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# GROUND-WATER CONDITIONS IN THE MEMPHIS AREA, TEXAS

By

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Prepared in cooperation with the United States
Department of the Interior, Geological Survey

June 1943

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# GROUND-WATER CONDITIONS IN THE MEMPHIS AREA, TEXAS

## PART I

## PRELIMINARY INVESTIGATION

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### Introduction

(See well records on pages 27 to 35 and water analyses on pages 36 to 39)

The City of Memphis in Hall County, northwest Texas, obtains nearly all its water supply from 41 shallow wells in three well-fields about 6 miles northwest of the city in Donley County (see map, fig. 1). Nine of the wells are in the east field and 16 in each of the middle and west fields. This system was not able to furnish an adequate supply during periods of peak demand in the late summer and fall in dry years, or in years in which the cotton crop was large and the demands for water by the cotton gins, compress and cotton oil mill were heavy. For this reason in the winter of 1941 a standby well (Hall County no. 5) was developed near a creek about one mile west of town on the Milam farm. The water from this well is much harder than that from the main system, and the well is used only as a supplemental source to assure an adequate supply for the city during periods of peak demand. The water system is owned by the Community Public Service Company. According to the company's records the total consumption in 1942 amounted to 67,500,000 gallons, an average of about 185,000 gallons a day.

About the middle of May, 1943 a request was made by the City officials to the Texas Board of Water Engineers for an investigation and report on the possibilities of developing an additional water supply averaging approximately 186,000 gallons of water a day for a proposed government hospital at Memphis. In response to this request the writer spent the period May 17 to 26 inclusive in a field investigation of ground water conditions in the areas of possible development around Memphis. Records were obtained of 30 wells and springs in southeastern Donley County and 12 wells in Hall County and 33 water samples were collected and analyzed.

These data have been used in writing this report together with records selected from mimeographed reports on water wells in Donley, Collingsworth and Childress Counties, published by the Texas Board of Water Engineers in cooperation with the Work Projects Administration, and the United States Geological Survey. The well records and chemical analyses are given on pages 27 to 39 .

Acknowledgments

The writer wishes to acknowledge the cooperation of Mr. D. W. Robinson of the Fort Worth office of the Community Public Service Company and Mr. Roy Fultz, Manager of the Memphis water office in making their records and time available. Messrs. Jim King and Morgan Baker accompanied the writer in the field and were otherwise helpful in getting the field data.

## History of Memphis water supply

A water supply for Memphis was first developed about 1908 by J. D. Browder in a spring area on his ranch northwest of town at the site of the present east well field. This source of supply although somewhat remote had several advantages. The ground water was close to the surface and wells could be easily and cheaply constructed, the water was soft whereas the well water in town was in general very hard; between the area and town there was a drop in altitude of about 250 feet permitting the water to be delivered to the town by gravity. By 1928 the water system included 18 wells, two concrete reservoirs having a combined capacity of approximately 300,000 gallons, and a 6-inch cast-iron pipe line. However all the wells were of small yield and according to city officials it was difficult to supply sufficient water during periods of peak demand. The system was operated by the Texas Water Utilities Company from 1928 to 1930 and in 1930 it was purchased by the Community Public Service Company.

In 1930 the company put down 10 new wells and built a 75,000 gallon steel collecting reservoir in the middle well field. A steel reservoir was also built at the main reservoir site about $\frac{1}{2}$ mile south of the east well field bringing the total storage capacity there to 510,000 gallons. A 10-inch cast-iron pipe was laid from the main reservoir site to Memphis, roughly paralleling the old 6-inch line.

From 1933 to 1940 16 new wells were developed and a 150,000 gallon concrete collecting reservoir was constructed in the west well field.

In January 1941, 20 test wells were sunk on the Milam farm west of Memphis for the purpose of locating a supplemental water supply. As a result of this exploration one well was developed which yielded approximately 40 gallons a minute without exhaustion during a 7-day pumping test. This well is 30 feet deep and draws water from the alluvial sands along the creek. It is gravel-walled to keep out the fine unconsolidated sand. According to Mr. Robinson of the Community Public Service Company the well has been pumped only occasionally and it may decline in yield under long periods of pumping. The hardness of the water in the 20 test wells varied considerably and the site selected for development had the softest water, however this water is much harder than that from the old system northwest of town.

## Present system

As previously stated there are now 41 wells in the three main well fields. The wells are dug, about 40 to 60-inches in diameter, and are curbed with brick. They range in depth from about 12 to 25 feet. Most of the wells in each field are located at successively higher elevations and where it is possible the water is siphoned by gravity to a collecting reservoir from which it is pumped into the pipe line to the main reservoirs. Some of the wells are equipped with small pumps and electric motors controlled by floats.

The water is conveyed from the west field to the middle field in a 6-inch pipe and from the middle field to the main reservoirs in an 8-inch pipe. Two cast-iron pipe lines, one 6-inch and the other 10-inch, connect the city with the main reservoirs.

A 125 gallon a minute booster pump powered by a 10 H.P. electric motor boosts the water over a ridge from the west well field to the main reservoir. A 50 gallon a minute pump and 3 H.P. electric motor pushes the water from the middle well field into the pipe line leading to the main reservoir. The water flows by gravity from the main reservoir into Memphis.

Mr. Roy Fultz, manager of the Memphis water office stated that the west well field is capable of yielding about 100 gallons a minute and the east and middle fields an average about 50 gallons a minute each. The period of greatest well development (13 wells) was during the dry years - 1933 to 1938 - when the wells are reported to have declined somewhat in yield and it became difficult to supply the demand, although there was no increase in customers during the period and very little change in the total amount of water used.

## Water requirements of city

The population of Memphis in 1940, according to the U S Census, was 3,869. During the 12 years 1931 to 1942 the city used from about 3,000,000 to about 8,000,000 gallons of water a month or about 100,000 to 250,000 gallons a day depending on the season and the size of the cotton harvest. The peak demand is usually in the fall or early winter as a result of the requirements of the cotton industry. The following table gives the monthly sales by the Community Public Service Company from 1931 to April 1943 in millions of gallons.

Water consumption by City of Memphis, Texas

Summary of sales, in millions of gallons, as tabulated by Mr. D. W. Robinson of the Community Public Service Company

| | 1931 | 1932 | 1933 | 1934 | 1935 | 1936 | 1937 | 1938 | 1939 | 1940 | 1941 | 1942 | 1943 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan. | 4.3 | 4.2 | 4.3 | 4.5 | 4.4 | 5.4 | 4.1 | 5.5 | 4.7 | 4.3 | 4.4 | 4.2 | 4.8 |
| Feb. | 3.6 | 4.4 | 3.8 | 4.6 | 3.4 | 4.9 | 4.1 | 5.0 | 4.5 | 4.0 | 5.1 | 5.5 | 4.5 |
| Mar. | 3.1 | 4.0 | 3.7 | 4.3 | 3.8 | 4.7 | 3.5 | 4.7 | 4.0 | 4.3 | 3.7 | 4.7 | 4.7 |
| Apr. | 3.6 | 4.5 | 3.9 | 4.5 | 4.1 | 4.9 | 4.0 | 4.9 | 4.4 | 6.0 | 4.6 | 5.3 | 5.3 |
| May | 3.6 | 3.9 | 3.7 | 4.2 | 3.9 | 5.7 | 4.0 | 4.7 | 5.4 | 6.0 | 4.3 | 4.6 | |
| June | 5.1 | 4.2 | 5.9 | 4.4 | 3.4 | 5.4 | 3.9 | 4.8 | 7.2 | 6.6 | 3.8 | 5.6 | |
| July | 6.1 | 4.8 | 5.0 | 6.7 | 5.1 | 7.2 | 6.2 | 6.0 | 6.5 | 7.6 | 4.8 | 6.8 | |
| Aug. | 6.3 | 6.0 | 4.9 | 5.6 | 5.9 | 6.6 | 6.6 | 7.9 | 6.7 | 6.2 | 5.9 | 6.9 | |
| Sept. | 6.5 | 5.8 | 4.3 | 4.3 | 6.2 | 5.4 | 4.9 | 5.5 | 7.2 | 6.5 | 5.2 | 6.7 | |
| Oct. | 5.4 | 5.2 | 5.9 | 4.5 | 6.2 | 4.3 | 6.3 | 6.5 | 5.7 | 5.7 | 5.1 | 5.3 | |
| Nov. | 5.1 | 5.3 | 5.5 | 4.3 | 5.2 | 5.4 | 7.1 | 6.3 | 5.0 | 5.1 | 6.1 | 6.9 | |
| Dec. | 4.6 | 3.5 | 4.6 | 3.6 | 4.9 | 4.0 | 5.4 | 4.9 | 3.9 | 3.5 | 6.3 | 5.0 | |
| Annual | 57.3 | 55.9 | 55.5 | 55.5 | 56.6 | 63.9 | 60.0 | 66.5 | 65.2 | 65.8 | 59.2 | 67.5 | |

Estimated loss between well fields and city customers' meters, about 25%.

## Rainfall

Official Weather Bureau precipitation records are available for both Memphis and Clarendon from 1905 to the present. The maximum for this period was 39.76 inches for Memphis and 37.51 inches for Clarendon in 1941. The minimum was 11.92 inches for Memphis in 1917 and 12.62 inches for Clarendon in 1927. The average for the 27-year period was 21.64 inches at Memphis and 23.92 inches at Clarendon.

The following table gives the annual precipitation at Memphis and Clarendon for the period 1931 to 1942. This period was selected because it covers the period of the most accurate figures on the water consumption at Memphis.

Annual precipitation in inches at Memphis and Clarendon, Texas

| Year | 1931 | 1932 | 1933 | 1934 | 1935 | 1936 | 1937 | 1938 | 1939 | 1940 | 1941 | 1942 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Memphis | 19.94 | 19.98 | 13.35 | 16.10 | 18.51 | 19.77 | 15.28 | 19.09 | 12.33 | 15.60 | 39.76 | 19.62 |
| Clarendon | 23.12 | 23.16 | 13.60 | 25.58 | 19.50 | 21.30 | 22.42 | 21.72 | 18.31 | 14.23 | 37.51 | 23.68 |

## Geologic formations and their water-bearing properties

Memphis and the adjacent territory is on the outcrop of the Permian Red Beds, which are covered in places by thin beds of Quaternary silts, sands and gravels. The area borders the eastern escarpment of the High Plains, the approximate position of which is indicated by the line of rimrock shown on the map (fig. 1). The High Plains are underlain by clays, silts, sands and gravels of the Ogallala formation of Tertiary age, which were deposited on an old redbed surface by streams,

some of which had their headwaters in the Rocky Mountains. Between the High Plains and the outcrop of the Permian Red Beds a belt one to 4 miles or more in width is underlain by outwash materials from the Plains, and in some localities by remnants of old High Plains deposits which have resisted erosion as the escarpment moved westward and are still in place. For convenience in this report the deposits in this belt will be called escarpment slope deposits. The discussion which follows is divided into four parts: Permian Red Beds; High Plains deposits (Ogallala formation); escarpment slope deposits; and alluvial and terrace deposits.

Permian Red Beds:-- Permian Red Beds underlie the surface or lie at shallow depths beneath Memphis and the adjacent territory. The log of well 313, 3 miles northwest of Memphis, shows a typical section of these sediments from 70 to 300 feet (see table of driller's logs). Wells sunk in these beds usually yield small amount of "gyp" water. The deeper-seated waters are usually very highly mineralized, but locally shallow wells in the more sandy beds may yield small amounts of water of less mineralization. The wells and springs drawing from Permian beds in this area, for which analyses are available in this office, contain total dissolved solids that range from about 1,900 to 4,200 parts per million. The chemical character of the water in the Permian Red Beds is indicated by the analyses for wells and springs nos. 308 and 336, Donley County; 9, Hall County; 491, 501, 504, 505, 510, 512 and 516 Collingsworth County; and 1, 5, 6, and 7, Childress County. (See table of analyses).

The data at hand lead to the conclusion that no water suitable for a public supply can be found in the Permian Red Beds in this area.

High Plains deposits (Ogallala formation):-- Back of the rimrock (see map, fig. 1) the High Plains extend westward and northwestward 200 miles or more. The Plains are underlain by a varying thickness of clays, silts sands and gravels, deposited mostly by streams, some of which had their headwaters in the Rocky Mountains. The name Ogallala formation has been given to these deposits. They rest on an uneven floor of older rocks - Permian Red Beds in this part of the High Plains, and as a result they are thicker in some places than they are in others. The thickness of the saturated portion of these deposits varies materially. In well 314, 2 miles southwest of Hedley, approximately 16 feet is saturated, of which 10 feet is reported to consist of sand and sandy clay and 6 feet of water sand and gravel. The owner states that this well was used, together with another well of similar depth about 200 feet away to supply water for two 3,000-gallon boilers and for drilling an oil test. He says that the two wells had a combined yield of 100 to 125 gallons a minute during periods of several hours of pumping. The log of well 315, an oil test 0.3 mile southeast of well 314, shows sand and gravel from 10 feet to 120 feet. Mr. Simmons of Hedley, who helped drill the well, reports that considerable water was encountered in sand and gravel in the upper 150 feet.

Wells 274 and 275, which supply the town of Hedley, are 100 feet deep and the static water level is about 40 feet below the land surface. The original test well, drilled 112 feet deep encountered a seep at about 40 feet and water-bearing sand from 98 to 112 feet. The test did not penetrate all the water-bearing sands. The pumps in these wells are set at approximately 85 feet below the surface because at lower settings they pump sand. Mr. Devine, the water superintendent, reports that the wells yield about 10 and 20 gallons a minute each. Other wells in this area are equipped with windmills and small cylinder pumps and none of them are known to have been pumped heavily. Wells 318, 319 and 324 have the following depths respectively: 55 feet, 195 feet and 56 feet, and respective depths to water of about 10 feet, 140 feet and 32 feet.

The log of well 271 (Donley County), a seismograph test well, shows caliche, sand, gravel, conglomerate, and "brown clay with streaks of gravel" from 3 feet to 142 feet; but no information is available regarding the saturated material. The log of well 272, also a seismograph test well, shows sandy gray clay, and sand and gravel from 5 feet to 80 feet, but here again no information is available regarding the amount that is saturated.

In general, waters in the Ogallala sands in this area contain less than 500 parts per million total dissolved mineral matter. The water from well 314, however contained 663 parts when sampled. The chemical character of the water is indicated in the table of analyses (nos. 274, 314, 317 and 319 to 324, Donley County). The water is low in dissolved minerals and closely resembles the present city supply of Memphis.

