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WATER LEVELS AND ARTESIAN PRESSURE IN OBSERVATION WELLS IN THE UNITED STATES IN 1935

WITH STATEMENTS CONCERNING PREVIOUS WORK AND RESULTS

Prepared under the direction of
O. E. MEINZER
Geologist in Charge of Ground-Water Investigations
and
L. K. WENZEL
Chairman of the Committee on Observation Wells

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INTRODUCTION

The present report consists of a group of papers prepared chiefly by members of the United States Geological Survey. It relates chiefly to the work of the Geological Survey and cooperating Federal, State, county, and local agencies in obtaining records of water levels and artesian pressure in observation wells in 25 States and the Territory of Hawaii. It is planned to be the first of a series of annual reports on the fluctuations of the ground-water levels and artesian pressures in the United States. No effort has been made to obtain strict uniformity among the several papers, either in subject matter or in the details of presentation.

The papers covering most of the States relate only to the work of the United States Geological Survey and cooperating agencies, but for some States the work of other agencies is also outlined. Thus an outline is given of practically all water-level work in California, including a large amount of valuable work done independently by State and other agencies. For most of the States that are covered a historical outline is given of the water-level work that has been done by the Geological Survey and cooperating agencies. For some States, however -- for example, Montana -- only the records of specific projects are given. Considerable water-level work has also been done in some of the States that are not included in this report. It is hoped that in the reports for ensuing years adequate information for all States can be presented.

In cooperation with the State geologist of South Dakota, about 75 artesian wells west of the Missouri River were investigated by T. W. Robinson in 1935, and, with certain exceptions, one or more measurements of depth to the water level or artesian pressure were made on each of these wells. The records of these wells are to be published in a bulletin of the State Geological Survey. Water levels were measured in several wells in Georgia in connection with an investigation of the Warm Springs area by D. F. Hewett and others. An automatic water-stage recorder was maintained on one observation well in Memphis, Tenn.

The water levels are given with reference to datum planes of different kinds. Some are given in depth below the measuring point -- that is, below the recognized reference mark at or near the top of the well from which the depth to the water level in the well is usually measured; some are given in height above mean sea level; and some are given in height above an arbitrary datum plane. The preferred method of expressing water levels is the arbitrary-datum method that was developed in connection with the work in Pennsylvania and is used also in this report for the records of the eight areas of the United States Soil Conservation Service in which the Geological Survey is cooperating. This method and its advantages are described in the report of the committee on observation wells.[1] According to this method a date is chosen when the water levels are at a low stage, and the arbitrary datum for each observation well is taken to be 10 feet below the water level in that well on that date. For the Pennsylvania project the date was November 28, 1931; for the eight Soil Conservation projects it was January 1, 1935. The depths to the water levels were not generally measured on January 1, 1935, but were computed by interpolating between the last measurement in December 1934 and the first measurement in January 1935. If on any project a new observation well is added after the program has been started, its arbitrary datum is determined by selecting a date when the other observation wells of the project have an average stage that is fairly close to 10 feet, and assuming that the water level in the new well on that date is at the average stage.

The present report and the plan to issue annual water-level reports in future years are to be regarded as a step in the realization of a Nation-wide program of water-level records which has been recommended by the National Resources Committee and on which the Geological Survey has been intensively working in recent years. In this connection attention is called to the report of the committee on observation wells of the Geological Survey, which is a preliminary manual of methods that was issued by the Department of the Interior in mimeographed form in May 1935; also to the series of papers that were presented in the symposium on ground-water levels at the meeting of the Section of Hydrology of the American Geophysical Union on May 1, 1936, and are to be published in the Transactions of the Union. In the introduction to the report of the committee on observation wells is given a general outline of the water-

1 Leggette, R. M., and others, Report of the committee on observation wells, United States Geological Survey -- a preliminary manual of methods (mimeographed), pp. 56-57, U. S. Dept. Interior, May 1935.

level work of the Geological Survey and a discussion as to what is needed to develop this work into an adequate Nation-wide program.

Acknowledgments for effective services in the preparation of this report are due to V. C. Fishel, especially for his work on the papers relating to the projects of the Soil Conservation Service, to Bernard H. Lane, who edited the entire report, and to Miss Florence Garrison, who typed the offset copy.

The following instructions were issued December 18, 1935, for the preparation of contributions to this report:

Each State section will consist of two parts -- first, a comprehensive description of the water-level work that has been done in the State; and second, a presentation of selected data.

The first part is required in full for each State and should give essentially the following information: (1) A brief historical review of water-level work that has been done in the State, including the essential facts in regard to agencies and personnel, the first measurements that were made, the development and interruptions of the water-level programs, and the length of records. (2) A comprehensive description of the water-level work in the calendar year 1935, including a statement regarding the cooperating agencies and approximate statements as to the total number of wells in which water levels were measured at least once in 1935, the number of wells in which more than one measurement was made during the year, and the total number of individual measurements made during the year. (3) A general statement as to the program of measurements -- about how many wells were measured weekly, monthly, or at other intervals in 1935, and something as to whether the measurements were made by our own regular staff, by men who were employed to make rounds of measurements at stated intervals, or by local observers of individual wells. (No statements need be included as to whether the measurements were voluntary or as to their cost.) (4) Information as to the number of automatic water-stage recorders that were operated during 1935. (5) Ground-water provinces covered. (6) General range in depth, diameter, and type of wells. (7) General classification of wells as water-table or artesian, and whether in areas affected or unaffected by heavy artificial withdrawal. (8) General information as to the character and permanency of measuring points and bench marks and to what extent they have been tied in by instrumental leveling. (9) References to existing publications that contain water-level data and a statement as to the availability to the public of unpublished records.

The second part of the State section will consist of information in regard to fluctuations of ground-water levels in 1935, and to some extent to fluctuations during the entire period since measurements were begun. Some data must be given in each State section, but wide latitude is allowed to the different men in regard to the amount of data contributed and also in the method of presentation. This latitude is granted in order that the project may not involve more work for any man than he can do successfully without essential interference with his other assigned work; also, in order that the report may be properly adapted to the other reports that are being prepared in the division. For example, in some States a large amount of data is being collected and there is provision for publishing the data in other reports, whereas in other States there are only a few observation wells and it may be desirable to give the complete records in this annual volume. A comprehensive and systematic plan should eventually be developed and executed for each State in which water-level measurements are made, but this work may require considerable time and should not be allowed to delay submission of material for the 1935 report.

In so far as practicable a concise summary should be given of the water-level fluctuations during the calendar year and also of the fluctuations during previous years for which there are records. This may be done by giving the average fluctuations of all the observation wells or of selected groups of wells, either in the text or in tabular form. Information is especially desired as to the average fluctuations

of the observation wells or of selected groups of wells, either in the text or in tabular form. Information is especially desired as to the average fluctuations of the observation wells in the State that are classified as water-table wells not situated in any recognized cone of depression. This information should include the number of wells used in obtaining the averages and the average water levels on or about January 1, 1935, and on or about January 1, 1936. It may also include the average on or about the first of each month in 1935 and in previous years.

It is desirable to include for several typical wells the complete 1935 records and also summaries of the records of previous years. Full information, such as is given on form 9-185, with full descriptions of the measuring points and benchmarks, must be given in regard to each well for which individual water-level data are presented. It is planned that this information will not be repeated in future annual reports. The records may be given either in depths below the measuring points or in elevations above an arbitrary datum. If an arbitrary datum is used its depth below the measuring point must be given.

Correlative records of precipitation and stream flow are not required but may be included in special cases. Furthermore, a concise description may be submitted of any especially interesting or unusual types of water-level fluctuations or interesting correlations of such fluctuations with precipitation, stream flow, pumping, or irrigation.

ARKANSAS

GRAND PRAIRIE REGION

By D. G. Thompson

Measurements of the depth to water in wells in the Grand Prairie region, comprising Arkansas County and parts of Prairie and Lonoke Counties, have been made since 1927 by the United States Geological Survey in cooperation with the Arkansas Geological Survey and the Arkansas Agricultural Experiment Station. Measurements were first made in 14 wells in September 1927 by O. E. Meinzer. Beginning in July 1928, from 100 to 150 wells were measured several times a year for 2 or 3 years. As funds for the work were reduced, the wells were measured only twice a year, and in 1934 and 1935 only once a year. Water-stage recorders have been maintained on one well continuously since July 20, 1928, and on five other wells for periods of 16 months or more.

The only significant draft on the principal water-bearing formation is that for rice irrigation and generally continues from about May 15 to September 15, sometimes with a little pumpage earlier or later than these dates. Therefore, when two measurements a year were possible these were made not later than May 15 or earlier than September 15. An effort was made to measure the wells several weeks before pumping began and after it stopped; and also, so far as possible, to make each succeeding annual measurement on the same day of the year as the previous measurement. In the first few years of the investigation the annual spring measurements were made in the later half of April and early May. However, it became desirable to have the results available earlier, and the measuring period was shifted to late February and early March. During the first 2 years after this shift most of the wells were measured both in February or March and in April or May, to afford a basis of comparison with the earlier records.

The Grand Prairie region is a part of the Gulf Coastal Plain. The section consists, at the top, of beds of clay, silt, sand, and gravel of Pleistocene age that range from less than 100 feet to 250 feet or more in thickness. Throughout practically the entire area the upper part of these beds, to a depth of 25 to 100 feet in different places, consists largely of clay or silt, which is apparently very impervious. There is good

evidence that very little if any recharge of the underlying water-bearing beds occurs by direct downward percolation from rainfall, and that the water moves in laterally from points of recharge beyond the borders of the region.

Beneath the Pleistocene beds is several hundred feet of clay and sand of Tertiary age. About 10 wells take water from some of these sands.

The altitudes of the measuring points of most of the observation wells have been determined by means of instrumental levels tied to a line of levels run from a United States Coast and Geodetic Survey bench mark at Varner, in Lincoln County, to a similar bench mark at Hazen, in Prairie County. Along this line permanent bench marks were established in the towns and at intervals of about 3 miles, and less permanent bench marks at shorter intervals. The levels were run by the topographic branch of the United States Geological Survey.

For many wells the measuring point is the top of the pump base, which is commonly an inch or two above the top of the steel well pit or casing. Inasmuch as the pumps of many wells are removed at intervals of a few years, some of the reference points have been disturbed and not always returned to the same altitude. It has not been possible to relevel to these wells, but an attempt has been made to apply approximate corrections wherever there has been a noticeable change in the altitude of the measuring point.

On the following pages records are given for 18 wells, on 5 of which automatic recorders have been maintained during at least a part of the period of observation. For the recorder wells the depth to the water level is given on dates when the wells were visited; for other wells all measurements are given.

All the wells for which automatic records are available, with one possible exception, show fluctuations that are caused by fluctuations of atmospheric pressure. These atmospheric fluctuations have been proved to be practically constant for wells 60 miles apart. Minor differences may be attributed largely to the differences in pressure in different parts of a high or low pressure area separated by such a distance. Observed fluctuations due to this cause have been as much as 1 foot within a few days and are frequently more than 6 inches as areas of high and low pressure pass across the region.

Most of the wells have hydrographs of similar types with highest points just before the irrigation season begins. Thereafter there is a drop rather rapid at first and then becoming slower and slower but generally

continuing to the end of the irrigation season. During the irrigation season the water level generally rises from a few inches to several feet when nearby pumps are shut down for periods of a few hours to a few days, the amount of rise depending on the distance from the pumping well. The lowest water level is generally reached at the end of the irrigation season. Thereafter the water level rises, at first rapidly, then more slowly. In a few wells near the White River, along the eastern edge of the region near Crocketts Bluff and St. Charles, the head has generally declined for several weeks after the end of the irrigation season. In the northeast and southeast corners of the area there is definite evidence that the head rises and falls in fairly close accord with the stage of the White River. Elsewhere there is no evidence of recharge from any of the streams in the region except possibly in one small area near the Arkansas River, at the extreme south end of the region.

Pumping for irrigation began about 1900, but it probably did not become great enough to affect the general static level very much until some time after 1910. Information is available in regard to the approximate depth to water in a considerable number of wells drilled within a few years before or after that date, and these data afford a basis for general comparison with present conditions. The evidence indicates that before there was any heavy pumping for irrigation the water was under artesian pressure practically everywhere in the region, and the piezometric surface was highest in the northwestern part and sloped eastward or southeastward, with a gradient between 1 and 2 feet to the mile or a little more. As a consequence of heavy pumping there has been developed a great irregular canoe-shaped depression in the piezometric surface, with its long axis trending north-northwest to south-southeast.[1] This depression apparently is completely closed, and the contours of the piezometric surface show that water is flowing into it from all directions beyond its border; except that in low stages of the White River there may be a break in the surrounding high part of the piezometric surface at its southeast corner, with some movement of water toward the White River. It is a striking fact that in much of the eastern part of the area the direction of flow has been reversed since about 1910.

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1 Ground-water supplies for rice irrigation in the Grand Prairie region, Arkansas: U. S. Dept. Interior Press Mem. 49844, 21 pp., 2 maps. Jan. 26, 1931.

The lowest part of the depression in the piezometric surface extends from a point a few miles east and northeast of Stuttgart southeastward to a point a few miles south of DeWitt. In some wells in this part of the area the head now is apparently 35 to 40 feet lower than it was about 1910. In some parts where there has been a great drop in head the upper part of the water-bearing beds has been drained, and the original artesian condition has been succeeded by a water table. In contrast to the great decline in head in the central part of the region, the decline around the borders has been only a few feet.

10 G. G. Fitch. Near northwest corner NE¼SE¼ sec. 12, T. 2 N., R. 8 W. Depth of well 200 feet; depth of pit 80+ feet. Measuring point, top of pit, level with land surface, until spring of 1930, when pump was installed; thereafter top of pump base, about 0.10 foot above top of pit. Measurements made from new point have been corrected to the original point by deducting 0.10 foot; altitude of original measuring point, 234.91 feet. Well equipped with automatic water-stage recorder, Dec. 1, 1928 to Mar. 30, 1930.

Date	Time		Depth to water level (feet)	Date	Time		Depth to water level (feet)
Oct. 25,1928	Noon		48.33	Oct. 10,1930	3:45	p.m.	52.21
Nov. 19	4:05	p.m.	47.75	Apr. 20,1931	12:30	p.m.	47.89
Nov. 21	10:55	a.m.	47.73	Feb. 20,1932	2:40	p.m.	48.48
Jan. 18,1929			45.10	Apr. 18	6:00	p.m.	47.68
July 3	1:20	p.m.	a 51.68	Oct. 13	11:30	a.m.	52.43
July 8	10:00	a.m.	51.91	Feb. 21,1933	12:40	p.m.	49.19
July 30	10:50	a.m.	b 53.32	Feb. 28,1934	4:10	p.m.	48.82
Aug. 4	11:40	a.m.	b 54.12	Aug. 24	3:45	p.m.	54.00
Feb. 20,1930	11:30	a.m.	47.08	Oct. 15	11:00	a.m.	51.97
Mar. 21	4:20	p.m.	46.68	Nov. 19	12:20	p.m.	50.80
Aug. 12			c	Feb. 19,1935	10:45	a.m.	49.57
Sept. 1	2:20	p.m.	d 54.85				

a Pumps running in wells ⅛ mile west and ¼ mile northwest.
b Pump running in well ¼ mile northwest.
c Pumping.
d New reference point used in this measurement.

51A. Mrs. A. Maxwell, SW¼SE¼ sec. 11, T. 2 N., R. 6 W. Measuring point, top of pit, approximately level with land surface; altitude not determined. This is an abandoned well. It has been equipped with an automatic water-stage recorder continuously since Oct. 29,1930, but because of breakage of the float cable and unavoidable irregularity in attendance there have been several breaks of considerable length since about Feb. 1,1933. The well is equipped with a continuous recorder which operates about 6 weeks without attendance. When it has not been possible to visit the recorder promptly after the clock has stopped, checks for both time and vertical scale have been lost. This well is on the extreme northern edge of the Grand Prairie region, and during the period of observation there has been no pumpage within at least a mile of the well. In contrast to most wells in the region the water level in this well generally reaches its highest level in June and its lowest level from about Nov. 1 to Dec. 31, or even later. This lag is perhaps due to drainage from the border territory, where there is no pumping, to the interior part of the area of heavy pumping. The following measurements are those made whenever the recorder was visited to change charts. In addition to the measurements in the table the highest and lowest levels reached each year according to the charts were as follows: 1930, highest (since beginning of record Oct. 29) 63.50 Nov. 9, lowest 63.85 Dec. 30; 1931, highest 62.98 May 9; lowest 64.30

Dec. 3; 1932, highest 62.80 May 20, lowest 64.93 Dec. 31; 1933, highest 63.45 May 27, (record for late part of year incomplete, lowest through Oct. 14 64.56 Oct. 1; thereafter record is so incomplete that highest and lowest points are not significant.)

Date	Time	Depth to water level (feet)	Date	Time	Depth to water level (feet)
Oct. 29,1930	3:20 p.m.	63.53	June 2, 1933	9:30 a.m.	63.50
Nov. 25	11:15 a.m.	63.64	Aug. 8	3:30 p.m.	64.01
Jan. 19,1931	10:00 a.m.	63.78	Oct. 14	8:20 a.m.	64.38
Apr. 11	4:00 p.m.	63.52	(No record Oct. 14, 1933 to Aug. 24,1934)		
May 22	4:30 p.m.	63.19			
June 13	2:30 p.m.	63.09	Aug. 24,1934	10:00 a.m.	64.55
July 3	3:40 p.m.	63.26	Aug. 27	1:30 p.m.	64.48
Sept.19	3:00 p.m.	63.94	Oct. 3	11:00 a.m.	64.73
Sept.24	3:50 p.m.	63.80	Oct. 9	9:00 a.m.	64.76
Oct. 12	10:00 a.m.	64.10	Oct. 19	9:00 a.m.	64.77
Dec. 22	10:40 a.m.	64.17	Oct. 22	3:00 p.m.	64.78
Feb. 20,1932	4:10 p.m.	62.59	Nov. 5	10:00 a.m.	65.00
Apr. 25	11:30 a.m.	62.70	Dec. 4	9:30 a.m.	65.13
June 22	3:00 p.m.	62.99	Mar. 7,1935	4:30 p.m.	65.28
Aug. 11	3:30 p.m.	63.38	Apr. 12	10:40 a.m.	65.10
Sept.29	4:16 p.m.	63.89	June 10	9:30 a.m.	64.63
Nov. 30	10:00 a.m.	64.23	July 18	2:00 p.m.	64.60
Jan. 14,1933	2:30 p.m.	64.35	Sept. 6		65.00
Mar. 15	11:00 a.m.	64.24	Dec. 1		65.38
May 18	2:00 p.m.	63.77	Feb. 21,1936		65.50

55 George Jensen (?) Near southwest corner sec. 13, T. 2 N., R. 5 W. Measuring point, top of pump base, level with top of pit, about 1 foot above land surface. Altitude of measuring point, 225.85 feet.

Date	Time	Depth to water level (feet)	Date	Time	Depth to water level (feet)
Aug. 24,1928	12:25 p.m.	76.37	Apr. 28,1930	4:00 p.m.	60.63
Sept.25	3:30 p.m.	64.85	May 12	2:30 p.m.	60.60
Nov. 13	11:10 a.m.	60.20	May 16	4:30 p.m.	59.17
Mar. 18,1929	5:30 p.m.	54.36	May 21	7:00 p.m.	52.75
Apr. 29	2:05 p.m.	52.50	June 8	4:30 p.m.	71.87
May 15	5:10 p.m.	53.80	June 30	4:00 p.m.	78.40
May 25	3:50 p.m.	53.78	July 9	4:30 p.m.	79.04
July 9	12:30 p.m.[a]	72.76	July 19	9:30 a.m.	81.40
Aug. 5	12:30 p.m.[b]	78.35	Aug. 15	[e]	
Aug. 28	3:30 p.m.[c]	79.38	Aug. 30	2:15 p.m.	82.10
Sept.12	11:45 a.m.[d]	78.25	Sept.19	11:00 a.m.	77.88
Sept.27	3:35 p.m.	71.78	Sept.29	8:30 a.m.	69.98
Nov. 13	3:30 p.m.	63.74	Nov. 19	9:30 a.m.	66.68
Feb. 20,1930	5:30 p.m.	55.40	Jan. 19,1931	9:00 a.m.	64.99
Mar. 31	8:00 a.m.	58.27	Feb. 28	1:00 p.m.	59.50
Apr. 15	8:00 a.m.	59.02	Apr. 22	8:10 a.m.	59.60
Apr. 23	9:30 a.m.	60.30	May 1	8:00 a.m.	59.23

[a] Pumps running in well ½ mile north and 1/3 mile southeast.
[b] Pumps running in wells ½ mile north and ½ mile west.
[c] Pumps running in nearby wells.
[d] Pump running in well 1/3 mile southeast.
[e] This well has been pumped, but not much. Steel tape hung on pump did not strike water.

55. George Jensen--Continued.

Date	Time	Depth to water level (feet)	Date	Time	Depth to water level (feet)
Aug. 27,1931	2:40 p.m.	71.28	Sept.26,1934	8:15 a.m.	69.42
Sept.29	8:30 a.m.	68.17	Oct. 19	8:40 a.m.	68.64
Feb. 20,1932	5:30 p.m.	56.24	Nov. 12	9:00 a.m.	68.45
Apr. 19	9:00 a.m.	58.34	Nov. 28	4:15 p.m.	67.80
Sept. 7	7:30 a.m.	73.68	Dec. 3	3:30 p.m.	66.70
Sept.29	6:00 p.m.	69.36	Dec. 4	1:20 p.m.	66.64
Feb. 21,1933	8:00 a.m.	57.48	Dec. 14	3:10 p.m.	64.87
Feb. 22,1934	1:20 p.m.	64.15 ?	Dec. 22	9:30 a.m.	65.25
Mar. 5	5:00 p.m.	57.66	Feb. 20,1935	1:30 p.m.	61.25
Aug. 23	5:00 p.m.	80.35	Mar. 13	8:15 a.m.	52.37 ?
Sept. 8		f	Mar. 18	4:00 p.m.	59.05
Sept.14	8:00 a.m.	g 72.00			

f Dry at 88 feet.
g Plant pumping 1 mile south.

116. Steve Shimek, Jr. NW¼NW¼ sec. 30, T. 1 N., R. 5 W. Measuring point, top of pump base, 0.15 foot above top of pit and 0.6 foot above land surface. Altitude of measuring point, 215.39 feet.

Date	Time	Depth to water level (feet)	Date	Time	Depth to water level (feet)
Sept.21,1927	...	64.39	Apr. 18,1930	3:20 p.m.	64.85
Apr. 18,1928	...	62.01	Sept.23	4:00 p.m.	68.80
Aug. 1	...	65.58	Apr. 18,1931	2:10 p.m.	66.72
Sept.24	10:55 a.m.	65.02	Aug. 13	8:10 a.m.	a 71.16
Oct. 23	9:00 a.m.	64.66	Sept. 3	8:45 a.m.	72.07
Nov. 9	5:00 p.m.	64.43	Sept.23	4:35 p.m.	69.22
Jan. 15,1929	2:40 p.m.	63.83	Feb. 22,1932	11:00 a.m.	67.80
Mar. 18	6:25 p.m.	63.46	Sept. 7	2:4t p.m.	b 73.99
Apr. 25	9:00 a.m.	62.87	Sept.22	9:00 a.m.	71.08
May 13	12:15 p.m.	63.13	Feb. 23,1934	9:45 a.m.	69.64
Sept. 4	10:00 a.m.	67.82	Aug. 23	4:10 p.m.	74.27
Sept.24	9:00 a.m.	66.80	Oct. 16	9:30 a.m.	71.43
Feb. 21,1930	5:00 p.m.	65.00	Feb. 21,1935	11:30 a.m.	70.30

a Shut down 8:30 p.m. Aug. 12.
b Plants nearby pumping.

126. Vennum & Patterson. NW¼NW¼ sec. 12, T. 1 S., R. 7 W. Depth of well 138 feet; depth of pit 80 feet; diameter of screen 13 inches. Measuring point, bottom of hole in side of pump, 0.2 foot above land surface. Altitude of measuring point, 212.17 feet.

Date	Time	Depth to water level (feet)	Date	Time	Depth to water level (feet)
Aug. 10,1928	...	33.70	Aug. 5,1929	6:00 p.m.	35.12
Sept.24	5:30 p.m.	33.60	Sept.11	11:00 a.m.	35.74
Nov. 20	9:00 a.m.	33.62	Sept.24	5:50 p.m.	35.35
Feb. 12,1929	3:45 p.m.	33.57	Apr. 21,1930	9:30 a.m.	34.12
May 21	4:10 p.m.	33.20	May 21	8:00 a.m.	34.12
July 8	4:20 p.m.	a 34.17	Aug. 12	9:30 a.m.	b 33.88

a Pump has been shut down for 10 days.
b This well not pumped this year. No nearby wells pumping.

126. Vennum & Patterson--Continued.

Date	Time	Depth to water level (feet)	Date	Time	Depth to water level (feet)
Sept. 1,1930	6:50 p.m.	37.88	Apr. 21,1932	4:15 p.m.	33.42
Sept. 24	1:00 p.m.	33.90	Sept.24	9:40 a.m.	34.84
Apr. 21,1931	12:05 p.m.	34.25	Feb. 20,1934	11:30 a.m. c	34.78
Sept. 7	Noon	35.40	Aug. 28	8:30 a.m. d	36.33
Sept. 24	1:30 p.m.	34.84	Sept.26	12:15 p.m.	36.18
Feb. 20,1932	11:25 p.m.	33.92	Feb. 19,1935	4:30 p.m.	35.55

c Pumped in 1933.
d Not pumped.

135. C. D. Yohe. SW¼NW¼ sec. 27, T. 1 S., R. 6 W. Depth of well 138 feet. Measuring point, top of pit. Altitude of measuring point, 204.92 feet. This is an abandoned well 95 feet south of well with pump. Depth to the water level reported to have been 28 feet in 1916.

Date	Time	Depth to water level (feet)	Date	Time	Depth to water level (feet)
July 30,1928	...	37.55	Aug. 15,1930	11:40 a.m. a	45.46
Aug. 18	10:30 a.m. a	44.06	Sept.18	1:30 p.m.	40.28
Sept.18	1:10 p.m. b	37.30	Apr. 25,1931	12:50 p.m.	39.11
Nov. 9	12:15 p.m.	37.36	Aug. 29	2:45 p.m. a	46.24
Jan. 19,1929	c	37.09	Oct. 22	9:40 a.m.	40.48
May 15	12:10 p.m.	36.90	Sept. 7,1932	5:00 p.m.	40.88
July 9	9:30 a.m. b	38.66	Oct. 20	Noon	40.84
July 31	9:15 a.m. b	38.51	Mar. 12,1934	1:00 p.m.	41.52
Sept.12	5:30 p.m. d	39.00	Aug. 25	10:40 a.m.	44.53
Sept.18	9:50 a.m.	38.80	Oct. 19	1:00 p.m.	42.72
Apr. 26,1930	1:30 p.m.	37.80	Feb. 21,1935	2:50 p.m.	42.22
May 14	5:15 p.m.	37.72	Mar. 13	1:00 p.m.	42.25

a Pump in nearby well running.
b Pump in nearby well shut down.
c Depth to water in well with pump - 36.49
d Depth to water in well with pump - 38.88

144. Powell. SE¼NE¼ sec. 8, T. 1 S., R. 5 W. Measuring point, top of outer raised rim of pump base, about 0.2 ft. above land surface. Altitude of measuring point, 219.96 feet.

Date	Time	Depth to water level (feet)	Date	Time	Depth to water level (feet)
Oct. 31,1928	2:25 p.m.	87.30	Oct. 22,1931	4:45 p.m.	91.32
Nov. 1	9:20 a.m. a	87.10	Feb. 22,1932	3:45 p.m.	88.08
Nov. 1	4:10 p.m. a	88.43	Apr. 19	10:15 a.m.	87.05
Apr. 15,1929	....	81.77	Oct. 20	1:00 p.m.	94.70
July 9	3:30 p.m. b	92.43	Feb. 23,1933	11:45 a.m.	89.45
July 31	Noon c	.....	Feb. 23,1934	11:00 a.m.	89.21
Apr. 18,1930	2:30 p.m.	82.98	Aug. 25	2:30 p.m. e	102.00
Sept.18	.... d	.....	Oct. 18	4:45 p.m.	95.00
Oct. 22	3:00 p.m.	94.86	Nov. 5	11:00 a.m.	93.95
Apr. 18,1931	1:40 p.m.	87.16	Nov. 28	1:30 p.m.	92.58
Aug. 28	3:20 p.m.	99.51	Feb. 21,1935	4:15 p.m.	90.46

a Measurements made during pumping test of well 145, 250 feet east.
b Pump running in well 250 feet east. c Tape line stuck in well.
d Pump running. e Pump had been shut down only a few minutes before measurement was made.

159. Henry Bull. N½SE¼ sec. 29, T. 1 S., R. 5 W., ¼ mile west of road. Depth of well 656 feet; depth of pit 96 feet; diameter of screen 8 inches. Measuring point, top of pump base at small hole on south side, 0.2 foot above land surface. Altitude of measuring point, 224.85 feet.

Date	Time	Depth to water level (feet)	Date	Time	Depth to water level (feet)
Sept.18,1928	...	70.20	Apr. 25,1931	1:40 p.m.	57.45
Sept.24	10:00 a.m.	61.05	May 1	4:05 p.m.	57.39
Nov. 9	11:35 a.m.	58.21	May 14	8:30 a.m.	57.34
Jan. 15,1929	9:00 a.m.	56.92	Oct. 22	11:20 a.m.	61.59
May 13	10:50 a.m.	59.72	Apr. 19,1932	10:20 a.m.	56.83
Sept.18	9:10 a.m.	64.25	Oct. 20	1:25 p.m.	62.10
Apr. 26,1930	12:30 p.m.	55.70	Feb. 23,1933	Noon	58.09
Apr. 28	5:30 p.m.	a 55.60	Feb. 23,1934	11:30 a.m.	58.90
Sept.18	1:00 p.m.	68.70	Oct. 18	3:45 p.m.	63.03
Oct. 22	12:20 p.m.	64.92	Nov. 10	2:10 p.m.	61.80
Apr. 18,1931	12:15 p.m.	57.74			

a Special measurements of this well made Apr. 28-30.

173. J. D. Minnis. NE¼NW¼ sec. 13, T. 1 S., R. 4 W. Depth of well 161 feet; depth of pit 105 feet; diameter of screen 11-5/8 inches. Measuring point, bottom of hole cut below top edge of pit on north side. Altitude of measuring point, 214.06 feet.

Date	Time	Depth to water level (feet)	Date	Time	Depth to water level (feet)
Nov. 13,1928	...	63.53	Sept.29,1932	11:30 a.m.	67.52
Jan. 9,1929	9:05 a.m.	63.34	Mar. 4,1933	4:00 p.m.	67.82
May 7	3:30 p.m.	62.65	Mar. 15,1934	4:10 p.m.	68.31
May 17	1:45 p.m.	a 62.85	Sept.12	3:15 p.m.	68.77
Sept. 6	.....	(b)	Oct. 2	Noon	68.78
Sept.21	5:40 p.m.	65.68	Nov. 12	3:20 p.m.	68.78
Apr. 23,1930	12:30 p.m.	64.32	Dec. 4	4:50 p.m.	68.98
Aug. 30	10:20 a.m.	c 70.28	Dec. 22	2:40 p.m.	68.80
Sept.29	2:00 p.m.	67.17	Mar. 6,1936	1:20 p.m.	68.47
Apr. 22,1931	11:20 a.m.	66.38	Mar. 15	4:45 p.m.	68.40
Sept.29	10:40 a.m.	68.16			

a Pump out for repairs.
b Pump running.
c Pump shut down at noon Aug. 29.

205. D. F. Fowler. Near northwest corner sec. 4, T. 2 S., R. 5 W. Depth of well 150 feet; depth of pit 110 feet; diameter of screen 11-5/8 inches. Measuring point, top of pit, level with land surface. This is an abandoned well, about 75 feet south of well with pump. Altitude of measuring point, 220.82 feet.

Date	Time	Depth to water level (feet)	Date	Time	Depth to water level (feet)
Sept.23,1927	.....	83.40	Aug. 18,1928	9:55 a.m.	b 92.70
Apr. 18,1928	.....	79.84	Sept.18	10:15 a.m.	a 84.61
July 28	11:40 a.m.	a 88.10	Sept.24	9:30 a.m.	a 84.54
Aug. 1	.....	b 91.06	Oct. 23	8:40 a.m.	83.75
Aug. 4	.....	b 92.33	Nov. 9	11:05 a.m.	83.43

205. D. F. Fowler--Continued.

Date	Time		Depth to water level (feet)	Date	Time		Depth to water level (feet)
Jan. 15,1929	8:15	a.m.	82.48	Sept.17,1930	10:30	a.m. h	88.39
Apr. 15	11:30	a.m.	81.38	Sept.23	3:00	p.m.	88.29
May 10	5:45	p.m.	81.62	Jan. 20,1931	10:00	a.m. h	90.38
May 31	4:00	p.m. c	84.55	Feb. 28	2:20	p.m.	87.38
June 3	11:10	a.m. d	81.39	Apr. 13	9:15	a.m.	87.31
July 9	8:30	a.m. e	89.86	Apr. 18	11:45	a.m.	87.35
July 30	4:30	p.m. f	93.40	Feb. 22,1932	4:30	p.m.	86.53
Aug. 28	9:30	a.m. f	94.65	Apr. 19	10:45	a.m.	86.79
Sept.14	3:00	p.m. a	88.85	Feb. 23,1933	1:00	p.m. i	88.00
Sept.17	8:50	a.m.	88.44	Feb. 22,1934	2:45	p.m.	89.00
Feb. 21,1930	5:30	p.m.	84.64	Sept.22	10:45	a.m.	93.36
Apr. 15	5:00	p.m.	83.96	Oct. 18	3:00	p.m.	91.20
Apr. 18	1:40	p.m.	84.31	Nov. 5	11:40	a.m.	92.12
Aug. 27	....	g	91.11	Dec. 8	2:00	p.m.	91.43

a Pump in nearby well not running.
b Pump in nearby well running.
c This measurement may not be correct.
d Depth to water in nearby well with pump 81.20 feet.
e Pump in nearby well shut down July 6, 7:00 p.m.; started again July 9, 6:30 a.m.
f Pumps running in wells 75 feet north and several hundred feet north.
g Temporary pump installed. Measurement is to oil in pit. Water level in pit may be lower.
h Tape line lodged on pump.
i Tape may have hit obstruction.

261. W. M. Trice. SW¼SE¼ sec. 9, T. 2 S., R. 3 W. Depth of well 158 feet. Measuring point, top of pit, 0.4 foot above pump base and 0.8 foot above land surface. Altitude of measuring point, 209.7 feet.

Date	Time		Depth to water level (feet)	Date	Time		Depth to water level (feet)
July 7,1928	.....		60.43	Sept. 2,1930	10:15	a.m.	61.85
Aug. 23		a	60.02	Sept. 29	4:20	p.m.	61.70
Sept.20	3:50	p.m.	61.25	Apr. 13,1931	2:45	p.m.	61.03
Oct. 18	2:00	p.m.	60.55	Sept. 5	3:30	p.m.	62.50
Jan. 11,1929	3:40	p.m.	60.02	Sept. 29	5:10	p.m.	62.75
Feb. 21	6:15	p.m.	59.35	Feb. 26,1932	1:40	p.m.	61.82
Apr. 18	3:00	p.m.	58.60	Apr. 19	11:45	a.m.	61.36
May 8	11:20	a.m.	58.38	Sept. 28	4:30	p.m. c	63.95
May 25	11:20	a.m.	57.90	Mar. 3,1933	3:30	p.m.	63.19
July 5	4:35	p.m. b	57.80	Mar. 15,1934	3:00	p.m.	63.76
Aug. 2	5:15	p.m.	58.13	Sept. 7	10:40	p.m. c	64.25
Sept. 2	10:05	a.m.	59.12	Oct. 1	4:00	p.m.	64.84
Sept.21	4:00	p.m.	59.65	Dec. 5	9:00	a.m.	65.35
Apr. 15,1930	2:20	p.m.	59.19	Feb. 22,1935	10:15	a.m.	64.05
Aug. 15	.....		61.05	Mar. 15	2:30	p.m.	63.88

a Pump shut down Aug. 20.
b This well not pumped season of 1930.
c Not pumped.

280. Fred Hedrick. NW¼NW¼ sec. 3, T. 3 S., R. 5 W. Measuring point, top of pit, level with land surface. Altitude of measuring

280. Fred Hedrick--Continued.

point, 216.0 feet. This is an abandoned well. It has been equipped with an automatic water-stage recorder continuously since Aug. 11,1928. The depth to water has been measured once a week for most of the time, and about once in 2 weeks otherwise. The following measurements after Aug. 11 are those made during the early part of each month. This well is affected by well 281, about 500 feet southeast, the water level in well 280 dropping about 3 feet when the pump in well 281 is started. Lowest level reached each year was as follows: 1931, 91.08 feet Aug. 13; 1932, 91.26 feet Aug. 19; 1933, 91.00 feet Aug. 28; 1934, 92.15 feet Aug. 11; 1935, 92.46 feet Aug. 30.

Date	Time	Depth to water level (feet)	Date	Time	Depth to water level (feet)
July 20,1928	1:40 p.m.	87.03	Jan. 30,1932	4:50 p.m.	84.30
July 27	1:35 p.m.	a 85.20	Mar. 5	3:50 p.m.	83.40
July 28	12:45 p.m.	b 88.00	Apr. 2	10:00 a.m.	83.75
Aug. 1	10:35 a.m.	87.00	Apr. 30	3:35 p.m.	83.20
Aug. 4	9:35 a.m.	87.33	June 4	10:25 a.m.	88.75
Aug. 11	5:40 p.m.	c 88.13	July 2	11:20 a.m.	88.75
Sept. 1	9:55 a.m.	82.88	July 30	10:15 a.m.	90.55
Oct. 2	11:00 a.m.	81.13	Sept. 3	2:08 p.m.	87.50
Nov. 2	1:40 p.m.	80.49	Oct. 2	12:30 p.m.	85.81
Dec. 18	1:30 p.m.	80.08	Oct. 30	7:30 a.m.	85.40
Jan. 12,1929	4:05 p.m.	79.80	Dec. 3	4:10 p.m.	84.88
Feb. 2	Noon	80.00	Dec. 31	1:55 p.m.	85.01
Mar. 2	1:10 p.m.	79.45	Jan. 28,1933	4:05 p.m.	84.69
Apr. 6	10:30 a.m.	79.23	Mar. 4	2:55 p.m.	84.61
May 20	9:20 a.m.	79.05	Apr. 1	1:05 p.m.	84.10
June 9	3:25 p.m.	81.06	Apr. 29	3:50 p.m.	83.91
July 3	3:50 p.m.	87.31	June 3	1:55 p.m.	84.32
Aug. 2	11:25 a.m.	90.00	July 1	10:38 a.m.	88.80
Sept. 2	5:00 p.m.	87.04	Aug. 5	11:00 a.m.	87.25
Oct. 3	10:00 a.m.	83.91	Sept. 2	Noon	87.80
Nov. 14	11:00 a.m.	82.57	Oct. 1	4:47 p.m.	86.65
Dec. 12	11:00 a.m.	82.19	Nov. 4	4:15 p.m.	85.60
Jan. 14,1930	3:20 p.m.	81.42	Dec. 4	2:30 p.m.	85.18
Feb. 1	2:30 p.m.	81.59	Dec. 30	11:15 a.m.	85.50
Mar. 1	3:35 p.m.	81.31	Feb. 3,1934	11:25 a.m.	85.02
Apr. 11	1:40 p.m.	81.30	Mar. 3	9:55 a.m.	84.36
May 15	.....	80.78	Mar. 31	11:25 a.m.	84.60
June 9	7:30 a.m.	87.80	May 5	9:20 a.m.	84.22
July 7	8:55 a.m.	90.85	June 2	9:35 a.m.	88.33
Aug. 2	11:20 a.m.	91.70	July 3	5:55 p.m.	89.89
Sept. 6	10:30 a.m.	90.42	July 28	10:35 a.m.	88.79
Oct. 4	9:35 a.m.	85.85	Sept. 1	5:05 p.m.	88.32
Nov. 1	3:40 p.m.	85.29	Sept.30	10:10 a.m.	87.74
Dec. 6	1:55 p.m.	84.24	Nov. 3	5:25 p.m.	86.17
Jan. 3,1931	3:15 p.m.	83.73	Dec. 1	4:30 p.m.	86.25
Feb. 7	9:50 a.m.	83.43	Jan. 2,1935	5:50 p.m.	86.26
Mar. 7	3:50 p.m.	82.83	Feb. 2	2:45 p.m.	86.16
Apr. 4	10:10 a.m.	83.28	Mar. 2	11:05 a.m.	85.88
May 2	11:30 a.m.	82.85	Mar. 30	1:20 p.m.	85.54
June 6	3:40 p.m.	88.91	May 4	1:15 p.m.	85.70
July 4	1:40 p.m.	87.9	June 1	11:30 a.m.	85.74
Aug. 1	3:45 p.m.	89.80	June 29	Noon	90.45
Sept. 1	....	86.76	Aug. 3	5:40 p.m.	91.63
Oct. 3	1:30 p.m.	85.46	Aug. 31	2:45 p.m.	91.75
Oct. 31	3:15 p.m.	85.20	Sept.28	5:00 p.m.	88.11
Dec. 5	4:55 p.m.	84.60	Nov. 3	10:10 a.m.	87.45
Jan. 2,1932	2:30 p.m.	84.20	Nov. 30	5:25 p.m.	87.16
			Dec. 29	....	86.61

a Pump in well 281 not running.
b Pump in well 281 running.
c Recorder installed.

318. University of Arkansas, Rice Branch Experiment Station. SE¼SE¼ sec. 3, T. 3 S., R. 4 W. Depth of well 127 feet; depth of pit 105 feet; diameter of screen 18 inches. Measuring point, top of pump base. Altitude of measuring point, 203.49 feet.

Date	Time		Depth to water level (feet)	Date	Time		Depth to water level (feet)
Apr. 17,1928	.....		75.25	Sept. 4,1931	4:40 p.m.		83.25
Sept.22	9:10 a.m.	a	79.42	Sept.22	9:00 a.m.		83.06
Dec. 31	11:45 a.m.		76.80	Feb. 25,1932	2:50 p.m.		80.77
Feb. 19,1929	2:10 p.m.		76.62	Apr. 20	8:00 a.m.		80.27
Apr. 22	1:15 p.m.		75.56	Sept.22	1:00 p.m.		83.84
May 9	4:30 p.m.		76.61	Mar. 2,1934	12:40 p.m.		81.82
Sept.23	8:20 a.m.		81.03	Sept. 8	9:40 a.m.		86.88
Apr. 18,1930	7:30 a.m.		78.22	Sept.21	8:20 a.m.		85.60
Sept.22	9:35 a.m.	b	83.36	Mar. 7,1935	12:30 p.m.		83.40
Apr. 17,1931	10:45 a.m.		80.06				

a Measurement uncertain.
b Pump was operated this day.

392. Fred E. Hillman. SW¼ sec. 1, T. 4 S., R. 4 W. Depth of well 143 feet, depth of pit 100 feet, diameter of screen 10 inches. Measuring point, top of pump base, 0.2 foot above top of pit. Altitude of measuring point, 201.12 feet.

Date	Time		Depth to water level (feet)	Date	Time		Depth to water level (feet)
Sept. 22,1927	....		74.92	Apr. 17,1931	9:15 a.m.		78.09
Apr. 17,1928	....		73.68	Sept. 4	3:25 p.m.		79.55
July 30	....	a	75.85	Sept.23	2:45 p.m.		79.75
Sept. 22	10:25 a.m.		75.60	Feb. 25,1932	2:10 p.m.		78.84
Oct. 2	4:25 p.m.		75.37	Apr. 20	8:40 a.m.		78.58
Dec. 31	1:15 p.m.		74.80	Sept. 9	5:20 p.m.	b	81.27
Apr. 17,1929	12:05 p.m.		74.70	Sept.23	6:00 p.m.		79.74
May 10	Noon		74.72	Mar. 2,1933	3:45 p.m.		79.54
Sept. 7	10:30 a.m.		77.04	Mar. 6,1934	4:20 p.m.		79.78
Sept. 23	9:15 a.m.		76.55	Sept. 8	1:15 p.m.		80.69
Apr. 17	6:30 p.m.		76.12	Sept.21	9:15 a.m.		80.78
Sept. 22	10:40 a.m.		80.50	Mar. 1,1935	4:00 p.m.		80.11

a Well in use this year.
b Not pumped in 1932.

456. E. W. McCuskey. Near northwest corner sec. 16, T. 5 S., R. 3 W. Depth of well 201 feet. Measuring point, top of raised rim of pump base, 0.5 foot above land surface. Altitude of measuring point, 198.04 feet.

Date	Time		Depth to water level (feet)	Date	Time		Depth to water level (feet)
Sept. 22,1927	....	a	79.60	Mar. 9,1929	7:10 a.m.		76.84
Apr. 18,1928	....	a	76.28	May 4	6:50 p.m.		76.08
July 20	5:05 p.m.		77.46	July 10	....		(b)
Aug. 13	4:00 p.m.		77.98	Aug. 13	10:00 a.m.		78.53
Sept. 22	12:50 p.m.		78.21	Sept. 3	10:20 a.m.	c	78.91
Nov. 14	3:25 p.m.		77.55	Sept.23	10:55 a.m.		78.64
Feb. 20,1929	8:05 a.m.		76.75	Mar. 20,1930	5:45 p.m.		76.90

456. E. W. McCuskey--Continued.

Date	Time	Depth to water level (feet)	Date	Time	Depth to water level (feet)
Apr. 17,1930	7:30 a.m.	76.82	Apr. 21,1932	7:30 a.m.	79.53
May 15	....	(b)	Sept. 8	6:00 p.m.	85.30
Aug. 11	3:15 p.m.	d 81.57	Sept.22	3:00 p.m.	f 87.95
Sept.22	1:20 p.m.	81.12	Feb. 24,1933	Noon	80.52
Apr. 16,1931	4:45 p.m.	78.75	Sept.11,1934	8:00 a.m.	g 83.58
May 15	6:00 p.m.	78.59	Sept.22	8:00 a.m.	83.21
Sept. 3	1:00 p.m.	e 82.91	Dec. 8	9:00 a.m.	81.84
Sept.22	11:25 a.m.	82.90	Feb. 23,1935	10:15 a.m.	81.44
Feb. 23,1932	5:00 p.m.	80.12			

a Reference point uncertain.
b Pump running.
c Pump shut down Aug. 29.
d Pump shut down Aug. 7.
e Pump had been shut down for 5 hours.
f Measurement uncertain.
g Had been pumped.

499. Quandt & Lowe. Spanish grant 2300, equivalent to sec. 27 or 34, T. 7 S., R. 3 W. Measuring point, top of pump base. Altitude of measuring point about 180 feet (estimated).

Date	Time	Depth to water level (feet)	Date	Time	Depth to water level (feet)
Sept. 22,1927	....	a 37.67	Apr. 25,1930	8:15 a.m.	34.75
Apr. 18,1928	....	34.37	Sept.22	5:30 p.m.	41.30
July 31	....	32.52	Apr. 16,1931	2:00 p.m.	38.96
Aug. 30	....	35.52	Apr. 28	3:00 p.m.	38.85
Sept. 13	12:50 p.m.	35.85	May 16	11:00 a.m.	38.50
Sept. 22	3:00 p.m.	36.21	Sept. 4	11:20 a.m.	41.81
Nov. 10	3:25 p.m.	37.51	Sept.22	3:10 p.m.	41.98
Dec. 9	2:20 p.m.	36.90	Feb. 24,1932	11:15 a.m.	35.66
Apr. 16,1929	2:25 p.m.	30.09	Apr. 21	11:20 a.m.	35.98
May 11	4:00 p.m.	28.76	Sept.22	9:20 a.m.	d 41.75
May 29	4:20 p.m.	26.30	Mar. 1,1933	2:30 p.m.	39.19
July 10	3:00 p.m.	b 33.69	Mar. 7,1934	3:10 p.m.	38.06
Sept. 3	.....	c	Sept.11	11:00 a.m.	e 41.79
Sept. 9	.....	c	Sept.24	5:30 p.m.	e 41.75
Sept. 23	1:15 p.m.	38.50	Feb. 28,1935	5:00 p.m.	39.75
Apr. 17,1930	10:00 a.m.	34.38			

a Pump not operated in season of 1927.
b Pump operated June 17 to July 6.
c Pump running.
d Shut down Sept. 19.
e Not pumped.

501. W. J. Bohnert. SW¼(?) sec. 32, T. 7 S., R. 3 W. Depth of well 162 feet. Measuring point until April 21, 1932, top of pit. Altitude of measuring point, 177.02 feet. After April 21, altitude of measuring point 177.27. This well was equipped with an automatic water-stage recorder from Aug. 21, 1928 to Oct. 3, 1930. The following measurements up to Oct. *, 1930 were made when the charts were changed.

501. W. J. Bohnert.--Continued.

Date	Time	Depth to water level (feet)	Date	Time	Depth to water level (feet)
Aug. 21,1928	5:40 p.m.	28.21	Nov. 18,1929	12:30 p.m.	26.72
Aug. 30	12:45 p.m.	28.00	Jan. 25,1930	1:40 p.m.	27.10
Sept.13	11:35 p.m.	28.20	Mar. 20	2:25 p.m.	26.22
Sept.19	3:45 p.m.	28.10	Apr. 25	9:00 a.m.	26.17
Sept.22	3:35 p.m.	28.16	June 9	2:10 p.m.	25.97
Oct. 20	3:45 p.m.	28.23	Aug. 1	4:40 p.m.	26.65
Oct. 29	4:35 p.m.	28.30	Aug. 28	12:35 p.m.	27.13
Nov. 10	3:55 p.m.	28.32	Oct. 3	11:00 a.m. a	27.60
Dec. 9	1:15 p.m.	28.24	Apr. 16,1931	2:50 p.m.	28.53
Jan. 27,1929	9:55 a.m.	27.98	May 16	11:30 a.m. b	28.60
Mar. 4	2:45 p.m.	27.48	Sept. 4	Noon	29.50
Apr. 16	1:40 p.m.	27.28	Sept.22	3:45 p.m.	30.64
May 11	4:50 p.m.	26.88	Feb. 24,1932	Noon	29.44
May 29	5:05 p.m.	26.54	Apr. 21	11:40 a.m.	28.88
July 10	1:10 p.m.	26.00	Sept. 9	9:30 a.m.	32.17
Aug. 8	1:00 p.m.	25.90	Sept.23	11:00 a.m.	31.36
Aug. 13	8:50 a.m.	25.92	Mar. 1,1933	1:20 p.m.	30.49
Sept. 9	3:40 p.m.	26.19	Sept.24,1934	5:00 p.m. c	31.40
Sept.23	1:35 p.m.	26.32	Feb. 28,1935	5:55 p.m.	31.05

a Recorder removed this day.
b Pump in well 1 mile southeast running since May 14.
c Not pumped.

507. J. M. Satchfield. Near southwest corner sec. 16, T. 7 S., R. 2 W. Depth of well 147 feet. Measuring point, top of pit level with land surface. Altitude of measuring point, 179.90 feet. This is an abandoned well. It was equipped with an automatic water-stage recorder from Oct. 30, 1928, to Aug. 28, 1930. The following measurements during that period were made when the charts were changed.

Date	Time	Depth to water level (feet)	Date	Time	Depth to water level (feet)
Oct. 30,1928	11:15 a.m.	39.56	May 15,1930	4:15 p.m.	34.37
Nov. 10	12:20 p.m.	37.68	June 9	11:20 a.m.	45.72
Nov. 17	6:50 p.m.	37.66	Aug. 1	2:20 p.m.	(a)
Dec. 9	3:15 p.m.	36.96	Aug. 28	4:50 p.m.	(b)
Jan. 27,1929	11:20 a.m.	35.98	Sept.23	8:30 a.m.	48.71
Mar. 6	2:35 p.m.	32.30	Apr. 16,1931	10:10 a.m.	42.57
Apr. 16	4:15 p.m.	20.18	May 16	9:15 a.m.	41.30
May 11	11:40 a.m.	20.14	Sept. 3	4:10 p.m.	52.00
May 29	11:25 a.m.	17.26	Sept.23	10:25 a.m.	43.85
July 10	10:20 a.m.	44.44	Apr. 21	9:00 a.m.	30.59
Aug. 8	8:45 a.m.	53.72	Sept. 9	Noon	47.84
Sept. 9	12:00 noon	49.73	Sept.23	12:50 p.m.	44.75
Sept.23	3:30 p.m.	41.42	Feb. 24,1933	3:30 p.m.	37.37
Oct. 1	1:30 p.m.	40.89	Mar. 7,1934	11:00 a.m.	38.80
Nov. 18	11:10 a.m.	39.67	Sept.11	3:10 p.m. c	46.13
Jan. 24,1930	3:15 p.m.	33.00	Sept.21	11:10 a.m.	45.10
Mar. 20	11:30 a.m.	30.52	Jan. 4,1935	11:00 a.m.	41.95
Apr. 25	11:15 a.m.	34.02	Feb. 28	1:45 p.m.	42.40

a Float of recorder appeared to be resting on mud bottom at 60 feet.
b Well dry, bottom at 58 feet. Recorder removed.
c Not pumped.

CALIFORNIA

GENERAL SUMMARY

By F. C. Ebert

Early work and later developments

Probably the earliest published reports containing data on depths to water levels in wells in California are found in publications of the State Mining Bureau in chapters relating to deep borings in California, as follows. Generally only one observation on each well is recorded.

California State Min. Bur. 7th Ann. Rept., for the year ending Oct. 1, 1887, 315 pp., 1888.

California State Min. Bur. 8th Ann. Rept., for the year ending Oct. 1, 1888, 948 pp., pls., 1888.

California State Min. Bur. 10th Ann. Rept., for the year ending Dec. 1, 1890, 983 pp., pls., 1890.

Physical data and statistics of California, State Eng. Dept., 1886.

California State Min. Bur. 11th Rept. (first biennial), 2 years ending Sept. 15, 1892, 612 pp., 1893.

California State Min. Bur. 12th Rept. (second biennial), 2 years ending Sept. 15, 1894, 541 pp., 1894.

Watts, W. L., The gas and petroleum yielding formations of the Central Valley of California: California State Min. Bur. Bull. 3, 99 pp., pls., maps, 1894.

Watts, W. L., Oil and gas yielding formations of Los Angeles, Ventura, and Santa Barbara Counties, pt. 1: California State Min. Bur. Bull. 11, 94 pp., pls., map, 1897.

The following reports of the U. S. Geological Survey, issued somewhat later, contain similar data:

Darton, N. H., Preliminary list of deep borings in the United States, pt. 1, Alabama-Montana: U. S. Geol. Survey Water-Supply Paper 57, pp. 12-16, 1902.

Darton, N. H., Preliminary list of deep borings in the United States (2d ed., with additions): U. S. Geol. Survey Water-Supply Paper 149, pp. 14-18, 1905.

Fuller, M. L., Lines, E. F., and Veatch, A. C., Record of deep-well drilling for 1904: U. S. Geol. Survey Bull. 264, p. 43, 1905.

Fuller, M. L., and Sanford, Samuel, Record of deep-well drilling for 1905: U. S. Geol. Survey Bull. 298, pp. 39-43, 1906.

Shortly before the turn of the century intensive use of ground waters began, first in southern California, and then in other parts of the State, until now there is scarcely an irrigation company that does not augment its gravity supply with pumped ground water. Many municipalities and irrigation companies are partly or wholly dependent

on pumped water, and thousands of individually owned pumping plants for domestic and irrigation supply are in use. Because of this intensive use the welfare of many localities is dependent upon an unfailing supply of ground water. It is very important, therefore, that replenishment of this resource should be sure. This may be accomplished naturally through absorption from stream channels and rainfall penetration, or by the bringing in of outside surface water and thus lessening the ground-water demand, or by increasing absorption by spreading storm water or surplus surface water on porous terrane, thus saving for beneficial use much of this water that normally would waste into the ocean. The relation of draft and replenishment is indicated by a long-time record of water-table fluctuation, and therefore it is essential that measurements of fluctuation be made. In this State measurements have been made at many localities and are being made in increasing numbers. References to publications or sources where records collected in various areas can be found are given below.

Coastal region of southern California

About 1900 the Geological Survey began its studies of underground waters in southern California. The hydrology of the San Bernardino area is treated in Water-Supply Papers 60, 61, and 142; the eastern coastal-plain region in Water-Supply Paper 137; the central coastal plain in Water-Supply Paper 138; the western coastal plain in Water-Supply Paper 139, and the foothill belt in Water-Supply Paper 219. A large number of measurements of the depths to water levels were made and the records were compiled in these reports. As a continuing program typical observation wells were selected in the several areas for measurements of water-level fluctuations.

In 1902, in anticipation of a future ground-water paper on the San Jacinto area, regular observations at selected typical wells were begun there. Measurements of the depths to water levels were made at the regular observation wells, and the records were published as chapters in Water-Supply Papers 213 and 251.

The report of the Conservation Commission of California for 1912 contains measurements of depths to water levels in the San Bernardino Basin.

In 1919 records of the depths to water levels in the San Jacinto and Temecula Basins were published in Water-Supply Paper 429.

In 1921 all measurements made at regular United States Geological Survey observation wells were published in Water-Supply Paper 468.

In 1912 several wells in San Diego County were selected for regular observations on variation in water level. The observations were published in Water-Supply Paper 446, 1919. Additional wells were selected after the publication of this paper, and these, with the original wells, were measured as a series for continuing observations.

The California Department of Public Works, Division of Water Rights, published in 1922 a report on the San Jacinto hydrographic investigation, containing hydrographs of water-level movements at many wells in the San Jacinto area.

In 1927 the State Division of Water Rights, in Bulletin 5, published observations of depths to water levels at a large number of wells in San Gabriel Valley, with measurements made at regular Geological Survey wells in the area. In State Division of Water Rights Bulletin 6, 1928, the additional observations made at wells treated in Bulletin 5 were published.

More and more individuals and organizations are taking an active interest in underground-water problems and making measurements of depths to water levels in wells. In the Santa Ana, San Gabriel, and Los Angeles River drainage basins the following organizations, in addition to the Geological Survey, are now making measurements: Los Angeles County Flood Control District, Orange County Flood Control District, Los Angeles Department of Water and Power, San Gabriel Valley Protective Association, Chino Basin Protective Association, Pomona Valley Protective Association, Cucamonga Conservation Association, Water Conservation Association, Lytle Creek Water Users Association, Riverside Basin Water Users Council, Riverside County Land Owners Association, Riverside Cement Co., San Bernardino Valley Conservancy District, and practically all the cities and water companies within the area. Measurements are also being made by individual well owners.

Acting as a clearing house for data collected by these different agencies, the State Department of Public Works, Division of Water Resources, in Bulletin 39, published the complete record of water-level fluctuations in hundreds of wells in the south coastal basins through 1931. Except the measurements in wells in San Gabriel Valley and published in this Division's Bulletins 5 and 6, the records were brought up to date. State Department of Public Works, Division of Water Resources, Bulletins 39a, 39b, and 39c carry the observations on through 1932 to 1934.

Bulletin 46A of the California Department of Public Works, Division of Water Resources, contains measurements of fluctuations of the water levels in Ventura County from 1927 to 1932. Observations at typical wells in this area are being continued by the Ventura County Water Survey engineer.

A paper entitled "An interpretation of water-level fluctuations at four wells in southern California" was presented by the writer on May 1, 1936, at the annual meeting of the American Geophysical Union in Washington, D. C., and is to be published in the Transactions of the Union for 1936. This paper gives the fluctuations of the water levels in the Williams well, in the upper part of the Santa Ana River drainage basin, since 1892; in the J. B. Neff well, in the lower part of the Santa Ana River drainage basin, since 1898; in the Baldwin Park well, in the San Gabriel River drainage basin, since 1904; and in well 72, in the San Jacinto Valley, since 1904.

Southeastern California

Records of depths to water levels in wells in the desert region of southern California have been published in the following reports:

Mendenhall, W. C., Some desert watering places in southeastern California and southwestern Nevada: U. S. Geol. Survey Water-Supply Paper 224, 1909.

Mendenhall, W. C., Ground waters of the Indio region, Calif.: U. S. Geol. Survey Water-Supply Paper 225, 1909.

Johnson, H. R., Water resources of Antelope Valley, Calif.: U. S. Geol. Survey Water-Supply Paper 278, 1911.

Lee, C. H., An intensive study of the water resources of a part of Owens Valley, Calif.: U. S. Geol. Survey Water-Supply Paper 294, 1912.

Lee, C. H., Ground-water resources of Indian Wells Valley: California Cons. Comm. Rept., 1913, pp. 401-429.

Tait, C. E., Utilization of Mojave River for irrigation in Victor Valley: California Dept. Eng. Bull. 5, 1918.

Thompson, D. G., Ground water in Lanfair Valley, Calif.: U. S. Geol. Survey Water-Supply Paper 450, pp. 29-50, 1920.

Waring, G. A., Ground water in Pahrump, Mesquite, and Ivanpah Valleys, Nevada and California: U. S. Geol. Survey Water-Supply Paper 450, pp. 51-86, 1920.

Brown, J. S., The Salton Sea region, Calif.: U. S. Geol. Survey Water-Supply Paper 497, 1923.

Thompson, D. G., The Mojave Desert region, Calif.: U. S. Geol. Survey Water-Supply Paper 578, 1929.

Mojave River investigation: California Dept. Public Works Bull. 47, 1934. Contains records of depths to water levels in wells in the vicinity of the Mojave River, not only the measurements made recently as a regular program but also previous measurements in these wells.

Blaney, H. F., and Ewing, Paul, Utilization of the waters of Mojave River, Calif. (mimeographed), U. S. Dept. Agr., 1935.

The Los Angeles Department of Water and Power has made measurements in typical wells in Owens Valley since the publication of Water-Supply Paper 294, and measurements in numerous wells in Coachella Valley are being made regularly by the Coachella Valley County Water District. These records for Owens and Coachella Valleys have not been published.

San Joaquin Valley

The following published reports deal with fluctuations of ground-water levels in the San Joaquin Valley or have chapters devoted to the subject:

Mendenhall, W. C., Preliminary report on the ground waters of San Joaquin Valley, Calif.: U. S. Geol. Survey Water-Supply Paper 222, 1908.

Mendenhall, W. C., Dole, R. B., and Stabler, Herman, Ground water in the San Joaquin Valley, Calif.: U. S. Geol. Survey Water-Supply Paper 398, 1916.

Water resources of Kern River and adjacent streams and their utilization: California Dept. Eng. Bull. 9, 1920. Contains a chapter on ground waters of the area, also a map showing hydrographic contours.

Harding, S. T., Ground-water resources of the San Joaquin Valley: Div. Eng. and Irrigation and Water Rights, Bull. 11, 1927. Contains a map showing distance to ground water in October 1925, also a map showing the change in ground-water level between 1920 and 1925. About 500 wells in Kern, Tulare, and King Counties were measured.

San Joaquin River Basin: California Dept. Pub. Works, Div. Water Resources, Bull. 29, 1931. Contains several maps showing the depths to the water table and ground-water profiles for the fall of 1929.

San Joaquin Valley, in State-wide water problem of California, Visalia, Calif., 1929. Brief presented on behalf of San Joaquin Valley by the San Joaquin Water Commission; gives general review of water and crop situation, has chart showing relation of pumping draft to loss of ground water, and Delano-Earlimart section, 1915-26.

Stearns, H. T., Robinson, T. W., and Taylor, G. H., Geology and water resources of the Mokelumne area, Calif.: U. S. Geol. Survey Water-Supply Paper 619, 1930.

Monett, C. H., Report of Kern County Water Development Commission of the cost per acre-foot of pumped irrigation water in Kern County, December 1933. Sponsored by Kern County Water Development Commission and Kern County Chamber of Commerce. Includes a map showing depths to the water table in 1924 and 1933.

Sacramento Valley

The following publications present data on water levels in wells in the Sacramento Valley:

Bryan, Kirk, Ground water for irrigation in Sacramento Valley: U. S. Geol. Survey Water-Supply Paper 375, pp. 1-49, 1915.

Hyde, C. G., Wilhelm, G. H., and Miller, F. C., Possible sources of water supply for city of Sacramento, California, 1916. Part 3 deals with the ground-water situation in that vicinity.

Bryan, Kirk, Geology and ground-water resources of Sacramento, Calif.: U. S. Geol. Survey Water-Supply Paper 495, 1923.

Sacramento River Basin: California Dept. Pub. Works, Div. Water Resources, Bull. 26, 1931. Appendix G gives records of depths to water levels in typical wells in Sacramento Valley in the fall of 1929, 1930, and 1931.

Santa Clara Valley

The following publications contain information on water-level fluctuation in the Santa Clara Valley:

Freeman, J. R., The Hetch Hetchy water supply for San Francisco, p. 95, 1912. Contains a map of ground-water contours in the Niles cone area.

Clark, W. O., Ground-water resources of the Niles cone and adjacent areas, California: U. S. Geol. Survey Water-Supply Paper 345, pp. 127-168, 1915.

Clark, W. O., Ground water for irrigation in the Morgan Hill area, Calif.: U. S. Geol. Survey Water-Supply Paper 400, pp. 61-105, 1917.

Clark, W. O., Ground water in Santa Clara Valley, Calif.: U. S. Geol. Survey Water-Supply Paper 519, 1924.

Tibbets, Anderson, Jones, and Hoehl, Report on waste-water salvage project to Board of Directors, Santa Clara Valley Water Conservation District, San Jose, Calif., 1931. Contains a map showing the drop in water levels from 1915 to 1930.

Santa Clara investigation: California Dept. Pub. Works, Div. Water Resources, Bull. 42, 1933. Appendix F deals with data on ground-water levels.

Salinas Valley

Hamlin, Homer, Water resources of Salinas Valley, Calif.: U. S. Geol. Survey Water-Supply Paper 89, 1904. Contains tables showing depths to water levels in wells in the valley.

U. S. Geological Survey records of measurements of depths to water levels, by W. O. Clark, 1916. Released in unpublished form.

Conkling, Harold, Report of Salinas Basin preliminary investigation, California Dept. Pub. Works, Div. Water Resources, 1933. Gives some averages of depths to water levels over the area.

WORK DONE IN 1935

The Geological Survey during 1935 made at least two rounds of measurements of depths to the water levels in its 13 observation wells in the San Bernardino Basin, 8 wells in the San Jacinto area, 34 wells in San Diego County, and 8 wells in Antelope Valley. One measurement was made in 1935 in each of 10 additional wells in Antelope Valley. Measurements were also made in 90 typical wells in the Mojave River Valley. The observation wells in the Los Angeles River, lower Santa Ana River, and San Gabriel River drainage basins were not visited; these, with hundreds of others, were measured at frequent intervals by county flood control, conservation, and protective agencies, and others. The Geological Survey, however, maintained a water-stage recorder in upper San Gabriel Valley on a well put down as an observation well. This well, 42a, is a companion well for well 42, described in Water-Supply Paper 468, page 47. It is in Baldwin Park, about 200 yards north of well 42.

Fluctuations in water levels were observed simultaneously in these two wells by use of water-stage recorders and found to be substantially the same.

In the south coastal basins during 1935 measurements of depths to water levels were made at about 1,800 wells by various agencies. About 1,300 of these records will be published by the State of California Department of Public Works, Division of Water Resources, in its annual progress report on the south coastal basin investigation. In Ventura County regular measurements at representative wells were made by the Ventura County Water Survey engineer. In Santa Barbara County the Water Department of the city of Santa Barbara made monthly observations of depths to water levels in representative wells in the Santa Ynez River basin. In San Joaquin Valley the State Division of Water Resources continued measurements on observation wells. Numerous and frequent measurements were made by domestic and irrigation companies and others concerned with such data. In Santa Clara Valley measurements of water levels were continued by the State Division of Water Resources and the Santa Clara Valley Conservation District. In Salinas Valley measurements were made by interested individuals and water users, to be included in the State Division of Water Rights bulletin on the area, when sufficient funds are available for its publication. In Owens Valley the Los Angeles Department of Water and Power continued measurements on typical wells. The publications that will contain the water-level data for 1935 will in general be widely distributed, and as far as known to the writer, all unpublished records are available to anyone interested.

As far as known, 30 wells in the State are equipped with water-stage recorders. A large percentage of the bench marks at wells that are being measured have been tied into the United States Geological Survey mean sea level datum by instrumental leveling.

MOKELUMNE AREA

By Arthur M. Piper

In the Mokelumne area, central California, measurements of ground-water level have been made in recent years by at least eight agencies in about 1 800 observation wells. These wells span an intensively cultivated area which is irrigated largely by pumping from wells, pumpage having ranged recently, according to careful computations, from 79,400 acre-feet in 1926-27 to 114,600 acre-feet in 1928-29. However, outlying wells lie beyond the area of heavy pumpage.

The agencies that have measured ground-water levels and the periods of their activity are (1) the United States Geological Survey, in 1906-7, 1913-14, and 1926-33; (2) C. H. Widdows, acting for a group of landowners in the central part of the area, in October 1925; (3) Cyril Williams, for the East Bay Municipal Utility District, from October to December 1925; (4) the Division of Water Resources, California Department of Public Works, in March and April, 1926; (5) the City of Stockton, in September 1926; (6) the City of Lodi, from January 1930 to May 1933; (7) the East Bay Municipal Utility District, beginning in May 1930; and (8) the Pacific Gas & Electric Co., beginning in May 1930. From 1926 to 1930 measurements were made monthly or quarterly in some 450 wells, largely by the United States Geological Survey. From 1930 to 1933, however, many new observation wells were established by the several agencies, and measurements were made daily or weekly in about 450 wells by one agency or another. The record for practically all these wells has been released to the public.[1]

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1 Stearns, H. T., Robinson, T. W., and Taylor, G. H., Geology and water resources of the Mokelumne area, California: U. S. Geol. Survey Water-Supply Paper 619, pp. 139-142, 292-398, 1930.

Table of well measurements, Mokelumne area, California (in the period July 1, 1929, to June 30, 1931): U. S. Geol. Survey typoscript report, 246 pp., Oct. 23, 1930, to Oct. 15, 1931.

Measurements of depth to water in observation wells of the Mokelumne area, California (in the period July 1, 1931, to July 4, 1933): U. S. Geol. Survey typoscript reports dated Dec. 24, 1931; Mar. 21, 1932; Apr. 30, 1932; July 29, 1932; Oct. 22, 1932; Feb. 1, 1933; Apr. 20, 1933; July 15, 1933.

Corrections to tables of measurements of depth to water in observation wells of the Mokelumne area, California, in the period prior to Feb. 1, 1933: U. S. Geol. Survey typoscript report, 12 pp., Mar. 18, 1933.

Well measurements in the vicinity of Lodi (in the period January 15, 1930, to Sept. 5, 1932); record of San Joaquin County Court, plaintiff's exhibit 6, 652 pages, September, 1932.

Depth to water and altitude of water surface in observation wells in T. 3 N., R. 7 E., Mokelumne area, California: U. S. Geol. Survey typoscript report, 288 pp., June 15, 1934.

Depth to water and altitude of water surface in observation wells in T. 3 N., R. 6 E., Mokelumne area, California: U. S. Geol. Survey typoscript report, 224 pp., Feb. 15, 1935.

Depth to water and altitude of water surface in observation wells in T. 4 N., R. 6 E., Mokelumne area, California: U. S. Geol. Survey typoscript report, 390 pp., June 10, 1935.

Between 1926 and 1933 water-level measurements were made periodically over the greater part of one year or longer in 1,394 wells, all of which have been referred to sea-level datum through spirit leveling by the East Bay Municipal Utility District, the City of Lodi, or the Geological Survey. Water-stage recorders have been maintained by the Geological Survey on 37 wells for terms ranging from 3 months to 6 years.[2]

The observation wells just cited vary rather widely in depth and in submergence (the distance that the well extends below the ground-water level); their water levels represent several distinct water-bearing zones. In about 30 percent of the wells, comprising chiefly the relatively deep wells, the water level commonly stands somewhat above or below the water table.[3]

Measurements of ground-water levels in the Mokelumne area were discontinued by the Geological Survey in July 1933 but have been made continuously since that time by the Pacific Gas & Electric Co. and the East Bay Municipal Utility District. In 1935 the Pacific Gas & Electric Co. made measurements about thrice a month in 218 wells, most of which had been observation wells of the Geological Survey. The East Bay Municipal Utility District determined water levels in 134 wells and borings as follows: Weekly or twice monthly, 13 wells; monthly, 48 wells; every 2 months, 23 wells; at longer intervals or discontinued during 1935, 48 wells. In most of these 134 wells water levels have not been measured by any other agency. Altogether, the two agencies made about 6,000 measurements of ground-water levels in the Mokelumne area during the year.

Fluctuations of ground-water levels in the Mokelumne area,[4] so far as they have been discriminated, are ascribed to (1) moving or changing load on the land surface (for example, passage of railroad trains or trucks); (2) seismic disturbances or earthquakes; (3) variation of barometric pressure; (4) ground-water draft by vegetation; (5) infiltration of rain and certain indirect effects of rainfall; (6) infiltration of water applied to the land for irrigation; (7) variation in the discharge of streams; and (8) pumping from wells. Of these, the first three are extraneous forces, which cause the ground-water level to fluctuate momentarily or through periods of a few hours or days. Each of the other five,

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Depth to water and altitude of water surface in observation wells in T. 4 N., R. 8 E., Mokelumne area, California: U. S. Geol. Survey typoscript report, 184 pp., June 22, 1935.

2 Piper, A. M., Thomas, H. E., and Robinson, T. W., Ground-water hydrology of the Mokelumne area, California: U. S. Geol. Survey typoscript report, pp. 37-40, Oct. 30, 1935.

3 Idem, pp. 45-50.

4 Idem, pp. 52-171.

on the other hand, may cause cyclic fluctuations whose periods range from hours to years but at the same time may tend to depress or to raise the ground-water level steadily over a relatively long term. Evaporation appears not to affect the ground-water level over most of the Mokelumne area, although commonly it causes relatively large fluctuations in other areas where the water table is shallow. Fluctuations whose cycles cover a term of years are common; usually they are the net result of several forces whose individual effects cannot be discriminated.

Records by the Pacific Gas & Electric Co. in 1935 for 24 typical wells follow. These have been selected from the 69 wells that compose three critical profiles across the area -- the Victor, Cherokee Lane, and Woodbridge profiles.[5]

Ground-water levels in typical wells of the Mokelumne area, 1935

(Measurements of depth to water made by Pacific Gas & Electric Co.; except as indicated, levels to measuring points by East Bay Municipal Utility District.)

363P1.[6] Lillian C. Schleef. Irrigation well, 12 inches in diameter and 117 feet deep, 500 feet west of road. Measuring point, top of concrete pit curb west of well, 0.4 foot above land surface, altitude 40.95 feet above sea level.

Date	Hour	Depth to water (feet)
Jan. 2, 1935	3:05 p.m.	13.56
15	3:00 p.m.	13.80
25	3:10 p.m.	13.98
Feb. 6	3:15 p.m.	14.10
14	3:05 p.m.	14.22
27	2:55 p.m.	14.42
Mar. 12	2:55 p.m.	14.67
25	4:10 p.m.	14.70
Apr. 17	2:50 p.m.	14.12
May 9	12:15 p.m.	12.91
27	3:00 p.m.	12.05
June 14	2:50 p.m.	b 25.60
July 1	2:50 p.m.	12.95
25	2:40 p.m.	12.81
Sept. 5	.....	(b)
Oct. 4	3:35 p.m.	12.24
Nov. 4	3:05 p.m.	12.58
12	2:20 p.m.	12.70
21	3:05 p.m.	12.90
Dec. 6	2:40 p.m.	13.31
16	3:10 p.m.	13.50
24	2:15 p.m.	13.60

368P1. G. W. and W. P. Vallem. Domestic well, 8 inches in diameter and 45 feet deep, about 800 feet west of Lafayette School and 80 feet north of Kettleman Lane, 15 feet south of 8-inch irrigation well 368P2. Measuring point, top of casing, 1.2 feet above land surface, altitude 25.95 feet.

Date	Hour	Depth to water (feet)
Jan. 3, 1935	9:45 a.m.	13.90
18	10:00 a.m.	12.53
30	9:40 a.m.	13.50
Feb. 7	9:45 a.m.	13.25
18	9:35 a.m.	13.05
28	9:45 a.m.	11.00
Mar. 14	9:10 a.m.	12.68
26	9:20 a.m.	12.32
Apr. 18	9:30 a.m.	11.73
May 10	9:25 a.m.	11.06
28	9:30 a.m.	a 11.80
June 19	9:20 a.m.	c 22.58
July 2	9:40 a.m.	13.97
26	9:40 a.m.	15.50
Sept. 10	9:50 a.m.	16.40
Oct. 7	9:00 a.m.	c 25.70
Nov. 5	9:55 a.m.	14.21
13	9:55 a.m.	14.02
22	10:00 a.m.	14.00

a Windmill at observation well pumping.

b Power-driven pump operating in observation well. c Power-driven pump known to be operating within a quarter of a mile of observation well.

5 Piper, A. M., Thomas, H. E., and Robinson, T. W., op. cit., pp. 41-44.

6 The number of a well indicates its location with respect to the official rectangular land surveys. See U. S. Geol. Survey Water-Supply Paper 619, p. 209.

Ground-water levels in typical wells of the Mokelumne area - Continued

368P1 - Continued

Date	Hour	Depth to water (feet)
Dec. 9, 1935	10:00 a.m.	13.75
18	10:05 a.m.	13.65
26	10:00 a.m.	13.58

3636R2. Leland W. Bunch. Domestic well, 8 inches in diameter and 85 feet deep, 150 feet north and 400 feet west from intersection of Eightmile Road and Cherokee Lane, 600 feet east of 8-inch irrigation well 3636R3, 20 feet east of domestic well 3636R1. Reference bench mark, top of well curb 1.65 feet north of southeast corner, copper nail with lead washer, altitude 38.67 feet. Measuring point (2) top of casing, 5 feet below land surface, altitude 33.00 feet.

Jan. 7, 1935	9:20 a.m.	16.59
21	10:20 a.m.	16.50
31	10:10 a.m.	16.50
Feb. 11	9:55 a.m.	16.40
19	10:00 a.m.	16.40
Mar. 5	9:50 a.m.	16.64
15	9:50 a.m.	16.02
Apr. 8	10:05 a.m.	15.60
23	9:50 a.m.	15.10
May 13	10:20 a.m.	b 15.5
29	10:15 a.m.	15.07
June 20	9:50 a.m.	15.24
July 3	9:50 a.m.	d 15.50
29	9:50 a.m.	16.03
Sept.11	9:10 a.m.	16.62
Oct. 8	10:00 a.m.	16.48
Nov. 6	9:00 a.m.	16.52
14	11:30 a.m.	16.48
29	9:00 a.m.	16.48
Dec. 10	8:50 a.m.	16.47
19	9:00 a.m.	16.48
30	9:00 a.m.	16.46

373B1. Jacob Knoll. Permanent observation well, 8 inches in diameter and 48 feet deep, 1,000 feet west of Soucie Pond, 1,000 feet northeast of irrigation well 373B2. Reference bench mark, 180 feet north of well, in root of oak tree, copper nail with washer, altitude 79.54 feet. Measuring point, top of casing at south side, 1.4 feet above land surface, altitude 81.85 feet.

373B1 - Continued

Date	Hour	Depth to water (feet)
Jan. 7, 1935	2:15 p.m.	38.62
21	2:35 p.m.	38.56
31	2:45 p.m.	37.93
Feb. 11	2:15 p.m.	37.60
19	2:25 p.m.	37.60
Mar. 5	2:20 p.m.	37.67
15	2:15 p.m.	j 37.08
Apr. 8	2:10 p.m.	34.77
23	2:05 p.m.	34.37
May 13	2:30 p.m.	34.74
29	2:30 p.m.	33.51
June 20	2:10 p.m.	32.06
July 3	2:40 p.m.	33.10
29	2:20 p.m.	34.78
Sept.11	1:55 p.m.	36.75
Oct. 8	2:50 p.m.	37.32
Nov. 6	2:45 p.m.	37.59
15	11:35 a.m.	37.63
29	1:35 p.m.	37.62
Dec. 10	2:15 p.m.	37.64
19	2:30 p.m.	37.64
30	2:30 p.m.	37.62

376J8. R. E. and Ruth F. Coker. Permanent observation well, 4 inches in diameter and 40 feet deep, 2 feet north of Southern Pacific Railroad right of way, 215 feet east of center of Cherokee Lane. Measuring point, top of casing, 0.4 foot above land surface, altitude 53.75 feet.

Jan. 2, 1935	9:00 a.m.	25.00
15	9:00 a.m.	24.87
25	9:20 a.m.	24.80
Feb. 6	9:15 a.m.	24.74
14	9:05 a.m.	23.76
21	8:45 a.m.	24.88
Mar. 12	9:00 a.m.	25.23
25	9:00 a.m.	25.65
Apr. 17	8:40 a.m.	25.15
May 8	11:10 a.m.	24.50
27	9:05 a.m.	24.53
June 14	9:05 a.m.	24.68
July 8	9:00 a.m.	25.64
25	8:45 a.m.	25.30
Sept. 5	9:00 a.m.	25.80
Oct. 4	9:25 a.m.	25.87
Nov. 4	9:30 a.m.	25.58
12	9:15 a.m.	25.39
21	9:15 a.m.	25.22
Dec. 6	9:05 a.m.	25.15
16	9:15 a.m.	24.96
24	9:20 a.m.	24.89

b Power-driven pump operating in observation well.
d Pump in observation well stopped a short time before measurement.
j Adjacent land wet from irrigation.

Ground-water levels in typical wells of the Mokelumne area - Continued

377J1. J. and Rachel K. Goetken. Irrigation well, 10 inches in diameter and 49 feet deep. Two irrigation wells and one service-station well within 400 feet. Reference bench mark, about 370 feet northwest of well, in the southwest angle of Cherokee Lane and T-road west, in center of east side of a square concrete sewer trap, chiseled square, altitude 50.58 feet (by U. S. Geol. Survey). Measuring point (3), pump-house floor south of well, brass nail with washer, 1.0 foot above land surface, altitude 53.65 feet.

Date	Hour		Depth to water (feet)
Jan. 2, 1935	8:45 a.m.		31.68
15	8:45 a.m.		31.50
25	9:00 a.m.		31.22
Feb. 6	9:00 a.m.		31.07
14	8:45 a.m.		31.27
27	8:30 a.m.		31.30
Mar. 18	8:40 a.m.		32.30
25	8:45 a.m.		33.00
Apr. 17	8:25 a.m.		33.91
May 8	.....		(b)
27	8:50 a.m.		34.75
June 4	8:50 a.m.		35.26
July 1	8:45 a.m.		35.45
25	8:30 a.m.		35.19
Sept. 5	8:40 a.m.		34.70
Oct. 4	9:05 a.m.		33.48
Nov. 4	9:10 a.m.		32.50
12	9:00 a.m.		32.40
21	8:55 a.m.		32.29
Dec. 6	8:45 a.m.		31.82
16	9:00 a.m.		31.62
24	9:05 a.m.		31.65

3710K3. Edward Preszler. Permanent observation well, 10 inches in diameter and 57 feet deep, about 50 feet west of Locust Avenue, 6 feet east of companion well 3710K4, and 100 feet northeast of 14-inch irrigation well 3710K1. Reference bench mark, in base of transformer pole 33 feet west of well, copper nail, altitude 74.52 feet. Measuring point, top of casing at south side, 1.2 feet above land surface, altitude 73.79 feet.

Date	Hour		Depth to water (feet)
Jan. 7, 1935	12:15 p.m.		41.60
21	12:45 p.m.		41.80
31	12:35 p.m.		42.34
Feb. 11	12:25 p.m.	c	44.30
19	12:30 p.m.		45.30
Mar. 5	12:25 p.m.		47.10

3710K3 - Continued

Date	Hour		Depth to water (feet)
Mar. 15, 1935	12:20 p.m.		48.90
Apr. 8	12:30 p.m.		48.35
23	12:15 p.m.	c	51.92
May 13	12:35 p.m.		52.78
29	12:40 p.m.		47.71
June 20	12:15 p.m.		48.00
July 3	12:40 p.m.		48.10
29	12:20 p.m.		49.26
Sept. 11	11:45 a.m.		47.25
Oct. 8	12:45 p.m.		45.15
Nov. 6	12:45 p.m.		43.55
15	10:45 a.m.		43.09
29	12:40 p.m.		42.50
Dec. 10	12:25 p.m.		42.22
19	12:35 p.m.		41.97
30	12:35 p.m.		42.20

3710K4. Edward Preszler. Permanent observation well, 12 inches in diameter to 121 feet, 10 inches to 190 feet. Measuring point, top of casing at south side, 0.7 foot above land surface, altitude 73.07 feet.

Date	Hour		Depth to water (feet)
Jan. 7, 1935	12:15 p.m.		40.70
21	12:45 p.m.		40.90
31	12:35 p.m.		41.90
Feb. 11	12:25 p.m.	c	43.38
19	12:30 p.m.		44.50
Mar. 5	12:25 p.m.		46.17
15	12:20 p.m.		47.95
Apr. 8	12:30 p.m.		47.09
23	12:15 p.m.	c	49.90
May 13	12:35 p.m.		50.07
29	12:40 p.m.		48.00
June 20	12:15 p.m.		47.88
July 3	12:40 p.m.		48.07
29	12:20 p.m.		48.95
Sept. 11	11:45 a.m.		46.78
Oct. 8	12:45 p.m.		44.06
Nov. 6	12:45 p.m.		42.37
15	10:45 a.m.		42.14
29	12:40 a.m.		41.60
Dec. 10	12:25 p.m.		41.32
19	12:35 p.m.		41.10
30	12:35 p.m.		41.60

3715P2. Eugene R. Hieb. Permanent observation well, 10 inches in diameter and 55 feet deep, 200 feet north of 14-inch irrigation well 3722B1. Reference bench mark, 16 feet south of well, at northeast corner of garage, in top of concrete curb, chiseled square, altitude 67.29 feet. Measuring point (2), top of instrument shelf, 3.5 feet above land surface, altitude 70.34 feet.

b Power-driven pump operating in observation well.

c Power-driven pump known to be operating within a quarter of a mile of observation well.

Ground-water levels in typical wells of the Mokelumne area - Continued

3715P2 - Continued

Date	Hour	Depth to water (feet)
Jan. 7, 1935	11:50 a.m.	44.70
21	12:25 p.m.	44.85
31	12:10 p.m.	44.30
Feb. 11	12:00 m.	44.03
19	12:05 p.m.	44.05
Mar. 5	12:00 m.	44.18
15	11:55 a.m.	45.10
Apr. 8	12:10 p.m.	47.10
23	11:50 a.m.	45.94
May 13	12:10 p.m.	47.17
29	12:15 p.m.	48.89
June 20	11:35 a.m.	50.35
July 3	12:15 p.m.	48.60
29	12:00 m.	51.45
Sept.11	11:20 a.m.	48.87
Oct. 8	12:20 p.m.	47.42
Nov. 6	12:15 p.m.	46.30
15	10:15 a.m.	46.03
29	.....	45.60
Dec. 10	12:00 m.	45.35
19	12:10 p.m.	45.13
30	12:10 p.m.	44.93

3719A2. C. M. Ferdun. Permanent observation well, 4 inches in diameter and 40 feet deep. Two irrigation wells within 300 feet. Reference bench mark, 45 feet north of well, in southeast angle of intersection of Cherokee and Harney Lanes, on top near east end of culvert headwall, chiseled square, altitude (by U. S. Geol. Survey) 47.54 feet. Measuring point, top of casing, 0.5 foot above land surface, altitude 48.82 feet.

Jan. 7, 1935	9:50 a.m.	31.88
21	9:50 a.m.	31.45
31	9:40 a.m.	31.25
Feb. 11	9:25 a.m.	31.03
19	9:30 a.m.	30.92
Mar. 5	9:20 a.m.	30.62
15	9:20 a.m.	30.70
Apr. 8	9:35 a.m.	31.20
23	9:20 a.m.	31.53
May 13	9:50 a.m.	31.77
29	9:45 a.m.	31.95
June 20	9:20 a.m.	32.80
July 3	9:20 a.m.	29.21
29	9:20 a.m.	31.72
Sept.11	8:40 a.m.	33.85
Oct. 8	9:30 a.m.	33.70
Nov. 6	10:00 a.m.	33.09
14	1:45 p.m.	32.90
29	10:00 a.m.	32.48
Dec. 10	9:50 a.m.	32.22
19	10:00 a.m.	32.02
30	9:55 a.m.	31.79

3727F3. John F. Heitzmann. Permanent observation well, 8 inches in diameter and 46 feet deep, 100 feet northwest of 8-inch irrigation well 3727F2. Reference bench mark, about 225 feet southeast of well, along south edge of Liveoak Road, in base on north side of power pole, copper nail with washer, altitude 61.24 feet (by U. S. Geol. Survey). Measuring point, top of casing, 1.7 feet above land surface, altitude 61.12 feet.

Date	Hour	Depth to water (feet)
Jan. 7, 1935	3:55 p.m.	39.17
21	4:15 p.m.	39.06
31	4:35 p.m.	38.94
Feb. 11	3:55 p.m.	38.80
19	4:10 p.m.	38.75
Mar. 5	4:10 p.m.	38.55
15	3:55 p.m.	38.50
Apr. 8	3:55 p.m.	38.28
23	3:40 p.m.	38.27
May 13	4:00 p.m.	38.36
29	4:00 p.m.	38.36
June 20	3:35 p.m.	38.78
July 3	4:00 p.m.	39.24
29	3:40 p.m.	39.74
Sept.11	3:30 p.m.	40.25
Oct. 8	4:05 p.m.	40.25
Nov. 6	4:05 p.m.	39.88
15	12:55 p.m.	40.80
29	3:35 p.m.	39.62
Dec. 10	3:45 p.m.	39.50
19	3:55 p.m.	39.40
30	3:50 p.m.	39.26

3730E2. W. L. Flanigan. Domestic well, 6 inches in diameter and 59 feet deep, about 100 feet south and 300 feet east of the intersection of Cherokee Lane and Liveoak Road. Two irrigation wells within 400 feet. Reference bench mark, about 150 feet north of well, along north edge of Liveoak Road, in base on south side of 18-inch fir tree, copper nail with washer, altitude 42.80 feet (by U. S. Geol. Survey). Measuring point (2), top of casing, 8.5 feet below land surface, altitude 33.30 feet.

Jan. 7, 1935	9:40 a.m.	17.57
21	10:00 a.m.	17.50
31	9:50 a.m.	17.35
Feb. 11	9:35 a.m.	17.09
19	9:40 a.m.	16.95
Mar. 5	9:30 a.m.	16.85
15	9:30 a.m.	16.76
Apr. 8	9:45 a.m.	16.59

Ground-water levels in typical wells of the Mokelumne area - Continued

3730E2 - Continued

Date	Hour	Depth to water (feet)
Apr. 23, 1935	9:30 a.m.	16.55
May 13	10:00 a.m.	17.26
29	9:55 a.m.	17.95
June 20	9:30 a.m.	20.40
July 3	9:30 a.m.	d 22.78
29	9:30 a.m.	23.90
Sept.11	8:50 a.m.	22.88
Oct. 8	9:40 a.m.	21.82
Nov. 6	10:10 a.m.	19.50
14	1:55 p.m.	19.16
29	10:10 a.m.	b 19.58
Dec. 10	10:00 a.m.	18.40
19	10:10 a.m.	18.30
30	10:05 a.m.	18.07

4612R1. G. A. Jahant. Domestic well, 6 inches in diameter and 84 feet deep, about 200 feet west and 100 feet north from intersection of Cherokee Lane and Jahant Road, 400 feet southwest of 10-inch irrigation well 4612R2. Measuring point (2), top of tile casing, 18.4 feet below land surface, altitude 38.94 feet (by U. S. Geol. Survey).

Jan. 2, 1935	11:10 a.m.	13.97
15	11:05 a.m.	13.72
29	11:30 a.m.	13.50
Feb. 6	11:20 a.m.	13.20
14	11:15 a.m.	13.08
27	10:55 a.m.	12.80
Mar. 12	10:55 a.m.	12.58
25	11:15 a.m.	12.35
Apr. 17	10:50 a.m.	11.87
May 8	2:50 p.m.	11.55
27	11:10 a.m.	11.86
July 25	10:50 a.m.	15.77
Sept. 5	11:15 a.m.	16.87
Oct. 4	11:40 a.m.	16.42
Nov. 4	11:45 a.m.	15.72
12	11:30 a.m.	15.55
21	11:20 a.m.	15.34
Dec. 6	11:10 a.m.	15.02
16	11:20 a.m.	14.78
24	11:25 a.m.	14.30

4634R1. E. M. Smith. Unused well, 10 inches in diameter and 34 feet deep, in northwest angle of intersection of Southern Pacific Railroad and Woodbridge Road, about 350 feet southwest of Smith Lake. Measuring point (2), top of outer casing, 0.2 foot above land surface, altitude 43.46 feet.

4634R1 - Continued

Date	Hour	Depth to water (feet)
Jan. 2, 1935	3:15 p.m.	12.71
15	3:05 p.m.	12.93
25	3:20 p.m.	13.58
Feb. 6	3:25 p.m.	14.07
14	3:20 p.m.	14.33
27	3:10 p.m.	14.68
Mar. 12	3:05 p.m.	14.77
25	4:15 p.m.	15.04
Apr. 17	3:00 p.m.	14.30
May 9	1:40 p.m.	6.29
27	3:15 p.m.	9.56
June 14	3:05 p.m.	2.80
July 1	3:05 p.m.	10.33
25	2:55 p.m.	10.93
Sept. 5	3:00 p.m.	11.15
Oct. 4	3:45 p.m.	11.00
Nov. 4	3:10 p.m.	11.10
12	3:00 p.m.	11.35
21	3:15 p.m.	11.68
Dec. 6	2:50 p.m.	12.35
16	3:15 p.m.	12.70
24	2:25 p.m.	12.91

4636A1. D. D. Smith and S. H. and I. Zimmerman. Unused well, 6 inches in diameter and 35 feet deep, about 100 feet east of 12-inch irrigation well 4636A2. Measuring point, top of casing, level with land surface, altitude 49.90 feet.

Jan. 2, 1935	2:25 p.m.	21.60
15	2:15 p.m.	21.80
25	2:30 p.m.	21.77
Feb. 6	2:35 p.m.	21.70
14	2:30 p.m.	21.80
27	2:20 p.m.	21.94
Mar. 12	2:15 p.m.	22.07
25	3:25 p.m.	23.65
Apr. 17	1:05 p.m.	24.30
May 9	11:40 a.m.	21.59
27	2:25 p.m.	21.69
June 14	2:15 p.m.	c 24.95
July 1	2:15 p.m.	22.15
25	2:10 p.m.	22.07
Sept. 5	2:20 p.m.	21.80
Oct. 4	2:55 p.m.	20.82
Nov. 4	2:05 p.m.	21.03
12	1:45 p.m.	21.32
21	2:25 p.m.	21.60
Dec. 6	2:00 p.m.	21.87
16	2:30 p.m.	21.52
24	1:35 p.m.	21.37

b Power-driven pump operating in observation well.
c Power-driven pump known to be operating within a quarter of a mile of observation well.
d Pump in observation well stopped a short time before measurement.

Ground-water levels in typical wells of the Mokelumne area - Continued

4715C3. Robert L. Carter. Permanent observation well, 8 inches in diameter and 64 feet deep, about 300 feet south of Jahant Road and 75 feet southeast of dwelling. Four domestic and irrigation wells within 800 feet. Measuring point, top of casing, 1.0 foot above land surface, altitude 93.05 feet.

Date	Hour	Depth to water (feet)
Jan. 14, 1935	12:10 p.m.	51.35
24	12:00 m.	51.30
Feb. 5	12:05 p.m.	50.94
13	12:05 p.m.	50.97
26	12:10 p.m.	50.82
Mar. 8	12:10 p.m.	51.80
22	12:00 m.	50.60
Apr. 16	12:00 m.	50.54
May 7	12:50 p.m.	50.27
23	11:20 a.m.	50.40
June 12	11:30 a.m.	50.91
28	11:45 a.m.	51.64
July 24	12:00 m.	52.78
Aug. 29	11:55 a.m.	53.55
Oct. 3	12:10 p.m.	53.30
10	12:10 p.m.	53.17
Nov. 7	12:25 p.m.	52.55
20	12:15 p.m.	52.36
Dec. 13	12:10 p.m.	52.02
23	12:15 p.m.	51.88

4718N3. Martha Eddlemon. Permanent observation well, 4 inches in diameter and 45 feet deep, along north edge of Peltier Road and 70 feet east of Cherokee Lane. Four irrigation wells within 900 feet. Measuring point, top of casing, 0.8 foot above land surface, altitude 59.84 feet (by U. S. Geol. Survey).

Jan. 2, 1935	10:25 a.m.	35.85
15	10:25 a.m.	35.50
25	10:45 a.m.	35.21
Feb. 6	10:40 a.m.	34.86
14	10:30 a.m.	34.86
21	10:10 a.m.	34.46
Mar. 12	10:10 a.m.	34.30
25	10:30 a.m.	34.10
Apr. 17	10:10 a.m.	33.67
May 8	12:25 p.m.	35.61
27	10:25 a.m.	34.45
June 14	10:15 a.m.	38.75
July 1	10:15 a.m.	41.41
25	10:05 a.m.	43.20
Sept. 5	10:25 a.m.	42.65
Oct. 4	10:55 a.m.	40.54
Nov. 4	11:00 a.m.	38.45
12	10:45 a.m.	38.13
21	10:40 a.m.	37.72
Dec. 6	10:25 a.m.	37.15
16	10:40 a.m.	36.76
24	10:45 a.m.	36.55

4722Q4. Adolphus Eddlemon. Permanent observation well, 10 inches in diameter and 51 feet deep, about 50 feet north of Acampo Road, 5 feet north of companion well 4722Q5. Three irrigation wells within 800 feet. Measuring point, top of casing, 0.8 foot above land surface, altitude 84.41 feet.

Date	Hour	Depth to water (feet)
Jan. 14, 1935	11:25 a.m.	42.80
24	11:20 a.m.	42.62
Feb. 5	11:20 a.m.	42.44
13	11:25 a.m.	42.34
26	11:30 a.m.	42.20
Mar. 8	11:30 a.m.	42.07
22	11:15 a.m.	42.29
Apr. 16	11:15 a.m.	42.02
May 7	12:10 p.m.	41.95
23	10:35 a.m.	42.16
June 12	10:50 a.m.	43.18
28	11:15 a.m.	44.15
July 24	11:05 a.m.	45.40
Aug. 29	11:15 a.m.	45.70
Oct. 3	11:30 a.m.	45.10
10	11:30 a.m.	44.88
Nov. 8	11:45 a.m.	43.75
20	11:40 a.m.	43.42
Dec. 5	11:35 a.m.	42.98
13	11:30 a.m.	42.82
23	11:40 a.m.	42.65

4722Q5. Adolphus Eddlemon. Permanent observation well, 10 inches in diameter and 266 feet deep. Measuring point, top of casing, 0.2 foot above land surface, altitude 84.03 feet.

Jan. 14, 1935	11:25 a.m.	41.60
24	11:20 a.m.	41.58
Feb. 5	11:20 a.m.	41.30
13	11:25 a.m.	41.35
26	11:30 a.m.	41.15
Mar. 8	11:30 a.m.	41.34
22	11:15 a.m.	43.70
Apr. 16	11:15 a.m.	42.14
May 7	12:10 p.m.	42.02
23	10:35 a.m.	j 47.36
June 12	10:50 a.m.	49.16
28	11:15 a.m.	51.40
July 24	11:05 a.m.	52.83
Aug. 29	11:15 a.m.	49.20
Oct. 3	11:30 a.m.	45.70
10	11:30 a.m.	45.06
Nov. 8	11:45 a.m.	42.70
20	11:40 a.m.	42.39
Dec. 5	11:35 a.m.	41.95
13	11:30 a.m.	41.33
23	11:40 a.m.	42.74

j Adjacent land wet from irrigation.

Ground-water levels in typical wells of the Mokelumne area - Continued

4727P1. Frank H. and Leonard W. Buck. Permanent observation well, 10 inches in diameter and 49 feet deep, along west edge of county road and 150 feet north of angle in road from south to east, 800 feet west of 12-inch irrigation well 4734G1. Measuring point, top of casing, 0.9 foot above land surface, altitude 82.10 feet.

Date	Hour	Depth to water (feet)
Jan. 14, 1935	11:05 a.m.	35.79
24	11:00 a.m.	35.65
Feb. 5	11:00 a.m.	35.45
13	11:05 a.m.	35.25
26	11:05 a.m.	35.03
Mar. 8	11:10 a.m.	34.95
22	10:55 a.m.	34.95
Apr. 16	10:55 a.m.	34.92
May 7	11:50 a.m.	34.90
23	10:15 a.m.	32.26
June 12	10:30 a.m.	30.30
28	10:50 a.m.	30.82
July 24	10:40 a.m.	j 33.02
Aug. 29	10:50 a.m.	34.78
Oct. 3	10:50 a.m.	34.90
10	11:10 a.m.	35.00
Nov. 8	11:25 a.m.	34.75
20	11:15 a.m.	34.68
Dec. 5	11:15 a.m.	34.59
13	11:10 a.m.	34.61
23	11:20 a.m.	34.50

4730J2. Clara A. Barton. Domestic well, 4 inches in diameter and 48 feet deep (reported), about 125 feet east of Cherokee Lane. Five irrigation wells within 1,000 feet. Reference bench mark, top of concrete pit curb near southwest corner, painted arrow, altitude 58.45 feet. Measuring point, top of casing, 13.6 feet below land surface, altitude 44.67 feet.

Date	Hour	Depth to water (feet)
Jan. 2, 1935	9:55 a.m.	17.52
15	9:55 a.m.	17.36
25	10:20 a.m.	17.20
Feb. 6	10:10 a.m.	17.05
14	10:00 a.m.	16.95
27	9:40 a.m.	16.85
Mar. 12	9:45 a.m.	16.90
25	10:00 a.m.	17.17
Apr. 17	9:40 a.m.	19.50
May 8	12:00 m.	19.38
27	9:55 a.m.	20.24
June 14	9:50 a.m.	20.83
July 1	9:45 a.m.	21.34
25	9:35 a.m.	21.40
Sept. 5	10:00 a.m.	21.50
Oct. 4	10:25 a.m.	20.00

4730J2 - Continued

Date	Hour	Depth to water (feet)
Nov. 4, 1935	10:35 a.m.	18.57
12	10:15 a.m.	18.30
21	10:15 a.m.	18.27
Dec. 6	10:00 a.m.	17.92
16	10:10 a.m.	17.80
24	10:15 a.m.	17.85

4731J3. Charles H. Woest. Domestic well, 6 inches in diameter and 50 feet deep, about 50 feet east of Cherokee Lane, 60 feet south of dwelling, and 700 feet north of the Mokelumne River. Four irrigation and domestic wells within 600 feet. Measuring point (4), top of casing, 11.2 feet below land surface, altitude 46.55 feet (by U. S. Geol. Survey).

