Geology and Occurrence of Ground Water in the Townsend Valley Montana

GEOLOGICAL SURVEY WATER-SUPPLY PAPER 1360-C

Geology and Occurrence of Ground Water in the Townsend Valley Montana

By H. W. LORENZ *and* R. G. McMURTREY

With a section on

CHEMICAL QUALITY OF THE GROUND WATER

By H. A. SWENSON

CONTRIBUTIONS TO HYDROLOGY OF THE UNITED STATES

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GEOLOGY AND OCCURRENCE OF GROUND WATER IN THE TOWNSEND VALLEY, MONTANA

By H. W. Lorenz and R. G. McMurtrey

ABSTRACT

The Townsend Valley in west-central Montana is a 600 square-mile intermontane basin bordered by the Big Belt Mountains on the east and by the Elkhorn Mountains on the west. It extends from approximately T. 4 N., to T. 11 N., inclusive. Rocks ranging in age from Precambrian to Cretaceous crop out in the mountainous areas that surround the valley, and rocks of Tertiary (Oligocene and Miocene) age crop out on the higher valley slopes and underlie the alluvial deposits in the valley bottom. The area is drained by the Missouri River, which enters the Townsend Valley through a gorge at the southern end of the valley and leaves through another gorge at the northern end.

The climate of the valley is semiarid; the average annual precipitation is 12.35 inches. Farming is the principal occupation. About one-third of the cultivated land is irrigated by water diverted from the Missouri River and perennial mountain streams, and the remaining cultivated land is farmed by dryland methods. Wheat, oats, barley, sugar beets, and potatoes are the principal crops.

Mining, which was once the chief industry of the area, is now (1951) sporadic and on a small scale. Gold, silver, and lead are the chief metals mined. Small amounts of coal, marble, quartzite, and iron ore have been mined during the past 10 years.

A large reservoir of ground water underlies the valley. On the valley floor shallow wells yield an abundant supply of water for domestic and stock use, but on the higher slopes wells must be drilled to a depth of 200 to 300 feet to obtain an adequate supply.

Water is confined under artesian pressure in Tertiary beds that underlie the southern end of the valley and the area along the west flank of the Dry Creek anticline east of Townsend.

The denser pre-Tertiary formations contain water in fissures and small openings and springs are numerous where these rocks crop out. Big and Plunket (Mockel) Springs, which yield about 57 and 8.7 cfs, respectively, are the largest.

The principal sources of recharge to ground water in the younger, unconsolidated deposits are streams, irrigation canals and laterals, and irrigation floodwater. About 8,500 acres of the land is waterlogged because the transmissibility of the underlying water-bearing materials is low or because the configuration of the bedrock is such that the movement of ground water is restricted. Of this total, 1,500 acres will be inundated by water impounded by the Canyon Ferry dam. Drainage of the remaining waterlogged land would greatly increase the agricultural potential of the valley.

Irrigation utilizing ground-water resources is in a pioneering stage in the Townsend Valley. In the summer of 1950 the first well for irrigation supply was drilled 3½ miles southeast of Townsend and when tested, using air compressors, produced about 240 gpm.

Water from ground and surface sources in the Townsend Valley generally is hard **but only** moderately mineralized and is suitable for most domestic and irrigation uses. **The range** in dissolved solids and hardness of 38 samples of ground water was 134 to 976 ppm **and** 84 to 602 ppm, respectively. Samples collected in 1921–22 and again in 1949 from **springs** in this region show about the same chemical character. The effects of waterlogging on the quality of the ground water cannot at present be determined, but evidence indicates that the mineral content of the ground water has not yet changed materially.

INTRODUCTION

LOCATION AND EXTENT OF AREA

The Townsend Valley trends slightly northwest across the central part of Broadwater County and the southeastern part of Lewis and Clark County, in west-central Montana. (See fig. 29.) The valley is bordered by the Big Belt Mountains on the east and by the Elkhorn Range on the west. The area studied extends from about T. 4 N., to T. 11 N., inclusive. Townsend, the county seat of Broadwater County, is in the central part of the valley and is 35 miles southeast of Helena, the capital of Montana.

The part of the valley underlain by Tertiary and younger sediments has a maximum width of 15 miles and a length of about 45 miles. The Missouri River flows northward, entering the valley near Toston and leaving it at Canyon Ferry. Near its southern

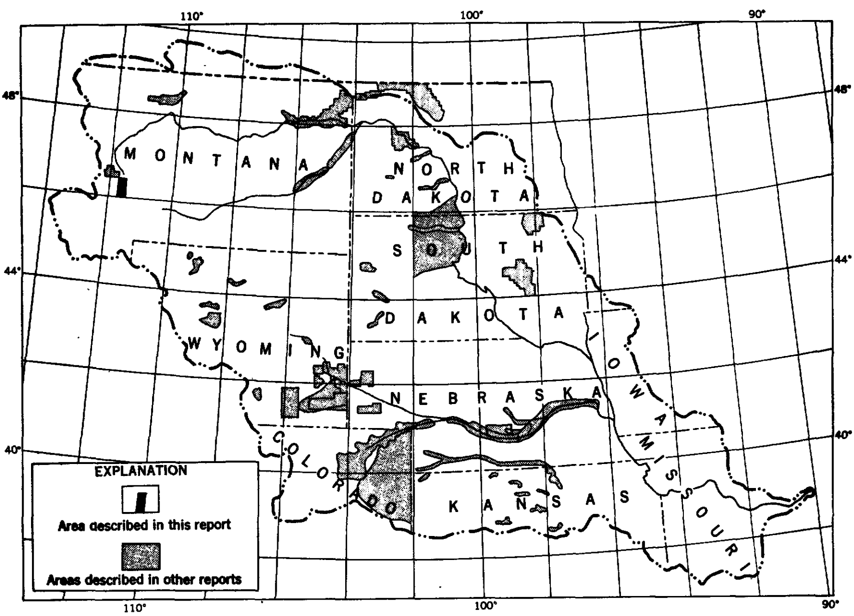

Figure 29.—Map showing areas in which ground-water studies have been made under the program for development of the Missouri River basin.

end the valley broadens into a low, gently sloping plain which is crossed by Crow Creek. This plain, approximately 10 miles wide from east to west and 15 miles long, will be referred to as the Crow Creek area in this report.

PURPOSE AND SCOPE OF INVESTIGATION

The purpose of the study was to collect and evaluate data pertaining to the general ground-water conditions of the Townsend Valley. The bottom lands of the valley are irrigated at the present time (1951), and the higher parts have been proposed for irrigation under the program of the United States Department of the Interior for development of the Missouri River basin. Fieldwork was done by the senior author between June and October 1949 and by both authors during the 1950 field season. However, periodic measurement of the water level in selected observation wells was continued by the junior author until February 1954.

Construction of the new Canyon Ferry dam across the Missouri River at the north end of the Townsend Valley was begun by the United States Bureau of Reclamation on July 22, 1949. When the water behind the completed dam reaches its maximum height (3,800 feet above sea level), the reservoir will contain 2 million acre-feet of water and will inundate 35,200 acres of land (see pl. 19). About 30,000 acres within the boundary of the proposed reservoir is farmland of which 10,000 acres is under irrigation and the remainder either dry-farmed or used for grazing.

According to plans made by the Bureau of Reclamation, about 5,000 additional acres in the Crow Creek area southwest of Toston is to be irrigated by pumping water from the Missouri River at a point about 2 miles below Lombard. Thus, the area proposed for irrigation will replace about half the 10,000 acres of irrigated farmland that will be inundated by backwater from the Canyon Ferry dam. Ground-water conditions in the area proposed for irrigation will be changed materially as a result of the irrigation.

The geology of the area was mapped by the senior author on aerial photographs and transferred later to a base map by use of a sketchmaster. The study of ground-water conditions included an inventory of wells used for domestic purposes, watering of stock, and irrigation. Measurements of the water level in observation wells were made periodically; hydrographs showing the water-level fluctuation in a few typical wells and a water-table contour map were prepared. The altitude of the measuring point of the wells was determined instrumentally.

The field investigation was under the general direction of A. N. Sayre, chief of the Ground Water Branch of the United States Geological Survey, and G. H. Taylor, regional engineer in charge of ground-water investigations in the Missouri River basin, and under the direct supervision of F. A. Swenson, district geologist in charge of ground-water investigations in Montana and northern Wyoming. The quality-of-water study was under the general direction of S. K. Love, chief of the Quality of Water Branch, and P. C. Benedict, regional engineer in charge of quality-of-water investigations in the Missouri River basin.

PREVIOUS INVESTIGATIONS

The first study of the geology and the ground-water resources of the Townsend Valley was made by Pardee (1925). No further geologic work of note was done in the Townsend Valley until 1946, when the geology and mineral resources of the Canyon Ferry quadrangle, including about 300 square miles in the northern part of the valley, were mapped by the U. S. Geological Survey. In 1949 Edward T. Ruppel,[1] of the Geological Survey, mapped the geology of the Limestone Hills southwest of Townsend. Reports based on these studies, and other reports describing the geology and the mineral resources of the region, were drawn on freely in the preparation of this report and are listed at the end of the report.

ACKNOWLEDGMENTS

The writers appreciate the assistance they received from many persons during the course of the field study and in the preparation and review of this report. Both the late A. H. Tuttle, recently retired district engineer, Surface Water Branch, and his successor, Frank Stermitz, gave much valuable help. M. R. Klepper of the Mineral Deposits Branch spent several days in the field with the senior author, and F. C. Koopman of the Ground Water Branch aided in the construction of observation wells. Leroy Kay of the Carnegie Museum, Pittsburgh, Pa., gave much assistance in the study of Tertiary deposits. F. V. Munro and others of the U. S. Bureau of Reclamation furnished ground-water data and maps of the proposed Crow Creek irrigation unit. Clayton Ogle, work unit conservationist of the Soil Conservation Service, made available some ground-water, soil, crop, and irrigation data from Broadwater County. Many farmers furnished information about their wells and gave permission for the periodic measurement of the water level in their wells.

[1] Ruppel, E. T., 1950, Geology of the Limestone Hills, Broadwater County, Mont., Master's thesis, Univ. Wyoming, Laramie; *also* U. S. Geol. Survey open-file rept.

HISTORY OF THE AREA

Members of the Lewis and Clark Expedition were the first white men to see the Townsend Valley and to record their passage through the area. On July 21, 1805, Lewis recorded in his journal (Thwaites, 1904):

> ***the country was rough mountainous and much as that of yesterday until towards evening when the river entered a beautiful and extensive plain country 10 or 12 miles wide which extends upwards further than the eye could reach. This valley is bounded by two nearly parallel ranges of high mountains which have their summits partially covered with snow***.

Four days were required for the expedition to travel up the valley from Canyon Ferry to the deep gorge where the river enters the valley near Toston. During their travel, they noted that many mountain streams joined the river and that a large number of springs fed these streams; they made specific reference to two that are now known as Big Spring and Plunket Spring.

After the departure of the Lewis and Clark Expedition, nothing of recorded historic importance occurred in the Townsend Valley for nearly 60 years. During the winter of 1864–65, gold was discovered by some Confederate soldiers of Price's army who had fled up the Missouri River in 1861. Some of the gravel in Confederate Gulch was reported to have the highest gold content ever found in Montana; a small amount of it yielded $1,000 worth of gold to the pan. Word of the fabulous richness of the gravel in Confederate Gulch spread rapidly; hundreds of miners hurried into the area, and their settlement in the gulch became known as Diamond City, the mining capital of western Montana. Prosperity lasted for only a decade and the once thriving mining center gradually became a ghost town.

In 1866 both lode and placer gold were found near Radersburg, which was then a small station on the overland route from Helena to Bozeman. For a short while, Radersburg was the county seat of Jefferson County and, during the prosperous mining days before the turn of the century, it was a thriving community. When lode mining was no longer successful in the vicinity, the town dwindled to a small trading post.

After the discovery of gold at Diamond City and the opening of the lode mines at Radersburg, the demand for food and farm produce greatly increased. A large grist mill, powered by water, was built and operated at Bedford during the 1870's. The remains of the mill, one of the oldest in the State, can be seen near U. S. Highway 10N, 3 miles northwest of Townsend.

Hassel, at one time called St. Louis, was situated along the banks of Indian Creek, 6 miles west of Townsend, and was the center of a gold- and silver-producing area for many years. At one time, one of the largest and most elaborate ore concentrators in Montana was located near Hassel on the Diamond Hill property. Large-scale mining ceased about 1900; eventually the town was abandoned and the last of its dwellings removed.

After mining became less profitable, many miners turned to farming, which later became the principal means of livelihood in this area. Townsend, founded in 1883, became the trading post. In 1897 it became the county seat of Broadwater County and soon grew to be the largest town in the valley.

WELL-NUMBERING SYSTEM

Wells described in this report are numbered according to their location within the U. S. Bureau of Land Management's system of land subdivision (fig. 30). The first letter of a well number indicates the quadrant of the meridian and baseline system in which the well is located. The quadrants are identified by capital letters, beginning with A in the northeast quadrant and proceeding counterclockwise. All of the wells described in this report are in the northeast (A) or northwest (B) quadrants of the principal meridian (Montana) and baseline system. The township in which a well is located is indicated by the first numeral of the well number, the range by the second numeral, and the section by the third. The two lowercase letters following the section number indicate the location of the well within the quarter section and the quarter-quarter section, respectively. The letters are assigned in a counterclockwise order, beginning with a in the northeast quarter or quarter-quarter section. Serial numbers are appended to the last lowercase letter if two or more wells are located within the same quarter-quarter section.

GEOGRAPHY

CLIMATE

The climate of the Townsend Valley is characterized by low rainfall and humidity, great temperature extremes, and an abundance of sunshine. Midsummer days are warm and occasionally hot, but, because the humidity is usually low, they are tolerable and pleasant. The extreme cold of winter also is tempered by the dry atmosphere. Often, cold spells are terminated by warm winds, or chinooks.

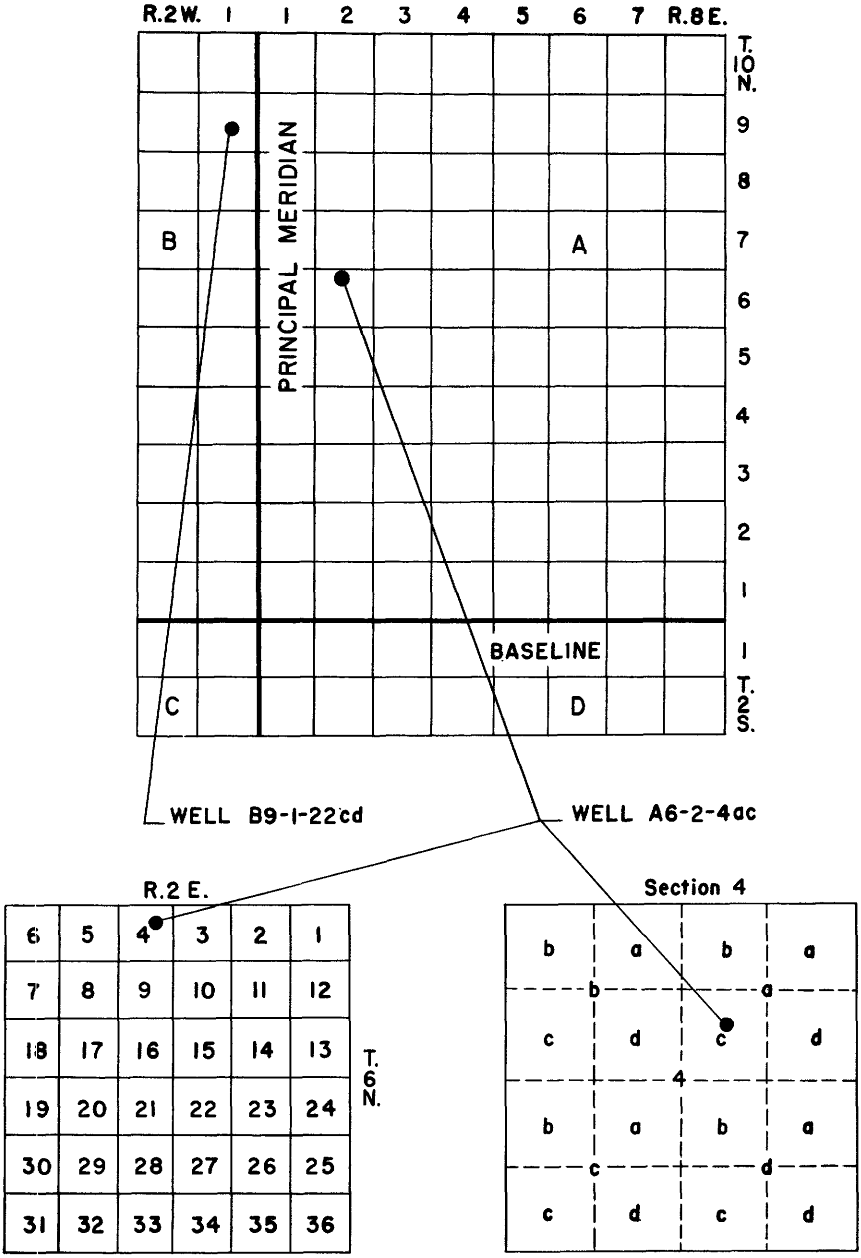

Figure 30.—Sketch showing well-numbering system.

In the summer, light thunderstorms occur frequently in the valley. Usually the storms move from west to east and are of short duration and of local extent. Generally much more moisture falls on the mountains than in the valley. The strong winds and hail that often accompany the rainstorms sometimes damage the farm crops. Precipitation on the valley floor is not sufficient for most crops.

The annual rainfall recorded by the United States Weather Bureau station at Canyon Ferry for a period of 51 years (1899–1949) averaged 11.35 inches. (See fig. 31.) An average of 37 percent of the annual precipitation falls during May and June; an average of 20 percent falls during June, the wettest month. Only 3 percent falls during February, the driest month. During the 51-year period, the annual precipitation has ranged from a minimum of 6.01 inches in 1919 to a maximum of 17.43 inches in 1947.

A longer record of precipitation has been made by the Weather Bureau station at Helena, which is approximately 15 miles west of Canyon Ferry. There, the average annual precipitation for a 66-year period (1884–1949) was 12.56 inches. (See fig. 32.) About 33 percent of the annual precipitation falls during May and June; an average of 18 percent falls during June, the wettest month. Only 5 percent falls during February, the driest month.

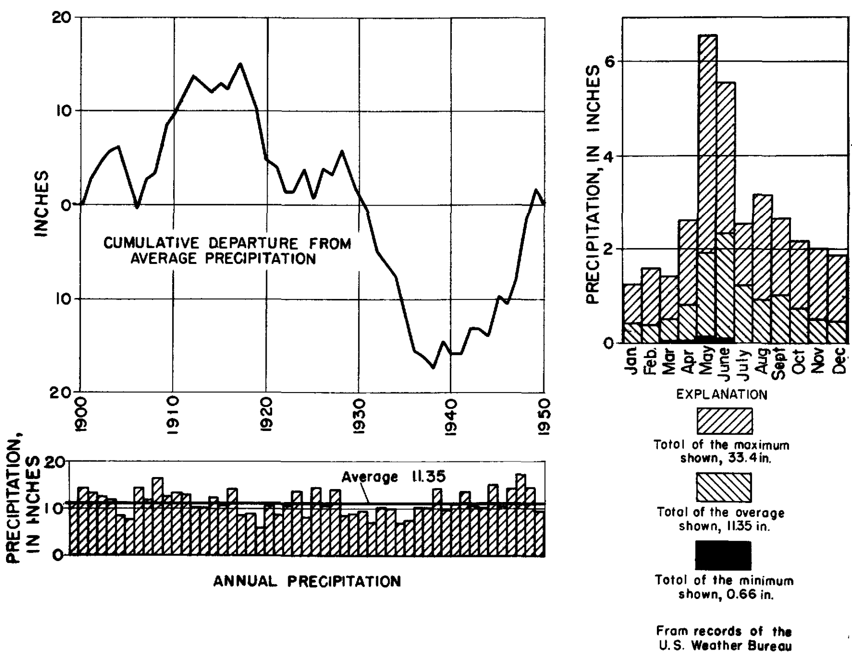

Figure 31.—Precipitation records at Canyon Ferry, 1899–1949.

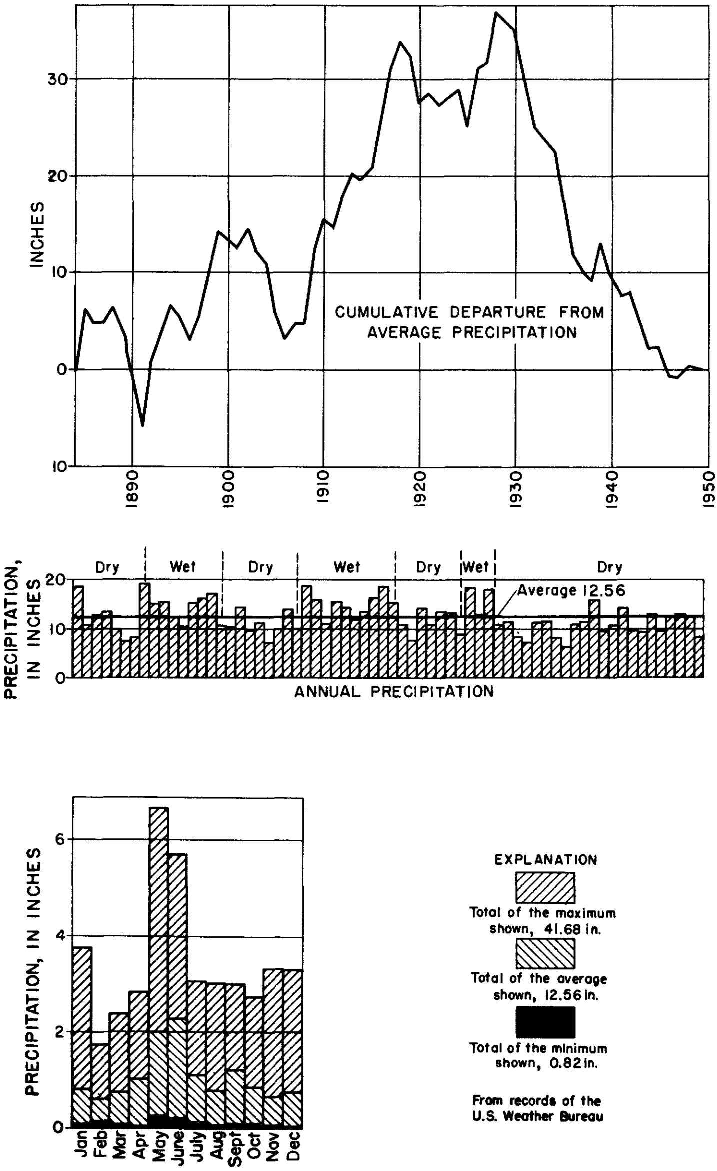

Figure 32. —Precipitation records at Helena, 1884–1949.

The graph (fig. 31) showing the cumulative departures from average precipitation at Canyon Ferry indicates that the periods 1899–1917 and 1937–50 were characterized by above-average precipitation and the intervening period, 1918–36, by below-average precipitation. Somewhat in contrast, precipitation records for Helena indicate that the period 1890–1927 was characterized by above-average precipitation and the period from 1928–47 by below-average precipitation.

The mountains and canyons surrounding the valley influence the movement of air masses across the valley floor; consequently, some parts of the valley have a longer frost-free growing season and also receive less damage from hail than do other parts. In the southern part of the valley, the average frost-free period is reported by Gieseker (1944, p. 13) to extend from late May to early September; in the northern part, however, it extends from early May to late September. The mean annual temperature at Canyon Ferry is 43.7° F. The lowest recorded midwinter temperature is -41° F and the highest recorded midsummer temperature is 104° F. January is the coldest month and has a mean temperature of 19.9° F; July is the warmest month and has a mean temperature of 68.6° F.

The mean annual temperature recorded at Helena is 43.8° F. The lowest recorded midwinter temperature was -42° F on January 31, 1893, and the highest recorded midsummer temperature was 103° F on August 21, 1940. January is the coldest month and has an average temperature of 20.5° F; July is the warmest month with an average temperature of 67.8° F.

DRAINAGE

The Missouri River and its tributaries drain all the area covered by this investigation. The river enters the Townsend Valley through a double-horseshoe gorge southeast of Toston and leaves the valley through a gorge at Canyon Ferry. A concrete dam, now (1951) under construction at Canyon Ferry, will regulate the flow of the Missouri River where it leaves the Townsend Valley. The altitude of the river near Toston is 3,900 feet and downstream at Canyon Ferry its altitude is 3,660 feet; the gradient of the river is a little more than 5 feet to the mile. The mean annual flow of the river at Toston for the periods 1910–16 and 1941–45 ranged from 5,060 to 6,990 cfs and the average flow was about 5,800 cfs. The maximum discharge of 29,800 cfs was measured June 1, 1913; the minimum discharge (regulated by power and storage dams upstream) of 562 cfs was measured on April 30, 1941. The minimum daily discharge (estimated) of 1,100 cfs occurred on

February 10, 1914 (Pardee, 1925, p. 9). Since 1940 the Broadwater Canal, which has a capacity of 350 cfs, has diverted water for irrigation from the river 3 miles above the gaging station at Toston.

Eleven perennial streams enter the Missouri River in the Townsend Valley. Deep Creek is the largest of the streams that issue from the Big Belt Mountains to the east of the valley. Crow Creek and Beaver Creek are the largest perennial streams that head in the Elkhorn Mountains west of the valley.

Two random measurements of the flow of Deep Creek, made about 10 miles east of its confluence with the Missouri River, are as follows: October 30, 1910, 17.4 cfs, and May 12, 1911, 45 cfs (U. S. Geol. Survey, 1911, p. 48, 49). The flow of Crow Creek, about 5 miles northwest of Radersburg, was measured during the period 1919–22; the maximum discharge was 817 cfs, the minimum discharge was 2.5 cfs, and the average discharge was 60.0 cfs (Colby and Oltman, 1938, p. 39). Deep Creek and Crow Creek contribute about half the total volume of water that is discharged by the perennial streams entering the Missouri River in the Townsend Valley. After they leave the mountains, all the perennial streams lose a large volume of water by seepage into the underlying sand and gravel. During the spring and summer months, much of the water in these main streams is diverted for irrigation; consequently, only a small fraction of the water in the upper stretches of the streams reaches the Missouri during that part of the year. However, many intermittent tributaries issue from the terraces and benchlands that border the river.

IRRIGATION

Irrigation in the Townsend Valley began during the early development of the area. The first water right for Crow Creek was recorded in 1865, for Deep Creek in 1866, and for Greyson Creek in 1867. By constructing small dams in the streams, the stockmen diverted the perennial flow and floodwaters onto meadowlands for the production of wild hay.

Since 1900 irrigation developments have been on a much larger scale. The irrigation systems are mostly privately owned, although a few companies or associations have been organized for the development and improvement of these and new systems. In 1901 the Montana Ditch Co. was organized to irrigate the lowlands northeast of Townsend. A number of smaller systems, which depended chiefly upon floodwater, also were developed. In 1939 the State Water Conservation Commission completed a diversion dam south of Toston in the double-horseshoe canyon of the Missouri River. (See fig. 33.) Water is diverted into a large canal that parallels the river downstream for about a mile and then branches into two smaller canals of unequal capacity. The larger of these canals crosses the Missouri River through a steel flume and furnishes irrigation water to about 15,000 acres of low-terrace land and benchland north of Toston. The smaller canal continues westerly along the south side of the river and irrigates about 3,000 acres in the lower part of the Crow Creek area. Water was first diverted into these canals in the spring of 1940. Water from Big Spring is diverted into another irrigation canal that supplies lands north and west of Toston.

About 35,500 acres is assessed as irrigated land in Broadwater County. The following table summarizes the water allotment for each canal, the number of users, and the number of acres irrigated by each major canal or irrigation project in the Townsend Valley. In addition to the land indicated in table 1, a considerable

Table 1.—*Irrigation canals, water rights, number of users, and irrigated acreage in Townsend Valley*

[From records of U. S. Soil Conservation Service office for Broadwater County, Townsend, Mont.]

Name of canal	Water right (Cubic feet per second)	Number of users	Acres irrigated
Missouri River Water Users Association (Broadwater Canals)	[1]400	....	18,000
Montana Ditch	110	20	2,200
Irish Ditch	50	9	800
Big Spring Ditch	50	7	1,200
Yankee Ditch	70	12	1,200
Warm Spring Creek	10.6	12	640

[1]Canal capacity 350 cfs.

acreage is privately irrigated. The type of agriculture on the larger irrigation projects in the valley has been gradually changing from stock raising and hay production to more diversified farm practices; increasingly larger acreages of small grains, sugar beets, peas, and potatoes are being planted. Uncontrolled flooding is practiced on many of the irrigated farms and, in places, this has resulted in the waterlogging of much land. A sprinkler-type irrigation system was introduced in the valley during the 1949 season and was viewed with much local interest. Several of these sprinkler-type systems were installed during the 1950 irrigation season, and this new and currently popular method may become increasingly important in future irrigation practices in the valley.

AGRICULTURE AND VEGETATION

After the decline of mining activity, agriculture became the principal means of livelihood in the Townsend Valley. About one-third of the cultivated land in the valley is irrigated, and the remaining two-thirds is farmed by dryland methods. Wheat, oats, barley, and rye are the important small grain crops that are raised on irrigated land. Sugar beets and potatoes, which are grown on a commercial scale, have been introduced in irrigated areas in recent years. The sugar beets are processed at Missoula, and the potatoes are shipped to eastern markets. Spring and winter wheat are the main crops raised on nonirrigated lands. In 1940, 43 percent of the total harvested acreage (dryland and irrigated land) was in small grains. Small acreages of alfalfa, clover, and timothy are raised for forage. The remaining land within the valley, including that too rough for cultivation and the swampy waterlogged bottom land, is utilized chiefly for grazing. Large numbers of sheep and cattle are raised in this area each year.

Native plants growing in the uncultivated areas include western wheat, grama, needle-and-thread grass, nigger wool, and sagebrush. Groves of cottonwood, dense thickets of willow, wild rose, alder, and other phreatophytes grow along the poorly drained flood plains of the Missouri River. Saltgrass, salt bush, greasewood, and buffalo bush are confined largely to the saline bottom lands, especially in the Crow Creek area. The high mountains are covered by fair stands of Douglas fir and lodgepole pine.

MINING

During its early development, the Townsend Valley was principally a mining region, but now the more highly mineralized areas are mined only sporadically. One of the outstanding discoveries of gold in Montana was made at Confederate Gulch in 1864. Estimates of the total value of placer gold that has been produced from this area are from $10 million to $30 million (Pardee and Schrader, 1933, p. 172). Although most of the gold was mined by 1870, small-scale placer mining with new and improved equipment still continues. The Radersburg district, which is known principally for its rich lode gold mines, also contains placer deposits along the streams that drain the area. By 1929 production from this district totaled about $6,130,000 (Pardee and Schrader, 1933, p. 304); however, there is only sporadic small-scale lode mining at the present time. Since 1870 the Park, or Hassel, district, which is on the east side of the Elkhorn Mountains west of Townsend, has continued to produce moderate

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amounts of gold, lead, and some silver from lode and placer deposits. Some of the precious metals are recovered by a small stamp mill, which is situated on Indian Creek near the central part of the district. The Iron Mask mine produces lead ore, which is shipped to East Helena to be smelted. The mine was operated for a short time in 1949 but was closed when lead prices declined. Placer mining, however, has continued along Indian Creek to the present time. Accurate reports on the total production are not available, but it is estimated to be not less than $1 million for the period 1870–1928 (Pardee and Schrader, 1933, p. 309). Mr. O. A. Ellis, who has recently reworked the placer gravel along Indian Creek, estimates that the total value of gold produced since 1928 is about $500,000.

Since 1928 marble from the Meagher limestone, quartzite from the Flathead quartzite, and iron ore have been mined in small quantities from the Limestone Hills between Townsend and Radersburg. The dark mottled marble from the Meagher limestone is mined and processed by the Vermont Marble Co. and is sold primarily as a decorative building stone. The quartzite and iron ore are used in the manufacture of cement at Trident, Mont.

The small amount of coal mined from the Tertiary beds near Toston is used locally.

TRANSPORTATION

The main line of the Northern Pacific Railway traverses the Townsend Valley; it parallels the Missouri River as far north as Townsend and continues northwestward to Helena through the gap between the Elkhorn Mountains and the Spokane Hills. The main line of the Chicago, Milwaukee, St. Paul, & Pacific Railroad crosses the southeast corner of the area; it crosses the Missouri River at Lombard and continues southward to Three Forks. These transcontinental railways provide freight transportation to eastern and western markets.

U. S. Highway 10N crosses the area; it parallels the Northern Pacific Railway between Helena and Toston, crosses the Missouri River at Toston, and thence continues southwestward to Three Forks. State Highway 6 crosses the area between Townsend and White Sulphur Springs, 40 miles to the northeast in Meagher County. Both highways are hard surfaced and facilitate the transportation of large amounts of perishable food from the valley to surrounding markets. Dirt and gravel farm-to-market roads traverse the rural areas.

GEOMORPHOLOGY

The Townsend Valley is in the north-central part of the Northern Rocky Mountains physiographic province (Fenneman, 1931, p. 223). It is one of the largest intermontane basins in the region. The southern part of the valley trends slightly northeast and the northern part of the valley trends northwest; consequently, the main axis of the valley is a moderate curve that is concave to the west.

The Big Belt Mountains, one of the front ranges of the Rocky Mountains, border the valley on the east and trend in a northwesterly direction. This prominent range rises from 3,000 to 4,000 feet above the valley floor and two of its summits, Mt. Baldy and Mt. Edith, northeast of Townsend, are 9,600 feet above sea level.

A low, broad ridge projects west from the Big Belt Mountains, between Sixmile and Sixteenmile Creeks, and continues south and west, forming the southeast margin of the Crow Creek area. Where the Missouri River enters the Townsend Valley, it has cut a deep double-horseshoe gorge through this ridge. (See fig. 33.) The ridge flattens to a low, broad rim as it curves to the south end of the Elkhorn Range, which borders the valley on the southwest. This range has approximately the same altitude as the Big Belt Mountains but the steep ridges form a more rugged divide. Elkhorn and Crow Peaks, west of Townsend, are summits of this range and are a little more than 9,000 feet above sea level. A low, wide gap separates the north end of the Elkhorn Range from the Spokane Hills, which rise about 1,000 feet above the river and border the valley on the northwest. The Spokane Hills are separated from the Big Belt Mountains by a deep gorge through which the Missouri River leaves the Townsend Valley. It is in this gorge that the Canyon Ferry dam is being built (1951).

The most striking topographic features within the valley are the gently sloping plains that extend from the mountain fronts toward the Missouri River. These slopes, which are modified by overlying alluvial fans and are dissected by youthful streams, represent ancient erosional surfaces cut on rocks of Tertiary age.

A lowland ranging in width from 1 to 6 miles borders the Missouri River, Crow Creek, and Warm Spring Creek. The low plain along Warm Spring Creek slopes northeastward at the rate of 4 feet to the mile and that along Crow Creek slopes eastward at the rate of 8 feet to the mile. Between Toston and Canyon Ferry, the Missouri River is bordered by bottom land that slopes northward at an average rate of 6 feet to the mile. The bottom land is mainly on the east side of the Missouri River and is widest about 5

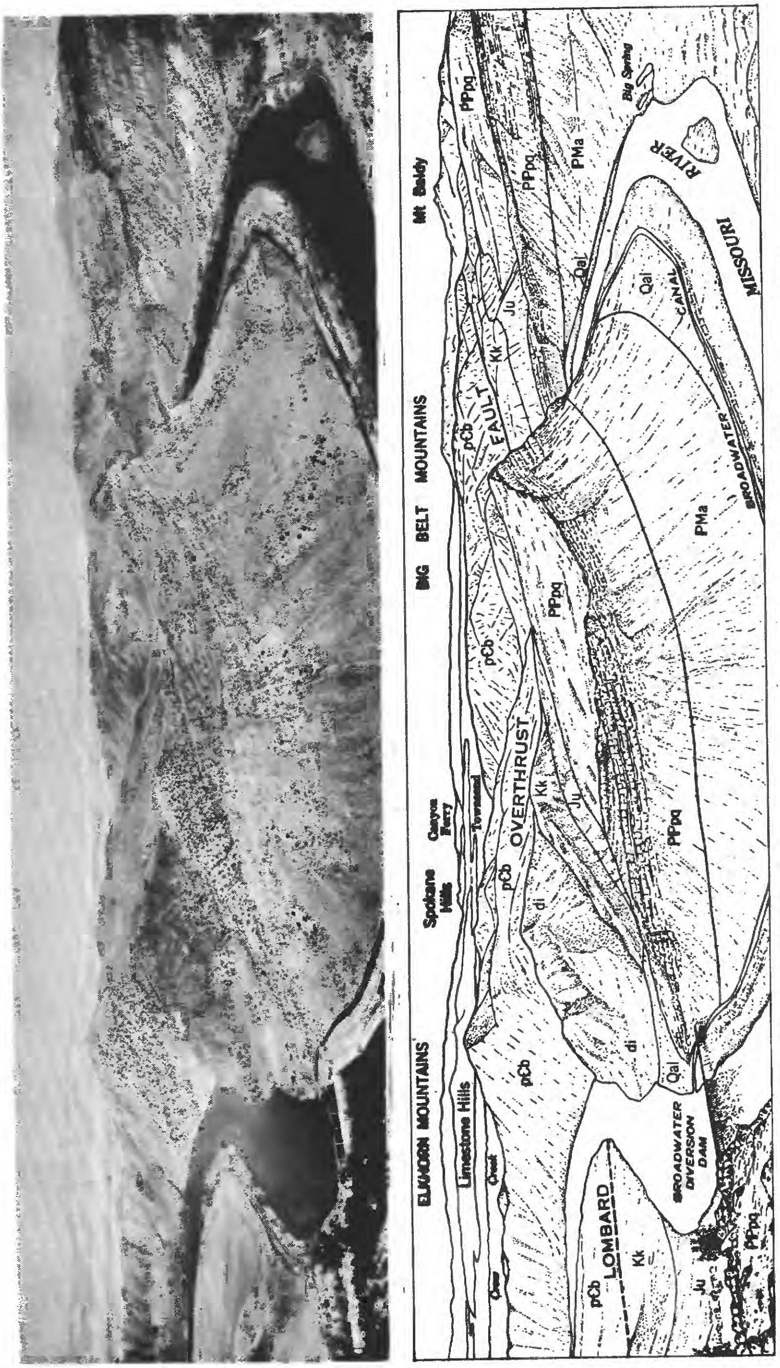

Figure 33.—Panoramic view of the Townsend Valley. (Explanation of symbols given on pl. 19.)

miles north of Townsend. The smooth surface of these low plains is interrupted only by the incised stream beds of the smaller tributaries and, in the Crow Creek area, by a small knoll of Precambrian shale. Nearly one-third of the area of the Townsend Valley consists of lowland bordering the stream.

Areas of flat to nearly flat land that are separated from the valley bottom and from one another by steep to moderate slopes were referred to by Pardee (1925) as benches. The highest of these surfaces was designated bench 1, the intermediate was designated bench 2, and the lowest was designated bench 3.

