TEXAS
WATER
DEVELOPMENT
BOARD

REPORT 18

GROUND-WATER RESOURCES OF HOUSTON COUNTY, TEXAS

MARCH 1966

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GROUND-WATER RESOURCES OF HOUSTON COUNTY, TEXAS

By

George E. Tarver
United States Geological Survey

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ABSTRACT

Houston County occupies an area of 1,232 square miles in the West Gulf Coastal Plain of eastern Texas. The climate of the county is subhumid, the average annual precipitation being about 44 inches. The rocks that contain fresh to slightly saline water consist of alternating beds of sand and shale chiefly of Eocene age. The rocks crop out in belts which trend generally northeastward, and they dip gently toward the southeast.

The principal water-bearing formations underlying the county are the Carrizo Sand, the Queen City Sand, and the Sparta Sand. Less important water-bearing formations include the Wilcox Group and the Spiller Sand Member (of Stenzel, 1940) of the Cook Mountain Formation. The Carrizo Sand and the Wilcox Group do not crop out in the county, but are present in the subsurface beneath the entire county. These two units contain water under artesian pressure. The other aquifers contain water under water-table conditions in their outcrop areas, and the water becomes artesian as the formations pass beneath less permeable rocks in the subsurface.

The source of all the ground water in Houston County is precipitation. Most of the recharge occurs as rainfall on the outcrops of the water-bearing formations, although lesser amounts of recharge probably result from seepage from streams that cross the outcrop areas. The water that enters the formations moves generally down the dip of the formations toward discharging wells or toward areas of natural discharge.

Average coefficients of transmissibility determined from pumping tests in and near Houston County were 25,000 gallons per day per foot for the Carrizo Sand, 3,800 for the Queen City Sand, and 20,000 for the Sparta Sand.

In 1963, about 3,300 acre-feet or 2.95 mgd (million gallons per day) of ground water was used in Houston County. Of this amount, nearly 1.2 mgd was used for municipal supply, about 0.25 mgd for irrigation, and the rest, which includes the water from uncontrolled flowing wells, for domestic and stock purposes and miscellaneous needs. As of 1963, there was practically no industrial use of ground water in the county.

Long-term records of fluctuations of water levels in Houston County are not available; however, measurements have been made monthly in 50 wells since 1963, and in 5 of these wells water levels had been measured also in 1961. The records show that the fluctuations have been very small during this period. The aquifers for all practical purposes are still as full of water as they were before pumping began. The greatest declines in water levels have been in the

vicinity of the city of Crockett and have resulted from the pumping of city wells. The city records indicate that the declines have been about 0.5 foot per year since 1930.

The water from the Carrizo Sand, Queen City Sand, and Sparta Sand, the principal aquifers in the county, is chiefly of the sodium bicarbonate type. It is generally soft to moderately hard, and conforms in most respects to the standards for drinking water established by the U.S. Public Health Service. The water from the Spiller Sand Member and other rock units in the county is generally of poorer quality. Probably the most serious chemical-quality problem in the county is that of an excess amount of iron in much of the water. However, this situation can generally be handled by relatively inexpensive treatment.

The aquifers underlying Houston County are, as of 1964, virtually untapped. Estimates indicate that the principal water-bearing formations, the Carrizo Sand, the Queen City Sand, and the Sparta Sand, are capable of supporting a total perennial ground-water development of at least 46 mgd with pumping levels not exceeding 400 feet along assumed lines of discharge. In addition to the 46 mgd that can be pumped indefinitely, during the process of lowering the water levels to 400 feet approximately 9 million acre-feet of water would be released from storage and made available to wells. The estimated perennial yields of the individual principal water-bearing formations are 19 mgd from the Carrizo Sand, about 6 mgd from the Queen City Sand, and about 21 mgd from the Sparta Sand.

GROUND-WATER RESOURCES OF HOUSTON COUNTY, TEXAS

INTRODUCTION

Location and Extent of Area

Houston County comprises 1,232 square miles in the central part of eastern Texas (Figure 1) midway between Dallas and Houston. It is bounded on the north by Anderson County, on the west along the Trinity River by Leon and Madison Counties, on the southeast by Walker and Trinity Counties, and on the northeast along the Neches River by Angelina and Cherokee Counties. Houston County, the first county created by the Republic of Texas in 1837, had a population of 19,376 in 1960, according to the U.S. Bureau of the Census. The populations of the principal towns were as follows: Crockett, the county seat and center of commerce, 5,356; Grapeland, the center of the vegetable- and fruit-growing area, 1,113; and Lovelady, the county's oil capital, 466.

Purpose and Scope

The investigation in Houston County was started March 1, 1963, and its purpose was to determine and describe the occurrence, availability, and quality of the ground water in Houston County. The purpose of the report is to present information and data that can be used as a guide to the development of the ground-water supplies.

Determinations were made of the location and extent of the water-bearing formations, the chemical quality of the water they contain, the quantity of water being withdrawn and the effects of these withdrawals on the water levels in wells, the hydraulic characteristics of the principal aquifers, and estimates of the quantities of ground water available for development.

The investigation was made under the immediate supervision of A. G. Winslow, district geologist of the U.S. Geological Survey in charge of ground-water investigations in Texas.

Methods of Investigation

The investigation in Houston County included the following items of work:

1. A geologic map was compiled from field notes and from maps in unpublished and published reports of geologic investigations in parts of the county (Plate 1).

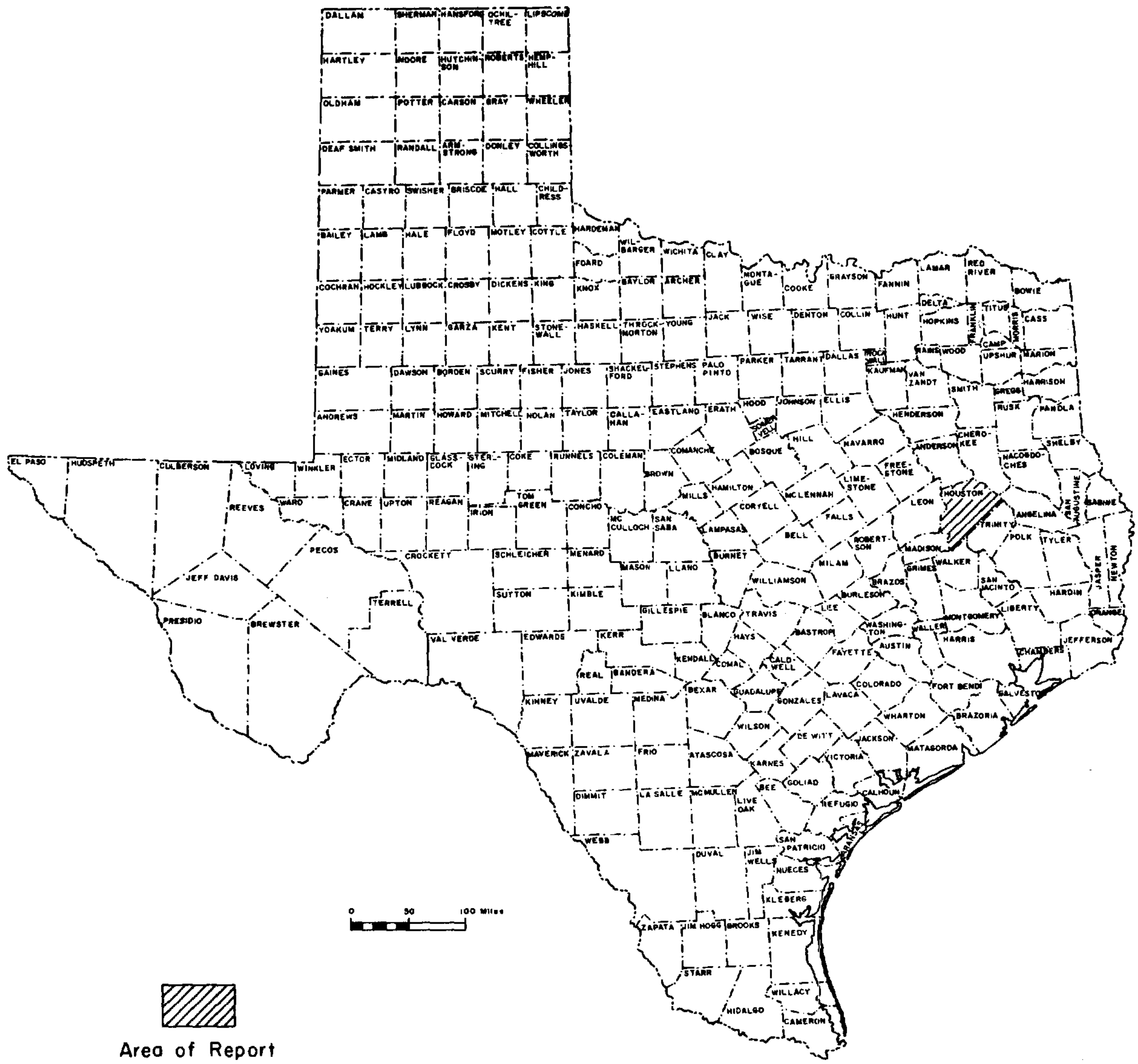

Figure 1

Map of Texas Showing Location of Houston County

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

2. Electric logs of a large number of wells were used for correlation purposes and for a study of the water-bearing properties of the formations. The locations of these wells are shown on Plate 1.

3. An inventory was made of 271 water wells, including all public supply, irrigation, and industrial wells, and a representative number of the domestic and stock wells. Their locations are shown on Plate 1.

4. Samples of water were collected from 62 wells for analysis to determine the chemical quality of water in the several aquifers.

5. An inventory was made of municipal, industrial, and irrigational pumpage.

6. Aquifer tests were run in 4 wells to determine the hydraulic characteristics of the aquifers.

7. Climatological data were collected and compiled (Figures 2 and 3).

8. Maps were made showing the extent and thickness of the sands containing fresh to slightly saline water and the altitudes of the tops of the principal aquifers (Figures 5-9, and 18-21).

9. A map showing the base of fresh to slightly saline water in the Wilcox Group was made from electrical-log data (Figure 17).

10. Hydrologic data were analyzed to determine the quality and quantity of water available for development.

11. Problems related to the development of ground-water supplies in Houston County were studied.

Previous Investigations

Detailed studies of the ground-water resources of Houston County had not been made prior to this investigation. However, considerable data are presented in reconnaissance reports on the ground-water resources--one on the Neches River Basin (Baker and others, 1963) and one on the Trinity River Basin (Peckham and others, 1963).

A detailed investigation of the geology has been made in a small area in the county by Stenzel (1943). A report on the regional geology (Sellards and others, 1932) and a report on Leon County (Stenzel, 1938) include descriptions of the geologic formations in or near this report area. The bentonite deposits of western Houston County were described by Webb (1942).

Economic Development

Houston County derives its income principally from agriculture, oil and gas, and timber. The raising of beef cattle has increased tremendously during the past 30 years, until it is the most important part of the agricultural economy; in 1963, it accounted for about 20 percent of the county's income. Other agricultural products are poultry, milk, peanuts, cotton, vegetables, and fruit; considerable grain and hay also are grown for livestock feed.

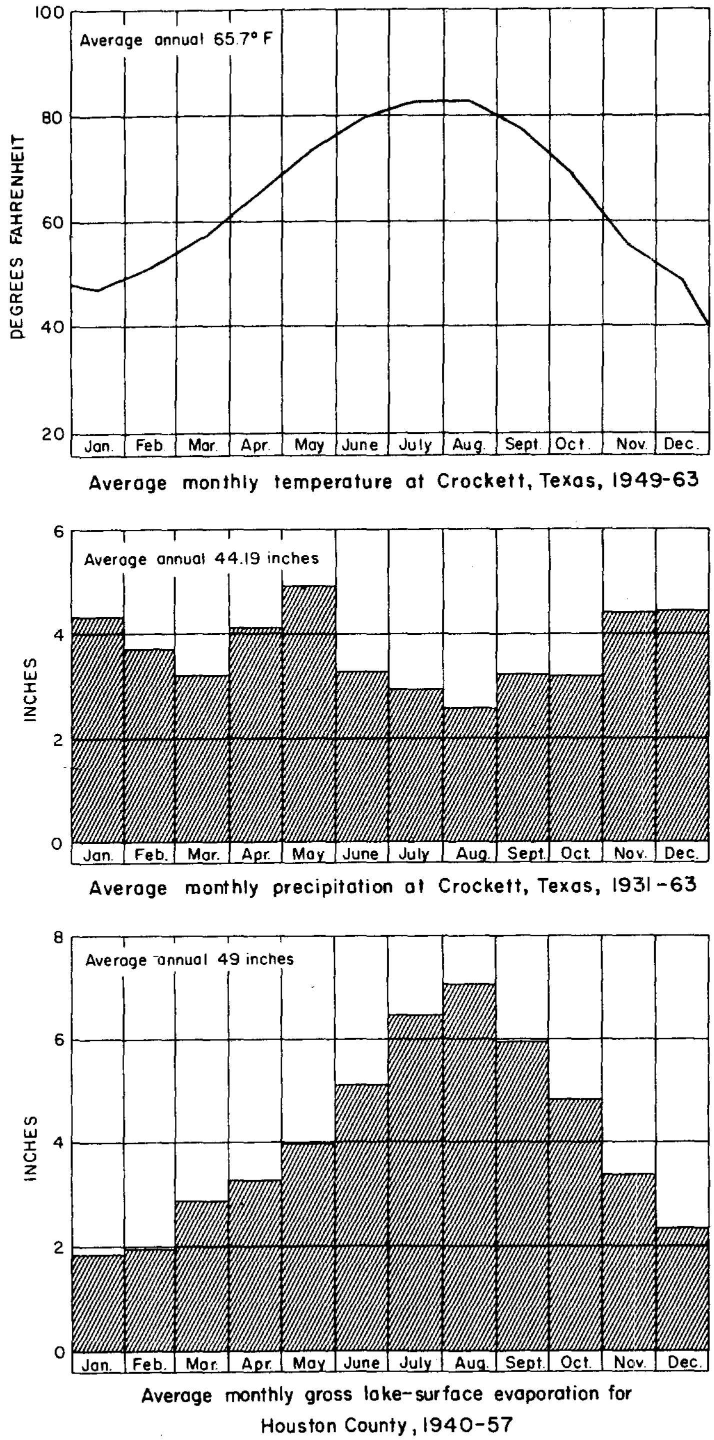

Figure 2

Monthly Temperature and Precipitation at Crockett and Monthly Evaporation for Houston County

(From records of U.S. Weather Bureau and Lowry, 1960)

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

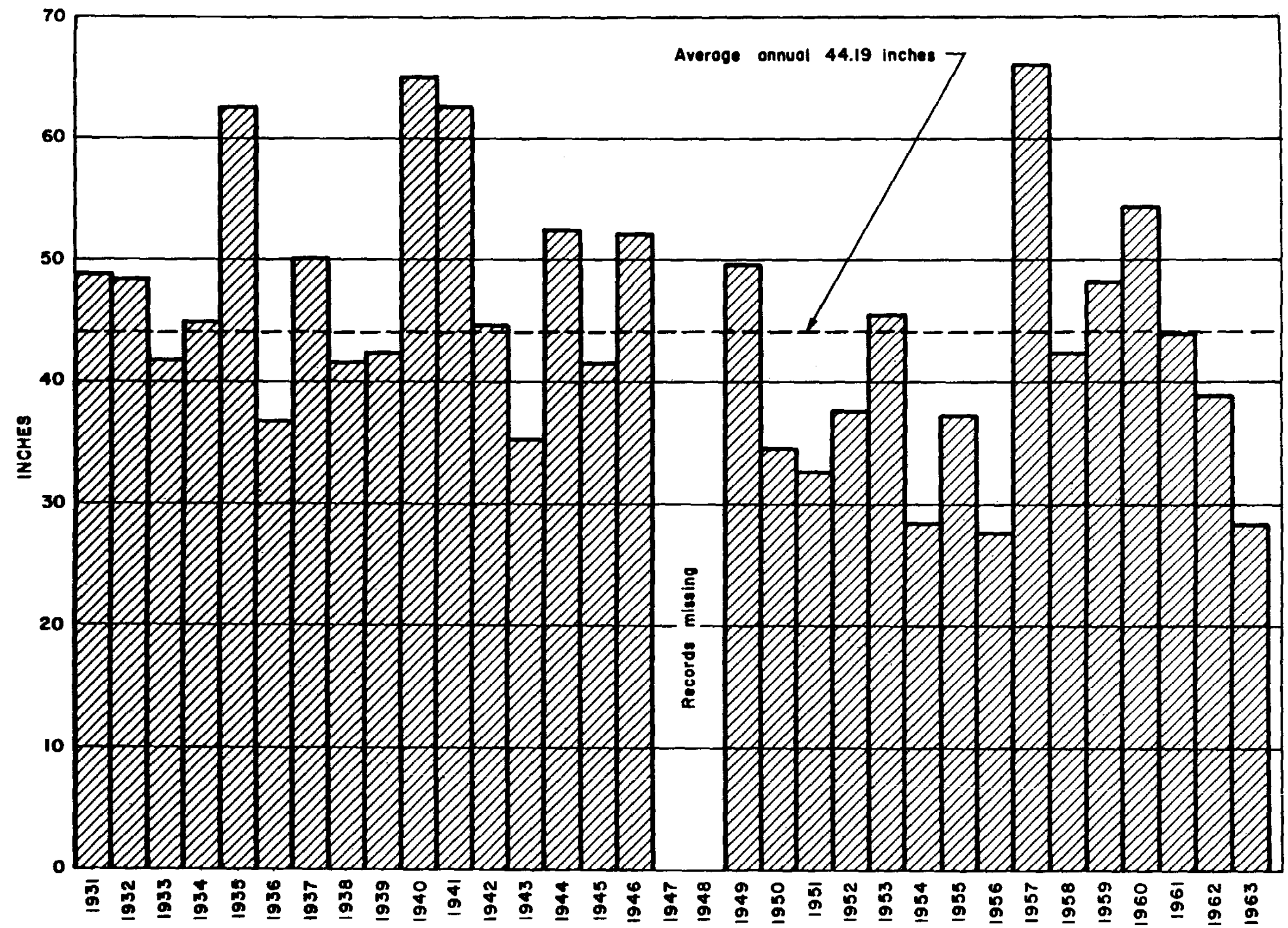

Figure 3

Average Annual Precipitation at Crockett

(From records of U.S. Weather Bureau)

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

The petroleum industry is the second most important source of revenue to the county. Oil was first discovered in 1934; approximately 10 million barrels of oil was produced to January 1, 1964. Liquefiable hydrocarbons, such as butane, are produced in a plant 12 miles southwest of Lovelady. The value of oil and gas production and mineral leasing was estimated to be 2.5 million dollars in 1963.

Forests, largely hardwood and pine trees, occupy 64 percent or about 500,000 acres of Houston County. The lumber is processed at five mills in the county, and pulpwood is shipped to nearby paper mills.

Physiography and Drainage

Houston County, in the West Gulf Coastal Plain of Texas, is characterized by gently rolling hills and intervening valleys, although in a few places the terrain is dissected by deep ravines between relatively steep rocky hills. The only nearly flat area is the flood plain along the Trinity River. The flood plain has a maximum width of about 4 miles and is covered by fertile silty black soil.

The land surface ranges in altitude from 145 feet in the Trinity River Valley where the Trinity leaves the county to 550 feet near the center of the Anderson-Houston county line. The altitude of most of the county lies between 250 and 450 feet. The hills, which trend generally eastward across the county, are characterized by a steep slope on the north and a gentle slope on the south.

Approximately the western two-thirds of the county is drained by the Trinity River and its tributaries, and the eastern one-third is drained by the Neches River. In the northern part of the county, most of the streams are perennial and have developed a trellis-type drainage pattern, whereas in the southern part of the county, most of the streams are intermittent and have developed a dendritic drainage pattern.

Climate

Houston County has a subhumid climate, as indicated in Figures 2 and 3. The precipitation, averaging 44.19 inches annually for the period 1931-63, is fairly well distributed throughout the year, being greatest in May and least in August. The distribution of rainfall in time and amount generally is sufficient for growing most crops without supplemental supplies of water.

The temperature generally is moderate except during July and August when the days are hot and dry. The average annual temperature at Crockett is about 66°F, the average January temperature being about 47°F and the average August temperature about 83°F. The long growing season of about 245 days is favorable to agriculture.

Figure 2 shows that the gross lake-surface evaporation for Houston County averages about 49 inches a year (Lowry, 1960), or about 5 inches more than the average annual precipitation. The evaporation is greatest during the period June through September, when the demand for soil moisture by plant life also is large. During this period, evaporation averages about 25 inches as compared to only 12 inches of precipitation.

Well-Numbering System

The well-numbering system used in this report is one adopted by the Texas Water Development Board for use throughout the State and is based on latitude and longitude. Under this system, each 1-degree quadrangle in the State is given a number consisting of two digits. These are the first two digits appearing in the well number. Each 1-degree quadrangle is divided into 7½-minute quadrangles which also 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 and 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 is inventoried, starting with 01. These are the last two digits of the well number. Thirty-four 7½-minute quadrangles are shown on the well location map of this report (Plate 1) and numbered in the northwest corner of each quadrangle. Also shown by the large double-lined figures 37, 38, and 60 are the 1-degree quadrangles. The 3-digit number shown with the well symbol contains the number of the 2½-minute quadrangle in which the well is located and the number of the well within the quadrangle. In addition to the 7-digit well number, a 2-letter prefix is used to identify the county. The prefixes for Houston and adjacent counties are shown below.