Date	Hour	Depth to water (feet)
Jan. 2, 1935	9:30 a.m.	14.25
15	9:30 a.m.	14.30
25	9:55 a.m.	14.33
Feb. 6	9:40 a.m.	14.16
14	9:35 a.m.	14.10
27	9:15 a.m.	14.10
Mar. 12	9:25 a.m.	14.17
25	9:35 a.m.	14.70
Apr. 17	9:15 a.m.	14.64
May 8	11:40 a.m.	14.55
27	9:35 a.m.	12.65
June 14	9:30 a.m.	9.75
July 1	9:25 a.m.	11.68
25	9:20 a.m.	11.92
Sept. 5	9:40 a.m.	12.92
Oct. 4	10:00 a.m.	12.60
Nov. 4	10:10 a.m.	13.30
12	9:50 a.m.	13.30
21	9:50 a.m.	13.50
Dec. 6	9:35 a.m.	13.68
16	9:45 a.m.	13.48
24	9:50 a.m.	13.45

4731N5. Jacob Goehring. Permanent observation well, 4 inches in diameter and 25 feet deep, 150 feet east of Cherokee Lane and 400 feet south of the Mokelumne River. Measuring point, top of casing, 2.9 feet above land surface, altitude 47.02 feet (by U. S. Geol. Survey).

Date	Hour	Depth to water (feet)
Jan. 2, 1935	9:15 a.m.	13.97
15	9:15 a.m.	14.05
25	9:35 a.m.	14.00
Feb. 6	9:25 a.m.	13.79
14	9:20 a.m.	13.62
21	8:55 a.m.	13.70
Mar. 12	9:10 a.m.	12.80

j Adjacent land wet from irrigation.

Ground-water levels in typical wells of the Mokelumne area - Continued

4731N5 - Continued

Date	Hour	Depth to water (feet)
Mar. 25, 1935	9:15 a.m.	13.88
Apr. 17	8:55 a.m.	12.30
May 8	11:25 a.m.	11.44
27	9:20 a.m.	8.43
June 14	9:20 a.m.	h 6.00
July 1	9:10 a.m.	8.98
25	9:00 a.m.	9.75
Sept. 5	9:20 a.m.	9.95
Oct. 4	9:45 a.m.	10.48
Nov. 4	9:55 a.m.	11.80
12	9:30 a.m.	12.47
21	9:35 a.m.	12.87
Dec. 6	9:20 a.m.	13.22
16	9:30 a.m.	12.96
24	9:35 a.m.	12.80

4734G1. John J. Schmiedt. Permanent observation well, 8 inches in diameter and 30 feet deep, 500 feet west of the Mokelumne River. Measuring point, top of casing, 0.7 foot above land surface, altitude 58.20 feet.

Jan. 1, 1935	2:05 p.m.		10.84
21	2:25 p.m.		10.54
31	2:35 p.m.		10.57
Feb. 11	2:05 p.m.		9.89
19	2:15 p.m.		9.80
Mar. 5	1:05 p.m.		9.75
15	2:05 p.m.		9.58
Apr. 8	2:00 p.m.		9.32
23	12:50 p.m.		9.40
May 13	2:20 p.m.	h	8.55
29	2:20 p.m.	h	3.28
June 20	12:55 p.m.	h	3.60
July 3	2:30 p.m.		6.20
29	2:10 p.m.		8.82
Sept.11	1:45 p.m.		9.87
Oct. 8	2:40 p.m.		9.94
Nov. 6	2:35 p.m.		9.69
15	11:25 a.m.		9.60
29	1:25 p.m.		9.49
Dec. 10	2:05 p.m.		9.57
19	2:10 p.m.		9.45
30	2:20 p.m.		9.45

h Adjacent land flooded.

CONNECTICUT

By W. H. Brothwell

Supervisor of the emergency work project relating
to ground water in Connecticut

GROUND-WATER PROVINCE AND GEOLOGIC AND GEOMORPHIC DIVISIONS OF THE STATE

The State of Connecticut lies entirely in the ground-water province known as the "Northeastern Drift Province." This province, which includes all the area of the New England States, is described by Meinzer in Water-Supply Paper 489 (p. 311) as follows:

> Northeastern Drift Province.--Principal ground-water supplies come from glacial drift. The till yields small supplies to many springs and shallow wells; the outwash gravels yield very large supplies, notably on Long Island. Many drilled rock wells receive small supplies, chiefly from joints in crystalline rocks or in Triassic sandstone. Ground water is generally soft and otherwise low in mineral matter.

Connecticut has three major geologic and geomorphic divisions. Broad belts of crystalline rocks occupy the eastern and western parts of the State, and a central strip is underlain by Triassic sandstone, shale, and trap. The crystalline belts are also upland areas characterized by irregularly spaced summits and steep valleys. The Triassic belt is a lowland area with prominent ridges, upheld by trap, elongated in a general north-south direction.

HISTORICAL REVIEW OF GROUND-WATER INVESTIGATIONS

The first studies of ground water in Connecticut were made by H. E. Gregory under the auspices of the United States Geological Survey. His first report, published in 1904, was followed by studies in the Triassic area of Connecticut by W. A. C. Pynchon and M. L. Fuller, also under the auspices of the Federal Survey. Gregory published a second general report on ground water in Connecticut in Water-Supply Paper 114 of the United States Geological Survey in 1905, and a general report on the relation of the geology of Connecticut to the water supply in the annual report of the Connecticut Board of Agriculture in 1906. A comprehensive report by Gregory and E. E. Ellis was published in 1909 by the United States Geological Survey as Water-Supply Paper 232, including a detailed study of water in crystalline rocks by Ellis. In 1911 a cooperative agreement was made between the Federal and State Surveys, as a result of which more detailed studies of particular areas were undertaken.

All these studies had many points in common; they all involved systematic collection of information regarding wells and springs in the area covered and studies of the quality of the ground water as shown by chemical analyses, the use of water from underground sources, possible extensions in the utilization of the ground-water resources, and, to some extent, the variations of the water table in the different environments.

The several papers and their authors are listed in the following bibliography. Two papers deserve special mention -- the report by J. S. Brown on coastal ground water in relation to the sea water, and that of O. E. Meinzer and N. D. Stearns on the drainage basin of the Pomperaug River with special reference to intake and discharge of ground water. In connection with the Pomperaug investigation, weekly measurements of depths to the water levels were made in 22 wells from October 4, 1913, to December 30, 1916.

Gregory, H. E., Notes on the wells, springs, and ground-water resources of Connecticut: U. S. Geol. Survey Water-Supply Paper 102, pp. 127-168, 1904.

Pynchon, W. H. C., Drilled wells of the Triassic area of the Connecticut Valley: U. S. Geol. Survey Water-Supply Paper 110, pp. 65-94, 1905.

Fuller, M. L., Triassic rocks of the Connecticut Valley as a source of water supply: U. S. Geol. Survey Water-Supply Paper 110, pp. 95-112, 1905.

Gregory, H. E., The underground waters of Connecticut: U. S. Geol. Survey Water-Supply Paper 114, pp. 76-81, 1905.

Gregory, H. E., The geology of Connecticut in relation to its water supply: Connecticut Board Agr. 39th Ann. Rept., pp. 283-297, 1906.

Ellis, E. E., Occurrence of water in crystalline rocks: U. S. Geol. Survey Water-Supply Paper 160, pp. 19-28, 1906.

Gregory, H. E., and Ellis, E. E., Underground water resources in Connecticut: U. S. Geol. Survey Water-Supply Paper 232, 1909.

Gregory, H. E., and Ellis, A. J., Ground water in the Hartford, Stamford, Willimantic, and Saybrook areas, Connecticut: U. S. Geol. Survey Water-Supply Paper 374, 150 pp., maps, 1916.

Ellis, A. J., Ground water in the Waterbury area, Connecticut: U. S. Geol. Survey Water-Supply Paper 397, 73 pp., maps, 1916.

Waring, G. A., Ground water in the Meriden area, Connecticut: U. S. Geol. Survey Water-Supply Paper 449, 83 pp., maps, 1920.

Palmer, H. S., Ground water in the Southington-Granby area, Connecticut: U. S. Geol. Survey Water-Supply Paper 466, 219 pp., maps, 1921.

Palmer, H. S., Ground water in the Southington-Granby area, Connecticut (abstract): Washington Acad. Sci. Jour., vol. 12, no. 1, pp. 19-20, January 4, 1922.

Palmer, H. S., Ground water in the Norwalk, Suffield, and Glastonbury areas, Connecticut: U. S. Geol. Survey Water-Supply Paper 470, 171 pp., maps, 1920.

Palmer, H. S., Ground water in the Norwalk, Suffield, and Glastonbury areas, Connecticut (abstract): Washington Acad. Sci. Jour., vol. 11, no. 21, p. 510, December 19, 1921.

Brown, J. S., Relation of sea water to ground water along coasts: Am. Jour. Sci., 5th ser., vol. 4, pp. 274-294, 7 figs., October 1922.

Brown, J. S., A study of coastal ground water, with special reference to Connecticut: U. S. Geol. Survey Water-Supply Paper 537, 101 pp., maps, 1925.

Brown, J. S., Ground water in the New Haven area, Connecticut: U. S. Geol. Survey Water-Supply Paper 540, 206 pp., maps, 1928.

Meinzer, O. E., and Stearns, N. D., A study of ground water in the Pomperaug Basin, Connecticut, with special reference to intake and discharge: U. S. Geol. Survey Water-Supply Paper 597, pp. 73-146, maps, 1929.

PRESENT STUDIES

The present studies of ground water in Connecticut were started in October 1934 as a project of the Federal Emergency Relief Administration, sponsored by the State Planning Board, the State Water Commission, and the United States Geological Survey. The technical direction of the work was undertaken by the United States Geological Survey. The project is being continued by the Works Progress Administration under the sponsorship of the State Planning Board, with technical direction by the United States Geological Survey. The Connecticut State Water Commission is also continuing in an advisory capacity.

The project was begun in the Hartford and Torrington areas, in the northern part of the State and in the New Haven and Bridgeport areas, along the coast. The work in the northern part of the State consists of a partial inventory of wells and springs and weekly observations at selected wells. Detailed topographic maps of the selected wells have been made, and the altitudes of many of the wells have been determined. The work in the coastal belt consists of an inventory of wells and springs in the several towns, the selection of wells for periodic observation, the mapping of these selected wells, the determination of their altitudes, and tests of the chloride contents of the waters of almost all wells and springs visited to determine the effects of the salt water on Long Island Sound on the ground water.

OBSERVATION-WELL PROGRAM

Most of the observation wells in the Hartford and Torrington areas (including Burlington) were selected in the later part of 1934, and observation work on them was continued throughout 1935. Scheduled observations on a few of the selected wells were discontinued for reasons such as unsuitability of wells for observation, unfavorable attitude by the owners, or replacement by more satisfactory or more accessible wells.

The following table shows the number of observation wells on which measurements were started in 1934 and in 1935 and the number on which observations were discontinued during 1934 and 1935:

Number of observation wells

Area	Started in 1934	Started in 1935	Discontinued in 1934	Discontinued in 1935	Under observation Jan. 1,1936
Hartford and Torrington	163	0	5	12	146
Bridgeport	18	28	0	10	36
New Haven	0	86	0	7	79
Total	181	114	5	29	261

The number of measurements made in the several areas, including all well and spring census measurements, is as follows: In 1934, Hartford and Torrington 1,655, New Haven 586, Bridgeport 440, total 2,681; in 1935, Hartford and Torrington 7,813, New Haven 2,818, Bridgeport 2,561, total 13,192. The grand total to January 1, 1936, is 15,873 measurements.

CONDITIONS OF PERIODIC OBSERVATION

All observation wells are measured weekly on an appointed day of the week (for example, Monday for wells in the Hartford and Torrington areas), except that on a few occasions it has been necessary to measure certain wells a day before or after the scheduled day. Every measurement to date has been made by a project employee. These men are assigned to visit and measure certain observation wells only after being thoroughly acquainted with the routes, owners, and measuring points. It is considered necessary to take a new observer around to the wells at least twice, in order to insure familiarity with local conditions. Once a field man is acquainted with certain observation wells and is obtaining the necessary cooperation from the owners, it is desirable to keep him reading the same wells. For each observation-well route, however, there are at least two employees familiar with the details of the wells, so that even in emergencies the scheduled observations are carried out.

ESTABLISHMENT OF MEASURING POINTS AND BENCH MARKS

All measuring points on observation wells are as permanent as is practicable. The description of the individual measuring points appears on all well-measurement records. The points are generally shown by

orange paint marks on the well tile or curbing, knife cuts, or keel marks. Where it is impracticable to deface the well with marks of the more permanent type, keel is used, and the marks are renewed periodically.

In the Hartford and Torrington areas reference bench marks have been selected convenient to all observation wells. The determination of altitudes above sea level by instrumental leveling from accurate bench marks was started July 17, 1935. Bench marks of the United States Geological Survey and the United States Coast and Geodetic Survey were used, supplemented by marks of the Connecticut State Highway Department that were known to be reliable. In a few places accurate bench marks of the above-named agencies were not available, and it was necessary to utilize town-survey markers, such as those of the Metropolitan District of Hartford, or to postpone leveling. No instrumental leveling has been done to date in the coastal belt, and no permanent measuring points other than painted or chalked marks have been established for any wells in that belt. Accurate altitudes were determined in 1935 for a total of 56 observation wells, of which 30 are in the Hartford northwest loop and 26 in the Hartford southwest loop.

FLORIDA

By V. T. Stringfield

Measurements of water levels and artesian pressure in wells in Florida have been made in connection with a cooperative ground-water investigation conducted by the Florida State Geological Survey and the United States Geological Survey in the fiscal years 1931, 1932, 1933, and 1936, and an investigation of the artesian conditions and head in the peninsular part of the State, with funds provided by the Public Works Administration, in the fiscal years 1934 and 1935. Measurements were made chiefly by F. C. Westendick and the writer, but some were made by D. S. Wallace, district engineer, United States Geological Survey, and his assistants, and some in 1930 by D. G. Thompson. Many of the measurements were made in Duval, Seminole, Orange, Manatee, and Sarasota Counties. Two automatic water-stage recorders have been in operation since 1930, one on a well near Sarasota and the other on wells in Jacksonville. Records of water levels and artesian pressure prior to 1930 are given in several published reports of the Federal and State Geological Surveys, especially in "Geology and ground waters of Florida," by G. C. Matson and Samuel Sanford, which was published in 1913 as Water-Supply Paper 319 of the Federal Survey. Many of these earlier records were reported by the owners or drillers of the wells.

The wells that have been measured since 1930 are drilled wells and range from less than 100 feet to as much as 1,000 feet in depth and from about 2 to 12 inches in diameter. They are chiefly artesian wells and should be distinguished from the shallow water-table wells that are essentially independent of the pressures in the artesian reservoir. Some are in areas that are affected by large withdrawals from pumped or flowing wells, some are in areas affected by artificial recharge through drainage wells, and some are in areas that are not appreciably affected by artificial withdrawal or recharge.

On nonflowing wells the measuring point, from which the depth to water is measured, is the top of the well casing. On flowing wells the measuring point is usually a point on the well to which the pressure gage or other device for determining the pressure is attached. The altitude of all measuring points with reference to the land surface at the wells has been recorded. A few of the measuring points are tied to Government bench marks with mean sea-level datum.

Measurements made during 1930 and 1931 in Sarasota County are recorded on pages 184 to 194 of the Twenty-third and Twenty-fourth Annual Report of the Florida State Geological Survey, 1933. Measurements of water levels or pressure heads made from 1930 to 1934 in other parts of the Florida peninsula are reported in U. S. Geological Survey Water-Supply Paper 773-C. The records of measurements made during 1935 in the Florida peninsula and a few in west Florida are still unpublished but are available to anyone who desires them.

About 500 measurements were made during 1935. About 100 wells in Orange and Seminole Counties were measured at least once during the field season, of which 75 wells were measured more than once, 50 were measured in both September and October, and 25 were measured weekly or daily during certain periods. About 75 wells outside of Orange and Seminole Counties were measured at least once. The two water-stage recorders were in operation during 1935. Prior to 1935 about 500 wells were measured one or more times.

The measurements in wells in Orange County during September and October 1935 show that at the end of this 2-month period the water levels in this county were in general about 2 feet higher than at the beginning of the period. This rise was caused chiefly by artificial recharge through drainage wells and perhaps partly by natural recharge. Fluctuations of as much as 10 feet within a few weeks are not unusual in this area. The water levels in September 1935 were about as low as has been indicated by any measurement since 1930, except during May 1933, when they were about 2 to 4 feet lower.

The measurements in wells in Seminole County in September and October 1935 show that the water levels were about 1 to 2 feet higher in October than in September, giving some indication of natural recharge. The measurements indicated that the water levels during September 1935 in a part of Seminole County were about 1 to 2 feet higher than during May 1933. Part of the wells in this county are within an area affected by large withdrawal of water, and measurements made during the winter season of heavy draft (November to March) doubtless will reflect that influence.

The most nearly complete record of water levels in Florida is that of the well on the Palmer farms, near Sarasota, on which a continuous water-stage recorder has been in operation since October 1930. The record of that well shows the influence of draft from nearby wells.

The water level in the well was about 3 feet lower in 1935 than when the record started in 1930, with slight fluctuations in 1935. During periods when the fluctuations are not large, the influence of changes in atmospheric pressure is reflected in the water levels in the well. The artesian wells near the coast in Sarasota County show the influence of the ocean tides.

Records of an artesian well at Jacksonville Beach, in Duval County, show a semidaily fluctuation in water level of 1 to 2 feet, which is undoubtedly caused by the ocean tide, as the maximum level occurs approximately at high tide and the low level at low tide. The pressure recorder on a well in the Water Works Park at Jacksonville indicated a fluctuation of about 18 feet, but this is doubtless caused largely by changes in the draft from the wells that furnish the public supply and possibly in part by changes in draft from industrial wells.

In general fluctuations of the water levels in the artesian wells in the Florida peninsula are small except in or near areas of natural or artificial recharge, where the fluctuation may be as much as 10 feet, and in areas affected by pumped or flowing wells.

HAWAII

By H. T. Stearns

INTRODUCTION

The Hawaiian archipelago consists of 21 islands. The largest are Hawaii, Maui, Molakai, Oahu, Kauai, Niihau, Lanai, and Kahoolawe; the others are small islets, reefs, and shoals. Honolulu, the capital of the Territory, is on Oahu. Prior to the arrival of the white man the Hawaiians obtained their water chiefly from springs and from wells along the coast. Some of these wells were cracks in rocks where fresh water flowed seaward, which they walled up on the seaward end to prevent the free inflow of ocean water. Others were shallow dug wells. In a few places large springs issued from the ocean floor close to shore, and divers obtained fresh water from these springs in gourds.

The development of the sugar-cane industry created a great demand for both surface and ground water. Except for a few spring-fed rivers, the streams are flashy even in the wettest areas, because of the high permeability of the rocks. Likewise reservoirs tend to leak badly, and most of the slopes are so steep that reservoirs of large capacity are scarce. These conditions have caused a steady increase in the development of ground water from basalt, both by high-level tunnels and by wells pumping from the basal zone of saturation. Additional small supplies of ground water are obtained from dug wells in the coastal-plain sedimentary deposits on Oahu and to a lesser extent on the other islands. The chief water-bearing rock in these deposits is reef limestone.

The essential problem in Hawaii is to obtain water free from salt, because the fresh water floats upon salt water according to the Ghyben-Herzberg principle except where the water is confined in the dike complex or perched at high levels on ash or soil beds. At the present time water is pumped from wells in large quantities on the islands of Maui, Oahu, and Kauai and to a lesser extent on Hawaii. Each year brings about an appreciable increase in the number of wells and in the amount of ground water used. For example, in 1936 five wells of the Maui type are to be constructed on Oahu with a total capacity of about 40,000,000 gallons a day.

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1 Stearns, H. T., and Vaksvik, K. N., Geology and ground-water resources of the Island of Oahu, Hawaii: Hawaii Dept. Public Lands, Div. Hydrography, Bull. 1, pp. 65, 237, 1935.

2 Idem, pp. 324-325.

The first well drilled in the Hawaiian Islands was completed at Honouliuli, near Ewa, Oahu, on September 22, 1879. It is a flowing well and is known as the Pioneer well (U.S.G.S. well 267). The success of this well gave impetus to further drilling. Flowing wells have been obtained only on Oahu and Kauai, because they are the only islands having areas of coastal-plain sedimentary rocks extensive enough to form artesian basins.

HISTORY OF WATER-LEVEL MEASUREMENTS ON OAHU

The first systematic water-level measurements on Oahu were made in 1910 by T. F. Sedgwick, an employee of the Public Works Department, as a result of a visit by W. C. Mendenhall, then in charge of ground-water investigations for the United States Geological Survey. Mr. Sedgwick measured most of the wells then in existence on Oahu, made systematic monthly readings of static heads of wells distributed about the island, and determined the salt content of a large number of samples of well water. This work was continued until 1916, and the data so collected have been essential in all subsequent investigations. Since 1917 the water-level measurements have been made by the Division of Hydrography of the office of the Commissioner of Public Lands, Territory of Hawaii. Because of lack of funds the collection of well data was reduced between 1919 and 1921, and the work was entirely dropped from 1921 until 1923. Since 1923 monthly measurements have been made of certain observation wells in most of the artesian areas on Oahu, and since 1930 these measurements have been made by the Division of Hydrography in financial cooperation with the United States Geological Survey. The Honolulu Sewer and Water Commission and its successor, the Honolulu Board of Water Supply, have made many water-level measurements in Honolulu since 1929. From 1931 to 1933 the United States Geological Survey made an intensive study of the ground-water conditions on Oahu and collected all available measurements. These data are to be published in a forthcoming bulletin of the Division of Hydrography.

In 1935 the wells on Oahu were renumbered, because of the confused and disorderly arrangement of the old numbering system. All well numbers used herein are the new numbers. (Tables listing the new and old numbers are given on pages 463-467 of Bulletin 1 of the Division of Hydrography.) In July 1932 the recorders on the wells in Honolulu, formerly maintained by the Division of Hydrography, were turned over to the Honolulu Board of Water Supply.

WATER-LEVEL MEASUREMENTS

Island of Oahu

During 1935 the Honolulu Board of Water Supply made measurements on 117 wells, of which 109 were measured more than once, a total of 254 measurements being made. The measurements were made by engineers in connection with simultaneous surveys of artesian head to determine whether or not any of the artesian wells in Honolulu were leaking.

During 1935 the United States Geological Survey made 187 water-level measurements in 18 wells, 16 of which were measured monthly. Water-level fluctuations in all except two of the twelve recognized isopiestic areas in Oahu are represented by these measurements and those made by the Honolulu Board of Water Supply. Many additional measurements were made by the plantation owners at their pumping stations. These records are not collected by the Geological Survey, but they are available at the plantation offices.

Automatic water-stage recorders were maintained by the Honolulu Board of Water Supply on 11 wells in the five isopiestic areas in Honolulu during 1935.

The observation wells range from about 100 to 800 feet in depth and from 6 to 12 inches in diameter, and all were put down by the churn-drill method. Most of them are cased through the cap rock to prevent salt water in the reef limestone and other permeable layers of the cap rock from entering the wells. They are all artesian, and many of them would overflow if it were not for the almost continuous heavy pumping for irrigation. The average quantity pumped during the period from 1928 to 1933 amounted to about 105,000,000,000 gallons a year, or about 287,000,000 gallons a day. Nearly 90 percent of this water came from the basalt of the Koolau Range, and the remainder from the basalt of the Waianae Range. All wells for which measurements are given in this report, except 1A and 406, are in areas of heavy pumpage. There are about 700 wells on the island of Oahu, over half of which have permanent bench marks tied to the Coast and Geodetic Survey mean sea-level datum by instrumental leveling. Many of the observation wells are equipped with plugs especially installed for attaching a U-tube for measuring static levels.

The important reports containing water-level data are as follows:

> Report of the Water Commission of 1917, vols. 2 to 5, unpublished and on file in the Public Archives at Honolulu. The table of contents of these volumes is given in the appendix to volume 1, published by the Hawaiian Gazette Co., Ltd., Honolulu, 1918.

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Report of the Honolulu Sewer and Water Commission to the Legislature of the Territory of Hawaii, 15th regular session, January 1929.

Supplement to the Report of the Board of Water Supply to the Legislature of the Territory of Hawaii, 16th Regular Session, February 1931.

Report of the Board of Water Supply to the Legislature of the Territory of Hawaii, 17th Regular Session, February 1935.

Stearns, H. T., and Vaksvik, K. N., The geology and ground-water resources of the Island of Oahu, Hawaii: Hawaii Dept. Public Lands, Div. Hydrography, Bull. 1, May 1935.

Other reports containing water-level data are listed in the "Annotated bibliography and index of geology and water supply of the island of Oahu, Hawaii," by Norah D. Stearns (Div. Hydrography Bull. 3, August 1935). However, most of the water-level data are still unpublished and are in the files of the United States Geological Survey at Honolulu and at Spreckelsville, Maui. It is planned to publish these data as a bulletin of the Division of Hydrography.

Other islands

Water-level measurements of wells were not made on any island except Hawaii during 1935 by any Government agency. On Maui the wells are all of the shaft type, and measurements are furnished to the Geological Survey by the plantations. During 1935 automatic water-stage recorders were maintained on three wells of this type on West Maui by the Pioneer Mill Co. There are no artesian wells on Maui. No wells were measured on Kauai during 1935 by the Geological Survey, but records have been obtained and a recorder was kept in operation for a time in previous years. Most of the ground water on Kauai is pumped from shafts, and measurements of the water level in these shafts are made by the plantations and are available to the Geological Survey upon request. On the island of Hawaii there are only a few shafts, and records of the water levels are kept by the plantation owners. One of these shafts was excavated at Olaa during 1935. Well water is used in only a few places on Hawaii at the present time. On Molokai and Lanai small quantities for domestic and stock use are obtained from shallow dug wells. Several wells of the Maui type with large capacity were constructed on Molokai many years ago but were never used. It is the plan of the United States Geological Survey to obtain continuing records of certain observation wells on each of the islands as soon as the systematic study of the ground water has been sufficiently advanced to make this practicable. These wells will be selected to typify ground-water conditions for each island.

FLUCTUATIONS OF GROUND-WATER LEVELS DURING 1935

Island of Oahu

The artesian areas on Oahu are designated by numbers. Areas 1 to 10 are along the shore side of the Koolau Range and areas 11 and 12 along the shore side of the Waianae Range.[3] Records showing the fluctuations of ground-water level are available in ten of the twelve areas. In general the high stage in the nine artesian areas was reached in either March or April, and the low stage between June and September except in area 10, where it occurred in February. Well 406, flowing at the rate of about 200 gallons a minute, is the only artificial draft from area 10. Measurements of this well are representative of water-level conditions outside of recognized cones of depression.

The water level was higher in six areas and lower in four areas at the end of the year than at the beginning. The table below shows that there was a slight gain in ground-water storage in Honolulu (areas 1, 2, and 3) and a loss in storage in the larger areas heavily pumped by sugar plantations (areas 6, 7, and 8). Because of 2 years of dry weather, pumpage for irrigation caused the water level in some of the wells to reach new low marks.

Time of high and low water levels in the artesian areas and the net gain or loss in static level for 1935 as shown by typical wells on Oahu

Area	Name	Well no.	High	Low	Gain or loss (feet)
1	St. Louis Heights	2	April	June	+0.90
2	Makiki-Pacific Heights	83	March	September	+.45
3	Kapalama	132	March	August	+.33
4	Moanalua	144	March	August	-.15
5	Wilhelmina Rise	1A	October	July	a +.18
6	Pearl Harbor	201, 244, 266	March	August	-1.19
7	Waialua	326	January b	June	-.40
8	Kahuku	356, 396	March	June-August	a -.83
10	Kaaawa	406	April	February	+.52
12	Mokuleia	286, 308	October-December c	June	a +.12

a Average; period Jan. 25 to Dec. 26.
b March record missing.
c Reached practically same height in March; November record missing.

3 Stearns, H. T., and Vaksvik, K. N., Geology and ground-water resources of the island of Oahu, Hawaii: Hawaii Dept. Public Lands, Div. Hydrography, Bull. 1, fig. 16, 1935.

In the following records the head of the water in the wells is expressed in feet with reference to mean sea level. In some of the wells this is the water level in the well as measured; in others it is the height to which the water would rise in a water-tight casing or tube, as indicated by the shut-in pressure.

Areas 1, 2, and 3

Because areas 1, 2, and 3 are pumped heavily to supply Honolulu, the water-level fluctuations in these areas closely parallel each other. The total draft from areas 1 to 3 averages about 25,000,000 gallons a day. A synopsis of the static level in area 2, for which the longest record is available, is given as representative of the three areas. The 1935 high level of 29.93 feet in well 83, in area 2, is only slightly below the high level for 1934 but 2 to 3 feet below the high levels of 1932 and 1933. It was nearly the same as the high levels for the period 1928-31 but 1½ to 4 feet above the high levels for the period 1924-27. Except for the four years 1916, 1917, 1918, and 1923, the annual high levels between 1913 and 1923 were lower than that of 1935. Between 1888 and 1912 the water level never at any time fell appreciably below the high level for 1935. Since 1888 the 1935 low level of 26.46 feet has been exceeded only in 1920, 1922, 1924-27, and 1929.

Water-level measurements in 1935 for typical wells in areas 1, 2, and 3 follow:

Well 2. - About 600 ft. north of Waialae road and 10 ft. east of Manoa Stream, Honolulu, in area 1. Owner, Bishop estate. Drilled, 1895. Altitude, 37 ft. Diameter, 8 in. Not in use. Recorder installed 1929. Bench mark, top of open 8-in. well casing at ground; altitude 37.28 ft. The head in this well, and in the others for which records are given, is expressed in feet with reference to mean sea level. Records furnished by Honolulu Board of Water Supply.

Date 1935	Head (feet)	Date 1935	Head (feet)	Date 1935	Head (feet)	Date 1935	Head (feet)
Jan. 5	25.66	Mar. 30	27.37	July 6	26.16	Oct. 5	26.47
12	25.80	Apr. 6	27.39	13	26.47	12	26.26
19	26.12	13	27.40	27	27.00	19	26.40
26	26.51	20	27.54	Aug. 3	26.84	26	26.13
Feb. 2	26.58	27	27.24	10	26.58	Nov. 2	25.86
9	26.78	May 4	27.27	17	26.61	9	25.87
16	26.87	11	27.29	24	26.56	16	26.07
23	26.82	18	26.92	31	26.56	23	26.15
Mar. 2	27.23	June 1	25.65	Sept. 7	26.75	30	26.14
9	27.35	8	25.06	14	26.85	Dec. 7	26.24
16	27.40	15	24.85	21	26.87	14	26.36
23	27.39	29	25.80	28	26.71	21	26.43
						28	26.56

Well 9. - On Kapahulu Road near Olu St., Honolulu, in area 1. Owner, J. J. Gouveia. Drilled, 1921. Altitude, 16 ft. Depth, 270 ft. Diameter, 6 in. Depth to top of aquifer, 256 ft. Use, irrigation. Casing, 256 ft. Bench mark, top of bead on northeast branch of cross union on top of well casing, 2 ft. above ground; altitude, 18.08 ft.

Date 1935	Head (feet)	Date 1935	Head (feet)	Date 1935	Head (feet)	Date 1935	Head (feet)
Jan. 25	26.16	Apr. 19	27.27	June 19	26.10	Sept.26	26.35
Feb. 21	26.61	25	27.20	July 17	26.59	Oct. 29	25.48
Mar. 22	27.03	May 17	26.76	Aug. 22	26.32	Dec. 27	26.30

Well 81. - South side of Young St., about 250 ft. east of Victoria St., Honolulu, in area 2. Owner, Archie Young. Drilled, 1914. Altitude, 18 ft. Diameter, 10 in. Use, domestic. Bench mark, top of flange at ground on vertical standpipe to which piezometer tube is attached; altitude, 18.04 ft.

Jan. 25	28.87	Apr. 25	29.66	July 17	28.00	Oct. 29	27.99
Feb. 21	29.17	May 17	29.22	Aug. 22	26.78	Dec. 27	28.86
Mar. 22	29.79	June 19	28.86	Sept.26	27.06		

Well 83. - In Thomas Square, corner Beretania Ave. and Kapiolani St., Honolulu, in area 2. Owner, City and County of Honolulu. Drilled, 1882. Altitude, 27 ft. Depth, 509 ft. Diameter, 8 in. at top and 6 in. at bottom. Depth to top of aquifer, 460 ft. Not in use. Recased from 10 in. Recorder installed 1925. Bench mark, top of flange bolted to valve on south side of well 3½ ft. below ground; altitude, 22.81 ft. Records furnished by Honolulu Board of Water Supply.

Jan. 5	28.54	Apr. 6	29.92	July 13	28.20	Oct. 12	27.45
12	28.88	13	29.87	20	27.98	Nov. 9	28.26
19	29.02	27	29.80	27	27.74	16	28.44
26	29.02	May 4	29.56	Aug. 3	27.39	23	28.68
Feb. 2	29.08	11	29.30	10	27.14	30	28.81
9	29.12	18	29.29	17	26.89	Dec. 7	28.88
Mar. 2	29.35	June 8	29.42	24	26.68	14	28.89
9	29.57	15	29.19	Sept. 7	26.46	21	28.96
16	29.75	22	28.82	14	26.62	28	28.99
23	29.81	29	28.55	21	26.89		
30	29.93	July 6	28.35	28	27.11		

Well 119. - At Honolulu Gas Works, Honolulu, in area 3. Owner, Honolulu Gas Co. Drilled, 1923. Altitude, 4 ft. Depth, 682 ft. Diameter, 10 in. Depth to top of aquifer, 617 ft. Use, industrial. Bench mark, top of bolts holding blind flange in tee on well at ground; altitude, 4.22 ft.

Jan. 26	28.69	Apr. 25	29.07	July 18	27.58	Oct. 29	27.71
Feb. 23	28.68	May 17	28.75	Aug. 22	26.41	Dec. 27	28.84
Mar. 22	29.52	June 20	28.17	Sept.26	26.79		

Well 132. - At old Kamehameha School pump house, in area 3. Owner, Bishop estate. Drilled 1911, by McCandless Bros. Altitude, 43 ft. Depth, 346 ft. Diameter, 12 in. top and 10 in. bottom. Not in use. Casing 265 ft. Recorder installed March 1929. Bench mark, top of vertical flange on elbow of well casing 6 ft. below ground; altitude, 37.14 ft. Records furnished by Honolulu Board of Water Supply.

Jan. 5	28.44	Apr. 6	29.60	July 6	27.98	Oct. 12	27.19
12	28.59	13	29.55	13	27.85	19	27.57
19	28.74	20	29.51	20	27.48	26	27.76
26	28.89	27	29.36	27	27.17	Nov. 2	27.85
Feb. 2	28.94	May 4	29.20	Aug. 3	26.90	9	28.02
9	29.01	11	29.01	17	26.58	16	28.15
16	28.96	18	28.90	24	26.44	23	28.33
23	28.89	25	28.73	31	26.42	30	28.50
Mar. 2	28.94	June 1	28.73	Sept. 7	26.50	Dec. 7	28.59
9	29.24	8	28.68	14	26.82	14	28.74
16	29.49	15	28.43	21	26.92	21	28.74
23	29.61	22	28.31	28	27.04	28	28.78
30	29.65	29	28.14	Oct. 5	27.13		

Area 4

Draft in area 4, averaging about 5,000,000 gallons a day, is for irrigation and military establishments. However, a well of the Maui type is now being constructed in this area by the Honolulu Board of Water Supply. The 1935 high level of 27.56 feet in well 144 was exceeded in every year since 1910, when the record began, except in 1913, 1925, 1926, 1927, and 1932. The 1935 low level of 23.80 feet was exceeded only by that of 23.46 feet in 1926.

Water-level measurements of two wells in this area for 1935 follow:

Well 144. - About 400 ft. south of King St. and in line with Middle St. extension, Honolulu. Owner, Pacific Guano & Fertilizer Co. Drilled, 1894. Altitude, 26 ft. Diameter, 8 in. Not in use. Recorder installed March 1927. Bench mark, top of tee, 1 ft. above ground on well; altitude 27.17 ft. Records furnished by Honolulu Board of Water Supply.

Date 1935	Head (feet)	Date 1935	Head (feet)	Date 1935	Head (feet)	Date 1935	Head (feet)
Jan. 5	26.55	Apr. 13	27.24	July 13	25.50	Oct. 19	25.68
12	26.60	20	27.11	20	25.47	26	25.95
19	26.70	27	26.93	27	25.32	Nov. 2	25.88
26	26.86	May 4	26.74	Aug. 3	25.12	9	25.95
Feb. 2	27.18	11	26.51	10	25.00	16	26.14
9	26.98	25	26.16	24	24.70	23	26.46
16	26.66	June 1	26.06	31	24.62	30	26.44
23	26.51	8	25.97	Sept. 7	24.70	Dec. 7	26.36
Mar. 2	26.37	15	25.85	14	25.12	14	26.49
16	27.48	22	25.74	21	25.15	21	26.40
23	27.56	29	25.61	28	25.08	28	26.40
30	27.50	July 6	25.60	Oct. 5	25.13		

Well 153. - About 25 ft. east of Manaiki Stream in Moanalua, at junction of two private roads, Honolulu. Owner, Sam Damon estate. Drilled, 1889. Altitude, 20 ft. Diameter, 10 in. Use, domestic and irrigation. Bench mark, top of vertical flange on elbow 2 ft. above ground at well; altitude, 22.38 ft.

Jan. 25	26.85	Apr. 25	26.84	July 17	25.38	Dec. 27	26.30
Feb. 20	26.40	May 21	26.12	Aug. 22	23.80		
Mar. 22	27.53	June 19	25.63	Sept. 26	24.93		

Area 5

Wells 1A and 1B are the only ones at present in area 5, although a well of Maui type is now under construction by the Honolulu Board of Water Supply. Well 1B is pumped at the rate of about 300,000 gallons a day. Well 1A, 75 feet east of well 1B, is not in use. In May 1934 the Honolulu Board of Water Supply installed an automatic recorder on this well. Prior to that time only a few measurements had been made. Available records show that the water level was higher in May 1933 than at any time since. It was also lower at the end of 1934 than at the end of 1935. A low level of 7.72 feet was reached in August 1934.

Well 1A. - 75 ft. east of pump house on north side of Waialae Golf Links, Honolulu. Drilled, 1881. Owner, Bishop estate. Altitude, 18 ft. Depth, 131 ft. Diameter, 10 in. Not in use. Bench mark, near well 1B, top of spike at ground; altitude, 18.12 ft. Records furnished by Honolulu Board of Water Supply.

Date 1935	Head (feet)	Date 1935	Head (feet)	Date 1935	Head (feet)	Date 1935	Head (feet)
Jan. 7	8.20	Apr. 8	8.31	July 8	8.21	Oct. 7	8.51
14	8.20	15	8.29	15	8.17	14	8.50
21	8.33	22	8.31	22	8.23	21	8.48
28	8.36	29	8.36	29	8.23	28	8.38
Feb. 4	8.39	May 6	8.17	Aug. 5	8.30	Nov. 4	8.41
11	8.28	13	8.30	12	8.30	12	8.37
18	8.18	20	8.24	19	8.30	18	8.48
25	8.27	27	8.26	26	8.27	25	8.37
Mar. 4	8.34	June 3	8.25	Sept. 3	8.35	Dec. 2	8.40
11	8.43	10	8.33	9	8.32	9	8.38
18	8.35	17	8.30	16	8.34	16	8.40
25	8.35	24	8.19	23	8.39	23	8.25
Apr. 1	8.36	July 1	8.17	30	8.40	30	8.38

Area 6

Area 6 yields the largest quantity of water on Oahu. It supplies irrigation water to the Honolulu, Oahu, and Ewa plantations. Pumpage between 1925 and 1933 ranged from 47,535,000,000 to 59,067,000,000 gallons a year.[4] The 1935 high level of 23.72 feet in well 244, in the center of this area, is nearly the same as that for the period 1928-34 but above that for the period 1923-27. It is about the same as that for 1919-21 but below even the lowest water levels for 1916-18. It is above the peaks of 1913-15 but below those of 1911-12. However, the 1935 low level of 18.46 feet was exceeded only in 1926, 1929, and 1934 during the period of record, which began in 1910.

Water-level measurements of five wells in area 6 for 1935 follow:

Well 190. - At pump house on Cooper estate at McGraw Peninsula, Honolulu. Owner, Mrs. C. B. Cooper. Drilled before 1889. Altitude, 23 ft. Depth, 300 ft. Diameter, 6 in. Use, domestic. Casing, 200 ft. Bench mark, top of flange, 3 ft. below ground on well casing; altitude, 19.73 ft.

Jan. 25	22.84	Mar. 21	22.77	May 17	20.55	July 17	20.00
Feb. 20	20.96	Apr. 25	21.28	June 19	20.01	Aug. 22	19.92
						Sept.26	20.19

Well 193. - At sharp bend in old main highway at Wainalu cut-off. Owner, L. L. McCandless. Altitude, 13 ft. Depth, 363 ft. Diameter, 12 in. Use, domestic. Bench mark, top of tee 5 ft. above ground directly above center of well; altitude, 18.05 ft.

Jan. 25	22.26	Apr. 25	20.93	July 17	19.76	Dec. 26	20.69
Feb. 20	20.40	May 17	20.05	Aug. 21	18.38		
Mar. 21	22.21	June 19	19.39	Oct. 30	19.97		

4 Stearns, H. T., and Vaksvik, K. N., op. cit., p. 314.

Well 201. - About 75 yards south of Oahu Railway and Light Co. tracks and 200 yards east of Pearl City railroad station. Owner, Bishop estate. Altitude, 9 ft. Diameter, 12 in. Use, irrigation. Bench mark, top of upper flange 4 ft. above ground on valve; altitude, 13.17 ft.

Date 1935	Head (feet)	Date 1935	Head (feet)	Date 1935	Head (feet)	Date 1935	Head (feet)
Jan. 25	20.67	Apr. 25	20.09	July 17	18.53	Oct. 30	19.30
Feb. 20	19.77	May 17	19.35	Aug. 21	17.91	Dec. 26	18.97
Mar. 22	21.37	June 19	18.64	Sept.26	18.19		

Well 244. - At Waipahu near water tank, about 150 yards south of Waipahu Theater. Owner, Bishop estate. Drilled, 1909. Altitude, 11 ft. Depth, 225 ft. Diameter, 12 in. Use, domestic. Casing, 58 ft. Bench mark, top of plate 2 ft. above ground and main valve; altitude, 12.47 ft.

Jan. 25	22.80	Apr. 25	21.74	July 17	19.33	Oct. 30	20.95
Feb. 21	21.30	May 17	20.45	Aug. 21	18.46	Dec. 26	21.85
Mar. 21	23.72	June 19	19.69	Sept.26	19.14		

Well 266. - At north corner of corral at Honouliuli Ranch. Owner, Honouliuli Ranch. Altitude, 13 ft. Diameter, 12 in. Use, irrigation. Bench mark, top of blind flange 2⅔ ft. above ground on top of well, altitude, 15.16 ft.

Jan. 24	22.87	Apr. 25	20.28	July 17	17.71	Oct. 30	19.88
Feb. 20	20.48	May 17	18.69	Aug. 21	16.83	Dec. 26	21.94
Mar. 21	23.40	June 19	18.20	Sept.26	17.53		

Area 7

The annual draft from area 7 during 1924-33 ranged from 8,273,000,000 to 15,988,000,000 gallons, practically all of which was used by the Waialua Agricultural Co. for irrigation. The water level in area 7 reached a high point of 11.82 feet in well 326 in January 1935. A high level during this month in this area is not uncommon. This high level in 1935 was lower than that of any other year since 1926 except 1934, and the low level of 10.04 feet was the lowest during the period of record, which began in 1911. This unusual low level followed 2 years of heavy pumpage.

Well 326. - In sugar-cane field near camp about 700 yards west of Two Bridges, Waialua. Owner, Waialua Agricultural Co. Altitude, 6 ft. Diameter, 8 in. Use, irrigation. Flowing at rate of 250,000 gallons a day in January 1934. Bench mark, top of blind flange on well 1½ ft. below ground; altitude, 4.69 ft.

Jan. 24	11.82	May 15	10.59	Aug. 21	10.33	Dec. 26	11.42
Feb. 20	10.82	June 20	10.04	Sept.25	10.22		
Apr. 25	11.01	July 17	10.15	Oct. 30	10.89		

Area 8

The draft from area 8 in 1932, the only year of practically complete records, amounted to about 27,000,000 gallons a day. Practically all the water is used by the Kahuku Plantation Co. for irrigation. The

1935 low level of 18.66 feet in well 396 in this area is the lowest during the period of record, which began in 1911; on the other hand, only in 1926 and 1934 has the peak stage of this well been lower than that of 1935. In 1934 the high level was 20.04 feet, as compared to 20.59 feet in 1935. Low levels a few tenths of a foot above that reached in 1935 occurred in 1926, 1929, 1931, 1933, and 1934.

The 1935 high level of 13.95 feet in well 356 is the lowest annual peak on record for this well, the next lowest being 14.41 feet in 1926. The low level of 11.41 feet reached in 1935 is the lowest stage on record.

Water-level measurements of three wells in this area for 1935 follow:

Well 337. - At Waialee Industrial School. Owner, Territory of Hawaii. Drilled, 1921, by A. H. Hobert. Altitude, 22 ft. Depth, 63 ft. Diameter, 8 in. Depth to top of aquifer, about 48 ft. Use, emergency. Casing, 36 ft. Bench mark, top of 4-in. tee 1 ft. below ground; altitude, 20.45 ft.

Date 1935	Head (feet)	Date 1935	Head (feet)	Date 1935	Head (feet)	Date 1935	Head (feet)
Jan. 24	13.37	Apr. 23	13.19	July 17	12.13	Oct. 30	13.71
Feb. 20	13.07	May 15	13.29	Aug. 21	13.28		
Mar. 21	13.42	June 20	12.22	Sept.25	13.37		

Well 356. - Emergency pump near Kahuku sugar mill. Owner, Kahuku Plantation Co. Altitude, 9 ft. Use, emergency. Bench mark, top of vertical flange 1 ft. above ground on valve on fire hydrant; altitude, 9.83 ft.

Jan. 24	14.92	Apr. 23	12.61	July 17	11.79	Oct. 30	12.87
Feb. 20	13.02	May 15	12.09	Aug. 21	11.68	Dec. 26	13.95
Mar. 21	13.65	June 20	11.41	Sept.25	11.73		

Well 396. - 100 yards south of railroad shop at Hauula. Owner, Kahuku Plantation Co. Altitude, 10 ft. Diameter, 8 in. Use, industrial. Bench mark, top of large cap 6 ft. above ground in cross union on main casing; altitude, 16.36 ft.

Jan. 24	20.50	Apr. 23	19.64	July 17	19.20	Oct. 30	19.74
Feb. 20	19.98	May 15	18.76	Aug. 21	18.66	Dec. 26	19.80
Mar. 21	20.59	June 20	18.96	Sept.25	18.66		

Area 10

About 200 gallons a day gravity flow from well 406 is the only artificial draft in area 10. Measurements of this well, begun in June 1929, show that the low level of 14.09 feet in 1935 was exceeded by stages of 13.83 feet in 1929 and 13.43 feet in 1934.

Well 406. - In Kaaawa about 400 yards south of highway bridge over Kaaawa Stream. Owner, Mrs. F. M. Swanzy. Altitude, 10 ft. Diameter, 9 in. Use, irrigation. Bench mark, highest point on well casing at ground; altitude, 10.27 ft.

Jan. 24	14.10	Apr. 23	14.63	July 17	14.44	Oct. 30	14.42
Feb. 20	14.09	May 15	14.58	Aug. 21	14.49	Dec. 26	14.62
Mar. 21	14.30	June 20	14.55	Sept.25	14.32		

Area 12

The average daily draft from area 12 in 1933 was estimated at 14,000,000 gallons, most of which is used for irrigation. During the period of record, which began in 1926, the high and low levels of well 308, in this area, were both lower in 1926, 1927, 1928, 1929, 1931, and 1934 than in 1935. They differed only slightly for the remaining years of record. Measurements of well 286, begun in January 1929, show that the water level was lower in 1929 than in 1935. This area did not show the effect of the drought nearly as much as the other areas pumped by plantations.

Water-level measurements of two wells in this area for 1935 follow:

Well 286. - On plantation road a quarter of a mile south of highway and 500 yards southwest of Mokuleia railroad station. Owner, Waialua Agricultural Co. Altitude, 12 ft. Diameter, 6 in. Use, irrigation. Recased to 6 in. in 1918. Flowing at the rate of 90,000 gallons a day in January 1934. Bench mark, top of 6-in. tee on well 6 in. above ground; altitude, 12.04 ft.

Date 1935	Head (feet)	Date 1935	Head (feet)	Date 1935	Head (feet)	Date 1935	Head (feet)
Jan. 24	17.45	Apr. 25	16.65	July 17	16.51	Oct. 30	17.47
Feb. 20	16.90	May 15	16.57	Aug. 21	16.64	Dec. 26	17.55
Mar. 21	17.54	June 20	16.36	Sept.25	16.81		

Well 308. - About 10 ft. west of high water tank 1.6 miles east of Mokuleia railroad station. Owner, J. F. Mendonca. Drilled, 1924, by McCandless Bros. Altitude, 8 ft. Depth, 548 ft. Diameter, 10 in. top and 8 in. bottom. Use, irrigation. Casing 10 in. to 396 ft., 8 in. to 440 ft. Flowing at the rate of 140,000 gallons a day in January 1934. Bench mark, top of ¼-in. plate at ground on 12-in. tee; altitude, 8.46 ft.

Jan. 24	18.93	Apr. 25	17.88	July 17	18.02	Oct. 30	19.45
Feb. 20	17.91	May 15	17.96	Aug. 21	18.40	Dec. 26	19.07
Mar. 21	19.21	June 20	17.82	Sept.25	18.54		

Island of Maui

The water level in the wells of the Hawaiian Commercial & Sugar Co. at the end of 1935 stood about 10 inches below the level at the beginning of the pumping season and several inches above the level at the end of the pumping season of 1933. On Maui 1933 was drier than 1926. On the leeward side of West Maui the Pioneer Mill Co. had to deepen the floor of some of the tunnels because of the drought of 1935. However, these tunnels are only a year or two old; hence previous water levels are unknown at these places.

The water level in the wells of the Maui Agricultural Co. at Paia did not show appreciable change in 1935 from that in 1934, according to J. H. Foss. Two wells of the Maui type have been completed within the

last few years near Paia. Additional tunneling has been done at the mill and the Lower Paia wells, because their salt content increased with the drought of 1933 and the draft from the new wells.

During 1935 surplus surface irrigation water was run into leaky reservoirs and down gulches for the first time, in order to recharge artificially the ground-water reservoir underlying Paia. It appears that this artificial recharge was successful in preventing a decline of the water levels in these wells.

IDAHO

About the beginning of the present century a notable series of reconnaissance surveys was made by Russell[1] in the lava-covered region of the Northwest, including the Snake River Plain and other parts of Idaho. These early reports contain fragmentary but nevertheless valuable information on wells and ground-water levels. Some information on ground water and water levels is also given in the geologic folios prepared in this early period by Waldemar Lindgren and N. F. Drake.[2]

Systematic measurements of ground-water levels in Idaho were begun about 1912 by the United States Reclamation Service in connection with drainage problems on the Minidoka and Boise projects. In subsequent years similar measurements were made by other agencies, including the United States Geological Survey, in different parts of the State, in connection with studies of water supply and drainage. In some areas periodic measurements have been made for several years, but in most of the areas the measurements were incidental to making maps of the water table, and hence only one or two measurements on a well were obtained.

In 1921 a general field study of ground-water conditions and problems in southern Idaho was made by O. E. Meinzer, and extensive ground-water investigations were begun under his direction in cooperation with the Idaho Bureau of Mines and Geology and the Idaho Department of Reclamation. These investigations included a large number of accurate measurements of water levels in wells, with periodic measurements in numerous wells that were selected as observation wells.

The most intensive work begun in 1921 was in the Mud Lake area, by H. T. Stearns and L. L. Bryan. Progress reports on the investigation in this area were issued in mimeographed form in 1922 and in several subsequent years. A report published in Water-Supply Paper 560 in 1925 summarizes the principal results up to March 1924 and includes hydrographs showing the fluctuation of the water levels in 8 wells. The

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1 Russell, I. C., Geology and water resources of the Snake River Plains of Idaho: U. S. Geol. Survey Bull. 199, 1902; Geology and water resources of Nez Perce County, Idaho, pt. 1: U. S. Geol. Survey Water-Supply Paper 53, 1901; Geology and water resources of Nez Perce County, Idaho, pt. 2: U. S. Geol. Survey Water-Supply Paper 54, 1901; Preliminary report on artesian basins in southwestern Idaho and southeastern Oregon: U. S. Geol. Survey Water-Supply Paper 78, 1903.

2 Lindgren, Waldemar, U. S. Geol. Survey Geol. Atlas, Folio 45, 1898. Lindgren, Waldemar, and Drake, N. F., idem, Folios 103 and 104, 1904.

complete report, including a few hundred well records and a few thousand water-level measurements, has been released to the public in typewritten form. The records of the wells and water levels are included in Water-Supply Paper 775, which is now in press.

Less intensive ground-water investigations were made in other areas in 1921 and subsequent years by A. M. Piper and others. Some of these investigations were made in cooperation and others independently by the Bureau of Mines and Geology. Most of them included considerable accurate water-level work. These investigations led to the preparation of a series of reports, most of which have been published by the Bureau of Mines and Geology, as follows:

Piper, A. M., Geology and water resources of the Goose Creek Basin, Cassia County, Idaho: Bull. 6, 1923.
Stearns, H. T., Craters of the Moon National Monument: Bull. 13, 1928.
Laney, F. B., Kirkham, V. R. D., and Piper, A. M., Ground-water supply at Moscow, Idaho: Pamph. 8, 1923.
Meinzer, O. E., Ground water in Pahsimeroi Valley, Idaho: Pamph. 9, 1924.
Piper, A. M., Geology and water resources of the Bruneau River Basin, Owyhee County, Idaho: Pamph. 11, (1924?).
Piper, A. M., Ground water for irrigation on Camas Prairie: Pamph. 15, 1925.
Piper, A. M., and Kirkham, V. R. D., Ground water for municipal supply at Idaho Falls, Idaho: Pamph. 16, 1926.
Kirkham, V. R. D., Ground water for municipal supply at St. Maries, Idaho: Pamph. 17, 1926.
Kirkham, V. R. D., Ground water for municipal supply at Potlatch, Idaho: Pamph. 23, 1927.
Kirkham, V. R. D., Underground water resources in the vicinity of Orofino, Idaho, and of Lapwai, Idaho: Pamph. 24, 1927.

A comprehensive investigation of the ground-water conditions of the Snake River Plain and tributary drainage basins in southern Idaho was begun in 1928 by the United States Geological Survey in cooperation with the Idaho Bureau of Mines and Geology and the Idaho Department of Reclamation. There was also cooperation, through the Idaho Department of Reclamation, by the North Side Canal Co., the Twin Falls Canal Co., the Minidoka Irrigation District, the Burley Irrigation District, and the Idaho Power Co. The field work of this investigation was completed in 1930. Data and conclusions obtained in this investigation have from time to time been released to the public in typewritten, mimeographed, or photostat form, in order to make the results available as promptly as possible prior to publication. The complete report by H. T. Stearns, Lynn Crandall, and W. G. Steward was released in typewritten form with a mimeographed memorandum issued July 17, 1934. Previous releases have been made as follows:

April 25, 1929.--Ground water for irrigation in Raft River Valley, Idaho. Mimeographed memorandum. Complete report released in typewritten form.

August 15, 1929.--Ground water in southern Idaho. Mimeographed memorandum releasing maps showing contours of the water table in the region, with the location of the wells in which the measurements were obtained.

May 24, 1930.--Ground water in Little Lost River Valley, Idaho. Mimeographed memorandum in regard to the drilling of test wells to determine the number and character of the water-bearing beds and the direction of underflow. Typewritten copies of the report giving the results of this investigation were also released.

June 23, 1930.--Ground water in Big Lost River Valley, Idaho. Mimeographed memorandum in regard to test-well drilling to determine the possobility of recovering ground water in this area. The results of the observations on these test wells and study of the records of stream flow were released in typewritten form.

September 5, 1930.--Ground water in southern Idaho. Mimeographed memorandum releasing the unpublished final map showing contours of the water table, and hence the direction of movement of the ground water under the Snake River Plain, and the location of the wells from which the measurements were obtained.

August 7, 1931.--Records of wells in southern Idaho released by the United States Geological Survey. Mimeographed memorandum in regard to records obtained as to the depth to the water level in a large number of wells, and the altitude of the water level in many of them as determined by instrumental leveling. Copies of these tabulated records were released in typewritten form.

October 5, 1931.--Loss and gain of water in the Snake River between Heise and King Hill, Idaho. Mimeographed memorandum releasing the chapter relating to the loss or gain of the Snake River in successive stretches from Heise to King Hill and also of the Henrys Fork of the Snake River.

February 25, 1932.--Inventory of the water supply on the Snake River Plain in southeastern Idaho. Mimeographed memorandum giving a general inventory of the water supply of this region from 1920 to 1927; also gives conclusions as to the economic use of the water.

The final report on the geology and ground-water resources of the Snake River Plain in southeastern Idaho and tributary basins is to be published as Water-Supply Paper 774. The records of about 4,000 wells and the records of about 20,000 measurements of the water levels in them is in press as Water-Supply Paper 775. Unfortunately it has not been possible to continue the program of periodic measurements in the Snake River Plain in recent years. Irrigation projects affected by drainage troubles have continued to obtain records of fluctuations in the water table, usually making occasional measurements at certain selected wells each year. Such records have been kept on the Minidoka and Twin Falls projects and possibly elsewhere.

An investigation of the Kootenai Valley, in the northern extremity of Idaho, was begun by the United States Geological Survey in 1928 to determine the effects of regulating the flow of the Kootenai River on the drainage outlets and the effects of the river on the water table. Records of the stream flow and ground-water levels were obtained in order that natural water-table conditions in each district might be well established and understood and that the best possible predictions might be made of the effects of the regulated river on the water table. The depths to the water levels have been measured regularly in about 300

wells since March 1930. In 1935 measurements were made about monthly on these wells and automatic water-stage recorders were operated on two wells. A network of levels to the wells was re-run during September and October. The water-level records are on file with the International Joint Commission. Several manuscript reports have been prepared on this investigation by T. R. Newell, district engineer of the United States Geological Survey, for presentation to the International Joint Commission.

In 1931 an investigation of the ground-water conditions in Malad and Curlew Valleys, in Oneida County, was made by D. G. Thompson through cooperation with the Idaho Department of Reclamation. This investigation included the measurement of water levels in a considerable number of wells. A typewritten report on the results of the investigation was released to the public with a mimeographed memorandum on May 7, 1932.

The Geological Survey and local geologists were employed in southern Idaho during the activities incident to the drought year of 1934. Advice was sought by the Emergency Drought Committee in locating sites for wells. G. A. Waring, of the Geological Survey, William Petersen, of the Utah Agricultural College, and T. H. Hite, of Idaho, made special studies in this connection. The Geological Survey, through the Grazing Division, later assigned Mr. Waring to do geologic work in selecting locations for wells in Federal grazing districts. Water-level measurements were also made in connection with a study of the possibilities of pumping from wells in Boise Valley to develop supplemental irrigation supplies, initiated by the State Water Conservation Board in cooperation with the United States Bureau of Reclamation.

It is reported that the ground-water levels in the southern part of the State generally reached their lowest stage in the early spring of 1935, following 6 years of deficient run-off that culminated in the drought of 1934. A moderate restoration of water levels occurred later in 1935 but was insufficient to bring the water table back to its earlier levels. The northern part of the State, which was not so adversely affected by the drought of 1934, showed less change during 1935.

Four of the observation wells on which weekly measurements have been made since 1934 in the Palouse River area of the United States Soil Conservation Service are in Idaho, the others being in Washington. (See under Washington.)

INDIANA

By R. C. Cady

During the summer of 1935 the United States Geological Survey and the State Department of Conservation of Indiana cooperated in the establishment of an observation well program. Under the agreement the writer, in cooperation with J. P. Kerr, assistant State geologist, located 87 wells that were deemed suitable for periodic measurements of the fluctuations of the water level. Arrangements to carry on these measurements semimonthly were made with the State Department of Conservation, United States Soil Conservation Service, United States Bureau of Agricultural Engineering, United States Bureau of Fisheries, Indianapolis Department of Sanitation, Indianapolis Water Co., and 16 municipal water departments having wells suitable for observation in their systems. Satisfactory records are being obtained on 73 wells. The records of most of the wells began on October 15, 1935, but some wells in Indianapolis have been measured for some time in the past. In many localities the program of measurements has been carried on without interruption, but in others the severe winter weather has interfered. One automatic water-stage recorder has been installed.

All the observation wells are situated in the North-Central Drift-Paleozoic ground-water province. This province is characterized by glacial drift ranging in thickness from only a few feet to 100 or 200 feet, resting on relatively undisturbed sedimentary rocks of Paleozoic age. The wells that are being measured include dug, driven, jetted, and drilled wells. Most of them are less than 50 feet deep, but some are between 50 and 100 feet deep, and 16 are more than 100 feet deep, including one well 800 feet deep and another 1,700 feet deep. Most of the shallow wells and some of the wells over 100 feet deep penetrate glacial drift without entering bedrock. Only about one-third of all the wells under observation enter the bedrock. The rock formation most extensively and successfully used as a source of water supply in the area is the Niagara limestone. Only a few of the observation wells exhibit any marked degree of artesian pressure. About 20 wells show the effect of steady or casual pumping, either from nearby wells or from the observation wells themselves.

During the period from October 15 or November 1, 1935, to February 1 or February 15, 1936, the water level in 18 wells rose an average net distance of about 1.9 feet, and the greatest authenticated rise was 4.2 feet. Two wells showed some fluctuation but practically no net rise, and two wells showed a net decline for the period -- one of 0.8 foot and the other of 1.16 feet. Records of the other wells are not yet available. Wells less than 50 feet deep showed an average rise of 1.8 feet, whereas one of the two wells between 50 and 100 feet deep showed a rise of 0.9 foot and the other showed a decline of 0.8 foot. The two wells over 100 feet deep showed net rises of 0.5 and 0.2 foot respectively. Of the wells less than 50 feet deep, those that showed a net rise of 3 feet or more are less than 25 feet deep, and of the four wells that showed no rise or a net loss, three are about 50 feet or more deep. Thus the water levels have in general risen more in the shallow wells than in the deeper ones. Moreover, the fluctuations in the deeper wells may be due to some extent to fluctuations in atmospheric pressure. Most of the wells, especially the shallow wells, showed a rise during the autumn but a decline after freezing weather set in.

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IOWA AND MISSOURI

TARKIO CREEK AREA OF SOIL CONSERVATION SERVICE

An observation-well program was begun in April 1934 in the Tarkio Creek area in Atchison County, Mo., and Page and Montgomery Counties, Iowa, by the Geological Survey in cooperation with the Soil Conservation Service. Measurements have been made on 17 wells, but the records of only 15 are included in this report, two wells used for domestic supplies being omitted. Of the 15 wells 13 are in Iowa and the other 2 in Missouri. The measurements are made by employees of both the cooperating agencies. A water-stage recorder has been kept on well 1, in Atchison County, Mo., since the beginning of the project, and another recorder has been moved from well to well in order to learn the behavior of all wells for short periods. Weekly tape measurements have been made on all the wells. A total of 1,400 measurements were made on these wells from the beginning of the project to January 1, 1936, of which 830 were made during 1935 -- an average of 49 measurements to the well.

Six of the wells (3, 7, 12, 14, 16, and 17) are dug wells and the other nine (1, 2, 5, 6, 8, 9, 10, 11, and 15) are bored wells. The dug wells are cased with brick or rock, and the bored wells with tile. The wells range from 18 to 63 feet in depth, and most of them penetrate alluvium or loess and glacial drift. The bedrock is in general of upper Pennsylvanian age. The depth to the water levels ranges from about 5 to 45 feet. The wells are essentially water-table wells, and those included in this report are not appreciably affected by withdrawals. Only the measurements that were nearest to the first of each month are given in the following table. The method of expressing the results of these measurements is explained in the introduction to this report. The depth to the water level on any date can be obtained by subtracting the altitude of the water level, as given in the second table, from the altitude of the measuring point, as given in the first table. The average of the measurements on all the wells for each date is given in the last column of the second table.

The effects of the rains that followed the severe drought of 1934 are reflected in the water levels, which for the most part represent replenishment of the underground reservoir. During the summer and fall

of 1935 the water table stood consistently higher than in corresponding seasons in 1934. The average level was 3 feet higher on July 1, 1935, than on the same or nearly the same date in 1934. Few measurements could be made on December 31, 1935, but on December 24, 1935, the water level averaged 1.61 feet higher than on December 29, 1934.

The water table declined gradually during the very dry spring and summer of 1934 and averaged about 1 foot lower in September and October than in May. The moderately abundant rains in the fall of 1934 produced some ground-water recharge, so that at the end of the year the water table was restored nearly to the average level at which it stood in May, when the first measurements were made. Very little rain or snow fell during the 5 months from December 1934 to April 1935. Therefore, although this is the period when vegetation makes almost no draft on the soil moisture and ground water, the water table remained virtually stationary. In May and June 1935 heavy rainfall occurred. Consequently, although in these months there is always considerable draft by vegetation, the water table rose about 2 feet in each month, and at the beginning of July it stood about 4 feet higher than in the winter. During the rest of the year the rainfall was only moderate, and accordingly the water table declined somewhat more than 2 feet during the remainder of the growing season and then remained nearly constant to the end of the year.

Wells in the Tarkio Creek area, in Page and Montgomery Counties, Iowa, and Atchison County, Mo.

(The depth to the water level given in the next to last column is the depth below the measuring point on Jan. 1, 1935. The height of the measuring point, given in the last column, is its height with reference to the arbitrary datum.)

Well no.	Owner and location	Depth (feet)	Diameter (inches)	Depth to water level (feet)	Height of measuring point (feet)
1	W. R. Marshall, NW¼NE¼ sec. 13, T. 66 N., R. 40 W.	29	12	17.53	27.53
2	H. W. Klutas, SW¼SW¼ sec. 1, T. 66 N., R. 40 W.	21	12	10.73	20.73
3	John Smith, NE¼SE¼ sec. 35, T. 68 N., R. 39 W.	39	48	32.63	42.63
5	John Toft, SW¼SW¼ sec. 7, T. 68 N., R. 38 W.	..	12	16.20	26.20
6	T. Slickerveer, SW¼SW¼ sec. 18, T. 69 N., R. 38 W.	50	12	8.74	18.74
7	E. F. Holquist, SE¼SE¼ sec. 11, T. 71 N., R. 38 W.	28	36	24.65	34.65
8	R. Stonelling, SW¼SW¼ sec. 4, T. 72 N., R. 37 W.	22	12	21.45	31.45
9	Elmer Oakleaf, NW¼SE¼ sec. 8, T. 71 N., R. 37 W.	49	12	40.68	50.68
10	R. Palmquist, NE¼SE¼ sec. 17, T. 70 N., R. 37 W.	40	12	26.94	36.94

Wells in the Tarkio Creek area - Continued

Well no.	Owner and location	Depth (feet)	Diameter (inches)	Depth to water level (feet)	Height of measuring point (feet)
11	R. Palmquist, SE¼SE¼ sec. 17, T. 70 N., R. 37 W.	26	12	7.61	17.61
12	Amil Windhorst, NW¼SW¼ sec. 20, T. 69 N., R. 37 W.	63	36	37.08	47.08
14	Floyd Hoskins, SE¼SE¼ sec. 19, T. 68 N., R. 38 W.	33	36	29.24	39.24
15	Metropolitan Life Insurance Co., NE¼NW¼ sec. 21, T. 67 N., R. 38 W.	29	12	10.18	20.18
16	Metropolitan Life Insurance Co., NE¼SE¼ sec. 20, T. 67 N., R. 38 W.	18	36	15.90	25.90
17	Albert Nordholm, SW¼SE¼ sec. 20, T. 67 N., R. 38 W.	20	36	17.52	27.52

Water levels in wells in the Tarkio Creek area in Iowa and Missouri, in feet above the arbitrary datum

Date	1	2	3	5	6	7	8	9
1934								
May 8	.....	10.53	10.89	9.74	11.06	9.11	.....	.....
31	.....	10.14	10.68	10.06	10.91	9.07	.....	12.96
June 28	.....	9.15	10.46	9.72	10.61	9.03	16.44	12.69
Aug. 2	9.48	7.56	10.20	9.22	10.27	8.95	13.53	12.02
29	9.16	6.50	10.03	8.92	10.06	8.89	11.95	11.15
Oct. 4	8.90	6.82	9.84	9.03	10.03	8.97	11.15	10.40
31	9.25	7.79	9.80	9.12	10.03	9.12	10.90	10.03
Nov. 21-23	9.54	8.42	9.73	9.23	10.01	9.35	10.60	9.94
Dec. 29	10.06	9.98	10.01	10.05	10.02	10.00	9.95	9.98
1935								
Jan. 29-Feb. 1	9.94	10.35	9.64	9.35	9.74	9.76	12.51	10.17
Feb. 25-28	9.84	10.50	9.52	9.14	9.90	9.50	.....	9.67
Apr. 1-3	9.98	10.82	9.42	9.09	.....	.....	16.54	9.63
Apr. 29-May 2	9.79	10.87	9.31	8.85	7.83	9.86	17.06	9.09
June 4-5	12.83	11.75	13.66	12.31	8.40	11.68	18.90	9.71
July 2-3	14.48	12.40	17.03	13.09	11.74	.....	21.56	15.21
July 30-31	14.89	11.96	17.32	11.29	10.73	12.29	20.35	18.71
Sept. 2-3	14.87	11.50	16.48	9.00	9.25	11.27	16.93	17.58
Sept.30-Oct. 1	13.62	11.16	15.11	8.57	8.77	10.51	15.40	14.42
Oct. 28-29	13.12	11.21	13.90	8.29	8.59	10.26	18.93	12.00
Nov. 25-26	13.27	11.49	14.54	8.92	9.03	.....	19.60	.....
Dec. 24	13.29	11.57	14.30	9.25	9.36	10.03	19.78	11.59
Dec. 30-31	13.24	11.53	.....	.....	.....	9.89	19.66	11.68

Date	10	11	12	14	15	16	17	Average
1934								
May 8	.....	.....	.....	.....	10.87	9.74	9.52	10.18
31	10.38	9.96	.....	.....	10.65	9.77	9.40	10.35
June 28	10.28	9.82	.....	.....	10.08	9.59	9.18	10.59
Aug. 2	10.14	9.42	9.20	8.43	9.16	9.27	8.88	9.71
29	10.06	8.76	8.57	8.32	8.57	9.00	8.67	9.24
Oct. 4	9.95	8.12	8.52	8.40	8.43	8.82	9.03	9.09
31	9.90	8.14	8.81	8.63	8.89	9.10	9.42	9.26
Nov. 21-23	9.91	8.86	9.11	8.73	9.43	9.25	9.55	9.44
Dec. 29	10.00	10.01	9.98	9.99	10.13	10.02	10.02	10.01

Water levels in wells in the Tarkio Creek area - Continued

Date	10	11	12	14	15	16	17	Average
1935								
Jan. 29-Feb. 1	10.05	9.89	10.26	9.39	9.68	8.30	9.86	9.92
Feb. 25-28	10.03	10.17	10.11	11.94	9.66	9.54	9.52	9.93
Apr. 1-3	10.15	10.27	.....	11.79	9.74	9.59	9.54	10.55
Apr. 29-May 2	10.10	10.13	9.57	9.68	6.95	9.50	9.32	9.86
June 4-5	10.20	11.01	11.32	12.92	10.92	12.20	11.34	11.94
July 2-3	10.65	11.31	13.33	16.60	10.90	14.68	11.03	13.85
July 30-31	11.02	10.82	13.30	16.59	9.30	12.32	10.80	13.44
Sept. 2-3	10.84	9.92	12.99	15.52	7.76	10.66	10.27	12.32
Sept.30-Oct. 1	10.94	9.48	12.99	14.30	7.07	9.92	9.92	11.48
Oct. 28-29	10.93	9.98	12.62	14.34	7.09	9.60	9.87	11.38
Nov. 25-26	11.11	10.52	12.68	12.88	7.12	9.81	9.92	11.60
Dec. 24	11.36	11.06	13.41	12.42	7.14	9.98	9.83	11.62

KANSAS

LIMESTONE CREEK AREA OF SOIL CONSERVATION SERVICE

An observation-well program was started in the Limestone Creek area, in Jewell County, near Mankato, Kans., during the spring of 1934 by the Geological Survey in cooperation with the Soil Conservation Service. This area lies in the ground-water province known as the Great Plains Pliocene-Cretaceous. Thirty wells were originally selected for measurements, but as the investigation progressed new wells were added and several of the original wells were abandoned. A total of 52 wells are now being measured, but the records of only 24 are included in the following tables. Most of the wells that are not included were affected by seepage from nearby reservoirs or have been only recently selected. As a rule measurements were made on all wells once a week. A total of about 4,000 measurements were made on all the wells from the beginning of the program to January 1, 1936. About 2,300 of these measurements were made during 1935, an average of 50 measurements to the well during the year. Ten water-stage recorders have been used in this area, one of which has been in operation on well 30 since August 1934 and one on each of wells 34, 42, 49, and 51 since October 1934. The other automatic recorders have been shifted about in order to get records for short periods on all the wells. Only the records of measurements that were made nearest to the first of each month are given in this report. The method of expressing the results of the measurements is explained in the introduction to the report.

The wells for which data were available ranged in depth from 19 to 88 feet. They are essentially water-table wells, some of which penetrate thin alluvium in small valleys and others penetrate limy shale of the Niobrara formation or the Benton shale -- both of Upper Cretaceous age. The depth to the water levels in the wells ranged from about 10 to 80 feet. A few of the wells were pumped occasionally to check the recovery of the water levels, but otherwise there was no pumping from these wells. No measurements are given in this report that were made after the wells had been pumped and before the water table had fully recovered. The measuring point for nearly every well was the top of the board cover over the well. Each measuring point was instrumentally tied in with a bench mark established near the well.

The average altitudes of the water levels in this area can be closely correlated with the precipitation. According to records of the United States Weather Bureau, covering the period 1901-33, the mean annual precipitation at Burr Oak is 24.68 inches, of which 18.75 inches occurs from April to September. From September 1933 to April 1935 the precipitation was very light. The rainfall from April to September 1934 was only 9.02 inches, or less than half the normal. There was not sufficient moisture to supply the needs of the vegetation, and only a minor amount of ground-water recharge occurred. Hence, with minor exceptions, the water levels declined gradually from the time the initial measurements were made, in March, April, or May 1934, until the end of April 1935, the average decline being about 1.8 feet during this period in the 24 wells for which records are given in the tables.

In May 1935 the rainfall at 26 stations in the Limestone Creek area ranged from 6.64 to 12.27 inches and averaged 9.36 inches, in contrast to the 33-year normal of 3.77 inches for May at Burr Oak. The water levels in the observation wells accordingly rose an average of 0.92 foot in May and 1.63 feet in June. In the last 6 months of 1935 the precipitation was not far from normal. However, in July it was very light, whereas in August it was nearly twice the normal. The water levels declined slightly in July and August but rose 0.56 foot in September and also rose substantially in October, November, and December. Thus at the end of 1935 the water levels averaged about 3.36 feet higher than at the beginning of the year and fully 1.5 feet higher than in the spring of 1934, when observations were commenced.

Wells in the Limestone Creek area in Jewell County, Kans.

(The depth to the water level given in the next to last column is the depth below the measuring point on Jan. 1, 1935. The height of the measuring point, given in the last column, is its height with reference to the arbitrary datum.)

Well no.	Owner and location	Depth (feet)	Depth to water level (feet)	Height of measuring point (feet)
2	E. E. Lewis, NE¼NE¼ lot 1, sec. 6, T. 3 S., R. 9 W.	71	46.25	56.25
2a	do.	..	49.50	59.50
4	S. B. Brown, NE¼NE¼ sec. 5, T. 3 S., R. 9 W.	53	48.58	58.58
6	H. C. Doud, SE¼SW¼ sec. 5, T. 3 S., R. 9 W.	50	45.73	55.73
8	Frank Zadina, SW¼SW¼ sec. 17, T. 3 S., R. 9 W.	75	68.05	78.05
12	M. W. Howe, lot 4, sec. 30, T. 3 S., R. 9 W.	88	77.00	87.00
14	C. Walker, SE¼SE¼ sec. 24, T. 3 S., R. 9 W.	53	46.48	56.48

Wells in the Limestone Creek area in Jewell County - Continued

Well no.	Owner and location	Depth (feet)	Depth to water level (feet)	Height of measuring point (feet)
16	G. N. Sorrell, NW¼NW¼ sec. 26, T. 4 S., R. 9 W.	39	32.81	42.81
18	Martin Johaneck, SE¼SW¼ sec. 29, T. 3 S., R. 9 W.	45	31.88	41.88
22	Meyer Miles, NE¼ sec. 10, T. 5 S., R. 9 W.	39	28.16	38.16
24	J. N. Sorrell, SE¼SW¼ sec. 29, T. 5 S., R. 9 W.	19	13.30	23.30
25	J. N. Sorrell, NW¼NW¼ sec. 29, T. 5 S., R. 9 W.	31	16.47	26.47
27	Darius Henningsen, lot 16, sec. 31, T. 3 S., R. 9 W.	47	41.84	51.84
28	do.	42	40.14	50.14
30	Fred Van Wey, SW¼ sec. 28, T. 4 S., R. 9 W.	50	42.54	52.54
31	Bernard Sawyer, SE¼SW¼ sec. 1, T. 3 S., R. 9 W.	58	48.35	58.35
40	R. L. McDaniel, SE¼NW¼ sec. 15, T. 4 S., R. 9 W.	45	43.48	53.48
41	Walter Dietz, SW¼ sec. 6, T. 5 S., R. 9 W.	24	27.57	37.57
42	L. Lowdermilk, NW¼NE¼ sec. 27, T. 3 S., R. 9 W.	36	31.36	41.36
44	Everett Gimple, SE¼SW¼ sec. 13, T. 4 S., R. 9 W.	37	23.96	33.96
45	Victor Yapp, SW¼SE¼ sec. 24, T. 4 S., R. 10 W.	38	31.93	41.93
48	Frank Rogers, SE¼SW¼ sec. 23, T. 4 S., R. 10 W.	39	28.06	38.06
49	E. Underwood, SW¼NE¼ sec. 5, T. 3 S., R. 9 W.	57	41.60	51.60
50	E. Strom, SW¼NW¼ of SE¼ sec. 31, T. 3 S., R. 9 W.	50	36.62	46.62

Water levels in wells in the Limestone Creek area in Jewell County, Kans., in feet above the arbitrary datum

Date	2	2a	4	6	8	12	14	16	18
1934									
Mar. 19-21	12.56	.....	10.83	12.43	12.91	12.56	8.79	12.66	11.91
May 7-9	10.93	.....	12.86	11.30	11.98	12.16	10.10	12.10	12.36
May 31-June 1	9.97	.....	12.63	11.17	11.67	11.96	9.23	11.30	11.82
July 3-4	10.75	.....	12.33	11.07	11.06	11.68	9.46	10.33	11.01
Aug. 2-6	10.60	.....	9.32	.....	10.81	11.40	9.63	9.29	10.28
Aug. 29-30	10.58	10.58	8.60	10.59	8.65	10.90	9.55	8.99	.....
Oct. 4-5	10.37	10.47	10.60	10.37	9.96	10.65	9.72	9.09	9.86
Nov. 1-3	10.14	10.29	10.55	10.20	11.10	10.43	9.83	9.55	9.77
Nov. 28-Dec. 1	10.17	10.16	10.41	10.10	10.12	10.24	9.92	9.86	9.99
1935									
Jan. 3-5	9.90	9.98	10.08	9.99	9.99	9.98	10.00	10.00	10.00
Jan. 31-Feb. 2	9.82	9.82	9.81	9.88	9.80	9.81	10.04	10.09	9.97
Feb. 28-Mar. 2	9.67	9.68	9.75	9.84	9.59	9.65	10.05	10.14	9.90
Mar. 28-30	9.48	9.71	9.52	9.79	9.38	9.46	10.07	10.11	9.95
May 2-4	9.06	9.44	9.14	8.66	9.10	9.25	10.10	9.98	9.51
May 30-June 4	8.99	.....	9.07	9.56	8.92	9.16	10.22	10.56	10.08
July 1-5	9.26	.....	10.57	9.69	8.97	10.61	10.28	12.07	11.00
Aug. 1-2	10.10	9.12	14.42	9.63	9.65	11.84	10.32	10.09	10.86
Aug. 29-31	10.13	9.11	15.23	9.66	11.10	12.29	10.34	9.70	10.33
Oct. 3-4	10.28	8.98	15.04	9.85	15.21	13.81	10.39	12.72	12.00

Water levels in wells in the Limestone Creek area - Continued

Date	2	2a	4	6	8	12	14	16	18
1935									
Oct. 31-									
Nov. 1	10.28	8.94	14.94	9.89	16.11	14.19	10.44	14.17	12.67
Nov. 29	10.26	8.82	14.88	9.87	17.15	14.18	10.45	15.15	13.50
1936									
Jan. 2-3	10.39	8.64	14.63	9.80	17.93	13.83	10.47	15.32	14.29

Date	22	24	25	27	28	30	31	40	41
1934									
Mar. 19-21	11.14	11.11	10.38	.....	.....	.....	.....	.....	.....
May 7-9	10.77	10.95	10.34	14.17	11.08	.....	.....	.....	.....
May 31-									
June 1	10.41	10.87	10.11	12.46	10.99	13.53	10.80	.....	.....
July 3-4	10.00	11.43	11.39	.....	10.88	9.94	10.63	.....	.....
Aug. 2-6	9.59	10.95	10.43	11.14	10.75	9.20	10.49	10.14	10.59
Aug. 29-30	10.02	10.62	10.21	10.70	10.60	8.91	10.34	10.07	10.16
Oct. 4-5	9.89	10.49	10.22	10.30	10.40	8.67	10.31	10.00	9.78
Nov. 1-3	9.87	10.34	10.18	10.09	10.25	9.38	10.26	10.04	9.64
Nov. 28-									
Dec. 1	9.94	10.20	10.19	10.09	10.13	9.76	10.17	10.03	9.87
1935									
Jan. 3-5	9.99	9.99	9.99	9.99	9.99	10.06	9.99	9.99	10.01
Jan. 31-									
Feb. 2	9.99	9.42	9.78	9.91	9.90	10.19	9.84	9.88	10.06
Feb. 28-									
Mar. 2	9.98	9.76	9.15	9.82	9.79	10.35	9.68	9.88	10.09
Mar. 28-30	9.94	9.53	9.59	9.75	9.62	10.61	9.65	9.94	10.10
May 2-4	.....	9.43	9.51	9.66	.....	10.58	9.50	10.04	10.00
May 30-									
June 4	12.04	9.59	9.55	13.42	9.44	12.00	9.70	9.85	10.39
July 1-5	12.32	10.66	11.09	14.78	11.08	11.72	11.27	9.80	12.42
Aug. 1-2	11.46	10.98	11.55	13.76	9.34	10.50	12.16	9.93	11.63
Aug. 29-31	11.34	10.50	11.32	13.12	9.25	10.15	12.14	9.77	11.07
Oct. 3-4	12.63	9.52	12.50	15.01	10.80	11.64	12.17	9.87	13.45
Oct. 31-									
Nov. 1	12.66	9.07	12.21	14.73	11.35	11.95	12.13	9.91	13.27
Nov. 29	12.65	8.73	11.98	14.67	11.56	12.38	12.04	10.05	13.41
1936									
Jan. 2-3	13.11	8.40	11.68	14.75	11.71	12.77	11.92	10.11	13.68

Date	42	44	45	48	49	50	Average
1934							
Mar. 19-21	.....	.....	.....	.....	.....	.....	11.57
May 7-9	.....	.....	.....	.....	.....	.....	11.62
May 31-							
June 1	.....	.....	.....	.....	.....	.....	11.26
July 3-4	.....	.....	.....	.....	.....	.....	10.85
Aug. 2-6	10.81	12.77	10.83	9.96	.....	.....	10.44
Aug. 29-30	10.43	13.22	10.47	9.48	13.75	10.83	10.36
Oct. 4-5	10.18	12.37	10.14	9.11	13.19	10.35	10.27
Nov. 1-3	10.13	12.39	10.04	8.89	12.55	10.07	10.25
Nov. 28-							
Dec. 1	10.11	11.61	9.93	9.14	.....	9.97	10.09
1935							
Jan. 3-5	10.06	9.67	10.00	10.03	.....	10.00	9.99
Jan. 31-							
Feb. 2	9.99	8.93	10.08	10.59	11.19	10.14	9.96
Feb. 28-							
Mar. 2	10.02	8.65	10.16	10.92	11.33	10.25	9.92
Mar. 28-30	10.96	8.76	10.23	10.95	11.33	10.22	9.94
May 2-4	9.87	8.53	10.18	10.88	11.10	10.25	9.71
May 30-							
June 4	12.48	11.37	12.58	13.26	11.42	10.88	10.63
July 1-5	14.83	12.88	13.73	13.63	26.41	12.89	12.26
Aug. 1-2	13.56	10.76	12.32	12.68	25.88	12.62	11.88

Water levels in wells in the Limestone Creek area - Continued

Date	42	44	45	48	49	50	Average
1935							
Aug. 29-31	13.23	10.55	11.59	12.04	24.64	12.11	11.69
Oct. 3-4	13.88	11.06	14.16	13.13	.....	13.82	12.25
Oct. 31-Nov. 1	13.61	11.28	14.40	13.60	24.59	14.07	12.93
Nov. 29	13.50	12.41	14.65	14.32	24.22	13.75	13.10
1936							
Jan. 2-3	13.49	14.02	14.94	14.96	23.89	15.76	13.35

MICHIGAN

By V. T. Stringfield

The present program of measurements of ground-water levels in Michigan was started in the fall of 1932, when the Geological Survey division of the Michigan Department of Conservation, in cooperation with the United States Geological Survey, began an investigation in Roscommon County to determine the areas in which ground water is available in sufficient quantity at depths of 20 feet or less, so that wells may be developed when needed for effective use in checking and suppressing forest fires. That work involved the construction of numerous observation wells. The Michigan Forest Fire Experiment Station, under the supervision of G. I. Stewart, director, demonstrated through experimental tests that such work is feasible and throughout the investigation has cooperated in developing equipment and technique for this work. During the fall of 1932 measurements of ground-water levels were made in four townships of Roscommon County by S. W. Lohman, of the Federal Survey, and A. W. Bergquist, of the State Survey. Ronald Bird, of the Michigan Department of Conservation, made water-level observations during the winter of 1932-33.

In the spring of 1933 a program of forest conservation and development was undertaken by the Federal Government through the organization of Civilian Conservation Corps camps in the forested areas of Michigan. Field parties, each consisting of six or seven Civilian Conservation Corps men, were organized and began the construction of wells in several counties. A geologist of the State Geological Survey was placed in charge of each party. This program of construction of test wells was made possible by technical advice from G. I. Stewart, director of the Michigan Forest Fire Experiment Station, R. A. Smith, State geologist, and O. E. Meinzer and A. G. Fiedler, of the United States Geological Survey. The work of the field parties was coordinated by W. Osgood and A. W. Bergquist, under the direction of the State geologist. The writer was the field representative of the Federal Survey. Water-level measurements were made by the geologists in charge of the field parties.

During 1934 O. F. Poindexter and A. W. Bergquist, of the State Survey, together with the writer, started a systematic program of selecting and measuring water levels in those of the test wells that were selected

as observation wells. That work has been continued to the present time. A water-stage recorder has been in continuous operation since November 5, 1934, on a well at the Michigan Forest Fire Experiment Station near Roscommon.

Mr. Bergquist supplied the writer with copies of the water-level measurements made under his supervision during 1935, and H. J. Hardenberg, of the State Survey, prepared hydrographs showing measurements of water levels in 152 wells representing 45 townships. Mr. Bergquist reports that during 1935 the water levels in 1,758 wells were measured at least once, and more than one measurement was made in each of 1,324 wells. Many of the wells were measured about once or twice a month. The total number of individual measurements made during the year was 9,806. These measurements were made chiefly by the following geologists of the State Survey: C. F. Bassett, H. J. Hardenberg, G. W. Jennings, E. Hess, Norman Billings. The water-stage recorder was in operation throughout the year.

The area is in the North-Central Drift-Paleozoic ground-water province. All the wells are in drift, and most of them in permeable outwash sand. The wells are of the jetted type and range from about 10 to 30 feet in depth. Most of them are 2 inches in diameter, a few are 3 or 4 inches in diameter, and the well near Roscommon on which the recorder is installed is 8 inches in diameter and about 17 feet deep.

All the wells are in areas that are unaffected by large artificial withdrawal of water. Most of them represent water-table conditions, but a few tap perched water and a few shallow artesian water. The top of the well casing is the measuring point, from which the depth to the water level is measured. The altitudes of the measuring points with reference to the land surface have been recorded, and a few of the measuring points have been tied by instrumental leveling to Government bench marks with mean sea level datum. The water-level records are still unpublished and are not yet available to the public. However, maps representing the position of the water table with reference to the land surface have been prepared for most of the area, and blue prints of these maps are available.

When the water-stage recorder was installed on the 8-inch well at the Forest Fire Experiment Station near Roscommon on November 5, 1934, the water level in that well was about 8 feet below the top of the casing and about 5.5 feet below the land surface. It rose gradually until December 10, when it stood 4.6 feet below the surface.

From the later part of December 1934 to March 5, 1935, it slowly declined to 5.2 feet below the surface. During this period the ground was frozen, and little or no recharge took place. Because of the frozen and therefore impervious condition of the ground, the effects of changes of atmospheric pressure were reflected in fluctuations of the water level in the well during a part of the period. From March 5 to 20 the water level rose 1.3 feet, apparently because of recharge after the thawing of the ground. On March 20 it stood 3.9 feet below the surface, which was the highest level of the period of record. It gradually declined during the succeeding months and was about 5.75 feet below the surface in the later part of September. From that time to February 15, 1936, the water level remained nearly stationary, ranging only between the depths of 5.65 to 5.8 feet below the surface. During the calendar year 1935 the range in fluctuation of the water level was only about 1.85 feet. The water level stood somewhat lower at the end than at the beginning of the year.

Hydrographs of 152 wells, representing 45 townships in Roscommon, Clare, Missaukee, Grand Traverse, Kalkaska, Crawford, Otsego, Charlevoix, and Cheboygan Counties, in general indicate that in most of the area the fluctuations of the water level were comparable to those described above, in that there was a gradual rise during the spring of 1935, followed by a gradual decline during the summer, with the water level standing somewhat lower at the end of the year than at the beginning. This decline ranged from less than 1 foot to about 1.5 feet. In a few of the wells the water levels were slightly higher at the end of 1935 than at the beginning, whereas in a few other wells the water levels declined throughout the year. The maximum range in fluctuation in any well during the year was about 5 feet.

MONTANA

FLATHEAD VALLEY BETWEEN FLATHEAD LAKE AND KALISPELL

By W. A. Lamb

An investigation of the ground-water levels in the valley and delta area between Kalispell and the head of Flathead Lake was begun in May 1928 by the United States Geological Survey under the authorization of the Federal Power Commission. The purpose of this investigation was to determine the effect of the altitude of the water surface in the lake and river on the position of the water table in the area. Regulation of the outflow of the lake was contemplated, and as the water table in this area stood within a few feet of the land surface it was necessary to evaluate the agricultural damage to the farms that might result from any appreciable raising of the water table. The work was conducted chiefly by C. S. Heidel and A. H. Tuttle, under the direction of W. A. Lamb, district engineer, in cooperation with the division of ground water of the Geological Survey.

Altogether 47 observation wells were put down, two of which have since been abandoned. These are all water-table wells, and few of them have been affected by any artificial withdrawal. Observations of the water levels in these wells have been made at intervals, usually monthly, up to the present time. Two of these wells (nos. 46 and 47) are equipped with automatic water-stage recorders. These two wells are 3 by 4 feet in cross section and about 14 feet deep. The other wells were bored with an auger and cased with a standard 1¼-inch galvanized pipe, which was fitted with a point made from 60-mesh gauze. The top of each casing, in wells 46 and 47, is used as a measuring point, and its altitude above sea level was determined. The measurements of water level are made with a steel tape connected to a sounding weight. The altitude of the water level in wells 46 and 47 is read directly from a staff gage whose zero point is near the bottom of the well.

About 108 measurements of the water level have been made in each well since July 1928. Sixteen measurements were made in most of the wells during 1935, making a total of 657 for the year. An accompanying table shows the arithmetic average of the water levels in wells for several times during the period of observation. Measurements were made only for a few months in 1928, but they indicate that the water table

was higher in that year than in any year since. An inspection of the average levels shows that there has been a definite seasonal fluctuation each year, the water levels rising to high stages in the late spring and declining to low stages in the winter. The average water level had an annual net decline from 1928 to 1931, but it recovered most of this loss in 1932 and 1933. Although the average water level had another net decline in 1934, it was at the end of the year only about 1 foot below the level of December 1928.

Observation wells in Flathead Valley, between Kalispell and Flathead Lakes, Montana

(The depth to the water level given in the next to last column is the depth below the measuring point, or top of pipe, on March 16, 1934. The figure given in the last column is the altitude above mean sea level on March 16, 1934.)

Well no.	Ranch name and location	Altitude of top of pipe (feet)	Top of pipe above ground (feet)	Depth to water level (feet)	Altitude of water level (feet)
1	Beauchamp, center of south edge, SE¼ sec. 17, T. 27 N., R. 20 W.	2,896.64	1.0	7.36	2,889.28
2	Oldenberg north, center of west edge NW¼ sec. 22, T. 27 N., R. 20 W.	2,896.06	.6	10.51	2,885.55
3	Oldenberg east, center NE¼ sec. 22, T. 27 N., R. 20 W.	2,896.60	.8	12.18	2,884.42
4	Oldenberg south, SW corner NW¼ sec. 22, T. 27 N., R. 20 W.	2,895.15	1.1	9.71	2,885.44
5	Van Rinsum, center of west edge SE¼ sec. 24, T. 27 N., R. 21 W.	2,896.86	.3	7.39	2,889.47
7	Cleary, SE corner SW¼ sec. 13, T. 27 N., R. 21 W.	2,908.17	.1	19.03	2,889.14
8	Koenig, NW corner NE¼ sec. 23, T. 27 N., R. 21 W.	2,894.82	2.2	5.45	2,889.37
9	Keller, center of NE¼ sec. 19, T. 27 N., R. 20 W.	2,895.63	.7	6.07	2,889.56
10	Yeaw, center of NW¼ sec. 20, T. 27 N., R. 20 W.	2,896.50	.7	7.13	2,889.37
11	Taylor north, NE corner NE¼ sec. 20, T. 27 N., R. 20 W.	2,895.14	1.6	8.35	2,886.79
12	Taylor open, NW corner NW¼ sec. 21, T. 27 N., R. 20 W.	2,892.72	...	5.64	2,887.08
13	Conrad no. 1 south, center sec. 21, T. 27 N., R. 20 W.	2,892.96	.7	5.69	2,887.27
14	Rousseille, NE corner NE¼ sec. 21, T. 27 N., R. 20 W.	2,898.36	.8	12.95	2,885.41
15	Heller open, north of center NE¼ sec. 22, T. 27 N., R. 20 W.	2,896.62	...	10.38	2,886.24
16	Welke open, SW corner SW¼ sec. 16, T. 27 N., R. 20 W.	2,896.72	...	10.13	2,886.59
17	Lee open, center NW¼ sec. 16, T. 27 N., R. 20 W.	2,893.83	...	7.66	2,886.17
18	Bellinger open, NE corner NE¼ sec. 8, T. 27 N., R. 20 W.	2,903.76	...	14.57	2,888.33
19	Manning, NW corner NW¼ sec. 8, T. 27 N., R. 20 W.	2,891.28	.6	3.31	2,887.97
20	Reed, NE corner SW¼ sec. 1, T. 27 N., R. 21 W.	2,892.21	.6	4.18	2,888.03
21	Thompson, center of north edge NE¼ sec. 6, T. 27 N., R. 20 W.	2,891.98	.4	5.29	2,886.69
22	Lowden, center SW corner NW¼ sec. 32, T. 28 N., R. 20 W.	2,905.62	.7	18.03	2,887.59
23	Lockheart, north edge SE¼ sec. 34, T. 28 N., R. 21 W.	2,901.98	.4	16.41	2,885.57

Observation wells in Flathead Valley - Continued

Well no.	Ranch name and location	Altitude of top of pipe (feet)	Top of pipe above ground (feet)	Depth to water level (feet)	Altitude of water level (feet)
24	Straights, SE corner NE¼ sec. 33, T. 28 N., R. 21 W.	2,900.16	0.8	11.05	2,889.11
25	Meuli, center SE¼ sec. 35, T. 28 N., R. 21 W.	2,905.40	.4	17.10	2,888.30
26	Caton, SW¼ sec. 35, T. 28 N., R. 21 W.	2,901.95	.6	13.39	2,888.56
27	Weaver, SE¼ sec. 36, T. 28 N., R. 21 W.	2,897.86	.7	12.07	2,885.79
28	Hancock, NE¼ sec. 1, T. 27 N., R. 21 W.	2,904.43	1.0	17.45	2,886.98
29	Syverson, NW¼ sec. 6, T. 27 N., R. 20 W.	2,895.81	2.2	9.87	2,885.94
30	Hodgson School, NW corner NW¼ sec. 5, T. 27 N., R. 20 W.	2,905.87	1.7	18.66	2,887.21
31	Hartman west, center NW¼ sec. 5, T. 27 N., R. 20 W.	2,906.68	1.0	19.13	2,887.55
32	Papendicks, center SE¼ sec. 32, T. 28 N., R. 20 W.	2,899.50	.7	8.47	2,891.03
33	Hartman east, NE corner NE¼ sec. 5, T. 27 N., R. 20 W.	2,898.63	.7	11.04	2,887.59
34	O'Connell, center NE¼ sec. 5, T. 27 N., R. 20 W.	2,900.40	1.2	12.56	2,887.59
35	Bellinger, SE¼ sec. 5, T. 27 N., R. 20 W.	2,901.74	.6	15.41	2,886.33
36	Wagoner, center SE¼ sec. 8, T. 27 N., R. 20 W.	2,903.32	.5	17.36	2,885.96
37	Damon, SE corner SE¼ sec. 8, T. 27 N., R. 20 W.	2,898.19	.2	12.32	2,885.87
38	Lee pipe, center SW¼ sec. 17, T. 27 N., R. 20 W.	2,890.57	.6	4.14	2,886.43
39	Conrad no. 2 north, center NE¼ sec. 21, T. 27 N., R. 20 W.	2,893.16	.6	7.51	2,885.65
40	Taylor south, center SE¼ sec. 20, T. 27 N., R. 20 W.	2,895.42	1.3	7.04	2,888.38
41	Zellar, center NE¼ sec. 20, T. 27 N., R. 20 W.	2,897.42	.8	8.77	2,888.65
43	Kleinhams, center NE¼ sec. 19, T. 27 N., R. 20 W.	2,898.05	.6	9.10	2,888.95
44	Websters, NW corner NW¼ sec. 19, T. 27 N., R. 20 W.	2,905.16	1.0	16.14	2,889.02
45	Three Corners, NE corner NE¼ sec. 23, T. 27 N., R. 21 W.	2,910.82	.7	21.40	2,889.42
46	Taylor automatic, center NW¼ sec. 21, T. 27 N., R. 20 W.	2,877.00	...	10.14	2,887.14
47	Parkers open automatic, NW¼ sec. 34, T. 28 N., R. 21 W.	2,880.00	...	9.12	2,889.12

Average monthly water levels in the observation wells in Flathead Valley

(The average given for each month was computed from the first series of measurements made in that month and indicates height, in feet, above an arbitrary datum; 2,800 must be added to convert these averages to altitude above sea level.)

Year	1928	1929	1930	1931	1932	1933	1934	1935
January	.....	85.65	86.89	86.75	86.58	.....	.....	.....
February	.....	87.79	.....	.....	.....	86.59	.....	86.93
March	.....	88.16	.....	86.92	86.70	86.71	87.51	86.76
April	.....	88.05	86.96	86.86	.....	86.83	87.82	.....
May	.....	88.13	87.48	87.03	87.21	86.87	88.53	87.01
June	.....	88.38	87.60	87.01	88.29	87.68	88.19	87.76
July	.....	88.37	87.30	86.79	87.98	89.14	.....	87.28
August	.....	87.59	86.91	86.59	87.28	88.24	87.53	.....
September	88.54	.....	86.77	.....	86.98	87.56	87.19	86.77
October	88.17	87.30	.....	86.29	86.75	87.37	.....	86.31
November	88.03	87.08	86.72	86.12	.....	.....	86.91	.....
December	87.91	87.03	.....	.....	86.75	87.44	86.83	.....

Water levels in the observation wells in Flathead Valley, Montana

(Measurements give the height of the water surface in the well above an arbitrary datum; 2,800 must be added to convert these measurements to altitude above sea level.)