Remnants of bench 3, which are 100 feet to 1 mile wide, border the east side of the valley bottom between Toston and Townsend. This bench, carved largely on Tertiary deposits, slopes westward at a rate of about 80 feet to the mile. In places it is separated from the bottom land by a much steeper slope that is 15 to 60 feet high but in other places the surface of the bench grades almost imperceptibly into the valley bottom. Varying thicknesses of unconsolidated alluvial materials mantle the Tertiary deposits.

The next higher erosional surface, bench 2, is an area of nearly 52 square miles along the east side of the Missouri River between Canyon Ferry and Gurnett Creek. This surface, which has its upper margin near the base of the Big Belt Mountains at an altitude of nearly 4,300 feet, slopes southwestward at a rate of about 100 feet to the mile and ends with a sharp break, or escarpment, at an altitude of about 3,800 feet, or nearly 100 feet above the bottom land. The surface is widest between Avalanche and White Creeks where it is about 5 miles wide; north of Gurnett Creek it extends westward from the base of the mountains for a distance of 2 miles.

Remnants of the highest and oldest erosional surface border the Big Belt Mountains between Gurnett and Fivemile Creeks. Bench 3 is best preserved in the area between Deep and Greyson Creeks. From an altitude of 4,700 feet, it slopes westward for nearly 4 miles at a rate of about 100 feet to the mile and it is 150 to 300 feet above the bottom land of Deep and Greyson Creek valleys. Both north and south of this area, bench 3 has a steeper gradient and does not extend as far from the mountains. Broad smooth surfaces slope toward the Missouri River between Townsend and Winston and also border Warm Spring Creek in the Crow Creek area. These probably represent different erosional levels but grade into each other without a break in slope.

GEOLOGY

A thick sequence of sedimentary rocks is exposed in the Townsend Valley. (See table 2.) In general, the rocks older than Tertiary have been strongly deformed by mountain-building processes, whereas those of Tertiary and Quaternary age are warped only slightly or are flat lying. Rocks of igneous origin, which have intruded the sedimentary rocks in many places in the valley, also are exposed.

Table 2.—*Sedimentary rocks of the Townsend Valley and their water-bearing properties*

System	Series		Formation	Thickness (feet)	Character	Probable water-bearing properties
Quaternary	Recent and Pleistocene		Alluvium		Sand, gravel, and clay deposited on the Missouri River valley bottom and along the tributaries of the river.	Yields adequate supplies for domestic and stock purposes. In some places, yields may be sufficient for irrigation.
Tertiary	Miocene		"Lake beds"	4,000-6,000(?)	Light-brown to buff, incoherent sand and gravel; a few thin clay beds.	Extent of beds too small for them to be considered as a source of water.
	Oligocene				Mainly fine-grained, light-colored clay and tuff of volcanic origin interbedded with sand and gravel and some lignite.	Yields adequate supplies for domestic and stock purposes.
Cretaceous	Upper and Lower		Colorado shale		Dark shale and some sandstone and quartzitic sandstone beds.	Not water bearing.
	Lower		Kootenai	[1]530	Dark sandstone and interbedded shale; gastropod-bearing limestone bed usually present near the top.	Locally contains a little water.
Jurassic	Upper		Morrison(?)	[1]525	Yellow to reddish nonmarine shale and lenticular sandstone.	Not an important source of water in this area.
	Middle		Sawtooth	[1]20	Fossiliferous marine sandstone with thin beds of limestone.	
Permian			Phosphoria	[1]45	Light-gray quartzite and chert with interbedded shaly limestone and shale, in part phosphatic.	Not water bearing.
Pennsylvanian			Quadrant	[1]325	Mainly gray quartzite; some beds of limestone, sandstone, and shale.	Yields small supplies, but not important as source of water.
Pennsylvanian and Mississippian			Amsden	[1]260	Dolomitic limestone; interbedded shale in the upper part and reddish shale and siltstone in lower part.	Not an important source of water.
Mississippian	Lower	Madison group	Mission Canyon limestone	[1]1,105	Light- to medium-gray very massive limestone; locally altered to coarsely crystalline marble.	Yields large supply of water to many springs.
			Lodgepole limestone	[1]595	Medium- to dark-gray, thin-bedded limestone; contains numerous crinoid stems and other fossil fragments.	

Table 2.—*Sedimentary rocks of the Townsend Valley and their water-bearing properties*—Continued

System	Series	Formation	Thickness (feet)	Character	Probable water-bearing properties
Devonian	Upper	Three Forks shale	1360	Mostly dark-gray to olive-gray fissile shale; contains a few yellowish calcareous siltstone sandy beds.	Generally not water bearing or is productive of only meager supplies.
		Jefferson limestone	1475	Dark-gray to brown evenly bedded fetid dolomitic limestone; massive appearing; surface becomes sugary textured on weathering.	Source of small springs.
Cambrian	Upper	Dry Creek shale	1110	Light-gray limestone in upper part and light brownish-yellow siltstone and sandy shale in lower part.	Yields very little water.
		Pilgrim limestone	1420	Upper unit is light-gray massive dolomitic limestone; middle unit is gray thin-bedded limestone; and lower unit is dark-gray partly mottled limestone.	Yields water to small springs from joints and solution passages.
	Middle	Park shale	1205	Dark-gray, green, or olive-drab thin-bedded micaceous to silty shale and a few beds of fine-grained sandstone.	Not water bearing.
		Meagher limestone	1510	Thin-bedded dark-gray mottled limestone; locally recrystallized to marble.	Yields water for small springs from joints, bedding planes, and solution channels.
		Wolsey shale	1390	Micaceous and calcareous gray-to-green shale and some limonitic sandstone.	Not water bearing.
		Flathead quartzite	1100	Vitreous fine- to medium-grained massive grayish-pink to pink quartzite; finely conglomeratic at base.	Yields meager supply of water to small springs from many cracks and fractures.

Precambrian	Belt	Helena limestone	800	Thin-bedded bluish-gray dolomitic limestone.	Yields water to small springs.
		Empire shale	1,000	Greenish-gray, massively bedded siliceous shale and some thin beds of quartzite.	Not water bearing.
		Spokane shale	1,500	Massive and thin-bedded deep-red siliceous shale.	Yields small supplies to many springs.
		Greyson shale	3,000	Dark-gray siliceous and arenaceous shale; bluish-gray fissile shale; dark siliceous and arenaceous shale; and quartzite.	Yields small supplies to springs.
		Newland limestone	2,000	Finely crystalline thinly bedded bluish-gray dolomitic limestone.	Not an important source of water.

[1]Thickness measured in the Limestone Hills by Edward T. Ruppel (1950), Geology of the Limestone Hills, Broadwater County, Mont., Master's thesis, Univ. Wyoming, Laramie; also U. S. Geol. Survey open-file rept.

STRATIGRAPHY

PRECAMBRIAN ROCKS

The oldest rocks exposed in the area described by this report belong to the Belt series of Precambrian age. Only 5 of the 8 Precambrian formations recognized by Walcott (1899) in this general region are present in this area. The oldest formation is the Newland limestone. It is best exposed in the mountains north of Confederate Gulch and consists mainly of finely crystalline, dark-bluish-gray, thin-bedded dolomitic limestone. The beds appear buff on weathered surfaces and show slaty cleavage in many places. The upper part of the formation includes argillaceous limestone and shale beds. Although the base is not exposed, the formation is estimated to be about 2,000 feet thick (Mertie, Fischer, and Hobbs, 1951, p. 18).

The Greyson shale, which overlies the Newland limestone, is well exposed along Deep Creek Canyon. It consists of dark-gray siliceous and arenaceous shale in its upper part, bluish-gray fissile shale in the middle part, and dark coarse arenaceous and siliceous shale and thick interbedded quartzite in the lower part. In the type section between Deep Creek and Greyson Creek, the thickness of the formation is 3,000 feet.

The Spokane shale, which overlies the Greyson shale, was named by Walcott because of its occurrence in the Spokane Hills. The formation is well exposed along the east and west flanks of the folded rocks southwest of Townsend. It is chiefly a massive to thin-bedded deep-red siliceous shale, but it contains some siltstone in its lower part. Much of the Spokane shale is mottled by spots and bands of green shale, particularly in the transitional zone between it and the overlying formation. East of the Spokane Hills, in the canyon of White Creek, the formation is nearly 1,500 feet thick (Pardee, 1925, p. 13).

The Empire shale overlies the Spokane shale and is a metamorphosed siliceous greenish-gray shale or argillite containing some thin beds of quartzite and gray limestone in its upper part. This formation crops out mainly in the northern part of the area. At Canyon Ferry the Empire shale is the bedrock on which the new dam is being built, and the construction has exposed fresh sections of the formation on both sides of the canyon. Outcrops along the west side of the low ridge south of Toston are less conspicuous; the beds here are not typical because they have been thrust over younger rocks and intruded by granitic and basaltic dikes and sills. The formation is estimated to be about 1,000 feet thick in this area.

The Helena limestone, the youngest Precambrian formation exposed in this area, is best exposed north and east of Canyon Ferry. It is predominantly an impure thinly bedded bluish-gray dolomitic limestone containing a few beds and partings of shale; on weathering it is buff. It is about 500 feet thick at Hellgate Gulch and possibly a little thicker in the vicinity of White Gulch; but owing to an erosional unconformity, this formation thins to a featheredge in the valley of Magpie Creek (Mertie, Fischer, and Hobbs, 1951, p. 20).

CAMBRIAN ROCKS

Rocks of Cambrian age are well exposed in the Limestone Hills, which is a prominent ridge of steeply dipping beds southwest of Townsend. (See fig. 34.) Six well-defined Cambrian formations, all conformable to one another, have been recognized. Their combined thickness is about 1,700 feet.

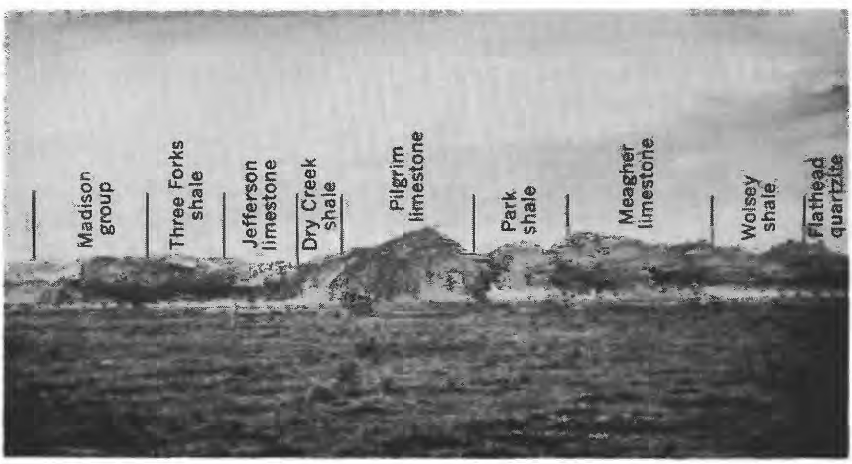

Figure 34.—View looking north from the southeast corner of sec. 4, T. 5 N., R. 1E., showing exposure of Cambrian, Devonian, and Mississippian formations in the south end of the Limestone Hills, 8 miles southwest of Townsend. The beds dip steeply to the west except in a few places where they are slightly overturned and dip to the east.

The Flathead quartzite of middle Cambrian age unconformably overlies the Spokane shale in the Limestone Hills and also the Empire shale and the Helena limestone at different places in the northern part of the area. It is a vitreous fine- to medium-grained grayish-pink to pink well-bedded to massive quartzite. In most places a thin bed of conglomerate is present near the base of the formation. The formation is about 100 feet thick in the Limestone Hills.

The Flathead quartzite is overlain by the Wolsey shale, which is a soft dark-gray to greenish micaceous and calcareous shale with interbedded limonitic sandstone layers. In places the Wolsey shale contains small limestone concretions at the base and thin beds of calcareous shale in the upper part. It is 390 feet thick in the Limestone Hills.

Overlying the Wolsey shale is the Meagher limestone. It is a thin-bedded dark-gray limestone that is conspicuously mottled and banded. An examination by Ruppel[2] of the samples collected by him in the Limestone Hills showed that the mottling is due to dolomitic limestone. In the Limestone Hills, the formation has been metamorphosed to a finely crystalline marble. Remains of trilobites are locally abundant in the shale partings in the lower part of the formation. The Meagher limestone is 510 feet thick in the Limestone Hills.

The Park shale, which overlies the Meagher limestone, is a thin-bedded olive-gray shale containing a few lenticular beds of fine-grained sandstone. It weathers readily and usually forms a covered slope between the Meagher limestone and the overlying Pilgrim limestone. The Park shale is 205 feet thick in the Limestone Hills.

The lower unit of Pilgrim limestone is massive dark-gray limestone that is mottled on weathered surfaces; the middle unit is thin-bedded gray limestone having crinkly ribbons of yellowish dolomite between the bedding planes; and the upper unit is light-gray, massive, very resistant dolomitic limestone. The Pilgrim limestone is 420 feet thick in the Limestone Hills, where it forms a prominent ridge. (See fig. 34.)

The Dry Creek shale, which is the youngest Cambrian formation of this area, overlies the Pilgrim limestone. The lower part of the formation consists mainly of brownish-yellow and pink sandy shale and siltstone. The upper part is light-gray limestone that is mottled and interbedded with thin shale partings. It is 110 feet thick in the Limestone Hills. In most places the Dry Creek shale is poorly exposed; a low saddle marks its position between the Pilgrim limestone and the overlying Jefferson limestone. The Dry Creek shale and the Pilgrim limestone were mapped as an undifferentiated unit. (See pl. 19.)

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[2] See footnote on p. 174.

DEVONIAN ROCKS

The Jefferson limestone, which is 400 to 600 feet thick and which is of Late Devonian age, lies disconformably upon the Dry Creek shale of Late Cambrian age. It is a fetid, dark-gray or brown dolomitic limestone containing zones of breccia. Although it is bedded where fresh, it appears to be a massive rock having a sugary texture where it is weathered.

The Three Forks shale, which is about 300 feet thick and which also is of Late Devonian age, overlies the Jefferson limestone. The lower part contains beds of reddish and brownish-yellow calcareous shale and grayish-brown limestone. The middle part consists of fossiliferous, argillaceous, and calcareous shale that is green, olive-gray, and black; locally it contains a conspicuous, highly fossiliferous limestone bed. The upper part consists chiefly of laminated yellow sandstone and siltstone.

MISSISSIPPIAN ROCKS

In this area the Lodgepole and the Mission Canyon limestones comprise the Madison group of early Mississippian age. The Lodgepole limestone consists of gray thin-bedded fossiliferous limestone. It is 595 feet thick where measured in the Limestone Hills and conformably overlies the Three Forks shale. The upper beds are more massive in the zone of transition between the Lodgepole and the overlying Mission Canyon limestone. The Mission Canyon limestone, which is about 1,600 feet thick, is an impure massive white to light-gray limestone that is not as fossiliferous as the Lodgepole limestone.

PENNSYLVANIAN AND PERMIAN ROCKS

Overlying the Mission Canyon limestone is the Amsden formation, which is of late Mississippian and early Pennsylvanian age and which is 260 feet thick. The lower part of this formation is characterized by beds of reddish shale and siltstone, and the upper part of the formation consists of beds of yellowish, red, and grayish-brown dolomitic limestone and interbedded shale. The Quadrant formation, also of early Pennsylvanian age, and the Phosphoria formation of Permian age were mapped as a single unit. (See pl. 19.) The Quadrant formation is predominantly a light-colored quartzitic sandstone that is interbedded with limestone and dolomite. The overlying Phosphoria formation consists of chert and quartzite and is in part phosphatic.

JURASSIC ROCKS

Mesozoic rocks are poorly exposed in this region. They consist mainly of variegated sandstone, calcareous shale, siltstone, and several conspicuous gastropod-bearing limestone beds. The formations are less resistant to weathering than those of Paleozoic and Precambrian age and, consequently, they form the foothills of the mountainous areas where the high ridges have been carved from the older formations.

Rocks of Triassic age are not present in this region; consequently, rocks of Jurassic age rest unconformably upon the Paleozoic formations. A reddish-brown fossiliferous marine sandstone having thin beds of limestone is believed to be the Sawtooth formation of the Ellis group; it unconformably overlies the Phosphoria formation. These marine beds are overlain by a buff to reddish nonmarine shale and lenticular sandstone, which probably belong to the Morrison formation. The Jurassic formations, which have an average thickness of about 550 feet, are well exposed along the low ridge east of Toston and poorly exposed along the west side of the Limestone Hills.

CRETACEOUS ROCKS

The Kootenai formation of Early Cretaceous age overlies the Morrison(?) formation. It consists of dark-colored sandstone, red and green shale, and a bed of gastropod-bearing limestone near the top. It is about 500 feet thick and is well exposed in the hills east of Toston. The Colorado shale of Early and Late Cretaceous age overlies the Kootenai formation. It is the youngest formation of Mesozoic age present in the area and is composed chiefly of dark-colored shale and some sandstone and quartzitic sandstone beds. An undetermined thickness of these rocks is poorly exposed along the flanks of the Elkhorn Mountains west of Townsend.

TERTIARY DEPOSITS

Tertiary deposits of Oligocene and Miocene age (commonly referred to as "lakebeds") underlie a large part of the Townsend Valley. They unconformably overlie the eroded surfaces of the folded and faulted older rocks and apparently underlie most of the younger sediments of the valley. The older Oligocene deposits consist mainly of light-colored fine-textured sediments and small amounts of interbedded sand and gravel. Much of the finer grained material is volcanic ash. Thin beds of coal are present in the area northeast of Toston. Locally there is an occasional stratum of diatomaceous earth. The younger Oligocene beds consist of coarser textured clastics that probably were deposited as alluvial fans or outwash from the surrounding mountains. They, too, contain large amounts of tuffaceous material.

Mertie, Fischer, and Hobbs (1951, p. 30) subdivided the rocks of Oligocene age in the Canyon Ferry quadrangle into four units, which they described as follows:

***Unit 1, of the Oligocene sequence, consisting of conglomerate, interbedded with red shale and some bentonitic beds, lies along the east side of the Spokane Hills. Unit 2, composed of volcanic conglomerate, tuffs, and other beds, extends eastward to the flats of the Missouri River. The principal deposits of bentonite occur at the base of this unit. Unit 3, composed mainly of reworked tuffaceous material without bentonite, extends from the Missouri River eastward, and occupies most of the foreland southwest of the Big Belt Mountains. Unit 4, consisting mainly of conglomerate with a calcareous matrix, lies still farther east, extending to the hard rock of the Big Belt Mountains. No unconformities or disconformities are known to separate units 1 to 3. On the contrary, all evidence indicates that these three units grade imperceptibly into one another; and the only basis for their separate delineation is the observable differences in their lithology. Unit 4, however, may lie unconformably on unit 3 ***.

The only Oligocene formations identified so far in the valley are the Chadron and Brule formations in an anticline extending from Sixmile Creek to north of Deep Creek (Leroy Kay, personal communication).

The first reported collection of vertebrate fossils from the Oligocene deposits in the Townsend Valley was made by Douglass (1902, p. 238–79, pl. 9). It included eight species from the "Toston beds," which are several miles northeast of Toston. In recent years Leroy Kay (personal communication) and others have collected a much larger number of species from these beds and also from the well-exposed Oligocene beds that border the east flanks of the Spokane Hills. The first fossil insects of Oligocene age were recently found in the bluffs that face the Missouri River north of Beaver Creek.

Miocene deposits in this area are poorly exposed and are difficult to recognize; however, fossil remains of Miocene age have been found in several exposures in bluffs that border the east bank of the Missouri River between Confederate Gulch and Canyon Ferry. Douglass (1902) reported fossil horse remains from the bluffs north of Confederate Gulch and from exposed deposits in the Deep Creek valley. Kay and others collected Miocene fossils from the bluffs along the Missouri River, southeast of the old Canyon Ferry dam. The Miocene deposits in these localities consist of light- to buff-colored sandy clay and sand and gravel beds that, in places, are overlain by conglomerate. In many places a 2- to 4-foot thickness of tuffaceous sand cemented with calcium carbonate is present near the base of the conglomerate that forms the upper unit of the deposit. The correlation of beds exposed in different parts of the valley is impossible because the lithologic character of the deposits changes considerably in a short distance; fossil remains are about the only means of dating the deposits.

The total thickness of Tertiary rocks in the Townsend Valley is estimated to be between 4,000 and 6,000 feet. A complete section of the deposits cannot be measured because the few exposures are incomplete. Tertiary beds dipping 10° to 15° to the northeast are exposed along the north side of the Deep Creek valley for a distance of about 5½ miles (from near the center of sec. 30, T. 7 N., R. 3 E., to the east side of sec. 25, T. 7 N., R. 3 E.). If the beds have not been duplicated by unsuspected faulting or folding, a total thickness of 5,000 to 6,000 feet of Tertiary sediments is exposed. Pardee (1925, p. 27) states that the total minimum thickness of the Oligocene beds that are exposed in the southeastern part of Townsend Valley is 800 feet and that the thickness of a section of Oligocene rocks that is exposed along Beaver Creek in the southeastern part of T. 9 N., R. 1 E., is 2,800 feet. Mertie, Fischer, and Hobbs (1951, p. 29) recognized between 6,000 and 10,000 feet of Tertiary beds in the north part of the valley.

An oil test well was drilled in the SW¼ sec. 36, T. 7 N., R. 2 E., between 1925 and 1930, and penetrated about 700 feet of unconsolidated Recent and Tertiary sediments before bedrock was reached. According to Edward Jacobson of Townsend, Mont., the hole was drilled to a depth of 1,310 feet, and no oil was found. Another test well for oil in sec. 7, T. 8 N., R. 1 E., reportedly penetrated Tertiary sediments to a depth of 1,780 feet.

The Tertiary sediments of the Townsend Valley are shown as a single unit on plate 19.

QUATERNARY DEPOSITS

A small terminal moraine of a valley glacier lies at the foot of Mount Baldy in sec. 13, T. 8 N., R. 3 E., and is about three-fourths of a mile long and half a mile wide. Its uneven surface is about 50 feet above the high erosional plain near the base of the mountain. Materials composing this semicircular ridge are typical glacial deposits and consist of unsorted debris containing faceted granite and quartzite cobbles.

Much of the Townsend Valley is mantled by a layer of alluvium that is of Pleistocene to Recent age. The alluvium consists of large cobbles, gravel, sand, silt, and clay and was deposited by streams as alluvial fans, as bottom-land deposits, and as a thin mantle over the benchland (the latter is often referred to as "bench gravel"). These alluvial deposits, which were deposited on the folded and eroded surface of Tertiary and older rocks, are usually thicker and coarser textured near the mountain and are thinner and finer textured toward the valley. Along Crow Creek the alluvium consists chiefly of large andesite cobbles, coarse gravel, and sand; along Warm Spring Creek it consists largely of fine-textured sediments; and along the Missouri River consists of sand and gravel and interbedded layers of clay. The maximum thickness of the Quaternary sediments is estimated to be not more than 60 feet.

IGNEOUS ROCKS

Igneous rocks intruded into the sedimentary deposits in the Townsend Valley occur as dikes, stocks, sills, and small plugs. The intrusive rocks were divided and mapped as five principal types, which are (1) granitic rocks (including chiefly monzonite, quartz monzonite, granodiorite, aplite, and latite), (2) monzonitic lamprophyres, (3) andesite and andesite porphyry and breccia, (4) diabase, and (5) diorite and gabbro. Extrusive igneous rock—basaltic lava—also is present in the Townsend Valley. Analyses of rock types have been reported by Haynes (1916); Mertie, Fischer, and Hobbs (1951); Pardee and Schrader (1933); Ruppel[a]; and Stone (1911).

The largest areas underlain by rocks of igneous origin include the north end of the Elkhorn Mountains between Winston and Townsend, the east slopes of the Elkhorn Mountains west of Radersburg, and Lone Mountain, a prominent butte 5 miles south of Radersburg. Rocks of the andesite type are most abundant in these areas; they include many varieties and are of both intrusive and extrusive origin. According to Pardee and Schrader (1933, p. 306), gold and small amounts of silver are present in the andesite of post-Cretaceous age at Radersburg. Lead, gold, and silver are included in the andesite in the Winston area. Dikes and sills of andesite, diorite, gabbro, and diabase occur throughout the west slopes of the Big Belt Mountains and intrude all the formations of the Belt series except the Empire shale and the Helena limestone (Mertie, Fischer, and Hobbs, 1951, p. 48). Granitic and andesitic intrusive bodies occur in the Spokane Hills.

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[a]See footnote on p. 174.

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SILLS

Igneous rock occurs as sills in the sedimentary rocks of the Limestone Hills in many places. A dark-brown diabase sill, which is nearly 200 feet thick, intrudes the Spokane shale about 3,000 feet below the contact of the Flathead quartzite and the Spokane shale. The intrusion extends 8 miles along the strike of the west limb of the anticline. Its location is marked by a deep topographic saddle between two parallel ridges. Along the zone of contact, the reddish Spokane shale was metamorphosed to a dark greenish-gray hornfels, which is more resistant to weathering than the diabase or the surrounding unmetamorphosed shale.

A granodiorite sill, which is nearly 3,000 feet thick, occurs in the central section of the Limestone Hills. The granitic mass intrudes the Three Forks shale and, in most places, is in contact with the Jefferson and Lodgepole limestone. According to Ruppel[4], the sill is a hornblende granodiorite, which is composed of andesine, hornblende, quartz, orthoclase, and a minor amount of epidote and magnetite. To the west, smaller sills in the Kootenai formation are composed of about the same minerals, but some of the minerals are more characteristic of dioritic rocks. Sills in the Colorado shale, both north and south of Indian Creek, are andesite and andesite porphyry. Many small sills occur in the Spokane Hills. Most of these are dark-colored medium-grained monzonitic lamprophyres and are closely related to quartz monzonite.

DIKES AND STOCKS

In the double-horseshoe bend, which is 2 miles west of Lombard, the Missouri River has cut a steep-walled gorge into an intrusive mass of granite. (See fig. 33.) The granite is light gray, of medium-fine texture, and somewhat porphyritic. In places the rock is almost entirely without quartz and grades into a syenite. A similar fine-grained granitic rock projects as a small butte above the benchland east of Warm Spring Creek. An irregular dikelike intrusion of diabase, which is 100 to 500 feet wide and which apparently follows the plane of the thrust fault that cuts across the double-horseshoe bend of the Missouri River is exposed about 1 mile west of Lombard. The intrusion has metamorphosed the adjoining country rock, particularly the Kootenai formation on the east side of the thrust fault. Where fresh, the diabase is dark greenish gray; where exposed, it is rusty brown and generally deeply weathered. Haynes (1916, p. 290) believed

[4] See footnote on p. 174.

that the age of the intruded body could not be closely determined, but that it clearly was later than the overthrust and, therefore, of Tertiary age. Northeast of Toston, at the mouth of Sixmile Creek, is a small plug of dark-colored diabase. It resembles the dikelike intrusion west of Lombard and probably is of similar origin.

The Canyon Ferry stock covers an area half a mile to 1 mile wide and nearly 4 miles long. The intrusion, which is situated along the east edge of the Spokane Hills, trends southeastward from the New Canyon Ferry dam site. At its north end the stock is primarily a coarse-grained medium-gray biotite-rich granite; farther south it grades into quartz monzonite. Building stone for the old Canyon Ferry dam and power plant was obtained from the stock. Small dikes of aplite and large intrusive bodies of lamprophyres are associated with the principal intrusion. All these intrusions are of Tertiary age (Mertie, Fischer, and Hobbs, 1951, p. 47).

Another large granite stock, referred to as the Gurnett stock, borders the east side of the valley between Duck and Ray Creeks. It is a light-gray fine-grained granite rich in plagioclase feldspar. The granitic mass intrudes shale of the Belt series and is of pre-Oligocene age; weathered pieces of the rock occur in the upper Oligocene beds. Mineralization, resulting chiefly in small concentrations of gold associated with iron sulfides, has taken place along the granite and shale contact at the north end of the stock.

STRUCTURE

The Townsend Valley is a broad structural trough, which was formed by downwarping and faulting. The upland surrounding the valley consists of closely folded strata cut by many faults.

FOLDS

Throughout this area the sedimentary rocks of Cretaceous age or older have been intricately folded; by comparison, the beds of Tertiary age have been only slightly deformed.

The most prominent fold within the area is an asymmetrical anticline between Townsend and the lower course of Crow Creek. The axis of the fold trends nearly due north. Truncation of the fold by erosion has exposed Precambrian beds. A complete sequence of Paleozoic and Mesozoic rocks (the "Limestone Hills section") is well exposed on the steeply dipping west limb of the anticline. Beds younger than the Spokane shale of Precambrian age have been eroded from the east limb of the structure. In the southwest corner of the Limestone Hills, Pennsylvanian and Permian formations have been tightly folded into a small anticline and syncline, both of which pitch to the south.

A syncline of folded Cambrian, Devonian, and Mississippian rocks borders the east rim of the valley between Deep Creek and Sixmile Creek. It pitches southward from sec. 34, T. 7 N., R. 3 E., to sec. 22, T. 6 N., R. 2 E., where it curves to the southeast. The north end of the syncline is nearly symmetrical; toward the south, however, the east limb of the syncline is overturned. Between Greyson and Dry Creeks the syncline is faulted, Precambrian shale having been thrust over Cambrian rocks.

South of Lombard, rocks of Cambrian to Cretaceous age are folded into a north-trending tightly folded syncline. The west limb of the fold is overturned and where the plane of the Lombard overthrust crosses this limb, shale of Precambrian age overlies beds ranging in age from Cambrian to Mississippian. Cambrian and Devonian formations are not exposed on the east limb of the fold, which is truncated and covered by younger sediments. Only the north end of this structure is in the area described by this report.

Along the east flank of the Spokane Hills, Devonian and Mississippian formations are folded into a small syncline. The axis of this structure, which trends northwest, is about 1 mile west of Lake Sewell.

A fold in the Tertiary rocks, which is referred to as the Dry Creek anticline, can be traced northwestward from Sixmile Creek for a distance of nearly 11 miles. North of Deep Creek the structure is barely discernible. The fold is nearly symmetrical and, in general, the beds dip 5° to 20° to the east and west. According to a personal communication from Leroy Kay, light-colored clay beds of the Oligocene series (Chadron and Brule formations) crop out along the eroded axis. Sand, gravel, and conglomerate of Miocene age are exposed along the flanks of the anticline.

Between the Spokane Hills and the Big Belt Mountains, beds of Tertiary age have been folded into a broad syncline. The best exposures are on the west flank of the fold, where the dip of the beds ranges from 5° to 30° to the east. Within a mile or two of the mountain front (formed by Paleozoic rocks) the dip of the beds gradually decreases and, near the foot of the mountains, along Cave and Magpie Creeks, it reverses and is about 20° toward the west.

FAULTS

The Lombard overthrust is one of the most important structural features of this area. It extends for about 14 miles from sec. 18, T. 5 N., R. 3 E., southward to the hills north of Three Forks (15 miles south of Lombard). The fault plane is well exposed in the horseshoe canyon of the Missouri River west of Lombard, where it dips about 40° to the west. Here strata of the Belt series (Precambrian) have been thrust over strata of Cretaceous age. Haynes (1916, p. 271, 273) described this fault as follows:

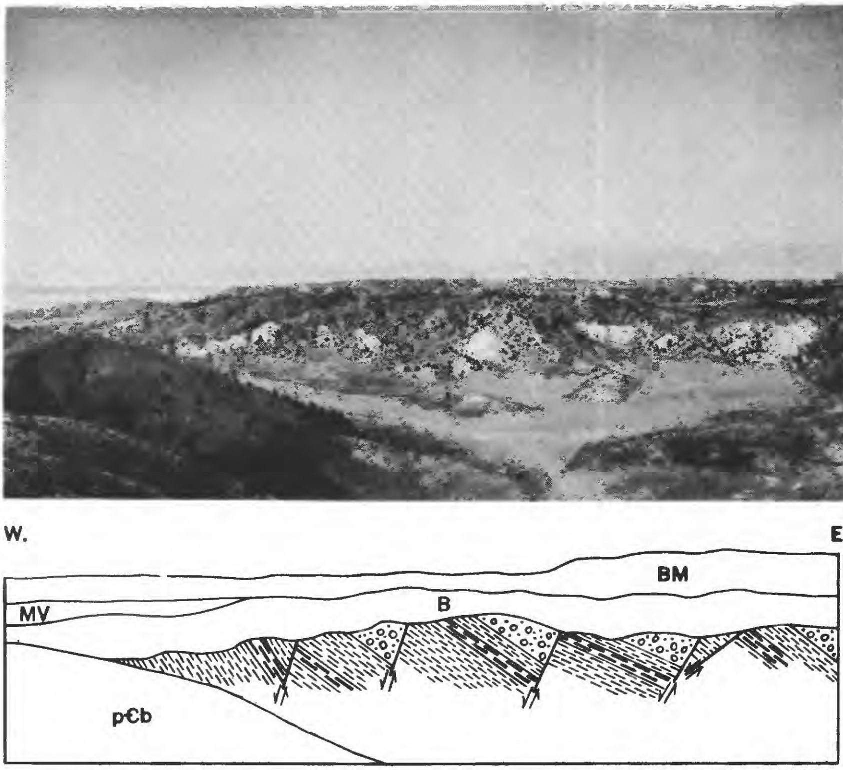
> The maximum displacement on the fault plane near Lombard cannot be very closely estimated, but it is approximately two miles, and the strata which are stratigraphically about 6,800 feet apart are here in contact.

The age of the fault, according to Haynes, is very late Cretaceous or early Tertiary.

In the Limestone Hills are many northwest-trending normal faults. Although the horizontal displacement along most of these faults is small, the displacement along two of the faults is more than 1,000 feet. The maximum stratigraphic displacement of the northernmost normal fault is about 1,400 feet where the Flathead quartzite of Middle Cambrian age is in contact with the Pilgrim limestone of Late Cambrian age. The fault trends approximately N. 45° W. The other large normal fault, known as the Indian Creek fault, trends approximately N. 50° W. For a short distance Indian Creek lies on the west extension of this fault. In sec. 16, T. 6 N., R. 1 E., the east extension of the fault splits into smaller normal faults. Two minor strike faults occur in the south part of the Limestone Hills. One cuts strata of Cambrian and Devonian age and the other cuts the Mission Canyon, Amsden, Quadrant, and Phosphoria formations, which are of Mississippian to Permian age.

Northwest-trending normal faults, which are similar to those of the Limestone Hills, cut across strata of the Spokane Hills, but the stratigraphic displacement along these faults is not as great as that along those in the Limestone Hills.

Numerous small normal faults, only a few of which are shown on plate 19, have displaced Tertiary deposits throughout the valley. In sec. 12, T. 5 N., R. 2 E., a well-exposed section of light-colored Oligocene clay beds, overlain by reddish siltstone and gravel, has been cut and displaced by four distinct normal step faults. (See fig. 35.) These faults strike approximately N. 20° to 30° W., dip 20° to 40° to the southwest, and are within a distance of less than 2,000 feet. The normal faulting has lowered the small



After J. T. Pardee, 1925

BM, Belt Mountains; B, conspicuous bench or erosional plain developed on Tertiary deposits; MV, Missouri River valley bottom; p€b, pre-Cambrian shale and intrusive diabase

Figure 35.—Faults in Tertiary lakebeds as seen across Sixmile Creek from the southeast corner of sec. 12, T. 5 N., R. 2 E. BM, Belt Mountains; B, prominent bench or erosional plain developed on Tertiary deposits; MV, Missouri River valley bottom; p€b, Precambrian shale and intrusive diabase.

fault blocks toward the valley and has exaggerated the apparent thickness of the Tertiary beds. Similar faulting probably has occurred in other parts of the valley where, however, the faults are poorly exposed and the repetition of Tertiary stratigraphic units cannot be recognized.

EARTHQUAKES

Earthquakes are not uncommon in the Townsend Valley; the area was severely shaken in 1925 and 1935. Pardee (1926, p. 7–23) believed the epicenter of the 1925 earthquake to have been a short distance southeast of Lombard where crustal movement apparently took place along a deep-seated north-trending fault along the west flank of the Big Belt Mountains. The intensities of the shock (Rossi-Farrel scale) in the Townsend Valley were as follows: Lombard 9+, Toston 9, Townsend 8+, Radersburg 8+, and Canyon Ferry 7+. Schoolhouses near the epicenter of the earthquake, including one at Radersburg, were damaged considerably. At most places within a radius of 75 miles of the epicenter, the damage from the shock consisted mostly of breaks in chimneys, plaster, and plate glass windows. Rock masses were shaken down from the steep slopes and cliffs within a radius of 12 or 15 miles of the epicenter. The railroad tracks near Lombard were broken. The ground cracked over a large area. One of the cracks was at Canyon Ferry, a distance of about 40 miles from the epicenter. Apparently the cracks were due to shaking and were not due to slippage along the line of a deep-seated fault. A week later, a chimney that was cracked by the earthquake caused a fire which destroyed most of the buildings on the main street of Toston. Sixmile Creek, the source of the town's water supply, is reported to have become dry as a result of the earthquake and no water for fighting the fire was available.

The Townsend Valley was also severely shaken by the 1935 earthquake, whose epicenter was near Helena, about 35 miles northwest of Townsend. The intensity rating of this earthquake near its epicenter was 9; hence, this earthquake was slightly less intense than the one of 1925. In the Townsend Valley the damage from the earthquake consisted mainly of broken chimneys, plaster, and plate glass windows; however, at Helena, four persons lost their lives, and property damage totaled millions of dollars.

SUMMARY OF THE GEOLOGIC HISTORY

In late Precambrian time the Townsend Valley was in a basin of subsidence in which was deposited a thick series of sediments, named the Belt series by Walcott. The absence of characteristic Cambrian fauna and the length of the erosional period following deposition of the sediments were considered by Walcott to be sufficient evidence for placing the entire Belt series in the Precambrian (Barrell, 1907, p. 23). These sedimentary rocks, which are about 8,000 feet thick in the Townsend Valley, comprise two limestone formations and three shale formations containing a few thin beds of sandstone.

After their deposition these sediments were slightly folded and warped. Erosion then reduced the surface to a peneplain before the sea again advanced over the area in Middle Cambrian time. The basal sediments of Cambrian age overlie the Precambrian formations with no discernible angular discordance, but the magnitude of the unconformity is evident inasmuch as the basal sediments rest on several different formations of the Belt series.

The Cambrian sequence of Flathead quartzite, Wolsey shale, and Meagher limestone indicates that a transgressive sea inundated this area after the Belt series was partly removed by erosion. During later Cambrian time, the sea fluctuated and Park shale, Pilgrim limestone, and Dry Creek shale were deposited successively.

As no rocks of Ordovician or Silurian age are present in this region, this part of Montana is believed to have been a land mass that was slightly above sea level and that was subjected to very little erosion during these periods. Late in Devonian time the area was again inundated by the sea and the Jefferson limestone was deposited unconformably upon the eroded surface of the Dry Creek shale. Fine clastics, known as the Three Forks shale, were deposited over the limestone, probably during a slight recession of the sea during late Devonian time.

