)	6	78
Sand, quartz, coarse to very fine, rounded to subrounded, light-yellowish-brown (iron-stained)	10	88
Sand, quartz, medium to very fine, rounded to subrounded, light-yellowish-brown (iron-stained)	12	100
Well DS-325		
[Location: Sec. 31, T. 12 N., R. 15 W.; alt: 228 ft]		
Pleistocene series—Terrace deposits:		
Clay, silty, yellow; small amount of very fine sand	5	5
Clay, silty, gray and red; small amount of very fine sand	5	10
Sand, quartz, very fine to fine, rounded to subrounded, light-yellow and gray (iron-stained), silty; occasional subangular grains of dark minerals	9	19
Clay, silty, light-gray and yellow; small amount of very fine sand	4	23
Sand, quartz, medium to fine, rounded to subrounded, light-yellowish-brown (iron-stained); occasional subangular grains of dark minerals	5	28
Sand, quartz, fine to medium, rounded to subrounded, light-yellowish-brown (iron-stained), silty; occasional subangular grains of dark minerals	10	38
Sand, quartz, very fine, rounded to subrounded, light-olive-brown (iron-stained), very silty	20	58
Paleocene series—Wilcox group undifferentiated:		
Sand, quartz, very fine to fine, rounded to subrounded, light-olive-gray, very clayey	10	68
Clay, dark-gray, silty, lignitic; thin laminae of gray and yellow very fine sand	5	73
Clay, olive-gray, sandy, (very fine, rounded quartz sand grains)	30	103
Well Texas A-1		
[Location: Shelby County; alt: 170 ft]		
Recent and Pleistocene series—Alluvium:		
Sand, quartz, very fine to fine, rounded to subrounded, light-yellowish-brown (iron-stained); small amount of clay	30	30
Sand, quartz, very fine to fine, rounded to subrounded, light-yellowish-gray; large amount of clay	1	31
Paleocene series—Wilcox group undifferentiated:		
Sand, quartz, medium to fine, rounded to subrounded, dark-yellowish-brown (iron-stained); small amount of subangular dark minerals	17	48
Sand, quartz, fine to very fine, rounded to subrounded, dark-brown (iron-stained); small amount of subangular dark minerals	25	73
Sand, quartz, fine to very fine, rounded to subrounded, dark-brown (iron-stained); scattered subangular grains of dark minerals	25	98
Sand, quartz, very fine to fine, rounded to subrounded, brownish-gray (iron-stained)	2	100

TABLE 16.—*Records of water-level measurements in observation wells*

Date	Water level in feet below land surfaec	Date	Water level in feet below land surface	Date	Water level in feet below land surface
Well DS-55					
[Owner: E. H. Powell; location: Sec. 10, T. 15 N., R. 14 W.]					
12-7-54	17.38	3-29-55	16.05	11-18-55	16.59
12-14-54	17.22	4-19-55	15.17	12-29-55	16.95
12-27-54	17.29	5-10-55	16.30	1-26-56	16.98
1-6-55	16.49	5-25-55	15.55	2-27-56	15.47
1-19-55	17.58	6-17-55	15.52	3-29-56	14.88
2-8-55	16.99	7-1-55	16.41	4-26-56	14.46
2-23-55	16.68	9-1-55	15.08	5-28-56	14.77
3-10-55	16.33	9-28-55	15.88	6-22-56	15.26
Well DS-59					
[Owner: De Soto Parish Police Jury; location: Sec. 36, T. 13 N., R. 14 W.]					
12-6-54	127.06	4-19-55	126.33	12-29-55	127.38
12-14-54	126.86	5-10-55	126.61	2-27-56	126.82
12-27-54	126.96	5-25-55	126.66	3-13-56	126.72
1-6-55	127.34	6-17-55	126.71	3-29-56	126.92
1-19-55	126.94	7-1-55	126.85	4-26-56	126.96
2-23-55	126.60	9-1-55	127.08	5-28-56	126.95
3-10-55	126.50	9-28-55	127.26	6-22-56	127.17
3-29-55	126.57	11-18-55	127.45		
Well DS-68					
[Owner: J. M. Ford; location: Sec. 30, T. 13 N., R. 14 W.]					
12-16-54	44.85	4-19-55	9.39	12-29-55	43.92
12-27-54	44.99	5-10-55	19.82	1-26-56	44.25
1-6-55	45.08	5-25-55	9.75	2-27-56	10.38
1-19-55	45.16	6-17-55	22.09	3-29-56	12.32
2-8-55	45.08	7-1-55	30.30	4-26-56	12.17
2-23-55	45.45	9-1-55	17.11	5-28-56	12.81
3-10-55	45.90	9-28-55	33.71	6-22-56	20.01
3-29-55	35.03	11-18-55	42.56		
Well DS-69					
[Owner: J. M. Ford; location: Sec. 30, T. 13 N., R. 14 W.]					
12-16-54	72.99	4-19-55	70.75	12-29-55	74.75
12-27-54	73.31	5-10-55	73.29	1-26-56	74.90
1-6-55	74.42	5-25-55	70.15	2-27-56	71.80
1-19-55	74.92	6-17-55	72.91	3-29-56	72.18
2-8-55	73.54	7-1-55	74.06	4-26-56	71.37
2-23-55	74.00	9-1-55	73.63	5-28-56	71.37
3-10-55	75.10	9-28-55	74.63	6-22-56	72.90
3-29-55	72.90	11-18-55	74.64		