The available data indicate that the Ogallala sands above the rimrock between Giles and Hedley offer opportunity for the development of a supplemental water supply for Memphis. However the amount the wells would yield cannot be predicted without exploratory drilling and testing.

Escarpment slope deposits:-- The escarpment slope deposits cover a belt one to 4 miles or more in width between the rimrock and the outcrop of the Permian Red Beds (see map, fig. 1). They are composed of outwash materials from the High Plains which in some localities are underlain by remnants of basal Ogallala beds that have resisted erosion and are still in place. In nearly every canyon that cuts back into the High Plains from Giles west there are springs and seeps which issue from the alluvial or Tertiary (Ogallala) sands at the contact with the Permian Red Beds or just above the contact. These springs are small having flows which are difficult to measure or estimate. Many of them issue from the sandy beds of the canyons, flow a short distance, and then disappear into the sand. In the vicinity of most of the springs there is a luxuriant growth of cottonwoods, tules, sedges and marsh grasses which indicates that a considerable amount of water is lost by seepage and transpiration. The springs are fed in part by ground-water discharge from the High Plains and in part from rainfall on the escarpment slopes.

The three well fields that supply most of the water for Memphis draw from these deposits. The wells are situated in small canyons near springs that occur just above the contact of the sands with Permian red shales and siltstones. The sands penetrated by the wells are fine- to coarse-grained and are unconsolidated, or loosely cemented and it is necessary to curb the wells tightly with brick. The saturated sand in the well fields ranges in thickness from about 8 to 15 feet and the total depth of the wells ranges from about 12 to 25 feet. At the time of the field investigation a small discharge of ground water was noted in the bed of the canyon below the west well field indicating that not all the available ground water was being recovered. Mr. Fultz, manager of the Memphis water system, reported that a small flow had been maintained here for several years except during periods of excessive drought. This suggests the possibility that the yield of the west field might be increased by putting down more wells or constructing infiltration galleries.

The quality of water from these wells is indicated by the analysis of a composite sample in the table of analyses, (wells 330-32, Donley County). The water is of excellent chemical character.

The Fort Worth and Denver City Railway utilizes a part of the spring flow of Buck Creek at Giles. A large well (no. 325) has been dug on the creek bank and both surface runoff and spring discharge is utilized as a water supply for

locomotives. The well is reported by the pumper to yield about 10,000 gallons an hour for short periods of pumping.

The largest flow of spring water observed by the writer in the escarpment area was from a group of 4 springs, 288-92 Donley County, on the Finch ranch. (See map, fig. 1). The discharge of the springs was estimated as 12 to 15 gallons a minute. About half of the water is led through a pipe line to the ranch house, and the remainder is wasted. Several other springs occur on the ranch and are reported to yield from 1 to 3 gallons a minute each. (See nos. 285, 293-95, 297-98 Donley County).

Two additional small springs were observed in the area, one having a flow of about 2 gallons a minute in a roadside park at the head of Parker Creek about 1 mile south of Giles, and the other with a flow of about 5 gallons a minute in a small canyon about ¼ mile north of the park.

The water from these springs closely resembles that from the city well field and is of excellent chemical character. See table of analyses, nos. 288-92, 298 and 305 Donley County.

Possibilities apparently exist of developing some additional water from three spring areas as follows: (1) at the head of Parker Creek; (2) in the vicinity of the Fort Worth and Denver Railway water station at Giles and (3) on the Finch ranch near the head of Indian Creek. However it is impossible to estimate the amount that can be developed without exploratory drilling supplemented by other detailed studies.

Alluvial and terrace deposits (local and Buck Creek, Collingsworth County area):— Some ground water is available in the vicinity of Memphis in alluvial and terrace deposits of Quaternary age. These deposits, referred to below as terrace deposits, are spread over large areas in Hall, Collingsworth and other nearby counties. They were derived in part from the Ogallala formation of the High Plains and in part from the Permian Red Beds, and were laid down on an uneven Red Bed floor. In general they are very thin, but locally may reach a thickness of 70 feet or more. The area covered by these deposits in the vicinity of Memphis comprises a north-south strip 3 to 4 miles wide between Parker and Indian Creeks extending from the vicinity of wells 312 and 338 Donley County southward 10 miles or more into Hall County. Memphis is situated on the eastern border of this strip.

The Milam well (no. 5, Hall County), which is a standby well for the City of Memphis, draws water from these deposits. It is 30 feet deep and penetrates 20 feet of saturated sand. The well is gravel-walled to keep out the fine sand. In a short test it is reported to have yielded about 75 gallons a minute, which exhausted the well, but it has been pumped 7 days continuously at the rate of about 40 gallons a minute without exhaustion. On May 18, 1943 it was pumped for 5 hours at about 40 gallons a minute and had a drawdown of 9.3 feet. According to the analysis of a sample obtained May 18, 1943, the water contained 938 parts per million of total solids, 329 parts of sulfate and 61 parts of chloride. The calculated hardness was 542. (See table of analyses, no. 5, Hall County).

The J. C Wilson swimming pool well (no. 7, Hall County) draws from terrace sands. It is 25 feet deep and is reported to have yielded about 20 gallons a minute during 14 days of continuous pumping without failing. This water is very hard which precludes its use as a municipal supply. An analysis by the International Filter Company, made in 1933, showed the water to have 1,338 parts per million of dissolved solids and 540 parts of sulfate. The total hardness was calculated as 899 parts per million.

Data were obtained from 3 wells drawing from terrace sands in the immediate vicinity of the Hospital site. (Hall County nos. 1 to 3). The T. J. Hampton well (no. 1) is 65 feet deep and penetrates about 15 feet of saturated sand. The Seth Thomas well (no. 2) is 52 feet deep and penetrates 5 feet of saturated sand. Mr. Thomas stated that he had bailed the well at the rate of about 20 gallons a minute in an attempt to lower the water enough to clean it out but could not lower the water level sufficiently for a man to work in the well. Neither this well nor the Hampton well reached the Red Beds according to the owners. The Arthur Whaley well, (no. 3), 44 feet deep with the water level at about 39 feet, is used to irrigate a large lawn and shubbery.

The waters from the Hampton and Thomas wells is comparatively low in dissolved solids and as far as their chemical character is concerned should be acceptable for a public water supply. Water from the Whaley well is somewhat more highly mineralized but is not excessively so (see table of water analyses).

It is possible that a moderate amount of water of acceptable chemical quality could be obtained from terrace deposits in the vicinity of the proposed hospital site. The water in the terrace deposits is derived from local rainfall and seepage from streams which cross them. The amount of water they are capable of yielding perennially in a given area depends upon the volume and permeability of the saturated sands beneath that area. If the sands are thin, as is known to be the case in much of the territory they cover they cannot be expected to yield much water. If however the terrace deposits fill a local depression in the old Red Bed surface of considerable depth and areal extent, and are reasonably permeable, they may yield relatively large supplies. Among the towns in this region that obtain their public supplies from the terrace sands and gravels are Estelline, Childress, Wellington, Quitaque and Matador.

With the data already available from wells 1, 2 and 3 and a moderate amount of test drilling and test pumping it should be possible to estimate the amount that could be obtained.

Thick sections of saturated sand are found in some places in the terrace deposits in the vicinity of Buck Creek in Collingsworth County. For example, wells 486, 487 and 508 (see map) have depths of 135, 102 and 173 feet respectively and water levels of 60, 70 and 120 feet below the land surface. These wells are equipped with windmills and small cylinder pumps and it is not known how much they would yield if larger pumps were installed The chemical character of the water from these sands is indicated in the table of analyses by nos. 486, 487, 490, 492, 502, 506, 507 and 508, Collingsworth County. The range in total dissolved solids is from 239 to 454 parts per million.

## Quality of other public water supplies in the region

The chemical quality of the water in the Memphis area has been discussed in the foregoing report.

The following table compiled from the files of the U. S. Geological Survey and State Board of Water Engineers is submitted to afford a comparison between the mineral content and hardness of the ground water from the city well fields northwest of Memphis with those of a few other public supplies in the region.

Mineral content and hardness of municipal water supplies of some West Texas cities

| County | City | Total dissolved solids | Total hardness (calc.) | Depth of well (ft.) |
|---|---|---|---|---|
| Hall | + Memphis | 309 | 223 | 15-25 |
| Hall | Estelline | 554 | 280 | 54 |
| Armstrong | Claude | 392 | 230 | 263 |
| Carson | Panhandle | 266 | 248 | 550 |
| Childress | Childress | 613 | 442 | 300 |
| Collingsworth | Wellington | 329 | 260 | 35 |
| Donley | Clarendon | 323 | 234 | 240 |
| Donley | Hadley | 383 | 218 | 100 |
| Potter | * Amarillo | 329 | 223 | 300± |
| | | 367 | 255 | |

\+ Samples from well field northwest of Memphis.
* Analyses by City chemist from two well fields.

## Conclusions

The result of the field investigation show there are some possibilities for the development of a supplemental water supply for Memphis northwest of the city in three areas as follows: in the Ogallala formation above the rimrock, in the escarpment slope deposits below the rimrock, and in terrace deposits near Memphis, on or immediately adjacent to the proposed hospital site. (See map).

In the Ogallala deposits the area between Giles and Hedley, in the vicinity of wells 272, 318, 319, 320, 321, 322 and 323, seems to be the most promising for development.

In the escarpment slope deposits the most promising sites for development are the areas of spring discharge on the Finch Ranch near the ranch house (springs 288-92), and those near Giles (springs 305 and 329). The spring area on the Finch Ranch is about 6 miles west of the main city reservoir and 10 miles from Memphis while springs 305 and 329 are only 1 to 1½ miles north of the reservoir. Some water perhaps could be obtained in the present west well field by means of additional wells or infiltration galleries. The water in both the Ogallala formation and the escarpment slope deposits is comparatively low in dissolved solids and well adapted for public supply. It should be pointed out that analyses by this office do not include a determination of the sanitary character of the water.

In the terrace deposits adjacent to Memphis the area in the vicinity of wells 1, 2 and 3, Hall County, is the most promising for development. Water from these wells averages slightly higher in total dissolved minerals than the present city supply, but should be acceptable for a public water supply in so far as the chemical character is concerned.

It is impossible to estimate how much water is available in any of these areas without detailed studies supplemented by test drilling and test pumping. Test drilling in any of these areas could be accomplished with comparatively shallow wells and should not be very costly nor require any great length of time.

Drillers' logs of wells in the Memphis area, Texas

Hall County

| | Thickness (feet) | Depth (feet) |
|---|---|---|

Well 5

Community Public Service Company, 1 mile west of Memphis. Log of test well drilled by Layne-Texas Company. Altitude of land surface, 2078.8 feet. Depth 74 feet.

| | | |
|---|---|---|
| Sandy soil and sand | 18 | 18 |
| Loose, fine to coarse-grained red sand | 15 | 33 |
| Clay, sand and gravel | 6 | 39 |
| Fine-grained red sand and red clay | 35 | 74 |

Large diameter well drilled to 30 feet, 12-inch steel casing and screen installed, and gravel wall put around casing.

Well 16

Milam farm (Community Public Service Company), 1½ miles west of Memphis. Test well drilled by Layne-Texas Company. Altitude of land surface, 2098.1 feet. Depth 87 feet.

| | | |
|---|---|---|
| Soil | 6 | 6 |
| Sandy clay | 14 | 20 |
| Coarse sand (good water sand) | 14 | 34 |
| Gray clay | 4 | 38 |
| Packsand and gravel | 13 | 51 |
| Fine-grained red sand and clay | 13 | 64 |
| Coarse red sand | 20 | 84 |
| Hard rock | 3 | 87 |

Water level 21 feet. Water too highly mineralized for public use.

# Drillers' logs of wells in the Memphis area, Texas

## Donley County

### Well 270

Carl Williamson, 9 miles north of Memphis. The Texas Company, driller.

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Sand | 10 | 10 |
| Sand and clay | 30 | 40 |
| Clay | 50 | 90 |
| Shale and clay | 75 | 165 |
| Gypsum with streaks of shale | 35 | 200 |
| Shale | 15 | 215 |
| Gypsum | 20 | 235 |
| Shale and clay | 85 | 320 |
| Shale with streaks of gypsum | 50 | 370 |
| Gypsum | 30 | 400 |

### Well 271

A. E. Ransom, 9 miles north of Memphis. The Texas Company, driller.

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Surface soil | 3 | 3 |
| Sand, gravel and caliche | 47 | 50 |
| Gravel with streaks of conglomerate | 15 | 65 |
| Brown clay with streaks of gravel | 77 | 142 |
| Sandy red shale | 171 | 313 |
| Gypsum | 2 | 315 |

### Well 272

Mrs. J. S. Beach, 10 miles northwest of Memphis. The Texas Company, driller.

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Surface soil | 5 | 5 |
| Sandy gray clay | 5 | 10 |
| Sand and gravel | 70 | 80 |
| Sandy red clay | 85 | 165 |
| Sandy red clay with streaks of hard sand | 22 | 187 |

### Well 275

City of Hedley, $1\frac{3}{4}$ miles northwest of Hedley. In edge of draw.

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Surface soil | 4 | 4 |
| Loam | 26 | 30 |
| Sandy loam (seeps) | 35 | 65 |
| Clay loam | 12 | 77 |
| Loam | 13 | 90 |
| Packsand | 8 | 98 |
| Water sand (loose) | 17 | 115 |

Did not go entirely through water sand.