The entire region apparently remained under stable marine conditions during Mississippian time when great thicknesses of limestone of the Madison group were deposited. In late Mississippian or early Pennsylvanian time, the sea began to recede, and fine clastics of the Amsden formation were deposited. Sandstone and some limestone of the Quadrant formation were deposited in the Pennsylvanian sea. The Phosphoria formation appears to have been deposited upon the Quadrant formation without a break in sedimentation; this suggests that there was no withdrawal of the sea between Pennsylvanian and Permian times.

At the end of Permian time, the sea withdrew and left an emerged land mass that remained comparatively high during Triassic and part of Jurassic time. During Late Jurassic time the land surface again was submerged, sandstone and some thin limestone beds of the Sawtooth formation were deposited, and then the land surface reemerged and remained above sea level during the deposition of the nonmarine sediments of the Morrison formation. Deposition of nonmarine sediments of the Kootenai formation continued during Early Cretaceous time. After the deposition of the Kootenai formation, submergence of the land occurred for the last time and silt of the Colorado shale was deposited in the shallow sea that covered the area.

All the formations deposited from Precambrian to Early Cretaceous time appear to be conformable or nearly so. Evidently no large-scale folding or warping of the earth's crust took place in this region until after Early Cretaceous and before Oligocene time—the Oligocene beds rest with angular discordance on the steeply folded older rocks. The folding probably took place during the Laramide revolution. Igneous intrusions are believed to be related to this period of movement, although some intrusions also occurred in early Tertiary time.

The structural deformation of the older rocks resulted in the formation of the Townsend Valley and the bordering mountains. The period of deformation was followed by a period of erosion that extended to Oligocene time. During this period the principal drainage courses were deepened and the surrounding mountain ranges were dissected; remnants of this mature topography are now evident among the mountain heights. The continental divide at this time is suggested by Atwood (1916, p. 697–740) to have been about 150 miles east of its present position—that is, along the crest line of the Big Belt Mountains, the Bridger Range, and the Gallatin Mountains. If these mountains formed the divide, the drainage of this area was in a southwesterly direction and was part of the ancestral Snake River system.

In Eocene or early Oligocene time the drainage systems in southwest Montana were closed either by renewal of crustal movement or, perhaps, by the great outpouring of lava in the Snake River region. The closed troughs became sites of aggradation in which were deposited the "lakebeds" or "Bozeman beds," which were so named by Peale (1896). In the Townsend Valley most of the lower beds consist of volcanic ash and other fine-textured sediments, which appear to have been laid down in shallow lakes or swamps. The coarser materials from the surrounding mountains were apparently deposited as broad alluvial fans. The large amount of tuff in these clastic beds indicates that volcanic activity occurred in this region during Oligocene time. Patches of these sediments occur on the high mountain slopes; hence, the troughs probably were filled to a much higher level during Tertiary time than at the present. A renewal of mountain growth, which probably came near the close of the Miocene epoch, warped the Tertiary sediments within the valley and elevated the Tertiary sediments that overlay the growing mountainous area.

Degradation followed the uplift and, during Pliocene and Pleistocene time, streams developed drainageways across and within the major troughs; and beds of the troughs were lowered and erosional plains were left above them. These now remain as dissected benchlands. The streams flowing over younger deposits were superposed across bedrock divides, which separated the neighboring structural basins. At these places the streams carved deep, narrow channels, such as the rocky gorges above Toston and at Canyon Ferry. Atwood (1916, p. 714) believed that the

Missouri River had worked its way westward at the beginning of this erosional period and, through piracy, captured this region of closed drainage. When the drainage of southwest Montana was opened to the northeast, the continental divide gradually shifted westward to its present position.

Degradation of the Tertiary sediments and older rocks in the Townsend Valley has continued to the present time. Glaciation apparently occurred late in the Pleistocene epoch. A small moraine lies at the foot of Mt. Baldy on the west side of the Belt Mountains, and fresh moraines and recently cleaned out cirques are present on the east slopes of this summit. Similar cirques are present on the slopes of the summits of the Elkhorn Range.

GROUND WATER

A large reservoir of ground water underlies the Townsend Valley. Part of the ground water in the Quaternary and Tertiary deposits is under water-table conditions and part is confined under artesian pressure. Most of the water in the pre-Tertiary formations is contained in fissures or solution channels.

RECHARGE

The pre-Tertiary aquifers that crop out in the higher mountainous area surrounding the Townsend Valley receive nearly all their recharge from rainfall and snowmelt. The chief sources of ground-water recharge in the valley are the perennial mountain streams, irrigation canals and laterals, and seepage from irrigation water. In parts of the valley the Tertiary deposits evidently are recharged by the upward migration of ground water from the underlying older rocks. Most of the precipitation that falls in the Townsend Valley penetrates to only a shallow depth and is lost later by transpiration and evaporation. Precipitation directly recharges the ground-water reservoir only in the lower parts of the valley where the water table is near the surface.

Many of the streams that head in the mountains lose a large part of their water to their underlying gravel before they reach the Missouri River. During the spring and summer, water from these tributary streams is diverted for the irrigation of the benchland that borders the bottom land. Influent seepage from the irrigation distribution system recharges the ground-water reservoir beneath these higher lands.

In the Crow Creek area the source of much ground-water recharge is Crow Creek and its tributary, Warm Spring Creek. During the summer months the entire flow from these perennial streams is diverted for irrigation. The water is carried to the farms in the lower parts of the valley by canals that traverse the coarse gravels of the benchland. A large part of the water is lost from the canals by seepage and much of the water that is spread on the fields for irrigation also is added to the ground-water reservoir.

Water diverted from the Missouri River and Big Spring is distributed to the farmland in the valley bottom between Toston and Canton by a series of five principal irrigation canals. As the water level in many of the observation wells in this part of the valley is highest late in the irrigation season, when little precipitation falls and when streams have a minimum flow, the ground water obviously is recharged largely by irrigation water.

CHANGES IN STORAGE

The stage of the water table is a general indication of the quantity of water in the ground-water reservoir; therefore, water-level fluctuations indicate changes in ground-water storage. In general, the fluctuations are an indication of the net recharge to or discharge from the ground-water reservoir. Monthly measurements of the water level in about 150 wells throughout the valley were made as part of this investigation. (See table 4.)

The greatest observed fluctuation of the water level occurred in wells along the upper course of Crow Creek; a difference of 20 feet between the high and low water-level readings was recorded in well A5-1-4cc. (See fig. 36.) This well penetrates the upper part of the alluvial fan of Crow Creek and the water level in the well depends to some extent upon the stream level. The rise of the water level in the early winter is caused by ice jams in the creek which cause backwater and flooding.

The water level in wells in the finer textured deposits of the bottom land shows the least fluctuation; the water level in several wells fluctuates less than a foot a year.

The hydrographs of most wells (fig. 36) indicate a decline of the water level during the winter months. In general, the water level in wells in the Crow Creek area (A5-1-4cc, A5-1-10cb, and A5-2-20bc1) is highest during the spring when the flow of the streams, which are the principal source of recharge, is greatest. Elsewhere, however, as in the valley bottom between Toston and

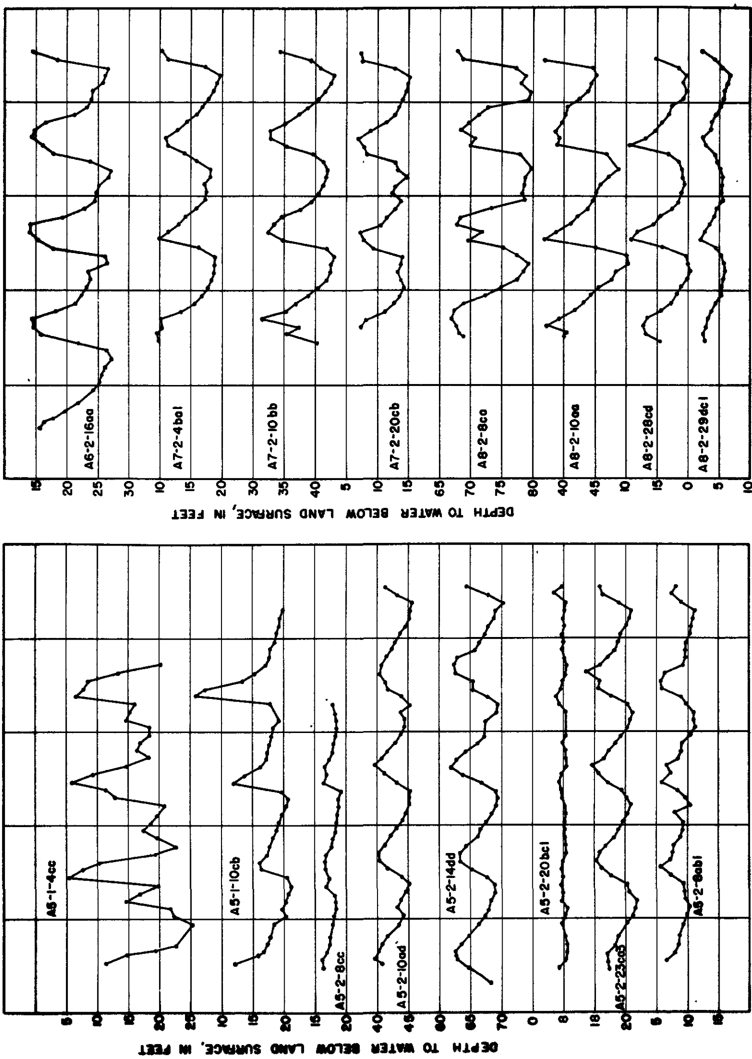


Figure 36.—Hydrographs showing fluctuations of the water level in observation wells.

Townsend and in the valley bottom north of Townsend, the winter decline ends in the spring when irrigation is begun. After a short period, which is dependent on the permeability of the soil in the area and on the amount of water applied, the recharge from irrigation is sufficient to overbalance the natural discharge from the reservoir and the water table begins to rise. (See hydrographs for wells A6-2-16aa, A7-2-4ba1, and A7-2-10bb.)

MOVEMENT

The rate of movement of ground water is dependent on the permeability of the aquifer and the hydraulic gradient of the water table or piezometric (artesian-pressure) surface. The permeability of an aquifer or water-bearing material is its capacity to transmit water through its interstices.

Contour maps, which show the configuration of the upper surface of the zone of saturation or of the piezometric surface, indicate that the ground-water gradient in some parts of the valley differs considerably from that in other parts of the valley. The ground-water gradient is steepest in the Crow Creek area and in the vicinity of the mountain front near Duck Creek, where the land slope is fairly steep, and the gradient is least along the fairly flat flood plain of the Missouri River. (See pl. 20 and fig. 37.)

Ground water moves from a position of high altitude to a position of low altitude in the direction of the steepest gradient. In the Townsend Valley the ground water moves from the bordering mountains toward the Missouri River in a direction that is almost parallel to the tributary streams and, therefore is nearly at right angles to the river. As the water nears the river, it veers in a downstream direction. Deep Creek contributes a considerable amount of water to the ground-water reservoir; in the alluvial fan of the creek the ground water moves northwestward toward Townsend. A large marsh has developed south of Townsend as the result of the recharge from this creek.

The slope of the ground-water surface in the Crow Creek area is 30 to 50 feet per mile. In the area between Toston and Townsend the slope is about 20 feet per mile, but it decreases to 10 feet per mile in the vicinity of Townsend. The ground-water gradient near the mountain front between Duck Creek and Confederate Gulch is about 70 feet to the mile. Ground-water contour maps could not be prepared for either the area north of Confederate Gulch or the area west of the Missouri River north of Crow Creek because of the small number of wells. However, the ground water in those areas is believed to move more or less directly from the mountain front to the Missouri River.

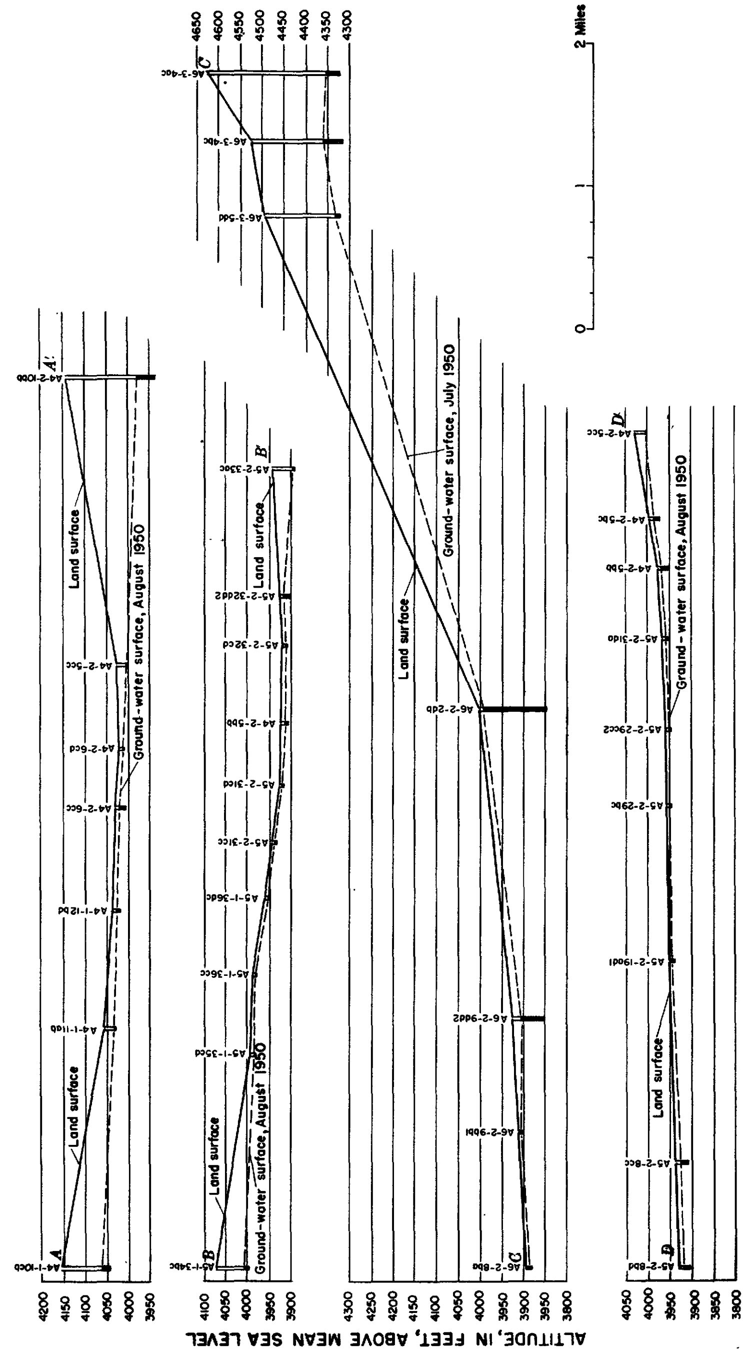


Figure 37. —Profiles showing relation of the ground-water surface to the land surface.

EFFECTS OF EARTHQUAKES

The severe earthquake in 1925 is reported to have caused some springs within a 50-mile radius of the epicenter to increase in flow and others to decrease. Springs that fed Sixmile Creek, which was the source of the Toston municipal water supply, nearly discontinued flowing after the severe tremors, and consequently, inhabitants of the town resorted to dug or drilled wells for their water supply. Big Spring is reported to have been muddy for 2 days after the earthquake. The flow of Plunket Spring is said to have increased but, as the flow in 1950 was slightly less than that in 1921, the increase apparently was temporary.

South of Lombard several cracks appeared in the bottom land along the Missouri River, and water and sand spouted up for several hours after the earthquake. Similar sand spouts were reported near Townsend. A few wells are reported to have gone dry and others to have become muddy. The earthquake in 1935, which had its epicenter near Helena and which caused property damage in the Townsend Valley, caused no apparent change in groundwater conditions in the Townsend Valley.

WATERLOGGING

About 8,500 acres in the Townsend Valley are waterlogged. More than half of this land is unproductive at the present time and the productivity of the remainder has decreased greatly. The extent of the waterlogged land was mapped from field observations and by inspection of aerial photographs. (See pl. 20.)

About 1,500 acres of the waterlogged land is west of Canton; most of this land is suitable only for grazing, but small plots are used for wild hay. This land will be covered by backwater from the Canyon Ferry dam.

Between Townsend and the lower course of Deep Creek an area of about 2,000 acres is waterlogged. Twenty-five years ago this land reportedly was productive, but now only small tracts can be farmed, and the remaining marsh land is barely suitable for grazing. In 1921 the water level in well A7-2-33cd was 12 feet below the land surface (Pardee, 1925, p. 51), and in August 1949 the water level in the same well was only 0.50 foot below the surface. The maximum yearly fluctuation of the water level in several wells nearby ranges from 0.50 to 1.5 feet. During recent years land upslope from the waterlogged area has been irrigated and influent seepage from the irrigation canals and laterals and from irrigation water applied to the fields has recharged the ground-water reservoir. The alluvial fan, through which the ground water is moving, is not sufficiently permeable and does not have sufficient gradient to transmit the extra recharge; consequently, some of the ground water is discharged at the surface in the form of springs and effluent seeps. Apparently the nearness to the surface of relatively impermeable bedrock affects the movement of the ground water in this part of the area. Precambrian shale is exposed for a distance of nearly 1,000 feet along the north bank of the Montana irrigation canal about half a mile east of Townsend and it underlies the gravel-covered benchland. An exposure of similar bedrock along the west bank of the Missouri River west of Townsend suggests that the alluvium in the vicinity of Townsend is thinner there than in other parts of the valley. (No known wells have been drilled into the alluvial fill in or near Townsend.) A drainage study of the waterlogged land east of Townsend was made by the U. S. Soil Conservation Service (Long and James, 1948), and plans for drainage ditches are now being made (1951).

Most of the remaining 5,000 acres of waterlogged land is in the Crow Creek area. Ground water is discharged by many springs and effluent seeps along the lower Crow Creek valley. The land is poorly drained, supports a heavy growth of phreatophytes, and is suitable only for grazing. The sediments beneath the valley land adjoining the lower course of Warm Spring Creek are fine textured and support a capillary fringe which, in many places, extends to the land surface. Clay and silt deposits ranging in thickness from 1 to 45 feet were penetrated when observation wells were jetted in this part of the valley. Wells (A4-2-5bb; A5-1-36cc, -36dc; A5-2-27bb1, -27bb2, -27bb3; A5-2-29cc, -29dd; A5-2-31cc2, -31da; and A5-2-32cd) ranging in depth from 5 to 28 feet were jetted into light-gray and bluish-gray clay without encountering gravel beds. The remaining jetted wells were terminated in gravel beds of an undetermined thickness. Well A5-2-33ac, the deepest jetted hole, reached a water-bearing layer of gravel after penetrating 45 feet of light-colored clay and silt.

A small waterlogged area in the NW¼ sec. 27, T. 5 N., R. 2 E., is of particular interest because it indicates the effect of the irrigation of benchland on the ground-water conditions of the adjoining lowland. The ground-water surface in the valley bottom is 4 to 6 feet below land surface in the winter season. In the spring as soon as water is in the Broadwater irrigation canal, the ground-water surface begins to rise and a small marshy area forms below the break in slope between the benchland and the valley bottom. Influent seepage from the irrigation canal appears to be the chief source of recharge to the ground-water reservoir; and, because the valley sediments are relatively impermeable, the added recharge is forced to the surface instead of percolating laterally through the alluvium.

DISCHARGE

The ground water in the Townsend Valley is discharged by wells and springs, by evaporation and transpiration, and by seepage into the Missouri River and tributary streams.

About 330 wells are in use in the Townsend Valley. (See pl. 20 and table 4.) Because most of these wells supply water only for domestic and stock needs, the discharge by wells is only a small part of the total ground-water discharge. The pumpage from all wells in the Townsend Valley probably does not exceed 200 acre-feet per year.

Some of the water that is discharged from the ground-water reservoir by springs is returned to the ground-water reservoir in the lower parts of the valley. Other springs, however, issue from the alluvium close to the Missouri River and discharge water directly into the river.

EVAPOTRANSPIRATION

The amount of ground water lost by evapotranspiration varies with the season. The rate of loss is highest during the growing season when the temperature is high and is lowest in the winter when relatively little plant growth takes place. In many places in the Townsend Valley the capillary fringe above the water table is close to the land surface. It is from these areas that large amounts of water are discharged from the ground-water reservoir during the growing season.

SEEPAGE INTO STREAMS

It is believed that more water is discharged from the underground reservoir into the effluent streams than by any other means. The Missouri River is effluent in its entire course through the Townsend Valley and is the principal drain for discharge of the ground water. Crow Creek, its tributaries, and Beaver Creek are effluent in their lower reaches, and all discharge ground water from the area.

SPRINGS

Big Spring (A4-3-5cc), which is on the east bank of the Missouri River 4 miles south of Toston, is the largest of the springs that issue from the older rocks in and around the valley. The water

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issues from a talus-covered slope that overlies the basal red shale of the Amsden formation. Because some faulting is evident in this vicinity, the water is thought to follow a fault zone that connects with a cavernous reservoir in a limestone of the Madison group. One and one-half miles south of the spring the Missouri River, joined by Sixteenmile Creek at Lombard, flows across the upper dip slope of this limestone at an altitude 30 feet higher than the spring. As several large caverns are exposed in the Madison near Lombard, Pardee (1925, p. 47) stated:

> These relations suggest that most of the water discharged by this spring may come through underground channels that tap the river or Sixteenmile Creek in the neighborhood of Lombard.

However, as the temperature of the water that issues from Big Spring is relatively high (59° F) and as it remains constant throughout the year, the distance to the source of recharge for the spring is thought to be greater than was suggested by Pardee; possibly it is much farther east along the course of Sixteenmile Creek. The flow of the spring is almost constant throughout the year and varies little from year to year. The flow in May 1922 was measured as 64.4 cfs (Pardee, 1925, p. 46), and the flow on May 5, 1951, was 56.7 cfs. The temperature of the water in July 1921, September 1949, and June 1950 was 59° F. During the spring and summer months most of the flow is diverted by a small concrete dam into a canal and is used to irrigate land north and west of Toston. A small amount spills into the river.

Plunket Spring (A4-1-27ab), which is known also as Mockel Spring, is near the head of Warm Spring Creek in the south-central part of the Crow Creek area. The water gushes from several openings in a small outcrop of the thin-bedded Lodgepole limestone, which is the older formation of the Madison group. The flow from this spring, which is reported to remain constant throughout the year, was 8.7 cfs in August 1949; this is 1 cfs less than that reported for May 1922 (Pardee, 1925, p. 47). The temperature of the water was 62° F both in July 1921 and in September 1949; this moderately warm temperature indicates relatively deep circulation. The water from the spring collects in a shallow pond, which is impounded by a small dam constructed to divert the flow for irrigation of the land along Warm Spring Creek.

The largest of the springs issuing from Tertiary beds is Bedford Spring (A7-1-23ba), 3 miles northwest of Townsend. The water issues over a small area and has an aggregate flow of about 3.0 cfs. In September 1949 the temperature of the water was 74° F; this indicates that the water probably rises from the bedrock that underlies the Tertiary deposits. The water percolates to the surface through small openings in the younger coarse-textured deposits. The flow is reported to remain constant throughout the year, and the water is used for irrigation and domestic supplies. It is said that the water was used in the 1870's to power a grist mill about a mile north of the spring.

A smaller spring, known as Kimpton Spring (A5-1-22ca), bubbles through a small pool on the flood plain of Crow Creek, 3 miles southeast of Radersburg. Its flow in September 1949 was estimated to be less than 100 gpm. The temperature of the water was 64°F. The water is believed to rise from deep within the Tertiary beds and probably reaches the surface through small fissures or cracks in the overlying sediments.

Other small springs issue at many places in the lowland near the confluence of Crow and Warm Spring Creeks. They form swampy patches that are the principal sources of several smaller tributaries to Crow Creek.

A short distance east of U. S. Highway 10N and 7 to 9 miles northwest of Townsend, springs cause several small swampy areas on the gently sloping benchland. Antelope Springs (A8-1-21ba, -21bd, and -28ad) issue from the sand and gravel overlying the Tertiary sediments. Some of the water collects in a small concrete reservoir and supplies stock water for the Cook ranch. No wells or bedrock exposures in this area indicate the ground-water conditions, but the northwest-trending line of small springs indicates that ground water moving from the base of the mountains toward the river is forced to the surface by warped or faulted impermeable beds.

A short distance north and west of Canton in secs. 19, 20, 29, 30, and 31, T. 8 N., R. 2 E., effluent seepage has caused most of the land adjoining the Missouri River to become swampy. Small springs issue from the alluvium and form a small creek.

Many small springs also issue from the gentle valley slopes east of Canton. The south end of the spring zone is in the central part of sec. 11, T. 7 N., R. 2 E., and the zone extends northward about 3 miles to sec. 26, T. 8 N., R. 2 E. The aggregate flow from springs in this zone is estimated to be 5 cfs. Part of the water is used for domestic and stock supplies and, in the summer, a small amount is used for irrigation. The temperature of two small springs nearly three-fourths of a mile apart on the Harold Marks ranch (sec. 2, T. 8 N., R. 2 E.) was 52°F on June 21, 1950. Although the temperature does not indicate a deep source, other ground-water conditions indicate that the water issuing in these springs is probably reaching the land surface along a fault plane that connects confined aquifers in the underlying Tertiary beds with the surface. Only a short distance west of this area, the water level in wells A7-2-3da and A7-2-10aa is reported to be 60 to 70 feet below the land surface.

WELLS

The pre-Tertiary rocks that surround the Townsend Valley are strongly folded or faulted. The few ranchers who live in areas of pre-Tertiary rocks obtain water either from springs or from shallow wells that have been drilled or dug into the alluvium in the valleys of the perennial streams. No wells are known to tap the pre-Tertiary formations. The water level in the mines that penetrate the igneous rocks west of Radersburg is reported to range from 200 to 250 feet below the surface.

Well A4-2-8bb2 was drilled in Tertiary rocks to a depth of 71 feet in the lower reaches of the benchland that adjoins Warm Spring Creek valley. The water level in this well is about 32 feet below the surface, and the well furnishes an adequate water supply (8 gpm) for stock use and garden irrigation. Another well, A4-2-10bb, on the higher part of the benchland, was bottomed in sand and gravel at a depth of 200 feet. The water level in this well is about 171 feet below the surface, and the yield of 10 gpm is adequate for a large herd of range cattle.

Wells drilled in Tertiary rocks on the higher benchland between Deep and Sixmile Creeks reach water at depths of 150 to 200 feet and yield an adequate supply (8 to 10 gpm) for domestic and stock use.

In the lower part of the Townsend Valley many of the wells drilled into the coarse permeable gravel of Pleistocene and Recent age yield at least 8 to 10 gpm. In the vicinity of Townsend, wells driven 20 to 30 feet into the coarse-textured alluvial fan of Deep Creek yield an adequate supply of water for domestic and stock needs. Dug and drilled wells between Deep Creek and Toston penetrate water-bearing layers of sand and gravel at depths of 20 to 60 feet; these wells yield an adequate water supply for domestic and stock use. Dug and drilled wells in the Crow Creek valley obtain an ample supply of water from coarse-textured gravel and cobble deposits.

Several wells drilled on the lowland adjoining Warm Spring Creek were reported to penetrate a considerable thickness of "quicksand" overlying an indurated clay bed, which is locally called hardpan. The hardened clay layer is probably of early

Oligocene age and is underlain by sand and gravel, which yield an adequate water supply for domestic and stock use. Apparently, as a result of differential subsidence, the Tertiary beds in the Crow Creek area form a shallow basin; and, in general, the beds dip toward the center of the area. Precipitation and seepage from irrigation canals and streams enter the permeable beds where they are exposed on the higher valley slopes. The water then moves down the dip of the permeable beds and becomes confined below the less permeable beds. Wells drilled in the central part of the area penetrated a small reservoir of confined water. In well A5-2-31bd, reported to be 75 feet deep, the water is under sufficient artesian pressure to flow at the surface. Several wells nearby also tap confined water, but the artesian pressure is not sufficient to cause the water to flow at the surface.

The only other artesian wells in the area are three wells east of Townsend; they appear to have penetrated aquifers on the west limb of the Deep Creek anticline. Well A6-2-2ca was drilled to a depth of 78 feet and the water level rose to within 4 feet of the land surface when the aquifer was penetrated. Well A6-2-2db, which was drilled to a depth of 164 feet to obtain a water supply for irrigation, penetrated four artesian aquifers, and the water in the well rose to a level about 5 feet below the land surface. Well A7-2-22bb penetrated an artesian aquifer at a depth of 156 feet, and the water level rose to within 30 feet of the land surface.

USE

In the Townsend Valley, ground water is used mainly for domestic and stock supplies. A few wells supply water for irrigation of garden plots and one well was recently drilled for an irrigation supply.

The older wells in the valley were dug by hand, but the newer wells are either drilled or driven. The dug wells are 3 to 5 feet in diameter, the drilled wells 4 to 6 inches, and most of the driven wells are 1¼ inches. As most of the wells extend only a few feet below the water table, they are limited to a small drawdown and, consequently, to a small yield. The yield, however, is sufficient for all domestic and stock needs.

The first well drilled to obtain a water supply for irrigation was constructed in 1950 on the property of Edward Heuer (A6-2-2db) about 3½ miles southeast of Townsend. The well is 164 feet deep and 12 inches in diameter and yields water from sand and gravel of both Quaternary and Tertiary age. The casing is closely perforated opposite the water-bearing strata, but elsewhere is sparsely perforated. Upon completion the well was bailed at approximately 60 gpm, and the water level was drawn down 35 feet. The yield of the well was increased by development, and the well is expected to yield about 350 gpm with a drawdown of 60 feet. The driller's log of the well is given below and also is shown diagrammatically in figure 38. Much local interest was shown in this irrigation well and, if it proves successful, other such wells probably will be drilled.

Driller's log of irrigation well A6-2-2db

	Thickness (feet)	Depth (feet)
Topsoil, sandy clay	6	6
Brown sandy clay	4	10
Coarse sand and gravel	4	14
Sandy clay with some fine gravel	10	24
Alternate thin strata of pea-size gravel and clay	28	52
Brown sandy clay; intermixed fine gravel	12	64
Brown sandy clay	16	80
Brown clay with some gravel	10	90
Hardpan, fine gravel, and clay	7	97
Soft silty clay	2	99
Sandy clay and gravel	8	107
Coarse, clean, washed gravel	3	110
Soft clay	8	118
Hardpan	14	132
Soft clay	12	144
Hard clay	1	145
Medium-sized washed gravel and sand	3	148
Fine sand and gravel, some clay	7	155
Fine sand and gravel, well washed	5	160
Clay	4	164

Townsend, which has a population of 1,300, obtains its municipal water supply from Deep Creek. In 1946 the old infiltration galleries (Pardee, 1925, p. 51–52) were abandoned, and a new collecting system was installed. Water is now diverted from Deep Creek into open sumps or settling basins. From the sumps, the water is transported 2½ miles through a 10-inch pipe to two open concrete reservoirs, which have a combined capacity of 360,000 gallons. The reservoirs are at an elevation about 220 feet above the town, and the water is delivered under the pressure of gravity through several miles of wood stave pipe mains. The daily water consumption in 1950 was estimated to be 300,000 to 400,000 gallons.

Since 1925, when the earthquake changed the flow of Sixmile Creek, the town of Toston has not had a municipal water supply. The residents obtain water from shallow wells.

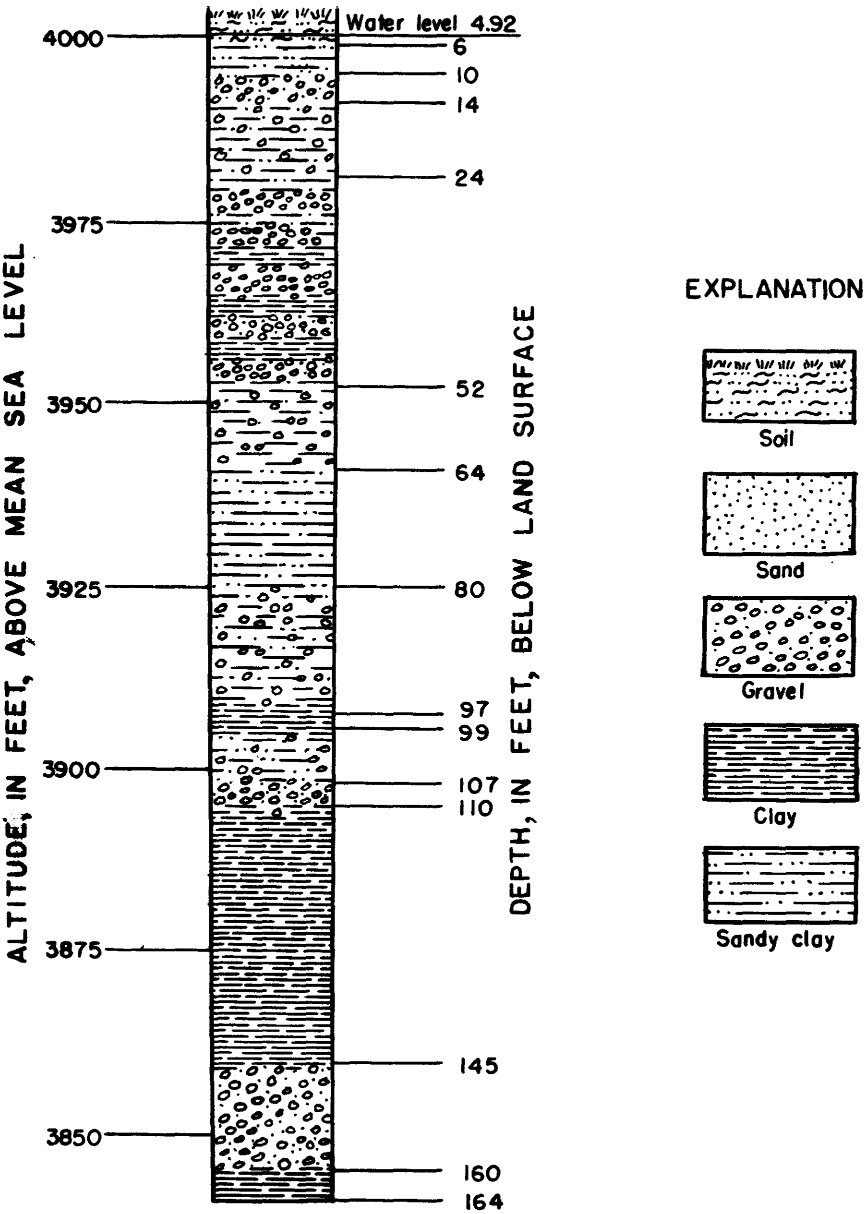

Figure 38. —Diagrammatic log of well A6-2-2db.

CHEMICAL QUALITY OF THE WATER

In the autumn of 1949 and 1950, samples were collected for chemical analysis from 47 water supplies in the Townsend Valley; the location of the sampling points is shown in plate 20. These samples represented supplies from the following ground and surface sources:

Source	Samples
Springs in pre-Tertiary rocks	2
Springs in Tertiary deposits	4
Wells in Tertiary deposits	16
Wells in Quaternary alluvium	13
Wells in undifferentiated deposits	3
Missouri River	1
Minor streams	8
Total	47

The analytical results are reported in table 3. The chemical character of ground water at a given locality usually remains fairly uniform in relation to time. An exception to this general statement is the change in the quality of the shallow ground water in irrigated tracts during the irrigation season. The chemical character of the surface supplies, which varies much more than that of the ground water, depends on conditions of flow; the higher concentrations of dissolved solids usually occur at times of low discharge. The analyses of ground-water samples in table 3 probably represent general range in composition of the ground water in the valley. The chemical examination of samples from the Missouri River and minor streams indicates the character of the water only at the time the samples were collected.

Information relating to the chemical quality of water in the Townsend Valley is useful in the evaluation of present supplies, the development of supplies for future needs, and the evaluation of changes that may occur as the result of irrigation or other activities of man.

