TEXAS WATER DEVELOPMENT BOARD

REPORT 135

GROUND-WATER RESOURCES OF CASS AND MARION COUNTIES, TEXAS

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ABSTRACT

Cass and Marion Counties, an area of 1,325 square miles in northeast Texas, are underlain by the Cypress aquifer which is composed of the Wilcox Group, Carrizo Sand, Reklaw Formation, and Queen City Sand, all of Eocene age. These geologic units are for the most part hydraulically interconnected and generally function as a single aquifer.

As a result of ground-water development, water levels in the artesian section of the aquifer have declined as much as 109 feet since 1964. Three areas in Cass and Marion Counties have been significantly affected by pumping, but elsewhere in the report area, water levels show no appreciable change. Pumpage of ground water in 1967 was 3.6 mgd (million gallons per day) or about 4,000 acre-feet.

The Cypress aquifer is capable of sustaining additional development. About 8.5 mgd of ground water is currently moving through the aquifer, and probably an equal or greater quantity of potential recharge is being rejected to streams as base flow. Current pumpage probably could be increased to more than four times the present rate without exceeding the rate of ground-water replenishment or depleting the supply. About 90 million acre-feet of fresh to slightly saline water is stored in the Cypress aquifer. Of that amount, 50 million acre-feet is available within 400 feet of the land surface. In areas where saturated sands are more than 400 feet thick, wells are capable of yielding 500 or more gpm (gallons per minute).

Water in the Cypress aquifer generally is fresh and is soft. In most of the areas, water suitable for public supply, irrigation, and many industrial uses is available for development. However, in places in the southern and northern parts of the area, chloride concentrations are high. Excessive concentrations of dissolved iron exist at generally predictable depths within the aquifer, and by proper well construction and pumping practices, the water of high iron content can be avoided.

GROUND-WATER RESOURCES OF CASS AND MARION COUNTIES, TEXAS

INTRODUCTION

Location and Extent of the Area

Cass and Marion Counties in northeast Texas are bordered by Bowie County on the north; Morris and Upshur Counties on the west; Harrison County on the south; and Miller County, Arkansas and Caddo Parish, Louisiana on the east (Figure 1). The two counties have an area of 1,325 square miles, of which 950 are in Cass County and 375 are in Marion County.

Figure 1.—Location of Cass and Marion Counties

Purpose and Scope of the Investigation

The purpose of the investigation was to determine and describe the ground-water resources of Cass and Marion Counties. The investigation was begun in 1967 by the U.S. Geological Survey in cooperation with the Texas Water Development Board.

Information was obtained on the occurrence, availability, dependability, quality, and quantity of ground-water resources. In this report, data are presented to show the vertical and lateral extent of the principal aquifer, the hydrologic properties of the aquifer, and the chemical quality of water in the aquifer. The report gives the quantities and uses of the ground water being withdrawn and the effects of these withdrawals on water levels. Problems associated with ground-water development are discussed and estimates are given on the quantity of ground water available for future development.

Methods of Investigation

The investigation was achieved largely through the cooperation of well owners and county, city, and industrial officials who allowed access to their property and permitted examination of pertinent records. Most of the data were collected during the period from October 1967 through June 1968. Basic information, including depths of wells, water levels, methods of well construction and water lift, yield characteristics, and use of water, was collected for 311 wells. Information previously collected by the U.S. Geological Survey and the Texas Water Development Board was updated. The locations of wells and springs are shown on Figure 9.

The static water levels in most wells and all water levels used for primary control points for the potentiometric map (Figure 4) were measured with a steel tape. Static water levels in other wells were reported by well owners or drillers. The altitudes of the land surface at the wells were determined either by altimeter measurements or by interpolation from U.S. Geological Survey 7½- and 15-minute quadrangle topographic maps (contour intervals, 10 to 20 feet). All of Marion County and about one-half of Cass County is covered by recent 7½-minute quadrangle topographic maps, and these maps generally provided sufficient horizontal and vertical control. The rest of the area in Cass County is covered by 15-minute quadrangle topographic maps published in 1907. Altitudes for critical control points in this area were obtained or checked with an altimeter.

Water samples were collected from 52 wells during this investigation. The records of chemical analyses are shown in Table 9 and include the results of additional analyses of water sampled from wells and springs during previous investigations. Water samples from five wells in the report area were analyzed for pesticides.

Ground-water pumpage for public supply and industrial use during 1967 (Table 4) was obtained from records provided by municipal and industrial officials. Pumpage for domestic and livestock use was estimated.

The geologic map (Figure 2) was taken largely from the Tyler and Texarkana sheets of the Geologic Atlas of Texas (Bureau of Economic Geology, 1964 and 1966). Subsurface control for the charts showing correlation of the geologic units (Figures 10, 11, and 12), for the map showing the altitude of and depths to the top of the Midway Group (Figure 3), and for the map showing the saturated sand thickness of the Cypress aquifer (Figure 8), was obtained from electrical logs of oil, gas, and water tests. Additional subsurface information was obtained from drillers' logs of water wells, a representative number of which are given in Table 8.

Aquifer tests (Table 3) were analyzed by the Theis nonequilibrium method as modified by Cooper and Jacob (1946), and by the Theis recovery method (Wenzel, 1942).

Previous Investigations

Deussen (1914), in his report on the geology and underground waters of the southeastern part of the Texas Coastal Plain, included a brief account of ground-water reservoirs and development in Marion County. The geology of the report area was described in a report by Sellards and others (1932) on the regional geology of Texas.

Follett and White (1942) made an inventory of wells and springs and reproted on ground-water development in Cass County. Broadhurst and Breeding (1943b) made an inventory of wells and springs and reported on ground-water development and stream runoff in Marion County. Sundstrom and others (1948), in a report on the public water supplies in eastern Texas, included information on the water supplies at Atlanta, Avinger, Hughes Springs, and Linden in Cass County, and at Jefferson in Marion County. Baker and others (1963), in a reconnaissance report on the ground-water resources of the Red River, Sulphur River, and Cypress Creek basins included information pertinent to the report area.

Detailed ground-water investigations in Texas in counties adjacent to the report area have been made in Harrison County (Broadhurst and Breeding, 1943a, and Broom and Myers, 1966); Camp, Franklin, Morris, and Titus Counties (Broom and others, 1965); and Gregg and Upshur Counties (Broom, 1969).

Physiography and Drainage

Cass and Marion Counties are in the West Gulf Coastal Plain of eastern Texas (Fenneman, 1938). The land surface, which slopes generally southeastward, supports a substantial growth of pine and hardwood. The area is drained by Sulphur River in the north and by Big Cypress Bayou in the south. However, the drainage to the two streams is unequally distributed because the drainage divide is in the northern part of Cass County, about on a line extending eastward from Marietta to Queen City; consequently, about 75 percent of the area is drained by Big Cypress Bayou and its tributaries. Except for the relatively flat flood plains of the principal streams, the terrain is gently rolling to hilly. Altitudes range from about 600 feet above mean sea level on the Sulphur River-Big Cypress Bayou drainage divide to about 170 feet along the downstream reaches of Big Cypress Bayou.

The U.S. Geological Survey maintains stream-gaging stations on Frazier Creek near Linden (7-3461.4) and Black Cypress Bayou at Jefferson (7-3460.45). The locations of the gaging stations are shown on Figure 9. The station on Frazier Creek, which gages streamflow from a drainage area of 48 square miles, provides a low-flow partial record from August 1958 to June 1961 and a continuous discharge record since November 1964. Discharge at the Frazier Creek station ranged from 2,620 cfs (cubic feet per second) on April 24, 1966, to no flow at times during each year of the period of continuous record.

The station on Black Cypress Bayou, which gages streamflow from a drainage area of 365 square miles, provides a low-flow partial record from September 1964 to August 1968 and a continuous record of discharge since August 1968.

Climate

The climate of Cass and Marion Counties is characterized by a surplus of water from precipitation in the winter and a deficiency of water in the summer. The normal annual precipitation at Jefferson, which provides the most complete precipitation data for the report area, is 46.00 inches for the period 1931-60, and the normal monthly precipitation in inches is as follows:

January	4.20	May	5.28	September	3.08
February	4.03	June	3.02	October	2.78
March	3.93	July	3.26	November	4.39
April	4.62	August	2.67	December	4.74

Generous rainfalls occur in April and May and again in November and December. These are the two peak rainfall periods before and after the drier summer months.

The normal minimum January temperature is 2°C (36°F), and the normal maximum July temperature is 34°C (94°F). The average dates of the first and last killing frosts are November 9 and March 18, respectively. The mean annual growing season is 236 days.

The annual gross lake-surface evaporation in the report area during the period 1940-65 ranged from 39 inches in 1950 to 56 inches in 1954 and averaged 46 inches (Kane, 1967, p. 55, 64).

Population and Economy

The U.S. Bureau of the Census shows a population of 23,227 for Cass County and 8,091 for Marion County in 1970. The populations in 1970 of principal cities in Cass County were: Atlanta, 4,947; Hughes Springs, 1,644; and Linden, 1,994. In Marion County, Jefferson had a population of 2,703 in 1970.

The economy of the area is based on industry and agriculture. The leading industry in both Cass and Marion Counties is the production of petroleum and related products. The production of oil in Cass County in 1965 was 1,476,000 barrels, and the cumulative production through 1965 was 72,574,600 barrels. The production in Marion County in 1965 was 810,700 barrels, and cumulative production through 1965 was 31,096,700 barrels (Railroad Commission of Texas, 1966). Other important industries in both counties include the production of lumber, pulpwood, and other wood products. Sales and services relating to water recreation and sports on Texarkana Reservoir, Lake O' the Pines, and Caddo Lake are important to the economy of the area.

Agriculture has evolved in recent years from predominantly row-crop farming to improved pastures and livestock. Beef cattle, poultry, and timber production provide most of the farm income. Other elements of the agricultural economy include minnow raising and production of fruits and vegetables.

Well-Numbering System

The well-numbering system used in this report was developed by the Texas Water Development Board for use throughout the State. Under this system, each 1-degree quadrangle is given a number consisting of two digits from 01 to 89. These are the first two digits in the well number, Each 1-degree quadrangle is divided into 7½-minute quadrangles which are given 2-digit numbers from 01 to 64. These are the third and fourth digits of the well number. Each 7½-minute quadrangle is subdivided into 2½-minute quadrangles which are given a single digit number from 1 to 9. This is the fifth digit of the well number. Finally, each well within a 2½-minute quadrangle is given a 2-digit number in the order in which it was inventoried, starting with 01. These are the last two digits of the well number.

Only the last three digits of the well number are shown at the location of a well on Figure 9; the second two digits are shown near the northwest corner of each 7½-minute quadrangle; and the first two digits are shown by the large block numerals 16 and 35.

In addition to the 7-digit well number, a 2-letter prefix is used to identify the county. The letter prefix for Cass County is DB, and for Marion County it is SX. Thus, well DB-16-62-701 (a well for the city of Linden) is in Cass County (DB), in the 1-degree quadrangle 16, in 7½-minute quadrangle 62, in the 2½-minute quadrangle 7, and was the first well inventoried in that 2½-minute quadrangle (Figure 9).

The well numbers used by authors of previous reports and the corresponding numbers used in this report are given in Table 1.

GEOLOGY AS RELATED TO GROUND WATER

Stratigraphy and Structure

Geologic units of Eocene age are the principal sources of ground water in Cass and Marion Counties. Rocks of Pleistocene and Holocene age would probably yield only small amounts of ground water. The geologic units and a summary of their water-bearing characteristics are given in Table 2.

Except for the alluvium, which is localized mostly in the larger streambeds, the units tend to crop out in northeasterly-trending belts that lie within or border the report area on the north and south (Figure 2). From the northwest and southeast corners of the area, the units that compose the Cypress aquifer dip toward the interior at about 30 to 40 feet per mile. In the interior parts of the area, the dips of the units tend to flatten and become irregular. In the general direction of dip, each unit is successively overlain by a younger unit so that a body of sediments, mostly water-bearing, thickens from about 300 feet in the northwest and southeast corners of the report area to 1,100 feet or more in the interior.

The stratigraphic relationships of the geologic units are shown on Figures 10, 11, and 12. Because of a general similarity in rock character, the contacts between the units often are difficult to determine from examination of drillers' and electrical logs; therefore, the contacts shown on Figures 10-12 and the thicknesses of the units shown in Table 2 are only approximate.

The base of fresh to slightly saline water in Cass and Marion Counties occurs at the top of the Midway Group. The Wilcox Group, the lowermost fresh water-bearing unit, contains more than half the available water-bearing sediments. Nearly all of the units above the Wilcox contain additional water-bearing sediments,

Table 1.—Well Numbers Used by Follett and White (1942) in Cass County, and by Broadhurst and Breeding (1943b) in Marion County, and Corresponding Numbers Used in This Report

OLD NUMBER	NEW NUMBER	OLD NUMBER	NEW NUMBER	OLD NUMBER	NEW NUMBER
		CASS COUNTY (DB)			
120	16-48-801	230	16-59-601	153	16-63-901
1	16-51-602	232	16-59-602	154	16-63-903
3	16-52-101	250	16-59-901	143	16-64-101
67	16-52-701	63	16-60-101	144	16-64-203
20	16-53-101	60	16-60-201	255	35-04-401
23	16-53-102	233	16-60-501	261	35-04-601
24	16-53-103	236	16-60-601	265	35-04-801
29	16-53-201	235	16-60-801	263	35-04-901
27	16-53-601	306	16-61-601	364	35-05-301
42	16-53-901	305	16-61-602	346	35-05-302
86	16-54-601	201	16-62-301	313	35-06-301
206	16-54-801	310	16-62-501	342	35-06-402
205	16-54-802	304	16-62-701	349	35-06-701
125	16-56-201	191	16-63-201	341	35-06-801
126	16-56-501	148	16-63-601	442	35-07-905
64	16-59-301	172	16-63-801	430	35-08-501
		MARION COUNTY (SX)			
31	35-14-502	53	35-15-501	10	35-20-201
15	35-14-704	54	35-15-701	13	35-21-501

and except for the alluvium, these units are assigned to the Claiborne Group.

The principal structural feature of the area is the East Texas Embayment, an elongate structural basin whose long axis trends northeasterly through Cass and Marion Counties. The configuration of the basin is shown by contours on top of the Midway Group (Figure 3). Two prominent lows or subbasins occur within the area. One underlies the Avinger area and is closed by the -800-foot (below sea level) contour. The other subbasin underlies an area that extends southward from about Atlanta to Kildare, and is closed by the -600-foot contour. A ridge that extends southward from about Douglassville to Jefferson divides the two subbasins. Altitudes on the ridge are -400 feet or higher.

The general structural patterns of the subbasins and the ridge are sharply altered in their southern reaches by the Rodessa Fault. This fault, which trends northeasterly, passes through the Jefferson and McLeod areas (Figures 2 and 3). The geologic units are downthrown on the south side of the fault. Vertical displacement ranges from less than 100 feet to 200 feet. A section across the fault between wells SX-35-15-203 and DB-35-06-803 is shown on Figure 12. As shown in the section, the Wilcox Group is partially displaced so that its basal part (downthrown side) is in vertical contact with the Midway Group; the Carrizo Sand is completely displaced and is in vertical contact with the upper part of the Wilcox; the Reklaw Formation is completely displaced and is in vertical contact with the uppermost part of the Wilcox and the lower half of the Carrizo. The Queen City Sand is partially displaced so that its basal part is in vertical contact with the upper half of the Carrizo and all of the Reklaw. The trace of the fault at the surface, which is mostly within the outcrop area of the Queen City, is obscure.

Table 2.--Geologic Units and Their Water-Bearing Characteristics

SYSTEM	SERIES	GROUP	UNIT	APPROXIMATE MAXIMUM THICKNESS (FT)	CHARACTER OF ROCKS		WATER-BEARING PROPERTIES
Quaternary	Holocene and Pleistocene		Alluvium	60	Sand silt, clay, and some gravel.		Not known to yield water to any wells; probably would yield small quantities of fresh water.
Tertiary	Eocene	Claiborne	Sparta Sand	50	Sand and sandy clay.		Yields small quantities of fresh water to shallow wells locally.
			Weches Formation	60	Glauconite glauconitic clay and sand; secondary deposits of limonite common in outcrop areas.		Yields small quantities of fresh water to wells locally.
			Queen City Sand	400	Sand silt, clay, and some lignite.	CYPRESS AQUIFER	Yields small quantities of fresh water to wells; would yield moderate quantities.
			Reklaw Formation	100	Glauconitic clay, sand, and some lignite; locally may consist largely of sand; commonly contains considerable limonite in outcrop areas.		Yields small quantities of fresh water to wells.
			Carrizo Sand	150	Sand, silt, and clay.		Yields small quantities of fresh water to wells; locally, probably would yield moderate quantities.
		Wilcox		550	Sand, silt, clay, and lignite.		Yields moderate to possibly large quantities of fresh water to wells.
	Paleocene	Midway		800	Calcareous clay and minor amounts of limestone, silt, and glauconitic sand.		Yields no water.

Physical Characteristics and Water-bearing Properties of the Geologic Units

Midway Group

The Midway Group underlies all of Cass and Marion Counties and crops out in counties to the north and west. The unit has a maximum thickness of about 800 feet and is composed chiefly of calcareous clay. Locally the unit may contain some stringers of limestone and glauconitic sand, and generally the unit tends to become silty in the upper part of the section. The Midway does not yield water but is hydrologically important because its upper surface serves as relatively impermeable basement for the overlying water-bearing units in Cass and Marion Counties.

Altitudes of the top of the Midway (Figure 3) range from near sea level in the northwest and southeast corners to at least 832 feet below sea level near the center of the report area.

Wilcox Group

The Wilcox Group conformably overlies the Midway Group and crops out along the northern border of Cass County and in the southeastern part of Marion County (Figure 2). The outcrop area of the Wilcox is characterized by a nearly level to gently rolling land surface, mantled by a clayey- to sandy-textured soil.

The Wilcox is about 300 feet thich in the areas of outcrop, and is normally about 450 feet thick elsewhere. In the subbasins around Avinger, Atlanta, and Kildare, the Wilcox locally attains a maximum thickness of about 550 feet. Typically, the Wilcox is composed of interbedded sand, silt, clay, and some lignite. Medium to very fine quartz sand generally constitutes one-third to one-half of the unit. Individual beds of sand generally are thin bedded and discontinuous, although in the subbassins, some of the beds of sand attain thickness of nearly 100 feet (well DB-35-04-501, Figure 11).

Because the sand beds are lenticular, the potential yields of wells tapping the Wilcox can be expected to range over fairly wide limits. Proven yields of wells tapping the Wilcox in Cass and Marion Counties range from about 200 gpm in the outcrop areas to nearly 500 gpm in the subbasin at Atlanta. The Wilcox probably would yield 500 gpm or more of fresh water to wells in the subbasin at Avinger; and probably not more than 300 gpm along the ridge from Douglassville to the Rodessa Fault near Jefferson. On the south side or downthrown side of the fault, a well at Jefferson yielded about 350 gpm from the Wilcox.

Claiborne Group

Carrizo Sand

The Carrizo Sand unconformably overlies the Wilcox Group. The full thickness of the Carrizo is variable in Cass and Marion Counties; it ranges from nearly 150 feet in the subbasins or local structural lows within the East Texas Embayment to about 50 feet or less elsewhere. Typically, the unit is composed of massive to crossbedded, coarse to fine sand. Locally, however, the sand is interbedded with silt and clay, so that in some places it is not easily distinguishable from the underlying Wilcox (well SX-35-11-203, Figure 11).

A firm estimate of potential well yields from the Carrizo in the report area cannot be made because the unit has been tapped mostly by wells with relatively small pump capacities. However, on the basis of production from Carrizo wells outside the report area, the Carrizo probably would yield 300 gpm or more of fresh water to wells in the subbasins; elsewhere, probably considerably less.