### Well 282

G. W. Sexaur, 8 miles west of Memphis. The Texas Company, driller.

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Sand and gravel | 40 | 40 |
| Sandy red clay | 146 | 186 |
| Gypsum | 1 | 187 |
| Sandy red clay | 17 | 304 |
| Gypsum | 5 | 309 |
| Clay with gypsum streaks | 71 | 380 |
| Dark red shale | 36 | 416 |
| Gypsum | 17 | 433 |
| Shale | 11 | 444 |
| Gypsum | 13 | 457 |
| Blue and red shale | 8 | 465 |

### Well 283

J. D. Browder, 8 miles northwest of Memphis, The Texas Company, driller.

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Surface soil | 5 | 5 |
| Sand | 45 | 50 |
| Shale and clay | 135 | 185 |
| Gypsum | 4 | 189 |
| Shale and clay | 6 | 195 |
| Shale with streaks of gypsum | 10 | 205 |

Drillers' logs of wells in the Memphis area, Texas--Continued

Donley County

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| **Well 287** | | |
| Fred M. Finch, 9 miles northwest of Memphis. The Texas Company, driller. | | |
| Surface soil | 5 | 5 |
| Sand | 50 | 55 |
| Sandy red clay | 162 | 217 |
| **Well 299** | | |
| Side of county road, 7 miles northwest of Memphis. Drilled by WPA. | | |
| Sandy top soil | 2 | 2 |
| Sand and caliche, some gravel and clay | 3 | 5 |
| Brown coarse-grained sand | 5 | 10 |
| Gravel, sand and caliche | 12 | 22 |
| Light-brown sand, clay nodules | 10 | 32 |
| Struck water at 27 feet. April 9, 1941. | | |
| **Well 301** | | |
| Side of county road, 6½ miles north of Memphis. Drilled by WPA. | | |
| Sandy top soil, caliche and gravel | 3 | 3 |
| White fine-grained sand | 6 | 9 |
| Coarse-grained sand, gravel and caliche | 3 | 12 |
| Struck water at 11 feet. April 10, 1941. | | |
| **Well 307** | | |
| W. P. Dial, 5½ miles north of Memphis. The Texas Company, driller. | | |
| Surface soil | 5 | 5 |
| Gray clay | 17 | 22 |
| Sandy red shale | 62 | 84 |
| Gypsum | 2 | 86 |
| Sandy red shale | 59 | 145 |
| Shale and broken gypsum | 20 | 165 |

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| **Well 309** | | |
| Side of county road, 5 miles north of Memphis. Drilled by WPA. | | |
| Brown sandy clay | 15 | 15 |
| Brown fine-grained sand | 9 | 24 |
| Brown clay | 14 | 38 |
| Brown fine-grained sand and clay | 9 | 47 |
| Struck water at 30.50 feet. Water level 30.40 feet below land surface, 3 hours after hole completed. April 15, 1941. | | |
| **Well 312** | | |
| Side of county road, 3 miles northwest of Memphis. Drilled by WPA. | | |
| Sandy top soil | 2 | 2 |
| Brown fine-grained sand and silt, some gravel | 7 | 9 |
| Light-brown clay | 4 | 13 |
| Light-tan sandy clay | 2 | 15 |
| Brown sandy clay and caliche | 2 | 17 |
| Brown fine-grained sand, some clay | 6 | 23 |
| Brown clay | 2 | 25 |
| Brown fine-grained sand | 5 | 30 |
| Yellow sand | 4 | 34 |
| Brown fine-grained sand and silt | 2 | 36 |
| Red fine-grained sand, some clay | 24 | 60 |
| April 15, 1941. | | |
| **Well 313** | | |
| Mrs. A. Hampton, 3 miles northwest of Memphis. The Texas Company, driller. | | |
| Sand | 70 | 70 |
| Shale | 78 | 148 |
| Gypsum | 12 | 160 |

(Continued on next page)

Drillers' logs of wells in the Memphis area, Texas--Continued

Donley County

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Well 313--Continued | | |
| Shale and clay | 40 | 200 |
| Clay with streaks of shale | 67 | 267 |
| Gypsum | 23 | 290 |
| Blue clay | 10 | 300 |

Collingsworth County

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Well 514, partial log | | |
| Columbus Oil and Securities Company, Ella A. Gibson well 1, 4 miles northeast of Memphis. | | |
| Red rock | 50 | 50 |
| Red formation | 25 | 75 |
| Lime | 12 | 87 |
| Red formation | 13 | 100 |
| Lime and gypsum | 5 | 105 |
| Quicksand | 17 | 122 |
| Lime and gypsum | 5 | 127 |
| Red formation | 33 | 160 |
| Quicksand | 12 | 172 |
| Red beds | 58 | 230 |
| Lime and gypsum | 28 | 258 |
| Hard gypsum | 7 | 265 |
| Red beds | 5 | 270 |
| Brown lime | 10 | 280 |
| Blue shale | 15 | 295 |
| Lime | 5 | 300 |
| TOTAL DEPTH | | 3830 |
| Casing Record: 58 feet of 20-inch. | | |

# PART II

## EXPLORATORY WATER WELL DRILLING

By

J. W. Lang

December 1943

### Introduction

In a report by the writer, dated June 21, 1943, entitled "Ground-water in the Memphis area, Texas" the present water supply system of Memphis is discussed, together with the possibilities of obtaining a supplementary supply of ground water in several different areas to the north and northwest of the City. One of the areas that was considered is the territory adjacent to the site of the proposed Government Hospital immediately to the north of the City, where a few domestic and stock wells draw water of comparatively good chemical quality from sands in alluvial terrace deposits. Little was known regarding the thickness of these deposits or the water bearing properties of the sands in them. If the sands in the zone of saturation are thin, as they are known to be in these deposits over large areas in this part of Texas, they could not be expected to yield much water. If, however, they are of considerable thickness and areal extent and are reasonably permeable they might be expected to yield water in fairly large quantities. It was decided, therefore, to explore these deposits by means of test drilling.

Eight test wells were put down. These wells are designated in the report that follows by the letters A, B, C, D, E, F, G and H. The wells were put down with a hydraulic rotary drill, were 4 inches in diameter and ranged in depth from 105 to 147 feet. Samples of cuttings were taken from the drilling mud at short intervals as the drilling progressed. These samples were studied by the writer and a log was compiled for each hole. Four of the test holes were reamed out and cased with $6\frac{1}{4}$-inch steel casing with slotted sections, and tested with a pump. Lines of instrumental levels were run to connect the test wells and nearby domestic and farm wells so that a map of the water table could be prepared. The location and depth of the test wells and domestic and stock wells in the adjacent areas together with the depth to water and other information regarding them is given in the table of well records. The logs are given in the table of well logs and the water analyses are given in the tables of analyses.

## Drilling operations and pumping tests

The test wells are described below in the order in which they were drilled, starting with A:

Well A:-- This well was drilled on the Soth Thomason farm, 2 miles northwest of Memphis (see map, figure 2), to a depth of 147 feet. The drill penetrated clays and silts and fine to medium-grained sands all the way down. Small selenite crystals and grains of gypsum were encountered in the lowermost seven feet indicating that the hole had penetrated to or nearly to the Permian Red Beds. Water sands were encountered at 50 to 81, 83 to 86, 87 to 89, 98 to 103 and 119 to 147 feet. The hole was reamed from the surface to 83 feet and 4-5/8-inch OD casing was installed, thereby shutting off the water sands from 50 to 81 feet. Then the hole was cleaned out to 126 feet (at which depth it started to cave) and it was bailed at the rate of about 20 gallons a minute for 20 minutes. The static water level was 49 feet below the land surface. After resting for one hour a gallon sample of water (A1) was bailed for analysis. This sample presumably was a mixture of water from sands between 81 and 126 feet.

The well was then reamed to 85 feet and $6\frac{1}{4}$ ID steel casing was installed with the lower 30 feet perforated with 1/8-inch x 10-inch slots spaced 3 inches apart from center to center. After this was done the well was bailed for 24 minutes at the rate of 19 gallons a minute which caused the water level to drop 21 feet to 70 feet. A water sample was then collected for analysis to show the character of the water in the sands between 50 and 85 feet. To make a pumping test the hole was then reamed to 129 feet and $4\frac{1}{2}$-inch casing perforated in the manner indicated above was installed from 89 to 129 feet.

For the pumping test the well was equipped with a 4 x 16-inch cylinder pump and pump-jack powered by a 6 h.p. gasoline engine. The pump was set at 60 feet and equipped with 42 feet of suction pipe, the unusual length of suction pipe being considered necessary to keep the sand pumped out and the well open to all the sands that were screened. The water level before pumping was started was 49.4 feet below the base of the pump-jack. Several attempts were made to run the pump but each time it became clogged with sand and stopped. The pump was then pulled and it was found the well had filled with sand to 90 feet. After cleaning out the well to 115 feet the pump was set at 78 feet with 4 feet of suction pipe. The well was then pumped continuously for 18 hours at 12 gallons a minute, and had a draw-down of 17 feet, indicating a specific capacity of 0.7 (yield in gallons a minute per foot of draw-down).

Well B:-- The second test hole was drilled to a depth of 131 feet on the I. W. Thomason farm $1\frac{1}{2}$ miles northwest of Memphis. The material penetrated to 130 feet was similar to that found in test well A except that the sands were somewhat coarser. From 130 to 131 feet the drill passed through solid white Permian gypsum. Water sands were encountered at 44 to 68, 77 to 83, 93 to 95, 98 to 104 and 121 to 130 feet. The static water level was about 44 feet below the land surface. The hole was reamed to 105 feet and $6\frac{1}{4}$-inch I. D. steel

casing installed with a screen from 45 to 105 feet, the screen being similar to that used in well A.

The pumping equipment was the same as that used in test well A. The pump was set at 92 feet with no suction pipe. On the first trial it ran for about one hour and broke down because of the large quantities of sand in the water. When the pump was removed it was found that the well had filled with sand to 90 feet. The sand was bailed down to 100 feet and the pump re-set at 92 feet. After operating continuously for about 15 hours with a yield of 20 to 22 gallons a minute the sand in the water wore out the pump leathers. Three additional unsuccessful attempts were made to pump the well at this setting but the pumping could be maintained only for short periods because of the sand. The pump was then raised to 62 feet and four attempts were made to operate it but the sand-laden water caused a breakdown each time, the hole meanwhile being partly filled with sand. Finally, however, continuous pumping was maintained for 8 hours during which the discharge of the pump was measured and the decline of the water level in the well was observed. After the pump was stopped the rate of recovery of the water level in the well was observed. The results indicated that the well had a specific capacity of 3.0 at a depth of 100 feet and 1.7 at a depth of 67 feet.

Well C:-- This test hole was drilled to a depth of 120 feet on the T. J. Hampton farm 2 miles northwest of Memphis. The alluvial sands were coarser, somewhat better sorted and contained less clay than those found in tests A and B. According to correlations by the writer the top of the Permain beds was reached at 117 feet and massive white gypsum was drilled from 117 to 120 feet. Water sands were encountered from 45 to 79, 80 to 84, and 86 to 101 feet and probably at 102 to 117 feet. The static water level when the well was completed was 45.4 feet below the land surface. The test hole was reamed to 87 feet and $6\frac{1}{4}$-inch I. D. steel casing was installed with perforations from 44 to 87 feet. After this was done the well was bailed for 3 hours and about 3 cubic yards of sand were removed; but the sand could not be lowered below 79 feet, and before the pump could be installed the hole had filled with sand to 68 feet.

A 4-inch cylinder pump was set at 62 feet with no suction pipe. When pumping was started several breakdowns were caused by the heavy sand-laden water. On October 1, after two hours of pumping at the rate of 32 gallons a minute, there was a draw-down of 10 feet in the well. The specific capacity therefore was 3.2. On a later test of 5 hours with the pump yielding an average of 16 gallons a minute the draw-down was 5.4 feet, indicating a specific capacity of 3.0. Since the well was only 68 to 70 feet deep during the tests, the data indicate that it tapped more permeable sands than either Well A or Well B.

The results obtained from tests A, B and C, indicated that the terrace deposits were unusually thick and apparently filled a valley or basin. Test wells D, E, F and G were put down chiefly for the purpose of obtaining additional information regarding the depth and areal extent of the basin. Drill cuttings were collected from which a log of each hole was compiled but none of them were pumped. Water samples were obtained from E and G.

Well D:-- This 4-inch test hole located on the Burl Smith farm in Hall County, 2½ miles northwest of Memphis was drilled to a depth of 105 feet in one hour and twenty minutes. Water sands were encountered from 46 to 53, 55 to 78, and 90 to 98 feet. The water level was estimated at about 45 feet. When drilling was stopped sand filled the hole to 45 feet and no water sample was obtained.

Well E:-- This test hole, 105 feet in depth was drilled on the Kendrick estate in Donley County, 3 miles northwest of Memphis. The water level stood at about 42 feet. The hole was reamed to a diameter to 6 inches from the surface to 54 feet and cased with 4½-inch blank casing. The hole filled up with sand to the bottom of the casing. Water rose in the casing 4 feet to about 50 feet and a sample was bailed from that level.

Well F:-- This test hole was drilled to a depth of 126 feet in one hour and fifteen minutes on the Gerald Knight farm, 2¾ miles northwest of Memphis. Water sands were encountered from 59 to 67 and 81 to 84 feet. The hole was reamed to 55 feet and cased with 4½-inch blank casing. The hole was then bailed dry to a depth of 62 feet. Water failed to come in and the casing was pulled. No sample was collected for analysis.

Well G:-- This well, 139 feet in depth, was drilled on the Seth Thomason farm, 1½ miles north of Memphis. Water level was about 48 feet. Water sample was obtained from sands above 62 feet.

Well H:-- This test hole was drilled on the Grover Moss farm, 1½ miles northwest of Memphis. Water sands were penetrated at 36 to 46, 49 to 51, 58 to 65, 67 to 73, and 75 to 79 feet. Gypsum was encountered at 98 feet. The water level was about 37 feet below the level of the ground. The hole was reamed to 56 feet and 4½-inch unperforated casing installed. While cleaning out to 75 feet the water level lowered to 63 feet. After the well was idle for one hour and 20 minutes a water sample was bailed for analysis. The hole was then reamed to 70 feet and 6¼-inch steel casing installed with the lower 20 feet perforated. The well was bailed for 2 hours, the yield at first being only about 12 gallons a minute but gradually increasing to about 20 gallons a minute. This slow development was probably due to the sealing off of some of the water sands by the drilling mud during reaming operations. On a 3-hour test, 6 days after the drilling was completed, the pump delivered about 35 gallons a minute. At the end of the test, which was terminated by a breakdown caused by sandy water, the water level was still declining slowly. Approximately 3 cubic yards of sand were pumped from the well during this short test.

## Depth and extent of ground water reservoir
(See map, figure 2)

As shown by the map the terrace deposits which overlie the Permian Red Beds in an area of several square miles northwest of Memphis have a width of about 2 miles at the Hall-Donley County line and narrow to a fraction of a mile, 3 miles to the north of that line. To the southwest the terrace deposits extend into Hall County and cover a large part of the north half of the county. These deposits

were laid down on an uneven basement of Permian rocks. In most places they are quite thin, but locally, where they overlie a buried valley or sink, they may be quite thick.

The accompanying illustrations, figures 3 and 4, show graphically the character and thickness of the terrace deposits northwest of Memphis where they have been explored by the test drilling, together with the position of the water table as shown by the water levels in the test wells themselves and in nearby domestic and stock wells. Figure 3 shows a cross section along the west-east line A-A' which coincides approximately with the Hall-Donley county boundary. Figure 4 shows a cross section along the northwest-southeast line B-B' following the railroad and Highway 287.