County	Prefix	County	Prefix
Anderson	AA	Leon	SA
Angelina	AD	Madison	SW
Cherokee	DJ	Trinity	YH
Houston	PA	Walker	YU

Acknowledgments

The investigation was greatly aided by the residents of Houston County who furnished information about their wells and permitted access to their property. Appreciation is also expressed to Messrs. F. M. Boone and W. B. Leathers for their interest in the field geology; to Mr. R. L. Taylor, retired well driller, for allowing free access to his log files; and to Mr. Curtis Sessions of Humble Oil Co. for making available geologic data.

GEOLOGIC FORMATIONS AND THEIR WATER-BEARING PROPERTIES

The rock formations that are pertinent to the occurrence of ground water in Houston County consist principally of alternating beds of sand, silt, and clay ranging in age from Eocene to Recent. The thickness, lithology, and water-bearing properties of the units are summarized in Table 1; their outcrops are shown on Plate 1.

The general geologic structure of Houston County is fairly simple. The formations crop out in belts that trend generally northeastward across the county except in the north-central part of the county where the outcrops of the older formations swing sharply northward, roughly parallel to the axis of the East Texas embayment. The dip of the formations is southeastward toward the Gulf

Table 1.--Rock formations and their water-bearing properties, Houston County

System	Series	Stratigraphic unit	Approximate maximum thickness (feet)	Character of rocks	Water-bearing characteristics
Quaternary	Recent or Pleisto-cene	Alluvium	70	Silt, sand, and gravel.	Yields small to moderate quantities of water to a few wells in the flood plain of the Trinity River.
Tertiary	Eocene	Jackson Group	100	Sand, shale, and limy sand.	Yields small quantities of water to a few wells chiefly for domestic and stock purposes.
		Yegua Formation	960	Sand, sandy clay, clay, lignite, bentonite, and peat.	Yields small to moderate quantities of water.
		Cook Mountain Formation	405	Shale, marl and sand with some limestone, gypsum, and glauconite.	Spiller Sand Member of Stenzel (1940), yields small quantities of water to domestic wells in southern part of county.
		Sparta Sand	340	Thickly bedded sand in lower part; thinly bedded silty sand and sandy shale in upper part.	Yields small to large quantities of water. Principal zones of ground water in Houston County.
		Weches Greensand	230	Glauconitic sand, sandstone, shale, limestone, and marl.	Not known to yield water to wells in this county. Electric logs indicate sandy beds probably contain water of poor quality.
		Queen City Sand	350	Fine to medium sand, interbedded with lignitic and sandy shale.	Yields small to moderate quantities of water to wells in the northwestern half of the county.
		Reklaw Formation	300	Predominantly shale in upper part and sand in lower part.	Not known definitely to yield water to wells. Sand in lower part may furnish water to some wells reportedly screened in Carrizo Sand.
		Carrizo Sand	250	Fine to medium sand and shale.	Yields moderate to large quantities of water to a few wells.
		Wilcox Group	3,600	Cross-bedded sand, lignitic clay, lignite lentils, and silt.	Yields slightly saline water to one well. Electric logs indicate little or no fresh water available in aquifer in Houston County.

Coast at a rate greater than the dip of the land surface. The dip is relatively gentle near the outcrop of each formation, but increases southward. The general structure and the variations in the dip of the formations are shown on two geologic sections (Plates 2 and 3). The contacts between the formations are based on the interpretation of electric logs of oil tests; consequently, they may be somewhat at variance with those based on paleontological data. An electric log showing the characteristic electrical properties of most of the formations is shown in Figure 4.

Faults are relatively common in the subsurface of Houston County, but generally they have little or no surface expression. Most of them are normal faults downthrown to the south and southeast, and they probably do not affect significantly the occurrence or movement of ground water. Only a few faults are shown on the geologic map (Plate 1) and none on the cross sections (Plates 2 and 3). Doubtless, many of the variations in dip shown in the cross sections can be attributed to faults.

A structural feature of small areal extent is the piercement-type salt dome which forms the Kittrell oil field, 7 miles southwest of Lovelady. The salt rises to within nearly 3,000 feet of the land surface, causing an upwarping of the strata close to and around the dome. The structure is expressed at the surface by radial dips of the exposed beds and a topographic depression at the center. The structure is also shown by the closed contours southwest of Lovelady on Figure 5.

Tertiary System

Eocene Series

Wilcox Group

Rocks of the Wilcox Group do not crop out in Houston County but underlie the county at progressively greater depths toward the coast (Plate 2). They rest on rocks of the Paleocene Midway Group, which consists predominantly of clay and shale. The Wilcox consists of a heterogeneous series of sandy lignitic clay, cross-bedded sand, noncalcareous clay, lignite lentils, and stratified deltaic silt. On the basis of electric logs of oil tests, sand makes up about 50 percent of the Wilcox. Although the unit locally contains thick beds of sand, the individual sand beds are not continuous, but grade into finer or coarser material in short distances.

The Wilcox ranges in thickness from about 1,800 feet in the northern part of the county to 3,600 feet in the southern part. The top of the Wilcox (Figure 5) ranges from an altitude of slightly less than 200 feet below sea level near Weches to about 2,500 feet below in the southern part of the county. About 7 miles southwest of Lovelady, the top of the Wilcox is only 1,925 feet below sea level, reflecting the upwarping caused by the salt dome that forms the Kittrell oil field.

The map shows also that the Wilcox dips southeastward at an increasing rate. North of Grapeland the dip is nearly flat; between Grapeland and Crockett it is about 60 feet per mile; between Crockett and Lovelady it is about 75 feet per mile; and in the extreme southern end of the county it is about 150 feet per mile.

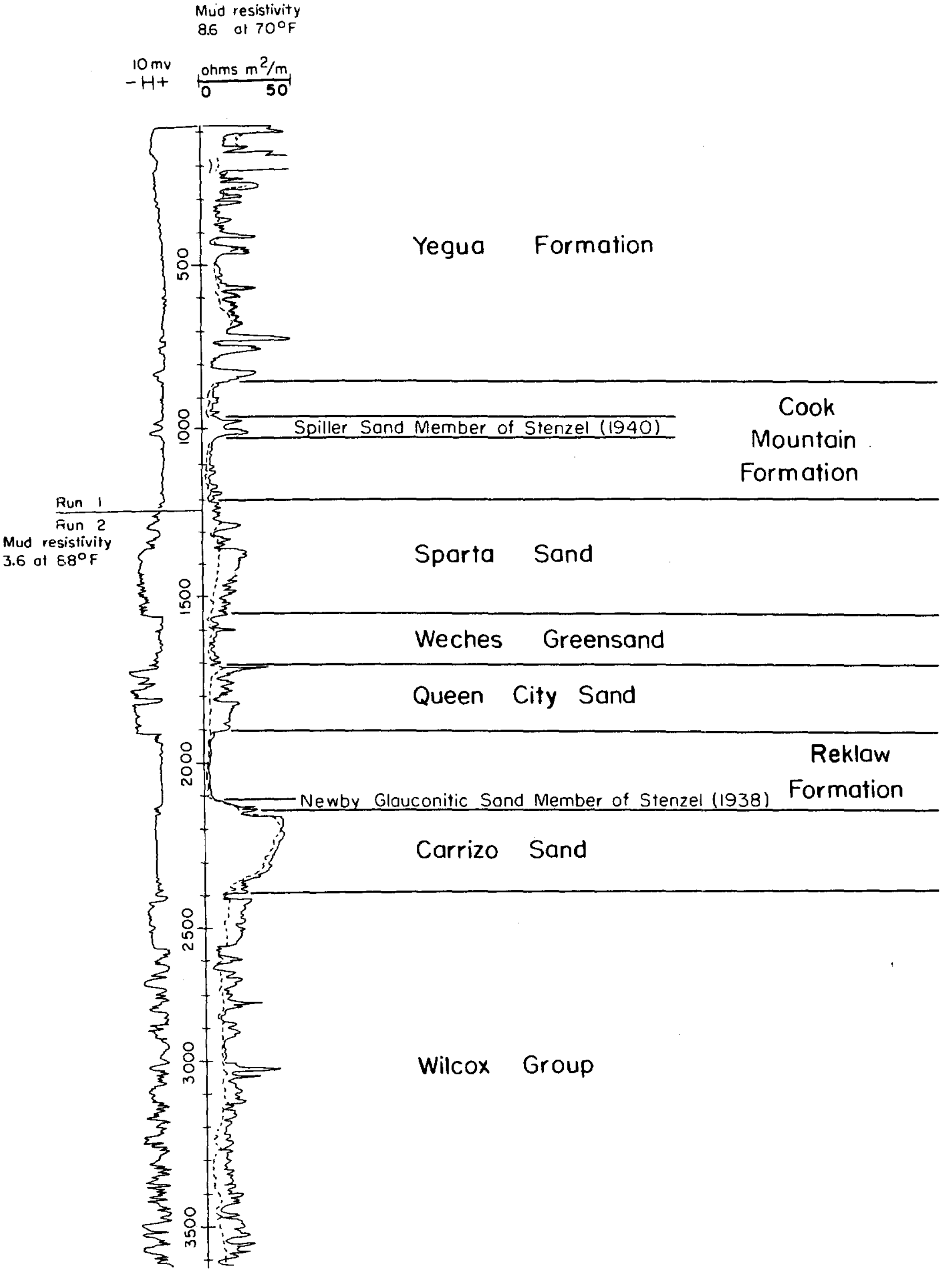

Figure 4

Electric Log of Well PA-38-61-202 Illustrating the Electrical Properties of the Geologic Formations Pertinent to the Occurrence of Ground Water in Houston County

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

Only one well (PA-38-35-203) in Houston County is known to obtain water from the Wilcox Group, principally because water of good quality is available in sands at shallower depths. The well reportedly is capable of yielding more than 1,000 gpm (gallons per minute) of slightly saline water (1,000 to 3,000 ppm [parts per million] dissolved solids). Electric logs indicate that although little or no fresh water (less than 1,000 ppm dissolved solids) is available in the Wilcox Group in the county, slightly saline water can be obtained at most places except in the southeastern and southern parts of the county where the water is moderately saline (3,000 to 10,000 ppm dissolved solids). The geologic cross section (Plate 2) shows the relation between fresh to slightly saline and moderately saline water. Numerous oil well drillers reported that locally the Wilcox contained natural gas and oil, but in amounts too small to be developed commercially.

Claiborne Group

The Claiborne Group in Houston County includes the Carrizo Sand, Reklaw Formation, Queen City Sand, Weches Greensand, Sparta Sand, Cook Mountain Formation, and the Yegua Formation. The group has a maximum thickness of about 2,825 feet.

Carrizo Sand

The Carrizo Sand crops out in two widely separated northward-trending belts that parallel the axis of the East Texas embayment; the nearest outcrop is about 18 miles northwest of Houston County where it occupies a northeastward-trending belt of irregular width; the other is about 25 miles northeast of the county where it trends northwestward. The Carrizo underlies the entire county at depths ranging from a few hundred feet in the extreme northeastern and northwestern parts of the county to at least 2,600 feet near the southern corner.

The Carrizo Sand consists of beds of massive, gray to white, fine to medium sand, and thin shale beds in a few places. The Carrizo is readily identified in electric logs (Figure 4) by its high degree of resistivity and its massive character in contrast to the underlying series of alternating beds of sand and shale of the Wilcox Group. The Carrizo Sand thickens southward, ranging from about 100 feet in the northern part of Houston County to about 250 feet south of Lovelady. The contact between the Carrizo and Wilcox, shown on the cross sections (Plates 2 and 3), was placed arbitrarily at or near the base of the massive sand overlying the alternating beds of shale and sand of the Wilcox. Hence, the Carrizo Sand, as used in this report, actually may include a part of the Wilcox. Doubtlessly, some wells that reportedly are screened in the Carrizo in fact obtain part of their water from a fairly prominent bed of sand that has been assigned to the overlying Reklaw Formation.

The top of the Carrizo Sand (Figure 6) ranges from near sea level at the northeast and northwest corners of the county to at least 2,216 feet below sea level on the flank of the salt dome in the Kittrell oil field, southwest of Lovelady. In this area, the top of the Carrizo has been upwarped to about 1,900 feet below sea level or about 2,300 feet below land surface.

The Carrizo Sand yields moderate (100 to 1,000 gpm) to large (more than 1,000 gpm) quantities of fresh to slightly saline water to a few wells, principally in the northern one-third of the county. There has been little or no development of the Carrizo in the rest of the county because water of good chemical quality is available at shallower depths.

Reklaw Formation

The Reklaw Formation crops out in a narrow belt along the west bank of the Neches River extending from the Anderson-Houston county line southeastward to San Pedro Creek (Plate 1). The Reklaw conformably overlies the Carrizo and consists of a lower part that is predominantly sand and an upper part that is chiefly shale (Figure 4). The basal sand, which is glauconitic and in places thick bedded, probably is equivalent to the Newby Glauconitic Sand Member of Stenzel (1938, p. 65-71). It ranges in thickness from 20 to 60 feet. The upper part of the formation is composed of thin-bedded, chocolate-colored lignitic shale containing numerous iron concretions; gypsum commonly is found in the area of outcrop. The thickness of the upper part ranges from 120 to 240 feet; the thickness of the total section of the Reklaw ranges from 140 feet near the outcrop to 300 feet near Lovelady.

The Reklaw Formation is not known definitely to yield water to wells in Houston County. However, the sand in the lower part of the formation probably furnishes some water to wells reportedly screened in the Carrizo Sand.

Queen City Sand

The Queen City Sand crops out in two separate areas in Houston County (Plate 1), one in the northwest corner and the other in the northeast. The outcrop in the northwest corner of the county is part of a wide belt that trends northeastward into Arkansas and Louisiana. In the northeast corner of the county, the outcrop of the Queen City occupies a fairly broad area near the confluence of San Pedro Creek and the Neches River; thence, it extends in a narrow belt up San Pedro Creek for a distance of several miles.

The Queen City Sand consists chiefly of cross-bedded, fine to medium sand interbedded with sandy and lignitic shale. The sand generally is gray to tan, but where it is overlain by the Weches Greensand, it is mainly red, due to the leaching of iron from the Weches. Where the entire section is present, the Queen City ranges in thickness from 350 feet near Grapeland to about 120 feet near Kennard. Part of the apparent variation in thickness is due to the difficulty in determining the contact between the Queen City and the underlying Reklaw (Figure 4).

The dip and configuration of the top of the Queen City Sand (Figure 7) is consistent with the underlying formation. The top of the Queen City ranges from about 400 feet above sea level northeast of Grapeland to about 2,000 feet below sea level in the southern part of the county.

The Queen City Sand yields small to moderate quantities of fresh to slightly saline water to wells in the northwestern half of the county. Farther south, the water is too highly mineralized, and most wells obtain water from either the Carrizo or sands at shallower depths. The interface between fresh to slightly saline water and moderately saline water in the Queen City is shown in one of the geologic cross sections (Plate 2).

Weches Greensand

The Weches Greensand crops out in two areas in the northern part of the county. In the northwestern part, the Weches outcrop forms a narrow, sinuous northeastward-trending belt; in the northeastern part, the Weches is exposed in a narrow belt on the south side of San Pedro Creek and in a broad belt on the north side of the creek.

The Weches, lying disconformably on the Queen City Sand, consists of glauconitic fossiliferous marl, sand, sandstone, shale, and limestone, and contains iron concretions and thin lenticular beds of iron-cemented sandstone. Locally, the lower contact is difficult to determine, owing to the similarity in the color of the sediments in the upper part of the Queen City Sand and those in the lower part of the Weches. However, the absence of glauconite in the Queen City Sand is a useful criterion for separating the two formations. The Weches, as shown in the electric log of well PA-38-61-202 (Figure 4), includes the predominantly shaly section between the underlying Queen City Sand and the overlying Sparta Sand. On this basis, the thickness of the Weches ranges from 70 feet near the area of outcrop to 230 feet in the southern part of the county. In general, the Weches dips southeastward at a rate consistent with the underlying formation except north of San Pedro Creek where the beds are nearly flat and are intercepted by faults, with the downthrown side facing the north.

The Weches is not known to yield water to wells in Houston County. Electric logs indicate that the thin beds of sand or sandstone probably contain water of poor chemical quality.

Sparta Sand

The Sparta Sand crops out in a northeastward-trending belt about 6 miles wide across the northern part of Houston County. The Sparta also caps the northward-trending ridge that separates the drainage basins of the Trinity and Neches Rivers north of Grapeland (Plate 1). The Sparta, disconformably overlying the Weches Greensand, consists of sand, sandy shale, and shale (Figure 4). The lower part is predominantly medium sand, generally unconsolidated and massively bedded. The sand grades upward into finer, thinly bedded sand and sandy shale. The uppermost part of the Sparta commonly consists of lignitic chocolate-colored shale and thin-bedded silty sand. According to electric logs, the Sparta has a relatively uniform thickness of about 300 feet; however, a maximum thickness of 340 feet has been observed in the county.

The dip of the Sparta Sand increases southeastward, ranging from 50 feet per mile near its outcrop to about 100 feet per mile in the southern part of the county. The top of the Sparta is penetrated by wells at altitudes ranging from 432 feet above sea level about 7 miles northeast of Crockett to at least 1,370 feet below sea level about 7 miles southwest of Lovelady (Figure 8).

The Sparta Sand is the principal source of ground water in Houston County, supplying small (0 to 100 gpm) to large quantities of water to a large number of wells, principally for domestic use; it also furnishes the water needs of the towns of Crockett and Kennard, as well as the Eastham State Prison Farm.

Cook Mountain Formation

The Cook Mountain Formation crops out in an arcuate belt ranging from 2 to 8 miles in width and passing through Crockett (Plate 1). Generally, the formation consists of shale, marl, and sand, with minor amounts of limestone, glauconite, and gypsum. A more detailed description would show, from bottom to top, 65 feet of blue to gray marl, lignitic shale, limestone lentils, and numerous ferruginous concretions; 100 feet of thinly bedded fossiliferous chocolate-colored shale, sandy shale, and ferruginous concretions; 65 to 100 feet of thinly bedded fine to medium sand interbedded with shale and silty shale, which Stenzel (1938, p. 149-150) designated as the Spiller Sand Member of the Crockett Formation and later (1940, p. 1663) assigned to the Cook Mountain Formation; and 100 feet of shale with some ferruginous concretions that have formed around selenite crystals. About 45 feet above the base of the marl is a persistent and mappable unit consisting of beds of spherical ferruginous concretions, as much as 6 inches in diameter, and beds of shale and bentonite. The thickness of the Cook Mountain Formation ranges from about 340 feet near its area of outcrop to 405 feet in the vicinity of Lovelady, and averages about 375 feet.

Small quantities of fresh to slightly saline water are obtained from a few small-capacity wells that tap the Spiller Sand Member of the Cook Mountain Formation in the southern part of the county.

Spiller Sand Member of Stenzel (1940).--The Spiller Sand Member of Stenzel (1940), a prominent sand body in the Cook Mountain Formation (Figure 4), crops out in a narrow belt ranging in width from half a mile to 2 miles. The unit dips south- and southeastward at a rate of slightly less than 80 feet per mile (Figure 9). Characteristically, it consists of medium to fine cross-bedded sand, in places interbedded with chocolate-colored shale and silty shale that contain lignitized plant fragments and mica. The thickness of the Spiller Sand Member is fairly uniform, ranging from about 50 feet near its outcrop to somewhat less than 100 feet along the Trinity County line. The top of the Spiller Member occurs at altitudes ranging from as much as 370 feet above sea level in the outcrop area to about 1,200 feet below sea level in the southern corner of the county (Figure 9).

The Spiller Sand Member is the only aquifer in the Cook Mountain Formation, furnishing small quantities of fresh to slightly saline water to a few wells, principally for domestic use.

Yegua Formation

The Yegua Formation crops out in a wide belt extending northeastward to about 2 miles northeast of Ratcliff, thence eastward, passing out of the county near the intersection of the Neches River and the Houston-Trinity county line (Plate 1). The Yegua consists of sand (about 50 percent), sandy clay, clay, lignite, bentonite, and peat. According to Sellards and others (1932, p. 673-674), the Yegua contains more gypsum and lignite than the other formations of the Claiborne Group; fragments of dark-colored petrified wood and logs are common throughout the strata of the Yegua, particularly in association with the lignite in the upper part of the formation. In this report, the contact between the Cook Mountain and the Yegua was placed arbitrarily at or near the base of the first prominent sand overlying the somewhat massive shale of the Cook Mountain Formation (Figure 4). On this basis, the Yegua has a maximum thickness of about 960 feet in Houston County.

The Yegua Formation yields small to moderate quantities of fresh to slightly saline water to wells principally for domestic use. The Yegua also supplies water to Lovelady and to a part of Eastham State Prison Farm.

Jackson Group

The Jackson Group crops out in a discontinuous belt along the southeastern Houston County line (Plate 1).

The Jackson, conformably overlying the Yegua, consists of tan to red sand, white limy sand, and chocolate-colored shale. Only the lower part of the Jackson is exposed in Houston County; the maximum thickness underlying the county is only about 100 feet, as compared to about 1,100 feet in Walker County (Winslow, 1950, p. 12) where wells penetrate the complete section. A few small-capacity wells draw water from sands of the Jackson Group for domestic and stock supply.

Quaternary System

Pleistocene and Recent Series

Alluvium

Alluvial deposits occur along the Trinity and Neches Rivers and in scattered places in the uplands. Only the alluvial deposits along the Trinity River are shown on the geologic map (Plate 1).