Reklaw Formation

The Reklaw Formation conformably overlies the Carrizo Sand and crops out in narrow northeastward-trending belts in the northern and southern parts of the report area (Figure 2). The outcrop of the Reklaw is expressed by a nearly level to gently rolling land surface, mantled by a red clayey to sandy soil containing limonite.

The Reklaw, which typically is a clay unit in much of the East Texas Embayment, exhibits considerable changes in composition and thickness in Cass and Marion Counties. In composition it varies from predominantly glauconitic clay to predominantly sand. Some lignite occurs in the formation. In thickness it varies from about 100 feet to 50 feet or less. In locations where the Reklaw is mostly sand, hydraulic continuity is enhanced between the units overlying and underlying the Reklaw. The dense clay character of the Reklaw as shown in well SX-35-20-203 (Figure 10) typifies the Reklaw as found southeastward in Gregg and Upshur Counties (Broom, 1969). In the vicinity of this well, the Reklaw tends to retard hydraulic continuity between the units.

The Reklaw yields small quantities of fresh water to domestic wells in Cass and Marion Counties.

Queen City Sand

The Queen City Sand has the most extensive outcrop area of any geologic unit in the report area (Figure 2). It has been completely removed by erosion only along the north edge of Cass County and in the southeastern segment of Marion County. Except for stream alluvium, the Queen City is overlain by scattered outliers of younger units in central parts of the report area. The outcrop of the Queen City is expressed by a hilly to moderately rolling land surface, mantled by a loose, gray to buff, sandy soil. Largely because of the scattered outliers of the overlying Weches Formation, which has caprock qualities, the Queen City has undergone differential erosion. The larger streams have created a relief of 200 feet or more in places on the Queen City outcrop.

The Queen City Sand, which attains a maximum thickness of about 400 feet, consists largely of massive to crossbedded fluvial sediments, locally stratified. It is composed generally of up to 80 percent medium to fine quartz sand, with small amounts of silt, clay, and lignite. The unit is tapped mostly for small domestic water supplies, but in some areas it probably would yield up to 200 gpm or more of fresh water to wells.

Weches Formation

The Weches Formation overlies the Queen City Sand, and occurs mostly as scattered outliers (Figure 2) on the higher hills and ridges in Cass and Marion Counties. The formation consists principally of interbedded glauconite, glauconitic clay, and sand. The glauconite commonly weathers to limonitic concretions ("ironstone") at or near the surface, creating a resistant caprock. The limonite and other iron minerals are mined as iron ore. Generally, the Weches, which reaches a maximum thickness of about 60 feet, is not considered an aquifer, but locally it does yield small quantities of fresh water to shallow domestic wells.

Sparta Sand

The Sparta Sand, which overlies the Weches Greensand, occurs in Cass and Marion Counties mostly as erosional remnants (Figure 2) on the higher ridges and hills. These remnants of Sparta are usually composed of fine sand and sandy clay and seldom reach a thickness of more than 50 feet. Locally they yield small quantities of fresh water to domestic wells.

Alluvium

Alluvial sediments occur in and near the floodplains of Sulphur River and Big Cypress Bayou and their larger tributaries. The sediments consist of clay and silt, some fine sand, and minor amounts of gravel. They reach a maximum thickness of about 60 feet along Sulphur River, and about 25 feet along Big Cypress Bayou. The alluvium is not known to yield water to wells in the report area; doubtlessly, it would yield small quantities of fresh water if tapped by wells.

Hydrological Designation of the Geologic Units

The Wilcox Group, Carrizo Sand, and the Queen City Sand are the principal sources of ground water in Cass and Marion Counties. Locally the Reklaw Formation seems to be capable of yielding significant quantities of water. The four units are hydraulically connected throughout most of the area and function as a single aquifer. Therefore, in this report the four geologic units are considered as one hydrologic unit which has been named the Cypress aquifer. For the same reason, these four geologic units were considered as one hydrologic unit—the Cypress aquifer—in adjacent counties to the northwest and south (Broom and others, 1965; Broom and Myers, 1966).

The Weches Formation, Sparta Sand, and alluvium are comparatively unimportant as sources of ground water in the report area; therefore, the remainder of the report is devoted chiefly to the Cypress aquifer.

GROUND-WATER HYDROLOGY

Occurrence and Movement of Ground Water

Ground water in the Cypress aquifer occurs under both artesian and water-table conditions in Cass and Marion Counties. Generally in the report area, shallow wells or any wells that do not penetrate a confining layer of rock, tap water under water-table conditions, which occur mostly in the outcrop areas of the geologic units that compose the Cypress aquifer. Deep wells, or any wells that penetrate a confining layer of rock, generally tap water under artesian conditions, which occur mostly downdip from the outcrop of the geologic units that compose the Cypress aquifer.

Ground water generally moves slowly (tens to hundreds of feet per year) from areas of recharge to areas of discharge. The direction of movement of water in the Cypress aquifer is indicated by water-level contours in Figure 4. The regional slope (or direction of water movement) of the potentiometric surface is southeastward at about 5 feet per mile. However, significant cones of depression have been created by concentrated ground-water pumping in the vicinities of Bryans Mill, Atlanta, and that part of the Rodessa oil field in the southeastern corner of Cass County. Consequently, in these three areas of pumping, the direction of water movement is toward each cone of depression. In the Bryans Mill area, the cone of depression has approximately 75 feet of vertical closure; the hydraulic gradient across the 225-foot contour averages about 12 feet per mile. In the Atlanta area, the cone of depression has approximately 100 feet of vertical closure; the hydraulic gradient across the 150-foot contour averages about 27 feet per mile. In the Rodessa oil field area, the cone of depression has a vertical closure of about 100 feet; the average hydraulic gradient across the 150-foot contour is about 18 feet per mile.

With the exception of a slight cone of depression at Linden, there appears to be little alteration of the potentiometric surface by pumping in the southwestern and extreme southern parts of the report area.

Recharge and Discharge

Ground water in the Cypress aquifer is derived from the infiltration of precipitation on the outcrop areas of the geologic units composing the aquifer, from runoff enroute to water courses, and from the infiltration of water from streams and lakes. The recharge areas of the Cypress aquifer include all of the report area and adjacent areas to the north, west, and south. In addition, ground-water pumping around Atlanta and in that part of the Rodessa oil field in the southeast corner of Cass County results in subsurface recharge in these areas from adjoining areas in Arkansas and Louisiana.

The rate of natural recharge is governed by a number of factors, the most important of which are: (1) the type of soil in the outcrop areas; (2) the duration and intensity of rainfall; (3) the slope of the land surface; (4) vegetation; and (5) the depth to the water table. The total quantity of recharge to the Cypress aquifer could not be determined from the available data.

Discharge of water from the Cypress aquifer occurs under natural and artificial conditions. The natural discharge is the flow of springs and seeps, evaporation from the water table, and transpiration by trees and plants whose roots reach the water table. The quantity of water discharged by each of the natural processes is difficult to determine, but natural discharge from the Cypress aquifer is at least several times the amount artificially discharged by wells.

Hydraulic Properties of the Cypress Aquifer

The hydraulic properties of an aquifer that determine its capacity to transmit and store water are expressed as the transmissivity and the storage coefficient. (See section of report on definition of terms).

The results of nine aquifer tests are shown in Table 3. The transmissivities determined from these tests ranged from 200 to 14,000 gpd per foot; discharge rates ranged from 37 to 475 gpm; and specific capacities ranged from 1.2 to 6.7 gpm per foot of drawdown. The range in transmissivities is due to variations in the permeability and thickness of the aquifer. In most cases, the wells used for tests did not fully penetrate the aquifer; consequently, the results of the tests generally gave values that are less than those that would have been obtained from fully penetrating wells.

The hydraulic conductivities, which were estimated from the total thickness of sand believed to be contributing water to the well (in most of the wells it was the equivalent of the footage of screened or perforated intervals in the well), ranged from 5 to 180 gpd per square foot and averaged about 65 gpd per square foot. Thus, where as much as 400 feet of sand is available in the aquifer, the transmissivity might be 26,000 gpd per foot.

The storage coefficient obtained from one test was 0.00014. This value is within the range generally attributable to artesian conditions. Although no tests were made in the water-table section of the aquifer, the storage coefficient for water-table conditions probably would be about 0.10.

The transmissivity and storage coefficient may be used to predict future drawdowns of water levels by pumping. Figure 5 shows the relation of drawdown to distance and time as a result of pumping from a water-table aquifer of infinite areal extent. If the transmissivity and storage coefficient are 5,000 gpd per foot and 0.10, respectively, which probably are representative of the water-table part of the Cypress aquifer, the decline in water level at a distance of 1,000 feet from a well pumping 300 gpm would be 1 foot after 30 days, about 12 feet after one year, and about 27 feet after 10 years. If the transmissivity was smaller than that assumed, the drawndown would be greater.

Figure 6 shows similar relation as a result of pumping from an artesian aquifer of infinite areal extent with a transmissivity of 20,000 gpd per foot and a storage coefficient of 0.0001. Under these conditions, the decline in water level at a distance of 1,000 feet from a well pumping at 500 gpm would be 22 feet after 30 days, about 29 feet after one year, and about 35 feet after 10 years.

Pumping from wells too closely spaced may cause intersecting cones of depression, which will cause additional lowering of the water levels and serious declines in the yields of the wells. Figures 5 and 6 should serve as a general guide for the spacing of wells that tap the Cypress aquifer.

USE AND DEVELOPMENT OF GROUND WATER

Pumpage and use of ground water in Cass and Marion Counties in 1967 are summarized in Table 4. In that year, approximately 3.6 mgd or 4,000 acre-feet was pumped from the Cypress aquifer for public supply, industrial use, and rural domestic and livestock purposes. No ground water was used for irrigation in 1967.

Table 3.—Results of Aquifer Tests

WELL	SCREENED INTERVAL (FEET)	AVERAGE DISCHARGE DURING TEST (GPM)	TRANS-MISSIVITY (GPD/FT)	SPECIFIC CAPACITY (GPM/FT)	STORAGE COEFFICIENT	REMARKS
DB-16-53-104	257-267 305-395	216	5,500	3.9	—	Drawdown in pumped well.
DB-16-55-801	670-720	38.5	1,100	1.2	—	Drawdown and recovery of pumped well.
DB-16-62-702	294-353 378-400 442-463 500-522 646-709	125	900	2.5	—	Drawdown in pumped well.
DB-16-63-301	660-829	475	14,000	—	—	Drawdown and recovery of pumped well.
DB-16-64-201	350-360 375-395 425-440	100	2,000	1.4	—	Recovery of pumped well. Data collected by Layne-Texas Co.
DB-35-04-803	271-321	37	2,300	1.2	—	Drawdown and recovery of pumped well.
DB-35-07-802	595-669	230	8,700	6.7	—	Drawdown in pumped well.
SX-35-12-802	232-272	—	200	—	0.00014	Drawdown in observation well. Well SX-35-12-801 pumping 23 gpm.
SX-35-14-703	708-781	348	13,000	4.4	—	Drawdown and recovery in pumped well.

Table 4.—Pumpage and Use of Ground Water in 1967

COUNTY	PUBLIC SUPPLY		INDUSTRIAL SUPPLY				RURAL DOMESTIC AND LIVESTOCK		TOTAL	
			COOLING AND PROCESS		REPRESSURIZATION					
	MGD	ACRE-FEET	MGD	ACRE-FEET	MGD	ACRE-FEET	MGD	ACRE-FEET	MGD	ACRE-FEET
Cass	1.04	1,166	0.47	527	1.25	1,401	0.40	448	3.16	3,542
Marion	.03	34	.05	56	.21	235	.10	112	.39	437
Total	1.07	1,200	0.52	583	1.46	1,636	0.50	560	3.55	3,979

Numbers should not be considered accurate to more than two significant figures.

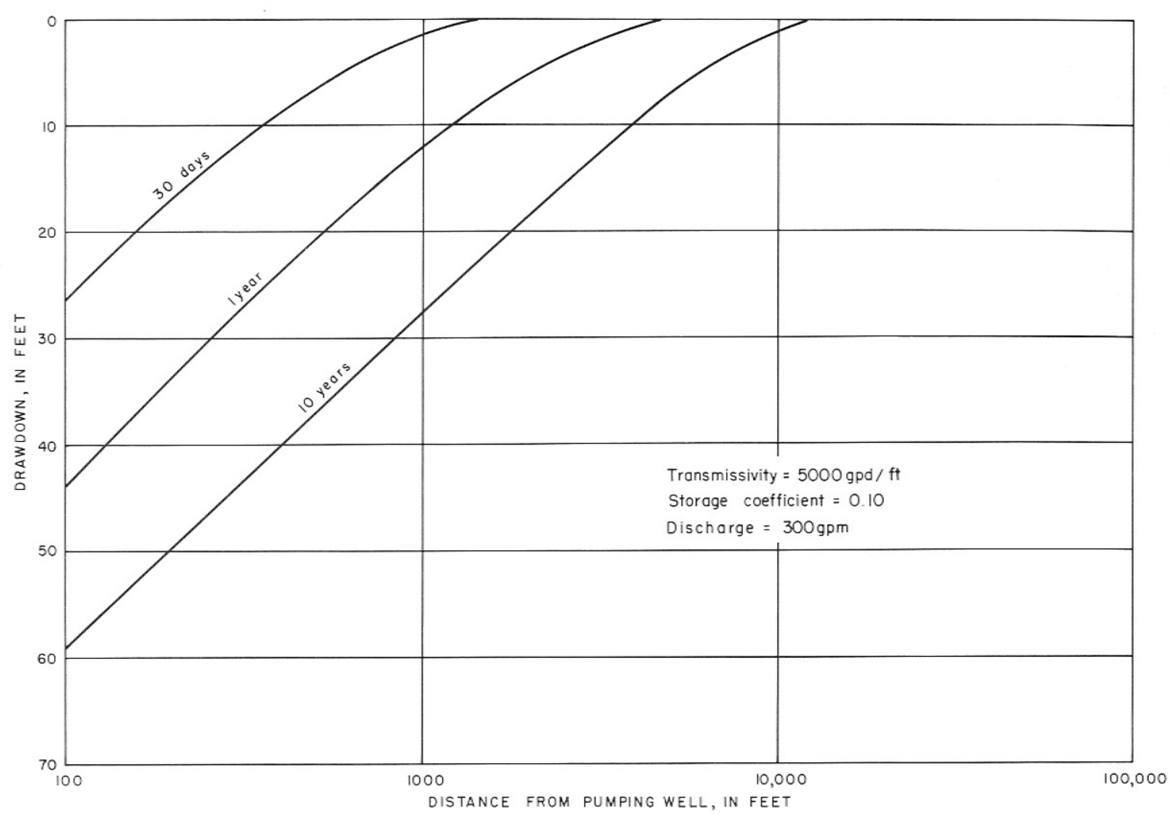

Figure 5.—Relation of Drawdown to Distance and Time, Water-Table Conditions

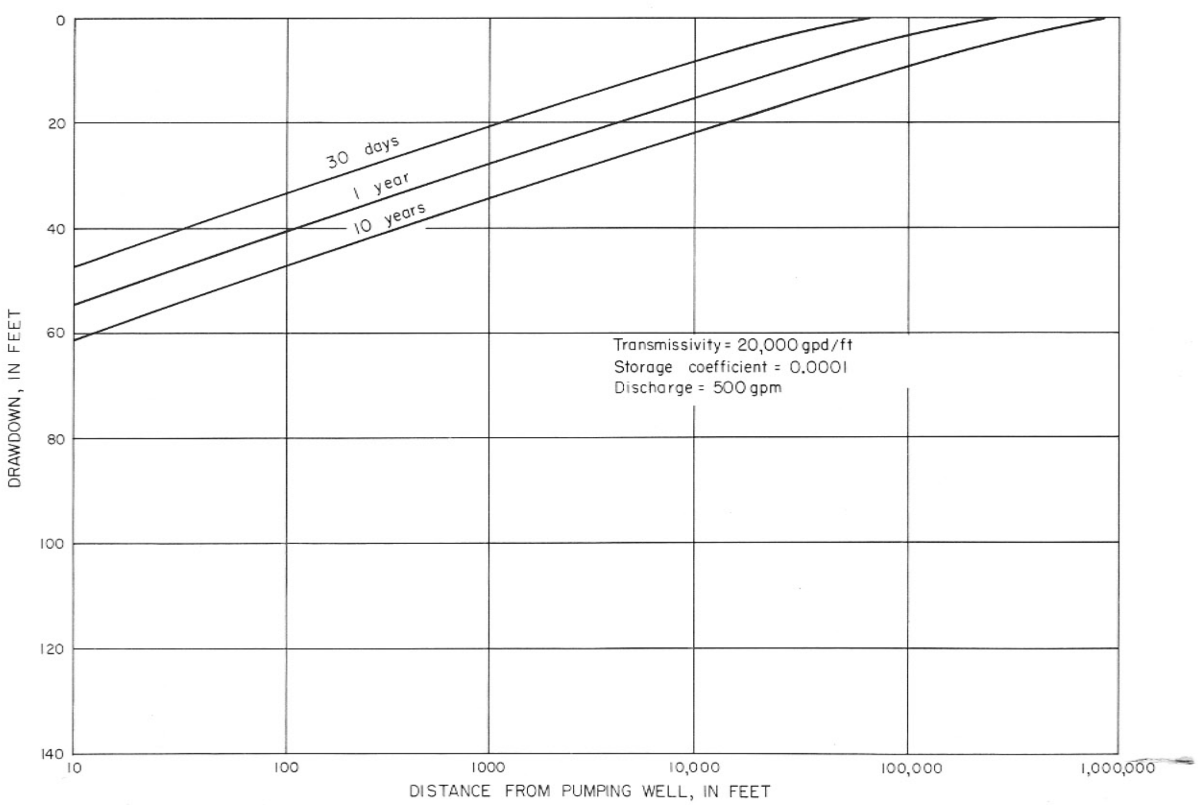

Figure 6.—Relation of Drawdown to Distance and Time, Artesian Conditions

Public Supply

Ground-water pumpage for public supplies in Cass and Marion Counties in 1967 was 1.1 mgd or 1,200 acre-feet (Table 4). This includes municipal pumpage for Atlanta (0.68 mgd or 760 acre-feet per year), Linden (0.13 mgd or 150 acre-feet per year), Queen City (0.10 mgd or 110 acre-feet per year), and all other towns, institutions, and park sites except the towns of Hughes Springs and Jefferson, which are now using surface-water supplies. Hughes Springs obtains its water from Lake O' the Pines and Jefferson obtains its supply from Big Cypress Bayou.

Industrial Use

Ground-water pumpage for industrial use in Cass and Marion Counties in 1967 was 2.0 mgd or 2,200 acre-feet. Practically all water used by industry in the report area in 1967 was ground water. Cooling and processing required 0.52 mgd or 580 acre-feet to be pumped; and waterflooding required 1.5 mgd or 1,600 acre-feet to be pumped (Table 4). The latter constitutes the largest use of ground water for all purposes in the report area, and the pumping is confined mostly to the Rodessa oil field.

Rural Domestic and Livestock Uses

Ground-water pumpage for rural domestic and livestock uses in Cass and Marion Counties in 1967 was 0.50 mgd or 560 acre-feet (Table 4). The use of ground water for livestock is mostly limited to poultry; generally, spring-fed creeks and numerous stock ponds supply the water needs of beef cattle.

CHANGES IN WATER LEVELS

Records of water levels in wells tapping the Cypress aquifer are given in Table 7. In general, the water levels have been measured too infrequently and for a period that is too short to determine a long-term trend. Available data indicate that water levels in the artesian section of the aquifer have declined considerably in areas where the aquifer is heavily pumped. In the Bryans Mill area, water levels have declined as much as 86 feet since 1961. In the Atlanta area, water levels have declined as much as 100 feet since 1936, and in parts of the Rodessa oil field, water levels have declined as much as 109 feet since about 1964. Elsewhere in the report area, water levels show no appreciable change during the period of record.