Date	1	2	3	4	5	7	8	9	10
1928									
July 16	93.69	90.08	.....	91.65	91.66	89.42	89.14	92.06	91.98
18	.....	90.02	91.15	91.65	91.63	89.39	89.07	92.01	91.94
29	91.46	89.78	90.64	91.14	90.96	89.45	99.27	91.47	91.07
Aug. 10	90.92	89.51	89.97	.....	90.66	89.53	89.17	90.89	90.49
17	90.63	89.44	89.60	.....	90.47	89.41	89.00	90.57	90.17
25	90.41	89.31	89.31	.....	90.32	89.53	88.98	.....	89.83
Sept. 1	90.27	89.24	89.12	89.32	90.29	89.57	88.93	90.23	89.76
Oct. 3	89.70	88.83	88.58	88.93	89.78	89.57	88.78	.....	89.22
Nov. 2	89.38	88.64	88.43	88.71	89.84	89.53	88.82	.....	89.05
23	89.29	88.46	88.29	88.59	89.66	89.56	88.93	.....	88.94
Dec. 15	89.06	88.35	88.29	88.49	89.32	89.57	88.78	.....	88.84
1929									
Jan. 17	89.05	88.30	88.18	88.39	89.31	89.55	89.07	89.17	88.73
Feb. 23	88.86	88.24	88.09	.....	.....	89.55	89.02	.....	.....
Mar. 21	89.46	88.44	89.36	88.79	89.84	89.59	89.63	89.19	89.47
Apr. 14	90.13	88.96	90.08	89.37	89.80	89.56	.....	89.88	89.99
28	90.05	88.89	90.06	89.29	89.89	89.61	.....	89.92	89.95
May 22	89.93	88.74	89.65	89.12	89.83	89.63	.....	89.81	89.82
June 7	89.87	88.62	88.41	88.91	89.76	89.64	.....	89.80	89.80
July 1	89.59	88.32	88.94	88.48	89.58	89.66	89.22	89.61	89.30
19	89.29	88.13	88.48	88.09	89.41	89.64	89.03	89.41	88.91
Aug. 9	88.98	87.87	87.99	87.84	89.16	89.65	88.65	89.08	.....
23	88.84	87.78	87.70	87.65	88.97	89.64	88.50	88.88	88.47
Oct. 3	88.55	87.41	87.19	87.31	88.66	89.54	88.48	88.61	88.11
19	88.45	87.31	87.08	87.21	88.59	89.50	88.49	88.53	88.06
Nov. 26	88.28	87.09	86.94	87.01	88.56	89.45	88.62	88.37	87.90
Dec. 9-11	88.22	87.06	86.92	86.97	88.54	89.40	88.62	88.34	87.86
1930									
Jan.16-17	88.04	86.81	86.83	86.80	88.58	89.24	88.58	88.04	87.82
Apr. 7	88.27	86.87	87.21	86.88	88.81	89.47	89.32	88.06	88.03
May 5	88.41	86.81	87.30	87.92	88.88	89.57	89.45	88.11	88.22
May 19-20	88.42	86.86	87.26	87.47	88.96	89.53	89.41	88.23	88.27
June 11	88.41	86.82	87.03	87.87	88.96	89.44	89.30	88.26	88.26
July 23-24	88.14	86.70	86.62	86.67	88.56	89.41	88.77	88.01	87.77
Aug. 25	87.88	86.50	86.28	86.46	88.40	89.40	88.38	87.87	87.56
Sept.21	87.85	86.42	85.94	86.33	88.32	89.34	88.32	87.74	87.39
Nov. 7	87.70	86.23	85.90	86.19	88.27	89.28	88.59	87.59	87.38
1931									
Jan. 26	87.58	85.95	85.92	.....	88.18	.....	88.83	87.49	86.35
Mar. 27	87.82	.....	86.24	86.09	88.55	89.21	89.08	87.38	87.65
Apr.21-22	87.84	.....	86.34	86.32	88.61	89.28	89.11	87.61	87.67
May 17	87.88	.....	86.23	86.11	88.59	89.28	88.96	87.64	87.66
30	87.87	85.99	85.97	86.05	88.56	89.27	88.75	86.63	87.63
June 10	87.81	85.94	85.68	85.93	88.49	89.05	88.54	87.60	87.55
July 13	87.64	85.86	85.54	85.90	88.04	.....	88.37	87.45	87.33
Aug. 8	87.55	85.75	85.18	85.77	88.05	89.17	88.05	87.44	87.26
30	87.49	85.64	85.00	85.61	87.94	79.12	87.90	87.35	87.18
Oct. 19	87.31	85.42	84.75	85.55	87.84	88.90	88.04	87.11	87.00
Nov. 28	87.19	85.36	84.79	85.53	87.68	88.87	87.14	.....	86.88
1932									
Jan. 26	87.58	85.95	85.92	.....	88.18	.....	88.83	87.47	87.35
Mar.24-25	88.08	85.72	86.62	.....	88.67	89.40	89.19	87.53	87.78
May 10	88.36	85.86	86.08	85.90	88.68	89.42	.....	87.78	88.10
18	88.37	85.86	86.05	85.90	88.81	89.42	89.26	87.83	88.10
June 4	88.43	85.87	86.02	85.93	88.98	89.45	89.34	87.93	88.31
7	88.39	85.84	86.00	85.89	88.99	89.37	89.26	87.93	88.27
13	88.41	85.84	86.02	85.84	89.02	89.38	89.21	88.03	88.37
20	88.45	85.78	85.86	85.75	89.06	89.40	89.12	88.10	88.40
27	88.44	85.72	85.62	85.75	88.97	89.42	89.03	88.16	88.58
July 5	88.42	85.66	85.58	85.73	88.92	89.40	88.93	88.21	88.43
Aug. 10	87.94	85.17	84.71	85.15	88.28	89.21	88.32	87.97	87.90
Sept.16	87.92	85.07	84.60	85.04	88.26	89.21	88.22	87.84	87.68
Oct. 24	87.81	84.93	84.27	84.66	88.18	89.15	88.27	87.60	87.60
Dec. 29	87.59	85.17	84.69	84.86	90.07	88.74	88.51	87.45	87.47
1933									
Feb. 20	87.47	85.05	84.75	84.83	88.20	88.94	88.58	87.45	87.38
Mar. 22	87.83	85.35	85.04	85.21	88.51	89.14	88.89	87.43	87.63

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Water levels in Flathead Valley - Continued

Date	1	2	3	4	5	7	8	9	10
1933									
Apr. 10	87.75	85.32	85.23	85.20	88.41	89.06	88.98	87.60	87.65
May 6	87.86	85.29	85.30	85.14	88.37	89.04	.....	87.52	87.70
9	87.83	85.33	85.29	85.26	88.54	89.03	.....	87.64	87.72
13	87.84	85.36	85.34	85.16	88.55	89.09	.....	87.63	87.79
16	87.91	85.37	85.37	85.17	88.58	89.11	.....	87.69	87.83
20	87.88	85.29	85.37	85.20	88.58	89.09	.....	87.70	87.91
23	87.93	85.32	85.36	85.24	88.57	89.09	.....	87.70	87.91
27	87.93	85.27	85.33	85.22	88.54	89.09	89.45	87.72	87.92
30	87.94	85.34	85.33	85.23	88.55	89.08	89.46	87.74	87.92
June 3	87.95	85.31	85.24	85.21	88.53	89.09	89.40	87.72	87.94
6	87.96	85.24	85.21	85.18	88.56	89.09	89.36	87.76	87.95
10	87.99	85.22	85.17	85.18	88.69	89.09	89.33	87.77	88.01
13	88.02	85.14	85.12	85.11	88.82	89.10	89.27	87.79	89.94
17	88.22	85.13	84.96	85.09	.....	89.09	89.21	.....	.....
20	88.45	85.93	84.82	84.18	.....	89.08	89.14	.....	.....
24	89.40	85.05	84.73	85.01	93.88	89.08	89.11	.....	94.47
27	89.79	85.04	84.69	85.02	94.15	89.05	89.05	93.92	93.54
July 1	90.20	85.09	84.72	85.07	92.62	89.08	89.10	93.51	93.07
5	90.03	85.11	84.72	85.08	92.24	89.08	89.01	92.52	92.02
8	90.02	85.11	84.70	85.08	92.00	89.06	88.94	92.10	91.58
11	89.95	85.10	84.65	85.03	91.82	89.05	88.90	91.85	91.24
15	89.83	84.99	84.53	84.88	91.53	89.05	88.80	91.53	90.81
18	89.77	85.09	84.44	84.93	91.35	89.08	88.77	91.34	90.64
22	89.71	85.05	84.40	84.91	91.06	89.08	88.71	91.11	90.41
25	89.64	85.01	84.39	84.88	90.96	89.07	88.67	91.10	90.28
Aug. 7	89.42	84.93	.....	84.85	90.43	89.05	88.56	90.36	89.71
30	89.21	84.96	.....	84.80	89.93	89.07	88.39	89.95	89.34
Sept.28	89.01	85.13	.....	84.87	89.45	89.11	88.45	89.48	88.93
Oct. 15	88.79	85.11	.....	84.93	89.26	89.02	88.39	89.23	88.75
Dec. 7	88.90	85.36	84.09	85.13	89.11	89.00	88.69	89.20	88.95
1934									
Mar. 16	89.28	85.55	84.42	85.44	89.47	89.14	89.37	89.56	89.37
Apr. 23	89.64	85.49	84.55	85.60	89.96	89.19	89.47	89.92	89.71
May 19	89.57	85.64	84.41	85.60	89.75	89.20	89.27	89.73	89.53
June 22	89.23	85.47	84.11	85.80	89.51	.....	88.91	89.46	88.86
Aug. 4	88.67	85.05	.....	85.05	89.03	89.21	88.45	89.38	88.51
Sept.11	88.55	84.82	83.35	84.72	88.86	89.16	88.32	88.60	88.17
Nov. 6	88.14	85.17	83.58	84.97	88.57	89.08	88.54	88.23	87.84
Dec. 21	88.06	85.24	83.76	84.99	88.49	89.01	88.68	88.12	87.86
1935									
Feb. 17	88.02	85.21	83.94	85.00	88.56	89.11	88.90	.....	87.93
Mar. 18	88.08	85.29	84.06	85.14	88.55	89.13	89.10	.....	87.99
May 12	88.19	85.16	84.18	85.08	88.68	89.07	89.16	.....	88.15
23	88.21	85.19	84.14	85.06	88.73	89.06	89.24	.....	88.19
June 14	88.36	84.94	83.64	84.82	88.90	89.06	88.94	89.30	88.37
July 30	88.17	84.79	83.17	84.50	88.59	89.06	88.56	88.38	88.07
Sept. 9	87.97	84.45	82.94	84.23	88.34	88.98	88.17	87.97	87.68
Oct. 27	86.62	84.55	82.93	84.32	88.13	88.93	88.33	.....	.....

Date	11	12	13	14	15	16	17	18	19
1928									
July 16	86.93	88.14	89.37	89.64	90.34	87.01	86.91	88.61	88.28
18	86.92	88.51	89.33	89.58	89.64	87.11	85.51	88.70	88.07
29	86.82	88.00	88.92	89.19	88.91	86.83	86.66	88.59	87.93
Aug. 10	86.64	87.83	88.42	88.71	87.35	86.89	86.91	87.59	87.54
17	86.52	87.41	88.10	88.40	87.41	86.00	85.99	86.83	87.83
25	86.48	87.62	87.77	88.04	87.05	86.69	86.99	88.36	87.28
Sept. 1	86.46	87.55	87.52	87.83	86.67	86.67	86.69	88.50	87.24
Oct. 3	86.57	87.59	86.95	86.86	85.95	86.54	86.43	86.33	87.48
Nov. 2	86.53	86.92	86.18	86.25	85.35	86.59	86.52	88.53	87.78
23	86.68	.....	86.76	86.06	85.23	86.34	86.07	88.59	87.95
Dec. 15	86.74	86.79	86.76	.....	85.12	86.62	86.76	87.14	88.07
1929									
Jan. 17	86.82	.....	86.75	85.61	.....	.....	.....	.....	88.04
Feb. 23	86.78	.....	.....	.....	.....	.....	.....	.....	87.96
Mar. 21	87.61	87.44	89.19	.....	85.39	86.97	87.59	88.31	90.06
Apr. 14	87.62	87.30	89.65	85.55	85.64	87.20	86.86	88.79	89.34
28	87.60	87.13	89.22	85.51	85.99	87.27	86.77	88.07	88.92
May 22	87.50	87.40	88.87	85.88	86.11	87.38	87.38	88.67	88.52

Water levels in Flathead Valley - Continued

Date	11	12	13	14	15	16	17	18	19
1929									
June 7	87.40	87.65	88.55	86.66	86.24	87.37	87.11	88.66	88.28
July 1	86.97	87.60	87.86	87.75	86.30	86.98	87.22	88.60	87.65
19	86.75	87.35	87.20	87.37	85.72	86.71	86.40	87.48	87.07
Aug. 9	86.38	87.14	86.73	86.83	89.20	86.54	86.70	86.49	86.31
23	86.21	86.77	86.41	86.46	85.02	86.42	85.57	88.46	86.27
Oct. 3	86.24	86.30	85.99	85.64	84.21	86.25	86.17	87.05	86.91
19	86.26	86.64	85.92	.....	84.38	86.29	86.10	88.30	87.10
Nov. 26	86.36	86.04	85.77	85.08	84.11	86.28	.....	88.39	87.44
Dec. 9-11	86.33	86.54	85.67	84.91	83.94	85.87	.....	88.51	87.38
1930									
Jan. 16-17	86.38	85.78	85.96	84.61	84.12	86.04	.....	88.16	87.49
Apr. 7	86.82	85.64	87.91	84.66	83.94	86.59	86.36	.....	88.96
May 5	86.87	86.62	87.31	85.22	84.65	86.35	87.05	88.63	88.93
19-20	86.93	86.55	87.10	85.74	84.30	86.73	87.03	88.62	.....
June 11	86.97	86.69	86.83	86.40	84.80	86.53	87.07	88.60	88.17
July 23-24	86.78	86.15	85.30	86.26	84.31	86.37	86.55	87.63	86.86
Aug. 25	86.60	86.24	85.02	85.60	84.00	86.30	85.83	.....	86.11
Sept.21	86.54	86.38	84.69	85.18	83.89	.....	85.93	.....	86.32
Nov. 7	86.61	86.09	84.96	84.66	83.94	86.08	86.27	.....	87.38
1931									
Jan. 26	86.67	86.56	85.17	84.32	83.73	86.29	86.23	87.91	87.93
Mar. 27	87.21	85.79	86.00	84.28	.....	86.52	87.19	.....	87.60
Apr. 21-22	87.15	86.03	85.99	84.31	84.29	86.73	86.12	.....	88.13
May 17	87.07	86.30	85.79	84.82	84.46	86.82	86.53	.....	87.74
30	86.97	86.19	85.54	85.36	84.55	86.28	86.03	88.09	87.41
June 10	86.87	86.04	85.29	85.76	84.49	86.64	85.86	86.74	86.97
July 13	86.50	85.86	84.60	85.89	83.84	86.40	85.61	.....	86.36
Aug. 8	86.40	83.79	84.28	85.42	83.38	86.23	85.70	.....	85.93
30	86.30	85.42	83.84	85.06	83.57	85.99	85.27	87.81	85.58
Oct. 19	86.17	85.25	83.95	84.42	83.38	86.17	85.72	87.59	86.53
Nov. 28	86.18	85.29	83.84	84.11	83.27	.....	85.33	.....	86.88
1932									
Jan. 26	86.67	86.56	85.17	84.32	83.73	86.29	86.23	.....	87.93
Mar. 24-25	87.16	85.92	85.88	84.35	84.14	86.72	86.76	87.66	89.60
May 10	87.22	85.72	85.86	85.86	84.77	87.08	86.70	88.11	88.45
18	87.24	85.90	85.88	85.16	85.05	87.18	86.79	87.71	88.10
June 4	87.24	86.50	85.78	86.50	84.92	87.18	87.67	87.75	88.52
7	87.38	86.23	85.82	86.63	84.96	.....	87.44	89.26	88.22
13	87.19	86.24	86.18	86.96	85.02	87.20	86.85	88.73	88.01
20	87.10	86.26	85.82	87.36	85.07	.....	87.19	.....	87.75
27	87.09	86.05	85.89	87.70	85.13	87.19	86.11	.....	87.48
July 5	87.00	86.00	85.43	87.85	.....	87.15	86.45	.....	87.30
Aug. 10	86.40	85.82	84.38	86.80	85.74	86.59	86.21	88.06	86.21
Sept.16	86.39	85.43	84.33	85.90	85.19	86.38	85.80	88.24	86.11
Oct. 24	86.19	.....	84.33	84.92	84.86	86.31	86.03	88.57	86.74
Dec. 29	86.17	86.15	84.56	84.75	85.05	86.36	.....	87.83	87.29
1933									
Feb. 20	86.18	86.03	.....	84.50	85.22	86.25	.....	87.96	87.13
Mar. 22	86.97	86.57	84.86	84.46	84.77	86.44	86.63	88.76	88.90
Apr. 10	86.87	86.19	85.38	84.43	85.45	86.50	86.63	88.81	88.79
May 6	86.78	86.24	85.45	84.60	85.65	86.51	87.04	88.54	88.07
9	86.81	88.27	85.50	89.69	.....	86.65	86.77	88.74	88.58
13	86.91	86.59	85.49	84.83	85.64	86.53	86.66	86.55	88.68
16	86.97	86.47	85.58	84.51	85.75	86.70	87.13	.....	88.49
20	86.88	86.35	85.59	85.08	85.75	86.59	87.22	88.60	88.44
23	86.96	86.30	85.58	85.17	85.81	86.67	87.25	88.50	88.37
27	86.92	86.31	85.59	85.31	85.78	86.60	87.12	88.55	88.09
30	86.93	86.53	85.61	85.43	85.63	86.59	86.69	87.81	87.99
June 3	88.06	86.07	85.63	85.65	85.78	86.64	86.86	87.76	87.80
6	86.90	86.24	85.62	85.87	85.85	86.69	86.42	87.14	87.70
10	86.85	86.18	85.60	86.22	85.91	86.61	86.91	86.84	87.57
13	86.82	86.17	85.61	86.52	85.91	86.56	86.62	87.29	87.52
17	86.81	86.39	85.73	87.02	85.92	86.62	86.58	87.32	87.36
20	86.75	85.72	85.98	87.48	86.16	86.66	86.29	87.53	87.15
24	86.67	86.78	86.72	88.12	86.56	86.60	86.05	88.45	87.01
27	86.66	86.98	87.17	88.58	86.73	86.33	86.15	87.34	86.91
July 1	86.61	87.84	87.54	88.93	87.09	86.58	86.97	86.96	86.95
5	86.58	87.20	87.60	89.16	87.33	86.66	86.29	87.04	86.86
8	86.58	87.30	87.49	89.21	87.45	86.66	86.20	86.48	86.80
11	86.54	87.36	87.34	89.19	87.46	86.60	86.20	.....	86.70
15	86.49	87.34	87.14	89.12	87.49	86.58	85.61	87.15	86.50

Water levels in Flathead Valley - Continued

Date	11	12	13	14	15	16	17	18	19
1933									
July 18	86.45	87.14	87.06	89.02	87.47	86.33	85.91	87.17	86.36
22	86.40	87.03	86.92	88.84	87.40	86.42	85.73	87.45	86.19
25	86.37	87.28	86.82	88.75	87.35	86.47	85.84	87.48	86.14
Aug. 7	86.20	87.35	86.41	88.12	86.95	.....	85.57	87.55	86.05
30	86.01	86.78	86.12	87.21	.....	86.37	85.86	87.55	85.86
Sept.28	86.01	87.15	85.89	86.34	86.06	86.27	85.80	87.38	86.27
Oct. 15	85.99	85.02	85.81	85.93	85.82	86.12	86.10	.....	86.31
Dec. 7	86.19	86.77	86.39	85.73	85.51	85.97	.....	87.45	87.19
1934									
Mar. 16	86.79	87.08	87.27	85.41	86.24	86.59	86.17	88.33	87.97
Apr. 23	87.20	87.10	87.85	85.50	86.83	86.77	86.55	86.97	87.88
May 19	87.04	.....	87.19	87.55	86.90	86.92	86.43	86.25	87.20
June 22	86.72	.....	86.13	88.34	87.05	86.98	86.12	87.49	87.51
Aug. 4	86.28	86.75	85.45	86.96	85.78	86.81	86.26	87.04	85.65
Sept.11	86.13	86.51	85.35	85.91	85.49	86.50	86.28	87.41	85.73
Nov. 6	86.20	86.17	85.24	84.99	84.33	.....	.....	.....	86.62
Dec. 21	85.20	86.29	85.32	84.83	85.07	85.97	.....	85.88	87.04
1935									
Feb. 17	86.63	.....	85.79	84.63	.....	.....	.....	.....	87.55
Mar. 18	86.68	86.38	85.93	84.58	.....	.....	.....	.....	87.49
May 12	86.80	86.48	85.96	84.78	85.33	.....	86.52	86.92	87.64
23	86.76	86.73	85.86	85.09	85.39	.....	86.55	87.19	87.47
June 14	86.44	.....	85.21	86.89	.....	.....	.....	.....	86.74
July 30	86.07	85.85	84.60	86.97	.....	.....	86.21	.....	85.79
Sept. 9	85.82	85.87	84.18	85.80	84.82	.....	85.51	87.37	85.17
Oct. 27	85.72	85.30	84.19	84.94	83.50	86.55	85.61	84.73	86.15

Date	20	21	22	23	24	25	26	27	28
1928									
July 16	88.95	89.28	89.87	92.51	94.98	.....	.....	.....	.....
18	88.93	89.23	89.85	92.49	94.94	.....	.....	.....	.....
29	88.81	89.21	90.01	90.51	93.83	.....	.....	.....	.....
Aug. 10	88.68	88.95	.....	.....	92.58	.....	.....	.....	.....
17	88.65	88.86	89.71	88.86	91.93	.....	.....	.....	.....
25	88.69	88.74	89.59	.....	91.60	.....	.....	.....	.....
Sept. 1	88.74	88.72	89.44	87.68	90.40	91.06	91.24	88.48	88.52
Oct. 3	88.78	88.28	88.92	86.75	89.50	90.23	90.65	87.11	88.13
Nov. 2	88.78	87.94	88.54	.....	88.83	89.47	90.19	86.38	87.85
23	88.81	87.66	88.34	85.05	88.51	89.02	89.79	86.02	87.70
Dec. 15	88.74	87.43	88.54	84.62	87.18	88.66	89.41	85.73	87.57
1929									
Jan. 17	88.72	87.37	88.37	84.20	87.76	88.13	88.93	85.41	87.37
Feb. 23	88.65	86.75	87.93	83.81	87.27	87,57	88.39	85.26	87.17
Mar. 21	89.02	86.75	87.71	83.77	87.57	87.21	88.03	.....	87.03
Apr. 14	88.97	87.01	87.39	83.86	87.88	87.00	87.81	84.98	86.96
28	88.86	86.70	87.32	84.70	87.71	86.87	87.70	84.91	86.89
May 22	88.81	86.46	87.27	89.16	87.88	87.13	87.48	85.83	87.09
June 7	88.78	86.51	88.04	91.67	.....	89.64	87.76	88.20	87.58
July 1	88.69	86.88	88.54	90.25	89.79	.....	88.10	89.33	87.99
19	88.54	87.13	88.55	88.13	89.53	.....	88.32	88.51	87.97
Aug. 9	88.36	86.94	88.28	86.36	.....	88.63	88.04	87.40	87.74
23	88.26	86.81	88.15	86.48	88.36	88.42	87.88	86.78	87.58
Oct. 3	88.25	86.63	87.74	.....	.....	87.65	87.45	85.60	87.19
19	88.26	86.57	87.61	.....	.....	87.39	87.27	85.37	87.07
Nov. 26	88.25	86.34	87.36	83.48	86.84	86.79	86.92	84.97	86.86
Dec. 9-11	88.17	86.24	87.35	83.37	86.30	86.67	86.76	84.86	86.81
1930									
Jan. 16-17	88.11	86.08	86.94	83.18	86.21	86.10	86.37	84.64	86.60
Apr. 7	88.34	86.34	86.73	83.78	85.93	.....	85.78	82.44	86.43
May 5	88.33	86.08	87.11	89.23	.....	86.13	85.77	85.98	86.76
19-20	88.25	86.08	87.44	89.23	87.07	.....	85.95	86.73	87.03
June 11	88.18	85.91	87.79	90.52	87.79	87.14	86.22	87.80	87.32
July 23-24	87.86	86.85	87.87	86.83	88.10	87.66	86.58	87.01	87.36
Aug. 25	87.72	86.38	87.59	85.08	87.44	87.25	86.44	85.94	86.98
Sept.21	87.75	86.23	87.32	84.30	.....	86.85	86.22	85.32	86.75
Nov. 7	87.84	86.15	87.08	83.92	86.36	.....	85.87	84.90	86.44
1931									
Jan. 26	87.86	.....	86.77	83.42	85.96	.....	.....	84.38	87.17
Mar. 27	87.85	85.75	.....	83.70	85.86	.....	.....	84.25	86.26

Water levels in Flathead Valley - Continued

Date	20	21	22	23	24	25	26	27	28
1931									
Apr. 21-22	87.92	85.67	.....	84.84	85.92	.....	.....	84.19	85.96
May 17	87.85	85.61	.....	89.92	86.25	85.78	85.48	85.59	86.34
30	87.81	85.61	87.20	89.93	86.69	86.03	85.68	86.99	86.61
June 10	87.65	85.63	87.37	89.67	87.08	86.46	85.73	87.51	86.80
July 13	87.59	85.86	87.52	86.75	87.53	87.06	86.17	86.83	86.85
Aug. 8	87.48	85.88	87.37	85.28	87.06	86.85	86.20	86.57	86.61
30	87.44	85.73	87.12	84.38	86.69	86.53	85.99	85.38	86.43
Oct. 19	87.35	85.73	86.74	83.68	85.86	85.83	85.62	84.71	86.05
Nov. 28	87.51	86.60	86.63	83.38	.....	85.48	85.35	84.31	85.96
1932									
Jan. 26	87.86	.....	86.77	83.42	85.96	.....	.....	84.38	86.17
Mar. 24-25	87.93	86.16	86.30	84.73	83.86	85.20	84.97	84.16	85.57
May 10	87.86	85.40	86.72	89.11	86.61	85.66	85.25	85.48	86.16
18	87.83	85.48	87.00	91.95	88.96	85.85	85.35	86.86	86.40
June 4	88.02	85.82	87.72	93.25	95.72	96.67	85.71	89.45	86.96
7	87.99	85.93	87.78	93.14	95.44	96.85	85.78	89.73	87.07
13	87.97	86.08	87.98	93.24	94.78	87.13	85.91	90.08	87.18
20	87.94	86.31	88.18	93.59	94.28	87.46	86.12	90.64	87.35
27	87.91	86.56	88.38	93.13	93.78	87.81	86.33	91.02	87.48
July 5	87.90	86.80	88.51	91.90	92.96	88.12	86.56	90.84	87.58
Aug. 10	87.55	87.18	88.21	87.27	90.08	88.41	87.21	88.41	87.39
Sept.16	87.68	87.15	87.87	85.31	88.70	87.91	87.28	86.72	87.09
Oct. 24	87.74	86.87	87.46	87.47	.....	87.47	87.03	85.63	87.70
Dec. 29	87.79	86.32	87.15	88.80	.....	88.80	86.57	85.05	86.44
1933									
Feb. 20	87.70	86.00	86.81	86.39	.....	86.39	86.40	84.68	86.17
Mar. 22	87.91	85.83	86.76	86.13	82.28	86.13	86.15	84.82	86.06
Apr. 10	87.91	85.85	86.67	86.03	87.65	86.03	86.18	84.60	86.02
May 6	87.80	85.69	86.81	86.08	86.86	86.08	86.05	85.28	86.17
9	87.99	85.64	86.76	86.16	86.92	86.16	86.08	85.57	86.28
13	87.92	85.61	86.93	86.24	87.10	86.24	86.14	85.86	86.34
16	87.91	85.81	86.98	86.42	87.21	86.42	86.18	86.07	86.37
20	87.93	85.89	87.03	86.50	87.27	86.50	86.20	86.37	86.49
23	87.89	85.90	87.18	86.58	87.42	86.58	86.30	86.62	86.57
27	87.86	85.93	87.28	86.69	87.58	86.69	86.35	86.95	86.65
30	87.85	85.99	87.36	86.78	87.69	86.78	86.48	87.40	86.73
June 3	87.82	86.04	87.49	93.94	96.09	86.91	86.47	87.96	86.87
6	87.83	86.10	87.61	95.34	.....	87.03	86.51	88.66	86.99
10	87.85	86.22	87.82	96.53	.....	87.22	86.61	89.77	87.17
13	87.83	86.34	87.98	97.04	.....	87.45	86.68	90.70	87.30
17	87.82	86.52	88.24	.....	.....	.....	.....	91.87	87.49
20	87.81	86.99	88.56	.....	.....	88.09	86.93	92.99	87.62
24	87.83	87.99	88.95	98.39	.....	88.49	87.18	93.62	87.76
27	87.83	87.63	89.13	97.46	97.63	88.92	87.40	93.83	87.87
July 1	87.90	87.70	89.36	96.60	97.10	89.36	87.74	93.91	87.96
5	87.92	87.85	89.50	95.54	96.78	89.73	86.08	93.71	88.07
8	87.92	87.97	89.58	94.73	96.51	89.98	88.31	93.48	88.10
11	87.90	88.05	89.55	93.99	96.28	90.14	88.53	93.14	88.09
15	87.84	88.11	89.51	92.90	95.81	90.40	88.76	92.68	88.10
18	87.85	88.21	89.54	92.32	95.49	90.55	89.02	92.37	88.16
22	87.83	88.29	89.50	91.47	95.01	90.67	89.25	91.94	88.17
25	87.82	88.30	89.47	90.93	94.70	90.73	89.38	91.67	88.15
Aug. 7	87.86	88.33	89.25	88.94	93.46	90.81	89.84	90.40	88.04
30	87.79	88.08	88.90	86.79	91.24	90.40	90.10	88.56	87.76
Sept.28	87.86	87.69	88.42	85.65	89.89	89.75	89.88	87.18	87.47
Oct. 15	87.83	87.46	88.22	85.23	89.34	89.33	89.64	86.63	87.35
Dec. 7	87.96	87.02	87.95	86.70	89.52	88.87	89.18	86.51	87.23
1934									
Mar. 16	88.03	86.69	87.59	85.57	89.11	88.30	88.56	85.79	86.98
Apr. 23	88.03	86.66	87.80	91.06	89.47	88.30	88.40	86.92	87.18
May 19	88.03	86.25	88.75	94.81	95.56	89.29	88.91	91.01	88.00
June 22	87.91	87.95	89.37	90.21	93.06	90.24	89.60	91.29	88.39
Aug. 4	87.78	87.65	88.83	86.71	.....	.....	.....	88.28	.....
Sept.11	87.89	87.32	88.35	84.93	.....	89.21	89.18	86.66	87.63
Nov. 6	87.97	86.71	87.75	84.38	.....	87.92	88.38	85.51	87.02
Dec. 21	87.87	86.24	87.45	84.68	.....	87.42	87.87	85.17	87.76
1935									
Feb. 17	87.82	86.06	87.13	84.44	.....	86.96	87.28	84.78	86.56
Mar. 18	87.93	85.94	87.05	84.28	.....	.....	87.13	84.64	86.60
May 12	87.81	85.75	86.84	88.34	.....	.....	86.79	85.27	86.49
23	87.80	85.86	87.27	91.25	.....	86.91	86.88	85.75	86.74

Water levels in Flathead Valley - Continued

Date	20	21	22	23	24	25	26	27	28
1935									
June 14	87.84	86.55	88.19	93.25	.....	88.11	87.48	90.35	87.55
July 30	87.64	87.20	88.60	88.19	.....	89.08	88.22	89.04	87.80
Sept. 9	87.53	86.88	88.05	85.29	.....	88.52	88.05	86.91	87.29
Oct. 27	87.60	86.46	87.57	84.01	.....	87.57	87.54	85.69	87.22

Date	29	30	31	32	33	34	35	36	37
1928									
July 16	.....	.....	.....	.....	.....	.....	.....	.....	.....
July 18	.....	.....	.....	.....	.....	.....	.....	.....	.....
29	.....	.....	.....	.....	.....	.....	.....	.....	.....
Aug. 10	.....	.....	.....	.....	.....	.....	.....	.....	.....
17	.....	.....	.....	.....	86.88	88.13	88.43	86.55	86.22
25	.....	.....	.....	.....	86.75	88.10	88.43	86.56	86.20
Sept. 1	87.97	88.50	88.23	89.12	86.71	88.05	88.49	86.55	86.17
Oct. 3	87.13	88.51	88.29	89.16	86.45	88.00	88.32	86.56	85.94
Nov. 2	86.67	88.47	88.27	89.08	86.36	88.00	88.32	86.56	85.91
23	86.47	88.37	88.27	89.06	86.43	87.96	88.16	86.51	85.94
Dec. 15	86.25	88.36	88.30	89.05	86.46	87.96	93.11	86.52	85.93
1929									
Jan. 17	86.04	88.41	88.40	89.10	86.50	88.00	88.11	86.52	86.03
Feb. 23	85.87	88.07	88.28	.....	86.51	88.00	93.07	86.44	85.97
Mar. 21	88.73	88.00	88.16	89.01	86.63	87.99	88.03	86.49	86.01
Apr. 14	85.66	87.95	88.21	89.01	86.99	87.95	88.11	86.55	86.18
28	85.64	87.89	88.16	89.20	87.00	88.00	88.16	86.48	86.26
May 22	86.52	87.83	88.12	89.45	86.82	88.03	88.16	86.56	86.27
June 7	88.00	87.81	88.11	89.56	86.70	88.05	88.16	86.54	86.34
July 1	88.49	87.82	88.02	89.50	86.40	87.94	.....	86.56	86.28
19	87.89	87.91	88.09	89.46	86.56	87.90	.....	86.60	86.19
Aug. 9	87.20	87.91	88.08	89.35	85.88	87.72	88.03	86.52	85.93
23	86.75	87.94	88.11	89.35	85.68	87.70	87.92	86.47	85.89
Oct. 3	86.10	87.82	88.07	89.26	85.38	87.63	87.85	86.42	85.65
19	85.94	87.80	88.01	89.24	85.32	87.62	87.82	86.37	85.66
Nov. 26	85.67	87.72	88.11	89.19	85.49	87.63	87.78	86.32	85.62
Dec. 9-11	85.59	87.73	88.11	89.14	85.58	87.64	87.82	86.27	85.62
1930									
Jan. 16-17	85.36	87.50	87.85	89.02	85.68	87.58	87.66	86.22	85.61
Apr. 7	85.31	87.98	88.00	90.03	86.25	87.85	87.98	86.18	85.04
May 5	86.58	87.84	88.04	89.86	86.27	87.85	87.95	86.22	86.06
19-20	87.09	87.76	88.00	89.79	86.27	87.85	87.92	86.24	86.06
June 11	87.79	.....	87.98	89.73	.....	87.84	87.89	86.23	86.09
July 23-24	87.03	87.74	87.93	89.50	85.93	87.83	87.74	86.17	85.89
Aug. 25	86.22	87.70	87.88	89.26	.....	87.74	87.65	86.07	85.65
Sept.21	85.81	85.73	87.92	89.23	85.06	87.75	87.61	86.08	85.59
Nov. 7	85.53	87.39	87.78	89.12	85.37	87.64	87.51	86.06	85.49
1931									
Jan. 26	85.14	87.22	87.93	90.03	85.74	87.55	92.31	83.06	85.54
Mar. 27	85.00	86.91	87.67	89.10	86.06	87.56	88.49	86.00	85.58
Apr. 21-22	85.00	87.00	87.58	89.26	86.09	87.50	87.40	85.93	85.70
May 17	86.19	87.06	87.53	89.36	86.02	87.57	87.35	85.99	85.81
30	87.06	86.95	87.54	89.33	85.96	87.50	87.40	86.00	85.82
June 10	87.38	86.88	87.50	89.15	85.80	87.43	87.29	85.99	85.81
July 13	86.73	86.99	87.55	89.17	85.30	87.43	87.36	85.97	85.71
Aug. 8	86.10	87.00	87.51	89.03	85.09	87.45	87.30	85.94	85.50
30	85.71	87.00	87.54	88.99	84.87	.....	87.28	85.92	85.37
Oct. 19	85.28	86.89	87.50	88.87	84.89	.....	87.14	85.88	85.21
Nov. 28	84.99	86.83	87.33	88.78	85.13	.....	87.06	85.74	85.31
1932									
Jan. 26	85.14	87.22	87.93	90.03	85.74	87.55	.....	83.06	85.54
Mar. 24-25	84.83	86.63	87.42	89.16	85.88	84.56	87.27	85.80	85.67
May 10	90.55	87.03	87.38	90.03	86.13	87.85	87.58	86.02	85.95
18	86.97	86.79	86.40	90.06	86.11	87.83	87.61	86.02	86.05
June 4	88.46	86.91	87.46	90.13	86.11	87.91	87.68	86.11	.....
7	88.63	86.85	87.34	90.05	86.03	87.88	87.63	85.92	86.04
13	88.84	86.89	87.34	90.02	86.04	87.86	87.63	86.09	86.07
20	89.19	86.93	87.35	89.98	86.02	87.90	87.66	86.12	86.09
27	89.33	86.99	87.36	89.93	85.94	87.91	87.76	86.13	86.11
July 5	89.11	87.07	87.37	89.87	85.85	87.90	87.67	86.13	86.09
Aug. 10	87.45	87.20	87.36	89.55	85.27	87.89	87.61	86.10	85.94
Sept.16	86.45	87.19	87.44	89.39	85.04	87.74	87.60	86.11	85.78

Water levels in Flathead Valley - Continued

Date	29	30	31	32	33	34	35	36	37
1932									
Oct. 24	85.80	87.15	87.33	88.93	84.99	87.71	87.50	86.15	85.73
Dec. 29	85.49	87.05	87.49	89.17	85.36	87.75	87.47	86.03	85.69
1933									
Feb. 20	85.17	86.79	87.40	89.03	85.52	87.59	87.31	85.94	85.68
Mar. 22	85.12	86.75	87.26	89.89	86.76	87.74	87.43	86.07	85.94
Apr. 10	85.00	87.04	87.37	89.80	86.06	87.78	87.71	86.08	85.98
May 6	85.74	86.87	87.40	89.82	86.00	87.80	87.51	86.05	86.01
9	85.94	86.94	87.38	89.83	86.04	87.79	87.65	86.15	86.01
13	86.12	84.84	87.35	89.74	86.11	87.78	87.68	86.17	86.02
16	86.24	86.90	87.38	89.82	86.04	87.82	87.61	86.10	86.05
20	86.53	86.90	87.36	89.77	86.05	87.78	87.66	86.18	86.09
23	86.70	86.89	87.44	89.83	86.08	87.86	87.66	86.17	86.08
27	86.95	86.89	87.50	89.82	86.08	87.84	87.62	86.16	86.07
30	87.21	86.92	87.46	89.86	86.11	87.59	87.66	86.17	86.11
June 3	87.67	86.93	87.45	89.86	86.07	87.60	87.66	86.20	85.10
6	88.08	86.93	87.43	89.84	86.06	87.60	87.64	86.17	86.12
10	88.78	86.92	87.36	89.80	86.06	87.59	87.60	86.16	86.08
13	89.30	86.94	87.49	89.83	86.06	87.57	87.61	86.16	86.09
17	90.13	86.98	87.44	.....	.....	87.63	87.62	86.16	86.10
20	90.63	86.96	87.35	.....	96.67	87.56	87.57	86.13	86.06
24	90.78	87.03	87.39	.....	95.31	87.57	87.59	86.13	86.07
27	90.79	87.06	87.49	.....	94.31	87.54	87.58	86.15	86.07
July 1	90.75	87.09	87.41	.....	93.79	87.56	87.57	86.13	86.04
5	90.55	87.14	87.38	.....	93.20	87.55	87.55	86.14	86.05
8	90.38	87.20	87.44	91.35	92.89	87.59	87.56	86.13	86.07
11	90.15	87.19	87.36	91.25	92.56	87.56	87.53	86.13	86.03
15	89.88	87.21	87.40	91.17	92.14	87.57	87.49	86.07	85.99
18	89.70	87.29	87.41	91.10	91.96	87.56	87.52	86.12	86.00
22	89.43	87.29	87.39	91.01	91.64	87.57	87.49	86.11	85.96
25	89.26	87.32	87.41	90.76	91.43	87.55	87.48	86.10	85.94
Aug. 7	88.57	87.44	87.37	90.81	90.58	87.55	87.43	86.01	85.80
30	87.59	87.48	87.46	90.58	89.44	87.51	87.25	86.06	85.71
Sept.28	86.82	87.47	87.53	90.53	88.68	87.57	87.27	86.05	85.66
Oct. 15	86.51	87.82	87.46	90.41	88.31	87.56	87.19	86.00	85.56
Dec. 7	86.49	87.99	87.59	90.50	87.92	87.58	87.12	85.95	85.70
1934									
Mar. 16	85.94	87.21	87.55	91.03	87.59	87.59	86.33	85.96	85.87
Apr. 23	87.02	87.10	87.53	91.48	87.86	87.59	87.23	85.98	86.02
May 19	89.68	87.17	87.48	91.26	87.54	87.63	87.16	86.00	86.07
June 22	89.42	87.40	87.51	90.88	87.32	87.66	87.24	86.02	85.98
Aug. 4	87.58	87.54	87.59	90.69	86.97	87.61	87.21	86.02	85.96
Sept.11	86.68	87.58	87.68	90.46	86.49	.....	87.20	86.03	85.60
Nov. 6	85.87	87.32	87.52	90.27	86.23	.....	87.08	85.94	85.63
Dec. 21	85.64	87.20	87.66	90.23	86.16	.....	87.10	85.95	85.61
1935									
Feb. 17	85.32	86.93	87.49	90.52	86.94	87.56	87.36	85.90	85.75
Mar. 18	85.24	86.95	87.58	90.57	86.81	87.64	87.40	86.03	85.87
May 12	85.85	86.75	87.42	90.66	86.81	87.50	87.27	85.97	85.85
23	86.15	86.77	87.45	90.69	86.36	87.53	87.26	86.03	85.93
June 14	89.06	86.32	87.40	90.61	86.46	87.52	87.21	85.98	85.84
July 30	87.95	87.08	87.41	90.24	86.04	87.43	87.11	86.03	85.62
Sept. 9	86.67	87.07	87.44	90.02	85.52	87.36	87.00	85.92	85.45
Oct. 27	85.92	86.96	87.47	89.92	85.24	87.34	87.02	85.90	85.42

Date	38	39	40	41	43	44	45	46	47
1928									
July 16	.....	.....	.....	.....	.....	.....	.....	.....	.....
18	.....	.....	.....	.....	.....	.....	.....	.....	.....
29	.....	.....	.....	.....	.....	.....	.....	.....	.....
Aug. 10	.....	.....	.....	.....	.....	.....	.....	.....	.....
17	86.96	86.80	87.92	.....	.....	.....	.....	.....	.....
25	86.92	86.63	87.63	.....	.....	.....	.....	.....	.....
Sept. 1	86.90	86.60	87.48	89.92	89.92	89.45	91.55	87.68	.....
Oct. 3	86.88	86.28	86.94	89.63	89.73	89.45	91.47	87.55	89.43
Nov. 2	86.84	86.14	86.90	89.42	89.55	89.46	91.45	87.39	88.77
23	86.84	86.05	86.94	89.33	89.49	89.47	91.42	87.33	88.51
Dec. 15	86.84	85.97	86.77	89.21	89.42	89.42	91.47	87.25	88.24

Water levels in Flathead Valley - Continued

Date	38	39	40	41	43	44	45	46	47
1929									
Jan. 17	86.86	85.90	86.74	89.12	89.32	89.44	91.48	87.27	87.89
Feb. 23	86.83	85.93	.....	88.98	89.00	89.39	91.48	87.14	87.25
Mar. 21	87.64	86.42	89.50	89.48	89.28	89.45	91.66	87.58	87.47
Apr. 14	87.35	87.07	88.90	90.09	89.63	89.65	91.70	87.69	87.74
28	87.37	87.04	88.67	89.96	89.70	89.68	91.74	87.74	87.68
May 22	87.40	86.85	.....	90.01	89.52	89.67	91.77	87.83	87.78
June 7	87.33	87.01	.....	89.79	89.73	89.64	91.78	87.89	88.93
July 1	86.82	86.80	88.18	89.47	89.67	89.62	91.71	87.72	89.87
19	86.67	86.37	87.11	89.24	89.53	89.53	91.65	87.46	89.66
Aug. 9	86.32	85.95	86.43	88.98	89.32	89.36	91.56	87.23	89.08
23	86.30	85.81	86.27	88.87	89.24	89.29	91.50	87.14	88.69
Oct. 3	86.30	85.54	85.92	88.61	89.08	89.26	91.36	86.99	87.68
19	86.28	85.44	85.86	88.55	89.03	89.22	91.37	86.91	87.32
Nov. 26	86.24	85.35	85.89	88.42	88.89	89.21	91.28	86.80	86.76
Dec. 9-11	86.37	85.38	85.77	88.34	88.88	89.20	91.29	86.76	86.41
1930									
Jan. 16-17	86.27	85.21	86.02	88.24	88.78	89.08	91.14	86.65	86.09
Apr. 7	86.69	85.87	86.37	88.70	88.88	89.42	.....	86.67	85.82
May 5	86.73	86.04	86.84	88.68	88.81	89.32	91.58	86.78	86.45
19-20	86.68	86.05	86.76	88.69	88.83	89.34	91.74	86.78	87.00
June 11	86.59	86.07	86.74	88.66	88.79	89.34	.....	86.87	87.78
July 23-24	86.07	85.71	85.87	88.35	88.67	89.13	91.56	86.63	88.04
Aug. 25	85.91	86.32	85.38	88.13	88.44	88.99	.....	86.54	87.35
Sept.21	85.93	85.18	85.22	88.09	88.44	88.94	91.34	86.51	86.82
Nov. 7	86.09	85.07	85.31	87.92	88.31	88.85	91.28	86.42	86.23
1931									
Jan. 26	86.12	85.11	85.46	87.81	88.17	88.84	91.26	86.38	85.91
Mar. 27	86.47	85.66	85.98	88.20	88.23	88.86	91.44	86.61	85.80
Apr. 21-22	86.52	85.50	86.03	88.15	88.21	88.95	91.50	86.58	85.84
May 17	86.57	85.62	85.95	88.12	88.23	88.94	91.48	86.63	86.19
30	86.50	85.62	85.82	88.02	88.25	88.92	91.50	86.56	86.69
June 10	86.29	85.58	85.60	87.92	88.22	88.79	91.42	86.48	87.14
July 13	86.24	85.29	85.19	87.67	88.17	88.68	91.30	86.32	87.54
Aug. 8	86.04	84.96	84.93	87.63	88.13	88.68	91.26	86.16	86.87
30	85.91	84.81	84.72	87.57	88.04	88.63	91.20	86.05	86.63
Oct. 19	85.91	84.46	84.54	87.42	89.67	88.56	90.91	85.92	85.46
Nov. 28	85.81	84.44	84.52	87.28	87.73	88.41	90.97	85.78	85.51
1932									
Jan. 26	86.12	85.11	85.46	87.81	88.17	88.84	91.26	86.38	85.91
Mar. 24-25	87.22	85.44	85.82	87.97	88.19	89.04	91.59	86.45	86.18
May 10	87.02	85.66	86.12	88.42	89.53	89.12	91.86	86.50	86.66
18	87.01	85.73	87.40	88.47	88.52	89.11	91.72	86.50	90.01
June 4	87.01	85.91	89.54	88.50	88.57	89.13	91.57	86.57	95.63
7	86.95	85.88	89.52	88.48	88.51	89.08	91.64	86.57	94.33
13	86.91	85.96	89.42	88.47	88.53	89.06	91.71	86.55	94.79
20	86.82	86.11	89.88	88.38	88.53	89.07	91.72	86.53	94.30
27	86.69	85.98	89.47	88.47	88.52	89.07	91.70	86.62	93.82
July 5	86.67	86.06	88.65	88.42	88.51	89.06	91.68	86.46	93.02
Aug. 10	86.22	85.33	86.29	88.08	88.29	88.70	91.45	86.13	90.14
Sept.16	86.25	85.10	85.83	87.94	88.16	88.69	91.35	86.05	88.79
Oct. 24	86.21	84.92	85.49	87.96	88.06	88.67	89.28	85.95	87.84
Dec. 29	86.21	84.76	85.60	87.71	87.98	88.63	89.17	85.91	87.23
1933									
Feb. 20	86.18	84.70	85.52	87.67	87.87	88.55	89.18	85.93	86.91
Mar. 22	86.65	85.48	86.44	87.81	88.05	88.69	89.49	86.31	86.90
Apr. 10	86.52	84.99	86.47	87.97	88.13	88.73	89.46	86.19	86.75
May 6	86.53	85.03	86.40	87.92	88.12	88.66	89.45	86.19	86.94
9	86.55	85.05	86.61	87.91	88.11	88.63	89.49	86.27	86.99
13	86.59	85.17	86.68	87.96	88.17	88.69	89.51	86.28	87.13
16	86.54	85.21	86.69	87.98	88.16	88.75	89.54	86.29	87.25
20	86.54	85.17	86.75	87.97	88.14	88.75	89.55	86.26	87.38
23	86.59	85.23	86.70	88.04	88.19	88.85	89.55	86.26	87.49
27	86.57	85.25	86.67	88.03	88.16	88.74	89.55	86.25	87.65
30	86.59	85.32	86.72	88.05	88.19	88.77	89.56	86.28	87.78
June 3	86.58	85.37	87.20	88.08	88.19	88.75	89.55	86.30	95.25
6	86.57	85.42	90.14	88.08	88.20	88.74	89.55	86.23	.....
11	86.52	85.43	92.65	88.05	88.17	88.72	89.55	86.25	.....
13	86.53	85.48	.....	88.06	88.18	88.72	89.54	86.26	.....
17	86.47	85.58	.....	.....	88.20	88.70	89.54	86.29	.....
20	86.41	85.61	.....	.....	88.17	88.71	89.53	86.34	.....
24	86.34	85.69	.....	94.47	88.21	88.71	89.51	86.53	.....
27	86.25	85.75	.....	93.54	88.22	88.68	89.49	86.62	98.12

Water levels in Flathead Valley - Continued

Date	38	39	40	41	43	44	45	46	47
1933									
July 1	86.31	85.83	.....	93.07	88.28	88.70	89.48	86.79	97.62
5	86.23	85.88	92.23	92.02	88.34	88.70	89.46	86.88	97.05
8	86.18	85.93	91.53	91.58	88.39	88.69	89.44	86.91	96.71
11	86.14	85.94	90.98	91.24	88.41	88.68	89.45	86.91	96.42
15	86.12	85.94	90.22	90.81	88.48	88.53	89.40	86.93	95.97
18	86.10	85.95	89.92	90.64	88.54	88.66	89.38	86.91	95.62
22	86.09	85.89	89.55	90.41	88.58	88.67	89.39	86.88	95.15
25	86.13	85.87	89.35	90.28	88.61	88.67	89.37	86.89	94.83
Aug. 7	86.01	85.63	88.71	89.71	88.67	88.63	.....	86.86	93.53
30	86.02	85.45	87.72	89.34	88.79	88.71	89.24	86.80	91.28
Sept.28	86.01	85.27	87.09	88.93	88.76	88.73	89.10	86.72	89.88
Oct. 15	85.97	85.11	86.92	88.75	88.70	88.74	89.10	86.63	89.36
Dec. 7	85.97	85.21	87.73	88.95	88.71	88.84	89.12	86.72	89.49
1934									
Mar. 16	86.43	85.65	88.38	88.65	88.95	89.02	89.42	87.14	89.12
Apr. 23	86.68	85.88	88.32	88.94	89.07	89.09	89.50	87.31	89.53
May 19	86.63	89.57	90.98	88.96	89.10	89.13	89.50	87.32	95.58
June 22	86.63	86.31	87.93	.....	89.11	89.07	89.45	87.14	93.29
Aug. 4	86.38	.....	86.47	88.58	88.89	88.93	89.99	86.74	90.92
Sept.11	86.28	.....	85.93	88.38	89.76	88.53	89.17	86.59	88.73
Nov. 6	86.15	.....	85.88	88.10	88.59	88.81	89.06	86.37	87.51
Dec. 21	86.08	.....	86.17	87.99	88.46	88.82	89.07	86.38	87.35
1935									
Feb. 17	.....	85.59	86.30	88.03	88.45	88.90	89.22	.....	.....
Mar. 18	86.79	85.49	86.42	88.13	88.44	88.94	89.30	86.48	87.01
May 12	86.63	86.46	86.56	88.19	88.45	88.79	89.33	86.51	87.31
23	86.55	85.59	88.50	88.20	88.46	88.88	89.39	86.53	87.61
June 14	86.26	85.82	89.45	88.11	88.46	88.74	89.29	86.42	92.87
July 30	85.94	85.67	86.50	87.91	88.41	88.65	89.15	86.14	90.74
Sept. 9	85.82	85.22	85.69	87.71	88.24	88.57	88.99	85.91	88.99
Oct. 27	85.78	84.95	85.14	87.62	88.12	88.46	.....	85.78	87.68

NEBRASKA

By Leland K. Wenzel

HISTORY AND DESCRIPTION OF PROGRAM OF WELL MEASUREMENTS

A cooperative investigation of the ground-water resources of Nebraska has been in progress since July 1, 1930, by the United States Geological Survey and the Conservation and Survey Division of the University of Nebraska, under the general supervision of O. E. Meinzer, of the Federal Survey, and G. E. Condra, State geologist. Attention was concentrated until 1934 on a study of the geology and ground-water resources of south-central Nebraska, including the part of the Platte River Valley between Chapman and Gothenburg.[1] As a part of the investigation in the Platte Valley single measurements of the depths to the water level were made in about 1,000 wells and periodic measurements were made on about 100 wells. In addition, several thousand water-level measurements in wells were made in connection with pumping tests to determine the permeability and specific yield of the water-bearing materials.[2]

As a result of increased interest in ground-water levels caused by deficient precipitation and other factors, a State-wide program of water-level measurements in wells was begun in 1934.[3] Included in this program were about 60 of the wells on which periodic measurements were begun in 1930. In 1935 the water-level program was continued and an investigation was made of the ground-water resources of Keith County, as a part of which measurements were made of the depths to water level in about 350 wells.

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1 Lugn, A. L., and Wenzel, L. K., Geology and ground-water resources of south-central Nebraska, with special reference to the part of the Platte River Valley between Chapman and Gothenburg: U. S. Geol. Survey Water-Supply Paper (in preparation).

2 Wenzel, L. K., Recent investigations of Thiem's method for determining permeability of water-bearing materials: Am. Geophys. Union, Trans. 13th Ann. Meeting, pp. 313-317, 1932; Specific yield determined from a Thiem's pumping test: Am. Geophys. Union, Trans. 14th Ann. Meeting, pp. 475-477, 1933; The Thiem method of determining permeability of water-bearing materials and its application to the determination of specific yield: U. S. Geol. Water-Supply Paper 679-A, 1936.

3 Waite, H. A., Ground-water level survey in Nebraska: Nebraska Geol. Survey Paper 7, 14 pp., 1935. Wenzel, L. K., A State-wide program of periodic measurements of ground-water level in Nebraska: Am. Geophys. Union Trans. 16th Ann. Meeting, vol. 2, pp. 495-498, 1935.

In addition to the cooperative State-wide water-level program that is being carried on there are in selected areas wells that are being measured periodically by other agencies under the general supervision of the United States Geological Survey and the Conservation and Survey Division of the University of Nebraska. These programs include about 55 wells in the vicinity of Grand Island that are measured by the city of Grand Island, about 175 wells in the vicinity of Columbus and Genoa that are measured by the Loup River Public Power District, and about 33 wells in Garden County that are measured by the United States Geological Survey. The Grand Island and the Columbus and Genoa programs were not begun until the fall of 1935, but the program in Garden County was begun in 1933, and the records are already of sufficient length to provide considerable information on ground-water level fluctuations in that area.

The State-wide water-level program includes about 350 wells on which measurements are made about once a month. In 1935 about 3,500 individual measurements were made in connection with this project. About 500 measurements of depth to water level in wells were made during the Keith County investigation in 1935, about 1,600 measurements were made by the United States Biological Survey in Garden County, and a total of about 600 measurements were made on the Grand Island and Columbus and Genoa projects. In all, about 6,200 individual measurements of depth to water level were made on these projects in 1935.

The observation wells are measured by technically trained men who are assigned to cover periodically wells on selected routes. The wells of the State group are measured about monthly, and those in Garden County, near Grand Island, and near Columbus and Genoa are measured weekly. The measurements in connection with the State-wide program were made in 1935 by H. A. Waite, O. J. Scherer, and Howard Haworth, all of the Conservation and Survey Division of the University of Nebraska, and the measurements on the other projects were made by the personnel of the other several agencies.

The observation wells in Nebraska are distributed somewhat uniformly throughout the State, in the Dakota Drift - Cretaceous, North-Central Drift - Paleozoic, Great Plains Pliocene - Cretaceous, and Black Hills Cretaceous ground-water provinces.[4] The wells in the eastern part of Nebraska end in glacial drift, alluvium in the stream valleys, or underlying Cretaceous or older hard-rock formations. In the central part of the State most of

4 Meinzer, O. E., The occurrence of ground water in the United States with a discussion of principles: U. S. Geol. Survey Water-Supply Paper 489, p. 311, 1923.

the wells end in Pleistocene or Tertiary sand and gravel formations, except in the extreme south, where these materials are absent and the wells penetrate older formations. The wells of western Nebraska mostly end in Tertiary formations except in the stream valleys, where more recent sediments have been deposited, and in the northwestern part of the State, where wells penetrate rather meagerly productive Cretaceous formations.

The observation wells vary greatly in depth, type, diameter, and depth to water level. In general, the deepest wells are in the western part of the State and the shallowest wells in the eastern part However, this is true only on the uplands, because the wells in the valleys of the principal streams are mostly shallow. The deepest observation well, in Lincoln County, southwestern Nebraska, extends about 285 feet below the land surface, and the water level in it stands about 273 feet below the surface. On the other hand, many observation wells throughout the State are less than 10 feet deep. The water level in many of these shallow wells stands within 3 or 4 feet of the land surface. The diameters of the observation wells range from 1 inch (shallow driven wells sunk exclusively for observation) to 8 feet (the size of an irrigation well in the Platte Valley on which periodic measurements are being made). Most of the observation wells, however, are between 3 and 24 inches in diameter. Many types of wells are included in the program. In the glacial-drift area the wells are mostly dug or bored, and in the central and western part of the State, where the water-bearing materials are generally more productive, the wells are chiefly drilled or driven. The dug wells are usually cased with brick, stone, wood, or concrete, the bored wells with tile or galvanized-iron casing or iron pipe, and the driven wells with iron pipe.

Most of the observation wells are not in use, but a few are used for domestic purposes or irrigation. Irrigation wells in Nebraska are usually satisfactory for observation wells, because they are generally used only a few weeks in the summer and are idle for the remainder of the time. Records are being collected on a few domestic wells, in order that a comparison may be had between the fluctuations of water level in used and unused wells. Most of the wells are in areas unaffected by heavy withdrawals, and the water levels in them essentially reflect water-table conditions -- that is, the ground water is not confined under pressure.

Definite and permanent measuring points, many of them the tops of the well casings, have been established at all the wells, and these points have been referred by instrumental leveling to nearby bench marks set in permanent objects.

The records of water-level measurements in Nebraska from 1930 to 1935 have not been published. However, a report is now in preparation that will include the measurements and the location of the wells.[5] A brief statement of the decline of the water level in the Platte Valley from 1930 to 1934 was released as a mimeographed memorandum in 1935.[6] A summary of this memorandum was later reprinted.[7] The well measurements are filed and may be consulted at the office of the United States Geological Survey in Washington, D. C., and at the office of the Conservation and Survey Division of the University of Nebraska in Lincoln, Nebr.

WATER-LEVEL FLUCTUATIONS

The water-level measurements have been made in the Platte Valley periodically since the fall of 1930, and hence these records provide more information than the records of water levels that have been begun more recently. During the period of measurement the precipitation in the valley has been considerably below normal, and the water table has declined. The accumulative departure from normal precipitation at stations of the United States Weather Bureau at Grand Island and Kearney amounted to about 25 inches in the period from January 1, 1931, to January 1, 1936. This is equivalent to the normal precipitation of about 1 year. At Lexington the precipitation in this period has been about 11 inches below normal.

The average water levels for 3-month intervals from January 1, 1930, to January 1, 1936, in four groups of wells in the Platte Valley, segregated according to location and different depths to water, are given in the following table. The water levels are expressed in feet above an arbitrary datum, the datum assumed for each well being 100 feet below the water level in that well on January 1, 1935. The water level in each State observation well is also referred to such an arbitrary datum, and hence the water-level fluctuations in any well or group of wells can readily be compared. The water levels on selected dates are determined by interpolation.

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5 Wenzel, L. K., and Waite, H. A., Fluctuations of ground-water level in Nebraska, 1930-35 (to be published by Nebraska Geol. Survey).

6 Wenzel, L. K., Four-year decline of the ground-water level in the Platte River Valley, Nebraska: U. S. Dept. Interior Press, Mem. 98079, 2 pp., 2 ills., April 1, 1935.

7 Hoyt, W. G., and others, Rainfall and run-off in the United States: U. S. Geol. Survey Water-Supply Paper 772, pp. 269-273, 1936.

A considerable quantity of ground water is withdrawn from wells for irrigation in the part of the Platte Valley between Grand Island and Kearney. On the other hand, there is considerable irrigation with water diverted from the Platte River in the part of the valley between Kearney and Gothenburg. The wells in these two parts of the valley have therefore been segregated. The wells in each part of the valley have been further segregated into groups according to whether the water level stands more or less than 10 feet below the land surface, in order to separate the different types of fluctuations that occur in wells with different depths to water level.

An inspection of the table shows there has been an average net decline in water level from January 1, 1931, to January 1, 1936, in all groups of wells, but that the decline ranges only from 0.81 foot to 1.63 feet. This decline has probably been caused by the deficiency in precipitation in this period. In only two years, 1932 and 1935, was there an average net rise of the water levels, and in these years the precipitation was about normal. In 1935 the average rise of the water levels in the different groups of wells ranged from 0.72 foot to 1.30 feet.

Average of water levels in wells expressed as heights above the arbitrary datum, in the Platte River Valley, Nebraska.

Date	Wells between Grand Island and Kearney		Wells between Kearney and Gothenburg	
	15 wells in which the water level stands from 10 to 30 feet below the land surface. (feet)	6 wells in which the water level stands from 1 to 10 feet below the land surface. (feet)	10 wells in which the water level stands from 10 to 30 feet below the land surface. (feet)	10 wells in which the water level stands from 1 to 10 feet below the land surface. (feet)
Jan. 1, 1931	102.23	102.11	102.58	102.20
Apr. 1	102.21	102.73	102.50	102.50
July 1	102.27	101.77	102.31	101.77
Oct. 1	101.23	100.55	100.58	100.21
Jan. 1, 1932	101.39	101.01	101.05	101.05
Apr. 1	101.82	102.69	101.33	101.48
July 1	102.56	102.92	101.55	101.70
Oct. 1	101.76	101.04	100.83	100.69
Jan. 1, 1933	101.77	101.68	100.96	101.06
Apr. 1	101.75	102.01	101.03	101.19
July 1	101.54	101.32	101.14	101.00
Oct. 1	101.05	100.80	100.83	100.74
Jan. 1, 1934	101.07	101.42	100.97	101.16
Apr. 1	101.14	101.74	100.92	101.19
July 1	100.36	100.51	99.83	99.59
Oct. 1	99.74	99.53	99.84	98.78
Jan. 1, 1935	100.00	100.00	100.00	100.00
Apr. 1	100.13	100.73	100.40	100.81
July 1	100.99	102.09	101.73	101.85
Oct. 1	100.64	100.74	100.82	100.81
Jan. 1, 1936	100.72	101.30	100.95	101.01
Net 5-year change	-1.51	-.81	-1.63	-1.19
Net change in 1935	+ .72	+1.30	+ .95	+1.01

The average monthly water levels in 252 wells distributed throughout Nebraska are given in the following table. This table indicates that there has been an appreciable recovery of the water levels in Nebraska in 1935 from the low drought levels in 1934. The average net rise in 1935 in the 252 wells amounts to 0.36 foot. The precipitation in Nebraska for the year, as computed by the United States Weather Bureau, averaged 97 percent of normal.

Average of water levels in 252 wells scattered throughout Nebraska, expressed in feet above the arbitrary datum in each well.

Date	Water level	Date	Water level
Oct. 1, 1934	99.54	June 1, 1935	100.90
Nov. 1	99.73	July 1	101.04
Dec. 1	99.90	Aug. 1	100.46
Jan. 1, 1935	100.00	Sept.1	100.21
Feb. 1	100.08	Oct. 1	100.17
Mar. 1	100.16	Nov. 1	100.23
Apr. 1	100.26	Dec. 1	100.30
May 1	100.47	Jan. 1, 1936	100.36

The net change in water level in different parts of Nebraska varied considerably in 1935. The water levels in many of the observation wells in the northeastern part of the State suffered net declines, whereas those in most of the wells in the southeastern part of the State rose appreciably. The precipitation in southeastern Nebraska in 1935 was about normal or above normal at most of the stations of the United States Weather Bureau, but the precipitation in northeastern Nebraska averaged only 81 percent of normal. Ground-water storage in southeastern Nebraska was severely depleted by the drought in 1934, and hence the recovery of water levels in that area in 1935 is especially significant.

In the following tables are given descriptions of several observation wells in different parts of Nebraska and records of water levels for 1935. Pawnee County well 1 is in the valley of a tributary to the Nemaha River, in southeastern Nebraska, and ends in alluvium. Dakota County well 1 is on a hillside in northeastern Nebraska and taps water in the glacial drift. Gosper County well 1, in south-central Nebraska, penetrates the permeable Pleistocene sand and gravel that occur below the deposit of loess that underlies the plains south of the Platte Valley. Cheyenne County well 2 ends in the more or less consolidated Tertiary deposits that occur under the high plain between Lodgepole Creek and the North Platte River.

Lincoln County well 7 is in the valley of the Platte River in central Nebraska, near the town of Brady, and taps the water in the permeable Pleistocene sand and gravel deposits that occur beneath the surface of the valley.

Records of observation wells in Nebraska

	Pawnee County well 1	Dakota County well 1	Gosper County well 1	Cheyenne County well 2	Lincoln County well 7
Location	NE¼ sec. 8, T. 2 N., R. 11 E.	SE¼ sec.28, T.27 N., R. 8 E.	NW¼ sec. 6, T.7 N., R. 21 W.	NW¼ sec.2, T.15 N., R.49 W.	NE¼ sec.14, T. 12 N., R. 27 W.
Owner or name	E. Hunzeker	R. Nelson	Larson Estate	A. Linn	Univ. of Nebr.
Type	Dug	Bored	Drilled	Drilled	Driven
Depth (feet)	31.6	36.6	132.3	218.3	18.3
Diameter (inches)	42	8	3	6	1
Type of casing	Brick	Tile	Iron	Galvanized iron	Iron
Type of pump	Force	Force	None	None	None
Kind of power	Electric	Hand	....	....	....
Use	Stock	None	None	None	None
Measuring point	Top of casing	Top of wooden platform	Top of pipe	Top of casing	Top of pipe
Distance of measuring point above land surface (feet)	1.0	0.6	0.4	0.5	1.7
Depth to water level below measuring point on Jan. 1,1935 (feet)	21.36	20.03	117.85	194.46	6.91
Height of measuring point above the arbitrary datum [1] (feet)	121.36	120.03	217.85	294.46	106.91
Water-bearing formation	Alluvium	Glacial drift	Pleistocene sand and gravel	Tertiary sand and gravel	Pleistocene sand and gravel

1 The arbitrary datum adopted for each well is 100 feet below the water level in that well on January 1, 1935.

Water levels, expressed in feet above the arbitrary datum, in several selected observation wells in Nebraska.

Date	Pawnee County 1	Dakota County 1	Gosper County 1	Cheyenne County 2	Lincoln County 7
Oct. 1, 1934	98.65	97.20	99.86	100.12	.....
Nov. 1	99.08	98.21	99.88	100.12	.....
Dec. 1	99.90	99.14	99.93	100.08	.....
Jan. 1, 1935	100.00	100.00	100.00	100.00	100.00
Feb. 1	99.76	100.73	100.00	100.02	100.12
Mar. 1	99.76	101.36	100.00	100.08	100.22
Apr. 1	99.79	102.01	100.02	99.96	100.21
May 1	100.42	102.42	100.03	99.81	100.47
June 1	102.26	102.41	100.00	100.12	101.65
July 1	106.71	100.01	99.94	100.07	101.39
Aug. 1	103.59	97.49	99.87	99.84	99.72
Sept.1	101.71	96.74	99.78	99.79	98.83
Oct. 1	102.88	96.46	99.66	99.91	99.19
Nov. 1	104.73	97.43	99.89	99.88	99.66
Dec. 1	105.07	98.55	99.79	99.67	99.96
Jan. 1, 1936	104.65	99.22	99.68	100.02	99.88

In the observation wells of the United States Biological Survey in Garden County there was not much average net change in water level from January 1, 1935, to January 1, 1936. In the preceding year, however, there were net declines of 1 foot or more in many of the wells, and hence the water levels in that area are still considerably below the levels at the beginning of 1934. The wells in Garden County are in the sand-hill area of Nebraska, where the water table is generally near the surface and where there are many lakes, whose levels usually denote the level of the water table. The sand and gravel formations of the sand-hill area contain large quantities of ground water. In this area the drainage is undeveloped, and the opportunity for seepage of the precipitation to the zone of saturation is great. Records of water level in a typical observation well (No. 3) in Garden County appear in the following table. Well 3 is on the north side of Crescent Lake, in Garden County, and is owned by the United States Biological Survey. It is cased with an iron pipe 1½ inches in diameter, equipped with a metal screen and drive point that extends about 6.5 feet below the land surface. Measurements of depth to water level are made from the top of the pipe, which is 1.2 feet above the land surface. On January 4, 1935, the depth to the water level below the measuring point was 5.80 feet, and the water stood 3,787.19 feet above mean sea level. The well ends in fine sand.

Water levels in observation well 3, on the Crescent Lake Bird Refuge, Garden County, Nebr.

(Measurements made by W. T. Krummes and E. W. Ladd, of the United States Biological Survey. The water level is expressed in feet above sea level minus 3,700.)

Date	Water level (feet)	Date	Water level (feet)
Nov. 12, 1933	88.35	June 11, 1934	87.72
Nov. 19	88.35	June 16	88.09
Dec. 3	88.50	June 23	87.89
Dec. 9	88.46	July 1	87.77
Dec. 17	88.38	July 8	87.51
Jan. 17, 1934	88.38	July 14	87.51
Jan. 28	88.32	July 21	87.34
Feb. 12	88.38	July 29	87.39
Mar. 1	88.37	Aug. 5	87.27
Mar. 12	88.36	Aug. 12	87.25
Mar. 25	88.36	Aug. 26	87.40
Apr. 8	88.38	Sept. 2	87.60
Apr. 19	88.26	Sept. 8	87.44
May 4	88.64	Sept.23	87.46
May 13	88.39	Sept.30	87.41
May 19	88.22	Oct. 7	87.46
May 27	88.02	Oct. 14	87.32
June 2	88.09	Oct. 21	87.54

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Water levels in observation well 3--Continued

Date	Water level (feet)	Date	Water level (feet)
Oct. 27, 1934	87.36	July 3, 1935	87.73
Nov. 11	87.31	July 16	87.56
Nov. 18	87.34	July 24	87.34
Nov. 26	87.32	Aug. 2	87.01
Dec. 17	87.23	Aug. 9	87.00
Dec. 28	87.21	Aug. 19	86.85
Jan. 4, 1935	87.19	Aug. 26	86.69
Jan. 11	87.17	Sept. 4	86.91
Jan. 21	87.14	Sept.11	86.92
Jan. 30	87.09	Sept.18	86.84
Feb. 6	87.10	Sept.25	86.83
Feb. 21	87.05	Oct. 4	86.83
Mar. 5	87.02	Oct. 16	86.81
Mar. 16	86.98	Oct. 24	86.79
Mar. 28	86.94	Nov. 1	86.79
Apr. 17	86.92	Nov. 19	86.75
May 2	87.16	Dec. 3	86.72
May 23	87.57	Dec. 18	86.70
June 6	87.68	Jan. 2, 1936	86.68
June 20	88.12		

NEW JERSEY

By Henry C. Barksdale

HISTORICAL REVIEW

Probably the earliest records of water levels in wells in New Jersey are those of the static water level in three wells published by the New Jersey State Geological Survey in 1868.[1] The State Survey has been in existence since 1864, and investigation of the water-supply problems in the State was naturally made a part of its work soon after its establishment. The continuity of its work is emphasized by the fact that during that period of 72 years there have been only three State geologists -- Dr. G. H. Cook, who served from 1864 to 1889; Dr. John C. Smock, from 1890 to 1901; and Dr. Henry B. Kummel, since 1901. The State Geological Survey has obtained numerous records of water levels in wells throughout New Jersey, and many of them have been published in its annual and special reports.

With the increased development of ground-water supplies, the need for more intensive studies to determine the safe yield of some of the water-bearing formations became apparent. In 1923 the State Department of Conservation and Development entered into a cooperative agreement with the United States Geological Survey for the purpose of making quantitative studies of the ground-water resources of the State. This cooperative arrangement was continued until 1927. From 1927 to 1931 the work was carried on independently by the State Department of Conservation and Development and its successor in water-supply matters--the State Water Policy Commission. Formal cooperation with the United States Geological Survey was resumed by the State Water Policy Commission July 1, 1931, and has been continued since that time.

O. E. Meinzer, geologist in charge of the division of ground water of the United States Geological Survey, and H. T. Critchlow, division engineer of the New Jersey Water Policy Commission, have exercised general supervision over the work since its beginning. David G. Thompson, of the Federal Survey, was in charge of the work from 1923 through June 1927. Mr. Thompson was assisted at different times by E. W. Downs

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1 Cook, G. H., Geology of New Jersey, pp. 701-708, 1868.

and H. C. Barksdale. From July 1927 to date Mr. Barksdale has been in charge of the work. In July 1931, when cooperation with the United States Geological Survey was resumed, Mr. Thompson renewed his connection with the work in an advisory capacity, and Raymond W. Sundstrom was assigned by the United States Geological Survey to assist in the work.

Most of the old records of water level obtained by the State Geological Survey are records of original static or pumping water levels in wells. Usually no subsequent records of water level in the same well have been obtained. The water levels in a well at the Netherwood station of the Plainfield Union Water Co. have been measured periodically by the company's engineers since 1891. This is probably the longest series of measurements of the water level in a single well or well field in the State. When the quantitative investigations were started, in 1923, regular observations of water level were begun on many wells in the State. The records of water level in 44 wells that are now being measured are at least 10 years long. On 8 of these wells water-stage recorders have been maintained for this length of time. The remaining 36 have been measured at more or less regular intervals. With the progress of the investigation, the number of wells being measured has gradually increased, so that there are a good many other wells in which water levels have been measured for several years, but not yet as long as 10 years.

AVAILABILITY OF RECORDS OF WATER LEVELS

Reference has already been made to the publications of the State Geological Survey and the annual reports of the State Geologist in which records of water levels have been published. In recent years the publications of the State Department of Conservation and Development, of which the State Geologist is now the director, have contained records of water levels. This is particularly true of Bulletins 30, 35, 38, and 39 of this department, which are reports by Mr. Thompson on the progress of the quantitative investigations being made in the Atlantic City, Asbury Park, Canoe Brook, and Camden regions respectively. Records of the fluctuations of the water levels in the Morrell well and in some of the other shallow wells nearby were published in the Transactions of the American Geophysical Union for 1933.[2] A second report on the Atlantic City region is soon to be published by the State Water Policy Commission. The unpublished water-level records obtained during the

2 Barksdale, H. C., A 10-year record of water-table fluctuations near Runyon, N. J.: Am. Geophys. Union Trans. 14th Ann. Meeting, pp. 466-471, 1933.

New Jersey quantitative ground-water investigations are filed at the office of the State Water Policy Commission in Trenton. Practically all of them are available for inspection by anyone interested. Some of the more significant records from each of the regions under study have been summarized on hydrographs, which can be blueprinted for distribution.

WATER-LEVEL WORK IN 1935

The water-level work in New Jersey for the calendar year 1935 was carried on under a cooperative agreement between the United States Geological Survey and the State Water Policy Commission. Voluntary cooperation was also given by numerous waterworks officials and owners or operators of private wells. During the year a total of 173 wells were measured at least once. Of this number 143 were measured more than once. The total number of individual measurements of water level made during the year was 5,069.

The program of water-level measurements in 1935 included daily measurements by local observers of the water level in 5 wells. Measurements were made approximately once a month in 137 wells, partly by the regular staff and partly by an observer employed to make regular rounds of measurements in about 75 wells in the vicinity of the Perth Amboy Water Works. The water level in 31 wells was measured occasionally by members of the regular staff.

During the year 29 water-stage recorders were maintained on wells in the State. Of these 3 were owned by water companies or industries and 26 by the United States Geological Survey or the State Water Policy Commission. In all respects the most satisfactory records of water levels obtained in New Jersey during 1935 were those from these water-stage recorders. As the records are continuous, many fluctuations of water level which might otherwise never be suspected are made available for study. The additional expense of such records is usually more than justified by the more valuable results obtained. Undoubtedly many wells now being measured periodically could be advantageously equipped with automatic recorders.

Three broad ground-water provinces are covered by the ground-water level work in New Jersey -- the Coastal Plain, in the southeastern part of the State; the area of Triassic sandstones and shales, in the central part; and the area of glacial sand and gravel, in the northern part. Most of the work has been done on wells in the Coastal Plain province, because large ground-water supplies are more numerous there than in other parts of the State. No work has been done in the crystalline rocks of

the northwestern part of the State, because water supplies in them are irregular and uncertain,both in occurrence and in yield.

The wells measured range in depth from a few feet to more than 1,000 feet and in diameter from 1¼ inches to 3 or 4 feet. The deeper wells are, without exception, drilled or bored wells with heavy casings. Most of them are wells that were formerly used as sources of water supply and have since been abandoned. A few are still being pumped. Many of the shallower observation wells, ranging from a few feet to about 100 feet in depth, were constructed during the course of the investigation in order to observe the water levels in them. Most of them are either 8-inch auger holes cased with light sheet-metal pipe or 1¼-inch driven-point wells. About 30 dug wells, most of which are still in use for rural domestic water supplies, are included in the wells measured monthly. Measurements were made of the water levels in 87 wells that extend only to the water table and in 86 wells that extend to beds in which the water is under artesian pressure. Only about 35 wells were measured in areas not affected by heavy artificial withdrawals of water. A definite and permanent reference point has been established at each observation well in the State. The altitudes of the measuring points have been determined by instrumental leveling at 107 of the 173 wells measured in 1935.

FLUCTUATION IN 1935 OF WATER LEVELS IN ARTESIAN WELLS AFFECTED BY PUMPING

Most of the wells being measured in New Jersey are in areas affected by heavy pumping. In such areas the water level frequently depends more upon the rate of pumping than upon natural factors. The Longport well, which penetrates the 800-foot sand in the Atlantic City region, is an excellent example of an observation well in which the major fluctuations of water level depend primarily upon changes in the rate of pumping from the sand. It is more than a mile from the nearest pumping well, but the major fluctuations in it are unquestionably a direct result of the fluctuations in pumpage from the 800-foot sand in the region. In this well, which is on a narrow strip of land between the ocean and a tidal bay, there is a daily fluctuation of 2 or 3 feet in the water level, corresponding to the fluctuations of the tide and caused by the tidal loading and unloading of the bottoms of the ocean and bay. When this tidal fluctuation is masked by averaging the high and low levels for each day, a broad seasonal and long-term fluctuation becomes apparent. A study of this long-term fluctuation in conjunction

with records of pumpage from the sand indicates that it is due primarily to changes in the rate of pumping. The Atlantic City region is primarily a summer resort, and the pumpage is therefore much higher in summer than in winter. Each year the lowest water level in the Longport well occurs early in September and the highest water level occurs during the winter, usually in February or March. Changes in the distribution of pumping in the region, tidal extremes, and probably barometric fluctuations affect the water level in the Longport well somewhat, but fluctuations of regional pumpage from the sand are the primary cause of the major movements of the water level in it. The general relation between the pumpage in the region and the water level in the Longport well is apparent from the following table.

Highest and lowest mean water levels in 14th avenue well at Longport, N. J., and rate of pumpage from Atlantic City 800-foot sand in February and August each year, 1925-35

Year	Water levels				Pumpage (million gallons a day)	
	Highest		Lowest			
	Depth to water (feet)	Date	Depth to water (feet)	Date	February	August
1925	22.7	Jan. 28	41.7	Sept. 12	5.207	11.237
1926	30.2	Feb. 10	45.8	Sept. 1	6.627	11.750
1927	36.0	Feb. 19	56.2	Sept. 7	7.909	12.410
1928	40.1	Mar. 18	57.0	Sept. 1	8.276	13.679
1929	43.6	Mar. 15	62.1	Sept. 3	7.967	14.380
1930	42.5	Mar. 8	58.4	Sept. 1	7.292	12.882
1931	39.8	Mar. 4	58.1	Sept. 14	6.741	12.334
1932	40.0	Mar. 6	57.4	Sept. 5	6.019	11.952
1933	40.2	Apr. 1	56.4	Sept. 4	5.346	11.576
1934	41.0	Jan. 28	56.3	Sept. 3	6.387	11.724
1935	37.6	Apr. 9	55.6	Sept. 2	.....	.....

FLUCTUATIONS IN 1935 IN WATER-TABLE WELLS NOT AFFECTED BY PUMPING

The best record in the State of the behavior of the water table, where it is not affected by pumping, is that of the fluctuations of water level in a dug well on the property of Joseph Morrell, near Old Bridge. A water-stage recorder has been maintained on this well since August 1923. The well is on low, flat, wooded ground entirely outside any recognized cone of depression. It was dug especially for observations of water level and passed through fine clayey sand through its entire depth. The proportion of clay decreased toward the bottom, which is about 8 feet below the surface. The fluctuations of water level in this well are probably typical of the behavior of the water table in similar areas throughout the State, where the water table ranges from less than 1 foot to about 7 feet below the surface. Where

the water table is deeper its seasonal fluctuations are somewhat different. The water levels in this well are recorded with reference to an assumed datum, which is about 6.5 feet below the land surface and 70.12 feet above mean sea level.

The height of the water level in this well above the assumed datum on the first day of each month from January 1935 to January 1936 and the average water level in the well on the same dates for the preceding years of record are given in the following table. The average water levels from January 1 to August 1 are based on 11 years of record; those from September 1 to December 1 on 12 years of record. An examination of the table indicates that the water level in this well in 1935 was fairly close to the average throughout the year. It was above the average on January 1, 1935, but this was partly due to rainfall during the preceding 24 hours, as the water level on December 31, 1934 was 5.84 feet, or exactly the average for January 1. In July and August it dropped somewhat below the average, and in November it was somewhat above the average. On January 1, 1936, the water level was about half a foot below the average.

Water levels in Joseph Morrell well on the first of each month, January 1935 to January 1936, and the average water levels on the same dates for the preceding years of record.
(All water levels are expressed in feet above the arbitrary datum.)

Date	Water level	Average water level in preceding years of record	Date	Water level	Average water level in preceding years of record
Jan. 1, 1935	6.21	5.84	Aug. 1,1935	3.54	3.82
Feb. 1	5.63	5.68	Sept.1	s 2.40	3.92
Mar. 1	5.84	5.81	Oct. 1	3.90	3.89
Apr. 1	a 5.90	5.88	Nov. 1	6.06	4.84
May 1	5.59	5.66	Dec. 1	5.94	5.45
June 1	5.55	5.40	Jan. 1,1936	5.34	.....
July 1	4.22	4.53			

a Estimated from preceding and subsequent records, the recorder being temporarily out of order.

The Morrell well is surrounded by a dense growth of deciduous bushes. During the growing season, when the water table is falling and is between 1 foot and 3 feet below the land surface, there is a marked diurnal fluctuation of the water level in this well. The water level falls much more rapidly during the day than during the night and occasionally it falls only during the day. It is believed that this fluctuation is caused by the varying demands for water of the plants surrounding the well at different hours of the day. At night the plants discharge comparatively little water by transpiration, but in the day time there is

pronounced vegetal discharge. Direct evaporation from the soil may also be a partial cause of the fluctuations, but the ground is covered with forest litter, which tends to reduce direct evaporation; furthermore the fluctuation has been observed only during the growing season. The fluctuations usually appear only on falling stages, as the rising stages in this well always occur during or soon after precipitation, when the plants do not need to draw upon the water table for moisture. When the water table falls more than 3 feet below the surface the fluctuations fade out, probably because most of the plant roots do not extend deep enough to draw water freely from greater depths.

The average fluctuation of water level in about 30 observation wells in the vicinity of Old Bridge has been computed for a series of measurements which began in 1923.[3] These wells are outside any recognized cone of depression. They have been separated into two groups on a basis of depth -- 24 of them less than 25 feet deep and 6 from 25 to 48 feet deep. This division is somewhat arbitrary but serves to illustrate the fact that the deeper wells do not respond as quickly to precipitation as the shallow wells and that the seasonal fluctuations of the water level in them is therefore different.

Neither the average depth to water nor the average altitude of the water levels in these wells was considered particularly significant, because they vary considerably in depth and altitude. The average fluctuation of the water levels in them is believed to be a much more satisfactory composite figure. On a day when all the wells were measured the water level in each of them was arbitrarily assumed to be 10 feet above an arbitrary datum for that well. The water levels on other days were averaged after being converted into altitudes referred to these assumed datum planes. When enough wells are included in the average this method permits the continuation of the average in spite of the necessity of discontinuing measurements in some of the wells that were originally included and the addition of other wells. If the averaged water level on a given day is 11 feet, the water table is 1 foot higher on an average than it was on the base date. Similarly when the average is below 10 feet, the water table is lower on an average than it was on the base date. The level of 10 feet in any well must not be considered a normal or average water level in that well, for it is merely the assumed water level in the well on an arbitrary date. The record is not long enough to justify the computation of a

3 Barksdale, H. C., op. cit.

normal water level, but the average of the altitudes above the assumed datum planes seems to be about 11 feet for the shallow wells and about 8 feet for the deep wells. It will be noted in the following table that the average water level in the shallow wells was somewhat higher in January 1936 than in January 1935, but the average in the deep wells was about 1⅛ feet lower. As suggested above, there is a considerable lag in the response of the deeper wells to wet and dry seasons. In January 1936 they were probably reflecting the dry weather in the summer of 1935. Since the beginning of the series of measurements, in October 1923, the highest average water level observed in the shallow wells was 13.72 feet on May 10, 1933, and the lowest was 6.72 feet on September 24, 1932; whereas in the deep wells the highest average water level was 11.85 feet on August 7, 1928, and the lowest 5.06 feet on October 20, 1932.

Average water levels in water-table wells near Old Bridge, January 1935 to January 1936, in feet above the arbitrary datum for each well.

Date	Shallow wells	Deep wells	Date	Shallow wells	Deep wells
Jan. 8, 1935	12.24	9.06	July 19, 1935	10.07	8.80
Feb. 6	11.89	8.98	Aug. 5	9.83	8.74
Mar.16	13.38	8.87	Sept. 9	10.86	6.47
Apr.16	13.18	9.37	Oct. 9	9.65	5.99
May 13	11.99	9.78	Nov. 19	12.44	5.84
June 6	10.87	9.49	Dec. 12	12.28	5.62
July 5	10.54	9.68	Jan. 14, 1936	12.91	7.46
July 13	10.54	9.31			

Descriptions of five typical wells in which water-level observations have been made periodically are given below, together with records of the measurements made in them during 1935.

Runyon old deep well

Field No.: OD-10.

Owner: Perth Amboy Water Department, Perth Amboy.

Location: Near pumping station, Runyon.

Description: 8-inch well, 440 feet deep (last 33 feet in rock), screen set in No. 1 sand above rock.

Measuring point: Top of casing, 6.63 feet above mean sea level.

Water-level measurements: First measured, September 10, 1929. Highest observed water level, 1.11 feet below measuring point, on May 10, 1933. (Flowed in 1914 when drilled and at intervals until 1930). Lowest observed water level, 42.03 feet below measuring point on October 8, 1935.

Runyon old deep well--Continued

Date	Depth to water (feet)	Water level (feet below sea level)	Date	Depth to water (feet)	Water level (feet below sea level)
Jan. 9,1935	11.12	4.49	July 5,1935	15.70	9.07
Feb. 8	14.65	8.02	Aug. 8	35.58	28.95
Mar. 14	13.75	7.12	Oct. 8	42.03	35.40
Apr. 15	17.24	10.61	Nov. 19	29.12	22.49
May 14	16.44	9.81	Dec. 14	24.22	17.59
June 7	16.30	9.67			

Runyon test well

Field No.: Runyon S-1

Owner: Perth Amboy Water Department, Perth Amboy.

Location: About 50 feet south of well 50 at Perth Amboy Water Works, Runyon.

Description: Auger hole cased with light sheet-metal pipe. Bored especially for water-level observations. Depth 12.5 feet, diameter 8 inches.

Measuring point: Top of casing at seam, 16.49 feet above mean sea level.

Bench mark: Copper nail and washer marked "U.S.G.S.-W.R." in base of twin white oak tree between well S-1 and well 50, 16.26 feet above mean sea level.

Water level measurements: First measured, January 25, 1924. Highest observed water level, 5.03 feet below reference point, April 16, 1935; lowest observed water level, dry (more than 12.8 feet below reference point) on several occasions.

Date	Depth to water (feet)	Water level (feet above sea level)	Date	Depth to water (feet)	Water level (feet above sea level)
Jan. 8,1935	7.58	8.91	July 3,1935	12.35	4.14
Feb. 6	6.90	9.59	July 13	Dry	Less than 3.7
Mar. 16	7.00	9.49			
Apr. 16	5.13	11.36	Sept.16	Do	Do
Do	5.03	11.46	Oct. 19	Do	Do
May 13	6.85	9.64	Nov. 19	9.00	7.49
June 6	9.80	6.69	Dec. 13	8.66	7.83

Runyon farm well

Field No.: F-3

Owner: Clyde Bowne

Location: 1.6 miles north of Browntown, 300 feet west of road on hilltop.

Description: Dug well about 46 feet deep.

Measuring point: Top of 4-inch sill on brick curb, 70.14 feet above mean sea level.

Bench mark: Copper nail and washer in root of apple tree in front of house, about 50 feet from well.

Water-level measurements: First measured, November 8, 1923. Highest observed water level, 38.65 feet below measuring point, October 16, 1928; lowest observed water level, 46.00 feet below measuring point, March 11, 1932.

Runyon farm well F-3--Continued

Date	Depth to water (feet)	Water level (feet above sea level)	Date	Depth to water (feet)	Water level (feet above sea level)
Jan. 8, 1935	41.30	28.84	July 19, 1935	41.36	28.78
Feb. 6	41.62	28.52	Aug. 5	41.60	28.54
Apr. 16	41.44	28.70	Sept. 8	41.89	28.25
May 13	41.15	28.99	Oct. 8	42.37	27.77
June 6	41.10	29.04	Nov. 19	41.80	28.34
July 3	41.12	29.02	Dec. 12	43.04	27.10
July 13	40.22	29.92			

Runyon farm well

Field No.: F-14

Owner: Wm. Jurman.

Location: Back of farm house west of side road about 0.6 mile north of point where it crosses the Browntown-Matawan road 0.6 mile east of Browntown.

Description: Dug well 17 feet deep.

Measuring points: Until September 9, 1931, top of wood frame in concrete cover over well; 42.54 feet above mean sea level. Since September 9, 1931, top of concrete cover over well, 43.24 feet above mean sea level.

Bench mark: Copper nail and washer marked "U.S.G.S.-W.R." in tree about 100 ft. southwest of well, 44.51 feet above mean sea level.

Water-level measurements: First measured, December 13, 1923. Highest observed water level, 4.12 feet below measuring point, May 19, 1924, 38.42 feet above mean sea level; lowest observed water level, 16.42 feet below measuring point, October 20, 1932, 26.82 feet above mean sea level.

Date	Depth to water (feet)	Water level (feet above sea level)	Date	Depth to water (feet)	Water level (feet above sea level)
Jan. 8, 1935	7.20	36.04	July 13, 1935	8.76	34.48
Feb. 6	7.30	35.94	July 19	9.22	34.02
Mar.16	6.01	37.24	Aug. 5	10.19	33.05
Apr.16	5.18	38.06	Sept. 8	11.90	31.34
May 13	5.32	37.92	Oct. 8	12.98	30.26
June 6	6.57	36.67	Nov. 19	12.35	30.89
July 3	8.08	35.16	Dec. 12	9.90	33.34

Roth well
East Paterson region

Owner: Charles Roth.

Location: At rear of Mr. Roth's residence on Falmouth Avenue, East Paterson.

Description: Drilled well, depth 175 feet, diameter 6 inches, cased to rock at a depth of 84 feet.

Measuring point: Top of casing, 48.63 feet above mean sea level.

Bench mark: None. Measuring point permanent.

Water-level measurements: First measured, August 23, 1926. Highest observed water level, 4.83 feet below measuring point, August 23, 1926 (flowed when drilled); lowest observed water level, 65.91 feet below measuring point, November 5, 1930.

Roth well--Continued

Date	Depth to water (feet)	Water level (feet below sea level)	Date	Depth to water (feet)	Water level (feet below sea level)
Jan. 10, 1935	64.60	15.97	Aug. 8, 1935	64.76	16.13
Feb. 11	55.93	7.30	Sept.10	64.66	16.03
Mar. 22	52.45	3.82	Oct. 14	64.64	16.01
Apr. 16	52.69	4.06	Nov. 6	64.97	16.34
May 27	58.09	9.46			

NEW MEXICO

LEA COUNTY

By C. V. Theis

A cooperative ground-water investigation in Lea County by the United States Geological Survey and the State engineer of New Mexico, involving among other projects the measurement of about 20 observation wells at monthly intervals, has been in progress since 1930. Three water-stage recorders are maintained. Records of water levels in the observation wells have been published in the 10th and 11th Biennial Reports of the State engineer. Most of the shallow-water area is capped by a dense limestone, but in a small part of it the limestone is not present. In that part which is capped by the limestone water-level fluctuations are very small, amounting generally to only a few hundredths of a foot in a month. In the part in which the limestone is not present, the fluctuations of the water level are much more pronounced.

Eight of the observation wells are so far removed from localities of heavy pumping as to show no apparent effects due to pumping. The greatest individual fluctuation in any one of these wells in any one month was 0.16 foot, and the greatest average fluctuation of all eight in any one month was a rise of 0.04 foot in August and September 1933, when a severe drought was broken. From a study of the rise of water levels in these wells during periods of rainfall and of the decline of the water levels during periods of drought, it has been concluded that the average recharge to the water body in Lea County does not exceed half an inch of water a year, which is about 4 percent of the precipitation.

MIMBRES VALLEY

The Mimbres Valley is essentially the lowland portion of the potential drainage basin of the Mimbres River, in southwestern New Mexico, and coincides largely with the area of Luna County. The wide bolsons of the Mimbres Valley in Luna County are underlain by thick sedimentary deposits, including beds of sand and gravel that contain considerable water, most of which is within 150 feet of the surface. The ground-water supply is derived chiefly from the Mimbres River and from San Vicente Arroyo and other tributaries, but minor contributions are made by the run-off from Cooks Range and the Florida Mountains and

by rainfall on the valley floor northward from Spalding. Practically none of the recharge comes from rainfall on the valley south of Spalding. Though the amount of water stored in the bolson deposits is large, the annual recharge to the underground reservoir is relatively small.

Irrigation with water from wells began in this area in 1908, and by 1915 nearly 200 wells had been constructed and equipped with pumping plants. Much of the early development was unsuccessful and ultimately was abandoned. About 1923 there was a revival in development, and in recent years there have been about 100 to 120 pumping plants in operation for the irrigation of 5,500 to 7,000 acres.

In connection with a study of the geology and ground-water conditions of this area by Darton[1] in 1910 to 1913, much information in regard to the wells and water levels was obtained. In 1913 the depth to the water levels was measured by A. T. Schwennesen in five wells, on which he made pumping tests.[2]

In 1927 A. G. Fiedler made a brief examination of the area with respect to the ground-water conditions and developments, and measured the water levels in several of the wells previously reported by Darton or Schwennesen. The records of these measurements were published in 1928.[3] An intensive investigation of the ground waters of Mimbres Valley was begun in 1928 by W. N. White, of the United States Geological Survey, through cooperation with the State engineer. In connection with this investigation measurements of the water levels were made in many wells and several water-stage recorders have been operated for different periods on representative wells. Monthly or other periodic measurements have been made in a number of selected observation wells since 1928, and the observation-well program is still being continued and is giving valuable results. The water-level records have been compiled in several reports prepared by Mr. White and have been published in the 9th, 10th, and 11th biennial reports of the New Mexico State Engineer, the most comprehensive compilation being in the 10th report. Information on the subject is also given in a report by White published in 1931.[4] It is contemplated that the records of current and future measurements will be published in biennial reports of the State engineer.

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1 Darton, N. H., Underground water of Luna County, N. Mex.: U. S. Geol. Survey Water-Supply Paper 345, pp. 25-40, 1915; Geology and underground water of Luna County, N. Mex.: U. S. Geol. Survey Bull. 618, 1916; U. S. Geol. Survey Geol. Atlas, Deming folio (no. 207), 1917.

2 Darton, N. H., op. cit., Water-Supply Paper 345, p. 38.

3 Fiedler, A. G., Report of reconnaissance of the ground-water area of the Mimbres Valley, Luna County, N. Mex.: New Mexico State Engineer 8th Bienn. Rept., pp. 160-171, 1928.

4 White, W. N., Preliminary report on the ground-water supply of Mimbres Valley, N. Mex.: U. S. Geol. Survey Water-Supply Paper 637, pp. 69-90, 1931.

PORTALES VALLEY

By C. V. Theis

An investigation of the ground-water supply in Portales Valley, Roosevelt County, was begun in 1931 by the United States Geological Survey and the State engineer, and has been carried on continuously since that time. Portales Valley is a broad, shallow depression in the High Plains, under a large part of which the ground water is within 50 feet of the surface. About 300 pumping plants supply water for the irrigation of about 10,000 acres of land and withdraw annually somewhat over 20,000 acre-feet of ground water. The water levels in about 40 observation wells have been measured monthly since January 1932, and water levels in about 150 wells have been measured annually since January 1935. Five automatic water-stage recorders are maintained. Records of water levels in the observation wells have been published in the 10th and 11th biennial reports of the State engineer.

The fluctuations of water levels in these wells during the period of measurement have shown that in certain sandy areas abnormally large amounts of rainfall are followed by an immediate rise in the water table, but over the larger part of the valley the effects of pumping have masked whatever variations in recharge there may have been. The water levels in the observation wells rose on an average about 0.2 foot from January 1932 to January 1933 and about 0.3 foot from January 1933 to January 1934, but they fell on an average about 1.2 feet from January 1934 to January 1935 and about 0.8 foot more from January 1935 to January 1936, giving an average net decline in the 4-year period of about 1.5 feet. During 1932, because of sharply diminished pumping, the water levels rose in the area that is usually most heavily pumped but fell in outlying areas, but despite further reduced pumping in 1935 the water levels fell in the entire valley except in the easternmost part, where heavy rains in August caused an immediate rise and an average rise for the year of the water levels of all the wells.

ROSWELL ARTESIAN BASIN

By A. G. Fiedler

The Roswell artesian basin is in the Pecos Valley, in southeastern New Mexico. The first systematic observations of the head of the artesian water in this area were made by C. A. Fisher[5] in June 1904 in connection with an investigation of the artesian basin. As an outgrowth of the report on this investigation, artesian-well supervisors were appointed by Chaves and Eddy Counties in 1905, and during the period from 1905 to 1918 many measurements of the head of the artesian water were made at irregular intervals.

The observations made by the artesian-well supervisors were never prepared systematically for publication, but they were studied and utilized in connection with later investigations of the area and are discussed in reports issued by the United States Geological Survey[6] and the State engineer.[7] These early measurements of head are especially valuable because they furnish a basis with which later observations can be compared and the long-term trend of the head of the artesian waters in this area can be determined. In 1916 O. E. Meinzer made a reconnaissance survey of the area and measured the head in several artesian wells.

The work of the well supervisors in measuring the head of the artesian wells was practically discontinued in 1918, and no further observations were made until 1925, when the United States Geological Survey started an intensive investigation of the artesian basin in cooperation with the State engineer and with Chaves and Eddy Counties. In the fall of 1925 two wells were equipped with water-stage recorders, and these recorders have been continued in operation essentially without interruption. Daily observations were started on one well in the northern part of the artesian area in July 1925 and were continued until July 1, 1928. In June 1926 a water-stage recorder was placed in operation on another well in this same general region, and continuous

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5 Fisher, C. A., Preliminary report on the geology and underground waters of the Roswell artesian basin, N. Mex.: U. S. Geol. Survey Water-Supply Paper 158, pp. 20-21, 1906.

6 Fiedler, A. G., and Nye, S. S., Geology and ground-water resources of the Roswell artesian basin, N. Mex.: U. S. Geol. Survey Water-Supply Paper 639, pp. 194-218, 1933.

7 Fiedler, A. G., Report on investigations of the Roswell artesian basin, Chaves and Eddy Counties, N. Mex., during the year ending June 30, 1926: New Mexico State Engineer 7th Bienn. Rept., pp. 31-43, 1926. Fiedler, A. G., and Nye, S. S., Ground-water investigation of the Roswell artesian basin, N. Mex.: New Mexico State Engineer 8th Bienn. Rept., pp. 91-98, 1928.

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records were obtained until November 1928. Detailed records of the observations made by the Geological Survey in the artesian basin during the period 1925 to 1928 are published in Water-Supply Paper 639 and the 7th and 8th biennial reports of the State engineer.

In the fall of 1925 the Geological Survey began more or less regular observations on about 100 representative artesian wells scattered throughout the basin, and these measurements were continued for about one year. However, it was found to be impossible to evaluate properly the effects of interference caused by the operation of other artesian wells in the vicinity, and therefore periodic observations at short intervals were discontinued. Only one observation a year was made on these wells thereafter -- usually late in December or early in January of each year, when interference caused by the operation of other artesian wells is at a minimum.

Though the intensive investigation was essentially completed in 1928, cooperation with the State engineer was maintained by the Geological Survey during 1929 and 1930, and an artesian-well supervisor worked under the supervision of the State engineer. Observations were continued on the three recorder-equipped artesian wells and on the 100 artesian wells that were measured once each year during December or January. These observations are recorded and discussed in a report published in the 11th biennial report of the State engineer. Since 1930 observations have been continued by the artesian-well supervisor under the supervision of the State engineer and the Pecos Valley Conservancy District, and his observations are published in the biennial reports of the State engineer.

During the course of the investigation of the artesian waters of the Roswell basin considerable local interest was displayed in the development of shallow ground water for the irrigation of a small area in the Rio Felix basin, west of Hagerman. As about 580 acres was in 1927 already under cultivation and being irrigated with water obtained from shallow wells, a brief field study was made of the area. In connection with this study, 35 shallow wells were measured at irregular intervals during 1927 and 1928 and a water-stage recorder was operated over one shallow well from March 19, 1927, to April 16, 1928. The observations made during 1927 and 1928 on the shallow wells in the Felix area are discussed in Water-Supply Paper 639 and in the 9th biennial report of the State engineer. During June 1932 a number of the shallow wells

previously under observation were again measured, and the results of these observations are given in the 10th biennial report.[8]

The Roswell artesian basin lies in the trans-Pecos Paleozoic ground-water province. The artesian wells derive their supply from Carboniferous limestone to which Nye has applied the name "Picacho limestone." The artesian wells range in diameter from 6 to 15 inches, but most of the wells are 8 inches in diameter. The wells differ widely in depth according to their location, being shallowest in the northern part of the area, where they range chiefly from about 200 to 600 feet, and deepest in the south-central and southern parts of the area, where they range from 600 to 1,450 feet. The wells in the Felix area are water-table wells and are chiefly 10 inches in diameter and about 100 feet in depth. Both the artesian wells and the water-table wells on which observations have been made are situated chiefly in areas in which there are relatively heavy withdrawals of water, especially during the irrigation season.

The observation wells have been tied in to sea-level datum by means of instrumental leveling, and at all of them measuring points from which all measurements are made have been established.