TABLE 16.—*Records of water-level measurements in observation wells*—Continued

Date	Water level in feet below land surface	Date	Water level in feet below land surface	Date	Water level in feet below land surface
Well DS-76					
[Owner: Town of Logansport; location: Sec. 3, T. 11 N., R. 16 W.]					
1-6-55	62.18	5-24-55	62.02	1-26-56	63.10
1-19-55	62.17	6-17-55	62.37	2-27-56	60.12
2-8-55	62.12	7-1-55	62.55	3-13-56	62.94
2-23-55	62.14	7-15-55	62.54	3-29-56	63.12
3-10-55	62.14	9-14-55	62.76	4-26-56	63.18
3-29-55	62.16	9-28-55	62.82	5-28-56	63.25
4-19-55	61.94	12-29-55	63.19	6-22-56	63.32
5-9-55	62.27				
Well DS-80					
[Owner: R. E. Nicholson; location: Sec. 20, T. 15 N., R. 14 W.]					
3-30-55	60.30	3-29-56	59.50	5-28-56	59.6
1-26-56	57.30	4-26-56	59.45	6-22-56	60.50
2-27-56	64.02				
Well DS-175					
[Owner: J. E. Tyler; location: Sec. 2, T. 14 N., R. 14 W.]					
3-3-55	15.85	9-1-55	22.47	2-27-56	21.39
4-22-55	21.96	9-28-55	23.21	3-29-56	21.19
4-27-55	21.88	11-18-55	22.48	4-26-56	21.15
5-25-55	26.81	12-29-55	22.69	5-28-56	21.15
7-1-55	26.24	1-26-56	21.56	6-22-56	21.20

TABLE 17.—*Range and median concentration of chemical constituents of water from Naborton formation and Dolet Hills formation*

[Analyses by U.S. Geol. Survey]

Range	Silica (SiO_2)	Iron (Fe)	Manganese (Mn)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Phosphate (PO_4)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$	Specific conductance (micromhos at 25° C)	Color	pH
	Parts per million																		
Naborton formation																			
Minimum	9.5	0.04	0.00	0.4	0.1	38	0.9	43	0.4	8	0.0	0.0	0.00	0.06	110	2	228	0	7.0
Maximum	36	4.8	.43	224	105	546	4.3	828	568	410	3.6	4.0	3.7	2.3	1,620	990	2,490	45	8.4
Median	16	.47	.02	6.8	2.1	153	2.2	336	10	37	.2	2.0	.53	.42	460	24	780	10	8.0
Number of determinations	17	13	16	18	18	17	17	20	20	20	19	18	15	16	18	20	16	16	16
Dolet Hills formation																			
Minimum	21	1.3	0.04	18	2.6	22	1.7	88	2.7	13	0.1	0.0	0.00	0.01	212	27	336	0	6.6
Maximum	59	22	.39	50	20	110	5.0	289	123	98	.3	3.2	.3	.46	530	194	874	10	8.0
Median	36	5.9	.10	31	13	39	2.2	220	16	26	.1	1.2	.01	.28	265	112	410	0	7.4
Number of determinations	6	5	6	6	6	6	6	7	7	7	7	6	6	6	6	7	6	6	6

TABLE 18.—*Drillers' logs of representative wells*

DE SOTO PARISH, LA.