WELL CONSTRUCTION

The yields from wells tapping the Cypress aquifer in Cass and Marion Counties depend on the well location, well spacing, and the method and type of well construction. Improper spacing of wells will cause unnecessary increases in water lifts and pumping costs. Because of the non-uniform water-bearing character of the aquifer, in localities where large yields are needed, it is advisable to choose a well site based on sand sampling, electric logging, and pumping tests of one or more test holes.

The construction of well DB-16-63-202 (Table 7) is typical of the municipal and industrial wells in Cass and Marion Counties. Briefly, the construction details of the well are as follows: (1) the well was drilled to 564 feet, 14-inch surface casing was set, and cement was pumped into the annulus between the wall of the well and the surface casing—the cement provided a seal against downward leakage of water along the casing to the producing zone and a deterrent to corrosion of the outer surface of the casing; (2) the well was then deepened to 670 feet; (3) the hole below the surface casing was underreamed to a diameter of 30 inches; (4) 8-inch blank steel liner and screen, with set nipple and back pressure valve on the bottom, was lowered into the well—the screen was positioned on the material string so as to be opposit the water-bearing sands when the set nipple reached the bottom of the well; (5) the underreamed part of the well, opposite the screen, was filled with small gravel, forming what is termed a "gravel pack" (the gravel allows larger screen openings to be used which reduces the velocity of water entering the well, thereby reducing the amount of fine sand that otherwise would enter the well and be pumped from it); and (6) drilling mud was washed from the well. The well was then equipped with a vertical turbine pump and tested for production. At a discharge of 300 gpm the well had a drawdown of 191 feet—a specific capacity of about 1.6 gpm per foot of drawdown.

Most of the inventoried rural domestic and livestock wells in the report area are less than 50 feet deep and tap the Cypress aquifer for only a few feet below the water table. Nearly all the shallow wells completed before 1940 were dug by hand and lined with brick or native rock; the diameter of these wells generally ranges from 3 to 4 feet. Most of the older wells were originally equipped with hand-lift pumps which have since been replaced by water-jet, cylinder, or centrifugal pumps powered by ¼- to ¾-horsepower electric motors. Recently completed shallow wells were bored by bucket-type power augers whose operating depths generally are limited to about 50 feet. The bored wells generally are lined with 30-inch diameter tiles of 3-foot lengths. Lift facilities are about the same as for the other shallow wells.

An increasing number of rural domestic and livestock wells are being drilled and constructed by methods similar to those used for municipal and industrial wells. These wells have a steel surface casing, usually 4 inches in diameter, set at the top of the water-bearing sand and the annulus between the wall of the hole and the surface casing is filled with cement. A 2- to 3-inch diameter screen or perforated liner is set opposite the water sand. A gravel- or sand-pack is sometimes used. The drilled rural domestic and livestock wells are usually equipped with water-jet or submergible turbine pumps, powered by electric motors of about 1 horsepower.

CHEMICAL QUALITY OF GROUND WATER

The major factors that determine the suitability of a water supply are the limitations imposed by the comtemplated use of the water. Among the various criteria established for water quality are: bacterial content; physical characteristics such as temperature, odor, color, and turbidity; and chemical constituents. Usually, the bacterial content and the undersirable physical properties can be alleviated economically, but the removal of undesirable chemical constituents can be difficult and expensive. The source and significance of dissolved-mineral constituents are summarized in Table 5.

Chemical analyses of water from 104 wells and one spring in the Cypress aquifer are shown in Table 9. Table 9 also contains one analysis of water from a flowing well (DB-16-60-101, Figure 9) that reportedly taps the Woodbine Formation at a depth of 3,000 or more feet below the Cypress aquifer.

Water-Quality Requirements

Public Supply

The U.S. Public Health Service (1962) has established, and periodically revises, standards of drinking water to be used on common carriers engaged in interstate commerce. The standards are designed to protect the traveling public and commonly are used to evaluate domestic and public water supplies. According to the standards, chemical constituents should not be present in a public water supply in excess of the listed concentrations of common constituents shown in the following table, except where other more suitable supplies are not available. Below is a partial list of the standards adopted by the U.S. Public Health Service (1962, p. 7-8); these constituents are included in the table of chemical analyses (Table 9).

SUBSTANCE	CONCENTRATION (MG/L)
Chloride (Cl)	250
Fluoride (F)	1.0*
Iron (Fe)	0.3
Nitrate (NO_3)	45
Sulfate (SO_4)	250
Dissolved solids	500

* Based on the annual average of maximum daily air temperatures of 77° F (25° C) at Marshall (15 miles south of Jefferson) from 1910 to 1968. The minimum desirable concentration is 0.7 mg/l.

Industrial Use

The quality of water suitable for industrial use does not necessarily depend on potability—it may or may not be acceptable for human consumption. Suggested water-quality tolerances for a number of industries have been summarized by Hem (1959, p. 250-254) and Moore (1940). Water used by industry is commonly classified by uses as cooling, boiler, and process waters. For cooling uses the natural water temperature may be significant. Any constituent of the water that may adversely affect the heat-exchange surfaces is undesirable for cooling uses. Calcium, magnesium, aluminum, iron, and silica may cause scale or incrustations in both cooling and boiler facilities. The scale-forming tendency of silica in boiler water increases with applied pressures. The maximum suggested concentrations of silica in boiler water (Moore, 1940), for various ranges of boiler pressure, are shown as follows:

CONCENTRATION OF SILICA (MG/L)	BOILER PRESSURE (PSI)
40	Less than 150
20	150-250
5	251-400
1	More than 400

Process water, the water incorporated into or used in contact with the manufactured products, is subject to a wide range of quality requirements. The quality requirements for this use may include physical and biological factors in addition to chemical factors. Many process waters must be low in dissolved solids and free of iron and manganese. Unlike cooling and boiler water, much of the process water is consumed or undergoes a change during the manufacturing process and subsequently is either not available or not suitable for reuse.

Irrigation

The suitability of water for irrigation generally cannot be evaluated on chemical content alone; the evaluation also should consider the type of soil, adequacy of drainage, tolerance of crops, and frequency

Table 5.—Source and Significance of Dissolved-Mineral Constituents and Properties of Water

CONSTITUENT OR PROPERTY	SOURCE OR CAUSE	SIGNIFICANCE
Silica (SiO_2)	Dissolved from practically all rocks and soils, commonly less than 30 mg/l. High concentrations, as much as 100 mg/l, generally occur in highly alkaline waters.	Forms hard scale in pipes and boilers. Carried over in steam of high pressure boilers to form deposits on blades of turbines. Inhibits deterioration of zeolite-type water softeners.
Iron (Fe)	Dissolved from practically all rocks and soils. May also be derived from iron pipes, pumps, and other equipment. More than 1 or 2 mg/l of iron in surface waters generally indicates acid wastes from mine drainage or other sources.	On exposure to air, iron in ground water oxidizes to reddish-brown precipitate. More than about 0.3 mg/l stains laundry and utensils reddish-brown. Objectionable for food processing, textile processing, beverages, ice manufacture, brewing, and other processes. U.S. Public Health Service (1962) drinking-water standards state that iron should not exceed 0.3 mg/l. Larger quantities cause unpleasant taste and favor growth of iron bacteria.
Calcium (Ca) and magnesium (Mg)	Dissolved from practically all soils and rocks, but especially from limestone, dolomite, and gypsum. Calcium and magnesium are found in large quantities in some brines. Magnesium is present in large quantities in sea water.	Cause most of the hardness and scale-forming properties of water; soap consuming (see hardness). Waters low in calcium and magnesium desired in electroplating, tanning, dyeing, and in textile manufacturing.
Sodium (Na) and potassium (K)	Dissolved from practically all rocks and soils. Found also in ancient brines, sea water, industrial brines, and sewage.	Large amounts, in combination with chloride, give a salty taste. Moderate quantities have little effect on the usefulness of water for most purposes. Sodium salts may cause foaming in steam boilers and a high sodium content may limit the use of water for irrigation.
Bicarbonate (HCO_3) and carbonate (CO_3)	Action of carbon dioxide in water on carbonate rocks such as limestone and dolomite.	Bicarbonate and carbonate produce alkalinity. Bicarbonates of calcium and magnesium decompose in steam boilers and hot water facilities to form scale and release corrosive carbon dioxide gas. In combination with calcium and magnesium, cause carbonate hardness.
Sulfate (SO_4)	Dissolved from rocks and soils containing gypsum, iron sulfides, and other sulfur compounds. Commonly present in mine waters and in some industrial wastes.	Sulfate in water containing calcium forms hard scale in steam boilers. In large amounts, sulfate in combination with other ions gives bitter taste to water. Some calcium sulfate is considered beneficial in the brewing process. U.S. Public Health Service (1962) drinking-water standards recommend that the sulfate content should not exceed 250 mg/l.
Chloride (Cl)	Dissolved from rocks and soils. Present in sewage and found in large amounts in ancient brines, sea water, and industrial brines.	In large amounts in combination with sodium, gives salty taste to drinking water. In large quantities, increases the corrosiveness of water. U.S. Public Health Service (1962) drinking-water standards recommend that the chloride content should not exceed 250 mg/l.
Fluoride (F)	Dissolved in small to minute quantities from most rocks and soils. Added to many waters by fluoridation of municipal supplies.	Fluoride in drinking water reduces the incidence of tooth decay when the water is consumed during the period of enamel calcification. However, it may cause mottling of the teeth, depending on the concentration of fluoride, the age of the child, amount of drinking water consumed, and susceptbility of the individual. (Maier, 1950)
Nitrate (NO_3)	Decaying organic matter, sewage, fertilizers, and nitrates in soil.	Concentration much greater than the local average may suggest pollution. U.S. Public Health Service (1962) drinking-water standards suggest a limit of 45 mg/l. Waters of high nitrate content have been reported to be the cause of methemoglobinemia (an often fatal disease in infants) and therefore should not be used in infant feeding. Nitrate has been shown to be helpful in reducing inter-crystalline cracking of boiler steel. It encourages growth of algae and other organisms which produce undesirable tastes and odors.
Dissolved solids	Chiefly mineral constituents dissolved from rocks and soils. Includes some water of crystallization.	U.S. Public Health Service (1962) drinking-water standards recommend that waters containing more than 500 mg/l dissolved solids not be used if other less mineralized supplies are available. Waters containing more than 1000 mg/l dissolved solids are unsuitable for many purposes.
Hardness as $CaCO_3$	In most waters nearly all the hardness is due to calcium and magnesium. . All the metallic cations other than the alkali metals also cause hardness.	Consumes soap before a lather will form. Deposits soap curd on bathtubs. Hard water forms scale in boilers, water heaters, and pipes. Hardness equivalent to the bicarbonate and carbonate is called carbonate hardness. Any hardness in excess of this is called non-carbonate hardness. Waters of hardness as much as 60 ppm are considered soft; 61 to 120 mg/l, moderately hard; 121 to 180 mg/l, hard; more than 180 mg/l, very hard.
Specific conductance (micromhos at 25°C)	Mineral content of the water.	Indicates degree of mineralization. Specific conductance is a measure of the capacity of the water to conduct an electric current. Varies with concentration and degree of ionization of the constituents.
Hydrogen ion concentration (pH)	Acids, acid-generating salts, and free carbon dioxide lower the pH. Carbonates, bicarbonates, hydroxides, and phosphates, silicates, and borates raise the pH.	A pH of 7.0 indicates neutrality of a solution. Values higher than 7.0 denote increasing alkalinity; values lower than 7.0 indicate increasing acidity. pH is a measure of the activity of the hydrogen ions. Corrosiveness of water generally increases with decreasing pH. However, excessively alkaline waters may also attack metals.

of rainfall. Generally, water may be used safely for supplemental irrigation if its conductivity (an index of the salinity hazard) is less than 2,250 micromhos per centimeter at 25°C and its SAR (sodium-adsorption ratio) is less than 14 (Wilcox, 1955, p. 15). High SAR of water causes soil, especially fine-textured soil, to become "tight".

Another factor used in assessing the quality of water for irrigation is the RSC (residual sodium carbonate). Excessive RSC will cause water to be alkaline, and the organic content of the soil will tend to dissolve. Wilcox (1955, p. 11) states that water containing more than 2.5 me/l (milliequivalents per liter) RSC is not suitable for irrigation. The degree of leaching, however, will modify the permissible limit to some extent (Wilcox, Blair, and Bower, 1954, p. 265).

Water Quality in the Cypress Aquifer

Chloride concentrations in 109 samples of water from wells ranged from 1.5 to 985 mg/l (Figure 7). The highest concentrations of chlorides were found in wells tapping the basal section of the aquifer in the vicinity of the Rodessa Fault. Wells producing high-chloride water were generally more than 400 feet deep. Water from wells less than 400 feet deep in the faulted area generally did not have excessive concentrations of chloride. Chlorides were not excessive in water from the areas that included Atlanta, Linden, and Avinger.

Concentrations of chloride in excess of 250 mg/l were found in water from wells more than 300 feet deep in the area extending northeastward from Douglassville. Only the very shallow wells (50 feet or less) contained water with concentrations of chlorides in excess of 250 mg/l in the Bryans Mill area. High concentrations of chloride in water from the shallow wells probably result from local natural circumstances rather than from pollution, because the analyses for those wells date back to 1941, before any significant industrial development. Elsewhere in the report area, all shallow segments of the aquifer yielded water very low in chloride content.

Fluoride concentrations in water samples from 70 wells ranged from 0.0 to 3.2 mg/l. Water from 16 wells contained more than 1.0 mg/l, and 50 contained less than the minimum desirable concentration of 0.7 mg/l.

Iron concentrations in 34 samples of water from wells ranged from 0.02 to 11 mg/l, and manganese in 2 water samples was 0.03 and 0.05 mg/l. The highest concentrations of iron generally were found in water from wells tapping the aquifer at depths of 50 to 200 feet. This intermediate depth zone that generally yields water having high iron content is typical for all the Tertiary sediments in the northeast Texas area. If wells are so constructed and pumped as to avoid drawing water from this zone, excessive iron concentrations in well water can be avoided. If water high in iron is used, the iron can be reduced substantially by proper treatment.

Nitrate concentrations in 98 samples of water from wells ranged from 0.0 to 104 mg/l. Only 5 samples had concentrations in excess of 45 mg/l. Four of these samples were from wells less than 50 feet deep; the other sample was from a well 158 feet deep. High nitrate concentrations are localized and occur mostly in the very shallow parts of the aquifer, especially in the vicinity of septic tanks, barnyards, and other sites of organic waste.

Sulfate concentrations are generally very low in water from the Cypress aquifer. In 101 samples of water from wells, only 2 samples had sulfate concentrations in excess of 250 mg/l, and only 13 samples had concentrations greater than 20 mg/l. The highest concentration, 352 mg/l, was in well SX-35-12-701, which is used for public drinking water at a recreation site on Lake O' the Pines.

Dissolved-solids content in 99 samples of water from wells ranged from 12 to 2,119 mg/l. The variation of dissolved-solids concentrations, geographically and with depth, generally follows that of chloride concentrations (Figure 7). In wells more than about 400 feet deep in the vicinity of the Rodessa Fault, dissolved solids generally range from 500 mg/l to more than 1,000 mg/l. In the central part of the report area that includes Atlanta, Linden, and Avinger, wells tapping the basal part of the aquifer produce water containing about 500 mg/l dissolved solids but not exceeding 1,000 mg/l. In the area extending northeastward from Douglassville, wells deeper than about 300 feet yield water containing about 1,000 mg/l dissolved solids. The deeper wells (about 300 to 400 feet) in the Bryans Mill area yield water having less than 500 mg/l dissolved solids, but the very shallow wells (50 feet or less in the Bryans Mill area yield water having concentrations of dissolved solids from 600 to 900 mg/l. Elsewhere in Cass and Marion Counties, water from shallow wells seldom has concentrations of more than 200 mg/l dissolved solids.

Hardness in 108 samples of water from wells ranged from 1 to 803 mg/l. Only 12 of the samples from the Cypress aquifer had hardness greater than 60 mg/l, and of those 12, most of the water came from wells less than 50 feet deep. Water in the Cypress aquifer is generally soft.

Silica concentrations in 48 samples of water from wells ranged from 6.6 to 88 mg/l, but only two samples had more than 40 mg/l. In general, concentrations of silica tended to be less in samples from deep wells.

The pH of 55 samples of water from wells ranged from 3.4 to 8.5. Practically all samples having a pH of 7.0 or less acid were from wells less than 200 feet deep, whereas samples showing a pH of more than 7.0 were from wells more than 200 feet deep. This generally places the position of neutral water about at the base of the intermediate-depth zone, which is high in iron. Thus waters above depths of 200 feet are generally more corrosive with respect to pH in addition to being high in iron.

Temperatures of water from the Cypress aquifer range from 18°C (64°-65°F) to 26°C (78°-79°F), gradually increasing with depth. The temperature increases about 0.5°C (1°F) per 100 feet in depth.

The specific conductance (conductivity) of 54 samples of water from wells ranged from 34 to 2,990 micromhos, and was less than 2,250 micromhos in all but 2 samples. The SAR values of water from 44 samples ranged from 0.1 to 75 and was less than 14 in half of the samples.

The RSC values of 52 samples of water from wells ranged from 0.00 to 10.9 me/l and exceeded 2.5 me/l in 67 percent of the samples. Most of the high RSC values were from wells several hundred feet deep.

The boron content of water does not seem to be a problem. Two determinations of boron from water in the report area and 22 determinations in Harrison County (Broom and Myers, 1966, p. 32), where hydrologic conditions are similar to those in the report area, showed that boron did not exceed 1.0 mg/l—the permissible limit for irrigating boron-sensitive crops (Wilcox, 1955, p. 11).

On the basis of SAR and RSC, much of the water would be considered undesirable for irrigation; however, because of the high rainfall, sandy soil, and well-drained land surfaces in Cass and Marion Counties, most of the water from the Cypress aquifer probably could be used safely for supplemental irrigation without serious detriment to the soils.

To provide information on the presence and extent of pesticidal contamination of ground water, pesticide analyses were made on five samples of ground water. The water was analyzed for nine insecticides and three herbicides recommended for monitoring by the Subcommittee on Pesticide Monitoring of the Federal Committee on Pest Control (Green and Love, 1967, p. 13-16). Samples of water were collected on July 13, 1968, from wells DB-16-47-501, DB-16-54-202, SX-35-12-402, SX-35-12-701, and SX-35-13-703, which ranged in depth from 46 to 115 feet (See Figure 9 for locations of the wells). The analyses indicated that no pesticides were present in the water sampled.

DISPOSAL OF OIL-FIELD BRINES

Considerable quantities of brine are produced with oil in Cass and Marion Counties. According to preliminary unpublished figures of a brine inventory in the two counties by the Texas Railroad Commission, brine production in 1967 was 2,606,222 barrels (about 336 acre-feet). Table 6 shows the amount of brine production reported in each field in 1967 and the methods of disposal. Figure 9 shows the location of the oil and gas fields. Without adequate disposal methods, brine may contaminate potable water supplies in the report area.

Methods of brine disposal are regulated by the Texas Railroad Commission. Rules require that oil-field brine be disposed of in such a way that surface- or ground-water sources are not contaminated. Of the brine produced in the report area, 90 percent was disposed of by injection wells and 10 percent was disposed of in open pits. Effective January 1, 1969, the Texas Railroad Commission prohibited the use of pits for storage and evaporation of oil-field brine and certain other mineralized waters (by Special Order No. 20-56, 841, amending Rule 8 of the General Conservation Rules of Statewide Application, State of Texas) except as may be approved by special Railroad Commission hearing.