The flood-plain deposits along the Trinity River are fairly wide, covering about 60,000 acres, and are extensively cultivated. They consist of gravel, sand, and silt, and range in thickness from 0 to 70 feet. In general, the upper part of the alluvial deposits is composed of black silt, at least 5 feet thick, underlain by yellow and gray silty sand interbedded with lentils of gravel and coarse sand. The gravel is similar to that scattered over the uplands. The alluvial deposits along the flood plain of the Trinity River yield small to moderate quantities of fresh to slightly saline water to a few wells. The upland gravels, however, are widely disseminated, thin, and generally do not yield water to wells in Houston County.

GROUND-WATER HYDROLOGY

Source and Occurrence of Ground Water

The ground water in Houston County is derived from precipitation on the outcrop areas of the various water-bearing formations. Much of the water from precipitation is evaporated at the land surface, transpired by plants, or retained by capillary forces in the soil. A small part migrates downward by gravity through the zone of aeration of practically dry rocks until it reaches the zone of saturation, where the rocks are saturated with water. The water then moves generally down the dip of the water-bearing beds into the artesian sections of the aquifers.

Ground water occurs under water-table or artesian conditions. Under water-table conditions, the water is unconfined and does not rise in wells above the top of the aquifer. Under artesian conditions, the water is confined under hydrostatic pressure in the sands between relatively impermeable beds, and where the elevation of the land surface at a well is considerably below the general level of the area of outcrop, the pressure may be sufficient to cause water to rise a considerable distance in the well. The level or surface to which water will rise in artesian wells is called the piezometric surface. Although the terms "water table" and "piezometric surface" are synonymous in the outcrop areas of the aquifers, the term "piezometric surface," as used in this report, is applicable only in the artesian part of the aquifer.

The homoclinal coastward-dipping beds in Houston County are ideally suited for the occurrence of artesian water. Artesian conditions prevail in the Wilcox Group and Carrizo Sand throughout the county and in the other formations where they are overlain by relatively impermeable material southeast of the areas of outcrop. Water-table conditions exist in the outcrop areas of the Queen City Sand, Sparta Sand, Cook Mountain Formation, and Yegua Formation, and in the scattered Quaternary deposits.

Recharge, Movement, and Discharge of Ground Water

Recharge to the aquifers underlying Houston County results from the infiltration of precipitation through the soil to the water table or by seepage from streams or lakes; recharge may also occur by artificial processes which include the infiltration of industrial waste water, sewage, and possibly irrigation water.

The sandy outcrops of the various aquifers present excellent facilities for recharge from precipitation whenever water is available in excess of soil-moisture requirements. Several factors affect recharge, including the intensity and amount of rainfall, the slope of the land surface, the type of soil, the permeability of the aquifer, the rate of evapotranspiration, and the quantity of water in the aquifer.

In an area of relatively high annual precipitation such as in Houston County, the recharge potential may be sharply restricted owing to the high stage of the water table in the recharge areas. As a result, the aquifer may become full to overflowing and potential recharge may be rejected; the excess water escapes into the valleys as flow from springs and seeps. Such seepage is common along most of the streams and creeks in the county, thereby sustaining their flows even during periods of below-normal rainfall. The total quantity of water rejected by the aquifers to the streams in Houston County is not known; however, an estimate of the minimum figure for recharge rejected by the Sparta Sand can be made. The outcrop area of the Sparta Sand is drained by four major creeks--Little and Big Elkhart, San Pedro, and Hickory Creeks (Plate 1). In July 1964, which was preceded by 2 months of little or no rainfall, the low flow of Little Elkhart Creek was estimated to be 3 million gallons per day, or about 70,000 gallons per day per square mile of drainage area. If it is assumed that the low flow of the other creeks (Big Elkhart, San Pedro, and Hickory) is proportionate to the surface area of the Sparta drained by these creeks, it follows that at least 13 million gallons per day, or about 14,500 acre-feet per year, is rejected by the Sparta Sand. This is roughly 4 times the quantity of ground water discharged by wells from all aquifers and for all purposes in Houston County.

Ground water in Houston County moves by gravity from areas of recharge to areas of discharge; the rate of movement is slow, perhaps on the order of only a few hundred feet per year. The rate, which is rarely uniform in space or time, is directly proportional to the hydraulic gradient, which is the difference in head between two points divided by the distance between them. The hydraulic gradient tends to steepen, and consequently the rate of flow tends to increase, near areas of natural discharge and around pumping wells. Although the general direction of movement in the county is southeastward, in detail the water is deflected in various directions according to variations in permeability within the aquifer, or by unequal addition of water to or removal from the ground-water reservoir.

The general direction of the movement of ground water in the Sparta Sand may be seen in Figure 10. The contours show the direction of movement, hence the general areas from which the water originates--the areas of recharge. Accordingly, much of the ground water in the Sparta originated in a small area southeast of Grapeland. The water moves eastward and westward and toward the Gulf except in the vicinity of Crockett, where heavy withdrawals of ground water have formed a steep hydraulic gradient north and northeast of the city.

Data are not available for the preparation of water-level maps of the other aquifers in the county; however, the general direction of movement in all the aquifers is toward the southeast.

The ground water in the aquifers underlying the county is discharged naturally by seepage or spring flow into streams or is dissipated by plants or evaporation from the soil. The quantity of water discharged by seeps and springs (rejected recharge) or by evapotranspiration is not known, but it is at least several times the present (1963) rate of withdrawal by all wells. The discharge by wells is described more fully in a following section on the development of the ground-water reservoirs.

Hydraulic Characteristics of the Aquifers

The value of an aquifer as a fully developed source of water depends on its ability to store and to transmit water. These characteristics are measured by the coefficients of storage (S) and transmissibility (T).

The coefficient of storage (S) of an aquifer is the volume of water it 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. In the water-table aquifer, the coefficient of storage is nearly equal to the specific yield, which is the amount of water a saturated formation will yield by draining under the force of gravity. The storage coefficients of water-table aquifers range from about 0.05 to about 0.30, whereas those of artesian aquifers range from about 0.00001 to 0.001. Where artesian conditions prevail, the coefficient of storage is a measure of the elasticity of the aquifer.

The coefficient of storage is important in any calculation of the quantity of water that could be obtained from an aquifer, but the availability of the water depends primarily on the ability of the aquifer to transmit water. The coefficient of permeability is a measure of that ability and is defined as the rate of flow of water in gallons per day through a cross-sectional area of 1 square foot under a unit hydraulic gradient (1 foot per foot) at a temperature of 60°F. In field practice, the adjustment to 60°F is commonly disregarded, and the permeability is then understood to be a field coefficient at the prevailing water temperature. The coefficient of transmissibility (T) is the product of the field coefficient of permeability and the saturated thickness of the aquifer.

Little is known about the hydraulic characteristics of the aquifers underlying Houston County. However, on the basis of the results of aquifer tests on four wells--two in Anderson County and two in Houston County--and data reported by Peckham and others (1963, p. 82) for wells in the Trinity River Basin, it is estimated that the average coefficient of transmissibility for the Carrizo Sand is 25,000 gpd (gallons per day) per foot; for the Queen City Sand, 3,800 gpd per foot; and for the Sparta Sand, 20,000 gpd per foot. Baker and others (1963, p. 32) reported an average coefficient of storage for these aquifers in the Neches River Basin of about 0.0002, and this figure probably is applicable to the artesian parts of the aquifers in Houston County.

The coefficients of transmissibility and storage may be used to predict the general order of magnitude of future drawdowns in water levels caused by pumping. The relation of drawdown to distance and time as a result of pumping from the Carrizo Sand, Queen City Sand, and Sparta Sand is shown in Figures 11, 12, and 13.

The calculations of drawdown are based on withdrawal rates closely approximating the yields that could be expected from properly drilled wells that fully penetrate the aquifers. Figure 11 assumes that the Carrizo Sand is an infinite aquifer. The drawdown curves for the Queen City Sand and the Sparta Sand (Figures 12 and 13), however, assume that the outcrop areas of the aquifers are within finite distance, 10 and 5 miles, respectively, and that recharge is sufficient to maintain the water levels in the outcrop areas. A comparison of these graphs indicates that the drawdown in a well pumping at a high rate from the Queen City Sand would be considerably greater than that in wells in either the Carrizo Sand or the Sparta Sand.

Water-Level Fluctuations

Water levels in wells fluctuate in response to changes in the rates of recharge to and discharge from the aquifers and, to a lesser extent, to changes in atmospheric pressure, tides, earthquakes, and numerous other disturbances.

Prior to the development of wells in Houston County, the aquifers were nearly in a state of equilibrium--that is, recharge balanced discharge. Pumping, however, disturbed this near equilibrium, and as a result, the water levels fluctuated in response to changes in storage, the magnitude of the change in storage depending on the degree of confinement of the water and the cause of the fluctuations. Water levels in artesian wells are many times more sensitive to changes in storage than are water levels in water-table wells, owing to the great difference in storage coefficients. A fluctuation of several feet in a well in an artesian aquifer may be equivalent to a change of only a fraction of a foot in a well in a water-table aquifer.

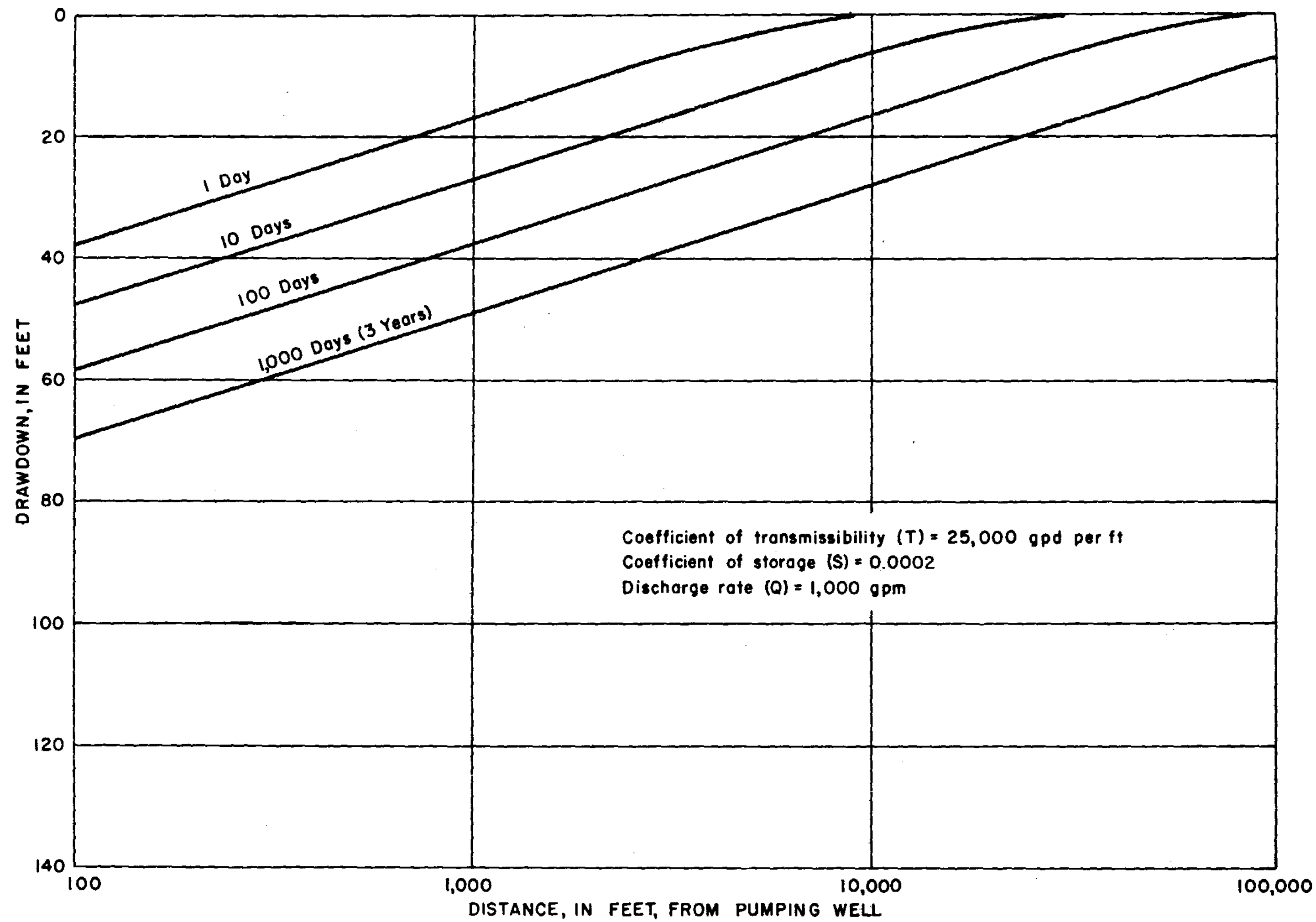

Figure 11

Relation of Distance to Time and Drawdown as a Result of Pumping From the Carrizo Sand

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

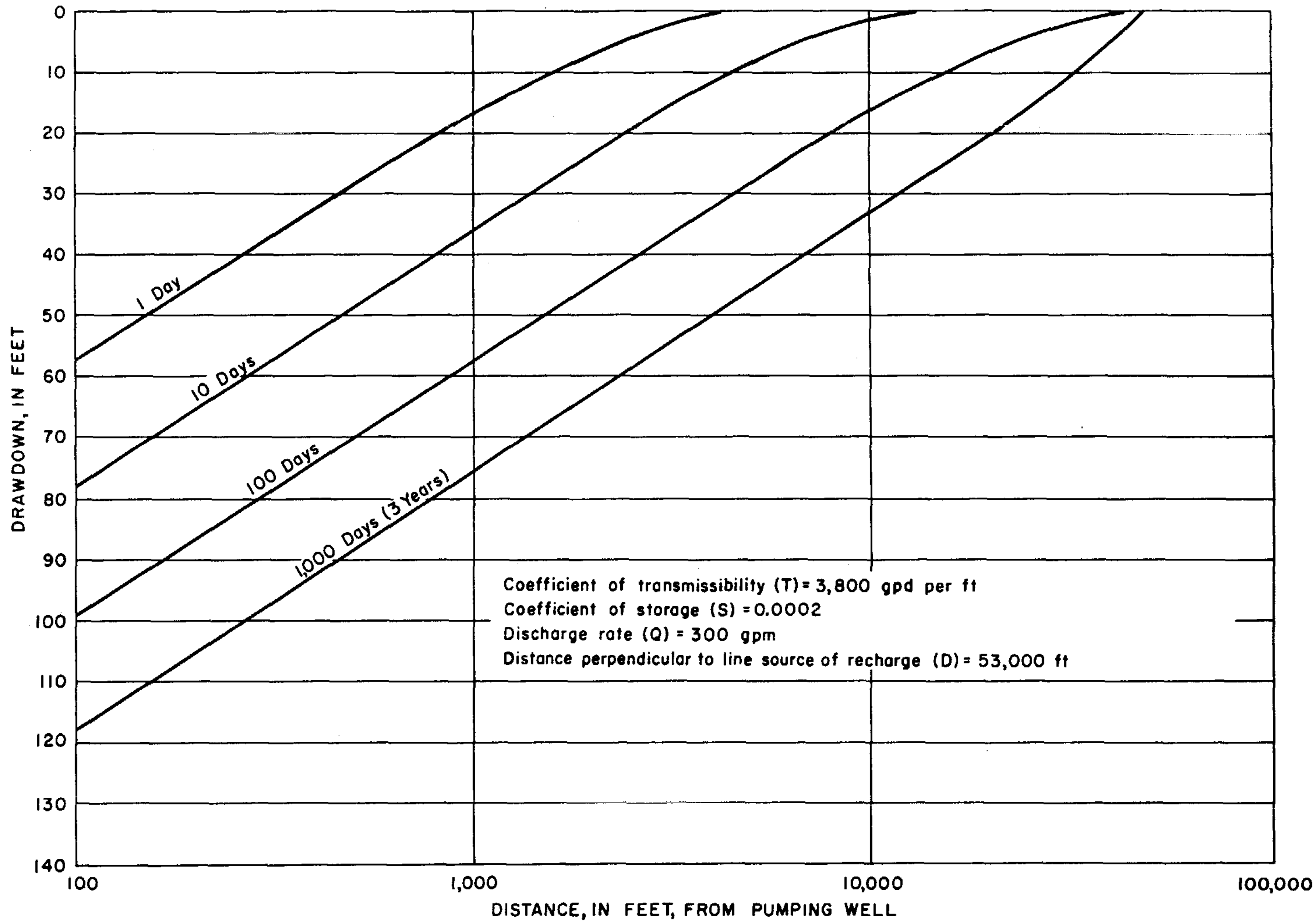

Figure 12

Relation of Distance to Time and Drawdown as a Result of Pumping From the Queen City Sand

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

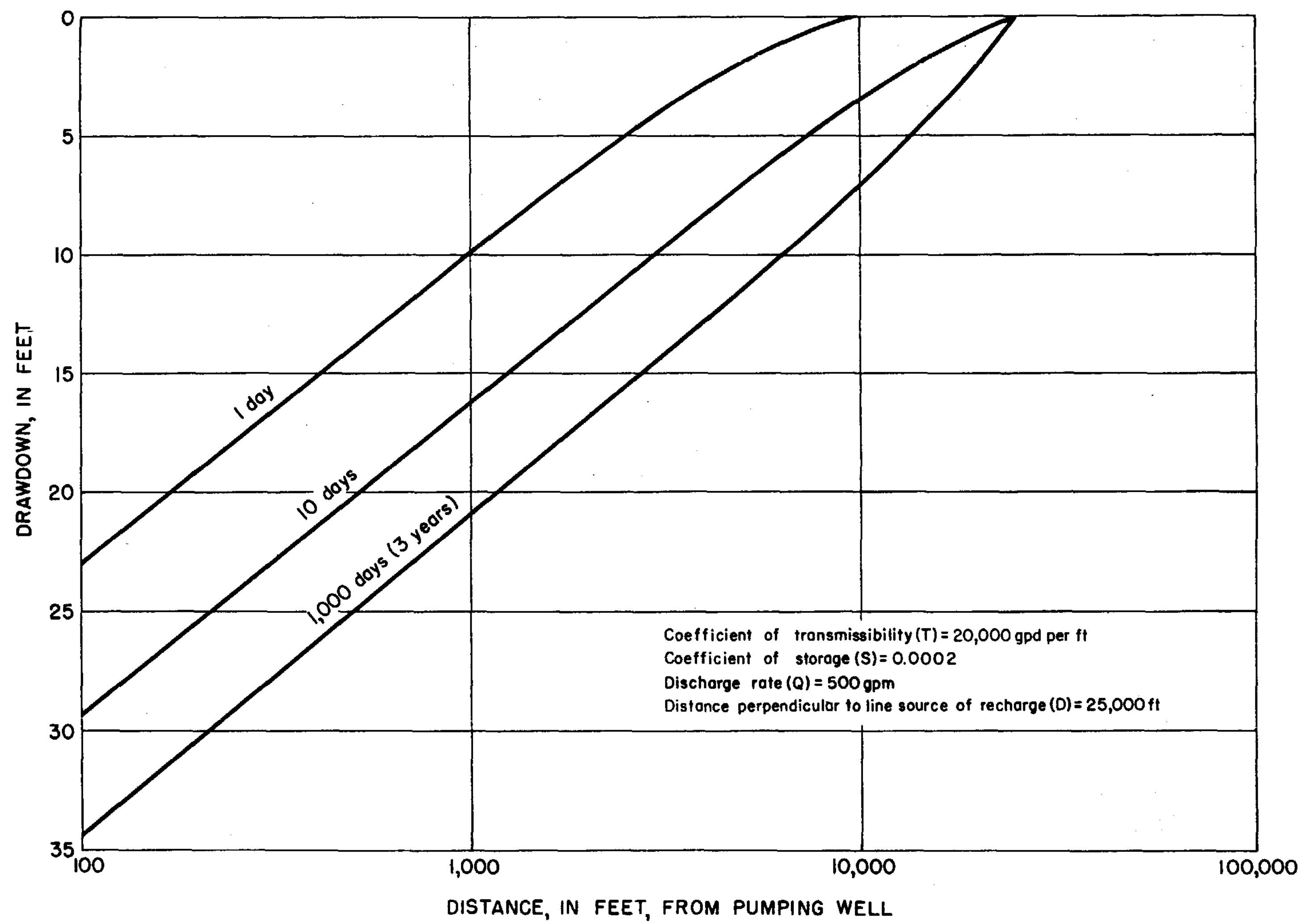

Figure 13

Relation of Distance to Time and Drawdown as a Result of Pumping From the Sparta Sand

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

Long-term records of water-level fluctuations in Houston County are not available. However, water levels have been measured monthly in 50 wells in the county since 1963; in 5 of these wells, water levels had been measured also in 1961. The records show that, in general, the water levels in most of the wells in the outcrop areas (recharge areas) of the aquifers in Houston County were lower in May 1964 than in May 1963. The declines ranged from 0.1 foot to as much as 6.3 feet and averaged about 1.2 feet. The declines probably reflect the deficiency of rainfall in 1963 when the precipitation was only about 28 inches, or 16 inches below normal. During this same period, the water levels in the artesian part of the aquifer fluctuated within rather wide limits, ranging from a decline of as much as 9.9 feet in a well tapping the Carrizo Sand to a rise of as much as 6.2 feet in a well in the Yegua Formation. These fluctuations merely represent a decrease or increase in pressure in the system; the aquifers, for all practical purposes, are still as full of water as they were before pumping began.

The water levels in wells that supply the city of Crockett are reported to have declined about 18 feet during the period 1930-34 and they rose about 9 feet during the period 1961-64. Elsewhere in the county, water-level records are insufficient to determine definite trends, but it is likely that the changes in aquifer storage, for all practical purposes, are negligible.