According to interpretation of the logs of the test holes by the writer the terrace deposits reach the following depths: Well A about 150 feet; Well B, 130 feet; Well C, 117 feet; Wells D and E a little more than 105 feet; Well F, 110 feet; Well G, 102 feet; Well H, 100 feet. In well 16 a test well drilled by the Layne-Texas Company, $\frac{3}{4}$ mile southwest of Well H, there was about 50 feet of alluvial fill. The estimated thickness of the saturated sands in the terrace deposits is approximately as follows: Well A, 57 feet; Well B, 40 feet; Well C, 47 feet; Well D, 38 feet; Well E, 40 feet; Well F, 11 feet; Well G, 9 feet; Well H, 22 feet.

The data point to the probability that the alluvial filled depression is a sink rather than a valley. Such sinks are not uncommon in the Permian Basin which includes many thousands of square miles in western Texas, and in Oklahoma and Kansas. They were caused by the removal of salt, gypsum and anhydrite from the Permian beds, by circulating ground waters. Some of the sinks have been completely covered by alluvial deposits and no trace of them appears at the surface. Others have been only partly filled and can be readily identified. The city of Childress, county seat of Childress County, obtains most of its water supply from a sink 300 feet deep in Hall County about 15 miles southeast of Memphis, which has become filled with alluvial clays, silts, sands and gravels. The test drilling and outcropping Permian rocks has defined the Memphis depression on the east, southeast and south; but more test drilling would be needed to determine its limits on the north, and on the southwest along the projection of a line through test H and well 13.

The records indicate that the terrace deposits have a thickness of 100 feet or more beneath an area of at least one square mile, and probably more than a square mile. Outside of this area to the southwest they have a thickness of 50 feet in well 16 and 40 feet or more in well 13; to the north they have a thickness of 40 feet or more in well 337 and 49 feet or more in well 339.

## Thickness and permeability of water-bearing sands

The ability of a water-bearing formation to yield water to wells depends primarily upon the thickness and permeability of the formation. If the supply is to last over a long period of years it is essential also that facilities should be favorable for the replenishment of the underground reservoir either by infiltration of water from the surface or by movement of ground water from territory outside the pumped area. As indicated above, the water-bearing sands are moderately thick, but they are mostly rather fine. Computations based on the recovery of the water level in Well B when it was shut-down after having been pumped for several hours gave a figure for coefficient of permeability that was rather low. The specific capacities of wells A, B and C, ranging from 1.7 to about 3 also pointed to a low permeability. However in all these tests a part of the water-bearing sands was shut off and the figures may have been materially lower than those that would be shown by properly constructed production wells screened in all the important sands.

## Replenishment of the underground reservoir

The water in the terrace deposits of the explored area is relatively fresh and good. The water-bearing beds are entirely cut off on the east and west, and almost entirely cut off on the north from any underground connection except through adjoining and underlying Permian beds containing rather highly mineralized water. It follows that the source of most of the fresh water must be the rain and snow that falls on the surface of the terrace deposits and seepage from the intermittent streams which cross them. The soil and sub-soil of the terrace is sandy in most places and little or no caliche is present such as is found in the form of a relatively impervious caprock over much of the High Plains a few miles to the northwest.

The draw which crosses sections 38, 22, 23 and 19 doubtless contributes considerable water to the underground reservoir. Medium- to coarse-grained clean buff sand crops out along this draw in a stretch at least one and one-half miles long in the vicinities of test wells D and E, and to the north of test E. Parker Creek doubtless also contributes in the upper part of its course shown on the map. In the lower part of its course the creek has cut through the terrace deposits into the Red Beds and drains water from the underground reservoir. Other draws in the area doubtless contribute some water. On the whole, therefore, conditions appear to be fairly favorable for replenishment of the underground reservoir.

## Movement and natural discharge of ground water

Lines of equal altitude compiled from water-level measurements and instrumental levelling shown on the map, figure 2, indicate that the slope of the water table in the eastern and central parts of the basin is toward the southeast at the rate of 30 feet to the mile, indicating that the movement of the ground water is in that direction.

In the western part of the basin the slope of the water table and movement of water may be toward the south or even the southwest but wells are too few to show whether or not this is the case. Ground water is entering the basin from the northwest. It is discharged through seeps and springs and by evaporation and transpiration in the bed of Parker Creek north of Memphis and in the draw which crosses sections 19 and 2 northwest and west of town.

In October 1943 after an unusually dry season the combined ground-water discharge of these two streams was estimated as 30 gallons a minute or about 40,000 gallons a day. The losses by evaporation and transpiration doubtless are considerable but are difficult if not impossible to estimate. Some of the ground water is believed to pass out of the area through the terrace deposits to the south and southwest and some may pass into the Permian sands.

## Ground water in storage

Under natural conditions before withdrawals of water are made by man a condition of equilibrium exists in an underground reservoir in which the average annual recharge to the reservoir is balanced by an approximately equal average annual discharge. It follows that water withdrawn from wells must be derived from two sources: (1) water taken from storage; (2) water salvaged from the supply which ordinarily is lost by natural discharge. When withdrawals are made from a water table area, such as the one under discussion, water moves downward to replace the pumped water, the upper part of the zone of saturation becomes unwatered and the water table declines, in the form of an inverted cone having its center at the well. The capacity of a water-bearing material to thus yield water from storage as it is unwatered is called its specific yield and is expressed as the ratio between the volume of water released and the volume of material unwatered. In parts of the High Plains of Texas where ground water occurs in materials that are not greatly different from those encountered in the Memphis area the specific yield has been computed to be between 14 and 15 per cent. If it is assumed that 15 per cent is applicable to the material penetrated by the Memphis test there will be released from storage a total of about 31,000,000 gallons per square mile for each foot of decline of the water. This is sufficient water to supply about 86,000 gallons a day for one year. At first all the water pumped comes from storage but as the cone of depression deepens and widens more and more water is salvaged from the natural discharge.

## Chemical character of water in terrace deposits

The table of analyses shows the chemical character of the water obtained from the test wells, and from a considerable number of stock and domestic wells in the area. In samples from the test wells the water was comparatively low in dissolved minerals, except in that from well G and sample 1 from well H which may have come partly from clay. In the other six test wells the dissolved minerals ranged from 372 to 628 parts per million and the hardness from 264 to 402 parts. On the average the water is somewhat more highly mineralized than that from the present well field northwest of Memphis, but not much more. Some of the mineralization in the

test wells may be from the Permian sands where the test wells were drilled into them, and the waters were not adequately sealed off or the well was not pumped or bailed long enough before the sample was taken.

The upper limit of total dissolved mineral matter considered desirable in a public water supply, as adopted by the United States Public Health Service, 1/

1/ U. S. Public Service, Drinking Water Standards: Public Health Reports reprint 1029, p. 24, 1928.

is 1,000 parts per million; and the upper limit of sulfate and chloride is 250 parts per million each.

## Conclusions

The most abundant supplemental supply of potable ground water available within 10 miles of Memphis occurs in the alluvial sands of the terrace north, and northwest of Memphis. The sands are thickest in a buried depression, probably a sink, the deepest part of which is beneath the NE¼ of sec. 19, NW¼ of sec. 20, SW¼ of sec. 21 and SE¼ of sec. 22. In this depression the saturated sands ranged from 22 feet to 57 feet in thickness and averaged 40 feet in test wells A, B, C, D, and E. They were somewhat thinner in wells F and G being 11 feet in the former and 9 feet in the latter.

The underground reservoir in these sands is supplied by rainfall on the alluvial area itself and by seepage from small intermittent streams that cross it. Approximately 2,500 acres of the area may contribute to the replenishment of the water sands. If 5 per cent of the rainfall reaches the water table, the recharge to the water sands would be at the average rate of about 180,000 gallons a day. The reservoir is in a state of approximate equilibrium in that the average annual intake from rainfall and stream seepage is balanced by the annual natural discharge.

When pumping is started in this area the water level in the vicinity of the pumped wells will decline as water is removed from storage. The water thus released, on the basis of 15 per cent specific yield, would amount to a total of about 31,000,000 gallons per square mile for each foot of decline of the water table. As pumping progresses the depression created in the water table will continue to decline and expand, and more and more water will be drawn laterally toward the wells which normally escapes to the places of natural discharge. Thus the natural discharge will be decreased as the water is intercepted by the wells but it cannot be stopped entirely.

Pumping tests made in the course of the test drilling indicated that the permeability of the sands is somewhat low. Since the construction of the test wells did not permit free access of water from the entire thickness of the saturated sands the true figures for permeability may be considerably higher than the computed figures.

Maximum recovery can be accomplished by locating the wells where the greatest thickness of sand was found in the test wells. Since most of the water-bearing material is fine unconsolidated sand the wells should be constructed with gravel walls and equipped with carefully selected screens, and should be put down by a competent driller who is experienced in the drilling and development of wells of large yield in fine sands.

On the basis of present information it appears that the wells should be spaced at least $\frac{1}{4}$ mile apart and pumped at a rate not to exceed 50 gallons a minute each (about 70,000 gallons a day). After a production well has been put down it should be properly developed and pumping tests should be made on it in which observations are made of the draw-down and recovery of the water level in the well during the pumping and after the pump has been shut off. The information thus obtained should indicate whether closer spacing of the wells or heavier pumping than that indicated above is permissible.

Conditions appear reasonably favorable for developing in the area a supply of the order of magnitude of 200,000 gallons a day. The chemical quality of the water although not quite as good as that of the water from the present city well field northwest of town compares favorably with the quality of other public supplies in this region.

Possibilities for developing considerable water may exist in other portions of the basin outside the explored area, for example the area between wells 13 and 14 (Hall County) west of Memphis. The water in wells 13 and 14 is of excellent chemical character; in fact somewhat lower in total dissolved minerals than that in any of the test wells (see table of analyses). The wells have 20 feet of water in them but did not penetrate all the sands. The amount that wells will yield in that area could be determined by further test drilling and pumping.

# LOGS OF TEST WELLS DRILLED BY CITY OF MEMPHIS, TEXAS

September and October, 1943

Drilled with rotary rig. E. M. Crenshaw, driller.

See appendix for detailed records of drilling and pumping

## Test well A

Seth Thomason farm, in Donley County, 2 miles northwest of Memphis. Altitude of land surface, 2139.1 feet. Depth 147 feet.

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| Sandy chocolate-brown soil | 5 | 5 |
| Sandy brownish-orange clay | 12 | 17 |
| Calcareous, clayey, fine-grained red sand | 14 | 31 |
| Fine-grained buff quartz sand | 1 | 32 |
| Fine to coarse-grained clayey buff quartz sand, small gravel in lower part | 7 | 39 |
| Sandy brownish-orange clay | 1 | 40 |
| Coarse-grained buff sand | 2 | 42 |
| Brownish-red clay (hardpan) | 8 | 50 |
| Fine to coarse-grained buff quartz sand and small gravel (water) | 5 | 55 |
| Very fine to medium-grained buff sand with thin lenses of clay. Fragments of small clam shells at 66-68 feet | 26 | 81 |
| Sandy buff clay (hard drilling) | 2 | 83 |
| Fine to medium-grained buff sand | 3 | 86 |
| Orange to buff clay | 1 | 87 |
| Silt and fine-grained buff sand | 2 | 89 |
| Chocolate clay | 9 | 98 |
| Very fine to medium-grained buff sandstone. Resembles caliche caprock of High Plains | 5 | 103 |
| Chocolate to yellow-brown clay | 16 | 119 |
| Fine to coarse-grained reddish sand, clayey in upper part and coarser toward the bottom | 21 | 140 |
| Coarse-grained reddish-brown sand with numerous selenite crystals and small grains of gypsum | 7 | 147 |

Water level 49 feet below level of ground. Two water samples obtained: A-1 from sands between 50 and 85 feet; A-2 from sands between 85 and 126 feet.

Logs of test wells drilled by City of Memphis, Texas-Continued

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| **Test well B** | | |
| I. W. Thomason farm, in Hall County 1½ miles northwest of Memphis. Altitude of land surface, 2124.1 feet. Depth 131 feet. | | |
| Sandy black soil | 5 | 5 |
| Brownish-orange clay | 12 | 17 |
| Sandy brownish-orange clay with caliche pebbles | 11 | 28 |
| Fine-grained light brown sand | 6 | 34 |
| Sandy brown clay | 6 | 40 |
| Fine to medium-grained buff sand | 2 | 42 |
| Medium to coarse-grained buff sand (water) | 10 | 52 |
| Hard sandstone | 1 | 53 |
| Medium to coarse-grained water sand | 15 | 68 |
| Sandy buff clay | 9 | 77 |
| Medium to coarse-grained clean buff sand | 6 | 83 |
| Buff clay | 10 | 93 |
| Coarse-grained buff to brown and white sand | 2 | 95 |
| Silty buff clay (caliche) | 3 | 98 |
| Clayey buff sand and medium to coarse-grained red sand (Lost some circulating water in this sand) | 6 | 104 |
| Sandy buff clay | 6 | 110 |
| Sandy chocolate clay | 5 | 115 |
| Reddish-brown clay (small snail shell found) | 6 | 121 |
| Brownish-red sand with scattering small selenite crystals | 8 | 129 |
| Fine to medium-grained red sand | 1 | 130 |
| Hard white gypsum | 1 | 131 |
| Water level 44 feet. Water sample from sands at 45 to 100 feet. | | |
| **Test well C** | | |
| T. J. Hampton farm, in Hall County 2 miles northwest of Memphis. Altitude of land surface, 2142.8 feet. Depth 120 feet. | | |
| Sandy brown soil | 4 | 4 |
| Silty brownish-orange clay | 6 | 10 |
| Sandy brownish-orange clay with caliche pebbles | 8 | 18 |
| Fine to coarse-grained clean buff sand | 22 | 40 |
| Sandy buff clay | 5 | 45 |
| Fine to medium-grained clean buff sand (water) | 5 | 50 |
| Medium to coarse-grained clean buff water sand | 29 | 79 |
| Small clam shells in sand from 61 to 68 feet | | |
| Brownish-red clay | 1 | 80 |
| Medium to coarse-grained buff sand | 4 | 84 |
| Tight reddish-brown clay with small gravel | 2 | 86 |
| Sandy buff clay and clayey sand | 8 | 94 |
| Fine to coarse-grained buff sand | 7 | 101 |

(Continued on next page)