Another potential source of contamination of ground-water supplies is brine that moves upward from deep strata through inadequately cased or improperly plugged oil and gas tests and wells. This contamination hazard has been minimized in many oil and gas fields by the regulations of the Railroad Commission, which specify in field rules the casing and plugging requirements. The field rules applying to surface-casing requirements in oil and gas fields in Cass and Marion Counties are sufficient to protect the Cypress aquifer.

AVAILABILITY OF GROUND WATER FOR FUTURE DEVELOPMENT

The availability of ground water for future development from the Cypress aquifer in Cass and Marion Counties depends principally on the capacity of the aquifer to transmit and store water and the rate of recharge to the aquifer. Another factor is the chemical quality of the water, which in some parts of the area may be a deterrent to development of the ground-water supplies, particularly for municipal and domestic uses.

The capacity of the Cypress aquifer to transmit water under the original hydraulic gradient that had not been significantly affected by pumping is a conservative indication of the rate of recharge and of the quantity of water that perennially would be available for development. On the basis of the present regional hydraulic gradient of about 5 feet per mile and an average transmissivity of 26,000 gpd per foot, about 8.5 mgd (about 9,500 acre-feet per year) currently passes through a vertical section of the Cypress aquifer 65 miles long and coincident with the 225-foot water-level contour (Figure 4).

Table 6.—Oil- and Gas-Field Brine Production and Disposal, 1967

FIELD NAME	BRINE PRODUCTION (BARRELS)	BRINE DISPOSAL: INJECTION WELL BARRELS	INJECTION WELL PERCENT	OPEN-SURFACE PITS BARRELS	OPEN-SURFACE PITS PERCENT
Bryans Mill	16,500	16,500	100	0	0
Clinton Lake	350	0	0	350	100
Excelsior	11,434	0	0	11,434	100
Friendship	215,190	213,000	99	2,190	1
Frost	8,471	7,208	85	1,263	15
Green Fox	15,330	15,330	100	0	0
Haynes	1,218,409	1,214,874	99.5	3,535	.5
Kildare	784,027	766,000	96.5	18,027	3.5
Lake Ferrell	20,834	20,834	100	0	0
Linden East	5,110	5,110	100	0	0
Marion County (Shallow)	11,132	0	0	11,132	100
Rodessa	167,706	2,670	1	165,036	99
Skeeters	182	0	0	182	100
Vickie Lynne	123,250	91,250	74	32,000	26
Woodlawn	8,297	1,100	13	7,197	87
Totals	2,606,222	2,353,876	90	252,346	10

Because the water levels in some wells have declined substantially over a period of several years and apparently are still declining, it is evident that the Cypress aquifer in Cass and Marion Counties has been affected by pumping. Data are not available to determine the undisturbed or original hydraulic gradient, and because the hydraulic gradient used in the calculation is believed to be slightly more than the original gradient, a conservative quantity of water that would be available perennially for development is probably somewhat less than 8.5 mgd.

Streamflow records for the report area are not sufficient to permit a determination of base flow of the streams, which would be an indication of potential recharge rejected as streamflow. However, based on studies in adjoining Harrison County (Broom and Myers, 1966) where hydrologic conditions are similar to those in Cass and Marion Counties, the quantity of water being discharged to the streams as rejected recharge is significant—probably equal to or greater than the 8.5 mgd being transmitted through the aquifer under the present gradient. Thus, considering the somewhat less than 8.5 mgd that was probably originally moving through the aquifer and about an equal amount of water that is rejected as streamflow, about 17 mgd of ground water is perennially available for development. Considering the 3.6 mgd of ground water that was used for all purposes in 1967, this pumpage probably could be increased slightly more than 4 times without exceeding the rate of replenishment and depeleting the supply.

The quantity of ground water that may be perennially available for development is small compared to the quantity of water that is in transient storage. Computations based on the saturated sand thickness (Figure 8) and a porosity factor of 30 percent indicate that approximately 90 million acre-feet of water is in transient storage, of which probably 50 million acre-feet is above 400-foot depths, which is an assumed limit for economically pumping water for most purposes. Of the 50 million acre-feet, only about half is recoverable by wells, and because of the low transmissibility of the aquifer, many small-capacity wells would be required to recover this quantity from storage.

The chemical quality of water, particularly the chloride content, may limit development of the ground water in places in the southern part of the area and locally in the northern part. The chloride concentration commonly is too high for municipal and rural domestic use in these areas. Likewise, high iron concentrations in the upper part of the aquifer is a limiting chemical factor. In most of the area, however, supplies of good quality water suitable for public supply, irrigation, and many industrial purposes are available for development.

The map showing the thickness of saturated sand in the Cypress aquifer (Figure 8) is useful in locating areas favorable for the development of large quantities of ground water in Cass and Marion Counties. The thickness of saturated sand ranges from about 100 feet in the northwestern and southeastern parts of the area to about 600 feet in the Avinger area. Generally, the most favorable areas for devleopment are those where the saturated sands are more than 400 feet thick, such as the Atlanta-Bloomburg area and the large area that includes Hughes Springs and Avinger. In these areas, properly constructed and adequately spaced wells probably would be capable of yielding 500 gpm or more. Yields of this magnitude have been proven only in the Atlanta area. Similar yields probably could be obtained in the Avinger area where saturated sands reach a total thickness of slightly more than 600 feet.

RECOMMENDATIONS FOR A CONTINUING OBSERVATION PROGRAM

In order to keep abreast of changes in water levels and water quality, a continuing program of water-level measurement and ground-water sampling for chemical analysis is needed.

Approximately 20 wells are recommended for periodic water-level measurements. They should be concentrated especially in the Atlanta, Bryans Mill, Rodessa Fault, and Linden areas, in order to monitor future changes in the cones of depression in these areas.

About 10 wells are needed for periodic sampling for chemical analysis. These should be located in areas where water-quality problems exist, such as near the Rodessa Fault and in the area northeast of Douglassville. Some wells near the oil fields shown on Figure 9 should also be monitored for possible salt-water contamination.

DEFINITION OF TERMS

Many of the following definitions have been taken or adapted from Meinzer (1923), American Geological Institute (1960), Langbein and Iseri (1960), and Ferris and others (1962).

Acre-foot (ac-ft).—The volume of water required to cover one acre to a depth of 1 foot (43,560 cubic feet or 325,851 gallons).

Aquiclude.—A formation, group of formations, or part of a formation that is non-water bearing, or is sufficiently impermeable to severely restrict the transmission of water.

Aquifer.—A formation, group of formations, or part of a formation that is water bearing, or is sufficiently permeable to allow transmission of considerable quantities of water.

Aquifer test.—A pumping test from which the essential hydrologic properties of an aquifer may be determined, such as the storage coefficient, hydraulic conductivity, and transmissivity.

Artesian aquifer.—An aquifer that is confined both above and below by a relatively impermeable formation (aquiclude), and in which water is under pressure greater than atmospheric pressure. Consequently, the water rises in artesian wells to levels above the top of the aquifer and sometimes rises to levels above land surface (flows).

Cone of depression.—Depression of the water table or potentiometric surface caused by a discharging well; more or less the shape of an inverted cone.

Drawdown.—The difference between the static water level and the pumping water level in a well.

Evapotranspiration.—A combined term for evaporation and transpiration; the amount of water withdrawn from surface and ground storage by evaporation and plants.

Fresh water and saline water.—The terms as applied in this report are taken from a general classification based on dissolved-solids content by Winslow and Kister (1956); fresh, 0 to 1,000 mg/l (milligrams per liter); slightly saline, 1,000 to 3,000 mg/l; moderately saline, 3,000 to 10,000 mg/l; very saline, 10,000 to 35,000 mg/l; and brine, more than 35,000 mg/l.

Hydraulic conductivity.—A measure of the capacity of an aquifer to transmit water. The rate of flow in gallons per day through a cross section of 1 square foot under a hydraulic gradient of 1 foot per foot and at a temperature 16°C (60°F).

Hydraulic gradient.—The slope of the water table or potentiometric surface, usually expressed in feet per mile.

Milliequivalents per liter (me/l).—The concentration of chemical substances in terms of the reacting values of electrically charged particles or ions in solution.

Milligrams per liter (mg/l).—A unit for expressing the concentration of chemical constituents in solution. Milligrams per liter represents the weight of solute per unit volume of water. As commonly measured and used, milligrams of a substance per liter of water is numerically equivalent to parts per million, when concentrations are less than about 7,000 mg/l.

Potentiometric surface.—An imaginary surface that everywhere concides with the static level of the water in an aquifer. The surface to which the water from a given aquifer will rise under its hydrostatic pressure or head.

Specific capacity.—The rate of yield of a well per unit of drawdown, usually expressed as gallons per minute per foot of drawdown.

Storage coefficient.—The volume of water that an 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.

Transmissivity.—The rate of flow of ground water in gallons per day through a vertical strip of the aquifer 1 foot wide extending through the vertical thickness of the aquifer at a hydraulic gradient of 1 foot per foot and at the prevailing temperature of the water.

Transmission capacity of an aquifer.—The quantity of water that can be transmitted through a given width of an aquifer at a given hydraulic gradient, usually expressed in acre-feet per year or million gallons per day (mgd).

Water table.—The upper surface of the saturated zone.

Water-table aquifer.—An aquifer that is unconfined; the upper surface of the saturated zone is under atmospheric pressure only and the water is free to rise or fall in response to the changes in the volume of water in storage. The depth to the static water level in a water-table well coincides with the depth to the water table.

Yield of a well.—The rate of discharge, usually expressed in gallons per minute (gpm). In this report, yields are classified as small, less than 50 gpm; moderate, 50 to 500 gpm; and large, more than 500 gpm.

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Table 7.--Records of Wells and Springs in Cass and Marion Counties

All wells are drilled unless otherwise noted in remarks column.
Water level : Reported water levels given in feet; measured water levels given in feet and tenths.
Method of lift and type of power: B, bucket; C, centrifugal; G, gasoline, butane, or diesel engine; H, hand; J, jet; N, none; P, piston; S, submergible; T, turbine; number indicates horsepower.
Use of water : D, domestic; Ind, industrial; P, public supply; S, livestock; U, unused.

WELL	OWNER	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	DIAMETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
					Cass County						
* DB-16-44-801	Humble Oil & Refining Co.	--	1955	7,238	--	315	--	--	--	--	Oil test. 1/
45-701	Lamar Hunt, et al.	--	1964	10,315	--	245	--	--	--	--	Do.
801	Shell Oil Co. well B-2	--	1965	9,863	--	227	--	--	--	--	Do.
802	Skelly Oil Co. well E-1	--	1965	9,855	--	231	--	--	--	--	Do.
* 47-501	Corps of Engineers Ramp well 1	Frank Dunn	1963	115	42,36, 24	300	--	--	S,E	P	Bored well, shored with cement tile. Supplies drinking water in Ramp 1 recreation area at Texarkana Reservoir.
601	Corps of Engineers	--	1952	410	4, 3	260	--	1952	T,E, 5	P	Casing: 4-in. to 110 ft, 3-in. liner from 110 ft to bottom with perforations from 370 ft to bottom. Stand-by well, seldom used. Reported yield 50 gpm.
801	do	Frank Dunn	1963	100	42,36, 24	250	--	--	S,E	P	Bored well, shored with cement tile. Supplies drinking water in Rocky Point recreation area at Texarkana Reservoir.
901	J.K. Wadley, et al. well 1	--	1940	3,426	--	280	--	--	--	--	Oil test. 1/
902	B.F. Weekly	--	1955	5,007	--	245	--	--	--	--	Do.
48-701	--	--	Old	39	36	324	28.1 28.1 29.7	Dec. 13, 1941 Aug. 18, 1960 Nov. 21, 1967	N	U	Dug well, shored with rock. Old Alamo School well.
702	L.V. Henderson	--	Old	17	30	243	15.8 15.9	Aug. 18, 1960 Nov. 21, 1967	B,H	D	Dug well, uncased.
703	H.A. King, well 1	--	1953	4,251	--	285	--	--	--	--	Oil test. 1/
704	H.A. King	--	1954	4,251	--	306	--	--	--	--	Do.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	DIAMETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
DB-16-48-801	International Paper Co.	H.A. King	1940	--	10	200	+	--	Flows	Ind	Oil test, converted as flowing water well. 1/
802	Shell Oil Co. Ahern well 1	--	1964	9,872	--	226	--	--	--	--	Oil test. 1/
* 51-601	J.L. Moore	Shirley Young	1956	275	3	400	--	--	J,E, 1	D	Perforated near bottom.
* 602	L.F. Hicks	--	1901	16	24	352	4.7 7.8	Dec. 9, 1941 Aug. 18, 1960	P,E, 1/2	D	Dug well, shored with clay tile.
603	Wm. Hicks	--	1930	25	30	335	14.8 14.6	Aug. 16, 1960 Dec. 13, 1967	P,E, 1/2	D	Dug well, shored with cement tile.
604	Pat Moore	-- Dickson	1954	60	36	345	36.7	Sept. 2, 1960	J,E, 1/2	D	Bored well; open hole to 33 ft, shored with cement tile from 33 ft to bottom.
* 52-101	Arthur Boyd	--	1938	24	36	360	19.6 19.3 21.5	Dec. 9, 1941 Aug. 16, 1960 Dec. 12, 1967	N	U	Dug well, uncased.
* 301	E.G. Dale	-- Williamson	1968	295	4, 2	330	125.0	May 28, 1968	S,E, 1	D	Casing: 4-in. to 191 ft; 2-in. liner from 190 ft to bottom. Perforated from 232 ft to bottom. Pump set 170 ft.
401	A.A. Hampton	Shirley Young	1952	375	3	350	--	--	J,E, 1	D	Perforated from 360 ft to bottom. Pump set 90 ft.
402	Gethsemane Church	--	--	20	42	360	13.6 13.0	Dec. 2, 1960 Dec. 13, 1967	B,H	D	Dug well, uncased.
* 501	Marietta Water Supply Corp.	Edington Drilling Co.	1965	593	8, 4	355	126.5	Oct. 26, 1967	S,E, 15	P	Casing: 8-in. to 558 ft, cemented; 4-in. liner and screen from about 558 ft to bottom. Pump set 300 ft. Reported discharge 100 gpm.
601	Marietta School	Floyd Smith	1958	36	30	365	10.7 20.4	Mar. 4, 1960 Jan. 15, 1968	J,E, 1/3	U	Bored well, shored with cement tile. Well unused since 1965.
602	Amerada Petroleum Corp., well 1	--	1961	11,270	--	371	--	--	--	--	Oil test. 1/
* 701	E.H. Hampton	--	1921	25	30	360	20.7 21.7 21.4	Dec. 9, 1941 Sept. 2, 1960 Dec. 13, 1967	N	U	Dug well, shored with cement tile.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	DIAMETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
DB-16-52-801	R.O. McCord	--	--	30	36	340	25.4	Sept. 14, 1960	J,E, 1/2	D	Dug well, uncased.
901	Bethlehem Community Center	--	1957	45	30	395	8.5 7.8	Mar. 4, 1960 Jan. 15, 1968	J,E, 1/3	P	Bored well, shored with cement tile. Formerly Bethlehem School well.
* 53-101	E.L. Stringer	--	Old	50	18	320	46.3 46.8 46.0	Dec. 9, 1941 Aug. 29, 1960 Dec. 18, 1967	N	U	Dug well, shored with cement tile.
* 102	Orvile Waldon	--	Old	49	30	325	39.3 40.4	Dec. 10, 1941 Aug. 29, 1960	J,E, 1/2	D	Dug well, shored with brick.
* 103	New Zion Church	--	Old	16	24	370	15.1 8.2 2.6	Dec. 10, 1941 Aug. 29, 1960 Dec. 18, 1967	B,H	D	Dug well, shored with clay tile. Formerly New Zion School well.
* 104	Shell Oil Co.	Layne-Texas Co.	1961	405	14, 8	325	93 154.7	Aug. 12, 1961 Mar. 5, 1968	T,E, 50	Ind	Casing: 14-in. to 250 ft, cemented; 8-in. liner and screen from 0 ft to bottom. Pump set 300 ft. Measured drawdown 56 ft after pumping 4 hours at 216 gpm, March 5, 1968.
105	Shell Oil Co. well 2	do	1961	455	14, 8	342	112.7 199.3	July 13, 1961 Mar. 5, 1968	T,E, 50	Ind	Casing: 14-in. to 260 ft, cemented; 8-in. liner and screen from 0 ft to bottom. Pump set 340 ft.
106	Shell Oil Co. well 1	do	1961	385	14, 8	345	101.3 182.3	June 14, 1961 Mar. 5, 1968	T,E, 30	Ind	Casing: 14-in. to 230 ft, cemented; 8-in. liner and screen from 0 ft to bottom. Drilled to 613 ft; plugged back to 385 ft. Pump set 320 ft. Reported discharge 160 gpm. 2/
107	Shell Oil Co.	--	--	190	4	337	140.0	May 28, 1968	N	U	Well developed for oil test drilling water.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	DIAMETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
* DB-16-53-201	Cass County	--	1925	33	30	305	19.5 11.2 12.8	Dec. 10, 1941 Mar. 11, 1960 Dec. 18, 1967	J,E, 3/4	D	Dug well, shored with cement tile. Formerly Spring Hill School well.
202	Welborn Griffin	H.P. Narramore	1956	263	4	325	35.7	Mar. 3, 1960	S,E, 1	D,S	Single casing with 60 ft of perforations near bottom. Pump set 147 ft.
203	Hugh Frost	--	1964	328	4	266	66.6	Mar. 1, 1968	N	U	Well developed for oil test drilling water.
204	Shell Oil Co. MacDonnell well A-1	--	1964	10,050	--	222	--	--	--	--	Oil test. 1/
301	Humble Oil & Refining Co., Heard well 1	--	1962	10,700	--	259	--	--	--	--	Do.
302	James Turner	Buster Dunn	1967	437	4	290	48.9	May 27, 1968	N	U	Well developed for oil test drilling water.
* 601	Homer Granberry	--	Old	28	24	275	17.6 17.2 12.3	Dec. 10, 1941 Aug. 16, 1960 Dec. 18, 1967	N	U	Dug well, shored with clay tile.
602	do	--	1958	47	30	280	18.3	Aug. 16, 1960	J,E, 1/2	D	Bored well, shored with cement tile.
603	W.W. McCoy	Shirley Young	1956	350	4	340	--	--	J,E, 1 1/2	D	Pump set 150 ft.
701	Floyd Valley School	--	--	50	30	430	45.0	Dec. 18, 1967	J,E, 3/4	P	Bored well, shored with cement tile.
* 901	Sarah Hare	--	Old	35	42	445	28.9 29.3	Dec. 10, 1941 Aug. 19, 1960	B,H	D	Dug well, shored with rock.
902	Grady Mansfield	Shirley Young	1957	250	3	420	--	--	J,E, 3/4	D	Well reported drilled to 315 ft; plugged back at 250 ft.
* 903	Neotis Roberson	Buster Dunn	1967	108	4	384	74.3	May 28, 1968	J,E, 3/4	D	
904	Superior Oil Co. Lambert well 1	--	1961	11,036	--	380	--	--	--	--	Oil test. 1/
54-101	Panhandle School	--	1934	33	30	310	25.3 24.5	Mar. 9, 1960 Oct. 26, 1967	J,E, 3/4	U	Dug well, shored with cement tile.
102	Kickapoo Lodge	Joe Hughes	1957	240	4	290	40.1 53.0	Apr. 22, 1958 Mar. 14, 1968	J,E, 2	P	Casing: 4-in. to 180 ft.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	DIAMETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
DB-16-54-201	Humble Oil and Refining Co., Methodist Home well 1	--	1955	7,016	--	248	--	--	--	--	Oil test. 1/
* 202	Corps of Engineers Jackson Creek well	Frank Dunn	1963	57	42	260	--	--	S,E	P	Bored well, shored with cement tile. Supplies drinking water in Jackson Creek recreation area of Texarkana Reservoir.
301	Corps of Engineers Armstrong Creek well	do	1962	60	42	270	--	--	S,E	P	Bored well, shored with cement tile. Supplies drinking water in Armstrong Creek recreation area of Texarkana Reservoir.
* 302	State of Texas	Edington Drilling Co.	1958	438	4	270	70.2 77.6	Aug. 17, 1960 Jan. 16, 1968	S,E, 2	P	Screened from 398 ft to bottom. Supplies drinking water for Atlanta State Park.
* 401	Douglassville School	--	Old	60	24	380	47.1 50.0	Aug. 16, 1960 Oct. 26, 1967	J,E	U	Dug well, shored with clay tile.
402	City of Douglassville	J.H. Walker	1954	496	6	392	165.5	Oct. 26, 1967	S,E	U	Pump set 260 ft.
* 403	do	Edington Drilling Co.	1965	664	8, 4	385	166	Feb. 1965	S,E, 7 1/2	P	Casing: 8-in. to 568 ft, cemented; screened from 568 ft to bottom. Drilled to 700 ft, plugged back to 664 ft. Reported drawdown 88 ft after pumping 24 hours at 168 gpm when drilled February 1965. 2/
404	Bowie-Cass Electric Coop.	Edington Drilling Co.	1958	702	8	390	--	--	S,E, 7 1/2	Ind	Casing: 8-in. to 640 ft, cemented; 4-in. liner and screen from 635 ft to bottom. Pump set 306 ft.
* 601	Elsie Turner	--	Old	33	30	365	27.9 28.1 28.3	Dec. 5, 1941 Aug. 30, 1960 Jan. 16, 1968	J,E, 1/3	D	Dug well, shored with cement tile.
* 801	Midway Church	--	Old	20	36	370	16.6 16.8 13.4	Oct. 27, 1941 Aug. 30, 1960 Jan. 16, 1967	P,H	U	Dug well, uncased.
* 802	O'Farrell Community Center	--	Old	30	24	395	8.4 6.7	Aug. 19, 1960 Jan. 16, 1968	P,H	P	Dug well, shored with clay tile. Formerly O'Farrell School well.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