Table 3.—*Chemical analyses of water in Townsend Valley, Mont.*

[Analyses in parts per million except as indicated]

Source	Date of collection	Depth of well (feet)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$		Percent sodium	Specific conductance (micromhos)	pH
																Total	Noncarbonate			
Pre-Tertiary rocks																				
A4-1-27ab (Plunket Spring).....	9-30-49	....	18	0.03	44	21	23	3.2	188	81	10	0.6	1.6	0.14	306	197	43	20	493	7.5
A4-3- 5cc (Big Spring)..........	9-30-49	....	23	.02	44	18	13	6.4	192	52	7.0	.2	.8	.14	266	184	27	13	419	7.4
Tertiary deposits																				
A4-2- 8bb2..........................	9-30-49	71.0	23	.86	70	31	22	5.6	216	131	31	.6	6.2	.20	442	302	125	13	676	7.1
-10bb..........................	9-30-49	200.1	38	.05	40	21	24	13	160	85	16	.6	8.4	.16	320	187	56	20	492	7.4
A5-1-22ca (Kimpton Spring)...	9-30-49	....	20	.04	24	5.7	6.0	4.8	104	14	4.0	.0	.4	.10	134	84	0	13	201	7.6
-35ca..........................	10- 3-49	78.7	24	.77	50	19	41	6.4	236	71	10	.0	20	.10	366	203	9	30	533	7.6
A5-2-28cd..........................	10- 3-49	62.3	25	.64	102	47	68	10	316	298	40	.6	4.4	.20	748	448	189	24	1,020	7.5
-31bd..........................	9-30-49	75.0	31	.02	86	23	55	11	128	292	29	.6	8.2	.16	620	309	204	27	868	7.1
A6-2- 2ca..........................	9- 1-50	78	15	.10	72	26	15	2.6	311	48	4.5	.1	1.2	.12	340	285	30	10	566	7.6
-27cc..........................	10- 3-49	35.1	36	.22	76	17	16	8.0	302	39	12	.0	4.6	.14	358	260	12	11	571	7.2
A7-1-23ba (Bedford Spring)....	10- 3-49	....	21	.03	52	19	13	3.2	150	103	7.0	.3	.7	.10	306	208	85	12	451	7.4
A7-2- 2bb (Spring)..............	9- 1-50	....	21	.10	90	31	23	8.4	310	114	12	.3	6.9	.13	476	350	96	12	723	7.9
-22bb..........................	9- 3-50	156.5	9.9	5.2	46	20	12	4.5	195	48	15	.1	.5	.02	258	199	39	11	437	7.4
A8-1- 6cb17..........................	9- 1-50	50	18	.08	42	14	22	3.1	167	58	6.0	.3	3.6	.08	272	163	26	22	399	7.7
- 6cc2..........................	9- 1-50	80	22	.36	46	9.5	20	1.4	139	70	4.5	.1	2.6	.09	256	154	40	22	379	7.6
-28ad (Antelope Spring)..	9- 1-50	....	21	.09	44	9.5	21	1.8	145	46	16	.1	2.0	.08	242	149	30	23	376	7.9
A8-2- 8ca..........................	9- 3-50	85.9	10	1.8	63	39	17	9.3	269	96	13	.4	16	.04	404	319	98	10	648	7.7
-11ab..........................	9- 1-50	142	14	.10	52	20	8.8	4.6	194	61	2.5	.2	1.3	.05	260	212	53	8	421	7.5
-14bb..........................	9- 1-50	107	12	.13	91	30	84	7.6	278	241	35	.1	6.7	.14	674	349	121	34	982	8.0
A9-2- 6dd..........................	9- 3-50	400	15	.24	54	37	10	3.4	167	116	31	.4	7.5	.17	398	285	148	7	591	7.5
-33cd..........................	9- 3-50	60.5	25	10	42	47	66	5.6	420	88	4.5	1.2	2.4	.28	500	299	0	32	770	8.0
A10-1-28ad..........................	9- 3-50	100+	15	.36	107	61	79	3.7	287	308	34	.5	86	....	906	517	282	27	1,240	7.9

Table 3.—*Chemical analyses of water in Townsend Valley, Mont.*—Continued

Source	Date of collection	Depth of well (feet)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids	Hardness as $CaCO_3$: Total	Hardness as $CaCO_3$: Noncarbonate	Percent sodium	Specific conductance (micromhos)	pH
Alluvium																				
A4-1- 2ca3	9-30-49	28.5	50	.02	102	17	44	11	462	46	3.0	....	18	.20	518	325	0	22	789	7.3
A5-1-23cc2	9-30-49	42.2	22	.07	40	6.2	8.7	4.0	158	17	4.4	....	.2	.10	180	126	0	13	293	7.5
A5-2- 4db	10- 3-49	25.2	37	.97	62	24	54	11	308	90	16	....	4.2	.30	448	253	0	31	708	7.4
-10ad	10- 3-49	61.2	30	.04	172	42	46	5.6	270	130	51	.1	364	....	976	602	381	14	1,340	7.3
-21ad	10- 3-49	16.2	43	.09	103	37	61	11	362	204	37	1.0	4.4	.40	712	409	112	24	988	7.3
-23ca4	10- 3-49	28.4	23	.02	61	17	27	5.6	228	68	17	.8	5.6	.10	358	222	35	20	540	7.2
A6-2- 9dd1	10- 3-49	36.9	22	.03	47	16	32	4.8	244	50	11	....	2.4	.14	306	184	0	27	509	7.4
A7-2-15cc	10- 3-49	115.0	22	1.5	106	45	14	7.2	146	154	136	.0	14	.10	702	450	330	6	979	7.2
-29ca2	10- 3-49	38.0	25	.13	67	25	35	9.6	324	66	14	.2	.4	.20	406	270	4	21	651	7.2
-31db	9- 3-50	20	25	.10	64	21	21	5.0	271	55	6.0	.2	1.5	.10	346	244	22	15	524	7.8
-33cd1	10- 3-49	20.0	16	.42	60	21	8.2	4.8	212	52	16	.2	2.0	.15	290	236	62	7	465	7.4
A8-2-29dc2	10- 1-50	30	26	.14	75	23	32	5.8	331	50	13	.5	6.0	.22	395	280	9	19	631	7.5
-32db2	9- 1-50	18	29	.11	83	23	54	6.3	297	70	49	1.2	35	.17	506	302	58	27	791	7.5
Undifferentiated																				
A7-2- 2bd	9- 1-50	117	19	.16	70	26	14	5.2	295	55	8.0	.4	6.3	.05	362	282	40	10	575	7.6
-10bb	9- 1-50	62.5	13	.42	84	42	34	6.8	320	128	37	.2	7.5	.14	535	382	120	16	825	7.8
A8-2-23cc2	9- 1-50	39	14	.14	60	21	16	5.1	193	70	26	.3	3.3	.07	334	234	76	13	522	7.5
Surface water																				
Missouri River near Toston	9-30-49	....	22	.02	42	14	24	4.8	192	46	13	1.0	.6	.20	276	163	6	24	426	7.6
Crow Creek	9-30-49	....	20	.04	21	3.9	2.2	3.2	74	12	3.0	....	.0	.06	102	69	8	6	155	7.2
Dry Creek	9- 3-50	....	25	.02	68	13	8.3		272	13	3.0	.1	.3	.07	276	223	0	8	432	8.2
Deep Creek	9-30-49	....	20	.02	53	19	12	6.4	234	50	6.0	.0	.1	.10	296	211	19	11	455	7.8
Ray Creek	9- 1-50	....	17	.02	48	16	5.3		188	34	4.5	.4	.7	.03	234	186	32	6	362	8.1
Gurnett Creek	9- 1-50	....	15	.01	41	10	5.8		162	19	1.5	.2	1.3	.08	186	144	11	8	297	8.0
Duck Creek	9- 1-50	....	15	.02	37	12	5.8		151	27	1.0	.2	1.2	.05	192	142	18	8	298	7.9
Confederate Gulch	9- 3-50	....	12	.02	57	26	16		199	110	3.0	.8	.6	.13	344	249	86	12	521	8.2
Beaver Creek	9- 1-50	....	16	.02	13	.9	5.3		43	10	1.0	.2	.3	.01	74	36	1	24	94	7.3

GROUND-WATER SUPPLIES

PRE-TERTIARY ROCKS

Big Spring, south of Toston, and Plunket (Mockel) Spring, near the head of Warm Spring Creek, issue from pre-Tertiary rocks. The water from both springs is hard and is similar in character to water known to have been in contact with limestone or dolomite. From a comparison of present analyses with earlier analyses reported by Pardee (1925, p. 57) it is concluded that the properties of the spring water have undergone little change in a period of about 30 years. The results of these analyses are shown below:

Analyses of spring water

[Parts per million]

Constituent	Big Spring		Plunket (Mockel) Spring	
	1922	1949	1921	1949
Silica (SiO_2)	20	23	22	18
Calcium (Ca)	46	44	70	44
Magnesium (Mg)	17	18	34	21
Sodium and potassium (Na + K)	17	19	32	26
Bicarbonate (HCO_3)	183	192	332	188
Sulfate (SO_4)	57	52	92	81
Chloride (Cl)	8.0	7.0	11	10
Nitrate (NO_3)	.49	.8	....	1.6
Hardness (as $CaCO_3$)	185	184	314	197
Dissolved solids	259	266	408	306

Although the chemical properties of the two samples of water from Plunket Spring differed somewhat, the difference was one of concentration rather than composition. The cumulative amounts, in percent, of the mineral solids for the two periods was in good agreement, as seen in figure 39.

TERTIARY DEPOSITS

Hard water of moderate mineral content is typical of supplies from Tertiary deposits in Townsend Valley. For 20 samples the average hardness and mineral content were 264 and 414 ppm, respectively. Water issuing from Kimpton Spring, 3 miles southeast of Radersburg, was the softest (84 ppm) of samples in this group.

The sample of water from Bedford Spring, 3 miles northwest of Townsend, was similar in chemical character to spring water

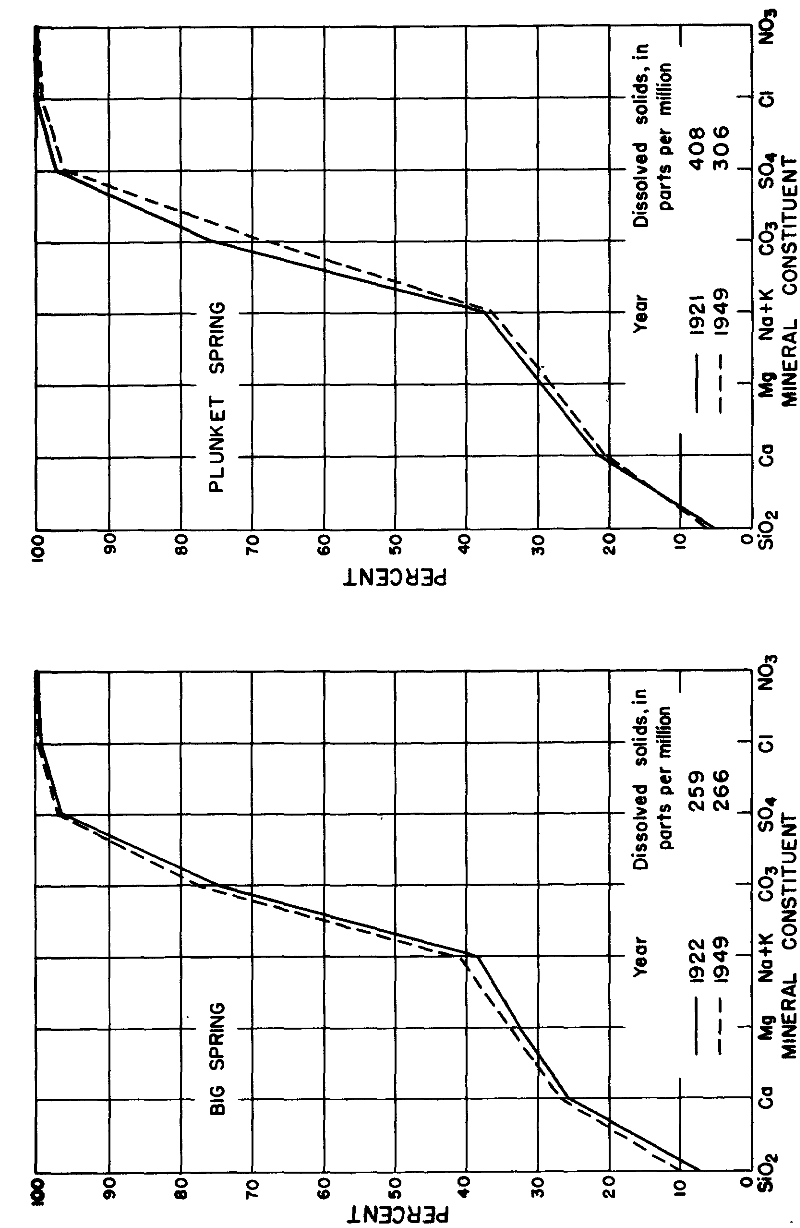

Figure 39. —Cumulative amounts, in percent, of minerals in spring water from pre-Tertiary rocks, 1921-22 and 1949.

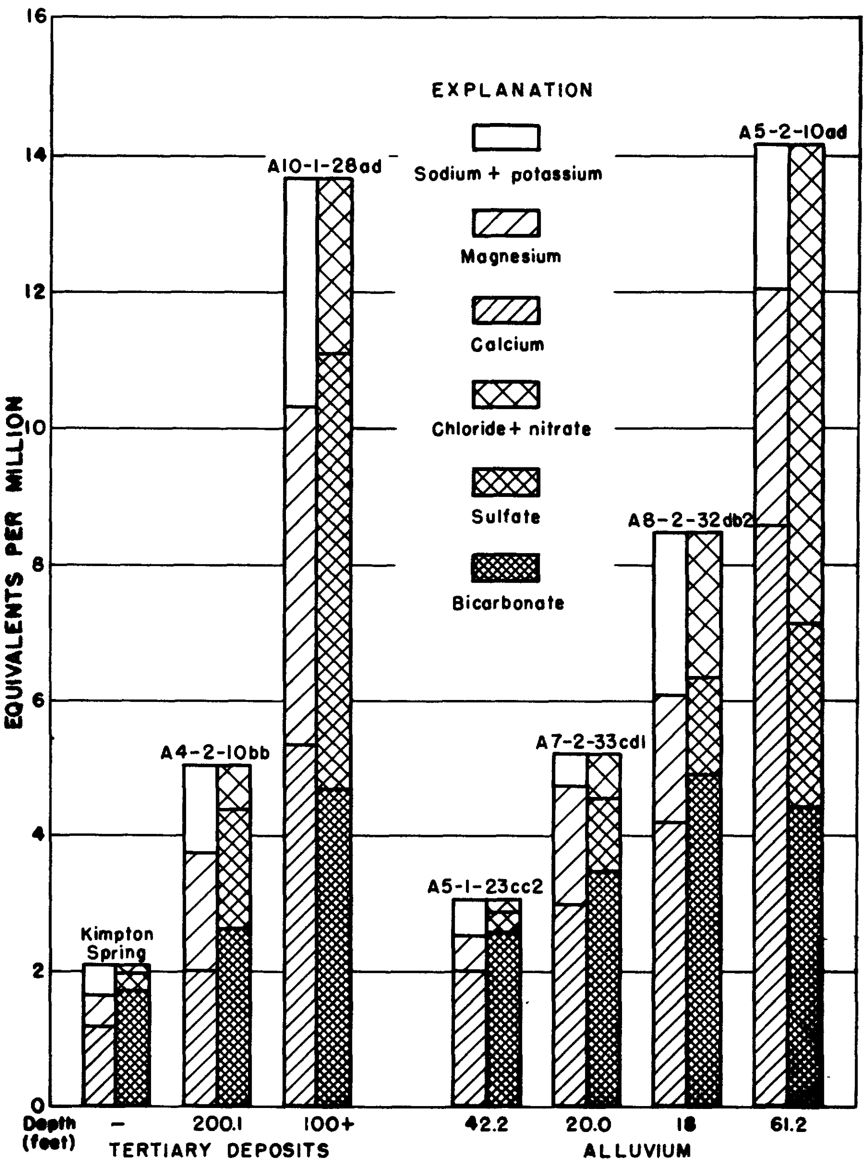

Figure 40. —Analyses of ground water in Tertiary deposits and alluvium, Townsend Valley.

from the pre-Tertiary rocks. The analysis also shows about the same concentration and chemical composition as reported for a sample collected in 1921 (Pardee, 1925, p. 57). These analyses of the water from this spring are shown below:

Analyses of water from Bedford Spring

[Parts per million]

	1921	*1949*
Silica (SiO_2)	16	21
Calcium (Ca)	60	52
Magnesium (Mg)	19	19
Sodium and potassium (Na + K)	18	16
Bicarbonate (HCO_3)	151	150
Sulfate (SO_4)	127	103
Chloride (Cl)	8.0	7.0
Nitrate (NO_3)	....	.7
Hardness (as $CaCO_3$)	228	208
Dissolved solids	336	306

The dissolved solids and hardness of shallow ground water are generally greater in the irrigated areas of the Townsend Valley than in the nonirrigated areas. For example, the sample from well A5-2-28cd, drilled 62.3 feet deep, contained 748 ppm of dissolved solids and had a hardness of 448 ppm. This greater mineralization is probably the result of the mixing of the ground water with recharge water that has reached the Tertiary sand and gravel as subsurface drainage from irrigated farmland.

Bar diagrams showing analyses of ground water from Tertiary deposits are shown in figure 40.

ALLUVIUM

Ground water from the alluvium is very similar in chemical properties to supplies from Tertiary deposits. For 13 samples from wells in alluvial deposits, the average dissolved-solids content and hardness were 473 and 300 ppm, respectively. Most of the wells from which water samples were collected are shallow wells drilled or dug in areas under irrigation. Because the alluvium is recharged largely by downward-percolating irrigation water, the mineral content of the ground water in the alluvium is determined in part by the chemical character of the irrigation water.

The sample of water from well A7-2-33cd1, in the waterlogged area southeast of Townsend, contained 290 ppm of dissolved solids. An earlier sample of water from this well, which was collected in 1921 (Pardee, 1925, p. 57) when the water level in the well was 12 feet below the surface, contained 306 ppm of dissolved solids. Although the total mineral content of the water has remained about the same, the composition of the dissolved solids has changed as follows:

Analyses of water in well A7-2-33cd1

[Parts per million]

	1921	1949
Silica (SiO_2)	14	16
Calcium (Ca)	48	60
Magnesium (Mg)	22	21
Sodium and potassium (Na + K)	21	13
Bicarbonate (HCO_3)	188	212
Sulfate (SO_4)	87	52
Chloride (Cl)	8.0	16
Nitrate (NO_3)	.5	2.0
Hardness (as $CaCO_3$)	210	236
Dissolved solids	306	290

Analyses, in equivalents per million, of water samples from the alluvium are shown in figure 40.

UNDIFFERENTIATED DEPOSITS

Samples were collected from three wells that produce water from aquifers that could not be identified. As these samples were similar in chemical character to water from Tertiary and alluvial deposits, it is thought that the source of the water was one or the other of these deposits, or both.

SURFACE-WATER SUPPLIES

Analyses of water samples from the Missouri River and eight minor streams (table 3) show that the surface water in the valley generally is less mineralized and is also softer than the ground water, although some exceptions occur. As previously noted, analyses of stream samples show the chemical character of the surface supply at the time of sampling only. The results cannot be interpreted as necessarily representing the quality of the water at all stages of flow.

SUITABILITY FOR USE

In the Townsend Valley springs and surface sources furnish water for irrigation, whereas water from wells is used largely for domestic purposes. In the following discussion, supplies from both ground and surface sources are considered in regard to their suitability for use.

IRRIGATION

Ground- and surface-water supplies sampled in 1949 and 1950 are suitable for use as irrigation water in accordance with permissible limits proposed by Wilcox (1948, p. 25–28) for electrical conductivity, percent sodium, and boron, Ratings of water from different sources are tabulated below:

Suitability of water for irrigation

Source	Number of samples	Rating	Grade
Pre-Tertiary rocks	2	2	Good.
Tertiary deposits	1	1	Excellent.
Do	14	2	Good.
Do	5	3	Permissible.
Alluvium	8	2	Good.
Do	5	3	Permissible.
Undifferentiated deposits	2	2	Good.
Do	1	3	Permissible.
Missouri River	1	2	Good.
Crow Creek	1	1	Excellent.
Miscellaneous streams	7	2	Good.

DOMESTIC

Except for hardness, the water for which analyses are reported in table 3 is generally satisfactory for domestic use, although iron is present in objectionable amounts in some ground-water supplies. Well A5-2-10ad, pumping water from alluvium, should not be used as a source of drinking water because of the high concentration (364 ppm) of nitrate in the water. Surface contamination is probably reaching this water, for the well is dug near a large stock-feeding corral.

SUMMARY AND CONCLUSIONS

Ground water in quantities large enough to supply domestic and stock needs can be obtained from wells drilled into the alluvial deposits of the valley bottom, or into the Tertiary deposits that flank the valley bottom for much of its length in the Townsend Valley. In parts of the valley, wells drilled into the alluvial deposits could probably obtain several hundred gallons of water per minute. Where conditions are favorable, limited supplies can be obtained from wells drilled into the limestone and sandstone formations of Paleozoic age. Springs issuing from pre-Tertiary sedimentary rocks supply domestic and stock water to ranchers who live in the higher parts of the valley and are the principal source of water that maintains the flow of perennial streams.

Ground water is under artesian pressure in the Tertiary deposits in the Crow Creek area and along the west flank of the Dry Creek anticline east of Townsend. In the Crow Creek area water supplies that are only large enough for domestic and stock needs are produced from the confined reservoir. Well A5-2-31bd is a flowing well. East of Townsend the artesian aquifers are capable of greater yields; the yield of well A6-2-2db is used for irrigation, and additional wells in this area probably could produce large enough water supplies for the same purpose.

The principal sources of ground-water recharge in the valley are the streams that flow across the area, the irrigation canals and laterals, and seepage from irrigated fields. In the lower parts of the valley where the water table is near the surface, a small amount of precipitation also reaches the ground-water reservoir. Influent seepage from streams and precipitation are the sources of recharge to the reservoirs in the older rocks of the mountainous area.

In general, the ground water in the Crow Creek area moves northeast toward the Missouri River, and the hydraulic gradient is 30 to 40 feet to the mile. In the valley bottom north of Toston, the water table slopes to the west at an average rate of 20 feet to the mile, and the movement of the ground water nearly parallels the perennial streams.

Waterlogging in the Townsend Valley is primarily the result of geologic conditions that control ground-water movement and of recharge from irrigation water. The high water table in parts of the valley makes the land suitable only for the growth of wild hay and for grazing.

The application of additional irrigation water to the benchland flanking Warm Spring Creek will increase the extent of waterlogging in the bottom land unless provision is made for more adequate drainage. In this part of the valley the Tertiary sand and gravel deposits, which are mantled by permeable windblown soil, are underlain by beds of hardened clay, locally referred to as "hardpan." If water is applied to these lands, a gradual rise in the water table will take place. This rise will result in the increased flow of existing springs in the lower part of the valley, and new springs will appear along the slope from the benchland to the valley bottom. In this area the valley bottom is underlain by relatively impermeable fine-textured clay. The capillary fringe above the water table will rise to the surface in much of the bottom land, saline soil will develop, and the land will eventually become unproductive. Waterlogging will become more extensive if irrigation water is applied to the benchland that lies at a higher

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elevation than the present irrigated land unless provision is made for more adequate drainage. This condition will exist not only in the Crow Creek area but also in other parts of the valley where additional irrigation is planned.

Backwater from the Canyon Ferry dam will raise the water table under the land adjoining the reservoir. To keep most of the farmland around the reservoir in production, adequate drainage facilities must be provided.

Water supplies in the Townsend Valley generally are hard but moderately mineralized. The quality of water from springs was about the same in 1949 as in 1921 or 1922. Ground water is used almost exclusively for domestic purposes or for watering of stock and, except for hardness, is generally satisfactory. Iron is present in objectionable amounts in some supplies. The effects of waterlogging on the quality of the water cannot be defined at the present time; a water sample from a shallow well in an area that is now waterlogged was only slightly different in quality from a sample from the same well before the area became waterlogged. Water both from ground and surface sources is satisfactory for irrigation on the basis of ratings that have been proposed by Wilcox.

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Measurement of water level in observation wells

Table 4.—*Measurements of the water level in observation wells*

[In feet below land-surface datum]

Date	Water level	Date	Water level	Date	Water level
A4-1-1ba					
June 29, 1949	1.55	Oct. 21, 1949	0.96	May 10, 1950	0.75
July 26	2.17	Dec. 7	.87	June 6	1.31
Aug. 26	2.55	Mar. 7, 1950	.80	July 10	.21
Sept. 27	1.28	Apr. 5	.85	Aug. 7	.42
A4-1-2ab					
May 2, 1949	7.58	Dec. 6, 1949	8.08	June 6, 1950	1.81
June 24	4.51	Jan. 10, 1950	8.07	July 10	5.56
July 28	6.65	Feb. 7	8.48	Aug. 7	6.65
Aug. 25	7.98	Mar. 7	8.48	Sept. 11	7.77
Sept. 27	8.29	Apr. 5	8.29	Oct. 9	7.80
Oct. 20	8.19	May 9	8.14	Nov. 15	7.50
A4-1-2bd1					
June 30, 1949	4.15	Jan. 10, 1950	8.39	July 10, 1950	5.96
July 28	6.82	Feb. 7	8.72	Aug. 7	7.08
Aug. 25	8.25	Mar. 7	8.76	Sept. 11	7.91
Sept. 27	8.52	Apr. 5	8.72	Oct. 9	7.98
Oct. 20	8.40	May 9	9.25	Nov. 15	8.53
Dec. 6	8.36	June 6	6.97	Dec. 13	8.50
A4-1-2ca3					
May 2, 1949	21.80	Nov. 15, 1950	20.35	Apr. 21, 1952	21.52
June 24	18.50	Dec. 13	20.73	May 20	20.22
July 29	18.01	Jan. 10, 1951	21.03	June 16	17.44
Aug. 25	19.10	Feb. 14	21.64	July 14	17.17
Sept. 27	19.92	Mar. 16	21.54	Aug. 13	18.44
Oct. 20	20.40	Apr. 13	21.13	Sept. 18	19.58
Dec. 6	21.06	May 11	21.77	Oct. 21	20.17
Jan. 10, 1950	21.34	June 16	18.92	Nov. 21	20.43
Feb. 7	22.82	July 18	18.62	Dec. 19	20.56
Mar. 7	[1]24.60	Aug. 15	19.33	Jan. 22, 1953	20.72
Apr. 5	23.96	Sept. 19	20.39	Feb. 19	20.90
May 9	22.04	Oct. 8	20.08	Mar. 19	21.02
June 6	20.77	Nov. 19	20.58	Apr. 20	21.21
July 10	17.58	Dec. 17	20.75	May 18	21.49
Aug. 7	18.23	Jan. 16, 1952	21.20	June 18	16.42
Sept. 11	19.41	Feb. 14	21.64	July 16	16.31
Oct. 9	19.80	Mar. 17	21.54		
A4-1-2cb1					
June 30, 1949	8.10	Jan. 10, 1950	12.00	July 10, 1950	8.53
July 28	9.71	Feb. 7	12.30	Aug. 7	9.49
Aug. 25	10.85	Mar. 7	12.39	Sept. 11	10.77
Sept. 27	11.45	Apr. 5	12.37	Oct. 9	11.07
Oct. 20	11.60	May 9	12.36	Nov. 15	11.35
Dec. 6	11.85	June 6	10.74		

[1]Pumping.

Table 4.—*Measurements of the water level in observation wells*—Continued

A4-1-10cb

Date	Water level	Date	Water level	Date	Water level
May 2, 1949	95.80	Oct. 9, 1950	93.52	Mar. 17, 1952	93.89
June 24	95.53	Nov. 15	93.79	Apr. 21	93.95
July 29	94.78	Dec. 13	94.14	June 16	94.00
Aug. 25	94.62	Jan. 10, 1951	93.81	July 14	94.36
Sept. 27	94.45	Feb. 14	94.05	Aug. 13	93.28
Oct. 20	94.55	Mar. 16	94.01	Sept. 18	93.03
Dec. 6	94.70	Apr. 13	93.91	Oct. 21	93.66
Jan. 10, 1950	94.65	May 11	93.87	Nov. 21	92.90
Feb. 7	94.92	June 16	94.28	Dec. 19	92.77
Mar. 7	95.08	July 18	94.26	Jan. 22, 1953	92.84
Apr. 5	94.96	Aug. 15	94.06	Feb. 19	93.22
May 9	95.13	Sept. 19	93.69	Mar. 19	92.83
June 6	95.03	Oct. 8	93.89	Apr. 20	93.12
July 10	95.66	Nov. 19	93.72	May 18	93.28
Aug. 7	93.89	Dec. 17	93.82	June 18	93.42
Sept. 11	93.50	Feb. 14, 1952	93.98	July 16	93.14

A4-1-11ab

Date	Water level	Date	Water level	Date	Water level
May 2, 1949	16.50	July 27, 1949	14.15	Sept. 27, 1949	14.51
June 24	9.50	Aug. 25	13.57		

A4-1-12bd

Date	Water level	Date	Water level	Date	Water level
May 2, 1949	6.97	Dec. 6, 1949	7.30	June 6, 1950	7.08
June 24	6.12	Jan. 10, 1950	7.02	July 10	8.11
July 29	8.30	Feb. 7	6.75	Aug. 7	8.53
Aug. 25	8.94	Mar. 7	6.77	Sept. 11	8.12
Sept. 27	7.55	Apr. 5	6.70	Oct. 9	8.09
Oct. 20	7.92	May 9	7.25	Nov. 15	8.27

A4-1-13cc

Date	Water level	Date	Water level	Date	Water level
Oct. 5, 1949	35.00	Nov. 7, 1949	37.01		

A4-1-14cc

Date	Water level	Date	Water level	Date	Water level
June 29, 1949	53.80	Jan. 10, 1950	51.81	July 10, 1950	52.69
July 28	53.70	Feb. 7	48.94	Aug. 7	53.41
Aug. 25	53.55	Mar. 7	50.28	Sept. 11	52.14
Sept. 27	53.00	Apr. 5	50.75	Oct. 9	51.73
Oct. 20	52.33	May 9	52.07	Nov. 15	52.03
Dec. 7	52.61	June 6	52.64		

A4-2-5bb

Date	Water level	Date	Water level	Date	Water level
Nov. 15, 1950	4.76	Oct. 8, 1951	4.99	Sept. 18, 1952	5.36
Dec. 13	4.57	Nov. 19	4.64	Oct. 21	5.11
Jan. 10, 1951	4.46	Dec. 17	4.58	Nov. 21	4.48
Feb. 14	4.55	Jan. 16, 1952	4.75	Dec. 19	4.54
Mar. 16	4.39	Feb. 14	4.41	Jan. 22, 1953	4.24
Apr. 13	2.64	Mar. 17	4.25	Feb. 19	4.11
May 11	2.03	Apr. 21	2.54	Mar. 19	3.71
June 16	3.74	May 21	2.23	Apr. 20	3.69
July 18	4.88	June 16	3.87	May 18	3.74
Aug. 15	5.36	July 14	4.46	June 18	3.85
Sept. 19	5.20	Aug. 13	4.86	July 16	4.86

Table 4.—*Measurements of the water level in observation wells*—Continued

A4-2-5bc

Date	Water level	Date	Water level	Date	Water level
Aug. 29, 1949	8.20	Jan. 10, 1951	7.40	May 21, 1952	5.50
Sept. 29	7.73	Feb. 14	7.48	June 16	7.96
Oct. 21	7.54	Mar. 16	7.44	July 14	7.08
Dec. 7	7.43	Apr. 13	6.33	Aug. 13	8.49
Jan. 10, 1950	7.42	May 11	4.99	Sept. 18	8.48
Feb. 7	7.34	June 16	7.33	Oct. 21	8.20
Mar. 7	7.32	July 18	7.99	Nov. 21	7.68
Apr. 5	6.09	Aug. 15	8.15	Dec. 19	7.80
May 9	5.94	Sept. 19	7.91	Jan. 22, 1953	7.70
June 6	7.12	Oct. 8	7.57	Feb. 19	7.68
July 10	7.54	Nov. 19	8.09	Mar. 19	7.52
Aug. 7	7.52	Dec. 17	8.05	Apr. 20	7.36
Sept. 11	7.91	Jan. 16, 1952	8.09	May 18	7.68
Oct. 9	7.56	Feb. 14	7.90	June 18	7.87
Nov. 15	7.57	Mar. 17	7.90	July 16	8.41
Dec. 13	7.52	Apr. 21	5.93		

A4-2-5bd

Date	Water level	Date	Water level	Date	Water level
July 29, 1949	7.24	Feb. 7, 1950	6.90	July 10, 1950	7.01
Aug. 25	7.79	Mar. 7	6.48	Aug. 7	7.44
Sept. 27	7.41	Apr. 5	5.89	Sept. 11	7.47
Oct. 21	7.12	May 9	5.38	Oct. 9	7.27
Dec. 6	6.80	June 6	6.16	Nov. 15	6.78
Jan. 10, 1950	6.84				

A4-2-5cc

Date	Water level	Date	Water level	Date	Water level
July 29, 1949	22.50	Dec. 13, 1950	22.97	Apr. 21, 1952	22.76
Aug. 25	22.60	Jan. 10, 1951	22.93	May 21	22.73
Sept. 29	22.76	Feb. 14	22.92	June 16	22.57
Oct. 20	22.85	Mar. 16	22.94	July 14	22.76
Dec. 7	22.98	Apr. 13	22.91	Aug. 13	22.83
Jan. 10, 1950	22.80	May 11	22.68	Sept. 18	22.53
Feb. 7	22.84	June 16	22.67	Oct. 21	22.65
Mar. 7	22.88	July 18	22.69	Nov. 21	22.74
Apr. 5	22.86	Aug. 15	22.78	Dec. 19	22.77
May 9	22.83	Sept. 19	22.81	Jan. 22, 1953	22.75
June 6	22.79	Oct. 8	22.91	Feb. 19	22.80
July 10	22.80	Nov. 19	22.94	Mar. 19	22.72
Aug. 7	22.79	Dec. 17	22.92	Apr. 20	22.79
Sept. 11	22.82	Jan. 16, 1952	22.91	May 18	22.65
Oct. 9	22.92	Feb. 14	22.86	June 18	22.60
Nov. 15	22.96	Mar. 17	22.95	July 16	22.57

A4-2-6aa

Date	Water level	Date	Water level	Date	Water level
Aug. 29, 1949	6.02	Feb. 7, 1950	5.65	July 10, 1950	5.07
Sept. 27	6.38	Mar. 7	5.47	Aug. 7	4.77
Oct. 21	6.20	Apr. 5	4.40	Sept. 11	6.15
Dec. 7	5.83	May 9	2.25	Oct. 9	6.01
Jan. 10, 1950	5.69	June 6	3.93		

A4-2-6cc

Date	Water level	Date	Water level	Date	Water level
Nov. 15, 1950	5.06	Nov. 19, 1951	4.76	Oct. 21, 1952	4.90
Jan. 10, 1951	3.93	Dec. 17	4.31	Nov. 21	4.19
Feb. 14	4.02	Jan. 16, 1952	4.36	Dec. 19	3.86
Mar. 16	3.81	Feb. 14	2.70	Jan. 22, 1953	3.37
Apr. 13	2.74	Apr. 21	2.24	Feb. 19	3.54
May 11	3.19	May 21	2.02	Mar. 19	3.41
June 16	4.58	June 16	4.28	Apr. 20	3.54
July 18	5.51	July 14	4.48	May 18	3.96
Aug. 15	6.01	Aug. 13	5.40	June 18	4.19
Sept. 19	6.33	Sept. 18	5.10	July 16	5.37
Oct. 8	5.18				

Table 4.—*Measurements of the water level in observation wells*—Continued

A4-2-6cd

Date	Water level	Date	Water level	Date	Water level
June 29, 1949	7.15	July 10, 1950	7.24	June 16, 1951	6.86
July 29	7.40	Aug. 7	7.22	July 18	7.42
Aug. 25	7.57	Sept. 11	7.17	Aug. 15	7.48
Sept. 27	7.20	Oct. 9	6.97	Sept. 19	7.52
Oct. 20	7.00	Nov. 15	6.85	Oct. 8	7.48
Dec. 7	6.94	Dec. 13	6.82	Nov. 19	6.99
Jan. 10, 1950	7.00	Jan. 10, 1951	6.78	Dec. 17	6.96
Feb. 7	6.94	Feb. 14	6.88	Feb. 14, 1952	7.01
Mar. 7	6.76	Mar. 16	7.69	Mar. 17	6.82
Apr. 5	6.58	Apr. 13	6.66	Apr. 21	6.39
May 9	6.59	May 11	6.83	May 21	6.28
June 6	8.13				

A4-2-8bb

Date	Water level	Date	Water level	Date	Water level
May 2, 1949	32.50	Dec. 7, 1949	32.88	May 9, 1950	33.72
June 23	32.52	Jan. 10, 1950	32.85	June 6	33.83
July 21	32.56	Feb. 7	32.85	July 10	33.71
Aug. 25	32.66	Mar. 7	32.85	Aug. 7	33.75
Sept. 29	32.68	Apr. 5	33.76	Sept. 11	33.77
Oct. 20	32.77				

A5-1-4cc

Date	Water level	Date	Water level	Date	Water level
July 7, 1949	11.20	Aug. 7, 1950	10.26	Sept. 19, 1951	18.12
Aug. 9	14.95	Sept. 8	19.24	Oct. 8	16.17
25	19.40	Oct. 9	22.51	Nov. 19	16.90
Sept. 27	22.78	Nov. 15	19.65	Dec. 17	18.46
Oct. 20	23.85	Dec. 13	17.53	Jan. 16, 1952	18.45
Dec. 6	25.10	Jan. 10, 1951	18.53	Feb. 14	14.66
Jan. 10, 1950	22.22	Feb. 14	19.54	Mar. 17	15.06
Feb. 7	21.70	Mar. 16	20.71	Apr. 21	16.00
Mar. 7	14.73	Apr. 13	12.95	May 20	6.40
Apr. 5	16.90	May 11	11.41	June 16	7.70
May 9	19.97	June 16	5.86	July 14	8.43
June 5	5.19	July 18	9.33	Aug. 13	13.49
July 10	7.74	Aug. 15	14.85	Sept. 18	20.14

A5-1-8cd2

Date	Water level	Date	Water level	Date	Water level
July 7, 1949	11.60	Dec. 13, 1950	15.51	May 20, 1952	16.69
Aug. 25	13.92	Jan. 10, 1951	16.23	June 16	14.96
Sept. 27	13.86	Feb. 14	17.52	July 14	13.70
Oct. 20	14.59	Mar. 16	17.13	Aug. 13	14.20
Dec. 6	15.31	Apr. 13	17.46	Sept. 17	15.08
Jan. 10, 1950	16.37	May 11	15.71	Oct. 21	16.05
Feb. 7	17.17	June 16	12.54	Nov. 21	17.24
Mar. 7	17.52	July 18	12.84	Dec. 19	17.17
Apr. 5	17.53	Aug. 15	13.84	Jan. 22, 1953	18.53
May 9	15.93	Sept. 19	11.71	Feb. 19	18.61
June 5	13.24	Oct. 8	13.82	Mar. 19	19.08
July 10	10.91	Nov. 19	14.21	Apr. 20	18.83
Aug. 7	12.77	Dec. 17	15.92	May 18	17.21
Sept. 8	13.17	Feb. 14, 1952	16.41	June 18	15.05
Oct. 9	13.66	Mar. 17	18.19	July 16	12.42
Nov. 15	14.87	Apr. 21	18.47		

Table 4.—*Measurements of the water level in observation wells*—Continued

A5-1-10cb

Date	Water level	Date	Water level	Date	Water level
July 6, 1949	11.91	Oct. 9, 1950	17.68	Jan. 16, 1952	18.27
Aug. 9	15.80	Nov. 15	18.27	Feb. 14	19.14
25	16.60	Dec. 13	18.73	Apr. 21	17.89
Sept. 27	17.26	Jan. 10, 1951	19.19	May 20	5.83
Oct. 20	17.60	Feb. 14	19.79	June 16	7.19
Dec. 6	18.37	Mar. 16	20.38	July 14	13.45
Jan. 10, 1950	20.10	Apr. 13	20.66	Aug. 13	15.20
Feb. 7	19.65	May 11	19.89	Sept. 18	17.03
Mar. 7	20.18	June 16	11.79	Oct. 21	17.61
Apr. 5	20.64	July 18	13.84	Nov. 21	17.90
May 9	21.04	Aug. 15	16.10	Dec. 19	18.50
June 5	20.60	Sept. 19	17.10	Jan. 22, 1953	18.98
July 10	16.49	Oct. 8	17.42	Feb. 19	19.21
Aug. 7	16.26	Nov. 19	17.86	Mar. 19	19.82
Sept. 8	17.13	Dec. 17	18.00	Apr. 20	19.90

A5-1-11cd

Date	Water level	Date	Water level	Date	Water level
July 7, 1949	5.85	Jan. 10, 1950	6.57	July 10, 1950	3.45
Aug. 9	6.10	Feb. 7	6.72	Aug. 7	5.95
25	6.17	Mar. 7	6.85	Sept. 8	6.22
Sept. 27	6.28	Apr. 5	[1]8.60	Oct. 9	6.35
Oct. 20	6.30	May 9	[1]8.55	Nov. 15	8.72
Dec. 6	6.80	June 5	6.34		

A5-1-22bb

Date	Water level	Date	Water level	Date	Water level
July 6, 1949	4.75	Jan. 10, 1950	21.83	July 10, 1950	9.36
Aug. 9	8.13	Feb. 7	23.82	Aug. 7	7.71
25	9.94	Mar. 7	25.25	Sept. 8	10.44
Sept. 27	12.92	Apr. 5	26.20	Oct. 9	11.98
Oct. 20	15.00	June 5	16.26	Nov. 15	14.48
Dec. 6	18.95				

A5-1-23bd

Date	Water level	Date	Water level	Date	Water level
May 2, 1949	2.37	Nov. 15, 1950	4.45	Apr. 21, 1952	4.64
June 24	2.00	Dec. 13	4.31	May 20	3.32
July 28	2.25	Jan. 10, 1951	4.83	June 16	3.94
Aug. 25	1.92	Feb. 14	5.55	July 14	3.34
Sept. 27	1.75	Mar. 16	5.93	Aug. 13	2.76
Oct. 20	1.58	Apr. 13	6.59	Sept. 18	2.08
Dec. 6	2.27	May 11	5.13	Oct. 21	1.81
Jan. 10, 1950	3.80	June 16	5.42	Nov. 21	1.82
Feb. 7	4.90	July 18	5.53	Dec. 19	2.59
Mar. 7	5.00	Aug. 15	5.21	Jan. 22, 1953	3.82
Apr. 5	5.40	Sept. 19	4.10	Feb. 19	4.82
May 9	6.64	Oct. 8	3.64	Mar. 19	5.66
June 5	6.57	Nov. 19	3.07	Apr. 20	5.77
July 10	5.83	Dec. 17	3.29	May 19	8.04
Aug. 7	6.21	Jan. 16, 1952	3.80	June 18	2.52
Sept. 8	5.89	Feb. 14	4.23	July 16	4.91
Oct. 9	5.02	Mar. 17	5.00		

[1]Pumping.