The fluctuations of the artesian head in the Roswell basin, as indicated by the observations on three representative artesian wells equipped with water-stage recorders, are shown in the tables below. The mean monthly water levels shown in the tables were ascertained by averaging the mean daily water level determined from an inspection of the recorder graph or, for days of wide fluctuations, by averaging the water level for fractional parts of a day. The mean annual water level was determined by averaging the mean monthly water levels. The records for the three wells for the period January 1, 1932, to June 30, 1934, are taken from records published in the 11th biennial report of the State engineer. The records for the period July 1, 1934, to December 31, 1935, were supplied through the courtesy of the artesian-well supervisor of the Roswell basin.

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8 Fiedler, A. G., and Nye, S. S., Progress report of the Roswell artesian basin investigation: New Mexico State Engineer 10th Bienn. Rept., pp. 179-180, 1932.

Mean monthly and mean annual artesian head in three observation wells in the Roswell artesian basin

Berrendo well

Location: SW¼SW¼ sec. 9, T. 10 S., R. 24 E.

Depth and size: 258 feet deep, 10 inches in diameter.

Depth to artesian aquifers: 170 feet; 241 feet.

Measuring point: Chisel-cut square at southwest corner of concrete curb of well pit, level with the land surface; altitude 3,586.2 feet. Add 3,500 feet to the levels given in the table to convert them to sea-level datum.

Year	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
Jan.	....	74.1	71.9	71.2	70.6	72.0	71.7	72.6	70.5	69.3
Feb.	....	73.7	71.5	70.4	69.9	71.7	71.4	72.4	70.4	68.9
Mar.	....	72.5	70.8	69.7	68.4	70.0	71.1	71.3	69.9	68.5
Apr.	....	71.0	69.8	68.7	66.9	69.8	69.2	69.8	69.7	66.5
May	....	69.9	70.2	68.6	68.5	70.3	68.7	69.0	68.0	67.1
June	71.7	70.0	69.0	69.1	69.1	68.7	67.8	68.2	67.1	65.7
July	70.2	69.1	67.8	67.7	66.9	67.3	67.2	67.4	65.1	64.4
Aug.	69.5	69.1	69.8	67.9	66.8	68.3	66.8	66.9	64.8	63.8
Sept.	70.8	69.7	70.9	67.8	67.3	67.5	69.1	68.2	66.3	66.4
Oct.	73.1	71.0	71.5	69.0	70.1	69.1	71.2	69.2	67.2	67.2
Nov.	73.9	71.7	72.5	70.1	71.2	68.1	71.8	69.9	68.4	68.0
Dec.	74.2	72.2	72.0	70.3	71.9	71.1	72.3	70.6	69.4	68.9
Annual	...:	71.2	70.6	69.2	69.0	69.5	69.9	69.6	68.1	67.1

Orchard Park well

Location: NW¼NW¼ sec. 23, T. 12 S., R. 25 E.

Depth and size: 810 feet deep, 8 inches in diameter.

Depth to artesian aquifers: 790 feet.

Measuring point: Chisel-cut cross at top of well casing, about 1.5 feet above surface; altitude 3,547.7 feet. Add 3,500 feet to the levels given in the table to convert them to sea-level datum.

Year	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
Jan.	....	30.7	34.0	28.2	29.7	29.7	32.4	34.4	34.2	29.0	27.0
Feb.	....	29.2	29.5	26.0	28.3	24.4	30.0	30.3	29.8	25.9	27.1
Mar.	....	24.6	24.1	21.6	22.2	18.0	23.0	25.6	23.7	23.9	23.4
Apr.	....	24.0	19.0	19.0	16.5	16.5	20.4	16.5	17.8	17.7	15.8
May	....	22.2	17.1	19.0	15.6	18.1	23.5	18.8	16.9	17.1	19.9
June	....	20.2	18.3	17.7	15.4	18.4	18.5	22.0	17.8	14.9	16.7
July	....	18.3	17.8	16.5	14.8	13.5	17.4	19.9	15.7	10.2	10.9
Aug.	25.9	18.0	20.0	25.0	16.7	14.2	21.5	14.2	14.8	10.6	8.8
Sept.	28.5	23.0	21.0	25.5	15.3	17.2	17.8	24.8	21.7	19.5	19.2
Oct.	32.0	31.7	25.7	27.0	23.0	27.9	29.2	35.2	28.2	24.4	27.1
Nov.	33.0	33.1	27.9	31.5	32.5	33.6	31.3	36.1	30.9	29.3	31.3
Dec.	31.6	33.2	28.7	31.7	32.3	33.6	33.6	36.5	32.7	32.2	32.4
Annual	....	25.7	23.6	22.3	21.9	22.1	24.9	26.2	23.7	21.2	21.6

Artesia well

Location: SW¼NW¼ sec. 32, T. 17 S., R. 26 E.

Depth and size: 861 feet deep, 8 inches in diameter.

Measuring point: Chisel-cut cross in top of well casing, about 0.5 foot above surface; altitude 3,406.7 feet. Add 3,300 feet to the levels given in the table to convert them to sea-level datum.

Year	1925	1926	1927	1928	1929	1930	1931	1932	1933	1934	1935
Jan.	....	98.0	90.7	85.5	90.5	90.0	92.1	97.3	95.5	87.8	87.1
Feb.	....	92.5	86.4	82.9	82.5	85.0	90.4	93.8	95.0	87.6	86.0
Mar.	....	83.6	83.5	79.5	78.2	79.9	86.7	92.7	91.0	84.2	83.7
Apr.	....	77.8	84.0	76.8	73.9	75.3	81.3	81.9	84.9	82.0	78.3
May	....	77.0	84.2	78.5	80.0	80.8	86.9	86.7	84.7	83.5	85.0
June	....	78.5	83.0	76.7	85.0	86.3	82.3	82.5	81.9	83.0	80.1
July	....	79.5	77.2	74.2	79.3	73.8	78.7	77.7	79.8	76.3	78.8
Aug.	....	79.3	76.0	83.5	80.5	72.2	83.1	77.5	77.6	74.2	70.9
Sept.	87.2	84.6	80.0	87.5	82.0	79.7	83.0	85.9	82.0	79.0	84.4
Oct.	94.0	93.7	87.6	89.5	82.0	90.9	90.5	94.9	90.4	83.8	89.5
Nov.	97.3	97.4	88.5	91.5	94.5	93.4	93.2	97.1	93.7	87.7	93.3
Dec.	97.3	95.0	88.5	93.0	94.0	92.6	95.9	96.7	92.4	90.1	95.3
Annual	....	86.4	84.1	83.3	83.5	83.3	87.0	87.2	87.4	83.3	84.4

The records for all three wells indicate a major seasonal fluctuation in the artesian head and a marked response to changes in the draft from wells for irrigation and to changes in precipitation. The head is generally highest during the period December to March and then declines more or less abruptly in response to draft for irrigation, generally reaching its lowest stage in July or August. It recovers during the fall as the irrigation demand is reduced and again reaches a high stage during the winter. It is difficult to segregate the effect of precipitation on the recovery of the artesian head from the effect caused by the reduction in draft for irrigation, because the draft is generally reduced rather promptly when precipitation of any consequence occurs. However, there is ample evidence to show that substantial recharge to the artesian reservoir occurs each year.

The mean annual artesian head recorded for the Berrendo well, in the northern part of the basin, declined more or less uniformly during the period 1927 to 1930 and was 2.2 feet lower in 1930 than in 1927. It gradually recovered during 1931 and 1932, the mean in 1932 being 1.8 feet higher than that in 1930. There was a slight decline in 1933 and a more pronounced decline in 1934 and 1935, doubtless because of the marked deficiency in precipitation, which in turn caused a heavy draft for irrigation. The mean annual head for 1935 was 2.8 feet less than that in 1932.

The mean annual artesian head in the Orchard Park well declined during 1926 to 1929 and was 3.8 feet lower in 1929 than in 1926. It recovered from 1930 to 1932, however, and the mean annual head in 1932 was 4.3 feet higher than it was in 1929. During 1933 to 1935 the head again declined and the mean annual head for 1935 was 4.6 feet less than that for 1932. The mean monthly water levels appear to indicate that deficient precipitation during the irrigation season caused unusually heavy draft for irrigation.

The mean annual artesian head in the Artesia well, in the southern part of the basin, declined during the period 1926 to 1930 and was 3.1 feet lower in 1930 than in 1926. The head recovered markedly in 1931 and moderately in 1932 and 1933, and the mean annual head for 1933 was 4.1 feet higher than that for 1930. During 1934 there was a decline of 4.1 feet, but in 1935 a recovery of 1.1 feet occurred, and the mean annual head for 1935 was 3.0 feet less than in 1933.

NEW YORK

LONG ISLAND

By D. G. Thompson

Historical statement

The possibility of a public water supply for the city of Brooklyn, on Long Island, was considered as long ago as 1834, but such a supply, at first obtained from surface sources, was actually not in use until 1856, when the population of the city was about 260,000.[1] From the very first consideration was given to wells as a source of supply, and until the public supply was completed most of the population undoubtedly obtained their water from wells. However, the early investigations did not favor ground water, and the earliest public supply from wells seems to have been put in service in 1882.

The first significant study of the possibility of using wells was made by John S. Stoddard in 1854.[2] In his report he gives the altitude above sea level of the water level in several wells in Brooklyn.

A report by James P. Kirkwood, in 1867, contains a contour map of the water table in the territory between Jamaica and Hempstead and extending from the shore of Jamaica Bay inland approximately to the latitude of Mineola.[3] This map is believed to be the first attempt in the United States to represent the position and shape of the water table by means of contours.

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1 For a historical review of the developments of ground-water supplies and of geological and hydrological investigations see DeVarona, I. M., History and description of the water supply of the city of Brooklyn, especially pp. 143-237, 1896; Brush, W. W., Development of surface and ground waters of Long Island for the supply of the Borough of Brooklyn, with historical notes on the Ridgewood system and other works: Board of Water Supply of City of New York, Report on Long Island sources, vol. 1, pp. 257-302, 1912; Fuller, M. L., The geology of Long Island, N. Y.: U. S. Geol. Survey Prof. Paper 82, pp. 4-20, 1914.

2 Stoddard, J. S. (city surveyor), Report on the subject of supplying Brooklyn with water by the well system: Documents and Plans submitted by the Water Committee to the Common Council of the City of Brooklyn for the year 1854, Dec. 9, pp. 87-99, 1854.

3 Kirkwood, J. P., The Brooklyn waterworks and sewers, a descriptive memoir, New York Board of Water Commissioners, 1867. Neither the map nor the report show definitely the date of collection of field data on which it is based. A statement on page 5 suggests that the field work may have been done between October 1859 and March 1860, with some elaboration of details up to January 1861.

In 1903 the City of New York at frequent intervals measured the water level in 1,378 wells, of which 1,045 were already existing domestic or other wells, and 333 were 2-inch wells driven especially for purposes of observation and the collection of samples of material.[4] Of these, 147 existing wells and 46 new wells were in the Borough of Queens, 396 existing wells and 239 new wells in Nassau County, and 502 existing wells and 38 new wells in Suffolk County. Between March 1 and November 1, 1903, when the observations were ended, 37,042 measurements were made. On the basis of these observations a map was prepared showing contours of the water table on July 1, 1903, in the Borough of Queens, Nassau County, and the western third of Suffolk County.[5]

During this investigation, for some unknown reason, no observations on water level were made in the Borough of Brooklyn. However, in 1933 Thomas H. Wiggin prepared a map which in addition to showing the contours of 1903, as just described, showed their continuation from the Borough of Queens into the Borough of Brooklyn. On the basis of his interpretation and interpolation of a variety of records, including altitude of water level reported by Stoddard in 1854, ground-water levels obtained from records of test borings for subway construction and trunk-sewer invert and ground elevations,[6] an approximate idea of the change of level in Brooklyn can be made by comparison of Wiggin's map with a contour map compiled in 1933 in connection with hearings before the New York Water Power and Control Commission.[7]

In 1908 the City of New York Board of Water Supply made further studies in Suffolk County and extended the contour map of the water table as far east as the longitude of Riverhead.[8]

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4 Burr, W. H., Hering, Rudolph, and Freeman, J. R., Report of the Commission on Additional Water Supply for the City of New York, p. 51, New York, A. B. Brown Co., 1904.

5 Idem, plate 8 opposite p. 810. A map of the water table, with the contours essentially similar to those on this map, and apparently based on the same data, but with some modifications, was published in Veatch, A. C., and others, Underground water resources of Long Island, New York: U. S. Geol. Survey Prof. Paper 44, pl. 12, 1906.

6 Wiggin, T. H., Engineering report submitted by New York Water Service Corporation to State of New York Water Power and Control Commission in the matter of application of the City of New York (No. 681) *** for securing an additional water supply from subsurface sources in the Boroughs of Brooklyn and Queens and in the County of Nassau, 1934.

7 Lease, W. F., Subsurface water supply of western Long Island and its utilization: Municipal Engineers Jour., 1st quarterly issue, map opposite p. 24, 1934.

8 Board of Water Supply of the City of New York, Long Island sources, an additional water supply for the City of New York, vol. 1, sheet 6, opposite p. 108, 1912.

Measurements of the water level in a considerable number of wells, principally the 2-inch wells driven for the purpose, were continued by the City of New York until 1916, and in a few wells through 1918; but there are breaks ranging from several months to several years in the records of many of these wells. Apparently no measurements were made between the end of 1918 and the late part of 1931. Since that time the City of New York Department of Water Supply, Gas, and Electricity has measured a considerable number of the 2-inch wells (commonly known as test wells) at frequent intervals. These records have been made available to the United States Geological Survey. Since January 1932 the Geological Survey, in cooperation with the State of New York, Water Power and Control Commission, and Nassau and Suffolk Counties, has also measured some of these and other wells. In addition it has maintained automatic water-stage recorders on a total of about 25 wells. Of these about 10 have been more or less permanent installations, with records ranging from 4 years to less than 1 year for those most recently installed.

The contour map of the water table on July 1, 1903, has generally been considered to show the "original" altitude and shape of the water table. However, the validity of this assumption may be questioned, for three reasons. First, pumping for public supplies was begun in some of the well fields of the Brooklyn Water Department as early as 1882. In the second place, the more or less detailed observations since 1903 show seasonal fluctuations of the water level in many wells of several feet, and within the period of observation maximum fluctuations of 5 to 8 feet or more. Finally, a study of the records of precipitation and of information in regard to the level of Lake Ronkonkoma -- which is, so to speak, a huge open well, whose level fluctuates with the water table -- shows that in earlier years the water table was probably much lower than in 1903. Lake Ronkonkoma is reported to have been at very low stages in 1857 and 1885 and at a very high stage in 1893.[9] The maximum fluctuation of the lake has been 18 feet or more, but it has been estimated that the fluctuation of the water table has not been more than 10 or 12 feet. These observations are in general accord with the record of precipitation in New York City. According to the record published by the United States Weather Bureau for New York City, covering the period 1826 to

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9 Burr, W. H., Hering, Rudolph, and Freeman, J. R., op. cit., pp. 817-819.

1930,[10] there was a dry period from 1831 to 1861, inclusive, during which the precipitation exceeded the 105-year mean (42.01 inches) in only 7 years and in 1835 reached the all-time recorded low of 28.78 inches. At the end of 1861 the accumulated deficiency was about 90 inches, or more than the precipitation of two "average" years.

It is noteworthy that, according to the contours on the map of 1867 shown in Kirkwood's report, the water table in that early year was in some places from 3 to 5 feet lower than in July 1903,[11] and as low or lower than the lowest level reached during any subsequent period of heavy pumping from wells.[12] After 1861 there were numerous years of excess precipitation, and the deficiency decreased in an irregular manner until it was wiped out and there was an accumulated excess, which reached a maximum of about 35 inches in 1903. An intermediate low point, not as low as that of 1861, was reached about 1885, and an intermediate high point about 1890, roughly coinciding with periods of low and high level of Lake Ronkonkoma mentioned above. From 1903 to about 1916 the annual precipitation showed only comparatively minor departures from the mean, but from 1916 to 1932 there was an irregular but increasing accumulated deficiency, which, however, was only moderate compared to the maximum deficiency reached about 1861.

All these facts point rather definitely to the conclusions that there has been no definite "original" position of the water table, that the water table was near its highest level when the data were collected for the contour map of 1903, and that at times within the period of historic record the more "natural" level -- that is, before there was any extensive pumping -- was several feet lower than in 1903. The facts are especially significant in showing that notable recovery of the water table is possible after long periods of deficient precipitation. The precipitation record, of course, raises the question whether Long Island has yet experienced the lowest point of the present rainfall cycle or whether deficiencies comparable to those of the first half of the nineteenth century may yet be experienced.

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10 Climatic summary of the United States, section 83, eastern New York, U. S. Weather Bureau, p. 21, (1934?).

11 Burr, W. H., Hering, Rudolph, and Freeman, J. R., op. cit., p. 821.

12 Lease, W. F., op. cit., profiles opp. p. 30, 1934. Also unpublished records.

Geologic conditions

All the observation wells on Long Island penetrate unconsolidated deposits. The water-bearing beds may be divided into three groups.[13] First and uppermost are beds of sand and gravel of middle or late Pleistocene age. The water in these beds throughout almost the entire island occurs under water-table conditions. Next in geologic age is the Jameco gravel, of early Pleistocene age. The water in this gravel is generally but not everywhere under artesian pressure. Next and lowermost are Cretaceous beds in which two water-bearing zones are recognized. The upper of these zones is of Magothy age, and the lower is the Lloyd sand. The Lloyd sand is nearly everywhere overlain by thick beds of clay, and the water in it is under artesian pressure. Impervious beds over the Magothy sands are apparently less widespread, and water-table conditions may occur in the Magothy in some places. There is some evidence that erosion channels have been cut locally through all confining clay beds, including those over the Lloyd sand, and from place to place there is a transition from artesian to water-table conditions -- perhaps within distances of a few hundred or a few thousand feet but certainly within distances of a few miles of a given observation well. The intake areas of all formations are definitely believed to lie on Long Island.

The records obtained by automatic recorders on several deep wells in which the water is known to be under artesian pressure generally show fluctuation due to changes in atmospheric pressure, whereas similar records for wells where a water table exists show no such fluctuations or only slight fluctuations. Accordingly, it is believed that pronounced barometric fluctuations in wells may be regarded as indicating that artesian conditions probably exist.

The atmospheric fluctuations of water level may be as much as 6 to 12 inches in a few days, and fluctuations of equal or much greater amounts are produced by pumping of other wells at distances of a few feet to as much as 2½ miles. For such wells occasional measurements or single measurements at regular intervals may not reveal the true trend of the water table or artesian head from year to year unless the secular movement is greater than the fluctuations due to temporary conditions. Rather, it becomes necessary to endeavor to correct for the temporary fluctuations -- a task at best difficult and in many cases impossible to accomplish -- or, as a simpler method, to plot in some

13 Thompson, D. G., Wells, F. G., and Blank, H. R., Recent geologic studies on Long Island with respect to ground-water supplies (abstract): Geol. Soc. America Bull., (in press).

detail the movement of the water level from day to day, and from the graph thus prepared draw by inspection a generalized curve to show the major seasonal and annual fluctuations.

Records of water levels

On the following pages are shown the highest and lowest depths to the water level recorded each year, with dates of measurement, in several water-table wells for which long-time records are available. These figures are based largely on records furnished by the City of New York, Department of Water Supply, Gas, and Electricity.[14] The lowest water level on the first day of each month is also given for several wells on which water-stage recorders have been maintained by the United States Geological Survey since March 1932. Because of the necessity of driving new wells to replace old ones, with disturbance of measuring points, the long-time records are given in feet above sea level, based on occasional releveling. Other records are given in feet below the measuring points.

New York Water Service Corporation test well (U.S.G.S. well 23k)

(Probably artesian conditions)

On southwest side of East 98th Street, near Rutland Road, Brooklyn. Well is 8 inches in diameter and was drilled to a depth of 383.6 feet but was later plugged at a depth of 295 feet. The well casing was perforated between depths of 280 and 290 feet. Measuring point, top of instrument shelf, about 2.3 feet above the land surface, which is about 40 feet above sea level. An automatic water-stage recorder has been operated on this test well since Sept. 7, 1932. The test well is about 41 feet southwest of a 101-foot well and about 18 feet northeast of a 295-foot well, both of which are used for public water supply. Pumping from the 101-foot well has essentially no effect on the water level in the test well, but it is affected by pumping from the 295-foot well and probably other wells nearby. Normally during 1935 the water level in the test well fluctuated through a range of about 0.5 foot each week.

Lowest water level on the first day of each month,

in feet below measuring point

Month	1932	1933	1934	1935	1936
January	.....	62.24	63.11	63.99	64.78
February	.....	62.36	63.04	64.07	.....
March	.....	62.42	63.30	64.06	.....
April	.....	62.38	62.92	63.91	.....
May	.....	62.42	63.32	64.06	.....
June	.....	62.37	63.39	64.00	.....
July	.....	62.83	63.69	64.20	.....
August	.....	63.10	63.79	64.50	.....
September	.....	62.70	63.97	64.60	.....
October	62.05	63.15	64.04	64.72	.....
November	62.12	62.96	63.92	64.98	.....
December	62.27	63.05	63.92	64.79	.....

14 In several years, particularly since and including 1932, as indicated by footnotes, the water-table wells were measured at infrequent intervals, in some instances not for several months before or after the usual times of high or low level in previous years. Therefore the lowest and highest levels for the years indicated may not be comparable with these levels in other years.

New York City Department of Water Supply abandoned well, formerly owned by Citizens Water Supply Co., pumping station no. 1

(Probably water-table conditions)

On southeast side of Cornish Street between Queens Boulevard and Poyer Street, Elmhurst. Well is 6 inches in diameter and about 50 feet deep. Measuring point, top of instrument shelf, about 4.5 feet above ground, which is about 15 feet above sea level. An automatic water-stage recorder has been operated on this well since April 20, 1933. The water level in this well may be slightly affected by pumping in the vicinity. The water level responds readily to rainfall. Normally the water level fluctuates through a range of less than 1 foot each week.

Lowest water level on the first day of each month

in feet below measuring point

Month	1933	1934	1935	1936
January	.....	a 17.76	15.95	16.65
February	.....	b 17.05	15.69	.....
March	.....	c 17.31	15.15	.....
April	.....	16.85	15.47	.....
May	18.02	16.90	16.00	.....
June	18.12	16.77	16.53	.....
July	18.15	.....	17.06	.....
August	18.38	d 17.00	17.06	.....
September	17.94	17.50	17.66	.....
October	17.29	16.39	17.35	.....
November	17.58	16.56	17.33	.....
December	17.93	16.69	17.25	.....

a Dec. 27, 1933.
b Jan. 28, 1934.
c Mar. 3, 1934.
d Estimated.

New York City California stovepipe well No. 3 (U.S.G.S. well 674c)

(Water-table conditions)

3,500 feet S. 49° E. from intersection of Udalls Road and Hunter Avenue, about 2 miles west of Bayshore. Well is 16 inches in diameter and 200 feet deep. Measuring point, top of instrument shelf, about 2.9 feet above ground, which is about 30 feet above mean sea level. An automatic water-stage recorder was operated on this well from June 22, 1933, to Oct. 31, 1935. Tape measurements were made about weekly from Dec. 2, 1935, to date. Normally the water level fluctuates through a range of only a few tenths of a foot during a week.

Lowest water level on the first day of each month

in feet below measuring point

Month	1933	1934	1935	1936
January	.....	14.54	14.20	a 15.22
February	.....	b 14.08	13.27	.....
March	.....	c 14.26	b 12.53	.....
April	.....	12.98	12.75	.....
May	.....	12.23	13.08	.....
June	.....	12.41	13.72	.....
July	.....	13.24	14.28	.....
August	14.57	14.15	14.80	.....
September	14.35	14.90	15.29	.....
October	13.57	14.96	15.20	.....
November	14.27	b 15.09	b 15.60	.....
December	14.81	14.80	d 15.33	.....

a Dec. 31, 1935.
b Estimated.
c Mar. 7, 1934.
d Dec. 2, 1935.

J. M. Hill well

(Probably artesian conditions)

On Wheatley Road near Cedar Swamp Road, Wheatley Hills. Well is 6 inches in diameter and about 300 feet deep. Measuring point, top of 6-inch casing, at about ground level, 218.77 feet above mean sea level. An automatic water-stage recorder has been operated on this well since September 21, 1932. The water level in this well fluctuates as much as 0.5 foot in response to changes in atmospheric pressure. Normally the water level fluctuates through a range of less than 1 foot each week.

Lowest water level on the first day of each month

in feet below measuring point

Month	1932	1933	1934	1935	1936
January	.....	142.62	141.65	139.00	137.78
February	.....	142.36	141.70	a 139.00	.....
March	.....	142.36	a 141.74	a 138.90	.....
April	.....	142.35	141.43	138.57	.....
May	.....	142.73	141.43	138.52	.....
June	.....	b 142.52	141.19	138.21	.....
July	.....	c 142.40	140.67	a 137.90	.....
August	.....	142.32	140.39	137.56	.....
September	.....	142.04	140.02	.....	.....
October	141.75	142.03	139.58	.....	.....
November	141.67	a 141.88	a 139.50	a 137.70	.....
December	141.86	142.08	139.20	a 137.50	.....

a Estimated.
b May 27, 1933.
c July 11, 1933.

Village of Freeport abandoned well

(Artesian conditions)

At municipal power station on Sunrise Highway, Freeport. Well is 12 inches in diameter and is reported by different persons to be 1,025 and 1,100 feet deep. Measuring point, top of 12-inch casing, about 0.3 foot above ground, which is about 20 feet above mean sea level. An automatic water-stage recorder has been operated on this well since March 15, 1932. Presumably the well penetrates the Lloyd sand. The nearest known pumping from this formation is 5 to 6 miles distant. It is reported that on completion the well flowed and had a head of 1 or 2 feet above the ground surface. The water level fluctuates as much as 0.5 foot in response to changes in atmospheric pressure. Normally the water level fluctuates through a range of less than 6 inches each week.

Lowest water level on the first day of each month

in feet below measuring point

Month	1932	1933	1934	1935	1936
January	....	3.14	2.63	3.03	4.05
February	....	2.43	2.60	a 3.25	....
March	....	2.27	2.97	3.46	....
April	2.42	2.17	2.41	3.12	....
May	2.23	2.50	2.73	3.10	....
June	2.65	2.73	2.56	a 3.65	....
July	3.00	3.58	3.58	b 4.71	....
August	4.92	4.90	5.26	5.14	....
September	5.53	5.48	5.52	....	....
October	4.76	4.44	4.28	....	....
November	3.96	3.38	3.27	4.57	....
December	3.06	3.18	2.89	a 4.00	....

a Estimated.
b July 15, 1935.

Village of Rockville Centre abandoned well

(Water-table conditions)

At municipal power station, Morris and Maple Avenues, Rockville Centre. Well is 8 inches in diameter and 46.3 feet deep. Measuring point, top of 8-inch casing at about the level of power-house basement floor, about 5 feet below ground level, which is about 26 feet above mean sea level. An automatic water-stage recorder was operated on this well from January 20 to August 23, 1934. Tape measurements were made about weekly from August 31, 1934, to date. A few hundred feet distant is a 550-foot well that is pumped daily, but this has no effect on the water level in the observation well. The observation well is beneath the power house, and for a radius of 50 feet or more the ground surface is largely covered by the building or pavements. Normally the water level fluctuates through a range of about 0.2 foot during the week.

Depth to water (lowest during the day from Feb. 1 to Aug. 1, 1934),

in feet below measuring point

Date	Depth to water (feet)	Date	Depth to water (feet)	Date	Depth to water (feet)
Feb. 1,1934	6.56	Sept.28,1934	6.71	June 7,1935	7.05
Mar. 1	7.01	Nov. 2	6.86	21	7.18
Apr. 1	6.14	30	7.14	Aug. 5	7.90
May 1	5.54	Dec. 28	7.18	Sept. 4	8.02
June 1	5.65	Feb. 1,1935	6.64	Oct. 1	8.37
July 1	6.13	Mar. 1	5.84	Nov. 1	8.64
Aug. 1	6.82	29	5.95	Dec. 3	8.66
31	7.40	Apr. 26	6.36	31	8.84

New York City Department of Water Supply abandoned well

Bayside No. 10 (U.S.G.S. well 2381)

(Artesian conditions)

Near Northern Boulevard at old New York City Bayside pumping station, Bayside. Well is 6 inches in diameter and about 375 feet deep. Measuring point, top edge of 6-inch flange, about 5 feet above ground level, which is about 9 feet above mean sea level. An automatic water-stage recorder has been operating on this well since September 20, 1933. The well ends in the Lloyd sand. The water level in this well is considerably affected by pumping from two wells that end in the Lloyd sand at the New York City Flushing pumping station, about 2.5 miles distant. Changes in atmospheric pressure affect the water level in the observation well. Normally, when the pumpage from the two wells at Flushing is constant, the water level in the observation well fluctuates through a range of only a few tenths of a foot during a week. However, when the Flushing wells are shut down or started up the water level in the observation well has fluctuated more than 4 feet in one month.

Lowest water level on the first day of each month

in feet below measuring point

Month	1933	1934	1935	1936
January	.....	9.80	20.05	19.30
February	.....	10.00	20.92	.....
March	.....	10.38	21.04	.....
April	.....	10.06	a 19.56	.....
May	.....	9.52	b 20.26	.....
June	.....	10.45	21.05	.....
July	.....	c 15.17	20.43	.....
August	.....	16.32	21.43	.....
September	.....	13.78	22.77	.....
October	c 11.74	13.54	20.76	.....
November	11.29	d 15.76	18.22	.....
December	10.22	15.42	19.09	.....

a Apr. 5, 1935.
b May 3, 1935.
c Estimated.
d Nov. 2, 1934.

New York City test well SU-81

About 1⅛ miles northwest of Bayshore, at northwest corner of Sacitkos Manor Lane and road 0.1 mile south of Bayshore Road. Measuring point, top of 2-inch pipe, 0.6 foot above ground, or 41.49 feet above mean sea level. No pumping of appreciably magnitude nearby. The water level in the test well was first measured on Oct. 21, 1912. Measurements were made at irregular intervals, about bimonthly. A total of about 45 measurements have been made. The water levels are given in feet above mean sea level.

Year	Lowest		Highest	
	Water level	Date	Water level	Date
1912 a	26.74	Dec. 7	27.39	Oct. 21
1913	26.68	Dec. 12	30.94	Apr. 23
1914	26.29	Nov. 3	30.11	May 26
1932 a	25.00	Nov. 2	26.73	Aug. 4
1933	25.64	Jan. 5	29.07	Apr. 27
1934 a	28.20	Aug. 1	29.51	May 16
1935	Dry	Sept.20	29.42	Mar. 15

a Record for year incomplete.

New York City test well SU-86

About 1⅛ miles southwest of Brentwood, on east side of Sacitkos Manor Lane about 1,000 feet south of Long Island Railroad; main line. Measuring point, top of 1½-inch pipe, 0.9 foot above ground, or 89.87 feet above mean sea level. No pumping of appreciable magnitude nearby. The water level in the test well was first measured Oct. 21, 1912. Measurements were made at irregular intervals, about bimonthly. A total of about 50 measurements have been made. The water levels are given in feet above mean sea level.

Year	Lowest		Highest	
	Water level	Date	Water level	Date
1912 a	50.16	Dec. 7	51.09	Oct. 21
1913	49.61	Jan. 10	52.79	May 21
1914	49.37	Jan. 23	52.87	June 17
1932 a	45.57	Dec. 1	47.17	Aug. 4
1933	45.24	Feb. 23	48.49	June 7
1934 a	50.15	May 16	50.22	Aug. 1
1935	48.46	Jan. 11	51.02	May 10

a Record for year incomplete.

New York City test well SU-75

About 2⅛ miles east of Babylon, on east side of Sacitkos Manor Lane about 4,250 feet south of Long Island Railroad; Montauk Branch. Measuring point, top of 1½-inch pipe, 0.7 foot above ground, or 15.85 feet above mean sea level. No pumping of appreciable magnitude nearby. The water level in the test well was first measured Oct. 21, 1912. Measurements were made at irregular intervals, about bimonthly. A total of about 40 measurements have been made. The water levels are given in feet above mean sea level.

Year	Lowest		Highest	
	Water level	Date	Water level	Date
1912 a	10.16	Oct. 21	10.75	Dec. 7
1913	9.85	Aug. 20	11.70	Apr. 23
1914	9.64	Oct. 7	11.60	Mar. 20
1932 a	9.45	Sept.12	10.82	Dec. 1
1933 a	11.01	Jan. 5	11.52	Feb. 23
1935 a	10.12	Sept.20	11.50	Mar. 1

a Record for year incomplete.

New York Board of Water Supply test well CH-201

At junction of Williston Avenue and Bacon Road, near Westbury. Measuring point, top of 1¼-inch pipe, 0.4 foot above ground, or 112.31 feet above mean sea level. Well is about 7 miles north of the nearest pumping by New York City, and the water level in it is probably only indirectly affected by this pumping. The water level in the test well was first measured May 12, 1913. In the earlier years measurements were made about semimonthly; in more recent years about monthly. A total of about 170 measurements have been made. The water levels are given in feet above mean sea level.

Year	Lowest		Highest	
	Water level	Date	Water level	Date
1913 a	76.51	Dec. 22	78.06	May 26
1914	76.21	Dec. 31	78.36	June 1
1915	76.21	Dec. 8	77.51	Mar. 26
1916	74.81	Dec. 30	76.31	May 5
1917	72.96	Dec. 17	74.66	Apr. 23
1918	71.31	Dec. 26	73.36	Apr. 4
1932 a	70.49	Dec. 5	71.81	June 13
1933 a	70.08	Feb. 27	71.93	Oct. 25
1934 a	71.53	Jan. 8	74.08	Dec. 5
1935 a	74.11	Nov. 11	75.65	May 10

a Record for year incomplete.

New York City test well M-183

North of Williams Street on west side of Massapequa Road, near Farmingdale. Measuring point, top of 1¼-inch pipe, 0.8 foot above ground, or 78.72 feet above mean sea level. Well is about 3 miles north of New York City's infiltration galleries, pumping from which probably produces moderate direct effect on the water level in the test well. The water level in test well was first measured Feb. 5, 1909. In the earlier years measurements were made about semimonthly; in more recent years about monthly. A total of about 240 measurements have been made. The water levels are given in feet above mean sea level.

Year	Lowest		Highest	
	Water level	Date	Water level	Date
1909	51.03	Dec. 14	54.08	June 1
1910 a	50.83	Jan. 3	52.78	Apr. 11
1912	51.92	Nov. 29	55.12	June 5
1913	51.12	Dec. 27	54.77	May 15
1914	50.72	Dec. 28	54.02	June 11
1915	50.62	Jan. 6	54.02	Mar. 18
1916	49.67	Dec. 21	53.02	May 11
1932	47.06	Jan. 26	49.20	May 26
1933	47.65	Jan. 24	50.32	June 7
1934	49.34	Jan. 3	52.23	May 16
1935 a	49.68	Nov. 11	52.76	Apr. 5

a Record for year incomplete.

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New York City test well S-45

100 feet south of Pittsburg Avenue on west side of Main Street in Massapequa. Measuring point, top of 1½-inch pipe, at ground level, 32.50 feet above mean sea level. Well is about half a mile north of New York City's infiltration galleries, pumping from which produces considerable direct effect on the water level in the test well. The water level in the test well was first measured June 6, 1903. In the earlier years measurements were made about weekly; in more recent years about monthly. A total of about 530 measurements have been made. The water levels are given in feet above mean sea level.

Year	Lowest		Highest	
	Water level	Date	Water level	Date
1903 a	20.57	Dec. 5	22.52	July 4
1904	20.42	Dec. 25	22.97	May 6
1905	19.62	Nov. 30	23.12	Apr. 13
1906	19.02	Dec. 24	22.67	Apr. 17
1907	19.02	Sept.27	21.37	Apr. 22
1911	16.70	Jan. 2	21.55	Dec. 25
1912	17.50	Dec. 26	23.20	Apr. 1
1913	17.35	Dec. 24	22.45	Apr. 30
1914	16.80	Dec. 11	21.65	May 13
1915	16.95	Jan. 7	21.30	Feb. 17
1916	16.30	Dec. 20	20.80	Apr. 26
1932	16.97	Jan. 26	20.28	Apr. 21
1933	18.82	Nov. 28	22.00	Apr. 27
1934	18.47	Oct. 5	22.27	Apr. 23
1935 a	17.10	Nov. 1	21.95	Mar. 1

a Record for year incomplete.

CENTRAL NEW YORK

By A. W. Harrington

Records of water levels have been obtained on three observation wells in central New York by the United States Geological Survey in cooperation with the New York State Department of Conservation. This work is under the direction of A. W. Harrington, district engineer of the Geological Survey. Observations were begun in August 1933 on the well in Cortland County and in October 1934 on the wells in Chenango and Delaware Counties. All three wells are now equipped with automatic recorders.

Shackham Brook well 1

Latitude 42°46'00", longitude 76°01'10". On top of hill about 300 feet upstream from stream-gaging station, 500 feet to left of Shackham Brook, and about 5 miles north of Truxton, Cortland County. Dug well lined with three 2½-foot sections of concrete tile 1 foot in diameter. Top is enclosed in 30-inch concrete tile fitted with hinged wooden cover. Measuring point, painted mark on top of inside tile, about 1 foot above the land surface, which is 1,600 feet above mean sea level. Readings made by measuring distance from measuring point to water surface. Read weekly Aug. 26, 1933, to June 6, 1935. Stevens water-stage recorder installed June 6, 1935.

Depth to water level, in feet below measuring point

Date	Depth to water (feet)	Date	Depth to water (feet)	Date	Depth to water (feet)
Aug. 26,1933	1.97	May 5,1934	1.84	Jan. 12,1935	0.45
27	2.20	12	2.19	19	.80
Sept. 2	3.17	19	2.84	26	.58
9	2.55	26	3.13	Feb. 2	1.41
16	2.94	June 2	3.55	9	1.60
23	a 2.96	9	3.90	16	.92
30	3.10	16	4.09	23	1.09
Oct. 7	3.51	23	4.15	Mar. 2	1.08
14	4.1	30	4.42	9	.75
21	4.21	July 7	4.60	16	.92
28	1.62	14	4.89	23	.80
Nov. 4	1.18	21	5.17	30	.73
11	1.49	28	5.44	Apr. 6	.83
18	.92	Aug. 4	5.65	13	.84
25	.68	11	6.03	20	.66
Dec. 2	.97	18	6.32	27	1.39
9	.79	25	6.56	May 4	.75
16	.95	Sept. 1	6.85	11	.94
23	.89	8	7.03	18	1.95
30	1.3	15	7.13	25	2.63
Jan. 6,1934	.61	22	5.56	June 1	3.52
13	.84	29	5.15	8	a 2.97
20	.21	Oct. 6	4.60	15	3.30
Feb. 3	1.12	13	4.70	22	2.47
10 Ice	1.12	20	4.55	29	4.15
18	.91	27	2.05	July 6	3.90
24	1.12	Nov. 3	1.35	13	.95
Mar. 3	.73	10	.85	20	1.53
10	.85	17	.63	27	.70
17	.69	24	.67	Aug. 3	1.30
24	.7	Dec. 1	.55	10	2.21
31	.54	8	.95	17	2.48
Apr. 7	.57	15	1.30	24	3.17
14	.52	22	.87	31	3.65
21	.72	29	.88	Sept. 7	4.20
28	1.08	Jan. 5,1935	1.42	14	3.95

a Estimated.

Shackham Brook well 1 - Continued

Date	Depth to water (feet)	Date	Depth to water (feet)	Date	Depth to water (feet)
Sept.21,1935	3.20	Oct. 26,1935	2.74	Nov. 30,1935	0.81
28	3.60	Nov. 2	.97	Dec. 7	1.15
Oct. 5	2.32	9	.89	14	.55
12	2.80	16	.70	21	.80
19	3.10	23	.81	28	1.20

Sage Brook well 2

Latitude 42°31'55", longitude 75°25'30". About 50 feet upstream from stream-gaging station, 100 feet to left of Sage Brook, and about 2.5 miles west of South New Berlin, Chenango County. Dug well lined with concrete tile 21 inches in diameter, 7.5 feet deep. Timber instrument shelter built on top of well. Measuring point, painted mark on floor of instrument shelter, about 1 foot above the land surface, which is 1,500 feet above mean sea level. Readings made by measuring distance from measuring point to water surface. Read weekly Oct. 27, 1934, to July 20, 1935. Gurley water-stage recorder installed July 20, 1935.

Depth to water level, in feet below measuring point

Date	Depth to water (feet)	Date	Depth to water (feet)	Date	Depth to water (feet)
Oct. 27,1934	1.73	Mar. 23,1935	1.41	Aug. 17,1935	1.54
Nov. 3	1.50	30	1.41	24	1.91
10	1.31	Apr. 6	1.50	31	2.10
17	1.31	13	1.45	Sept. 7	1.99
24	1.23	20	1.41	14	1.82
Dec. 1	1.19	27	1.94	21	1.77
8	1.50	May 4	1.40	28	1.85
15	1.52	11	1.40	Oct. 5	1.70
22	1.43	18	1.65	12	1.87
29	1.43	25	1.83	19	1.96
Jan. 5,1935	1.47	June 1	1.96	26	1.81
12	1.30	8	2.16	Nov. 2	1.67
19	1.43	15	2.34	9	1.67
26	1.54	22	1.85	16	1.66
Feb. 2	1.84	29	1.94	23	1.66
9	1.84	July 6	2.40	30	1.66
16	1.72	13	1.48	Dec. 7	1.79
23	1.78	20	1.94	14	1.58
Mar. 2	1.96	27	1.67	21	1.67
9	1.51	Aug. 3	1.72	28 Ice	1.78
16	1.44	10	2.00		

Cold Spring Brook well 1

Latitude 42°09'35", longitude 75°23'35". About 150 feet to left of stream-gaging station on Cold Spring Brook, about 1 mile above China, and 2 miles west of Upper Barbourville, Delaware County. Dug well lined with vitrified tile 18 inches in diameter, 12 feet deep. Timber instrument shelter built on top of well. Measurements made with hook rod and scale and are distances to water surface below zero of hook scale, about 2 feet above the land surface, which is 1,540 feet above mean sea level. Gurley water-stage recorder installed October 24, 1934.

Depth to water level, in feet below measuring point

Date	Depth to water (feet)	Date	Depth to water (feet)	Date	Depth to water (feet)
Oct. 24,1934	7.72	Nov. 22,1934	4.62	Dec. 14,1934	6.75
27	7.49	24	3.17	18	7.37
Nov. 3	7.60	Dec. 1	2.87	24	5.12
10	4.18	3	3.11	31	6.87
17	4.55	10	5.78	Jan. 5,1935	7.76

Cold Spring Brook well 1 - Continued

Date	Depth to water (feet)	Date	Depth to water (feet)	Date	Depth to water (feet)
Jan. 7,1935	4.40	May 5,1935	3.63	Sept. 1,1935	9.05
14	4.47	12	4.50	8	9.33
21	5.37	19	6.63	15	9.65
25	4.97	22	6.88	19	9.86
28	6.20	26	7.23	22	9.94
Feb. 4	7.38	June 2	7.68	29	10.20
11	8.18	9	7.97	Oct. 6	10.48
18	5.03	16	8.20	13	10.80
25	6.91	23	8.20	20	11.02
Mar. 4	5.00	30	8.61	27	11.23
6	3.43	July 7	8.72	Nov. 3	4.11
11	1.92	14	5.22	10	4.86
18	3.07	16	5.92	17	4.89
21	2.91	21	6.77	24	6.09
25	3.6	28	5.54	Dec. 1	5.69
Apr. 1	3.20	Aug. 4	7.02	8	5.10
7	3.78	11	7.86	15	3.05
14	2.96	15	8.21	22	4.60
21	4.08	18	8.47	29	5.98
28	5.91	25	8.75		

NORTH CAROLINA

STATE-WIDE PROJECT

By E. D. Burchard

A program of water-level measurements in observation wells was begun in North Carolina in 1931 by the United States Geological Survey in cooperation with the State Department of Conservation and Development, largely through the initiative of Thorndike Saville, chief engineer of the Department. Twenty-two wells were selected throughout the State in 1931 and 1932, and periodic measurements of the water levels in them were made by local observers. Thirteen of the wells have since been abandoned.

Three of the nine wells that are still under observation are equipped with automatic water-stage recorders; the other six wells are measured about weekly by means of steel tapes or float-tape gages. The wells are protected against surface run-off and are securely housed. Definite measuring points have been established, and one or more bench marks have been set near most of the wells, and these marks have been referred to the measuring points to avoid loss of the records in case the measuring points on the well are disturbed.

Records of water levels in eight of the observation wells, together with the locations and descriptions of the wells, are given in the following table. The water levels in each well are expressed in feet above an arbitrary datum selected for that well. The record of the observation well at Chapel Hill is not included. Daily water levels are given for the Kurfee well at Mocksville, but only monthly water levels are included in this report for the other seven wells.

The water levels in most of the wells show a seasonal fluctuation ranging from about 5 to 10 feet. In general the highest levels shown by the records occurred in the spring of 1933 and the spring of 1935. Notably high levels also occurred in some wells in the spring of 1934, but as a rule these were lower than those of 1933 and 1935.

The greatest decline in the water levels occurred in the last half of 1933, when the lowest stage of record was reached in most of the wells. This decline was doubtless caused chiefly by deficient precipitation, as the average precipitation in North Carolina in 1933 was about 10 inches below normal. Throughout the last half of 1934 the water levels were

maintained at stages well above the low levels of 1933, but in the summer and fall of 1935 they suffered considerable decline. In most of the wells the water levels stood lower at the end of 1935 than at the beginning of the year but appreciably higher than at the beginning of 1933.

The daily records of the Kurfee well, at Mocksville, show in detail the fluctuations of the water level in the well. The lowest stage (2.74 feet) was recorded on January 5, 1932, and the next lowest stage (3.17 feet) in the later part of February 1934. The highest recorded level (12.76 feet), which was 10.02 feet above the low stage of 1932, was reached on April 21, 1935. The declines of water level in the well are mostly gradual, but many of the rises are abrupt and occur without appreciable lag after heavy rains, recorded at Statesville. For example, the water level rose 0.57 foot in the well on February 13 and 14, 1935, when a rain of 1.10 inches was recorded at Statesville, and 2.10 feet on March 12, 1935, when 1.94 inches of rain was recorded at Statesville. On September 5, 1935, near the end of the growing season, the water level rose 0.40 foot in response to rain, which at Statesville amounted to 2.77 inches on September 4 and 5.

Kurfee well at Mocksville

On south line of Kurfee property on U. S. highways 64 and 601, one block south of court house. Dug well 3 feet in diameter and 32 feet deep. Lined with rock; concrete curb and wooden well house; on gently sloping land about 500 feet south from top of hill. Equipped with a continuous water-stage recorder. Measuring point, top of instrument shelf, about 3 feet above the land surface. The arbitrary datum is 33.40 feet below the measuring point. The water levels are given in feet above this datum. United States Geological Survey true meridian bench mark in the northwest corner of the Mocksville square.

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1932												
1	2.98	4.83	5.70	7.38	7.89	7.68	7.55	6.05	4.98	3.62	4.41	5.80
2	2.85	4.82	5.72	7.38	7.85	7.67	7.53	6.02	4.93	3.58	4.23	5.80
3	2.80	4.91	5.72	7.39	7.82	7.65	7.46	5.98	4.88	3.56	4.14	5.83
4	2.76	5.09	5.75	7.40	7.81	7.64	7.43	5.93	4.85	3.51	4.11	5.87
5	2.74	5.03	5.77	7.43	7.83	7.63	7.37	5.88	4.80	3.47	4.11	5.90
6	2.93	5.02	6.32	7.49	7.84	7.62	7.32	5.87	4.77	3.45	4.18	5.92
7	3.82	5.02	7.83	7.53	7.84	7.60	7.29	5.89	4.73	3.42	4.28	5.95
8	4.91	5.05	6.91	7.57	7.85	7.55	7.26	5.81	4.66	3.37	4.25	5.96
9	5.30	5.06	6.49	7.60	7.88	7.49	7.20	5.77	4.61	3.34	4.76	5.96
10	4.53	5.08	6.36	7.61	7.92	7.43	7.13	5.74	4.55	3.30	4.70	5.96
11	4.07	5.12	6.36	7.64	7.92	7.39	7.10	5.71	4.49	3.27	4.56	6.10
12	3.85	5.26	6.43	7.66	7.92	8.00	7.05	5.67	4.44	3.23	4.52	7.26
13	3.76	5.40	6.54	7.66	7.91	7.72	7.01	5.63	4.40	3.21	4.52	7.21
14	3.74	5.32	6.62	7.66	7.90	7.64	6.97	5.59	4.35	3.21	4.52	7.65
15	3.77	5.31	6.64	7.67	7.90	7.62	6.92	5.56	4.31	3.21	4.56	7.36
16	3.85	5.32	6.67	7.67	7.90	7.62	6.89	5.53	4.26	3.51	4.60	6.96
17	3.94	5.34	6.73	7.70	7.90	7.62	6.85	5.50	4.20	6.51	4.64	6.87
18	4.04	5.38	6.74	7.72	7.89	7.63	6.79	5.47	4.14	5.21	4.70	6.87
19	4.12	5.40	6.75	7.72	7.87	7.64	6.69	5.44	4.09	4.40	6.22	6.87
20	4.21	5.42	6.77	7.72	7.86	7.66	6.66	5.40	4.06	4.06	5.72	6.87
21	4.28	5.44	6.79	7.73	7.86	7.67	6.59	5.37	4.03	3.93	5.30	6.92
22	4.37	5.53	7.70	7.73	7.87	7.68	6.54	5.32	3.99	3.88	5.19	7.66
23	4.46	5.56	7.32	7.74	7.84	7.68	6.48	5.28	3.94	3.87	5.16	8.36
24	4.52	5.56	7.15	7.75	7.81	7.68	6.42	5.25	3.90	3.87	5.16	8.36
25	4.56	5.57	7.12	7.75	7.79	7.68	6.38	5.22	3.85	3.87	5.17	8.79

Kurfee well at Mocksville - Continued

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1932												
26	4.59	5.60	7.14	7.75	7.79	7.67	6.33	5.19	3.81	3.87	7.75	8.80
27	4.64	5.65	7.19	7.74	7.78	7.65	6.30	5.16	3.77	3.89	6.83	8.92
28	4.66	5.69	7.26	7.72	7.76	7.63	6.25	5.12	3.74	3.91	6.13	9.10
29	4.69	5.70	7.24	7.72	7.72	7.60	6.20	5.08	3.70	3.92	5.87	8.90
30	4.86	....	7.24	7.73	7.69	7.57	6.14	5.04	3.65	3.93	5.81	8.73
31	4.86	....	7.34	....	7.68	....	6.09	5.01	....	3.93	....	8.75
1933												
1	8.67	10.02	11.46	10.94	10.67	10.13	8.87	7.31	6.21	5.55	4.59	3.66
2	8.71	10.04	11.45	10.94	10.67	10.08	8.82	7.26	6.17	5.51	4.56	3.63
3	8.81	10.03	11.42	10.93	10.68	10.06	8.77	7.22	6.14	5.48	4.52	3.62
4	8.90	10.06	11.38	10.86	10.58	10.03	8.68	7.18	6.10	5.46	4.48	3.60
5	8.96	10.04	11.24	10.78	10.70	10.00	8.65	7.12	6.12	5.45	4.45	3.58
6	8.96	9.95	11.24	10.82	10.74	10.00	8.62	7.05	6.13	5.42	4.43	3.58
7	9.02	10.44	11.46	10.81	10.68	9.96	8.59	7.00	6.08	5.40	4.40	3.84
8	9.04	10.91	11.47	10.76	10.68	9.92	8.54	6.97	6.04	5.37	4.36	3.67
9	9.78	10.32	11.36	10.73	10.66	9.90	8.50	6.94	6.03	5.32	4.32	3.58
10	9.49	10.27	11.30	10.71	10.63	9.84	8.46	6.90	6.02	5.28	4.28	3.52
11	9.60	10.41	11.23	10.70	10.58	9.78	8.42	6.87	6.00	5.24	4.24	3.48
12	10.05	10.42	11.22	11.12	10.57	9.77	8.35	6.82	5.97	5.22	4.21	3.44
13	9.78	10.43	11.23	10.80	10.57	9.74	8.28	6.77	6.13	5.19	4.20	3.41
14	9.78	10.51	11.24	10.79	10.57	9.64	8.23	6.72	6.04	5.16	4.16	3.38
15	9.80	11.03	11.23	10.84	10.54	9.57	8.20	6.63	5.98	5.12	4.12	3.35
16	9.85	10.87	11.07	10.90	10.54	9.55	8.16	7.25	5.95	5.09	4.09	3.32
17	9.92	10.88	11.05	10.91	10.52	9.53	8.10	6.92	5.93	5.09	4.05	3.29
18	9.96	10.90	11.06	10.91	10.48	9.48	8.04	6.83	5.91	5.06	4.03	3.26
19	10.00	10.88	11.07	10.91	10.44	9.42	7.96	6.71	5.89	5.00	4.01	3.29
20	10.00	11.64	11.18	10.90	10.44	9.39	7.92	6.65	5.88	4.97	3.98	3.97
21	10.00	11.42	11.31	10.89	10.44	9.35	7.88	6.59	5.85	4.94	3.94	3.63
22	9.97	11.33	11.09	10.89	10.42	9.30	7.82	6.55	5.82	4.91	3.92	3.45
23	9.96	11.40	11.05	10.88	10.37	9.24	7.76	6.55	5.78	4.89	3.89	3.35
24	10.01	11.42	10.99	10.87	10.34	9.17	7.72	6.52	5.75	4.86	3.85	3.27
25	10.21	11.51	10.98	10.90	10.32	9.12	7.67	6.48	5.72	4.84	3.82	3.21
26	10.14	11.55	11.02	10.89	10.29	9.09	7.63	6.43	5.70	4.80	3.80	3.48
27	10.16	11.47	10.98	10.80	10.26	9.05	7.58	6.39	5.67	4.78	3.77	3.41
28	10.08	11.46	10.97	10.76	10.21	9.00	7.52	6.36	5.65	4.73	3.75	3.27
29	10.02	.....	10.96	10.71	10.14	8.95	7.43	6.32	5.62	4.68	3.71	3.19
30	10.02	.....	10.92	10.67	10.21	8.91	7.41	6.27	5.58	4.65	3.68	3.18
31	10.02	.....	10.92	.....	10.18	.....	7.37	6.24	....	4.62	....	3.18
1934												
1	3.29	3.26	4.82	6.39	7.90	7.71	8.18	7.28	8.65	8.72	8.65	8.78
2	3.23	3.23	4.41	6.11	7.95	7.67	8.17	7.27	8.65	8.71	8.57	8.21
3	3.18	3.18	7.61	6.03	7.99	7.66	8.09	7.23	8.69	8.71	8.51	8.09
4	3.18	3.18	7.75	6.03	8.00	7.76	8.03	7.21	8.72	8.71	8.51	8.10
5	3.22	3.18	6.54	6.04	8.00	8.73	7.99	7.18	8.72	8.71	8.48	8.11
6	3.19	3.18	5.72	6.09	8.00	8.51	7.93	7.14	8.72	8.78	8.43	8.20
7	3.42	3.18	5.16	6.15	8.00	8.37	7.88	8.09	8.72	8.75	8.40	8.29
8	3.54	3.18	4.87	6.18	7.99	8.31	7.90	8.01	8.73	8.69	8.35	8.34
9	3.31	3.18	4.78	9.14	7.97	8.34	7.93	7.62	8.71	8.67	8.25	8.37
10	3.20	3.18	4.76	8.24	7.97	8.42	7.86	7.53	8.70	9.14	8.21	8.40
11	3.18	3.18	4.76	7.65	7.97	8.49	7.81	7.51	8.70	9.15	8.20	8.42
12	3.22	3.18	4.78	7.41	7.95	8.53	7.79	7.52	8.69	9.00	8.16	8.40
13	3.23	3.18	4.81	7.31	7.94	8.54	7.79	7.54	8.60	8.93	8.13	8.41
14	3.19	3.18	4.87	7.28	7.93	8.55	7.79	7.56	8.62	8.89	8.09	8.40
15	3.18	3.18	4.91	7.27	8.11	8.56	7.77	7.57	8.63	8.89	8.01	8.36
16	3.18	3.18	4.95	7.95	8.06	8.57	7.73	7.58	9.09	8.90	7.96	8.35
17	3.18	3.18	4.97	7.68	7.96	8.57	7.70	7.59	8.86	8.90	7.93	8.35
18	3.18	3.18	5.02	7.61	7.92	8.57	7.66	7.96	8.77	8.91	7.90	8.33
19	3.18	3.18	5.04	7.61	7.90	8.57	7.62	8.47	8.75	8.91	7.86	8.35
20	3.18	3.18	5.32	7.64	7.89	8.54	7.59	8.12	8.74	8.90	7.82	8.45
21	3.18	3.17	5.27	7.67	7.87	8.51	7.57	8.03	8.74	8.90	7.77	8.33
22	3.18	3.17	5.22	7.69	7.87	8.49	7.54	8.03	8.74	8.90	7.74	8.30
23	3.18	3.17	5.19	7.73	7.86	8.48	7.48	8.06	8.72	8.89	7.72	8.22
24	3.18	3.17	5.32	7.78	7.83	8.45	7.49	8.14	8.70	8.85	7.68	8.21
25	3.18	4.23	5.69	7.80	7.81	8.41	7.43	8.58	8.70	8.84	7.60	8.21
26	3.18	9.08	5.45	7.82	7.76	8.37	7.40	8.47	8.70	8.83	7.54	8.21
27	3.18	6.92	6.46	7.87	7.73	8.33	7.37	8.37	8.68	8.80	7.50	8.15
28	3.18	5.62	7.58	7.88	7.71	8.28	7.35	8.36	8.64	8.74	7.42	8.13
29	3.18	....	6.61	7.88	7.77	8.23	7.35	8.36	9.15	8.71	8.81	8.16
30	3.18	....	6.18	7.88	7.93	8.19	7.35	9.02	8.82	8.67	8.36	8.13
31	3.18	....	6.98	....	7.80	....	7.31	8.71	....	8.66	....	8.42

Kurfee well at Mocksville - Continued

Day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1935												
1	9.40	9.30	9.86	12.13	12.31	11.13	9.78	8.81	7.65	7.01	5.86	5.50
2	8.85	9.34	9.90	12.04	12.28	11.08	9.73	8.77	7.61	6.98	5.83	5.45
3	8.72	9.43	9.90	12.04	12.24	11.07	9.66	8.73	7.58	6.95	5.81	5.42
4	8.65	9.40	9.88	12.05	12.18	11.07	9.63	8.71	7.62	6.92	5.77	5.41
5	8.63	9.32	9.80	12.06	12.14	11.03	9.61	8.67	8.02	6.86	5.75	5.39
6	8.68	9.28	9.93	12.17	12.13	10.96	9.59	8.63	7.99	6.82	5.71	5.37
7	8.74	9.21	9.96	12.23	12.11	10.90	9.54	8.61	7.72	6.78	6.65	5.32
8	8.78	9.22	9.88	12.47	12.03	10.88	9.53	8.57	7.63	6.75	6.16	5.31
9	9.29	9.26	9.77	12.24	11.98	10.84	9.54	8.52	7.62	6.72	5.82	5.39
10	9.16	9.32	9.78	12.16	11.96	10.80	9.66	8.48	7.63	6.68	5.70	5.34
11	9.09	9.27	9.86	12.14	11.93	10.77	9.47	8.45	7.58	6.63	5.65	5.29
12	9.01	9.21	11.96	12.18	11.88	10.72	9.42	8.40	7.57	6.56	5.63	5.38
13	9.02	9.86	11.36	12.19	11.86	10.65	9.41	8.36	7.57	6.50	6.54	6.48
14	9.07	10.43	10.94	12.14	11.84	10.60	9.38	8.33	7.56	6.46	6.07	5.97
15	9.06	10.40	10.86	12.14	11.78	10.55	9.34	8.28	7.54	6.43	5.81	5.55
16	9.08	9.96	10.89	12.13	11.72	10.50	9.30	8.22	7.56	6.36	5.74	5.46
17	9.10	9.91	10.94	12.08	11.70	10.45	9.23	8.18	7.47	6.33	5.73	5.34
18	9.08	9.88	10.92	12.05	11.64	10.41	9.18	8.16	7.44	6.32	5.72	5.32
19	9.04	9.91	10.95	12.03	11.59	10.38	9.15	8.12	7.41	6.30	5.71	5.31
20	9.04	9.92	11.03	12.00	11.60	10.35	9.14	8.09	7.39	6.26	5.70	5.30
21	9.07	9.92	10.98	12.76	11.64	10.30	9.13	8.17	7.35	6.23	5.69	5.28
22	9.32	9.80	10.92	12.59	11.54	10.28	9.11	8.08	7.30	6.19	5.68	5.27
23	9.55	10.04	10.89	12.50	11.49	10.19	9.08	8.02	7.26	6.16	5.65	5.27
24	9.39	9.96	10.89	12.52	11.54	10.12	9.05	7.98	7.21	6.12	5.60	5.25
25	9.30	9.97	11.64	12.52	11.46	10.07	9.02	7.93	7.18	6.07	5.58	5.24
26	9.30	10.10	11.60	12.49	11.36	10.03	8.98	7.90	7.15	6.05	5.57	5.24
27	9.30	10.06	11.37	12.48	11.32	9.97	8.94	7.88	7.14	6.03	5.55	5.22
28	9.28	9.88	11.40	12.46	11.28	9.92	8.92	7.83	7.12	6.02	5.68	5.21
29	9.29	.....	11.35	12.42	11.26	9.87	8.91	7.79	7.09	6.02	5.70	5.20
30	9.30	.....	11.38	12.40	11.25	9.83	8.86	7.75	7.04	5.94	5.56	5.19
31	9.30	.....	11.72	.....	11.20	.....	8.84	7.69	....	5.89	....	5.16

Freuhler well, at Roanoke Rapids

In rear of warehouse on property of Mr. Freuhler, 500 feet north of U. S. Highway 158 and half a mile west of Seaboard Air Line Railway station, at a sharp turn in the road. Dug well 15 feet deep, lined with terra cotta pipe that extends 2 feet above the land surface; in a shallow swale several acres in extent. The well is covered, and the surface drainage is away from the well. Equipped with a continuous water-stage recorder. Measuring point, top of instrument shelf, about 2½ feet above the land surface. The arbitrary datum is 15 feet below the measuring point. The water levels are given in feet above this datum. Three bench marks set in nearby objects and referred to measuring point by instrumental levels.

Water levels in the Freuhler well, at Roanoke Rapids,

expressed in feet above the arbitrary datum

Date	Water level	Date	Water level	Date	Water level	Date	Water level
1932		1933		1934		1935	
May 1	5.17	May 1	8.04	Apr. 1	7.28	Mar. 1	7.23
June 1	4.46	June 1	7.59	May 1	7.14	Apr. 1	8.50
July 1	4.37	July 1	6.38	June 1	7.02	May 1	8.73
Aug. 1	3.62	Aug. 1	6.57	July 1	6.09	June 1	7.07
Sept. 1	3.17	Sept. 1	5.66	Aug. 1	6.18	July 1	6.03
Oct. 1	2.49	Oct. 1	4.94	Sept. 1	5.51	Aug. 1	7.39
Nov. 1	2.98	Nov. 1	4.14	Oct. 1	5.91	Sept. 1	6.70
Dec. 1	4.12	Dec. 1	3.45	Nov. 1	5.02	Oct. 1	7.50
1933		1934		Dec. 1	6.66	Nov. 1	6.33
Feb. 1	7.13	Jan. 1	2.82	1935		Dec. 1	6.35
Mar. 1	7.41	Feb. 1	2.45	Jan. 1	5.87	31	5.95
Apr. 1	7.53	Mar. 1	3.45	Feb. 4	6.40		

Holt well, at Haw River

In front yard of J. W. Thompson residence on south side of Haw River--Graham highway, a quarter of a mile west of the Haw River. Dug well 7 feet in diameter and 61 feet deep, lined with brick and completely housed. Equipped with a float-tape gage. Measured about weekly. Measuring point, top of timber sill over well, about 4½ feet above the land surface. The arbitrary datum is 33.50 feet below the measuring point. The water levels are given in feet above this datum. Two bench marks have been set in nearby objects and referred to measuring point by instrumental levels.

Water levels in the Govenor Holt well, at Holt River,

expressed in feet above the arbitrary datum

Date	Water level	Date	Water level	Date	Water level	Date	Water level
1932		1933		1934		1935	
June 16	7.65	Apr. 4	6.90	Feb. 5	2.24	Jan. 7	7.47
July 6	6.23	May 9	6.06	Mar. 13	3.78	Feb. 4	7.56
Aug. 9	3.98	June 1	4.90	Apr. 10	9.08	Mar. 6	6.97
Sept. 6	3.27	July 3	3.68	May 8	5.32	Apr. 3	11.83
Oct. 4	3.00	Aug. 1	3.46	June 5	7.52	May 12	9.52
Nov. 4	3.16	Sept. 6	3.40	July 16	5.67	June 1	9.48
Dec. 5	5.01	Oct. 4	2.98	Aug. 23	4.98	Aug. 24	3.50
1933		Nov. 1	2.98	Sept. 4	4.09	Sept. 4	3.48
Jan. 3	9.74	Dec. 1	2.60	Oct. 8	5.74	Oct. 9	3.40
Feb. 8	7.60	1934		Nov. 7	4.29	Nov. 18	4.30
Mar. 7	8.94	Jan. 1	2.51	Dec. 3	7.52	Dec. 19	5.09

Fishdam well, near Northside

On the bottom lands on the left bank of the Neuse River, half a mile above Fishdam Bridge, 60 feet south of old Fishdam Plantation house, and 2 miles west of Northside, about 1 mile downstream from point where U. S. highway 15 crosses the Neuse River. Dug well 4 feet in diameter and 25 feet deep, lined with rock and poorly covered. Flooded by river occasionally. Equipped with float-tape gage and measured about weekly. Measuring point, nail head in timber at side of well. The arbitrary datum is 15 feet below the measuring point. The water levels are given in feet above this datum. Three bench marks have been set in nearby objects and referred to the measuring point by instrumental levels.

Date	Water level	Date	Water level	Date	Water level	Date	Water level
1932		1933		1934		1935	
July 2	7.05	June 3	5.42	Apr. 1	7.97	Feb. 4	8.50
Aug. 2	3.67	July 1	3.85	May 6	7.68	Mar. 4	8.00
Sept. 3	3.00	Aug. 6	3.30	June 3	7.85	July 1	5.62
Oct. 1	2.50	Sept. 2	3.87	July 8	5.52	Aug. 5	6.26
Nov. 5	4.30	Oct. 9	2.63	Aug. 5	6.50	Sept. 2	4.26
Dec. 3	7.45	Nov. 5	2.30	Sept. 3	6.60	Oct. 7	4.97
1933		Dec. 11	2.40	Oct. 1	7.78	Nov. 4	4.31
Feb. 3	9.90	1934		Nov. 5	5.45	Dec. 2	6.68
Mar. 5	8.67	Jan. 7	1.82	Dec. 10	9.52	25	7.98
Apr. 1	8.20	Feb. 4	1.84	1935			
May 15	7.32	Mar. 11	5.59	Jan. 7	8.52		

Alston well, at Cockrell Bridge, near Nashville

Half a mile north of Cockrell Bridge over the Tar River, 60 feet east of State highway 58, and to right of small house. Dug well 30 inches in diameter and 25 feet deep, lined with tile, timber box over the well. Equipped with a float-tape gage, which is read twice a week. Measuring point, indicator on float-tape gage. The arbitrary datum is 25.31 feet below the indicator of the float-tape gage, or 23.40 feet below the top of the instrument shelf, which is about 2 feet above the land surface. The water levels are given in feet above this datum. No bench marks.

Water levels in the Alston well, at Cockrell Bridge, near Nashville,

expressed in feet above the arbitrary datum

Date	Water level	Date	Water level	Date	Water level	Date	Water level
1932		1933		1934		1935	
Aug. 6	8.66	Aug. 2	9.93	June 2	11.84	May 1	13.92
Sept. 4	10.63	Sept. 2	8.86	July 4	12.62	June 1	13.54
Oct. 1	6.59	Oct. 4	7.62	Aug. 1	11.48	July 3	10.70
Nov. 2	6.56	Nov. 1	6.56	Sept. 1	13.00	Aug. 3	12.72
Dec. 3	8.79	Dec. 2	5.80	Nov. 3	10.96	Sept. 4	11.92
1933		1934		Dec. 1	12.46	Oct. 2	12.03
Jan. 3	13.45	Jan. 3	5.51	1935		Nov. 2	10.29
Apr. 1	13.13	Feb. 3	5.49	Jan. 2	13.92	Dec. 4	10.99
May 3	12.95	Mar. 3	5.52	Feb. 6	13.55	28	12.00
June 3	11.42	Apr. 4	9.42	Mar. 2	13.74		
July 1	9.85	May 2	12.45	Apr. 3	13.54		

Brick pit near Goldsboro

Opposite house of Mary Teachey Moores, on property of Borden Brick & Tile Co., 200 feet east of U. S. highway 117. About 3⅛ miles south of Goldsboro. Open abandoned borrow pit of brick plant about 3 acres in extent. No surface inflow except when the Neuse River, 200 yards to the west, overflows into the pit. Measuring point, enamel-scale staff gage. The staff gage is set so that the zero mark on it is 12 feet above the zero datum of the nearby gaging station on the Neuse River. The water levels are given in feet above the arbitrary datum or zero mark on the staff gage in the pit. Two bench marks have been set in nearby objects and referred to the staff gage by instrumental levels.

Water levels in the brick pit near Goldsboro,

expressed in feet above the arbitrary datum

Date	Water level	Date	Water level	Date	Water level	Date	Water level
1932		1933		1934		1935	
June 1	3.30	May 6	4.88	Apr. 7	1.52	Mar. 3	5.18
July 2	2.82	June 2	4.28	May 4	2.18	Apr. 6	4.74
Aug. 6	2.12	July 8	3.24	June 2	2.20	May 4	4.44
Sept. 3	1.62	Aug. 5	2.62	July 7	3.40	June 1	3.72
Oct. 1	1.22	Sept. 2	2.56	Aug. 4	5.08	July 6	2.92
Nov. 5	1.30	Oct. 7	2.00	Sept. 1	4.24	Aug. 3	3.10
Dec. 3	2.08	Nov. 4	1.54	Oct. 8	3.94	Sept. 7	2.96
1933		Dec. 2	1.22	Nov. 3	2.22	Oct. 5	3.68
Jan. 7	3.42	1934		Dec. 1	2.92	Nov. 2	3.04
Feb. 4	4.04	Jan. 6	.90	1935		Dec. 7	2.66
Mar. 4	4.70	Feb. 17	.72	Jan. 5	(1)	28	3.26
Apr. 1	4.30	Mar. 3	.78	Feb. 2	5.66		

1 Over gage.

Huffine well, at Huffine's mill, near Gibsonville

Half a mile south of Huffine's mill, at northeast corner of road intersection, about 6 miles northwest of Gibsonville. Dug well 18 inches in diameter and 36 feet deep, lined with terra cotta pipe and covered with a well house. Equipped with a float-tape gage that is read at irregular periods. Measuring point, center of board across top of well. The arbitrary datum is 37.02 feet below the measuring point. The water levels are given in feet above this datum. Three bench marks have been set in nearby objects and referred to the measuring point by instrumental levels.

Water levels in Huffine well, at Huffine's mill, near Gibsonville,

expressed in feet above the arbitrary datum

Date	Water level	Date	Water level	Date	Water level	Date	Water level
1932		1933		1934		1935	
Aug. 2	3.2	May 1	6.4	Mar. 7	9.0	Jan. 12	5.1
Sept.12	3.2	June 2	7.3	May 1	8.8	Feb. 8	4.9
Oct. 1	2.8	July 14	7.3	June 7	4.7	Mar. 14	7.4
5	7.2	Aug. 5	5.3	July 5	5.4	Apr. 11	4.3
Nov. 5	6.4	Sept. 2	4.9	Aug. 4	5.2	May 8	7.1
Dec. 2	7.1	Oct. 28	3.5	Sept. 1	4.6	June 7	7.9
1933		Nov. 13	6.8	Oct. 4	5.2	July 1	6.4
Jan. 3	9.1	Dec. 1	6.7	Nov. 16	4.1	Aug. 27	6.7
Feb. 8	6.9	1934		Dec. 3	5.2	Sept.20	6.2
Mar. 13	6.8	Jan. 7	4.5			Dec. 15	5.5
Apr. 13	4.1	Feb. 5	4.9				

Baldwin well, at Blantyre

On west side of Baldwin's house, at crossing of U. S. highway 64 near Blantyre, about 200 yards west of the depot. Dug well 5 feet in diameter and 41 feet deep, lined with rock, curbed and covered. Equipped with float-tape gage and read daily. Measuring point, top of nail driven in side of timber well cover near trap door, about 1 foot above land surface. The arbitrary datum is 41 feet below the measuring point. The water levels are given in feet above this datum. Two bench marks have been set in nearby objects and referred to the measuring point by instrumental levels.

Water levels in the Baldwin well, near Blantyre,

expressed in feet above the arbitrary datum

Date	Water level	Date	Water level	Date	Water level	Date	Water level
1932		1933		1934		1935	
July 15	9.46	Mar. 1	11.28	Oct. 19	6.36	June 1	9.37
Aug. 1	8.98	Apr. 1	11.86	Nov. 16	6.53	July 1	9.00
Sept. 1	8.47	May 1	11.94	Dec. 1	6.61	Aug. 1	7.73
Oct. 1	7.89	June 1	11.93	1935		Sept. 1	6.75
Nov. 1	7.53	July 1	10.89	Jan. 1	6.96	Oct. 1	6.43
Dec. 1	7.95	Aug. 1	9.26	Feb. 1	7.38	Nov. 1	5.53
1933		Sept. 1	7.91	Mar. 1	8.05	Dec. 11	5.72
Jan. 1	9.17	Oct. 1	6.94	Apr. 1	8.68	31	5.82
Feb. 1	10.40			May 1	9.12		

DEEP RIVER AREA OF SOIL CONSERVATION SERVICE

An observation-well program was started in the Deep River area, in Guilford, Forsyth, and Randolph Counties, near High Point, N. C., during the summer of 1934 by the Geological Survey in cooperation with the Soil Conservation Service, as part of a national soil-conservation program. A total of 28 wells have been measured, 4 of which, however, have been abandoned.

The wells in this area are all dug wells. Wells 1, 2, 4, 10, and 15 are cased with tile; wells 5, 6, 14, 17, 21, 23, and 27 with loose rock; and wells 7, 8, 12, 13, 18, 19, 20, 24, and 25 with brick. The wells range in depth from about 11 to 54 feet. They penetrate the

weathered granite and associated rocks of the Piedmont Plateau. They are water-table wells, unaffected by heavy withdrawals. The depth to water level in the different wells ranges from about 5 to 50 feet. As a rule the measuring point is the edge of a hole in the platform covering the well.

Weekly measurements have been made by members of either the Geological Survey or the Soil Conservation Service. A total of 1,750 measurements have been made from the beginning of the program to January 1, 1936, of which 1,190 were made during the year 1935 -- an average of 51 measurements to the well for the year. Only the records of measurements that were made nearest to the first of each month are given in the following table. The method of expressing the results of the measurements is explained in the introduction to this report. An automatic water-stage recorder has been maintained on well 1 since July 1934, and two others have been in continuous operation but have been shifted from well to well in order to get continuous records for short periods on all the wells.

The monthly averages of the water levels in the observation wells in this area show a fluctuation during 1935 of about 4.5 feet. The maximum fluctuation in any of the wells was about 16 feet and the minimum about 0.5 foot. As a rule the relatively deep wells fluctuated less than the shallow wells. On April 2, 1935, the water levels reached their highest stage for the year, the average being 2.85 feet higher than on December 3, 1934. From April 2 to November 29 they declined an average of 4.44 feet. On December 27 the water levels stood about the same as during November, but by January 3, 1936, the average of the levels was 2.74 feet higher than the average on November 29 and 1.77 feet higher than the average on January 8, 1935. The second table shows that in several of the observation wells the water levels fluctuate greatly. The rise in some of these wells just prior to January 3, 1936, appears to have been especially great. Further study must be made of these wells and the character of the material through which they extend, together with their weekly records and the daily precipitation, before the significance of their fluctuations can be fully understood.

Wells in the Deep River area in Guilford, Forsyth, and Randolph Counties, N. C.

(The depth to the water level given in the next to last column is the depth below the measuring point on Jan. 1, 1935. The height of the measuring point, given in the last column, is its height with reference to the arbitrary datum.)

Well no.	Owner and location	Depth (feet)	Diameter (inches)	Depth to water level (feet)	Height of measuring point (feet)
1	M. L. Willard, Deep River church	30	24	27.50	37.50
2	Lindale Dairy Corporation, near High Point	39	18	28.75	38.75
4	W. O. Atkins, near Colfax	34	18	32.85	42.85
5	Isaac Tonkins, Groomtown	54	48	47.15	57.15
6	D. G. Berry, near Providence	32	36	18.23	28.23
7	E. J. Welch, near High Point	28.5	34	23.57	33.57
8	Welch place, 1304 E. Lexington Ave., High Point	34	32	27.64	37.64
10	W. F. Beason, near Cedar Square Church	30	20	27.00	37.00
12	John Blair estate, 1 mile SE. of High Point	37	30	37.10	47.10
13	Blair's dairy, 1 3/4 miles SE. of High Point	36.5	36	35.34	45.34
14	Clodfelter's dairy, 2 miles SE. of High Point	23.5	24	19.00	29.00
15	C. C. Robbins, 2¼ miles SE. of High Point	11	18	5.00	15.00
17	C. W. Fields, 2½ miles NW. of Climax	40	36	22.50	32.50
18	Federal transient camp, 1/2 mile SE. of Kernersville	22.5	30	22.73	32.73
19	W. C. Michael, 1/2 mile S. of Kernersville	48	36	46.47	56.47
20	Dr. Bush, Archdale	27	30	24.30	34.30
21	J. W. Young, 2⅛ miles W. of Randleman	31	24	28.00	38.00
23	Mrs. Lonnie Pugh, New Salem	48.5	30	46.00	56.00
24	H. L. Miller, 2½ miles SW. of Trinity	31	22	11.00	21.00
25	J. S. White, 1½ miles S. of Trinity	36	36	29.00	39.00
27	Walter Lambeth, 4 miles SW. of Trinity	27	18	24.40	34.40

Water levels in wells in the Deep River area in Guilford, Forsyth, and Randolph Counties, N. C., in feet above the arbitrary datum

Date	1	2	4	5	6	7	8	10
1934								
Dec. 3-7	9.75	8.57	10.15	10.05	7.07	10.10	9.33	9.04
1935								
Jan. 8	10.25	10.00	10.05	9.92	7.70	9.99	10.34	10.24
Jan. 29-30	10.56	9.65	.....	9.89	8.45	9.92	10.87	10.54
Mar. 5	10.85	10.40	10.56	9.98	9.70	9.80	11.48	11.54
Apr. 2	12.16	11.14	11.01	10.09	17.41	10.32	15.40	12.29
30	12.37	11.94	11.51	10.36	14.43	11.37	15.11	13.79
June 3	12.17	12.32	12.11	10.47	12.35	10.82	14.06	13.65
July 1	10.12	12.11	12.33	10.49	6.97	10.62	12.78	.....
29	10.31	12.14	12.20	10.53	5.20	10.49	12.84	.....
Sept. 2	9.36	11.62	11.72	10.41	2.52	10.31	11.31	8.46
30	9.33	11.50	11.27	10.32	2.13	10.30	10.77	7.89

Water levels in wells in the Deep River area - Continued

Date	1	2	4	5	6	7	8	10
1935								
Nov. 1	8.81	10.88	10.74	10.17	1.00	10.17	9.94	7.06
29	9.02	10.51	.....	10.13	2.05	10.09	.....	7.05
1936								
Jan. 3-4	12.59	10.27	10.62	10.67	17.28	10.74	13.48	8.04

Date	12	13	14	15	17	18	19	20
1934								
Dec. 3-7	9.26	9.64	9.97	11.76	9.98	9.83	9.09	.....
1935								
Jan. 8	10.08	10.05	10.10	11.21	10.23	10.02	10.02	10.13
Jan. 29-30	10.35	10.45	10.26	10.04	10.71	10.12	10.01	10.50
Mar. 5	10.75	10.52	10.94	9.51	11.69	10.40	10.15	11.15
Apr. 2	11.31	11.22	12.74	12.76	14.95	10.96	10.31	11.85
30	.....	.....	13.04	11.01	14.07	11.26	10.45	12.46
June 3	12.26	11.98	.....	11.39	14.22	11.50	10.75	12.73
July 1	11.62	11.37	11.94	7.61	11.54	11.29	10.93	.....
29	11.71	11.11	11.47	9.56	10.23	10.98	11.05	.....
Sept. 2	10.92	10.48	10.75	6.14	8.46	10.42	11.06	11.32
30	10.62	10.06	10.32	6.14	7.65	10.05	10.99	10.83
Nov. 1	9.94	9.59	9.82	4.84	6.52	9.62	10.81	10.21
29	9.69	9.09	9.60	5.65	5.92	.....	10.62	9.84
1936								
Jan. 3-4	9.50	8.91	10.88	13.27	11.05	9.48	.....	9.72

Date	21	23	24	25	27	Average
1934						
Dec. 3-7	.....	.....	9.52	.....	12.73	9.75
1935						
Jan. 8	.....	.....	11.58	.....	10.42	10.13
Jan. 29-30	9.70	10.14	10.70	9.46	10.56	10.14
Mar. 5	10.34	9.37	10.88	8.94	11.31	10.51
Apr. 2	12.18	13.95	16.40	12.05	14.19	12.60
30	11.68	11.76	11.99	12.49	11.78	12.25
June 3	11.57	12.05	8.42	11.69	10.39	11.85
July 1	9.88	12.04	5.92	10.67	9.72	10.53
29	9.60	12.00	4.77	10.08	10.34	9.83
Sept. 2	7.84	11.39	3.53	9.10	8.42	9.30
30	7.70	10.88	2.92	8.69	8.88	9.01
Nov. 1	6.70	10.11	2.15	8.01	8.17	8.34
29	7.39	9.64	2.18	7.86	10.59	8.16
1936						
Jan. 3-4	15.65	14.51	.....	8.07	21.31	11.90

OKLAHOMA

STILLWATER CREEK AREA OF SOIL CONSERVATION SERVICE

An observation-well program was started in the Stillwater Creek area, near Stillwater, Oklahoma, in the spring of 1934 by the Geological Survey in cooperation with the Soil Conservation Service as part of a national soil-conservation program. This area is located in the South-Central Paleozoic ground-water province. A total of 17 wells have been measured. Two of these wells have since been abandoned, but weekly measurements have been made on the others by members of either the Geological Survey or the Soil Conservation Service. A total of 1,285 measurements have been made from the beginning of the program to January 1, 1936, of which 650 were made during 1935 -- an average of 50 measurements to the well during the year. A water-stage recorder has been in operation on well 17 since the beginning of the program.

The wells are in an area of gentle topography and penetrate thin alluvium or shaly or sandy rocks of lower Permian age. They range in depth from 21 to 47 feet and in diameter from 6 to 8 inches. They are all drilled except well 17, which is dug. All but two are cased with galvanized iron; well 11 is uncased, and well 17 is cased with rock. They range from about 5 to 40 feet in depth to water level. At each well two 4 by 4 inch posts were driven to a solid foundation, and a 4 by 4 inch cross bar was bolted at the top of these upright posts, and a sharp-edged iron plate was fastened to the cross bar to mark the measuring point. A bench mark was placed near each well, and the measuring point was instrumentally tied to it, but no attempt has been made to determine the altitude of the measuring points with respect to sea level. Only the records of measurements that were obtained nearest to the first of each month are given in this report. The method of expressing the results is explained in the introduction.

On June 2, 1934, the water levels in the observation wells stood on an average 10.77 feet above the arbitrary datum planes. They gradually declined during the growing season, which was also a period of low rainfall, and by August 31, 1934, they were down to an average of only 8.74 feet. The rainfall amounted to about 7.5 inches in September, 1.68 inches in October, and about 4 inches in November; responding to this rainfall, the average of the water levels rose to 9.68 feet by the end of September and to 10 feet by January 1, 1935.

Rainfall of only 0.78 inch in December 1934 and 0.72 inch in January 1935 permitted the water levels to decline slightly during January, but they showed a small recovery in February, which had 1.18 inches of rain. The rainfall amounted to 3.20 inches in March, 2.00 inches in April, and 3.59 inches in May. The water levels, in response to this rainfall, reached an average of 11.25 feet by July 1. In July the rainfall was less than half an inch, and the water levels declined sharply. There was a rainfall of 2.67 inches in August, 2.50 inches in September, 1.87 inches in October, and 2.96 inches in November. This rainfall was essentially required to supply the demands of the vegetation to replenish the soil moisture, with the result that the water levels continued to decline until the early part of December. The water levels averaged 9.19 feet on December 2, but in December there was 1.67 inches of rainfall, and by December 30 the water levels rose to an average of 9.43 feet. Thus the average was 0.58 foot lower at the end of 1935 than at the beginning of the year.

Wells in the Stillwater Creek area, in Payne County, Okla.

(The depth to the water level given in the next to last column is the depth below the measuring point on Jan. 1, 1935. The height of the measuring point, given in the last column, is its height with reference to the arbitrary datum.)

Well no.	Owner and location	Depth (feet)	Diameter (inches)	Depth to water level (feet)	Height of measuring point (feet)
1	Unknown oil company; SW¼ sec. 15, T. 19 N., R. 4 E.	21.1	8	5.45	15.45
2	J. F. Gilchrist, NW¼ sec. 36, T. 20 N., R. 3 E.	35.2	6	7.85	17.85
3	V. D. Hesser, NW¼ sec. 23, T. 20 N., R. 3 E.	26.8	6	8.47	18.47
4	W. O. Snyder, NW¼ sec. 2, T. 19 N., R. 3 E.	33.9	6	22.21	32.21
7	Charles Focht, NW¼ sec. 20, T. 19 N., R. 3 E.	30.3	6	22.09	32.09
9	Owner unknown, SW¼ sec. 21, T. 20 N., R. 2 E.	40.8	6	23.47	33.47
11	May Jetterman, NW¼ sec. 10, T. 19 N., R. 1 W.	31.1	8	26.16	36.16
12	Mrs. Martie Edwards, NE¼ sec. 13, T. 19 N., R. 1 W.	44.7	6	33.79	43.79
13	Erma T. Pool, SW¼ sec. 23, T. 19 N., R. 1 E.	47.0	7	26.64	36.64
14	E. C. Parks, NW¼ sec. 35, T. 19 N., R. 2 E.	40.4	6	18.00	28.00
15	Lovell Brothers, NE¼ sec. 35, T. 19 N., R. 3 E.	44.8	6	40.12	50.12
17	R. J. Haskett, NE¼ sec. 12, T. 19 N., R. 1 E.	20.5	24	11.20	21.20

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Water levels in wells in the Stillwater Creek area, in Payne County, Okla., in feet above the arbitrary datum

Date	1	2	3	4	7	9	11
1934							
June 2	9.04	10.74	11.09	12.46	11.23	10.06	.....
30	8.54	10.40	9.85	11.26	10.12	10.02	.....
July 28	8.16	9.92	8.50	10.10	9.34	9.43	.....
Aug. 26-31	7.87	9.51	7.68	9.13	8.95	9.29	.....
Sept.29	8.66	9.75	9.52	9.14	9.06	9.57	10.10
Nov. 3	8.97	9.57	8.80	8.91	9.28	9.99	10.56
Dec. 1	10.31	9.76	10.42	9.56	9.34	9.89	10.19
29	10.02	10.00	10.01	10.01	9.99	10.02	10.06
1935							
Feb. 2	9.96	10.07	9.46	10.17	9.97	9.45	9.27
Mar. 2	10.33	10.14	9.87	10.34	10.50	9.22	9.55
30	10.86	10.42	12.05	11.28	11.12	9.24	9.95
Apr. 27	10.48	10.50	11.23	11.80	11.24	9.47	10.16
June 1	10.65	10.57	11.42	12.08	11.53	10.11	10.24
July 1	11.16	10.82	12.01	13.16	12.93	10.46	10.77
29	9.84	10.57	10.12	12.32	11.90	10.49	10.87
Sept. 3	9.83	9.82	7.35	10.68	10.31	9.82	10.79
30	9.31	9.66	6.79	10.01	9.76	9.54	11.08
Nov. 4	9.21	9.43	6.62	9.62	9.28	9.44	10.81
Dec. 2	9.46	9.53	6.31	9.74	8.78	9.25	10.06
30	9.70	10.10	6.67	10.03	9.15	9.32	10.12

Date	12	13	14	15	17	Average
1934						
June 2	.....	.....	.....	.....	.....	10.77
30	.....	.....	.....	.....	.....	10.03
July 28	.....	.....	.....	.....	.....	9.25
Aug. 26-31	.....	.....	.....	.....	.....	8.74
Sept.29	9.81	10.19	10.62	10.06	.....	9.68
Nov. 3	9.98	10.68	10.65	10.28	.....	9.77
Dec. 1	9.97	10.19	10.24	10.00	9.64	9.96
29	10.02	10.06	9.99	9.98	10.00	10.01
1935						
Feb. 2	9.72	9.39	9.75	9.83	10.08	9.76
Mar. 2	9.84	9.80	9.99	10.08	10.28	9.99
30	10.10	9.77	10.06	10.13	10.91	10.49
Apr. 27	10.21	9.41	10.34	9.94	11.11	10.49
June 1	10.33	9.69	10.77	10.12	11.51	10.75
July 1	11.22	9.53	11.08	10.12	11.72	11.25
29	10.48	9.62	11.24	10.12	9.84	10.61
Sept. 3	9.58	9.80	11.20	9.88	9.25	9.91
30	9.42	9.86	11.01	9.86	8.50	9.56
Nov. 4	9.12	9.81	10.37	9.71	9.53	9.41
Dec. 2	8.95	9.14	9.84	9.34	9.87	9.19
30	9.17	9.51	9.82	9.57	10.08	9.43

OREGON

By Arthur M. Piper

Before 1935 there was no continuing regional program of water-level measurements in Oregon; rather, measurements had been made for a year or two in a few widely separated districts and then discontinued. Concurrent data for two or more districts are not available.

In the autumn of 1935 a small beginning was made on a continuing program of water-level measurements in the semiarid region east of the Cascade Mountains; this is being accomplished through cooperation between the United States Geological Survey and the Oregon Water Resources Department. Groups of former observation wells have been reestablished in three districts. Also, through a project of the Works Progress Administration, seven water-table wells have been constructed in one district to be used exclusively for measurements of ground-water levels. The project is being continued in 1936 to afford measurements at similar wells in at least three additional districts. The data from this regional program in 1935 are reported below for the respective districts.

PUBLISHED DATA

Russell,[1] in describing general geologic and hydrologic conditions in southeastern and central Oregon, gives a few general statements as to artesian head but does not list specific measurements.

In 1906-7 Waring made reconnaissance surveys of ground-water conditions over an extensive area on the high semiarid plateau of southeastern Oregon. He reports single measurements of depth to water to the nearest whole foot as follows:[2] For the Christmas and Silver Lake Valleys, in 35 wells and test holes that range in depth from 10 to 247 feet and in submergence from half a foot to 198 feet; for the Harney Basin, in 52 wells; and for the Alvord Valley, in 11 wells. It is inferred that the measurements were made with respect to the land surface. None of the measuring points were tied in by instrumental leveling.

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1 Russell, I. C., Preliminary report on the geology and water resources of central Oregon: U. S. Geol. Survey Bull. 252, 138 pp., 1905.

2 Waring, G. A., Geology and water resources of a portion of south-central Oregon: U. S. Geol. Survey Water-Supply Paper 220, p. 64, 1908; Geology and water resources of the Harney Basin region, Oregon: U. S. Geol. Survey Water-Supply Paper 231, pp. 58-59, 75-76, 1909.

Stearns[3] lists the reported depth to water in 26 wells of the Middle Deschutes River Basin and shows the form of the water table with respect to sea-level datum by a contour map. With two exceptions the measurements of depth to water are listed to whole feet. In depth, the wells range from 18 to 1,690 feet; in submergence, from 5 to 1,033 feet.

In describing the hydrology of the Dalles region of north-central Oregon, Piper[4] gives water-level data for 46 wells, comprising from one to three measurements in each of 18 wells in 1930, and reported single depths to water in 26 wells additional. These wells range in depth from 10 to 1,710 feet; in submergence from 1 to 1,620 feet. Supplemental data are given for three critical wells, as follows: (1) In the 4-year period 1926-30, 92 determinations of water level were made in the municipal well at The Dalles,[5] largely by the city water commission. In addition a water-stage recorder was maintained on this well by the United States Geological Survey through most of June 1930. This well taps the regional zone of saturation. Its water level has been shown to respond faithfully to changes in barometric pressure. (2) In 1930, 121 determinations of water level were made in a relatively deep irrigation well operated by the Cherry Hill District Improvement Co.[6] This well is on a high dissected terrace and taps perched ground water. (3) From January to September, 1930, 28 water-level determinations were made in an irrigation well owned by R. F. Kelley;[7] this well also taps perched ground water. At these three critical wells the altitude of the measuring point with respect to sea-level datum is known from spirit leveling by the city engineer.

UNPUBLISHED DATA

Willamette Valley.--In 1928-29 the United States Geological Survey and the Oregon Agricultural Experiment Station collaborated in a reconnaissance of ground-water conditions in the Willamette Valley of western Oregon. About 1,400 determinations of ground-water level were made as follows: In 269 wells, once or twice during the 2-year period; in 37 wells, monthly from September 1928 to July 1930; in one well, daily from December 1928 until June 1930. Water-stage recorders were maintained

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3 Stearns, H. T., Geology and water resources of the Middle Deschutes River Basin, Oreg.: U. S. Geol. Survey Water-Supply Paper 637, pp. 188-189, 1931.

4 Piper, A. M., Geology and ground-water resources of the Dalles region, Oreg.: U. S. Geol. Survey Water-Supply Paper 659, pp. 170-183, 1932.

5 Idem, p. 159.

6 Idem, pp. 153-155.

7 Idem, p. 153.

at three of these wells for terms of 10 to 21 months. These wells range in depth from 6 to 540 feet, but few of them are more than 150 feet deep. Most of them show the level of the main water table, but some tap perched water and others tap confined water.

In 1935 the United States Engineer Department established 113 observation wells in the valley, including 32 wells in which water levels had been determined by the Geological Survey in 1928-30. Water-level determinations have been made weekly by the Engineer Department in these wells, beginning in October 1935; altogether about 1,100 determinations were made by the end of that year. The following records for 12 typical wells compare ground-water levels in 1928, 1929, and 1935:

Water levels in typical wells of the Willamette Valley, Oregon, in 1928, 1929, and 1935

Measurements of depth to water made by United States Geological Survey prior to and including October 5, 1935; thereafter by United States Engineer Department. Except as indicated, altitudes refer to sea-level datum, general adjustment of 1929, by the United States Engineer Department, by instrumental leveling.

W. J. Gering, lot 3, sec. 4, T. 4 S., R. 2 W. Domestic dug well, 30 inches in diameter and 23 feet deep, concrete-tile casing to 23 feet. Measuring point, top of tile casing at east side, 1.8 feet above land surface, altitude 125.37 feet.

Date	Hour	Depth to water (feet)
Sept. 26, 1928	.....	18.8
July 3, 1929	.....	17.45
Aug. 5	.....	18.75
Sept. 24	.....	20.94
Oct. 27	.....	20.47
Nov. 29	.....	20.70
Dec. 30	.....	20.25
Feb. 2, 1930	.....	18.30
Mar. 2	.....	16.65
30	.....	16.50
Apr. 27	.....	16.65
July 25	.....	18.90
Oct. 3, 1935	12:40 p.m.	18.45
12	7:00 a.m.	18.42
15	12:40 p.m.	18.83
23	3:10 p.m.	18.79
28	10:35 a.m.	18.80
Nov. 4	11:20 a.m.	18.83
11	10:30 a.m.	18.80
18	11:15 a.m.	18.82
Dec. 2	3:50 p.m.	19.07
9	10:35 a.m.	18.59
16	1:45 p.m.	17.74
23	9:00 a.m.	17.68
30	2:00 p.m.	16.78

Johnson School, SE¼SE¼ sec. 34, T. 4 S., R. 2 W. Domestic dug well, 18 inches in diameter and 20 feet deep, concrete-tile casing. Measuring point, top of tile casing, altitude 174.66 feet. Land-surface altitude 172.9 feet, by U. S. Geological Survey, datum of 1927.

Date	Hour	Depth to water (feet)
Sept. 26, 1928	.....	17.9
Oct. 20	.....	18.5
Dec. 17	.....	15.3
Feb. 3, 1929	.....	2.9
Mar. 23	.....	5.45
May 12	.....	6.40
June 7	.....	10.10
July 3	.....	13.6
Aug. 5	.....	16.55
Sept. 24	.....	18.30
Oct. 27	.....	18.95
Nov. 29	.....	19.55
Dec. 30	.....	12.00
Feb. 2, 1930	.....	3.40
Mar. 2	.....	3.45
30	.....	4.75
Apr. 27	.....	7.55
July 22	.....	15.31
Oct. 3, 1935	5:10 p.m.	19.33
10	12:25 p.m.	19.37
15	4:05 p.m.	19.35
23	4:40 p.m.	19.28
28	1:25 p.m.	19.57

Johnson School - Continued

Date	Hour	Depth to water (feet)
Nov. 4, 1935	2:20 p.m.	19.80
11	1:10 p.m.	19.65
18	1:40 p.m.	19.57
Dec. 2	5:20 p.m.	19.22
9	12:10 p.m.	19.61
16	3:30 p.m.	18.67
23	10:35 a.m.	18.24
30	4:10 p.m.	15.61

George Fuller, NW¼NE¼ sec. 13, T. 5 S., R. 5 W. Drilled well, 6 inches in diameter and 64 feet deep, standard steel casing. Measuring point, top of casing, about 0.5 foot above land surface, altitude 151.59 feet.

Sept.24, 1928	.....	20.15
Oct. 21	.....	20.90
Dec. 17	.....	18.75
Feb. 3, 1929	.....	11.2
Mar. 24	.....	12.2
May 12	.....	11.9
June 8	.....	13.45
Aug. 5	.....	17.80
Sept.24	.....	20.75
Oct. 27	.....	21.70
Nov. 29	.....	22.30
Dec. 30	.....	17.50
Feb. 2, 1930	.....	12.60
Mar. 2	.....	10.35
30	.....	11.45
Apr. 27	.....	12.70
July 25	.....	17.83
Oct. 3, 1935	3:00 p.m.	22.15
18	3:35 p.m.	22.35
21	12:00 m.	22.47
28	1:30 p.m.	22.44
Nov. 5	9:40 a.m.	22.80
11	12:30 p.m.	23.08
18	11:00 a.m.	29.42
26	10:15 a.m.	22.75
Dec. 2	3:10 p.m.	22.96
9	1:30 p.m.	22.07
16	12:30 p.m.	21.99
23	12:15 p.m.	20.22
30	12:30 p.m.	18.24

Gideon E. Stolz, SE¼SE¼ sec. 33, T. 6 S., R. 3 W. Drilled well, 8 inches in diameter and 57 feet deep, standard steel casing to 57 feet, perforated at bottom. Measuring point from July 3, 1929, to Nov. 5, 1935, top of 8-inch casing in pit, altitude 118.58 feet; measuring point after Nov. 5, 1935, top of timber pump support at 1-inch bored hole, altitude 133.16 feet. Bench mark is top of concrete pit curb at northwest corner, altitude 132.28 feet. Land-surface altitude about 132 feet.

Gideon E. Stolz - Continued

Date	Hour	Depth to water (feet)
July 3, 1929	.....	10.30
Aug. 3	.....	12.30
Sept.23	.....	14.09
Oct. 26	.....	14.50
Nov. 29	.....	14.75
Dec. 13	.....	14.63
30	.....	10.30
Jan. 12, 1930	.....	10.40
25	.....	10.90
Feb. 2	9:20 a.m.	10.85
Mar. 2	9:00 a.m.	6.34
19	2:45 p.m.	7.77
30	10:10 a.m.	8.25
Apr. 27	11:00 a.m.	9.85
July 24	2:48 p.m.	12.81
Oct. 4, 1935	9:10 a.m.	14.58
11	3:35 p.m.	14.67
16	2:40 p.m.	14.70
24	3:30 p.m.	14.65
29	9:25 a.m.	14.58
Nov. 5	8:15 a.m.	14.17
12	11:45 a.m.	28.68
19	8:50 a.m.	27.60
Dec. 3	3:10 p.m.	27.72
10	11:10 a.m.	27.97
17	4:40 p.m.	27.30
24	9:30 a.m.	27.17
31	1:55 p.m.	27.22

Fred Lucht, lot 3, sec. 7, T. 6 S., R. 1 E. Stock dug well, 3½ feet in diameter and 21 feet deep, brick curb. Measuring point, top of 2-inch plank well cover, altitude 259.49 feet. Land surface altitude 258.5 feet.

Sept.21, 1928	.....	12.6
Oct. 20	.....	12.85
July 3, 1929	.....	9.15
Aug. 5	.....	11.45
Sept.24	.....	14.10
Oct. 26	.....	15.60
Nov. 29	.....	16.25
Dec. 30	.....	3.20
Feb. 2, 1930	.....	1.25
Mar. 2	.....	2.25
30	.....	3.60
Apr. 27	.....	4.85
July 25	.....	10.69
Oct. 3, 1935	6:20 p.m.	15.96
11	9:00 a.m.	14.32
16	7:00 a.m.	13.68
24	10:20 a.m.	15.20
28	4:25 p.m.	15.05
Nov. 4	4:50 p.m.	16.27
11	3:50 p.m.	16.30
18	4:40 p.m.	11.64
Dec. 3	10:45 a.m.	14.81
9	2:40 p.m.	9.04
17	12:45 p.m.	7.68
23	1:20 p.m.	9.12
28	4:50 p.m.	8.41
31	9:10 a.m.	3.18

Henry Hoefer, SE¼NW¼ sec. 12, T. 10 S., R. 4 W. Domestic dug well, 2 feet in diameter and 24 feet deep, concrete-tile casing. Measuring point, top of tile casing at southwest side, 1.7 feet above land surface, altitude 187.44 feet.