Development of Ground Water

The use of ground water in Houston County in 1963 amounted to about 3,300 acre-feet, or 2.95 mgd (million gallons per day). Of this amount, nearly 1.2 mgd, or about 40 percent, was for municipal supply, and 0.25 mgd, or about 8 percent, was for irrigation. The rest of the water was used for domestic and stock supply (about 1 mgd) and for miscellaneous purposes (about 0.5 mgd) which includes water from uncontrolled flowing wells. The quantity of water pumped from the different aquifers was not determined because of the small quantities involved; doubtless, a large part of the total pumpage in 1963 was from the Sparta Sand; and then in order, from the Queen City Sand and the Carrizo Sand. The total pumpage in 1963 is roughly equivalent to slightly more than a hundredth of an inch of precipitation over the entire county.

The city of Crockett was the principal user of ground water, pumping about 670,000 gpd from three wells that tap the Sparta Sand. The depths of the wells range from 540 to 576 feet, and their yields reportedly range from 400 to 520 gpm.

Eastham Prison Farm, the second largest user of ground water for public supply, pumped about 328,000 gpd from 3 wells. The wells range in depth from 200 feet (Yegua Formation) to 1,635 feet (Sparta Sand) and yield from 42 to 1,200 gpm.

The city of Grapeland pumped 110,000 gpd in 1963 from two wells that tap the Carrizo Sand. The wells, 783 and 802 feet deep, yielded 150 and 750 gpm. Kennard pumped about 40,000 gpd from one well, 810 feet deep, that taps the Sparta; Lovelady pumped a similar amount from two wells, 150 and 350 feet deep, in the Yegua Formation.

Irrigation by ground water is practiced only on a small scale in Houston County. In 1963, an estimated 275 acre-feet of water was used to irrigate 200 acres, most of which was in the flood plain of the Trinity River.

Industrial use of ground water in 1963 was practically negligible. For several years prior to 1962 an average of 175,000 gpd was pumped, principally for gasoline-plant operation in the vicinity of Grapeland. The function of the gasoline plant was to process natural gas and extract from it the primary distillates, butane and propane. The water was used principally for cooling; however, plant operations were discontinued in 1962, and since then the industrial use of water in the county has been limited to oil-field operations, principally oil-well drilling.

Significant increases in demand on the ground-water supplies in Houston County probably will take place for irrigation. Additional acreage presently devoted to timber probably will be diverted to growing feed crops for the expanding cattle industry. Although the rainfall generally is adequate in both time and amount, the readily available ground-water supplies preclude the harsh effects of the infrequent droughts. Also, the ground-water supplies make possible the growing of crops that require large quantities of water, such as alfalfa.

Historic records of ground-water use in Houston County are scarce; however, Figure 14 shows the breakdown of the pumpage of ground water for municipal, industrial, and irrigation purposes since 1955. Pumpage for these purposes has been fairly uniform, ranging from a low of 1.28 mgd in 1962 to a maximum of 1.66 mgd in 1959.

Construction of Wells

Most of the water wells in Houston County are large-diameter (3 to 4 feet) dug wells that supply a large part of the water for domestic needs. The wells are shallow, mostly less than 50 feet deep; they yield only small quantities of water because they generally are dug to only a few feet below the water table.

In recent years, many of the wells used to supply the domestic and stock needs have been drilled and cased with 4-inch casing that extended from the surface to the top of the aquifer; the casing was cemented to the wall of the well to prevent possible contamination from the surface and interformational leakage. Blank pipe and screen, commonly $2\frac{1}{2}$ inches in diameter and 10 to 20 feet in length, were run with a short liner and lowered to the bottom of the aquifer--the screen was placed opposite the water sands. The space between the 4-inch casing and the $2\frac{1}{2}$-inch liner was sealed with lead. The wells were developed by jetting with air or by pumping.

A few abandoned oil test wells have been plugged back to the base of an aquifer and completed as water wells by gun-perforating the casing opposite the water-bearing sand. Generally, these wells pump large quantities of sand, resulting in the wear of pumps and casing, and perhaps eventually the loss of the well by collapse of the casing. Some wells that have natural flows yield very little sand, although they may eventually sand up.

All the large-capacity wells that are used for municipal and industrial supplies are drilled and cased with 6-inch or larger casing to the top of the aquifer. The casing is cemented from the land surface to the top of the aquifer,

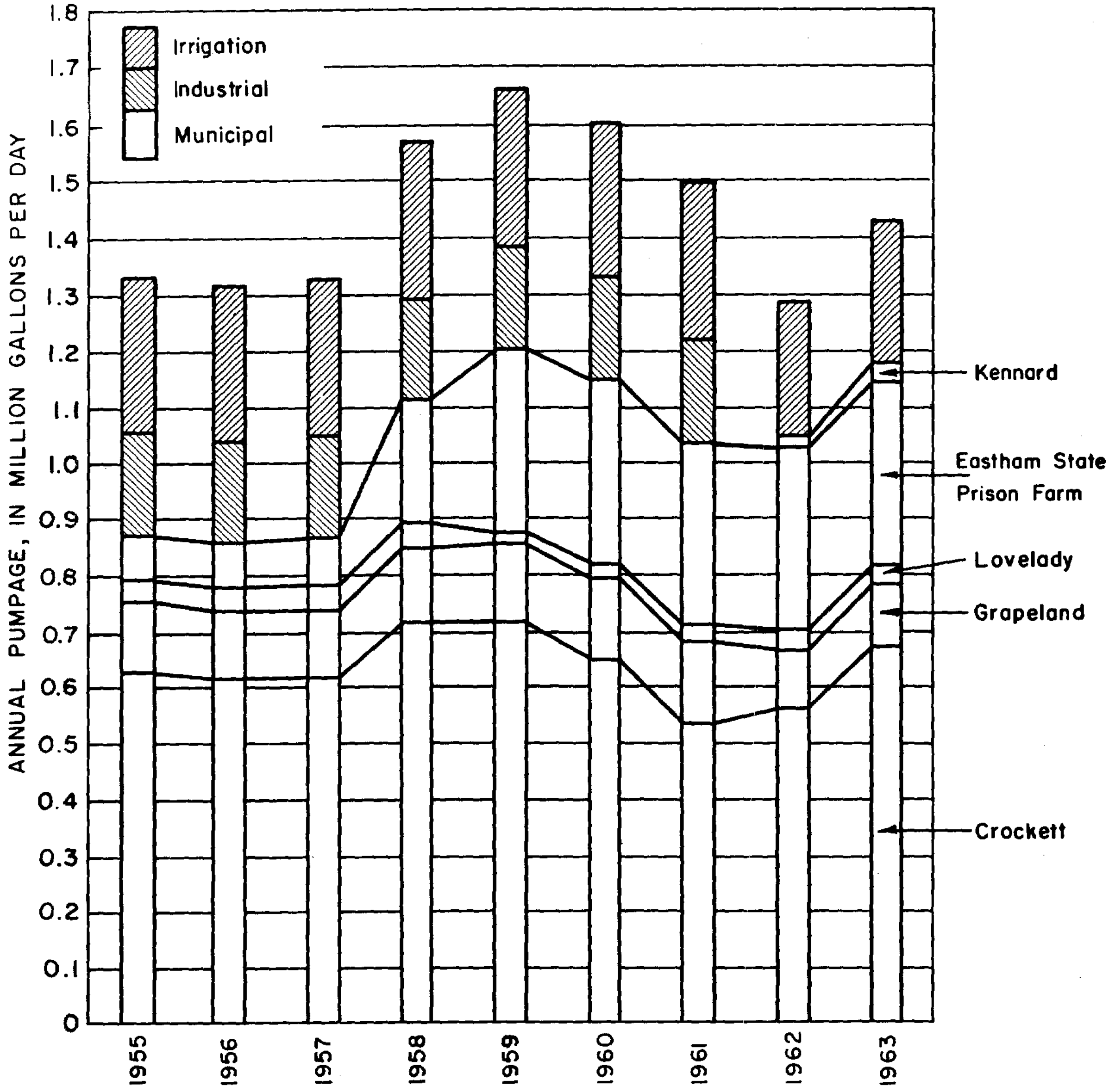

Figure 14

Pumpage of Ground Water in Houston County for Municipal, Industrial, and Irrigation Purposes, 1955-63

U S Geological Survey in cooperation with the Texas Water Development Board and the well is underreamed to the bottom of the aquifer to a larger diameter than the surface casing. Screen and liner are then placed in the well; the screen is placed opposite the water-bearing sands. The space between the screen and liner and the wall of the well is packed with gravel. The well then is developed by either jetting with air, pumping, or swabbing.

CHEMICAL QUALITY OF GROUND WATER

The suitability of a water supply is determined largely by the chemical quality and contemplated use of the water. In general, water of good chemical quality suitable for most uses can be obtained from wells in and near the outcrop areas of nearly all the aquifers underlying Houston County. As the water moves through the aquifers, however, it comes into contact with and dissolves soluble material in the rocks; consequently, the aquifers lying at considerable depth below the surface and containing water derived from distant sources generally yield water that is more highly mineralized than do aquifers that lie at shallow depths or that obtain water from nearby sources. During the investigation in Houston County, samples of water were collected from 62 wells in the county and analyzed by the U.S. Geological Survey, except where otherwise noted; the results of the analyses are given in Table 3. The chloride and dissolved-solids content of the water from the various aquifers is shown on Figure 15.

Most of the water pumped in Houston County is used for municipal and domestic purposes. In general, the water contains chemical constituents in concentrations well below the maximum limits recommended by the U.S. Public Health Service for water used on interstate carriers. These recommended limits have gained wide acceptance as standards against which to measure water quality. According to the standards, chemical constituents in a public water supply should not exceed the concentrations listed in the following table, except where other more suitable supplies are not available (U.S. Public Health Service, 1962, p. 7-8):

Substance	Concentration (ppm)
Chloride (Cl)	250
Fluoride (F)	1.0 *
Iron (Fe)	.3
Manganese (Mn)	.05
Nitrate (NO_3)	45
Sulfate (SO_4)	250
Total dissolved solids	500

* The appropriate upper limit based on the annual average of maximum daily air temperature (1960-64) of 77.4°F at Crockett. The U.S. Public Health Service states also that fluoride in average concentrations greater than twice the optimum value, or 1.6 ppm, may constitute grounds for rejection of the supply. Fluoride in the proper concentration in drinking water reduces the incidence of tooth decay when the water is consumed during the period of enamel calcification. However, excessive concentrations may cause teeth to become mottled.

Iron and sulfate concentration and hardness are usually the most troublesome chemical characteristics of the water in Houston County. An excessive amount (more than 0.3 ppm) of iron gives the water an unpleasant taste, causes a yellow or reddish stain on plumbing fixtures and cooking utensils, and stains clothes. Moreover, many industrial processes cannot tolerate excessive iron in water.

Sulfate in water containing calcium forms a hard scale in steam boilers. In large amounts, sulfate in combination with other ions imparts a bitter taste to water and may have a laxative effect.

Hardness of water is caused principally by calcium and magnesium. Excessive hardness consumes soap before a lather will form and induces the formation of scale in hot water heaters and water pipes. A commonly accepted classification of water hardness is given in the following table:

Hardness range (ppm)	Classification
60 or less	Soft
61 to 120	Moderately hard
121 to 180	Hard
More than 180	Very hard

For many purposes, the dissolved-solids content is a major limitation on the use of the water. A rough measure of the dissolved-solids concentration is provided by the specific conductance, which expresses the ease with which an electrical current can be passed through the water. The conductance depends directly on the amount and nature of the dissolved solids; however, no information on the individual chemical constituents can be obtained from the specific-conductance measurement. As used in this report, ground water is classed according to the dissolved-solids content and follows the classification proposed by Winslow and Kister (1956, p. 5):

Description	Dissolved-solids content (ppm)
Fresh	Less than 1,000
Slightly saline	1,000 to 3,000
Moderately saline	3,000 to 10,000
Very saline	10,000 to 35,000
Brine	More than 35,000

Although only a small part of the total water used in Houston County in 1963 was for irrigation, the possibility of a substantial expansion of irrigation requires consideration of the suitability of the ground-water supplies in the county for such use. The following brief discussion offers criteria for an overall evaluation of the suitability of the water for irrigation rather than establishes rigid limits on the concentrations of certain chemical constituents in water to be used for irrigation. Several factors other than chemical quality are involved in determining the suitability of water for irrigation. The type of soil, adequacy of drainage, crops grown, climatic conditions, and quantity of water used all have important bearing on the continual productivity of irrigated land.

A classification commonly used for judging the quality of a water for irrigation was proposed in 1954 by the U.S. Salinity Laboratory Staff (1954, p. 69-82). In brief, the classification is based on the salinity hazard as measured by the electrical conductivity of the water and the sodium hazard as measured by the SAR (sodium-adsorption ratio). However, Wilcox (1955, p. 15) stated that this system of classification of irrigation water "...is not directly applicable to supplemental waters used in areas of relatively high rainfall." The average annual rainfall in Houston County is about 44 inches and most irrigation would be on a supplemental basis. Wilcox (p. 16) also reported that generally water may be used safely for supplemental irrigation if its conductivity is less than 2,250 micromhos per centimeter at 25°C and its SAR is less than 14.

The RSC (residual sodium carbonate) also is used to assess the quality of water for irrigation. According to Wilcox (p. 11) water containing more than 2.5 epm (equivalents per million) RSC is not suitable for irrigation; 1.25 to 2.5 epm is marginal; and less than 1.25 epm probably is safe. However, the use of soil amendments and the degree of leaching probably will modify the permissible limit to some extent.

Although boron is essential to normal growth of plants, the amount required is very small; an excess of boron is very injurious to some plants. Wilcox (1955, p. 11) has indicated that a boron concentration of as much as 1.0 ppm is permissible for irrigating sensitive crops; a concentration of as much as 3.0 ppm is permissible for tolerant crops. Boron was determined in only three samples, one from the Spiller Sand Member (of Stenzel, 1940) of the Cook Mountain Formation and two from the Carrizo Sand. The concentrations were 1.7 ppm for the sample from the Spiller and 0.35 and 0.24 for the samples from the Carrizo. These few samples should not be considered representative on a large area basis; the boron content should be determined if the use of ground water for irrigation is contemplated.

The suitability of water for industrial use ranges within wide limits, and almost every industrial use has different standards. For some uses, such as cooling, the chemical quality requirements are not particularly critical as compared to those for the water used in the manufacture of high-grade paper or for use in modern high-pressure steam boilers. Water temperature and the seasonal fluctuation of the temperature are important considerations in water used for cooling by industry. Ground water generally is superior to surface water for this purpose because of its relatively constant temperature. Available data indicate that the temperature of water from shallow wells ranges from 67° to 73°F and that the temperature increases with depth about 1.3°F for each 100 feet.

In Houston County, water is obtained from the Wilcox Group, Carrizo Sand, Queen City Sand, Sparta Sand, Spiller Sand Member (of Stenzel, 1940) of the Cook Mountain Formation, the Yegua Formation, and the alluvium. The chemical quality of the water from wells tapping these aquifers and the areal extent of the sands containing fresh to slightly saline water are discussed briefly in the following pages.

The base of slightly saline water in Houston County was determined roughly from the true resistivity of the water-bearing sands shown on electric logs. The determinations were based on the method described by the Schlumberger Well Surveying Corporation (1962) and on chemical analyses of water from wells tapping the various aquifers.

Wilcox Group

Data regarding the chemical quality of the water from the Wilcox Group in Houston County are meager--only one well (PA-38-35-203) obtains water from the Wilcox. The water is used for irrigation and livestock. It is moderately hard, being of the sodium bicarbonate type (Table 3); the sodium content amounts to 94 percent of all the cations in solution. The water is slightly saline having a dissolved-solids content of 1,240 ppm. The suitability of this water for irrigation is questionable because of its high sodium and salinity hazard (Figure 16). However, the moderately high annual rainfall in the county results in a considerable amount of leaching which doubtlessly lessens the harmful effects of the water. Soil amendments such as gypsum or lime also may tend to lessen the undesirable effects of excess sodium in the water by increasing the available calcium.

Although samples of water from the Wilcox in other parts of the county are not available, electric logs show that the water increases in mineralization with depth and distance from the outcrop. The geologic section (Plate 2) shows that nearly all the Wilcox in the northern one-fourth of the county contains fresh to slightly saline water. The fresh water-salt water interface slopes gently downward throughout most of the area between Grapeland and Crockett, but at a rate considerably less than the dip of the aquifer. Consequently, the interface occurs progressively higher in the aquifer in the direction of the dip. Southward from Crockett, the interface slopes steeply upward until it coincides with the top of the Wilcox in the vicinity of Lovelady. The altitude of the base of fresh to slightly saline water in the Wilcox is shown in Figure 17. The contours reveal a southwestward-trending trough in which fresh to slightly saline water extends to a depth of slightly more than 3,700 feet below sea level, or about 3,870 feet below land surface.

Carrizo Sand

The Carrizo Sand yields water of good chemical quality to wells north and northwest of a line approximating State Highway 21; south and southeast of this line no wells penetrate the Carrizo, inasmuch as water of good quality is available in overlying aquifers.

The water from 14 wells (Table 3) tapping the Carrizo conforms in most respects to the drinking-water standards of the Public Health Service. In general, the water is soft, being a sodium bicarbonate type, and relatively low in dissolved-solids content. However, the chemical analyses show that the iron content might cause concern. Of the 14 wells sampled, 8 had iron in excess of the recommended maximum of 0.3 ppm.

The relatively highly mineralized water from well PA-38-30-901 is not representative of the chemical quality of the water in the Carrizo. The well is believed to obtain some water from the overlying Reklaw Formation, which, in

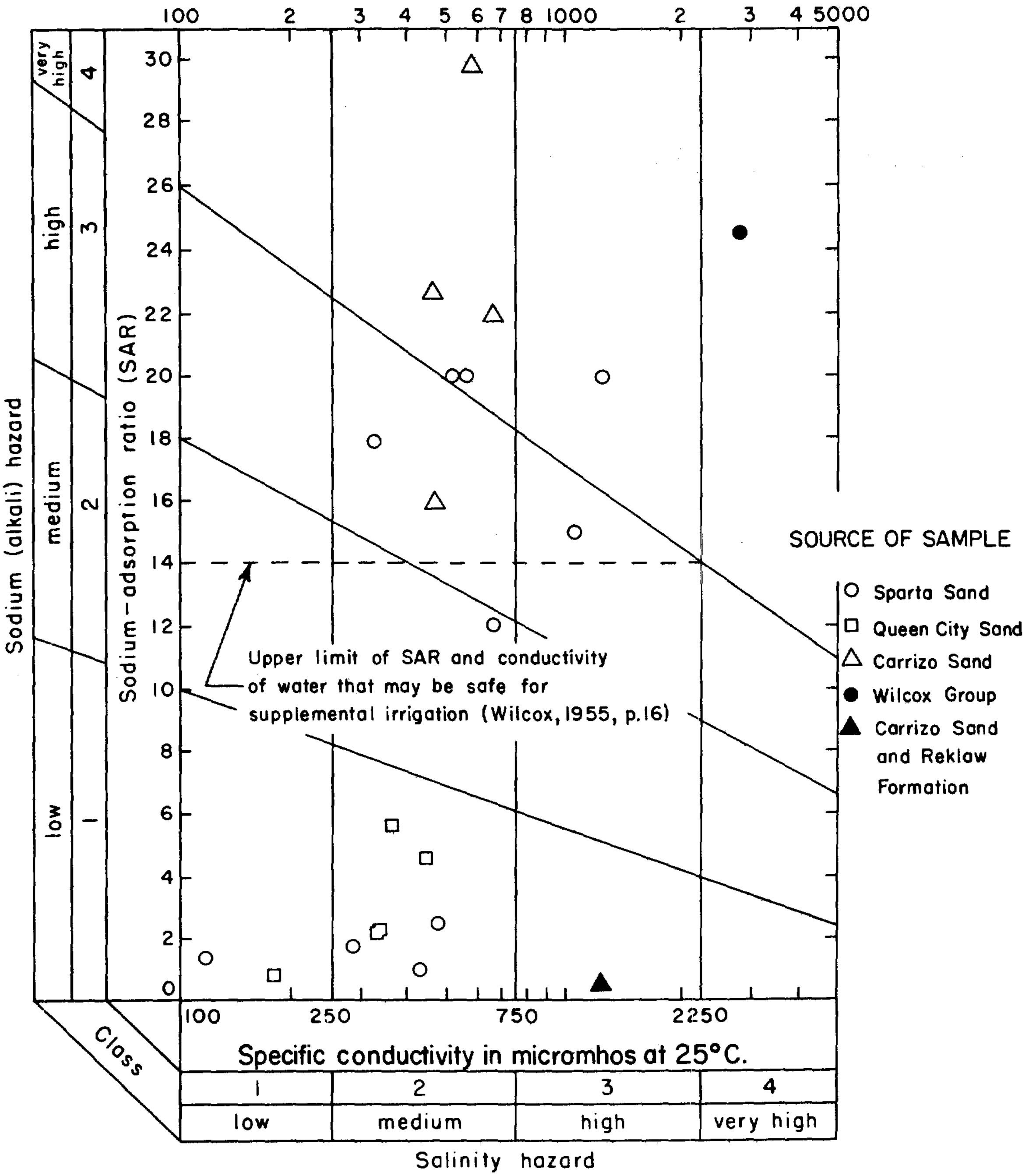

Figure 16

Diagram for the Classification of Irrigation Waters

(After United States Salinity Laboratory Staff, 1954, p. 80)

U S Geological Survey in cooperation with the Texas Water Development Board some places in the county, is in hydraulic connection with the Carrizo. Water from this well was very hard and considerably higher in dissolved-solids and sulfate content than that from the Carrizo.