Table 4.—*Measurements of the water level in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
		A5-1-23cc1			
June 29, 1949	2.95	Dec. 13, 1950	7.82	Apr. 21, 1952	10.06
July 28	3.83	Jan. 10, 1951	8.78	May 20	4.50
Aug. 25	4.63	Feb. 14	10.46	June 16	1.50
Sept. 27	6.58	Mar. 16	10.57	July 14	1.84
Oct. 20	6.19	Apr. 13	11.23	Aug. 13	4.95
Dec. 6	7.40	May 11	7.67	Sept. 18	5.81
Jan. 10, 1950	9.15	June 16	4.11	Oct. 21	5.90
Feb. 7	10.42	July 18	4.42	Nov. 21	8.59
Mar. 7	11.30	Aug. 15	6.14	Dec. 21	8.73
Apr. 5	11.68	Sept. 19	7.32	Jan. 22, 1953	10.00
May 9	13.02	Oct. 8	7.10	Feb. 19	10.59
June 6	9.09	Nov. 20	7.01	Mar. 19	10.86
July 10	3.89	Dec. 17	8.16	Apr. 20	10.96
Aug. 7	5.67	Jan. 16, 1952	9.41	May 19	12.52
Sept. 11	7.25	Feb. 14	9.83	June 18	2.52
Oct. 9	7.14	Mar. 17	11.51	July 16	2.97
Nov. 15	7.58				
		A5-1-24db			
June 28, 1949	1.48	Jan. 10, 1950	2.66	July 10, 1950	3.05
July 28	2.23	Feb. 7	3.13	Aug. 7	1.25
Aug. 25	2.87	Mar. 7	2.56	Sept. 8	3.90
Sept. 27	2.70	Apr. 5	2.13	Oct. 9	3.73
Oct. 20	2.46	May 9	2.75	Nov. 15	3.49
Dec. 6	2.05	June 5	3.45		
		A5-1-26ac2			
June 29, 1949	3.45	Dec. 6, 1949	4.58	May 9, 1950	5.89
July 25	4.12	Jan. 10, 1950	5.12	June 6	5.11
Aug. 25	4.30	Feb. 7	5.52	July 10	3.75
Sept. 27	4.26	Mar. 7	5.75	Aug. 7	4.11
Oct. 20	4.14	Apr. 5	5.70		
		A5-1-26cd			
May 2, 1949	8.51	Nov. 15, 1950	7.83	Apr. 21, 1952	8.61
June 24	5.06	Dec. 13	8.04	May 20	7.64
July 28	6.89	Jan. 10, 1951	8.26	June 16	5.53
Aug. 25	7.56	Feb. 14	8.64	July 14	3.24
Sept. 27	7.75	Mar. 16	8.91	Aug. 13	6.47
Oct. 20	7.70	Apr. 13	8.86	Sept. 18	7.26
Dec. 6	8.03	May 11	8.75	Oct. 21	7.34
Jan. 10, 1950	8.50	June 16	5.39	Nov. 21	7.57
Feb. 7	8.84	July 18	5.58	Dec. 19	7.71
Mar. 7	8.89	Aug. 15	7.04	Jan. 22, 1953	8.27
Apr. 5	8.98	Sept. 19	7.48	Feb. 19	8.53
May 9	9.05	Oct. 8	9.00	Mar. 19	8.60
June 6	8.26	Nov. 20	7.53	Apr. 20	8.52
July 10	6.48	Dec. 17	7.88	May 19	9.10
Aug. 7	5.76	Jan. 16, 1952	8.36	June 18	5.32
Sept. 11	7.47	Feb. 14	8.50	July 16	4.79
Oct. 9	7.64	Mar. 17	8.78		
		A5-1-34aa			
July 5, 1949	13.30	Feb. 7, 1950	18.13	July 10, 1950	14.45
Aug. 25	15.77	Mar. 7	18.47	Aug. 7	13.71
Sept. 27	16.51	Apr. 5	18.62	Sept. 11	15.72
Oct. 20	16.66	May 9	18.98	Oct. 9	16.28
Dec. 6	17.24	June 6	17.44	Nov. 15	16.81
Jan. 10, 1950	17.72				

Table 4.—*Measurements of the water level in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
		A5-1-35ca			
May 2, 1949	8.40	July 28, 1949	6.78	Oct. 6, 1949	17.04
June 24	6.35	Aug. 25	8.02		
		A5-1-35cd			
June 30, 1949	4.49	Dec. 13, 1950	6.35	Apr. 21, 1952	5.78
July 28	5.93	Jan. 10, 1951	6.50	May 20	6.02
Aug. 25	7.45	Feb. 14	7.01	June 16	4.87
Sept. 27	7.34	Mar. 16	7.01	July 14	4.20
Oct. 20	7.02	Apr. 13	6.12	Aug. 13	5.48
Dec. 6	6.70	May 11	6.06	Sept. 18	7.01
Jan. 10, 1950	6.96	June 16	1.89	Oct. 21	6.71
Feb. 7	7.42	July 18	5.61	Nov. 21	6.13
Mar. 7	6.92	Aug. 15	7.20	Dec. 19	6.40
Apr. 5	6.60	Sept. 19	6.88	Jan. 22, 1953	6.00
May 9	6.47	Oct. 8	6.64	Feb. 19	6.16
June 6	7.07	Nov. 20	6.19	Mar. 19	5.99
July 10	4.92	Dec. 17	5.94	Apr. 20	6.13
Aug. 7	6.24	Jan. 16, 1952	6.94	May 19	6.77
Oct. 9	6.58	Feb. 14	6.74	June 18	5.31
Nov. 15	6.41	Mar. 17	6.56	July 16	5.91
		A5-1-36ad			
Aug. 29, 1949	4.38	Dec. 7, 1949	3.18	July 10, 1950	3.94
Sept. 27	4.12	June 6, 1950	3.76	Aug. 7	4.06
Oct. 21	3.92				
		A5-1-36cc			
Nov. 15, 1950	0.42	Oct. 8, 1951	0.45	Oct. 21, 1952	0.99
Dec. 13	.31	Nov. 19	.49	Nov. 21	.49
Jan. 10, 1951	.31	Dec. 17	.45	Dec. 19	.55
Feb. 14	.35	Jan. 16, 1952	.45	Jan. 22, 1953	.55
Mar. 16	.30	Feb. 14	.45	Feb. 19	.55
Apr. 13	.37	Mar. 17	.20	Mar. 19	.31
May 11	.11	Apr. 21	.57	Apr. 20	.56
June 16	1.19	June 16	1.56	May 18	.76
July 18	2.36	July 14	2.12	June 18	1.48
Aug. 15	2.65	Aug. 13	2.56	July 16	2.80
Sept. 19	1.17	Sept. 18	1.97		
		A5-1-36dc			
Nov. 15, 1950	3.98	Oct. 8, 1951	4.89	Oct. 21, 1952	5.01
Dec. 13	3.42	Nov. 19	3.98	Nov. 21	4.23
Jan. 10, 1951	3.57	Dec. 17	3.83	Dec. 19	4.29
Feb. 14	3.67	Jan. 16, 1952	4.04	Jan. 22, 1953	2.82
Mar. 16	3.63	Feb. 14	3.47	Feb. 19	2.78
Apr. 13	1.94	Mar. 17	2.73	Mar. 19	2.46
May 11	2.13	Apr. 21	1.98	Apr. 20	2.83
June 16	3.13	June 16	3.65	May 18	2.91
July 18	5.30	July 14	4.41	June 18	3.34
Aug. 15	6.07	Aug. 13	4.72	July 16	5.32
Sept. 19	5.36	Sept. 18	5.60		

Table 4.—*Measurements of the water level in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
		A5-1-36dd			
Aug. 29, 1949	2.48	Nov. 15, 1950	0.53	July 14, 1952	0.51
Sept. 27	1.86	Dec. 13	.34	Aug. 13	.83
Oct. 21	1.40	Apr. 13, 1951	.46	Sept. 18	1.11
Dec. 7	.66	May 11	.31	Oct. 21	1.16
Mar. 7, 1950	.40	June 16	.49	Nov. 21	.98
Apr. 5	.15	July 18	.80	Dec. 19	1.10
May 9	+.02	Aug. 15	1.31	Jan. 22, 1953	.60
June 6	.08	Sept. 19	.97	Mar. 19	.37
July 10	1.15	Oct. 8	1.28	Apr. 20	.33
Aug. 7	1.96	Nov. 19	.98	May 18	.30
Sept. 11	.66	Apr. 21, 1952	.51	June 18	.26
Oct. 9	.62	June 16	.40	July 16	.57
		A5-2-8bd			
June 27, 1949	15.08	Jan. 10, 1950	15.83	July 10, 1950	15.58
July 28	14.50	Feb. 7	16.00	Aug. 7	15.16
Aug. 25	15.39	Mar. 7	15.84	Sept. 8	15.79
Sept. 27	15.26	Apr. 5	15.92	Oct. 9	15.87
Oct. 20	15.27	May 9	14.36	Nov. 15	15.34
Dec. 6	15.64	June 5	14.91		
		A5-2-8cc			
June 27, 1949	16.41	July 10, 1950	16.85	June 16, 1951	16.40
July 29	16.05	Aug. 7	16.75	July 18	16.92
Aug. 25	16.94	Sept. 8	16.82	Aug. 15	16.51
Sept. 27	17.21	Oct. 9	17.67	Sept. 19	17.15
Oct. 20	17.34	Nov. 15	17.99	Oct. 8	17.61
Dec. 6	17.74	Dec. 13	18.18	Nov. 19	17.93
Jan. 10, 1950	17.98	Jan. 10, 1951	18.47	Dec. 19	18.32
Feb. 7	18.20	Feb. 14	18.56	Jan. 16, 1952	18.39
Mar. 7	18.32	Mar. 16	18.98	Feb. 14	18.43
Apr. 5	18.28	Apr. 13	18.70	Mar. 17	18.36
May 9	16.86	May 11	19.01	Apr. 21	17.91
June 5	17.03				
		A5-2-10ad			
July 7, 1949	40.92	Dec. 13, 1950	43.22	Apr. 21, 1952	46.32
July 29	39.62	Jan. 10, 1951	44.09	May 20	43.79
Aug. 26	40.10	Feb. 14	44.79	June 16	41.65
Sept. 29	40.73	Mar. 16	45.24	July 14	41.19
Oct. 24	41.66	Apr. 13	45.03	Aug. 13	40.25
Dec. 7	43.52	May 11	45.25	Sept. 18	40.71
Jan. 11, 1950	44.09	June 15	43.02	Oct. 21	41.62
Feb. 8	43.36	July 18	41.24	Nov. 21	42.36
Mar. 8	43.82	Aug. 15	39.63	Dec. 19	42.81
Apr. 6	44.67	Sept. 19	40.76	Jan. 22, 1953	43.89
May 10	45.11	Oct. 8	41.59	Feb. 19	44.55
June 6	44.00	Nov. 19	42.97	Mar. 19	45.07
July 11	41.56	Dec. 17	43.82	Apr. 20	45.21
Aug. 8	40.44	Jan. 16, 1952	44.23	May 19	45.63
Sept. 12	40.32	Feb. 14	44.48	June 18	43.07
Oct. 10	41.05	Mar. 17	43.92	July 16	41.04
Nov. 15	42.48				

Table 4.—*Measurements of the water level in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
		A5-2-14dd			
Apr. 30, 1949	68.40	Oct. 10, 1950	64.24	Apr. 21, 1952	69.18
June 24	64.84	Nov. 15	66.17	May 20	67.84
July 25	63.00	Dec. 13	66.51	June 16	65.46
Aug. 1	62.90	Jan. 10, 1951	67.51	July 14	65.20
26	62.73	Feb. 14	68.44	Aug. 13	62.40
Sept. 29	63.55	Mar. 16	69.03	Sept. 18	62.23
Oct. 24	64.69	Apr. 13	69.23	Oct. 21	62.81
Dec. 7	66.37	May 11	69.07	Nov. 21	65.66
Jan. 11, 1950	67.42	June 15	66.91	Dec. 19	66.42
Feb. 8	67.75	July 18	63.88	Jan. 22, 1953	67.42
Mar. 8	68.27	Aug. 15	61.92	Feb. 19	67.89
Apr. 6	68.80	Sept. 19	62.87	Mar. 19	68.73
May 10	68.88	Oct. 8	64.41	Apr. 20	68.91
June 6	67.53	Nov. 19	66.09	May 19	70.14
July 11	65.10	Dec. 17	67.05	June 18	67.88
Aug. 8	63.36	Feb. 14, 1952	67.41	July 16	64.48
Sept. 12	63.35	Mar. 17	69.08		
		A5-2-15da1			
July 7, 1949	10.43	Feb. 8, 1950	11.83	July 11, 1950	10.33
Aug. 9	10.57	Mar. 8	13.28	Aug. 8	10.39
26	10.86	Apr. 6	13.98	Sept. 12	10.91
Sept. 29	11.16	May 10	14.29	Oct. 10	11.38
Oct. 24	11.57	June 6	13.37	Nov. 15	12.22
Dec. 7	12.70				
		A5-2-16db			
June 28, 1949	6.95	Oct. 20, 1949	9.14	Feb. 7, 1950	6.35
July 29	8.40	Dec. 6	9.62	Mar. 7	8.65
Aug. 25	9.65	Jan. 10, 1950	9.48	Apr. 5	9.67
Sept. 27	8.71				
		A5-2-19ad1			
May 2, 1949	3.87	Dec. 6, 1949	4.77	June 5, 1950	4.80
June 24	3.96	Jan. 10, 1950	5.38	July 10	4.66
July 28	5.28	Feb. 7	5.78	Aug. 7	4.98
Aug. 25	5.78	Mar. 7	5.33	Sept. 8	5.70
Sept. 27	5.86	Apr. 5	4.74	Oct. 9	5.63
Oct. 20	5.50	May 9	4.82	Nov. 15	5.36
		A5-2-20bc1			
June 27, 1949	4.36	Nov. 15, 1950	5.04	May 20, 1952	3.74
July 28	5.16	Dec. 13	5.09	June 16	4.56
Aug. 25	5.53	Jan. 10, 1951	5.12	July 14	4.79
Sept. 27	5.52	Feb. 14	5.27	Aug. 13	5.08
Oct. 20	5.22	Mar. 16	5.13	Sept. 18	5.35
Dec. 6	4.73	Apr. 13	4.70	Oct. 21	5.05
Jan. 10, 1950	5.21	May 11	4.61	Nov. 21	4.74
Feb. 7	5.54	June 16	4.29	Dec. 19	4.98
Mar. 7	4.73	July 18	4.83	Jan. 22, 1953	4.81
Apr. 5	4.75	Aug. 15	5.30	Feb. 19	5.02
May 9	4.60	Sept. 19	5.26	Mar. 19	4.83
June 5	4.92	Oct. 8	5.12	Apr. 20	5.01
July 10	4.73	Nov. 19	4.94	May 19	5.16
Aug. 7	4.93	Dec. 17	5.14	June 18	3.45
Sept. 8	5.43	Mar. 17, 1952	5.20	July 16	4.78
Oct. 9	5.23	Apr. 21	4.25		

Table 4.—*Measurements of the water level in observation wells*—Continued

A5-2-20db1

Date	Water level	Date	Water level	Date	Water level
May 2, 1949	3.77	Oct. 9, 1950	4.25	Apr. 21, 1952	3.62
June 24	3.84	Nov. 15	4.32	May 20	3.07
July 28	4.44	Dec. 13	4.31	June 16	3.97
Aug. 25	4.55	Jan. 10, 1951	4.33	July 14	4.04
Sept. 27	4.58	Feb. 14	4.57	Aug. 13	4.12
Oct. 20	4.42	Mar. 16	4.42	Sept. 18	4.30
Dec. 6	4.40	Apr. 13	3.75	Oct. 21	3.92
Jan. 10, 1950	4.36	May 11	3.69	Nov. 21	4.12
Feb. 7	4.73	June 16	3.44	Dec. 19	4.44
Mar. 7	4.50	July 18	4.12	Jan. 22, 1953	4.05
Apr. 5	4.00	Aug. 15	4.09	Feb. 19	4.11
May 9	3.87	Sept. 19	4.05	Mar. 19	3.78
June 5	4.16	Oct. 8	3.99	Apr. 20	3.81
July 10	4.07	Nov. 19	4.24	May 19	4.26
Aug. 7	4.17	Dec. 17	4.35	June 18	4.02
Sept. 8	4.46	Mar. 17, 1952	4.40	July 16	3.96

A5-2-21ad

Date	Water level	Date	Water level	Date	Water level
May 2, 1949	13.04	July 27, 1949	8.05	Sept. 27, 1949	10.16
June 24	8.00	Aug. 25	10.29	Oct. 20	11.77

A5-2-21bc

Date	Water level	Date	Water level	Date	Water level
May 2, 1949	4.20	Dec. 6, 1949	4.45	May 9, 1950	3.88
June 24	3.11	Jan. 10, 1950	4.77	June 5	3.75
July 28	1.90	Feb. 7	4.90	July 10	1.38
Aug. 25	3.52	Mar. 7	4.73	Aug. 7	2.63
Sept. 27	3.20	Apr. 5	4.63	Sept. 8	3.68
Oct. 20	3.86				

A5-2-21bd

Date	Water level	Date	Water level	Date	Water level
Nov. 15, 1950	7.04	Oct. 8, 1951	6.44	Sept. 18, 1952	6.30
Dec. 13	7.13	Nov. 19	6.93	Oct. 21	6.64
Jan. 10, 1951	7.44	Dec. 17	7.18	Nov. 21	7.08
Feb. 14	7.89	Jan. 16, 1952	7.58	Dec. 19	7.17
Mar. 16	8.07	Feb. 14	7.66	Jan. 22, 1953	7.54
Apr. 13	7.27	Mar. 17	7.94	Feb. 19	7.70
May 11	6.73	Apr. 21	6.93	Mar. 19	7.81
June 16	4.79	May 20	6.12	Apr. 20	7.93
July 18	4.68	June 16	4.60	May 19	5.20
Aug. 15	3.87	July 14	4.94	June 18	5.14
Sept. 19	5.90	Aug. 13	4.79	July 16	5.87

A5-2-22ad

Date	Water level	Date	Water level	Date	Water level
May 2, 1949	20.63	July 28, 1949	19.20	Sept. 27, 1949	19.10
June 24	17.60	Aug. 25	20.47	Oct. 20	19.70

A5-2-23ca3

Date	Water level	Date	Water level	Date	Water level
June 30, 1949	17.30	Jan. 11, 1950	21.23	July 11, 1950	16.05
July 25	17.10	Feb. 8	21.50	Aug. 8	15.33
Aug. 1	17.00	Mar. 8	21.84	Sept. 12	15.90
Sept. 29	18.15	Apr. 6	20.51	Oct. 10	16.94
Oct. 24	18.93	May 10	20.16	Nov. 15	18.06
Dec. 7	20.14	June 6	17.67	Dec. 13	18.71

Table 4.—*Measurements of the water level in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
		A5-2-23ca3—Continued			
Jan. 10, 1951	19.59	Dec. 17, 1951	19.24	Oct. 21, 1952	17.11
Feb. 14	20.42	Jan. 16, 1952	20.12	Nov. 21	18.04
Mar. 16	20.94	Feb. 14	20.68	Dec. 19	18.84
Apr. 13	20.03	Mar. 17	21.02	Jan. 22, 1953	19.39
May 11	19.46	Apr. 21	20.21	Feb. 19	20.07
June 15	17.02	May 20	17.52	Mar. 19	20.52
July 18	15.63	June 16	15.54	Apr. 20	20.96
Aug. 15	14.66	July 14	15.80	May 19	18.78
Sept. 19	16.56	Aug. 13	13.32	June 18	16.30
Oct. 8	17.18	Sept. 18	15.96	July 16	15.70
Nov. 19	18.35				
		A5-2-23ca6			
June 27, 1949	16.66	Jan. 10, 1950	19.43	July 10, 1950	16.01
July 28	17.12	Feb. 7	19.22	Aug. 7	16.48
Aug. 25	17.80	Mar. 7	19.57	Sept. 8	17.89
Sept. 27	17.92	Apr. 5	19.65	Oct. 9	17.77
Oct. 20	18.22	May 9	19.72	Nov. 15	17.80
Dec. 6	18.73	June 5	18.01		
		A5-2-23dc1			
July 1, 1949	30.65	Feb. 8, 1950	35.37	July 11, 1950	33.30
Aug. 1	30.25	Mar. 8	35.63	Aug. 7	31.43
Sept. 29	32.24	Apr. 6	35.89	Sept. 12	31.26
Oct. 24	27.75	May 10	34.68	Oct. 10	32.22
Jan. 11, 1950	34.85	June 6	32.13	Nov. 15	33.34
		A5-2-26ac			
July 1, 1949	17.20	Sept. 29, 1949	18.76	Dec. 7, 1949	19.77
Aug. 25	18.16	Oct. 24	19.24		
		A5-2-26ca3			
July 1, 1949	8.75	Feb. 8, 1950	13.04	July 11, 1950	7.51
Aug. 1	9.00	Mar. 8	13.00	Aug. 7	8.81
Sept. 29	10.05	Apr. 6	12.75	Sept. 12	9.42
Oct. 24	10.62	May 10	12.80	Oct. 9	10.01
Dec. 7	11.14	June 6	8.80	Nov. 15	10.84
Jan. 11, 1950	12.41				
		A5-2-27bb2			
Nov. 15, 1950	1.54	Oct. 8, 1951	0.31	Oct. 21, 1952	0.69
Dec. 13	2.36	Nov. 19	1.67	Nov. 21	1.41
Jan. 10, 1951	3.15	Dec. 17	2.52	Dec. 19	2.10
Feb. 14	3.95	Feb. 14, 1952	3.80	Jan. 22, 1953	2.78
Mar. 16	4.45	Mar. 17	4.43	Feb. 19	3.37
Apr. 13	2.41	Apr. 21	3.83	Mar. 19	3.62
May 11	3.23	June 16	1.12	Apr. 20	3.71
June 16	1.59	July 14	.11	May 18	1.86
July 18	+.18	Aug. 13	+.74	June 18	1.20
Aug. 15	.23	Sept. 18	+.06	July 16	1.04
Sept. 19	+.18				

Table 4.—*Measurements of the water level in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
		A5-2-27bb4			
Nov. 15, 1950	4.61	Oct. 8, 1951	3.12	Oct. 21, 1952	3.56
Dec. 13	5.18	Nov. 19	4.43	Nov. 21	4.36
Jan. 10, 1951	5.76	Dec. 17	5.18	Dec. 19	4.97
Feb. 14	6.64	Feb. 14, 1952	6.27	Jan. 22, 1953	5.45
Mar. 16	7.02	Mar. 19	6.58	Feb. 19	5.88
Apr. 13	5.03	Apr. 21	5.85	Mar. 19	6.16
May 11	5.94	June 16	3.98	Apr. 20	6.37
June 16	4.68	July 14	3.13	May 18	4.79
July 18	3.63	Aug. 13	1.33	June 18	4.11
Aug. 15	3.41	Sept. 18	2.87	July 16	3.31
Sept. 19	2.34				
		A5-2-27bc			
Aug. 29, 1949	0.40	Oct. 21, 1949	1.25	Dec. 7, 1949	2.55
Sept. 29	.65				
		A5-2-29bc			
May 3, 1949	7.63	Dec. 7, 1949	8.47	May 9, 1950	8.30
June 24	8.60	Jan. 10, 1950	8.58	June 14	6.72
July 29	9.00	Feb. 7	8.65	July 11	8.53
Aug. 25	9.15	Mar. 7	8.30	Aug. 7	7.86
Sept. 29	8.90	Apr. 5	8.27	Sept. 12	8.81
Oct. 21	8.58				
		A5-2-29cc			
May 3, 1949	6.57	Aug. 25, 1949	6.96	Dec. 7, 1949	6.76
June 24	6.30	Sept. 29	6.94	Jan. 10, 1950	6.91
July 29	7.40	Oct. 21	6.85	Feb. 7	7.12
		A5-2-29cc2			
Nov. 15, 1950	3.87	Oct. 8, 1951	3.60	Sept. 18, 1952	2.85
Dec. 13	3.89	Nov. 19	3.65	Oct. 21	4.26
Jan. 10, 1951	3.86	Dec. 17	3.87	Nov. 21	4.28
Feb. 14	4.20	Jan. 16, 1952	4.41	Dec. 19	4.37
Mar. 16	4.09	Feb. 14	4.28	Jan. 22, 1953	4.13
Apr. 13	3.07	Mar. 17	3.91	Feb. 19	3.86
May 11	2.36	Apr. 21	2.38	Mar. 19	3.76
June 16	2.73	May 21	2.27	Apr. 20	3.73
July 18	1.83	June 16	.53	May 18	.80
Aug. 15	2.93	July 14	3.64	June 18	.01
Sept. 18	2.29	Aug. 13	3.83	July 16	3.25
		A5-2-29dd			
Nov. 15, 1950	6.58	Oct. 8, 1951	5.84	Oct. 21, 1952	6.06
Dec. 13	6.86	Nov. 19	6.44	Nov. 21	6.21
Jan. 10, 1951	7.10	Dec. 17	6.83	Dec. 19	6.64
Feb. 14	7.69	Jan. 16, 1952	7.40	Jan. 22, 1953	2.44
Mar. 16	7.92	Feb. 14	7.74	Feb. 19	2.37
Apr. 13	6.61	Mar. 17	7.90	Mar. 19	3.46
May 11	6.59	Apr. 21	6.65	Apr. 20	3.61
June 16	1.15	June 16	3.79	May 18	6.69
July 18	4.43	July 14	3.67	June 18	4.13
Aug. 15	4.50	Aug. 13	4.05	July 16	3.32
Sept. 19	5.69	Sept. 18	5.32		

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Table 4.—*Measurements of the water level in observation wells*—Continued

Date		Water level	Date		Water level	Date		Water level
			A5-2-31cd					
July	29, 1949	6.10	Feb.	8, 1950	5.62	July	10, 1950	5.36
Aug.	29	6.72	Mar.	7	4.63	Aug.	7	5.89
Sept.	29	7.00	Apr.	5	1.78	Sept.	12	5.76
Oct.	21	6.60	May	10	1.63	Oct.	9	6.17
Dec.	7	5.26	June	6	4.09	Nov.	15	6.53
Jan.	10, 1950	5.49						
			A5-2-31da					
Nov.	15, 1950	3.36	Oct.	8, 1951	4.16	Sept.	18, 1952	4.86
Dec.	13	3.34	Nov.	19	3.54	Oct.	21	4.96
Jan.	10, 1951	3.13	Dec.	17	3.35	Nov.	21	4.08
Feb.	14	3.40	Jan.	16, 1952	3.62	Dec.	19	4.21
Mar.	16	3.32	Feb.	14	3.39	Jan.	22, 1953	3.37
Apr.	13	1.87	Mar.	17	2.82	Feb.	19	3.12
May	11	.93	Apr.	21	.98	Mar.	19	2.70
June	16	2.57	May	21	.89	Apr.	20	2.65
July	18	4.10	June	16	2.70	May	18	2.51
Aug.	15	4.29	July	14	3.55	June	18	2.51
Sept.	19	4.61	Aug.	13	3.93	July	16	4.29
			A5-2-32aa					
Aug.	29, 1949	6.65	Jan.	10, 1950	Dry	May	10, 1950	5.78
Sept.	29	6.43	Feb.	8	Dry	June	6	3.74
Oct.	21	6.48	Mar.	7	Dry	July	11	4.72
Dec.	7	7.15	Apr.	5	Dry	Aug.	7	4.99
			A5-2-32ab					
Aug.	29, 1949	3.86	Sept.	29, 1949	3.40			
			A5-2-32cd					
Nov.	15, 1950	4.32	Nov.	19, 1951	3.87	Oct.	21, 1952	5.04
Dec.	13	3.88	Dec.	17	3.81	Nov.	21	4.68
Jan.	10, 1951	3.71	Jan.	16, 1952	4.46	Dec.	19	4.30
Feb.	14	4.10	Feb.	14	3.67	Jan.	22, 1953	3.79
Mar.	16	3.81	Mar.	17	3.44	Feb.	19	3.32
Apr.	13	1.92	Apr.	21	2.02	Mar.	19	2.74
May	11	1.96	June	16	3.46	Apr.	20	2.95
June	16	3.25	July	14	4.11	May	18	3.00
July	18	4.56	Aug.	13	4.51	June	18	3.04
Sept.	19	4.95	Sept.	18	5.38	July	16	4.86
Oct.	8	4.60						
			A5-2-32dc					
Aug.	29, 1949	5.70	Jan.	10, 1950	4.93	May	9, 1950	2.15
Sept.	29	5.38	Feb.	8	5.26	June	6	3.40
Oct.	21	5.13	Mar.	7	4.38	July	10	4.31
Dec.	7	4.72	Apr.	5	3.05	Aug.	7	4.99
			A5-2-32dd1					
May	3, 1949	10.58	Dec.	7, 1949	12.14	May	9, 1950	11.04
June	24	10.84	Jan.	10, 1950	12.40	June	6	11.60
July	29	12.15	Feb.	8	12.92	July	10	11.96
Aug.	25	12.52	Mar.	7	12.20	Aug.	7	11.34
Sept.	29	12.32	Apr.	5	11.62	Sept.	12	11.74
Oct.	21	12.29						

Table 4.—*Measurements of the water level in observation wells*—Continued

A5-2-32dd2

Date	Water level	Date	Water level	Date	Water level
Nov. 15, 1950	2.36	Nov. 19, 1951	2.64	Oct. 21, 1952	3.12
Dec. 13	2.81	Dec. 17	2.82	Nov. 21	3.02
Jan. 10, 1951	2.94	Jan. 16, 1952	3.37	Dec. 19	3.02
Feb. 14	3.32	Feb. 14	2.97	Jan. 22, 1953	2.80
Mar. 16	3.31	Mar. 17	2.97	Feb. 19	2.58
Apr. 13	1.81	Apr. 21	1.73	Mar. 19	2.21
May 11	2.06	June 16	2.37	Apr. 20	2.45
June 16	2.39	July 14	2.61	May 18	2.52
July 18	2.99	Aug. 13	3.03	June 18	2.22
Sept. 19	3.01	Sept. 18	3.29	July 16	3.04
Oct. 8	2.89				

A5-2-33bb1

Date	Water level	Date	Water level	Date	Water level
July 11, 1949	14.32	Nov. 15, 1950	15.31	Apr. 21, 1952	16.07
29	14.69	Dec. 13	15.82	June 16	15.89
Aug. 25	14.89	Jan. 10, 1951	16.07	July 14	15.41
Sept. 29	13.76	Feb. 14	16.71	Aug. 13	13.66
Oct. 21	15.06	Mar. 16	17.03	Sept. 18	11.54
Dec. 7	15.24	Apr. 13	15.53	Oct. 21	14.16
Jan. 10, 1950	15.97	May 11	16.01	Nov. 21	14.68
Feb. 8	17.26	June 16	12.68	Dec. 19	15.42
Mar. 7	17.42	July 18	12.78	Jan. 22, 1953	15.89
Apr. 5	17.32	Aug. 15	12.04	Feb. 19	16.08
May 10	14.09	Sept. 19	13.11	Mar. 19	16.28
June 6	14.82	Oct. 8	14.55	Apr. 20	16.33
July 11	14.10	Nov. 19	15.44	May 18	17.24
Aug. 7	13.21	Dec. 17	15.79	June 18	15.43
Sept. 12	13.58	Feb. 14, 1952	16.57	July 16	13.38
Oct. 9	13.73	Mar. 17	16.97		

A5-2-33cb

Date	Water level	Date	Water level	Date	Water level
June 16, 1951	7.32	Feb. 15, 1952	13.79	Dec. 19, 1952	12.72
July 18	9.61	Apr. 21	12.54	Jan. 22, 1953	12.91
Aug. 15	10.21	June 16	10.54	Feb. 19	13.00
Sept. 19	11.07	July 14	9.71	Mar. 19	13.10
Oct. 8	11.69	Aug. 13	8.62	Apr. 20	13.21
Nov. 19	12.46	Sept. 18	9.60	May 18	11.20
Dec. 17	12.41	Oct. 21	11.75	June 18	10.19
Jan. 16, 1952	13.51	Nov. 21	12.20	July 16	7.81

A6-2-4ac

Date	Water level	Date	Water level	Date	Water level
Aug. 8, 1949	0.90	July 11, 1950	1.10	Apr. 11, 1951	0.26
Sept. 29	.67	Aug. 8	.87	May 9	.29
Oct. 25	.98	Sept. 12	.66	June 16	.78
Dec. 12	1.31	Oct. 10	.80	July 18	.53
Jan. 11, 1950	1.53	Nov. 16	.72	Aug. 15	.62
Feb. 11	1.80	Dec. 11	1.03	Sept. 19	+.30
Mar. 8	1.62	Jan. 8, 1951	.99	Oct. 8	1.05
Apr. 6	1.32	Feb. 12	.99	Nov. 20	Dry
May 17	Dry	Mar. 14	1.42	Dec. 17	Dry

A6-2-4cd1

Date	Water level	Date	Water level	Date	Water level
Aug. 9, 1949	1.84	Mar. 8, 1950	6.67	Sept. 12, 1950	3.79
Sept. 29	4.93	Apr. 6	6.60	Oct. 10	4.44
Oct. 25	5.38	May 17	6.52	Nov. 16	4.56
Dec. 12	6.34	June 9	3.71	Dec. 11	5.34
Jan. 11, 1950	6.55	July 11	2.18	Jan. 8, 1951	5.69
Feb. 11	6.71	Aug. 8	3.67	Feb. 12	5.87

Table 4.—*Measurements of the water level in observation wells*—Continued

A6-2-4cd1—Continued

Date	Water level	Date	Water level	Date	Water level
Mar. 14, 1951	5.73	Feb. 14, 1952	7.61	Jan. 23, 1953	7.62
Apr. 11	6.09	Apr. 21	8.24	Feb. 19	7.72
May 9	5.32	May 20	7.42	Mar. 19	8.26
June 16	3.67	June 16	7.53	Apr. 21	8.28
July 18	2.43	July 14	5.07	May 18	7.49
Aug. 15	3.91	Aug. 14	4.99	July 6	5.6
Sept. 19	5.37	Sept. 18	5.30	Aug. 7	6.1
Oct. 8	6.20	Oct. 22	6.10	Sept. 9	5.4
Nov. 20	7.26	Nov. 21	6.80	Oct. 8	5.2
Dec. 17	7.63	Dec. 17	6.91	Nov. 10	6.2
Jan. 16, 1952	7.42				

A6-2-4db

Date	Water level	Date	Water level	Date	Water level
Aug. 9, 1949	0.00	Dec. 11, 1950	1.03	Mar. 17, 1952	Dry
Sept. 29	.22	Jan. 8, 1951	1.00	Apr. 21	Dry
Oct. 25	.36	Feb. 12	1.30	May 20	Dry
Dec. 12	.98	Mar. 14	1.15	June 16	Dry
Jan. 11, 1950	1.07	Apr. 11	Dry	July 14	1.78
Feb. 11	1.20	May 9	1.35	Aug. 14	1.87
Mar. 8	1.06	June 16	.35	Sept. 18	1.53
Apr. 6	.93	July 18	+.19	July 6, 1953	1.48
May 17	.28	Aug. 15	.07	Aug. 7	.98
June 9	.93	Sept. 19	1.00	Sept. 9	.68
July 11	+.27	Oct. 8	1.09	Oct. 8	1.88
Aug. 8	.01	Nov. 20	1.34	Nov. 10	2.9
Sept. 12	.04	Dec. 17	1.81	Dec. 10	3.1
Oct. 10	.86	Jan. 16, 1952	1.69	Jan. 7, 1954	3.7
Nov. 16	.98	Feb. 14	1.79	Feb. 2	4.2

A6-2-5bb1

Date	Water level	Date	Water level	Date	Water level
Aug. 9, 1949	1.70	Mar. 8, 1950	Dry	July 11, 1950	3.12
Oct. 25	4.20	Apr. 6	Dry	Sept. 11	3.92
Jan. 11, 1950	Dry	May 17	3.72	Oct. 10	4.09
Feb. 8	Dry	June 9	3.91		

A6-2-5bb2

Date	Water level	Date	Water level	Date	Water level
Aug. 9, 1949	5.00	Jan. 8, 1951	6.40	May 20, 1952	6.00
Sept. 29	5.92	Feb. 12	6.62	June 17	5.76
Oct. 25	6.05	Mar. 14	6.57	July 15	5.23
Dec. 12	Dry	Apr. 11	6.06	Aug. 13	5.54
Jan. 11, 1950	Dry	May 9	5.45	Sept. 18	6.45
Feb. 8	Dry	June 16	5.75	Oct. 22	6.53
Mar. 8	Dry	July 18	5.01	Nov. 21	6.58
Apr. 6	5.70	Aug. 15	5.12	Dec. 19	Dry
May 17	5.47	Sept. 19	5.85	Jan. 23, 1953	Dry
June 9	5.73	Oct. 8	6.11	Feb. 19	Dry
July 11	5.35	Nov. 19	6.35	Mar. 21	Dry
Aug. 8	5.39	Dec. 17	6.37	Apr. 21	Dry
Sept. 12	5.90	Jan. 16, 1952	6.57	May 20	4.99
Oct. 10	6.04	Feb. 14	6.61	June 18	4.44
Nov. 16	6.29	Apr. 21	5.72	July 16	5.03
Dec. 11	6.34				

A6-2-5bb3

Date	Water level	Date	Water level	Date	Water level
Aug. 9, 1949	3.73	Jan. 11, 1950	4.95	June 9, 1950	4.10
Sept. 29	4.28	Mar. 8	4.59	July 11	4.04
Oct. 25	4.33	Apr. 6	4.27	Aug. 8	3.72
Dec. 12	4.62	May 17	3.84	Sept. 12	4.19

Table 4.—*Measurements of the water level in observation wells*—Continued

A6-2-5bb3—Continued.