Date	Hour	Depth to water (feet)
Aug. 1, 1928	.....	21.80
Sept. 7	.....	22.95
Oct. 20	.....	23.6
Dec. 17	.....	21.2
Feb. 23, 1929	.....	19.4
Mar. 19	.....	20.1
May 12	.....	19.7
June 7	.....	20.30
July 3	.....	20.80
Aug. 3	.....	21.65
Sept. 24	.....	23.25
Oct. 26	.....	23.80
Nov. 28	.....	24.15
Dec. 29	.....	19.70
Feb. 2, 1930	.....	19.50
Mar. 2	.....	18.40
30	.....	20.65
Apr. 27	.....	20.20
May 29	.....	20.65
July 24	.....	21.89
Oct. 4, 1935	12:10 p.m.	24.00
11	5:45 p.m.	24.20
17	9:50 a.m.	24.20
25	12:20 p.m.	24.20
28	3:20 p.m.	24.20
Nov. 5	3:35 p.m.	24.40
12	5:00 p.m.	24.30
20	9:10 a.m.	24.30
Dec. 4	11:00 a.m.	24.00
10	3:40 p.m.	24.90
18	10:35 a.m.	24.75
24	4:35 p.m.	23.30

Oregon Agricultural Experiment Station (east farm), SW¼SE¼ sec. 36, T. 11 S., R. 5 W. One of two irrigation drilled wells at northeast corner of common pit, 8 inches in diameter and 42 feet deep, standard steel casing. Measuring point, top of 8-inch casing, level with zero of staff gage on east face of pit curb, altitude 197.38 feet. Measurements with the plus sign (+) are in feet above measuring point; other readings are in feet below measuring point. Land-surface altitude 218.9 feet.

Date	Hour	Depth to water (feet)
Sept. 26, 1929	.....	1.96
27	.....	1.96
28	.....	1.98
29	.....	1.98
30	.....	2.00
Oct. 1	7:45 a.m.	2.00
2	6:20 a.m.	2.02
3	6:34 a.m.	2.04
4	6:50 a.m.	2.05
5	7:10 a.m.	2.06

Oregon Agricultural Experiment Station - Continued

Date	Hour	Depth to water (feet)
Oct. 6, 1929	7:50 a.m.	2.07
7	6:30 a.m.	2.08
8	7:30 a.m.	2.08
9	7:40 a.m.	2.06
10	7:40 a.m.	2.06
11	7:20 a.m.	2.06
12	8:30 a.m.	2.02
13	9:25 a.m.	2.02
14	6:55 a.m.	2.05
15	12:30 p.m.	2.06
16	12:50 p.m.	2.07
17	12:00 m.	2.10
18	12:35 p.m.	2.10
19	12:55 p.m.	2.11
20	1:25 p.m.	2.12
21	12:45 p.m.	2.12
22	12:40 p.m.	2.12
23	12:45 p.m.	2.13
24	12:45 p.m.	2.14
25	12:45 p.m.	2.15
26	1:00 p.m.	2.15
27	1:35 p.m.	2.16
28	12:50 p.m.	2.17
29	12:45 p.m.	2.20
30	12:50 p.m.	2.23
31	12:50 p.m.	2.26
Nov. 1	2:45 p.m.	2.26
2	2:50 p.m.	2.25
3	2:50 p.m.	2.25
4	12:45 p.m.	2.25
5	12:55 p.m.	2.24
6	12:50 p.m.	2.24
7	11:50 a.m.	2.24
8	12:50 p.m.	2.25
9	11:20 a.m.	2.25
10	11:05 a.m.	2.25
11	12:50 p.m.	2.24
12	12:50 p.m.	2.23
13	11:00 a.m.	2.22
14	12:40 p.m.	2.23
15	12:45 p.m.	2.24
16	12:10 p.m.	2.25
17	12:40 p.m.	2.26
18	12:40 p.m.	2.26
19	12:45 p.m.	2.27
20	12:05 p.m.	2.28
21	12:10 p.m.	2.29
22	12:50 p.m.	2.30
23	12:40 p.m.	2.30
24	12:55 p.m.	2.30
25	1:00 p.m.	2.30
26	12:50 p.m.	2.31
27	1:05 p.m.	2.32
28	12:55 p.m.	2.32
29	12:50 p.m.	2.34
30	12:50 p.m.	2.35
Dec. 1	12:50 p.m.	2.34
2	12:55 p.m.	2.35
3	12:45 p.m.	2.35
4	12:05 p.m.	2.35
5	11:50 a.m.	2.36
6	12:40 p.m.	2.35
7	12:50 p.m.	2.34
8	12:05 p.m.	2.34
9	11:50 a.m.	2.33
10	11:40 a.m.	2.33
11	11:45 a.m.	2.17
12	12:40 p.m.	2.00
13	12:50 p.m.	1.72

Oregon Agricultural Experiment Station - Continued

Date	Hour	Depth to water (feet)
Dec. 14, 1929	10:50 a.m.	1.20
15	11:55 a.m.	.48
16	1:35 p.m.	+.90
17	11:55 a.m.	+1.55
18	11:50 a.m.	+2.20
19	5:05 p.m.	+2.80
20	6:00 p.m.	+9.55
21	12:00 m.	+13.32
22	12:10 p.m.	+12.10
23	11:55 a.m.	+11.80
24	12:30 p.m.	+11.65
25	12:05 p.m.	+11.42
26	12:10 p.m.	+11.00
27	12:10 p.m.	+10.12
28	12:20 p.m.	+10.25
29	12:05 p.m.	+10.10
30	12:15 p.m.	+10.15
31	12:00 m.	+9.00
Jan. 1, 1930	11:55 a.m.	+8.47
2	12:30 p.m.	+8.40
June 29	.....	.45
30	.....	.50
Oct. 5, 1935	12:10 p.m.	1.93
12	5:15 p.m.	1.96
18	12:00 m.	1.65
21	3:00 p.m.	1.70
30	3:00 p.m.	1.85
Nov. 7	8:45 a.m.	1.95
13	8:30 a.m.	1.73
20	3:25 p.m.	1.12
29	10:00 a.m.	1.15
Dec. 4	11:05 a.m.	2.01
11	11:45 a.m.	1.54
18	11:45 a.m.	+.40
26	8:20 a.m.	+.20

J. H. Swatzka, SE¼SE¼ sec. 9, T. 12 S., R. 3 W. Domestic dug well, 30 inches in diameter and 19 feet deep, brick curb. Measuring point from July 28, 1928, to July 23, 1930, top of recorder table, 1.2 feet above land surface; measuring point from Oct. 4, 1935, to Nov. 6, 1935, top of 2-inch plank deck, 0.2 foot above land surface, 1.05 feet below top of recorder table, altitude 272.9 feet; measuring point after Nov. 6, 1935, 0.15 foot above top of 2-inch plank deck. Land-surface altitude 272.7 feet.

July 28, 1928	.....	10.65
Sept. 3	.....	13.78
6	.....	14.03
15	.....	14.57
Oct. 8	.....	15.81
21	.....	16.32
Dec. 16	.....	5.90
Jan. 6, 1929	.....	3.50
20	.....	3.20
Feb. 2	.....	2.90
16	.....	4.59

J. H. Swatzka - Continued

Date	Hour	Depth to water (feet)
Mar. 7, 1929	.....	4.27
31	.....	4.11
Apr. 18	.....	3.49
May 9	.....	4.82
13	.....	6.18
July 4	.....	8.12
15	.....	8.86
Aug. 2	.....	10.23
Sept. 3	.....	13.51
7	.....	13.79
23	.....	15.13
Oct. 25	.....	16.69
Nov. 27	2:55 p.m.	17.55
Dec. 31	12:40 p.m.	3.92
Jan. 5, 1930	.....	3.40
11	.....	4.05
18	.....	4.70
26	.....	5.17
Feb. 1	12:55 p.m.	2.90
9	.....	3.02
16	.....	3.33
23	.....	2.75
Mar. 1	12:00 m.	3.49
19	.....	4.73
29	1:00 p.m.	4.22
Apr. 6	.....	4.95
26	12:30 p.m.	4.33
May 28	4:00 p.m.	5.70
July 23	11:10 a.m.	9.81
Oct. 4, 1935	3:00 p.m.	15.60
12	8:00 a.m.	15.81
17	1:10 p.m.	15.45
30	10:45 a.m.	16.15
Nov. 6	10:50 a.m.	16.28
12	1:10 p.m.	16.20
20	2:45 p.m.	16.00
Dec. 4	4:00 p.m.	15.74
11	10:55 a.m.	14.22
18	1:35 p.m.	11.13
26	1:45 p.m.	10.27
28	2:20 p.m.	9.32

Ray Fisher, NE¼NW¼ sec. 14, T. 12 S., R. 2 W. Irrigation dug well, 8 feet square and 19 feet deep, timber curb. Measuring point from Aug. 17, 1928, to July 23, 1930, top of pump-house sill, altitude 352.35 feet; measuring point beginning Oct. 4, 1935, top of 6 by 6 inch pump support at painted arrow, altitude 353.15 feet.

Aug. 17, 1928	.....	13.9
Oct. 21	.....	13.0
Dec. 16	.....	11.9
Feb. 2, 1929	.....	12.2
Mar. 27	.....	10.55
May 9	.....	11.00
June 6	.....	11.90
July 4	.....	12.30
Aug. 2	.....	13.8
Sept. 23	.....	14.95
Oct. 25	.....	14.75
Nov. 27	.....	14.90
Dec. 31	.....	9.80

Ray Fisher - Continued

Date	Hour	Depth to water (feet)
Feb. 1, 1930	.....	10.95
Mar. 1	.....	10.50
29	.....	11.05
Apr. 26	.....	12.05
May 28	.....	11.80
July 23	.....	13.84
Oct. 4, 1935	4:10 p.m.	16.25
12	9:00 a.m.	16.26
17	11:25 a.m.	15.79
30	9:10 a.m.	15.45
Nov. 6	9:25 a.m.	15.47
13	10:20 a.m.	15.23
20	11:20 a.m.	15.14
Dec. 4	12:45 p.m.	14.58
11	10:30 a.m.	14.38
18	11:55 a.m.	13.33
26	10:20 a.m.	13.72

Keeney School, District 51, SW¼SW¼ sec. 34, T. 13 S., R. 3 W. Driven well, 1¼ inches in diameter and 18 feet deep. Measuring point, lower valve seat of pump, 2.5 feet above concrete platform, altitude 287.5 feet.

Aug. 16, 1928	.....	9.5
Oct. 25, 1929	.....	11.15
Nov. 27	.....	11.40
Dec. 31	.....	5.65
Feb. 1, 1930	.....	5.00
Mar. 1	.....	5.05
29	.....	5.25
Apr. 26	.....	4.95
May 28	.....	6.38
July 23	.....	8.71
Oct. 4, 1935	5:05 p.m.	10.91
12	10:00 a.m.	10.93
17	3:45 p.m.	11.02
30	4:20 p.m.	10.30
Nov. 6	3:50 p.m.	10.35
13	4:55 p.m.	10.24
21	8:30 a.m.	10.00
Dec. 5	9:10 a.m.	8.72
11	3:45 p.m.	7.50
18	4:15 p.m.	6.28
26	5:00 p.m.	5.68
28	1:55 p.m.	5.80

Junction City, NW¼SW¼ sec. 32, T. 15 S., R. 4 W. Fire-protection dug well, 8 feet in diameter and 20 feet deep, in northwest angle of Seventh and Holly Streets, masonry curb. Measuring point, top face of manhole rim at southeast side, level with street surface, altitude 323.4 feet.

Aug. 23, 1928	.....	8.9
July 4, 1929	.....	7.1
Aug. 2	.....	8.2
Sept.23	.....	9.75
Oct. 26	.....	10.3
Nov. 28	.....	10.65

Junction City - Continued

Date	Hour	Depth to water (feet)
Jan. 2, 1930	.....	5.25
31	.....	4.0
Feb. 28	.....	4.6
Mar. 28	.....	5.55
Apr. 25	.....	5.75
May 23	.....	6.28
July 23	.....	8.32
Oct. 5, 1935	11:55 a.m.	10.64
12	3:20 p.m.	10.69
18	10:50 a.m.	10.48
21	5:20 p.m.	10.54
30	12:30 p.m.	10.85
Nov. 7	4:35 p.m.	10.81
13	3:00 p.m.	10.52
20	1:00 p.m.	10.55
29	12:45 p.m.	10.60
Dec. 5	10:50 a.m.	10.77
12	3:40 p.m.	9.76
19	3:30 p.m.	9.53
27	2:30 p.m.	9.40

Leo Sidwell, SW¼NE¼ sec. 32, T. 16 S., R. 3 W. Irrigation dug well, 4 feet in diameter and 19 feet deep, 36-inch concrete-tile casing, at southwest corner of field about 200 yards west of dwelling. Measuring point from Sept. 5, 1928, to July 3, 1930, top of recorder table, altitude 390.2 feet; measuring point beginning Oct. 5, 1935, inner lip of tile casing at south side, altitude about 388.98 feet. Land-surface altitude 389.0 feet.

Aug. 21, 1928	.....	12.45
Sept. 5	.....	13.79
15	.....	13.82
Oct. 8	.....	13.86
Nov. 2	.....	13.88
Dec. 16	.....	13.60
Feb. 2, 1929	.....	11.88
Mar. 7	.....	11.67
Apr. 18	.....	11.96
May 9	.....	11.35
June 3	.....	12.24
July 4	.....	12.81
Sept.23	.....	12.63
Oct. 26	.....	12.75
Nov. 18	.....	12.75
Dec. 31	.....	9.60
Feb. 9, 1930	.....	10.53
Mar. 29	.....	10.75
Apr. 26	.....	11.25
July 23	.....	12.22
Oct. 5, 1935	10:05 a.m.	12.60
12	1:55 p.m.	12.60
17	5:40 p.m.	12.32
31	3:00 p.m.	12.98
Nov. 7	2:25 p.m.	13.00
14	2:05 p.m.	12.52
21	2:45 p.m.	12.50
Dec. 5	3:25 p.m.	12.38
12	3:55 p.m.	12.22
19	2:40 p.m.	11.78
27	3:55 p.m.	11.72

Harney Basin.--In another cooperative investigation by the United States Geological Survey and the Oregon Agricultural Experiment Station, about 3,800 determinations of ground-water levels were made in the Harney Basin in 1930-32. These data have been released to the public in a preliminary report.[8] In 279 wells the depth to water was measured in the autumn of 1930 and the spring of 1931 and again in the spring of 1932. Supplemental measurements of depth to water were made as follows: In 68 of the foregoing wells, monthly from August 1930 to August 1932; in 29 of the wells, weekly throughout the irrigation seasons of 1931 and 1932, also monthly during the nonirrigation seasons; in 3 wells, daily during most of the irrigation seasons and monthly for the remainder of the term. Water-stage recorders were operated for about 2 months at each of 4 wells, also for 21 months at each of 2 wells. The observation wells range in depth from 6 to about 800 feet, but most are less than 150 feet. About 175 of these wells tap unconfined water in valley fill, 75 wells tap confined water in deep pervious beds in valley fill, and 28 wells tap pervious zones in bedrock. The altitude of the measuring point at about 100 wells has been determined by instrumental leveling.

Ground-water levels in the basin fluctuate in response to rise and fall of streams, to pumpage from the deep pervious beds, and to transpiration by native ground-water vegetation. However, the water levels for the several pervious zones respond unequally to these forces.

In connection with the regional program that was started in 1935, seven permanent observation wells were dug to the water table along rights of way for public roads in the Silvies River subarea of the Harney Basin. In addition, 18 of the former observation wells were reestablished, and 1 well was newly selected for water-level measurements, with permission of the owner. It is contemplated that indexes for the seven permanent wells will be developed to evaluate mean water-level fluctuations in the subarea and that observations in the supplemental wells will ultimately be discontinued. Descriptive and water-level data follow.

8 Piper, A. M., Robinson, T. W., and Park, C. F., Jr., Geology and ground-water resources of the Harney Basin, Oreg.: U. S. Geol. Survey typewritten report, pp. 477-551, June 22, 1935.

Water levels in typical wells in the Harney Valley, Oreg., in 1931-32 and 1935-36

Except as indicated, measurements of depth to water were made by United States Geological Survey; altitudes by Geological Survey, datum of 1927, by instrumental leveling.

Frank Triska, NW¼NE¼ sec. 36, T. 22 S., R. 32 E. Domestic drilled well, 6 inches in diameter and 44 feet deep. Measuring point, top of casing, 0.6 foot above land surface, altitude 4,133 feet (interpolated). Depth to water: Dec. 4, 1931, 10.75 feet; Dec. 20, 1935, 8.6 feet; rise, 2.15 feet.

I. L. Poujade, NE¼NW¼ sec. 36, T. 22 S., R. 32½ E. Unused dug well, 5 feet in diameter and 14 feet deep. Measuring point, top of 2- by 14-inch plank, level with land surface, altitude 4,143 feet (interpolated). Depth to water: Dec. 4, 1931, 12.3 feet; Dec. 22, 1935, 10.8 feet; rise, 1.5 feet.

Permanent observation well on right of way for Burns-Drewsey highway, lot 4, sec. 3, T. 23 S., R. 31 E., constructed in December 1935, 18 inches square and 14 feet deep. Wood curbing to 12 feet, perforated 12-inch steel casing 10 to 14 feet. Measuring point, top of wood curb, a copper nail with washer, 1.0 feet above land surface. Depth to water 1936: January 15, 10.30 feet; February 18, 10.32 feet.

Estate of William Hanley, lot 3, sec. 5, T. 23 S., R. 31 E. Domestic bored well, 3 feet in diameter and 42 feet deep. Measuring point, top of plank well cover, copper nail with washer, 2.0 feet above land surface, altitude 4,162 feet (interpolated). Depth to water: Dec. 4, 1931, 16.7 feet; Dec. 23, 1935, 12.4 feet; rise, 4.3 feet.

Hansen, lot 1, sec. 7, T. 23 S., R. 31 E. Unused drilled well, 4 inches in diameter and 14 feet deep. Measuring point, top of casing, 2.3 feet above land surface, altitude 4,157 feet (interpolated). Depth to water: Jan. 4, 1932, 13.1 feet; Dec. 27, 1935, 8.26 feet; rise, 4.8 feet.

Burns Airport, SW¼SW¼ sec. 9, T. 23 S., R. 31 E. Domestic bored well, 4½ inches in diameter and 25 feet deep. Measuring point, top of casing, 0.3 foot above land surface, altitude 4,150.19 feet. Depth to water: Jan. 6, 1932, 13.55 feet; Dec. 16, 1935, 10.92 feet; rise, 2.63 feet.

Permanent observation well on right of way for county road, NE¼NE¼ sec. 14, T. 23 S., R. 31 E., constructed in December 1935, 18 inches square and 17 feet deep. Wood curbing to 14 feet, perforated 12-inch steel casing 13 to 17 feet. Measuring point, top of wood curb, copper nail with washer, 1.0 foot above land surface. Depth to water: Jan. 15, 1936, 13.70 feet.

J. S. Cook, NE¼NW¼ sec. 13, T. 23 S., R. 31 E. Stock drilled well, 6 inches in diameter and 179 feet deep. Measuring point, top of casing, 1.0 foot above land surface, altitude 4,140 feet (interpolated). Depth to water: Dec. 17, 1935, 11.58 feet.

Permanent observation well on right of way for Burns-Narrows highway, SW¼NW¼ sec. 16, T. 23 S., R. 31 E., constructed in January 1936, 18 inches square and 14 feet deep. Wood curbing to 11 feet, perforated 12-inch steel casing 10 to 14 feet. Measuring point, top of wood curb, copper nail with washer, 1.0 foot above land surface. Depth to water: Jan. 15, 1936, 10.10 feet.

Observation well, NE¼NW¼ sec. 17, T. 23 S., R. 31 E., bored by U. S. Geological Survey, 4 inches in diameter and 11 feet deep. Measuring point, top of stovepipe casing, 0.8 foot above land surface, altitude 4,147.26 feet. Depth to water: Dec. 6, 1931, 8.33 feet; Dec. 17, 1935, 7.10 feet; rise, 1.23 feet.

Permanent observation well on right of way for Burns-Narrows highway, SW¼NW¼ sec. 33, T. 23 S., R. 31 E., constructed in December 1935, 18 inches square and 12½ feet deep. Wood curbing to 10 feet, perforated 12-inch steel casing from 8½ to 12½ feet. Measuring point, top of wood curbing, copper nail with washer, 1.0 foot above land surface. Depth to water: Jan. 15, 1936, 9.10 feet.

Harney Branch Experiment Station, NE¼SW¼ sec. 7, T. 23 S., R. 32 E. Observation bored well, 11½ feet deep, about 20 feet northeast of 18-inch well, record of which is given below. Measuring point, top of stovepipe casing, 0.4 foot above land surface, altitude 4,135.6 feet.

Date	Depth to water (feet)	Date	Depth to water (feet)	Date	Depth to water (feet)
Jan. 2, 1933	9.1	Apr. 1, 1934	8.8	Mar. 1, 1935	8.85
Feb. 2	9.3	18	7.5	Apr. 3	8.8
Mar. 1	9.4	May 4	7.5	May 5	8.9
Apr. 1	9.2	June 3	5.9	June 6	8.25
May 4	9.3	29	5.3	July 5	6.7
June 5	7.7	July 28	5.4	Aug. 3	6.25
July 7	5.6	Sept. 4	6.6	Oct. 2	8.1
Sept. 2	4.8	Oct. 5	7.8	Nov. 4	8.5
Oct. 1	5.9	Nov. 5	8.3	27	8.7
Nov. 1	6.8	29	8.6	Dec. 16	8.3
Dec. 1	7.9	Dec. 22	8.7		
26	8.3	Feb. 7, 1935	8.9		

Harney Branch Experiment Station, NE¼SW¼ sec. 7, T. 23 S., R. 32 E. Irrigation bored well, 18 inches in diameter and 93 feet deep. Measuring point, center of pneumatic depth gage, 1.4 feet above land surface, altitude 4,136.8 feet.

Jan. 2, 1933	7.7	Dec. 1, 1933	10.5	Mar. 1, 1935	9.0
Feb. 2	7.6	26	8.2	Apr. 3	8.5
Mar. 1	7.5	Apr. 1, 1934	8.0	May 5	8.2
Apr. 1	7.5	18	8.0	Nov. 4	10.5
May 4	7.3	Nov. 5	11.6	27	9.2
Sept. 2	16.0	29	11.4	Dec. 16	9.2
Oct. 1	11.0	Dec. 22	11.2		
Nov. 1	10.5	Feb. 7, 1935	9.0		

Harney Branch Experiment Station, SW¼SE¼ sec. 7, T. 23 S., R. 32 E. Irrigation drilled well, 8 inches in diameter, initial depth reported 218 feet. Measuring point, center of pneumatic depth gage, 0.7 foot above land surface, altitude 4,137.4 feet. Depth to water (by R. E. Hutchison): 1931, Apr. 29, 12.0 feet; May 5, 16.3 feet; Dec. 5, 10.0 feet. 1935, Apr. 3, 8.8 feet; May 5, 9.3 feet; Nov. 27, 11.2 feet; average rise, 3.0 feet.

Permanent observation well on right of way for Burns-Crane highway, SE¼SE¼ sec. 30, T. 23 S., R. 32 E., constructed in January 1936, 18 inches square and 15 feet deep. Wood curbing to 15 feet, perforated 12-inch steel casing 15⅛ to 19⅛ feet. Measuring point, top of wood curbing, copper nail with washer, 1.0 foot above land surface. Depth to water: Jan. 29, 1936, 15.00 feet.

Permanent observation well on right of way for Burns-Narrows highway, SW¼SW¼ sec. 28, T. 24 S., R. 31 E., constructed in December 1935, 18 inches square and 17 feet deep. Wood curbing to 15 feet, perforated 12-inch steel casing 13 to 17 feet. Measuring point, top of wood curbing, copper nail with washer, 1.0 foot above land surface. Depth to water: Jan. 15, 1936, 14.00 feet.

Permanent observation well on right of way for Burns-Crane highway, NE¼NE¼ sec. 25, T. 24 S., R. 32 E., constructed in January 1936, 18 inches square and 48 feet deep. Wood curbing to 40 feet, perforated 12-inch steel casing 40 to 48 feet. Measuring point, top of wood curbing, copper nail with washer, 1.0 foot above land surface. Depth to water: Jan. 29, 1936, 44.50 feet.

C. M. Spencer, lot 3, sec. 30, T. 24 S., R. 33 E. Unused bored well, 6 inches in diameter and 16 feet deep. Measuring point, top of wood curbing, 0.7 foot above land surface, altitude 4,111 feet (interpolated). Depth to water: Oct. 7, 1930, 16.5 feet; Dec. 18, 1935, 16.0 feet; rise, 0.5 foot.

E. N. Nelson, SE¼SW¼ sec. 9, T. 25 S., R. 31 E. Stock drilled well, 6 inches in diameter and 105 feet deep. Measuring point, top of casing, 1.1 feet above land surface, altitude 4,124 feet (interpolated). Depth to water: Dec. 6, 1931, 14.95; Dec. 18, 1935, 14.80; rise, 0.15 foot.

Owner unknown, SE¼SE¼ sec. 28, T. 25 S., R. 31 E. Unused well, 2 inches in diameter and 31 feet deep. Measuring point, lower valve seat of pump, 1.7 feet above land surface, altitude 4,113 feet (interpolated). Depth to water: Jan. 6, 1932, 17.55 feet; Dec. 22, 1935, 18.22 feet; decline, 0.67 foot.

Frank Klitzke, NE¼SE¼ sec. 30, T. 25 S., R. 31 E. Unused well, 4 inches in diameter and 60 feet deep. Measuring point, top of casing, 1.0 foot above land surface, altitude 4,186 feet (interpolated). Depth to water: Oct. 16, 1930, 54.40 feet; Dec. 18, 1935, 55.50 feet; decline, 1.10 feet.

C. M. Spencer, SE¼SW¼ sec. 1, T. 25 S., R. 32⅔ E. Unused well, 10 inches in diameter and 23 feet deep. Measuring point, top of 2-inch plank platform, 0.2 foot above land surface, altitude 4,103.10 feet. Depth to water: Jan. 5, 1932, 22.00 feet; Dec. 23, 1935, 21.82 feet; rise, 0.18 foot.

Fred Timm, lot 3, sec. 5, T. 25 S., R. 32⅔ E. Domestic well, 8 inches in diameter and 22 feet deep. Measuring point, top of box pump support, 2.1 feet above land surface, altitude 4,107.40 feet. Depth to water: Jan. 5, 1932, 23.25 feet; Dec. 27, 1935, 21.35 feet; rise, 1.90 feet.

Owner unknown, NW¼NW¼ sec. 23, T. 25 S., R. 33 E. Unused well, 2 inches in diameter and 28⅔ feet deep. Measuring point, top of casing, 2.0 feet above land surface, altitude 4,110 feet (interpolated). Depth to water: Dec. 4, 1931, 26.3 feet; Dec. 18, 1935, 25.10 feet; rise, 1.20 feet.

Observation well, NE¼NE¼ sec. 15, T. 26 S., R. 31 E., bored by United States Geological Survey, 3 inches in diameter and 14 feet deep. Measuring point, top of stovepipe casing, 0.5 foot above land surface, altitude 4,096.41 feet. Depth to water: Dec. 6, 1931, 13.45 feet; Dec. 16, 1935, 13.62 feet; decline, 0.17 foot.

Among the wells listed above, 13 afford comparisons of water-table level about the end of 1931 and 1935; these are not influenced by large artificial withdrawals. The 4-year change in water level ranges from a rise of 2.63 feet to a decline of 0.67 foot; the average is a rise of 1.58 feet. One well, at the Harney Branch Experiment Station, affords monthly determinations of water level through most of the 4-year period. The averages of the 12 measurements in 1931 and of the 11 measurements in 1935 indicate a rise of 0.38 foot in the 4 years, whereas the two year-end measurements indicate a rise of 1.0 foot. The intervening yearly changes in average water level are: 1932, rise 0.65 foot; 1933, rise 0.15 foot; 1934, rise 0.47 foot; 1935, decline 0.89 foot.

Walla Walla Basin.--In 1932-33 about 2,900 determinations of ground-water level were made in that part of the Walla Walla Basin that lies in Oregon. These determinations were made in 77 observation wells maintained in collaboration between the United States Geological Survey, the Water Resources Department of Oregon, the Umatilla County Court (Oregon), and the Washington Department of Conservation and Development. The data have been released to the public.[9] The wells range in depth from 4 to 98 feet, but only 7 wells exceed 50 feet. From December 1932 until September 1933 float gages at 10 of the wells were read twice weekly by the owners. From May until September 1933 water levels were determined weekly at 57 of the wells, twice a month at 9 wells, and monthly at 1 well. A water-stage recorder was operated at one well for 14 months and at another well for 5 months. So far as known, all these observation wells show water-table levels. Most measuring points have been tied to sea-level datum by instrumental leveling.

In the Oregon portion of the Walla Walla Basin the water-table level appears to depend chiefly upon the stage of the Walla Walla River, which is a flashy intermittent stream. The water table also fluctuates in response to the infiltration of rain or of water applied to the land for irrigation, as well as in response to heavy pumping in a small district near Freewater.[10] Flashy storm run-off in the Walla Walla River sets up pronounced ground-water waves that move outward through the coarse alluvial fill and that may cause the water level in certain wells to rise and fall rapidly several times during the year. With the oncoming spring freshet, the ground-water level may rise 10 feet in as many days; within 2 months it may rise 25 feet and pass from its lowest level to its highest level of the year. As the freshets wane, ground-water decline is nearly as rapid, even before the pumping season begins.

In October 1935, 21 of the observation wells were reestablished in connection with the regional water-level program. Subsequently, depth to water has been measured monthly in each of these wells by the district water master; at three of these wells float gages were installed and have been read twice a week by the owners. Altogether 134 determinations of ground-water level were made in 1935; these are shown in the following list.

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9 Piper, A. M., Robinson, T. W., and Thomas, H. E., Ground water in the Walla Walla Basin, Oregon-Washington: U. S. Geol. Survey typewritten report, pp. 107-238, October 30, 1933.

10 Idem, pp. 70-80.

Water levels in typical wells in the Walla Walla Basin, Oregon, in 1933 and 1935

Measurements of depth to water made by United States Geological Survey, Oregon Water Resources Department, and Washington Department of Conservation and Development. Altitudes refer to sea-level datum, general adjustment of 1929, by the Geological Survey and the Oregon Water Resources Department.

M. O. Beauchamp, SE¼SE¼ sec. 13, T. 6 N., R. 34 E. Domestic dug well, 1.5 feet in diameter and 11 feet deep, tile casing. Measuring point, top of wood well cover at 1½-inch hole, painted arrow, altitude 684.87 feet. Bench mark, immediately south of well, top of concrete stock-watering trough at its southwest corner; altitude 647.65 feet. Land-surface altitude 682.9 feet.

Date	Depth to water (feet)	Date	Depth to water (feet)	Date	Depth to water (feet)
May 31, 1933	6.11	Aug. 29, 1933	6.92	Oct. 31, 1933	8.37
June 21	6.59	Sept. 5	6.99	Dec. 5	6.64
July 5	6.11	12	7.20	28	6.90
15	6.96	21	7.43	Jan. 3, 1934	6.28
Aug. 1	6.36	26	8.36	Oct. 23, 1935	9.05
8	5.47	Oct. 3	7.42	Nov. 7	9.14
15	6.70	10	7.65	Dec. 5	7.54
22	6.75	16	7.88		

Owner unknown, SW¼SW¼ sec. 24, T. 6 N., R. 34 E. Unused driven well, 1 inch in diameter and 12 feet deep, cased with iron pipe. Measuring point, top of 1-inch pipe at painted arrow, altitude 638.47 feet. Land-surface altitude 636.3 feet.

Dec. 5, 1933	9.08	Jan. 3, 1934	8.35	Nov. 7, 1935	10.62
28	8.59	Oct. 23, 1935	10.68		

Conrad Miller, NE¼SW¼ sec. 14, T. 6 N., R. 35 E. Domestic dug well, 7 feet in diameter and 15 feet deep, concrete curbing to 8 feet. Measuring point, top of concrete curb at northeast side, painted arrow, altitude 789.76 feet. Bench mark, 400 feet east of well at Queener's service station, on south end of concrete base to gasoline pumps, painted cross, altitude 789.51 feet.

Sept.26, 1933	6.42	Oct. 31, 1933	7.67	Oct. 23, 1935	7.77
Oct. 2	6.53	Dec. 5	7.56	Nov. 8	8.27
10	7.25	30	5.45	Dec. 7	9.27
16	7.59	Jan. 4, 1934	5.04		

Claude Winn, NW¼NE¼ sec. 16, T. 6 N., R. 35 E. Unused dug well, 4 feet square and 13 feet deep, horizontal wood lagging. Measuring point, top of 2- by 4-inch post at northwest corner of well, marked by copper nail and washer, altitude 730.81 feet. Land-surface altitude 730.8 feet.

May 11, 1933	3.91	Aug. 16, 1933	5.62	Dec. 6, 1933	4.14
June 2	4.16	30	5.65	Oct. 23, 1935	4.35
19	4.55	Sept.13	5.56	Nov. 8	2.63
July 2	4.68	27	4.88	Dec. 7	3.98
17	5.22	Oct. 11	4.87		
Aug. 3	5.43	Nov. 2	4.17		

Herman Markman, SW¼NE¼ sec. 20, T. 6 N., R. 35 E. Domestic dug well, 5 feet in diameter and 18 feet deep, concrete curb. Measuring point, top of concrete floor of pump house, at painted arrow, altitude 734.82 feet. Bench mark, top of concrete curb at east entrance to pump house, painted square, altitude 737.00 feet.

Date	Depth to water (feet)	Date	Depth to water (feet)	Date	Depth to water (feet)
Dec. 28, 1933	1.74	Oct. 23, 1935	7.39	Dec. 5, 1935	3.70
Jan. 3, 1934	1.74	Nov. 7	6.58		

Jackson, SW¼SE¼ sec. 20, T. 6 N., R. 35 E. Irrigation dug well, 5 feet square and 38 feet deep, concrete curbing. Measuring point from Sept. 4, 1933, to Jan. 3, 1934, top of concrete curb at southwest corner, painted arrow, altitude 762.89 feet; measuring point beginning Oct. 23, 1935, bottom of tee at top of discharge pipe, altitude 764.33 feet. Bench mark, in base of south side of power pole 70 feet southeast of well, spike, altitude 763.87 feet.

Sept. 4, 1933	33.33	Oct. 10, 1933	34.79	Jan. 3, 1934	32.24
12	33.97	16	34.57	Oct. 23, 1935	38.6
21	34.23	31	32.98	Nov. 7	35.40
25	34.55	Dec. 5	31.47	Dec. 5	33.30
Oct. 2	33.75	28	31.94		

Behnke, SE¼NE¼ sec. 21, T. 6 N., R. 35 E. Irrigation dug well, 5.5 feet in diameter and 19 feet deep, concrete curbing to 12 feet. Measuring point, top of concrete curb at south side, painted arrow, altitude 784.62 feet. Land-surface altitude 784.6 feet.

May 15, 1933	14.94	Aug. 21, 1933	18.98	Oct. 16, 1933	18.97
June 6	16.43	29	19.16	31	19.08
21	15.71	Sept. 4	18.97	Dec. 4	17.40
July 5	13.62	12	19.35	28	17.38
15	17.49	21	18.96	Jan. 3, 1934	19.04
31	19.02	25	18.75	Oct. 23, 1935	15.52
Aug. 7	18.99	Oct. 2	18.95	Dec. 5	19.41
15	18.78	12	18.08		

William Pomeringin, NE¼NW¼ sec. 24, T. 6 N., R. 35 E. Domestic dug well, 9 feet square and 34 feet deep, uncased. Measuring point, top of plank cover near southeast corner of trap door, above a copper nail and washer in vertical edge of plank, altitude 851.04 feet. Bench mark, top of southwest concrete footing of tank house, altitude 851.72 feet. Land-surface altitude 851.0 feet.

Aug. 21, 1933	30.32	Oct. 2, 1933	30.60	Jan. 4, 1934	31.19
29	29.93	10	30.80	Oct. 23, 1935	31.98
Sept. 4	30.00	16	30.86	Nov. 8	32.42
12	30.35	31	31.09	Dec. 7	32.08
20	30.45	Dec. 5	31.20		
26	30.73	30	31.40		

C. B. Miller, SW¼SE¼ sec. 24, T. 6 N., R. 35 E. Irrigation dug well, 6 feet square and 33 feet deep, concrete casing. Measuring point July 5, 1933, to Oct. 24, 1935, top of metal hoist frame near northeast corner of well, altitude 864.30 feet; measuring point beginning Nov. 9, 1935, top of concrete curb at pump-discharge pipe, altitude about 862.8 feet. Bench mark, top of concrete inlet box near gate in fence, painted cross, altitude 862.10 feet. Land-surface altitude 862.3 feet.

July 5, 1933	12.30	Aug. 21, 1933	23.98	Oct. 16, 1933	15.79
8	12.45	28	16.43	30	16.38
15	12.52	Sept. 4	16.79	Dec. 4	13.30
17	19.81	11	16.98	30	11.04
22	13.33	20	25.68	Jan. 4, 1934	10.97
31	21.26	25	15.95	Oct. 24, 1935	16.98
Aug. 7	24.85	Oct. 2	14.93	Nov. 9	16.18
14	23.34	9	15.15	Dec. 7	19.00

Boerstler, NE¼NW¼ sec. 26, T. 6 N., R. 35 E. Irrigation well, 6 feet square, dug 28 feet and drilled 28 to 46 feet, concrete curbing to 12 feet. Measuring point from Aug. 18, 1933, to Jan. 4, 1934, nail in vertical face of wood block spiked on top of sill of well cover, south side of well, altitude 867.61 feet; measuring point beginning Oct. 23, 1935, top of well cover near center of west side, open slot, altitude 867.70 feet. Bench mark, at southeast corner of well, top of tee in galvanized-iron pipe, altitude 867.72 feet. Land-surface altitude 867.1 feet.

Date	Depth to water (feet)	Date	Depth to water (feet)	Date	Depth to water (feet)
Aug. 18, 1933	19.36	Sept.26, 1933	13.43	Nov. 11, 1933	19.89
21	21.04	Oct. 2	14.13	Dec. 5	19.65
29	17.84	10	16.97	31	15.36
Sept. 4	17.37	16	17.92	Jan. 4, 1934	16.04
12	15.48	28	19.35	Nov. 9, 1935	19.83
20	14.26	31	19.84	Dec. 7	26.92

O. K. Goodman, SE¼SW¼ sec. 26, T. 6 N., R. 35 E. Domestic dug well, 3.5 feet in diameter and 42 feet deep, dry rubble curbing to 8.5 feet. Measuring point, top of 2- by 4-inch timber at southeast corner of trap in well cover, copper nail and washer in vertical face of timber below point, altitude 908.97 feet. Bench mark, about 175 feet south of well, in northwest angle of cross road, top of southwest wing wall of concrete weir box, painted square, altitude 910.59 feet. Land-surface altitude 906.1 feet. Record largely by owner, from float gage. Depth to water, 1935: Oct. 24, 42.72 feet; Oct. 28 to Dec. 31, 45.5+ feet (well dry).

W. J. Rand, SE¼NE¼ sec. 28, T. 6 N., R. 35 E. Irrigation dug well, 4 feet square and 16 feet deep, cased with wood lagging to 12 feet. Measuring point from May 22, 1933, to Dec. 28, 1934, top of 1- by 6-inch wood curb, south side of well near southwest corner, copper nail and washer, altitude 829.29 feet; measuring point beginning Oct. 23, 1935, top of 4- by 4-inch pump support near southwest corner of well, vertically above copper nail with washer, altitude 829.66 feet. Bench mark, top of concrete foundation at southwest corner of house, altitude 829.36 feet. Land-surface altitude 829.1 feet.

May 22, 1933	10.48	Aug. 22, 1933	11.59	Oct. 16, 1933	11.04
June 6	10.35	29	11.69	31	10.83
21	10.06	Sept. 5	11.75	Dec. 5	10.88
July 6	10.10	12	11.59	28	11.22
15	10.17	21	11.42	Oct. 23, 1935	11.58
31	10.70	25	11.30	Nov. 7	11.28
Aug. 7	11.02	Oct. 2	11.20	Dec. 5	10.98
15	10.25	10	11.00		

Lottie M. McKnight, SW¼SW¼ sec. 28, T. 6 N., R. 35 E. Unused irrigation dug well, 7 feet square and 37 feet deep, concrete curbing to 16+ feet. Measuring point, top of concrete curb, north side of well, painted arrow, altitude 817.01 feet. Bench mark, 15 feet east and 30 feet north from well, top of concrete weir box at its east end, painted cross, altitude 817.96 feet. Land-surface altitude 817.0 feet.

Aug. 21, 1933	17.11	Sept.25, 1933	16.99	Dec. 4, 1933	10.17
29	17.90	Oct. 3	16.03	28	13.02
Sept. 4	17.97	9	15.00	Jan. 3, 1934	15.55
12	17.96	16	12.96	Oct. 23, 1935	15.25
21	17.36	30	11.17	Dec. 5	8.22

John Patras, NW¼SW¼ sec. 29, T. 6 N., R. 35 E. Domestic well, dug 6 feet square to 37 feet, drilled 37 to 100 feet, concrete curbing to 16 feet. Measuring point, top of concrete curb, northwest corner of well, painted mark, altitude 758.18 feet. Bench mark, 20 feet northwest of well, top of uppermost concrete cellar step at its southeast corner, altitude 757.65 feet. Land-surface altitude 758.2 feet.

Date	Depth to water (feet)	Date	Depth to water (feet)	Date	Depth to water (feet)
Sept.21, 1933	19.28	Oct. 16, 1933	17.22	Jan. 3, 1934	16.48
25	20.28	30	13.87	Oct. 23, 1935	19.76
Oct. 3	19.26	Dec. 5	13.12	Nov. 7	18.97
9	18.32	28	16.38	Dec. 5	15.10

Sam Givens, lot 3, sec. 30, T. 6 N., R. 35 E. Domestic dug well, 5 feet square and 30 feet deep, concrete curbing to 10 feet. Measuring point, top of wood well cover, east side of well, painted arrow, altitude 689.81 feet. Bench mark, top of wood well platform at its northwest corner, nail, altitude 687.48 feet. Land-surface altitude 687.2 feet.

Oct. 23, 1933	28.29	Dec. 4, 1933	24.66	Jan. 2, 1934	22.36
27	25.73	9	26.16	3	22.20
31	24.22	11	25.70	7	22.25
Nov. 1	24.12	16	24.75	9	21.94
9	25.83	18	24.90	13	21.83
14	25.70	20	25.00	Oct. 23, 1935	28.93
20	23.97	23	25.38	Nov. 7	28.92
23	25.43	26	25.11	Dec. 5	27.87
Dec. 1	24.69	28	24.72		
3	24.73	30	23.02		

Alpha Reese, NE¼NW¼ sec. 34, T. 6 N., R. 35 E. Irrigation dug well, 8 feet square and 54 feet deep, concrete curbing to 20 feet. Measuring point, top of concrete curb, north side of well, painted arrow, altitude 882.15 feet. Land-surface altitude 881.6 feet. Record largely by owner, from float gage.

Nov. 8, 1933	30.37	Dec. 22, 1933	42.39	Nov. 24, 1935	40.79
14	34.9	25	42.01	27	41.37
17	36.8	27	42.71	29	41.68
19	38.8	28	43.26	Dec. 1	42.05
21	41.58	29	43.04	3	42.67
23	40.82	31	44.16	5	43.80
26	40.99	Jan. 2, 1934	44.12	5	43.60
28	41.37	4	44.21	7	44.15
30	42.01	4	44.77	9	44.76
Dec. 2	42.50	6	44.95	11	45.10
3	42.84	8	45.13	13	45.36
4	43.11	10	46.34	15	45.65
5	43.13	12	46.50	17	45.93
7	43.78	14	47.29	19	46.28
9	44.31	16	47.50	21	46.74
11	43.98	18	47.71	23	46.90
13	42.53	Oct. 23, 1935	31.26	26	47.34
15	42.32	Nov. 7	43.08	30	47.64
18	42.20	20	40.07		
20	43.02	22	40.05		

Redfern, NE¼NW¼ sec. 36, T. 6 N., R. 35 E. Unused dug well, 5 feet square and 40 feet deep, concrete curbing to 25 feet. Measuring point, top of concrete curb, west side of well at trap door, painted arrow, altitude 928.15 feet. Land-surface altitude 926.0 feet.

Redfern well - Continued

Date	Depth to water (feet)	Date	Depth to water (feet)	Date	Depth to water (feet)
July 21, 1933	35.76	Sept. 4, 1933	37.80	Nov. 24, 1933	37.48
22	35.94	11	37.19	Dec. 4	37.88
24	36.35	20	35.13	19	22.08
31	36.92	25	35.56	25	16.02
Aug. 7	36.42	Oct. 2	36.89	28	15.95
14	37.07	9	36.93	Jan. 4, 1934	14.82
21	38.27	16	37.63	Oct. 24, 1935	39.61
28	38.19	30	39.42	Nov. 9	41.06

Walter Herman, SE¼NE¼ sec. 36, T. 6 N., R. 35 E. Domestic dug well, 4 feet square and 44 feet deep, concrete curbing to 18 feet. Measuring point, top of concrete curb, east side of well, painted arrow, altitude 931.75 feet. Bench mark, top of concrete well cover, west side of well, painted cross, altitude 929.85 feet. Land-surface altitude 929.8 feet. Record largely by owner, from float gage.

Nov. 5, 1933	21.28	Dec. 13, 1933	29.47	Nov. 15, 1935	32.80
6	20.99	14	28.87	16	33.04
7	20.57	16	27.56	18	33.45
9	19.93	19	24.83	20	34.04
10	19.73	20	24.49	22	34.41
12	19.73	22	23.74	23	34.64
14	20.10	23	23.30	25	35.14
15	20.69	25	21.55	27	35.57
16	21.10	28	18.92	29	35.93
17	21.58	29	18.06	Dec. 2	36.43
18	22.27	29	17.94	4	36.58
20	23.89	Jan. 1, 1934	15.61	6	36.64
21	24.51	4	14.19	7	36.81
25	26.96	5	13.94	9	37.11
26	27.62	8	13.43	12	37.68
28	28.77	9	13.32	13	37.50
Dec. 1	30.36	10	13.25	14	37.36
2	30.82	12	13.33	16	37.28
3	31.26	13	13.35	18	37.26
4	31.64	15	13.37	20	37.18
5	31.95	18	13.45	23	36.95
6	32.21	Oct. 24, 1935	28.06	26	36.78
7	32.45	Nov. 9	31.82	28	37.16
8	32.52	12	32.18	31	37.48
9	32.50	13	32.36		
10	32.15	14	32.62		

John Clark, lot 3, sec. 1, T. 5 N., R. 35 E. Irrigation dug well, 6 by 8 feet and 37 feet deep, concrete curbing to 19 feet. Measuring point, top of wood girder of well cover, west side of well, marked by copper nail and washer, altitude 995.60 feet. Bench mark, top of concrete flume at east side of pump house, altitude 996.88 feet. Land-surface altitude 995.6 feet.

Sept. 4, 1933	28.82	Oct. 9, 1933	24.59	Jan. 4, 1934	14.53
11	24.59	16	24.38	Oct. 24, 1935	22.69
20	22.84	30	21.97	Nov. 9	23.73
25	23.58	Dec. 4	24.05	Dec. 7	24.03
Oct. 2	23.57	29	14.80		

E. J. McSherry, lot 3, sec. 2, T. 5 N., R. 35 E. Irrigation dug well, 5 feet square and 23 feet deep, concrete curbing to 10 feet. Measuring point, top of plank pump support, painted arrow, altitude 975.82 feet. Bench mark, south of well, in top of concrete post at northwest corner of yard, brass screw, altitude 978.56 feet.

E. J. McSherry well - Continued

Date	Depth to water (feet)	Date	Depth to water (feet)	Date	Depth to water (feet)
Sept.11, 1933	13.34	Oct. 16, 1933	15.75	Oct. 23, 1935	15.93
20	14.92	30	16.77	Nov. 7	17.26
25	15.11	Dec. 4	17.81	Dec. 5	18.13
Oct. 2	16.12	28	18.02		
9	16.04	Jan. 4, 1934	17.26		

J. M. Morse estate, SE¼NE¼ sec. 3, T. 5 N., R. 35 E. Domestic dug well, 3.5 feet square. concrete curb around top. Measuring point from Oct. 30, 1933, to Jan. 4, 1934, top of concrete curb at center of south side, altitude 959.02 feet; measuring point beginning Oct. 23, 1935, top of concrete curb 0.8 foot north of outside southeast corner, altitude 959.05 feet. Bench mark, top of concrete curb, west side of irrigation well about 0.1 mile south, altitude 959.35 feet. Land-surface altitude 958.2 feet.

Oct. 30, 1933	25.10	Jan. 4, 1934	31.71	Dec. 5, 1935	30.34
Dec. 4	31.92	Oct. 23, 1935	22.36		
30	31.98	Nov. 7	30.18		

Of the water-table wells listed above, 17 afford comparisons of ground-water levels in December 1933 and 1935. The changes range from a rise of 1.95 feet to a decline of 7.2 feet; the average 2-year decline was 1.58 feet.

Fort Rock Valley.--In September 1932 the ground-water levels were determined in two water-table wells and five deep wells in the Fort Rock Valley of central Oregon. These wells range in depth from 25 to about 350 feet. In November 1935 water levels were again determined in four of the deep wells; one of the water-table wells was dry and the other was not visited. Data for the four deep wells follow. In these four wells, the average water-level decline from 1932 to 1935 was 1.49 feet.

Harry Crampton, SW¼NW¼ sec. 15, T. 25 S., R. 14 E. Irrigation well, 16 inches in diameter, depth unknown. Measuring point, top of 16-inch casing in pit, about 41.2 feet below land surface. Depth to water: Sept. 4, 1932, 4.35 feet; Nov. 27, 1935, 5.89 feet; decline, 1.54 feet.

H. W. Ostrom, NW¼NE¼ sec. 22, T. 26 S., R. 15 E. Irrigation well, 16 inches in diameter and 240 feet deep. Measuring point, top of pump-base flange, at drilled hole, 0.3 foot above land surface. Depth to water: Sept. 4, 1932, 24.96 feet; Nov. 27, 1935, 26.59 feet; decline, 1.63 feet.

H. M. Parks, SW¼NE¼ sec. 4, T. 27 S., R. 15 E. Irrigation well, 16 inches in diameter and about 250 feet deep. Measuring point, top of pump-base flange at drilled hole, 0.5 foot below land surface. Depth to water: Sept. 4, 1932, 38.21 feet; Nov. 27, 1935, 39.58 feet; decline, 1.37 feet.

H. M. Parks, SW¼NE¼ sec. 4, T. 27 S., R. 15 E. Stock well, 8 inches in diameter and 100 feet deep. Measuring point, top of 8-inch casing, 0.7 foot above land surface and approximately level with measuring point of preceding well. Depth to water: Sept. 4, 1932, 40.32 feet; Nov. 18, 1935, 41.75 feet; decline, 1.43 feet.

PENNSYLVANIA

By Stanley W. Lohman

HISTORY AND DESCRIPTION

A systematic survey of the ground-water resources of the State of Pennsylvania was begun in 1925 by the United States Geological Survey in cooperation with the Pennsylvania Topographic and Geologic Survey, under the general supervision of O. E. Meinzer, geologist in charge of the division of ground water, United States Geological Survey. In that year the thirteen counties and parts of two other counties of southeastern Pennsylvania were studied by Hall,[1] and in 1926 the six counties of southwestern Pennsylvania were studied by Piper,[2] but no observation wells were established in either area. No field work was done in 1927. In 1928 and 1929 the twelve counties of northwestern Pennsylvania were studied by Leggette,[3] who in December 1928 selected one dug well in Sligo, Clarion County, for monthly observation by a local observer. This was the first observation well established in Pennsylvania by the United States Geological Survey or its cooperating agency, and monthly measurements to the nearest inch have been continued on this well up to the present time. In 1930 the twelve counties and parts of two other counties of northeastern Pennsylvania were studied by the writer,[4] who in July 1930 selected one unused dug well in Montrose, Susquehanna County, for monthly observation by a local observer. Since the fall of 1931 this well has been measured weekly to the nearest 0.01 foot, and since August 1935 it has also been equipped with a 7-day automatic recorder.

Owing to the growing interest in ground-water levels occasioned by the drought of 1930, the areal ground-water survey in Pennsylvania was temporarily set aside in 1931, and a cooperative State-wide observation well program was begun.[5] Through the help of J. W. Mangan, dis-

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1 Hall, G. M., Ground water in southeastern Pennsylvania: Pennsylvania Geol. Survey, 4th ser., Bull. W2, 255 pp., 7 pls., 7 figs., 1934.

2 Piper, A. M., Ground water in southwestern Pennsylvania: Pennsylvania Geol. Survey, 4th ser., Bull. W1, 406 pp., 1 pl., 40 figs., 1933.

3 Leggette, R. M., Ground water in northwestern Pennsylvania: Pennsylvania Geol. Survey, 4th ser., Bull. W3 (in press).

4 Lohman, S. W., Ground water in northeastern Pennsylvania: Pennsylvania Geol. Survey, 4th ser., Bull. W4 (in press).

5 Lohman, S. W., Investigations of the fluctuations of the ground-water table in Pennsylvania: Am. Geophys. Union Trans. 13th Ann. Meeting, pp. 373-375, 1932.

trict engineer of the United States Geological Survey at Harrisburg, it was planned to locate observation wells near stream-gaging stations so far as possible, so that well measurements could be made by the local stream observers in conjunction with their regular duties. Accordingly in the fall of 1931 all the 99 stream-gaging stations in the State were visited by the writer, and at 31 of the stations unused wells, mostly dug, were selected for observation. In addition six similar wells were measured by independent local observers, including the two wells started in 1928 and 1930, making 37 wells in all. Nine of the wells were equipped with Kinnison float gages, one was equipped with a 7-day automatic recorder and a float gage, and the rest were measured by the visible ripple method,[6] using steel tapes with attached brass weights of known length, all measurements being made to 0.01 foot. Well measurements by local stream gagers are recorded on the weekly gage-height cards and sent to the district engineer at Harrisburg, who transfers them and forwards them to Washington; those made by independent local observers are sent directly to Washington on franked post cards. Engineers from the district office have aided materially in making repairs at observation wells equipped with float gages.

In order to have some means of averaging the water levels in all wells each week, the arbitrary datum method[7] was chosen, and the water level in each well was assumed to be 10.00 feet above the datum on November 28, 1931, a date on which all the water levels stood about at their annual minimum.

No field work was done in 1932, but in 1933 the cooperative ground-water survey of the State was resumed, and in 1933 and 1934 the 14 counties of south-central Pennsylvania[8] were studied by the writer. In 1935 the eight counties of north-central Pennsylvania[9] were studied by the writer, thus completing the areal ground-water survey of the State.

The use of several observation wells was unavoidably lost at different times, because their owners had filled in the wells or reclaimed them for use, and measurements on some wells were interrupted for brief periods because of breakdowns of equipment or carelessness of the local

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6 Leggette, R. M., and others, Report of the committee on observation wells, U. S. Geological Survey -- a preliminary manual of methods (mimeographed), pp. 19, 20, U. S. Dept. Interior, May 1935.

7 Idem, pp. 56, 57.

8 Lohman, S. W., Ground water in south-central Pennsylvania (manuscript report filed at offices of the United States Geological Survey and the Pennsylvania Topographic and Geologic Survey).

9 Report in preparation.

observers. A few new wells were added from time to time as opportunity permitted, and many of the new wells are being measured by the wetted-tape method.[10] Thus in 1931 one well was lost, in 1932 three wells were lost and two wells were added, in 1933 one well was lost, in 1934 five wells were lost, and in 1935 four new wells were added and the automatic recorder was transferred from one well to another. Of the wells being measured at the end of 1935 1 had been measured each month continuously for 7 years, 1 had been measured continuously for 5⅛ years (1⅛ years monthly and 4 years weekly), 27 had been measured each week fairly continuously for 4 years, and 4 had been measured each week continuously for 3 to 4 months. Thirty-two wells in all were being observed during 1935, 1 measured monthly and 31 measured weekly, including 1 well equipped with an automatic recorder, and a total of 1,308 individual measurements were made during the year.

The distribution of the 32 observation wells measured during 1935 among the principal ground-water provinces[11] of the State is as follows: 2 are in the Piedmont province, 8 in the Blue Ridge-Appalachian Valley province, 3 in the Northeast Drift province, 8 in the North-Central Drift -- Paleozoic province, and 11 in the South-Central Paleozoic province. There are no wells in the Atlantic Coastal Plain province, which covers only a very small part of the State. At the present time additional wells are needed in the Piedmont province and in the southwestern part of the South-Central Paleozoic province.

Three of the observation wells are 6-inch drilled wells with iron casings, one is a bored well with 7-inch tile casing, and the rest are dug wells 3 to 4 feet in diameter. Most of the dug wells are curbed with stone, but several are lined with tile or concrete. They range in depth from 5 to 72 feet, but two-thirds of them are from 10 to 30 feet deep. Of the wells for which records of a year or more are available, the water-level fluctuations range from 2½ to 29 feet and average about 8 feet. The maximum fluctuation is in a well 64 feet deep, and the minimum is in a well only 13 feet deep.

All the wells are thought to be water-table wells, but several may tap bodies of perched water. Most of the wells are in areas unaffected by heavy artificial withdrawal except for two or three wells that are pumped for a few weeks during each year.

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10 Leggette, R. M., and others, op. cit., pp. 17-19.

11 Meinzer, O. E., The occurrence of ground water in the United States with a discussion of principles: U. S. Geol. Survey Water-Supply Paper 489, pl. 31, 1923.

The measuring point is, as a rule, a marked point on a sharp edge of the wood, stone, or concrete platform, or, for the drilled wells, the edge of the casing. Most of the measuring points are fairly substantial, but some are rather insecure and should be replaced. Some of the measuring points have been tied in to bench marks by instrumental leveling, and it is intended to set additional bench marks as soon as the opportunity and funds are available.

The weekly water levels for all wells, tabulated in feet above the arbitrary datum, are filed quarterly in the offices of the United States Geological Survey in Washington, of G. H. Ashley, State geologist, Harrisburg, and of J. W. Mangan, district engineer, United States Geological Survey, Harrisburg. In addition, one copy is sent to C. F. Merriam, Pennsylvania Water & Power Co., Baltimore, who, with H. W. Lowy, of the same company, has been studying the relation between ground-water levels in the Susquehanna Basin and ground-water run-off in the Susquehanna River in connection with the prediction of the minimum stream flow available for two large hydroelectric power plants. Other information sent to the above named offices includes weekly average water levels and descriptions of new observation wells. The average water levels for the first 33 weeks were published in 1932,[12] and described briefly in a mimeographed statement releasing the data to the public.[13]

Hydrographs of 8 wells in northwestern Pennsylvania[14] and of 8 wells in northeastern Pennsylvania[15] are in process of publication, and hydrographs of 12 wells in south-central Pennsylvania and 7 wells in north-central Pennsylvania will be published by the writer in subsequent reports.

WATER-LEVEL FLUCTUATIONS

The weekly average water levels in observation wells in Pennsylvania from November 28, 1931, to January 4, 1936, are given in the following table. Five of the wells being measured at the start of the program were omitted from the average. These include three that had to be abandoned

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12 Lohman, S. W., Investigations of the fluctuations of the ground-water table in Pennsylvania: Am. Geophys. Union Trans. 13th Ann. Meeting, p. 374, 1932.

13 Lohman, S. W., Replenishment of ground water recorded by observation wells in Pennsylvania: Dept. Interior Press Mem. 62307, April 27, 1932.

14 Leggette, R. M., Ground water in northwestern Pennsylvania: Pennsylvania Geol. Survey, 4th ser., Bull. W3 (in press).

15 Lohman, S. W., Ground water in northeastern Pennsylvania: Pennsylvania Geol. Survey, 4th ser., Bull. W4 (in press).

after only a few weeks' records were obtained, one that is so close to a large river that flood waters produce abnormally high ground-water levels, and one that is measured only once a month. In computing the arithmetic averages missing well measurements for individual wells for short periods were obtained by interpolation, and those for longer periods were dropped from and subsequently added to the average in such a way that the effect on the average was only 0.03 foot a week or less. This was accomplished by assuming that the water level in the particular well was equal to the average for all other wells on a particular day several weeks after measurements had ceased and on a particular day several weeks before measurements were resumed. Then the intermediate readings were supplied by interpolation.

Weekly average water levels in observation wells in Pennsylvania

The water level in each well is expressed in feet above the arbitrary datum for that well. The weekly average water level given in this table is the average of the water levels thus expressed in all observation wells measured in that week.

Date	Number of wells	Water level (feet)	Date	Number of wells	Water level (feet)
1931			1932		
Nov. 28	32	10.00	Aug. 6	33	11.08
Dec. 5	32	10.17	13	33	11.00
12	32	10.66	20	33	10.83
19	32	11.34	27	33	10.50
26	32	11.41	Sept. 3	33	10.41
1932			10	33	10.42
Jan. 2	32	11.81	17	33	9.96
9	32	12.87	24	33	9.73
16	32	12.67	Oct. 1	33	9.77
23	32	12.97	8	31	10.71
30	32	13.21	15	31	10.71
Feb. 6	32	13.55	22	31	11.21
13	32	13.81	29	31	11.39
20	32	13.29	Nov. 5	31	12.00
27	32	12.83	12	31	13.18
Mar. 5	32	12.73	19	31	13.90
12	32	12.62	26	31	13.48
19	32	12.79	Dec. 3	30	12.94
26	33	13.71	10	30	12.59
Apr. 2	33	15.24	17	30	12.36
9	33	14.42	24	30	12.43
16	33	14.19	31	30	13.26
23	33	13.66	1933		
30	33	13.14	Jan. 7	30	13.16
May 7	33	13.24	14	30	12.87
14	33	14.32	21	30	13.01
21	33	13.64	28	30	13.79
28	33	13.08	Feb. 4	30	13.50
June 4	33	12.68	11	30	13.30
11	33	12.23	18	30	13.32
18	33	12.22	25	30	13.56
25	33	12.03	Mar. 4	30	13.30
July 2	33	12.02	11	30	13.61
9	33	12.07	18	30	14.87
16	33	11.55	25	30	15.10
23	33	11.44	Apr. 1	30	14.99
30	33	11.41	8	30	15.28

Weekly average water levels in observation wells - Continued

Date	Number of wells	Water level (feet)
1933		
Apr. 15	30	15.29
22	30	15.21
29	30	14.39
May 6	30	14.13
13	31	14.60
20	31	14.38
27	31	14.14
June 3	31	13.94
10	31	13.94
17	31	13.33
24	31	12.80
July 1	31	12.47
8	31	12.69
15	31	12.27
22	30	11.80
29	30	11.69
Aug. 5	30	11.54
12	29	11.53
19	29	11.69
26	29	13.11
Sept. 2	29	12.97
9	29	12.83
16	29	13.34
23	29	12.99
30	29	12.67
Oct. 7	29	12.26
14	29	11.77
21	29	11.82
28	29	11.91
Nov. 4	29	11.76
11	29	12.08
18	29	12.27
25	29	12.22
Dec. 2	29	12.17
9	29	12.16
16	29	12.31
23	29	12.82
30	29	13.24
1934		
Jan. 6	29	14.07
13	30	14.40
20	30	13.81
27	30	13.66
Feb. 3	30	13.44
10	30	12.83
17	29	12.48
24	29	12.47
Mar. 3	29	12.43
10	29	12.66
17	29	12.58
24	29	12.81
31	29	13.94
Apr. 7	29	14.18
14	29	14.62
21	29	14.45
28	29	13.78
May 5	29	13.66
12	29	13.20
19	29	12.88
26	28	12.61
June 2	28	12.30
9	28	12.10
16	28	11.94
23	27	12.22
30	27	11.91
July 7	27	11.68
14	27	11.43
21	27	11.01
28	27	11.00
Aug. 4	27	10.99
11	27	11.03
18	27	11.15
25	27	11.16
1934		
Sept. 1	27	10.82
8	27	10.86
15	27	11.12
22	27	11.77
29	26	12.04
Oct. 6	26	12.40
13	26	12.28
20	26	11.84
27	26	11.60
Nov. 3	25	11.75
10	25	12.15
17	25	12.11
24	25	12.39
Dec. 1	25	13.18
8	25	13.22
15	25	12.96
22	25	12.86
29	25	13.11
1935		
Jan. 5	23	13.06
12	23	13.74
19	23	13.68
26	23	13.72
Feb. 2	24	13.31
9	24	13.07
16	24	13.52
23	24	13.74
Mar. 2	24	14.29
9	24	14.64
16	24	14.99
23	24	15.04
30	24	14.64
Apr. 6	24	14.25
13	25	14.82
20	25	14.41
27	25	14.09
May 4	25	14.03
11	24	14.71
18	24	14.16
25	24	13.54
June 1	24	13.34
8	24	12.67
15	24	12.35
22	24	12.66
29	24	12.39
July 6	24	12.16
13	24	12.80
20	25	12.37
27	25	12.87
Aug. 3	25	12.62
10	25	12.52
17	25	12.29
24	26	11.98
31	27	11.52
Sept. 7	27	11.58
14	27	11.28
21	27	11.03
28	27	10.74
Oct. 5	27	10.60
12	27	10.49
19	27	10.17
26	27	10.05
Nov. 2	27	10.66
9	27	10.76
16	28	11.74
23	28	11.77
30	28	12.03
Dec. 7	28	11.85
14	28	12.88
21	28	13.53
28	28	13.04
1936		
Jan. 4	28	13.40

As shown in the above table, the average of the ground-water levels in all the observation wells in the State was practically the same at the beginning and at the end of the year 1935. From December 29, 1934, to December 28, 1935, there was a net decline of only 0.07 foot, but from January 5, 1935, to January 4, 1936, there was a net gain of 0.34 foot. By comparison, there was a net decline of 0.13 foot during 1934, a net decline of 0.02 foot during 1933, and a net gain of 1.85 feet during 1932. Thus the only appreciable net yearly change occurred in 1932, and this was due in part to the uneven monthly distribution of precipitation for that year. The precipitation over the State was only 2 inches below normal in 1935 but was more than 3 inches below normal in 1932 and 1934 and was 3 inches above normal in 1933. Moreover, the monthly distribution of precipitation in 1935 was more nearly normal than in any of the other three years. The average water levels for 1935 are also probably more nearly normal than those of any of the other years.

In 1935 the total range of fluctuation in the average weekly water levels was 5 feet, from the highest average stage of 15.04 feet on March 23 to the lowest of 10.05 feet on October 26. The range for other years was from 3.76 feet in 1933 to 5.51 feet in 1932, in which the highest water levels occurred in April and the lowest in August or September. In 1935 the water levels reached the lowest weekly average since 1932. The summer declines in 1933 and 1934 were arrested sharply by abnormally heavy tropical rainstorms in August and September 1933 and in September 1934, and therefore the lowest levels reached in those years were 2 and 3 feet above those for 1932 and 1935. In July 1935 the precipitation was 1 inch above normal, and the June water levels were thus maintained through July, but the water levels declined steadily during August, September, and October. Winter recharge in 1935 began late in October, and, with above-normal precipitation in November, the water levels rose steadily throughout the remainder of the year. In former years winter recharge had begun as early as October 1 and as late as December 5.

The observation well which has the longest record and which is also typically representative of water-table conditions in an area unaffected by pumping is the one established July 15, 1930, at Montrose. It is an unused dug well, 38.2 feet deep below the ground surface, near a hilltop on the Carlton Farm just within the northern boundary of the borough and 0.35 mile east of the northwest corner of the borough. It is curbed with loose stones and has a substantial concrete top. The well is thought to be entirely in Wisconsin glacial drift. The measuring point is the top edge of a 3-inch hole cut into a 2- by 12-inch plank in the floor of the recorder shelter and is

1.09 feet above the top of the concrete platform, which is at ground level. All measurements were made by P. F. Chamberlain, superintendent of the farm. Measurements were made monthly to the nearest inch from July 15, 1930, to November 8, 1931, and weekly to the nearest 0.01 foot by the visible-ripple method from November 14, 1931, to August 3, 1935. Since August 10, 1935, the well has been equipped with a 7-day automatic recorder, and as a check weekly measurements have been made to the nearest 0.01 foot by the wetted-tape method. All measurements listed in the table below are in feet above the arbitrary datum, which is 20.19 feet below the measuring point; therefore the water levels may be compared with those in the first table for similar dates.

The lowest water level recorded in this well was 9.77 feet above the arbitrary datum on December 5, 1931, and the highest was 16.65 feet on November 19, 1932. Normally the highest water levels in this well occur in April, and the lowest in the fall. The complete records of water levels in this well up to January 4, 1936, are given in the following table:

Water levels in the observation well at Montrose, Susquehanna County, Pa., in feet above the arbitrary datum

Date	Water level (feet)	Date	Water level (feet)	Date	Water level (feet)
1930		1932		1932	
July 15	13.2	Feb. 13	16.50	Oct. 1	10.28
Aug. 1	11.9	20	15.25	8	13.66
Sept. 1	10.8	27	14.22	15	13.07
Oct. 1	11.9	Mar. 12	13.20	22	13.01
Nov. 1	10.8	19	12.85	29	12.82
Dec. 1	10.3	26	12.90	Nov. 5	14.49
1931		Apr. 2	16.02	12	16.03
Jan. 1	10.5	9	15.84	19	16.65
Feb. 1	10.4	16	15.8	26	15.10
Mar. 2	12.3	23	14.75	Dec. 3	14.70
Apr. 1	16.0	30	14.00	10	13.84
May 1	14.1	May 7	16.47	24	12.36
June 11	14.8	14	15.76	31	13.24
July 1	12.9	21	14.65	1933	
Aug. 1	14.9	28	13.10	Jan. 7	13.60
Sept. 1	11.7	June 4	12.47	14	13.25
Oct. 1	10.9	11	11.85	21	13.14
Nov. 1	10.3	18	11.65	28	14.32
8	10.22	25	11.30	Feb. 4	13.80
14	10.14	July 2	11.65	11	12.75
21	10.05	9	11.95	18	12.70
28	10.00	16	11.95	25	12.50
Dec. 5	9.97	23	11.88	Mar. 4	12.35
12	10.20	30	11.62	11	14.44
19	10.38	Aug. 6	11.40	18	14.77
26	10.60	13	11.17	25	15.94
1932		20	11.18	Apr. 1	15.66
Jan. 2	10.80	27	11.05	8	16.10
9	15.10	Sept. 3	10.92	15	16.13
16	14.99	10	10.69	22	15.62
23	16.38	17	10.30	29	14.65
30	16.30	24	10.42	May 6	14.00

Water levels in the observation well at Montrose - Continued

Date	Water level (feet)	Date	Water level (feet)	Date	Water level (feet)
1933		1934		1935	
May 13	13.84	Apr. 7	14.04	Mar. 9	16.21
20	13.70	14	15.34	16	15.22
June 3	13.94	21	14.80	23	15.03
10	14.20	28	14.21	30	13.80
17	13.45	May 5	13.09	Apr. 6	13.90
24	12.22	12	12.34	13	16.37
July 1	11.74	19	11.78	20	14.30
8	11.75	26	11.41	27	14.48
15	11.50	June 2	11.05	May 4	13.95
22	11.29	9	10.89	11	14.80
29	11.03	16	10.72	25	12.72
Aug. 5	10.99	23	11.40	June 1	11.63
12	11.11	30	10.84	8	11.31
19	11.39	July 7	10.94	15	11.13
26	16.24	14	10.89	22	10.94
Sept. 2	15.13	21	10.84	29	10.91
9	15.71	28	10.90	July 6	10.85
16	16.44	Aug. 4	10.88	13	11.05
23	15.11	11	11.15	20	11.29
30	14.19	18	11.12	27	11.29
Oct. 7	13.39	25	10.97	Aug. 3	11.21
14	11.87	Sept. 1	10.84	10	11.12
21	11.48	8	10.90	17	11.04
28	11.79	15	11.13	24	10.99
Nov. 4	13.04	22	13.32	31	10.89
11	12.07	29	13.68	Sept. 7	10.72
18	12.26	Oct. 6	15.31	14	10.65
25	13.25	13	14.93	21	10.57
Dec. 4	12.99	20	13.71	28	10.47
9	13.01	27	12.98	Oct. 5	10.39
16	12.73	Nov. 3	12.42	12	10.29
23	13.32	10	13.23	19	10.19
30	14.19	17	13.31	26	10.09
1934		24	14.24	Nov. 2	10.12
Jan. 6	14.01	Dec. 1	17.49	9	10.19
13	13.62	8	15.5	16	12.72
20	12.00	15	13.9	23	14.99
27	12.30	22	12.79	30	16.29
Feb. 3	11.97	1935		Dec. 7	15.60
10	11.64	Jan. 5	12.09	14	15.33
17	11.14	19	12.79	21	15.86
24	10.87	26	12.68	28	15.07
Mar. 3	11.40	Feb. 2	12.00	1936	
10	13.20	9	10.90	Jan. 4	14.75
17	12.72	16	12.26		
24	11.89	23	12.89		
31	14.43	Mar. 2	12.60		

SOUTH CAROLINA

TIGER RIVER AREA OF SOIL CONSERVATION SERVICE

An observation-well program was started in the Tiger River area, in Spartanburg and Greenville Counties, S. C., in July 1934, by the Geological Survey in cooperation with the Soil Conservation Service, as part of a national soil-conservation program. A total of 28 wells have been measured in this area, 9 along the North Fork of the Tiger River and 19 along the South Fork. Measurements have been discontinued on 4 wells in the South Tiger area.

The 9 wells in the North Tiger area are all dug wells; 1 and 3 are cased with rock, 2 and 8 with tile, and 4, 5, 6, 7, and 9 are uncased. In the South Tiger area wells 6, 8, 9, 10, 11, 12, 14, and 15 are dug, wells 1 and 7 are drilled, and wells 2, 3, and 4 are bored. Wells 6, 8, and 14 are cased with tile or brick, but the other dug wells are uncased; well 1 is cased with iron casing, and well 7 with tile; the bored wells are all cased with tile. The wells range in depth from 15 to 65 feet. They penetrate deeply weathered rocks of the Piedmont Plateau, chiefly metamorphic. They are essentially water-table wells and are not affected by heavy withdrawals. The depth to water level in the different wells ranges from about 15 to 65 feet. The measuring point for each well is a keel mark either on the instrument table over the well or on a cross-bar over the center of the well. The altitude of each measuring point has been instrumentally tied in with bench marks.

The measurements of depth to water level have been made weekly by members of either the Geological Survey or the Soil Conservation Service. A total of 2,100 measurements were made on the 24 wells from the beginning of the program to January 1, 1936, of which 1,250 were made during the year 1935 -- an average for the year of 52 measurements to the well. Only the records of measurements that were made nearest to the first of each month are given in this report. The method of expressing the results of the measurements is explained in the introduction. A water-stage recorder has been in operation on well 3, in the South Tiger area, since the beginning of the program. Four other automatic recorders have been in use at times, but only two of them are in use at present. They have been shifted from well to well in order to get continuous records for short periods on all the wells.

The average fluctuations of the water levels in the North and South Tiger areas are practically the same in amplitude and essentially synchronous in phase, but the fluctuations in some of the individual wells, especially in the South Tiger area, deviated widely from the averages. Thus the times of the highest and lowest stages in some of the wells varied as much as several months from the highest and lowest averages. On the average, the water levels rose from the beginning of June 1934, when the first measurements were made, until about the later part of July and then declined until the following January. They rose, on the average, from January 1935 until July, when the highest average stage of the year was reached -- about 1.6 feet higher than at the beginning of the year. They declined from July to about the middle of December. Very few measurements were made during the latter part of December or the first part of January 1936, but those that were made indicate a slight average rise.

Wells in the Tiger River area, in Spartanburg and Greenville Counties, S. C.

(The depth to the water level given in the next to last column is the depth below the measuring point on Jan. 1, 1935. The height of the measuring point, given in the last column, is its height with reference to the arbitrary datum.)

Well no.	Owner and location	Depth (feet)	Diameter (inches)	Depth to water level (feet)	Height of measuring point (feet)
	North Tiger area				
1	B. L. Bane, 1 mile S. 5° E. of Walnut Grove	32	6	29.22	39.22
2	John Wingo, 2⅛ miles S. 84° E. of Switzer	40	1.5	36.77	46.77
3	J. L. Foster, 1/2 mile S. 45° E. of Roebuck	56	3	51.68	61.68
4	W. G. Sloan, 2⅛ miles S. 67° E. of Duncan	41	6	39.63	49.63
5	A. B. Grouse, 1/2 mile N. 80° E. of Duncan	31	5	27.76	37.76
6	E. E. Brown, 1⅛ miles S., 10° W. of Fairforest	30	5	27.55	37.55
7	C. P. Cleveland, 6 miles N. 10° W. of Duncan	44	5	41.05	51.05
8	A. B. Grouse, 5⅛ miles N. 40° W. of Duncan	42	5	40.40	50.40
9	W. C. Suddeth, 8 miles N. 5° W. of Duncan	29	6	27.18	37.18
	South Tiger area				
1	C. O. Fowler, 4 3/4 miles N. 56° E. of Woodruff	65+	6	64.90	74.90
2	C. O. Fowler, 2⅛ miles N. 73° E. of Woodruff	35.5	14	33.65	43.65
3	C. D. Turner, 1/4 mile S. 45° E. of Switzer	.....	14	32.18	42.18
4	Walter Cox, 1/8 mile N. 30° W. of Switzer	.....	12	39.39	49.39

Wells in the Tiger River area - Continued

Well no.	Owner and location	Depth (feet)	Diameter (inches)	Depth to water level (feet)	Height of measuring point (feet)
	South Tiger area - Continued				
6	J. D. Darby, 3⅛ miles S. 25° E. of Reidville	51	60	47.42	57.42
7	T. O. Fowler, 2 3/4 miles S. 21° E. of Reidville	15	6	15.25	25.25
8	C. S. Vaughn, 3⅛ miles N. 82° E. of Reidville	37	60	35.47	45.47
9	Mrs. Ila L. Wilson, 1 mile N. 26° W. of Reidville	29	60	30.68	40.68
10	J. E. Raven, 1 3/4 miles S. 45° E. of Duncan	27	60	26.68	36.68
11	J. O. Forest, 3 miles S. 20° W. of Duncan	32	60	26.75	36.75
12	J. G. R. Armstrong, 2 miles N. 50° W. of Duncan	37	60	35.79	45.79
14	R. B. Taylor, 2 miles N. 71° W. of Greer	31	72	25.46	35.46
15	A. W. Neves, 6 miles N. 46° W. of Greer	57	48	55.64	65.64
16	J. T. Bridwell, 7¼ miles N. 60° W. of Greer	53	54	45.29	55.29

Water levels in wells in the Tiger River area, in Spartanburg and Greenville Counties, S. C., in feet above the arbitrary datum

Date	1	2	3	4	5	6
			North Tiger area			
1934						
June 1-12	10.00	.....	9.86	10.57	11.10	11.02
July 2-9	11.27	10.83	10.04	11.39	11.94	11.32
30	11.65	11.15	10.24	11.76	12.32	10.89
Sept. 3-5	11.22	11.20	10.49	11.57	11.76	10.25
Oct. 1-4	10.70	10.89	10.54	10.94	11.11	10.12
29	10.70	10.66	10.51	10.51	10.66	9.97
Dec. 3	10.34	10.21	10.30	10.30	10.30	10.10
31	9.93	10.00	10.08	10.01	10.01	10.04
1935						
Jan. 28	10.38	10.13	9.45	9.76	9.85	10.25
Mar. 4	11.13	10.58	9.92	10.17	10.35	10.56
Apr. 1	11.81	11.09	10.06	10.98	10.94	10.60
29	12.60	11.56	10.23	11.79	11.40	10.49
June 3	13.00	11.89	10.47	12.56	11.70	10.54
July 1	13.16	11.93	10.68	12.96	11.61	10.18
29	12.79	11.69	10.86	13.01	11.30	10.02
Sept. 2	12.03	11.20	10.93	12.54	11.02	9.99
30	11.55	10.80	10.95	12.12	10.82	10.09
Nov. 4	11.00	10.31	10.83	11.48	10.41	9.96
Dec. 2	10.41	9.87	10.63	10.82	9.94	9.91
1936						
Jan. 6	10.05	.....	11.12	.....	10.13	.....

Date	7	8	9	Average
1934				
June 1-12	9.22	10.19	11.00	10.37
July 2-9	10.09	10.58	11.68	11.01
30	10.88	10.99	11.75	11.29
Sept. 3-5	11.09	11.19	11.35	11.12
Oct. 1-4	10.77	11.02	10.82	10.76
29	10.53	10.74	10.53	10.53
Dec. 3	10.22	10.32	10.06	10.24
31	10.01	10.01	.....	10.01

Water levels in wells in the Tiger River area - Continued

Date	7	8	9	Average
	North Tiger area - Continued			
1935				
Jan. 28	9.92	9.84	.....	9.95
Mar. 4	10.24	10.04	10.87	10.42
Apr. 1	10.60	10.33	11.20	10.84
29	10.82	10.59	11.42	11.22
June 3	11.03	10.89	11.60	11.41
July 1	11.15	11.06	11.71	11.60
29	10.95	11.12	11.61	11.48
Sept. 2	10.80	11.09	11.57	11.24
30	10.61	11.04	11.30	11.03
Nov. 4	10.15	10.71	10.75	10.63
Dec. 2	9.57	10.46	10.56	10.24
1936				
Jan. 6	.....	.....	.....	.....

Date	1	2	3	4	6	7	8	9
	South Tiger area							
1934								
June 1-12	10.69	9.30	11.00	11.54	9.82	13.45	10.00	14.15
July 2-9	10.39	9.69	11.43	9.86	10.21	13.13	10.56	14.78
30	10.22	10.56	10.71	10.34	10.66	11.73	10.94	14.54
Sept. 3-5	.....	10.92	10.93	10.80	10.92	10.35	11.10	12.96
Oct. 1-4	.....	10.81	10.49	10.79	.....	9.51	10.89	11.74
29	10.07	10.62	10.48	10.62	10.55	10.20	10.57	10.95
Dec. 3	10.05	10.19	11.12	10.23	10.26	9.53	10.09	10.35
31	.....	.....	10.06	.....	10.01	10.00	.....	10.01
1935								
Jan. 7	10.00	10.01	10.30	9.94	9.95	11.22	.....	9.98
28	9.95	10.07	10.70	9.74	9.89	12.39	.....	10.04
Mar. 4	9.90	10.83	11.31	9.90	10.21	13.84	9.63	11.02
Apr. 1	9.93	11.79	11.76	10.39	10.67	14.31	10.05	11.80
29	10.05	12.73	12.19	10.71	11.04	15.05	10.51	12.32
May 27	10.24	13.24	12.27	11.05	11.23	14.36	10.90	12.58
July 1	10.58	13.44	11.97	11.44	11.44	12.89	10.40	12.28
29	10.82	13.33	11.62	11.61	11.27	12.05	11.55	11.55
Sept. 2	11.04	12.86	11.17	11.56	11.12	11.45	11.40	10.75
30	11.13	12.48	10.90	11.35	10.88	10.69	11.15	10.33
Nov. 4	11.20	11.80	10.42	11.94	10.57	9.33	10.84	9.83
Dec. 2	11.14	11.35	10.03	10.54	10.21	9.08	10.44	.....
1936								
Jan. 6	11.13	11.58	11.73	.....	9.96	.....	10.30	.....

Date	10	11	12	14	15	16	Average
1934							
June 1-12	12.32	12.27	10.87	11.39	9.25	9.40	11.10
July 2-9	12.63	13.15	11.55	12.21	9.52	11.04	11.44
30	12.36	13.15	11.65	11.81	9.98	12.79	11.53
Sept. 3-5	11.50	12.12	11.39	10.60	10.64	13.57	11.37
Oct. 1-4	10.90	11.12	11.14	10.21	10.82	12.99	10.95
29	10.61	.....	10.73	9.42	10.84	12.15	10.60
Dec. 3	10.33	10.54	10.24	9.75	10.41	10.95	10.29
31	10.00	10.02	10.01	.....	10.02	10.09	10.02
1935							
Jan. 7	9.98	9.90	9.97	.....	9.98	.....	10.11
28	9.99	9.76	9.83	10.34	9.59	9.32	10.12
Mar. 4	10.60	10.37	9.85	11.20	9.14	8.79	10.47
Apr. 1	11.26	11.24	10.24	11.70	8.91	8.85	10.92
29	11.57	11.77	10.95	11.99	8.77	9.48	11.36
May 27	11.72	12.28	11.37	12.03	8.78	10.14	11.58
July 1	11.49	12.63	11.38	11.45	9.19	10.75	11.52
29	11.14	12.22	11.35	10.64	9.50	10.87	11.39
Sept. 2	10.80	11.31	11.17	10.81	9.70	10.75	11.13
30	10.61	10.95	10.98	11.35	9.78	10.94	10.96
Nov. 4	10.13	10.17	10.71	10.15	9.82	11.03	10.56
Dec. 2	9.92	9.46	10.41	9.74	9.80	10.63	10.21

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TEXAS

STATE-WIDE PROJECT

By W. N. White and A. N. Sayre

Detailed investigations of ground-water conditions in certain areas in Texas were begun in 1929 as a State-wide project by the United States Geological Survey in cooperation with the Texas State Board of Water Engineers and the Engineering Experiment Station of the Agricultural and Mechanical College of Texas. Additional investigations have since been started in other areas, and at the present time all or parts of about 30 counties have been covered. In nearly all the areas investigated a serious problem of ground-water supply exists owing to lowering of the water levels by heavy withdrawals for municipal use or irrigation. Consequently the investigations have dealt especially with the quantity of available ground water and the best methods of utilizing and conserving these supplies for beneficial use. Periodic measurements of water levels in selected wells have been made in 21 of these counties. The areas in which these measurements have been made, the principal investigators in each area, the date on which the investigation was begun, and the approximate number of observation wells are as follows:

Winter Garden area: Dimmit and Zavala Counties, including parts of La Salle and Maverick Counties, by W. N. White, T. W. Robinson, S. F. Turner, and Penn Livingston; begun in 1929; includes about 100 observation wells.

Houston area: Harris County and parts of Galveston, Fort Bend, Brazoria, Waller, Grimes, and Montgomery Counties, by Penn Livingston, S. F. Turner, and W. N. White; begun in 1930; includes about 90 observation wells.

South Texas area: Duval County, by A. N. Sayre; begun in 1931; includes 47 observation wells. Webb County, by J. T. Lonsdale and J. R. Day; begun in 1932. Brooks County, by S. F. Turner and J. C. Cumley, begun in 1932; includes 15 observation wells. Kleberg County, by Penn Livingston and T. W. Bridges; begun in 1932; includes 40 observation wells. Jim Wells and Jim Hogg Counties, by S. F. Turner, J. C. Cumley, and W. A. Lynch; begun in 1933.

San Antonio area: Bexar County and parts of Comal County, by Penn Livingston and A. N. Sayre; begun in 1932; includes 38 observation wells. Uvalde and Medina Counties, by A. N. Sayre; begun in 1929; includes 32 observation wells.

The principal water-bearing formations in all these areas are sandstones or limestones that dip from their outcrops toward the Gulf of Mexico at a rate somewhat greater than the slope of the surface, and consequently the water in them is under artesian pressure except in the outcrop areas. Some of the wells have artesian flow. The water is under

water-table conditions in the outcrop areas of these formations and also in the areas of stream and terrace gravel, which in some places yield considerable quantities of water.

Many of the wells that recover water from the stream and terrace gravel are dug wells that range in depth from a few feet to a hundred feet or more and in diameter from 3 to 6 feet, whereas most of the wells that penetrate the deeper formations are drilled and range in depth from about 50 to about 2,000 feet and in diameter from 3 to 24 inches.

In most wells the point from which the measurements are taken is either the top of the casing or the top of the drop-pipe clamp, but in the wells pumped by power the measurements are usually made from the pump base. The altitudes above sea level of the measuring points of wells in the Houston, San Antonio, and Winter Garden areas and in Kleberg County have been determined by leveling and are given in the tables.

Water levels were measured monthly for the first year or two after each investigation was begun. With the data thus obtained the periods of the year in which the measurements appeared to be the most significant were selected, and thereafter measurements were made during these periods, two or three measurements being made on each well each year. Automatic water-stage recorders were installed over one or more wells in each area and maintained for a sufficient time to indicate the characteristics of the fluctuations in water level. From three to six recorders have been in use since 1929.

The periodic measurements of water levels in observation wells are being continued, but most of the detailed work of the investigations listed above has been completed, and detailed reports on them have been or are being prepared for publication. The following reports contain information relative to water-level fluctuations in areas that have been investigated in the State-wide project begun in 1929:

White, W. N., and others, Survey of the underground waters of Texas: U. S. Dept. Interior mimeographed memorandum, Feb. 16, 1931.

White, W. N., Livingston, Penn, and Turner, S. F., Ground-water resources of the Houston-Galveston area, Texas: U. S. Dept. Interior mimeographed memorandum, Oct. 17, 1932.

White, W. N., and Livingston, Penn, Ground-water resources of the Houston district: U. S. Dept. Interior mimeographed memorandum, Dec. 29, 1933.

Fiedler, A. G., Artesian water in Somerville County, Tex.: U. S. Geol. Survey Water-Supply Paper 660, 1934.

White, W. N., Turner, S. F., and Lynch, W. A., Ground-water in Dimmit and Zavala Counties, Tex.: U. S. Dept. Interior mimeographed memorandum, Apr. 11, 1934.

White, W. N., Summary report on the survey of the underground waters of Texas: U. S. Dept. Interior mimeographed memorandum, March 1935.

Lonsdale, J. T., Geology and ground-water resources of Atascosa and Frio Counties, Tex.: U. S. Geol. Survey Water-Supply Paper 676, 1935.

Sayre, A. N., Geology and ground-water resources of Uvalde and Medina Counties, Tex.: U. S. Geol. Survey Water-Supply Paper 678 (in press).

Livingston, Penn, Sayre, A. N., and White, W. N., Ground-water resources of the San Antonio area, Tex.: U. S. Geol. Survey Water-Supply Paper 773-B (in press).

Livingston, Penn, and Bridges, T. W., Ground-water resources of Kleberg County, Tex.: U. S. Geol. Survey Water-Supply Paper 773-D (in press).

Sayre, A. N., Geology and ground-water resources of Duval County, Tex.: U. S. Geol. Survey Water-Supply Paper 776 (in press).

A reconnaissance was made by C. V. Theis, H. P. Burleigh, and H. A. Waite, in 1933 and 1934, of the ground-water conditions in the southern part of the High Plains, an area of about 70,000 square miles extending from the Smoky Hill River, in Kansas, southward through parts of Kansas, Colorado, Oklahoma, Texas, and New Mexico. This work, which was accomplished by means of an allotment of funds by the Public Works Administration, resulted in a map showing the approximate depths to the water table throughout the area, but it did not include any program of periodic measurements of water levels. A mimeographed memorandum giving the principal results of the investigation and including a small-scale hydrologic map was issued October 30, 1935.

In general records of wells and water levels are released for public inspection as soon as practicable and may be consulted in the office of the United States Geological Survey in Washington, D. C., or in the office of the Texas Board of Water Engineers in Austin, Tex. Records of water levels in observation wells in Bexar, Brooks, Dimmit, Duval, Galveston, Harris, Jim Hogg, Jim Wells, Maverick, and Zavala Counties, most of which have not previously been published, are given below.

Bexar County

The Edwards limestone is the principal water-bearing formation in Bexar County and supplies all the wells listed in the following table except 5 and 6, which are supplied by the Glen Rose limestone, and 35, which is supplied by the Austin chalk. Most of the discharge occurs in the vicinity of San Antonio, where flowing wells, springs, and pumped wells have yielded for the last 20 years an average of over 100,000,000 gallons of water a day.

Miscellaneous water-level measurements were made by the San Antonio Water Works Co. in standpipes at the waterworks plant on Market Street from 1893 to 1900. Since 1911 the City Water Department has kept daily records of the artesian pressure at the Brackenridge pumping plant. In 1932 the United States Geological Survey and the State Board of Water Engineers began measuring the water levels in 38 wells in the area and maintained a water-stage recorder on another well. The measurements show that the artesian pressure fluctuates within rather wide limits, but there is no evidence of any marked rising or declining trend. During the greater part of the period since the Geological Survey and State Board of Water Engineers began making measurements the water levels have declined, but between the measurements of April and June 1935 a general rise occurred, and the June measurements showed the water levels to be higher than at any other time since the beginning of the investigation. The significance of these fluctuations is discussed in Water-Supply Paper 773-B, which is now in press. The records are given in the following table:

Water levels in wells in Bexar County

(Water levels given in feet above mean sea level)

1. Mrs. Kate Benke, Culebra Road near Medina-Bexar County line. Diameter 6 in. Depth 1,010 ft. Measuring point, top of pipe clamp, 0.5 ft. above land surface. Altitude 1,044.64 ft.

Date	Water level (feet)
Sept.22,1933	757.24
May 23,1934	757.43
June 21	751.99
July 31	764.55
Aug. 24	747.68
Sept.21	743.93
Oct. 10	742.09
Dec. 21	740.87
Feb. 3,1935	735.12
Feb. 4	735.08
Apr. 9	734.38
May 21	789.37
June 28	825.12
Aug. 2	804.54
Sept.27	807.99

2. Ed Bacon, Bacon ranch, south side of Camp Bullis. Depth 320 ft. Measuring point, top of casing, 1.0 ft. above land surface. Altitude 1,004.92 ft.

2. - Continued

Date	Water level (feet)
Dec. 22,1933	715.84
Mar. 2,1934	715.42
Oct. 12	712.24
Mar. 1,1935	712.64

3. Ben Biering, Bandera Road, 2 miles southeast of Helotes. Diameter 5 inches. Depth 210 ft. Measuring point, top of casing, 1.0 ft. above land surface. Altitude 969.04 ft.

Date	Water level (feet)
Oct. 18,1932	723.1
Nov. 18	722.39
Jan. 15,1933	721.09
Apr. 9	721.23
July 18	715.67
Sept.18	712.25
Oct. 17	711.06
Nov. 20	709.72
Dec. 18	708.38
Jan. 19,1934	707.47
Feb. 19	708.08
Mar. 19	709.48
Apr. 18	712.29
May 21	714.89
June 19	712.99
July 30	711.16
Aug. 22	710.02
Sept.19	708.03

3. - Continued

Date	Water level (feet)
Oct. 13,1934	706.81
Nov. 20	704.96
Dec. 19	703.14
Feb. 2,1935	702.51
28	702.92
Apr. 10	702.10
June 28	738.94
Sept.29	752.49

4. Theo. Biering, 1¼ miles south of Helotes. Diameter 8 in. Depth 344 ft. Measuring point, top of pipe clamp. Altitude 987.74 ft.

Oct. 18,1932	725
Nov. 18	724.74
Jan. 15,1933	722.7
Apr. 9	723.5
July 18	718.32
Aug. 17	716.5
Sept.18	714.81
Oct. 17	713.45
Nov. 20	712.12
Dec. 18	710.70
Jan. 19,1934	709.92
Feb. 19	710.16
Apr. 18	713.74
May 21	716.23
June 19	715.18
July 30	713.89

Water levels in wells in Bexar County - Continued

4. - Continued

Date	Water level (feet)
Sept.19,1934	710.79
Oct. 13	709.42
Nov. 20	707.50
Dec. 19	705.61
Feb. 2,1935	704.96
Apr. 10	704.08
May 20	708.81

5. A. L. Fuller, Helotes. Diameter 6 in. Depth 450 ft. Measuring point, top of pipe clamp, 1.0 ft. above land surface. Altitude 1,043.81 ft.

Sept.27,1933	881.09
Jan. 19,1934	872.41
Feb. 19	879.04
Mar. 1	876.16
19	867.2
Apr. 18	875.41
May 21	875.8
June 19	850
July 30	877.49
Oct. 12	873.95
Dec. 19	873.62
Feb. 2,1935	871.66
Apr. 10	871.01
May 20	874.07
June 28	909.76
Aug. 5	898.19
Sept.29	905.95

6. R. W. Barham, Bandera Road, 0.2 mile north of Helotes Creek. Diameter 6 in. Depth 216 ft. Measuring point, hole in pump base, at land surface. Altitude 1,050.33 ft.

Mar. 19,1934	972.33
Apr. 18	974.13
May 21	972.59
June 19	972.57
July 30	974.41
Aug. 22	972.13
Sept.19	972.09
Oct. 12	972.07
Nov. 20	972.40
Dec. 19	972.29
Feb. 2,1935	972.00
28	972.60
Apr. 10	972.94
May 20	984.50
June 28	979.22
Aug. 5	978.23
Sept.29	981.53

7. George Calvert, Bandera Road, 10 miles northwest of San Antonio. Diameter 5 in. Measuring point, top of pipe clamp. Altitude 876.57 ft.

Date	Water level (feet)
July 21,1932	685.3
Oct. 18	690.7
Nov. 18	689.86
Apr. 9,1933	689.6
July 18	685.40
Aug. 17	685.06
Sept.18	684.92
Oct. 17	684.34
Nov. 20	683.92
Dec. 18	683.54
Jan. 19,1934	683.92
Feb. 19	684.53
Mar. 19	685.61
Apr. 18	686.81
May 21	684.73
June 19	681.96
July 30	682.96
Aug. 22	680.18
Sept.19	679.03
Nov. 20	678.43
Dec. 19	678.06
Feb. 2,1935	678.18
28	678.52
Apr. 10	677.87
May 20	693.67
June 28	705.29
Aug. 5	699.17
Sept.29	699.85

8. Adolphe Benke, 15 miles northwest of San Antonio. Diameter 5 in. Depth 285 ft. Measuring point, top of pipe clamp, 0.5 ft. above land surface. Altitude 907.33 ft.

July 21,1932	702.1
Oct. 18	706.18
Nov. 18	705.85
Apr. 9,1933	705.77
July 18	701.90
Aug. 17	700.65
Sept.18	699.69
Oct. 17	699.10
Nov. 20	698.02
Dec. 18	697.10
Jan. 19,1934	696.51
Feb. 19	697.25
Mar. 19	698.35
Apr. 18	699.81
May 21	700.88
June 19	699.29
July 30	697.29
Aug. 22	697.00
Sept.19	695.33
Oct. 11	694
Nov. 20	692.78
Dec. 19	691.84

8. - Continued

Date	Water level (feet)
Feb. 2,1935	691.47
28	691.74
Apr. 10	690.90
May 20	695.33
June 28	718.71
Sept.29	721.93

9. I. G. Yates, Bulverde Road, 4 miles north of Wetmore. Diameter 6 in. Depth 300 ft. Measuring point, top of casing, 1.0 ft. above land surface. Altitude 949.22 ft.

July 20,1932	689.2
Oct. 19	687.7
Apr. 10,1933	686.27
July 17	685.80
Aug. 18	686.82
Oct. 18	685.58
Nov. 21	685.47
Dec. 20	685.27
May 22,1934	688.5

10. H. H. Classen, 2 miles north of Wetmore. Depth 400± ft. Measuring point, top of pipe clamp, 1.0 ft. above land surface. Altitude 908.65 ft.

July 20,1932	673.57
Oct. 19	675.2
Jan. 16,1933	675.27
July 17	672.97
Sept.19	672.37
Nov. 21	671.88
Dec. 20	671.61
Jan. 19,1934	671.48
Feb. 20	672.77
Mar. 20	674.08
Apr. 19	674.11
May 22	673.45
June 20	671.89
July 30	671.02
Aug. 23	670.83
Sept.20	669.65
Oct. 10	669.25
Nov. 20	668.65
Feb. 2,1935	669.17
Mar. 1	670.03
Apr. 10	669.47
June 26	684.40
Aug. 3	686.02

11. John Eisenhauer, Wetmore road. Diameter 6 in. Depth 239 ft. Measuring point, top of casing, 0.5 ft. above land surface. Altitude 874.82 ft.

Water levels in wells in Bexar County - Continued

11. - Continued

Date	Water level (feet)
July 20,1932	672.18
Oct. 19	674.27
Jan. 16,1933	674.64
Apr. 10	674.26
July 17	671.14
Aug. 18	671.49
Oct. 18	671.24
Nov. 21	670.93
Dec. 20	670.82
Jan. 19,1934	670.97
Feb. 20	671.84
Mar. 20	673.01
Apr. 19	673.47
May 22	672.01
June 20	670.03
July 30	669.78
Aug. 23	668.95
Sept.20	668.07
Oct. 10	667.62
Nov. 20	667.45
Dec. 19	667.40
Feb. 4,1935	668.01
Apr. 10	668.19
May 20	674.14
Sept.29	684.57

12. Amos Lorenz, Nacogdoches Road. Diameter 8½ in. Depth 370 ft. Measuring point, top of pipe clamp, 0.5 ft. above land surface. Altitude 821.16 ft.

July 19,1932	669.41
Oct. 19	675.16
July 17,1933	671.61
Aug. 18	671.78
Sept.19	672.12
Oct. 18	671.38
Nov. 21	671.40
Dec. 20	671.43
Jan. 19,1934	671.78
Feb. 20	672.11
Apr. 19	673.78
June 20	668.85
Aug. 23	667.48
Sept.20	667.15
Oct. 10	666.76
Nov. 20	667.26
Dec. 19	667.24
Feb. 4,1935	667.49
Mar. 1	667.90
Apr. 8	667.01
May 19	675.51
June 26	685.31
Sept.26	680.61

13. Ed Haag, North Loop Road, 4 miles southwest of Wetmore. Diameter 8 in. Measuring point, top of pipe clamp, 0.5 ft. above land surface. Altitude 782.81 ft.

13 - Continued

Date	Water level (feet)
Sept.29,1933	673.04
Feb. 20,1934	672.82
Mar. 20	673.57
Apr. 19	674.47
May 22	672.01
June 20	669.92
Aug. 23	668.05
Sept.20	667.81
Oct. 11	667.41
Nov. 20	667.87
Dec. 19	667.81
Feb. 4,1935	668.11
Mar. 1	668.45
Apr. 10	667.63
May 20	677.81
June 26	688.92
Aug. 3	683.29
Sept.26	682.43

14. Albert Theis, Wetmore. Diameter 6 in. Measuring point, top of casing, 0.5 ft. above land surface. Altitude 821.57 ft.

Oct. 2,1933	682.76
18	681.89
Nov. 21	681.65
Dec. 20	680.80
Jan. 19,1934	681.08
Feb. 20	684.00
Mar. 20	685.14
Apr. 19	686.06
May 22	687.06
June 20	684.40
July 30	683.91
Aug. 23	681.73
Sept.20	681.33
Oct. 10	681.42
Nov. 20	682.42
Dec. 19	679.10
Feb. 4,1935	682.27
Mar. 1	685.72
Apr. 10	684.27
May 20	696.73
June 26	713.57
Aug. 3	701.12
Sept.26	692.99

15. Robert Mechler, Castroville Road, 6 miles east of Castroville. Diameter 6 in. Depth 918+ ft. Measuring point, top of pipe clamp, 1.5 ft. above land surface. Altitude 810.64 ft.

Sept.15,1933	692.30
Jan. 4,1934	690.53
Apr. 20	692.67
May 23	689.38
June 21	686.90
July 31	687.77

15 - Continued

Date	Water level (feet)
Aug. 24,1934	684.87
Sept.21	684.05
Oct. 9	684.24
Nov. 21	683.59
Dec. 21	683.17
Feb. 3,1935	683.06
Mar. 2	683.14
Apr. 9	682.27
May 21	691.80
June 28	706.78
Aug. 3	703.64

16. G. A. Kuentz, Culebra Road, 13 miles northwest of San Antonio. Diameter 6 in. Depth 216 ft. Measuring point, top of pipe clamp, 0.5 ft. above land surface. Altitude 849.02 ft.