	WELL	OWNER	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	DIAMETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
	DB-16-54-803	H.A. King Riley well 1	--	1958	4,635	--	358	--	--	--	--	Oil test. 1/
	55-201	Oval Kinney	--	1958	35	8	340	25.4	Aug. 17, 1960	B,H	D	Bored well, tile casing.
	202	Arkla Oil Co. Lindsey well 1	--	1948	7,278	--	320	--	--	--	--	Oil test. 1/
	203	H.A. King East Texas Iron Co. well 1	--	1955	4,503	--	363	--	--	--	--	Do.
	301	S.H. Barnwell	W.C. Barnwell	1952	128	6	280	40.3	Mar. 9, 1960	J,E	D	Cased to 60 ft, open hole from 60 ft to bottom. Reported to discharge water high in dissolved iron.
	501	Darnell Brown	--	1948	24	30	270	18.4	Aug. 17, 1960	J,E, 1/2	D	Dug well, shored with cement tile.
	502	Humble Oil & Refining Co., Hicks well 1	--	1961	10,900	--	321	--	--	--	--	Oil test. 1/
	601	H.A. King Campbell well 1	--	1950	4,511	--	307	--	--	--	--	Do.
	701	I.L. Beck	--	1936	26	24	335	13.8	Aug. 30, 1960	J,E	D	Dug well, shored with clay tile.
*	801	R.C. Hardy Water Co.	B.F. Weekley Oil Co.	1955	840	10	324	174.7 180.1	June 26, 1963 Oct. 26, 1967	S,E, 5	P	Originally drilled as oil test to 5,016 ft; plugged back to 840 ft, and converted to water well in 1955. Produces from approximately 670 to 720 ft. Pump set 260 ft. Measured drawdown 32 ft after pumping 4 hours at 39 gpm, June 26, 1963. 1/
	802	Humble Oil & Refining Co., Gilley well 1	--	1961	10,987	--	292	--	--	--	--	Oil test. 1/
*	901	R.C. Hardy Water Co.	J.H. Walker	1948	400	6	384	--	--	S,E, 7 1/2	P	Screened from 370 ft to bottom.
	902	Humble Oil & Refining Co., Beaver well 1	--	1960	11,612	--	315	--	--	--	--	Oil test. 1/
	56-101	R. Kamon Savage well 1	--	1934	3,767	--	250	--	--	--	--	Oil test. 1/
*	201	P.H. Phillpott	--	--	--	8	210	+ + 0.5	Oct. 27, 1941 Nov. 21, 1967	N	U	Originally drilled as oil test to about 1,300 ft in 1927; converted to water well. Flowed until about 1965.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	DIAM-ETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
DB-16-56-401	Buck Lee	V.L. Shirley	1956	320	3, 2	290	--	--	J,E, 1	D	Casing: 3-in. to 200 ft; 2-in. liner and screen from 200 ft to bottom.
* 501	Mrs. Carl Spivey	--	Old	24	30	245	14.0 10.0 13.5	Oct. 27, 1941 Mar. 9, 1960 Nov. 21, 1967	N	U	Dug well, shored with cement tile. Formerly Cass Springs School well.
502	do	V.L. Shirley	1955	285	3	245	--	--	J,E, 1	D	Casing: 3-in. to 100 ft; open hole from 100 ft to bottom.
503	Purnell & Coleman Davis well 1	--	1958	1,702	--	228	--	--	--	--	Oil test. 1/
701	Voight Farms, Inc.	--	1959	465	4, 2	330	115.1	Dec. 12, 1967	S,E, 5	D,S	Casing: 4-in. to 190 ft; 2-in. liner, perforated at two or more intervals from 190 ft to bottom.
702	do	Buster Dunn	1966	325	8	300	--	Dec. 1966	S,E, 15	S	Casing: 8-in. to 280 ft. Pump set 275 ft. Supplies water for catfish ponds.
703	J.S. Griffin Daniel well 1	--	1940	4,270	--	320	--	--	--	--	Oil test. 1/
* 801	E.E. Hurt	--	1961	74	30	335	--	--	J,E, 1/2	D	Bored well, shored with cement tile.
802	Bryan Hurt	--	1950	47	30	320	28.7	Dec. 6, 1967	J,E, 1/2	D	Do.
803	Humble Oil & Refining Co., Walters well 1	--	1958	11,061	--	268	--	--	--	--	Oil test. 1/
* 59-301	W.L. Jacobs	--	Old	25	36	380	22.0 21.8 24.8	Dec. 8, 1941 Sept. 14, 1960 Dec. 13, 1967	N	U	Dug well, uncased. Well unused since 1960.
302	Atlas Oil & Refining Co., Thomas well 1	--	1946	5,507	--	390	--	--	--	--	Oil test. 1/
* 601	Irvin Bros.	--	1925	20	42	385	16.8 16.2 18.0	Dec. 8, 1941 Sept. 14, 1960 Dec. 13, 1967	J,E, 1/2	U	Dug well, uncased.
* 602	J.C. Hall	--	Old	25	42	315	14.9 14.4	Dec. 8, 1941 Sept. 14, 1960	N	U	Do.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	DIAM-ETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL		METHOD OF LIFT	USE OF WATER	REMARKS
							BELOW LAND SURFACE DATUM (FT)	DATE OF MEASUREMENT			
* DB-16-59-901	City of Hughes Springs	Layne-Texas Co.	1935	367	13, 8	410	120.1	Oct. 22, 1967	S,E, 8 1/2	U	Casing: 13-in. to 283 ft, cemented; top of 8-in. liner at 217 ft and screens from 284-307 and 324-354 ft. Well deepened in 1956 to 367 ft. Pump set 360 ft. 2/
* 60-101	Leon Coker	Grady Bell	1921	3,990	10	325	+ +	Dec. 8, 1941 Dec. 13, 1967	Flows	U	Reported to be unplugged oil test. Flows about 1/2 gpm or less.
102	Membria Brown	--	1958	26	30	325	23.5	Sept. 14, 1960	J,E, 1/3	D	Bored well, shored with cement tile. Pump set 24 ft.
* 201	Quinn Patterson	--	Old	25	30	292	21.6 20.7	Dec. 8, 1941 Sept. 14, 1960	B,H	D	Dug well, shored with cement tile.
202	Mrs. Ernest Hall	V.L. Shirley	1954	600	3	375	90.6 87.9	Oct. 2, 1963 May 31, 1968	P,E	U	Casing: 3-in. to 90 ft, 2-in. liner from approximately 90 ft to bottom.
301	W.F. Tindal	Frank Dunn	1957	58	30	385	37.2	Sept. 2, 1960	J,E, 1/2	D	Bored well, shored with cement tile.
401	Placid Oil Co. Irvin well 1	--	1948	5,610	--	328	--	--	--	--	Oil test. 1/
* 501	Crossroads Community Center	--	Old	45	36	335	39.4 38.5 16.5	Oct. 28, 1941 Sept. 13, 1960 May 31, 1968	J,E	P	Dug well, uncased.
* 601	O.G. Womack	--	Old	49	42	325	34.3 42.9	Dec. 9, 1941 Sept. 14, 1960	J,E, 1/2	D	Do.
* 801	F.L. Edwards	--	1941	44	42	345	31.9 32.4 32.7	Dec. 8, 1941 Sept. 14, 1960 Jan. 15, 1968	N	U	Dug well, shored with brick.
* 901	L.C. Pruitt	--	1919	60	36	322	38.2	Sept. 14, 1960	J,E, 1/4	D	Dug well, shored with cement tile.
902	Arkla Exploration Co., Leftwich well 1	--	1965	12,900	--	327	--	--	--	--	Oil test. 1/
61-401	Fred Dooley	--	1954	27	30	385	18.8 18.3	Sept. 14, 1960 Jan. 15, 1968	P,E, 1/3	D	Bored well, shored with cement tile.
501	Boyz Young	Boyz Young	1955	23	30	340	20.5	Sept. 14, 1960	B,H	D	Dug well, shored with cement tile.
* 601	Warren Springs Community Center	--	Old	25	30	445	19.0 15.7 15.3	Oct. 27, 1941 Mar. 9, 1960 Jan. 15, 1968	J,E, 1/2	P	Do.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	DIAM-ETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
* DB-16-61-602	Pleasant Hill Community Center	--	Old	20	48	440	10.5 7.4 7.7	Dec. 10, 1941 Mar. 9, 1960 Jan. 15, 1968	C,E, 1/4	P	Dug well, shored with cement tile.
701	Antioch Missionary Baptist Church	--	1966	55	30	320	18.5	Jan. 15, 1968	J,E, 1/2	D	Bored well, shored with cement tile.
* 62-301	Bailey Coates	--	Old	30	42	400	22.0 23.3 22.0	Dec. 15, 1941 Sept. 2, 1960 Dec. 6, 1967	B,H	D	Dug well, shored with rock.
401	R.C. Beard	Frank Dunn	1953	50	30	340	28.4	Aug. 19, 1960	J,E, 1/4	D	Bored well, shored with cement tile.
402	Coates Drilling Co. Moseley well 1	--	1955	4,746	--	382	--	--	--	--	Oil test. 1/
* 501	Cass County	--	Old	30	30	305	22.9 21.6	Aug. 19, 1960 Dec. 6, 1967	N	U	Dug well, shored with brick.
502	L.J. Bryant	--	1920	22	36	265	17.9 18.3	Aug. 19, 1960 Dec. 6, 1967	J,E, 3/4	D	Dug well, shored with cement tile.
* 701	City of Linden well 1	Layne-Texas Co.	1934	826	8, 6	385	--	--	T,E	P	Casing: 8-in. to 617 ft, cemented; 6-in. liner and screens from 642 ft to 823 ft. Reported drawdown 46 ft while pumping 118 gpm when drilled. 2/
* 702	City of Linden well 3	Edington Drilling Co.	1964	719	8, 4	361	140 163.2 160.0	Nov. 1964 Oct. 19, 1967 Apr. 19, 1968	S,E, 15	P	Casing: 8-in. to 294 ft, cemented; 4-in. liner and screen from approximately 290 ft to bottom. Measured drawdown 49 ft after pumping 4 hours at 125 gpm, April 19, 1968.
63-101	Howe Bros. Minnow Farm	Dunn & Wood	1956	265	4	320	--	--	T,E, 3	S	Cased 4-in. to bottom, perforated from 200 ft to bottom.
* 102	do	do	1958	231	8	296	82.9	May 28, 1968	S,E, 10	S	Estimated discharge 125 gpm, May 28, 1968.
* 201	City of Atlanta well 2	Layne-Texas Co.	1936	844	13, 7	254	54 159.8 154.0	Feb. 1936 Oct. 26, 1967 Mar. 20, 1968	T,E, 50	P	Casing: 13-in. to 703 ft, cemented; top of 7-in. liner at 621 ft; screened from 737 ft to 836 ft. Pump set 320 ft. Reported drawdown 78 ft after pumping 24 hours at 400 gpm when drilled in 1936. 2/

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	DIAM-ETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
DB-16-63-202	City of Atlanta well 3	Layne-Texas Co.	1949	670	14, 8	325	182	July 28, 1949	T,E, 60	P	Casing: 14-in. to 564 ft, cemented; 8-in. liner and screen from 505 ft to bottom. Pump set 470 ft.
* 301	City of Atlanta well 4	C.F. Ketchum	1953	829	14, 6	242	102 110.0 109.1	Nov. 1953 Feb. 16, 1960 May 10, 1961	T,E, 50	P	Casing: 14-in. to 660 ft, cemented; 6-in. liner and screen from 610 ft to bottom. Measured drawdown 73 ft after pumping 2 hours at 475 gpm, May 10, 1961. Discharge choked down to approximately 350 gpm since 1961. 1/
401	J.A. Thomas	--	Old	30	36	285	22.5 19.9	Aug. 19, 1960 Dec. 12, 1967	B,H	D	Dug well, uncased.
* 601	T.H. McConnell	--	Old	19	30	265	12.2 16.4 10.8	Dec. 13, 1941 Aug. 31, 1960 Dec. 12, 1967	C,E, 1/2	D	Dug well, shored with cement tile.
701	British American Oil Producing Co., well 1	--	1941	4,314	--	320	--	--	--	--	Oil test. 1/
702	Happy Gist, et al. Grant well 1	--	1960	11,285	--	271	--	--	--	--	Do.
* 801	Cass County	--	Old	34	48	320	32.3 24.8 15.0	Nov. 3, 1941 Aug. 19, 1960 Jan. 17, 1968	J,E, 3/4	U	Dug well, shored with concrete. Formerly Bivins School well.
802	R.F. Maxwell	--	1952	57	30	300	28.6 23.3	Aug. 19, 1960 Jan. 17, 1968	J,E, 3/4	D	Bored well, shored with cement tile.
* 803	M.L. Morris	Buster Dunn	1964	313	4	320	114.1	Jan. 17, 1968	S,E, 1/2	D	
* 901	J.H. Williams	--	Old	24	24	330	14.3 19.9 20.6	Oct. 31, 1941 Aug. 31, 1960 Dec. 12, 1967	J,E, 1/4	D	Dug well, shored with cement tile. Formerly Huffines School well.
902	Huffines Community Center	--	--	517	4	330	111.3 129.5 116.6	Apr. 17, 1958 Aug. 31, 1960 Dec. 12, 1967	S,E, 3/4	P	Formerly Huffines School well.
* 903	E.V. Waites	--	1921	21	42	290	13.5 15.9 13.9	Dec. 13, 1941 Aug. 31, 1960 Dec. 12, 1967	C,E, 1/3	D	Dug well, uncased.
* 64-101	Charlie Coates	--	Old	29	24	330	24.4 24.0	Dec. 13, 1941 Aug. 18, 1960	J,E, 1/4	D	Dug well, shored with tile.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	DIAMETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL		METHOD OF LIFT	USE OF WATER	REMARKS
							BELOW LAND SURFACE DATUM (FT)	DATE OF MEASUREMENT			
* DB-16-64-201	Bloomberg Water Supply Corp.	Layne-Texas Co.	1964	450	10, 6	310	117	Aug. 27, 1964	S,E, 7 1/2	P	Casing: 10-in. to 330 ft, cemented; 6-in. liner and screen from 250 ft to bottom. Pump set 205 ft.
202	J.B. Hilliard	Noah Tyson	1967	253	4, 2	320	93.9	Dec. 12, 1967	S,E, 3/4	D	Casing: 4-in. to 205 ft; 2-in. liner from 205 ft to bottom. Pump set 189 ft.
* 203	J.A. Cantrell	--	1938	19	24	260	6.7 13.8 12.2	Dec. 13, 1941 Aug. 18, 1960 Nov. 20, 1967	B,H	D	Dug well, shored with tile.
401	L.P. Arceneaux	Noah Tyson	1956	123	4	310	39.6 38.7	Aug. 18, 1960 Dec. 5, 1967	N	U	Reported unused because well yields water high in dissolved iron.
402	Arkla Oil Co. Brooks Bros. well 1	--	1947	7,200	--	220	--	--	--	--	Oil test. 1/
* 501	Texas Eastern Transport Corp.	Rayburn Drilling Co.	1950	214	10	300	74.4 94.1	Aug. 8, 1960 Nov. 20, 1967	S,E, 3	Ind	Pump set 200 ft.
502	Mrs. Beulah White	Gregg & Walker	1955	200	4	320	101.8 102.6	Aug. 18, 1960 Nov. 20, 1967	S,E	D	
503	Cecil Lummus	--	1955	206	4	260	39.9 44.5	Mar. 8, 1960 Nov. 20, 1967	S,E, 1 1/2	D	Cased 4-in. to bottom; perforated from 186 ft to bottom. Pump set 105 ft.
504	A.D. Glass	--	1960	55	30	325	32.2	Dec. 5, 1967	J,E, 1/2	D	Bored well, shored with cement tile.
505	Arkla Oil Co. Glass well 1	--	1947	7,338	--	325	--	--	--	--	Oil test. 1/
801	W.C. Williams	-- Walker	1958	305	4	238	27.7	May 31, 1968	S,E	D	Screened from 270 ft to bottom. Pump set 40 ft.
35-03-301	Humble Oil & Refining Co., Turner well 1	--	1952	8,308	--	428	--	--	--	--	Oil test. 1/
601	Fayon Amox	O. Holmes	1956	366	4	443	163.9	Sept. 12, 1960	S,E, 1/2	D	Cased 4-in. to 323 ft; open hole from 323 ft to bottom. Pump set 204 ft.
04-101	City of Hughes Springs well 3	Cooper-Herring	1952	480	6	370	89.5	Oct. 22, 1967	T,E, 15	U	Screened from 450 ft to bottom. Well yield reported 75 gpm when last used. Pump set 335 ft.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	DIAM-ETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
DB-35-04-102	City of Hughes Springs well 2	Cooper-Herring	1951	476	6	350	93.1	Oct. 22, 1967	T,E, 30	U	Pump set 330 ft. Yield reported 27 gpm when last used.
301	Nenney & Powell well 1	--	1948	4,235	--	341	--	--	--	--	Oil test. 1/
* 401	H.L. Jenkins	--	Old	24	42	285	20.5 20.8 21.9	Dec. 6, 1941 Sept. 12, 1960 Oct. 22, 1967	P,E, 1/2	D	Dug well, shored with boards.
501	H.F. Richardson well 1	--	1960	4,130	--	308	--	--	--	--	Oil test. 1/
* 601	Marshall Felker	--	1931	--	12	247	+ +	Oct. 28, 1941 Apr. 10, 1968	Flows	S	Originally drilled as oil test to 3,708 ft; completed as flowing water well. Measured flow 1/2 gpm, April 10, 1968.
* 801	City of Avinger well 1	J.C. Boling	1938	380	10, 5	390	151.0 150.7	Apr. 23, 1958 Mar. 7, 1960	N	U	Cased 10-in. to 200 ft, 5-in. liner from surface to bottom. Perforations from 360 ft to bottom.
802	City of Avinger well 2	--	1950	340	8	390	--	--	T,E, 10	P	Screened near bottom.
* 803	City of Avinger well 3	Edington Drilling Co.	1963	321	8, 4	392	145.4 154.2	June 25, 1963 Oct. 22, 1967	S,E, 7 1/2	P	Casing: 8-in. to 270 ft, cemented; 4-in. liner and screen from approximately 270 ft to bottom. Drilled to 403 ft, plugged back to 321 ft. Measured drawdown 30.8 ft after pumping 4 hours at 37 gpm, June 25, 1963. 2/
804	W.A. Patterson Turner well 1	--	1948	5,053	--	430	--	--	--	--	Oil test. 1/
* 901	L. Stevenson	--	Old	19	42	350	15.1 17.0	Sept. 6, 1941 Sept. 12, 1960	B,H	D	Dug well, shored with rock.
* 05-301	C.C. Grubbs	--	Old	25	36	365	19.0 23.0	Dec. 4, 1941 Sept. 13, 1960	J,E, 1/4	D	Dug well, uncased.
* 302	C.W. Wells	--	Old	49	42	400	39.9 43.4	Dec. 4, 1941 Sept. 13, 1960	J,E, 1/4	D	Dug well, shored with brick.
501	Mrs. Zulme Williams	--	1957	57	30	399	41.8 40.7	Sept. 13, 1960 Jan. 15, 1968	J,E, 1	D	Bored well, shored with cement tile.
502	Max Agress, well 1	--	1940	3,516	--	375	--	--	--	--	Oil test. 1/