Well DS-7

[Location: Sec. 22, T. 14 N., R. 15 W.; altitude: 330 ft]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Clay	22	22	Sand, black	24	127
Sand	10	32	Shale	8	135
Clay	70	102	Sand, black	27	162
Rock	1	103	Shale	19	181

Well DS-10

[Location: Sec. 9, T. 12 N., R. 13 W.; altitude: 340 ft]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Gumbo	10	10	Soapstone	5	162
Quicksand	17	27	Sand	38	200
Rock	.3	27.3	Gumbo, tough	10	210
Gumbo	67.7	95	Boulders	.3	210.3
Rock	.5	95.5	Soapstone	16.7	227
Sand	33.1	128.6	Sand	10	237
Rock	.2	128.8	Soapstone	10	247
Gumbo	8.2	137	Sand	24	271
Rock, soft (soapstone)	13	150	Gumbo	13	284
Shale and lignite	7	157			

Well DS-13

[Location: Sec. 19, T. 12 N., R. 13 W.; altitude: 310 ft]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Clay	20	20	Gumbo, tough	14	125
Quicksand	10	30	Soapstone and gumbo	15	140
Lignite	8	38	Rock	1	141
Gumbo	29	67	Gumbo	34	175
Rock	1	68	Rock	1	176
Gumbo	12	80	Shale and rock	1	177
Sand, fine	10	90	Gumbo, tough	17	194
Sand, shale	20	110	Sand	30	224
Rock	1	111	Rock, gumbo, and shale	51	275

Well DS-15

[Location: Sec. 9, T. 12 N., R. 13 W.; altitude: 325 ft]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Clay, sandy	55	55	Shale, gummy	30	170
Gumbo	55	110	Shale, sandy	35	205
Shale, sandy	27	137	Boulders and shale	24	229
Rock, sandy	3	140	Sand, fine, gray	30	259

Well DS-16

[Location: Sec. 9, T. 12 N., R. 13 W.; altitude: 320 ft]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Clay, red	30	30	Gumbo, soft, blue	3	184
Gumbo, soft, blue	50	80	Rock	1	185
Streaks fine sand and gumbo	15	95	Gumbo, soft	10	195
Shale and lignite	47	142	Sand, fine	30	225
Gumbo, soft, blue	38	180	Gumbo	34	259
Rock	1	181			

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TABLE 18.—*Drillers' logs of representative wells*—Continued

DE SOTO PARISH, LA.—Continued

Well DS-18

[Location: Sec. 9, T. 12 N., R. 13 W.; altitude: 330 ft]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Fill	15	15	Shale	10	187
Sand	5	20	Rock	1	188
Shale	41	61	Shale, hard	4	192
Lignite	3	64	Rock, hard	1	193
Shale, sticky	19	83	Shale, hard	1	194
Rock	1	84	Rock	1	195
Shale	4	88	Gumbo	10	205
Sand	14	102	Sand	38	243
Shale, hard, sandy, brown	68	170	Shale	2	245
Sand and shale	7	177			

Well DS-19

[Location: Sec. 9, T. 12 N., R. 13 W.; altitude: 345 ft]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Topsoil and sandy clay	25	25	Sand, fine, gray	35	220
Gumbo	160	185	Shale	78	298

Well DS-20

[Location: Sec. 9, T. 12 N., R. 13 W.; altitude: 280 ft]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Clay, sandy	30	30	Boulders, gumbo, and shale	92	174
Shale and gumbo	50	80	Sand, coarse, gray	46	220
Boulders	2	82			

Well DS-23

[Location: Sec. 3, T. 10 N., R. 12 W.; altitude: 320 ft]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Clay	12	12	Shale	6	149
Sand, yellow	8	20	Shale, sandy	14	163
Clay and shale	80	100	Rock	1	164
Rock	1	101	Shale, sandy	27	191
Shale	7	108	Rock	1	192
Boulders	6	114	Shale, sandy	26	218
Shale, sandy	10	124	Shale	7	225
Rock	1	125	Shale, sandy	70	295
Shale, sandy	17	142	Sand	82	377
Rock	1	143			