Date	Water level	Date	Water level	Date	Water level
Oct. 10, 1950	4.40	Sept. 19, 1951	4.18	Oct. 22, 1952	5.08
Nov. 13	4.52	Oct. 8	4.46	Nov. 22	5.24
Dec. 11	4.58	Nov. 19	4.74	Dec. 19	5.36
Jan. 8, 1951	4.65	Dec. 17	5.01	Jan. 23, 1953	5.54
Feb. 12	5.11	Apr. 21, 1952	3.97	Feb. 19	5.41
Mar. 14	4.81	May 20	4.26	Mar. 21	5.46
Apr. 11	4.29	June 17	4.03	Apr. 21	5.42
May 9	3.74	July 15	3.86	May 20	3.58
June 16	4.07	Aug. 13	3.89	June 18	2.82
July 18	3.39	Sept. 18	4.71	July 16	3.31
Aug. 15	3.73				

A6-2-5cc

Date	Water level	Date	Water level	Date	Water level
Aug. 3, 1949	2.84	Feb. 8, 1950	3.99	July 11, 1950	2.53
25	3.24	Mar. 8	3.30	Aug. 8	2.68
Sept. 30	3.67	Apr. 6	3.10	Sept. 12	3.30
Oct. 24	3.67	May 10	3.26	Oct. 10	3.89
Dec. 7	3.98	June 9	2.39	Nov. 16	3.75
Jan. 11, 1950	3.97				

A6-2-8ab1

Date	Water level	Date	Water level	Date	Water level
July 15, 1949	6.55	Dec. 11, 1950	9.17	Apr. 21, 1952	9.64
Aug. 29	7.80	Jan. 8, 1951	9.23	May 20	8.98
Sept. 30	8.40	Feb. 12	7.87	June 17	5.95
Oct. 24	8.69	Mar. 14	10.33	July 14	5.72
Dec. 7	9.41	Apr. 11	9.54	Aug. 13	6.34
Jan. 11, 1950	9.96	May 9	8.32	Sept. 18	9.02
Feb. 8	10.45	June 16	5.73	Oct. 22	9.51
Mar. 8	9.64	July 18	7.16	Nov. 21	9.49
Apr. 6	9.43	Aug. 15	6.60	Dec. 19	9.59
May 10	9.35	Sept. 19	8.48	Jan. 23, 1953	10.30
June 9	7.36	Oct. 8	9.00	Feb. 20	10.42
July 11	5.60	Nov. 19	9.09	Mar. 21	10.70
Aug. 8	7.34	Dec. 17	10.48	Apr. 21	11.13
Sept. 12	7.52	Jan. 16, 1952	11.05	May 20	8.93
Oct. 10	7.78	Feb. 14	10.98	June 18	7.36
Nov. 16	8.90	Mar. 19	10.91	July 16	8.09

A6-2-8ba

Date	Water level	Date	Water level	Date	Water level
Aug. 8, 1949	1.68	Mar. 14, 1951	2.20	Sept. 18, 1952	2.40
Sept. 29	1.94	Apr. 11	1.88	Oct. 22	2.58
Oct. 26	2.27	May 9	1.58	Nov. 21	2.45
Dec. 12	2.54	June 16	1.04	Dec. 19	2.62
Jan. 11, 1950	2.80	July 18	1.51	Jan. 23, 1953	2.62
Feb. 8	3.15	Aug. 15	1.06	Feb. 19	2.61
Mar. 8	2.83	Sept. 19	1.79	Mar. 21	2.69
Apr. 6	2.27	Oct. 8	2.15	Apr. 21	2.83
May 17	2.52	Nov. 19	2.58	May 20	2.02
June 9	1.41	Dec. 17	1.73	July 6	3.5
July 11	1.22	Feb. 14, 1952	3.12	Aug. 7	3.8
Aug. 8	1.49	Mar. 17	3.01	Sept. 9	1.6
Sept. 12	1.74	Apr. 21	2.21	Oct. 8	1.6
Oct. 10	1.97	May 20	1.94	Nov. 10	2.0
Nov. 16	1.99	June 17	1.41	Dec. 10	2.3
Dec. 11	2.09	July 15	1.80	Jan. 7, 1954	3.1
Jan. 8, 1951	2.44	Aug. 13	1.30	Feb. 2	4.5
Feb. 12	2.81				

Table 4.—*Measurements of the water level in observation wells*—Continued

A6-2-8db

Date	Water level	Date	Water level	Date	Water level
July 15, 1949	4.12	Feb. 8, 1950	6.35	July 11, 1950	3.49
Aug. 29	4.76	Mar. 8	5.86	Aug. 8	3.95
Sept. 29	5.30	Apr. 6	5.79	Sept. 12	4.79
Oct. 24	5.34	May 10	5.75	Oct. 10	4.89
Dec. 7	5.68	June 9	3.51	Nov. 16	4.69
Jan. 11, 1950	6.05				

A6-2-9ba3

Date	Water level	Date	Water level	Date	Water level
Aug. 8, 1949	2.97	July 11, 1950	0.46	Apr. 11, 1951	Dry
Sept. 29	6.03	Aug. 8	2.51	May 9	Dry
Oct. 25	5.05	Sept. 12	3.90	June 16	2.26
Dec. 12	Dry	Oct. 11	5.39	July 18	1.23
Jan. 11, 1950	Dry	Nov. 16	5.65	Aug. 15	2.50
Feb. 11	Dry	Dec. 11	6.90	Sept. 19	[a]6.46
Mar. 8	Dry	Jan. 8, 1951	7.07	Oct. 8	Dry
Apr. 6	Dry	Feb. 12	7.11	Nov. 19	Dry
May 17	Dry	Mar. 14	6.99	Dec. 17	Dry
June 9	2.60				

A6-2-9bb1

Date	Water level	Date	Water level	Date	Water level
Aug. 8, 1949	7.10	June 6, 1950	Dry	Dec. 11, 1950	5.92
Sept. 29	Dry	July 11	2.05	June 16, 1951	2.76
Oct. 25	Dry	Aug. 8	4.09	July 18	1.84
Dec. 12	Dry	Sept. 12	4.40	Aug. 15	3.63
May 17, 1950	Dry				

A6-2-9bb2

Date	Water level	Date	Water level	Date	Water level
Aug. 8, 1949	7.22	Apr. 6, 1950	10.32	July 11, 1950	4.98
Sept. 29	8.45	May 17	10.15	Aug. 8	5.89
Oct. 25	9.02	June 9	7.14	Sept. 12	7.69
Dec. 12	10.00				

A6-2-9dd

Date	Water level	Date	Water level	Date	Water level
July 14, 1949	16.85	Feb. 8, 1950	28.28	July 11, 1950	11.14
Aug. 29	19.95	Mar. 8	28.10	Aug. 8	15.18
Sept. 29	22.02	Apr. 6	29.15	Sept. 12	15.96
Oct. 24	24.35	May 22	25.84	Oct. 10	19.94
Dec. 7	27.40	June 9	18.63	Nov. 16	21.56
Jan. 11, 1950	28.10				

A6-2-16aa

Date	Water level	Date	Water level	Date	Water level
July 14, 1949	15.62	July 11, 1950	15.85	July 18, 1951	15.06
Aug. 9	16.25	Aug. 8	14.57	Aug. 15	13.93
29	17.82	Sept. 12	14.46	Sept. 19	14.07
Sept. 29	19.72	Oct. 10	18.22	Oct. 8	19.35
Oct. 24	21.64	Nov. 16	21.23	Nov. 19	22.87
Dec. 7	24.33	Dec. 13	22.34	Dec. 17	24.42
Jan. 11, 1950	25.30	Jan. 10, 1951	23.17	Jan. 16, 1952	24.88
Feb. 8	25.50	Feb. 14	23.77	Feb. 14	25.09
Mar. 8	26.01	Mar. 16	23.29	Mar. 17	26.65
Apr. 6	27.01	Apr. 11	26.49	Apr. 21	27.05
May 10	26.46	May 9	26.03	May 20	23.62
June 9	21.92	June 15	17.91	June 16	17.76

[a]Drain ditch installed nearby.

Table 4.—*Measurements of the water level in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
A6-2-16aa—Continued					
July 14, 1952	16.03	Dec. 19, 1952	23.18	Apr. 20, 1953	26.10
Aug. 13	14.37	Jan. 23, 1953	23.98	May 19	26.66
Sept. 18	14.76	Feb. 19	24.09	June 18	18.40
Oct. 21	16.53	Mar. 19	25.98	July 16	14.46
Nov. 21	21.06				
A6-2-16db					
July 14, 1949	10.15	Mar. 8, 1950	14.54	Oct. 10, 1950	11.07
Aug. 29	10.65	Apr. 6	14.95	Nov. 16	12.51
Sept. 29	11.60	May 10	14.91	Dec. 13	12.99
Oct. 24	12.38	June 9	12.05	Jan. 10, 1951	13.83
Dec. 7	13.56	July 11	9.94	Feb. 14	14.29
Jan. 11, 1950	13.79	Aug. 8	9.19	Mar. 16	14.73
Feb. 8	14.36	Sept. 12	8.05		
A6-2-22ab					
July 13, 1949	19.40	Feb. 8, 1950	34.22	July 11, 1950	21.64
Aug. 29	22.94	Mar. 8	34.54	Aug. 8	18.46
Sept. 29	27.00	Apr. 6	36.45	Sept. 12	23.38
Oct. 24	28.63	May 10	36.98	Oct. 10	27.48
Dec. 7	31.17	June 9	31.25	Nov. 16	30.24
Jan. 11, 1950	33.56				
A6-2-22bb1					
July 13, 1949	23.15	Feb. 8, 1950	28.99	Sept. 12, 1950	20.66
Aug. 9	21.95	Mar. 8	29.32	Oct. 10	23.97
26	22.50	Apr. 6	29.93	Nov. 16	26.88
Sept. 29	24.24	May 10	30.28	Dec. 13	27.31
Oct. 24	25.77	June 9	29.01	Jan. 10, 1951	28.18
Dec. 7	27.74	July 11	24.63	Feb. 14	28.89
Jan. 11, 1950	28.62	Aug. 8	20.85	Mar. 16	29.39
A6-2-27bb1					
July 13, 1949	10.64	Dec. 7, 1949	12.76	Apr. 6, 1950	13.53
Aug. 26	11.18	Jan. 11, 1950	12.09	May 10	13.99
Sept. 29	11.40	Feb. 8	12.42	June 6	12.49
Oct. 24	12.24	Mar. 8	13.20		
A6-2-27cc					
July 12, 1949	22.54	Sept. 29, 1949	22.88	Dec. 7, 1949	23.96
Aug. 26	22.80	Oct. 23	24.14	Jan. 11, 1950	22.66
A6-2-34ad1					
July 12, 1949	42.85	July 11, 1950	42.93	June 15, 1951	44.36
Aug. 26	42.55	Aug. 8	41.91	July 18	43.47
Sept. 29	43.34	Sept. 12	41.64	Aug. 15	42.01
Oct. 24	44.25	Oct. 10	43.39	Sept. 19	43.23
Dec. 7	46.00	Nov. 15	45.18	Oct. 8	44.45
Jan. 11, 1950	46.89	Dec. 13	46.47	Nov. 19	45.63
Feb. 8	46.51	Jan. 10, 1951	47.30	Dec. 17	46.79
Mar. 8	47.29	Feb. 14	48.21	Jan. 16, 1952	46.35
Apr. 6	48.03	Mar. 16	48.93	Feb. 14	47.60
May 10	48.22	Apr. 16	48.71	Mar. 17	48.18
June 6	46.07	May 9	47.68	Apr. 21	48.42

Table 4.—*Measurements of the water level in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
		A6-2-34cd			
Apr. 30, 1949	6.82	Dec. 7, 1949	7.55	July 11, 1950	4.19
June 24	5.70	Mar. 8, 1950	8.19	Aug. 8	3.93
July 29	6.12	Apr. 6	9.64	Sept. 12	5.62
Aug. 26	4.55	May 10	9.43	Oct. 10	6.29
Sept. 29	6.63	June 6	5.71	Nov. 15	7.09
Oct. 24	6.61				
		A6-2-34dc			
Apr. 30, 1949	39.50	Feb. 8, 1950	38.65	Oct. 10, 1950	37.17
June 30	35.86	Mar. 8	39.68	Nov. 15	38.56
July 28	36.45	Apr. 6	40.42	Dec. 13	39.29
Aug. 29	36.25	May 10	40.67	Jan. 10, 1951	39.92
Sept. 29	37.08	June 6	38.77	Feb. 14	40.24
Oct. 24	37.64	July 11	36.19	Mar. 16	41.11
Dec. 7	38.91	Aug. 8	35.72	Apr. 13	40.91
Jan. 11, 1950	39.64	Sept. 12	36.32	May 9	40.51
		A6-2-34dd			
Apr. 29, 1949	55.30	Aug. 26, 1949	51.02	Oct. 24, 1949	52.76
June 29	51.25	Sept. 26	52.00	Dec. 7	54.09
July 29	51.12				
		A7-1-24dd1			
Mar. 19, 1952	4.78	Sept. 18, 1952	6.05	Mar. 19, 1953	6.51
Apr. 22	4.79	Oct. 22	6.18	Apr. 21	6.71
May 20	2.11	Nov. 22	6.07	May 19	6.63
June 16	2.62	Dec. 17	6.19	June 18	2.08
July 14	3.63	Jan. 22, 1953	6.26	July 16	4.50
Aug. 14	5.42	Feb. 19	6.42		
		A7-1-24dd2			
Aug. 3, 1949	5.30	June 9, 1950	2.38	Apr. 11, 1951	4.88
25	6.00	July 11	3.05	May 9	4.69
Sept. 30	6.12	Aug. 8	4.83	June 16	2.54
Oct. 24	6.00	Sept. 12	5.79	July 18	4.55
Dec. 7	6.05	Oct. 10	5.67	Aug. 15	5.69
Jan. 11, 1950	4.73	Nov. 13	5.72	Sept. 19	6.05
Feb. 8	3.30	Dec. 11	5.91	Oct. 8	6.12
Mar. 8	3.87	Jan. 8, 1951	5.98	Nov. 19	6.08
Apr. 6	5.14	Feb. 12	5.45	Dec. 17	6.28
May 10	5.38	Mar. 14	4.94		
		A7-1-25ad			
Sept. 30, 1949	15.30	Oct. 24, 1949	15.81	Dec. 7, 1949	16.38
		A7-2-4aa			
Aug. 9, 1950	15.42	Apr. 12, 1951	17.65	Dec. 18, 1951	17.52
Sept. 7	17.42	May 10	17.57	Jan. 18, 1952	17.38
Oct. 11	17.70	June 16	17.49	Feb. 15	17.48
Nov. 14	17.57	July 18	14.71	Mar. 19	17.30
Dec. 12	17.58	Aug. 16	13.36	Apr. 22	17.27
Jan. 9, 1951	15.92	Sept. 20	15.81	May 21	17.30
Feb. 13	17.50	Oct. 9	17.53	June 17	16.39
Mar. 15	17.61	Nov. 20	17.17	July 15	17.63

Table 4.—*Measurements of the water level in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
		A7-2-4aa—Continued			
Aug. 14, 1952	14.31	Dec. 17, 1952	17.85	Apr. 20, 1953	17.78
Sept. 19	17.29	Jan. 23, 1953	17.86	May 21	17.28
Oct. 21	17.48	Feb. 20	17.81	June 19	15.96
Nov. 22	17.60	Mar. 19	17.83	July 17	15.99
		A7-2-4ba1			
June 26, 1950	9.97	July 18, 1951	9.84	Aug. 13, 1952	10.93
July 18	9.87	Aug. 15	11.29	Sept. 19	12.74
Aug. 9	10.26	Sept. 21	13.00	Oct. 22	14.42
Sept. 7	10.15	Oct. 9	14.03	Nov. 22	15.80
Oct. 11	13.62	Nov. 19	15.99	Dec. 17	16.75
Nov. 14	15.52	Dec. 18	17.18	Jan. 23, 1953	17.88
Dec. 12	16.68	Jan. 17, 1952	17.39	Feb. 20	18.57
Jan. 8, 1951	17.65	Feb. 15	17.01	Mar. 21	19.21
Feb. 12	18.24	Mar. 19	18.05	Apr. 20	19.85
Mar. 14	18.76	Apr. 22	18.11	May 21	17.11
Apr. 11	18.76	May 21	15.97	June 18	11.33
May 9	18.97	June 17	13.80	July 17	10.36
June 16	16.33	July 15	11.33		
		A7-2-5ab1			
June 19, 1950	3.35	Aug. 10, 1950	4.98	Oct. 11, 1950	6.18
July 18	3.61	Sept. 7	4.68		
		A7-2-5bd1			
June 26, 1950	1.91	June 16, 1951	5.41	June 17, 1952	5.99
July 18	2.02	July 20	3.43	July 15	4.48
Aug. 10	2.11	Aug. 17	2.88	Aug. 13	2.24
Sept. 7	2.71	Sept. 21	4.49	Oct. 21	5.15
Oct. 11	2.96	Oct. 9	5.63	Nov. 22	6.00
Nov. 14	5.99	Nov. 19	5.94	Dec. 17	6.32
Dec. 11	6.38	Dec. 18	6.23	Jan. 23, 1953	6.60
Jan. 8, 1951	6.57	Jan. 17, 1952	6.31	Feb. 20	7.02
Feb. 12	6.70	Feb. 15	6.59	Mar. 21	8.10
Mar. 14	7.11	Mar. 19	7.04	Apr. 20	8.40
Apr. 11	7.47	Apr. 22	6.40	May 21	6.50
May 9	7.21	May 21	6.30	June 18	4.09
		A7-2-5dc1			
June 19, 1950	3.02	June 16, 1951	7.59	Sept. 19, 1952	5.54
July 12	1.79	July 18	3.89	Oct. 22	6.58
Aug. 9	4.24	Aug. 15	1.46	Nov. 22	7.29
Sept. 7	4.16	Sept. 21	5.56	Dec. 17	8.20
Oct. 11	5.67	Oct. 9	6.22	Jan. 23, 1953	8.86
Nov. 14	7.06	Dec. 18	8.39	Feb. 20	9.48
Dec. 11	7.94	Mar. 19, 1952	7.75	Mar. 21	10.08
Jan. 8, 1951	8.68	Apr. 22	7.51	Apr. 20	10.50
Feb. 12	8.41	May 21	7.93	May 21	8.58
Mar. 14	8.78	June 17	6.79	June 18	5.66
Apr. 11	9.28	July 15	4.38	July 17	3.52
May 9	9.28	Aug. 13	2.14		

Table 4.—*Measurements of the water level in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
		A7-2-9ab			
Aug. 9, 1950	13.04	Feb. 13, 1951	Dry	Aug. 15, 1951	13.21
Sept. 5	13.42	Mar. 15	Dry	Sept. 20	13.30
Oct. 11	Dry	Apr. 12	Dry	Oct. 9	Dry
Nov. 14	13.46	May 10	Dry	Nov. 20	Dry
Dec. 12	13.30	June 16	13.60	Dec. 18	Dry
Jan. 9, 1951	Dry	July 18	13.29		
		A7-2-9ba3			
Aug. 9, 1950	9.06	Aug. 15, 1951	9.30	Aug. 14, 1952	8.63
Sept. 5	9.22	Sept. 20	9.28	Sept. 19	9.18
Oct. 11	9.25	Oct. 9	9.23	Oct. 21	9.22
Nov. 14	9.24	Nov. 20	8.96	Nov. 22	9.53
Dec. 12	9.21	Dec. 18	9.24	Dec. 17	9.32
Jan. 9, 1951	9.21	Jan. 18, 1952	9.30	Jan. 23, 1953	9.46
Feb. 13	9.15	Feb. 15	9.28	Feb. 20	9.36
Mar. 15	9.19	Mar. 19	9.31	Mar. 19	9.32
Apr. 12	9.21	Apr. 22	9.24	Apr. 20	9.29
May 10	9.18	May 21	9.26	May 21	9.20
June 16	9.55	June 17	7.06	June 19	6.21
July 18	9.15	July 15	7.15	July 17	9.10
		A7-2-10bb			
June 16, 1950	40.15	July 18, 1951	34.67	Aug. 13, 1952	32.71
July 12	35.25	Aug. 15	32.42	Sept. 19	32.70
Aug. 10	37.43	Sept. 21	33.40	Oct. 22	35.08
Sept. 7	31.30	Oct. 9	34.56	Nov. 22	37.40
Oct. 11	35.04	Nov. 19	37.58	Dec. 17	38.64
Nov. 14	36.76	Dec. 18	39.33	Jan. 23, 1953	40.54
Dec. 11	38.79	Jan. 17, 1952	40.54	Feb. 20	41.62
Jan. 8, 1951	40.19	Feb. 15	41.28	Mar. 21	42.54
Feb. 12	41.75	Mar. 19	41.72	Apr. 20	43.06
Mar. 14	42.25	Apr. 22	41.99	May 21	40.98
Apr. 11	42.32	May 21	41.31	June 18	39.36
May 9	43.03	June 17	39.61	July 17	34.40
June 16	41.91	July 15	35.38		
		A7-2-17aa			
Aug. 9, 1950	9.26	Feb. 13, 1951	9.38	Aug. 15, 1951	9.48
Sept. 5	9.45	Mar. 15	9.43	Sept. 20	9.50
Oct. 11	9.52	Apr. 12	Dry	Oct. 9	9.45
Nov. 14	9.48	May 10	Dry	Nov. 20	9.45
Dec. 12	9.45	June 16	9.10	Dec. 18	9.46
Jan. 9, 1951	8.73	July 18	9.40		
		A7-2-17ab3			
May 22, 1950	13.01	June 16, 1951	9.83	June 17, 1952	9.61
June 15	8.67	July 18	7.26	July 15	6.82
July 12	6.00	Aug. 15	5.89	Aug. 13	6.38
Aug. 9	7.17	Sept. 21	8.41	Sept. 19	8.11
Sept. 7	8.19	Oct. 9	9.49	Oct. 21	9.66
Oct. 11	9.29	Nov. 19	10.94	Nov. 22	10.92
Nov. 13	10.64	Dec. 18	12.19	Dec. 17	11.72
Dec. 11	11.75	Jan. 17, 1952	10.34	Feb. 20, 1953	12.94
Jan. 8, 1951	12.50	Feb. 15	11.21	Mar. 19	13.83
Feb. 12	11.77	Mar. 19	12.18	Apr. 20	14.18
Mar. 14	12.08	Apr. 22	11.79	May 21	12.08
Apr. 11	12.71	May 21	10.81	June 18	8.86
May 9	12.52				

Table 4.—*Measurements of the water level in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
A7-2-17bd					
Aug. 11, 1949	5.70	May 7, 1950	11.36	Dec. 11, 1950	10.51
Sept. 30	7.85	June 15	7.42	Jan. 8, 1951	11.24
Oct. 24	8.98	July 12	4.93	Feb. 12	10.43
Dec. 12	10.63	Aug. 9	5.82	Mar. 14	11.62
Jan. 11, 1950	9.55	Sept. 12	6.25	Apr. 11	11.36
Feb. 8	10.06	Oct. 11	7.90	May 9	11.49
Mar. 8	10.80	Nov. 13	8.07	June 16	8.26
Apr. 6	11.94				
A7-2-17cd2					
Aug. 9, 1950	6.71	Aug. 15, 1951	5.76	Aug. 14, 1952	5.56
Sept. 5	7.30	Sept. 20	9.49	Sept. 19	8.04
Oct. 11	10.20	Oct. 9	10.72	Oct. 21	10.78
Nov. 13	11.93	Nov. 20	12.50	Nov. 22	12.53
Dec. 11	13.13	Dec. 17	13.70	Dec. 17	13.17
Jan. 8, 1951	13.98	Jan. 17, 1952	12.03	Jan. 23, 1953	14.18
Feb. 12	13.53	Feb. 15	12.40	Feb. 20	14.82
Mar. 14	13.52	Mar. 17	13.84	Mar. 19	15.26
Apr. 11	14.27	Apr. 22	13.58	Apr. 20	15.65
May 9	14.52	May 21	12.35	May 21	12.48
June 16	9.38	June 17	7.40	June 18	6.93
July 18	7.09	July 15	7.18	July 17	6.87
A7-2-17db1					
Apr. 29, 1949	10.04	July 14, 1949	6.96	Aug. 25, 1949	7.60
June 30	8.10	Aug. 4	6.68		
A7-2-17dc					
Aug. 9, 1950	9.40	Feb. 12, 1951	Dry	Aug. 15, 1951	7.48
Sept. 5	9.50	Mar. 14	Dry	Sept. 20	9.59
Oct. 11	9.60	Apr. 11	Dry	Oct. 9	9.50
Nov. 13	9.66	May 9	Dry	Nov. 20	9.45
Dec. 11	9.69	June 16	9.19	Dec. 18	9.60
Jan. 8, 1951	Dry	July 18	9.32		
A7-2-20ab3					
Aug. 9, 1950	8.54	Feb. 12, 1951	Dry	Aug. 15, 1951	7.03
Sept. 5	8.73	Mar. 14	Dry	Sept. 20	11.77
Oct. 11	12.94	Apr. 11	Dry	Oct. 9	13.59
Nov. 13	15.26	May 9	Dry	Nov. 20	15.81
Dec. 11	16.41	June 16	12.88	Dec. 17	Dry
Jan. 8, 1951	Dry	July 17	8.53		
A7-2-20ac					
Aug. 9, 1950	5.43	Feb. 12, 1951	14.95	Aug. 15, 1951	4.84
Sept. 5	5.88	Mar. 14	14.95	Sept. 20	9.29
Oct. 11	10.23	Apr. 11	Dry	Oct. 9	10.89
Nov. 13	12.47	May 9	Dry	Nov. 20	13.10
Dec. 11	13.79	June 16	8.84	Dec. 17	14.49
Jan. 8, 1951	15.02	July 18	5.74		

Table 4.—*Measurements of the water level in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
		A7-2-20bc1			
Aug. 9, 1950	4.16	Feb. 12, 1951	5.73	Aug. 15, 1951	4.11
Sept. 5	4.62	Mar. 14	3.81	Sept. 20	5.40
Oct. 11	5.51	Apr. 11	7.26	Oct. 9	5.91
Nov. 13	6.49	May 9	7.03	Nov. 20	6.79
Dec. 11	6.93	June 16	4.69	Dec. 17	7.73
Jan. 8, 1951	7.29	July 18	4.20		
		A7-2-20bc2			
Aug. 4, 1949	6.30	Jan. 11, 1950	9.82	May 17, 1950	10.92
25	6.65	Feb. 8	10.33	June 16	5.81
Sept. 30	8.62	Mar. 8	10.95	July 12	4.84
Oct. 25	9.22	Apr. 6	11.96	Aug. 9	5.63
Dec. 12	10.85				
		A7-2-20bd2			
Aug. 9, 1950	5.53	Aug. 15, 1951	4.86	Aug. 14, 1952	6.90
Sept. 5	6.47	Sept. 20	9.11	Sept. 19	6.58
Oct. 11	9.78	Oct. 9	10.32	Oct. 21	10.28
Nov. 13	11.42	Nov. 20	11.80	Nov. 22	11.61
Dec. 11	12.49	Dec. 17	12.94	Dec. 17	12.48
Jan. 8, 1951	13.23	Jan. 17, 1952	11.39	Jan. 23, 1953	13.35
Feb. 12	12.75	Feb. 15	11.92	Feb. 20	13.88
Mar. 14	12.41	Mar. 19	12.95	Mar. 19	14.30
Apr. 11	13.21	Apr. 22	12.67	Apr. 21	14.49
May 9	13.39	May 21	12.43	May 20	11.45
June 16	7.94	June 17	6.20	June 18	6.10
July 18	6.14	July 15	6.12	July 17	4.77
		A7-2-20cb			
Aug. 9, 1950	7.46	Aug. 15, 1951	7.06	Aug. 14, 1952	6.95
Sept. 5	8.19	Sept. 19	10.48	Sept. 19	8.78
Oct. 11	11.10	Oct. 9	11.57	Oct. 21	11.49
Nov. 13	12.58	Nov. 20	12.88	Nov. 22	12.65
Dec. 11	13.50	Dec. 17	13.82	Dec. 17	13.42
Jan. 8, 1951	14.18	Jan. 17, 1952	12.27	Jan. 23, 1953	14.09
Feb. 12	13.64	Feb. 15	12.71	Feb. 20	14.59
Mar. 14	13.01	Mar. 19	14.64	Mar. 19	14.95
Apr. 11	13.88	Apr. 22	13.34	Apr. 21	15.11
May 9	13.93	May 21	12.99	May 20	12.70
June 16	9.11	June 17	8.19	June 18	7.48
July 18	7.68	July 15	7.73	July 17	7.21
		A7-2-21cc			
Aug. 5, 1949	10.30	Sept. 30, 1949	16.24	Oct. 24, 1949	19.95
25	11.85				
		A7-2-29ab			
Aug. 29, 1949	8.99	Nov. 13, 1950	Dry	June 16, 1951	10.73
Sept. 30	11.21	Dec. 11	Dry	July 18	7.01
Oct. 24	Dry	Jan. 8, 1951	Dry	Aug. 15	6.23
June 15, 1950	10.41	Feb. 12	Dry	Sept. 19	Dry
July 12	7.50	Mar. 14	Dry	Oct. 8	Dry
Aug. 8	6.42	Apr. 11	Dry	Nov. 19	Dry
Sept. 12	8.86	May 9	Dry	Dec. 17	Dry
Oct. 11	Dry				

Table 4.—*Measurements of the water level in observation wells*—Continued

A7-2-29bb1

Date	Water level	Date	Water level	Date	Water level
Aug. 26, 1949	3.48	Sept. 30, 1949	3.98	Mar. 8, 1950	Dry

A7-2-29bb2

Date	Water level	Date	Water level	Date	Water level
Aug. 9, 1950	6.63	Feb. 8, 1951	12.13	Aug. 15, 1951	6.30
Sept. 5	7.05	Mar. 14	11.43	Sept. 19	9.15
Oct. 11	9.76	Apr. 11	12.08	Oct. 9	Dry
Nov. 13	11.17	May 9	12.28	Nov. 20	Dry
Dec. 11	11.94	June 16	8.56	Dec. 17	Dry
Jan. 8, 1951	12.49	July 18	6.15		

A7-2-29ca1

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1949	6.93	Feb. 12, 1951	14.25	June 17, 1952	9.62
25	7.10	Mar. 14	13.89	July 15	5.04
Sept. 30	9.10	Apr. 11	13.70	Aug. 13	4.91
Oct. 24	11.50	May 9	12.26	Sept. 18	8.64
Apr. 6, 1950	13.35	June 16	12.43	Oct. 21	10.48
May 10	13.65	July 18	4.01	Nov. 22	12.02
June 15	8.31	Aug. 15	6.33	Dec. 17	13.01
July 12	5.64	Sept. 19	10.01	Jan. 23, 1953	13.69
Aug. 8	6.08	Oct. 8	11.25	Feb. 20	13.78
Sept. 12	7.06	Nov. 20	12.55	Mar. 21	14.10
Oct. 11	10.57	Dec. 17	13.27	Apr. 20	14.81
Nov. 13	10.93	Mar. 19, 1952	13.78	May 21	13.60
Dec. 11	12.42	Apr. 22	13.69	June 18	9.30
Jan. 8, 1951	12.54	May 21	13.30		

A7-2-30ac3

Date	Water level	Date	Water level	Date	Water level
Aug. 4, 1949	4.20	Feb. 8, 1950	3.27	July 11, 1950	2.83
25	4.42	Mar. 8	3.99	Aug. 8	3.59
Sept. 29	4.27	Apr. 6	4.38	Sept. 12	4.00
Oct. 24	4.35	May 10	4.51	Oct. 10	4.17
Dec. 7	4.68	June 9	3.25	Nov. 13	4.48
Jan. 11, 1950	2.88				

A7-2-30ac4

Date	Water level	Date	Water level	Date	Water level
Sept. 30, 1949	5.12	Feb. 12, 1951	0.21	May 20, 1952	3.99
Oct. 25	5.26	Mar. 14	4.55	June 16	3.94
Dec. 7	5.60	Apr. 11	5.14	July 14	4.21
Jan. 11, 1950	4.13	May 9	4.91	Aug. 14	4.32
Feb. 8	4.44	June 16	3.99	Sept. 18	5.20
Mar. 8	4.90	July 18	4.43	Oct. 22	5.53
Apr. 6	5.30	Aug. 15	4.69	Nov. 22	5.57
May 10	5.37	Sept. 19	6.26	Dec. 17	5.79
June 9	4.20	Oct. 8	5.36	Jan. 22, 1953	6.04
July 11	3.60	Nov. 19	5.48	Feb. 19	6.03
Aug. 8	4.21	Dec. 17	5.84	Mar. 19	6.13
Sept. 12	4.85	Jan. 16, 1952	4.01	Apr. 21	6.20
Oct. 10	5.12	Feb. 14	4.56	May 20	4.93
Nov. 13	5.41	Mar. 19	5.24	June 18	2.69
Dec. 11	5.87	Apr. 22	4.56	July 16	4.29
Jan. 8, 1951	5.84				

Table 4.—*Measurements of the water level in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
A7-2-30ac5					
Aug. 8, 1950	2.68	July 18, 1951	2.68	Sept. 18, 1952	3.45
Sept. 5	3.16	Aug. 15	2.94	Oct. 22	3.71
Oct. 10	3.33	Sept. 19	3.40	Nov. 22	3.82
Nov. 13	3.56	Oct. 9	3.53	Dec. 17	4.02
Dec. 11	3.46	Nov. 19	3.70	Jan. 22, 1953	4.31
Jan. 8, 1951	4.04	Dec. 17	4.06	Feb. 19	4.46
Feb. 12	.07	Apr. 22, 1952	2.76	Mar. 19	4.38
Mar. 14	.75	May 20	2.18	Apr. 21	4.48
Apr. 11	3.33	June 16	2.19	May 20	3.38
May 9	3.17	July 14	2.44	June 18	.71
June 16	2.21	Aug. 14	2.65	July 16	2.51
A7-2-30ad2					
Aug. 9, 1950	3.97	Aug. 15, 1951	4.08	Aug. 13, 1952	1.96
Sept. 5	4.30	Sept. 19	7.03	Sept. 18	6.44
Oct. 11	7.42	Oct. 9	7.88	Oct. 22	7.76
Nov. 13	8.52	Nov. 19	8.64	Nov. 22	8.58
Dec. 11	9.11	Dec. 17	9.16	Dec. 17	9.10
Jan. 8, 1951	9.44	Jan. 16, 1952	8.18	Jan. 22, 1953	9.60
Feb. 12	9.34	Feb. 15	8.38	Feb. 19	9.82
Mar. 14	8.80	Mar. 19	9.12	Mar. 19	10.02
Apr. 11	8.99	Apr. 22	8.94	Apr. 21	10.23
May 9	9.08	May 20	8.48	May 20	6.05
June 16	4.52	June 16	6.24	June 18	5.72
July 18	2.67	July 14	3.85	July 16	2.47
A7-2-30bd					
Aug. 8, 1950	3.55	July 18, 1951	3.48	Sept. 18, 1952	4.10
Sept. 5	4.14	Aug. 15	4.17	Oct. 22	4.06
Oct. 10	3.37	Sept. 19	3.85	Nov. 22	3.81
Nov. 13	3.48	Oct. 9	3.67	Dec. 17	3.81
Dec. 11	3.63	Nov. 19	3.59	Jan. 22, 1953	3.98
Jan. 8, 1951	3.59	Dec. 17	4.07	Feb. 19	4.22
Feb. 12	1.91	Apr. 22, 1952	2.10	Mar. 19	4.21
Mar. 14	.36	May 20	1.42	Apr. 21	4.35
Apr. 11	2.53	June 16	1.74	May 20	3.84
May 9	2.47	July 14	3.00	June 18	.91
June 16	2.20	Aug. 14	4.13	July 16	3.32
A7-2-30cb					
Aug. 8, 1950	4.59	Aug. 15, 1951	5.18	Aug. 14, 1952	4.94
Sept. 5	5.12	Sept. 19	4.98	Sept. 18	5.20
Oct. 10	4.66	Oct. 8	4.88	Oct. 22	5.07
Nov. 13	4.64	Nov. 19	4.68	Nov. 22	4.86
Dec. 11	4.49	Dec. 17	4.89	Dec. 17	4.89
Jan. 8, 1951	4.79	Jan. 16, 1952	2.74	Jan. 22, 1953	4.92
Feb. 12	.66	Feb. 15	2.15	Feb. 19	5.07
Mar. 14	2.96	Mar. 19	3.34	Mar. 19	5.08
Apr. 11	3.30	Apr. 22	3.23	Apr. 21	5.25
May 9	3.44	May 20	2.49	May 20	4.75
June 16	3.38	June 16	2.79	June 18	1.31
July 18	4.52	July 14	4.01	July 16	4.22

Table 4.—*Measurements of the water level in observation wells*—Continued

A7-2-30dc1

Date	Water level	Date	Water level	Date	Water level
Aug. 9, 1949	3.12	May 17, 1950	2.98	Nov. 13, 1950	4.89
Sept. 30	3.50	June 9	2.21	Dec. 11	4.70
Oct. 25	4.04	July 11	1.66	Jan. 8, 1951	4.36
Feb. 8, 1950	1.37	Aug. 8	1.81	Feb. 12	4.22
Mar. 8	3.46	Sept. 12	3.56	Mar. 14	4.59
Apr. 6	4.06	Oct. 10	4.28	Apr. 11	4.46

A7-2-30dc2

Date	Water level	Date	Water level	Date	Water level
Aug. 8, 1950	4.15	Aug. 15, 1951	4.79	Aug. 14, 1952	4.56
Sept. 12	4.85	Sept. 19	5.30	Sept. 18	5.64
Oct. 10	5.52	Oct. 8	5.44	Oct. 22	5.94
Nov. 13	5.79	Nov. 19	5.76	Nov. 22	5.87
Dec. 11	5.27	Dec. 17	5.78	Dec. 17	6.16
Jan. 8, 1951	5.63	Jan. 16, 1952	5.28	Jan. 22, 1953	6.02
Feb. 12	4.93	Feb. 14	5.23	Feb. 19	6.12
Mar. 14	5.53	Mar. 19	5.71	Mar. 19	6.18
Apr. 11	5.32	Apr. 22	5.43	Apr. 21	6.13
May 9	5.12	May 20	5.17	May 19	5.26
June 16	4.62	June 16	5.54	June 18	4.62
July 18	4.70	July 15	4.72	July 16	4.74

A7-2-31bb

Date	Water level	Date	Water level	Date	Water level
Aug. 8, 1950	4.05	Aug. 15, 1951	4.22	Aug. 14, 1952	4.92
Sept. 5	4.23	Sept. 19	4.41	Sept. 18	4.71
Oct. 10	4.50	Oct. 8	4.45	Oct. 22	4.68
Nov. 13	4.41	Nov. 19	4.49	Nov. 22	4.66
Dec. 11	4.29	Dec. 17	4.55	Dec. 17	4.77
Jan. 8, 1951	4.23	Jan. 16, 1952	3.76	Jan. 22, 1953	4.86
Feb. 12	1.28	Feb. 15	4.03	Feb. 19	4.91
Mar. 14	2.97	Mar. 19	3.83	Mar. 19	4.66
Apr. 11	3.04	Apr. 22	3.25	Apr. 21	4.80
May 9	3.36	May 20	3.06	May 19	4.36
June 16	3.81	June 16	3.92	June 18	3.73
July 18	4.20	July 14	4.38	July 16	4.25