Sept.21,1933	690.79
Jan. 9,1934	688.36
Apr. 20	695.15
May 23	690.05
June 21	687.14
July 31	688.53
Aug. 24	685.22
Sept.21	683.88
Oct. 11	683.36
Dec. 21	680.86
Feb. 4,1935	682.66
Mar. 2	683.12
Apr. 9	682.52
May 21	698.67
June 28	715.44
Aug. 2	708.20
Sept.27	708.22

17. F. A. Fitch, Bandera Road, 8½ miles northwest of San Antonio. Diameter 6 in. Measuring point, top of pipe clamp, 1.0 ft. above land surface. Altitude 881.83 ft.

July 21,1932	677.98
Oct. 18	682.38
Nov. 18	681.86
Jan. 15,1933	682.13
Apr. 8	681.33
July 18	677.77
Aug. 17	677.83
Sept.18	677.94
Oct. 17	677.33
Nov. 20	677.11
Dec. 18	676.97
Jan. 19,1934	677.38
Feb. 19	677.78
Mar. 19	678.68
Apr. 18	679.41
May 21	677.28
June 19	674.54
July 30	675.71
Aug. 22	673.11

Water levels in wells in Bexar County - Continued

17 - Continued

Date	Water level (feet)
Sept.19,1934	672.38
Oct. 12	671.65
Nov. 20	672.23
Dec. 19	672.08
Feb. 2,1935	672.25
28	672.61
Apr. 10	671.81
May 20	682.43
June 28	693.98
Aug. 5	689.01
Sept.29	689.63

18. Alfred Reininger, Bandera Road, 9 miles northwest of San Antonio. Diameter 5 in. Depth 366 ft. Measuring point, top of pipe clamp, 0.5 ft. above land surface. Altitude 892.13 ft.

July 21,1932	679.03
Oct. 18	683.86
Nov. 18	683.29
Jan. 15,1933	683.58
Apr. 9	682.83
July 18	679.09
Aug. 17	679.05
Sept.18	679.15
Oct. 17	678.53
Nov. 20	678.28
Dec. 18	678.09
Jan. 19,1934	678.54
Feb. 19	678.94
Mar. 19	679.98
Apr. 18	680.77
May 21	678.57
June 19	675.89
July 30	676.98
Aug. 22	674.25
Sept.19	673.46
Oct. 12	672.74
Nov. 20	673.20
Dec. 19	673.12
Feb. 2,1935	673.15
Apr. 10	672.71
May 20	684.29
June 28	695.81
Aug. 5	690.48
Sept.29	691.40

19. Mrs. J. H. Landa, Bandera Road, 7 miles northwest of San Antonio. Diameter 4 in. Depth 385 ft. Measuring point, top of pipe clamp, 1.0 ft. above land surface. Altitude 773.09 ft.

Oct. 29,1932	678.32
Apr. 9,1933	678.65
July 18	675.09

19 - Continued

Date	Water level (feet)
Aug. 17,1933	674.67
Sept.18	674.90
Oct. 17	674.54
Nov. 20	674.39
Dec. 18	674.09
Jan. 18,1934	674.51
Feb. 19	674.86
Mar. 19	675.75
Apr. 18	677.09
May 21	674.8
June 19	672.34
July 27	671.98
Aug. 22	670.73
Oct. 12	669.25
Nov. 20	669.70
Dec. 19	669.70
Jan. 31,1935	670.01
Mar. 1	670.24
Apr. 8	669.35
May 20	679.84
June 26	691.04
Aug. 3	685.86
Sept.26	685.18

20. Lake View Addition, Monterey and Wood Sts., San Antonio. Depth 1,000 ft. Measuring point, top of pump base, 1.0 ft. above land surface. Altitude 711.26 ft.

Aug. 25,1933	676.36
Sept.18	676.65
Oct. 17	675.91
Dec. 20	675.71
Jan. 18,1934	675.84
Feb. 19	676.32
Mar. 19	677.08
Apr. 19	678.21
May 21	675.49
June 19	672.93
Aug. 22	671.48
Sept.19	671.09
Oct. 11	670.49
25	669.98
Nov. 19	671.05
Dec. 20	671.16
Feb. 1,1935	671.09
28	671.48
Apr. 9	670.82
May 21	680.22
June 28	690.08
Aug. 3	686.04
Sept.27	686.21

21. Davis Heights Addition, Blanco Road and Granada St., San Antonio. Measuring point, top of pipe clamp, at land surface. Altitude 761.46 ft.

21 - Continued

Date	Water level (feet)
Aug. 24,1933	674.71
Sept.18	675.26
Oct. 17	674.69
Nov. 20	674.58
Dec. 18	674.51
Feb. 19,1934	675.25
Mar. 19	676.06
Apr. 18	676.72
June 19	672.09
Aug. 22	670.56
Sept.19	670.06
Oct. 12	669.44
25	668.96
Nov. 20	670.01
Dec. 19	670.03
Jan. 31,1935	670.09
Mar. 1	670.48
Apr. 8	669.62
May 20	679.77
June 26	690.86
Aug. 3	685.78
Sept.26	685.31

22. Westmoorland College, French and Ashby Sts., San Antonio. Diameter 5 in. Depth 900 ft. Measuring point, top of casing, at land surface. Altitude 715.94 ft.

Aug. 25,1933	675.37
Sept.18	675.64
Oct. 12	675.06
Nov. 20	674.96
Dec. 18	674.86
Jan. 18,1934	675.05
Feb. 19	675.71
Mar. 19	676.35
Apr. 18	676.96
May 21	675.44
June 19	672.35
July 30	673.60

23. Mrs. L. M. Hubble, 1119 Menchaca St., San Antonio. Diameter 5 5/8 in. Depth 498 ft. Measuring point, top of 1⅛-inch plug, 1.9 ft. above land surface. Altitude 665.23 ft.

July 21,1932	674.7
Oct. 18	679.3
Nov. 18	678.1
Apr. 9,1933	677.0
July 18	674.2
Aug. 17	674.5
Sept 18	674.5
Oct. 17	674.0
Nov. 20	673.9
Dec. 20	673.9
Jan. 18,1934	674.2
Feb. 19	674.5

Water levels in wells in Bexar County - Continued

23 - Continued

Date	Water level (feet)
Apr. 19,1934	676.1
May 21	673.8
June 19	671.1
July 27	672.4
Aug. 22	669.71
Sept.19	669.48
Oct. 11	668.94
25	668.48
Nov. 19	669.63
Dec. 20	669.74
Jan. 31,1935	669.81
Feb. 28	670.03
Apr. 8	669.33
May 20	677.68
June 27	688.81
Aug. 3	684.83
Sept.27	685.03

24. R. Keilman, 607 Perez St., San Antonio. Diameter 5 5/8 in. Depth 802 ft. Measuring point, top of 6-inch standpipe, 5.0 ft. above land surface.

Aug. 1,1933	672.86
Sept.18	673.40
Nov. 20	672.36
Dec. 18	672.47
Jan. 18,1934	672.80
Feb. 19	673.04
Mar. 19	673.47
Apr. 19	674.69
May 21	671.51
June 19	668.91
July 27	669.59
Aug. 22	667.88
Sept.19	667.56
Oct. 11	667.02
25	666.16
Nov. 19	667.75
Dec. 20	668.21
Jan. 31,1935	668.36
Mar. 1	668.61
Apr. 8	668.03
May 21	676.11
June 27	684.86
Sept.27	681.06

25. Owner unknown, Morales and 24th Sts., San Antonio. Measuring point, top of 1-inch pipe, 1.5 ft. above land surface. Altitude 677.60 ft.

Apr. 8,1933	677.53
July 18	674.55
Aug. 17	674.72
Sept.18	675.00
Oct. 17	674.26
Nov. 20	674.25
Dec. 20	674.20
Jan. 18,1934	674.35
Feb. 19	674.86

25 - Continued

Date	Water level (feet)
Mar. 19,1934	675.54
Apr. 19	676.71
May 21	674.25
June 19	671.65
Aug. 22	670.41
Sept.19	669.96
Oct. 11	669.43
25	668.87
Nov. 19	669.68
Dec. 20	670.01
Jan. 31,1935	670.24
Feb. 28	670.32
Apr. 8	669.44
May 20	677.85
June 27	688.10
Aug. 3	683.80
Sept.27	684.05

26. Fuller's Earth Plant, Castroville Road, 13½ miles west of San Antonio. Diameter 6 in. Depth 872 ft. Measuring point, top of concrete pump base, 2.0 ft. above land surface. Altitude 790.15 ft.

Sept.15,1933	684.95
Jan. 4,1934	683.48
Apr. 20	685.93
May 23	682.28
June 21	679.75
July 31	680.88
Aug. 24	677.71
Sept.21	677.02
Oct. 11	676.39
Nov. 20	676.87
Dec. 21	676.45
Feb. 3,1935	676.47
Mar. 2	676.63
Apr. 9	675.87
May 21	685.65
June 28	698.47
Aug. 3	696.30
Sept.27	696.94

27. A. J. Vogt, Castroville Road, 12 miles west of San Antonio. Diameter 6 in. Depth 786 ft. Measuring point, top of pipe clamp, 1.0 ft. above land surface. Altitude 765.97 ft.

Sept.15,1933	684.27
Jan. 4,1934	683.37
Apr. 20	686.13
May 23	682.46
June 21	680.10
July 31	681.44
Aug. 24	678.34
Sept.21	677.79

27 - Continued

Date	Water level (feet)
Oct. 11,1934	677.18
Nov. 20	677.71
Dec. 21	677.39
Feb. 3,1935	677.57
Mar. 2	677.66
Apr. 9	676.89
May 21	686.72
June 28	699.41
Aug. 3	695.53
Sept.27	696.39

28. Robert Boenig, Pinn Road, 8 miles west of San Antonio. Diameter 6 in. Depth 888 ft. Measuring point, top of pipe clamp, 1.0 ft. above land surface. Altitude 745.45 ft.

Sept.20,1933	682.15
Jan. 4,1934	680.80
Apr. 20	683.62
May 23	679.82
June 21	677.56
July 31	679.09
Aug. 24	675.82
Sept.21	675.40
Oct. 11	674.81
12	674.55
Nov. 20	675.35
Dec. 21	675.16
Feb. 3,1935	675.31
Mar. 2	674.53
Apr. 9	674.71
May 21	684.19
June 28	696.32
Aug. 3	692.24
Sept.27	692.99

29. N. H. White, Oriental St. at International & Great Northern R.R., San Antonio. Diameter 6 in. Depth 700 ft. Measuring point, packing box on valve, 0.5 ft. above land surface. Altitude 652.53 ft.

Sept.15,1933	673.5
Oct. 18	674.0
Nov. 20	675.0
Dec. 20	675.6
Jan. 18,1934	674.5
Feb. 19	674.5
Mar. 19	674.9
Apr. 19	675.9
May 21	671.7
June 19	670.5
July 27	671.73
Aug. 22	668.9
Sept.19	668.9
Oct. 9	669.1
25	668.2
Nov. 19	670.08

Water levels in wells in Bexar County - Continued

29 - Continued

Date	Water level (feet)
Dec. 20,1934	670.3
Jan. 31,1935	668.43
Feb. 28	671.23
Apr. 8	670.4
May 21	679.23
June 27	687.9
Aug. 5	685.1
Sept.27	672.33

30. Pruitt Bros.(?), 2 miles southwest of Von Ormy. Diameter 8 in. Depth 1,800 ft. Measuring point, top of valve, 4.0 ft. above land surface. Altitude 594.12 ft.

Aug. 26,1933	687.6
Oct. 20	687.4
May 22,1934	685.3
Oct. 10	681.8

31. Mrs. Mattke, 130 Olmos St., San Antonio. Diameter 6 in. Measuring point, top of pipe clamp, at land surface. Altitude 773.89 ft.

Aug. 24,1933	672.4
Sept.18	673.00
Oct. 17	672.40
Nov. 20	672.41
Dec. 18	672.43
Jan. 18,1934	672.56
Feb. 19	672.99
Mar. 19	673.69
Apr. 19	674.67
June 19	669.77
July 27	670.03
Aug. 22	668.35
Sept.19	668.08
Oct. 12	667.47
25	667.17
Nov. 19	668.20
Dec. 19	668.45
Jan. 31,1935	668.48
Apr. 8	667.97
May 19	676.14
June 26	684.51
Aug. 3	681.06

32. Sunset Wood & Coal Co., Lamar and Walnut Sts., San Antonio. Diameter 8 in. Depth 1,020 ft. Measuring point, top of valve, 3.1 ft. above land surface. Altitude 678.40 ft.

32 - Continued

Date	Water level (feet)
Aug. 4,1933	670.41
Sept.18	671.63
Oct. 18	670.53
Nov. 21	670.56
Dec. 20	671.73
Jan. 18,1934	671.29
Feb. 20	672.24
Mar. 20	672.86
Apr. 19	673.07
May 22	669.48
June 20	667.33
July 27	668.28
Aug. 22	665.98
Sept.19	666.25
Oct. 12	665.78
25	665.66
Nov. 19	666.87
Dec. 20	667.09
Jan. 31,1935	667.20
Mar. 1	667.76
Apr. 8	666.72
May 19	675.14
June 27	678.40+

33. Moore estate, Houston St. and Broadway, San Antonio. Diameter 6 in. Depth 765 ft. Measuring point, top of horizontal pipe, 1.3 ft. above floor. Altitude 645.66 ft.

July 26,1933	671.1
Sept.19	673.4
Oct. 18	669.05
Nov. 21	672.3
Dec. 20	672.3
Jan. 18,1934	672.9
Feb. 20	672.5
Mar. 20	673.4
Apr. 19	673.9
May 22	671.1
June 20	668.0
July 27	669.9
Aug. 22	667.2
Sept.19	667.3
Oct. 12	667.5
25	667.6
Nov. 19	668.3
Dec. 20	668.1
Jan. 31,1935	668.8
Mar. 1	669.0
Apr. 9	668.5
May 21	676.9
June 27	684.9
Aug. 5	682.2
Sept.26	681.96

34. Southern Ice Co., Pierce and Sharer Sts., San Antonio. Diameter 6 in. Depth 900 ft. Measuring point, top of concrete base, at land surface. Altitude 710.34 ft.

34 - Continued

Date	Water level (feet)
Aug. 7,1933	671.58
Sept.19	672.55
Oct. 18	671.39
Nov. 21	671.66
Dec. 20	671.64
Jan. 20,1934	671.70
Feb. 20	672.39
Mar. 20	672.60
Apr. 19	673.96
May 22	670.79
June 20	668.31
July 27	668.88
Aug. 23	666.92
Sept.20	666.87
Oct. 8	667.18
25	666.01
Nov. 19	667.23
Dec. 20	667.58
Jan. 31,1935	667.49
Mar. 1	667.92
Apr. 8	667.06
May 19	675.61
June 27	684.10
Aug. 3	680.20
Sept.26	680.54

35. Dr. D. T. Atkinson, Alamo Heights, San Antonio. Diameter 8 in. Depth 245 ft. Measuring point, top of casing, 0.3 ft. above land surface. Altitude 803.54 ft.

July 20,1932	671.47
Oct. 19	674.94
Jan. 23,1933	675.05
Apr. 10	674.34
July 17	671.41
Aug. 18	671.54
Sept.19	671.93
Oct. 18	671.23
Nov. 21	671.22
Dec. 20	671.23
Jan. 19,1934	671.54
Feb. 20	671.94
Mar. 20	672.62
Apr. 19	673.41
May 22	670.96
June 20	668.65
July 27	668.71
Aug. 23	667.30
Sept.20	666.99
Oct. 12	666.34
25.	666.03
Nov. 19	666.98
Dec. 20	667.15
Jan. 31,1935	667.32
Mar. 1	667.71
Apr. 8	666.84
May 19	674.91
June 26	684.76
Aug. 3	680.54
Sept.26	680.03

Water levels in wells in Bexar County - Continued

36. A. A. Rothe, Seguin and W. W. White Roads, San Antonio. Diameter 6 in. Depth 970 ft. Measuring point, top of pipe clamp, 1.6 ft. above land surface. Altitude 678.07 ft.

Date	Water level (feet)
Nov. 13,1932	676.19
Feb. 7,1934	673.26
Oct. 8	667.76

37. San Antonio and Aransas Pass R. R., Simpson & Probant, San Antonio. Depth 1,100 ft. Measuring point, top of 8-inch cross at top of casing, 2.5 ft. above land surface. Altitude 629.55 ft.

Date	Water level (feet)
Aug. 2,1933	674.6
Sept.18	674.8
Oct. 18	674.8
Nov. 20	674.2
Dec. 20	674.1
Jan. 18,1934	674.2
Feb. 19	674.8

37 - Continued

Date	Water level (feet)
Mar. 19,1934	675.8
Apr. 19	676.3
May 21	673.7
June 19	670.8
July 27	671.9
Aug. 22	669.4
Sept.19	669.1
Oct. 9,1934	669.5
25	668.65
Apr. 10,1935	669.75
May 21	679.05
June 27	688.05
Aug. 5	684.95
Sept.27	684.8

38. San Antonio School Board, South Flores, Sayers and Laclede Sts., San Antonio. Diameter 8 in. Depth 1,800-1,900 ft. Measuring point, top of concrete cap on well. Altitude 622.57 ft.

Date	Water level (feet)
Aug. 21,1933	660.6
Sept.19	661.4
Oct. 18	661.0
Nov. 20	660.4

38 - Continued

Date	Water level (feet)
Dec. 20,1933	660.2
Jan. 18,1934	660.2
Feb. 19	660.5
Mar. 19	661.6
Apr. 19	661.6
May 21	660.2
June 19	658.1
July 27	656.2
Aug. 22	656.2
Sept.19	656.2
Oct. 9	656.0
25	655.3
Nov. 19	656.6
Dec. 20	655.6
Feb. 1,1935	656.2
28	656.5
Apr. 10	657.5
May 21	659.6
June 27	670.4
Aug. 5	668.8
Sept.27	667.3

Water levels in wells in Brooks County

Shallow wells (less than 150 feet deep).

202. E. O. Lasater estate, 4 miles northwest of Falfurrias. Drilled. Depth 112 ft., windmill. Measuring point, top of lowest point in casing, at surface.

Date	Depth to water (feet)
Dec. 8,1932	30.38
Sept.20,1933	31.89
Feb. 7,1935	29.20
Feb. 3,1936	29.65

269. J. W. Story, 1 mile northwest of Falfurrias. Depth originally 650 to 700 ft, caved and now 100 ft. Drilled. Measuring point, top of casing, 1 ft. above surface.

269 - Continued

Date	Depth to water (feet)
Oct. 21,1932	20.40
Nov. 29	20.29
Jan. 5,1933	20.21
Feb. 20	20.22
May 26	20.81
June 27	20.41
July 25	20.48
Aug. 10	20.16
Sept. 2	19.99
Oct. 3	16.90
17	16.50
Feb. 7,1935	17.67
Feb. 4,1936	16.71

278. Serveriano Guerrero, 1/2 mile northwest of Falfurrias. Dug. Depth 22 ft. Measuring point, top of casing.

278 - Continued

Date	Depth to water (feet)
Sept.25,1933	7.03
Oct. 5	6.50
22	7.13
Feb. 7,1935	....

322. Baltasal, 1/2 mile southwest of center of Falfurrias. Bored. Depth 17 ft. Hand pump. Measuring point, top of pipe clamp, 2½ ft. above surface.

Date	Depth to water (feet)
Sept.20,1933	6.39
Oct. 5	5.72
22	6.10
Feb. 7,1935	7.05
Feb. 4,1936	7.93

Water levels in wells in Brooks County - Continued

323. R. D. Donahoe, 1 mile southwest of center of Falfurrias. Hand-auger well. Depth 25 ft. Hand pump. Measuring point, pump clamp 1½ feet above surface.

Date	Depth to water (feet)
Sept.20,1933	6.88
Oct. 6	6.05
24	6.36
Feb. 7,1935	7.88
Feb. 4,1936	9.42

324. L. O. Atkinson, 1 mile south of Falfurrias. Dug. Depth 18 ft., windmill. Measuring point, top of casing, at surface.

Dec. 5,1932	13.04
Sept.20,1933	6.69
Oct. 6	6.41
22	6.80
Jan. 2,1935	10.06
Feb. 4,1936	10.75

333. A. L. Brochet, 1 mile south of Falfurrias. Dug. Depth 11 ft. Hand pump. Measuring point, bottom of 1 by 6 in. plank across top, at surface.

Sept.20,1933	4.08
Oct. 5	3.03
22	3.56
Jan. 2,1935	6.98
Feb. 4,1936	7.55

334. Cecilio Salinas, 1 mile south of center of Falfurrias. Dug. Depth 16 ft. Hand pump.

Sept.20,1933	6.14
Oct. 5	4.82
24	4.90
Feb. 7,1935	7.15
Feb. 4,1936	10.20

335. E. E. Freeze, 1½ miles south of center of Falfurrias. Dug. Depth 18 ft. Measuring point, top of 4-in. cog 3 in. above surface.

335 - Continued

Date	Depth to water (feet)
Sept.20,1933	5.49
Oct. 5	4.28
22	4.73
Jan. 2,1935	8.55
Feb. 7	6.36
Feb. 4,1936	8.07

336. E. E. Freeze, 1½ miles south of center of Falfurrias. Bored. Depth 20 ft. Hand pump. Measuring point, top of casing, at surface.

Dec. 5,1932	9.8
Sept.20,1933	4.90
Oct. 5	3.70
22	4.15
Jan. 2,1935	8.00
Feb. 7	5.78
Feb. 4,1936	7.45

453. J. D. Helms, 2 miles southeast of Falfurrias. Bored. Depth 24½ ft. Not used. Measuring point, top of inner galvanized casing, 2 feet above surface.

Nov. 28,1932	19.32
Jan. 5,1933	19.48
Feb. 20	19.71
May 26	20.09
Sept.20	17.35
Oct. 3	16.74
17	16.62

822. Garcia Ramos Bros., 12 miles west of Rochal. Dug and drilled. Depth 97 ft., windmill. Measuring point, bottom of east 4 by 6 in. cross timber.

Sept.20,1933	57.06
Oct. 6	56.90
20	56.93
Jan. 2,1935	60.96

865. Florencio Rodriguez, 5 miles west of Rochal. Drilled. Depth 130 ft. Hand pump. Measuring point, pump clamp, 1¼ feet above surface.

865 - Continued

Date	Depth to water (feet)
Sept.20,1933	78.10
Oct. 6	77.97
20	77.97
Jan. 2,1935	77.71
Feb. 6,1936	77.74

872. Victor Martinez, 1 mile north of Los Perez. Drilled. Depth 68 ft., windmill. Measuring point, top of casing, at surface.

Mar. 16,1933	44.5
Sept.20	44.94
Oct. 6	44.74
20	44.72
Jan. 2,1935	42.96
Feb. 6,1936	42.36

874. Matilde Martinez, Los Perez, 8 miles west of Rochal. Drilled. Depth 80 ft. Measuring point, pump clamp, 2 feet above surface.

Mar. 14,1933	50.
Sept.20	45.58
Oct. 6	45.51
20	45.49
Jan. 2,1935	42.62
Feb. 6,1936	42.21

882. E. Villareal, 5 miles west of Rochal. Drilled. Depth 138 ft. Hand pump. Measuring point, top of pump clamp, 2 feet above surface.

Mar. 14,1933	74.0
Sept.20	74.23
Oct. 6	74.19
20	74.14
Jan. 2,1935	72.96
Feb. 6,1936	71.85

885. Juan Longoria, 4½ miles west of Rochal. Depth 100± ft. Hand pump. Measuring point, 4 by 6 in. beam, 1 3/4 feet above surface.

Water levels in wells in Brooks County - Continued

885 - Continued

Date	Depth to water (feet)
Sept.20,1933	72.75
Oct. 6	71.69
20	71.42
Jan. 2,1935	70.88
Feb. 6,1936	69.75

918. Jose Garcia Ramos, west side of highway, Encino settlement. Depth 45 ft. Hand pump. Measuring point, top of 4-inch casing 1 foot above surface.

Sept.20,1933	38.25
Oct. 6	37.33
20	36.33
Jan. 2,1935	38.90
Feb. 6,1936	39.28

920. Prospero Mangel, Jr., west side of highway, Encino settlement. Depth 45 to 50 ft. Hand pump. Measuring point, pump clamp, 2 feet above surface.

Date	Depth to water (feet)
Sept.20,1933	35.40
Oct. 6	36.98
20	35.85

921. Nicolas Cantu, east side of highway, Encino settlement. Bored. Depth 42 ft. Hand pump. Measuring point, top of concrete curb 6 in. above surface.

921 - Continued

Date	Depth to water (feet)
Sept.20,1933	36.84
Oct. 6	35.70
20	34.93
Jan. 2,1935	36.04
Feb. 6,1936	37.20

Deep wells (470 to 800 feet or more).

254. E. G. Maun, 2½ miles northwest of Falfurrias. Drilled. Depth 500 ft. Windmill. Measuring point, top of 4 by 6 in. wood pump clamp above concrete base, 3 feet above surface. Altitude 131.35 feet.

Oct. 23,1932	11.23
Jan. 5,1933	8.28
Feb. 22	9.00
May 26	14.75
June 27	11.25
July 25	9.51
Aug. 10	8.52
Sept. 2	7.81
Oct. 3	7.26
Jan. 2,1935	7.61
Feb. 3,1936	6.96

266. Mrs. B. M. McCullar, 2 miles northwest of Falfurrias. Drilled. Depth 500 ft. Measuring point, top of pump clamp on top of round concrete curb, 18 inches above surface. Altitude 129.46 feet.

266 - Continued

Oct. 23,1932	12.15
Jan. 5,1933	11.02
Feb. 22	11.03
May 26	13.52
June 27	12.10
July 25	12.81
Aug. 10	10.99
Sept. 2	10.36
Oct. 3	9.48
Jan. 2,1935	10.63
Feb. 3,1936	10.22

270. J. W. Story, 1 mile northwest of Falfurrias. Drilled. Depth 638 ft. Air lift.

Oct. 21,1932	21.27
Nov. 29	19.67
Jan. 5,1933	18.18
Feb. 20	20.22
May 26	22.11
June 27	21.26
Oct. 4	18.12
Jan. 2,1935	19.04

272. Oliver, 2 miles west of Falfurrias. Drilled. Depth 730 to 740 ft. Windmill. Measuring point, top of rope at surface. Altitude 132.17 feet.

Oct. 23,1932	15.00
Jan. 5,1933	13.03
Feb. 22	12.88
May 26	17.18
June 27	15.11
July 25	13.89
Aug. 10	12.93
Sept. 1	12.17
Oct. 3	11.05
Jan. 2,1935	13.81

273. George Franks, 1½ miles west of Falfurrias. Drilled. Depth 710 to 730 ft. Well once had a flow. Measuring point, top of pump clamp, 1 foot above surface. Altitude 128.45 feet.

Nov. 31,1932	11.80
Jan. 5,1933	11.29
May 26	15.76
June 27	14.00
July 25	12.25

Water levels in wells in Brooks County - Continued

273 - Continued

Date	Depth to water (feet)
Aug. 10,1933	11.40
31	10.57
Oct. 3	9.76
Jan. 2,1935	10.10
Feb. 3,1936	9.58

281. C.P.& L. City Water Works, center of Falfurrias. Drilled. Depth 749 ft. Measuring point, top of horizontal pipe, 3 feet above surface. Altitude 11.54 feet.

Date	Depth to water (feet)
Oct. 22,1932	19.33
Jan. 7,1933	14.25
Feb. 22	14.89
May 26	20.52
June 27	16.62
July 25	16.58
Aug. 10	14.41
31	15.70
Oct. 3	12.92
Jan. 2,1935	15.80
Feb. 8	13.48
Feb. 5,1936	12.12

337. Mrs. J. S. Donahoe, 1½ miles south of Falfurrias. Drilled. Depth 800 to 1,000 ft. Measuring point, top of casing, 3 feet above surface. Altitude 115.67 feet.

Date	Depth to water (feet)
Dec. 5,1932	9.60
Jan. 5,1933	7.43
Feb. 20	6.74
May 26	11.17
June 27	8.80
July 25	8.50
Aug. 10	6.78
31	6.50
Oct. 3	5.59
Jan. 2,1935	7.31
Feb. 6,1936	6.68

340. Dr. H. M. Bennett, 2 miles south of Falfurrias. Drilled. Depth 742 ft. Measuring point, top of brace, 2 feet above surface. Altitude 11.45.

340 - Continued

Date	Depth to water (feet)
Nov. 6,1932	4.15
Jan. 5,1933	3.24
Feb. 20	2.68
May 26	7.68
June 27	4.43
July 25	4.69
Aug. 10	2.85
31	2.47
Oct. 3	1.28
Jan. 2,1935	2.63
Feb. 6,1936	2.38

390. Southern Pacific Railway, Falfurrias. Drilled. Depth 810 ft. No pump. Measuring point, top of casing, at surface. Altitude 107.62 feet.

Date	Depth to water (feet)
Oct. 25,1932	11.50
Jan. 5,1933	8.97
Feb. 22	8.77
May 26	15.21
June 27	11.58
July 25	10.39
Aug. 10	8.96
31	8.75
Oct. 4	6.60
Jan. 2,1935	8.21
Feb. 4,1936	7.70

397. J. W. Dale, 2 miles east of Falfurrias. Drilled. Depth 520 ft. No pump. Measuring point, top of casing, at surface; altitude 104.64 feet.

Date	Depth to water (feet)
Dec. 7,1932	16.60
Jan. 5,1933	16.65
Feb. 20	16.45
May 26	17.75
June 27	17.20
July 25	17.59
Aug. 10	17.01
31	16.89
Oct. 3	13.98
Jan. 7,1935	15.18

399. J. Brit Dekle, 3 3/4 miles east of Falfurrias. Drilled. Depth 500 ft. Windmill. Measuring point, top of pump clamp, 2 feet above surface. Altitude 99.23 feet.

399 - Continued

Date	Depth to water (feet)
Dec. 7,1932	15.85
Jan. 5,1933	14.78
Feb. 20	15.06
May 26	21.89
June 26	16.74
July 25	16.13
Aug. 10	15.11
31	14.36
Oct. 4	12.64
Feb. 7,1935	13.95
Feb. 4,1936	14.37

405. A. Rupp, 5 miles east of Falfurrias. Drilled. Depth 612 ft. Measuring point, top of casing encased in concrete, 2 feet above surface. Altitude 100.00 feet.

Date	Depth to water (feet)
Oct. 21,1932	19.10
Jan. 5,1933	18.14
Feb. 20	18.02
May 26	20.54
June 27	19.13
July 25	18.70
Aug. 10	18.07
31	17.87
Oct. 4	17.30
Feb. 7,1935	17.84
Feb. 4,1936	18.36

467. Flowella townsite, 5 miles southeast of Falfurrias. Drilled. Depth 640 ft. Windmill. Measuring point, top of wood pump clamp, 18 inches above surface.

Date	Depth to water (feet)
Jan. 5,1933	10.57
Feb. 20	10.6
May 26	13.08
June 27	11.50
July 25	11.17
Aug. 31	10.36
Oct. 3	9.74
Feb. 7,1935	10.32
Feb. 4,1936	10.50

474. A. Rupp, 5½ miles east-southeast of Falfurrias. Drilled. Depth 472 ft. Windmill. Measuring point, top of wood suction clamp, 1 foot above surface. Altitude 94.07 feet.

Water levels in wells in Brooks County - Continued

474 - Continued

Date	Depth to water (feet)
Oct. 21,1932	19.03
Jan. 5,1933	17.01
Feb. 20	17.18
May 26	29.18
Feb. 7,1935	16.86
Feb. 4,1936	17.75

504. Neal Rupp, 5⅛ miles east-southeast of Falfurrias. Drilled. Depth 488 ft. Air lift. Measuring point, top of T discharge, 4 feet above surface.

504 - Continued

Date	Depth to water (feet)
Oct. 21,1932	21.77
Jan. 5,1933	19.88
Feb. 20	20.05
May 26	32.55
June 27	21.48
July 25	20.35
Aug. 10	20.49
31	19.49
Oct. 3	18.52
Feb. 7,1935	19.85
Feb. 4,1936	20.08

505. Neal Rupp, 5⅛ miles east-southeast of Falfurrias. Drilled. Depth 620 ft. Measuring point, bottom of T point, 5 feet above surface.

505 - Continued

Date	Depth to water (feet)
Oct. 21,1932	20.25
Jan. 5,1933	19.69
Feb. 20	19.63
May 26	21.90
June 27	20.40
Oct. 3	18.77
Feb. 7,1935	19.42
Feb. 4,1936	19.51

Water levels in wells in Dimmit County

M9-9. -- Myers, 2½ miles southwest of Cometa. Measuring point, top of casing. Altitude 688.55 feet.

Dec. 12,1929	78.10
Feb. 19,1930	78.15
Aug. 26	78.50
Feb. 6,1931	78.55
Mar. 4	78.60
Apr. 25	78.60
June 8	78.75
July 3	78.85
Aug. 5	78.80
Oct. 2	78.90
Nov. 6	79.00
Dec. 4	79.05
Jan. 7,1932	79.15
Feb. 11	79.35
Mar. 17	79.40
July 6	79.49
Aug. 29	79.38
Dec. 21	79.62
Mar. 22,1933	79.75
Aug. 27,1934	80.50
Mar. 13,1935	80.85
July 31	80.75
Jan. 26,1936	80.70

N7-21. Owner unknown, 4 miles southeast of Cometa. Measuring point, top of casing. Altitude 649.70 feet.

Oct. 29,1929	66.20
Nov. 22	67.10
Dec. 4	67.40
18	68.15
Jan. 16,1930	68.70

N7-21 - Continued

Feb. 19,1930	70.35
Mar. 10	72.05
Apr. 16	72.00
May 19	71.75
July 15	69.30
Aug. 26	68.90
Sept. 25	69.25
Dec. 18	67.55
Feb. 6,1931	68.05
Mar. 4	67.40
Apr. 25	68.65
June 8	67.00
Oct. 2	66.05
Nov. 6	68.30
Dec. 4	70.60
Jan. 7,1932	70.15
Feb. 11	70.90
Mar. 18	70.60
July 6	71.15
Aug. 29	70.80
Dec. 22	71.23
Mar. 18,1933	69.55
Aug. 27,1934	77.15

N7-27. Price & Kidwell, 5⅝ miles southeast of Cometa. Measuring point, top of pump base. Altitude 634.55 feet.

Oct. 28,1929	58.05
Nov. 22	76.65
Dec. 18	69.70
Jan. 16,1930	a 72.00
Feb. 19	a 74.85
Mar. 17	71.15
Apr. 16	(b)
May 19	64.95
June 16	60.65
July 15	60.15

N7-27 - Continued

Sept. 25,1930	69.40
Dec. 11	(b)
Apr. 25,1931	61.70
June 8	62.80
Oct. 2	(b)
Nov. 6	(b)
Dec. 4	69.20
Jan. 7,1932	(b)
Feb. 11	(b)
Mar. 18	70.15
Mar. 18,1933	68.30
Sept. 21	67.65

N7-34. A. Johnson, 2 miles northwest of Winter Haven. Measuring point, top of casing. Altitude 576.40 feet.

Dec. 7,1929	50.70
Feb. 5,1930	64.60
Apr. 18	60.15
May 24	50.70
June 21	46.80
July 16	45.20
Aug. 20	47.10
Sept. 25	50.50
Oct. 30	49.40
Dec. 9	45.70
Jan. 8,1931	51.60
Feb. 4	44.00
Mar. 2	37.80
Apr. 23	44.90
May 23	35.80
June 24	35.50
July 24	28.65
Sept. 28	33.35
Nov. 3	50.60
Dec. 1	56.65

a Pump running in nearby well.
b Pumping at time of measurement.

Water levels in wells in Dimmit County - Continued

N7-34 - Continued

Date	Depth to water (feet)
Jan. 4,1932	45.85
Feb. 2	46.55
Mar. 17	44.15
May 5	45.00
July 5	41.70
Aug. 26	41.70
Dec. 19	45.05
Mar. 17,1933	40.15
Sept.15	35.90
Aug. 29,1934	41.85
July 28,1935	44.25
Jan. 24,1936	58.95

N7-48. H. Hagelstein, 1 mile east of Winter Haven. Measuring point, top of pump base. Altitude 569.31 feet.

Oct. 9,1929	61.00
Nov. 22	72.65
Dec. 18	a 79.60
Jan. 21,1930	76.90
Feb. 20	(b)
Mar. 24	(b)
Apr. 18	(b)
May 24	68.20
June 27	51.90
July 16	47.15
Aug. 20	(b)
Sept.25	(b)
Dec. 9	52.30
Jan. 8,1931	68.60
Feb. 4	47.00
Mar. 2	(b)
Apr. 23	48.40
May 23	33.85
June 24	32.15
July 24	24.40
Sept.28	29.50
Nov. 2	68.30
Dec. 1	97.40
Jan. 4,1932	66.75
Feb. 2	73.20
Mar. 17	59.10
May 5	61.60
July 5	44.20
Aug. 26	40.70
Dec. 19	(b)
Mar. 17,1933	42.00
Sept.15	33.90
Aug. 29,1934	43.85
July 28,1935	45.40
Jan. 24,1936	60.38

N7-53. L. L. Williams, 5 miles northwest of Carrizo Springs. Measuring point, top of casing, altitude 670.05 feet.

N7-53 - Continued

Date	Depth to water (feet)
Dec. 19,1929	81.50
Jan. 16,1930	80.90
Feb. 19	81.15
Mar. 17	81.45
Apr. 16	82.00
May 19	82.40
June 16	82.00
July 15	82.50
Aug. 26	85.90
Sept.25	83.15
Dec. 11	82.75
Jan. 9,1931	83.05
Feb. 6	82.45
Mar. 4	82.60
Apr. 25	83.00
June 8	(b)
July 3	83.60
Oct. 2	85.80
Nov. 6	84.35
Dec. 4	86.05
Jan. 7,1932	84.30
Feb. 11	84.80
Mar. 18	85.25
June 30	85.14
Aug. 29	85.50
Dec. 22	85.75
Mar. 18,1933	86.55
Sept.21	(c)

N7-73. J. English, 6 miles west of Carrizo Springs. Measuring point, top of pipe clamp. Altitude 662.15 feet.

Jan. 16,1930	9.60
Feb. 19	b 32.00
Mar. 17	b 32.10
Apr. 16	b 14.00
May 13	b 11.00
June 7	9.70
July 15	b 18.00
Aug. 26	b 12.60
Oct. 20	9.30
Jan. 9,1931	b 21.60
Feb. 7	c 27.30
Apr. 25	8.60
June 8	8.20
July 2	8.00
Dec. 4	12.50
Jan. 7,1932	8.80
Feb. 11	(b)
Mar. 19	(b)
July 1	11.44
Sept.18	(b)

N7-74. J. English, 5 miles west of Carrizo Springs. Measuring point, top of 4 by 4 in. pipe clamp. Altitude 714.05 feet.

Date	Depth to water (feet)
Sept.24,1929	73.80
Nov. 22	79.90
Dec. 18	79.70
Jan. 16,1930	74.45
Feb. 19	c 75.50
Mar. 17	(b)
Apr. 16	c 74.65
May 13	74.00
June 17	73.65
July 15	73.90
Aug. 26	81.75
Sept.25	c 89.00
Oct. 20	74.70
Jan. 9,1931	c 82.40
Feb. 7	c 81.70
Mar. 4	76.40
Apr. 25	73.55
June 8	73.70
July 2	73.65
Oct. 3	79.10
Dec. 4	73.10
Jan. 7,1932	73.00
Mar. 19	73.15
July 1	73.14
Aug. 27	73.60
Mar. 18,1933	72.50
Sept.21	72.40
Aug. 28,1934	73.60

N7-78. C. Schmitt, 2 miles northwest of Carrizo Springs. Measuring point, top of casing. Altitude 676.00 feet.

Jan. 6,1930	92.70
Feb. 19	92.95
Mar. 17	93.00
Apr. 16	(b)
May 19	(b)
June 17	93.40
July 15	93.65
Aug. 26	93.80
Sept.25	93.90
Oct. 20	94.00
Dec. 11	94.05
Jan. 9,1931	94.90
Feb. 6	94.15
Mar. 4	(b)
Apr. 25	94.70
June 8	94.70
July 2	95.00
Oct. 2	95.20
Nov. 6	95.70
Dec. 4	95.30
Jan. 7,1932	95.30
Feb. 11	(b)
Mar. 19	96.00
June 30	96.85
Aug. 28	97.47

a Pump running in nearby well.
b Pumping at time of measurement.
c Pump stopped a short time before measurement.

Water levels in wells in Dimmit County - Continued

N7-78 - Continued

Date	Depth to water (feet)
Dec. 22,1932	97.40
Mar. 18,1933	97.20
Sept.20	98.10
July 31,1935	100.70
Jan. 24,1936	100.55

N7-95. M. E. Cook, 3 miles west of Carrizo Springs. Measuring point, top of casing. Altitude 696.00 feet.

Jan. 6,1930	69.95
Feb. 19	70.00
Mar. 17	70.10
Apr. 16	70.70
May 19	71.95
June 17	70.75
July 15	69.90
Aug. 26	71.60
Sept.25	71.55
Oct. 20	71.35
Dec. 11	69.85
Jan. 9,1931	69.85
Feb. 7	68.70
Mar. 4	68.80
Apr. 25	68.45
June 8	72.25
July 2	72.70
Nov. 6	73.15
Dec. 4	74.60
Jan. 7,1932	73.60
Mar. 19	74.10
July 1	80.25
Aug. 27	c 79.30
Dec. 22	74.50
Mar. 18,1933	74.65
Sept.21	(c)
Aug. 27,1934	74.05
July 31,1935	77.80
Jan. 24,1936	72.85

N7-125. J. Gardner, Carrizo Springs. Measuring point, top of casing. Altitude 613.54 feet.

Feb. 26,1930	58.50
Sept.12	59.50
Feb. 6,1931	59.30
Apr. 25	59.75
June 8	59.35
Oct. 3	59.60
Dec. 4	60.00
Jan. 7,1932	59.85
Feb. 11	59.65
Mar. 19	60.55
July 1	61.08
Aug. 29	60.83
Dec. 22	59.78

N7-127. Mrs. F. F. Kellogg, 1/2 mile northeast of Carrizo Springs. Measuring point, top of casing, at surface. Altitude 580.80 feet.

Date	Depth to water (feet)
Oct. 8,1929	58.10
Nov. 22	62.40
Dec. 5	55.60
19	53.40
Jan. 21,1930	55.85
Feb. 20	64.15
Mar. 24	59.35
Apr. 18	68.65
May 24	58.55
June 21	51.95
July 9	53.15
Aug. 20	59.20
Sept.25	62.00
Oct. 30	51.90
Dec. 9	52.60
Mar. 2,1931	48.50
May 23	45.80
July 24	43.30
Aug. 26,1932	42.02
Dec. 19	31.23
Mar. 17,1933	32.20
Sept.15	26.55
Mar. 9,1935	30.50
July 28	29.35?
Jan. 24,1936	32.74

N7-135. J. L. Bell, 2 miles southwest of Carrizo Springs. Measuring point, top of casing. Altitude 614.15 feet.

Jan. 7,1930	26.05
Feb. 19	26.60
Mar. 17	26.35
Apr. 16	26.45
May 19	26.20
June 16	25.90
July 15	26.10
Aug. 26	26.45
Sept.25	26.60
Oct. 20	26.60
Dec. 11	26.60
Jan. 9,1931	26.45
Feb. 7	26.25
Mar. 4	26.25
Apr. 25	26.40
June 8	26.00
July 2	25.95
Oct. 3	26.05
Nov. 6	26.35
Dec. 4	26.30
Jan. 7,1932	26.40
Feb. 11	26.40
Mar. 19	26.35
June 30	27.00
Aug. 29	26.73

N7-135 - Continued

Date	Depth to water (feet)
Mar. 18,1933	26.25
Sept.20	27.10
Aug. 27,1934	27.70
Mar. 12,1935	29.90
July 28	29.43
Jan. 24,1936	30.30

N7-138. Owner unknown, 1 mile east of Carrizo Springs. Measuring point, top of casing. Altitude 579.30 feet.

Oct. 24,1929	50.05
Dec. 17	50.45
Jan. 17,1930	50.95
Feb. 21	58.80
Mar. 18	58.70
Apr. 21	58.60
May 17	50.00
June 17	47.50
July 17	46.55
Aug. 26	52.00
Sept.24	55.65
Oct. 27	48.50
Dec. 9	46.40
Jan. 9,1931	50.20
Feb. 5	43.85
Mar. 6	43.85
Apr. 29	44.60
June 4	41.80
24	43.00
July 30	40.15
Sept.30	44.10
Nov. 4	50.65
Dec. 2	49.50
Jan. 5,1932	44.25
Sept.15,1933	43.20
Aug. 27,1934	46.30

N8-14. Mrs. C. Gray, 3 miles south of Crystal City. Measuring point, top of casing. Altitude 550.09 feet.

Nov. 14,1929	61.30
Dec. 4	64.20
19	66.00
Feb. 20,1930	91.50
Mar. 25	85.80
Apr. 19	79.40
May 24	62.75
June 20	51.10
July 9	48.45
Aug. 20	47.75
Sept.25	57.80
Oct. 30	47.70
Jan. 8,1931	65.65
Feb. 4	45.10
Mar. 2	35.25

c Pump stopped a short time before measurement.

Water levels in wells in Dimmit County - Continued

N8-14 - Continued

Date	Depth to water (feet)
Apr. 23,1931	40.20
May 23	29.80
June 24	24.00
July 24	18.55
Sept.28	20.85
Nov. 3	61.00
Dec. 1	61.00
Jan. 4,1932	54.00
Feb. 2	54.00
Mar. 17	53.10
Aug. 26	33.85
Dec. 19	17.11
Mar. 17,1933	Caved in.

N8-19. Owner unknown, 2 miles southeast of Winter Haven. Measuring point, top of oil barrel. Altitude 602.60 feet.

Dec. 18,1929	94.50
Jan. 21,1930	92.70
Feb. 20	106.20
Mar. 24	107.10
Apr. 18	111.20
May 24	93.80
June 27	80.00
July 16	78.50
Aug. 20	82.05
Sept.25	89.75
Oct. 30	78.00
Dec. 9	77.00
Jan. 8,1931	88.60
Feb. 4	75.35
Mar. 2	68.15
Apr. 23	77.20
May 23	65.30
June 24	63.30
July 8	60.98
24	58.08
Aug. 15	56.75
Sept.28	61.48
Nov. 3	87.89
Dec. 1	102.80
Jan. 4,1932	87.98
Feb. 2	88.80
Mar. 17	82.13
Apr. 13	92.45
May 5	87.06
27	81.40
July 5	79.00
Aug. 26	77.10
Dec. 19	87.01
Mar. 17,1933	71.25
Sept.15	Capped.

N8-23. L. Sparks, 4 miles east of Winter Haven. Measuring point, top of curb, 4 feet above surface. Altitude 562.64 feet.

N8-23 - Continued

Date	Depth to water (feet)
Nov. 15,1929	73.65
Dec. 18	80.75
Jan. 21,1930	84.30
Feb. 20	101.80
Mar. 25	99.80
Apr. 19	89.40
May 24	79.40
June 20	67.70
July 17	62.10
Aug. 20	63.25
Sept.25	72.20
Oct. 30	64.70
Dec. 9	64.15
Jan. 8,1931	80.15
Feb. 4	61.25
Mar. 2	51.20
Apr. 23	54.90
May 23	45.70
June 24	40.30
July 24	35.35
Sept.28	35.95
Nov. 3	72.60
Dec. 1	111.50
Feb. 2,1932	84.50
Mar. 17	69.40
May 5	70.20
Aug. 26	52.70
Dec. 19	76.11
Mar. 17,1933	53.30
Sept.15	42.40
Aug. 29,1934	54.60
Mar. 6,1935	100.52

N8-26. Chas. Dunn, 4 miles southeast of Winter Haven. Measuring point, top of casing. Altitude 548.80 feet.

Nov. 19,1929	62.95
Dec. 19	70.40
Jan. 21,1930	73.40
Feb. 20	85.00
Mar. 25	93.75
Apr. 19	86.80
May 24	76.50
July 17	60.10
Aug. 20	59.90
Sept.25	67.55
Oct. 30	63.60
Dec. 9	54.60
Jan. 8,1931	64.45
Feb. 4	57.50
Mar. 2	48.70
Apr. 23	50.70
May 23	43.50
June 24	37.40
July 24	33.20
Sept.28	30.80
Nov. 3	50.70
Dec. 1	82.20
Jan. 4,1932	65.80
Feb. 2	65.80
Mar. 17	60.10
May 5	(b)

N8-26 - Continued

Date	Depth to water (feet)
Aug. 26,1932	50.77
Dec. 19	62.15
Mar. 17,1933	47.70
Sept.15	(b)
Aug. 29,1934	57.40
Mar. 6,1935	80.30

N8-28. J. C. Brazil, 4 miles southeast of Winter Haven. Measuring point, top of pipe clamp. Altitude 548.51 feet.

Nov. 18,1929	64.80
Dec. 19	72.35
Jan. 21,1930	75.25
Feb. 20	87.00
Apr. 19	88.05
May 24	78.20
July 17	61.30
Aug. 20	61.55
Sept.25	66.05
Oct. 30	64.90
Dec. 9	55.85
Jan. 8,1931	66.35
Feb. 4	58.60
Mar. 2	49.40
Apr. 23	50.95
May 23	43.80
June 24	36.80
July 24	32.35
Sept.28	30.00
Nov. 3	50.90
Dec. 1	82.80
Jan. 4,1932	67.50
Feb. 2	69.60
Mar. 18	60.15
May 5	70.90
Aug. 26	50.95
Dec. 19	c 62.80
Mar. 17,1933	46.55
Sept.15	46.75
Aug. 29,1934	58.40
Mar. 6,1935	82.46
July 31	55.80
Jan. 25,1936	56.12

N8-29. J. C. & O. E. Bookant, 4½ miles southeast of Winter Haven. Measuring point, top of pump base, at surface. Altitude 553.43 feet.

Nov. 15,1929	66.20
Dec. 19	75.20
Jan. 21,1930	78.20
Feb. 20	91.10
Mar. 25	97.75
Apr. 19	89.00
May 24	79.30

b Pumping at time of measurement.
c Pump stopped a short time before measurement.

Water levels in wells in Dimmit County - Continued

N8-29 - Continued

Date	Depth to water (feet)
June 20,1930	68.70
July 17	62.00
Sept.25	68.30
Oct. 30	65.65
Dec. 9	58.75
Jan. 9,1931	70.65
Feb. 4	60.50
Mar. 2	51.10
Apr. 23	52.40
May 23	45.60
June 24	39.25
July 24	34.80
Sept.28	33.80
Nov. 3	57.85
Dec. 1	93.15
Jan. 4,1932	70.00
Feb. 2	75.35
Mar. 17	63.90
May 5	67.75
Aug. 26	51.75
Dec. 19	68.45
Mar. 17,1933	50.20
Sept.15	41.50
Aug. 29,1934	56.95
July 30,1935	55.55
Jan. 25,1936	58.80

N8-40. M. V. Kerley, 3 miles northeast of Carrizo Springs. Measuring point, 3 feet above surface, inside wooden box. Altitude 557.59 feet.

Dec. 5,1929	51.50
19	43.65
Jan. 21,1930	51.90
Feb. 20	75.70
Mar. 24	a 58.90
Apr. 18	a 84.20
May 24	54.35
June 21	34.50
July 16	a 41.00
Aug. 20	55.50
Sept.25	68.00
Oct. 30	31.70
Dec. 9	37.00
Jan. 8,1931	53.00
Feb. 4	26.85
Mar. 2	25.40
Apr. 23	33.30
May 23	22.85
June 24	32.60
July 24	19.45
Sept.28	37.70
Nov. 3	72.60
Dec. 1	47.75
Jan. 4,1932	32.80
Feb. 2	42.05
Mar. 17	35.75
July 5	38.54
Aug. 26	46.95
Dec. 19	33.80

N8-40 - Continued

Date	Depth to water (feet)
Mar. 17,1933	26.30
Sept.15	45.45
Mar. 6,1935	47.50
July 30	33.30
Jan. 24,1936	41.40

N8-45. R. S. McEachem, 2 miles east of Carrizo Springs. Measuring point, top of discharge pipe. Altitude 592.90 feet.

Jan. 28,1928	74.60
Oct. 9,1929	88.00
Nov. 18	90.70
Dec. 17	85.95
Jan. 17,1930	90.60
Feb. 21	a 107.40
Mar. 18	a 102.65
June 17	78.20
July 17	a 83.20
Aug. 26	90.55
Sept.24	94.30
Oct. 27	79.55
Dec. 9	a 77.60
Jan. 9,1931	a 87.50
Feb. 5	70.40
Mar. 6	72.00
Apr. 29	71.65
June 4	65.00
24	69.20
July 30	63.25
Sept.30	71.50
Nov. 4	86.80
Dec. 2	83.30
Jan. 5,1932	72.00
Feb. 3	76.45
Mar. 20	75.60
July 1	80.95
Aug. 27	80.00
Mar. 18,1933	67.65
Sept.16	78.20

N8-47. C. W. Miller, 2 miles east of Carrizo Springs. Measuring point, top of casing. Altitude 602.25 feet.

Oct. 12,1929	98.20
Nov. 18	86.40
Dec. 5	88.90
17	91.40
Jan. 17,1930	96.90
Feb. 21	a 112.70
Mar. 18	107.00
Apr. 21	a 109.90
May 17	89.80
June 17	84.35
July 17	a 87.45
Aug. 26	95.75

N8-47 - Continued

Date	Depth to water (feet)
Sept.24,1930	99.50
Oct. 27	85.85
Dec. 9	85.55
Jan. 9,1931	a 92.75
Feb. 5	77.00
Mar. 6	78.50
Apr. 29	78.40
June 4	72.20
24	75.60
July 30	70.20
Sept.30	77.80
Nov. 4	91.10
Dec. 2	88.75
Jan. 5,1932	79.00
Feb. 3	82.50
Mar. 20	83.10
July 1	88.67
Aug. 27	88.05
Dec. 22	79.42
Mar. 18,1933	74.70
Sept.16	85.50
Mar. 14,1935	90.35
July 30	82.10
Jan. 26,1936	82.50

N8-50. R. H. Price, 3 miles east of Carrizo Springs. Measuring point, top of casing. Altitude 564.80 feet.

Oct. 14,1929	74.30
Nov. 18	73.55
Dec. 17	73.40
Jan. 17,1930	74.00
Feb. 21	82.00
Mar. 18	a 83.45
Apr. 21	82.20
May 17	75.80
June 17	71.15
July 17	68.90
Aug. 26	71.60
Sept.24	73.35
Oct. 27	70.10
Dec. 9	64.70
Jan. 9,1931	67.40
Feb. 5	61.40
Mar. 5	58.10
Apr. 29	61.00
June 4	53.55
24	53.05
July 30	48.70
Sept.30	54.65
July 1,1932	64.90
Aug. 27	67.33
Dec. 22	60.64
Mar. 18,1933	55.90
Sept.16	59.25
Aug. 28,1934	67.95

N8-56. G. & C. Hagelstein, 4½ miles northeast of Carrizo Springs. Measuring point, top

a Pump running in nearby well.

Water levels in wells in Dimmit County - Continued

N8-56 - Continued

of casing. Altitude 533.75 feet.

Date	Depth to water (feet)
Oct. 14,1929	59.40
Nov. 18	a 59.95
Dec. 17	62.50
Jan. 17,1930	66.40
Feb. 21	81.95
Mar. 18	87.90
Apr. 21	85.90
May 17	71.75
June 17	59.10
July 17	55.10
Aug. 26	59.40
Sept.24	a 67.65
Oct. 27	58.05
Dec. 9	45.90
Jan. 9,1931	a 56.65
Feb. 5	44.50
Mar. 5	38.50
Apr. 29	41.05
July 1,1932	49.15

N8-58. G. & C. Hagelstein, 6 miles northeast of Carrizo Springs. Measuring point, top of concrete curb, 1 foot above surface. Altitude 526.80 feet.

Oct. 16,1929	46.70
Nov. 18	48.30
Dec. 17	55.25
Jan. 17,1930	58.80
Feb. 21	71.70
Mar. 18	81.15
Apr. 21	75.70
May 17	64.50
June 17	52.65
July 17	46.20
Aug. 26	48.90
Sept.24	55.95
Sept.30,1931	18.90
Nov. 4	35.80
Dec. 2	59.45
Jan. 5,1932	46.95
Feb. 3	51.50
Mar. 20	42.75
July 1	40.50
Aug. 27	38.90
Dec. 22	42.02
Mar. 18,1933	29.55
Aug. 28,1934	48.05
Mar. 14,1935	57.95
Jan. 26,1936	37.30

N8-70. G. & C. Hagelstein, 5 miles east of Carrizo Springs.

Nov. 29,1929	58.00
Dec. 5	58.75

N8-70 - Continued

Date	Depth to water (feet)
Dec. 17,1929	62.55
Jan. 17,1930	66.00
Feb. 21	78.45
Mar. 18	84.60
Apr. 21	82.25
May 17	68.10
June 21	55.60
July 17	53.60
Aug. 26	57.80
Sept.24	66.10
July 1,1932	47.85

N8-71. S. M. Owens, 5 miles southwest of Brundage. Measuring point, top of pump base. Altitude 524.10 feet.

Nov. 29,1929	52.90
Dec. 17	57.35
Jan. 17,1930	61.35
Feb. 21	74.95
Mar. 18	82.70
Apr. 21	79.50
May 17	66.25
June 17	54.10
July 17	47.40
Sept.24	61.00
Jan. 9,1931	49.00
Feb. 5	39.25
Mar. 6	32.95
Apr. 29	36.15
June 4	26.40
24	23.70
July 30	19.45
Sept.30	20.80
Nov. 4	38.20
Dec. 2	58.95
Jan. 5,1932	46.80
Feb. 3	53.25
Mar. 20	42.45
July 1	41.60
Aug. 27	40.08
Dec. 22	40.54
Mar. 18,1933	29.45
Sept.16	28.60
Aug. 28,1934	49.10
Mar. 14,1935	56.44
July 30	40.25
Jan. 26,1936	36.12

N8-73. C. W. Wheeler, 2 miles southwest of Brundage. Measuring point, top of pipe clamp. Altitude 505.00 feet.

Oct. 21,1929	31.45
Nov. 18	35.00
Dec. 24	38.30
Jan. 21,1930	44.05

N8-73 - Continued

Date	Depth to water (feet)
Feb. 18,1930	57.45
Mar. 19	61.80
Apr. 17	60.00
May 16	53.00
June 17	39.25
July 14	c 38.10
Aug. 22	40.25
Sept.23	c 51.40
Dec. 10	27.60
Feb. 9,1931	c 24.00
Mar. 3	19.80
Apr. 24	23.20
June 4	13.75
26	15.65
July 27	7.60
Sept.29	10.70
Dec. 2	41.35
Jan. 11,1932	31.90
Feb. 4	45.05
Mar. 22	31.05
May 6	36.20
July 5	25.80
Aug. 27	c 23.20
Dec. 20	24.46
Mar. 21,1933	19.89
Sept.18	15.60

N8-103. Nueces Land & Irrigation Co., 4 miles southwest of Brundage. Measuring point, top of pump base. Altitude 501.60 feet.

Nov. 26,1929	40.25
Dec. 24	42.00
Jan. 21,1930	51.05
Mar. 20	66.35
Apr. 17	71.50
June 17	41.15
July 14	(b)
Aug. 22	(b)
Sept.23	(b)
Dec. 10	36.80
Feb. 9,1931	26.20
Mar. 3	22.10
Apr. 24	27.00
June 4	16.55
26	(b)
July 27	10.10
Sept.29	12.00
Dec. 3	(b)
Jan. 11,1932	(b)
Feb. 4	53.10
Mar. 27	(b)
May 6	41.20
July 5	27.38
Aug. 27	25.48
Dec. 20	23.67
July 30,1935	25.15

N9-5. P. C. Levering, 3 miles northeast of Brundage. Measuring point, top of pump base. Altitude 575.73 feet.

a Pump running in nearby well.
b Pumping at time of measurement.
c Pump stopped a short time before measurement

Water levels in wells in Dimmit County - Continued

N9-5 - Continued

Date	Depth to water (feet)
Nov. 29,1929	89.65
Dec. 17	91.80
Jan. 17,1930	(b)
Feb. 21	(b)
Mar. 20	108.10
Apr. 21	(b)
May 17	102.00
June 21	94.70
July 17	(b)
Aug. 26	(b)
Dec. 12	(b)
Feb. 5,1931	83.10
Mar. 5	(b)
Apr. 5	80.00
June 4	74.60
24	(b)
July 28	(b)
Sept.30	(b)
Dec. 2	(b)
Jan. 5,1932	(b)
Feb. 3	(b)
Mar. 29	(b)

N9-8. T. S. Buchanan, 1½ miles north of Big Wells. Measuring point, top of casing, at surface. Altitude 537.30 feet.

Nov. 30,1929	54.05
Dec. 17	54.35
Jan. 17,1930	55.40
Feb. 24	60.85
Apr. 22	74.70
May 21	58.35
June 21	54.00
July 18	52.30
Aug. 23	54.45
Sept.24	(b)
Oct. 31	50.60
Dec. 12	49.40
Jan. 13,1931	51.80
Feb. 5	45.60
Mar. 5	47.45
Apr. 29	42.10
May 27	42.30
June 24	42.10
July 28	38.40
Sept.30	(b)
Nov. 4	50.35
Dec. 2	49.10
Jan. 12,1932	(b)
Feb. 3	52.30
Mar. 29	51.60
July 2	49.80
Aug. 27	48.30
Dec. 22	50.90
Mar. 23,1933	(b)
Sept.19	45.30

N9-12. R. J. Rothe, 1 mile west of Big Wells. Measuring point, bottom of hole in wood cover. Altitude 494.79 feet.

Date	Depth to water (feet)
Oct. 18,1929	18.60
Nov. 18	21.70
Dec. 5	20.50
17	21.35
Jan. 17,1930	22.50
Feb. 24	31.50
Mar. 20	30.50
Apr. 21	36.00
May 21	29.65
June 21	18.90
July 17	18.80
Aug. 26	19.80
Sept.24	24.80
Oct. 27	16.85
31	16.65
Dec. 12	18.90
Jan. 9,1931	22.40
Feb. 5	11.80
Mar. 5	17.50
Apr. 29	12.65
May 27	8.05
June 24	10.80
July 28	7.80
Sept.30	8.90
Nov. 4	16.75
Dec. 2	17.80
Jan. 5,1932	13.85
Feb. 3	13.80
Mar. 29	23.30
July 2	15.44
Aug. 27	14.95
Dec. 22	15.40
Mar. 23,1933	24.10
Sept.19	13.20
Aug. 28,1934	29.85
Mar. 14,1935	28.14
July 30	17.70
Jan. 27,1936	25.85

N9-16. R. B. White Co., 1½ miles east of Big Wells. Measuring point, top of railroad rail. Altitude 552.05 feet.

Nov. 18,1929	75.00
Dec. 17	68.25
Jan. 17,1930	(b)
Feb. 24	73.55
Apr. 22	(b)
May 21	72.15
June 21	67.75
July 18	66.40
Aug. 23	(b)
Sept.24	(b)

N9-16 - Continued

Date	Depth to water (feet)
Oct. 31,1930	64.75
Dec. 12	(b)
Jan. 13,1931	64.65
Feb. 5	60.90
Mar. 5	60.30
Apr. 30	61.10
May 27	57.65
June 25	57.70
July 28	54.80
Oct. 5	(b)
Dec. 5	62.75
Jan. 12,1932	(b)
Feb. 12	(b)
Mar. 24	(b)
July 2	64.70
Aug. 27	62.80
Dec. 22	67.35
Mar. 23,1933	(b)
Sept.19	(b)
July 30,1935	67.00

N9-25. South Texas Estates, 4 miles southeast of Brundage. Measuring point, top of casing. Altitude 488.40 feet.

Nov. 29,1929	18.70
Dec. 17	21.95
Jan. 17,1930	22.85
Feb. 21	31.95
Mar. 20	36.65
Apr. 21	38.15
May 17	29.80
June 21	20.45
July 10	18.15
Aug. 23	18.30
Sept.24	24.30
Oct. 31	16.65
Dec. 12	12.75
Jan. 9,1931	17.00
Feb. 5	9.40
Mar. 6	7.20
Apr. 30	8.40
May 27	3.85
June 24	4.45
July 2,1932	13.60
Aug. 27	12.65
Dec. 22	12.03
Sept.19,1933	4.50
Mar. 14,1935	23.98
July 30	12.80
Jan. 27,1936	21.30

N9-32. Owner unknown, 2½ miles south of Big Wells. Measuring point, top of casing. Altitude 499.20 feet.

b Pumping at time of measurement.
c Pump stopped a short time before measurement.

Water levels in wells in Dimmit County - Continued

N9-32 - Continued

Date	Depth to water (feet)
Dec. 3,1929	22.85
17	23.50
Jan. 17,1930	23.10
Feb. 24	26.80
Apr. 21	39.55
May 21	32.60
June 21	27.35
July 18	28.20
Aug. 23	29.25
Sept.24	c 32.15
Oct. 31	28.50
Dec. 12	a 25.25
Jan. 13,1931	26.25
Feb. 5	22.00
Apr. 29	21.35
May 27	19.30
June 24	19.30
July 28	15.50
Sept.30	16.40
Dec. 5	25.55
Jan. 12,1932	20.90
Feb. 12	25.15
Mar. 20	26.60
July 2	24.80
Aug. 27	24.38
Dec. 22	22.83
Mar. 23,1933	24.50
Sept.19	(b)

N9-39. Vincent & Gray, 4 miles south of Big Wells. Measuring point, inside of T on discharge pipe. Altitude 494.85 feet.

Jan. 31,1928	d 16.2
Sept...	d 15.3
May 13,1929	d 32.5
24	d 31.2
June 1	d 30.0
10	d 28.0
July 9	d 25.0
Sept.22	d 21.0
Jan. 16,1930	26.15
Feb. 24	33.00
Apr. 21	39.55
May 21	(b)
June 21	26.40
July 18	24.60
Aug. 23	23.50
Sept.24	(b)
Oct. 31	(b)
Dec. 12	(b)
Jan. 13,1931	22.20
Feb. 5	18.65
Mar. 5	(b)
Apr. 29	20.10
June 24	17.00
July 28	13.10
Sept.30	(b)
Dec. 5	19.85

N9-39 - Continued

Date	Depth to water (feet)
Jan. 12,1932	(b)
Feb. 12	(b)
Mar. 29	19.00
July 2	21.40
Aug. 27	19.83
Mar. 23,1933	(b)

N9-43. R. D. Buchanan, 5½ miles southeast of Big Wells. Measuring point, top of casing, at surface. Altitude 504.05 feet.

Jan. 3,1930	27.00
Feb. 24	30.20
Apr. 22	32.00
May 21	30.60
June 26	27.75
July 18	26.50
Aug. 23	26.30
Sept.24	28.25
Oct. 31	25.90
Dec. 12	24.20
Jan. 13,1931	24.85
Feb. 5	23.15
Mar. 6	21.50
Apr. 30	23.30
May 27	20.80
June 25	21.30
July 28	17.75
Oct. 5	20.35
Dec. 5	21.70
Jan. 12,1932	19.55
Feb. 12	20.60
Mar. 24	20.40
July 2	25.20
Aug. 27	24.17
Dec. 22	22.15
Mar. 23,1933	21.05
Sept.16	22.05
Aug. 28,1934	34.25
Mar. 14,1935	29.80
July 30	26.60
Jan. 27,1936	32.20

O7-3. Wimar-Richardson, 9 miles northwest of Big Wells. Measuring point, top of casing. Altitude 604.65 feet.

Nov. 18,1929	96.60
Oct. 17	94.55
Jan. 17,1930	95.50
Feb. 24	94.95
Apr. 22	96.55
May 21	96.90
June 26	96.65
July 18	96.15

O7-3 - Continued

Date	Depth to water (feet)
Aug. 23,1930	95.70
Sept.24	95.65
Oct. 31	96.00
Dec. 12	94.90
Jan. 13,1931	94.70
Feb. 5	94.00
Mar. 5	93.30
Apr. 30	93.45
May 27	92.85
June 25	92.25
July 28	91.55
Oct. 5	90.60
Dec. 5	91.50
Jan. 12,1932	91.20
Feb. 12	91.60
Mar. 24	91.90
July 2	93.24
Aug. 27	93.43
Dec. 22	92.75
Mar. 23,1933	92.40
Sept.16	92.75
Aug. 28,1934	99.75
July 30,1935	98.80

S1-1. Carl Johnson, 5⅛ miles southwest of Carrizo Springs. Measuring point, top of bent casing. Altitude 743.55 feet.

Jan. 9,1930	101.60
Mar. 17	101.25
Apr. 16	101.35
May 19	101.60
June 17	101.35
Oct. 20	101.55
Dec. 11	101.65
Jan. 9,1931	101.70
Feb. 7	101.60
Apr. 25	101.70
June 8	101.65
July 2	101.70
Nov. 6	102.00
Dec. 4	101.95
Jan. 7,1932	102.00
Feb. 11	102.00
Mar. 19	102.05
June 30	101.90
Aug. 29	102.02
Mar. 18,1933	101.95
Sept.20	102.20
Aug. 27,1934	102.10

S1-11. C. T. Lindenborn, 3 miles southwest of Carrizo Springs. Measuring point, top of 4 by 4 in. pipe clamp. Altitude 654.40 feet.

a Pump running in nearby well.
b Pumping at time of measurement.
c Pump stopped a short time before measurement.

Water levels in wells in Dimmit County - Continued

S1-11 - Continued

Date	Depth to water (feet)
Jan. 7,1930	45.20
Feb. 19	(b)
Mar. 17	(b)
Apr. 16	45.00
May 19	45.05
June 17	44.90
July 15	c 45.05
Aug. 26	45.20
Sept.25	45.75
Oct. 20	45.25
Dec. 11	c 45.70
Jan. 9,1931	45.70
Feb. 7	45.60
Mar. 4	45.50
Apr. 25	45.75
June 8	45.65
July 2	45.65
Oct. 3	45.40
Nov. 6	45.65
Mar. 18,1932	45.15
June 30	45.88
Aug. 29	c 46.08
Mar. 18,1933	45.00
Sept.20	45.05

S1-15. South Texas Winter Gardens, Inc., 6 miles southwest of Carrizo Springs. Measuring point, top of pump base.

Apr. 1,1930	53.40
May 19	53.70
July 15	53.70
Aug. 26	53.80
Sept.25	53.65
Oct. 20	53.95
Dec. 11	53.70
Jan. 9,1931	53.90
Feb. 7	53.75
Mar. 4	53.65
Apr. 25	53.65
June 8	53.75
July 2	53.85
Oct. 3	53.80
Nov. 6	54.10
Dec. 4	53.90
Jan. 7,1932	54.20
Feb. 11	53.95
Mar. 18	53.90
June 30	54.15
Aug. 29	54.15
Dec. 22	53.96
Mar. 18,1933	53.90
Sept.20	54.50
Aug. 27,1934	54.80

S1-16. C. W. Gilfiller & Son, 4½ miles southwest of Carrizo Springs. Measuring point, top of pump base.

S1-16 - Continued

Altitude 670.20 feet.

Date	Depth to water (feet)
Mar. 1,1930	55.90
June 13	56.00
July 15	56.00
Aug. 26	56.10
Sept.25	56.20
Oct. 20	56.25
Mar. 4,1931	56.35
Apr. 25	56.50
June 8	(b)
July 2	56.50
Oct. 3	56.60
Nov. 6	56.90
Dec. 4	56.65
Jan. 7,1932	56.75
Feb. 11	56.85
Mar. 18	57.00
June 30	57.05
Aug. 29	57.15
Dec. 22	56.25
Mar. 18,1933	56.40
Sept.20	56.90
Mar. 12,1935	57.80
July 28	57.90
Jan. 24,1936	57.75

S1-18. South Texas Winter Gardens, Inc., 3⅛ miles southwest of Carrizo Springs. Measuring point, top of casing. Altitude 706.10 feet.

Mar. 18,1930	101.00
May 19	103.80
June 16	103.60
July 15	103.60
Aug. 26	103.85
Sept.26	104.00
Oct. 20	104.00
Dec. 11	104.00
Jan. 9,1931	104.40
Feb. 7	103.90
Mar. 4	103.80
Apr. 25	104.20
June 8	103.80
July 2	103.90
Oct. 3	103.70
Nov. 6	104.15
Dec. 4	104.15
Jan. 7,1932	104.25
Feb. 11	104.30
Mar. 18	104.20
June 30	104.21
Aug. 29	104.53
Dec. 22	104.03
Sept.20,1933	104.45
Aug. 27,1934	105.10
Mar. 12,1935	105.55
July 28	105.25
Jan. 24,1936	105.42

S2-24. L. V. Richardson, 5⅛ miles southeast of Carrizo Springs. Measuring point, top of pump base. Altitude 583.70 feet.

Date	Depth to water (feet)
Nov. 1,1928	138
15	140
July 14,1930	107.15
Aug. 22	(b)
Sept.23	(b)
Oct. 31	108.62
Dec. 10	98.40
Jan. 15,1931	108.60
Feb. 9	93.40
Mar. 3	89.00
Apr. 24	103.90
May 26	86.40
June 26	80.55
July 27	(b)
Sept.29	(b)
Dec. 3	111.15
Jan. 6,1932	96.40
Feb. 4	(b)
Mar. 22	(b)
May 6	108.10
July 3	99.40
Aug. 29	101.00
Dec. 20	95.50
Mar. 21,1933	(b)
Sept.18	94.65
July 29,1935	93.35
Jan. 23,1936	92.98

S2-27. J. A. McDonald, 3⅛ miles northeast of Asherton. Measuring point, top of pump base. Altitude 529.35 feet.

Nov. 26,1929	76.20
Dec. 24	77.45
Jan. 15,1930	82.40
Feb. 18	90.40
Mar. 20	101.70
Apr. 17	99.10
May 16	87.45
June 18	72.10
July 14	66.15
Aug. 22	(b)
Sept.23	80.55
Dec. 10	60.40
Feb. 9,1931	57.10
Mar. 3	50.60
Apr. 24	61.10
June 4	47.70
26	45.90
July 27	40.00
Sept.29	40.60
Dec. 3	67.45
Jan. 11,1932	55.10
Feb. 4	62.35
Mar. 22	57.60

b Pumping at time of measurement.
c Pump stopped a short time before measurement.

Water levels in wells in Dimmit County - Continued

S2-27 - Continued

Date	Depth to water (feet)
May 6,1932	68.90
July 5	57.30
Aug. 30	57.10
Dec. 20	53.20
Mar. 21,1933	48.00
Sept.18	46.00
Mar. 11,1935	57.55
July 30	52.40
Jan. 23,1936	50.45

S2-29. E. W. Tackett, 4 miles northwest of Asherton. Measuring point, top of concrete curb. Altitude 591.95 feet.

Oct. 2,1929	87.80
Dec. 17	84.50
Feb. 18,1930	92.4
Apr. 17	(b)
May 16	89.00
July 14	74.60
Aug. 22	82.45
Sept.23	(b)
Dec. 10	72.75
Jan. 15,1931	79.70
Feb. 9	68.40
Mar. 3	64.30
Apr. 24	75.70
May 26	62.50
June 26	59.65
July 27	54.75
Sept.29	60.90
Dec. 3	78.10
Jan. 6,1932	68.75
Feb. 4	71.25
Mar. 22	70.95
May 6	78.25
July 3	73.90
Aug. 29	73.90
Dec. 20	70.05
Mar. 21,1933	63.60
Sept.18	68.00
Mar. 10,1935	70.10
July 29	68.20
Jan. 23,1936	65.48

S2-77. Dr. Nueck, 2½ miles northeast of Asherton. Measuring point, top of casing. Altitude 522.30 feet.

Dec. 14,1929	72.55
Jan. 15,1930	77.20
Feb. 18	85.85
Mar. 20	95.95
Apr. 17	(b)
May 16	79.55

S2-77 - Continued

Date	Depth to water (feet)
June 18,1930	62.90
July 14	58.30
Aug. 22	(b)
Sept.23	(b)
Dec. 3,1931	59.45
Jan. 11,1932	(b)
Feb. 4	(b)
Mar. 22	(b)
May 6	60.95
July 5	48.00
Aug. 30	49.23
Dec. 20	45.76
Mar. 21,1933	(b)
Sept.18	38.40

S2-78. J. W. Robinson, 2⅛ miles southwest of Asherton. Measuring point, top of pump base. Altitude 637.05 feet.

Dec. 7,1929	191.25
Jan. 15,1930	201.40
Feb. 18	(b)
Mar. 19	211.20
Apr. 17	216.65
May 16	194.10
June 18	187.20
July 14	175.15
Aug. 22	173.40
Sept.23	191.60
Oct. 31	174.00
Dec. 10	174.20
Jan. 15,1931	181.95
Feb. 9	163.75
Apr. 24	176.20
May 26	158.15
June 26	151.90
July 27	146.85
Sept.29	149.80
Dec. 3	171.05
Jan. 6,1932	162.75
Feb. 4	166.10
Mar. 22	(b)
May 6	173.85
July 3	168.25
Aug. 30	163.68
Dec. 20	158.80
Mar. 21,1933	160.05
Sept.18	153.50
Mar. 10,1935	162.75
July 29	153.65
Jan. 23,1936	154.45

S2-86. E. Hess, 4 miles southeast of Asherton. Measuring point, top of pump base. Altitude 615.66 feet.

S2-86 - Continued

Date	Depth to water (feet)
Nov. 1,1928	e 133
15	e 137
July 14,1930	149.80
Aug. 22	150.90
Sept.23	(b)
Oct. 31	150.28
Dec. 10	146.00
Jan. 15,1931	155.70
Feb. 9	141.60
Mar. 3	(b)
Apr. 24	149.70
May 26	(b)
June 26	131.00
July 27	126.15
Sept.29	126.70
Dec. 3	143.80
Jan. 11,1932	136.90
Feb. 4	(b)
Mar. 22	146.00
May 6	149.30
July 3	143.70
Aug. 30	141.80
Dec. 20	135.10
Mar. 21,1933	(b)
Sept.18	129.60
Mar. 10,1935	134.00
July 29	130.20
Jan. 23,1936	131.30

S2-90. R. E. Brooks, 6 miles east of Asherton. Measuring point, top of pump base. Altitude 569.70 feet.

Dec. 14,1929	128.50
Jan. 15,1930	122.40
Feb. 18	c 131.05
Mar. 20	138.15
Apr. 17	(b)
May 16	128.70
June 18	128 +
July 14	109.80
Aug. 22	109.40
Sept.23	116.70
Dec. 10	105.00
Feb. 9,1931	103.00
Mar. 3	95.85
Apr. 24	107.20
June 4	94.00
26	90.60
July 27	86.95
Sept.29	85.35
Dec. 3	103.55
Jan. 11,1932	96.85
Feb. 4	99.40
Mar. 22	98.60
May 6	108.60
July 5	101.90
Aug. 30	100.20
Dec. 20	96.30
Mar. 21,1933	91.50
Sept.18	91.60

b Pumping at time of measurement.
c Pump stopped a short time before measurement.
e Measurement made by Central Power & Light Co.

Water levels in wells in Dimmit County - Continued

S2-91. L. Zounhecker, 5 miles south of Asherton. Measuring point, top of concrete curb. Altitude 651.45 feet.

Date	Depth to water (feet)
Dec. 13,1929	153.90
Jan. 15,1930	154.50
Feb. 18	155.80
Mar. 19	157.20
Apr. 17	156.70
May 16	156.15
June 18	154.70
July 14	154.15
Aug. 22	153.50
July 3,1932	142.00
Aug. 30	141.00
Dec. 20	141.00
Sept.18,1933	(f)
Mar. 10,1935	139.85
July 29	139.60
Jan. 23,1936	138.50

S2-94. A. J. Frey, 9 miles west of Catarina. Measuring point, top of pump base. Altitude 694.60 feet.

Dec. 10,1929	191.20
Jan. 15,1930	192.50
Feb. 18	192.20
Mar. 19	192.90
Apr. 17	192.10
May 16	191.60
June 19	190.10
July 14	190.00
Aug. 22	190.30
Sept.23	192.80
Oct. 31	192.55
Dec. 10	189.20
Jan. 15,1931	190.40
Feb. 9	188.85
Mar. 3	187.60
Jan. 11,1932	194.20
Feb. 4	191.10
Mar. 22	183.00
May 6	188.10
July 3	182.40
Aug. 30 c	183.50
Dec. 20	177.80
Mar. 21,1933 c	177.40
Sept.18	175.00
Mar. 10,1935	173.45
July 29	174.70
Jan. 23,1936	172.85

S2-102. J. P. Giles, 4 miles northwest of Catarina. Measuring point, top of pump base. Altitude 582.95 feet.

S2-102 - Continued

Date	Depth to water (feet)
Oct. 25,1929	110.80
Nov. 19	120.90
Dec. 17	126 +
Jan. 15,1930	(b)
Feb. 18	141.80
Mar. 19	149.50
Apr. 17	(b)
May 16	134.60
June 19	124.80
July 14	120.60
Aug. 22	(b)
Sept.23	126.80
Oct. 31	119.85
Dec. 10	(b)
Feb. 9,1931	113.10
Mar. 3	117.40
Apr. 24	121.20
June 4	(b)
26	104.75
July 27	100.50
Sept.29	99.85
Dec. 3	(b)
Jan. 11,1932	106.10
Feb. 4	(b)
Mar. 22	116.35
May 6	120.00
July 5	117.75
Aug. 30	114.90
Dec. 20	107.25
Mar. 21,1933	101.00
Sept.18	101.00
Mar. 11,1935	107.45
July 29	103.00
Jan. 23,1936	107.60

S3-8. A. W. Fowler, 3 miles north of Catarina. Measuring point, top of pump base. Altitude 589.65 feet.

Nov. 19,1929	146.30
Dec. 17	139.70
Jan. 15,1930	143.80
Feb. 18	(b)
Mar. 19	152.30
Apr. 17	156.10
May 16	144.80
June 19	134.30
July 14	130.40
Aug. 22	130.45
Sept.23	135.15
Dec. 10	131.25
Feb. 9,1931	124.10
Mar. 3	122.85
Apr. 24	139.10
June 4	118.75
26	114.60
Sept.29	109.70
July 5,1932	Sealed.

S3-10. G. W. Taggert, 4½ miles northeast of Catarina. Measuring point, top of casing. Altitude 545.35 feet.

Date	Depth to water (feet)
Dec. 17,1929	84.00
Jan. 15,1930	83.55
Feb. 18	86.90
Mar. 19	93.15
Apr. 17	(b)
May 16	(b)
June 19	83.80
July 14	79.95
Aug. 22	79.60
Sept.23	(b)
Dec. 10	(b)
Feb. 9,1931	74.80
Mar. 3	71.60
Apr. 24	(b)
May 26	70.40
June 26	68.60
July 27	66.25
Sept.29	64.10
Dec. 3	70.45
Jan. 11,1932	68.35
Feb. 4	68.40
Mar. 22	68.40
May 6	74.20
July 5	73.30
Aug. 30	72.25
Dec. 20	68.20
Mar. 21,1933	64.50

S5-3. Ingram & Eckler, 6 miles east of Catarina. Measuring point, top of pump base. Altitude 598.20 feet.

Dec. 10,1929	122.70
Jan. 15,1930	127.40
Feb. 18	129.90
June 19	127.20
July 14	123.70
Aug. 22	118.75
Sept.23	119.25
Oct. 31	118.40
Dec. 10	114.80
Jan. 15,1931	119.40
Feb. 9	113.10
Mar. 3	108.50
Apr. 24	116.40
May 26	110.00
June 26	107.00
July 27	101.35
Sept.29	97.65
Dec. 3	107.35
Jan. 11,1932	103.15
Feb. 4	104.40
Mar. 22	105.15
May 6	112.80
July 3	111.50
Aug. 30	110.85
Dec. 20	104.90

b Pumping at time of measurement.
c Pump stopped a short time before measurement.
f Obstruction at depth of 138 feet.

Water levels in wells in Dimmit County - Continued

S5-3 - Continued

Date	Depth to water (feet)
Mar. 21,1933	98.50
Sept.18	98.50
Mar. 10,1935	98.55
July 29	99.10
Jan. 23,1936	98.75

S5-5. Claude Lindley, 13⅛ miles southwest of Catarina. Measuring point, top of pump base. Altitude 613.70 feet.

Date	Depth to water (feet)
Dec. 10,1929	73.45
Jan. 15,1930	73.15
Feb. 18	74.70
Mar. 19	75.20
Apr. 17	76.60
May 16	c 93.80
June 19	75.60
July 14	74.85
Aug. 22	73.70
Sept.23	72.80
Oct. 31	73.40
Dec. 10	71.80
Feb. 9,1931	71.15
Mar. 3	70.40
Apr. 24	69.85
May 26	69.70
June 26	69.20
July 27	68.00
Sept.29	66.00
Dec. 3	66.10
Jan. 11,1932	66.00
Feb. 4	66.40
Aug. 30	68.20
Dec. 20	66.60
Mar. 21,1933	65.50
Sept.18	65.40

S5-10. -- Watson, 5 miles southwest of Catarina. Measuring point, top of concrete casing. Altitude 571.70 feet.

Date	Depth to water (feet)
Dec. 11,1929	86.40
Jan. 15,1930	87.00
Feb. 18	96.65
Mar. 19	97.95
Apr. 17	b 105.10
May 16	101.40
July 14	96.35
Aug. 22	94.60
Sept.23	94.15
Oct. 31	92.70
Dec. 10	89.55
Jan. 15,1931	91.75
Feb. 9	c 89.35

S5-10 - Continued

Date	Depth to water (feet)
Mar. 3,1931	86.25
Apr. 24	89.90
May 26	(b)
June 26	84.15
July 27	81.70
Sept.29	78.30
Dec. 3	82.35
Jan. 11,1932	81.20
Feb. 4	80.50
Mar. 22	80.40
May 6	85.75
July 3	86.25
Aug. 30	c 86.00
Dec. 20	80.14
Mar. 21,1933	73.75
Sept.18	78.40
July 29,1935	77.65
Jan. 23,1936	77.40

S6-4. -- Ray, 1⅛ miles southeast of Catarina. Measuring point, top of pump base. Altitude 482.26 feet.

Date	Depth to water (feet)
Nov. 1,1928	e 23
15	e 30
Jan. 15	24.65
Feb. 18	(b)
Mar. 19	37.20
Apr. 17	38.80
May 16	33.15
June 19	24.90
July 14	23.80
Aug. 22	24.80
Sept.23	26.30
Oct. 31	20.43
Dec. 10	18.60
Feb. 9,1931	16.70
Mar. 3	14.00
Apr. 24	20.80
May 26	13.80
June 26	12.00
July 27	7.30
Sept.29	7.10
Dec. 3	12.15
Jan. 11,1932	9.60
Feb. 4	11.60
Mar. 22	13.15
May 6	18.60
July 3	17.75
Aug. 30	14.75
Dec. 20	8.38
Mar. 21,1933	1.05
Mar. 10,1935	10.10
July 29	6.80
Jan. 23,1936	10.50

S6-5. C. E. Lukar, 3⅛ miles southeast of Catarina. Measuring point, top of casing. Altitude 531.05 feet.

Date	Depth to water (feet)
Oct. 21,1929	50.48
Nov. 4	g 50.48
5	50.34
20	50.61
Dec. 26	49.51
Jan. 15,1930	49.47
29	49.72
Feb. 18	49.71
Mar. 19	50.40
Apr. 17	50.37
May 16	50.23
June 19	49.44
27	49.52
July 11	49.33
Aug. 22	49.12
Sept.23	49.12
Mar. 3,1931	48.15
Apr. 24	48.33
May 26	64.00
June 26	51.80
July 27	(b)
Sept.29	(b)
Dec. 3	(b)
Jan. 11,1932	(b)
Feb. 4	(b)
Mar. 22	(b)
July 3	54.30
Mar. 21,1933	c 55.70
Sept.18	49.00?

T1-5. -- Flecher, 2⅛ miles east of Valley Wells. Measuring point, top of pipe clamp. Altitude 484.25 feet.

Date	Depth to water (feet)
Jan. 6,1930	3.50
Feb. 24	b 3.50
Apr. 22	b 6.80
May 21	b 6.90
June 26	b 4.90
July 18	b 4.05
Aug. 23	4.30
Sept.24	4.85
Oct. 31	c 3.80
Dec. 12	2.95
Jan. 13,1931	2.95
Feb. 5	1.65
Mar. 5	Flow
Apr. 30	1.75
May 27	Flow
June 25	do.
July 28	do.
Oct. 5	do.
Dec. 5	do.
Jan. 12,1932	do.
Aug. 28,1934	7.50

b Pumping at time of measurement.
c Pump stopped a short time before measurement.
g Water-stage recorder installed on well.
e Measurement made by Central Power & Light Co.

Water levels in wells in Duval County

55. L. N. Garcia, 3.7 miles west of San Diego. Dug. Depth 80 feet. Windmill. Measuring point, top of curb.

Date	Depth to water (feet)
June 8,1931	75.00
Aug. 22,1933	55.63
Sept. 8	53.30
26	50.39
Oct. 11	49.67
25	47.85
Nov. 16	48.49
Feb. 16,1934	51.72
Dec. 11	59.21
Apr. 12,1935	50.14
Jan. 31,1936	41.40
Feb. 18	41.65

59. Candeladio Cuellar, 6 miles west of San Diego. Drilled. Depth 150 feet. Windmill. Measuring point, top of pipe clamp, 1 foot above surface.

June 9,1931	65.00
Aug. 22,1933	62.58
Sept. 9	62.51
25	62.20
Oct. 11	61.77
Nov. 16	61.74
Dec. 11,1934	64.61
Apr. 12,1935	65.12
Jan. 31,1936	58.20
Feb. 18	58.62

61. Jose M. Sepulyida, 7 miles northwest of San Diego. Dug and drilled. Depth 100± feet. Hand pump.

Sept.26,1933	47.46
Oct. 11	46.10
25	45.65
Nov. 16	44.98
Feb. 16,1934	45.49
Dec. 11	52.61
Apr. 12,1935	56.28
Jan. 31,1936	32.52

68. Cantu estate, 9 miles west of San Diego. Drilled. Depth 190 ft. Windmill. Measuring point, top of pipe clamp, 1 foot above surface.

68 - Continued

Date	Depth to water (feet)
June 9,1931	80.00
Aug. 22,1933	65.14
Sept. 8	63.51
26	64.45
Oct. 11	63.85
25	62.30
Nov. 16	62.28
Feb. 16,1934	61.37
Dec. 11	64.00
Apr. 12,1935	64.12
Jan. 31,1936	57.25
Feb. 28	57.34

69. Juan Peralez, 9 miles west of San Diego. Drilled. Depth 140 ft. Hand pump.

Sept.26,1933	77.29
Oct. 11	77.69
25	77.28
Feb. 16,1934	76.28
Dec. 11	77.37
Apr. 12,1935	77.33
Jan. 31,1936	75.68
Feb. 18	75.85

70. M. Cantu, 10.4 miles west of San Diego. Drilled. Depth 110 feet. Windmill. Measuring point, top of casing, 1 foot above surface.

June 9,1931	57.00
Aug. 22,1933	50.18
Sept. 8	48.99
26	48.40
Oct. 11	48.33
25	48.20
Feb. 16,1934	49.87
Dec. 11	54.18
Jan. 31,1936	46.90
Feb. 18	46.95

71. Helena de Pena, 11.2 miles west of San Diego. Dug. Depth 110 ft. Windmill. Measuring point, top of curb, 2½ feet above surface.

June 9,1931	46.00
Aug. 22,1933	42.77
Sept. 8	40.58
26	38.95
Oct. 11	40.83
25	39.65
Nov. 16	40.55

71 - Continued

Date	Depth to water (feet)
Feb. 16,1934	40.39
Dec. 11	43.01
Apr. 12,1935	47.56
Jan. 31,1936	43.25
Feb. 18	43.20

72. Cecilio Valerio, 12 miles west of San Diego. Dug. Hand lift. Depth 50 ft. Measuring point, top of 4-in. casing, 1 foot above surface.

Apr. 2,1931	38.60
Aug. 22,1933	39.41
Sept. 8	39.22
26	39.00
Oct. 11	38.82
25	38.76
Nov. 16	38.65
Feb. 16,1934	38.71
Dec. 11	39.84
Apr. 12,1935	40.08
Jan. 31	38.55
Feb. 18	38.50

73. Severo Ranjel, 11 miles west of San Diego. Dug. Depth 40 ft. Rope and bucket.

Sept.26,1933	38.02
Oct. 11	38.07
25	38.02
Nov. 16	37.41
Feb. 16,1934	37.73
Dec. 11	39.23
Apr. 12,1935	38.90
Jan. 31,1936	37.50
Feb. 18	37.82

143. Salidonia Ruiz, Benavides. Dug. Depth 40 ft. Rope and bucket. Measuring point, top of concrete curb, 2 feet above surface.

Sept.20,1933	42.70
Oct. 13	42.58
26	42.93
Nov. 17	42.68
Feb. 5,1934	42.00
Dec. 7	42.39
Apr. 13,1935	42.58
Jan. 31,1936	41.50
Feb. 17	41.56

Water levels in wells in Duval County - Continued

144. Pete Coronada, Benavides. Dug. Depth 48 ft. Power lift.

Date	Depth to water (feet)
Sept. 20,1933	46.00
Oct. 13	45.61
26	45.47
Nov. 17	45.30
Feb. 5,1934	45.10
Dec. 15	45.92
Apr. 13,1935	46.15
Jan. 31,1936	44.65

145. T. Ramirez, Benavides. Dug. Depth 48 ft. Windmill. Measuring point, top of pump clamp, 6 in. above board cover.

Sept. 20,1933	46.27
Oct. 13	45.79
26	45.41
Feb. 5,1934	45.90
17	45.90
Dec. 15	46.66
Apr. 13,1935	46.90
Jan. 31,1936	44.20
Feb. 17	44.36

157. Francisco Vaello, 2½ miles southwest of Benavides. Drilled. Depth 140 ft. Windmill. Measuring point, pump clamp, 0.53 ft. above top of casing.

Sept. 27,1933	93.77
Oct. 13	93.49
Nov. 20	93.39
Feb. 5,1934	93.69
Dec. 17	94.03
Apr. 13,1935	94.05
Jan. 30,1936	92.50
Feb. 17	92.63

158. Marco Gomez, 1 3/4 miles southwest of Benavides. Drilled. Depth 132 ft. Hand pump. Measuring point, pump clamp, 1¼ feet above top of casing.

Sept. 27,1933	96.95
Oct. 13	96.85
25	96.89
Nov. 20	96.82

158 - Continued

Date	Depth to water (feet)
Feb. 5,1934	97.94
Dec. 7	97.90
Apr. 12,1935	97.93
Jan. 31,1936	97.45
Feb. 17	97.48

173. Ismael Garcia, 2 1/3 miles east of Benavides. Dug. Depth 80± ft. Rope and bucket.

Sept. 28,1933	47.85
Oct. 13	46.93
26	46.76
Nov. 17	46.86
Feb. 17,1934	48.17
Dec. 17	50.31
Apr. 13,1935	51.05
Feb. 1,1936	47.52
17	47.56

175. Mrs. Tom Cavenaugh, 1 mile east of Benavides. Dug. Windmill.

Sept. 27,1933	51.43
Oct. 13	51.36
26	49.14
Nov. 17	49.45
Feb. 17,1934	49.39
Dec. 7	52.02
Apr. 13,1935	53.15
Jan. 31,1936	43.92
Feb. 17	44.05

179. J. Halff, 5½ miles east-northeast of Benavides. Dug. Depth 60 ft. Windmill.

Sept. 27,1933	49.15
Oct. 13	49.56
26	48.93
Nov. 17	49.62
Dec. 7,1934	51.30
Apr. 12,1935	51.54
Jan. 31,1936	51.43
Feb. 17	51.36

183. Lazaro Vela, 8 miles south of San Diego. Drilled. Depth 110 ft. Windmill. Measuring point, top of pump clamp, 6 in. above surface.

183 - Continued

Date	Depth to water (feet)
May 15,1931	58.00
Aug. 22,1933	56.58
Sept. 8	56.60
28	56.39
Oct. 10	56.36
26	56.32
Nov. 17	56.32
Feb. 16,1934	56.30
Feb. 1,1936	53.65
Feb. 17	53.82

184. Eusebio Alanis, 7½ miles south-southwest of San Diego. Dug. Depth 90± ft. Hand pump.

Sept. 28,1933	45.45
Oct. 15	45.78
27	45.92
Nov. 17	45.88
Feb. 16,1934	47.45
Dec. 12	48.40
Apr. 13,1935	47.90
Feb. 1,1936	41.86
17	42.35

185. Cervando Saenz, 10 miles south of San Diego. Drilled. Depth 90 ft. Windmill. Measuring point, top of curb, 1½ feet above surface.

May 25,1931	42.5
Aug. 22,1933	37.01
Sept. 8	36.43
28	36.27
Oct. 16	36.13
27	36.12
Nov. 17	36.23
Feb. 16,1934	36.02
Dec. 12	36.24
Apr. 13,1935	36.50
Feb. 1,1936	35.77
17	35.80

187. Ranchita Anjerlina, 10½ miles south of San Diego. Dug. Depth 70 ft. Windmill. Measuring point, surface.

May 25,1931	42.00
Aug. 22,1933	51.18
Dec. 12,1934	43.88
Apr. 13,1935	43.82

Water levels in wells in Duval County - Continued

188. Encarnacion Pena, 1 mile north of San Jose. Drilled. Depth 130 ft. Rope and bucket.

Date	Depth to water (feet)
Sept. 28, 1933	76.11
Oct. 16	76.16
26	76.07
Nov. 17	76.06
Feb. 17, 1934	76.04
Dec. 12	75.94
Apr. 13, 1935	76.21
Feb. 1, 1936	75.82
17	76.04

189. Pedro Lopez, 13 miles south of San Diego at San Jose. Drilled. Depth 100 ft. Windmill. Measuring point, top of pipe clamp, 1½ feet above surface.

Date	Depth to water (feet)
May 15, 1931	64.5
Aug. 22, 1933	63.34
Sept. 8	63.39
28	63.19
Oct. 13	63.20
27	63.17
Dec. 17, 1934	62.77
Apr. 13, 1935	62.76
Feb. 1, 1936	62.44
17	62.45

190. Margarita Lopez, 1/2 mile south of San Jose. Dug. Depth 90± ft. Windmill.

Date	Depth to water (feet)
Sept. 28, 1933	40.05
Oct. 16	40.78
26	41.12
Nov. 17	41.82
Dec. 12, 1934	45.27
Apr. 13, 1935	45.88
Feb. 1, 1936	44.10
17	44.18

191. Pedro Bazan, 2 miles southwest of San Jose. Dug and drilled. Depth 107 ft. Windmill. Measuring point, top of pump clamp, 2 feet above surface.

191 - Continued

Date	Depth to water (feet)
May 28, 1931	55.00
Sept. 28, 1933	31.66
Oct. 16	33.61
27	34.11

201. Maria Villareal de Saenz, 1¼ miles north of Santa Cruz. Drilled. Depth 125 ft. Windmill. Measuring point, top of pipe clamp, 1 foot above surface.

Date	Depth to water (feet)
May 26, 1931	78.80
Aug. 22, 1933	78.31
Sept. 11	78.25
29	78.22
Oct. 18	78.28
28	78.08
Nov. 20	78.14
Feb. 5, 1934	78.10
Apr. 15, 1935	77.60
Feb. 2, 1936	76.20

203. N. E. Martinez, Santa Cruz. Drilled. Depth 200 ft. Windmill. Measuring point, top of pipe clamp, 2½ feet above surface.

Date	Depth to water (feet)
Jan. 7, 1933	49.05
Feb. 22	48.82
May 31	49.24
June 26	49.67
July 24	49.39
Aug. 10	49.15
22	49.00
Sept. 11	48.68
29	48.53
Feb. 5, 1934	48.25
Dec. 10	49.46
Apr. 15, 1935	49.35
Feb. 2, 1936	48.44

204. Hilario Saenz, 1 mile south of Santa Cruz. Drilled. Depth 310 ft. Windmill. Measuring point, top of pipe clamp, 2½ feet above surface.

204 - Continued

Date	Depth to water (feet)
May 26, 1931	60.90
Dec. 9, 1932	63.60
Aug. 22, 1933	61.29
Sept. 11	60.73
29	60.73
Feb. 5, 1934	60.34
Dec. 10	61.80
Apr. 15, 1935	61.64
Feb. 2, 1936	60.56

207. Guadalupe Silva Salinas, 2 miles east of Conception. Drilled. Depth 81 ft. Windmill. Measuring point, top of casing, 1¼ feet above surface.

Date	Depth to water (feet)
Jan. 7, 1933	61.37
Feb. 22	61.81
May 31	62.00
June 26	63.22
July 24	63.90
Aug. 10	62.23
22	62.14
Sept. 11	61.40
29	60.49
Oct. 18	59.62
28	59.26
Nov. 11	59.03
Feb. 5, 1934	58.52
Dec. 10	60.17
11	60.00
Apr. 15, 1935	60.34
Feb. 2, 1936	54.18
15	54.24

209. W. S. Evans, Conception. Drilled. Depth 156 ft. Gas jack pump. Measuring point, top of pipe clamp, 1 foot above surface.

Date	Depth to water (feet)
May 29, 1931	45.30
Jan. 7, 1933	47.05
Feb. 22	46.63
May 31	46.54
June 26	43.16
July 24	45.90
Aug. 10	41.09
22	35.96
Sept. 11	31.12
29	30.10
Oct. 18	31.20
30	32.30
Nov. 11	32.41
Feb. 5, 1934	39.27
Dec. 10	45.28
Apr. 15, 1935	44.85
Feb. 2, 1936	30.70
15	31.22

Water levels in wells in Duval County - Continued

211. J. Perez, 1 1/3 miles north of Conception. Drilled. Depth 93 ft. Windmill. Measuring point, top of casing, 6 in. above surface.

Date	Depth to water (feet)
May 29,1931	50.00
Aug. 22,1933	47.35
Sept.11	46.58
29	45.33
Oct. 19	45.59
28	45.10
Nov. 20	45.56
Feb. 5,1934	45.01
Dec. 10	46.09
Apr. 15,1935	46.35
Feb. 2,1936	41.42
15	41.63

230. San Antonio Loan & Trust Co., 3⅜ miles south of Realitos. Dug. Depth 90± ft. Windmill.

Sept.28,1933	60.00
Oct. 16	59.74
30	59.70
Nov. 21	60.97
Feb. 17,1934	61.70
Dec. 5	61.10
Apr. 14,1935	61.82
Feb. 1,1936	59.58

240. Gus Minges, 1½ miles northeast of Realitos. Drilled. Depth 154 ft. Windmill. Measuring point, top of pipe clamp, 1½ feet above surface.