Well DS-30

[Location: Sec. 29, T. 14 N., R. 15 W.; altitude: 315 ft]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Surface	30	30	Shale	8	103
Sand, clay	26	56	Sand	16	119
Lignite, shale, hard	4	60	Shale	99	218
Shale	33	93	Sand	80	298
Rock	2	95	Shale	52	350

Well DS-67

[Location: Sec. 26, T. 15 N., R. 13 W.; altitude: 205 ft]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
No record	15	15	Sand	5	63
Shale	23	38	Shale	17	80
Sand	6	44	Sand	27	107
Shale	14	58	Rock	7	114

TABLE 18.—*Drillers' logs of representative wells*—Continued

DE SOTO PARISH, LA.—Continued

Well DS-79

[Location: Sec. 30, T. 15 N., R. 14 W.; altitude: 280 ft]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Surface	3	3	Rock	3	109
Clay	15	18	Shale	21	130
Shale	31	49	Sand and shale	15	145
Sand	6	55	Shale	18	163
Shale	35	90	Sand	7	170
Sand	5	95	Shale	60	230
Shale	11	106			

Well DS-84

[Location: Sec. 19, T. 12 N., R. 13 W.; altitude 360 ft]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Clay, red	18	18	Rock	1	190
Shale	22	40	Shale	4	194
Shale, sandy	16	56	Rock	1	195
Lignite and shale	12	68	Shale, sandy	10	205
Shale	39	107	Sand	23	228
Rock	2	109	Sand and shale	32	260
Shale	37	146	Sand	35	295
Sand	17	163	Shale, brown	5	300
Shale, sandy	26	189	Sand	21	321

Well DS-173

[Location: Sec. 21, T. 14 N., R. 14 W.; altitude: 250 ft]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Soil	30	30	Sand and shell	22	170
Sand and shell	82	112	Gumbo	18	188
Rock, shell	2.5	114.5	Sand, white, and shell	40	228
Sand, salt and pepper	25.5	140	Sand, white	50	278
Gumbo	8	148			

Well DS-178

[Location: Sec. 7, T. 13 N., R. 15 W.; altitude: 300 ft]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Shale	136	136	Rock	2	282
Rock	1	137	Shale	27	309
Shale	99	236	Sand	10	319
Rock	1	237	Shale and lignite	4	323
Sand	15	252	Sand	22	345
Shale	28	280	Shale	8	353

Well DS-184

[Location: Sec. 22, T. 12 N., R. 13 W.; altitude: 320 ft]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Clay, red	13	13	Rock	2	253
Clay, sandy, white	6	19	Sand, fine, gray	8	261
Clay	48	67	Rock	3	264
Shale	72	139	Sand	5	269
Sand, fine, blue	8	147	Rock	4	273
Shale	24	171	Sand, gray	4	277
Sand	6	177	Rock	2	279
Shale	74	251	Shale	33	312

TABLE 18.—*Drillers' logs of representative wells*—Continued

DE SOTO PARISH, LA.—Continued

Well DS-187

[Location: Sec. 10, T. 12 N., R. 13 W.; altitude: 345 ft]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Shale, clay	30	30	Sand	48	223
Sand	5	35	Shale	47	270
Shale	40	75	Sand	15	285
Sand strips	15	90	Shale	5	290
Shale, brown	85	175	Sand	17	307

NOTE.—Shale below 307 ft, although not shown in driller's log.

Well DS-188

[Location: Sec. 22, T. 14 N., R. 15 W.; altitude: 330 ft]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Surface soil and sand	16	16	Shale	58	312
Sand and shale	38	54	Lignite	3	315
Shale, sandy, black	51	105	Shale, sandy	79	394
Rock	1	106	Gumbo	5	399
Shale	1	107	Lignite	8	407
Sand, black	5	112	Shale	22	429
Shale, sandy, black	2	114	Sand, fine, blue	10	439
Rock	3	117	Rock	3	442
Sand, black	10	127	Shale and lignite	18	460
Lignite and shale	3	130	Gumbo	25	485
Sand, black	35	165	Shale	35	520
Shale, sandy	10	175	Boulders	9	529
Gumbo	6	181	Gumbo	43	572
Shale and lignite	8	189	Rock	1	573
Shale	32	221	Shale, brown	32	605
Shale, sandy	12	233	Rock, hard	1	606
Shale and sand	21	254	Gumbo	108	714