A7-2-31bc

Date	Water level	Date	Water level	Date	Water level
Aug. 8, 1950	2.49	Aug. 15, 1951	2.68	Aug. 14, 1952	3.73
Sept. 5	3.04	Sept. 19	2.97	Sept. 18	3.31
Oct. 10	3.06	Oct. 8	3.07	Oct. 22	3.36
Nov. 13	3.16	Nov. 19	3.18	Nov. 22	3.37
Dec. 11	3.24	Dec. 17	3.30	Dec. 17	3.50
Jan. 8, 1951	3.25	Jan. 16, 1952	2.19	Jan. 22, 1953	3.58
Feb. 12	2.79	Feb. 15	2.50	Feb. 19	3.60
Mar. 14	3.08	Mar. 19	2.69	Mar. 19	3.27
Apr. 11	2.48	Apr. 22	2.50	Apr. 21	3.43
May 9	2.36	May 20	2.41	May 19	3.05
June 16	2.23	June 16	2.21	June 18	1.83
July 18	2.20	July 14	2.41	July 16	2.61

A7-2-31bd1

Date	Water level	Date	Water level	Date	Water level
Aug. 3, 1949	6.70	July 11, 1950	5.83	Apr. 11, 1951	7.11
Sept. 30	7.04	Aug. 8	6.43	May 9	6.85
Oct. 25	7.20	Sept. 12	7.05	June 16	6.19
Dec. 12	7.28	Oct. 10	7.30	July 18	6.50
Mar. 8, 1950	7.03	Nov. 13	7.46	Aug. 15	6.72
Apr. 6	7.15	Jan. 8, 1951	7.60	Sept. 19	7.16
May 10	7.02	Feb. 12	7.35	Oct. 8	7.33
June 9	6.52	Mar. 14	6.68	Nov. 19	7.58

Table 4.—*Measurements of the water level in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
		A7-2-31bd1—Continued			
Dec. 17, 1951	7.75	July 15, 1952	6.57	Feb. 19, 1953	8.00
Jan. 16, 1952	7.55	Aug. 14	6.72	Mar. 21	7.96
Feb. 14	7.55	Sept. 18	7.50	Apr. 21	7.79
Mar. 19	7.55	Oct. 22	7.47	May 19	7.24
Apr. 21	7.20	Nov. 21	7.87	June 18	7.20
May 20	6.64	Dec. 19	7.72	July 16	6.46
June 16	7.31	Jan. 22, 1953	7.79		
		A7-2-31bd8			
Aug. 3, 1949	6.32	Mar. 14, 1951	6.82	June 16, 1952	5.96
Sept. 30	6.54	Apr. 17	6.75	July 15	6.13
Oct. 25	6.70	May 9	6.43	Aug. 14	6.14
Dec. 12	6.65	June 16	5.93	Sept. 18	6.98
Jan. 11, 1950	6.97	July 18	6.00	Oct. 22	7.07
Feb. 8	6.82	Aug. 15	6.10	Nov. 21	7.15
Mar. 8	6.52	Sept. 19	6.70	Dec. 19	7.37
Apr. 6	6.58	Oct. 8	6.83	Jan. 22, 1953	7.50
May 10	6.47	Nov. 19	6.93	Feb. 19	7.54
June 9	5.99	Dec. 17	7.13	Mar. 21	7.46
July 11	5.47	Jan. 16, 1952	6.36	Apr. 21	7.39
Aug. 8	5.84	Feb. 14	6.64	May 19	6.71
Sept. 12	6.59	Mar. 19	6.71	June 18	5.91
Oct. 10	6.85	Apr. 21	6.63	July 16	5.99
Nov. 13	6.95	May 20	6.31		
		A7-2-31cb			
Aug. 3, 1949	7.10	Dec. 11, 1950	7.98	June 16, 1951	5.91
25	7.47	Jan. 8, 1951	8.02	July 18	6.41
Sept. 30	7.42	Feb. 12	7.50	Aug. 15	7.01
Aug. 8, 1950	6.79	Mar. 14	7.73	Sept. 19	7.42
Sept. 12	7.49	Apr. 11	7.25	Oct. 8	7.71
Oct. 10	7.62	May 9	7.01	Nov. 19	7.90
Nov. 13	7.74				
		A7-2-31dd			
Aug. 9, 1949	2.55	Jan. 8, 1951	3.98	May 20, 1952	1.02
Sept. 29	3.80	Feb. 12	3.97	June 17	1.13
Oct. 24	3.83	Mar. 14	3.95	July 15	1.16
Dec. 12	3.80	Apr. 11	3.88	Aug. 13	1.30
Jan. 11, 1950	3.93	May 9	3.73	Sept. 18	1.05
Feb. 8	3.85	June 16	3.71	Oct. 22	1.32
Mar. 8	3.70	July 18	3.65	Nov. 22	1.40
Apr. 6	3.69	Aug. 15	3.55	Dec. 19	1.46
May 17	3.58	Sept. 19	3.46	Jan. 23, 1953	1.51
June 9	3.93	Oct. 8	3.56	Feb. 19	1.58
July 11	3.85	Nov. 19	3.56	Mar. 21	1.58
Aug. 8	3.88	Dec. 17	3.60	Apr. 21	1.67
Sept. 12	3.72	Jan. 16, 1952	3.58	May 20	.75
Oct. 10	3.90	Feb. 14	3.64	June 18	1.78
Nov. 13	3.97	Mar. 19	3.72	July 16	1.82
Dec. 11	3.96	Apr. 21	.90		
		A7-2-32ab			
Aug. 9, 1949	4.12	Feb. 11, 1950	7.41	July 11, 1950	2.81
Sept. 29	6.00	Mar. 8	6.67	Aug. 8	2.87
Oct. 25	7.02	Apr. 6	6.78	Sept. 12	4.74
Dec. 12	7.96	May 17	7.12	Oct. 10	6.35
Jan. 11, 1950	8.22	June 9	5.26	Nov. 13	7.67

Table 4.—*Measurements of the water level in observation wells*—Continued

A7-2-32ab—Continued

Date	Water level	Date	Water level	Date	Water level
Dec. 11, 1950	8.36	Jan. 16, 1952	9.22	Feb. 19, 1953	9.90
Jan. 8, 1951	8.83	Feb. 14	9.19	Mar. 21	10.00
Feb. 12	9.22	Apr. 21	8.87	Apr. 21	10.25
Mar. 14	8.72	May 20	8.76	May 18	5.31
Apr. 11	8.67	June 16	5.71	July 6	4.4
May 9	8.53	July 14	3.66	Aug. 7	4.1
June 16	5.92	Aug. 13	4.66	Sept. 7	5.5
July 18	4.84	Sept. 18	6.40	Oct. 8	5.9
Aug. 15	3.89	Oct. 22	7.24	Nov. 10	7.2
Sept. 19	6.71	Nov. 21	8.29	Dec. 10	8.3
Oct. 8	7.42	Dec. 19	8.91	Jan. 7, 1954	7.4
Nov. 19	8.27	Jan. 23, 1953	9.01	Feb. 2	6.6
Dec. 17	8.98				

A7-2-32ba2

Date	Water level	Date	Water level	Date	Water level
Aug. 9, 1949	2.30	Mar. 14, 1951	4.38	Sept. 18, 1952	3.14
Sept. 29	3.47	Apr. 11	3.18	Oct. 22	3.28
Oct. 25	3.70	May 9	4.08	Nov. 21	3.40
Dec. 12	4.48	June 16	4.19	Dec. 19	3.49
Jan. 11, 1950	4.62	July 18	3.19	Jan. 23, 1953	3.54
Feb. 11	3.12	Aug. 15	3.30	Feb. 19	3.62
Mar. 8	3.18	Sept. 19	3.46	Mar. 21	3.91
Apr. 6	3.28	Oct. 8	3.59	Apr. 21	3.74
May 17	3.44	Nov. 20	3.78	May 18	3.82
June 9	3.82	Dec. 17	3.82	June 10	3.02
July 11	1.66	Jan. 16, 1952	3.89	July 6	4.1
Aug. 8	2.21	Feb. 14	4.26	Sept. 9	3.1
Sept. 12	4.00	Mar. 17	3.05	Oct. 10	3.2
Oct. 10	4.13	Apr. 21	3.20	Nov. 10	3.2
Nov. 13	4.26	May 20	3.31	Dec. 10	3.5
Dec. 11	4.25	June 16	3.42	Jan. 7, 1954	4.1
Jan. 8, 1951	4.33	July 14	3.01	Feb. 2	5.1
Feb. 12	4.36	Aug. 13	2.71		

A7-2-32bb

Date	Water level	Date	Water level	Date	Water level
Aug. 9, 1949	4.75	July 11, 1950	1.96	Apr. 11, 1951	Dry
Sept. 29	5.80	Aug. 8	2.18	May 9	Dry
Oct. 25	5.96	Sept. 12	5.43	June 16	3.96
Dec. 12	6.20	Oct. 10	6.34	July 18	4.58
Jan. 11, 1950	Dry	Nov. 13	6.84	Aug. 15	3.50
Feb. 8	Dry	Dec. 11	Dry	Sept. 19	6.18
Mar. 8	6.30	Jan. 8, 1951	Dry	Oct. 8	Dry
Apr. 6	6.15	Feb. 12	Dry	Nov. 19	Dry
May 17	6.02	Mar. 14	Dry	Dec. 17	Dry
June 9	4.20				

A7-2-32cb

Date	Water level	Date	Water level	Date	Water level
Aug. 9, 1949	2.55	Oct. 10, 1950	4.28	Nov. 20, 1951	5.17
Sept. 29	3.76	Nov. 13	4.66	Dec. 17	5.48
Oct. 25	4.18	Dec. 11	4.84	Jan. 16, 1952	5.52
Dec. 12	4.68	Jan. 8, 1951	4.99	Feb. 14	5.38
Jan. 11, 1950	5.06	Feb. 12	5.34	Mar. 17	5.74
Feb. 11	5.41	Mar. 14	5.38	Apr. 21	4.61
Mar. 8	5.12	Apr. 11	5.03	May 21	4.33
Apr. 6	4.51	May 9	4.41	June 16	2.40
May 17	4.09	June 16	4.53	July 14	3.38
June 9	3.14	July 18	3.61	Aug. 13	3.33
July 11	3.11	Aug. 15	2.65	Sept. 18	4.61
Aug. 8	2.39	Sept. 19	4.31	Oct. 22	5.29
Sept. 12	3.97	Oct. 8	4.67	Nov. 21	5.58

Table 4.—*Measurements of the water level in observation wells*—Continued

A7-2-32cb—Continued

Date	Water level	Date	Water level	Date	Water level
Dec. 19, 1952	5.63	May 19, 1953	3.00	Nov. 10, 1953	4.9
Jan. 23, 1953	6.11	June 10	1.90	Dec. 10	6.1
Feb. 19	6.02	July 6	2.90	Jan. 7, 1954	6.0
Mar. 19	6.09	Sept. 9	4.0	Feb. 2	6.0
Apr. 21	6.13	Oct. 8	4.9		

A7-2-32da

Date	Water level	Date	Water level	Date	Water level
Sept. 23, 1949	5.30	June 9, 1950	1.99	Jan. 8, 1951	6.96
Oct. 25	5.85	July 11	3.23	Feb. 12	7.57
Dec. 12	6.61	Aug. 8	2.49	Mar. 14	7.46
Jan. 11, 1950	6.95	Sept. 12	4.22	Apr. 11	6.82
Feb. 11	6.67	Oct. 10	5.48	May 9	6.29
Mar. 8	5.80	Nov. 13	6.12	June 16	.91
Apr. 6	5.53	Dec. 11	6.68	July 18	3.21
May 17	5.71				

A7-2-33cd2

Date	Water level	Date	Water level	Date	Water level
Aug. 1, 1949	2.95	June 9, 1950	3.94	Apr. 11, 1951	3.49
Sept. 30	1.92	July 11	3.12	May 9	3.81
Oct. 25	2.40	Aug. 8	3.31	June 16	3.94
Dec. 12	3.30	Sept. 12	2.26	July 18	3.21
Jan. 11, 1950	3.30	Oct. 10	2.20	Aug. 15	2.48
Feb. 11	3.06	Nov. 16	2.29	Sept. 19	5.49
Mar. 8	3.10	Dec. 11	2.42	Oct. 8	6.46
Apr. 6	3.52	Jan. 8, 1951	3.18	Nov. 20	7.39
May 17	4.14	Feb. 12	3.17	Dec. 17	7.84

A8-2-3dc1

Date	Water level	Date	Water level	Date	Water level
July 5, 1950	26.49	Aug. 10, 1950	22.82	Sept. 7, 1950	24.36
18	26.51				

A8-2-6ac

Date	Water level	Date	Water level	Date	Water level
July 19, 1950	8.86	July 20, 1951	9.36	Aug. 13, 1952	10.10
Aug. 10	10.55	Aug. 17	11.16	Sept. 19	11.30
Sept. 7	12.20	Sept. 21	11.46	Oct. 21	12.22
Oct. 11	12.74	Oct. 9	11.52	Nov. 22	12.29
Nov. 14	12.52	Nov. 19	11.83	Dec. 17	12.05
Dec. 11	12.72	Dec. 18	11.22	Jan. 23, 1953	10.54
Jan. 8, 1951	12.06	Jan. 17, 1952	11.67	Feb. 20	12.80
Feb. 12	13.62	Feb. 15	12.31	Mar. 21	10.24
Mar. 14	14.29	Mar. 19	13.04	Apr. 20	11.03
Apr. 11	13.89	Apr. 22	11.60	May 21	10.90
May 9	12.71	June 17	9.10	June 18	5.85
June 16	8.45	July 15	9.38		

A8-2-7aa1

Date	Water level	Date	Water level	Date	Water level
July 7, 1950	25.13	Apr. 11, 1951	29.84	Feb. 15, 1952	28.81
18	24.56	May 9	29.60	Mar. 19	29.21
Aug. 10	25.61	June 16	27.75	Apr. 22	29.66
Sept. 7	27.24	July 20	26.65	June 17	28.01
Oct. 11	27.60	Aug. 17	27.09	July 15	26.59
Nov. 14	27.58	Sept. 21	26.15	Aug. 13	27.68
Dec. 11	28.06	Oct. 9	26.69	Sept. 19	28.34
Jan. 8, 1951	28.69	Nov. 19	27.63	Oct. 21	28.21
Feb. 12	29.45	Dec. 18	28.41	Nov. 22	28.38
Mar. 14	29.77	Jan. 17, 1952	28.51	Dec. 17	28.50

Table 4.—*Measurements of the water level in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
		A8-2-7aa1—Continued			
Jan. 22, 1953	29.07	Apr. 20, 1953	29.92	June 18, 1953	26.31
Feb. 20	29.21	May 21	29.71	July 17	21.92
Mar. 21	29.74				
		A8-2-8ca			
July 7, 1950	68.65	July 20, 1951	69.54	Aug. 13, 1952	70.80
18	68.03	Aug. 17	71.81	Sept. 19	68.39
Aug. 10	67.53	Sept. 21	67.71	Oct. 21	69.70
Sept. 7	66.76	Oct. 9	68.23	Nov. 22	71.23
Oct. 11	67.38	Nov. 19	73.17	Dec. 17	72.81
Nov. 14	68.97	Dec. 18	78.65	Jan. 23, 1953	79.43
Dec. 11	72.54	Jan. 17, 1952	78.32	Feb. 20	79.60
Jan. 8, 1951	74.98	Feb. 15	78.51	Mar. 21	78.14
Feb. 12	77.47	Mar. 19	78.60	Apr. 20	78.93
Mar. 14	78.44	Apr. 22	79.96	May 21	77.30
Apr. 11	79.24	June 17	77.70	June 18	68.62
May 9	77.48	July 15	69.98	July 17	67.98
June 16	75.04				
		A8-2-9bc			
July 5, 1950	5.48	Aug. 10, 1950	4.63	Sept. 7, 1950	5.93
18	5.29				
		A8-2-10aa			
July 6, 1950	40.01	June 16, 1951	45.01	July 15, 1952	38.94
18	40.43	July 20	36.64	Aug. 13	39.31
Aug. 10	37.07	Aug. 17	38.85	Sept. 19	38.58
Sept. 11	39.21	Sept. 21	41.00	Oct. 22	39.65
Oct. 11	41.60	Oct. 9	42.09	Nov. 22	40.20
Nov. 14	43.06	Nov. 19	43.68	Dec. 17	40.54
Dec. 11	44.25	Dec. 18	44.62	Jan. 23, 1953	42.46
Jan. 8, 1951	45.46	Jan. 17, 1952	45.06	Feb. 20	43.80
Feb. 12	47.62	Feb. 15	45.98	Mar. 21	44.40
Mar. 14	48.94	Mar. 19	47.35	Apr. 20	45.32
Apr. 11	50.31	Apr. 22	48.62	May 21	44.80
May 9	50.03	June 17	46.72	June 18	36.89
		A8-2-14bb			
June 30, 1950	91.57	July 18, 1950	89.23	Aug. 10, 1950	90.31
		A8-2-20cd1			
June 26, 1950	1.76	Aug. 10, 1950	2.93	Oct. 11, 1950	2.63
July 18	2.79	Sept. 7	2.94	Nov. 14	3.87
		A8-2-21ca			
June 27, 1950	1.87	Feb. 12, 1951	6.73	Oct. 9, 1951	3.91
July 18	.75	Mar. 14	7.06	Nov. 19	4.60
Aug. 10	2.43	Apr. 11	6.20	Dec. 18	4.73
Sept. 7	2.53	May 9	5.91	Feb. 15, 1952	4.43
Oct. 11	2.55	June 16	4.42	Mar. 19	5.54
Nov. 14	4.69	July 19	2.53	Apr. 22	4.76
Dec. 11	5.25	Aug. 17	3.21	June 17	2.48
Jan. 8, 1951	5.83	Sept. 21	3.03	Aug. 13	2.86

Table 4.—*Measurements of the water level in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
A8-2-21ca—Continued					
Sept. 19, 1952	4.55	Jan. 23, 1953	5.72	Apr. 20, 1953	6.38
Oct. 21	4.68	Feb. 20	5.80	May 21	5.80
Nov. 22	4.83	Mar. 21	6.14	June 18	2.36
Dec. 17	5.46				
A8-2-23cc1					
June 27, 1950	9.91	June 16, 1951	7.36	July 15, 1952	9.24
July 18	8.59	July 20	9.16	Aug. 13	9.42
Aug. 10	8.96	Aug. 17	8.44	Oct. 22	10.42
Sept. 7	9.64	Sept. 21	8.45	Nov. 22	9.81
Oct. 11	9.67	Oct. 9	8.96	Dec. 17	10.10
Nov. 14	9.34	Nov. 19	9.18	Jan. 23, 1953	10.41
Dec. 11	9.46	Dec. 18	9.65	Feb. 20	10.30
Jan. 8, 1951	9.06	Jan. 17, 1952	10.43	Mar. 21	10.60
Feb. 12	9.30	Feb. 15	10.29	Apr. 20	10.51
Mar. 14	9.67	Mar. 19	10.20	May 21	9.73
Apr. 15	9.67	Apr. 22	9.81	June 18	5.57
May 9	9.49	June 17	9.18		
A8-2-28cd					
June 20, 1950	15.49	July 20, 1951	10.83	July 15, 1952	10.47
July 18	13.02	Aug. 17	11.74	Aug. 13	13.02
Aug. 10	12.67	Sept. 21	14.44	Sept. 19	14.60
Sept. 7	13.46	Oct. 9	15.43	Oct. 22	15.80
Oct. 11	15.55	Nov. 19	17.44	Nov. 22	16.82
Nov. 14	17.17	Dec. 18	18.43	Dec. 17	17.18
Dec. 11	18.11	Jan. 17, 1952	18.81	Jan. 23, 1953	19.03
Jan. 8, 1951	18.95	Feb. 15	19.48	Feb. 20	19.88
Feb. 12	19.92	Mar. 19	19.16	Mar. 21	19.08
Mar. 14	20.12	Apr. 22	18.88	Apr. 20	19.84
Apr. 11	19.93	May 21	18.33	May 21	18.41
May 9	19.66	June 17	16.70	June 18	14.89
June 16	15.82				
A8-2-29dc1					
June 19, 1950	2.61	July 20, 1951	1.81	Aug. 13, 1952	2.34
July 18	2.46	Aug. 17	2.61	Sept. 19	3.70
Aug. 10	2.86	Sept. 21	3.49	Oct. 22	3.86
Sept. 7	3.08	Oct. 9	4.03	Nov. 22	4.52
Oct. 11	3.69	Nov. 19	4.66	Dec. 17	5.02
Nov. 14	4.49	Dec. 18	5.52	Jan. 23, 1953	5.61
Dec. 11	5.32	Jan. 17, 1952	5.11	Feb. 20	5.70
Jan. 8, 1951	5.34	Feb. 15	5.39	Mar. 21	6.15
Feb. 12	5.54	Mar. 19	5.44	Apr. 20	6.75
Mar. 14	5.99	Apr. 22	5.01	May 21	5.15
Apr. 11	5.64	May 21	4.64	June 18	4.16
May 9	5.13	June 17	4.32	July 17	2.21
June 16	4.48	July 15	2.64		
A8-2-32aa					
June 20, 1950	5.44	Jan. 8, 1951	9.42	Aug. 17, 1951	5.60
July 18	5.56	Feb. 12	9.72	Sept. 21	7.11
Aug. 10	5.69	Mar. 14	10.29	Oct. 9	7.66
Sept. 7	6.17	Apr. 11	9.82	Nov. 19	8.62
Oct. 11	7.42	May 9	9.76	Dec. 18	9.47
Nov. 14	8.41	June 16	8.22	Jan. 17, 1952	9.46
Dec. 11	9.03	July 20	4.58	Feb. 15	9.51

Table 4.—*Measurements of the water level in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
A8-2-32aa—Continued					
Mar. 19, 1952	9.09	Sept. 19, 1952	7.22	Feb. 20, 1953	9.69
Apr. 22	9.16	Oct. 22	7.95	Mar. 21	10.32
May 21	7.93	Nov. 22	8.56	Apr. 20	10.51
June 17	7.17	Dec. 17	9.15	May 21	9.12
July 15	5.60	Jan. 23, 1953	9.59	June 18	7.21
Aug. 13	5.40				
A8-2-32db1					
June 19, 1950	4.21	June 16, 1951	6.79	July 15, 1952	4.56
July 18	3.96	July 20	3.94	Aug. 13	4.16
Aug. 17	4.83	Aug. 17	4.48	Sept. 19	5.85
Sept. 7	4.67	Sept. 21	5.77	Oct. 22	6.30
Oct. 11	5.84	Oct. 9	6.18	Nov. 22	6.80
Nov. 14	6.70	Nov. 19	7.02	Dec. 17	7.40
Dec. 11	7.35	Feb. 15, 1952	7.41	Jan. 23, 1953	7.89
Jan. 8, 1951	8.20	Mar. 19	8.03	Feb. 20	8.02
Feb. 12	7.96	Apr. 22	7.37	Mar. 21	8.61
Mar. 14	8.46	May 21	7.09	May 21	7.18
Apr. 11	8.31	June 17	6.32	June 18	5.68
May 9	7.24				
A9-2-19da2					
July 19, 1950	2.38	Jan. 8, 1951	3.50	July 19, 1951	3.71
Aug. 10	2.29	Feb. 12	3.13	Aug. 17	3.19
Sept. 7	3.22	Mar. 14	2.57	Sept. 21	4.58
Oct. 11	2.45	Apr. 11	4.89	Oct. 9	4.13
Nov. 14	1.78	May 9	3.56	Nov. 19	4.26
Dec. 11	2.87	June 16	1.01	Dec. 18	4.48
A9-2-20db					
July 19, 1950	4.09	Jan. 8, 1951	6.88	July 20, 1951	4.11
Aug. 10	5.14	Feb. 12	7.04	Aug. 17	5.88
Sept. 7	6.11	Mar. 15	7.97	Sept. 21	6.73
Oct. 11	5.80	Apr. 11	8.88	Oct. 9	6.30
Nov. 14	7.09	May 9	6.50	Nov. 19	6.34
Dec. 11	6.31	June 16	4.72	Dec. 18	6.41
A9-2-31da					
July 18, 1950	35.30	July 20, 1951	36.54	Aug. 13, 1952	37.30
Aug. 10	37.52	Aug. 17	37.41	Sept. 19	38.07
Sept. 7	39.21	Sept. 21	39.35	Oct. 21	38.89
Oct. 11	40.03	Oct. 9	37.86	Nov. 22	40.12
Nov. 14	40.69	Nov. 19	39.34	Dec. 17	42.01
Dec. 11	41.12	Dec. 18	38.86	Jan. 23, 1953	42.66
Jan. 8, 1951	41.54	Jan. 17, 1952	39.91	Feb. 22	42.71
Feb. 12	42.44	Feb. 15	40.51	Mar. 21	37.00
Mar. 14	42.93	Mar. 19	41.73	Apr. 20	37.31
Apr. 11	43.26	Apr. 22	40.68	May 21	36.63
May 9	42.73	June 17	38.70	June 18	34.29
June 16	38.13	July 15	34.92		

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Table 4.—*Measurements of the water level in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
		A9-2-33cd			
July 7, 1950	48.29	Jan. 8, 1951	57.34	July 20, 1951	50.73
18	47.04	Feb. 12	47.01	Aug. 17	46.85
Aug. 10	46.83	Mar. 14	47.43	Sept. 21	43.90
Sept. 7	46.33	Apr. 11	48.65	Oct. 9	45.13
Oct. 11	46.72	May 9	47.81	Nov. 19	42.10
Nov. 14	49.59	June 16	53.42	Dec. 18	44.22
Dec. 11	56.68				

RECORD OF WELLS AND SPRINGS

Table 5.—*Record of wells and springs*

[Well no.: See text for description of well-numbering system.
Type of well: B, bored; D, driven; DD, dug and drilled; Dr, drilled; Du, dug; Sp, spring.
Depth of well: Measured depths are given in feet and tenths below measuring point; reported depths are given in feet below land surface.
Type of casing: C, concrete; M, masonry; P, iron or steel pipe; W, wood.
Geologic source: Al, alluvium; Mlp, Lodgepole limestone; Mm, limestone of Madison group; Tg, Tertiary deposits.
Method of lift:
Type of pump: C, centrifugal; Cy, cylinder; F, natural flow; HR, hydraulic ram; J, jet; N, none; P, pitcher; PP, reciprocating piston pump.
Type of power: E, electric motor; G, gasoline engine; H, hand operated; W, wind.
Use of water: D, domestic; I, irrigation; In, industrial; N, none; O, observation of water-level fluctuations by U. S. Geological Survey; S, stock.
Measuring point: Bco, bottom of cover; L, land surface; Tca, top of casing; Tco, top of cover; Tcp, top of cover in pit; Tcu, top of curb; Tp, top of pitcher pump; Tpb, top of pump base; Tpc, top of pipe above casing; Tpf, top of pump platform; Tpp, top of 2-inch plank on floor of porch; Ttp, top of 2-inch diameter pipe in pit; Tvs, top of valve seat in pitcher pump.
Remarks: A, adequate supply; Ca, water sample collected for chemical analysis; I, inadequate supply; O, observation well of Soil Conserv. Service, U. S. Dept. Agriculture]

Well no.	Owner or tenant	Type of well	Depth of well (feet)	Diameter of well (inches)	Type of casing	Geologic source	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (-) land surface (feet)	Measuring point: Height above mean sea level (feet)	Depth to water level below measuring point (feet)	Date of measurement	Remarks
A4-1-1ba	P. Williams	Du	9.1	60 x 36	W	Al	Cy, W	S, O	Tpf	1.0	4,017.27	2.55	6-30-49	A
-2ab	J. Sherlock	Du	10.4	18	P	Al	N	O	Tcu	.0	4,048.36	7.58	5- 2-49	
-2ba1	W. Sherlock	Du	15.7	24	P	Al	Cy, W, H	N	Tpf	.2	4,049.41	5.55	6-30-49	
-2ba2	......do	Du	20	15	P	Al	Cy, E	S	....	....	....	....	....	A
-2ba3	......do	Dr	100	6	P	Al	J, E	D	Tpf	.5	4,048.54	5.82	6-30-49	A
-2bd1	F. Kitto	Dr	91	6	P	Al	N	O	Tcu	.5	4,051.21	4.65	6-30-49	
-2bd2	W. Turman	Dr	87.1	6	P	Al	J, E	D, S	Tcu	.5	4,054.44	8.50	6-29-49	A
-2ca1	J. Kitto	Du	21	24	P	Al	Cy, W	I	....	....	....	....	....	
-2ca2	......do	Du	18	48	M	Al	J, E	D	L	.0	....	6.50	6-30-49	A
-2ca3	I. Jenkins	Du	28.5	36	M	Al	J, E	D, S, O	Tpf	.9	4,066.04	22.70	5- 2-49	A, Ca
-2db1	W. Kitto	Du	21.2	36	M	Al	Cy, W	S	Tpf	.0	4,053.29	8.10	6- 3-49	A
-2db2	......do	Du	21	36	M	Al	J, E	D	....	....	....	....	....	
-2dd1	P. Williams	Dr	25	6	P	Al	Cy, H	D	Tpf	1.4	4,054.22	12.83	6-29-49	A
-2dd2	......do	Dr	20.2	6	P	Al	Cy, H	D	Tpf	2.4	4,054.78	13.92	6-29-49	A
-2dd3	......do	Dr	24.6	6	P	Al	Cy, E	S	Tpf	2.2	4,053.90	13.55	6-29-49	A

-10aa	J. Smetters	Dr	90	6	P	Tg	J,E	D	...	...	...	...	...	
-10cb	......do	Dr	112.8	6	P	Tg	N	O	Tpf	1.2	4,152.83	97.00	5- 2-49	
-11ab	T. Williams	Du	23.6	36	P	Al	J,E	S, O	Tcu	.3	4,056.98	16.80	5- 2-49	A
-12aa	W. Kitto	Dr	110	6	P	Al	Cy, W	S	Tpf	.4	4,028.95	5.90	8-11-49	A
-12bd	T. Williams	Dr	16.1	6	P	Al	Cy, W	S, O	Tca	.8	4,041.32	7.77	5- 2-49	A
-12dc	...	Sp	...	...	...	...	F	...	...	...	...	...	...	
-13cc	C. Nelson	Dr	100	6	P	Al	N	O	Tca	1.0	4,093.65	36.00	10- 5-49	
-14cc	......do	Dr	64.2	6	P	Al	Cy, H	S, O	Tpf	.8	4,111.45	54.60	6-29-49	A
-16da	State of Mont.	Dr	145	6	P	Tg	N	N	Tca	.6	4,203.83	144.20	8- 8-49	
-22cb	C. Nelson	Dr	100	6	P	Tg	Cy, H	N	Tca	.5	4,174.69	95.62	7-11-49	
-27ab	...	Sp	...	...	...	Mlp	...	...	...	...	...	...	...	Ca
A4-2-4ab	U. S. Geol. Survey	J	34.1	3/4	P	Tg	N	N	Tca	2.3	4,020.86	Dry	8-30-50	
-4bc	......do	J	26.8	3/4	P	Tg	N	N	Tca	2.7	4,013.73	Dry	8-30-50	
-5ac	......do	J	24.1	3/4	P	Al	N	N	Tca	1.2	3,999.19	14.53	8-30-50	
-5bb	......do	J	28.5	3/4	P	Al	N	N	Tca	1.8	3,981.73	7.11	8-29-50	
-5bc	......do	J	17.4	3/4	P	Tg	N	O	Tca	2.2	3,994.27	10.25	8-29-50	
-5bd	J. Gruber	Du	12.3	48	M	Al	Cy, E	D,S,O	Tpf	.0	3,990.65	7.24	7-29-49	A
-5cc	......do	Dr	27.5	6	P	Tg	N	O	Tca	.0	4,025.67	22.50	7-29-49	
-6aa	U. S. Geol. Survey	D	9.5	2	P	Al	N	O	Tca	1.6	3,983.46	7.62	8-26-49	
-6cc	......do	J	15.7	3/4	P	Al	N	N	Tca	1.7	4,027.54	7.38	8-29-50	
-6cd	Miller & Hansen	DD	12.2	40	M	Al	Cy, W	S, O	Tpf	.2	4,017.33	7.35	6-29-49	A
-6dd	W. Hossfeld	Du	17.2	48	M	Al	Cy, H	N	Tpf	.2	4,018.13	15.10	5- 2-49	
-8bb1	I. Jenkins	Du	35.5	36	M	Tg	Cy,H,E	S,I,O	Tpf	1.0	4,036.54	33.50	5- 2-49	
-8bb2	......do	Dr	71	6	P	Tg	J,E	S	...	...	...	32	...	Ca
-10bb	T. McMullan	Dr	200.1	6	P	Tg	Cy, E	S	Tpf	1.5	4,140.86	172.10	7-22-49	Ca
-16aa	......do	Dr	298.1	6	P	Tg	N	N	Tca	2.0	4,240.08	282.00	7-22-49	
-35cc	...	Sp	...	...	...	Mm(?)	...	...	...	...	...	...	...	Ca
A5-1-4cc	T. Williams	Dr	24.8	6	P	Al	N	O	Tca	.8	4,348.62	12.00	7- 7-49	
-5ad	E. Toma	Dr	24.1	1½	P	Al	P	D,S	Tca	2.75	4,404.11	10.20	9-28-49	A
-8bc	R. Harris	Dr	47	6	P	Al	J,E	D,S	...	...	...		7- 7-49	A
-8bd	T. Williams	Dr	40	6	P	Al	J,E	D,S	...	...	...	...	7- 7-49	A
-8ca	Raderburg Grade School	Dr	34.1	6	P	Al	Cy, H	D	Tpf	.7	4,316.67	11.38	7- 7-49	A
-8cd1	R. Seaman	Dr	54.1	2	P	Al	N	N	Tcu	.0	4,314.56	19.10	5- 2-49	
-8cd2	C. Edenfield	Dr	20.1	3	P	Al	P	In,O	Tpf	.0	4,304.97	11.60	7- 7-49	A
-9dc	F. Poe	Du	18	36	M	Al	J, E	D,S	...	...	...	...	7- 7-49	A

Table 5.—*Record of wells and springs*—Continued

Well no.	Owner or tenant	Type of well	Depth of well (feet)	Diameter of well (inches)	Type of casing	Geologic source	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (-) land surface (feet)	Measuring point: Height above mean sea level (feet)	Depth to water level below measuring point (feet)	Date of measurement	Remarks
A5-1-10ad	E. Toma	Du	22.2	36	M	Al	N	N	Tpf	0.5	4,182.40	10.30	10- 5-49	
-10cb	W. Parker	Dr	42.8	6	P	Al	Cy,H	S,O	Tca	1.0	4,240.16	12.91	7- 7-49	
-11cd	R. Barringer	Du	11.7	60	M	Al	Cy,G	S,O	Tpf	.5	4,143.24	6.35	7- 7-49	A
-13dd	T. McMullan	Dr	50.8	6	P	Al	Cy,G	S	Tpf	.8	3,999.88	10.62	6-28-49	A
-14ab	......do	Du	6.2	60	W	Al	N	N	Tpf	.0	4,118.09	4.20	7- 7-49	
-16bd	G. Webb	Du	25	36	M	Al	Cy,H	D	...	...	...	...	...	A
-16dc	W. Parker	Dr	60	6	P	Al	J,E	D	...	...	...	...	...	A
-17ab	M. Wilder	Dr	70	3	P	Al	Cy,E	D	...	...	...	...	...	A
-21ab	W. Parker	Dr	84.5	4	P	Al	J,E	D	...	...	...	...	...	A
-22bb	R. Dundas	Du	27.5	24	M	Al	N	O	Tpf	.5	...	5.25	7- 6-49	
-22bd	......do	Dr	50	6	P	Al	J,E	D,S	...	...	...	...	...	A
-22ca	...	Sp	...	...	...	Tg(?)	...	...	...	...	...	...	...	Ca
-23bd	A. Doughty	Dr	31.2	6	P	Al	Cy,W	S,O	Tca	.9	4,060.08	3.27	5- 2-49	A
-23cc1	W. Spangler	Du	16.6	30	M	Al	N	N	Tpf	.2	4,069.92	3.15	6-29-49	
-23cc2	......do	Dr	42.2	4	P	Al	J,E	D,S	Tca	.7	4,070.41	3.97	6-29-49	A, Ca
-23cc3	......do	Dr	...	...	...	Al	...	...	...	...	...	...	...	
-24db	T. Williams	D	12.4	2	P	Al	N	O	Tca	5.3	4,007.84	6.78	6-28-49	
-25bb	T. McMullan	Du	6.9	12	P	Al	Cy,H	S	Tca	.2	4,021.12	3.22	7-22-49	A
-26ac1	A. Doughty	Dr	19.3	6	P	Al	Cy,H	D	Tpf	.6	4,045.99	2.27	6-29-49	A
-26ac2	......do	Du	9.4	30	M	Al	N	O	Tpf	.3	4,045.39	3.75	6-29-49	
-26cd	J. Miller	Du	14.8	36	M	Al	Cy,E	S,O	Tpf	2.5	4,049.42	11.01	5- 2-49	A
-27ac	V. Hensley	Du	45	36	M	Tg	J,E	D,S	...	...	...	...	...	A
-33ad	F. Slifka	Dr	90	6	P	Tg	J,E	D,S	...	...	...	...	...	A
-34aa	E. Kimpton	Dr	31.1	6	P	Al	Cy,E	S,O	...	.0	4,065.53	13.30	7- 7-49	A
-34ad1	C. Kimpton	Du	25	36	M	Al	Cy,E	S	...	...	...	15	...	A
-34ad2	......do	Dr	60	6	P	Al	J,E	D	...	...	...	15	...	A