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	DIAM-ETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
DB-35-05-601	George M. Jordan Bittendorf well 1	--	1957	6,692	--	400	--	--	--	--	Oil test. 1/
801	T.E. Hollis	V. Shirley	1956	350	3	340	--	--	J,E, 1	D	Cased to 80 ft, open hole to bottom.
06-101	City of Linden well 2	Layne-Texas Co.	1949	712	14, 8	392	178 201.1 199.8	Nov. 11, 1949 Oct. 18, 1967 Apr. 19, 1968	T,E, 30	P	Casing: 14-in. to 426 ft, cemented; 8-in. liner and screen from 330 ft to bottom. Reported drawdown 188 ft after pumping 24 hours at 144 gpm when drilled in 1949.
* 102	Fairview High School	L.E. Simmons	1958	260	4	295	--	--	S,E, 1 1/2	P	Pump set 105 ft.
* 201	Linden-Kildare High School	--	1963	51	30	340	--	--	S,E	P	Bored well, shored with cement tile.
202	Pan American Petroleum Corp., well 1	--	1960	11,473	--	267	--	--	--	--	Oil test. 1/
* 301	Norwood White	--	1928	27	36	275	20.9 22.7 22.1	Dec. 3, 1941 Sept. 2, 1960 Oct. 18, 1967	J,E, 1/2	D	Dug well, shored with tile
401	C.E. Maloney	Frank Dunn	1957	87	30	372	35.6 49.8	Dec. 2, 1960 Oct. 18, 1967	J,E, 1	D	Bored well, shored with cement tile. Supplies water for cafe and motel.
* 402	Hardy Dooley	--	--	Spring	--	370	+ +	Dec. 3, 1941 Oct. 18, 1967	Flows	D	Estimated flow 20 gpm.
601	Sklar Production Co., et al., Sheppard well 1	--	1960	11,184	--	301	--	--	--	--	Oil test. 1/
* 701	Cass County	--	Old	21	42	360	16.0 16.5 16.0	Dec. 4, 1941 Sept. 13, 1960 Oct. 18, 1967	N	U	Dug well, shored with brick.
* 801	L.W. Kay	--	Old	26	30	340	15.7 22.9 26.5	Dec. 2, 1941 Sept. 12, 1960 Oct. 18, 1967	P,E, 1/3	D	Dug well, shored with cement tile.
* 802	Sklar Production Co.	Mustang Drilling Co.	1962	764	8, 4	249	86	Nov. 1962	T,G	Ind	Casing: 8-in. to 640 ft, cemented; 4-in. liner and screen from 600 ft to bottom. Screen from 680 ft to 760 ft. Reported drawdown 34 ft after pumping 6 hours at 145 gpm in November 1962.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	DIAMETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
DB-35-06-803	Sam Sklar, et al.	--	1959	7,150	--	290	--	--	--	--	Oil test. 1/
* 901	Killingsworth Oil Co.	W.C. Barnwell	1960	640	10	215	35	1960	T,G, 14	Ind	Screened from 600 to 630 ft. Pump set 160 ft.
902	H.L. Hawkins Weaver well A-2	--	1956	6,650	--	219	--	--	--	--	Oil test. 1/
07-301	Humble Oil & Refining Co., Hosey well 1	--	1959	11,521	--	347	--	--	--	--	Do.
302	Mack Hays, et al. Allday well 1	--	1964	7,055	--	277	--	--	--	--	Do.
401	Linden-Kildare Elementary School	Frank Dunn	1952	57	30	310	18.7 26.9	Mar. 7, 1960 Oct. 19, 1967	J,E, 1/2	P	Bored well, shored with cement tile.
402	Linden-Kildare Junior High School	Frank Dunn	1952	56	30	315	14.3 30.9	do do	J,E, 1	P	Do.
501	W.G. Skelly Baldwin Heirs well 1	--	1955	6,700	--	207	--	--	--	--	Oil test. 1/
601	--	--	--	--	4	200	+ 3.3	Apr. 1, 1968	N	U	Well drilled for oil test; now drilling water. Water level stands inside casing which extends 5.5 ft above land surface. Reported flowed until about 1965.
602	Vaughn Production Co., Ryley well 1	--	1938	6,290	--	210	--	--	--	--	Oil test. 1/
701	Breckenridge Gasoline Co., well 1	Walker & Groggin	1958	307	7	225	75.5 76.1	Oct. 16, 1967 Mar. 26, 1968	T,E, 3	Ind	Cased to 300 ft. Perforated from 277 to 300 ft. Pump set 200 ft.
702	Breckenridge Gasoline Co., well 2	do	--	338	7	205	16.6 51.0	Mar. 16, 1960 Oct. 16, 1967	T,E, 3	Ind	Cased to 330 ft. Perforated from 309 to 330 ft. Pump set 200 ft.
* 703	Killingsworth Oil Co.	Killingsworth Oil Co.	1965	572	8	245	--	--	T,G	Ind	Casing: 8-in. to 515 ft, cemented. Screened from 515 ft to bottom. Pump set 425 ft. Measured pumping level 161.9 ft below land surface March 26, 1968.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	DIAMETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
* DB-35-07-704	Killingsworth Oil Co.	Killingsworth Oil Co.	1966	287	7	245	--	--	T,G	Ind	Casing: 7-in. to 225 ft, cemented. Screened from 256 ft to bottom. Pump set 209 ft. Well located 20 ft north of DB-35-07-703.
705	do	Mustang Drilling Co.	1964	700	8, 4	245	--	--	T,G	Ind	Casing: 8-in. to 643 ft, cemented; 4-in. liner and screen from 606 ft to bottom. Pump set 425 ft.
* 801	Livingston Oil Co. well 1	do	1964	715	8, 4	250	74 178.9	July 1964 Apr. 1, 1968	T,G	Ind	Casing: 8-in. to 505 ft, cemented; 4-in. liner and screen from 405 ft to bottom. Measured pumping level 204.7 ft below land surface March 25, 1968.
802	Livingston Oil Co. well 2	do	1964	672	8, 4	249	69 178.0	Aug. 1964 Apr. 1, 1968	T,G	Ind	Casing: 8-in. to 590 ft, cemented; 4-in. liner and screen from 552 ft to bottom. Measured drawdown 34.2 ft after pumping 4 hours at 230 gpm, April 1, 1968.
803	Livingston Oil Co. well 3	do	1964	675	8, 4	270	--	--	T,G	Ind	Casing: 8-in. to 585 ft, cemented; 4-in. liner and screen from 547 ft to bottom.
804	Livingston Oil Co. well 4	do	1964	708	8, 4	243	105 166.6	Oct. 1964 Apr. 1, 1968	T,G	Ind	Casing: 8-in. to 620 ft, cemented; 4-in. liner and screen from 580 ft to bottom. Measured pumping level 183.4 ft below land surface March 25, 1968.
805	do	--	--	350	7	200	42.5 46.1	Oct. 16, 1967 Mar. 26, 1968	T,G	Ind	Screened from 260 ft. Standby well, unused for more than a year at the time of last water level measurement, March 26, 1968.
806	Killingsworth Oil Co.	Killingsworth Oil Co.	1965	657	7, 4	212	60	Aug. 1965	T,G	Ind	Casing: 7-in. to 611 ft, cemented; 4-in. liner and screen from about 572 to 657 ft. Pump set 225 ft.
* 901	Breckenridge Gasoline Co.	Phillips Petroleum Co.	1937	300	7	207	--	--	S,E, 5	Ind	Cased to 254 ft, gravel-filled hole from 254 ft to bottom. Pump set 220 ft.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	DIAMETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
DB-35-07-902	Breckenridge Gasoline Co.	Phillips Petroleum Co.	1937	300	6	200	85.4	Oct. 16, 1967	N	U	
* 903	do	do	1937	1,000	8	198	--	--	T,G	Ind	Pump set 220 ft.
904	Superior Oil Production Co. Chatten well 1	--	1936	5,945	--	200	--	--	--	--	Oil test. 1/
905	Arthur Arnold	Walter Meller	1936	640	6	192	20.3 84.4	Oct. 29, 1941 Mar. 29, 1968	P,E, 2	D	Perforated from 515 ft to bottom. Pump set 112 ft.
* 08-101	Sklar Production Co.	Triangle Pump & Supply Co.	1967	350	8, 4	256	74	July 5, 1967	T,G	Ind	Casing: 8-in. to 270 ft, cemented; 4-in. liner and screen from 218 ft to bottom. Screened from 270 ft to 330 ft. Reported drawdown 121 ft after pumping 4 hours at 72 gpm, July 1967.
102	Sklar Production Co. Starcke well B-4	--	1966	6,105	--	269	--	--	--	--	Oil test. 1/
401	David Crow	Triangle Pump & Supply Co.	1967	360	8, 4	310	--	--	S,E, 10	Ind	Casing: 8-in. to 300 ft, cemented; 4-in. liner and screen from 269 ft to bottom. Screen from 303 to 353 ft. Pump set 260 ft.
402	Lyons Petroleum Corp., et al., Long well 1	--	1964	5,007	--	304	--	--	--	U	Oil test. 1/
* 501	A.I. Tolleson	W.A. Meller	1936	708	6	315	137.1 171.8	Mar. 15, 1960 Oct. 11, 1967	S,E, 2	P	Pump set 240 ft. Well supplies water for McCleod Community.
502	United Production Corp., Terry well 1	--	1937	5,660	--	320	--	--	--	--	Oil test. 1/
503	United Production Corp., Land well 1	--	1937	2,335	--	243	--	--	--	--	Do.
701	Arthur Arnold	--	1936	--	6	190	71.8	Mar. 29, 1968	P,E	D	
					Marion County						
* SX-35-07-706	Killingsworth Oil Co.	Mustang Drilling Co.	1964	658	8, 4	260	--	--	T,G	Ind	Casing: 8-in. to 602 ft, cemented; 4-in. liner and screen from 563 ft to bottom. Screened from 605 to 658 ft.
807	do	Killingsworth Oil Co.	1967	185	7	220	--	--	T,G	Ind	Screened from 150 to 180 ft. Pump set 90 ft.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	DIAMETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
SX-35-11-201	Davis Surratt	--	1962	83	30	270	31.7	Jan. 18, 1968	J,E, 1	D	Bored well, shored with cement tile.
202	Berl Bishop	--	--	100	4	270	35.4	do	J,E, 1/2	D	
203	L.A. Grelling Lawrence well 1	--	1953	3,831	--	237	--	--	--	--	Oil test. 1/
* 301	B.L. Starkey	--	1966	212	3	285	--	--	J,E, 2	D	Perforated from 185 ft to bottom.
302	L.A. Grelling Simpson well 1	--	1952	4,012	--	285	--	--	--	--	Oil test. 1/
601	Corps of Engineers	Dickerson Water Wells	1965	40	42,36, 24	260	15	Mar. 1965	S,E	P	Bored well, cement tile casing; reduced from 42-in. diameter at surface to 24-in. at bottom. Perforated from 22 ft to bottom. Well supplies drinking water in Railroad Bluff recreation area at Lake O' the Pines.
12-101	Magnolia Petroleum Co., Orr well 1	--	1945	4,522	--	332	--	--	--	--	Oil test. 1/
* 201	Southwestern Electric Wilkes Power Plant well 1-A	Wayne Hightower	1964	280	4, 2	290	52.6	Apr. 10, 1968	S,E	Ind	Casing: 4-in. to 210 ft, cemented; 2-in. liner and screen from 172 ft to bottom. Screened from 212 to 252 ft. Pump set 158 ft.
202	Southwestern Electric well 2-A	Buster Dunn	1964	272	4, 2	290	--	--	S,E	Ind	Casing: 4-in. to 231 ft, cemented; 2-in. liner and screen from 212 ft to bottom. Screened from 233 to 272 ft. Pump set 157 ft.
203	Southwestern Electric	Wayne Hightower	--	237	4, 2	300	--	--	S,E	P	Casing: 4-in. to 198 ft, cemented; 2-in. liner and screen from 188 ft to bottom. Screened from 203 to 223 ft. Pump set 158 ft. Supplies drinking water for Southwestern Electric recreation area.
301	Dean Bros. Hale well 1	--	1942	3,769	--	295	--	--	--	--	Oil test. 1/
401	B.L. Starkey	--	1966	212	3	340	--	--	J,E, 1 1/2	D	Perforated from 188 ft to bottom. Reported water high in dissolved iron.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	DIAMETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
* SX-35-12-402	Corps of Engineers	Dickerson Water Wells	1965	46	42,36, 24	260	25	Mar. 1965	S,E	P	Bored well, cement tile casing, reduced from 46-in. diameter at surface to 24-in. at bottom. Perforated about 28 ft to bottom. Well supplies drinking water in Alley Creek recreation area at Lake O' the Pines.
501	Victory School	H.P. Narramore	1957	188	4	304	85.3 71.5	Mar. 21, 1960 Jan. 18, 1968	S,E, 1	P	Well reported to discharge water with dissolved iron and odor.
* 502	Amerada Petroleum Corp.	--	1964	832	8, 4	290	51	Oct. 1964	T,E, 7 1/2	Ind	Casing: 8-in. to 780 ft, cemented; 4-in. liner and screen from 740 ft to bottom. Screened from 782 to 830 ft. Pump set 150 ft.
503	Great Expections Oil Co., Connor well 1	--	1956	3,757	--	299	--	--	--	--	Oil test. 1/
504	Great Expections Oil Co., Bradley well 1	--	1956	3,737	--	253	--	--	--	--	Do.
* 701	Corps of Engineers	Frank Dunn	1963	84	42,36, 24	285	--	--	S,E	P	Bored well, cement tile casing reduced from 46-in. diameter at surface to 24-in. at bottom. Well supplies drinking water at Copeland Creek recreation area at Lake O' the Pines.
* 801	R.D. Baskett well 1	Wayne Hightower	1963	272	4, 2	290	--	--	S,E, 2	P	Perforated from 232 ft to bottom. Measured discharge 25 gpm, April 17, 1968.
802	R.D. Baskett well 2	Sam Barnwell	1967	272	6	290	61.9	Apr. 17, 1968	S,E, 3	P	Perforated from 232 ft to bottom. Reported discharge 55 gpm. This well located 43 ft northeast of well SX-35-12-801.
803	Corps of Engineers	Frank Dunn	1963	64	42,36, 24	270	41	Apr. 1963	S,E	P	Bored well, cement tile casing; reduced from 42-in. diameter at surface to 24-in. at bottom. Perforated from about 40 ft to bottom. Well supplies drinking water in Johnson Creek recreation area at Lake O' the Pines.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	DIAMETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
SX-35-12-804	C.M. Watts	--	--	45	30	251	16.6	Jan. 19, 1968	J,E, 1	D	Bored well, shored with cement tile.
901	Corps of Engineers	Frank Dunn	1963	65	42,36, 24	280	43	Apr. 1963	S,E	P	Bored well, cement tile casing; reduced from 42-in. diameter at surface to 24-in. at bottom. Perforated from about 45 ft to bottom. Well supplies drinking water in Hurricane Creek recreation area at Lake O' the Pines.
902	Lyons & Logan Braden well 1	--	1957	3,800	--	270	--	--	--	--	Oil test. 1/
903	O.C. Billingsley Dake well 1	--	1950	3,700	--	210	--	--	--	--	Do.
* 13-201	W.T. Ware	--	Old	--	6, 4	200	+	Jan. 25, 1968	Flows	S	Reported to be old abandoned oil test drilled to about 1,700 ft. Water flows from between 6-in. and 4-in. casing. Estimated flow 1 gpm.
202	Whelan Bros. Torrans well 2	--	1959	7,595	--	221	--	--	--	--	Oil test. 1/
501	W.T. Ware	J.C. Boling	1937	350	10, 5	310	60	--	J,E, 1	D	Casing: 10-in. to 40 ft, 5-in. liner from surface to bottom. Perforated from 246 to 249, 291 to 315, and 321 to 327 ft. Pump set 100 ft. Well formerly supplied sawmill and company homes. 2/
601	Jefferson Rural Academy	--	1914	41	30	280	30.4 29.5	Nov. 28, 1960 Jan. 25, 1968	J,E, 1/2	P	Dug well, shored with cement tile.
701	Corps of Engineers	B.F. Edington	1955	690	6, 3	285	42	--	T,E, 5	P	Casing: 6-in. to 644 ft, cemented; 3-in. liner and screen from 642 ft to bottom. Screened from 644 to 690 ft. Pump set 140 ft.
* 702	do	do	1956	755	4, 2	275	38.9 50.0	Apr. 11, 1958 Apr. 11, 1968	S,E, 1 1/2	P	Casing: 4-in. to 715 ft; 2-in. liner and screen from approximately 715 ft to bottom.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	DIAMETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL		METHOD OF LIFT	USE OF WATER	REMARKS
							BELOW LAND SURFACE DATUM (FT)	DATE OF MEASUREMENT			
* SX-35-13-703	Corps of Engineers	Frank Dunn	1963	54	42,36, 24	260	21	Apr. 1963	S,E	P	Bored well, cement tile casing; reduced from 42-in. diameter at surface to 24-in. at bottom. Perforated from about 20 ft to bottom. Well supplies drinking water in East Abutment recreation area at Lake O' the Pines.
* 704	Southwest Water Services (Holiday Harbor Subdivision)	Layne-Texas Co.	1967	720	8, 4	305	75	July 1967	S,E	P	Casing: 8-in. to 650 ft, cemented; 4-in. liner and screen from 572 ft to bottom. Pump set 250 ft. Reported drawdown 54 ft after pumping 8 hours at 128 gpm when drilled, July 1967.
705	Hollandsworth Oil Co. Wright well 1	--	1949	4,996	--	377	--	--	--	--	Oil test. 1/
801	Winwell Exploration Co., Henderson well 1	--	1964	6,600	--	256	--	--	--	--	Do.
901	Ark-La Gas Co. Pitts well 1	--	1938	3,215	--	195	--	--	--	--	Do.
* 14-101	D.E. Kendrick, Jr.	Buster Dunn	1965	396	4	295	82.6	June 4, 1968	S,E, 1	D	Perforated from 375 to 396 ft. Pump set 165 ft.
102	International Paper Co.	Edington Drilling Co.	--	800	14	380	150.6	do	N	U	Well drilled for irrigation by former owner. Present owner has no use for it.
201	C.E. Grubaugh	--	1943	32	30	327	20.3	Sept. 22, 1960	C,E, 1/4	D	Dug well, shored with cement tile.
202	United Production Corp., Hutchinson well 3	--	1937	6,091	--	275	--	--	--	--	Oil test. 1/
301	Lewis Chapel	--	--	40	36	335	33.8 31.5	Sept. 22, 1960 Jan. 10, 1968	B,H	D	Dug well, uncased.
302	Ark-La Gas Co. Belcher well 2	--	1939	6,126	--	320	--	--	--	--	Oil test. 1/
303	Ark-La Gas Co. Hurst well 1	--	1939	2,051	--	305	--	--	--	--	Do.
304	Arkansas Fuel Co. Simms well 1	--	1939	2,186	--	300	--	--	--	--	Do.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	DIAM-ETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
* SX-35-14-401	Southern Wood Co.	--	1964	485	6	237	37.7	June 4, 1968	S,E, 3	Ind	
501	Arthur Arnold	Rodessa Deep Water Well Co.	1938	698	6	340	122.2	Apr. 16, 1942	P,E, 3/4	D	Pump set 196 ft.
* 502	Arkansas-Louisiana Chemical Corp., well 4	-- Bagley	1941	815	6	285	130.0	May 31, 1968	N	U	Perforated from 780 to 812 ft.
503	Arkansas-Louisiana Chemical Corp., well 6	--	1951	854	8	285	--	--	T,E	Ind	Standby well, seldom used.
* 504	Arkansas-Louisiana Chemical Corp., well 5	Blevins Bros.	1945	840	8	285	--	--	G,J	Ind	Screened from 562 to 594, and 728 to 762 ft. Measured pumping level 150.0 ft below land surface, May 31, 1968.
* 505	Arkansas-Louisiana Chemical Corp., well 7	-- Mayeaux	1959	264	4	285	--	--	S,E, 1	Ind	Screened from 254 to 262 ft. Pump set 164 ft.
506	Hall School	--	1935	30	30	282	9.5	Mar. 16, 1960	J,E, 1/2	P	Dug well, shored with cement tile.
507	-- Stewart Brown Estate well 1	--	1945	7,209	--	350	--	--	--	--	Oil test. 1/
508	Arkansas Fuel Oil Co. Barnes well 1	--	1939	6,086	--	285	--	--	--	--	Do.
509	Arkansas Fuel Oil Co. Cromer well 1	--	1939	5,967	--	221	--	--	--	--	Do.
701	Blackburn Syrup Co.	W.C. Barnwell	1955	850	6	235	51.7	Mar. 23, 1960	S,E	Ind	Measured pumping level 112.5 ft below land surface, January 25, 1968.
702	do	--	1940	40	--	235	24.1 37.7	Mar. 23, 1960 Jan. 25, 1968	T,E	Ind	Dug well, shored with bricks.
703	City of Jefferson well 2	Layne-Texas Co.	1947	797	13,12, 6	215	45 57.4 27.0	Apr. 1947 May 8, 1961 Nov. 20, 1967	T,E, 40	U	Casing: 13-in. to 364 ft, cemented; 12-in. liner from approximately 364 to 703 ft, and 6-in. liner and screen from 585 ft to bottom. Pump set 200 ft. Measured drawdown 79 ft after pumping 2 hours at 348 gpm, May 8, 1961.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	DIAMETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
* SX-35-14-704	City of Jefferson well 1	Layne-Texas Co.	1926	780	12,10, 6	190	--	--	N	U	Casing: 12-in. to 148 ft, 10-in. liner from 129 to 720 ft, and 6-in. liner and screen from 720 ft to bottom. Reported flowed 50 gpm when drilled. Reported drawdown 57 ft while pumping 200 gpm in 1942.
705	Wimwell Exploration Co., Ragley well 1	--	1957	6,300	--	256	--	--	--	--	Oil test. 1/
706	Ark-La Gas Co. Howard well 1	--	1938	2,006	--	230	--	--	--	--	Do.
707	Ark-La Gas Co. Badgett well 1	--	1938	1,028	--	186	--	--	--	--	Do.
901	R.W. Fair Mason well 4	--	1953	1,035	--	180	--	--	--	--	Do.
15-201	Billy Love	--	--	17	30	260	15.1 11.5	Sept. 22, 1960 Apr. 18, 1968	J,E, 1/2	D	Bored well, shored with cement tile.
202	Henry Stewart	--	1952	30	30	300	23.5 22.9	Sept. 22, 1960 Apr. 18, 1968	B,H	D	Dug well, shored with cement tile.
203	W.C. Curry Chatten well 1	--	1948	3,500	--	270	--	--	--	--	Oil test. 1/
401	Gordon Brooks	Buster Dunn	1967	465	4, 2	310	--	--	S,E, 1	D	Casing: 4-in. to 428 ft, cemented; 2-in. liner with perforations from 413 ft to bottom. Pump set 231 ft.
* 501	Logan Chapel	--	1939	17	36	235	3.7 11.7 3.0	May 5, 1942 Mar. 25, 1960 Apr. 18, 1968	B,H	D	Dug well, uncased.
* 502	Smithland School	W.M. Brummett	1956	285	6	232	56.4 67.3 54.9	Apr. 14, 1958 Sept. 21, 1960 Mar. 18, 1968	S,E, 1 1/2	P	Screened from 252 to 284 ft.
* 601	Calvin Moseley	--	1932	158	6	252	--	--	J,E, 1	D	Bored well. Pump set 149 ft.
602	J.H. Buchanan McNeely well 1	--	1951	3,447	--	202	--	--	--	--	Oil test. 1/
* 701	Judea Church	--	1937	24	30	282	2.5 5.4	May 1, 1942 Apr. 18, 1968	C,E, 1/6	D	Dug well.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	DIAM-ETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
SX-35-15-702	Robert Pepper	-- Rayborne	1947	325	6	305	104.7 105.2 106.9	Apr. 10, 1958 Sept. 21, 1960 Apr. 18, 1968	J,E, 1	D	Casing: 6-in. to 136 ft. Pump set 120 ft.
801	Tex-Mex Drilling Co.	White Drilling Co.	1965	350	3	250	61.4	Apr. 18, 1968	N	U	Well drilled for oil; now drilling water. Perforated from 150 to 169 ft, and 315 to 350 ft.
802	Barnwell Drilling Co., Cowherd well 1	--	1957	2,507	--	201	--	--	--	--	Oil test. 1/
901	The Chicago Corp. Rowell well 1	--	1954	6,050	--	175	--	--	--	--	Do.
16-201	Ryan Consolidated Petroleum Corp., Schluter well 1	--	1947	3,008	--	260	--	--	--	--	Do.
401	Felix Spencer	--	1946	23	30	247	19.0 17.6	Sept. 21, 1960 Jan. 29, 1968	B,H	D	Dug well, shored with cement tile.
402	F.C. Clements	--	1935	28	36	270	15.6 13.9	Sept. 20, 1960 Jan. 29, 1968	P,H	D	Dug well, uncased.
* 403	Davis & Smith	--	--	509	7	305	--	--	P,E, 5	Ind	Cased to bottom, cemented; perforated from 385 to 399, and 434 to 437 ft. Pump set 380 ft.
501	Hollondsworth Drilling Co., Hartzo well 1	--	1940	2,535	--	230	--	--	--	--	Oil test. 1/
502	H.W. Snowden Watts well 1	--	1946	2,561	--	200	--	--	--	--	Do.
701	Allen Livingston	--	1950	100	4	177	10.7	Jan. 29, 1968	S,E, 1/4	D	Pump set 35 ft.
702	M.E. Merriman, et al. Dumider well 1	--	1960	2,310	--	204	--	--	--	--	Oil test. 1/
801	Allen Livingston	Texas Highway Dept.	1947	485	4	240	65.3	Jan. 29, 1968	S,E, 1	D	Cased to 84 ft, open hole from 84 ft to bottom.
802	W.G. Davis	--	--	202	6	265	101.3	Apr. 10, 1958	J,E, 3/4	D	
803	Amerada Petroleum Corp., Gray well 1	--	1961	2,281	--	247	--	--	--	--	Oil test. 1/