Well DS-190

[Location: Sec. 3, T. 11 N., R. 16 W.; altitude: 170 ft]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Sand	25	25	Sand, gray	14	117
Rock	2	27	Rock	1	118
Sand	11	38	Sand	63	181
Lignite	2	40	Rock	1	182
Sand, lignite	10	50	Shale	2	184
Sand, gray	43	93	Lignite	11	195
Rock, red	4	97	Shale	30	225
Lignite	4	101	Sand	25	250
Rock	2	103	Shale, sandy	25	275

Well DS-191

[Location: Sec. 33, T. 12 N., R. 16 W.; altitude: 190 ft]

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
Clay and sand	8	8	Shale	2	80
Sand, yellow	4	12	Sand	16	96
Sand, white	13	25	Shale	12	108
Sand, hard	12	37	Rock	1	109
Shale	1	38	Sand, pack	13	122
Sand	3	41	Lignite	3	125
Rock	1	42	Shale	5	130
Shale	4	46	Sand, pack	20	150
Rock	2	48	Rock	2	152
Shale	9	57	Sand, soft	57	209
Sand	5	62	Shale	3	212
Rock	2	64	Lignite	6	218
Shale	10	74	Shale, sandy	17	235
Lignite	4	78	Sand	10	245

TABLE 18.—*Drillers' logs or representative wells*—Continued

Material	Thickness (feet)	Depth (feet)	Material	Thickness (feet)	Depth (feet)
DE SOTO PARISH, LA.—Continued					
Well DS-192					
[Location: Sec. 23, T. 12 N., R. 13 W.; altitude: 340 ft]					
Topsoil	5	5	Rock	1	106
Clay	15	20	Shale	4	110
Shale and sand	23	43	Sand	21	131
Shale	14	57	Shale	116	247
Sand	5	62	Shale and very fine sandy shale	18	265
Shale and sand streaks	23	85	Rock	1	266
Shale	9	94	Shale	176	442
Rock	1	95	Rock	2	444
Shale	10	105	Shale	59. 5	503. 5
Well DS-208					
[Location: Sec. 35, T. 11 N., R. 11 W.; altitude: 230 ft]					
Clay	8	8	Shale, sandy	42	133
Sand	52	60	Rock	2	135
Shale	10	70	Shale, sandy	30	165
Rock	1	71	Sand, fine	20	185
Shale	18	89	Sand	35	220
Rock	2	91			
Well DS-316					
[Location: Sec. 30, T. 12 N., R. 13 W.; altitude: 345 ft]					
Record missing	30	30	Sand, fine, gray	7	210
Shale	40	70	Sand	20	230
Sand	38	108	Rock	3	233
Shale	32	140	Sand, coarse, gray	23	256
Sand, gray	14	154	Shale	4	260
Shale, sandy	32	186	Sand	13	273
Rock, hard	1	187	Shale, black	17	290
Shale	6	193	Lignite and shale	7	297
Rock, hard	1	194	Sand, fine	13	310
Shale	9	203			
SHELBY COUNTY, TEX.					
Well Texas 75					
[Location: Shelby County; altitude: 170 ft]					
Loam	10	10	Sand, pack	53	91
Quicksand	17	27	Rock	1	92
Lignite	11	38	Sand, gray	113	205