Logs of test wells drilled by City of Memphis, Texas-Continued

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| **Test well C--Continued** | | |
| Dark blue-gray clay (resembles lake mud) | 1 | 102 |
| Coarse-grained gray and buff sand (sand consists of quartz, red siltstone and limestone) | 3 | 105 |
| Reddish-brown clay, silt and fine-grained sand (drills easily) | 12 | 117 |
| Massive white gypsum | 3 | 120 |
| Water level, 45 feet. Water sample from sands above 68 feet. | | |
| **Test well D** | | |
| Burl Smith farm, in Hall County 2¼ miles northwest of Memphis. Altitude of land surface, 2146.1 feet. Depth 105 feet. | | |
| Sandy brown soil | 3 | 3 |
| Sandy buff clay | 3 | 6 |
| Silty buff clay with caliche (rock) pebbles | 12 | 18 |
| Fine to medium-grained buff sand and sandy clay | 13 | 31 |
| Buff sandstone (hard drilling) | 2 | 33 |
| Medium to coarse-grained buff sand. Streaks of sandy clay in upper part | 11 | 44 |
| Sandy buff clay | 2 | 46 |
| Medium to coarse-grained buff sand | 7 | 53 |
| Silty buff clay | 2 | 55 |
| Coarse-grained buff sand. Clam shells at 60 to 61 feet. | 7 | 62 |
| Fine to medium-grained buff sand | 8 | 70 |
| Medium to coarse-grained buff sand | 8 | 78 |
| Reddish-buff clay (hard drilling) | 3 | 81 |
| Sandy reddish-buff clay | 9 | 90 |
| Fine to coarse-grained reddish-buff sand | 8 | 98 |
| Reddish-buff clay | 2 | 100 |
| Dark blue-gray clay (like lake mud) | 5 | 105 |
| Well was not cased. Water level about 45 feet. No water sample obtained. | | |
| **Test well E** | | |
| Kendrick Estate, in Donley County 3 miles northwest of Memphis. Altitude of land surface, 2159.5 feet. Depth, 105 feet. | | |
| Gray and buff sand and sandy top soil | 3 | 3 |
| Silty light gray soil | 3 | 6 |
| Sandy yellow clay | 6 | 12 |
| Sandy yellow clay with caliche pebbles | 8 | 20 |
| Medium to coarse-grained clean buff sand. First water at about 42 feet | 34 | 54 |
| Reddish-brown clay | 2 | 56 |
| Medium to coarse-grained buff sand. Thin bed of clam shells at 57 feet | 11 | 67 |

(Continued on next page)

Logs of test wells drilled by City of Memphis, Texas-Continued

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| **Test well E--Continued** | | |
| Yellow clay | 1 | 68 |
| Fine to medium-grained buff sand | 5 | 73 |
| Reddish-brown clay and sandy clay | 8 | 81 |
| Fine-grained red sand | 1 | 82 |
| Red sand and gravel | 1 | 83 |
| Very fine-grained red sand | 11 | 94 |
| Sticky red clay | 3 | 97 |
| Sandy reddish-brown clay (easy to drill) | 6 | 103 |
| Sticky dark blue-gray clay | 2 | 105 |
| Water level 43 feet. Water sample from sand at about 54 feet. | | |
| **Test well F** | | |
| Gerald Knight farm, in Donley County $2\frac{3}{4}$ miles northwest of Memphis. Altitude of land surface, 2174.7 feet. Depth 126 feet. | | |
| Sandy black soil | 2 | 2 |
| Chocolate clay sub-soil | 2 | 4 |
| Buff clay with caliche nodules | 6 | 10 |
| Reddish-brown clay | 6 | 16 |
| Silty to sandy yellow clay with caliche pebbles | 3 | 19 |
| Fine to medium-grained clean buff sand | 7 | 26 |
| Sandy buff clay with caliche pebbles | 16 | 42 |
| Reddish-buff clay | 6 | 48 |
| Fine to medium-grained clean buff sand | 9 | 57 |
| Medium to coarse-grained clean buff sand (water) | 10 | 67 |
| Reddish-buff clay | 14 | 81 |
| Medium to coarse-grained buff sand and sandy clay | 3 | 84 |
| Impervious orange-red clay | 14 | 98 |
| Clayey reddish-brown sand | 4 | 102 |
| Reddish-brown to dark blue-gray clay (drills up into soft balls) | 3 | 105 |
| Chololate clay | 5 | 110 |
| Orange-red clay polka-dotted with blue siltstone | 16 | 126 |
| Water level 59 feet. No water sample obtained. | | |
| **Test well G** | | |
| Seth Thomason farm, in Hall County $1\frac{1}{2}$ miles north of Memphis. Altitude of land surface, 2127.3 feet. Depth 139 feet. | | |
| Sandy chocolate soil | 4 | 4 |
| Chocolate soil polka-dotted with gray clay | 4 | 8 |
| Red and gray clay | 6 | 14 |
| Sandy reddish-brown clay | 4 | 18 |
| Fine to medium-grained buff sand | 7 | 25 |
| Sandy buff clay and clayey sand. Caliche (rock) pebbles in upper part | 9 | 34 |

(Continued on next page)

Logs of test wells drilled by City of Memphis, Texas-Continued

| | Thickness (feet) | Depth (feet) |
|---|---|---|
| **Test Well G--Continued** | | |
| Fine to medium-grained buff sand | 4 | 38 |
| Sandy reddish-buff clay | 16 | 54 |
| Impervious yellow clay | 6 | 60 |
| Sandy red clay and fine-grained red sand | 3 | 63 |
| Sandy red clay | 8 | 71 |
| Fine to medium-grained buff sand | 9 | 80 |
| Clayey fine to medium-grained buff sand | 3 | 83 |
| Sandy buff clay | 11 | 94 |
| Impervious chocolate clay | 9 | 103 |
| Very fine-grained red sand | 15 | 118 |
| Orange-red silt and fine-grained sandstone | 4 | 122 |
| Sandy brick-red clay | 7 | 129 |
| Very fine-grained brick-red sand and siltstone | 9 | 138 |
| Massive white gypsum | 1 | 139 |
| Well was not cased. Water level 48 feet. Water sample obtained from sand at about 62 feet. | | |
| **Test well H** | | |
| Grover Moss farm, in Hall County 1½ miles northwest of Memphis. Altitude of land surface, 2120.7 feet. Depth 105 feet. | | |
| Sandy chocolate-brown soil | 5 | 5 |
| Sandy gray clay | 2 | 7 |
| Sandy brown and red clay with caliche nodules | 2 | 9 |
| Sticky brownish-red clay | 6 | 15 |
| Fine to medium-grained buff sand | 2 | 17 |
| Medium to coarse-grained clean buff sand | 3 | 20 |
| Sandy brownish-red clay with lenses of buff sand | 6 | 26 |
| Red and brown clay | 10 | 36 |
| Fine to medium-grained buff sand (water) | 4 | 40 |
| Medium to coarse-grained clean buff sand | 6 | 46 |
| Red and brown clay | 3 | 49 |
| Fine to medium-grained buff sand | 2 | 51 |
| Sandy buff clay | 7 | 58 |
| Medium to coarse-grained clean buff sand. Fragments of clam shells at 62 to 65 feet | 7 | 65 |
| Sandy red and brown clay | 2 | 67 |
| Fine to medium-grained buff sand and sandy clay | 6 | 73 |
| Red and brown clay | 2 | 75 |
| Medium to coarse-grained clean buff sand | 4 | 79 |
| Sticky red and brown clay | 5 | 84 |
| Sandy red and brown clay | 4 | 88 |
| Sticky brown and gray clay | 7 | 95 |
| Blue-gray clay (resembles lake mud) | 3 | 98 |
| White and clay-like gypsum | 3 | 101 |
| Black muddy clay and gypsum | 3 | 104 |
| Reddish-brown clay | 1 | 105 |
| Water level 37 feet. Water sample from sandy clay from 56 to 57 feet and from sand at about 65 feet. | | |

Records of wells and springs in the Memphis area, Texas [a]
See map and tables of well logs and water analyses

| Well | Distance from Memphis | Owner | Depth of well (ft.) | Diameter of well (in.) | WATER LEVEL Below land surface | Method of lift [b] | Use of water [c] | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | Domestic and stock wells in Hall County | | | | | |
| 1 | 2 miles northwest | T. J. Hampton | 65 | 40 | 46.5 | C,W | D,S | Water level after well had been idle about 20 hours. Serves water to 4 families. |
| 2 | do. | Seth Thomason | 52 | 40 | 48.7 | C,W | D,S | Owner reported bailed 20 gallons a minute without exhausting well. |
| 3 | In Memphis | Arthur Whaley | 44 | 40 | 38.8 | C,E | Irr,S | Irrigates large lawn and garden. |
| 4 | 3½ miles west | Mrs. R. T. McElreath | 98 | 40 | 80.5 | C,W | D,S | Water is from Permian sandstone. |
| 5 | 1 mile west | Community Public Service Company | 30 | 12 | 10.2 | T,E | P | Drawdown, 9.3 feet after 5 hours pumping estimated 45 gallons a minute. See log of test well. |
| 6 | do. | A. G. Kasco | 64 | 4⅕ | 47.5 | C,W | D,S | |
| 7 | In southwest Memphis | J. C. Wilson | 25 | 60 | 11.5 | C,E | P | Supplies water for swimming pool. Has been pumped 324 hours continuously without exhaustion. |
| 8 | 1 mile southwest | do. | 66 | 6 | d/28 | C,W | D,S | |
| 9 | In south Memphis | City of Memphis | 16 | 90 | 9.4 | S,E | Irr | Water is from Permian sand. For irrigation of park. |
| 10 | 2½ miles northwest | Kendrick Estate | 56 | 40 | 49.7 | C,W | S | White crust precipitated on discharge pipe. |
| 11 | do. | T. J. Hampton | 48 | 36 | 39.7 | -- | D,S | Water is drawn by hand. |
| 12 | 2¼ miles northwest | Burl Smith | 67 | 4⅕ | 40.3 | C,W | D,S | |

a/ In Hall County water levels in wells 3 and 5 to 9 inclusive, were measured in May 1943; remainder were measured in October 1943. In Donley County, wells 337 and 338 were measured in May 1943, and the remainder in October 1943.
b/ T, turbine; S, siphon; C, cylinder; E, electric; W, windmill.
c/ P, public supply; D, domestic; S, stock; Irr, irrigation.
d/ Water level reported by driller or owner.

Records of wells and springs in the Memphis area, Texas--Continued [a/]

| Well | Distance from Memphis | Owner | Depth of well (ft.) | Diameter of well (in.) | WATER LEVEL Below land surface | Method of lift [b/] | Use of water [c/] | Remarks |
|---|---|---|---|---|---|---|---|---|
| **Domestic and stock wells Hall County** | | | | | | | | |
| 13 | 2½ miles west | E. Prater | 60 | 40 | 39.0 | C,W | D,S | |
| 14 | 2 miles west | C. S. Compton | 58 | 4½ | 34.7 | C,W | D,S | Drawdown, 6 feet after several hours pumping 2 gallons a minute. |
| 15 | 1½ miles west | Milam farm | Spring | -- | -- | -- | -- | At contact of alluvial sands with Permian clays. Flow fluctuates widely with seasonal changes. |
| 16 | do. | do. | 87 | -- | -- | -- | -- | Test well 14 drilled by Layne-Texas Company. See log. |
| 17 | 1 mile west | C. T. Palmer | 38 | 40 | 30.6 | C,W | D,S | |
| 18 | 1 mile northwest | Mrs. -- Sanderson | 48 | 4½ | 35.0 | C,W | D,S | Local residents report this well supplied many families in Memphis before present system was built. |
| 19 | 1½ miles northwest | Grover Moss | 42 | 40 | 36.5 | -- | D,S | Water is drawn by hand. |
| 20 | In northwest Memphis | -- Delaney | 39½ | 4½ | 39.5 | -- | -- | Unused well. Water level questionable. |
| 21 | 1 mile northwest | I. W. Thomason | 55 | 36 | 45.3 | C,W | D,S | |
| 22 | 1½ miles north | -- Brown | 58 | 5 | 48.5 | C | D,S | Pumped by hand. |
| 23 | In Memphis | Albert Gerlach | 48 | 4 | d/33 | C,F | Irr | Water is from Permian sand. Unfit for drinking. |
| **Domestic and stock wells Donley County** | | | | | | | | |
| 270 | 9 miles north | Carl Williamson | 400 | -- | -- | -- | -- | Test well drilled by The Texas Company. See log. |
| 271 | do. | A. F. Ranson | 315 | -- | -- | -- | -- | Do. |
| 272 | 10 miles northwest | Mrs. J.S. Beach | 165 | -- | -- | -- | -- | Do. |

Records of wells and springs in the Memphis area, Texas--Continued [a/]

| Well | Distance from Memphis | Owner | Depth of well (ft.) | Diameter of well (in.) | WATER LEVEL Below land surface | Method of lift b/ | Use of water c/ | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | Domestic and stock wells in Donley County | | | | | |
| 273 | In Hedley | Foxhall Cotton Company | 200 | 4½ | — | A | Ind | Formerly supplied cotton gin. Now sanded. |
| 274 | 1½ miles west Hedley | City of Hedley | 100 | 8 | d/40 | C,E | P | Pump set at 85 feet. Reported yield about 20 gallons a minute. |
| 275 | do. | do. | 100 | 6 | d/40 | C,E | P | Pump set at 85 feet. Reported yield about 10 gallons a minute. See log. |
| 281 | 9⅓ miles west | Fred M. Finch | Spring | -- | -- | -- | -- | |
| 282 | 8 miles west | G. W. Sexaur | 455 | -- | -- | -- | -- | Test well drilled by The Texas Company. See log. |
| 283 | 8 miles northwest | J. D. Browder | 205 | -- | -- | -- | -- | Do. |
| 284 | do. | Fred M. Finch | Spring | -- | -- | -- | -- | In sandy bed of creek. Water piped to tank. |
| 285 | 8⅓ miles northwest | do. | Spring | -- | -- | -- | -- | Reported flow 2 gallons a minute. Water piped to tank. |
| 286 | do. | do. | Spring | -- | -- | -- | -- | Reported flow 1 gallon a minute from opening in Canyon Wall. |
| 287 | 9 miles northwest | do. | 217 | -- | -- | -- | -- | Test well drilled by The Texas Company. See log. |
| 288 to 292 | 10 miles northwest | do. | Springs | -- | -- | -- | D,S | Approximately one-half of flow from 4 springs is utilized. Measured yield from pipe line 6⅔ gallons a minute. Springs have been used for 18 years without failing. |
| 293 | 9⅓ miles northwest | do. | Spring | -- | -- | -- | -- | Reported flow 3 gallons a minute. |
| 294 | do. | do. | Spring | -- | -- | -- | -- | Do. |