The samples from the Carrizo Sand showed a high to very high sodium hazard and a medium to high salinity hazard (Figure 16); hence, the use of this water as a primary source for irrigation may be hazardous. Nevertheless, one well produces water from the Carrizo to irrigate about 100 acres without apparent soil damage. Doubtless, the leaching from the high annual rainfall as well as the use of soil amendments, such as lime, renders the water suitable as a supplementary source for irrigation.

Available data, which include electric logs of oil tests, show that the Carrizo contains fresh to slightly saline water throughout its subsurface extent in Houston County, except in a small area southwest of Lovelady (Figure 6).

Queen City Sand

Water from 10 wells in the Queen City Sand generally meets the standards of the U.S. Public Health Service for drinking water. The water is of the sodium bicarbonate type, being soft to moderately hard and low in dissolved-solids content. In general, the wells yielding soft water are more than 400 feet deep; this fact suggests natural softening in which base-exchange reactions have substituted sodium for calcium and magnesium as the water moves through the formation. The iron content ranges from 0.06 to 2.4 ppm; it was less than 0.3 ppm in 7 of the 10 samples analyzed. The use of water from the Queen City Sand as a principal irrigation supply depends upon the depth of the well. The water from wells less than 400 feet deep apparently is satisfactory for irrigation; however, the water from deeper wells may be doubtful because of the very high sodium hazard. The SAR of water from five wells (578 to 1,058 feet deep) in the Queen City Sand exceeded 30; consequently, the data are not shown in Figure 16. Probably the water, at least from that part of the Queen City north and northwest of State Highway 21, is suitable for supplemental irrigation.

The Queen City Sand contains fresh to slightly saline water throughout its subsurface extent in Houston County except in a lobe-shaped area that extends from the Trinity County line near Lovelady northwestward to a point about 5 miles south of Crockett (Figure 7). The geologic section (Plate 2) shows that the water is fresh to slightly saline in the Queen City in well PA-38-45-507, but becomes moderately to very saline in well PA-38-53-501.

Sparta Sand

The Sparta Sand yields water that generally conforms to the drinking-water standards of the U.S. Public Health Service. The water is low in dissolved-solids content, generally less than 500 ppm, and is of the sodium bicarbonate type. Calcium sulfate type water, however, was obtained from well PA-38-38-804 which was screened opposite the Sparta Sand, though it obtained water also from the overlying Cook Mountain Formation. Most of the wells tapping the Sparta yield water that is soft or moderately hard (Table 3). Of the 24 analyses, 17 were of soft water, 3 were of moderately hard water, 1 was of hard water, and 2 were of very hard water.

The relatively high iron content probably is the major quality problem in the use of water from the Sparta Sand. The iron content ranged from 0 to 30 ppm, exceeding 0.3 ppm in 16 of the 24 samples analyzed. The chemical analyses indicate that the iron content of the water is related to the depths of the wells. Most of the water from wells less than 600 feet deep contains iron in excess of 0.3 ppm. Several owners reportedly have abandoned wells in the Sparta because of the high iron content.

Water from the Sparta Sand is not used for irrigation at present (1964). When judged according to the classification diagram (Figure 16), the water in and near the outcrop generally is suitable for continuous irrigation; the water in the deeper part of the aquifer may be unsuitable for continuous irrigation because of the high SAR. This water probably could be used, however, on a supplementary basis.

The Sparta Sand contains fresh to slightly saline water except in a small area near Lovelady (Figure 8). The geologic section (Plate 2) shows that the interface between fresh to slightly saline water and moderately saline water slopes gently upward from the base of the Sparta in well PA-38-53-501 until at well PA-38-61-202 it coincides with the top of the Sparta.

Spiller Sand Member (of Stenzel, 1940) of Cook Mountain Formation

Water from the Spiller Sand Member (of Stenzel, 1940) of the Cook Mountain Formation ranges widely in chemical quality. The chemical analyses of water from 5 of 7 wells (Table 3) tapping the Spiller indicate that the water is suitable for domestic use if water of better chemical quality is not readily available. The water from two wells (PA-38-45-601, and YH-38-48-302 in Trinity County) have sulfate contents in excess of the 250 ppm recommended by the U.S. Public Health Service. The dissolved-solids content exceeded 500 ppm in six of the seven samples and exceeded 1,200 in two samples.

Although the water from the Spiller Sand Member is suitable for irrigation, the small yields that can be expected from this aquifer virtually preclude it as a source of water for irrigation.

Yegua Formation

The Yegua Formation yields water that generally is suitable for domestic and stock purposes. The water is mostly of the sodium bicarbonate type, being soft to moderately hard except in one sample in which the water was hard. The dissolved-solids content ranged from 103 ppm in well PA-38-52-901, 240 feet deep, to 1,320 ppm in well PA-38-60-501, 287 feet deep. The sulfate content in two wells exceeded the 250 ppm maximum recommended by the U.S. Public Health Service. The high sulfate content probably can be attributed to solution of the gypsum that is characteristic of the shale and clay in the Yegua.

Water from the Yegua probably is suitable for irrigation at least on a supplementary basis. The water ranged from low to very high in sodium hazard and low to high in salinity hazard.

The Yegua contains fresh to slightly saline water throughout its extent in Houston County.

Alluvium

Data are insufficient for an appraisal of the chemical quality of the water from the alluvial deposits in Houston County. The water from one well, PA-60-03-303, contained 463 ppm dissolved solids and was very hard (Table 3). Although the hardness of the water may present a problem to the user as a domestic supply, the water would be suitable for irrigation and stock.

CONTAMINATION OF THE GROUND WATER

Contamination of the water in the aquifers underlying Houston County may occur from the infiltration of oil-field brine from unlined disposal pits, by the movement of brines from the underlying salt-water-bearing formations through improperly cased or plugged oil wells, from defective wells, or from the lateral movement or "coning upward" of salt water.

According to the records of the Texas Water Commission and the Texas Water Pollution Control Board (1963, p. 133-137), 690,000 barrels (29 million gallons, or about 89 acre-feet) of brine reportedly was produced in Houston County in 1961. Of this amount, 255,000 barrels (10.7 million gallons, or 33 acre-feet) or about 37 percent was disposed of through unlined surface pits, most of which are in the outcrop areas of the Queen City Sand and Sparta Sand. Several pits were observed in the sandy outcrop areas of the Yegua Formation in the Fort Trinidad field in the southwestern part of the county.

Brine placed in the unlined surface pits either evaporates, overflows, or seeps into the ground, eventually percolating downward to the water table. The average yearly net evaporation rate from a free-water surface in Houston County is only 5 inches; hence, it cannot be depended upon to dispose of the large quantities of brine continuously being produced. Furthermore, the pits in the county range widely in size, but few of the pits observed had sufficient surface area to allow for appreciable evaporation. Actually, the evaporation rate of the brine probably is considerably less than that of water from a free-water surface because of the presence of a film of oil on the brine in most of the pits. Other factors, such as the dissolved-solids content, may affect the evaporation rate also.

No contamination through the use of unlined pits has been reported. However, owing to the low velocity of movement of ground water, the brine that is placed in a pit may not affect the chemical quality of the water in nearby wells for many years. In a few isolated areas, levees around the pits have been breached, consequently some soil damage has occurred. A part of the released brine entered nearby surface watercourses.

The Oil and Gas Division of the Railroad Commission of Texas is responsible for the proper construction of oil and gas wells, and the Texas Water Development Board is furnishing ground-water data to oil operators and to the Railroad Commission in order that all fresh water may be protected. No instances of contamination from inadequate casing or plugging have been observed or reported in Houston County.

Improperly constructed water wells reportedly have resulted in the contamination of the ground water in localized areas. In some parts of the county it is necessary to drill through formations that contain water of poor quality in order to reach fresh-water aquifers. If the wells are not properly constructed, which includes cementing of the casing above the aquifer, the more mineralized water may move along the casing from one formation to the other. Well PA-38-38-804, which tapped the Sparta Sand, reportedly yielded water of good quality until January 1957 when highly mineralized water invaded the well, apparently moving downward from the Cook Mountain Formation. The well was abandoned and replaced by well PA-38-38-803 in 1958.

The possibility of contamination of the fresh-water supplies in Houston County by the lateral movement of salt water seems remote because of the small amount of development. However, large-scale development of the aquifers or the drilling of large-capacity water wells near the interface between the fresh and salt water may result in the updip movement of the salt water or the "coning upward" of salt water where it directly underlies the fresh to slightly saline water. Electric logs of oil tests show that locally the interface between fresh and salt water is in a thick sand section. Thus, in these wells at least, the water of good quality may not be separated from the salt water by even a thin layer of clay. Consequently, when such a well is pumped, the salt water may move relatively freely upward into the fresh water.

AVAILABILITY OF GROUND WATER

The ground-water resources of Houston County are, for all practical purposes, untapped. In fact, the quantity of ground water pumped in 1963 from all aquifers (3,300 acre-feet) was much less than the quantity of water that was rejected to streams by only one of the aquifers, the Sparta Sand.

The quantity of ground water potentially available from all the aquifers in the county is difficult to determine accurately; it depends upon the ability of the aquifers to transmit water, the amount of water in storage, and the rate of recharge to the aquifers. Estimates of availability are predicated on several assumptions, some of which are not precisely applicable to Houston County. Moreover, the figures should be considered as correct only in their order of magnitude, because the effect of future large-scale development of ground water from these aquifers in adjoining areas was not considered.

The isopachous maps (Figures 18-21), which show the net thickness of sand and gravel containing fresh to slightly saline water, are useful in computing the amount of ground water in transient storage. On the basis of these maps, the volume of fresh to slightly saline water in transient storage in all the aquifers underlying Houston County is computed to be 122 million acre-feet. However, only a small fraction of this water is available for development by known methods at present (1964) costs.

For the purposes of this report, the amount of ground water that can be obtained continuously was based on (1) pumping lifts of not more than 400 feet along lines of discharge across the county, and (2) recharge in the outcrop area of the aquifers sufficient to supply the water that can be transmitted to the lines of discharge.

The saturated thickness of sand containing fresh to slightly saline water in the Carrizo Sand ranges from zero feet in the Kittrell oil field near Lovelady to a maximum of about 240 feet in a well about 1 mile north of Lovelady (Figure 18). The amount of water potentially available from the Carrizo Sand is based on an assumed northeast-trending line of discharge more or less parallel to the outcrop of the formation. The line of discharge was 36 miles long and was about 10 miles south of the Anderson-Houston county line. The volume of water released from artesian storage as the water level was lowered to 400 feet along the line of discharge would amount to only 31,000 acre-feet. After the water level had been lowered to 400 feet below the land surface and a hydraulic gradient of about 20 feet per mile had been established, the aquifer would transmit annually on the order of 19 mgd, or about 21,000 acre-feet per year, from the outcrop area to the assumed line of discharge. The amount of recharge on the outcrop necessary to replace the water moving downdip (19 mgd) was not computed, principally because of the difficulty in determining the effective area of recharge of the Carrizo. However, because of the large amount of rainfall in the general outcrop area of the aquifer, recharge is probably more than adequate to supply the water that would be moving downdip.

The low coefficient of transmissibility of the Queen City Sand probably will retard full development of the aquifer, principally because very large drawdowns are required to obtain large quantities of water. The isopachous map (Figure 19) shows that the saturated thickness of sand containing fresh to slightly saline water in the Queen City ranges from zero feet in a fairly large area near Lovelady and in a small area along the Neches River in the northern part of the county to about 200 feet in the northern and northwestern parts of the county. To determine the volume of water that is potentially available for development from the Queen City, it was assumed that the water level would be drawn down to the top of the aquifer where its depth is 400 feet below the land surface about 1 mile south of the contact between the Sparta Sand and the Cook Mountain Formation. If the wells were distributed so that the aquifer could be dewatered to where the top of the aquifer is 400 feet below the land surface, and if the specific yield of the dewatered sediments was 15 percent, about 5 million acre-feet of water would be available. After the water level had been lowered to the top of the aquifer, the aquifer would transmit on the order of 6.3 mgd (7,000 acre-feet per year), which is equivalent to slightly less than 2 inches of water effectively recharging approximately 50,000 acres of the outcrop area. This amounts to less than 5 percent of the average annual precipitation.

The approximate thickness of sand containing fresh to slightly saline water in the Sparta Sand ranges from zero feet at the contact of the Sparta with the underlying Weches Greensand to more than 250 feet in a trough that trends northeastward through Crockett (Figure 20). In and near Lovelady the saturated thickness is less than 50 feet and a short distance south and southeast it is zero. The volume of water estimated to be available for development from the Sparta is based on the same conditions postulated for the Queen City Sand. On this basis, 4.4 million acre-feet of water would be obtained by lowering the water level to the top of the aquifer where the top is 400 feet below the land surface, about 7 miles south of the contact between the Sparta Sand and the Cook Mountain Formation. This would actually dewater a segment of the aquifer. At the gradient established under these conditions (50 feet per mile), the aquifer would transmit about 50 mgd (56,000 acre-feet per year). The 50 mgd is equivalent to about 5.4 inches of water effectively recharging the outcrop of the Sparta Sand, or about 12 percent of the average annual rainfall.

It is somewhat questionable whether the 50 mgd could be produced perennially--the recharge may be insufficient. However, on the basis of the present gradient of 8 feet per mile, about 8 mgd, the effective recharge, moves through the aquifer. Also, at least 13 mgd of potential recharge, which might be salvaged, is rejected to streams from the outcrop area of the Sparta Sand and an unknown, but possibly large, quantity is lost by transpiration. Thus, at least

21 mgd, and perhaps significantly more, is perennially available for development without depleting the aquifer. This perennial supply is roughly equivalent to 2.3 inches of recharge on the outcrop.

Little hydraulic information is available regarding the Wilcox Group in Houston County, principally because large supplies of ground water of good chemical quality are available at shallower depths and the Wilcox is practically untapped. Nevertheless, the volume of fresh to slightly saline water potentially available from the Wilcox probably is large, on the basis of the net thickness of the saturated sand in the aquifer (Figure 21). The approximate thickness of sand containing fresh to slightly saline water ranges from 0 in places along the Walker and Trinity county line to more than 1,400 feet a few miles east of Grapeland.

It is recognized that estimates of the quantity of water potentially available from the aquifers in Houston County are based on limited basic data. Nevertheless, the data indicate that the untapped ground-water supplies from the Sparta Sand, Queen City Sand, and Carrizo Sand are capable of supporting a ground-water development of at least 46 mgd indefinitely with pumping levels not exceeding 400 feet along lines of discharge and assuming that recharge in the outcrop areas of the aquifers is sufficient. This quantity is approximately 25 times the present rate of development.

A factor that should not be overlooked is the extremely large quantity of water that would be available from storage while the water levels were being lowered to 400 feet. This quantity, 9 million acre-feet, is roughly equivalent to 1.4 times the total conservation capacity of all the present (1964) reservoirs having 5,000 or more acre-feet of storage in the Trinity and Neches River Basins.

Actually the estimates of availability are conservative because the assumed withdrawals are along lines of discharge rather than being distributed throughout the county; pumping levels are assumed not to exceed 400 feet, whereas considerably greater pumping levels may be economical; the water obtained from storage is based on no recharge; and the water available from the Wilcox Group and other aquifers was not included. On the other hand, the effect of future large-scale development from these aquifers in adjoining counties was not considered, which would influence the total quantity of water that can be obtained on a sustained basis.

The proper development of these aquifers depends upon the availability of basic data. Such data include records of pumpage, water levels, and chemical analyses of water samples. More detailed and accurate data will permit the calculation of more reliable estimates than those presented above.

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Table 2.--Records of wells in Houston and adjacent counties

All wells are drilled unless otherwise noted under "Remarks."
Water-bearing unit : Qal, Alluvium; Tc, Carrizo Sand; Tcs, Spiller Sand Member (of Stenzel, 1940) of the Cook Mountain Formation; Tqc, Queen City Sand; Ts, Sparta Sand; Tw, Weches Greensand; Twi, Wilcox Group; Ty, Yegua Formation.
Water level : Reported water levels given in feet; measured water levels given in feet and tenths.
Method of lift and type of power: A, airlift; B, bucket and rope; C, cylinder; Cf, centrifugal; E, electric; G, gasoline, butane, or diesel engine; H, hand; J, jet; N, none; Ng, natural gas; T, turbine; W, windmill. Number indicates horsepower.
Use of water : D, domestic; Ind, industrial; Irr, irrigation; N, none; P, public supply; S, stock.

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water-bearing unit	Altitude of land surface (ft)	Water level		Method of lift	Use of water	Remarks
								Below land-surface datum (ft)	Date of measurement			
							Houston County					
PA-37-33-701	Southern Pine Lumber Co. well 1	Coastal Refining Co.	1942	4,283	--	--	291	--	--	--	--	Oil test.
38-27-701	Moore & Wardlaw	--	--	420	16	Tc	200	21.2	May 13, 1963	Flows	Irr	Oil test; converted to water well. Cased to 30 ft. Estimated flow 400 gpm in 1963. Temp. 74°F.
* 801	R. E. Smith	J. S. Murchison	1954	452	4	Tc	290	46.1	do	J,E, 3	D,S	Cased to 452 ft. Temp. 73°F.
802	do	do	1956	160	4	Tqc	275	50	1956	C,W	S	Cased to 150 ft. Sand from 0 to bottom.
* 901	do	do	1956	160	4	Tqc	275	50	1956	J,E, 1	S	Do.
902	C. W. Mathews	do	1954	240	4	Tqc	340	--	--	J,E, 1	D,S	Reported obstruction at 80 ft.
903	R. E. Smith	do	1956	515	4	Tc	340	--	--	T,E	D,S	
904	B. Jones, et al., well 1	New Seven Falls Co.	1958	6,041	--	--	310	--	--	--	--	Oil test. 1/
28-401	H. C. McGrady well 1	C. A. Douglas	1956	6,113	--	--	--	--	--	--	--	Oil test. 2/
402	V. Brown well 1	L. A. Grelling	1954	6,112	--	--	360	--	--	--	--	Oil test. 1/
501	S. B. Hendrix Heirs, well 1	L. H. Moon	1963	6,205	--	--	424	--	--	--	--	Oil test. 2/
601	F. A. (Nora) Shelton well 1	do	1963	5,921	--	--	414	--	--	--	--	Oil test. 1/
701	M. W. Petty	J. S. Murchison	1952	547	4	Tc	378	125 131.1	1954 May 13, 1963	T,E	D,S	Pump set at 170 ft. Reported deepened from 271 ft to 547 ft because of sand.
702	J. H. Eden well 1	Jack Frost, et al.	1958	6,134	--	--	327	--	--	--	--	Oil test. 1/
703	B. S. Mathews well 1	Trice Production Co.	1956	6,123	--	--	281	--	--	--	--	Do.
* 801	E. E. Huff	J. S. Murchison	1947	90	4	Ts	495	--	--	J,E	D,S	Pump set at 55 ft. Temp. 70°F.
802	-- Price well 1	Wynne Drilling Co.	1936	6,112	--	--	480	--	--	--	--	Oil test. 1/

See footnotes at end of table.

Table 2.--Records of wells in Houston and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
PA-38-28-901	Herrod & Finch	Lone Star Production Co.	1958	6,027	--	--	453	--	--	--	--	Oil test. [1]
903	Geier & Jackson Co.	Layne-Texas Co.	1941	890	8, 4	Tc	470	270	1963	T,G, 25	D	Reported discharge 100 gpm. Pump set at 290 ft. Used as industrial well at recycling plant, but plant closed down; well now used only as domestic well.
29-402	Ben L. Keen well 1	Globe Drilling Co.	1959	5,998	--	--	490	--	--	--	--	Oil test. [2]
403	Sam Caskey well 1	Sam B. King	1957	6,069	--	--	508	--	--	--	--	Oil test. [1]
404	Kerry Guenther well 1	Investors Syndicate of the Southwest	--	6,000	--	--	516	--	--	--	--	Oil test. [2]
501	J. G. Garner well 1	Apache Drilling Co.	1955	5,972	--	--	436	--	--	--	--	Oil test. [1]
502	L. Mosley well 1	Oil Properties Inc.	1957	6,200	--	--	462	--	--	--	--	Oil test. [2]
601	Bush & Jensen	Layne-Texas Co.	1957	369	10	Tqc	513	209.9	July 12, 1961	T,G, 70	Irr	Reported discharge 300 to 400 gpm. Screened from 213 to 363 ft. Irrigates 60 acres of peanuts and 30-acre orchard. Sprinkler system used.
602	E. A. Peterson	do	1956	365	10, 8	Tqc	500	194.3	do	T,G	Irr	Estimated discharge 320 gpm.
603	O. C. Daniels	J. S. Murchison	1953	250	4	Tqc	430	140	1960	T,E, 1	D	Estimated discharge 15 gpm. Pumping level 190 ft. Reported reworked in 1960.
604	Clara M. Dickey	Taylor Drilling Co.	1956	212	4, 2	Tqc	419	125	Aug. 1956	J,E, 1	D	Reported 40 ft of water sand.
605	H. M. Lively	J. S. Murchison	1954	150	4	Tqc	410	--	--	J,E	N	
606	Roy Bishop well 1	Stevens & Bishop	1958	6,157	--	--	468	--	--	--	--	Oil test. [1]
801	E. C. Lively	Cook & Mayo	1938	5,896	--	--	383	--	--	--	--	Do.
901	J. S. Elliott well 1	T. D. Humphery & Sons, Ltd.	1957	6,031	--	--	377	--	--	--	--	Do.
30-401	G. J. Hays well 1	J. R. Phillips	1958	5,999	--	--	315	--	--	--	--	Do.
601	Southern Pine Lumber Co. well 1	Billy Birdwell	1956	5,754	--	--	300	--	--	--	--	Do .
701	-- Warrock well 1	Cook & Mayo	1938	5,890	--	--	378	--	--	--	--	Oil test. [2]
702	-- Lipscomb	J. S. Murchison	1963	235	4	Tqc	400	108.2	Apr. 5, 1963	T,E, 1	D	
801	N. W. Sheridan	do	1962	228	4	Tqc	381	99.0	do	T,E	D,S	

See footnotes at end of table.