TABLE 19.—*Description of wells used in cross sections and fence diagram*

Well on pls. 5 and 8	Location			Company	Well
	Section	Township N.	Range W.		
1	2	15	15	The Texas Co	J. C. Williams, Jr., 1.
2	2	15	14	Benedum-Trees Oil Co	D. E. Nicholson 1.
3	8	15	13	D. C. Richardson	Trammell.
4	8	15	12	Mid-Century Oil & Gas Co	Mattie F. Hutchinson 2.
5	20	15	12	Isbrandtsen Co. of La	Thigpen 2.
6	32	15	12	Carter Oil Co	Thigpen 1.
7	7	14	11	Allied Oil Co	Yearwood 1.
8	17	14	11	U.S.G.S	RR-153.
9	29	14	11	U.S.G.S	RR-156.
10	20	13	11	C. Taylor Cole et al	Waller Estate 1.
11	8	12	11	Roberts Bros	N. W. Jenkins 1.
12	14	12	11	Myron Buttram	Wemple-Sexton 1.
13	35	12	11	Pan-Southern Petroleum Corp.	Franks Grocery 1.
14	24	11	11	The Superior Oil Co	Mansfield Hardwood Lumber Co. 1.
15	15	11	10	John E. Yerger	B. L. Crow 1.
16	34	11	10	Como Drilling Co. & E. C. Wentworth.	Saffort 1.
17	1	10	11	Reilly Oil Co	Mary Yancy 2.
18	14	10	11	W. C. O'Ferral & Co	Jim Bowden 1.
19	9	10	11	Caddo Oil Co	Mansfield Hardwood Lumber Co. 1.
20	3	10	12	Gibson Drilling Co	Kate P. McDonnell 1.
21	1	10	13	A. E. Roscoe & A. G. Carter	McGill et al. 1.
22	6	10	13	Joe W. Brown	Harris et al. 2.
23	1	10	14	Barnwell Drilling Co	Evans 1.
24	1	10	15	G. D. Juan	Frost Industries Corp. 1.
25	19	11	15	P. & F. Drilling Co	Olin Industries 1.
26	12	11	16	Southern Production Co	Gannon Frost Unit Well 1.
27	36	12	16	Arkansas Fuel Oil Co	Mae Fletcher Unit 1.
28	33	12	16	Union Producing Co	M. E. Garrett B-1.
29	20	12	16	Skelly Oil Co	Thelma Nash 1.
30	5	12	16	Skelly Oil Co	Eliza Pyle 2.
31	17	14	16	Jack W. Grigsby	Johns-Johnson 1.
32	13	14	16	Jones-O'Brien, Inc	Keatchie Investment Corp. 1.
33	10	14	15	Triangle Drilling Co	Fisher 1.
34	5	13	15	U.S.G.S	DS-315.
35	10	13	15	Jack W. Grigsby	Schuler Estate 1.
36	19	13	14	The Texas Co	A. J. Gamble 1.
37	10	13	14	Edward W. Pfeffer	Union Central Life Insurance Co. B-1.
38	12	13	14	Guy Mabee	Rodgers 1.
39	10	13	13	Dale W. Moore	Ruffin 1.
40	8	13	12	A. W. Phillips	W. M. Pollock 1.
41	21	13	14	Mid-Century Oil & Gas Co	A. E. Simpson 1.
42	9	12	14	Mid States Oil Corp	Wagner 2.
43	21	12	14	McAlester Fuel Co	Jennie Shelly et al. A-1.
44	28	12	14	Kerr-McGee Oil Industries, Inc.	Nabors.
45	4	12	13	Richard W. Norton, Jr., et al	B. Goss 1.
46	9	12	13	City of Mansfield	DS-183.
47	3	11	13	L. L. Chevalier	J. J. Guy 2.
48	33	15	14	E. C. Laster	R. N. Hall 1.
49	2	14	14	J. E. Tyler	DS-175.
50	33	14	13	Texas Mineral Land Co	E. P. Lee 4.
51	2	12	12	The Texas Co	R. W. Wemple 1.
52	15	12	11	Lawrence Potter	P. Jenkins 2.
53	11	12	12	W. C. Nabors	Nabors Fee 1.
54	12	12	13	Caddo Oil Co	White 1.
55	10	12	13	Skelly Oil Co	J. B. Parker 1.
56	30	11	13	Carter Oil Co	B. D. Bailey.
57	10	11	13	H. L. Ritter	M. Bell 1.
58	6	11	12	Lazorene & Robilio	Franklin 1.
59	22	12	12	W. C. Nabors	J. Reves 1.
60	26	10	12	D. C. Carnes	T. N. Hardee 1.
61	18	10	11	F. N. Gillespie	DS-201.
62	31	11	11	F. W. Scott	Sample Estate 1.
63	5	11	11	W. C. Nabors	C.O.G. 1.

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