Records of wells and springs in the Memphis area, Texas—Continued [a/]

| Well | Distance from Memphis | Owner | Depth of well (ft.) | Diameter of well (in.) | WATER LEVEL Below land surface | Method of lift [b/] | Use of water [c/] | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | Domestic and stock wells in Donley County | | | | | |
| 295 | 10 miles northwest | Fred M. Finch | Spring | -- | -- | -- | -- | Reported flow 3 gallons a minute. Yield declines in dry seasons. |
| 297 | 9 miles northwest | do. | Spring | -- | -- | -- | -- | Reported flow 1 gallon a minute. |
| 298 | 9½ miles northwest | do. | Spring | -- | -- | -- | -- | Estimated flow 2 gallons a minute. |
| 299 | 7 miles northwest | -- | 32 | -- | d/27 | -- | -- | Test well drilled by WPA. See log. |
| 301 | 6½ miles north | -- | 12 | -- | d/11 | -- | -- | Do. |
| 305 | 6 miles north | State Highway Department | Spring | -- | -- | -- | P,S | At roadside park. Estimated flow 2 gallons a minute. |
| 307 | 5½ miles north | W. P. Dial | 165 | -- | -- | -- | -- | Test well drilled by The Texas Company. See log. |
| 308 | 5 miles north | do. | 100 | 6 | 84.5 | C,W | S | Crust precipitated on discharge pipe. |
| 309 | do. | -- | 47 | -- | 30.4 | -- | -- | Test well drilled by WPA. See log. |
| 310 | 4½ miles north | W. P. Dial | 76 | 4½ | 68.5 | C,W | D,S | |
| 311 | 4 miles north | do. | 174 | 4½ | 125.7 | C,W | S | Water is reported hard. |
| 312 | 3 miles northwest | -- | 60 | -- | -- | -- | -- | Test well drilled by WPA. See log. |
| 313 | do. | T. J. Hampton | 300 | -- | -- | -- | -- | Test well drilled by The Texas Company. See log. |
| 314 | 12 miles northwest | A. T. Simmons | 56 | 6 | d/40 | C,W | L,S | Two wells supplied water for rotary rig and boilers for drilling oil test. Reported yield 55 gallons a minute. See log. |

Records of wells and springs in the Memphis area, Texas--Continued [a/]

| Well | Distance from Memphis | Owner | Depth of well (ft.) | Diameter of well (in.) | WATER LEVEL Below land surface | Method of lift [b/] | Use of water [c/] | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | Domestic and stock wells in Donley County | | | | | |
| 315 | 11½ miles northwest | N. Kuteman | 4,407 | -- | -- | -- | -- | Oil test, drilled by Robinson and Jones. |
| 316 | 11 miles northwest | John Alexander | 190 | 6 | d/175 | C,W | D,S | |
| 317 | 10½ miles northwest | Roy Jewell | 186 | 5 | d/182 | C,W | D,S | Originally sunk to 196 feet without penetrating all water sand. |
| 318 | 10 miles northwest | do. | 55 | 5 | d/ 10 | -- | -- | Located near draw. |
| 319 | do. | W.W.Mendenhall | 195 | 5 | d/140 | C,W | D,S | Pump set at about 165 feet. |
| 320 | 9½ miles northwest | C. F. Kinslow | 140 | 5 | -- | C,W | D,S | |
| 321 | 9 miles northwest | Mrs.W.D.Berger | 130 | 3½ | -- | C,W | D,S | Reported deepened from 75 to 130 feet to obtain more water. |
| 322 | do. | Mrs.T.E.Bailey | 106 | 5 | 98.5 | C,W | D,S | Water level while pumping about 1 gallon a minute. |
| 323 | 8 miles northwest | Baker Jones | 105 | 4 | -- | C,W | D,S | |
| 324 | 7 miles northwest | A.L.Stanford | 56 | 6 | d/ 32 | C,W | S | Waters about 50 head of cattle. |
| 325 | 7 miles north | Fort Worth and Denver Railway | 12 | -- | 6.8 | C,O | RR | Sump on creek bank at Giles. Reported has never failed. |
| 326 | do. | Giles Public School | 131 | 5 | 92.8 | C,W | P,S | |
| 327 | do. | Buck Creek | Spring | -- | -- | -- | -- | Estimated flow 5 gallons a minute. Contact of alluvial sand and Permian Red Beds. |
| 328 | 6 miles north | Arthur Ranson | 148 | -- | -- | C,W | D,S | Brown precipitate on discharge pipe. |

Records of wells and springs in the Memphis area, Texas—Continued [a/]

Domestic and stock wells in Donley County

| Well | Distance from Memphis | Owner | Depth of well (ft.) | Diameter of well (in.) | WATER LEVEL Below land surface | Method of lift [b/] | Use of water [c/] | Remarks |
|---|---|---|---|---|---|---|---|---|
| 329 | 6½ miles northwest | — Parker | Spring | -- | — | -- | -- | Estimated flow 5 gallons a minute near head of Parker Creek. |
| 330 | 7 miles northwest | Community Public Service Co. | 12 to 25 | -- | — | S,E | P | Memphis water supply. Nine wells in this (east) battery. |
| 331 | 6 miles northwest | do. | 15 to 25 | 40 to 60 | — | S,E | P | Memphis water supply. Sixteen wells in this (middle) battery. |
| 332 | do. | do. | 15 to 25 | 40 to 60 | — | S,E | P | Memphis water supply. Sixteen wells in this (west) battery. |
| 333 | 5½ miles northwest | O. B. Smith | 135 | 5 | [d/] 58 | C,W | D,S | Pump set at 120 feet. |
| 334 | 6½ miles northwest | Troy Broome | — | 6 | — | C,W | S | Brown crust precipitated on pipe. |
| 335 | 6 miles northwest | do. | Creek | -- | -- | -- | S | Sample taken from Indian Creek. Estimated flow 15-25 gallons a minute. |
| 336 | 5½ miles northwest | do. | 35 | 6 | [d/] 5 | C,W | S | Brown crust precipitated on pipe. |
| 337 | 4½ miles northwest | Charlie Hill | 88 | 5 | 40.1 | C,W | D,S | |
| 338 | 4 miles northwest | Burl Smith | 45 | 6 | 40.7 | C,W | S | Water level while pumping about 1 gallon a minute. |
| 339 | 3 miles northwest | Gerald Knight | 54 | 36 | 48.7 | C,W | D,S | |
| 340 | do. | Kendrick Estate | 57 | 6 | 33.6 | C,W | D,S | Water is from alluvial sands. |
| 341 | do. | W.T.Reed Estate | 71 | 7 | 40.2 | C,W | S | Water is from Permian sandstone near outcrop. |
| 342 | 2¼ miles northwest | -- | 65 | 36 | 52.6 | C | S | Pumped by hand. |

Records of wells and springs in the Memphis area, Texas--Continued [a/]

| Well | Distance from Memphis | Owner | Depth of well (ft.) | Diameter of well (in.) | WATER LEVEL Below land surface | Method of lift [b/] | Use of water [c/] | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | Domestic and stock wells in Collingsworth County | | | | | |
| 485 | 14 miles northeast | Viola M. Reed | Spring | — | Flows | None | S | Estimated yield, 10 gallons a minute from two openings in sand. |
| 486 | 13 miles northeast | N. T. King | 135 | 4½ | 60 | C,W | D,S | Reported never fails. |
| 487 | 14 miles northeast | Ira Morgan | 102 | -- | 69.8 | C,W | D,S,I | Irrigates garden. |
| 490 | 13 miles northeast | J. F. White | -- | 4½ | -- | C,W | D,S | Obstructed. |
| 491 | 12 miles northeast | P. E. Starr | Spring | -- | Flows | None | S | Estimated yield, 15 gallons a minute from seeps in "Red Beds" along banks of draw. |
| 492 | 11 miles northeast | do. | 26 | 36 | -- | C,W | D,S | Dug well. Concrete curb; galvanized casing. Reported supplies water for 150 head of cattle. |
| 501 | 10 miles northeast | W. D. Dial | Spring | -- | Flows | None | S | Estimated yield, 5 gallons a minute from seeps in sand along bed of creek. |
| 502 | 12 miles northeast | R. V. Sweatt | 77 | 4½ | 54.3 | C,W | D,S | |
| 504 | 9½ miles northeast | Ruth Ellison | Spring | -- | Flows | None | S | Slight flow from seeps along north bank of creek. |
| 505 | 10 miles northeast | do. | 112 | 4½ | 86.1 | C,W | D,S | |
| 506 | do. | Noel Gudd | 66 | 4½ | 41.2 | C,W | D,S | Reported never fails. |
| 507 | do. | J. W. Stokes | 106 | 4½ | 90.5 | C,W | D,S | |
| 508 | 9 miles northeast | J. M. Lane | 173 | 6 | 119.5 | C,W | D,S | Reported never fails. |
| 509 | 7 miles northeast | J. D. Browder | 140 | 5 | 118.6 | C,W | N | |

Records of wells and springs in the Memphis area, Texas--Continued [a/]

| Well | Distance from Memphis | Owner | Depth of well (ft.) | Diameter of well (in.) | WATER LEVEL Below land surface | Method of lift [b/] | Use of water [c/] | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | Domestic and stock wells in Collingsworth County | | | | | |
| 510 | 5½ miles northeast | Ella A. Gibson | Spring | -- | Flows | None | N | Slight flow from seeps along both banks of south fork of creek. |
| 511 | 5 miles north | Brookhollow Country Club | Tank | -- | -- | None | P | Lake about 60 acres in area and 40 feet in depth. Formed by earth dam 300 feet long and 50 feet high. Stocked with fish. |
| 512 | 4 miles north | W. L. Nell | 93 | 4½ | 58.5 | C,W | S | Reported never fails. |
| 513 | 3 miles north | T. J. Dunbar | 32 | 42 | 27.9 | C,W | N | Dug well. Brick curb. |
| 514 | 3½ miles northeast | Ella A. Gibson | 3,830 | 20 | -- | None | N | Oil test. See log. |
| 515 | 6½ miles northeast | -- Thorn | 75 | 4½ | 51.9 | C,W | S | Water reported slightly mineralized. |
| 516 | 7 miles east | J. C. Doneghy | 106 | 6 | 55.4 | C,W | S | Reported weak supply. |
| | | | Domestic and stock wells in Childress County | | | | | |
| 1 | 9 miles east | -- | 225± | 4½ | 134.94 | C,W | S | |
| 4 | 10 miles east | W. B. McQueen | 97 | 5½ | 77.50 | C,W | S | Yield reported small. |
| 5 | 10 miles southeast | C. L. Caviness | 325± | 5½ | 146.51 | C,W | S | Do. |
| 6 | 9 miles southeast | A. Hutchinson | 132 | 5 | 129.54 | C,W | S | Do. |
| 7 | do. | F. K. Smith | 150 | 5 | 122.90 | C,W | S | |

Records of wells and springs in the Memphis area, Texas--Continued [a]

| Well | Distance from Memphis | Owner | Depth of well (ft.) | Diameter of well (in.) | WATER LEVEL Below land surface | Method of lift [b] | Use of water [c] | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | Memphis test wells | | | | |
| A | 2 miles northwest | City of Memphis | 147 | 4, 6¼ | 49 | B,C,G | -- | Water samples from sands at 50 to 85 and 85 to 126 feet. |
| B | 1⅓ miles northwest | do. | 131 | 4, 6¼ | 44 | C,G | -- | Water sample from sands at 45 to 100 feet. |
| C | 2 miles northwest | do. | 120 | 4, 6¼ | 45 | C,G | -- | Water sample from sands above 68 feet. |
| D | 2¼ miles northwest | do. | 105 | 4 | 45 | None | -- | No water sample collected. |
| E | 3 miles northwest | do. | 105 | 4 | 43 | B | -- | Water sample from sands at about 54 feet. |
| F | 2¾ miles northwest | do. | 126 | 4 | 59 | None | -- | No water sample collected. |
| G | 1⅓ miles northwest | do. | 139 | 4 | 48 | B | -- | Water sample obtained from sand at about 62 feet. |
| H | do. | do. | 105 | 4, 6¼ | 37 | C,G | -- | Water sample from sandy clay from 56 to 57 feet, and from sand at about 65 feet. |

[a] In Hall County water levels in wells 3 and 5 to 9 inclusive, were measured in May 1943; remainder were measured in October 1943. In Donley County, wells 337 and 338 were measured in May 1943, and the remainder in October 1943.

[b] T, turbine; S, siphon; C, cylinder; E, electric; W, windmill.

[c] P, public supply; D, domestic; S, stock; Irr, Irrigation.

[d] Water level reported by driller or owner.