Table 2.--Records of wells in Houston and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
PA-38-30-802	Katy Cutler well 1	H. L. Hawkins	1957	5,855	--	--	320	--	--	--	--	Oil test. 1/
901	Glover School District	R. L. Taylor	1937	600	4	Tc	315	44	1939	J,E, 3	P	Reported reworked and deepened from 482 ft to 600 ft, Feb. 6, 1938. Pump set at 220 ft. Slotted pipe from 500 ft to bottom.
902	W. H. Holcomb	A. D. Adams, et al.	1948	100	4	Tqc	316	69.7	Nov. 26, 1963	N	N	Slotted pipe from 0 to bottom.
903	do	do	1948	5,865	--	--	314	--	--	--	--	Oil test. 1/
31-401	Mission State Park	H. P. Cutler	1939	43	30	Tqc	300	28.6	July 24, 1961	J,E	D,P	Temp. 71°F.
402	Mrs. G. Boykin well 1	J. B. Daniels Oil Co.	1947	5,944	--	--	437	--	--	--	--	Oil test.
501	Loyd Lovell	John Frye	1962	496	4	Tc	400	--	--	T,E, 1	D,S	Temp. 72°F.
701	O. P. Meador	Ben Hearn	1953	6,563	--	--	400	--	--	--	--	Oil test. 1/
801	Houston County Timber Co. well 1	Magnolia Petroleum Co.	1946	7,407	--	--	352	--	--	--	--	Do.
802	do	B. G. Byars	1957	6,218	--	--	303	--	--	--	--	Do.
32-701	S. S. McGee well 1	Coats Drilling Co.	1954	6,663	--	--	225	--	--	--	--	Oil test. 1/ 2/
35-101	R. S. Dailey "C" well 1	Carter-Gragg Oil Co.	1964	5,836	--	--	207	--	--	--	--	Oil test.
201	H. W. L. Shepherd well 1	Humble Oil & Refining Co.	1954	5,927	--	--	275	--	--	--	--	Oil test. 1/ 2/
202	T. F. Dailey Heirs well 1	Leland Fink	1955	5,926	--	--	274	--	--	--	--	Do.
203	R. S. Dailey well 1	W. C. McGlothlin	1940	1,800	10	Twi	268	+	--	Flows	Irr,S	Reported left 1,800 ft of casing in hole; maybe open hole below 1,800 ft. Not plugged. Used to irrigate pasture and fill stock tank. Estimated flow 150 gpm.
204	R. E. Smith	Sid Katz	1954	360	4	Tc	273	35	1956	C,E	S	
205	do	R. Spence	1950	380	4	Tc	--	35	1956	C,E	S	
206	W. L. Moody Estate well 1	Katz & Smith	1954	6,005	--	--	284	--	--	--	--	Oil test. 1/
301	-- Dailey Heirs well 1	P. G. Lake	1953	5,820	--	--	286	--	--	--	--	Oil test. 2/
303	B. E. Dailey	F. R. Jackson	1957	6,150	--	--	267	--	--	--	--	Do.
501	F. E. Taylor	-- Moore	1940	312	4	Tc	220	+	1963	Flows	S	

See footnotes at end of table.

Table 2.--Records of wells in Houston and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
PA-38-35-502	H. F. Taylor	J. S. Murchison	1955	412	4	Tc	--	+	1963	Flows	D,S	
503	Nell Rhea well 1	Humble Oil & Refining Co.	1962	10,574	--	--	275	--	--	--	--	Oil test. [1]
504	R. S. and H. H. Dailey well 4	Lone Star Production Co.	1958	5,863	--	--	263	--	--	--	--	Oil test. [2]
601	C. G. Hill well 1	Humble Oil & Refining Co.	1955	5,903	--	--	233	--	--	--	--	Do.
602	Geo. L. Richards well 1	Azalea Oil Co.	1959	5,785	--	--	316	--	--	--	--	Oil test. [1]
603	-- Smith well 1	Oil Properties Inc., et al.	1957	6,139	--	--	342	--	--	--	--	Do.
604	O. M. & Ira Rials well 1	Southern Producing Co.	1955	5,900	--	--	228	--	--	--	--	Oil test. [2]
*802	A. E. Murray	Geier & Jackson Co.	1956	350	10	Tc	197	+	1963	Flows	Irr,S	Measured flow 125 gpm. Temp. 74°F.
901	A. E. Murray, et al. well 1	Perryman & Greer	--	5,908	--	--	207	--	--	--	--	Oil test. [1]
36-103	Frank Hamby, et al. well 1	F. R. Jackson, et al.	1957	6,150	--	--	267	--	--	--	--	Do.
104	Hill Huff well 1	P. G. Lake, Inc.	1950	6,314	--	--	433	--	--	--	--	Do.
401	Dailey-Frazier well 1	Ralph Spence	1951	6,392	--	--	403	--	--	--	--	Do.
901	Martin Bigger	J. S. Murchison	1953	597	4	Tqc	--	--	--	J,E, 1-1/2	D	
902	R. M. Sims	R. L. Taylor	1950	156	6	Ts	--	72	June 1950	J,E, 1	N	Destroyed because of iron in water.
*37-101	City of Grapeland well 1	J. W. Jackson	1930	746	6	Tc	475	--	--	N	N	Abandoned and plugged.
102	City of Grapeland well 2	Layne-Texas Co.	1940	784	8	Tc	475	200	June 1940	N	N	Abandoned.
*103	City of Grapeland well 3	do	1944	783	8, 6	Tc	475	206	May 1944	T,E, 20	P	Reported discharge 150 gpm in 1944. Pump set at 250 ft. Screen from 701 to 769 ft.
*104	City of Grapeland well 4	J. S. Murchison	1952	784	8	Tc	475	--	--	N	N	Abandoned.
*105	City of Grapeland well 5	Layne-Texas Co.	1957	802	8, 4	Tc	482	243.0	July 12, 1961	T,E	P	Measured discharge 750 gpm. Drawdown 32 ft after 4 hrs. pumping 880 gpm. Gravel-packed. Pump set at 350 ft. Screen from 690 to 789 ft.
*106	Arwine Skidmore	R. L. Taylor	1942	300	6	Tqc	445	20	1943	T,E	D,S	Reported drilled to 120 ft in 1933; deepened to 300 ft in 1942. Temp. 65°F.
107	Marie Atteberry	John Frye	1955	384	6	Tqc	435	170	July 1962	J,E, 1	D,S, Irr	Cased to 364 ft. Screen at 20 ft. Pump set at 210 ft.

See footnotes at end of table.

Table 2.--Records of wells in Houston and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
PA-38-37-108	Arwine Skidmore	Roscoe English	1961	90	4	Ts	395	4.7	May 14, 1963	C,W	S	
109	J. H. Burns	John Frye	1962	130	4	Ts	--	--	--	J,E, 1/2	D	
201	Mrs. L. Brown well 1	Trans-Texas Drilling Co.	1952	5,852	--	--	327	--	--	--	--	Oil test. 2/
* 301	W. S. Tyre	R. L. Taylor	1948	142	6	Ts	455	71.9	Apr. 18, 1963	J,E, 1-1/2	D	Measured discharge 20 gpm. Temp. 74°F.
* 302	H. R. Whitaker	do	1936	351	4	Tqc	455	186	1962	C,E	D,S	Temp. 69°F.
303	T. I. Whitaker	--	1850	Spring	--	Ts	375	+	--	J,E, Flows	D,S	Reported flow 5 gpm.
304	Luther Kleckley	Dale Shroyer	1959	243	4	Tqc	382	--	--	T,E, 1	D,S	
401	J. E. Byrd	-- Crothers	1957	110	4	Ts	411	20.5	Apr. 18, 1963	J,E, 1/2	D,S	
402	M. R. Murchison	--	--	26	60	Ts	340	16.2	May 14, 1963	--	D,S	Dug well.
501	Southland Paper Co.	West & Rehaop	1963	470	6	Tqc	460	209.2	July 8, 1963	A,-	Ind	
502	Southern Pine Lumber Co. well 1	Delta Drilling Co.	1963	5,819	--	--	473	--	--	--	--	Oil test. 1/
503	Southern Pine Lumber Co. well A-1	do	1963	6,819	--	--	426	--	--	--	--	Do.
601	D. E. Marsh well 1	J. R. Phillips, Jr.	1957	6,425	--	--	477	--	--	--	--	Oil test. 1/ 2/
* 602	W. L. Martin	John Frye	1963	903	4	Tc	454	228.3	June 3, 1963	T,E, 1-1/2	D,S	Reported discharge 60 gpm. Temp. 72°F.
603	H. G. Bruce	H. G. Bruce	1962	48	30	Ts	480	40.1	Apr. 7, 1963	J,E, 1/2	D,S	Dug well.
604	W. A. Reed	W. A. Reed	1950	35	30	Ts	390	24.3	May 18, 1963	J,E, 1/2	S	Do.
605	do	do	1950	46	30	Ts	400	33.7	do	J,E, 1/2	D,S	
606	J. W. Grounds well 1	Magnolia Petroleum Co.	1947	7,394	--	--	420	--	--	--	--	Oil test. 1/ 2/
701	Latexo School District	J. S. Murchison	1956	535	6	Tqc	396	154.6	May 7, 1963	T,E	P	
702	S. J. Shaver	Crockett Drilling Co.	1954	515	4	Tqc	387	--	--	T,E, 1-1/2	D,S	Reported sand from 475 ft to bottom.
703	do	R. L. Taylor	1941	208	6	Ts	390	--	--	C,W	D,S	Screen from 198 ft to bottom. Observation well.

See footnotes at end of table.

Table 2.--Records of wells in Houston and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
PA-38-37-704	R. L. Westbrook	J. S. Murchison	1955	496	4	Tqc	395	150.0	Apr. 7, 1963	T,E	D,S, Irr	
705	Parshall Heirs	Glover Geiselman	1963	260	4	Ts	404	130.7	July 8, 1963	A,-	Ind	Reported water seep at 30 ft on outside of casing. 1/
706	Parshall Heirs well 1	do	1963	6,766	--	--	412	--	--	--	--	Oil test. 1/
801	W. K. McLean	John Frye	1952	550	4	Tqc	335	--	--	T,E, 2	D,S	
901	Margaret Harrison	do	1956	315	4	Ts	441	60.3	Apr. 19, 1963	N	N	Abandoned because of iron in water.
902	Guy Hill	Crockett Drilling Co.	1961	246	4	Ts	406	102.9	Apr. 11, 1963	T,E, 1/2	D,Irr	Reported supplies water for irrigation of lawn.
38-201	Houston County Timber Co. well 1	Carter & Kaemmerer	1957	6,354	--	--	434	--	--	--	--	Oil test. 1/
401	J. F. Mason well 1	A. G. Hill	1946	6,622	--	--	477	--	--	--	--	Do.
* 501	J. H. Kuttner	--	1954	160	4	Ts	426	107.7	May 1, 1963	J,E, 1	D,S	Cased to 150 ft. Temp. 74°F.
502	Guy Hill	R. L. Taylor	1950	253	4	Ts	385	--	--	J,E, 1/2	D,S	Cased to 243 ft.
503	Mrs. Alice Potter	--	1930	275	4	Ts	422	35	1960	J,E, 3/4	D,S	Cased to 265 ft.
* 701	H. H. McAmis Estate	John Frye	1960	640	4	Tqc	410	164.3	Apr. 17, 1963	T,E, 1-1/2	D,S	Cased to 630 ft. Screen from 630 ft to bottom. Temp. 76°F.
702	K. Von Pohle	do	1959	618	4	Tqc	385	120	1959	T,E	D,S	Reported discharge 2-1/2 gpm. Cased to 608 ft.
703	do	R. L. Taylor	1945	350	44	Ts	385	--	--	N	N	Abandoned because of iron in water.
704	H. H. McAmis Estate	--	--	200	4	Ts	410	60.4	May 28, 1963	--	D	Reported pumped sand. Observation well.
801	R. P. Barnhill	John Frye	1960	75	44	Tcs	327	1.8	May 30, 1963	--	S	
802	Tom Rhoden	J. S. Murchison	1960	256	4	Ts	402	78.3	do	T,E, 1/2	S	
803	Cecil F. Cook	do	1958	256	4	Ts, Tcs	405	--	--	C,E	S	Drilled as replacement for well PA-38-38-804.
* 804	do	do	1946	256	4	Ts	405	--	--	N	N	Abandoned January 1957 because water was too highly mineralized.
901	J. E. Tunstall	do	1946	235	4	Ts	338	22.3	May 30, 1963	J,E	D,S	

See footnotes at end of table.

Table 2.--Records of wells in Houston and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
*PA-38-39-302	Alfred Best	Roscoe English	1961	138	2	Ts	265	--	--	J,E	D,S	Temp. 71°F.
303	U.S. Forest Service	--	--	70	--	Ts	210	+	1963	Flows	S	Estimated flow 25 gpm, May 1963. Old well. Temp. 70°F.
304	do	--	--	70	--	Ts	215	+	1963	Flows	S	Estimated flow 30 gpm, May 1963. Old well. Temp. 71°F.
305	J. B. Best	R. C. English	1954	160	4	Ts	237	+5.3	May 29, 1963	Flows	Irr,S	Measured flow 30 gpm, May 1963. Temp. 70°F.
306	do	J. B. Best	1959	190	4	Ts	234	+	do	Flows	Irr,S	Estimated flow 2 gpm, May 1963. Temp. 70°F.
401	H. A. Pyle Estate	Clark Butler	--	500	4	Tqc	315	--	--	C,E	D,S	
402	C. M. Harvin	Humble Oil & Refining Co.	1956	1,000	--	Tc	260	--	--	--	--	Test well.
501	Texas Highway Dept.	John Frye	1956	233	4	Ts	270	+	--	Flows	N	Reported flow 50 gpm.
502	C. M. Harvin	do	1958	202	4	Ts	332	85	1958	T,E	D,S	
701	Roy Julian	do	1963	612	4	Ts	405	123.3	Aug. 20, 1963	T,E	P	Screen from 590 to 610 ft. Temp. 75°F.
702	John McClinton	--	1930	400	4	Ts	345	60.0	May 17, 1963	T,E	D	Temp. 74°F.
703	Wilse Brown	John Frye	1962	202	4	Ts	340	70.1	do	T,E, 1	D,S	Temp. 72°F.
801	Edgar Harrison	Roscoe English	1962	215	2	Tcs	373	--	--	J,E	D	
*901	U.S. Forest Service	Rushing Drilling Co.	1956	245	4	Tcs	340	53.1	July 18, 1961	T,E	D	Reported supplies water for workshop and houses on east side of Lake Ratcliff. Pump set at 194 ft. Temp. 72°F.
902	Clayton Ashby	Hoyet English	1959	159	4	Tcs	400	--	--	J,E	D	Reported supplies water for store.
903	A. W. Bates	J. B. Best	1949	32	33	Ty	395	24.8	June 5, 1963	J,E	D	Dug well. Reported supplies water for store. Temp. 70°F.
904	U.S. Forest Service	Jack Whampler	1956	255	4	Tcs	325	--	--	T,E	P	Temp. 73°F.
905	do	Roscoe English	1962	255	4	Tcs	335	--	--	T,E	P	Do.
906	J. E. Steed	--	1962	50	30	Ty	340	35.7	June 5, 1963	J,E	D	Do.
40-801	Houston County Timber Co. well 1	Hunt Trust Co.	1945	8,195	--	--	337	--	--	--	--	Oil test. 1/ 2/
43-201	-- Patterson well 1	Fletcher Oil & Gas Drilling Co.	1955	7,209	--	--	192	--	--	--	--	Oil test. 1/
*301	M. L. Thompson	John Frye	1963	593	4	Tc	231	1.1	June 3, 1963	T,E	D,S	Temp. 72°F.

See footnotes at end of table.

Table 2.--Records of wells in Houston and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
PA-38-43-302	M. L. Thompson	--	1940	367	6	Tqc	233	--	--	C,W	N	Abandoned because of sand.
303	King Mitchell well 1	Lytle & Halbouty	1950	7,008	--	--	--	--	--	--	--	Oil test. [1]
601	S. L. Murchison well 1	Bobby Manziel	1952	7,181	--	--	204	--	--	--	--	Oil test. [2]
701	G. L. Potter	J. S. Murchison	1950	300	4	Ts	--	+	Apr. 1963	Flows	S	Temp. 74°F.
* 801	do	Sun Oil Co.	1960	1,230	6	Tc	189	+17.1	Apr. 9, 1964	Flows	S,Irr	Oil test; converted to water well. Temp. 75°F.
802	G. L. Potter	J. S. Murchison	1955	300	4	Ts	183	+ 7.5	do	Flows	S	
803	do	R. L. Taylor	1955	34	4	Qal	182	14.4	Apr. 8, 1963	N	N	
804	do	J. S. Murchison	1950	300	4	Ts	--	+	1963	Flows	S	Supplies water for Goose Pond well. Temp. 72°F.
805	do	do	1955	300	4	Ts	--	--	--	C,E	D,S	
806	do	do	1955	300	4	Ts	--	--	--	C,E	S	
807	do	Sun Oil Co.	1960	7,901	--	--	264	--	--	--	--	Oil test. [1] [2]
901	E. P. Adams	Trice Production Co.	1955	7,803	--	--	333	--	--	--	--	Do.
* 44-101	Roy White	Crockett Drilling Co.	1963	285	4	Ts	215	10.9	Aug. 23, 1963	T,E	D,S	Temp. 70°F.
301	Grover Gieselman	J. S. Murchison	1964	642	4	Tqc	--	91.1	July 5, 1963	T,E, 5	D,Irr	
302	V. Dykes well 1	J. S. Michael	1960	7,100	--	--	255	--	--	--	--	Oil test. [1]
501	P. C. Moore well 1	Cherry & Kidd	1943	7,130	--	--	335	--	--	--	--	Oil test. [1] [2]
502	P. J. Porth	Crockett Drilling Co.	1952	500?	4	Ts	--	182.8	May 20, 1963	T,E	D,S	
503	Porter Springs School District	do	1955	400?	4	Ts	374	161.8	May 8, 1963	T,E	P	Supplies water for school.
504	-- Scott well 1	Wise & Windpohr	1953	7,442	--	--	332	--	--	--	--	Oil test. [1]
* 601	Cauble & Speights	John Frye	1962	386	4	Ts	--	--	--	T,E, 5	S	Pump set at 173 ft. Temp. 74°F.
* 602	M. M. Shipp	--	1850	45	34	Tcs	390	24.9	May 8, 1963	J,E	D,S	Temp. 71°F.
603	Mrs. Dan Ripley	Crockett Drilling Co.	1952	385	4	Ts	--	--	--	T,E	D,S	
* 701	Porter Springs School District	R. L. Taylor	1939	375	6	Ts	325	--	--	A,E	D,P	Supplies water for school and 8 houses.
702	J. B. Casey	Crockett Drilling Co.	1963	300	4	Ts	--	145.1	May 8, 1963	T,E	D,S	Reported iron in water.

See footnotes at end of table.

Table 2.--Records of wells in Houston and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
PA-38-44-703	Edmond Dawson	Crockett Drilling Co.	1948	355	6	Ts	325	--	--	T,E	D	
704	Earl Dishon	John Frye	1960	385	4	Ts	325	--	--	T,E	D	
705	W. W. Patrick	Crockett Drilling Co.	1962	270	4	Ts	320	--	--	T,E	D,S	
706	B. F. Fritz	do	1953	365	4	Ts	340	--	--	C,E	D,S	
707	R. L. Turner	do	1960	313	4	Ts	334	124.9	Apr. 8, 1963	J,E	D,S	
708	Mrs. J. L. Corder	J. S. Murchison	1962	360	4	Ts	--	139.5	do	T,E	D	Pump set at 190 ft.
901	Leon Bromberg	do	1962	350	4	Ts	332	122.4	May 21, 1963	T,E	D,S Irr	Pump set at 150 ft.
902	Cull Richards	do	1951	380	4	Ts	--	--	--	C,E	D,S	Reported sulfur in water.
903	Leon Bromberg	do	1959	360	4	Ts	--	152.6	May 21, 1963	T,E	D,S	Pump set at 150 ft.
904	C. M. Griswold	John Frye	1959	500	4	Ts	404	205.3	May 15, 1963	T,E, 5	D,S	
905	do	do	1959	500	4	Ts	--	206.6	do	T,E, 5	D,S	
45-101	Charles G. Heyne well 1	British American Oil Co.	1959	7,915	--	--	313	--	--	--	--	Oil test. 1/ 2/
*102	Texas Power & Light Co.	Layne-Texas Co.	1948	586	6	Tqc	360	75	1949	T,E, 3	D	Supplies water for house at substation. Pump set at 220 ft. Temp. 70°F.
*103	G. E. Brubaker	J. S. Murchison	1957	578	8	Ts?	--	75	1957	T,E, 50	Irr	Reported discharge 700 gpm. Slotted from 150 to 290 ft, and from 538 ft to bottom. Pump set at 200 ft.
104	do	do	1948	570	4	Tqc	330	80	1948	T,E	D	Pump set at 185 ft. Temp. 74°F.
105	Charles Heyne	do	1960	308	4	Ts	311	77.5	Apr. 26, 1963	C,W	S	
106	do	do	1954	525	6	Tqc	309	72.6	do	N	N	Observation well.
107	do	do	1955	308	4	Ts	310	--	--	C,W	S	
108	do	do	1962	308	4	Ts	300	70.8	Apr. 26, 1963	C,W	S	
109	do	do	1959	308	4	Ts	335	--	--	C,W	S	
110	do	do	1960	308	4	Ts	322	--	--	C,W	S	
111	do	do	1955	308	4	Ts	300	--	--	C,W	S	
*201	R. J. Hafner	John Frye	1963	694	4	Tqc	330	95.0	Apr. 17, 1963	T,E, 5	P	Measured discharge 50 gpm. Temp. 77°F.