Jan. 7,1933	93.95
Feb. 22	94.55
May 31	94.16
June 26	94.29
July 24	94.29
Aug. 10	94.02
22	94.15
Sept. 8	94.15
28	94.05
Oct. 13	93.76
26	93.70
Nov. 20	93.55
Feb. 5,1934	93.53
Dec. 5	94.55
Apr. 13,1935	94.58
Jan. 30,1936	94.15

271. J. Mann, 5⅛ miles south-southeast of Realitos. Drilled. Depth 90± ft. Hand pump.

Date	Depth to water (feet)
Sept.28,1933	76.37
Oct. 18	76.35
Nov. 11	76.37
Dec. 5,1934	75.97
Apr. 14,1935	76.00
Feb. 1,1936	75.92
15	76.45

272. San Antonio Loan & Trust Co., 4¼ miles northwest of Sejita. Dug. Depth 100± ft. Gas jack pump.

Sept.28,1933	84.14
Oct. 18	84.67
30	84.28
Nov. 11	84.52
Feb. 17,1934	84.87
Dec. 5	85.03
Apr. 14,1935	84.85
Feb. 1,1936	85.04
15	85.08

276. Herman Damier, 10¼ miles south of Realitos. Drilled. Depth 102 ft. Windmill. Measuring point, top of pipe clamp, 1 foot above surface.

May 30,1931	37.6
Aug. 22,1933	38.43
Sept.11	37.69
28	36.09
Oct. 18	34.84
Nov. 1	34.24
21	33.98
Feb. 17,1934	32.95
Dec. 8	34.46
Apr. 14,1935	35.50
Feb. 2,1936	35.36

281. G. A. Nieft, 2 miles southwest of Sejita. Drilled. Depth 117 ft. Windmill. Measuring point, top of pipe clamp, 1⅛ feet above surface.

May 30,1931	38
Aug. 21,1933	35.96
Sept.29	34.99
Oct. 19	34.56
Nov. 1	34.12
21	33.83

281 - Continued

Date	Depth to water (feet)
Feb. 17,1934	32.08
Dec. 8	32.30
Apr. 14,1935	33.10

287. Virginia J. Ramidez, 4 miles southwest of Conception. Drilled. Depth 170 ft. Windmill. Measuring point, top of pipe clamp, 2 feet above surface.

June 3,1931	50.3
Aug. 22,1933	50.7
Sept.11	50.61
29	50.28
Oct. 19	49.85
Nov. 1	49.45
22	49.32
Feb. 17,1934	49.08
Dec. 8	48.47
Apr. 16,1935	49.44
Feb. 1,1936	47.60

289. Adolfo Garcia, 3¼ miles northeast of Sajita. Drilled. Depth 80 ft. Windmill.

Aug. 22,1933	47.69
Sept.11	47.60
29	47.57
Oct. 19	47.50
Nov. 1	47.37
11	47.33
Feb. 17,1934	47.50
Dec. 15	47.10
Apr. 16,1935	47.40
Feb. 1,1936	46.48
Feb. 15	46.45

290. Andalasia Garcia (Javelina Pasture), 3 miles northeast of Sejita. Drilled. Depth 100± ft. Windmill. Measuring point, top of pipe clamp, 2 feet above surface.

June 3,1931	54.00
Aug. 22,1933	54.20
Sept.11	54.25
29	54.10
Oct. 19	54.06
Nov. 1	53.94
22	53.88
Feb. 17,1934	53.57
Dec. 15	53.06
Apr. 16,1935	53.24
Feb. 15,1936	52.48

Water levels in wells in Duval County - Continued

292. Raphael Flores, 1 mile east of Sejita. Drilled. Windmill. Measuring point, top of pump clamp, 2 feet above surface.

Date	Depth to water (feet)
May 29,1931	30.5
Aug. 22,1933	31.01
Sept.11	30.60
29	29.85
Oct. 18	29.41
30	29.15
Nov. 22	29.04
Feb. 17,1934	28.28
Dec. 8	28.45
Apr. 14,1935	29.42
Feb. 2,1936	29.33
15	29.34

297. San Antonio Loan & Trust Co., 6⅛ miles south-southeast of Sajita. Drilled. Depth 200 ft. Windmill. Measuring point, top of pipe clamp.

May 29,1931	61.5
Aug. 22,1933	54.04
Sept.29	53.80
Nov. 21	53.64
Dec. 8,1934	52.82
Apr. 14,1935	53.90
Feb. 2,1936	53.20
15	53.21

301. Virginia Garcia, 5 miles south of Conception. Drilled. Depth 280 ft. Windmill. Measuring point, top of pump clamp, 1 foot above surface.

May 29,1931	50.6
Mar. 30,1933	50.0
Aug. 22	51.04
Sept.11	50.60
29	50.76
Feb. 15,1934	50.14
Dec. 11	50.16
Apr. 16,1935	50.22
Feb. 2,1936	50.85
15	50.78

302. Rafael Garcia, 4⅛ miles south of Conception. Drilled. Depth 80 ft. Hand pump.

302 - Continued

Date	Depth to water (feet)
Sept.29,1933	32.55
Oct. 19	32.77
Nov. 1	32.87
22	32.80
Feb. 15,1934	33.11
Dec. 11	35.21
Apr. 16,1935	35.48
Feb. 2,1936	30.42
15	30.40

304. Rafael Garcia, 3 miles south of Conception. Drilled. Depth 90 ft. Windmill. Measuring point, top of pipe clamp, 1 foot above surface.

May 28,1931	63.6
Aug. 22,1933	58.00
Sept.11	58.10
29	57.88
Oct. 19	57.68
Nov. 1	57.32
22	57.19
Dec. 11,1934	55.83
Apr. 16,1935	56.03
Feb. 2,1936	54.55
15	54.62

315. Reuben Shultz, 6 3/4 miles south-southwest of Santa Cruz. Drilled. Depth 280 ft. Windmill. Measuring point, top of wood pipe clamp, 6 in. above surface.

Dec. 9,1932	48.2
Jan. 7,1933	48.56
Feb. 22	48.39
May 31	49.36
June 26	49.72
July 24	49.71
Aug. 10	49.57
22	49.44
Sept.11	49.04
29	48.92
Feb. 15,1934	48.22
Dec. 11	48.20
Apr. 14,1935	48.02
Feb. 2,1936	48.40

318. Manuel Saenz, 3 miles south of Santa Cruz. Drilled. Depth 240-260 ft. Windmill. Measuring point, top of pipe clamp, 2⅛ feet above surface.

318 - Continued

Date	Depth to water (feet)
May 26,1931	29.20
Aug. 22,1933	29.80
Sept.10	29.33

319. San Antonio Loan & Trust Co., 5¼ miles south-southeast of Santa Cruz. Drilled. Depth 340 ft. Windmill. Measuring point, top of pipe clamp, 1⅛ feet above surface.

May 27,1931	24.6
Jan. 7,1933	24.77
Feb. 22	24.58
May 31	25.11
June 26	25.14
July 24	25.34
Aug. 10	25.00
22	24.82
Sept.11	24.41
29	24.34
Feb. 15,1934	23.81
Dec. 11	24.69
Apr. 14,1935	24.32
Feb. 2,1936	24.12

322. Santone Hinojosa, 3/4 mile east of La Copita. Drilled. Depth 50 ft. Windmill. Measuring point, top of pipe clamp, 2 feet above surface.

Dec. 9,1932	39.67
Jan. 7,1933	39.65
Feb. 22	41.92
May 31	40.14
June 26	40.05
July 24	40.48
Aug. 10	39.92
22	39.56
Sept.11	39.40
29	38.83
Oct. 18	38.70
30	38.68
Nov. 21	38.59
Feb. 15,1934	38.39
Dec. 7	39.27
Apr. 14,1935	39.10
Feb. 2,1936	38.44

Water levels in wells in Galveston County

1. -- Garretson, 8 miles northwest of League City. Drilled. Depth 600 ft. Gas and deep well turbine. Measuring point, pump base, 6 inches above surface.

Date	Depth to water (feet)
Sept.11,1931	39.05
Nov. 8,1932	39.00
26	38.71
Dec. 30	38.15
May 9,1933	37.79
Oct. 26	39.93
Feb. 28,1936	42.15

3. Mrs. A. Voss, 5 3/4 miles west of League City. Drilled. Depth 763 ft. Gas and turbine pump. Measuring point, pump base, at surface.

Sept.11,1931	33.05
Nov. 8,1932	31.00
26	13.15
Dec. 30	13.12
May 9,1933	31.78
Oct. 26	32.14
Aug. 23,1935	34.00
Feb. 28,1936	31.71

26. Galveston, Houston & Henderson Railway, at League City. Drilled. Depth, 1,020 ft. Not used. Measuring point, top of casing, 3 feet above surface.

Apr. 15,1931	14.86
Sept. 4	17.53
May 10,1932	15.82
Sept.20	17.19
Oct. 7	16.98
Nov. 8	17.22
26	17.43
Dec. 30	18.71
Feb. 1,1933	16.30
Mar. 14	15.85
May 9	16.18
Oct. 26	16.73
Aug. 23,1935	15.80
Feb. 28,1936	14.45

28. Galveston, Houston & Henderson Railway, at League City. Drilled. Depth

28 - Continued

560± ft. No pump. Measuring point, top of casing, at surface.

Date	Depth to water (feet)
Apr. 15,1931	25.25
Sept. 4	28.66
May 10,1932	26.26
Sept.20	29.52
Oct. 7	29.54
Nov. 8	29.40
26	29.12
Dec. 30	28.10
Feb. 1,1933	27.76
Mar. 14	27.38
May 9	27.81
Aug. 23,1935	Obstructed at 31.7

105. R. E. Newell, 5 miles north of Alta Loma. Drilled. Depth 240 ft. Small power pump. Measuring point, top of casing, at surface.

Sept.20,1932	6.65
Oct. 7	6.54
Nov. 8	6.75
26	6.67
Dec. 30	6.27
Feb. 1,1933	5.94
Mar. 14	5.82
Feb. 28,1936	5.72

109. Dickinson High School, 6⅛ miles northeast of Alta Loma. Drilled. Depth 230 ft. No pump. Measuring point, top of casing, at surface.

Apr. 15,1931	13.37
Sept.20,1932	14.97
Oct. 7	14.72
Nov. 8	15.36
26	14.68
Dec. 30	14.64
Feb. 1,1933	13.65
Mar. 14	13.73
May 9	16.88
Oct. 26	15.12
Aug. 23,1935	Obstructed at 12.5

112. Galveston, Houston & Henderson Railway, 6⅛ miles northeast of Alta Loma. Drilled. Depth 750

112 - Continued

ft. Hand pump. Measuring point, top of casing, 1 foot above surface.

Date	Depth to water (feet)
Apr. 15,1931	18.89
Sept.16	23.12
Oct. 7,1932	24.10
Nov. 8	24.37
26	23.33
Dec. 30	21.41
Feb. 1,1933	20.82
Mar. 14	20.57
May 9	22.86
Oct. 26	25.10
Aug. 23,1935	35.68
Feb. 28,1936	37.48

113. E. Menotti, 7 miles northeast of Alta Loma. Drilled. Depth 504 ft. Gas and air pump. Measuring point, top of pipe clamp, 6 inches above surface.

Sept.20,1932	14.92
Oct. 7	14.98
Nov. 8	15.17
26	15.20
Dec. 30	15.40
Feb. 1,1933	14.94
Mar. 14	14.86
Apr. 9	16.12
Oct. 26	15.70
Aug. 23,1935	18.25
Feb. 28,1936	19.45

115. J. W. Palmer, 6 miles northeast of Alta Loma. Drilled. Depth 526 ft. No pump. Measuring point, top of air line, 4¼ feet above surface.

Sept.20,1932	19.38
Oct. 7	19.36
Nov. 8	19.56
26	19.55
Dec. 30	19.16
Feb. 1,1933	18.93
Mar. 14	18.80
May 9	19.15
Oct. 26	20.14
Aug. 23,1935	23.95
Aug. 28,1936	27.25

Water levels in wells in Galveston County - Continued

203. Highway Department, 4¼ miles west of Texas City. Drilled. Depth 860 ft. No pump. Measuring point, top of casing, at surface.

Date	Depth to water (feet)
Apr. 15,1931	2.24
Sept.16	3.45
Sept.21,1932	4.16
Oct. 7	4.00
Nov. 8	4.02
26	4.04
Dec. 30	3.47
Feb. 1,1933	3.35
Mar. 14	3.32
May 9	3.40
Oct. 26	4.14
Aug. 23,1935	Obstructed at 11.0

206. A. J. Biran, 3½ miles west of Texas City. Drilled. Depth 926 ft. Windmill. Measuring point, hole under 1-inch pipe, 11 inches above top of casing.

Apr. 15,1931	7.23
Oct. 7,1932	9.64
Nov. 8	9.13
26	8.96
Dec. 30	9.13
Feb. 1,1933	9.28
Mar. 14	9.07
May 9	9.43
Oct. 26	12.10
Aug. 23,1935	30.30
Feb. 28,1936	30.00

228. Owner unknown, at Texas City. Drilled. Depth 740 ft. No pump. Measuring point, face of tee, 6 inches above surface.

Oct. 22,1931	7.68
Nov. 8,1932	9.00
26	8.46
Dec. 30	7.72
Feb. 1,1933	7.47
Mar. 14	7.02
May 9	7.33
Oct. 26	8.50
Aug. 23,1935	Obstructed at 25.5

272. City of Galveston, at Alta Loma. Drilled. Depth 809 ft. No pump. Measuring point, top of 12-inch receiver, 7 feet above surface.

Date	Depth to water (feet)
Sept.23,1932	38.84
Oct. 7	38.20
Nov. 8	37.12
26	32.63
Dec. 30	37.61
Feb. 1,1933	34.13
Mar. 14	34.10
May 9	39.67
Oct. 26	40.52
Aug. 23,1935	53.50
Feb. 28,1936	37.52

283. James Balcher, 2 miles east-southeast of Alta Loma. Drilled. Depth 720 ft. No pump. Measuring point, top of casing, 2 feet above surface.

Sept.23,1932	13.30
Oct. 7	12.63
Nov. 8	12.31
26	12.51
Dec. 30	11.85
Feb. 1,1933	12.02
Mar. 14	11.88
May 9	12.67
Oct. 26	11.78
Aug. 23,1935	13.85
Feb. 28,1936	13.45

286. A. Cook, 2⅛ miles southeast of Alta Loma. Drilled. Depth 720 ft. Not used. Measuring point, top of casing, 6 inches above surface.

Sept.23,1932	12.42
Oct. 7	11.50
Nov. 8	11.78
26	11.42
Dec. 30	10.59
Feb. 1,1933	10.58
Mar. 14	10.36
Oct. 26	9.78
Feb. 28,1936	18.73

297. Charles Schiro, 4 miles southeast of Alta Loma. Drilled. Depth 720± ft. Gas engine pump. Measuring point, top of casing, 6 inches above surface.

297 - Continued

Date	Depth to water (feet)
Sept.22,1932	12.52
Oct. 7	11.71
Nov. 8	11.68
26	11.48
Dec. 30	10.71
Feb. 1,1933	10.66
Mar. 14	10.50
May 9	11.10
Oct. 26	11.82
Aug. 23,1935	19.96
Feb. 28,1936	19.10

300. Chris Jensen, 4 3/4 miles east-southeast of Alta Loma. Drilled. Depth 500 ft. No pump. Measuring point, top of tee at top of casing, at surface.

Sept.22,1932	10.86
Oct. 7	10.74
Nov. 8	10.69
26	10.65
Dec. 30	10.26
Feb. 1,1933	10.11
Mar. 14	9.87
May 9	10.42
Oct. 26	9.43
Aug. 23,1935	16.70
Feb. 28,1936	15.83

302. Joe Torraso, 4 miles east-southeast of Alta Loma. Drilled. Depth 790 ft. Gas engine pump. Measuring point, top of casing.

Oct. 7,1932	5.04
Nov. 8	5.00
Dec. 30	3.59
Feb. 1,1933	3.88
Mar. 14	3.86
May 9	3.93
Oct. 26	4.95
Aug. 23,1935	3.92
Feb. 28,1936	3.85

356. R. L. Whitburn, 3½ miles west-southwest of Texas City. Drilled. Depth 117 ft. Hand pump. Measuring point, top of wooden platform, 2 feet above surface.

Water levels in wells in Galveston County - Continued

356 - Continued

Date	Depth to water (feet)
Sept. 21, 1932	9.42
Oct. 7	9.14
Nov. 8	9.38
26	9.32
Dec. 30	9.70
Feb. 1, 1933	9.27
Mar. 14	9.03
May 9	9.36
Aug. 23, 1935	9.52
Feb. 28, 1936	9.95

Water levels in wells in Harris County

6a. H. H. Strickland, Waller. Depth 30 ft. Rope and bucket. Measuring point, top of wood casing, 3 feet above surface.

Apr. 13, 1931	10.00
May 28	11.36
June 19	13.04
July 23	14.05
Aug. 13	15.30
Sept. 24	16.80
Nov. 7	17.85
Dec. 11	17.90
Jan. 13, 1932	14.68
Feb. 10	12.02
Mar. 15	10.35
Apr. 19	11.48
May 24	12.34
June 22	14.42
July 22	15.43
Aug. 28	16.62
Sept. 29	17.10
Oct. 28	18.07
Nov. 28	18.42
Dec. 28	18.21
Jan. 31, 1933	17.82
Mar. 13	15.61
June 26	18.04
Nov. 20	19.52
Apr. 25, 1934	10.62
Nov. 24	17.58
May 30, 1935	9.25

10. J. A. Hafner, 2½ miles southeast of Waller. Bored test hole. Depth 21 ft. Measuring point, surface.

May 1, 1931	4.03
5	3.97
6	4.10
13	4.60
28	9.00

10 - Continued

Date	Depth to water (feet)
June 5, 1931	8.60
19	Dry 11.50
Nov. 3	Deepened 17.00
14	17.04
Dec. 11	16.60
23	15.53
30	14.87
Jan. 6, 1932	14.57
13	13.62
20	12.36
27	9.35
Feb. 3	7.28
10	7.20
16	7.15
23	3.26
Mar. 1	3.65
8	2.32
15	2.77
22	3.52
29	4.27
Apr. 5	4.45
12	5.13
19	6.10
26	7.60
May 17	8.53
June 15	10.38
July 14	12.65
Aug. 18	14.35
Sept. 15	16.32
Oct. 28	17.68
Nov. 28	18.30
Jan. 31, 1933	17.72
Mar. 13	13.11
May 10	14.50
June 26	15.73
Nov. 20	18.75
Apr. 25, 1934	3.18
Nov. 28	Dry
May 30, 1935	3.30
Aug. 19	11.65
Feb. 25, 1936	1.71

11. J. A. Hafner, 2½ miles southeast of Waller. Depth 70 ft. Measuring point, pump base 6 inches above surface.

Date	Depth to water (feet)
Apr. 13, 1931	45.15
25	45.12
May 22	45.29
28	45.16
June 19	45.82
Sept. 24	45.60
Nov. 3	45.70
20	45.38
27	45.42
Dec. 4	45.32
11	45.26
16	45.14
30	45.10
Jan. 13, 1932	45.50
20	45.58
27	45.32
Feb. 3	45.10
10	45.18
16	45.16
Mar. 15	44.98
Apr. 12	45.32
May 24	45.28
June 22	45.04
July 21	45.28
Aug. 25	44.98
Sept. 8	45.27
Oct. 28	45.34
Jan. 31, 1933	Obstructed
Feb. 25, 1936	45.38

31. R. L. Burton, 1/2 mile west of Hockley. Drilled. Depth 297 ft. Electric pump. Measuring point, top of casing, 6 inches above surface.

Water levels in wells in Harris County - Continued

31 - Continued

Date	Depth to water (feet)
Apr. 13,1931	43.75
May 28	43.95
June 19	44.18
July 23	44.45
Sept.24	44.97
Dec. 11	44.78
Jan. 13,1932	44.30
Feb. 10	44.54
Apr. 19	44.60
May 24	44.68
June 22	44.98
July 22	45.28
Aug. 25	45.65
Sept.29	45.82
Oct. 28	45.95
Dec. 28	45.66
Jan. 31,1933	45.34
Mar. 13	45.42
May 10	45.87
June 26	46.08
Nov. 20	46.85
May 30,1935	45.15
Aug. 19	45.51
Feb. 25,1936	44.65

35. O. M. Taylor, 1¼ miles east of Hockley. Drilled. Depth 35 ft. Rope and bucket. Measuring point, lowest point in broken tile, 1 foot above surface.

Apr. 13,1931	20.25
25	20.39
May 22	21.20
28	21.50
June 5	22.16
19	22.24
July 14	23.60
Aug. 13	23.30
Sept.24	23.30
Nov. 3	23.50
14	23.75
20	23.67
27	23.50
Dec. 4	23.62
11	23.44
16	23.42
23	23.78
30	23.58
Jan. 27,1932	22.92
Mar. 22	21.39
Apr. 12	22.35
19	22.37
May 17	22.44
June 15	22.73
July 14	22.91
Aug. 18	23.68
Sept.15	24.10
Oct. 28	23.52
Nov. 28	23.50
Dec. 28	23.64

35 - Continued

Date	Depth to water (feet)
Jan. 31,1933	23.82
Mar. 13	23.60
May 10	23.81
June 26	24.28
Apr. 25,1934	23.50
Nov. 28	23.75
May 30,1935	23.42
Aug. 19	24.47
Feb. 25,1936	22.65

36. O. M. Taylor, 1¼ miles east of Hockley. Dug. Depth 12 ft., deepened to 21½ ft. Nov. 3, 1931. No pump. Measuring point, top of board cover at surface.

Apr. 28,1931	5.12
May 1	4.80
6	5.57
13	5.95
22	6.27
28	6.45
June 19	7.11
July 14	8.00
23	8.10
Aug. 13	8.60
Nov. 3	21.00
Dec. 4	21.45
Jan. 6,1932	Dry
Feb. 10	20.05
Mar. 8	16.14
Apr. 12	19.67
May 12	20.81
June 15	21.15
July 14	21.33
Aug. 18	21.35
Apr. 25,1934	20.84
Nov. 28	Dry
May 30,1935	19.56
Aug. 19	Dry

95. H. C. Middlestead, 1 3/4 miles southwest of Spring. Dug. Depth 32 ft. Measuring point, top of brick curb on southeast side, 2 ft. above surface.

Nov. 9,1931	25.95
Dec. 9	26.25
22	26.09
29	25.43
Jan. 5,1932	25.38
28	22.93
Feb. 29	19.02
Mar. 28	18.85

95 - Continued

Date	Depth to water (feet)
Apr. 25,1932	21.28
May 16	22.38
July 1	24.04
Aug. 31	25.50
Sept.27	25.74
Oct. 21	26.20
Nov. 26	26.60
Dec. 30	26.07
Jan. 25,1933	26.88
Mar. 15	25.90
May 8	26.00
June 24	26.83
Apr. 26,1934	24.92
Nov. 29	27.27
May 29,1935	23.54
Aug. 22	26.05
Feb. 26,1936	22.30

97. H. C. Middlestead, 1 3/4 miles southwest of Spring. Bored test well. Depth 16⅔ ft. Measuring point, top of board cover.

Nov. 9,1931	16.45
25	16.40
Dec. 9	16.38
15	16.12
22	15.18
29	14.97
Jan. 28,1932	12.08
Feb. 29	11.13
Mar. 28	11.96
Apr. 25	12.62
May 16	12.86
July 1	14.17
Aug. 31	15.69
Oct. 21	Dry
Jan. 25,1933	Dry
Mar. 15	15.20
May 8	15.42
June 24	Dry
Apr. 26,1934	14.75
Nov. 29	Dry
May 29,1935	12.08
Aug. 22	14.95
Feb. 26,1936	7.97

166. Owner unknown, 1 3/4 miles northwest of Cypress. Bored test hole. Depth 11 ft., deepened to 18.8 ft. Nov. 4,1931. Measuring point, top of board cover, at surface.

May 5,1931	2.10
7	2.80

Water levels in wells in Harris County - Continued

166 - Continued

Date	Depth to water (feet)
May 13,1931	3.85
22	4.40
28	4.90
June 19	6.95
July 23	9.20
Nov. 4	15.04
Dec. 4	15.02
11	14.33
16	13.56
23	11.78
30	9.87
Jan. 6,1932	6.32
13	2.81
20	2.83
27	1.02
Feb. 3	1.76
10	2.49
16	2.15
23	1.00
Mar. 1	2.13
8	1.58
15	2.39
Apr. 5	3.90
May 3	5.07
June 1	6.98
15	7.94
29	8.86
July 7	9.49
Aug. 4	11.84
Sept. 8	13.50
29	13.90
Oct. 28	14.82
Nov. 28	15.26
Dec. 28	14.78
Jan. 31,1933	13.10
Mar. 11	4.70
May 10	7.51
June 26	10.42
Nov. 20	15.65
Nov. 28,1934	7.37
May 30,1935	2.24
Aug. 19	8.05
Feb. 25,1936	1.76

167. Russ Mitchell, 1 3/4 miles north of Cypress. Drilled. Depth 105 ft. Not used. Measuring point, top of casing, 1 foot above surface.

Apr. 3,1931	6.87
May 7	7.53
13	7.97
28	8.30
June 19	9.71
July 23	11.65
Aug. 13	12.90
Sept.24	14.40
Oct. 30	15.04
Nov. 4	15.06
7	15.27
14	15.25

167 - Continued

Date	Depth to water (feet)
Nov. 20,1931	15.13
27	15.16
Dec. 4	15.08
11	14.88
16	14.74
23	14.46
30	13.96
Jan. 6,1932	13.54
13	12.68
20	11.70
27	10.65
Feb. 3	9.74
10	9.40
16	9.24
23	8.85
Mar. 1	8.34
8	7.92
15	7.90
Apr. 5	8.64
May 3	9.62
June 15	11.50
Sept.29	15.10
Oct. 28	15.43
Nov. 28	15.50
Dec. 28	15.30
Jan. 31,1933	14.83
Mar. 11	12.86
May 10	12.98
Apr. 25,1934	10.60
Nov. 28	15.12
May 30,1935	8.17
Aug. 19	12.46
Feb. 25,1936	7.08

171. E. H. Juergen, Cypress. Drilled. Depth 72 ft. No pump. Measuring point, top of casing, 2 feet above surface.

Apr. 3,1931	8.49
June 19	11.89
July 23	14.25
Aug. 13	15.70
Sept.24	17.30
Nov. 14	17.76
Dec. 11	17.34
Jan. 13,1932	15.65
Feb. 10	11.85
Mar. 15	9.70
Apr. 19	10.88
May 24	12.40
June 24	14.20
July 22	15.88
Aug. 25	17.17
Sept.29	17.53
Oct. 28	17.86
Nov. 28	17.93
Dec. 28	17.74
Jan. 31,1933	17.56
Mar. 11	16.57
May 10	15.78
June 26	17.00
Nov. 20	18.76

171 - Continued

Date	Depth to water (feet)
Apr. 25,1934	12.62
Nov. 28	17.76
May 30,1935	9.72
Aug. 19	14.70
Feb. 25,1936	8.43

178. K. P. Black, 5 miles southeast of Cypress. Drilled. Depth 40 ft. No pump. Measuring point, top of casing, 4 inches above surface.

Apr. 3,1931	2.43
May 28	5.26
June 19	6.78
July 23	7.85
Aug. 13	10.00
Sept.24	14.30
Nov. 14	14.54
Mar. 15,1932	2.92
Apr. 19	4.84
June 27	7.70
July 22	9.71
Aug. 25	11.83
Sept.29	12.53
Oct. 28	13.16
Nov. 28	14.87
Dec. 28	14.03
Jan. 31,1933	13.61
Mar. 11	8.32
May 10	9.28
Nov. 20	13.82
Aug. 19,1935	8.18
Feb. 25,1936	2.34

180. J. Williams, 5½ miles southeast of Cypress. Bored test hole. Depth 11½ ft., deepened to 19 ft. Nov. 14. Measuring point, top of board cover at surface.

Apr. 25,1931	3.58
28	3.80
May 5	2.88
13	3.97
19	4.50
22	4.70
June 19	7.27
July 23	7.95
Aug. 13	10.10
Sept.24	Dry
Nov. 14	15.35
20	15.10
27	11.82
Dec. 4	12.30
12	10.28
16	9.34

Water levels in wells in Harris County - Continued

180 - Continued

Date	Depth to water (feet)
Dec. 23,1931	8.63
30	7.26
Jan. 6,1932	5.64
13	3.52
20	3.97
27	1.86
Feb. 3	2.26
10	2.08
Mar. 1	1.95
8	.70
15	2.06
22	3.05
Apr. 5	3.69
19	4.66
May 17	4.97
June 1	5.76
30	6.85
July 28	8.83
Aug. 25	10.62
Sept.22	11.97
Oct. 6	12.03
Well filled to 10 feet.	

181. J. Williams, 5⅛ miles southeast of Cypress. Drilled. Depth 60 ft. Hand and jack pump. Measuring point, lowest point in break in pump base, 1 foot above surface.

May 19,1931	5.73
22	5.87
June 19	8.27
July 23	2.49
Aug. 13	11.17
Sept.24	13.85
Oct. 30	15.50
Nov. 4	15.60
14	15.98
27	11.96
Dec. 16	8.67
30	7.16
Jan. 13,1932	3.84
Feb. 3	2.38
Mar. 1	3.33
Apr. 5	5.02
26	6.31
	Sealed

205. Humble Pipe Line Co., 6¼ miles southeast of Cypress. Drilled. Depth 700 ft. Air and oil pump. Measuring point, top of casing, 1 foot above surface.

205 - Continued

Date	Depth to water (feet)
Apr. 7,1931	23.91
May 19	23.34
June 19	24.13
July 23	24.17
Sept.24	26.22
Dec. 12	25.62
Jan. 13,1932	25.30
Feb. 10	25.11
Mar. 16	24.70
May 25	24.56
June 24	25.29
Aug. 28	27.00
Nov. 28	27.30
Dec. 28	26.77
Mar. 11,1933	26.02
Apr. 25,1934	26.46
Aug. 20,1935	27.17
Feb. 25,1936	26.78

206. R. B. Tucker, 6⅛ miles southeast of Cypress. Drilled. Depth 450± ft. Air and gas pump. Measuring point, top of board cover by suction pipe.

Apr. 2,1931	22.50
June 19	23.59
July 23	25.18
Sept.24	27.30
Dec. 12	26.51
Jan. 13,1932	25.78
Mar. 16	23.67
Apr. 19	23.55
May 25	23.90
June 24	25.32
July 22	26.62
Sept.29	27.87
Oct. 28	27.94
Mar. 11,1933	26.82
June 26	27.08
Nov. 20	28.38
Nov. 28,1934	28.05
May 30,1935	25.52
Aug. 20	27.84
Feb. 25,1936	27.92

207. R. B. Tucker, 6½ miles southeast of Cypress. Dug. Depth 7 ft. Not used. Measuring point, top of old casing, 6 inches below surface.

May 19,1931	1.65
June 19	2.60
July 23	2.05
Sept.24	6.50
Nov. 14	Dry
Feb. 10,1932	Dry
Mar. 16	6.12
Apr. 19	6.60

207 - Continued

Date	Depth to water (feet)
May 25,1932	6.85
June 24	1.24
July 22	.54
Aug. 25	.92
Sept.29	1.15
Oct. 28	2.32
	Filled in.

209. Houston and Texas Central Railroad (Southern Pacific) 7¼ miles southeast of Cypress. Bored test hole. Depth 13.6 ft., deepened to 19.6 ft. Sept. 24,1931. Measuring point, top of board cover, 2 inches above surface.

May 19,1931	4.50
22	4.64
28	5.10
June 5	5.71
19	6.93
July 23	7.22
Aug. 13	9.21
Sept.24	10.30
Nov. 4	12.86
14	13.15
Dec. 12	7.23
Jan. 14,1932	4.48
Feb. 10	3.08
Mar. 8	1.91
Apr. 5	4.41
May 4	5.28
June 8	7.92
July 7	9.84
Aug. 11	12.28
Sept. 8	12.34
Oct. 6	13.24
Nov. 28	14.88
	Destroyed.

210. Owner unknown, 7¼ miles southeast of Cypress. Drilled. Depth 68 ft. Windmill and jack pump. Measuring point, top of casing, 1 foot above surface.

Apr. 2,1931	11.37
May 14	9.93
19	10.62
22	10.40
28	10.82
June 5	11.12
19	12.12
July 23	13.40
Aug. 13	15.19
Sept.21	16.74

Water levels in wells in Harris County - Continued

210 - Continued

Date	Depth to water (feet)
Oct. 31,1931	19.58
Nov. 4	19.55
Dec. 4	19.22
Jan. 6,1932	17.49
Feb. 3	15.80
Mar. 1	14.10
Apr. 5	13.92
May 4	14.32
June 1	14.52
July 7	17.25
Aug. 4	18.32
Sept. 8	19.26
Oct. 6	19.76
Nov. 28	20.37
Dec. 28	20.08
Jan. 31,1933	19.65
Mar. 11	17.98
May 10	18.58
June 26	19.33
Apr. 25,1934	12.36
Nov. 28	20.12
May 30,1935	11.32
Aug. 20	Obstructed at 11.00

254. J. M. Blake, 2⅛ miles northwest of Aldine. Drilled test hole. Depth 20 ft. Measuring point, top of board cover.

Nov. 25,1931	19.43
Dec. 9	6.60
15	5.04
22	4.06
29	5.14
Jan. 5,1932	.36
12	.17
19	4.38
28	2.10
Feb. 2	3.74
9	5.03
15	5.38
Mar. 7	3.47
Apr. 4	5.83
May 2	7.85
July 1	13.11
Aug. 31	14.33
Nov. 26	15.55
Dec. 30	2.59
Jan. 25,1933	12.15
Mar. 15	4.85
May 8	7.18
June 24	11.78
Apr. 26,1934	4.80
Nov. 29	1.57
May 29,1935	4.79
Aug. 22	6.85
Feb. 26,1936	4.16

256. J. M. Blake, 2⅛ miles northwest of Aldine. Drilled.

256 - Continued

Depth 189 ft. No pump. Measuring point, plug in top of casing.

Date	Depth to water (feet)
Nov. 9,1931	28.86
25	28.95
Dec. 9	28.80
15	28.78
22	28.69
29	28.73
Jan. 5,1932	28.61
12	28.54
19	28.60
28	28.35
Feb. 2	28.36
9	28.24
Mar. 7	27.60
Apr. 4	27.31
May 2	27.15
July 1	27.53
Aug. 31	28.20
Sept. 27	28.64
Oct. 21	28.92
Nov. 26	29.36
Dec. 30	29.30
Jan. 25,1933	29.42
Mar. 15	28.96
May 8	28.43
June 24	28.68
Apr. 26,1934	28.75
Nov. 29	30.49
May 29,1935	28.75
Aug. 22	29.00
Feb. 27,1936	28.20

264. Weary Place, 3 miles north of Aldine. Drilled. Test for oil. Depth 1,610 ft. No pump. Measuring point, top of casing. Reported that well flowed from 900-ft. sand until 1930.

May 29,1931	3.00
Nov. 18	5.08
Jan. 19,1932	5.36
Mar. 21	5.66
May 21	6.44
July 25	7.46
Sept. 27	8.30
Oct. 21	8.36
Nov. 26	8.69
Dec. 30	8.66
Jan. 25,1933	8.92
Mar. 15	8.96
May 8	9.66
June 24	10.10
Aug. 22,1935	21.30
Feb. 26,1936	21.37

439. F. W. Tanner, 1/2 mile northwest of Fairbanks. Drilled. Depth 57 ft. Windmill and jack. Measuring point, top of 12-inch casing, 2 feet above surface.

Date	Depth to water (feet)
Apr. 2,1931	5.10
May 21	8.00
July 23	11.28
Oct. 28	17.07
Dec. 12	14.40
Mar. 16,1932	5.44
Apr. 19	7.73
May 25	8.54
June 27	11.86
Aug. 25	13.02
Oct. 28	16.60
Nov. 28	17.41
Jan. 31,1933	14.38
Mar. 11	9.08
Aug. 20,1935	9.80

440. C. W. Hahl, 1/2 mile northwest of Fairbanks. Bored test well. Depth 10 ft., deepened to 20 ft. Oct. 28. Measuring point, top of board cover.

May 19,1931	8.65
21	8.70
June 5	8.92
19	9.50
Oct. 28	Dry
Nov. 4	Dry
Dec. 12	9.16
16	12.23
Jan. 14,1932	13.82
Feb. 16	11.60
Mar. 16	9.73
Apr. 19	9.29
May 17	9.46
June 15	10.45
July 14	12.56
Aug. 18	14.10
Sept. 15	15.08
Oct. 28	16.08
Nov. 28	16.40
Dec. 28	16.61
Jan. 31,1933	16.48
Mar. 11	16.62
May 10	16.61
June 26	14.76
Nov. 20	14.58
Nov. 28,1934	14.94
May 30,1935	7.15
Aug. 20	12.82
Feb. 25,1936	3.15

512. Ed Nichols, 8⅛ miles northwest of Houston. Drilled.

Water levels in wells in Harris County - Continued

512 - Continued

Depth 50 ft. Air and electric pump. Measuring point, top of tin casing, 6 inches above surface.

Date	Depth to water (feet)
Mar. 30,1931	5.42
May 21	7.00
June 19	9.72
July 23	10.26
Sept.24	14.70
Nov. 14	17.30
Jan. 14,1932	9.75
Feb. 11	8.12
Mar. 16	6.80
Apr. 19	7.90
May 25	8.32
June 24	10.43
July 22	12.40
Aug. 25	13.48
Sept.30	14.31
Oct. 28	16.00
Nov. 28	17.27
Dec. 28	15.43
Jan. 31,1933	13.70
Mar. 11	7.86
May 10	9.62
June 26	12.43
Nov. 20	13.60
Apr. 25,1934	5.08
Aug. 20,1935	9.57
Feb. 25,1936	3.82

514. Owner unknown, 8 miles northwest of Houston. Bored test well. Depth 19 ft. Measuring point, top of board cover.

June 19,1931	11.80
July 23	8.00
Aug. 13	9.81
Sept.24	12.36
Dec. 12	10.20
Jan. 14,1932	6.77
Feb. 11	5.16
Mar. 16	3.61
Apr. 19	5.76
May 25	6.79
June 27	9.65
July 22	11.58
Aug. 25	11.93
Sept.30	12.41
Oct. 28	14.88
Dec. 28	14.20
Jan. 31,1933	12.96
Mar. 13	8.21
May 10	9.36
Aug. 20,1935	Destroyed.

518. John W. Beall, 7 miles northwest of Houston. Drilled. Depth 153 ft. No pump. Measuring point, top of casing, 1 foot above surface.

Date	Depth to water (feet)
Mar. 30,1931	35.04
May 21	34.59
June 19	35.18
July 23	35.63
Aug. 13	36.10
Sept.24	36.76
Nov. 5	37.39
14	37.35
Dec. 12	37.05
Jan. 14,1932	36.51
Feb. 11	35.92
Mar. 16	35.05
Apr. 19	34.81
May 25	34.77
Oct. 28	37.44
Nov. 28	37.52
Dec. 28	37.33
Aug. 20,1935	32.75

590. City of Houston, 4½ miles northwest of Houston post office. Drilled. Depth 1,362 ft. Turbine pump. Measuring point, top of pump base, at surface. Abandoned well.

Nov. 3,1931	65.54
Dec. 5	60.94
Jan. 7,1932	58.62
Feb. 6	58.70
Mar. 4	61.38
Apr. 8	60.06
May 7	62.20
June 7	64.00
July 7	63.84
Aug. 8	66.28
Sept. 7	65.12
Oct. 8	62.90
Nov. 4	63.35
Dec. 29	60.87
31	60.25
Jan. 26,1933	60.64
Mar. 9	59.32
Apr. 15	58.80
May 12	59.45
June 23	64.38
Aug. 18	65.47
Sept.20	65.95
Oct. 31	63.91
Nov. 22	63.38
Dec. 23	62.07
Jan. 23,1934	60.57
Feb. 21	59.87

590 - Continued

Date	Depth to water (feet)
Mar. 21,1934	58.38
30	59.76
Apr. 20	59.24
May 22	59.88
June 26	66.79
July 24	65.01
Aug. 16	65.51
Sept.22	66.30
Oct. 23	65.75
Nov. 21	62.52
Dec. 21	60.71
Jan. 31,1935	64.11
Mar. 1	62.20
22	62.25
Apr. 24	63.05
May 21	63.10
June 19	65.14
July 26	68.55
Aug. 17	69.74
Sept.21	69.27
Oct. 26	67.20
Nov. 23	64.56
Feb. 20,1936	65.02

602. River Oaks Country Club, 4 miles west of Houston post office. Drilled. Depth 1,038 ft. Electric turbine pump. Measuring point, 1/2-inch hole in pump bowl, 2 feet above surface.

Jan. 19,1931	48.54
Apr. 7	47.10
May 21	48.05
July 2	51.56
Aug. 12	51.65
Sept.10	52.29
Nov. 3	49.97
Dec. 5	48.48
Jan. 7,1932	46.38
Feb. 6	45.14
Mar. 4	44.18
Apr. 8	43.22
July 9	48.09
Sept. 7	45.86
Nov. 7	44.00
28	43.05
Jan. 2,1933	42.10
30	42.16
Mar. 10	41.18
Apr. 15	41.00
Feb. 23,1934	44.74
Apr. 20	44.45
Nov. 21	49.32
Dec. 21	47.11
Jan. 31,1935	45.49
Apr. 29	47.34
May 21	46.84
Aug. 17	49.22
Nov. 23	48.62

Water levels in wells in Harris County - Continued

619. City of Houston (Lincoln Pool), 1 mile northwest of Houston post office. Drilled. No pump. Measuring point, top of casing, 2 feet above surface.

Date	Depth to water (feet)
Jan. 30,1931	55.50
May 31	54.46
July 1	57.27
Sept.10	60.00
Nov. 3	58.46
Dec. 5	56.45
Jan. 7,1932	54.76
Feb. 6	53.65
Mar. 4	52.92
Apr. 8	51.25
May 7	52.10
June 7	54.73
July 9	55.86
Aug. 8	56.64
Sept. 7	57.23
Oct. 8	56.02
Nov. 4	54.68
29	52.65
Dec. 31	51.72
Jan. 28,1933	49.78
Mar. 10	48.95
Apr. 15	48.86
May 13	50.92
June 23	55.24
Aug. 18	57.12
Sept.19	57.13
Oct. 31	56.72
Nov. 22	57.45
Dec. 23	56.70
Jan. 23,1934	55.13
Feb. 21	54.83
Mar. 21	54.11
30	54.65
Apr. 20	55.67
May 22	56.17
June 26	59.57
July 25	61.40
Aug. 16	61.81
Sept.22	61.80
Oct. 23	61.29
Nov. 21	59.89
Dec. 21	58.13
Jan. 31,1935	56.68
Mar. 1	56.67
22	56.56
Apr. 24	55.84
May 21	56.77
June 19	57.33
July 26	58.64
Aug. 17	61.44
Sept.21	61.63
Oct. 26	60.82
Nov. 23	59.40
Feb. 20,1936	57.15

656. Texas Creosoting Co., 4½ miles north of Houston post office.

656 - Continued

Drilled. Depth 622 ft. Air-lift pump. Measuring point, top of eduction pipe under umbrella, 5 feet above surface.

Date	Depth to water (feet)
Jan. 9,1931	62.68
Apr. 6	62.46
July 28	65.98
Nov. 3	67.00
Dec. 3	64.33
Feb. 6,1932	62.86
Mar. 3	61.74
Apr. 7	62.51
June 7	63.82
Nov. 29	61.85
Jan. 27,1933	59.95
May 12	59.45
Aug. 19	64.42
Nov. 22	62.20
Dec. 23	63.31
Jan. 23,1934	62.61
Feb. 21	62.78
Mar. 21	62.47
30	62.49
May 22	64.99
July 24	67.97
Sept.21	68.58
Jan. 30,1935	65.88
Feb. 28	65.46
Mar. 21	66.01
May 20	65.27
June 18	66.22
Aug. 16	68.34
Sept.20	68.38
Oct. 25	68.21

680. Houston Electric Co., 1/2 mile northeast of Houston post office. Drilled. Depth 1,350± ft. No pump. Measuring point, board cover at top of casing.

Jan. 8,1931	33.25
Feb. 18	27.35
May 20	40.33
30	44.74
June 30	47.24
Aug. 11	47.87
Sept. 8	46.50
Nov. 2	42.15
Dec. 1	40.03
Jan. 7,1932	36.20
Feb. 5	40.53
Mar. 3	41.83
Apr. 7	42.93
May 6	36.91
June 6	37.80
July 8	41.85

680 - Continued

Date	Depth to water (feet)
Aug. 5,1932	46.58
Sept. 6	37.46
Oct. 10	35.95
Nov. 3	38.00
28	31.37
Dec. 27	29.67
Jan. 27,1933	32.03
Mar. 9	29.92
Apr. 15	33.07
May 11	40.30
June 22	45.52
Aug. 18	45.84
Sept.19	43.95
Oct. 30	37.70
Nov. 21	36.90
Dec. 21	35.40
Jan. 22,1934	32.60
Feb. 20	34.82
Mar. 20	39.72
30	36.96
Apr. 19	39.59
May 21	38.60
June 25	53.18
July 23	49.94
Aug. 15	50.21
Sept.21	48.82
Oct. 22	45.36
Nov. 20	43.77
Dec. 20	41.79
Jan. 30,1935	46.10
Feb. 28	42.21
Mar. 21	43.05
Apr. 23	43.96
May 20	43.18
June 18	51.05
July 25	59.66
Aug. 16	60.01
Sept.20	57.34
Oct. 25	51.49
Nov. 22	47.50
Feb. 19,1936	51.66

741. Houston Electric Co., 1 3/4 miles east of Houston post office. Drilled. Depth 540 ft. No pump. Measuring point, top of air line, 9½ inches above surface.

Jan. 8,1931	47.95
Mar. 25	48.54
July 2	49.22
Aug. 12	49.61
Sept. 8	49.84
Nov. 2	50.24
Dec. 1	50.43
Jan. 8,1932	50.65
Feb. 5	50.80
Mar. 3	50.92
Apr. 7	51.06
May 6	51.20
June 6	51.37

Water levels in wells in Harris County - Continued

741 - Continued

Date	Depth to water (feet)
July 8,1932	51.45
Aug. 5	51.70
Sept. 6	51.84
Oct. 10	52.00
Nov. 3	52.10
28	52.26
Dec. 28	52.30
Jan. 27,1933	52.12
Mar. 9	52.51
Apr. 14	52.32
May 11	52.54
June 22	52.86
Aug. 18	52.78
Sept.19	53.30
Oct. 30	53.45
Nov. 21	53.52
Dec. 21	53.62
Jan. 22,1934	53.72
Feb. 20	53.75
Mar. 20	53.81
29	53.84
Apr. 19	53.81
May 21	54.00
June 25	54.10
July 23	54.23
Aug. 15	54.34
Sept.21	54.50
Oct. 22	54.64
Nov. 20	54.77
Dec. 20	54.84
Jan. 30,1935	54.96
Feb. 28	55.00
Mar. 21	55.05
Apr. 23	55.12
May 20	55.18
June 18	55.26
July 25	55.35
Aug. 16	55.43
Sept.20	55.50
Oct. 25	55.67
Nov. 22	55.72
Feb. 19,1936	55.80

757. Layne-Bowler Co., 4¼ miles east of Houston post office. Drilled. Depth 676 ft. Air lift pump. Measuring point, pump base, at surface.

Feb. 25,1931	57.61
Mar. 19	57.33
May 27	58.26
Sept. 9	62.00
Dec. 3	61.18
Jan. 8,1932	59.40
Feb. 6	58.44
Mar. 3	56.90
Apr. 7	55.69
May 6	55.53
Oct. 11	57.92
Nov. 3	57.35
Dec. 28	56.12
Mar. 9,1933	53.98
Apr. 15	53.72

757 - Continued

Date	Depth to water (feet)
June 22,1933	57.30
Aug. 19	59.81
Sept.20	60.73
Oct. 31	61.90
Nov. 22	61.80
Dec. 23	61.61
Jan. 23,1934	60.81
Feb. 21	60.12
Mar. 21	59.03
29	59.21
May 21	60.25
July 24	63.47
Aug. 15	64.05
Oct. 22	64.23
Nov. 20	63.82
Dec. 20	62.32
Jan. 30,1935	60.91
Feb. 28	60.11
Mar. 21	59.74
Apr. 23	59.10
May 20	58.78
June 18	59.20
July 25	60.34
Aug. 16	60.89
Oct. 25	61.37
Nov. 22	60.84
Feb. 19,1936	59.03

759. Port City Compress, 4 3/4 miles east of Houston post office. Drilled. Depth 396 ft. Electric air pump. Measuring point, top of casing.

Feb. 26,1931	56.8
July 3	59.28
Aug. 13	60.41
Sept. 9	60.98
Nov. 3	60.51
Dec. 3	59.63
Jan. 8,1932	57.76
Apr. 7	56.13
May 6	55.95
July 9	57.25
Sept. 6	56.83
Nov. 3	61.00
28	60.70
Dec. 28	59.82
Jan. 27,1933	59.26
Mar. 9	57.60
Apr. 15	57.67
May 12	58.17
Aug. 19	64.36
Oct. 31	66.08
Jan. 23,1934	64.52
Feb. 20	63.91
Mar. 20	62.26
29	62.91
Apr. 19	63.05
May 21	63.99
June 25	66.23
July 23	67.56
Aug. 15	68.11
Sept.21	68.37

759 - Continued

Date	Depth to water (feet)
Oct. 22,1934	67.99
Nov. 20	67.43
Dec. 20	64.77
Jan. 30,1935	64.39
Feb. 28	63.55
Mar. 21	63.26
May 20	62.38
June 18	63.10
July 25	64.14
Sept.20	66.19
Nov. 22	64.50
Feb. 19,1936	62.58

783. Houston Riding & Polo Club, 6 miles west of Houston post office. Drilled. Depth 350± ft. Air-lift pump. Measuring point, top of casing, 6 in. above surface.

July 8,1932	38.10
Aug. 8	38.57
Sept. 7	38.47
Oct. 5	38.54
Nov. 7	38.45
28	38.25
Jan. 2,1933	37.52
30	36.98
Mar. 10	36.37
Apr. 15	36.27
May 13	36.44
June 23	37.36
Sept.18	38.16
Oct. 31	38.36
Nov. 22	38.40
Dec. 23	38.29
Jan. 23,1934	37.87
Feb. 21	37.46
Mar. 21	37.37
30	37.36
Apr. 20	37.10
May 22	37.17
June 26	38.77
July 24	39.75
Aug. 16	40.18
Sept.22	40.65
Oct. 23	40.59
Nov. 21	40.94
Dec. 21	39.72
Jan. 31,1935	38.96
Mar. 1	39.00
22	38.85
Apr. 24	38.55
May 21	38.50
June 19	38.60
July 26	38.97
Aug. 17	39.30
Sept.21	40.16
Oct. 26	40.30
Nov. 23	39.94
Feb. 20,1936	38.83

Water levels in wells in Harris County - Continued

1203. Harris County, in South Houston. Drilled. Depth 600 ft. No pump. Measuring point, top of casing, 6 inches above surface.

Date	Depth to water (feet)
Apr. 3,1931	34.73
Sept.16	36.91
Oct. 7,1932	38.25
Nov. 8	38.70
26	38.97
Dec. 30	39.04
Feb. 1,1933	39.15
Mar. 14	38.62
May 9	38.90
Oct. 26	39.85
Aug. 22,1935	43.81
Feb. 28,1936	39.36

1209. Fireworks Co., 1/2 mile southeast of South Houston. Drilled. Depth 650 ft. Not used. Measuring point, top of air line, 4 feet above surface.

Oct. 7,1932	39.66
Nov. 8	39.95
26	40.03
Dec. 30	39.75
Feb. 1,1933	39.83
Mar. 14	39.41
Apr. 9	39.83
Oct. 26	40.72
Aug. 22,1935	43.77
Feb. 28,1936	39.18

1302. City of Genoa, Genoa. Drilled. Depth 832 ft. Windmill. Measuring point, hole in 6-inch casing, 1 foot above surface.

Apr. 3,1931	48.06
Sept. 4	51.18
May 10,1932	50.19
Oct. 7	52.12
Nov. 8	51.92
26	51.92
Dec. 30	51.43
Feb. 1,1933	51.19
Oct. 26	52.18
Aug. 22,1935	53.02

1318. J. M. West, 5½ miles northwest of Webster. Drilled. No pump. Measuring point, top of casing, 1 foot above surface.

Date	Depth to water (feet)
Oct. 7,1932	11.50
Nov. 8	11.70
26	12.05
Dec. 30	11.73
Feb. 1,1933	10.52
Mar. 14	9.08
May 9	9.95
Oct. 26	11.54
Aug. 22,1935	11.43
Feb. 28,1936	8.23

1321. Fig Plant Co., Ellington Field, 5 miles northwest of Webster. Drilled. Depth 78 ft. No pump. Measuring point, top of casing, at surface.

Oct. 7,1932	4.30
Nov. 8	4.45
26	4.80
Dec. 30	4.40
Feb. 1,1933	4.22
Mar. 14	1.90
May 9	2.76
Oct. 26	4.18
Aug. 22,1935	4.24
Feb. 28,1936	3.84

1324. J. M. West, 1½ miles northwest of Webster. Drilled. Depth 400 ft. Windmill. Measuring point, top of casing, 1 foot above surface.

Oct. 7,1932	42.90
Nov. 8	42.14
26	41.53
Dec. 30	40.48
Feb. 1,1933	39.97

1360. Mrs. Fain (S. Siabara), 1/4 mile east of Webster. Drilled. Depth 659 ft. Electric pump. Measuring point, top of casing, 2 feet above surface.

1360 - Continued

Date	Depth to water (feet)
Apr. 3,1931	31.47
Aug. 7	37.29
Sept. 4	36.00
May 10,1932	32.25
July 9	37.26
Oct. 7	36.54
Nov. 8	35.96
26	35.36
Dec. 30	34.45
Feb. 1,1933	33.76
Mar. 14	33.43
May 9	34.30
Feb. 28,1936	38.70

Water levels in wells in Jim Hogg County

52. Rita and San Juana Garcia, Las Animas. Dug and drilled. Depth 47 ft. Windmill. Measuring point, top of caliche curb.

Date	Depth to water (feet)
Oct. 13,1933	30.41
26	30.15

53. Felicita Hinojosa de Yzaguirre, Las Animas. Dug. Depth 49 ft. Windmill. Measuring point, top of caliche curb, 5 feet above surface.

Date	Depth to water (feet)
Mar. 17,1933	32.0
Oct. 13	29.15
26	28.23

54. Nieves Villareal, Las Animas. Dug. Depth 41 ft. Windmill. Measuring point, top of caliche curb, 5 feet above surface.

Date	Depth to water (feet)
Mar. 17,1933	35.0
Oct. 13	31.50
26	31.60

Water levels in wells in Jim Wells County

193. M. Morales, 8½ miles west-northwest of Ben Bolt. Dug. Depth 40 ft. Rope and bucket. Measuring point, top of wooden curb, 1¼ feet above surface.

June 30,1933	28.50
Oct. 5	25.49
23	25.29
Feb. 6,1935	29.10
Feb. 5,1936	21.08

201. Santos Garcia. Measuring point, top of pipe clamp, 1½ feet above surface.

Oct. 23,1933	32.53
Feb. 6,1935	33.67
Feb. 5,1936	29.14

206. Emilio Barrera, 6½ miles west of El Par. Dug. Depth 75 ft. Windmill. Measuring point, top of concrete curb, 3½ feet above surface.

June 30,1933	33.80
Oct. 5	32.64
23	49.96
Feb. 6,1935	54.32
Feb. 5,1936	49.36

207. Roman Saenz, 6 miles west of El Par. Bored. Depth 99 ft. Windmill. Measuring point, top of casing, 1¼ feet above surface.

June 29,1933	77.00
Oct. 5	72.97
23	72.83
Feb. 6,1935	73.08
Feb. 5,1936	71.30

221. Felix Perez Cadena, 6 miles west-northwest of Wadota. Dug. Depth 90 ft. Windmill. Measuring point, top of concrete curb on south side, 1 foot above surface.

July 1,1933	59.21
Oct. 5	51.28
23	51.21
Feb. 6,1935	56.42
Feb. 5,1936	47.58

222. Manuel Cadena, 6 miles west-northwest of Wadoto. Dug. Depth 80± ft. Windmill. Measuring point, crack in floor, 1 foot above surface.

222 - Continued

Date	Depth to water (feet)
July 1,1933	56.67
Oct. 5	53.11
23	52.46
Feb. 6,1935	54.05
Feb. 5,1936	48.24

252. Cerapio Hinojosa, 6⅛ miles west-southwest of Ella. Dug. Depth 60 ft. Windmill. Measuring point, top of curb on south side, 2½ feet above surface.

June 19,1933	53.56
Oct. 5	48.85
23	48.83
Feb. 6,1935	51.35
Feb. 5,1936	44.92

253. San Juan Hinojasa, 6⅛ miles west-southwest of Ella. Dug and bored. Depth 125 ft. Windmill. Measuring point, top of curb on south side, 3½ feet above surface.

June 19,1933	56.70
Oct. 5	51.36
23	51.17
Feb. 6,1935	54.26
Feb. 5,1936	46.56

Water levels in wells in Jim Wells County - Continued

374. E. G. Maun, 4½ miles northwest of Falfurrias. Measuring point, top of casing, 2½ feet above surface. Altitude 155.59 feet.

Date	Depth to water (feet)
Oct. 23,1932	16.80
Dec. 6	16.80
Jan. 5,1933	16.49
Feb. 22	16.22
May 26	18.08
June 27	17.37
July 25	17.44
Sept. 1	16.00
Jan. 2,1935	17.00

376. Cliff Burdett, 3½ miles northwest of Falfurrias. Drilled. Depth 450 ft. Windmill. Measuring point, top of casing, 3 feet above surface. Altitude 135.37 feet.

Date	Depth to water (feet)
Dec. 6,1932	5.60
Jan. 5,1933	5.20
Feb. 22	5.02
May 26	7.48
June 27	7.78
July 25	6.39
Aug. 10	5.70
Sept. 1	4.88
Oct. 3	4.33

391. O. A. Fore, 2½ miles north of Falfurrias. Drilled. Depth 610 ft. Turbine pump. Measuring point, top of casing, 1 foot above surface. Altitude 125.82 feet.

Date	Depth to water (feet)
Dec. 1,1932	21.67
Jan. 5,1933	19.85
Feb. 20	20.10
May 26	23.25
June 27	20.98
July 25	21.29
Aug. 10	20.17
Sept. 2	19.54
Oct. 3	18.66
Jan. 2,1935	19.84
Feb. 5,1936	19.88

Water levels in a well in Maverick County

M3-21. Owner unknown, 18 miles west of La Pryor. Measuring point, top of casing, 1 foot above surface. Altitude 705.00 feet.

Feb. 6,1930	45.55
22	45.50
Mar. 31	45.55
Apr. 18	46.10
June 20	45.70
July 11	45.55
Aug. 25	45.60
Sept.29	45.80
Oct. 20	45.80
Dec. 18	46.20
Feb. 11,1931	46.75
June 9	46.50
July 6	46.55
Jan. 8,1932	46.15
Feb. 10	45.90
Mar. 23	46.03
Aug. 28	46.02
Dec. 21	45.72
Mar. 24,1933	45.60
Sept.22	45.65

Water levels in wells in Zavala County

H7-2. N. B. Pulliam, 10 miles north of La Pryor. Measuring point, top of water-pipe clamp, 1½ ft. above surface.

Date	Depth to water (feet)
Oct. 8,1929	35.80
Nov. 15	35.05
Dec. 18	34.95
Jan. 16,1930	35.00
Mar. 13	35.30
June 23	35.70
July 22	c 34.50
Aug. 29	34.95
Oct. 1	c 35.40
Nov. 25	b 34.10
Dec. 17	34.10
May 14,1931	33.40
July 11	(b)
Oct. 30	34.20
Jan. 15,1932	34.20
Apr. 2	34.10
Apr. 11,1933	33.20
July 21	33.70

H7-13. Ray Cornett, 5 miles north of La Pryor. Measuring point, top of casing, 1½ ft. above surface. Altitude 787.54 ft.

Feb. 8,1928	111.70
Nov. 7,1929	114.55
19	114.70
23	114.60
Dec. 18	115.00
Jan. 16,1930	115.10
Feb. 28	115.70
Mar. 13	115.70
Apr. 9	115.95
18	116.10
May 20	116.05
June 23	116.15
July 22	116.15
Aug. 27	116.40
Sept.29	116.30
May 14,1931	117.40
July 10	(b)
Oct. 29	117.75
Jan. 13,1932	118.40
Mar. 31	118.95
Aug. 28	119.20
Apr. 11,1933	120.60

H7-20. W. R. Terpening, 5½ miles north of La Pryor. Measuring point, top of 1-in. board cover on top of casing, 6 in. above surface. Altitude 765.45 ft.

H7-20 - Continued

Date	Depth to water (feet)
Nov. 13,1929	73.35
Jan. 3,1930	73.30
Feb. 28	73.40
Mar. 13	73.40
Apr. 9	73.35
18	75.70
May 20	73.55
June 23	73.50
July 22	73.80
Aug. 27	73.80
Sept.29	73.85
Dec. 17	73.90
May 14,1931	74.80
July 11	(b)
Oct. 30	74.35
Jan. 13,1932	74.70
Apr. 2	74.70
Aug. 31	74.75
Apr. 11,1933	74.75
July 21	74.50

H8-1. A. W. West, 9½ miles northeast of La Pryor. Measuring point, top of water-pipe clamp, 1 ft. above surface.

Nov. 11,1929	79.90
Dec. 18	82.50
Jan. 16,1930	81.15
Apr. 9	80.05
May 20	79.95
June 23	79.85
July 22	79.65
Aug. 27	95.40
Sept.29	83.80
Dec. 17	(b)
May 14,1931	79.50
July 10	(b)
Oct. 29	(b)
Jan. 16,1932	79.25
Mar. 31	79.50

H8-17. A. W. West, 8½ miles northeast of Batesville and 1 mile southwest of Uvalde-Batesville road. 6-in. well. Depth 234 ft. Windmill. Used for stock. Measuring point, top of water-pipe clamp, 6 in. above surface.

Oct. 28,1929	179.50
Dec. 23	180.00
Jan. 15,1930	180.30
Apr. 8	180.90
May 22	180.60

H8-17 - Continued

Date	Depth to water (feet)
June 25,1930	180.85
July 24	b 181.15
Aug. 29	181.85
Oct. 1	180.50

H9-2. Kincaid Brothers, 8½ miles northeast of Batesville. Measuring point, top of casing, 3 in. above surface. Altitude 869.71 ft.

Nov. 5,1929	188.25
Dec. 21	188.70
Jan. 14,1930	187.50
Mar. 13	187.90
May 22	b 191.00
June 25	188.15
July 24	c 188.30
Aug. 29	189.05
Oct. 1	190.05
Dec. 20	190.10
May 13,1931	189.10

H9-3. Kincaid Brothers, 11 miles northeast of Batesville. Measuring point, top of casing, 6 in. above surface. Altitude 840.36 ft.

Nov. 5,1929	161.00
Apr. 16,1930	163.50
May 22	163.50
June 25	162.25
July 24	163.90
Aug. 29	163.90
Oct. 1	166.30
Dec. 20	163.95

H9-4. -- Baxter, 4 miles north of Batesville. Measuring point, top of stoop. Altitude 753 ft.

Nov. 12,1929	42.35
Dec. 23	41.95
Jan. 15,1930	42.00
Apr. 11	41.85
May 22	42.35
June 25	41.00
July 24	42.35
Aug. 29	Dry
Oct. 1	50.25

b Pumping at time of measurement.
c Pump stopped a short time before measurement.

Water levels in wells in Zavala County - Continued

M3-7. M. Rambie, 15 miles west of La Pryor. Measuring point, top of casing, at surface. Altitude 689.50 ft.

Date	Depth to water (feet)
Jan. 27,1930	30.50
Feb. 22	30.15
Mar. 29	30.20
Apr. 18	30.35
May 19	30.25
June 20	30.20
July 11	30.20
Aug. 25	30.30
Sept.29	30.40
Oct. 18	30.30
Dec. 18	30.30
Feb. 11,1931	30.25
June 9	30.15

M3-28. Hope & Perkins, 13 miles west of La Pryor. Measuring point, top of casing, at surface.

Feb. 12,1930		41.47
Apr. 3	g	41.14
18		42.16
May 7		42.16
20		42.20
June 4		42.22
20		42.21
July 16		42.24
Aug. 25		42.32
Sept.29		42.31
Dec. 18		42.33
Feb. 11,1931		42.31
Feb. 10,1932		42.40
Mar. 23		42.43
Mar. 24,1933		42.40
Sept.22		42.50

M3-29. Hal Mangum, 12 miles west of La Pryor. Measuring point, top of 4 by 4 in. timber pipe clamp, 6 in. above surface. Altitude 755.65 ft.

Jan. 25,1930		97.20
Feb. 22		97.55
Mar. 30	b	111.20
Apr. 18		96.80
May 20		96.70
June 20		95.80
July 16		96.70
Aug. 25		96.80
Sept.29		96.85
Dec. 18	b	97.00
Jan. 8,1932		(b)
Feb. 10		96.60

M3-29 - Continued

Date	Depth to water (feet)
Mar. 23,1932	(b)
Aug. 28	96.75
Dec. 21	96.45
Sept.22,1933	96.90

M6-9. King Ware, 8½ miles north-northwest of Cometa. Measuring point, top of iron pipe clamp, 6 in. above surface. Altitude 656.05 ft.

Jan. 17,1930		68.10
Feb. 19		71.10
Mar. 17		71.05
Apr. 16		73.85
May 19		82.80
June 17		80.50
July 15		81.85
Aug. 26		75.25
Sept.25		77.15
Nov. 4		69.15
Dec. 11		67.20
Feb. 6,1931		65.20
Mar. 4		65.35
Apr. 25		68.65
June 8	c	72.25
July 3		67.00
Oct. 2		(b)
Nov. 6		65.80
Dec. 4		67.25
Jan. 7,1932		68.20
Feb. 11		68.30
Mar. 18	c	68.90
July 6		70.60
Aug. 29		74.19
Dec. 22		68.50
Mar. 18,1933		69.30
Sept.21		65.25
Aug. 27,1934		63.20
Mar. 13,1935		62.45
July 31		58.20
Jan. 26,1936		55.05

M6-10. W. M. Van Cleve, 7½ miles northwest of Cometa. Measuring point, top of pipe clamp, 2 ft. above surface. Altitude 653.15 ft.

Jan. 21,1930		71.65
Feb. 19	c	73.40
Mar. 17		(b)
Apr. 16		(b)
May 19		(b)
June 17		74.95
July 11		73.80
Aug. 26		72.10
Sept.25	c	71.85

M6-10 - Continued

Date		Depth to water (feet)
Dec. 11,1930		70.10
Feb. 6,1931		71.00
Mar. 4		70.60
Apr. 25		70.70
June 8		69.70
July 3		68.95
Oct. 2		67.10
Nov. 6		69.10
Dec. 4		72.75
Jan. 7,1932		73.70
Feb. 11	c	74.75
Mar. 18	c	74.85
July 6		74.52
Aug. 29	c	72.70
Dec. 22	c	72.70
Mar. 18,1933		71.75
Sept.21		70.15
Aug. 27,1934		74.60

M6-16. J. S. Steward, 6 miles northwest of Cometa. Measuring point, top of casing. Altitude 626.55 ft.

Jan. 17,1930		43.90
Feb. 19		42.70
Mar. 17		42.85
Apr. 16		42.80
May 19		42.00
June 17		41.40
July 15		41.10
Aug. 26		40.90
Sept.25		40.85
Nov. 4		40.40
Dec. 11		40.25
Feb. 6,1931		40.55
Mar. 4		40.55
Apr. 25		40.75
June 8		40.80
July 2		40.70
Oct. 2		40.05
Nov. 6		40.35
Dec. 4		40.95
Jan. 7,1932		41.10
Feb. 11		41.50
Mar. 18		41.60
July 6		41.90
Aug. 29		41.75
Dec. 22		41.76
Mar. 18,1933		41.80
Aug. 27,1934		42.35
Mar. 13,1935		43.70
Jan. 26,1936		42.70

M6-18. N. E. Ware, 4 miles northwest of Cometa. Measuring point, top of pipe clamp. Altitude 612.90 ft.

b Pumping at time of measurement.
c Pump stopped a short time before measurement.
g Water-stage recorder installed on well.

Water levels in wells in Zavala County - Continued

M6-18 - Continued

Date	Depth to water (feet)
Jan. 17,1930	b 36.50
Feb. 19	c 40.70
Mar. 17	41.50
Apr. 16	42.60
May 19	42.35
June 17	39.10
July 15	37.50
Aug. 26	39.35
Sept.25	40.70
Nov. 4	34.90
Dec. 11	(b)
Feb. 6,1931	34.60
Mar. 4	c 36.55
Apr. 25	(b)
June 8	32.90
July 3	32.10
Oct. 2	30.35
Nov. 6	34.05
Dec. 4	38.25
Jan. 7,1932	38.10
Feb. 11	c 40.80
Mar. 18	c 39.10
July 6	38.85
Aug. 29	c 36.37
Dec. 22	c 36.62
Mar. 18,1933	35.40
Sept.20	33.65
Aug. 27,1934	39.15
Mar. 13,1935	47.18
Jan. 26,1936	40.50

M6-19. L. D. Van Cleve, 3 miles northwest of Cometa. Measuring point, top of pipe clamp. Altitude 632.55 ft.

Jan. 17,1930	49.65
Feb. 19	c 50.90
Mar. 17	50.95
Apr. 16	52.10
May 19	c 51.10
June 17	50.10
July 15	c 50.10
Aug. 26	50.65
Sept.25	c 50.80
Nov. 4	49.90
Dec. 11	c 49.85
Feb. 6,1931	c 50.05
Mar. 4	c 49.80
Apr. 25	52.55
June 8	54.30
July 3	49.20
Oct. 2	49.00
Nov. 6	50.70
Dec. 4	51.60
Jan. 7,1932	51.65
Feb. 11	52.40
Mar. 18	52.15
July 6	(b)
Aug. 29	c 52.28
Dec. 22	c 52.02
Mar. 18,1933	51.45
Sept.21	51.80

M6-19 - Continued

Date	Depth to water (feet)
Aug. 27,1934	42.35
Mar. 13,1935	57.30
July 31	55.60
Jan. 26,1936	52.40

M9-1. T. B. Mear, Cometa. Measuring point, top of pipe clamp. Altitude 633.30 ft.

Feb. 6,1928	46.20
Dec. 19,1929	59.20
Jan. 16,1930	62.20
Feb. 19	60.80
Mar. 17	61.80
Apr. 16	b 71.70
May 19	58.00
June 17	55.30
July 15	54.75
Aug. 26	56.25
Sept.25	c 58.25
Nov. 4	53.65
Dec. 11	c 52.25
Mar. 4,1931	52.50
Apr. 25	54.45
July 3	51.65
Nov. 6	58.15
Dec. 4	60.75
Jan. 7,1932	57.40
Feb. 11	64.70
Mar. 18	62.15
July 6	58.10
Aug. 29	c 56.85
Dec. 22	57.45
Mar. 18,1933	57.60
Sept.21	55.75
Aug. 27,1934	65.10

N1-17. Matthews ranch, 5 miles west of La Pryor. Measuring point, top of pipe clamp. Altitude 771.70 ft.

Jan. 27,1930	126.60
Feb. 22	125.50
Apr. 18	127.00
May 20	126.10
June 20	125.70
July 16	125.30
Aug. 25	125.00
Sept.29	124.70
Oct. 30	124.95
Dec. 18	c 126.70
Feb. 11,1931	c 125.85
June 9	126.10
July 6	124.70
Jan. 8,1932	127.40
Feb. 10	128.00
Mar. 23	127.60
July 7	127.00
Aug. 28	c 126.27

N1-17 - Continued

Date	Depth to water (feet)
Dec. 21,1932	127.42
Mar. 24,1933	c 128.40
Sept.21	c 128.40
Jan. 22,1936	137.68

N1-24. J. C. Williams, 2½ miles northwest of La Pryor. Measuring point, top of pipe clamp. Altitude 754.00 ft.

Dec. 23,1929	120.50
Feb. 22,1930	123.10
Mar. 26	121.10
Apr. 18	120.80
May 20	119.40
June 20	118.15
July 16	116.50
Aug. 25	116.30
Sept.29	115.90
Oct. 30	117.75
Dec. 18	121.90
Feb. 11,1931	118.60
June 9	115.60
July 6	115.00
Jan. 8,1932	126.90
Feb. 10	126.40
Mar. 23	(b)
July 7	119.10
Aug. 28	117.65
Dec. 21	123.80
Mar. 24,1933	120.80
Mar. 15,1935	130.85
July 27	124.10
Jan. 22,1936	128.82

N1-39. Hal Mangum, 8 miles west of La Pryor. Measuring point, top of pipe clamp. Altitude 732.90 ft.

Jan. 25,1930	75.80
Feb. 22	76.10
Apr. 18	(b)
June 20	(b)
July 16	76.40
Aug. 25	b 79.15
Sept.29	b 78.15
Dec. 18	b 78.70
Feb. 11,1931	79.50
June 9	(b)
July 6	77.70
Jan. 8,1932	b 79.60
Feb. 10	b 81.60
Mar. 23	c 77.30
Mar. 24,1933	76.33

b Pumping at time of measurement.
c Pump stopped a short time before measurement.

Water levels in wells in Zavala County - Continued

N1-40. I. T. Pryor, 2 miles west of La Pryor. Measuring point, top of pipe clamp. Altitude 732.90 ft.

Date	Depth to water (feet)
Jan. 4,1930	113.80
Feb. 22	117.20
Apr. 18	116.20
May 20	115.00
June 20	112.90
July 16	111.00
Aug. 25	110.00
Oct. 30	110.15
Dec. 18	113.75
Feb. 11,1931	113.00
June 9	106.50
July 6	104.75
Feb. 10,1932	121.35
Mar. 23	117.50
July 7	111.00
Aug. 28	108.45
Dec. 21	116.33
Mar. 24,1933	111.40
Sept.21	105.90
Mar. 15,1935	125.40
July 27	115.60

N1-58. Hal Mangum, 8½ miles southwest of La Pryor. Measuring point, top of pipe clamp. Altitude 680.68 ft.

Feb. 6,1930		64.25
Mar. 31		67.35
Apr. 18	b	68.50
May 20		68.60
June 20	b	68.70
July 16		67.60
Aug. 25		(b)
Sept.29		(b)
Dec. 18		(b)
Feb. 11,1931		64.20

N1-59. Gunter Hardy, 11 miles southwest of La Pryor. Measuring point, top of pipe clamp. Altitude 631.25 ft.

Feb. 6,1930		40.95
May 20	c	47.50
July 16	b	45.40
Aug. 25	b	53.00
Sept.29		48.10
Dec. 18	c	45.50
Feb. 11,1931	c	45.25
June 9		44.75

N1-67. I. T. Pryor, 6 miles south of La Pryor.

Date		Depth to water (feet)
Oct. 23,1929	c	264.70
Nov. 22		98.50
Dec. 23		98.40
Jan. 27,1930		98.50
Feb. 22	c	125.00
Mar. 25		(b)
Apr. 18		(b)
May 24		(b)
June 20		(b)
July 16	c	124.30
Aug. 25		(b)
Sept.29		109.25
Apr. 3,1931		109.30
July 6		(b)
Jan. 8,1932		104.70
Feb. 15		160.20
Mar. 23		103.90

N4-8. New California Townsite Co., 7 miles north of Crystal City. Measuring point, top of casing.

Dec. 23,1929		125.00
Jan. 21,1930		122.30
Feb. 20		164.30
Mar. 25		159.50
May 24		144.30
June 20		134.20
July 16		128.00
Aug. 20		127.00
Sept.29		140.70
Oct. 30		128.25
Aug. 26,1932		119.00
Dec. 19		143.15
Mar. 24,1933		130.15

N4-41. Mrs. D. J. Willims, 8 miles west of Crystal City. Measuring point, top of 4 by 4 in. pipe clamp. Altitude 577.82 ft.

Oct. 30,1929		17.85
Nov. 22		24.40
Dec. 18	a	33.95
Jan. 16,1930		35.70
Feb. 19		(b)
Mar. 17		(b)
Apr. 16	a,b	53.70
May 19		34.60
July 15	b	20.50
Aug. 25		22.45
Sept.25	a,b	27.70
Nov. 4		18.15

N4-41 - Continued

Date	Depth to water (feet)
Mar. 4,1931	16.80
Apr. 25	22.35
June 8	11.80
July 9	9.90
Oct. 2	14.10
Nov. 6	37.70
Jan. 7,1932	29.55
Mar. 18	30.60
July 6	21.70
Aug. 29	18.72
Dec. 22	26.37
Mar. 18,1933	19.50
Sept.21	14.00
Aug. 27,1934	25.30
Mar. 13,1935	49.95

N5-4. A. J. Plummer, 8½ miles north of Crystal City.

Nov. 22,1929	74.60
Dec. 18	75.90
Jan. 21,1930	76.50
Feb. 20	85.85
Mar. 25	83.55
Apr. 19	81.90
May 24	71.70
June 20	64.10
July 17	58.65
Aug. 20	56.75
Sept.25	73.50
Oct. 30	59.20
Dec. 9	64.15
Jan. 8,1931	81.45
Feb. 4	61.40

N5-7. Cross S Winter Garden Farms, 9 miles northeast of Crystal City. Measuring point, top of casing. Altitude 624.01 ft.

Nov. 27,1929	66.84
Aug. 20,1930	56.75
Feb. 4,1931	63.40
Apr. 23	57.45
May 23	53.45
June 24	48.20
July 24	43.95
Sept.28	53.30
Jan. 4,1932	79.75
Feb. 2	86.00
May 5	70.85
Aug. 26	52.50
Dec. 19	74.65
Mar. 22,1933	58.50
Sept.15	46.10
Aug. 29,1934	58.40
Mar. 7,1935	92.10

a Pump running in nearby well.
b Pumping at time of measurement.

Water levels in wells in Zavala County - Continued

N5-15. Owner unknown, 6½ miles north of Crystal City. Measuring point, top of casing. Altitude 609.45 ft.

Date	Depth to water (feet)
Nov. 23,1929	87.80
Dec. 18	91.60
Jan. 21,1930	92.40
Feb. 20	98.80
Mar. 25	94.25
Apr. 19	a 87.60
May 24	78.10
June 20	68.85
July 17	60.95
Aug. 20	a 63.00
Sept.25	79.95
Oct. 30	63.90
Dec. 9	a 72.75
Jan. 8,1931	a 90.30
Feb. 4	65.60
Mar. 2	55.95
Apr. 23	63.75
May 23	51.20
June 24	47.05
July 24	41.80
Sept.28	58.85
Nov. 2	102.60
Dec. 1	116.60
Jan. 4,1932	86.90
Feb. 2	103.20
Mar. 17	83.60
May 5	79.10
Aug. 26,1932	52.65
Dec. 19	83.10
Mar. 17,1933	58.60
Sept.15	46.35
Aug. 29,1934	60.38

N5-20. -- Wright, 5½ miles northeast of Crystal City.

Nov. 23,1929	81.10
Dec. 18	85.15
Jan. 21,1930	89.50
Feb. 20	102.80
Mar. 25	95.15
Apr. 19	94.85
May 24	72.05
June 20	62.50
July 17	56.45
Aug. 20	59.95
Sept.25	72.45
Oct. 30	58.20
Dec. 9	a 66.90
Jan. 8,1931	a 85.70
Feb. 4	59.00

N5-31. C. & M. Produce Co., 3 miles northeast of Crystal City. Measuring point, top of metal curb. Altitude 583.86 ft.

N5-31 - Continued

Date	Depth to water (feet)
Nov. 25,1929	79.25
Dec. 18	81.55
Jan. 21,1930	89.80
Feb. 20	a 112.90
Mar. 25	92.60
Apr. 19	96.55
May 24	69.70
June 20	67.30
July 17	51.60
Aug. 20	51.60
Sept.25	69.30
Oct. 30	53.30
Dec. 9	61.20
Jan. 8,1931	81.95
Feb. 4	53.20
Mar. 2	44.20
Apr. 23	54.30
May 23	39.50
June 24	36.45
July 24	29.45
Sept.28	43.80
Nov. 3	114.30
Dec. 1	120.15
Jan. 4,1932	84.30
Feb. 2	90.80
Mar. 17	73.00
May 5	68.00
Aug. 26	43.30
Dec. 19	74.70
Mar. 17,1933	51.90
Sept.15	38.55
Mar. 7,1935	113.15
Aug. 1	57.30
Jan. 25,1936	85.65

N5-39. C. R. Jarratt, 2 miles northeast of Crystal City. Measuring point, top of pump base. Altitude 584.40 ft.

Nov. 26,1929	75.60
Dec. 18	89.35
Jan. 21,1930	(b)
Feb. 20	(b)
Mar. 25	102.90
Apr. 19	106.90
May 24	76.90
June 20	64.25
July 17	59.20
Aug. 20	64.20
Sept.25	78.35
Oct. 30	60.80
Dec. 9	68.60
Jan. 8,1931	90.90
Feb. 4	60.80
Mar. 2	44.20
Apr. 23	61.10
May 23	45.80
Nov. 3	(b)
Dec. 1	129.90
Jan. 4,1932	86.60
Feb. 2	98.15
Mar. 17	79.70
May 5	75.55
Aug. 26	49.10

N5-39 - Continued

Date	Depth to water (feet)
Dec. 19,1932	82.65
Mar. 17,1933	60.10
Sept.15	46.65
Aug. 29,1934	57.10
Mar. 7,1935	117.10
Aug. 1	58.60
Jan. 25,1936	91.18

N5-40. C. R. Jarratt, 2½ miles east of Crystal City. Measuring point, top of pump base. Altitude 578.74 ft.

Nov. 26,1929	81.40
Dec. 18	88.85
Jan. 21,1930	(b)
Feb. 20	122.70
Mar. 25	102.50
Apr. 19	101.40
May 24	74.85
June 20	62.80
July 17	57.65
Aug. 20	61.30
Sept.25	77.10
Oct. 30	58.70
Dec. 9	68.75
Jan. 8,1931	89.10
Feb. 4	58.80
Mar. 2	48.75
Apr. 23	61.10
May 23	(b)
June 24	(b)
July 24	33.30
Sept.28	46.35
Nov. 3	(b)
Dec. 1	130.60
Jan. 4,1932	85.00
Feb. 2	96.90
Mar. 17	75.30
May 5	72.65
Aug. 26	47.10
Dec. 19	81.95
Mar. 17,1933	57.05
Sept.15	42.55
Aug. 29,1934	56.50
Mar. 7,1935	116.30
Aug. 1	54.90

N5-47. Owner unknown, 6 miles east of Crystal City. Measuring point, pipe clamp. Altitude 613.97 ft.

Nov. 26,1929	105.15
Dec. 18	112.70
Jan. 18,1930	121.60
Feb. 20	c 142.50
Mar. 25	126.60
Apr. 19	b 116.70
May 24	c 103.20

a Pump running in nearby well. b Pumping at time of measurement.
c Pump stopped a short time before measurement.

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Water levels in wells in Zavala County - Continued

N5-47 - Continued

Date	Depth to water (feet)
June 20,1930	94.45
July 17	88.70
Aug. 20	(b)
Dec. 9	108.50
Jan. 8,1931	115.40
Mar. 2	82.40
Apr. 23	83.25
May 23	77.75
June 24	71.00
July 24	66.00
Sept.28	75.60
Nov. 3	122.30
Dec. 1	143.95
Jan. 4,1932	114.15
Feb. 2	123.05
Mar. 17	103.15
May 5	99.00
Aug. 26	77.90
Dec. 19	114.30
Mar. 17,1933	90.10
Sept.15	71.50
Aug. 29,1934	84.80
Aug. 1,1935	88.15
Jan. 25,1936	132.10

N5-55. Cribbs and Davidson, 2⅛ miles east of Crystal City. Measuring point, top of pump base, southeast side. Altitude 578.15 ft.

Nov. 27,1929	82.65
Dec. 18	112.70
Jan. 21,1930	(b)
Feb. 20	121.80
Mar. 25	107.40
Apr. 19	105.00
May 24	80.25
June 20	67.40
July 17	62.00
Aug. 20	65.70
Sept.25	80.75
Oct. 30	64.70
Dec. 9	71.75
Jan. 8,1931	92.30
Feb. 4	62.90
Mar. 2	52.55
Apr. 23	61.10
May 23	47.50
June 24	43.40
July 24	36.50
Sept.28	47.05
Nov. 3	(b)
Dec. 1	132.95
Jan. 4,1932	86.55
Feb. 2	98.15
Mar. 17	77.95
May 5	76.90
Aug. 26	51.10
Dec. 19	85.86
Mar. 17,1933	60.40
Sept.15	45.40

N5-55 - Continued

Date	Depth to water (feet)
Aug. 29,1934	57.55
Mar. 7,1935	117.60
July 30	58.70
Jan. 25,1936	86.85

N5-60. E. L. Reedy, 4 miles east of Crystal City. Measuring point, top of casing, southeast side. Altitude 582.85 ft.

Nov. 16,1929	81.00
Jan. 21,1930	109.40
Feb. 20	(b)
Mar. 25	111.20
Apr. 19	99.60
May 24	81.55
June 20	71.15
July 17	63.00
Aug. 20	64.25
Sept.25	89.70
Oct. 30	64.95
Dec. 9	(b)
Jan. 8,1931	(b)
Feb. 4	66.70
Mar. 2	56.35
Apr. 23	59.10
May 23	48.85
June 24	44.25
July 24	38.80
Sept.28	58.75
Nov. 3	(b)
Dec. 1	(b)
Jan. 4,1932	(b)
Feb. 2	(b)
Mar. 17	83.25
May 5	77.30
Aug. 26	51.70
Dec. 19	95.90
Jan. 25,1936	114.10

N7-2. -- Murray, 1 mile southeast of Cometa. Measuring point, top of casing. Altitude 609.25 ft.

Oct. 30,1929	26.50
Nov. 22	29.30
Dec. 4	30.00
18	33.95
Jan. 16,1930	a 34.80
Feb. 19	35.85
Mar. 17	38.40
Apr. 16	a 47.10
May 19	33.10
June 17	30.30
July 15	29.15
Aug. 25	30.65
Sept.25	32.65

N7-2 - Continued

Date	Depth to water (feet)
Nov. 4,1930	28.70
Dec. 11	29.65
Feb. 6,1931	28.55
Mar. 4	27.40
Apr. 25	29.90
June 8	26.60
July 2	26.40
Oct. 2	29.90
Nov. 2	38.25
Dec. 4	36.20
Jan. 7,1932	32.50
Feb. 11	38.50
Mar. 18	37.60
July 6	31.80
Aug. 29	31.95
Dec. 22	33.02
Mar. 18,1933	33.00
Aug. 27,1934	42.15
Mar. 13,1935	45.72
July 31	35.85
Jan. 26,1936	40.15

N7-4. E. Holdsworth, 1½ miles east of Cometa. Measuring point, top of 6 by 6 in. clamp. Altitude 595.50 ft.

Oct. 30,1929	22.55
Nov. 22	25.65
Dec. 4	31.55
18	35.50
Jan. 16,1930	36.65
Feb. 19	40.45
Mar. 17	44.80
May 19	35.10
June 17	28.45
July 15	25.75
Aug. 25	29.35
Feb. 6,1931	24.30
Mar. 4	21.65
Apr. 25	26.95
June 8	20.00
July 3	19.35
Oct. 2	22.90
Jan. 7,1932	31.35
Feb. 11	42.95
July 6	27.85
Aug. 29	30.15
Dec. 22	30.40
Mar. 18,1933	28.00
Sept.21	25.90
Mar. 13,1935	49.62
July 31	30.78
Jan. 26,1936	39.70

N8-7. W. W. Walker, 3 miles southeast of Crystal City. Measuring point, base of pump. Altitude 571.45 ft.

a Pump running in nearby well.
b Pumping at time of measurement.

Water levels in wells in Zavala County - Continued

N8-7 - Continued

Date	Depth to water (feet)
Nov. 27,1929	79.35
Dec. 18	87.25
Jan. 21,1930	93.10
Feb. 20	114.20
Mar. 25	104.20
Apr. 19	97.40
May 24	78.45
June 20	68.25
July 17	61.50
Aug. 20	62.90
Sept.25	77.65
Oct. 30	63.75
Dec. 9	71.40
Jan. 8,1931	89.60
Feb. 4	61.70
Mar. 2	51.35
Apr. 23	57.40
May 23	45.35
June 24	40.90
July 24	34.80
Sept.28	41.35
Nov. 3	97.25
Jan. 4,1932	82.00
Feb. 2	93.05
Mar. 17	72.96
May 5	73.10
Aug. 26	50.00
Dec. 19	84.85
Mar. 17,1933	58.15
Sept.15	43.20
Aug. 29,1934	57.80
Mar. 6,1935	115.65
July 30	57.40
Jan. 25,1936	81.45

N9-2. H. Armstrong, 5 miles north of Big Wells. Measuring point, top of pipe clamp. Altitude 557.14 ft.

Jan. 31,1930	52.35
Aug. 23	51.60
Jan. 13,1931	49.85
Feb. 10	48.95
Mar. 5	47.20
Apr. 29	46.10
May 27	44.65
June 25	42.10
July 28	40.35
Nov. 4	40.15
Dec. 2	46.30
Jan. 12,1932	b 48.15
Feb. 12	b 49.30

b Pumping at time of measurement.

ELM CREEK AND DEER CREEK AREAS OF SOIL CONSERVATION SERVICE

An observation-well program was started in the Elm Creek and Deer Creek areas, near Temple, Tex., during the spring of 1934 by the Geological Survey in cooperation with the Soil Conservation Service. Measurements of the water levels have been made on 28 wells, but only 20 of the wells are included in this report. The other wells have either been abandoned, or their value as observation wells has been seriously impaired by domestic pumping. Some of the 20 wells included in this report are also used at times, but their water levels were not measured until after they had apparently recovered their normal positions. Most of the wells are water-table wells which penetrate either alluvium or chalky or shaly rocks of Upper Cretaceous age. Further information concerning the wells is not available. The measurements of the depths to the water levels were made in each well from an established measuring point. As a rule weekly measurements were made on all the wells from the beginning of the program to January 1, 1936. Of these measurements 720 were made during 1935, giving an average of 36 measurements to the well for the year. Only the records of measurements that were nearest to the first of each month are given in this report. The method of expressing the results of measurements is described in the introduction. Water-stage recorders have been in operation on six of the wells since the beginning of the program.

There is a close correlation between the fluctuation of the water levels in the wells and the precipitation in the area. The first water-level measurements were made on April 25, 1934, when all except 3 of the 20 wells were measured. On that day the average height of the water levels above the arbitrary datum planes was 14.93 feet. Records of precipitation were not obtained in connection with this investigation until November 1934, but the area was severely affected by the great drought. The water levels persistently declined until by October 29, 1934, the average was down to 8.55 feet, which was an average decline of 6.38 feet from April 25. About 7 inches of rain during November raised the water levels an average of 1.49 feet by December 1, and they were maintained at nearly the same average throughout December and January. There was about 3 inches of precipitation in February 1935, and during the month the water levels rose an average of about 2 feet. A dry March permitted a slight decline, but about 2 inches of rain in April, 8 inches in May, and 8 inches in June brought the average of the water levels to 14.55 feet on July 6, 1935. The precipitation averaged less than 2 inches in July and

August, and the water levels declined nearly 3 feet during these months. However, about 7 inches of rain in September caused a rise of about 1.7 feet, and about 6 inches in December caused another large rise. Thus on December 18, 1935, the average of the water levels was 15.19 feet, which was the highest during the period of record. The few measurements that were made after December 18 indicate no great change in the rest of the year.

Wells in the Elm Creek and Deer Creek areas, near Temple, Tex.

(The depth to the water level given in the next to last column is the depth below the measuring point on Jan. 1, 1935. The height of the measuring point, given in the last column, is its height with reference to the arbitrary datum.)

Well no.	Owner and location	Depth (feet)	Diameter (inches)	Depth to water level (feet)	Height of measuring point (feet)
1	Mrs. Gibson, 1/4 mile SE. of Eddy	21.6	3 by 7	14.60	24.60
7	C. L. Bridges, 3½ miles S. and 2½ miles W. from Chilton	23.3	3	19.52	29.52
8	--- Hamlett, 1½ miles W. of Chilton	17.1	2.25 by 3	16.52	26.52
11	Cemetery well, 1 mile N. of Temple	21.0	2.5	13.75	23.75
12	E. O. Lamar, 1½ miles N. and 1½ miles E. from Temple	23.0	2.5	6.50	16.50
13	Owner unknown, 1 mile S. and 1/2 mile W. from Troy	21.0	2 by 2.5	15.74	25.74
14	Owner unknown, 2½ miles S. and 3/4 mile E. from Moody	25.8	3.5	14.72	24.72
19	T. W. Neal, 1½ miles W. of Oenaville	16.1	3	8.40	18.40
20	J. K. Hughes, 1 mile N. and 1/4 mile E. from Oenaville	20.8	2	13.84	23.84
22	--- Bravnec, 2½ miles W. of Ocker	24.5	2.5	13.62	23.62
23	Owner unknown, 2 miles S. and 1/4 mile W. from Ocker	25.8	3.5	6.20	16.20
24	L. U. Wentreck, 4 miles S. of Ocker	23.0	2.5	18.00	28.00
25	--- Stranad, 7 miles N. of Heidenheimer	27.8	3	18.49	28.49
26	Charles, Simek, 6 miles W. and 1½ miles N. from Heidenheimer	20.2	2.5	18.65	28.65
27	J. B. Little, 4 miles W. of Heidenheimer	14.3	3.5	12.20	22.20
28	Owner unknown, 1 mile S. and 5 miles E. from Temple	19.3	3.5	15.62	25.62
29	Vince Dusek, 3 miles E. and 1 mile S. from Temple	20.9	2.5	14.51	24.51
30	--- Herna, 3 miles E. and 1/2 mile N. from Temple	11.5	3	9.93	19.93
31	Sam Garth, 3 miles N. and 1/2 mile E. from Temple	16.9	2	6.30	16.30
32	Flint and Hammersmith (Sanders), 2 miles S. and 1/2 mile E. from Troy	11.3	.5	10.88	20.88

Water levels in wells in the Elm Creek and Deer Creek areas, near Temple, Tex., in feet above the arbitrary datum

Date	1	7	8	11	12	13	14
1934							
Apr. 24-30	.....	13.62	11.52	17.59	13.33	19.59	17.87
June 1	.....	12.79	11.52	16.08	12.00	13.47	12.57
25	10.70	12.72	11.52	14.15	10.60	10.77	12.12
July 30	10.10	12.52	9.92	10.95	8.50	9.12	10.82
Sept. 4	10.10	11.72	10.32	7.50	6.55	8.36	10.07
Oct. 2	9.89	10.87	10.22	5.75	6.03	8.26	9.64
29	10.00	5.42	9.94	4.80	4.78	8.08	9.22
Dec. 1	10.07	10.05	10.18	8.28	9.52	16.54	11.72
1935							
Jan. 3	10.00	10.00	9.97	10.28	9.98	9.68	9.99
29	9.79	9.93	9.86	10.07	10.23	9.98	9.52
Mar. 1	10.53	10.00	9.81	16.22	13.20	19.64	10.87
29	9.12	10.29	9.59	16.73	13.08	14.39	11.30
May 11	11.09	10.37	9.79	.....	12.81	17.19	12.92
June 10	14.84	12.06	10.30	.....	13.41	20.34	19.00
July 6	16.74	12.72	10.71	18.11	10.71	20.26	20.22
Aug. 2	11.76	12.78	10.24	16.53	11.44	15.89	14.13
29	10.60	12.02	9.55	14.02	9.82	10.29	14.53
Oct. 3	12.60	11.48	9.73	16.77	12.80	20.39	17.27
30	11.18	11.50	9.82	17.38	13.94	19.46	14.54
Nov. 18	13.28	11.15	9.96	17.51	14.05	19.64	16.52
Dec. 18	12.24	11.60	10.24	18.53	14.13	21.10	21.62
1936							
Jan. 1	.....	.....	.....	.....	.....	21.05	19.77

Date	19	20	22	23	24	25	26
1934							
Apr. 24-30	11.55	14.84	16.22	14.20	20.00	14.29	13.65
June 1	10.90	14.34	15.12	13.90	17.50	13.94	13.65
25	10.80	13.64	14.32	12.18	16.00	13.59	13.65
July 30	9.20	12.54	13.32	10.20	13.90	12.84	12.85
Sept. 4	8.75	11.34	12.22	9.11	12.30	11.79	11.95
Oct. 2	8.54	10.68	11.02	8.68	11.23	11.07	11.27
29	8.36	10.16	10.12	8.39	9.91	10.55	10.77
Dec. 1	9.50	10.04	10.34	9.07	10.18	10.16	10.32
1935							
Jan. 3	10.06	10.00	9.97	9.98	10.00	10.00	10.00
29	10.43	10.44	9.68	10.40	9.79	9.79	9.81
Mar. 1	11.94	11.35	11.07	12.94	11.59	10.00	9.88
29	11.66	11.17	10.84	11.85	11.62	9.97	9.85
May 11	13.32	11.94	12.40	13.59	11.98	9.82	9.90
June 10	12.69	12.76	14.16	13.95	15.57	10.80	11.03
July 6	12.59	13.67	16.29	14.26	16.56	11.92	12.01
Aug. 2	10.89	13.38	14.76	12.72	15.26	12.04	12.13
29	9.76	12.66	13.64	10.95	13.95	11.69	11.90
Oct. 3	10.02	13.63	13.14	13.64	15.23	11.51	11.01
30	10.10	13.77	13.82	12.81	14.15	11.28	11.77
Nov. 18	9.97	13.96	13.49	12.07	13.63	11.19	11.64
Dec. 18	10.94	14.84	16.50	14.22	16.65	11.28	12.49
1936							
Jan. 1	.....	.....	.....	14.30	.....	.....	.....

Date	27	28	29	30	31	32	Average
1934							
Apr. 24-30	11.70	16.20	13.51	13.68	.....	.....	14.93
June 1	11.70	15.23	11.18	13.01	.....	.....	13.46
25	11.30	14.32	8.30	11.98	.....	11.12	12.30
July 30	10.50	.....	8.06	9.38	9.50	8.68	10.67
Sept. 4	9.90	11.52	7.41	.....	8.90	.....	9.98
Oct. 2	9.02	10.50	7.25	.....	8.55	.....	9.35
29	8.71	9.88	7.01	.....	8.01	.....	8.55
Dec. 1	11.02	9.84	8.79	5.90	10.22	9.19	10.04

Water levels in wells in the Elm Creek and Deer Creek areas - Continued

Date	27	28	29	30	31	32	Average
1935							
Jan. 3	9.93	10.02	9.91	10.09	10.02	10.06	9.98
29	9.82	9.99	10.27	11.20	10.07	10.20	10.05
Mar. 1	10.22	11.25	11.59	13.36	10.69	13.38	11.99
29	10.20	11.46	11.83	13.80	10.55	14.34	11.68
May 11	10.84	11.95	11.65	14.53	10.95	16.02	12.26
June 10	12.39	14.16	11.35	15.64	11.78	16.76	13.83
July 6	13.34	16.20	11.92	15.37	11.64	15.89	14.55
Aug. 2	12.57	14.98	9.55	13.99	10.87	13.94	12.99
29	11.31	13.84	8.12	11.73	10.25	11.49	11.60
Oct. 3	12.20	14.02	10.17	13.37	11.32	15.99	13.31
30	12.24	13.50	10.73	13.53	.....	17.04	13.28
Nov. 18	12.12	13.38	11.66	13.40	11.55	16.60	13.33
Dec. 18	.....	15.51	14.41	15.35	.....	16.96	15.19
1936							
Jan. 1	.....	15.67	.....	.....	.....	.....	.....

UTAH

By G. H. Taylor and H. E. Thomas

INTRODUCTION

This report is a brief outline of the ground-water work that has been done in Utah prior to January 1, 1936, including a summary of what is known in regard to the ground-water conditions and especially the ground-water levels in the different parts of the State and a list of publications on the subject. The report does not include all parts of the State. Only those areas which have been visited by the writers at least once during 1935 are discussed in any detail, but some other areas are described briefly.

PAST INVESTIGATIONS

The principal results of past investigations of the ground-water resources of Utah have been published in the reports listed in the following bibliography. Some study of ground-water conditions in the State, especially in the vicinity of Huntsville, in Ogden Valley, and Morgan, in Weber River Valley, was made by Samuel Fortier before the end of the 19th century, and two reports by him gave information on the subject. A few data relating to ground water are contained in a report on irrigation in the Mountain Water District, in Salt Lake County, by E. R. Morgan. The first work for the primary purpose of investigating ground-water conditions in the State was done by G. B. Richardson in the Utah Lake and Jordan River Valleys in 1903 and 1904, and in the Sanpete and Sevier Valleys in 1905. General ground-water investigations were made in the Beaver Valley in 1906 by W. T. Lee; in Juab, Millard, and Iron Counties in 1908 by O. E. Meinzer; and in Boxelder County and the eastern part of Tooele County in 1911 by Everett Carpenter. All these investigations except those in Boxelder and Tooele Counties were made by the United States Geological Survey in cooperation with the State engineer; Sanpete, Sevier, and Beaver Counties also cooperated. During this period of cooperation Caleb Tanner was the State engineer, and much credit is due to him for recognizing the importance of the ground-water resources of the State. During 1925-27 W. N. White, of the United States

Geological Survey, made an intensive investigation in the Escalante Valley, with particular emphasis on the quantities of ground-water discharge by plants and through evaporation from the soil. All these investigations resulted in reports that were published as water-supply papers and are listed in the bibliography.

A ground-water investigation was made by R. M. Leggette and G. H. Taylor in the Jordan River Valley in 1931-35, through cooperation between the United States Geological Survey and Salt Lake City. Periodic observations, made about once a month, are now available for about 45 wells in the Jordan River Valley from about August 1, 1931, to January 1, 1936. Less frequent measurements are available for more than 100 additional wells in the valley. Records of automatic water-stage and pressure recorders for several wells and over varying periods are available from about October 1931 to January 1936. The final report on this investigation is not yet published, but a preliminary report was issued in mimeographed form in 1932, and subsequent unpublished reports formed the basis for developments made by Salt Lake City in 1934.

A ground-water investigation of the Ogden Valley was made from 1932 to 1934 by R. M. Leggette, G. H. Taylor, and L. K. Wenzel, through cooperation between the United States Geological Survey and the city of Ogden. Automatic recorders have been operated continuously on four wells in this valley since September 1932 and on nine wells for shorter periods. Observations made weekly or monthly on 22 wells in the valley are available for the period September 1932 to October 1933 and at yearly intervals to January 1, 1936. The final report on the Ogden Valley was made public in typewritten form on September 17, 1935, when a mimeographed summary of the report was issued.