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COMPLETED	DEPTH OF WELL (FT)	DIAMETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL: BELOW LAND SURFACE DATUM (FT)	WATER LEVEL: DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
SX-35-16-804	J.H. Holt Gray well 2	--	1947	3,195	--	203	--	--	--	--	Oil test. 1/
805	J.W. Reneau Davis well 1	--	1947	2,700	--	260	--	--	--	--	Do.
* 20-201	Jackson Community Center	--	Old	19	30	285	10.8 12.3 9.4	Mar. 17, 1942 Sept. 28, 1960 Apr. 11, 1968	N	U	Dug well, shored with cement tile.
* 202	M.K. Knight	Edington Drilling Co.	1960	679	8, 4	300	57.8	Sept. 28, 1960	S,E, 10	P	Casing: 8-in. to 618 ft, cemented; 4-in. liner and screen from 577 ft to bottom. Pump set 250 ft.
203	Helmrich & Payne Hook well 1	--	1940	5,004	--	270	--	--	--	--	Oil test. 1/
* 301	Macedonia School	--	1947	28	30	275	19.7 20.6	Mar. 21, 1960 Apr. 11, 1968	J,E, 1/3	P	Dug well, shored with cement tile.
21-101	LeCuno Oil Co. Benton well 1	--	1956	7,115	--	203	--	--	--	--	Oil test. 1/
201	Carter-Jones Drilling Co., Whelon well 1	--	1956	6,987	--	207	--	--	--	--	Do.
202	Bobby Manziel Whelon well B-1	--	1956	6,129	--	193	--	--	--	--	Do.
* 301	C.A. Arnold	Mustang Drilling Co.	1963	350	4	345	150	Feb. 23, 1963	S,E, 2	D	Screen from 318 to 348 ft. Pump set 205 ft.
302	Ark-La Gas Co. Moseley well 1	--	1938	6,160	--	187	--	--	--	--	Oil test. 1/
* 501	New Zion Church	--	1933	32	30	252	11.2 17.0 6.8	Mar. 17, 1942 Sept. 29, 1960 Apr. 11, 1968	J,E, 1/4	D	Dug well, shored with cement tile.
22-101	Dan Lester	--	1968	160	4	205	20.7	Apr. 11, 1968	S,E, 3/4	S	
24-101	Lewis Luttrell	Shirley-Williamson	1946	300	4	200	22.1	Jan. 29, 1968	J,E, 1/2	D	Pump set 84 ft.
201	T.W. Allen	--	1941	30	30	240	19.5	Sept. 20, 1960	J,E, 1/4	D	Dug well, shored with clay tile.
202	W.G. Allen	--	1957	190	4	235	60.4	Sept. 20, 1960	S,E	D	Casing: 4-in. to 90 ft.

See footnotes at end of table.

Table 7.-- Records of Wells and Springs in Cass and Marion Counties--Continued

WELL	OWNER	DRILLER	DATE COM-PLET-ED	DEPTH OF WELL (FT)	DIAM-ETER OF WELL (IN.)	ALTITUDE OF LAND SURFACE (FT)	WATER LEVEL BELOW LAND SURFACE DATUM (FT)	WATER LEVEL DATE OF MEASUREMENT	METHOD OF LIFT	USE OF WATER	REMARKS
SX-35-24-203	H.M. Hammer Poole well 1	--	1947	2,690	--	202	--	--	--	--	Oil test. 1/
501	Mrs. W.E. Haggard	--	--	Spring	--	205	+	Jan. 29, 1968	Flows	D	Estimated flow 5 gpm.

1/ Electric log in files of U.S. Geological Survey, Austin, Texas, and Texas Water Development Board, Austin, Texas.
2/ For drillers' logs of wells, see Table 8.
* For chemical analyses of water from wells and springs, see Table 9.

Table 8.—Drillers' Logs of Wells in Cass and Marion Counties

Cass County

Well DB-16-53-106

Owner: Shell Oil Co.
Driller: Layne-Texas Co.

	THICKNESS (FEET)	DEPTH (FEET)
Clay, red	4	4
Sand and clay	5	9
Clay	9	18
Sand	6	24
Clay	11	35
Sand and clay layers	69	104
Shale, gray, hard, sandy	16	120
Sand, gray, and streaks of shale	46	166
Shale, lignite, and thin sand layers	34	200
Sand, fine, gray, and sandy shale	15	215
Shale and lignite	8	223
Sand	10	233
Shale	12	245
Sand	12	257
Rock and hard shale layers	5	262
Sand	6	268
Shale and sandy shale	11	279
Sand	7	286
Shale and sandy shale	10	296
Shale	14	310
Sand and shale layers	14	324
Shale and sandy shale	6	330
Sand (cut good)	33	363
Shale	2	365
Sand (cut good)	5	370
Shale	76	446
Shale, sandy	17	463
Shale	150	613

Well DB-16-54-403

Owner: City of Douglassville.
Driller: Edington Drilling Co.

	THICKNESS (FEET)	DEPTH (FEET)
Surface	4	4
Clay	17	21
Sand	6	27
Clay, sandy	23	50
Rock	1	51
Sand, fine	12	63
Shale, sandy	18	81
Shale	11	92
Shale, sandy	21	113
Shale and sandy shale, broken	15	128
Sand	16	144
Shale	106	250
Rock	1	251
Shale	37	288
Shale and lignite	3	291
Shale	151	442
Sand	7	449
Sand and sandy shale	10	459
Shale	13	472
Shale, sandy and sandy shale, broken	112	584
Sand, fine	29	613
Sand, gray	19	632
Shale	15	647
Sand	40	687
Shale	13	700

Well DB-16-59-901

Owner: City of Hughes Springs.
Driller: Layne-Texas Co.

	THICKNESS (FEET)	DEPTH (FEET)
Shale, sandy	10	10
Shale	15	25
Shale, sandy	93	118
Shale and lignite	106	224
Sand and shale	57	281
Sand, good	32	313
Rock	1	314
Sand	39	353
Shale, sandy	6	359

	THICKNESS (FEET)	DEPTH (FEET)
Well DB-16-62-701		
Owner: City of Linden. Driller: Layne-Texas Co.		
Topsoil	1	1
Clay	24	25
Rock	3	28
Shale	37	65
Sand, muddy, and lignite	50	115
Shale, hard	32	147
Rock, hard	2	149
Shale	111	260
Rock	1	261
Sand, muddy	19	280
Shale and boulders	24	304
Sand, hard	16	320
Rock, hard	2	322
Sand	21	343
Sandrock	2	345
Sand	32	377
Shale	20	397
Rock	1	398
Shale, sticky	56	454
Packsand, hard	13	467
Shale, hard	29	496
Rock	3	499
Shale, hard	37	536
Shale, sandy	118	654
Packsand, hard	24	678
Sand and shale	44	722
Sand, hard	22	744
Shale	38	782
Shale, sandy	18	800
Sand	25	825
Shale, sandy	18	843
Well DB-16-63-201		
Owner: City of Atlanta, well 2. Driller: Layne-Texas Co.		
Topsoil	1	1
Clay, sandy	27	28
Sand	1	29
Sand, muddy, and lignite	65	94
Sand and lignite	74	168
Sand, green	29	197
Sand and boulders	4	201
Sand and lignite	77	278
Rock, hard	½	278½
Shale, sandy, and lignite	54½	333
Rock, soft	2	335
Shale, sandy	40	375
Sand, fine, muddy, and shale	63	438
Shale	12	450
Shale, sandy	20	470
Sand, fine	42	512
Shale	16	528
Rock	1	529
Shale	54	583
Lignite	10	593
Shale, sandy	56	649
Sand and shale layers	37	686
Rock, hard	1	687
Sand	8	695
Rock and boulders	10	705
Sand, fine	33	738
Boulders	1	739
Sand, fine	28	767
Rock	2	769
Sand, good	32	801
Shale, hard layers	7	808
Sand, good	35	843
Rock	1	844
Well DB-35-04-803		
Owner: City of Avinger. Driller: Edington Drilling Co.		
Surface	15	15
Shale	22	37
Sand	21	58
Shale	21	79

Table 8.—Drillers' Logs of Wells in Cass and Marion Counties—Continued

	THICKNESS (FEET)	DEPTH (FEET)
Well DB-35-04-803—Continued		
Sand	6	85
Shale and sand streaks	41	126
Sand	13	139
Shale	58	197
Sand	20	217
Shale	5	222
Sand	6	228
Shale	33	261
Sand and shale streaks	5	266
Sand	35	301
Rock	½	301½
Sand	22½	324
Shale	79	403

Marion County

Well SX-35-13-501

Owner: W. T. Ware.
Driller: J. C. Boling.

	THICKNESS (FEET)	DEPTH (FEET)
Clay, yellow	16	16
Surface, water	4	20
Shale, black	220	240
Lignite	5	245
Sand, water	4	249
Shale, gray	41	290
Sand, water	25	315
Shale, blue	5	320
Sand, water	7	327
Shale, blue	23	350

Table 9.--Chemical Analyses of Water From Wells and Springs in Cass and Marion Counties

(Analyses given are in milligrams per liter except percent sodium, sodium-adsorption ratio, residual sodium carbonate, specific conductance, temperature, and pH.)

WELL	DEPTH OR PRODUCING INTERVAL (FT)	DATE OF COLLECTION	SILICA (SiO_2)	IRON (Fe)	CALCIUM (Ca)	MAGNESIUM (Mg)	SODIUM (Na)	POTASSIUM (K)	BICARBONATE (HCO_3)	SULFATE (SO_4)	CHLORIDE (Cl)	FLUORIDE (F)	NITRATE (NO_3)	DISSOLVED SOLIDS	HARDNESS AS $CaCO_3$	PERCENT SODIUM	SODIUM ADSORPTION RATIO (SAR)	RESIDUAL SODIUM CARBONATE (RSC)	SPECIFIC CONDUCTANCE (MICROMHOS AT 25°C)	TEMPERATURE	pH
									Cass County												
DB-16-47-501	115	May 29, 1968	30	0.11	30	0.1	2.0	0.4	88	6.4	2.3	0.0	0.1	114	75	5	0.1	0.00	163	--	7.3
48-701	39	Dec. 13, 1941	--	--	2.4	2.7	2.8 *	--	12	2	7.0	.2	1.0	24	17	--	--	--	--	--	--
51-601	275	May 28, 1968	9.2	.09	8.5	1.8	124	2.9	241 c/	85	12	.5	2.6	396	28	89	10	3.38	613	--	8.3
602	16	Dec. 9, 1941	--	--	a/	7.5	14 *	--	31	20	10	--	1.0	68	31	--	--	--	--	--	--
52-101	24	do	--	--	2.4	2.7	3.7 *	--	6	2	9.0	--	7.0	30	17	--	--	--	--	--	--
301	232- 295	May 28, 1968	9.4	--	12	1.9	132	2.0	306	32	29	.4	2.2	371	38	88	9.3	4.26	642	21	7.7
501	563- 593	Mar. 14, 1968	12	.09	1.8	.3	235	1.2	420	18	114	.6	.0	590	6	99	42	6.77	1,020	23	8.2
701	25	Dec. 9, 1941	--	--	.4	3.9	5.3 *	--	6	12	2.5	--	9.0	36	17	--	--	--	--	--	--
53-101	50	do	--	--	50	49	148 *	--	214	49	298	--	3.0	702	326	--	--	--	--	--	--
102	49	Dec. 10, 1941	--	--	128	118	46 *	--	317	23	438	.4	2.0	911	803	--	--	--	--	--	--
103	16	do	--	--	46	61	65 *	--	31	300	120	.3	2.0	609	368	--	--	--	--	--	--
104	257- 267 305- 395	Mar. 5, 1968	12	.02	16	2.9	140	2.9	250	52	68	.3	3.7	421	52	85	8.4	3.06	722	21	7.4
201	33	Dec. 10, 1941	--	--	30	52	212 *	--	55	236	323	.1	1.5	882	287	--	--	--	--	--	--
601	28	do	--	--	2.0	1.5	9.7 *	--	12	2	6.0	--	14	41	11	--	--	--	--	--	--
901	35	do	--	--	a/	1.2	4.6 *	--	0	2	3.0	--	11	22	5	--	--	--	--	--	--
903	108	May 28, 1968	25	11	9.8	3.9	6.1	2.0	40	16	3.9	.0	.1	87	40	24	.4	.00	121	20	7.0
54-202	57	May 29, 1968	31	.46	16	.3	3.7	.4	52	3.6	2.6	.0	.1	84	41	16	.3	.03	108	--	6.7
302	398- 438	Jan. 16, 1968	6.6	--	7.0	1.2	399	2.1	452 c/	.4	370	1.0	.5	1,020	22	97	37	7.26	1,860	19	8.5
401	60	Oct. 27, 1941	--	--	5.6	6.1	16 *	--	12	10	21	1.6	25.0	91	39	--	--	--	--	--	--
403	568- 664	Mar. 14, 1968	11.0	.14	4.2	.8	374	1.5	504	.6	300	1.1	.3	942	14	98	43	7.98	1,670	23	7.9
601	33	Dec. 5, 1941	--	--	23	12	5.8 *	--	12	2	20	--	100	169	108	--	--	--	--	--	--
801	20	Oct. 27, 1941	--	--	2.4	1.2	.2 *	--	6	2	3.0	.2	b/	12	11	--	--	--	--	--	--
802	30	Oct. 5, 1941	--	--	4.4	3.9	11 *	--	24	5	9.5	.1	14	60	27	--	--	--	--	--	--
55-801	670- 720	Mar. 7, 1968	--	--	--	--	--	--	344	3.2	172	--	--	--	7	--	--	5.50	1,080	23	7.6
901	370- 400	do	9.8	.14	.5	.1	51	1.3	123	8.4	1.8	.1	1.2	134	2	97	16	1.98	220	21	7.2
56-201	--	Oct. 27, 1941	--	--	2.8	3.6	69 *	--	177	2	17	--	b/	181	22	--	--	--	--	19	--
501	24	do	--	--	2.8	2.4	4.4 *	--	6	3	13	.2	b/	29	17	--	--	--	--	--	--
801	74	Mar. 19, 1968	16	.03	26	1.4	3.1	1.5	90	.8	2.6	.0	.2	96	71	9	.2	.06	154	--	7.3

See footnotes at end of table.