See footnotes at end of table.

Table 2.--Records of wells in Houston and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
PA-38-45-202	L. E. Williams	J. S. Murchison	--	270	4	Ts	345	113.0	Apr. 29, 1963	T,E	S	
203	do	John Frye	1956	590	4	Tqc	345	100.3	do	T,E	D,S	
204	do	do	1963	611	4	Tqc	355	108.7	do	T,E	S	
205	Gus Merriwether	J. C. Murchison	1952	420	4	Ts	370	--	--	T,E	D,S	
206	R. M. Sims	R. L. Taylor	1949	193	6	Ts	350	62.6	Apr. 29, 1963	N	N	Drawdown 15 ft after 1 hr. pumping 20 gpm. Screen from 177 ft to bottom.
207	do	Fred Blankenship	1930	29	30	Tcs	350	11.8	do	N	N	
208	C. N. Sullivan	J. S. Murchison	1963	596	4	Tqc	333	91.8	Apr. 15, 1964	T,E	D,S	
301	Lipscomb Williams	Hoyet English	1960	596	6	Ts	430	163.5	May 29, 1963	J,E	D,S	
* 302	D. C. Sanders	R. L. Taylor	1950	230	6	Ts	375	43.0	Apr. 16, 1963	J,E	D,S	Temp. 72°F.
* 401	City of Crockett well 1	Layne-Texas Co.	1930	544	16	Ts	348	138.9	June 11, 1961	T,E, 40	P	Reported discharge 508 gpm.
* 402	City of Crockett well 2	do	1934	576	16	Ts	372	158.9	do	T,E, 40	P	Reported discharge 520 gpm. Sand from 250 to 568 ft. Gravel-packed. Screen from 385-427, 491-512, 532-553 ft.
* 403	City of Crockett well 3	J. S. Murchison	1955	540	16	Ts	334	131.5	Sept. 5, 1964	T,E, 70	P	Reported discharge 400 gpm.
501	Jeanette Renfro	John Frye	1957	565	6	Ts	336	112.8	May 16, 1963	J,E, 3	D,S	Pump set at 185 ft.
502	do	R. L. Taylor	1938	89	6	Tcs	342	14.9	do	N	N	Reported pumped sand. Observation well.
503	Wade Minter	J. S. Murchison	--	265	4	Ts	332	112.0	do	J,E	D,S, Irr	Supplies water for irrigation of yard.
504	R. O. Rutledge	Frank Fereck	1922	86	4	Tcs	313	9.5	do	Cf,E	D,S	Temp. 69°F.
505	do	do	1922	86	4	Tcs	310	13.1	do	Cf,E	D,S	Do.
506	Russell Thomasson	C. Peterkin, Jr.	--	1,400	10	Tc	331	2.4	do	N	N	Oil test; converted to water well.
507	-- Austin well 1	Duffie & Chism	1941	3,611	--	--	375	--	--	--	--	Oil test. 1/
* 601	Mrs. Strat Richards	R. L. Taylor	1947	186	6	Tcs	400	84.5	Aug. 23, 1963	J,E	D,S	Drawdown 15 ft after 1 hr. pumping 15 gpm. Temp. 74°F.
602	Sam Turner	Quinton Allee	1924	250	4	Tcs	328	--	--	N	N	Reported good water; no iron. Destroyed by seismograph crew.
603	do	J. S. Murchison	1963	410	4	Ts	328	--	--	T,E	D,S	Pump set at 170 ft. Reported much iron.
604	Nattie English	--	1920	35	30	Tcs	390	9.8	June 4, 1963	J,E	S	Dug well.

See footnotes at end of table.

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
PA-38-45-605	Frank Smith	--	--	184	4	Tcs	390	79.3	June 4, 1963	T,E	D,S	
606	J. H. Reinicke	Roscoe English	1952	425	4	Ts	393	--	--	T,E	D,S	
607	do	--	1948	145	4	Tcs	373	--	--	N	N	Abandoned.
608	Lucy LeGory well 1	Humble Oil & Refining Co.	1946	4,545	--	--	385	--	--	N	N	Oil test. 1/
701	Mrs. Henry Marks	R. L. Taylor	1940	260	6	Tcs	346	41.4	Apr. 25, 1963	J,E	D,S	
702	C. M. Griswold	John Frye	1962	535	4	Ts	407	94.8	May 15, 1963	T,E	D,S	
703	do	R. L. Taylor	1948	515	6	Ts	415	97.8	do	N	N	Abandoned. Well plugged.
704	Carl Christy	do	1948	422	6	Ts	380	--	--	J,E	D,P	
802	D. R. Northcut	--	1952	556	4	Tcs, Ts	363	74	1952	T,E	Ind,D	
46-101	Fred Swindell	Crockett Drilling Co.	1952	258	4	Ts	398	--	--	C,E	D,S	Reported sand from 235 ft to bottom. Temp. 74°F.
201	B. F. Hodges	Roscoe English	1949	625	4	Ts	410	--	--	J,E	D	Reported discharge 5 gpm. Temp. 72°F.
202	Henry Wolfe	do	1954	165	4	Ty	429	53.0	Mar. 5, 1963	N	N	Abandoned because of too much iron in water.
203	J. L. Chesson	J. S. Murchison	1953	330	4	Ts	405	60	Jan. 1963	T,E	D,S	Reported much iron in water.
401	H. E. Prince	--	--	60	4	Tcs	405	14.2	July 14, 1961	N	S	Old well.
402	E. D. English	Roscoe English	1951	580	4	Ts	370	40	1951	J,E	D,S	Reported water level 40 ft when drilled in 1951.
403	A. G. Bond	J. S. Murchison	1956	620	4	Ts	345	--	--	T,E	D,S	
404	V. L. Huntsman	--	1960	160	6	Tcs	425	33.1	June 4, 1963	N	N	Abandoned. Screen collapsed.
405	do	--	--	35	18	Ty	424	16.2	do	J,E	D	Dug well. Temp. 70°F.
406	Sam Long	J. S. Murchison	1962	240	4	Ty?	365	48.4	May 16, 1963	J,E	D,S, Irr	Supplies water for irrigation of garden.
501	H. E. Prince	Crockett Drilling Co.	1956	696	10	Ts	348	78.3	July 14, 1961	T,G, 50	Irr	Measured discharge 780 gpm. Pump set at 180 ft. Both surface water and ground water used to irrigate grass. Temp. 78°F.
701	Louis Tolles	Seismograph Crew	1959	125	2	Ty	305	+	Apr. 24, 1963	Flows	S	Estimated flow 15 gpm. Temp. 68°F.
801	M. P. Lively	J. S. Murchison	1952	295	4	Tcs	305	--	--	J,E	D,S	Reported much iron in water.

See footnotes at end of table.

Table 2.--Records of wells in Houston and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
PA-38-46-802	E. A. Satterwhite	J. S. Murchison	--	68	6	Ty	285	+	1963	Flows, C,E	D,S	Reported flow 10 gpm. Temp. 67°F.
47-101	Carl Curry	Roscoe English	1948	120	4	Ty	360	--	--	J,E	D,S	
201	J. S. Merriwether	Marine Gathering Co.	1952	7,573	--	--	320	--	--	--	--	Oil test. 1/ 2/
* 202	Kennard School District	Roscoe English	1950	360	6, 4	Tcs	355	90	1950	J,E, 3	P,D	Reported discharge 25 gpm. Supplies water for school and one house. Pump set at 148 ft. Temp. 74°F.
203	Max Steed	Crockett Drilling Co.	1947	119	6	Ty	415	--	--	J,E	N	Abandoned.
* 204	Town of Kennard	Layne-Texas Co.	1962	810	7	--	418	162.0	July 24, 1962	T,E	P	Temp. 80°F.
205	Houston County Timber Co. well 1	Frankel & English	--	7,715	--	--	359	--	--	--	--	Oil test. 2/
402	Houston County Timber Co.	H. R. Fender	1959	7,999	--	--	395	--	--	--	--	Oil test. 1/
403	Houston County Timber Co. well 1	Athens Drilling Co.	1963	285	4	Ty	382	58.8	May 6, 1963	A,Ng	Ind	Observation well. Slotted pipe from 220 ft to bottom.
801	B. N. Curry well 1	Humble Oil & Refining Co.	1959	8,454	--	--	370	--	--	--	--	Oil test. 2/
802	B. N. Curry	Roscoe English	1955	220	3	Ty	366	110	1961	T,E	D,S	
* 901	Grover Westerman	J. S. Murchison	1945	280?	4	Ty	371	98.2	July 14, 1961	T,E	D,S	Temp. 72°F.
* 902	U.S. Forest Service	Wampler Drilling Co.	1957	249	4	Ty	402	143	1957	T,E	D	Reported discharge 40 gpm. Pump set at 205 ft.
903	Roscoe English	Roscoe English	1950	310	6	Ty	357	99.3	Jan. 29, 1964	N	S	
904	Grover Westerman well 1	British American Oil Co.	1960	8,432	--	--	367	--	--	--	--	Oil test. 1/
48-101	-- Smitherman	Roscoe English	1959	100	2	Ty	280	--	--	J,E	D,S	
102	Dent Lenderman	do	1961	89	4	Ty	282	46.2	June 5, 1963	J,E	D,S	Pump set at 87 ft.
201	Woodrow Robinson	do	1958	120	4	Ty	277	35.2	do	J,E	D,S	
* 301	H. L. Spring	John Frye	1955	546	4	Ts	270	--	--	J,E	D,S	Temp. 72°F.
50-901	T. J. Maples	John Champion	1964	950	9	Tqc	161	+58.5	Sept. 18, 1964	Flows	Irr	Oil test; converted to water well. Temp. 77°F.
51-101	G. L. Potter	--	1937	114	4	Ts	--	--	--	J,E	D,S	
102	do	--	1940?	100	4	Ts	--	--	--	J,E	S	
* 202	F. W. Ayers	J. S. Murchison	1957	300?	4	Tcs	270	81.6	Aug. 27, 1963	T,E	S	Temp. 76°F.

See footnotes at end of table.

Table 2.--Records of wells in Houston and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
PA-38-51-203	F. W. Ayers	J. S. Murchison	1956	250	4	Tcs	272	--	--	T,E	S	
204	Edmond Dawson	do	1954	390	4	Ts	--	--	--	C,-	D,S	
301	F. W. Ayers	do	1956	600	6	Ts	300	105.0	June 25, 1963	T,E	S	
302	J. A. Moore	John Frye	1957	395	4	Ts	--	--	--	J,E	D,S	Pump set at 100 ft.
* 501	F. W. Ayers	J. S. Murchison	1957	600	6	Ts	270	72.5	June 24, 1963	T,E	D,S	Temp. 74°F.
502	L. N. Brown	do	1954	465	4	Ts	--	50.0	do	J,E	D,S	
601	Wayman & Bromberg	M. W. Shivers	1947	7,813	--	--	286	--	--	--	--	Oil test. 1/ 2/
602	J. B. Coon	Quinton Allee	1935	100	4	Tcs	--	--	--	C,W	N	
603	G. M. Jeffus	Crockett Drilling Co.	1963	193	4	Tcs	--	--	--	J,E	Irr	
604	do	R. L. Taylor	1946	215	6	Tcs	--	55	Feb. 1946	J,E	D,Irr	
605	Raymond Hirom	do	1947	154	4	Tcs	--	65	Mar. 1947	J,E	D	Drawdown 25 ft after 1 hr. pumping 10 gpm.
606	F. E. Christian	John Frye	1955	421	4	Ts	--	90.9	June 27, 1963	J,E	D,S	
607	L. A. Dawson	do	1955	415	4	Ts	--	71	1955	J,E	D	
608	Lawrence Nettles	R. L. Taylor	1938	180	4	Tcs	--	--	--	J,E	D	
609	A. D. Morgan	Crockett Drilling Co.	1958	165	4	Tcs	--	26.1	May 21, 1963	T,E	D,S	
610	A. T. McCullar	R. L. Taylor	1936	157	4	Tcs	--	40	1936	J,E	D	Pump set at 80 ft.
611	J. B. Coon	do	1930	250	4	Tcs	--	--	--	J,E	D,S	
701	Homer Jones	Magnolia Petroleum Co.	1953	2,500	10	Ts,Tc	170	+	1953	Flows	Irr	Casing: 10-inch. to about 2,500 ft. Estimated flow 500 gpm. Oil test; converted to water well. Temp. 87°F.
702	A. B. Spence	do	1955	8,976	--	--	177	--	--	--	--	Oil test. 1/
801	T. J. Maples	R. L. Taylor	1935	165	4	Tcs	--	25	1935	T,E	D,S	
802	J. T. Wilcox Estate	do	1940	200	4	Tcs	--	--	--	J,E	D	
803	J. E. Morgan	do	1938	145	4	Tcs	--	--	--	J,E	D,S	
901	Arthur Dowell	John Frye	1959	175	6	Tcs	--	--	--	J,E	D,S	
52-101	E. R. and W. C. Lamb	-- Lane	1955	400	4	Ts	--	--	--	J,E	D,S	Reported gas in water.
102	Wayman & Bromberg	R. L. Taylor	1938	350?	6	Ts	--	--	--	J,E	D,S	
103	do	do	1949	360	4	Ts	--	--	--	J,E	D,S	Reported gas in water.

See footnotes at end of table.

Table 2.--Records of wells in Houston and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
PA-38-52-104	E. M. and J. R. Ryles	R. L. Taylor	1941	325	6	Ts	274	36.1	May 22, 1963	N	S	
105	-- Smith, et al. well 1	U. M. Harrison	1959	8,232	--	--	286	--	--	--	--	Oil test. 1/
201	A. B. Cason	J. S. Murchison	1948	255	6	Ts	275	23.0	May 21, 1963	J,E	D,S	
202	do	Seismograph crew	1950?	100?	2	Tcs	250	+ 6.0	do	Flows	S	Reported flow 10 gpm. Temp. 67°F.
203	Rudolph Masterson	J. S. Murchison	1951	400?	4	Tcs	--	--	--	C,E	D,S	
204	Frank Smith well 1	E. A. Ellison	1960	8,452	--	--	332	--	--	--	--	Oil test. 1/
301	R. L. Hazlett	John Frye	1962	288	4	Tcs	--	--	--	T,E	D,S	Pump set at 100 ft. Temp. 73°F.
302	D. R. Hazlett	do	1958	244	4	Tcs	--	100	1958	J,E	D,S	Reported sand from 230 ft to bottom.
501	J. C. Yarbrough well 1	Alton Coats	1950	8,511	--	--	294	--	--	--	--	Oil test. 1/ 2/
502	J. L. Bynum	Crockett Drilling Co.	1958	299	4	Ty	--	58.4	May 9, 1963	J,E	D,S	Pump set at 100 ft.
503	Pure Oil Co.	J. S. Murchison	1946	190	4	Ty	330	22.3	do	J,E	D	
601	J. O. Crowson	do	1954	275	4	Ty	--	40.2	June 11, 1963	J,E	D,S	
602	-- Crowson well 1	C. C. Dixon	1940	3,987	--	--	302	--	--	--	--	Oil test. 1/
603	N. E. Martin well 1	Skelly Oil Co.	1955	11,489	--	--	335	--	--	--	--	Do.
701	J. B. Coon	J. S. Murchison	1963	558	4	Ts	274	69.1	May 22, 1963	A,Ng	Ind	
702	J. T. Wilcox Estate	John Frye	1960	350	4	Tcs	250	60.3	May 23, 1963	J,E	S	
703	E. F. Nettles	E. F. Nettles	1942	27	8	Ty	275	23.9	do	Cf,E	D,S	
704	J. B. Coon well 1	Humble Oil & Refining Co.	1963	--	--	--	280	--	--	--	--	Oil test. 1/
* 901	S. C. Millican	--	1948	240	4	Ty	--	--	--	J,E	D,S	Reported much iron in water. Temp. 76°F.
53-101	R. L. Barrett	J. S. Murchison	1955	264	4	Ty	255	--	--	J,E	D,S	
201	Hattie LaRue	do	1958	168	4	Ty	305	44.1	June 6, 1963	B,H	D,S	
202	Charlie Edwards	do	1958	170?	4	Ty	300	40.0	do	J,E	D,S	
402	A. J. Patterson	do	1955	317	4	Tcs	293	--	--	C,E	D,S	
403	E. S. Brashers	R. L. Taylor	1939	206	4	Ty	303	20	1939	C,W	D,S	
404	A. J. Krenek	-- Kerns	1956	475	4	Tcs	313	49.0	June 11, 1963	J,E	D,S	
405	do	J. S. Murchison	1959	256	4	Ty	275	46	1959	J,E	D	

See footnotes at end of table.

Table 2.--Records of wells in Houston and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
PA-38-53-406	Preston Dunn	John Frye	1961	365	4	Tcs	304	--	--	T,E	D	
501	B. E. Wooters well 1	Continental Oil Co.	1948	8,237	--	--	296	--	--	--	--	Oil test. 1/ 2/
601	Cleveland Terry	J. S. Murchison	1962	450	4	Ty	252	--	--	T,E	D,S	Reported screen collapsed.
602	Lovelady School District	R. L. Taylor	1940	135	2	Ty	233	--	--	J,E	P	Supplies water for Center Grove School.
701	C. C. Matchett	J. S. Murchison	1962	205	4	Ty	315	103.2	May 9, 1963	T,E	D,S	
702	H. N. Wright well 1	Pure Oil Co.	1963	12,055	--	--	296	--	--	--	--	Oil test. 1/
* 801	City of Lovelady well 1	R. L. Taylor	1936	150	8	Ty	288	75.1	May 9, 1963	T,E	P	Used as standby well.
* 802	City of Lovelady well 2	--	1953	300	--	Ty	285	--	--	T,E	P	
803	Houston County Coal Co. well 1	O. W. Killian	1942	3,416	--	--	266	--	--	--	--	Oil test. 1/
804	King, et al. & Houston County Coal Co. well 1	do	1941	3,070	--	--	316	--	--	--	--	Do.
* 54-101	Nolan Cecil	Roscoe English	1945	265	4	Ty	335	70	1959	J,E	D,S, Ind	Temp. 75°F.
102	J. W. Wilson	do	1948	265	4	Ty	330	--	--	J,E	D	
201	L. R. Smith	Charles Fritz	1940	178	4	Ty	312	--	--	C,W	N	
202	R. A. McWilliams	J. B. Bradford & Sons	1964	635	4	Ts	260	+30.0	Apr. 2, 1963	Flows	Ind	Measured flow 100 gpm, April 1964. Temp. 76°F.
203	Jim Grady Waller	John Frye	1956	529	4	Ty	272	15.6	do	T,E	D,S	
204	R. A. McWilliams	Chambers & Kennedy	1964	11,015	--	--	270	--	--	--	--	Oil test. 1/
* 301	Deal Craven	John Frye	1958	490	4	Ty	305	74.0	June 14, 1963	T,E	D,S	Temp. 73°F.
501	Groveton School District	--	1935	705	6	Ty	295	57.5	do	J,E	P	
502	S. Watson Heirs well 1	F. K. Lytle	1945	6,003	--	--	313	--	--	--	--	Oil test. 1/ 2/
601	J. S. Seale	R. L. Taylor	1956	352	4	Ty	357	89	1956	J,E	D,S	
55-401	Hugh Arnold	John Frye	1957	495	6	Ty	357	92.5	Oct. 18, 1963	J,E	D,S	
59-101	-- Craddock well 1	Midwest Oil Co.	1957	8,509	--	--	173	--	--	--	--	Oil test. 1/ 2/
* 102	Seven J Stock Farm, Inc.	-- Neal	1961	742	4	Ts	170	+	1963	Flows	S	Reported flow 100 gpm. Temp. 72°F.
201	Seven J Stock Farm, Inc. well 1	Woodley Petroleum Co.	1944	8,501	--	--	174	--	--	--	--	Oil test. 2/

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Table 2.--Records of wells in Houston and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
*PA-38-59-202	Seven J Stock Farm, Inc.	Woodley Petroleum Co.	1945	1,500	--	Tc	165	+	1963	Flows	D,S	Oil test; converted to water well. Reported flow 350 to 400 gpm. Drilled to 8,029 ft, plugged back to 1,500 ft. Temp. 82°F.
* 203	do	-- Neal	1948	1,058	42 to 2	Tqc	175	+	do	Flows	D,S	Reported flowed 60 gpm through a 2-in. pipe. Supplies 27 concrete water troughs and 17 houses. Temp. 86°F.
* 204	do	Neal Drilling Co.	1959	240	4	Tcs	190	13	1959	T,E	S	Reported discharge 30 gpm. Supplies water for stock trough. Temp. 78°F.
205	G. L. Murray & Sons well 1	Ivy & Moran	1944	5,377	--	--	170	--	--	--	--	Oil test. [1]
206	Murray Bros. well 1	Woodley Petroleum Co.	1945	8,029	--	--	170	--	--	--	--	Do.
207	Seven J Stock Farm, Inc. well 8	Pure Oil Co.	1962	5,158	--	--	170	--	--	--	--	Do.
208	G. L. Murray & Sons well 2	Ivy & Moran	1945	8,501	--	--	170	--	--	--	--	Do.
601	W. T. Bruton well 1	Woodley Petroleum Co.	1951	10,038	--	--	166	--	--	--	--	Oil test. [2]
602	Pure Oil Co.	Neal Drilling Co.	1963	151	7	Ty	165	17.2	June 10, 1963	T,E	Ind	
901	Wallace Adams	Athens Drilling Co.	1963	325	4	Ty	170	6.5	Apr. 27, 1964	A	Ind	Reported water salty.
60-101	Maples Estate well 1	Feldman & Texmo Oil Co.	1954	9,513	--	--	231	--	--	--	--	Oil test. [2]
201	J. T. Knox well 1	Reynolds Mining Corp.	1954	9,518	--	--	322	--	--	--	--	Do.
202	E. P. Adams well 1	Pure Oil Co.	1962	12,193	--	--	256	--	--	--	--	Oil test. [1]
301	D. D. Odham	Ab. Henderson	1961	165	4	Ty	--	67.1	June 10, 1963	J,E	D	
302	Antioch Baptist Church	do	1956	165	2	Ty	--	--	--	J,E	D	
303	-- Henderson well 1	Keith RR Equipment Co.	1947	5,733	--	--	338	--	--	--	--	Oil test. [1]
401	Seven J Stock Farm well 7	Pure Oil Co.	1962	10,904	--	--	225	--	--	--	--	Do.
* 501	Clifford Adams	Ab. Henderson	1959	287	4	Ty	297	156.6	June 10, 1963	T,E	D	Temp. 73°F.
502	J. C. Evans	John Frye	1957	320	6	Ty	295	94.5	do	T,E	D,S	
801	W. E. Maxie	Ab. Henderson	1956	105	2	Ty	--	--	--	J,E	D	
802	Leslie Parker	J. S. Murchison	1963	204	4	Ty	--	--	--	T,E	D	
803	Charles Hinson	Ab. Henderson	1959	294	3	Ty	--	--	--	T,E	D	

See footnotes at end of table.