In 1933 and 1934 a general investigation of ground-water conditions in the southeastern part of the State was made by G. A. Waring and M. M. Knechtel, of the United States Geological Survey, as a part of a program of ground-water investigations financed by the Public Works Administration. The resulting report was made public in typewritten form on April 7, 1936, when a mimeographed memorandum was issued summarizing the principal results, especially as to the artesian conditions and prospects. Typewritten copies of the report are available for inspection at the offices of the United States Geological Survey in Washington, D. C., in the Federal Building in Salt Lake City, Utah, and in the Post Office Building in Denver, Colo.

A ground-water study of Utah, consisting mainly of a brief discussion of available data and of the results of well drilling by the Drought Relief Administration, during 1934-35, was made by G. M. P. Dougall and H. R. Watson and was published in mimeographed form by the Utah State Planning Board in September 1935. This report contains several maps and illustrations that are of particular interest.

A considerable amount of unpublished data on ground-water conditions in various parts of Utah has been gathered by the Utah Agricultural Experiment Station. The results of some special investigations in Cache Valley have been published. Some information concerning past ground-water conditions in small areas can be obtained from court records resulting from litigation between users of ground water in the State.

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CURRENT INVESTIGATIONS

The United States Geological Survey is now engaged in systematic ground-water investigation of the State of Utah, in cooperation with T. H. Humpherys, State engineer. In this investigation wells are being selected in the major ground-water areas and in smaller areas, so far as practicable, in which measurements of the static water level are made at periodic intervals. The interval between observations is about 6 weeks in areas of major ground-water development and 3 or 6 months in areas of minor importance, the less frequent observations being made especially where the seasonal fluctuation of the static level is small. In a few critical areas it has been necessary to measure the water levels at more frequent intervals.

By the end of 1935 a total of about 230 wells had been selected for observation throughout the State, about 550 measurements of water levels in these wells had been made, and the discharge of most of the flowing observation wells had been measured. The selection of these wells began about August 1, 1935, and the number of measurements on each well during 1935 ranged from one to five. In addition to the work on the selected observation wells, about 350 measurements were made on 241 miscellaneous wells, and about 75 wells were visited which could not be measured.

During 1935 L. E. Tueller, county agricultural agent of Iron County, made 149 measurements of the water levels in 14 wells in the vicinity of Cedar City. Howard Gospill, a rancher in the vicinity of Milford, made 21 measurements on 10 wells in the Milford pumping district, in the Escalante Valley. Earl Lemmon, of Willard, made 35 measurements of the water levels in his well during 1935. He had made 101 measurements in this well between 1917 and 1935. The records of these measurements have been made available to the Geological Survey.

The Salt Lake City Corporation has continued and locally enlarged upon the work that was carried on in cooperation with the Geological Survey during 1931-35 in the Jordan River Valley. During 1935 the city, with a personnel of four full-time and two part-time employees, made 8,496 measurements on 156 wells that are measured weekly, 532 measurements on 62 wells that are measured monthly for all or part of the year, and 588 measurements on 422 other wells that are measured one or more times during the year -- a total of 9,616 measurements on 640 individual wells. The city officials have kindly made available to the Geological Survey the data which they collected during 1935 on the wells that were used for observation during the period of the 1931-35 cooperation. These data consist of 1,723 measurements on 32 wells measured weekly, 117 measurements on 14 wells measured monthly during all or part of 1935, and 200 measurements on 70 other wells measured one or more times during 1935. The Geological Survey made 39 miscellaneous measurements on as many wells in the Jordan River Valley, which were also observed by the Salt Lake City Corporation, and 24 measurements on 24 wells in the Jordan River Valley observed neither by the Salt Lake City Corporation nor regularly under the State cooperative program.

Thus, records of 3,168 individual measurements of the water level in 636 wells in Utah have been collected by the Geological Survey from the following sources: 923 measurements on 495 wells by the Geological Survey, 2,040 measurements on 116 wells by the Salt Lake City Corporation, and 205 measurements on 25 wells by individuals.

Records were obtained from five water-stage recorders operated on six wells in Ogden Valley during 1935. These recorders were continued in operation after the completion of the cooperative ground-water investigation in Ogden Valley, by the courtesy of the United States Bureau of Reclamation, which is building the Pine View dam and reservoir, which will inundate the major portion of the area of artesian flow.

Salt Lake City maintained, for the Geological Survey, a pressure recorder on one well and water-stage recorders on two wells during 1935; also pressure recorders on two other wells until August 1935. Between August 1935 and February 1936 eight recorders were placed on wells in areas other than the Ogden and Jordan River Valleys. In addition, Salt Lake City operated 16 other recorders on 20 wells for a part or all of 1935. Thus, a total of 33 automatic recorders were being operated on wells in Utah February 1, 1936, and the records from 16 are available at the office of the United States Geological Survey in Salt Lake City.

All measurements of water levels in wells are made from the top of the well casing, well curb, or other point at the well which appears to be permanent. These points are always referred to the natural land surface at the well. The measuring points for nearly all the wells that have been observed in the Jordan River and Ogden Valleys have been tied to sea-level datum by instrumental levels, and a nearby bench mark of known altitude has been established. The measuring points for observation wells in other parts of the State have not yet been referred to sea-level datum nor to a nearby permanent bench mark. The State engineer is now engaged in accurately locating all wells upon which claims are being filed in accordance with the State ground-water law, and determining the sea-level altitude at these wells. He expects eventually to have such data complete for all wells in the State. The State engineer is also gathering all other available information concerning each well visited. Information from this source will be utilized whenever possible.

GROUND-WATER PROVINCES

Utah lies in four of the major ground-water provinces of the United States[1] -- the Southwestern Bolson province, which occupies the western part of the State; the Montana-Arizona Plateau province, which occupies the plateau region in the eastern and central parts of the State; the Northern Rocky Mountain province, which occupies some of the northeastern part of the State; and a very small portion of the Columbia Plateau Lava province, which occupies the extreme northwest corner of the State.

The largest supplies of ground water are found in the Southwestern Bolson province. The major part of this province in Utah was once covered by the Pleistocene Lake Bonneville,[2] and now, especially in its northern

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1 Meinzer, O. E., The occurrence of ground water in the United States: U. S. Geol. Survey Water-Supply Paper 489, pp. 309-314, 1923.
2 Gilbert, G. K., Lake Bonneville: U. S. Geol. Survey Mon. 1, 1890.

part, it includes extensive flat lands, which were once the floor of the lake, and isolated mountain ranges of the Basin Range type, which projected above the highest lake level. The major mountain ranges and valleys have a general north-south trend. The area that was covered by the ancient Lake Bonneville is underlain by stream and lake deposits, in some places known to be more than 2,000 feet thick. The margins of this ancient lake are marked by conspicuous features of shore erosion and deposition, such as sea cliffs, wave-cut and wave-built terraces, beaches, spits and bars, and deltas. Especially prominent are the benches or terraces formed about 1,000 feet above the present level of Great Salt Lake during the Bonneville stage, the highest level reached by the lake, and about 600 feet above the present Great Salt Lake during the Provo stage, the most strongly marked of all the shore lines. The sediments along the margin of the lake are ordinarily coarse but vary widely in character even over short distances, owing to the shifting of shore currents, stream currents, and wave action. On the benches or terraces where the coarsest sediments are found water-table conditions generally exist, and the water level is a considerable distance below the surface. At greater distances from the mountains beds of finer material, such as silt and clay, alternate with more permeable beds of sand and gravel, giving rise to artesian conditions in many parts of the area. The pumped wells on the benches usually yield large supplies of water. The artesian wells farthest from the mountains, where the aquifers consist of finer sediments, generally have the smallest yield. Shallow ground-water bodies are generally found above the artesian confining beds, the water table lying at variable depths below the surface, and often considerable amounts of water can be recovered from these sources. However, in many places, especially near the centers of the basins, the shallow water is of poor quality.

The precipitation is greatest along the western slope of the Wasatch Mountains, and hence the most abundant supplies of both ground and surface water are found in the adjacent valleys. Of the several ground-water areas, four of the most intensively developed -- the Utah Lake Valley, the Jordan River Valley, the East Shore area, and the Malad and lower Bear River Valley -- are located in this zone just west of the Wasatch Mountains.

That part of the Montana-Arizona Plateau province which lies in Utah consists mainly of the Colorado River basin, which occupies about half of the State but contains only about one-eighth of the population.

Meinzer[3] includes the part of the Sevier River Basin above the Sevier Canyon in this Montana-Arizona province, and it is so classified in this report. However, preliminary field examination indicates that, because of the similarity of ground-water conditions, some of the Sevier River Basin below the canyon between Marysvale and Sevier may finally be classified with the Southwestern Bolson province.

Ground-water developments in the part of the Northern Rocky Mountain province which lies in Utah are very small. The area is extremely rugged and mountainous but contains small intermontane valleys. Most of the water supplies come from mountain springs and streams; only a few from shallow wells. Practically no published information is available concerning ground-water supplies or conditions in this province, and the area has not been studied during the current investigation. It is probable, however, that considerable ground water could be recovered from the valley fill of several of the intermontane valleys. The water for summer irrigation and much of the water contributed as recharge to ground-water bodies at lower altitudes is derived from the snow which falls upon this area and which, owing to the high altitudes and low temperatures, often remains throughout the summer. Local precipitation is insufficient to sustain ground-water levels and irrigation at lower altitudes, and when the snowfall in the high mountains of this area is deficient there is a resulting shortage of summer water in the lower cultivated areas. Thus, the conditions that exist in the Northern Rocky Mountain province, although not conducive to developments of ground water within the province, are most necessary to supply water for the recharge of ground-water bodies and for irrigation in adjacent provinces.

Only a very small part of the northwest corner of the State is included in the Columbia Plateau Lava province. Practically no ground-water developments have been made in this area, and it is unimportant as a future source of ground water in Utah.

GROUND-WATER DEVELOPMENTS AND OBSERVATION WELLS

The following tables give estimates concerning the number of wells in the areas that have been discussed, the common depth and diameter of the wells, and the common use of the ground water recovered by the wells. For the Jordan River and Ogden Valleys the estimated number of wells is believed to be nearly correct. The remainder of the estimates are subject to extensive revision as more information becomes available.

3 Meinzer, O. E., op. cit., pl. 31.

However, the estimates here given serve to indicate the general conditions in the different areas with respect to the present ground-water developments.

Ground-water developments in the Southwestern Bolson province

Area	Estimated data concerning wells			
	Number in area	Common depth (feet)	Common diameter (inches)	Common use
Cedar City Valley	50-150	50-200	6-12	Irr., Dom.
Parowan Valley	25-75	75-500	4-12	Irr., Dom., Stock
Beaver Valley	25-75	150-350	2-8	Dom., Stock, Irr.
Escalante Valley	200-400	40-100	10-16	Irr., Dom.
Pavant Valley	50-100	300-400	6-10	Irr., Dom.
Sevier Desert	500-1,500	200-500	1¼	Dom., Stock
Utah Lake Valley	2,000-4,000	100-300	2-4	Irr., Dom.
Juab Valley	50-150	100-200	2-12	Stock, Irr.
Cedar Valley	25-50	50-400	2-10	Dom., Stock
Tooele Valley	300-500	100-300	2-3	Dom., Irr.
Rush Valley	50-150	50-250	2-8	Dom., Stock
Jordan River Valley	2,700-3,000	40-700	2-4	Dom., Irr.
East Shore area	2,500-3,500	200-600	2-4	Dom., Irr., Stock
Malad and lower Bear River Valley	200-1,000	50-200	2-60	Irr., Stock
Blue Springs Valley	25-75	.....	.....	Dom., Stock
Park Valley	25-75	.....	.....	Dom., Stock.
Cache Valley	1,000-3,000	100-400	2-4	Irr., Stock
Ogden Valley	150-170	15-250	2-60	P. S., Dom.

Observation wells in the Southwestern Bolson province

Area	Number of recorders operating Feb. 1, 1936	Number of observation wells in 1935	Date of earliest available periodic measurement
Cedar City Valley	1	9	1931
Parowan Valley	0	6	1935
Beaver Valley	0	5	1935
Escalante Valley	1	24	1925
Pavante Valley	1	7	1929
Sevier Desert	0	11	1935
Utah Lake Valley	2	15	1935
Juab Valley	0	6	1935
Cedar Valley	0	2	1935
Tooele Valley	0	9	1935
Rush Valley	0	5	1935
Jordan River Valley	4	20	1931
East Shore area	1	23	1935
Malad and lower Bear Valley	0	10	1935
Blue Springs Valley	0	1	1935
Park Valley	0	3	1935
Cache Valley	0	8	1935
Ogden Valley	5	0	1932

Ground-water developments in the Montana-Arizona Plateau province

Area	Estimated data concerning wells			
	Number in area	Common depth (feet)	Common diameter (inches)	Common use
Central Sevier Valley	1,000-1,800	50-200	1½-2	Irr., Dom.
Upper Sevier Valley	25-150	20-150	2-48	Dom., Stock
Sanpete Valley	2,500-3,500	100-200	1½-2	Stock, Irr.
Grass Valley	25-75	100-200	1½-2	Dom., Stock, Irr.
Uinta Basin	(?)	(?)	(?)	Dom., Irr.

Observation wells in the Montana-Arizona Plateau province

Area	Number of recorders operating Feb. 1, 1936	Number of observation wells in 1935	Date of earliest available periodic measurement
Central Sevier Valley	0	20	1935
Upper Sevier Valley	0	6	1935
Sanpete Valley	2	21	1935
Grass Valley	0	2	1935
Uinta Basin	0	13	1935

GROUND-WATER LEVELS

Detailed data on ground-water levels in the various ground-water areas in the State are available only for the Jordan River and Ogden Valleys. With the exception of the records obtained from automatic recorders, only from one to five periodic measurements have been obtained on observation wells in other areas. Residents in most of the developed ground-water areas report a general lowering of ground-water levels in recent years. The decline is probably due in part to smaller recharge during the recent years of subnormal precipitation and in lesser part to increased ground-water withdrawal to supplement the decreased surface-water supply. In some areas the decline of the ground-water levels has become alarming to the residents, but it is believed that with normal precipitation and the stoppage of waste from flowing wells the ground-water levels in most areas will return to normal unless large future developments are made.

The State engineer made a special effort during the fall and winter of 1935 to eliminate waste from flowing artesian wells, to conform to the law, enacted during 1935, regulating the use of ground water. Many wells that heretofore have wasted large quantities of water have been controlled and the beneficial effects of this conservation are evident in the rise of the ground-water levels in several areas -- the rise being as much as 20 feet in some places.

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Sufficient observations to show the general trend of the water levels are available for wells in only a few localities in the State. Brief descriptions of ten of these wells and records showing the fluctuations of the water level in them are given in the following pages. The following table summarizes the annual change in water levels in nine of these wells.

Annual changes, in feet, in water levels in nine observation wells in Utah

Well no.	Ground-water area	1930	1931	1932	1933	1934	1935
(A-6-1)12aa	Ogden Valley	....	....	....	+0.1	-3.4	+0.4
(B-7-2)2ab	Lower Bear River Valley	....	....	....	....	a-5.0	- .3
(C-21-5)21ab	Pavant area	-1.9	-4.5	a-2.5	a+1.5	a-2.0	a- .5
(C-29-10)6dd	Escalante Valley	....	....	....	a- .6	a- .9	- .8
(C-35-11)33aa	Cedar City Valley	....	....	+1.0	0	-10.0	+1.4
(C-2-1)22bd	Jordan River Valley	....	....	-1.6	-2.1	a-5.5	a-3.8
(D-2-1)4dc	do.	....	....	+2.5	+ .2	-7.5	+2.1
(D-2-1)7bc	do.	....	....	....	....	- .7	- .9
(D-2-1)8ad	do.	....	....	a+ .8	+ .1	+4.1	+1.2

a Estimated.

Well (A-6-1)12aa

Description.--City of Ogden, owner. An 8½-inch nonflowing artesian well, drilled 108 feet deep by H. M. Robinson; cased the entire depth with 8½-inch open-end unperforated steel casing. Drilled in 1932 for tests by the United States Geological Survey in cooperation with the city of Ogden.

Location.--In Ogden Valley, in the NE¼NE¼ sec. 12, T. 6 N., R. 1 E., Salt Lake base and meridian; about 1,200 feet south and 500 feet west from the northeast corner of sec. 12, a short distance below the upper limits of the Ogden Valley artesian area, about half a mile east of a group of small flowing wells used by a fish hatchery, and about 2 miles east of about 50 flowing wells used by the city of Ogden for a municipal supply. The withdrawal from these wells ranges between about 13 and 20 second-feet.

Log of well

(By U. S. Geological Survey)

	Thickness (feet)	Depth (feet)
Top soil	1.5	1.5
Gravel and sand, coarse, as large as 1.5 inches in diameter	8.5	10
Clay, gray, sand, and gravel	12	22
Clay, bluish gray	13	35
Clay, silty, considerable sand (some coarse), brown	3	38
Gravel, sand, and clay, grayish brown	2	40
Gravel, brown, and coarse sand	7	47
Sand, chiefly fine, some medium to coarse, yellow	4	51
Gravel and coarse sand, yellow	4	55
Sand, fine to medium, yellow	10	65
Gravel and coarse sand, yellow	3	68
Clay, laminated, brown, black, and gray	6	74
Alternate layers of fine sand, coarse sand, and gravel; some layers contain yellow clay and silt	34	108

Measuring point.--Top of recording-gage platform, 4.0 feet above surface, 4,884.12 feet above mean sea level, United States Geological Survey datum.

Observations.--The measurements of this well show an annual cycle of water-level fluctuations, the highest yearly water level occurring during May or June and the lowest during February or March. The low-water level during September or October of each year is an artificial condition caused by heavy summer withdrawals from the artesian basin. During November and December the recovery from the effects of the heavy summer withdrawals gives a double amplitude to the curve of the yearly cycle. The water level was nearly as high during the summer of 1935 as during any other period of the record. This gain, occurring immediately after the drought of 1934, when the water level dropped to the extreme low point of the period of record, illustrates the rapid recharge of the ground-water basin when there is available sufficient precipitation and surface-water run-off over the recharge area. The investigation of the Ogden Valley has led to the conclusion that unless there should in the future be heavy pumping from wells in the recharge area, the artesian-water supply will be perennially adequate for at least the present rate of consumption, and moreover, that somewhat greater utilization of the artesian reservoir would be possible by making heavier withdrawals at times when the water is needed and inducing greater recharge at times of surplus water.

An automatic water-stage recorder has been maintained on this well since September 1932. The following table of well measurements includes only a sufficient number to outline the general trend of the water level. The complete record is available at the office of the United States Geological Survey in Salt Lake City.

Water levels in well (A-6-1)12aa,

in feet above or below the measuring point

Date	Water level	Date	Water level	Date	Water level
Sept. 17, 1932	-11.58	Nov. 1, 1933	-10.92	Dec. 15, 1934	-14.86
Oct. 1	-11.50	15	-10.97	Jan. 1, 1935	-14.77
15	-11.07	Dec. 1	-10.96	15	-14.51
Nov. 2	-10.41	15	-10.79	Feb. 1	-14.06
23	-10.35	Jan. 1, 1934	-11.35	15	-12.96
Dec. 1	-10.24	15	-11.78	Mar. 1	-11.69
15	-10.74	Feb. 1	-12.38	15	-10.80
Jan. 1, 1933	-11.46	15	-12.83	Apr. 1	-10.16
15	-12.05	Mar. 1	-12.75	15	-9.73
Feb. 1	-13.07	15	-12.07	May 1	-9.34
15	-13.83	Apr. 1	-11.04	15	-9.38
Mar. 1	-14.36	15	-10.28	June 1	-9.08
15	-14.53	May 1	-9.52	15	-9.20
Apr. 1	-13.28	15	-9.87	July 1	-9.20
15	-10.65	June 1	-10.29	15	-9.62
May 1	-9.72	15	-10.91	Aug. 1	-10.52
15	-9.43	July 1	-11.71	15	-11.15
June 1	-9.18	15	-12.67	Sept. 1	-11.82
15	-8.95	Aug. 1	-13.79	15	-12.56
July 1	-9.00	15	-14.93	Oct. 1	-13.05
15	-9.31	Sept. 1	-16.34	15	-13.22
Aug. 1	-10.19	15	-17.31	Nov. 1	-12.40
15	-10.76	Oct. 1	-18.25	15	-12.88
Sept. 1	-11.10	15	-18.20	Dec. 1	-13.14
15	-11.61	Nov. 1	-17.24	15	-13.54
Oct. 1	-11.56	16	-15.50	Jan. 1, 1936	-14.32
15	-11.45	Dec. 1	-14.81	9	-14.76

Well (B-7-2)2ab

Description.--Earl Lemmon, owner. Irrigation and domestic well, dug and drilled 65 feet deep; size 4 by 6 feet from 0 to 44 feet, 10 inches from 44 to 65 feet; cased 44 to 65 feet with unperforated steel casing. Dug to 44 feet by the owner in January 1914; deepened to 65 feet in April 1934.

Location.--In Boxelder County, in the NW¼NE¼ sec. 2, T. 7 N., R. 2 W., Salt Lake base and meridian; in pumphouse at northeast corner of orchard, 225 feet northeast of house. Well is on the moderately steep gravel slope at the foot of the Wasatch Range, within and near the edge of the area submerged by Lake Bonneville, in the recharge area of an artesian area farther west; there are no withdrawals of ground water to the east.

Log of well

(Authority, driller)

	Thickness (feet)	Depth (feet)
Gravel and sand	36	36
Quicksand	8	44
Clay, red	5	49
Gravel, coarse	16	65

Measuring point.--In the period May 27, 1917, to August 1, 1932, "bottom of base plate", 35.3 feet below surface; in the period beginning May 5, 1934, top of 10-inch casing, east side, 43.5 feet below surface.

Observations.--According to available measurements, the water level in 1934-35 was considerably lower than in the same season in 1919-20. In 1932 it rose to nearly the maximum stage reached in 1922. The slight rise of the water level at the end of 1934 appears to be correlative with unusually heavy rain during the preceding month. The much greater rise each spring is likewise due in part to the precipitation in the immediate vicinity of the well but is probably due in a larger part to recharge from run-off from the mountains at the east.

All available measurements of the water level in this well are tabulated below, and all measurements were made by the owner of the well except as noted.

Water levels in well (B-7-2)2ab,

in feet above or below the measuring point

Date	Water level	Date	Water level	Date	Water level
May 27, 1917	-1.75	June 1, 1922	+.35	May 15, 1932	-2.10
June 1	-1.25	June 10	+1.00	20	-.50
3	-1.00	Apr. 29, 1923	-4.65	25	.00
5	-.85	May 14	-3.85	June 5	+.35
June 1, 1918	-2.50	27	-3.00	15	+.25
Apr. 5, 1919	Dry	June 15	-2.75	Aug. 1	-.10
June 3	-12.00	May 27, 1924	-5.60	May 5, 1934	-2.55
Feb. 15, 1920	-14.50	June 16	-6.15	20	-2.85
23	-15.00	23	-6.35	25	-3.00
Mar. 1	-15.00	Dec. 11, 1931	-11.35	30	-3.15
May 26	-15.00	20	-11.45	June 6	-3.35
Apr. 16	-14.90	26	-11.40	14	-3.55
27	-14.15	Jan. 1, 1932	-11.60	22	-3.80
May 9	-13.35	6	-11.70	28	-4.00
14	-12.25	16	-11.80	July 6	-4.25
20	-11.15	20	-11.85	11	-4.40
30	-9.00	30	-11.90	17	-4.60
June 12	-8.40	Feb. 5	-11.95	25	-4.85
Mar. 25, 1921	-9.25	10	-12.00	30	-5.15
Apr. 10	-8.50	25	-12.05	Aug. 5	-5.40
15	-7.90	Mar. 1	-11.95	17	-5.50
25	-7.25	10	-11.40	25	-5.60
May 7	-6.50	25	-10.85	30	-5.80
19	-4.50	30	-10.25	Sept. 5	-5.90
23	-3.50	Apr. 5	-9.90	15	-6.15
June 5	-2.50	10	-9.35	20	-6.25
15	-2.00	15	-8.60	30	-6.45
26	-2.00	20	-8.40	Oct. 7	-6.60
Apr. 28, 1922	-4.15	May 1	-5.75	14	-6.70
May 12	-.50	5	-4.50	Nov. 6	-7.10

Water levels in well (B-7-2)2ab - Continued

Date	Water level	Date	Water level	Date	Water level
Nov. 10, 1934	-7.15	Mar. 3, 1935	-7.65	June 21, 1935	-2.75
16	-7.20	10	-7.70	25	-2.85
25	-7.35	25	-7.70	July 4	-3.10
Dec. 1	-7.40	Apr. 1	-7.55	20	-3.75
10	-7.45	7	-7.40	30	-4.15
15	-7.45	15	-7.40	Aug. 15	-4.85
20	-7.45	26	-6.60	25	-5.25
31	-7.35	30	-6.25	Sept.10	-5.85
Jan. 5, 1935	-7.35	May 12	-5.25	21	-6.10
16	-7.40	20	-4.65	Oct. 5	a -6.51
25	-7.50	29	-4.25	27	a -7.00
Feb. 1	-7.55	June 5	-3.60	Dec. 7	a -7.42
16	-7.65	10	-3.25		
25	-7.65	15	-2.75		

a By U. S. Geological Survey.

Well (C-21-5)21ab

Description.--State of Utah, owner. Unused, nonflowing artesian well, drilled 246 feet deep, diameter 6¼ inches, cased 220 feet with unperforated steel casing. Drilled by Jack Wilkins in March 1917.

Location.--In the Flowell area, Millard County, in the NW¼NE¼ sec. 21, T. 21 S., R. 5 W., Salt Lake base and meridian; about 100 feet south and 0.35 mile west from the northeast corner of sec. 21. Well is along the eastern margin of the Flowell artesian area, which was submerged by Lake Bonneville. The only known ground-water withdrawals between this well and the recharge area are by a few wells equipped with windmills, but west of this well there are several flowing artesian wells, which are used for irrigation.

Log of well

(Authority, driller)

	Thickness (feet)	Depth (feet)
Soil (fresh-water fossils).	2	2
Boulders	8	10
Gravel; surface water encountered at 12 feet	10	20
Clay	5	25
Gravel	10	35
Clay	7	42
Gravel	6	48
Clay	14	62
Gravel	11	73
Clay	41	114
Hardpan	5	119
Clay	10	129
Gravel, cemented	14	143
Clay	8	151
Hardpan	5	156
Gravel	7	163
Clay	48	211
Gravel; flowing water	5	216
Clay	4	220
Gravel; flowing water	16	236
Clay	10	246

Measuring point.--Top of coupling on 6¼-inch casing, which is 1.5 feet above surface.

Observations.--This well is reported to have been a flowing artesian well prior to 1927. The further development of ground water in the area and years of low precipitation have caused the water level to decline materially during the period of observation. It has been successively lower each year since 1929, except in the spring of 1934, when the water level was about 2 feet higher than during March 1933. The total decline from January 1930 to January 1936 is about 10 feet -- an average decline of 1 2/3 feet a year. The measurements show that the highest water level occurs during February and March, and the lowest during September of each year. For several years an ordinance in Millard County has required the capping of flowing wells for 6 months of each year, and wells in the Flowell district are generally closed from October 1 to April 1. However, marginal wells that do not flow during the summer are permitted to remain open throughout October and March. The water level in well (C-21-5)21ab commonly rises about 5 feet within a few days of October 1 and rises still more after the marginal wells are closed November 1. Likewise, in the spring a slight decline of the static level during March appears to result from the opening of marginal wells, and a much greater decline follows the opening of the larger flowing wells during April. The measurements indicate that the annual withdrawals have been in excess of the annual recharge to the ground-water basin except in the winter of 1933-34, which followed a year of about normal precipitation.

An automatic water-stage recorder was installed on this well September 26, 1935. Measurements of depth to water prior to September 19, 1935, were made by the Utah Agricultural Experiment Station; thereafter by the United States Geological Survey. The following table shows all available measurements of the water level in this well prior to September 26, 1935, and only a sufficient number of measurements to outline the general trend of the water level subsequent to that date. The complete record is available at the office of the United States Geological Survey at Salt Lake City.

Water levels in well (C-21-5)21ab

Date	Water level	Date	Water level	Date	Water level
May 26, 1929	-17.4	Apr. 1, 1931	-10.4	Dec. 3, 1933	-15.0
June 21	-17.9	June 4	-19.2	Jan. 11, 1934	-14.0
July 27	-17.8	Aug. 4	-21.6	Mar. 1	-13.2
Aug. 7	-17.75	Sept. 2	-21.6	Apr. 1	-13.8
Oct. 1	-17.0	29	-22.0	May 1	-21.25
Nov. 4	-11.8	Nov. 3	-15.25	June 6	-22.75
Dec. 4	-7.6	Dec. 3	-13.25	July 2	-23.25
Jan. 4, 1930	-6.6	Jan. 3, 1932	-13.0	Sept. 1	-24.6
Feb. 4	-5.1	Feb. 3	-12.8	Sept.19, 1935	-26.66
Mar. 4	-4.4	Mar. 1	-12.8	30	-25.73
30	-7.0	30	-13.8	Oct. 3	-24.00
May 1	-15.8	Apr. 5	-19.0	10	-25.44
June 3	-17.6	May 1	-20.5	20	-21.46
July 1	-18.0	16	-22.8	31	-20.63
Aug. 1	-18.8	June 1	-23.0	Nov. 15	-19.77
Sept. 1	-19.5	July 12	-23.4	Dec. 1	-18.21
26	-19.2	Mar. 1, 1933	-15.2	15	-17.54
Jan. 1, 1931	-8.5	May 1	-23.8	Jan. 1, 1936	-16.98
Mar. 1	-7.9	Oct. 1	-22.8		

Well (C-29-10)6dd

Description.--Duluth Land Co., owner. Unused well, dug and drilled 73 feet deep; 4- by 6-foot wood-curbed pit dug 38 feet deep; cased from 37 to 73 feet with 14-inch perforated Colorado casing (a riveted galvanized-iron casing, ordinarily pre-perforated; see Code, W. E., Construction of irrigation wells in Colorado: Colorado Exper. Sta. Bull. 415, pp. 13-15, 1935). Drilled in 1921.

Location.--In the northern part of Escalante Valley, Beaver County, in the SE¼SE¼ sec. 6, T. 29 S., R. 10 W., Salt Lake base and meridian, about 0.15 mile west and 75 feet north from the southeast corner of sec. 6; in an area submerged by Lake Bonneville. The nearest well pumped for irrigation is about half a mile to the east, and the district of most intensive pumping occupies a zone 1 to 3 miles to the north.

Log of well

(Authority, driller)

	Thickness (feet)	Depth (feet)
Soil	11	11
Gravel	39	50
Clay	4	54
Gravel	19	73

Measuring point.--Top of 2- by 4-inch collar on wooden curb, west side of well, at surface. Measurement February 3, 1936, by United States Geological Survey; all others by Utah Agricultural Experiment Station.

Water levels in well (C-29-10)6dd

Date	Water level	Date	Water level	Date	Water level
....., 1921	-30.0	Dec. 5, 1932	-37.2	Apr. 8, 1934	-36.7
June .., 1929	-34.0	Jan. 4, 1933	-36.9	May 10	-37.2
Apr. 22, 1932	-35.5	Feb. 1	-36.6	June 2	-38.5
July 6	-37.2	Mar. 1	-36.4	Jan. 10, 1935	-38.4
Aug. 3	-37.8	Apr. 1	-36.0	Feb. 10	-38.3
Sept. 4	-38.2	May 4	-36.3	Mar. 20	-38.0
Oct. 2	-38.4	June 4	-36.4	May 5	-38.2
30	-38.0	Mar. 11, 1934	-36.9	Feb. 3, 1936	-39.2

Well (C-33-9)6dc

Description.--Hugh L. Adams, owner. Irrigation, stock, and domestic well, dug and drilled 499 feet deep; 5- by 5-foot concrete-lined pit, 76 feet deep; cased from 75 to 490 feet with 4½-inch steel casing, perforated as shown in log. Drilled in February 1925.

Location.--In Parowan Valley, Iron County, in the SW¼SE¼ sec. 36, T. 33 S., R. 9 W., Salt Lake base and meridian; 1,261 feet east and 32 feet north from the south quarter corner of sec. 36; in pumphouse at southeast corner of reservoir. Well is in an artesian area higher than the highest stage of Lake Bonneville. Marked seasonal fluctuations result from withdrawals from this well and from other irrigation wells to the south and west.

Log of well

(Authority, driller)

	Thickness (feet)	Depth (feet)
No record	76	76
Clay	9	85
Sand and gravel	23	108
Clay	20	128
Sand and gravel	3	131
Clay	23	154
Sand and gravel (12 perforations)	8	162
Clay	12	174
Sand and gravel (13 perforations)	9	183
Clay	5	188
Sand and gravel (2 perforations)	2	190
Clay	6	196
Sand and gravel (6 perforations)	4	200
Clay	6	206
Sand and gravel (12 perforations)	8	214
Clay	12	226
Sand and gravel (6 perforations)	4	230
Clay	25	255
Sand, fine	4	259
Sand and gravel (6 perforations)	3	262
Clay	7	269

Log of well (C-33-9)6dc - Continued

	Thickness (feet)	Depth (feet)
Sand and gravel (8 perforations)	6	275
Clay	27	302
Sand and gravel (5 perforations)	4	306
Clay	12	318
Sand and gravel (4 perforations)	3	321
Clay	15	336
Sand and gravel (16 perforations)	11	347
Clay	4	351
Sand and gravel (5 perforations)	3	354
Clay	8	362
Sand and gravel (6 perforations)	6	368
Clay	3	371
Sand and gravel (6 perforations)	4	375
Clay	5	380
Sand and gravel (8 perforations)	6	386
Clay	9	395
Sand and gravel (5 perforations)	5	400
Clay	4	404
Sand and gravel (6 perforations)	6	410
Clay	3	413
Sand and gravel (10 perforations)	10	423
Clay	39	462
Sand and gravel (8 perforations)	8	470
Clay	7	477
Sand and gravel (11 perforations)	14	491
Clay	6	497
Sand and gravel	2	499

Total perforations, 155; size 3/8 by 1 3/8 inches

Measuring point.--Top of concrete curb, at arrow along northeast side of pit, which is at surface; 5,796.2 feet above sea level, United States Geological Survey datum. Measurements by the Utah Agricultural Experiment Station except on January 31, 1936.

Water levels in well (C-33-9)6dc

Date	Water level	Date	Water level	Date	Water level
Feb. .., 1925	-32.0	July 18, 1934	a-68.8	May 31, 1935	a-73.0
May 31, 1933	a-69.3	Oct. 31	-46.8	June 24	a-72.0
July 8	a-69.8	Nov. ..	-46.8	July 19	a-72.0
Aug. 25	a-70.1	Dec. 19	-45.3	Aug. 31	a-73.0
Sept.28	a-70.5	Jan. 29, 1935	-50.8	Oct. 22	-48.3
Dec. 28	a-70.5	Feb. ..	-49.8	Nov. 18	-47.3
Jan. .., 1934	a-70.3	Mar. 14	-44.3	Dec. 20	-46.8
May ..	a-64.8	Apr. 22	-44.8	Jan. 31, 1936	-45.8

a Pumping.

Well (C-35-11)33aa

Description.--Cottonwood Irrigation Co., owner. Drilled irrigation well; diameter 15½ inches; cased with 15½-inch stovepipe casing. Complete information concerning this well has not yet been obtained.

Location.--In Cedar City Valley, Iron County, in the NE¼NE¼ sec. 33, T. 35 S., R. 11 W., Salt Lake base and meridian; along west side of field about 30 feet east of lane; in an area higher than the highest stage of Lake Bonneville. Both flowing and nonflowing artesian wells are found in the vicinity. This well is along the eastern margin of a district of intensive pumping of ground water for irrigation.

Log of well.--Not available.

Measuring point.--Top of 15½-inch casing at seam, which is at surface.

Observations.--The measurements of the water level in this well do not show a distinct annual cycle, although the rise due to spring recharge and the decline during the irrigation season are definitely indicated. More frequent measurements would probably show a definite annual cycle. The total decline between January 1931 and January 1936 was about 9 feet -- an average of about 1.8 feet a year. However, during January of 1932, 1933, and 1934 the water level was nearly the same; it declined about 10 feet between January 1934 and January 1935 and rose about 1.4 feet between January 1935 and January 1936. The seasonal fluctuation of the static water level, amounting to 2 or 3 feet, is probably due in part to the heavy withdrawals in the district of intensive pumping. The measurements prior to January 29, 1936, were made by the Utah Agricultural Experiment Station.

Water levels in well (C-35-11)33aa

Date	Water level	Date	Water level	Date	Water level
Oct. 8, 1931	-57.7	Dec. 27, 1932	-55.0	Jan. 29, 1935	-65.0
Nov. 5	-56.5	Jan. .., 1933	-55.0	Feb. ..	-65.0
Jan. 8, 1932	-56.0	Mar. 30	-52.2	Mar. 18	-62.2
Feb. 18	-56.0	Apr. 28	-53.5	Apr. 22	-63.0
Mar. 31	-53.5	July 8	a-71.0	May 31	-62.0
Apr. 23	-53.7	Sept.28	-60.0	June 29	-64.0
May 27	-52.3	Dec. 28	-56.0	July 27	-64.3
June 23	-52.0	Jan. .., 1934	-55.0	Oct. 31	-67.5
July 28	a-69.5	May ..	a-74.5	Dec. 28	-64.0
Aug. 29	a-71.0	July 13	a-75.0	Jan. 29, 1936	-63.62
Sept.30	-53.9	Oct. 25	-67.0	Feb. 2	-63.40
Oct. 28	-53.7	Nov. ..	-67.5		
Nov. 30	-55.0	Dec. 20	-64.5		

a Pumping.

Well (C-2-1)22bd (field no. 57)

Description.--Walter A. Diamond, owner. A 3-inch jetted well, reported depth 324 feet, nonflowing but probably artesian; not used; equipped with an abandoned windmill; steel casing, depth and finish unknown, probably unperforated and open at end.

Location.--In the Jordan River Valley, Salt Lake County, in the SE¼NW¼ sec. 22, T. 2 S., R. 1 E., Salt Lake base and meridian; about 2,100 feet east and 1,900 feet south from the northwest corner of sec. 22; near west side of railroad right of way, about 150 feet west of Redwood Road. This well is in an area of essentially no ground-water development and 3 to 4 miles southwest of the highly developed ground-water area in the vicinity of Murray, Utah.

Log of well.--None available.

Measuring point.--Top of casing at surface; 4,435.37 feet above mean sea level, United States Geological Survey datum.

Observations.--The water level in this well is highest during August or September and lowest during May. According to the hydrograph for this well, the water level is not appreciably affected by withdrawals from nearby wells, although the withdrawals in the main artesian basin may have been partly responsible for the general downward trend since the observations were begun, in 1931. From October 1931 to October 1935 the total decline of the water level was about 15.5 feet, an average decline of nearly 4 feet a year. The greatest annual decline was about 6.5 feet between October 1933 and October 1934 -- a year of extreme drought. Although the water level in this well had a downward trend from 1931 to 1933, the water level in well (D-2-1)4dc had an upward trend notwithstanding the heavy ground-water withdrawals near that well. This difference is probably explained by the greater opportunity for ground-water recharge on the east side of the Jordan River Valley from precipitation, surface-water run-off, and irrigation.

All measurements on this well were made by hand. Only a sufficient number have been tabulated below to outline the general trend of the water level. The complete record is available at the office of the United States Geological Survey at Salt Lake City, Utah.

Water levels in well (C-2-1)22bd

Date	Water level	Date	Water level	Date	Water level
Sept.12, 1931	-68.35	Sept.15, 1932	-72.75	Oct. 9, 1933	-74.85
Oct. 7	-69.55	Oct. 13	-72.78	Nov. 13	-76.06
Nov. 10	-70.62	Nov. 17	-73.56	Dec. 21	-77.15
Dec. 11	-72.06	Dec. 15	-74.55	Jan. 11, 1934	-77.56
Jan. 8, 1932	-73.45	Jan. 19, 1933	-75.45	Aug. 6	-80.97
Feb. 11	-74.43	Feb. 16	-76.43	Oct. 30	-81.45
Mar. 10	-75.39	Mar. 16	-77.14	May 15, 1935	a-85.02
Apr. 14	-76.42	Apr. 13	-78.13	June 17	a-84.81
May 12	-77.33	May 18	-78.63	Oct. 7	a-84.85
June 16	-76.20	June 8	-78.20	25	-85.17
July 14	-74.85	July 6	-76.30		
Aug. 11	-73.22	Aug. 17	-74.07		

a By Salt Lake City Corporation.

Well (D-2-1)4dc (field no. 80)

Description.--Matt Templeman, owner. A jetted, artesian well; not used, formerly used for domestic purposes and irrigation. Reported depth 310 feet; 3-inch open-end unperforated steel casing the entire depth. Jetted during 1923 by W. D. Harkness, Murray, Utah.

Location.--In the Jordan River Valley, Salt Lake County, in the SW¼SE¼ sec. 4, T. 2 S., R. 1 E., Salt Lake base and meridian; about 1,600 feet west and 950 feet north from the southeast corner of sec. 4; under an apple tree about 75 feet southeast of owner's residence. It is on the valley floor, near the toe of the Provo Bench, between the recharge area and the most extensively developed ground-water area of Salt Lake County. There are numerous flowing wells to the west within half a mile of this well. Practically no ground-water withdrawals are made between this well and the recharge area.

Log of well.--None available.

Measuring point.--Top of casing, at surface; 4,384.13 feet above mean sea level, United States Geological Survey datum.

Observations.--The water-level measurements show a yearly cycle with the highest level during July, August, or September and the lowest level during March or April of each normal year. Natural ground-water recharge begins during April or May. The general upward trend of the water level during 1931, 1932, and 1933 shows that the amount of water stored in the ground was increasing during that period, in spite of the increasing development of ground water in the area. During 1934 there was essentially no replenishment of the ground water, and this, coupled with increased ground-water withdrawals, caused the water level to drop continuously from August 1933 to November 1934. Some recharge of the ground-water body occurred during the summer of 1935, but the amount was considerably below the normal. The highest water level during 1935 was about 7 feet lower than the highest level during 1933. The large drop in the water level during 1933 and 1934 was probably caused more by the low precipitation and absence of water available for recharge than by increased withdrawals. A great many measurements were made on this well which are not tabulated below, only a sufficient number being given to show the general trend of the water level in the well. All the measurements are available at the office of the United States Geological Survey at Salt Lake City, Utah. The tabulated measurements for the period September 16, 1931, to August 18, 1932, were made by the United States Geological Survey; thereafter by the Salt Lake City Corporation.

Water levels in well (D-2-1)4dc

Date	Water level	Date	Water level	Date	Water level
Sept.16, 1931	-1.75	Feb. 16, 1933	-1.30	Aug. 17, 1934	-6.30
Oct. 15	-2.17	Mar. 17	-1.37	Sept.17	-8.04
Nov. 5	-2.56	Apr. 18	-1.91	Oct. 26	-9.26
Dec. 7	-3.20	May 13	-2.42	Nov. 21	-9.16
Jan. 5, 1932	-3.44	June 19	-.66	Dec. 18	-8.59
Feb. 15	-4.11	July 18	+1.03	Jan. 15, 1935	-8.19
25	-4.41	Aug. 14	+1.72	Feb. 20	-8.08
Mar. 17	-4.49	Sept.18	+1.25	Mar. 19	-8.01
Apr. 21	-4.41	Oct. 24	+.82	Apr. 18	-8.31
May 19	-3.88	Nov. 20	+.47	May 14	-8.09
June 16	-2.40	Dec. 27	-.46	June 19	-6.86
July 21	-.14	Jan. 15, 1934	-.67	July 25	-5.16
Aug. 18	+.45	Feb. 19	-1.73	Aug. 20	-5.57
Sept.17	+.58	Mar. 19	-2.32	Sept.18	-6.20
Oct. 15	+.84	Apr. 16	-2.99	Oct. 15	-6.53
Nov. 26	+.10	May 18	-3.65	Nov. 14	-5.91
Dec. 16	-.35	June 18	-4.05	Dec. 11	-5.84
Jan. 23, 1933	-.91	July 19	-5.10	Jan. 6, 1936	-6.07

Well (D-2-1)7bc (field no. 1391)

Description.--American Smelting & Refining Co., owner. A jetted artesian well, not used; formerly used for domestic purposes. Measured depth of well November 16, 1933, 184 feet. Cased with 2-inch open-end unperforated steel casing, probably to bottom of well. Date of jetting unknown but probably before 1925.

Location.--In the Jordan River Valley, Salt Lake County, in the SE¼NW¼ sec. 7, T. 2 S., R. 1 E., Salt Lake base and meridian; about 700 feet east and 2,200 feet south from the northwest corner of sec. 7, in vacant lot about 75 feet west of State Street and 150 feet north of Little Cottonwood Creek. This well is near the edge of the intensively developed artesian area in the vicinity of Murray. A considerable amount of ground water is being withdrawn in the immediate vicinity of this well, although heavier withdrawals occur half a mile or more distant.

Log of well.--None available.

Measuring point.--This well is equipped with an automatic pressure recording gage. The measuring point is the center line of the recorder connection to the well, 3.0 feet above the ground surface, 4,276.55 feet above mean sea level, United States Geological Survey datum.

Observations.--The record of this well is not of sufficient length to show the general conditions before the extreme drought of 1933-34. However, the annual cycle is clearly indicated, the high-water level occurring from December to April or May and the low-water level during August and September. This annual cycle is nearly the opposite to the cycle shown by the measurement of well (D-2-1)4dc. It is probable that a great part of the seasonal fluctuation shown by this well is caused by the heavy withdrawals by flowing wells during the summer. The rise in the static level, which ordinarily begins in September or October, coincides with the closing of a large number of these flowing wells. During years of normal precipitation this rise may be augmented by annual recharge of the ground-water basin, the effects of which arrive at this well several months after the recharge area is refilled by the spring flood waters. However, during 1934 and 1935 the spring recharge to the ground-water basin was very small, and nearly all of the annual cycle during those years is presumably caused by ground-water withdrawals. The water level in this well was only about 0.7 foot lower in January 1935 than in January 1934, despite the low recharge and the heavy summer withdrawals during 1934. The water level was 0.9 foot lower during January 1936 than during January 1935. Only enough observations from the pressure recording gage are tabulated below to show the general trend of the water level in the well. The charts from the recorder are available at the office of the United States Geological Survey at Salt Lake City.

Water levels in well (D-2-1)7bc

Date	Water level	Date	Water level	Date	Water level
Nov. 1, 1933	+14.6	Aug. 1, 1934	+12.6	May 1, 1935	+13.7
15	+14.7	15	+11.3	15	+13.8
Dec. 1	+14.5	Sept. 1	+11.6	June 1	+13.6
15	+14.3	15	+11.8	15	+12.2
Jan. 1, 1934	+14.9	Oct. 1	+12.2	July 1	+11.8
15	+14.8	15	+12.0	15	+11.3
Feb. 1	+15.0	Nov. 1	+12.5	Aug. 1	+11.6
15	+14.7	15	+13.0	15	+11.0
Mar. 1	+14.7	Dec. 1	+13.5	Sept. 1	+11.0
15	+14.9	15	+14.1	15	+10.6
Apr. 1	+14.2	Jan. 1, 1935	+14.2	Oct. 1	+11.4
15	+14.2	15	+14.1	15	+11.3
May 1	+13.6	Feb. 1	+13.8	Nov. 1	+11.9
15	+13.6	15	+13.8	15	+12.8
June 1	+12.8	Mar. 1	+14.0	Dec. 1	+13.2
15	+12.8	15	+13.8	15	+13.2
July 1	+13.2	Apr. 1	+13.8	Jan. 1, 1936	+13.3
15	+12.7	15	+13.8		

Well (D-2-1)8ad (field no. 73)

Description.--Chester Cahoon, owner. A jetted artesian well; measured depth 95.5 feet below measuring point on November 18, 1932; probably cased entire depth with 3-inch open-end unperforated steel casing; not used, previously used by a fish hatchery.

Location.--In the Jordan River Valley, Salt Lake County, in the SE¼NE¼ sec. 8, T. 2 S., R. 1 E., Salt Lake base and meridian; about 1,450 feet south and 500 feet west from the northeast corner of sec. 8; about 125 feet west of 13th East Street and about 50 feet east of an abandoned fish hatchery building. This well is near the center of the intensively developed ground-water area near Murray, a few hundred feet east of a group of flowing wells that were originally used by a fish hatchery and are now owned and operated by the Salt Lake City Corporation. These wells, when flowing freely, discharge 5 to 8 cubic feet a second.

Log of well.--None available.

Measuring point.--Top of recording-gage platform, about 8.75 feet above the surface, 4,333.00 feet above mean sea level, United States Geological Survey datum.

Observations.--The hydrograph for this well has a gradual upward trend from 1931 to 1933, showing that the ground-water additions to the area were in excess of the withdrawals. During these years and a part of 1934 the fluctuations of the water level in this well were similar to those in well (D-2-1)4dc but smaller in magnitude. The water level was highest in July, August, and September and lowest in February and March. The period of recovery began in March or April. A pronounced drop in the water level occurred during July 1934, caused by the drilling of a new well in the vicinity. The observations after November 1934 are extremely interesting, as they show the effect of closing flowing wells when the water is not being used. Before November 1934 several wells in the vicinity had been allowed to flow continuously. Since that date they have been closed except during periods of use. When these wells were closed the water level in well (D-2-1)8ad rose about 5 feet. The low-water levels after November 1934 occurred when these closed wells were opened.

The observations after June 14, 1932, tabulated below, were obtained from an automatic water-stage recorder. Observations before June 14, 1932, are measurements by hand, converted to read as if measured from the present measuring point. Only enough measurements are given to indicate the general trend of the water level in the well. The complete record of observations is available at the office of the United States Geological Survey at Salt Lake City.

Water levels in well (D-2-1)8ad

Date	Water level	Date	Water level	Date	Water level
Sept. 16, 1931	-8.74	June 15, 1933	-8.05	Oct. 15, 1934	-10.00
Oct. 15	-8.94	July 1	-7.73	Nov. 1	-9.93
Nov. 5	-9.00	15	-7.67	15	-9.98
Feb. 15, 1932	-9.52	Aug. 1	-7.75	Dec. 13	-4.83
Mar. 4	-9.54	15	-7.79	31	-4.37
Apr. 16	-9.24	Sept. 1	-7.80	Jan. 1, 1935	-4.37
May 6	-8.97	15	-7.89	15	-4.70
June 4	-8.40	Oct. 1	-7.95	Feb. 1	-5.19
15	-8.36	15	-8.00	15	-4.73
July 1	-8.10	Nov. 1	-7.93	Mar. 1	-4.56
15	-7.88	15	-8.03	15	-4.51
Aug. 1	-7.89	Dec. 1	-8.18	27	-4.55
15	-7.93	13	-8.30	Apr. 15	-4.16
Sept. 1	-7.85	Jan. 1, 1934	-8.43	May 1	-4.00
15	-7.92	19	-8.50	15	-3.77
Oct. 1	-7.92	Feb. 1	-8.56	June 1	-3.35
15	-7.91	15	-8.66	15	-3.34
Nov. 1	-8.20	Mar. 1	-8.78	July 1	-9.54
15	-8.36	15	-8.84	15	-9.64
Dec. 1	-8.36	Apr. 1	-8.91	Aug. 1	-9.84
15	-8.47	15	-8.97	14	-9.79
Jan. 1, 1933	-8.54	May 1	-8.96	Sept. 1	-9.54
15	-8.50	15	-8.94	15	-9.94
Feb. 1	-8.70	June 1	-8.77	Oct. 1	-9.84
15	-8.75	15	-8.79	15	-9.94
Mar. 1	-8.93	July 1	-8.83	Nov. 1	-9.74
15	-9.02	15	-9.90	15	-3.99
Apr. 1	-8.89	Aug. 1	-10.05	Dec. 1	-3.86
15	-8.83	15	-10.10	12	-3.39
May 1	-8.80	30	-10.22	Jan. 1, 1936	-3.18
15	-8.55	Sept. 15	-10.00		
31	-8.27	Oct. 1	-10.12		

VIRGINIA

By O. E. Meinzer, R. C. Cady, and V. C. Fishel

Five wells in Arlington and Fairfax Counties, Va., near Washington, D. C., have been under continuous observation since the spring of 1932; one of them has furnished a record of water-level fluctuations since the spring of 1928, and two others since the autumn of 1931. The project was carried on by the United States Geological Survey with cooperation by the Virginia Geological Survey during 1931, 1932, and part of 1933. All five are dug wells. They range in depth from 12 to 35 feet and penetrate unconsolidated material lying upon the crystalline rocks that characterize much of the Piedmont area of the Appalachian region.

Four of these wells (Ross, Swart, Bacon, and Bell) have been equipped with automatic water-stage recorders, but weekly tape measurements have been made on all the wells. On each well equipped with a recorder the measurements are made from a measuring point at the top surface of the platform upon which the shelter rests. In the Halls Hill well, which is not equipped with a recorder, the measuring point is the top edge of the rim that supports the cover over the well. The measuring point on each well has been instrumentally tied to two bench marks. The location and description of each well and the description of the bench marks are as follows:

Ross well, 1918 North Wayne Street, Rosslyn. Depth 29 feet; diameter 25 inches; casing, tile; measuring point 18 inches above the land surface. Bench mark 1 is a cross cut in the top of the concrete retaining wall beside the basement door at the southwest corner of the house, 23.5 feet south and 7.5 feet east from the well. It is 1.03 feet below the measuring point. Bench mark 2 is the top of an iron water-meter box in the center of the driveway, 27.5 feet south and 77.5 feet east from the well. It is 2.46 feet below the measuring point.

Halls Hill well, at Langston School. Depth 35 feet; diameter 24 inches; casing, tile; measuring point at the land surface. Bench mark 1 is a cross cut in the top of the concrete retaining wall on the north side of the steps leading to the basement door on the east side of the school building, 35 feet east and 18 feet south from the well. It is 0.89 foot above the measuring point. Bench mark 2 is a nail and copper washer at the base of a tree, 60 feet west and 50 feet south from the well. It is 3.33 feet below the measuring point.

Bell well, at Ash Grove, about 1 mile northwest of Tysons Crossroads, on road leading from Falls Church to Leesburg. Depth 18 feet; diameter 25 inches; casing, tile; measuring point 6 inches above land surface. Bench mark 1 is a nail and copper washer at the base of a tree 3½ feet in diameter, 66 feet north and 40 feet west from the well. It is 0.03 foot above the measuring point. Bench mark 2 is a nail and copper washer at the base of a tree 2⅛ feet in diameter, 51 feet west and 10 feet south of the well. It is 2.64 feet above the measuring point.

Bacon well, about 2 miles from Fairfax on U. S. Highway 50. Depth 24 feet; diameter 48 inches; casing, rock; measuring point 6 inches above land surface. Bench mark 1 is a nail and copper washer at the base of a tree 50 feet south of the well. It is 1.29 feet above the measuring point. Bench mark 2 is a point at the west end of the lower concrete step of the front porch of the house, snug against the brick side and in front of the second step. It is 4.03 feet above the measuring point.

Swart well, near Difficult Run, about 1½ miles from Fairfax on U. S. Highway 50. Depth 11 feet; diameter 25 inches; casing, tile; measuring point 18 inches above land surface. Bench mark 1 is a nail and copper washer at the base of a tree 3½ feet in diameter, 50 feet north of the road and 200 feet east of the bridge on Difficult Run. It is 5.91 feet above the measuring point. Bench mark 2 is a nail and copper washer at the base of a double tree 4½ feet in diameter, 125 feet south of the road and 250 feet east of the bridge. It is 4.10 feet above the measuring point.

None of the wells are influenced by pumping from nearby wells. The Ross and Halls Hill wells are in areas served by public water supplies and containing some cesspools, but there is reason to believe that the levels in the wells have not been materially affected by these conditions. The Swart well is on the flood plain of Difficult Run, and the water level in it shows a daily fluctuation during the growing season in response to transpiration by the marsh plants that grow nearby. Other wells show barometric fluctuations, especially during periods when the soil is moist.

Records of the water levels in these wells are plotted currently and may be consulted at the office of the Geological Survey in Washington, D. C. At intervals the records have been given special study, and the results have been summarized in the following publications:

Recent replenishment of ground-water supply recorded by observation well near Washington, D. C.: U. S. Dept. Interior Press Mem. 53047, April 28, 1931.

Replenishment of ground water recorded by observation well near Washington, D. C.: U. S. Dept. Interior Press Mem. 60319, February 25, 1932.

Cady, R. C., Investigations of the fluctuations of water levels in observation wells in Virginia: Am. Geophys. Union Trans. 13th Ann. Meeting, pp. 370-373, 1932.

Water levels in wells in northern Virginia: U. S. Dept. Interior Press Mem. 65826, September 6, 1932.

Cady, R. C., The upward trend of the ground-water level in northern Virginia: U. S. Dept. Interior Press Mem. 72602, June 20, 1933.

Cady, R. C., Ground-water resources of northern Virginia (to be published as a bulletin of the Virginia Geological Survey, Charlottesville, Va.).

Under normal climatic conditions in this area the water that falls as rain in the summer is largely absorbed by the soil and subsequently withdrawn by evaporation or by action of the vegetation. Therefore, as a rule, the water in the zone of saturation is drained lower and lower as it issues from springs or is withdrawn by evaporation and transpiration in low places. Large recharge, however, occurred during wet periods in the growing seasons of each of the years of record, except 1929, 1930, and

Water levels in the Ross well, in Virginia near Washington, D. C., from June 1928 to August 1931

(The record of this well from August 1931 to December 1935 is given in the next table. The water levels are given in feet below the measuring point.)

Date	Depth to water (feet)	Date	Depth to water (feet)	Date	Depth to water (feet)
June 12, 1928	23.27	Jan. 7, 1930	25.87	Nov. 15, 1930	26.56
19	23.06	11	25.95	22	26.57
July 12	23.50	18	25.87	29	26.63
21	23.80	25	25.74	Dec. 6	26.65
Aug. 4	23.92	Feb. 1	25.65	13	26.69
13	23.44	8	25.27	20	26.72
20	21.94	15	24.90	27	26.74
25	21.90	26	24.68	Jan. 3, 1931	26.77
Sept. 1	22.09	Mar. 29	23.68	Mar. 21	26.92
8	21.95	Apr. 5	24.52	25	26.91
15	21.87	12	23.99	28	26.92
Oct. 27	23.14	19	23.78	Apr. 4	26.75
Nov. 3	23.23	27	23.78	11	26.53
Jan. 7, 1929	24.74	May 5	23.77	18	26.36
15	24.82	13	23.90	25	26.29
23	24.92	19	24.04	May 2	26.26
Feb. 3	24.99	27	24.14	9	26.24
7	24.96	June 5	24.33	16	26.23
13	24.94	11	24.45	23	26.22
14	24.49	19	24.56	29	26.20
Apr. 10	23.32	26	24.66	June 5	26.10
May 22	22.63	July 6	24.87	12	25.99
Aug. 8	23.96	31	25.27	19	25.91
20	24.22	Aug. 7	25.36	26	25.86
26	24.31	15	25.48	July 3	25.81
Sept. 1	24.44	22	25.57	11	25.78
9	24.58	29	25.66	18	25.75
12	24.64	Sept. 5	25.73	25	25.74
18	24.78	12	25.80	Aug. 1	25.72
24	24.89	20	25.91	8	25.71
28	24.99	28	26.05	15	25.73
Oct. 5	25.13	Oct. 18	24.64		
9	25.60	27	26.31		
16	25.70	Nov. 8	26.45		

Water levels in five observation wells in Virginia near Washington, D. C., and weekly precipitation at the Weather Bureau in Washington

(The water levels are given in feet below the measuring points)

Date	Ross	Bacon	Halls Hill	Bell	Swart	Precipitation (inches)
1931						
Aug. 22	25.67	22.60	.....	.....	.....	....
29	25.54	22.75	.....	.....	.....	1.00
Sept. 5	25.40	22.80	.....	.....	.....	.17
12	25.31	22.86	.....	.....	.....	.09
19	25.26	22.95	.....	.....	.....	.16
26	25.23	22.99	.....	.....	.....	2.37
Oct. 3	25.22	22.17	34.0	.....	.....	.00
10	25.27	23.13	33.97	.....	.....	.34
17	25.20	23.20	34.45	.....	.....	.38
24	25.25	23.26	34.52	.....	.....	Trace
31	25.28	23.33	34.58	.....	.....	.56
Nov. 7	25.37	23.40	34.61	.....	.....	Trace
14	25.43	23.44	34.72	.....	.....	.03
21	25.50	23.49	34.73	.....	.....	.41
28	25.55	23.52	34.79	.....	.....	.18

lower than the highest stages in the preceding year, because of the relatively low precipitation from the autumn of 1933 to the summer of 1934, which resulted in only moderate rise in the normal recharge period of 1933-34. The record monthly rainfall of 17.45 inches in September 1934 caused a rise of 3 to 5 feet in the water levels. As a result of light precipitation in October and November 1934, there was a sharp decline of the water level in the Ross well, but the water levels in the Halls Hill and Bacon wells remained nearly constant. The water levels rose further during the recharge period in the spring of 1935, with the result that high stages were reached -- in the Bacon and Ross wells essentially the same as in 1933 but in the Halls Hill well about 2.5 feet higher. The water levels began a gradual decline in April 1935, and in response to relatively droughty conditions they continued to decline until the following November except for a small rise in September. The year 1935 ended with the water levels only slightly above the lowest stage of the year and considerably lower than at the beginning of the year.

In the following table are given the highest and lowest stages of the water levels in each year of record in the Bacon, Halls Hill, and Ross wells, and their water levels on January 1 of each year. The depth to the water level on January 1 was interpolated in some cases from the measurements immediately preceding and following that date.

Summary of water levels in the Bacon, Halls Hill, and Ross observation wells, in Virginia near Washington, D. C.

Year	Depth to water level on January 1 (feet below measuring point)			Extreme water levels during year (feet below measuring point)						Annual precipitation at Washington, D. C. (inches)
				Highest			Lowest			
	Bacon	Halls Hill	Ross	Bacon	Halls Hill	Ross	Bacon	Halls Hill	Ross	
1928	.....	.....	.....	.....	.....	.....	.....	.....	.....	43.40
1929	.....	.....	24.70	.....	.....	22.63	.....	.....	25.70	39.41
1930	.....	.....	25.85	.....	.....	23.68	.....	.....	26.74	21.66
1931	.....	.....	26.77	.....	.....	25.20	.....	.....	26.92	33.42
1932	23.66	34.80	25.46	15.30	27.70	21.04	23.66	34.80	25.47	49.55
1933	15.40	27.70	21.11	11.38	20.15	17.35	16.80	27.70	23.16	49.11
1934	16.71	25.25	23.15	14.42	25.86	17.70	17.69	25.86	23.15	51.14
1935	14.73	22.50	20.85	11.27	17.74	17.47	17.09	25.07	23.74	43.53
1936	16.08	24.46	23.45	.....	.....	.....	.....	.....	.....	.....

Water levels in the Ross well, in Virginia near Washington, D. C., from June 1928 to August 1931

(The record of this well from August 1931 to December 1935 is given in the next table. The water levels are given in feet below the measuring point.)

Date	Depth to water (feet)	Date	Depth to water (feet)	Date	Depth to water (feet)
June 12, 1928	23.27	Jan. 7, 1930	25.87	Nov. 15, 1930	26.56
19	23.06	11	25.95	22	26.57
July 12	23.50	18	25.87	29	26.63
21	23.80	25	25.74	Dec. 6	26.65
Aug. 4	23.92	Feb. 1	25.65	13	26.69
13	23.44	8	25.27	20	26.72
20	21.94	15	24.90	27	26.74
25	21.90	26	24.68	Jan. 3, 1931	26.77
Sept. 1	22.09	Mar. 29	23.68	Mar. 21	26.92
8	21.95	Apr. 5	24.52	25	26.91
15	21.87	12	23.99	28	26.92
Oct. 27	23.14	19	23.78	Apr. 4	26.75
Nov. 3	23.23	27	23.78	11	26.53
Jan. 7, 1929	24.74	May 5	23.77	18	26.36
15	24.82	13	23.90	25	26.29
23	24.92	19	24.04	May 2	26.26
Feb. 3	24.99	27	24.14	9	26.24
7	24.96	June 5	24.33	16	26.23
13	24.94	11	24.45	23	26.22
14	24.49	19	24.56	29	26.20
Apr. 10	23.32	26	24.66	June 5	26.10
May 22	22.63	July 6	24.87	12	25.99
Aug. 8	23.96	31	25.27	19	25.91
20	24.22	Aug. 7	25.36	26	25.86
26	24.31	15	25.48	July 3	25.81
Sept. 1	24.44	22	25.57	11	25.78
9	24.58	29	25.66	18	25.75
12	24.64	Sept. 5	25.73	25	25.74
18	24.78	12	25.80	Aug. 1	25.72
24	24.89	20	25.91	8	25.71
28	24.99	28	26.05	15	25.73
Oct. 5	25.13	Oct. 18	24.64		
9	25.60	27	26.31		
16	25.70	Nov. 8	26.45		

Water levels in five observation wells in Virginia near Washington, D. C., and weekly precipitation at the Weather Bureau in Washington

(The water levels are given in feet below the measuring points)

Date	Ross	Bacon	Halls Hill	Bell	Swart	Precipitation (inches)
1931						
Aug. 22	25.67	22.60	.....	.....	.....	....
29	25.54	22.75	.....	.....	.....	1.00
Sept. 5	25.40	22.80	.....	.....	.....	.17
12	25.31	22.86	.....	.....	.....	.09
19	25.26	22.95	.....	.....	.....	.16
26	25.23	22.99	.....	.....	.....	2.37
Oct. 3	25.22	22.17	34.0	.....	.....	.00
10	25.27	23.13	33.97	.....	.....	.34
17	25.20	23.20	34.45	.....	.....	.38
24	25.25	23.26	34.52	.....	.....	Trace
31	25.28	23.33	34.58	.....	.....	.56
Nov. 7	25.37	23.40	34.61	.....	.....	Trace
14	25.43	23.44	34.72	.....	.....	.03
21	25.50	23.49	34.73	.....	.....	.41
28	25.55	23.52	34.79	.....	.....	.18

Water levels and weekly precipitation - Continued

Date	Ross	Bacon	Halls Hill	Bell	Swart	Precipitation (inches)
1931						
Dec. 5	25.58	23.53	34.8	.....	.....	0.48
12	25.59	23.57	34.80	.....	.....	1.15
19	25.63	23.61	34.80	.....	.....	.23
26	25.69	23.66	34.80	.....	.....	.53
1932						
Jan. 4	25.26	23.66	34.80	.....	.....	1.35
9	25.47	23.61	34.53	.....	.....	2.57
16	25.05	23.30	34.43	.....	.....	.02
23	24.86	23.07	34.23	.....	.....	.07
30	24.72	22.86	33.88	.....	.....	.74
Feb. 6	24.60	22.58	33.70	.....	.....	1.80
13	24.27	22.08	33.58	.....	.....	.12
20	24.20	21.74	33.38	.....	.....	.39
27	24.10	21.54	33.19	.....	.....	.12
Mar. 5	24.10	21.37	32.90	.....	.....	.83
12	23.91	21.06	32.79	.....	.....	1.52
19	23.64	20.80	32.65	.....	.....	.13
26	23.43	20.47	32.45	.....	.....	1.16
Apr. 2	22.31	19.39	31.88	.....	.....	2.86
9	22.15	19.02	31.74	.....	.....	1.48
16	21.49	18.24	31.40	.....	.....	.41
23	21.33	18.10	30.98	5.82	3.41	.00
30	21.53	18.12	30.76	6.40	3.45	.22
May 7	21.67	18.09	30.48	6.30	3.38	1.00
14	21.48	15.40	30.05	2.06	2.13	3.33
21	21.04	16.01	29.91	3.83	3.09	.13
27	21.20	16.11	29.70	4.80	3.37	.61
June 4	21.45	16.29	29.50	6.57	3.65	.00
11	21.79	16.48	29.44	6.55	3.91	.16
18	22.03	16.49	30.22	6.33	2.72	2.33
25	22.04	16.08	29.07	7.25	3.60	.01
July 2	22.15	16.17	28.96	7.84	3.64	.34
9	22.47	16.38	29.00	7.87	3.39	1.12
16	22.66	16.60	28.58	8.77	3.42	.70
23	22.76	16.79	28.90	9.54	4.00	.21
30	22.97	17.04	28.99	10.42	4.15	.40
Aug. 6	23.05	17.27	28.92	11.11	4.09	.29
13	23.27	17.50	29.14	11.60	4.10	.59
20	23.41	17.68	29.25	12.38	4.33	.48
27	23.50	17.92	29.33	13.06	4.73	.00
Sept. 2	23.66	18.15	29.46	13.74	4.95	.15
6	23.70	18.27	.....	13.27	3.88	2.15
10	23.86	18.38	29.71	13.69	4.29	.00
17	23.93	18.54	29.75	14.20	4.59	.00
24	24.07	18.77	29.66	14.60	4.75	1.70
Oct. 1	24.24	19.01	30.11	14.93	4.89	.24
8	24.29	19.13	30.03	10.84	3.84	3.98
15	24.36	19.26	30.29	12.51	4.10	.00
22	23.80	19.12	29.98	6.99	3.39	2.92
29	23.75	19.14	30.02	9.17	3.33	.45
Nov. 5	23.45	18.75	29.86	6.89	3.08	1.84
12	22.16	17.68	29.41	3.51	2.63	2.76
19	21.86	17.29	29.20	2.03	2.74	1.83
26	21.62	16.61	28.84	4.13	2.78	.05
Dec. 3	21.78	16.55	28.68	5.03	3.05	.00
10	22.06	16.61	28.59	5.57	3.20	.41
17	22.20	16.62	.....	5.51	2.96	1.41
24	22.33	16.63	.....	4.06	2.44	.02
31	21.11	15.30	27.70	1.95	2.26	2.09
1933						
Jan. 7	20.91	15.33	27.69	2.70	2.73	.00
14	21.09	15.33	27.59	2.81	2.79	.75
21	21.08	15.34	27.27	2.85	2.57	.33
28	20.73	14.28	26.95	1.75	2.22	2.17
Feb. 4	20.30	14.25	26.74	2.36	2.60	.50
11	20.13	14.13	26.43	2.10	2.57	1.18
18	20.11	13.98	26.13	1.92	2.48	.16
25	19.79	13.65	25.71	2.15	2.60	.77

Water levels and weekly precipitation - Continued

Date	Ross	Bacon	Halls Hill	Bell	Swart	Precipitation (inches)
1933						
Mar. 2	19.89	13.73	.....	2.47	2.81	0.02
9	20.14	13.85	.....	2.25	2.77	.48
16	20.61	14.09	.....	2.41	2.85	.55
18	20.37	13.98	24.91	2.41	2.94	.20
25	19.90	13.37	24.62	2.11	2.56	1.94
Apr. 1	19.42	13.28	24.02	2.08	2.71	.06
8	19.53	13.25	23.70	1.81	2.53	1.58
15	19.17	12.92	23.36	1.95	2.64	1.00
22	17.92	12.05	22.64	1.69	2.35	2.10
May 2	17.92	12.33	.....	2.50	3.16	.35
6	18.11	12.35	21.66	1.60	2.44	1.29
13	17.85	12.23	21.27	1.59	2.53	1.56
20	17.35	11.38	20.81	2.15	2.58	1.35
27	17.44	11.72	20.41	2.29	2.80	1.16
June 3	17.97	11.93	20.44	2.36	3.08	.55
10	18.57	12.32	20.44	2.41	3.21	1.31
17	18.81	12.62	20.15	2.66	3.09	.88
24	19.36	13.11	20.58	4.04	3.63	.47
30	19.49	13.38	20.60	3.07	3.68	1.22
July 8	19.46	.....	20.78	3.05	3.52	2.49
15	19.65	14.01	20.90	3.63	3.61	.27
22	19.99	14.38	21.24	4.37	3.85	.42
29	19.95	14.53	21.48	2.30	3.25	3.53
Aug. 5	20.30	14.85	21.55	3.93	3.74	.16
12	20.43	15.07	21.69	4.56	3.57	.91
19	20.74	15.33	21.93	5.23	3.83	.65
26	18.63	13.08	21.55	2.27	2.85	7.99
Sept. 2	18.85	13.45	21.83	2.80	3.13	.20
9	19.18	13.72	21.80	3.21	3.36	.63
16	19.68	14.02	22.03	1.95	2.50	1.27
23	20.20	14.39	22.31	3.34	3.33	.16
30	20.64	14.74	22.87	2.46	3.25	.56
Oct. 7	20.70	14.91	22.52	2.66	3.31	1.15
14	21.22	15.27	23.07	2.91	3.19	.33
21	21.42	15.45	23.32	2.71	3.24	.98
28	21.51	15.55	23.38	3.38	3.40	.10
Nov. 6	21.65	15.67	23.52	2.77	2.97	.64
13	21.74	15.79	23.75	3.53	3.36	.09
18	21.90	15.89	23.94	3.79	3.35	.11
25	22.37	16.13	24.45	4.27	3.46	.00
Dec. 2	22.53	16.25	24.69	4.53	3.53	.11
9	22.64	16.38	24.89	4.59	3.42	.21
16	22.78	16.57	25.14	4.76	3.33	.26
22	22.77	16.56	25.18	3.15	3.06	1.17
29	23.16	16.80	.....	4.15	3.39	.79
1934						
Jan. 5	22.95	16.69	25.26	1.87	2.69	.99
11	22.51	16.50	25.59	2.50	2.96	.12
20	22.66	16.60	25.86	3.23	3.39	.15
27	22.48	16.60	25.66	2.61	3.25	.68
Feb. 3	22.77	16.76	.....	3.60	3.39	.86
10	22.99	16.94	.....	3.96	3.48	.11
17	23.06	17.03	.....	4.15	3.43	.02
24	23.04	16.95	.....	3.00	3.12	.87
Mar. 5	21.97	16.09	25.56	1.40	2.29	1.87
10	21.56	15.94	.....	1.58	2.63	1.17
17	21.21	15.73	25.21	2.01	2.98	.01
24	21.23	15.75	24.98	2.24	3.12	.65
Apr. 3	20.46	14.98	24.38	1.82	2.78	1.87
7	20.19	14.86	.....	1.79	2.82	.22
18	20.28	14.67	23.55	1.55	2.51	1.73
21	20.05	14.48	23.32	1.81	2.83	.06
29	.....	14.62	23.20	2.23	3.36	.26
May 5	20.05	14.42	22.63	2.23	2.94	1.00
12	20.50	14.58	22.61	1.91	3.30	.46
19	20.70	14.68	22.50	2.20	3.44	.70
26	20.86	14.81	22.38	1.68	.....	1.54
June 2	20.96	14.99	22.45	2.66	3.50	.15
9	21.17	15.25	22.61	3.13	3.70	.50
16	21.33	15.46	.....	3.57	3.84	.43

Water levels and weekly precipitation - Continued

Date	Ross	Bacon	Halls Hill	Bell	Swart	Precipitation (inches)
1934						
June 23	21.55	15.75	22.69	1.76	3.42	1.30
30	21.70	16.04	22.99	3.80	4.05	.64
July 7	21.92	16.38	23.19	4.50	4.05	.12
14	22.04	16.55	23.33	5.33	4.30	.07
21	22.33	16.89	23.68	6.43	4.52	.09
28	22.53	17.14	23.96	7.36	4.06	.63
Aug. 4	22.71	17.32	24.26	8.07	3.88	2.24
11	22.88	17.50	24.53	8.76	3.74	.87
18	22.73	17.35	24.73	5.71	2.96	3.22
25	22.88	17.46	24.89	7.03	3.56	.80
Sept. 1	23.01	17.63	25.22	7.32	3.82	.00
8	22.39	17.69	24.79	3.19	2.74	5.39
15	20.18	17.64	24.95	2.00	2.65	6.01
22	18.18	15.54	23.71	1.57	2.23	4.16
29	18.07	15.15	23.49	2.48	2.92	.83
Oct. 7	17.70	14.48	22.88	1.74	2.59	1.60
13	18.47	14.58	22.64	2.66	3.19	.00
20	19.04	14.68	22.54	3.25	3.82	.01
27	19.40	14.75	22.35	3.45	3.34	.20
Nov. 3	20.09	14.98	22.67	3.85	3.37	.12
10	20.40	15.10	22.76	3.71	3.32	.37
17	20.88	15.29	23.01	4.09	3.39	.00
24	21.18	15.45	23.10	3.56	2.75	1.11
Dec. 1	20.72	15.11	22.96	1.26	2.06	3.15
8	19.97	14.55	22.69	2.16	3.01	1.31
15	20.49	14.73	.....	2.48	3.18	.11
22	20.46	14.68	22.75	2.01	2.89	.97
29	20.42	14.69	22.52	1.88	2.91	.34
1935						
Jan. 5	21.05	14.93	.....	2.29	3.15	.56
12	21.09	14.61	22.70	2.02	2.83	.35
19	21.30	14.58	.....	2.09	2.88	.97
26	19.25	12.46	.....	1.70	2.35	3.67
Feb. 2	19.02	13.28	.....	1.87	2.71	.00
9	19.05	13.45	21.15	1.79	2.73	.16
16	18.47	12.51	21.37	1.48	2.31	.79
23	18.40	12.50	20.05	1.77	2.65	.30
Mar. 2	18.47	12.26	19.77	1.64	2.48	1.12
9	18.98	12.48	.....	1.85	2.73	.15
16	17.80	11.56	18.81	1.71	2.43	1.96
23	17.97	11.83	18.70	1.87	2.71	.41
30	18.47	12.05	18.67	1.98	2.89	.34
Apr. 6	18.61	11.99	18.54	1.87	2.74	1.15
13	.....	11.88	17.84	1.63	2.36	2.66
20	17.47	11.27	17.74	1.95	2.77	.01
27	17.92	11.53	17.75	2.14	3.12	.25
May 4	18.57	11.87	17.97	2.15	3.13	.48
11	19.01	12.17	18.17	2.19	3.09	.94
18	19.33	12.47	18.33	2.53	3.34	.66
25	19.74	12.80	18.63	2.47	3.24	.82
June 1	20.16	13.11	18.95	2.33	3.19	1.06
8	20.41	13.44	19.22	3.20	3.42	1.67
15	20.47	13.63	19.35	1.93	2.74	1.08
22	20.67	13.90	19.62	3.41	3.43	.63
29	21.04	14.28	20.10	4.26	3.78	.05
July 6	21.29	14.57	20.34	4.86	3.79	.02
13	21.57	14.90	.....	5.68	3.90	1.39
20	21.85	15.25	21.19	6.56	4.07	.16
27	22.11	15.58	21.54	7.55	4.18	.67
Aug. 3	22.24	15.90	21.78	8.46	4.46	.06
10	22.48	16.17	22.20	8.98	4.04	.70
17	22.71	16.44	22.60	9.40	4.35	.11
24	22.89	16.68	22.91	9.28	4.28	1.44
31	23.06	16.93	23.35	9.88	4.55	.00
Sept. 7	22.37	16.22	23.29	2.38	2.65	7.19
14	22.27	16.12	23.32	4.07	3.31	.52
21	22.36	16.15	23.36	5.10	3.50	.01
28	22.57	16.29	23.53	5.71	3.62	.46
Oct. 5	23.00	16.55	23.96	6.25	3.60	.25

Water levels and weekly precipitation - Continued

Date	Ross	Bacon	Halls Hill	Bell	Swart	Precipitation (inches)
1935						
Oct. 12	23.16	16.70	24.11	6.35	3.50	0.34
19	23.27	16.86	24.25	6.81	3.61	.00
26	23.44	16.99	24.55	6.78	3.52	.43
Nov. 2	23.59	17.02	24.73	4.84	3.23	1.74
9	23.74	17.09	24.96	5.10	3.15	.56
16	23.69	17.04	25.07	3.31	3.08	1.43
23	23.29	16.45	24.83	2.83	3.13	1.05
30	23.20	16.31	24.69	1.70	2.87	.99
Dec. 7	23.23	16.31	24.81	3.45	3.33	.01
14	23.20	17.43	24.68	1.97	2.62	.77
21	23.18	17.62	24.32	3.00	3.24	.11
28	23.34	17.58	24.46	3.57	3.32	.39
1936						
Jan. 1	23.45	17.52	24.55	3.73	3.15	.75

WASHINGTON

GENERAL SUMMARY

In Washington there has been no continuing regional program for the determination of ground-water levels; rather, as in Oregon, determinations have been made for a year or two in a few widely scattered districts and then discontinued. There is no current program for water-level measurements in the State by the United States Geological Survey or any cooperating agencies except in the Palouse River area of the United States Soil Conservation Service.

Calkins[1] lists single measurements of depth to water in 44 wells in east-central Washington, as follows: In the Connell-Ritzville district, 30 wells that range in depth from 110 to 674 feet and in submergence from 14 to 293 feet; in the Hartline district, 10 wells that range in depth from 137 to 293 feet and in submergence from 14 to 200 feet; and in the Quincy district, 4 wells that range in depth from 194 to 330 feet and in submergence from 4 to 140 feet. These measurements are listed to whole feet; it is inferred that they are based on reports by drillers. No altitudes with respect to sea level are given.

In his report on ground-water conditions in south-central Washington, Waring[2] compares water levels in nine wells in the Sunnyside district of the Yakima Valley in the years of drilling, 1890-1900, and again in 1902. The earlier measurements are given to whole feet, the later measurements to the nearest half foot. Waring also lists single measurements of depth to water to the nearest whole foot in 50 wells in the surrounding region. These range in depth between 14 and 1,101 feet and in submergence from less than 1 foot to 532 feet.

Schwennesen and Meinzer,[3] in their investigation in the Quincy Valley, in central Washington, ascertained the depth to water at about 250 widely distributed points, at most of which it was accurately measured in wells. Where measurement was not possible, reports were obtained from well owners, drillers, and other reliable persons. These data have not been published but are on file in the Geological Survey office in Washing-

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1 Calkins, F. C., Geology and water resources of a portion of east-central Washington: U. S. Geol. Survey Water-Supply Paper 118, pp. 71-72, 76-77, 1905.

2 Waring, G. A., Geology and water resources of a portion of south-central Washington: U. S. Geol. Survey Water-Supply Paper 316, pp. 27, 44-45, 1913.

3 Schwennesen, A. T., and Meinzer, O. E., Ground water in Quincy Valley, Washington: U. S. Geol. Survey Water-Supply Paper 425, p. 145, 1918.

ton, D. C. The ground-water levels with respect to sea level are shown in Water-Supply Paper 425 by a contour map on a scale of 1:1,000,000.

The cooperative investigation of ground-water conditions in the Walla Walla Basin that was made in 1932-33 involved about 400 determinations of ground-water levels in that part of the basin that lies in Washington. The data, which have been released to the public,[4] comprise twice-monthly determinations in 32 wells and twice-weekly determinations in 1 well that was equipped with a float gage for observation by the owner. The wells range in depth from 8 to 137 feet, but only two exceed 50 feet. No water-level measurements have been made since 1933.

PALOUSE RIVER AREA OF SOIL CONSERVATION SERVICE

An observation-well program was started along the South Fork of the Palouse River, in Whitman County, Wash., and Latah County, Idaho, during the fall of 1934 by the Geological Survey in cooperation with the Soil Conservation Service. A total of 28 wells have been measured, 1 of which, however, has been abandoned, and 5 are either being used for water supply or are occasionally affected by flood water. Records on the other 22 wells are given in the following tables. Eighteen of these wells are in Washington, and 4 are in Idaho. Of the 22 wells 14 (1, 2, 4, 5, 7, 12, 18, 19, 20, 20a, 21, 24, 35, and 36) are dug, and 8 (6, 11, 23, 26, 27, 31, 32, and 37) are bored. The dug wells are all cased with brick except well 20a, which is cased with wood; the bored wells are all cased with pipe except well 31, which is cased with tile. The wells range in depth from 12 to 39 feet. Most of them penetrate the so-called Palouse soil, which is a wind-blown silt, the underlying bedrock being basalt. They are essentially water-table wells, and none of them are affected by heavy withdrawals. The depths to the water levels in the different wells range from about 2 to 30 feet.

The measurements of depth to water level are made in each well from an established measuring point, which as a rule is the top of the casing, but if there is a pump on the well it is the top of the pump base. Bench marks have been established near each well, and the measuring points have been instrumentally tied to them. About 1,400 measurements have been made on the 22 wells from the beginning of the program to January 1, 1936;

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4 Piper, A. M., Robinson, T. W., and Thomas, H. E., Ground water in the Walla Walla Basin, Oregon-Washington: U. S. Geol. Survey typewritten report, released to the public Oct. 30, 1933.

of these, 1,150 were made during 1935, giving an average of 52 measurements to the well for the year. Only the records of measurements that were made nearest to the first of each month are given in the following table. The method of expressing the results of the measurements is explained in the introduction of this report. Two water-stage recorders have been used in this area since the beginning of the program. One of them has been in continuous operation on well 20; the other has been stationed for shorter periods on four of the other wells.

The water levels in all the wells had an average height above the arbitrary datum planes of 8.60 feet on November 5, 1934, when the first measurements were made in this area. They rose on an average 1.4 feet by January 1, 1935, and an additional 2.8 feet during January, and continued to rise gradually until about the end of April, when the highest average stage for the year was reached. About May 1 the average height of the water levels was 13.72 feet, which was 3.72 feet higher than it was at the beginning of the year. The water levels declined an average of 5.47 feet from about May 1 to about October 1, when they were at the lowest stage for the year. At the end of 1935 they stood at an average of 9.06 feet, which was 1.42 feet above the low stage about October 1 and 0.94 foot below the average on January 1, 1935.

Wells in the South Fork area of the Palouse River, in Washington and Idaho

(The depth to the water level given in the next to last column is the depth below the measuring point on Jan. 1, 1935. The height of the measuring point, given in the last column, is its height with reference to the arbitrary datum.)

Well no.	Owner and location	Depth (feet)	Diameter (inches)	Depth to water level (feet)	Height of measuring point (feet)
1	T. Griffin, NE¼NW¼SW¼ sec. 18, T. 14 N., R. 45 E.	18	....	7.50	17.50
2	A. Luck, W½SW¼NE¼ sec. 19, T. 14 N., R. 45 E.	30	48	9.40	19.40
4	Mrs. Strevey, NW¼SW¼NW¼ sec. 27, T. 15 N., R. 45 E.	39	....	25.70	35.70
5	T. Pritchard, NW¼NE¼ sec. 28, T. 15 N., R. 45 E.	10	....	2.60	12.60
6	-- O'Donnel, NW¼NW¼ sec. 19, T. 15 N., R. 46 E.	18	1.5	10.20	20.20
7	C. Stirewalt, NW¼SE¼ sec. 20, T. 15 N., R. 46 E.	15	....	8.30	18.30
11	U.S.G.S., SE¼NW¼SE¼ sec. 25, T. 15 N., R. 45 E.	15.8	1.5	5.40	15.40
12	G. Mix, SE. corner NE¼SW¼ sec. 1, T. 39 N., R. 6 W.	22	....	15.70	25.70
18	F. Druffel, center E½ NW¼SW¼ sec. 3, T. 13 N., R. 45 E.	15	....	7.80	17.80
19	A. Shriver, SE¼SW¼ sec. 7, T. 14 N., R. 46 E.	12.5	....	9.20	19.20

Wells in the South Fork area of the Palouse River - Continued

Well no.	Owner and location	Depth (feet)	Diameter (inches)	Depth to water level (feet)	Height of measuring point (feet)
20	W. Benedict, NE. corner SW¼SE¼ sec. 24, T. 14 N., R. 44 E.	26	....	12.00	22.00
20A	do.	12	....	3.00	13.00
21	J. E. Woods, center E½ NW¼ sec. 32, T. 14 N., R. 46 E.	20	....	6.00	16.00
23	U.S.G.S., NW¼SW¼SW¼ sec. 11, T. 14 N., R. 45 E.	15	1.5	8.00	18.00
24	C. J. Bowers, NE. corner NE¼NW¼ sec. 7, T. 14 N., R. 46 E.	15	....	2.45	12.45
26	A. Snow, NW¼NW¼SE¼ sec. 30, T. 39 N., R. 5 W.	31.1	....	20.20	30.20
27	-- Laney, SW¼SW¼NE¼ sec. 17, T. 39 N., R. 5 W.	36.3	....	7.80	17.80
31	W. Buttler, NW¼NW¼NE¼ sec. 35, T. 40 N., R. 5 W.	24	....	3.49	13.49
32	U.S.G.S., center of N. line, SW¼NE¼ sec. 10, T. 39 N., R. 5 W.	21.5	1.5	18.40	28.40
35	R. Barr, center SW¼ sec. 17, T. 15 N., R. 44 E.	27	....	15.45	25.45
36	School district, SE¼SW¼NW¼ sec. 17, T. 15 N., R. 44 E.	18	....	6.48	16.48
37	U.S.G.S., SE. corner NE¼ sec. 3, T. 40 N., R. 45 E.	20	1.5	12.00	22.00

Water levels in wells in the South Fork area of the Palouse River, in Washington and Idaho, in feet above the arbitrary datum

Date	1	2	4	5	6	7	11	12
1934								
Nov. 5	8.67	4.47	9.40	.....	.....	9.48	.....	10.12
Dec. 6	8.81	7.56	9.37	.....	.....	9.22	.....	9.56
Dec. 29-Jan. 3 1935	9.83	9.77	10.02	.....	10.02	9.90	9.97	9.87
Jan. 29-30	11.24	13.06	11.36	9.88	13.12	11.49	10.86	16.81
Feb. 25-27	11.15	12.69	11.63	9.80	14.23	11.60	10.73	18.70
Apr. 1-3	12.15	13.36	12.10	9.83	15.07	12.48	11.23	21.46
Apr. 29-May 1	11.54	13.16	13.40	9.72	15.64	12.66	10.60	21.70
May 27-29	10.19	11.75	13.18	9.56	12.58	11.59	9.70	20.37
June 25-26	9.78	10.36	11.81	9.44	8.80	10.94	8.91	18.91
July 29-30	9.32	6.89	10.52	9.38	5.90	10.45	7.83	16.34
Sept. 3-4	8.77	1.68	9.53	9.45	4.24	10.16	7.06	13.07
Sept.30-Oct. 2	8.59	.50	9.38	9.46	3.61	9.94	7.10	11.46
Oct. 28-30	8.63	3.28	9.59	9.51	3.92	10.07	7.51	10.56
Dec. 2-4	8.53	6.28	9.58	9.52	3.59	9.53	7.61	9.56
Dec. 30-Jan. 2	8.85	9.30	9.72	9.66	3.73	9.65	7.88	9.33

Water levels in wells in South Fork area of Palouse River - Continued

Date	18	19	20	20A	21	23	24	26
1934								
Nov. 5	.....	9.16	.....	.....	.....	9.39	.....	9.60
Dec. 6	.....	9.40	.....	.....	.....	9.67	.....	9.20
Dec. 29-Jan. 3	10.07	10.00	9.92	9.78	.....	10.14	10.00	10.00
1935								
Jan. 29-30	12.33	12.95	17.40	10.60	11.45	13.11	10.07	23.29
Feb. 25-27	13.05	13.00	17.33	10.55	10.72	12.33	9.95	18.93
Apr. 1-3	14.08	13.82	18.42	10.57	11.50	14.04	10.03	20.40
Apr. 29-May 1	13.43	13.35	17.55	10.45	11.70	12.70	9.90	21.40
May 27-29	11.81	11.82	15.41	10.10	10.47	11.46	7.43	15.68
June 25-26	10.54	10.57	11.62	9.78	9.48	10.03	6.97	13.03
July 29-30	8.50	9.10	6.65	9.85	8.44	8.90	5.73	11.95
Sept. 3-4	7.24	8.16	3.94	9.69	8.15	7.18	4.91	11.45
Sept.30-Oct. 2	7.07	7.97	3.67	9.87	8.13	7.02	4.55	11.01
Oct. 28-30	7.93	8.07	5.78	10.17	8.25	7.96	4.59	10.82
Dec. 2-4	8.70	8.29	7.64	10.26	8.34	8.35	5.03	10.38
Dec. 30-Jan. 2	9.76	8.70	11.25	10.82	8.67	8.63	9.75	10.67

Date	27	31	32	35	36	37	Average
1934							
Nov. 5	.....	6.21	.....	8.47	9.65	.....	8.60
Dec. 6	.....	6.62	.....	8.90	9.74	.....	8.91
Dec. 29-Jan. 3	9.99	9.96	9.94	10.05	10.04	.....	9.96
1935							
Jan. 29-30	12.52	10.86	10.10	11.39	12.37	14.06	12.74
Feb. 25-27	12.29	10.58	14.05	11.77	10.89	15.93	12.81
Apr. 1-3	13.35	10.74	15.83	12.83	11.18	16.69	13.69
Apr. 29-May 1	13.65	10.79	17.14	13.95	10.57	16.85	13.72
May 27-29	12.22	9.89	16.60	13.50	9.40	15.33	12.27
June 25-26	10.93	8.70	14.69	11.34	9.34	13.97	10.90
July 29-30	9.42	6.95	13.04	7.99	9.26	.....	9.16
Sept. 3-4	8.08	5.82	12.07	7.43	9.29	9.75	8.05
Sept.30-Oct. 2	6.99	5.19	11.28	7.39	9.32	8.73	7.64
Oct. 28-30	6.83	5.28	11.40	8.15	9.49	8.68	8.02
Dec. 2-4	6.92	5.59	10.33	8.52	9.35	8.93	8.22
Dec. 30-Jan. 2	7.08	6.04	10.19	10.21	10.01	9.51	9.06

WISCONSIN

CENTRAL AND NORTHEASTERN WISCONSIN

The Wisconsin Conservation Department, in connection with an investigation of the shallow ground-water resources of the Forest Protection Districts, installed four observation wells in 1935 and began periodic measurements on the water levels in them. The United States Geological Survey has cooperated only informally in this project.

The wells are in Langlade, Oneida, and Marionette Counties, in the northeastern part of the State, and Adams County, in the central part. They are equipped with float-tape gages, which are read daily by local observers.

In this report the daily record, supplied by G. T. Owen, of the Conservation Department, is given for the Adams County well, on which measurements were begun September 12, 1935. This well is at the district ranger station at Friendship, in the NW¼ sec. 8, T. 17 N., R. 6 E., about 956 feet above sea level. The well is 8 inches in diameter and 24 feet deep and obtains its water from glacial drift. A log of the well follows:

	Thickness (feet)	Depth (feet)
Sand and rock fill	2	2
Peat and muck	2	4
Dune, alluvial, and lake sand	7	11
Laminated glacial-lake clay	5	16
Glacial-lake sand	4	20
Laminated glacial-lake clay	4	24

The measuring point on the well is the pointer on the float-tape gage, 4.6 feet above the land surface. The depths to the water level have been converted to heights above an arbitrary datum, the datum selected being 10 feet below the water level on September 12, 1935. The depth to the water level below the measuring point on that date was 13.63 feet.

Daily records of the precipitation have been obtained from a rain gage 30 feet from the observation well. Daily water levels, expressed in feet above the arbitrary datum, and the daily precipitation for the period from September 12, 1935, to January 1, 1936, are given in the following table:

Daily water levels in an observation well and daily precipitation at Friendship, Adams County, Wis.

Date	Water level (feet)	Precipitation (inches)	Date	Water level (feet)	Precipitation (inches)	Date	Water level (feet)	Precipitation (inches)
1935			1935			1935		
Sept. 12	10.00	....	Oct. 18	9.47	0.18	Nov. 23	9.25	....
13	10.00	....	19	9.53	....	24	9.25	....
14	10.05	....	20	9.49	....	25	9.39	....
15	9.98	....	21	9.61	.06	26	9.26	....
16	10.02	....	22	9.43	.02	27	9.54	0.43
17	10.01	....	23	9.38	.10	28	9.51	a .30
18	9.96	....	24	9.42	....	29	9.48	....
19	10.06	0.89	25	9.38	....	30	9.56	....
20	10.20	.48	26	9.37	Trace	Dec. 1	9.47	....
21	10.20	Trace	27	9.43	....	2	9.47	....
22	10.18	....	28	9.43	....	3	9.54	....
23	10.10	....	29	9.37	Trace	4	9.46	Trace
24	10.10	....	30	9.35	.31	5	9.49	....
25	10.04	....	31	9.36	.22	6	9.45	Trace
26	9.96	.32	Nov. 1	9.35	....	7	9.48	.15
27	9.83	....	2	9.35	....	8	9.46	....
28	9.93	....	3	9.61	.27	9	9.50	....
29	9.85	....	4	9.61	.48	10	9.45	....
30	9.90	....	5	9.61	.07	11	9.45	....
Oct. 1	9.47	....	6	9.60	.03	12	9.42	....
2	9.70	....	7	9.82	Trace	13	9.36	....
3	9.72	.09	8	9.71	....	14	9.31	.10
4	9.57	....	9	9.80	....	15	9.31	.02
5	9.51	....	10	9.81	.08	16	9.28	....
6	9.45	....	11	9.59	.02	17	9.34	....
7	9.51	....	12	9.59	....	18	9.30	....
8	9.54	....	13	9.57	....	19	9.30	....
9	9.51	....	14	9.53	....	20	9.14	a .03
10	9.52	.30	15	9.49	....	21	9.15	....
11	9.45	.09	16	9.51	....	22	9.20	a .08
12	9.45	Trace	17	9.54	....	23	9.09	a .12
13	9.49	.02	18	9.58	....	24	8.99	a .05
14	9.48	.35	19	9.58	.14	25	8.97	a .22
15	9.43	Trace	20	9.45	.13	1936		
16	9.43	....	21	9.45	Trace	Jan. 2	8.97	a .04
17	9.44	.27	22	9.17	.02			

a Snow.

COON CREEK AREA OF SOIL CONSERVATION SERVICE

An observation-well program was started in June 1934 in the Coon Creek area, in Vernon, Monroe, and La Crosse Counties, Wis., by the Geological Survey in cooperation with the Soil Conservation Service as part of a national soil-conservation program. Water-level measurements were begun on 15 wells, 1 of which has since been abandoned.

The wells range in depth from about 13 to 182 feet. Some of them end in alluvium or other surficial deposits, and others in dolomite or sandstone of early Paleozoic age. Six of the wells (1, 4, 6, 10, 12, and 13) are bored wells, and two (3 and 5) are drilled wells; these eight are cased with galvanized pipe. Three (7, 8, and 9) are dug wells and are cased with loose rock or sandstone. Information is not available as to the type and casing of wells 2, 11, and 14.

The wells are not affected by heavy withdrawals. The depth to water level in the different wells ranges from about 6 to 110 feet. Most of them are essentially water-table wells, but some of the deeper wells are known to have distinct barometric fluctuations and are probably artesian. The measurements of the depth to water level are made in each well from a definite measuring point, which is generally the top of the casing or the edge of a hole in the floor of the platform. Bench marks have been established near each well, and the altitude of the measuring point has been instrumentally tied to them. A total of 1,245 measurements were made from the beginning of the program to January 1, 1936, of which 770 were made during 1935 -- an average of 51 measurements to the well during the year. Only the records of measurements that were made nearest to the first of each month are given in this report. The method of expressing the results of the measurements is described in the introduction. Water-stage recorders have been in operation on wells 7 and 8 since the beginning of the program.

The severe drought culminated in this area in May 1934 and was effectively broken in June or July. The precipitation recorded at La Crosse was 3.56 inches in June, 8.27 in July, 1.90 in August, 9.04 in September, 2.38 in October, 7.01 in November, and 1.12 in December. Thus in spite of the deficiency in the first 5 months of the year, the annual precipitation was 6.92 inches above normal.

In the first 4 months on well observations, from July to October 1934, the water levels fluctuated through only a small range and showed little tendency either to rise or to fall. Doubtless a large part of the precipitation was required to restore depleted soil moisture and to supply the demands of vegetation during the growing season. However, about enough water apparently penetrated to the water table to replace the ground water lost by effluent seepage and transpiration. The heavy rains in November produced a moderate rise in most wells, but there was a general decline in December, with the result that on January 1, 1935, the average of the water levels was not far from the average at the beginning of the observations.

The precipitation in the winter of 1934-35 was not far from normal. The water levels did not change much until early spring, when there was a notable rise in the shallow wells and an average rise in all wells of more than 2.5 feet. From May to October 1935 the rainfall at La Crosse was greater than normal in all except one month, and the total in this 6-month period was about 11 inches above normal. Consequently there was

considerable recharge during the period and the water levels were in general well sustained. At the end of 1935 the water levels in a few of the wells were distinctly higher than at the beginning of the year, but in most of the wells there was no considerable net rise or fall.

The relatively deep observation wells did not fluctuate as much as the shallower wells. The water levels in wells 8 and 9, both of which are a little more than 50 feet deep, did not rise notably in the spring of 1935 but tended to rise gradually during the summer, and each showed a small net rise for the year. The water level in well 5, which is 182 feet deep, showed fluctuations of only small range, which were probably due mainly to changes in atmospheric pressure. It did not respond to precipitation or to the spring thaw, but on the average stood more than 6 inches lower in 1935 than during the period of record in 1934.

Wells in the Coon Creek area, in Vernon, Monroe, and La Crosse Counties, Wis.

(The depth to the water level given in the next to last column is the depth below the measuring point on Jan. 1, 1935. The height of the measuring point, given in the last column, is its height with reference to the arbitrary datum.)

Well no.	Owner and location	Depth (feet)	Diameter (inches)	Depth to water level (feet)	Height of measuring point (feet)
1	Ed Clements, SE¼NE¼ sec. 22, T. 15 N., R. 5 W.	13.5	7	6.32	16.32
2	Joe Anderson, SE¼SE¼ sec. 34, T. 15 N., R. 4 W.	20	6	18.30	28.30
3	Anton Bekkum, NE¼NE¼ sec. 12, T. 14 N., R. 5 W.	21.7	6.5	18.16	28.16
4	Albert Storbakken, NE¼NE¼ sec. 14, T. 14 N., R. 5 W.	20.7	4.7	14.00	24.00
5	John Bakkestuen, SW¼SW¼ sec. 15, T. 14 N., R. 5 W.	182	6	106.25	116.25
6	Ole Olson, NE¼SE¼ sec. 7, T. 14 N., R. 5 W.	21.3	4	14.07	24.07
7	A. Michel, SW¼ sec. 36, T. 14 N., R. 6 W.	.....	48	15.06	25.06
8	C. Stylen, SE¼NE¼ sec. 26, T. 14 N., R. 7 W.	54.7	30	52.11	62.11
9	F. Lenser, NW¼NE¼ sec. 14, T. 14 N., R. 7 W.	52	48	51.00	61.00
10	Dennis Shea, NW¼NW¼ sec. 5, T. 15 N., R. 3 W.	15.3	7	11.45	21.45
11	John Sullivan, SW¼NE¼ sec. 27, T. 16 N., R. 3 W.	11.5	6	8.77	18.77
12	Melvin Olson, SE¼NE¼ sec. 32, T. 16 N., R. 4 W.	32.9	6	28.79	38.79
13	W. W. Poss, SE¼NW¼ sec. 3, T. 16 N., R. 4 W.	14	8	9.97	19.97
14	Chris Benrud, NE¼NW¼ sec. 6, T. 14 N., R. 4 W.	25	6	6.86	16.86