Table 9.--Chemical Analyses of Water From Wells and Springs in Cass and Marion Counties--Continued

WELL	DEPTH OR PRODUCING INTERVAL (FT)	DATE OF COLLECTION	SILICA (SiO_2)	IRON (Fe)	CAL-CIUM (Ca)	MAGNE-SIUM (Mg)	SODIUM (Na)	POTAS-SIUM (K)	BICAR-BONATE (HCO_3)	SUL-FATE (SO_4)	CHLO-RIDE (Cl)	FLUO-RIDE (F)	NI-TRATE (NO_3)	DIS-SOLVED SOLIDS	HARD-NESS AS $CaCO_3$	PER-CENT SO-DIUM	SODIUM ADSORP-TION RATIO (SAR)	RESI-DUAL SODIUM CAR-BONATE (RSC)	SPECIFIC CONDUCT-ANCE (MICROMHOS AT 25°C)	TEMPER-ATURE	pH
DB-16-59-301	25	Dec. 8, 1941	--	--	4.8	12	3.7 *	--	6	2	18	--	48	92	63	--	--	--	--	--	--
601	20	do	--	--	8.8	14	11 *	--	6	3	44	--	40	124	78	--	--	--	--	--	--
602	25	do	--	--	39	21	18 *	--	0	86	92	--	3.5	260	183	--	--	--	--	--	--
901	284- 307 324- 354	Oct. 14, 1941	13	10	14	5.6	18 *	--	86	17	6.0	--	.5	116	58	--	--	--	--	--	--
60-101	3,990	Dec. 8, 1941	--	--	1,298	214	22,015 *	--	275	2	36,700	0.1	.0	60,364	4,122	--	--	--	--	--	--
201	25	do	--	--	2.8	5.1	4.4 *	--	6	2	16	--	10	43	28	--	--	--	--	--	--
501	45	Oct. 28, 1941	--	--	2.8	2.4	.5 *	--	6	8	3.0	.2	b/	20	17	--	--	--	--	--	--
601	49	Dec. 9, 1941	--	--	1.6	8.8	.9 *	--	6	25	7.0	.2	1.0	47	40	--	--	--	--	--	--
801	44	Dec. 8, 1941	--	--	2.4	2.7	.9 *	--	6	5	4.5	--	2.0	21	16	--	--	--	--	--	--
901	60	July 27, 1961	23	.31	14	.5	3.8	1.1	48	.4	3.0	.0	3.2	73	37	18	0.3	--	103	--	5.9
61-601	25	Oct. 27, 1941			.8	2.4	1.8 *	--	12	2	2.5	.2	b/	16	12	--	--	--	--	--	--
602	20	Dec. 10, 1941	--	--	0	1.5	7.8 *	--	12	3	3.5	.1	6.0	28	6	--	--	--	--	--	--
62-301	30	Dec. 15, 1941	--	--	5.6	.2	9.4 *	--	18	3	7.0	--	9.0	43	15	--	--	--	--	--	--
501	30	Oct. 28, 1941	--	--	.8	2.4	4.4 *	--	18	2	2.5	.3	b/	21	12	--	--	--	--	--	--
701	642- 685 730- 750 802- 823	Oct. 13, 1941	20	.08	3.0	1.2	274 *	--	440	3	174	--	.0	698	12	--	--	--	--	--	--
702	290- 353 378- 400 442- 463 500- 522 646- 709	Mar. 13, 1968	10	.22	1.5	.5	170	1.8	320	6.0	78	.6	.2	427d/	6	98	30	5.13	740	22	7.8
63-102	213- 231	May 28, 1968	9.2	--	15	4.3	11	3.3	90	4.6	2.9	.0	.0	94	55	29	.6	.37	167	--	7.2
201	737- 836	Jan. 8, 1941	20	.07	2.6	.8	215 *	--	382 c/	2	115	--	.2	545	10	--	--	--	--	--	8.4
201	737- 836	Oct. 24, 1941	--	--	4.8	2.4	208 *	--	366	4	118	.6	1.5	520	22	--	--	--	--	--	--
301	660- 829	Mar. 8, 1968	11	.50	2.0	.3	252	1.2	396	1.2	164	.6	2.2	631e/	6	99	45	6.37	1,110	--	7.9
601	19	Dec. 13, 1941	--	--	21	15	14 *	--	0	8	50	--	82	190	114	--	--	--	--	--	--
801	34	Nov. 3, 1941	--	--	a/	4.1	4.8 *	--	6	18	3.0	.2	b/	33	17	--	--	--	--	--	--
803	313	Jan. 17, 1968	10	--	3.5	.6	78	2.3	183	26	4.8	.2	1.8	217	11	92	10	2.78	352	--	8.0
901	24	Oct. 31, 1941	--	--	1.6	1.7	1.4 *	--	12	2	1.5	--	b/	14	11	--	--	--	--	--	--
903	21	Dec. 13, 1941	--	--	4.0	1.5	1.6 *	--	12	3	4.0	--	1.0	21	16	--	--	--	--	--	--
64-101	29	do	--	--	1.2	5.1	4.4 *	--	12	2	7.0	--	14	40	24	--	--	--	--	--	--

See footnotes at end of table.

Table 9.--Chemical Analyses of Water From Wells and Springs in Cass and Marion Counties--Continued

WELL	DEPTH OR PRODUCING INTERVAL (FT)	DATE OF COLLECTION	SILICA (SiO_2)	IRON (Fe)	CAL-CIUM (Ca)	MAGNE-SIUM (Mg)	SODIUM (Na)	POTAS-SIUM (K)	BICAR-BONATE (HCO_3)	SUL-FATE (SO_4)	CHLO-RIDE (Cl)	FLUO-RIDE (F)	NI-TRATE (NO_3)	DIS-SOLVED SOLIDS	HARD-NESS AS $CaCO_3$	PER-CENT SO-DIUM	SODIUM ADSORP-TION RATIO (SAR)	RESI-DUAL SODIUM CAR-BONATE (RSC)	SPECIFIC CONDUCT-ANCE (MICROMHOS AT 25°C)	TEMPER-ATURE	pH
DB-16-64-201	350- 360 375- 395 425- 440	Mar. 19, 1968	9.9	0.15	4.2	1.2	55	2.8	151	9.6	3.9	0.4	0.1	161	15	86	6.2	2.17	264	22	7.6
203	19	Dec. 13, 1941	--	--	10	2.7	22 *	--	61	20	9.0	--	1.0	95	37	--	--	--	--	--	--
501	200- 214	May 29, 1968	11	.52	9.2	2.6	42	2.8	121	19	6.8	.1	.1	154	34	71	3.1	1.31	263	--	7.7
35-04-401	24	Dec. 6, 1941	--	--	4.4	3.9	4.4 *	--	12	3	10	--	12	44	27	--	--	--	--	--	--
601	--	Oct. 28, 1941	--	--	1.2	3.4	71 *	--	177	18	4.5	.1	b/	185	17	--	--	--	--	--	--
601	--	Apr. 10, 1968	--	--	--	--	--	--	156	--	3.3	--	--	--	6	--	--	2.44	286	19	7.6
801	360- 380	Oct. 28, 1941	--	--	6.4	1.2	38 *	--	98	15	6.0	.3	b/	115	22	--	--	--	--	--	--
803	271- 321	Apr. 8, 1968	10	.21	1.0	.6	45	1.8	104	13	2.8	.3	.6	126	5	93	8.7	161	204	--	7.6
901	19	Dec. 6, 1941	--	--	2.8	12	42 *	--	6	6	80	--	32	178	58	--	--	--	--	--	--
05-301	25	Dec. 4, 1941	--	--	2.4	3.9	21 *	--	6	4	22	--	34	100	22	--	--	--	--	--	--
302	49	do	--	--	4.0	10	4.4 *	--	18	2	31	--	54	134	51	--	--	--	--	--	--
06-102	260	May 31, 1968	11	.11	4.5	1.6	50	3.3	153	.2	3.4	.2	.7	150	18	83	5.1	2.15	253	--	7.4
201	51	do	12	1.6	3.0	1.0	1.3 *	.4	12	.2	3.2	.0	1.2	28	12	19	.2	.00	34	--	6.5
301	27	Dec. 3, 1941	--	--	6	1.5	14 *	--	37	3	10	--	6.0	59	21	--	--	--	--	--	--
402	Spring	do	--	--	a/	.2	10 *	--	12	2	6.0	--	3.0	24	1	--	--	--	--	--	--
701	21	Dec. 4, 1941	--	--	4.0	1.5	5.3 *	--	18	2	3.0	.1	8.0	33	16	--	--	--	--	--	--
801	26	Dec. 2, 1941	--	--	4.0	1.5	5.3 *	--	18	7	3.0	--	1.5	31	16	--	--	--	--	--	--
802	680- 760	Mar. 25, 1968	--	--	--	--	--	--	482	--	332	--	--	--	8	--	--	7.74	1,740	--	8.0
901	600- 630	do	--	--	--	--	--	--	510	--	402	--	--	--	11	--	--	8.14	1,980	25	8.2
07-703	515- 572	Mar. 26, 1968	11	.06	3.0	.5	394	1.6	538	.2	300	1.2	.9	977	10	99	54	8.63	1,730	24	8.1
704	256- 287	do	12	.06	3.2	.7	308	1.9	528 c/	.0	182	1.3	1.3	770	11	98	40	8.45	1,320	21	8.4
801	595- 701	Apr. 1, 1968	--	--	--	--	--	--	576	--	495	--	--	--	16	--	--	9.12	2,390	23	7.9
901	254- 300	May 29, 1968	10	--	3.2	.7	242	2.1	532	.0	75	1.7	2.8	600	11	98	32	8.50	1,030	20	8.1
903	1,000	do	17	--	4.0	1.3	272	2.3	374	.0	220	1.1	2.3	704	16	97	30	5.82	1,280	22	7.6
08-101	270- 330	Jan. 17, 1968	11	--	2.5	.5	98	2.0	258	.0	5.2	.4	.0	247	8	95	15	4.06	413	20	7.9
501	708	Nov. 4, 1941	--	--	a/	1.7	370 *	--	451	2	310	1.2	b/	907	7	--	--	--	--	--	--
501	708	Mar. 22, 1968	12	.06	2.8	3.9	370	1.6	468	.0	312	1.1	1.2	935	23	97	34	7.21	1,680	24	8.2

See footnotes at end of table.

Table 9.--Chemical Analyses of Water From Wells and Springs in Cass and Marion Counties--Continued

WELL	DEPTH OR PRODUCING INTERVAL (FT)	DATE OF COLLECTION	SILICA (SiO_2)	IRON (Fe)	CAL-CIUM (Ca)	MAGNE-SIUM (Mg)	SODIUM (Na)	POTAS-SIUM (K)	BICAR-BONATE (HCO_3)	SUL-FATE (SO_4)	CHLO-RIDE (Cl)	FLUO-RIDE (F)	NI-TRATE (NO_3)	DIS-SOLVED SOLIDS	HARD-NESS AS $CaCO_3$	PER-CENT SO-DIUM	SODIUM ADSORP-TION RATIO (SAR)	RESI-DUAL SODIUM CAR-BONATE (RSC)	SPECIFIC CONDUCT-ANCE (MICROMHOS AT 25°C)	TEMPER-ATURE	pH
Marion County																					
SX-35-07-706	605- 658	Mar. 26, 1968	--	--	--	--	--	--	492	--	382	--	--	--	18	--	--	7.70	1,900	25	8.0
11-301	185- 215	Mar. 31, 1968	14	0.61	8.5	2.9	50	6.0	143	16	11	0.2	0.0	179	33	73	3.8	1.68	302	--	7.5
12-201	212- 252	Apr. 10, 1968	--	--	--	--	--	--	312	--	16	--	--	--	19	--	--	4.73	511	--	7.8
402	28- 46	May 31, 1968	62	.08	11	1.0	11	1.5	30	24	5.4	.0	1.0	132	32	42	.8	.00	138	--	6.4
502	782- 830	Mar. 10, 1968	--	--	--	--	--	--	540	--	315	--	--	--	9	--	--	8.67	1,770	26	8.0
701	84	May 31, 1968	88	10	34	18	11	1.1	0	352	3.6	.0	.6	512 f/	159	7	.4	.00	707	--	3.4
801	232- 272	Apr. 10, 1968	9.2	.13	3.0	1.2	217	6.6	496	.4	52	1.0	.3	535	12	96	27	7.88	906	21	8.2
13-201	--	Jan. 25, 1968	--	--	--	--	--	--	492	--	189	--	--	--	9	--	--	7.88	1,320	18	8.2
702	720- 740	Apr. 11, 1968	--	--	--	--	--	--	538	--	195	--	--	--	8	--	--	8.66	1,410	--	8.0
703	54	May 31, 1968	19	4.4	27	1.7	6.7	3.0	104	4.4	3.6	.0	.0	116	74	16	.3	.22	194	--	6.8
704	659- 704	Apr. 11, 1968	12	.23	2.0	.5	343	1.1	556 c/	.0	212	1.1	3.8	830	7	99	56	8.99	1,470	22	8.5
14-101	375- 396	June 4, 1968	12	.02	3.5	.6	307	1.9	646	.0	110	1.9	.8	756	11	98	41	10.4	1,310	--	7.6
401	485	do	10	--	2.2	.5	374	1.8	586 c/	.0	245	1.8	4.1	927	8	99	57	9.46	1,650	21	8.4
502	780- 812	Apr. 17, 1942	--	--	2.8	1.0	849 *	--	567	2	985	--	--	2,119	11	--	--	--	--	26	--
504	562- 594 728- 762	May 31, 1968	10	--	4.5	.6	648	2.3	550 c/	.2	700	1.6	1.3	1,640	14	99	75	8.76	2,990	25	8.4
505	264	do	12	--	4.2	1.1	282	2.2	564	.0	121	1.8	1.2	702	15	97	32	8.94	1,230	22	7.7
704	742- 780	May 24, 1942	--	--	11	2.2	381 *	--	531	2	302	.6	.0	960	36	--	--	--	--	26	--
704	742- 780	May 5, 1942	20	.10	2.0	.9	395 *	--	540	.7	299	.8	.0	985	8	--	--	--	--	26	--
15-501	17	do	--	--	1.2	1.9	11 *	--	12	3	11	.1	7.0	41	11	--	--	--	--	--	--
502	252- 284	Apr. 18, 1968	10	--	8.8	3.1	326	3.5	482	51	207	1.8	2.4	851	35	95	24	7.20	1,490	--	7.8
601	158	do	21	.27	6.0	8.3	10	3.6	0	.2	24	.4	104	179 g/	49	17	.6	.00	316	19	3.8
701	24	Apr. 1, 1942	--	--	16	4.4	14 *	--	67	11	13	.4	2.0	94	58	--	--	--	--	--	--
16-403	385- 399 434- 437	Apr. 18, 1968	9.8	--	4.0	1.1	434	2.6	600	.2	325	3.2	.3	1,080	14	98	50	9.54	1,910	21	8.1
20-201	19	Mar. 17, 1942	--	--	4.8	2.4	21 *	--	6	12	32	.3	6.0	82	22	--	--	--	--	--	--
202	619- 674	May 31, 1968	13	.04	2.0	.3	324	1.4	674	.0	119	1.4	.2	792	6	99	53	10.9	1,370	--	7.6
301	28	July 27, 1961	22	1.9	2.0	1.1	3.4	.4	4	.0	9.0	.1	1.2	41	10	43	.5	--	44	--	4.7
301	28	Apr. 11, 1968	18	.12	6.0	.7	2.8	.7	20	.0	4.2	.0	1.4	44	18	25	.3	.00	58	18	6.0

See footnotes at end of table.

Table 9.--Chemical Analyses of Water From Wells and Springs in Cass and Marion Counties--Continued

WELL	DEPTH OR PRODUCING INTERVAL (FT)	DATE OF COLLECTION	SILICA (SiO_2)	IRON (Fe)	CALCIUM (Ca)	MAGNESIUM (Mg)	SODIUM (Na)	POTASSIUM (K)	BICARBONATE (HCO_3)	SULFATE (SO_4)	CHLORIDE (Cl)	FLUORIDE (F)	NITRATE (NO_3)	DISSOLVED SOLIDS	HARDNESS AS $CaCO_3$	PERCENT SODIUM	SODIUM ADSORPTION RATIO (SAR)	RESIDUAL SODIUM CARBONATE (RSC)	SPECIFIC CONDUCTANCE (MICROMHOS AT 25°C)	TEMPERATURE	pH
SX-35-21-301	318- 348	June 4, 1968	11	--	3.2	.6	412	2.1	508	.2	350	.9	3.9	1,030	10	99	57	8.12	1,880	--	7.5
501	32	Mar. 17, 1942	--	--	a/	1.2	11 *	--	12	3	5.0	.2	10	36	5	--	--	--	--	--	--

* Sodium and potassium calculated as sodium (Na).
a/ Calcium (Ca) less than 5 mg/l.
b/ Nitrate (NO_3) less than 20 mg/l.
c/ Includes any carbonate (CO_3) present.
d/ Includes 0.03 mg/l manganese (Mn), 0.77 mg/l phosphate (PO_4), and 0.37 boron (B).
e/ Includes 0.05 mg/l manganese (Mn), 1.2 mg/l phosphate (PO_4), and 0.43 boron (B).
f/ Includes 3.7 mg/l acidity as H^{+1}.
g/ Includes 1.1 mg/l acidity as H^{+1}.