Partial analyses of water from wells in the Memphis area, Texas

Well numbers correpond to those used on map and in table of well records.- (Results are in parts per million)

| Well | Owner | Depth of well (ft.) | Date of collection | Total dissolved solids | Silica ($SiO_2$) | Iron (Fe) | Calcium (Ca) | Magnesium (Mg) | Sodium and Potassium (Na+K) (calc.) | Bicarbonate ($HCO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Total hardness as $CaCO_3$ (calc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Domestic and stock wells in Hall County** | | | | | | | | | | | | | | |
| 1 | T. J. Hampton | 65 | May 21, 1943 | 329 | - | - | 54 | 28 | 30 | 263 | 42 | 34 | - | 11 | 250 |
| 2 | Seth Thomason | 52 | do. | - | - | - | - | - | - | 271 | 70 | 28 | - | - | - |
| 3 | Arthur Whaley | 44 | do. | 475 | - | - | 60 | 43 | 50 | 239 | 130 | 74 | - | 0.0 | 327 |
| 4 | Mrs.R.T.McFlreath | 98 | Oct. 15, 1943 | 389 | - | - | 44 | 24 | 72 | 320 | 69 | 19 | - | 3.2 | 203 |
| 5 | Community Public Service Co. | 30 | May 20, 1943 | 938 | 11 | 0.10 | 146 | 43 | 44 | 240 | 329 | 61 | 0.4 | 13 | 542 |
| 6 | A. G. Rasco | 64 | May 25, 1943 | - | - | - | - | - | - | 284 | 45 | 11 | - | - | - |
| 7 | J. C. Wilson | 25 | May 22, 1943 | - | - | - | - | - | - | 246 | 1,500-2,000 | 84 | - | - | - |
| 8 | do. | 66 | May 21, 1943 | - | - | - | - | - | - | 277 | 270 | 21 | - | - | - |
| 9 | City of Memphis | 61 | May 22, 1943 | - | - | - | - | - | - | 267 | 3,000± | 87 | - | - | - |
| 10 | Kendrick Estate | 56 | Oct. 14, 1943 | 1,010 | - | - | 132 | 64 | 136 | 331 | 259 | 234 | - | 22 | 592 |
| 11 | T. J. Hampton | 48 | Oct. 13, 1943 | 755 | - | - | 66 | 25 | 182 | 408 | 142 | 114 | - | 25 | 268 |
| 12 | Burl Smith | 67 | Oct. 15, 1943 | 317 | 27 | 0.05 | 55 | 25 | 16 | 265 | 15 | 3.0 | 0.6 | 45 | 240 |
| 13 | — Prater | 60 | do. | 260 | - | - | 46 | 15 | 29 | 210 | 23 | 14 | - | 30 | 176 |
| 14 | C. S. Compton | 58 | Oct. 14, 1943 | 343 | - | - | 74 | 24 | 12 | 210 | 95 | 18 | - | 17 | 283 |
| 17 | C. T. Palmer | 38 | do. | 939 | - | - | 110 | 90 | 83 | 262 | 319 | 185 | - | 23 | 644 |
| 18 | Mrs. -- Sanderson | 48 | do. | 580 | - | - | 63 | 55 | 61 | 266 | 125 | 85 | - | 60 | 333 |
| 21 | I. W. Thomason | 55 | Oct. 7, 1943 | 350 | - | - | 48 | 39 | 29 | 304 | 62 | 21 | - | 1.0 | 280 |
| 23 | Albert Gerlach | 48 | Oct. 15, 1943 | - | - | - | - | - | - | 254 | 1,429 | 38 | - | - | - |
| | **Domestic and stock wells in Donley County** | | | | | | | | | | | | | | |
| 274 | City of Hedley | 100 | May 19, 1943 | 383 | 13 | 0.15 | 72 | 9.5 | 53 | 320 | 31 | 13 | 1.6 | 20 | 218 |
| 288-292 | Fred M. Finch | Spring | May 24, 1943 | 238 | - | - | 62 | 5.9 | 23 | 232 | 21 | 11 | - | 1.0 | 179 |
| 298 | do. | Spring | do. | - | - | - | - | - | - | 218 | 8 | 8.0 | - | - | - |
| *299 | WPA Test | 32 | Apr. 9, 1941 | 204 | - | - | 56 | 8.3 | 12 | 207 | 14 | 12 | - | - | 175 |

* Analyses from Donley County WPA report.

Partial analyses of water from wells and springs in the Memphis area, Texas—Continued
(Results are in parts per million)

| Well | Owner | Depth of well (ft.) | Date of collection | Total dissolved solids | Silica ($SiO_2$) | Iron (Fe) | Calcium (Ca) | Magnesium (Mg) | Sodium and Potassium (Na+K) (calc.) | Bicarbonate ($HCO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Total hardness as $CaCO_3$ (calc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Domestic and stock wells in Donley County | | | | | | | | | | | |
| 305 | State Highway Dept. | Spring | May 20, 1943 | 421 | - | - | 94 | 20 | 47 | 448 | 11 | 28 | - | 0.0 | 316 |
| 308 | W. P. Dial | 100 | Apr. 17, 1941 | 2,703 | - | - | 576 | 91 | 112 | 146 | 1,827 | 24 | 0.9 | - | 1,816 |
| *309 | WPA Test | 47 | Apr. 15, 1941 | 1,091 | - | - | 183 | 98 | 14 | 122 | 669 | 66 | .5 | - | 860 |
| *310 | W. P. Dial | 76 | Apr. 17, 1941 | 504 | - | - | 46 | 54 | 69 | 336 | 74 | 96 | .5 | - | 338 |
| 314 | A. T. Simmons | 56 | May 19, 1943 | 663 | - | - | 95 | 21 | 114 | 329 | 122 | 92 | - | 57 | 324 |
| 317 | Roy Jewell | 186 | May 24, 1943 | - | - | - | - | - | - | 252 | 75 | 9.0 | - | - | - |
| 319 | W.H.Mendenhall | 195 | do. | 332 | - | - | 74 | 7.1 | 42 | 270 | 45 | 17 | - | 14 | 214 |
| 320 | C. F. Kinslow | 140 | do. | - | - | - | - | - | - | 268 | 27 | 13 | - | - | - |
| 321 | Mrs.W.D.Berger | 130 | May 20, 1943 | - | - | - | - | - | - | 279 | 50 | 42 | - | - | - |
| 322 | Mrs.T.E.Bailey | 106 | do. | - | - | - | - | - | - | 250 | 26 | 20 | - | - | - |
| 323 | Baker Jones | 105 | May 24, 1943 | - | - | - | - | - | - | 312 | 80 | 14 | - | - | - |
| 324 | A.L.Stanford | 56 | May 19, 1943 | 247 | - | - | 75 | 6.9 | 12 | 263 | 9.7 | 9.0 | - | 4.5 | 216 |
| 325 | Fort Worth and Denver Railway | 12 | do. | 441 | 12 | 0.45 | 93 | 20 | 27 | 292 | 64 | 42 | 1.0 | 7.2 | 314 |
| 326 | Giles Public School | 131 | May 20, 1943 | 249 | - | - | 38 | 33 | 11 | 220 | 21 | 37 | - | 0.5 | 230 |
| 327 | Buck Creek | Spring | do. | - | - | - | - | - | - | 253 | 260 | 121 | - | - | - |
| 328 | Arthur Ransom | 148 | May --, 1943 | - | - | - | - | - | - | 208 | 40 | 64 | - | - | - |
| 329 | — Parker | Spring | May 19, 1943 | 311 | - | - | 73 | 9.2 | 34 | 235 | 30 | 15 | - | 9.0 | 220 |
| 330-332 | Community Public Service Co. | 12 to 25 | May 20, 1943 | 309 | 26 | 0.12 | 73 | 10 | 19 | 260 | 20 | 17 | 0.6 | 5.0 | 223 |
| 333 | O. B. Smith | 135 | May 21, 1943 | - | - | - | - | - | - | 172 | 135 | 13 | - | - | - |
| 335 | Troy Broome | Creek | do. | - | - | - | - | - | - | 182 | 3,000± | 57 | - | - | - |
| 336 | do. | 35 | do. | - | - | - | - | - | - | 48 | 3,000± | 43 | - | - | - |
| 337 | Charlie Hill | 88 | do. | - | - | - | - | - | - | 307 | 1,100 | 150 | - | - | - |
| 338 | Burl Smith | 45 | do. | - | - | - | - | - | - | 350 | 80 | 36 | - | - | - |

* Analyses from Donley County WPA report.

Partial analyses of water from wells in the Memphis area, Texas--Continued
(Results are in parts per million)

Domestic and stock wells in Donley County

| Well | Owner | Depth of well (ft.) | Date of collection | Total dissolved solids | Silica ($SiO_2$) | Iron (Fe) | Calcium (Ca) | Magnesium (Mg) | Sodium and Potassium (Na+K) (calc.) | Bicarbonate ($HCO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Total hardness as $CaCO_3$ (calc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 339 | Burl Knight | - | Oct. 11, 1943 | 278 | - | - | 63 | 19 | 14 | 242 | 17 | 20 | - | 26 | 235 |
| 340 | Vivian Kendrick | 57 | Sept.30, 1943 | 300 | - | - | 55 | 25 | 27 | 285 | 22 | 29 | - | 2.0 | 240 |
| 341 | W.R.Reed Estate | 71 | Oct. 15, 1943 | 666 | - | - | 80 | 68 | 53 | 308 | 213 | 64 | - | 36 | 479 |

*Domestic and stock wells in Collingsworth County

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 485 | Viola M. Reed | Spring | Oct. 20, 1938 | - | - | - | - | - | - | - | 84 | 45 | - | - | - |
| 486 | N. T. King | 135 | Sept. 6, 1938 | 396 | - | - | 67 | 32 | 36 | 354 | 32 | 18 | 0.4 | 37 | 300 |
| 487 | Ira Morgan | 102 | do. | 308 | - | - | - | - | - | 305 | 15 | 15 | - | - | - |
| 490 | J. F. White | - | do. | 359 | - | - | - | - | - | 281 | 60 | 28 | - | - | - |
| 491 | P. E. Starr | Spring | Oct. 20, 1938 | 2,453 | - | - | - | - | - | 299 | 1,481 | 70 | - | - | - |
| 492 | do. | 25 | Sept. 6, 1938 | 417 | - | - | - | - | - | 348 | 68 | 23 | - | - | - |
| 501 | W. D. Dial | Spring | Oct. 20, 1938 | 2,979 | - | - | 605 | 160 | 64 | 171 | 2,022 | 44 | 0.8 | - | 2,168 |
| 502 | R. V. Sweatt | 77 | Sept. 6, 1938 | 369 | - | - | - | - | - | 293 | 48 | 28 | - | - | - |
| 504 | Ruth Ellison | Spring | do. | 3,451 | - | - | 586 | 250 | 108 | 244 | 2,271 | 116 | - | - | 2,494 |
| 505 | do. | 112 | Sept.27, 1938 | 1,902 | - | - | - | - | - | 220 | 1,190 | 16 | - | - | - |
| 506 | Noel Gudd | 66 | Sept. 6, 1938 | 380 | - | - | 66 | 30 | 35 | 311 | 44 | 34 | - | - | 288 |
| 507 | J. W. Stokes | 106 | do. | 454 | - | - | 68 | 40 | 42 | 238 | 85 | 102 | - | - | 335 |
| 508 | J. M. Lane | 173 | do. | 239 | - | - | 40 | 23 | 21 | 232 | 24 | 17 | - | - | 194 |
| 510 | Ella A.Gibson | Spring | Sept. 7, 1938 | 8,361 | - | - | 1,067 | 930 | 87 | 183 | 5,909 | 268 | 0.4 | - | 6,494 |
| 511 | Brookhollow Country Club | Tank | do. | 823 | - | - | 196 | 35 | - | 61 | 552 | 9 | - | - | 637 |
| 512 | W. L. Neel | 98 | do. | 2,437 | - | - | - | - | - | 30 | 1,673 | 27 | - | - | - |
| 516 | J. C. Donegby | 106 | do. | 3,218 | - | - | 598 | 165 | 151 | 61 | 2,056 | 218 | 0.2 | - | 2,172 |

* Analyses from Collingsworth County WPA report.

*Domestic and stock wells in Childress County

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | - | 225±Apr. | 9, 1941 | 3,564 | - | - | 686 | 184 | 139 | 146 | 2,294 | 189 | - | - | 2,474 |
| 5 | C.L.Caviness | 325±Jan. | 3, 1941 | 4,190 | - | - | 638 | 153 | 503 | 159 | 2,138 | 680 | - | - | 2,224 |
| 6 | A. Hutchinson | 132 | do. | 3,235 | - | - | 632 | 149 | 138 | 98 | 2,138 | 130 | - | - | 2,192 |
| 7 | F. K. Smith | 150 | do. | 3,750 | - | - | 626 | 165 | 312 | 146 | 2,255 | 320 | - | - | 2,242 |

* Analyses from Childress County WPA report.

Partial analys s of water from wells in the Memphis area, Texas--Continued
(Results are in parts per million)

| Well | Owner | Depth of well (ft.) | Date of collection | Total dissolved solids | Silica ($SiO_2$) | Iron (Fe) | Calcium (Ca) | Magnesium (Mg) | Sodium and Potassium (Na+K) (calc.) | Bicarbonate ($HCO_3$) | Sulfate ($SO_4$) | Chloride (Cl) | Fluoride (F) | Nitrate ($NO_3$) | Total hardness as $CaCO_3$ (calc.) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Memphis test wells | | | | | | | | |
| A1 | City of Memphis | 35 | Sept.23, 1943 | 417 | 44 | 0.04 | 60 | 34 | 21 | 245 | 103 | 18 | 0.5 | 1.2 | 290 |
| A2 | do. | 126 | Sept.22, 1943 | 555 | 31 | 0.05 | 78 | 39 | 23 | 198 | 180 | 29 | 0.8 | 0.2 | 355 |
| B | do. | 105 | Sept.28, 1943 | 372 | 44 | 0.04 | 48 | 35 | 22 | 257 | 68 | 19 | 0.5 | 1.5 | 264 |
| C | do. | 68 | Oct. 1, 1943 | 628 | 31 | 0.10 | 100 | 37 | 41 | 250 | 154 | 76 | 0.4 | 21 | 402 |
| E | do. | 54 | Oct. 2, 1943 | 470 | 19 | 0.05 | 78 | 22 | 39 | 220 | 144 | 26 | 0.9 | 0.2 | 285 |
| G | do. | 62 | Oct. 6, 1943 | 707 | 40 | 0.04 | 92 | 60 | 31 | 254 | 237 | 23 | 0.8 | 1.8 | 476 |
| H1 | do. | 57 | Oct. 7, 1943 | - | - | - | - | - | - | 250 | 591 | 21 | - | - | - |
| H2 | do. | 65 | Oct. 13, 1943 | 438 | 49 | 0.14 | 65 | 32 | 32 | 282 | 95 | 22 | 0.9 | 0.8 | 294 |