Table 2.--Records of wells in Houston and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
PA-38-61-101	W. L. Maxwell	John Frye	1960	300?	4	Ty	265	54.7	June 10, 1963	T,E	D,S	
201	D. E. Lawson well 1	John B. Moore	1959	3,388	--	--	292	--	--	--	--	Oil test. [1]
202	Dan Hartt well 1	Superior Oil Co.	1952	10,710	--	--	278	--	--	--	--	Do.
503	Southland Paper Mills well 1	G. O. Blaylock	1955	3,520	--	--	402	--	--	--	--	Do.
701	Mollie Shaw well 10	Humble Oil & Refining Co.	1957	3,866	--	--	311	--	--	--	--	Oil test. [2]
705	Trinity State Bank well 1	do	1956	4,602	--	--	274	--	--	--	--	Do.
706	Trinity State Bank well 6	Boone Bros.	--	--	--	--	310	--	--	--	--	Oil test.
707	Trinity State Bank	A. F. and J. E. Boone	1940?	250?	4	Ty	375	--	--	J,E	Ind,D	
708	Trinity State Bank Well 6	do	1940	250?	4	Ty	375	21.5	Apr. 8, 1963	A,G	Ind	
709	do	do	1940?	250?	4	Ty	375	--	--	N	Ind	
* 60-03-301	Texas Dept. of Correction	Layne-Texas Co.	1954	1,600	12, 6	Ts	205	24.0	Apr. 30, 1963	T,E,30 Flows	P	Reported flow 446 gpm. Screen from 1,432 to 1,461; 1,470 to 1,492; and 1,500 ft to bottom. Temp. 98°F.
302	do	Katy Drilling Co.	1959	1,635	13	Ts	192	+	July 11, 1961	Flows	P,Irr	Reported flow 1,200 gpm. No pump on well. Flows. Used to irrigate crops. Drilled to 1,661 ft, plugged back to 1,635 ft.
* 303	Texas Dept. of Correction	Inmates of Prison Farm	1960?	37	4	Qal	155	+	--	C,W	S	Temp. 71°F.
* 04-101	do	James Siggert & Son	1958	200	4	Ty	200	28.0	Oct. 1, 1958	N	N	Abandoned, July 11, 1961.
* 102	do	Layne-Texas Co.	1961	200	6	Ty	200	18.7	July 11, 1961	T,E	P	Reported discharge 42 gpm. Supplies water for approximately 25 houses of prison personnel.
103	K. E. Powell	--	1958	360	4	Ty	207	49.2	June 10, 1963	T,E	D,S	
201	T. G. Turney	John Frye	1955	308	4	Ty	208	35	1955	J,E	D,S	

Anderson County

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
AA-38-27-401	Moore & Wardlaw	Moore & Wardlaw	1960?	417	9	Tc	203	+22.3	July 25, 1964	Flows	Irr	Measured flow 200 gpm, July 25, 1964. Temp. 74°F.
702	do	do	--	--	9	Tc, Twi	198	+	May 13, 1963	Flows	Irr	Oil test; converted to water well. Estimated flow 250 gpm. Temp. 74°F.

See footnotes at end of table.

Table 2.--Records of wells in Houston and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water-bearing unit	Altitude of land surface (ft)	Water level: Below land-surface datum (ft)	Water level: Date of measurement	Method of lift	Use of water	Remarks
AA-38-27-703	Moore & Wardlaw	--	--	--	9	Tc, Twi	201	+	1964	Flows	Irr	Temp. 76°F.
704	do	Moore & Wardlaw	--	--	8	Twi	199	+30.4	July 25, 1964	Flows	Irr	Measured flow 520 gpm, July 25, 1964. Temp. 76°F.
705	do	--	--	--	8	Tc	220	+ 9.0	do	Flows	Irr	Estimated flow 10 gpm, 1964. Temp. 74°F.
706	do	--	1959?	425	8	Tc	220	+	1964	Flows	Irr	Supplies water for fish hatchery well. Temp. 74°F.
Angelina County												
AD-37-33-501	Angelina Lumber Co. well 1	D. H. Byrd	1946	7,505	--	--	352	--	--	--	--	Oil test. 2/
41-201	G. Henderson well 1	Coastal Refining Co.	1942	4,530	--	--	181	--	--	--	--	Do.
Leon County												
SA-38-43-102	J. R. Cauble	Texas Standard Oil Co.	1956	813	--	Tc	290	--	--	T,G	S,Irr	Oil test; converted to water well. 1/ 2/
202	do	do	1956	1,152	--	Tc	190	+	1964	Flows	S,Irr	Do.
402	Swift & Co. well 1	H. L. Hunt Trust Co.	1962	7,029	--	--	190	--	--	--	--	Oil test. 1/
50-601	J. M. Leathers well 1	D. H. Byrd	1962	8,052	--	--	218	--	--	--	--	Do.
Madison County												
SW-38-59-603	Forest Street Unit 20-1	Pure Oil Co.	1963	11,297	--	--	270	--	--	--	--	Oil test. 2/
Trinity County												
YH-37-41-501	Southern Pine Lumber Co. well 1	Quintana Petroleum Co.	1962	8,168	--	--	257	--	--	--	--	Oil test. 1/ 2/
* 38-48-302	D. B. Friday	C. C. Innerarity	1961	287	4	Tcs	235	15	1961	J,E	P	Reported sand from 275 ft to bottom. Temp. 71°F.
601	Houston County Timber Co. well 1	Geier & Jackson	1949	8,431	--	--	295	--	--	--	--	Oil test. 1/ 2/
55-402	J. H. Dominy	R. L. Taylor	1947	182	6	Ty	340	44.7	May 13, 1947	J,E	D	Measured discharge 16 gpm.
403	Pennington School District	do	1940	200	6	Ty	340	41.9	June 14, 1963	J,E	P	Abandoned school.
56-201	Southern Pine Lumber Co. well 1	Shell Oil Co.	1957	13,006	--	--	350	--	--	--	--	Oil test. 1/ 2/
61-501	Foy A. Easton	Frank Laird	1951	100	4	Ty	198	--	--	N	N	Abandoned.
502	do	-- Bland	1946	614	4	Ty	198	--	--	N	N	Do.
601	Thompson Bros. Lumber Co. well 2	Humble Oil & Refining Co.	1949	9,191	--	--	170	--	--	--	--	Oil test. 1/ 2/

See footnotes at end of table.

Table 2.--Records of wells in Houston and adjacent counties--Continued

Well	Owner	Driller	Date completed	Depth of well (ft)	Diameter of well (in.)	Water-bearing unit	Altitude of land surface (ft)	Water level		Method of lift	Use of water	Remarks
								Below land-surface datum (ft)	Date of measurement			
YH-38-62-301	-- Lawson well 1	P. R. Rutherford	1955	9,497	--	--	268	--	--	--	--	Oil test. 1/ 2/
401	Thompson Bros. Lumber Co. well 1	Humble Oil & Refining Co.	1947	12,002	--	--	180	--	--	--	--	Do.
				Walker County								
YU-38-61-703	Texas Longleaf Lumber Co. well 1	Dey Pree	1940	2,940	--	--	280	--	--	--	--	Oil test. 1/ 2/
60-03-901	D. F. McAdams well 1	Standard Oil of Texas	1960	11,653	--	--	183	--	--	--	--	Oil test. 2/
04-701	Thompson Bros. Lumber Co. well 1	The Texas Co.	1934	3,304	--	--	150	--	--	--	--	Do.

* For chemical analyses of water from wells in Houston and adjacent counties see Table 3.
1/ Electric log in files of U.S. Geological Survey, Austin, Texas.
2/ Electric log in files of Texas Water Development Board.

Table 3.--Chemical analyses of water from wells in Houston and adjacent counties

(Analyses given are in parts per million except specific conductance, pH, percent sodium, and sodium adsorption ratio)

Well	Depth of well (ft)	Date of collection	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$	Percent sodium	Sodium adsorption ratio (SAR)	Specific conductance (micromhos at 25°C)	pH
Wilcox Group																			
1/ PA-38-35-203	1,800+	Mar. 30, 1959	--	--	4	14	*498	1,030	8	210	--	--	--	1,240	68	94	25	--	--
Carrizo Sand																			
PA-38-27-801	452	Aug. 22, 1963	12	0.52	2.5	.7	*108	236	35	8.3	0.3	1.0	--	284	9	96	16	470	7.7
28-903	890	Aug. 1, 1949	14	.14	.1	.3	147 2.0	337	23	15	.4	1.0	0.35	379	1	100	64	612	8.4
30-901	600	July 20, 1961	13	.91	131	75	*29	194	438	58	.2	1.8	--	841	636	9	.5	1,220	6.9
31-501	496	Aug. 24, 1963	11	.6	1.5	.1	*214	474	47	22	.4	.0	--	529	4	99	47	850	8.0
35-802	350	July 18, 1961	11	.79	.0	.6	*114	248	31	9.5	.2	.0	--	288	2	99	35	453	7.3
37-101	746	June 24, 1943	12	.89	1.1	.3	138 2.0	316	31	9.0	.8	.8	--	361	4	98	30	585	8.0
102	784	do	13	.04	1.1	.3	148 1.8	320	32	19	1.0	2.0	--	369	4	98	32	596	8.0
2/ 102	784	Nov. --, 1946	11	1.2	5	2	*134	--	31	21	.3	.4	--	356	21	--	--	--	7.9
2/ 103	783	Nov. --, 1946	10	.06	5	2	*129	--	29	21	.2	<.04	--	333	21	--	--	--	7.6
2/ 104	784	Mar. --, 1952	--	6	6	1	*141	--	47	25	.1	.4	--	705	19	--	--	--	8.2
2/ 105	802	May 10, 1957	14	.15	1.3	.4	*137.6	299	28.2	17	--	--	--	519	5	--	--	540	8.3
2/ 105	802	May 16, 1957	13	.3	.8	.3	*138.9	307.4	26.7	17	--	--	--	523	3	--	--	561	8.2
602	903	Aug. 23, 1963	13	.10	.8	.0	*147	326	29	16	.4	.0	--	366	2	99	45	608	8.2
43-301	593	do	13	.30	1	.4	107 1.1	252	24	6.8	.3	.0	--	278	4	98	23	463	7.9
801	1,230	Aug. 27, 1963	13	2.5	3.5	.4	162 1.4	328	66	21	.3	.2	.24	429	10	97	22	681	7.8
59-202	1,500	July 25, 1961	15	.14	.2	.2	*195	430	33	26	.4	.0	--	481	2	100	60	773	8.1
Queen City Sand																			
PA-38-27-901	160	Aug. 22, 1963	15	0.07	8.0	2.9	*74	194	12	14	0.2	1.0	--	223	32	83	5.7	373	7.4
29-603	250	July 25, 1961	28	2.4	17	7.8	*44	121	47	15	.2	.0	--	219	74	56	2.2	338	6.5
31-401	43	July 24, 1961	35	.07	13	5.3	*13	35	4.6	26	.1	16	--	130	54	35	.8	182	6.0
37-106	300	Aug. 28, 1963	13	.18	24	6.8	*48	220	8.6	2.3	.2	.0	--	211	88	54	2.2	349	7.1

See footnotes at end of table.

Table 3.--Chemical analyses of water from wells in Houston and adjacent counties--Continued

Well	Depth of well (ft)	Date of collection	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$	Percent sodium	Sodium adsorption ratio (SAR)	Specific conductance (micromhos at 25°C)	pH
PA-38-37-302	351	Aug. 28, 1963	11	0.61	19	7.9	*95	232	74	13	0.2	0.0	--	334	80	72	4.6	538	6.9
38-701	640	Aug. 24, 1963	12	.23	1.0	.0	*124	270	38	6.7	.3	1.2	--	316	2	99	38	513	7.7
45-102	586	July 18, 1961	11	.22	.2	.3	*140	308	33	12	.4	.8	--	349	2	100	43	566	7.9
103	578	do	12	.31	.5	.5	*182	404	41	15	.7	2.0	--	453	3	99	46	731	7.9
201	694	Aug. 23, 1963	12	.06	2.2	.1	202 1.4	424	75	19	.8	.0	--	522	6	98	36	833	7.9
59-203	1,058	Aug. 25, 1961	12	.10	.5	.5	*270	640	6.6	39	1.1	.0	--	645	3	99	68	1,050	8.1
Sparta Sand																			
PA-38-28-801	90	Aug. 22, 1963	11	0.36	2.8	1.7	1.2 1.9	2	0.0	2.1	0.1	18	--	40	14	14	0.1	55	4.9
37-301	142	Aug. 28, 1963	15	10	2.5	.7	3.8 2.3	8	9.6	2.3	.1	.0	--	40	9	41	.6	49	5.2
38-501	160	Aug. 24, 1963	44	30	5.0	1.8	*13	21	10	14	.2	.0	--	98	20	53	1.3	111	6.1
† 804	256	Jan. 23, 1957	11	.1	646	228	*496	35	2,440	750	--	2.0	--	--	2,550	--	--	5,390	--
39-302	138	Aug. 26, 1963	37	23	28	17	*27	102	28	61	.2	.0	--	248	140	30	1.0	421	5.7
44-101	285	Aug. 23, 1963	9.5	8.9	7.5	3.3	*155	430	4.4	7.1	.6	.2	--	399	32	91	12	675	7.6
601	386	Aug. 28, 1963	29	7.6	26	10	*57	90	92	43	.1	.0	--	301	106	54	2.4	493	6.2
701	375	July 24, 1961	11	1.1	12	4.3	*233	326	184	63	.8	5.9	--	674	48	91	15	1,080	7.6
45-302	230	Aug. 26, 1963	22	3.6	77	25	*76	130	218	89	.1	.0	--	571	295	36	1.9	909	6.9
401	544	June 21, 1943	43	1.7	7.4	3.5	54 3.8	73	45	34	.0	.0	--	231	33	76	4.1	--	6.4
2/ 401	544	June --, 1951	42	1.6	10	3	*58	--	46	39	.10	<.40	--	228	38	--	--	--	7.5
2/ 401	544	Apr. --, 1958	--	1.4	14	4	*52	--	46	33	.3	.4	--	225	49	--	--	375	7.1
402	576	June --, 1943	37	1.6	32	5.2	26 4.8	75	52	34	.2	.1	--	237	101	35	1.1	--	6.4
2/ 402	576	Feb. --, 1950	36	2.10	15	6	*55	--	55	39	.10	<.40	--	250	62	--	--	--	6.9
2/ 402	576	Apr. --, 1957	--	2.05	14	5	*53	--	55	36	.5	.4	--	260	56	--	--	430	6.5
2/ 403	540	Sept. --, 1959	--	1.2	8	3	*56	--	54	37	.2	.4	--	216	32	--	--	360	6.8
46-201	625	July 24, 1961	14	.01	1.0	1.1	*119	245	38	16	.2	3.0	--	312	7	97	20	506	7.8
501	696	July 14, 1961	18	1.5	1.0	1.2	*131	256	45	24	.1	.0	--	346	8	97	20	563	7.5

See footnotes at end of table.

Table 3.--Chemical analyses of water from wells in Houston and adjacent counties--Continued

Well	Depth of well (ft)	Date of collection	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$	Percent sodium	Sodium adsorption ratio (SAR)	Specific conductance (micromhos at 25°C)	pH
4/ PA-38-47-204	810	July 6, 1962	11	0.01	2.5	2.6	*119	288	0	27	--	--	--	349	--	--	--	555	8.56
48-301	546	Aug. 26, 1963	13	.16	1.0	.4	*226	568	13	9.6	0.8	0.5	--	543	4	99	49	860	8.1
51-501	600	Aug. 28, 1963	12	.07	11	3.5	300 3.7	720	.4	80	.6	.2	--	766	42	93	20	1,220	7.5
3/ 59-102	742	July 25, 1961	13	.15	.2	.5	*70	162	3.0	12	.5	.0	--	179	3	98	18	292	8.6
3/ 60-03-301	1,600	Aug. 3, 1954	17	.2	.4	0	*84	163	4	18	--	--	--	319.5	1	--	--	--	8.6
3/ 302	1,635	1959	18	.1	1.1	.1	*72	139	1	13	--	--	--	266	3	--	--	325	9.7
Spiller Sand Member (of Stenzel, 1940) of Cook Mountain Formation																			
PA-38-39-901	245	July 17, 1961	13	0.11	29	8.4	*181	314	186	32	0.2	3.8	--	607	107	79	7.6	941	7.3
44-602	45	Aug. 22, 1963	48	.17	40	2.0	*13	118	24	8.2	.1	4.0	--	197	108	21	.5	271	6.3
45-601	186	Aug. 23, 1963	18	30	112	44	*161	182	406	166	.1	5.7	--	1,000	460	43	3.3	1,500	6.4
47-202	360	July 17, 1961	13	.47	24	6.9	*190	290	196	42	.3	.0	--	615	88	82	8.8	980	7.5
YH-38-48-302	287	Aug. 26, 1963	11	.06	5.5	2.1	560 3.1	588	498	180	1.9	.0	1.7	1,550	22	98	52	2,340	7.7
PA-38-51-202	300	Aug. 28, 1963	12	.72	13	4.5	*299	700	0	89	.5	.0	--	762	51	93	18	1,220	7.4
59-204	240	July 25, 1961	8.8	.09	6.5	2.2	*473	720	224	156	2.4	5.7	--	1,230	25	98	41	1,980	7.7
Yegua Formation																			
PA-38-47-901	280	July 11, 1961	38	15	31	6.0	*118	217	82	66	0.0	1.5	--	450	102	71	5.1	718	6.5
902	249	Jan. 11, 1961	16	11	45	7.9	*361	490	308	146	.1	1.5	--	1,130	145	84	13	1,810	7.5
52-901	240	Aug. 27, 1963	26	16	8.5	2.4	*19	65	3.4	11	.2	.2	--	103	31	57	1.5	153	5.5
53-801	150	June 24, 1943	50	13	25	5.6	133 7.6	236	85	71	.9	0	--	503	86	75	6.2	770	7.2
3/ 802	300	1954	12	.15	3	1	*197	360	68	55	.15	--	--	697	12	--	25	--	8.4
54-101	265	Aug. 26, 1963	32	.80	36	5.3	*106	280	28	59	.2	.8	--	405	112	67	4.4	652	6.9
301	490	do	15	.28	1.5	.6	*246	436	60	83	.9	1.8	--	623	6	99	44	994	7.7
60-501	287	Aug. 27, 1963	25	.04	18	1.9	*471	528	316	220	.4	4.0	--	1,320	53	95	28	2,020	7.3
60-04-101	200	June 7, 1958	--	1.12	10	4	*152	349	12	53	.5	.4	--	401	26	--	13	668	7.9

See footnotes at end of table.

Table 3.--Chemical analyses of water from wells in Houston and adjacent counties--Continued

Well	Depth of well (ft)	Date of collection	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium and potassium (Na + K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$	Percent sodium	Sodium adsorption ratio (SAR)	Specific conductance (micromhos at 25°C)	pH
Alluvium																			
PA-60-03-303	37	Aug. 27, 1963	19	0.09	110	4.3	*60	356	6.8	87	0.3	0.5	--	463	292	31	1.5	799	6.7

* Sodium and potassium calculated as sodium (Na).
† Sample probably represents a mixture of water from the Sparta Sand and the Cook Mountain Formation.
1/ Analyses by Texas A & M College.
2/ Analyses by Texas State Department of Health.
3/ Analyses by Curtis Laboratories.
4/ Analyses by Microbiology Service Laboratory, Houston, Texas