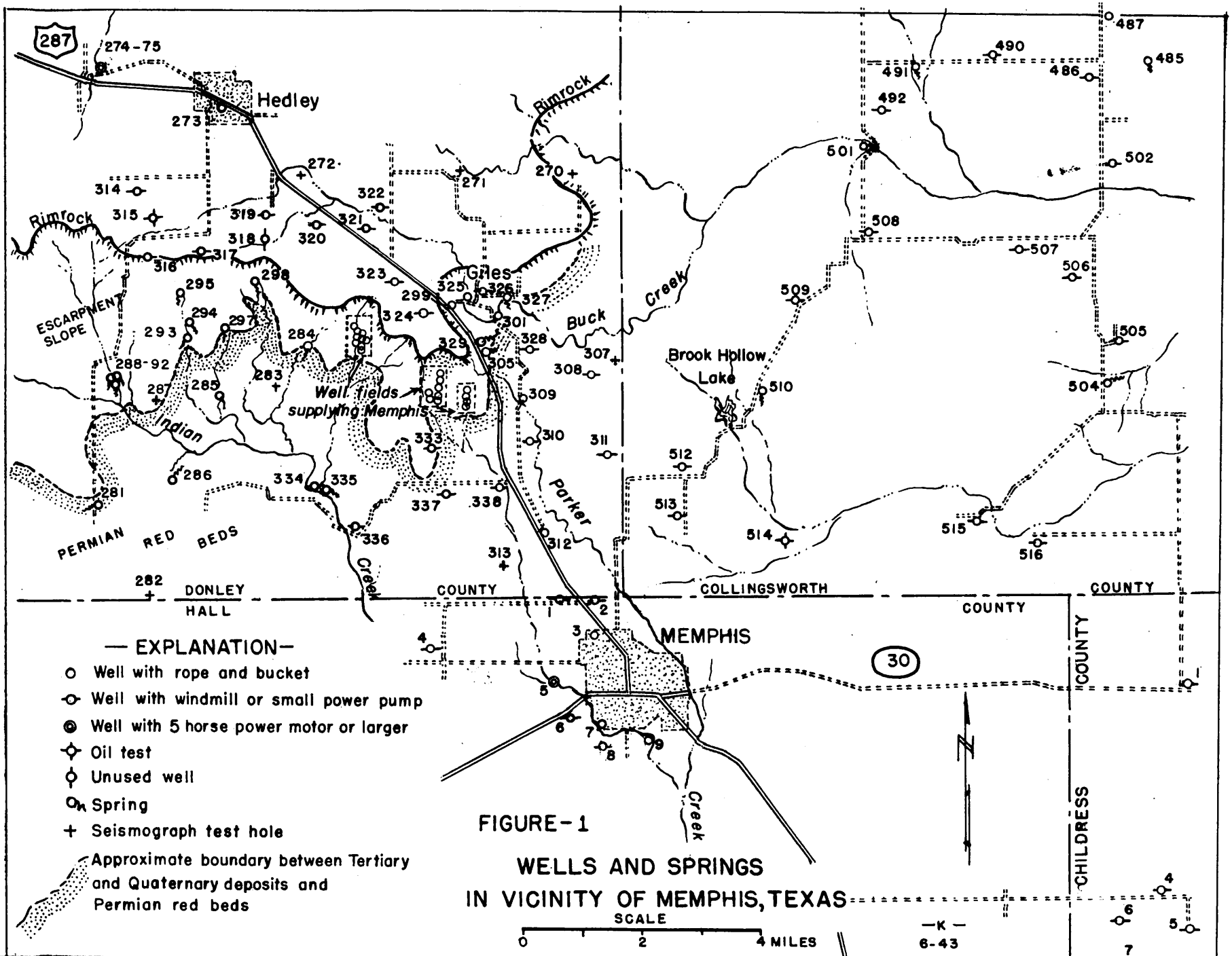


FIGURE-1

WELLS AND SPRINGS IN VICINITY OF MEMPHIS, TEXAS

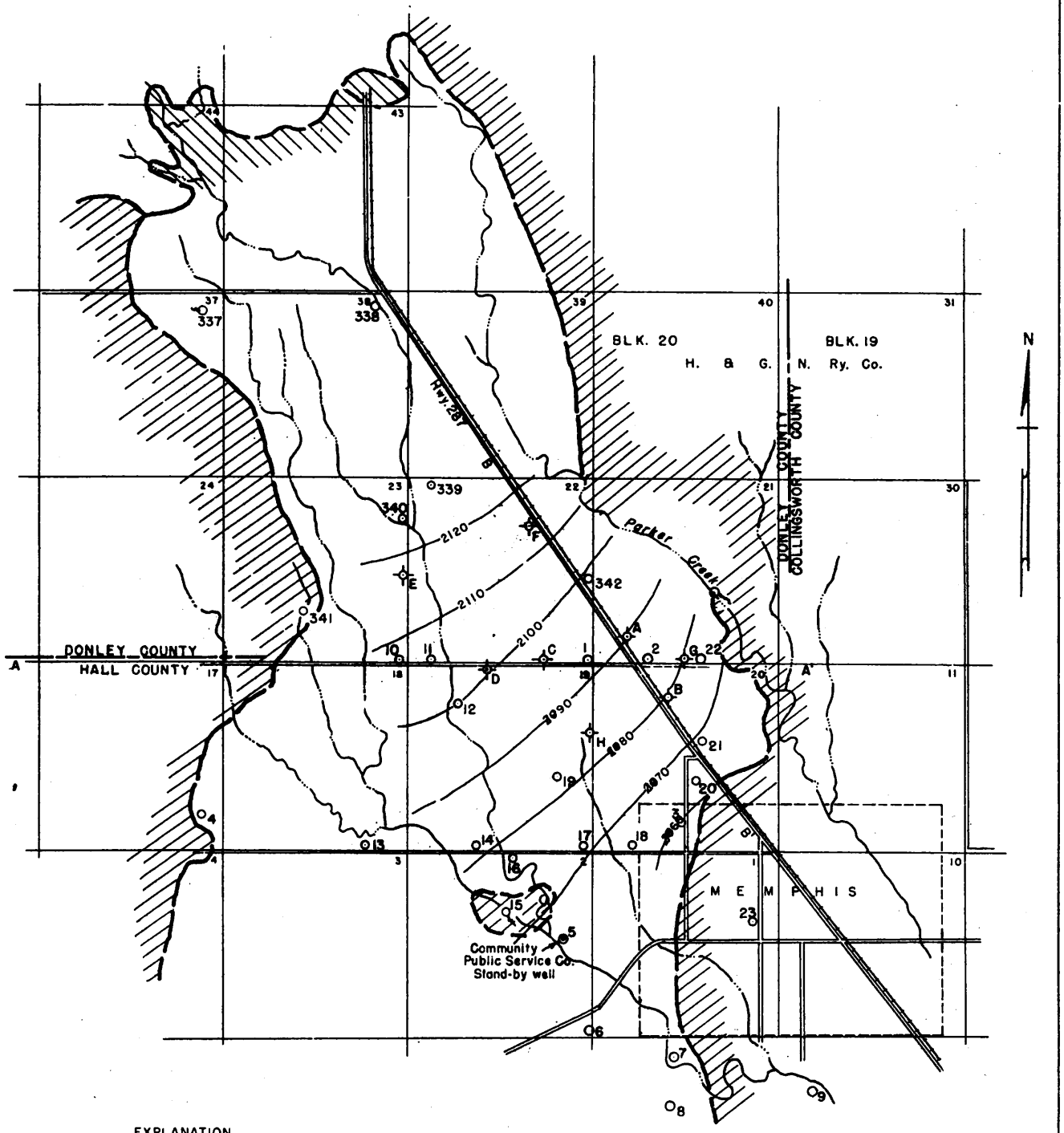


FIGURE-2

MAP SHOWING AREA EXPLORED BY TEST DRILLING NEAR MEMPHIS, TEXAS SEPT. AND OCT. 1943

12-3-43 A.C.C.

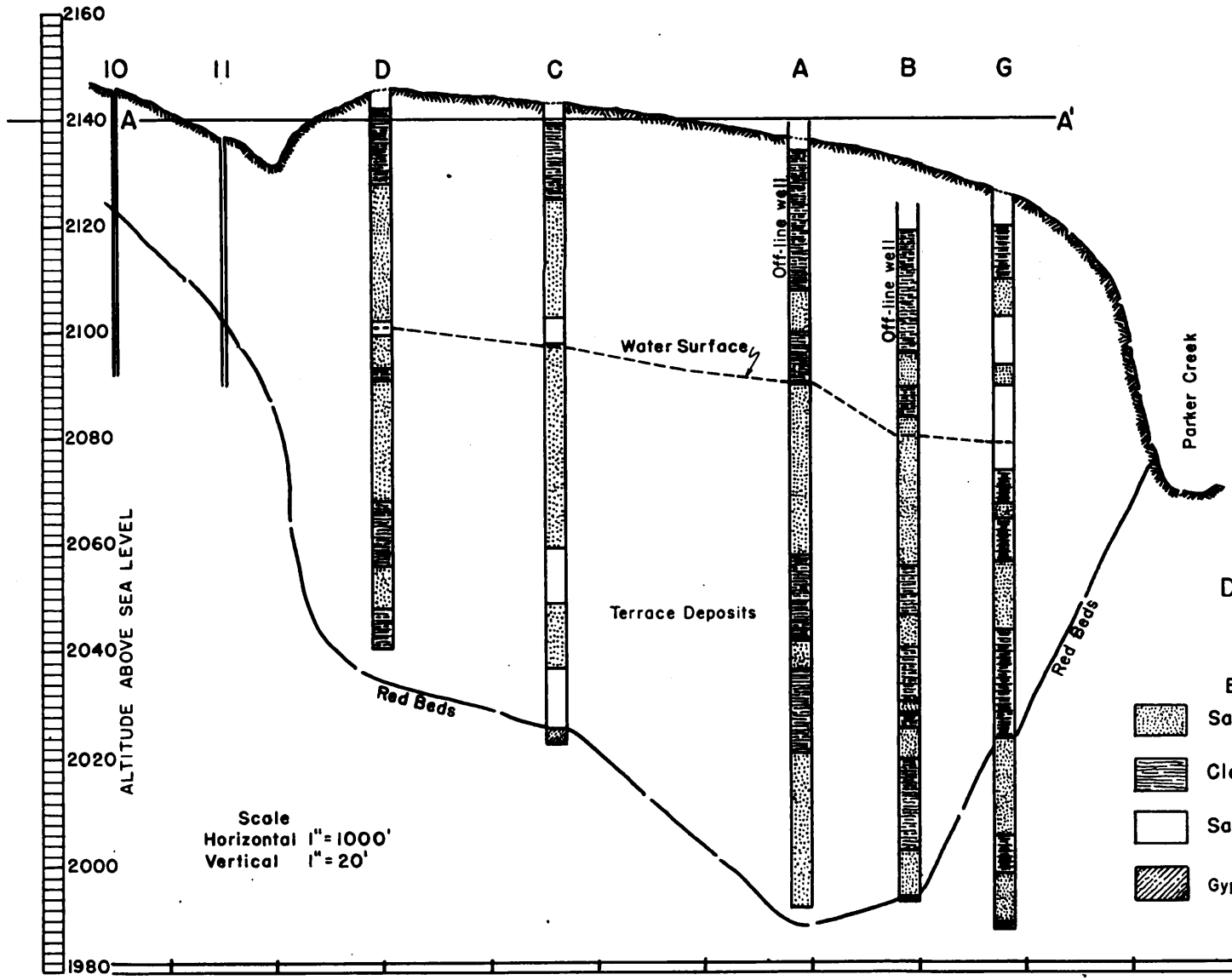


FIGURE-3

CROSS-SECTION ALONG
DONLEY-HALL COUNTY LINE
NEAR MEMPHIS, TEXAS

EXPLANATION

- Sand, and sand with clay lens
- Clay
- Sandy soil, sandy silt and sandy clay
- Gypsum

12-2-43 AGG.

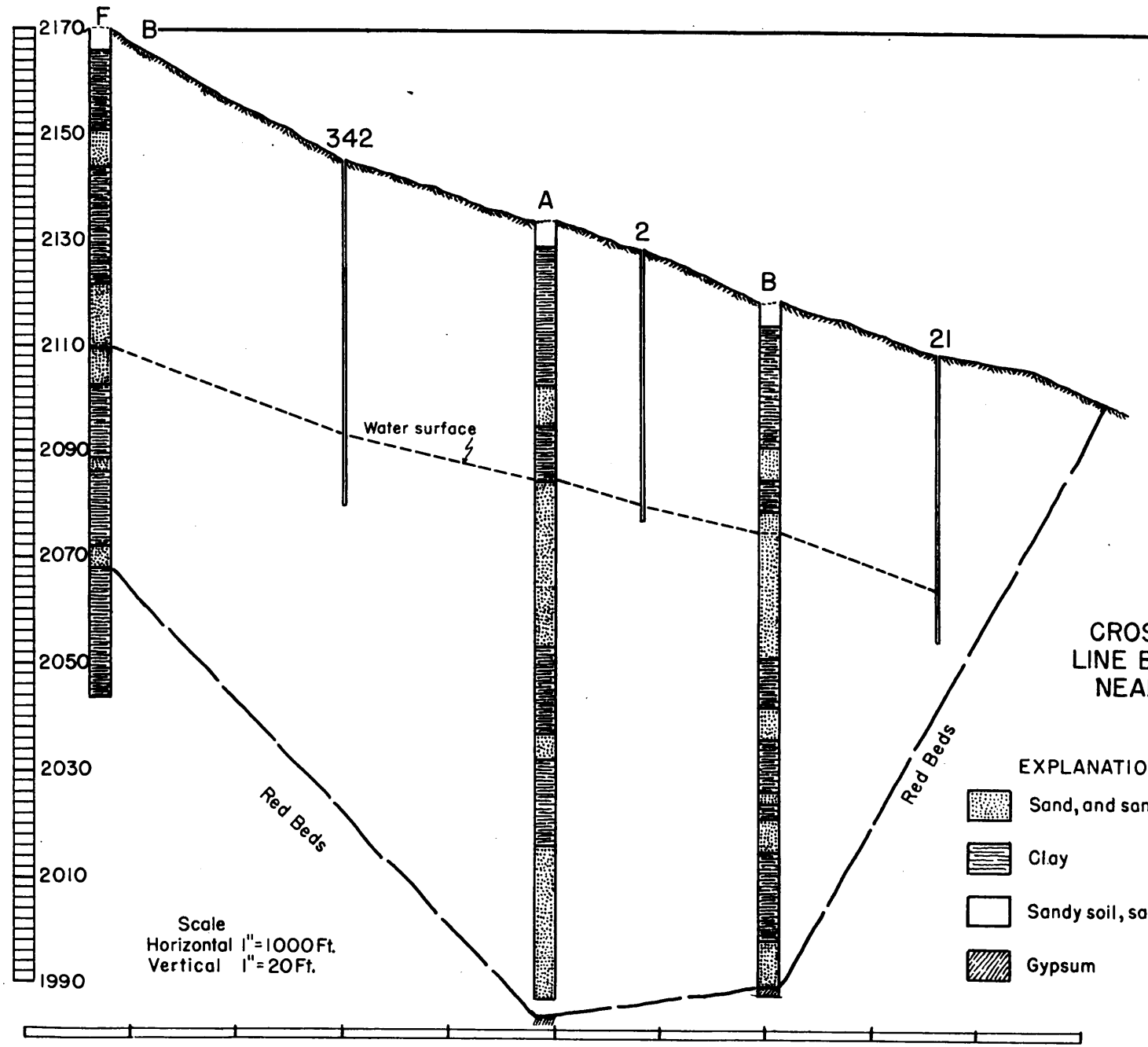


FIGURE-4

CROSS-SECTION ALONG LINE B-B' ALONG HWY. 287 NEAR MEMPHIS, TEXAS

12-3-43 ACC