-34bc	D. Williams..........	Du	78.1	48	M	Tg	J,E	D,S	Tpf	.5	4,124.28	62.15	7- 7-49	A
-35bd	W. Spangler..........	Dr	43	6	P	Al	J,E	S	....	....	....	....	....	A
-35ca	Standard School......	Dr	78.7	6	P	Tg	Cy,H	D,O	Tca	.2	4,049.36	8.60	5- 2-49	A,Ca
-35cd	N. Sherlock..........	Du	9.4	18	P	Al	N	O	Tca	.7	4,047.71	5.19	6-24-49	
-36ad	R. Dundas............	B	9.5	2	P	Al	....	O	Tca	2.0	3,984.04	6.38	8-26-49	
-36cc	U. S. Geol. Survey..	J	10.1	3/4	P	Al	N	N	Tca	2.8	4,025.39	4.64	8-29-50	
-36dc	......do..............	J	10.1	3/4	P	Al	N	N	Tca	2.0	4,013.89	7.41	8-29-50	
-36dd	......do..............	B	8.5	2	P	Al	N	O	Tca	1.0	3,998.32	3.48	8-26-49	
A5-2-2bb	D. Davis..............	Dr	....	6	P	Al	J,E	D	Tca	....	....	....	....	A
-2cb	O. Nielson............	Dr	65.5	6	P	Al	Cy,G	S	Tpf	-5.00	3,925.92	41.35	7-11-49	A
-3ac	......do..............	Dr	55	6	P	Al	J,E	D,S	....	....	....	....	....	A
-3da1	H. Wallace...........	Dr	45.4	6	P	Al	J,E	D,S	Tpf	.0	3,908.79	32.65	7- 7-49	A
-3da2	......do..............	Dr	40	6	P	Al	Cy	N	....	....	....	....	....	
-4db	......do..............	Dr	25.2	6	P	Al	Cy,H	D,S	Tca	1.0	3,879.08	7.65	7- 7-49	A,Ca
-5bd	....	Sp	....	....	....	....	....	....	....	....	....	....	....	
-8bd	A. Smith..............	Dr	36.4	6	P	Al	J,E	O	Tpf	.0	3,931.92	15.08	6-27-49	
-8ca	......do..............	Du	8	36	M	Al	J,E	D	....	....	....	....	....	A
-8cc	School dist. 31.......	Dr	35.1	6	P	Al	Cy,H	O	Tca	.5	3,940.96	16.91	6-27-49	
-9ca	E. Spatzierath........	Dr	37.1	6	P	Al	Cy,H	S	Tca	.8	....	13.85	8- 1-49	A
-10ad	C. Flynn..............	DD	61.2	30	M	Al	J,E	D,S,O	Tpf	.5	3,921.44	41.42	7- 7-49	A
-10da	E. Spatzierath........	Dr	50	6	P	Al	Cy,E	D	....	....	....	....	....	A
-11bc	C. Flynn..............	Dr	55	6	P	Al	Cy,E	D,S	....	....	....	....	....	A
-14dd	J. Grieves............	Dr	....	6	P	Al	Cy,H	O	Tpf	1.0	3,957.92	69.40	4-30-49	N
-15ac	W. Berberet..........	Du	40	30	M	Al	J,E	D,S	Tca	.0	3,909.72	23.50	7- 7-49	A
-15da1	W. Clark..............	Du	18.3	36	M	Al	Cy,W	S,O	Tpf	1.0	3,899.77	11.43	7- 7-49	A
-15da2	......do..............	Dr	40	6	P	Al	J,E	S	....	....	....	....	....	A
-15da3	......do..............	Dr	40	6	P	Al	J,E	D	....	....	....	....	....	A
-16db	L. Smith..............	Du	14.3	16	P	Al	J,E	S,O	Tca	1.8	3,892.79	8.75	6-28-49	A
-19ad1	T. McMullan..........	Du	10.9	30	P	Al	Cy,H	S,O	Tpf	.7	3,950.87	4.57	5- 2-49	
-19ad2	......do..............	Dr	25.7	6	P	Al	C,G	S	Tpf	.5	3,949.33	7.10	5- 2-49	
-19da	A. Booher............	Du	9.6	24	M	Al	Cy,H	S	Tpf	.5	3,954.10	2.31	6-27-49	A
-20bc1	A. Doughty...........	Du	10.1	30	M	Al	Cy,H	O	Tpf	.6	3,944.48	4.96	6-27-49	
-20bc2	......do..............	Dr	42	6	P	Al	J,E	D,S	....	....	....	....	....	A
-20db1	F. Jurries............	Du	10.35	30	W	Al	Cy,W	S,O	Tpf	.8	3,936.15	4.57	5- 2-49	A

Table 5.—*Record of wells and springs*—Continued

Well no.	Owner or tenant	Type of well	Depth of well (feet)	Diameter of well (inches)	Type of casing	Geologic source	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below(-) land surface (feet)	Measuring point: Height above mean sea level (feet)	Depth to water level below measuring point (feet)	Date of measurement	Remarks
A5-2-20db2	F. Jurries	Du	8.2	36	M	Al	Cy,H	D	Tpf	0.2	3,936.03	6.94	7-11-49	A
-20db3	......do	D	12	2	P	Al	P,H	D						A
-21ad	G. Sanderson	Dr	16.2	6	P	Al	PP,E	D,S,O	Tca	-6.0	3,909.83	7.04	5- 2-49	A, Ca
-21bc	A. Jarosh	Du	8.5	36	M	Al	C,G	S,O	Tpf	.8	3,918.99	5.00	5- 2-49	A
-21bd	U. S. Geol. Survey	J	13.8	3/4	P	Al	N	N	Tca	1.8	3,920.07	7.84	8-29-50	
-21da	......do	J	12.5	3/4	P	Al	N	N	Tca	2.0	3,918.33	11.77	8-29-50	
-22ad	G. Sanderson	Du	28.2	24	M	Al	Cy,H	D,O	Tpf	.9	3,911.41	21.53	5- 2-49	A
-22bb	U. S. Geol. Survey	J	10.7	3/4	P	Al	N	O	Tca	2.2	3,908.09	Dry	8-29-50	
-22bd	E. Spatzierath	Dr	40	4	P	Al	Cy,G	S						A
-22db	U. S. Geol. Survey	J	13.1	3/4	P	Al	N	O	Tca	2.6	3,911.25	Dry	8-29-50	
-23bd	H. Hargrove	Dr	30	4	P	Al	J,E	D						A
-23ca1	N. P. Railway	Dr	21.3	4	P	Al	Cy,H	D	Tca	.6	3,910.82	13.88	7- 8-49	A
-23ca2	E. Talbert	Dr	47.3	6	P	Al	Cy,H	D	Tpf	.2	3,914.78	18.25	6-30-49	A
-23ca3	H. Clack	Du	25.4	40	W	Al	PP	In,O	Tpf	.8	3,912.88	16.50	6-30-49	A
-23ca4	G. Cole	Dr	28.4	8	P	Al	C,E	D	Tpf	.7	3,912.99	17.10	6-30-49	A, Ca
-23ca5	A. Chubbuck	Du	12	24	M	Al	P,H	D,S	Tpf	.1	3,906.27	7.56	6-27-49	A
-23ca6	......do	Dr	26.1	6	P	Al	N	O	Tpf	.3	3,914.23	16.96	6-27-49	
-23cb	N. Lorentz	Du		14	P	Al	Cy,H	S						I
-23db	Toston Grade School	Dr	50.1	4	P	Al	Cy,H	D	Tpf	.5	3,935.85	37.65	7- 1-49	A
-23dc1	B. Quinn	Dr	50	6	P	Al	Cy,H	D,S,O	Tpf	.5	3,929.50	30.65	7- 1-49	A
-23dc2	E. Johnson	Du	43.1	24	M	Al	Cy,E	D,S	Tpf	.4	3,933.84	34.00	7- 1-49	A
-23dc3	H. Johnson	Du					J,E	D						
-26ac	R. Johnson	Du	26.6	24	M	Al	PP,E	D,O	Tpf	.0	3,922.74	17.20	7- 1-49	A
-26bd	A. Jarosh	Du	22.2	42	W	Al	Cy,H	D,S	Tpf	.5	3,922.38	16.20	6-28-49	A
-26ca1	A. Jersey	Dr	77.5	4	P	Al	Cy,H	D	Tca	1.0	3,915.41	8.90	7- 1-49	A
-26ca2	......do	Dr	91	6	P	Al	J,E	D						A
-26ca3	......do	Du	21.2	36	W	Al	Cy,H	O	Tpf	.0	3,915.48	8.75	7- 1-49	

-27ad	U. S. Geol. Survey..	J	12.1	3/4	P	Al	N	N	Tca	1.8	3,903.04	10.39	8-30-50	
-27bb1	E. Spatzierath.........	Dr	35.2	6	P	Al	Cy,H	S	Tca	.8	3,916.67	6.45	6-28-49	A
-27bb2	U. S. Geol. Survey..	J	12.6	3/4	P	Al	N	N	Tca	1.7	3,920.21	1.16	8-29-50	
-27bb3	......do..................	J	6.1	3/4	P	Al	N	N	Tca	1.6	3,918.54	1.06	8-29-50	
-27bb4	......do..................	J	8.7	3/4	P	Al	N	N	Tca	1.8	3,920.05	3.86	8-29-50	
-27bc	......do..................	B	4.5	2	P	Al	N	O	Tca	2.0	3,920.18	2.40	8-26-49	
-27cc	......do..................	J	23.3	3/4	P	Tg	N	N	Tca	2.0	3,964.58	Dry	8-29-50	
-27dd	......do..................	J	19.8	3/4	P	Tg	N	N	Tca	1.0	3,965.46	Dry	8-30-50	
-28ad	J. Jarosh................	Du	19.1	48	M	Tg	N	N	....	....	....	Dry	....	
-28cd	G. Rauser...............	Dr	62.3	6	P	Tg	Cy,H	D	Tca	.8	3,959.36	21.75	5- 3-49	A, Ca
-29bc	Hansen & Miller......	Du	9.1	8	P	Al	P,H	O	Tca	1.8	3,953.65	5.83	5- 3-49	
-29cc1	......do..................	Dn	20.2	1¼	P	Al	P,H	D,O	Tca	2.3	3,959.31	8.87	5- 3-49	A
-29cc2	U. S. Geol. Survey..	J	17.5	3/4	P	Al	N	N	Tca	2.2	3,960.05	6.55	8-29-50	
-29dd	......do..................	J	16.7	3/4	P	Al	N	O	Tca	2.0	3,952.96	6.78	8-29-50	
-30bc1	T. McMullan..........	Du	8.3	30	W	Al	N	N	Tpf	1.8	3,980.48	4.09	5- 3-49	
-30bc2	......do..................	Dr	36.2	6	P	Al	N	N	Tca	1.0	3,982.81	4.10	7-28-49	
-31bd	E. Kimpton............	Dr	75	4	P	Tg	F,P,H	D,S	....	....	....	....	7-29-49	Ca
-31cc	U. S. Geol. Survey..	J	24.4	3/4	P	Al	N	N	Tca	2.0	3,998.95	2.97	8-29-50	
-31cd	J. Gruber...............	Dr	15.6	6	P	Al	Cy,H	O	Tpf	2.0	3,993.12	8.10	7-29-49	
-31da	U. S. Geol. Survey..	J	17.9	3/4	P	Al	N	N	Tca	2.0	3,972.65	6.48	8-29-50	
-32aa	......do..................	B	11.2	2	P	Al	N	O	Tca	1.9	3,954.15	8.55	8-26-49	
-32ab	......do..................	B	6.9	2	P	Al	N	O	Tca	1.9	3,953.52	5.76	8-26-49	
-32bc1	Hansen & Miller......	Dr	100	6	P	Al	Cy,H	N	Tpf	.2	3,968.46	4.82	6-28-49	
-32bc2	......do..................	Dr	100	6	P	Al	J,E	D,S	....	....	....	....	6-28-49	A
-32cd	U. S. Geol. Survey..	J	17.4	3/4	P	Al	N	O	Tca	2.0	3,974.35	7.13	8-29-50	
-32dc	......do..................	B	8.8	2	P	Al	N	O	Tca	2.0	3,974.68	7.70	8-26-49	
-32dd1	G. Rauser...............	Du	13.5	30	M	Al	N	O	Tpf	.4	3,976.96	10.98	5- 3-49	
-32dd2	U. S. Geol. Survey..	J	24.2	3/4	P	Al	N	N	Tca	2.4	3,971.46	5.59	8-29-50	
-33aa	R. Barringer...........	Dr	15.4	5	P	Tg	N	N	Tca	.2	3,966.09	Dry	8-29-50	
-33ab	U. S. Geol. Survey..	J	20.9	3/4	P	Tg	N	N	Tca	1.8	3,962.46	19.24	8-29-50	
-33ac	......do..................	J	46.1	3/4	P	Tg	N	N	Tca	1.0	3,992.46	45.3	8-30-50	
-33bb1	R. Barringer...........	Du	23.5	36	W	Tg	Cy,E	S,O	Tpf	1.5	3,965.45	15.82	7-11-49	A
-33bb2	......do..................	Dr	40	6	P	Tg	J,E	D	....	....	....	....	7-11-49	A
-33cb	U. S. Geol. Survey..	J	22.6	3/4	P	Al(?)	N	N	Tca	2.4	3,967.26	12.24	8-29-50	
-34ba	......do..................	J	22.9	3/4	P	Tg	N	N	Tca	1.0	3,975.95	Dry	8-30-50	
-35ba	......do..................	J	10.2	3/4	P	Tg	N	N	Tca	2.3	3,942.32	Dry	8-30-50	

Table 5.—*Record of wells and springs*—Continued

Well no.	Owner or tenant	Type of well	Depth of well (feet)	Diameter of well (inches)	Type of casing	Geologic source	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below(-) land surface (feet)	Measuring point: Height above mean sea level (feet)	Depth to water level below measuring point (feet)	Date of measurement	Remarks
A5-3-6aa	Chris Miller	Dr	96	6	P	Tg	Cy,G	S				60	5-22-50	
A6-2-2aa	Jake Mitchell	Dn	16	1¼	P	Al	P,H	D				8	5-22-50	
-2ca	Edward Heuer	Dr	78	4	P	Tg	J,E	D,S				6	5-23-50	Ca
-2db	do	Dr	164.2	12	P	Tg	J,T	I	Tca	1.3	4,006.16	6.22	8- 1-50	
-3dd1	George Ridgeway	Dr	82	4	P	Tg	J,E	D,S				20	5-23-50	
-4ac	U. S. Soil Cons. Service	Dr	5.6	1	P	Al		O	Tca	3.0	3,849.66	3.90	8- 8-49	O
-4bc	do	Dr	13.1	1	P	Al			Tca	2.0	3,844.06	5.20	8- 9-49	O
-4bd	do	Dr	6.1	1	P	Al			Tca	3.8	3,850.36	5.40	8- 8-49	O
-4cd1	do	Dr	16.1	1	P	Al		O	Tca	2.3	3,854.76	4.14	8- 9-49	O
-4cd2	do	Dr	20	1	P	Al			Tca	.2	3,857.61	1.54	8- 8-49	O
-4db	do	Dr	6.4	1	P	Al		O	Tca	2.6	3,855.56	4.02	8- 8-49	O
-5ba	do	Dr	7.3	1	P	Al			Tca	2.4	3,831.76	4.35	8- 9-49	O
-5bb1	do	Dr	6.6	1	P	Al		O	Tca	1.8	3,831.76	3.50	8- 9-49	O
-5bb2	do	Dr	9.2	1	P	Al		O	Tca	2.5	3,831.96	7.50	8- 9-49	O
-5bb3	do	Dr	9.6	1	P	Al		O	Tca	1.4	3,827.96	5.13	8- 9-49	O
-5cc	C. Ragen	Du	7.5	36	W	Al	N	O	Tpf	.8	3,834.75	3.64	8- 3-49	
-5da		Dr	6.5	3	P	Al			Tca	1.8	3,849.96	3.44	8- 8-49	O
-6cd1	L. Soleni	D	12	1.25	P	Al	P,H	S						A
-6cd2	do	D	22	1.25	P	Al	P,H	D						A
-8ab1	R. Wallace	Du	15.2	36	M	Al	Cy, W	S,O	Tpf	.5	3,851.85	7.05	7-15-49	A
-8ab2	do	Du	20	36	M	Al	PP,E	D						A
-8ba	do	Dr	19.1	1	P	Al		O	Tca	2.4	3,845.96	4.08	8- 8-49	A
-8db	C. Ragen	Du	10.3	36	M	Al	Cy,H	S,O	Tpf	.6	3,848.16	4.72	7-15-49	A
-9ba1	N. Bruce	Du	18.1	36	M	Al	N	N	Tpf	.0	3,866.84	8.22	7-15-49	
-9ba2	do	Dr	100	4	P	Al	Cy,E	S	Tpf	.0	3,866.84	8.20	7-15-49	A
-9ba3	do	Dr	8.4	1	P	Al		O	Tca	.9	3,861.76	3.87	8- 8-49	O
-9bb1	do	Dr	9.4	3	P	Al		O	Tca	1.5	3,859.06	8.60	8- 8-49	O

-9bb2	......do......	Dr	16.1	1	P	Al	......	O	Tca	2.0	3,856.06	9.22	8- 8-49	O
-9bc	E. Grimm......	D	30	1.25	P	Al	Cy,E	S	Tpf	.0	3,861.79	4.45	7-14-49	A
-9cb	A. Arnett......	DD	13.7	2	P	Al	Cy,N	N	Tpf	.8	3,866.30	9.95	7-14-49	
-9cc	P. Carson......	D	40	2	P	Al	Cy,H	N	Tpf	.0	3,864.50	9.10	7-14-49	
-9cd	Miller-Post......	D	20	1.25	P	Al	Cy,E	D,S	......	......	......	......	......	A
-9dd1	C. Miller......	Du	36.9	72	M	Al	J,E	D,S,O	Tpf	.5	3,886.54	18.35	7-14-49	Ca
-9dd2	......do......	Dr	78.2	6	P	Al	N	In	Tca	1.0	3,884.86	20.33	5-22-50	Ca
-10ba	William Prosser......	Dr	81	4	P	Tg(?)	J,E	D,S	......	......	......	60	5-23-50	
-11bb	John Zubrick......	Dr	87	6	P	Tg(?)	J,E	D,S	......	......	......	65	5-23-50	
-12aa	Jake Mitchell......	Dr	122.5	4	P	Tg	Cy,H	S	Tca	.0	......	90.55	5-25-50	
-14ca	F. Flynn......	Dr	88.5	4	P	Al	Cy,E	D	Tpf	.5	3,973.92	63.20	7-13-49	A
-14cc	......do......	Dr	75	6	P	Al	J,E	D	......	......	......	......	......	A
-15bb	W. Vennekolt......	Dr	99	6	P	Al	J,E	D,S	......	......	......	......	......	A
-15dc	Dean-Shelly......	Dr	57.1	4	P	Al	Cy,E	D	Tpf	.50	3,932.97	21.75	7-13-49	A
-16aa	W. Vennekolt......	Dr	60.2	4	P	Al	Cy,H	O	Tca	3.0	3,884.16	18.62	7-14-49	
-16bb	F. Grimms......	D	......	......	......	......	......	......	......	......	......	......	......	
-16cd	L. Holden......	Dr	80	6	P	Al	J,E	D,S	......	......	......	......	......	A
-16db	R. Moudree......	Dr	20.3	1.5	P	Al	N	O	Tcu	1.20	3,857.07	11.35	7-14-49	
-17ad	......	Dr	20.4	1.25	P	Al	P,H	D	Tca	2.30	3,853.62	12.60	8-11-49	A
-21ab	R. Moudree......	Dr	41.2	6	P	Al	J,E	D,S	Tca	.0	3,864.72	12.80	6-28-49	A
-22ab	Dean-Shelly......	Dr	40.7	4	P	Al	Cy,H	D,S,O	Tpf	1.5	3,917.56	20.90	7-13-49	A
-22bb1	J. Welch......	Du	33.8	36	M	Al	Cy,H	O	Tpf	.5	3,884.98	23.65	7-13-49	
-22bb2	......do......	Dr	......	6	P	Al	J,E	D,S	......	......	......	......	......	A
-26cb	O. Nielson......	Dr	68	6	P	Al	J,E	D	Tpf	.0	3,934.00	51.20	7-12-49	A
-27bb1	R. Salisbury......	Du	16.3	48	M	Al	Cy,H	D,O	Tpf	.5	3,872.26	11.14	7-13-49	A
-27bb2	......do......	DD	......	2	P	Al	Cy,E	S	......	......	......	......	......	A
-27cc	C. Kracaw......	Dr	35.1	4	P	Tg	Cy,H	D,S,O	Tpf	.5	3,885.18	23.04	7-12-49	A,Ca
-28aa1	G. Deering......	D	18	1.25	P	Al	PP,E	D	......	......	......	......	......	A
-28aa2	......do......	D	18	2	P	Al	PP,E	S	......	......	......	......	......	A
-34ad1	C. Kracaw......	Du	52.2	36	M	Al	N	O	Tpf	.8	3,916.52	43.65	7-12-49	A
-34ad2	......do......	Dr	......	......	......	Al	J,E	......	......	......	......	......	......	A
-34ca1	D. Davis......	Dr	25.1	4	P	Al	Cy,E	S	Tpf	3.5	3,882.69	17.93	7-13-49	A
-34ca2	......do......	Dr	28.3	8	P	Al	Cy,H	D	Tpf	.8	3,883.42	16.65	7-13-49	A
-34cd	H. Doggett......	Du	12.3	48	W	Al	Cy,G	S,O	Tpf	.6	3,874.65	7.42	5-30-49	A
-34dc	D. Davis......	Dr	49	4	P	Al	N	O	Tca	.1	3,908.99	39.60	5-30-49	
-34dd	......do......	Dr	67.2	6	P	Al	Cy,E	S,O	Tpf	.0	3,926.49	55.30	5-30-49	A

Table 5.—*Record of wells and springs*—Continued

Well no.	Owner or tenant	Type of well	Depth of well (feet)	Diameter of well (inches)	Type of casing	Geologic source	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below(-) land surface (feet)	Measuring point: Height above mean sea level (feet)	Depth to water level below measuring point (feet)	Date of measurement	Remarks
A6-3-4ac	Clopton	Dr	300 +	5	P	Tg	Cy,H	N	Tca	1.0	4,628.17	288.75	5-31-50	
-4bc	do	Dr	210	4	P	Tg	Cy,W	D,S			4,523.92	180	5-31-50	
-5dd	Fred Williams	Dr	182.2	6	P	Tg	Cy,G	S	Tca	.50	4,497.83	158.45	5-31-50	
-8ad	Donald Shearer	Dr	163.2	6	P	Tg	N	N	Tca	.80	4,470	146.02	5-31-50	
-9bb	Fred Williams	Dr	162.3	5	P	Tg	N	N	Tca	1.0	4,503.38		5-31-50	
-17da	Don Shearer	Dr	43	5	P	Tg	P,H	D,S				8	5-29-50	
-32dd	Chris Miller	Dr	186.5	4	P	Tg	Cy,N	S	Tpf	1.60		87.87	5-22-50	
-34ac	do	Dr	120	4	P	Tg	Cy,G	D,S				90	5-22-50	
A7-1-23ba		Sp												Ca
-24dd1	R. Brenner	D	15.8	1.25	P	Al	N	N	Tca	.5	3,807.02	5.78	8- 3-49	
-24dd2	do	Du	12.1	48 x 72	W	Al	Cy,E	O	Tpf	1.0	3,807.66	6.30	8- 3-49	
-24dd3	do	Dr	30	6	P.	Al	J,E	D						A
-25ad	F. Campbell	Du	21.1	48	M	Tg	Cy,H	D,S,O	Tpf	.2	3,869.70	15.50	9-30-49	A
A7-2-2bb		Sp					J							Ca
-2bd	Harold Marks	Dr	117	5	P		E	D				12	6-21-50	Ca
-2ca	Sewell Marks	Sp					HR	D						
-3ad	Vance Pope	Dr	91	6	P	Al	J,E	D				73	6-21-50	
-3bc1	Henry Meyer	Dr	60	5	P	Al	J,E	D				36	6-23-50	
-3bc2	do	Dr	60	5	P	Al	J,E	S				36	6-23-50	
-3cb	Pat Van Meter	Dr	53	4	P	Al	J,E	D				39	6-26-50	
-4aa	U. S. Bur. of Reclamation	Dr	19.1	2	P	Al	N	O	Tca	.9	3,814.6	16.32	8- 9-50	
-4ab	do	Dr	10.8	2	P	Al	N	N	Tca	.9	3,803.1	Dry	8- 9-50	
-4ad1	do	Dr	19.6	2	P	Al	N	N	Tca	.8	3,814.2	Dry	8- 9-50	
-4ad2	do	Dr	21.9	2	P	Al	N	N	Tca	.8	3,802.1	Dry	8- 9-50	
-4ba1	A. Johnson	Dn	22.7	1¼	P	Al	P,H	D,O	Tca	1.8	3,796.27	11.77	6-26-50	
-4ba2	do	Dr	24	4	P	Al	J,E	D				10	6-26-50	
-4ba3	do	Dr	23.6	6	P	Al	Cy,E	S	Bco	.8	3,793.61	10.47	6-26-50	

-4ba4	......do......	Du	14.2	11	W	Al	N	N	Tca	.4	3,792.04	9.41	6-26-50
-4cd1	William Sullivan......	Du	37	54	P	Al	Cy,E	S	Tpf	.4	3,802.25	19.48	6-16-50
-4cd2	......do......	Dr	30	6	P	Al	J,E	D	......	......	......	20	6-16-50
-4db	U. S. Bur. of Reclamation......	Dr	10.9	2	P	Al	N	N	Tca	.6	3,801.9	9.87	8- 9-50
-4dd1	Phillip Whaley......	Du	65	4	P	Al	Cy,N	N	Tpf	.4	3,820.32	36.46	6-15-50
-4dd2	......do......	Dr	70	4	P	Al	J,E	D,S	......	......	......	40	6-16-50
-4dd3	U. S. Bur. of Reclamation......	Dr	26	2	P	Al	N	N	Tca	.8	3,820.8	25.74	8- 9-50
-5ab1	Richard Gill......	Du	14	30	M	Al	N	O	Tco	1.0	3,782.51	4.35	6-19-50
-5ab2	......do......	Dn	21	1 ¼	P	Al	PP,E	D	......	......	......	6	6-19-50
-5ab3	......do......	Dn	21	1 ¼	P	Al	C,G	S	......	......	......	6	6-19-50
-5bd1	John Plymale......	Dr	22.7	6	P	Al	PP,G	S,O	Tpc	.8	3,781.91	2.71	6-26-50
-5bd2	......do......	Dn	28	1 ¼	P	Al	PP,E	D	......	......	......	3	6-26-50
-5bd3	......do......	Dn	28	1 ¼	P	Al	P,H	S	......	......	......	3	6-26-50
-5bd4	......do......	Dn	22	1 ¼	P	Al	P,H	D	......	......	......	3	6-26-50
-5cd1	Ed Nield......	Du	12.2	40	M	Al	Cy,G	S	Tpf	.4	3,784.71	3.61	6-15-50
-5cd2	......do......	Dn	15	1 ¼	P	Al	J,E	D	......	......	......	6	6-15-50
-5dc1	Mary Gill......	Du	13.5	72	M	Al	Cy,E	S,O	Tpf	.5	3,786.01	9.82	6- 2-50
-5dc2	......do......	Dn	18	1 ¼	P	Al	P,H	D	......	......	......	10	6- 2-50
-6da1	H. J. Schreiner......	Dn	28	1 ¼	P	Al	PP,E	D	......	......	......	2	6-27-50
-6da2	......do......	Dn	14	1 ¼	P	Al	Cy,E	S	......	......	......	2	6-27-50
-8aa	R. Blakely......	Dn	21.4	1 ¼	P	Al	P,H	D	Tp	3.40	3,791.59	17.04	6- 2-50
-8ad1	Jerome Merritt......	Du	16.5	14	P	Al	Cy,G	S	Tpf	.50	3,788.66	11.22	6- 2-50
-8ad2	......do......	Dn	18	1 ¼	P	Al	P,H	D	......	......	......	12	6- 2-50
-8ad3	......do......	Dn	20	1 ¼	P	Al	J,E	D	......	......	......	12	5- 2-50
-8cd1	Phillip Merritt......	Dr	23.4	4	P	Al	C,E	S	Tca	.6	3,791.99	11.13	5-22-50
-8cd2	......do......	Dn	25	1 ¼	P	Al	J,E	D	......	......	......	12	5-22-50
-8dd	Margaret Olsen......	Dn	20	1 ¼	P	Al	P,H	D	......	......	......	10	6-15-50
-9aa	J. W. Merritt......	Dr	48	4	P	Al	J,E	D,S	......	......	......	25	6-16-50
-9ab	U. S. Bur. of Reclamation......	Dr	14.5	2	P	Al	N	O	Tca	.5	3,809.4	13.54	8- 9-50
-9ac1	George Snell......	Dr	50.1	4	P	Al	J,E	D,S	Tco	.0	3,810.67	27.15	6-16-50
-9ac2	U. S. Bur. of Reclamation......	Dr	12	2	P	Al	N	O	Tca	.0	3,806.9	Dry	8- 9-50
-9ba1	Robert Blakely......	Dr	20	6	P	Al	J,E	D	......	......	......	15	6-15-50
-9ba2	......do......	Dn	20	1 ¼	P	Al	Cy,E	S	......	......	......	15	6-15-50

Table 5.—*Record of wells and springs*—Continued

Well no.	Owner or tenant	Type of well	Depth of well (feet)	Diameter of well (inches)	Type of casing	Geologic source	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below(-) land surface (feet)	Measuring point: Height above mean sea level (feet)	Depth to water level below measuring point (feet)	Date of measurement	Remarks
A7-2-9ba3	U. S. Bur. of Reclamation	Dr	10.9	2	P	Al	N	O	Tca		3,803.3	10.06	8- 9-50	
-9ca	......do	Dr	10.8	2	P	Al	N	N	Tca	0.6	3,802.7	Dry	8- 9-50	
-9cc1	Riley Estate	Dr	51.2	4	P	Al	J,E	D	L	.0	3,810.17	29.06	6- 1-50	
-9cc2	......do	Du	40	48	P	Al	Cy,E	S				30	6- 1-50	
-9cc3	U. S. Bur. of Reclamation	Dr	18	2	P	Al	N	N	Tca	.8	3,813.2	Dry	8- 9-50	
-9cd	......do	Dr	17.3	2	P	Al	N	N	Tca	.0	3,812.2	Dry	8- 9-50	
-9da	W. Glenn Kirscher	Dr	68	4	P	Al	J,E	D,S				50	6- 1-50	
-9db	U. S. Bur. of Reclamation	Dr	18.6	2	P	Al	N	N	Tca	.7	3,810.2	Dry	8- 9-50	
-10ad	William Biber	Dr	119	4½	P	Tg(?)	J,E	D,S				60	6-16-50	
-10bb	W. Glenn Kirscher	Dr	62.5	6	P		Cy,H	D,O	Tca	.5	3,824.37	40.65	6-16-50	Ca
-10bd	......do	Dr	105	4	P	Tg(?)	J,E	D,S				50	6-16-50	
-10cc	William Gaab	Dr	81.4	4	P	Tg(?)	Cy,E	D	Tca	.8	3,848.84	67.81	6- 1-50	
-10da	Mike Massa	Dr	118	6	P	Tg(?)	J,E	D,S				75	6-16-50	
-15cb	Samuel Kirksy	Dr	120	4	P	Tg(?)	Cy,E	D				95	6- 1-50	
-15cc	T. Watkins	Dr	115	6	P	Al(?)	J,E	D	Tca	-6.0	3,874.25	71.40	10- 4-49	A
-16ba	P. G. Kinney	Dr	50	4	P	Al	J,E	D,S				25	6- 1-50	
-16bb	U. S. Bur. of Reclamation	Dr	17.9	2	P	Al	N	N	Tca	.8	3,816.2	Dry	8- 9-50	
-16cc	E. Ragen	D	20	2	P	Al	Cy,H	S						A
-16cd	P. Ragen	Dr	40	6	P	Al	Cy,E	D,S						A
-17aa	U. S. Bur. of Reclamation	Dr	10.9	2	P	Al	N	O	Tca	.9	3,802.6	10.16	8- 9-50	
-17ab1	Harold Manly	Dr	46.0	6	P	Al	J,E	D	Tca	-5.2	3,796.60	7.91	5-22-50	
-17ab2	......do	Dn	35	1½	P	Al	P,H	D				12	5-22-50	
-17ab3	......do	Dr	60	6	P	Al	Cy,E	S,O	Tpf	1.0	3,797.38	14.01	5-22-50	

-17bd	D. Sullivan	Dn	24.2	1¼	P				Tp	2.8	3,799.53	8.50	8-11-49	
-17cd1	......do	D	25	1¼	P	Al	P,H	D						A
-17cd2	U. S. Bur. of Reclamation	Dr	19	2	P	Al	N	O	Tca	-.7	3,804.2	7.41	8- 9-50	
-17da	....do	Dr	18	2	P	Al	N	N	Tca	1.0	3,812.8	Dry	8- 9-50	
-17db1	D. Sullivan	Du	12	48	W	Al	Cy,E	S,O	Tpf	.3	3,800.92	10.34	5-29-49	A
-17db2	......do	Du	17.5	36	W	Al	Cy,H	N	Tpf	.0	3,800.53	6.91	8- 4-49	
-17db3	U. S. Bur. of Reclamation	Dr	10.7	2	P	Al	N	N	Tca	1.0	3,801.9	8.83	8- 9-50	
-17dc	......do	Dr	10.9	2	P	Al	N	O	Tca	.9	3,806.1	10.39	8- 9-50	
-20ab1	J. E. Oberg	Dn	25	1¼	P	Al	J,E	D				12	6- 2-50	
-20ab2	......do	Dn	25	1¼	P	Al	Cy,E	S				12	6- 2-50	
-20ab3	U. S. Bur. of Reclamation	Dr	18.2	2	P	Al	N	O	Tca	.7	3,807.6	9.24	8- 9-50	
-20ac	......do	Dr	16.4	2	P	Al	N	O	Tca	.9	3,806.5	6.33	8- 9-50	
-20bc1	O. Billquist	Dn	19.5	1¼	P	Al	P,H	O	Tca	3.0	3,806.04	9.30	8- 4-49	
-20bc2	U. S. Bur. of Reclamation	Dr	14.2	2	P	Al	N	O	Tca	1.0	3,804.7	5.16	8- 9-50	
-20bb1	O. Billquist	Dn	20	1¼	P	Al	PP,E	D					8- 4-49	A
-20bb2	U. S. Bur. of Reclamation	Dr	17.9	2	P	Al	N	O	Tca	.8	3,807.5	6.33	8- 9-50	
-20cb	......do	Dr	17	2	P	Al	N	O	Tca	1.1	3,812.0	8.56	8- 9-50	
-20cd	Nick Helner	Dn	22	1¼	P	Al	Cy,E	D,S						A
-20dd	J. Fisher	Dr	50	6	P	Al	J,E							A
-21cc	R. Sullivan	Dr	28.2	6	P	Al	Cy,E	D,S,O	Tca	.0	3,819.63	10.30	8- 5-49	A
-22bb	Mark Moorman	Dr	156.5	6	P	Tg	J,E	D,S	Tca	-6.0	3,883.03	89.86	6-1-50	Ca
-22cb	Samuel Kirksy	Dr	165	6	P	Tg	J,E	D				85	6- 1-50	
-27cc	J. Sheets	Dr	140	6	P	Tg	J,E	D,S						A
-28ad	Mark Moorman	Dr	218	6	P	Tg	Cy,E	D				32	6- 1-50	
-28bc	L. Delger	Dr	35	4	P	Al	Cy,E	D						A
-29ab	U. S. Geol. Survey	B	13.7	2	P	Al	N	O	Tca	2.0	3,817.93	10.99	8-26-49	
-29bb1	......do	B	7.5	2	P	Al	N	O	Tca	1.2	3,807.49	4.68	8-26-49	
-29bb2	U. S. Bur. of Reclamation	Dr	18.9	2	P	Al	N	O	Tca	.9	3,813.8	7.53	8- 9-50	
-29bb3	......do	Dr	18.1	2	P	Al	N	N	Tca	1.0	3,813.4	8.54	8- 9-50	
-29ca1	J. Schiltz	Du	16.2	36	W	Al	Cy,E	S,O	Tpf	.5	3,820.12	7.43	8- 4-49	
-29ca2	......do	Dr	38	6	P	Al	J,E	D						A,Ca
-29cb	......do	Dn	16.8	1¼	P	Al	P,H	D	Tca	3.2	3,822.64	10.02	8- 4-49	A

Table 5.—*Record of wells and springs*—Continued

Well no.	Owner or tenant	Type of well	Depth of well (feet)	Diameter of well (inches)	Type of casing	Geologic source	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (-) land surface (feet)	Measuring point: Height above mean sea level (feet)	Depth to water level below measuring point (feet)	Date of measurement	Remarks
A7-2-29cc1	J. Strandley	Dn	15.1	1¼	P	Al	P,H	S	Tca	2.5	3,821.04	7.51	8- 4-49	A
-29cc2	James H. Linker	Dr	39	6	P	Al	J,E	D	Tca	-5.0	...	6.30	6- 2-50	
-30aa	U. S. Bur. of Reclamation	...	...	...	...	...	...	...	...	1.0	...	8.54	8- 9-50	
-30ac1	E. Ragen	Dr	38	6	P	Al	J,E	D	...	...	...	...	...	A
-30ac2	...do	Dn	40	1¼	P	Al	P,E	S	...	...	...	...	8- 4-49	A
-30ac3	L. Green	Dn	12.1	1¼	P	Al	N	O	Tca	2.0	3,810.93	6.20	8- 4-49	
-30ac4	U. S. Geol. Survey	B	7.9	1¼	P	Al	N	O	Tca	.6	...	5.72	9-30-49	
-30ac5	U. S. Bur. of Reclamation	Dr	16	2	P	Al	N	O	Tca	1.0	3,808.9	3.68	8- 9-50	
-30ad1	Rest Home	Dn	20.1	1¼	P	Al	P,H	D	Tca	2.8	3,814.18	5.95	8- 4-49	
-30ad2	U. S. Bur. of Reclamation	Dr	22	2	P	Al	N	O	Tca	.9	3,816.0	4.87	8- 9-50	
-30bd	...do	Dr	10.2	2	P	Al	N	O	Tca	1.0	3,810.2	4.55	8- 8-50	
-30cb	...do	Dr	10.9	2	P	Al	N	O	Tca	.8	3,811.7	5.3	8- 8-50	
-30da	E. Ragen	Dn	20	1¼	P	Al	J,E	D	...	...	...	...	...	A
-30dc1	U. S. Soil Cons. Serv.	Dr	6.1	1	P	Al	N	O	Tca	.0	3,813.6	3.12	8- 9-49	
-30dc2	...do	...	...	...	...	...	N	O	Tca	.0	...	4.15	8- 8-50	
-31aa	...	Dr	9.1	1	P	Al	N	N	Tca	1.8	3,819.36	6.55	8- 9-49	
-31ac1	U. S. Soil Cons. Serv.	Dr	8.5	1	P	Al	N	N	Tca	...	...	8.02	8- 8-50	
-31ac2	N. P. Railroad	Du	15.28	48 x 72	M	Al	C,E	In	Tpf	-4.53	...	5.32	7-10-50	
-31bb	U. S. Bur. of Reclamation	Dr	10.5	2	P	Al	N	O	Tca	1.0	3,815.6	5.05	8- 8-50	
-31bc	...do	Dr	10.5	2	P	Al	N	O	Tca	1.0	3,816.1	3.49	8- 8-50	
-31bd1	V. Doig	Du	8.4	48	M	Al	C,N	O	Tpf	.5	3,819.36	6.20	8- 3-49	
-31bd2	...do	D	20	1.25	P	Al	J,E	D	...	...	...	...	...	A

-31bd3	R. Mathis	D	25	3	P	Al	J,E	D	......	......	......	......	......	A
-31bd4	......do	Du	8.3	72	W	Al	C,G	I	Tpf	.5	......	6.70	8- 3-49	I
-31bd5	N. Doggett	D	30	1.25	P	Al	J,E	D	......	......	......	......	......	A
-31bd6	......do	Du	6.9	60	W	Al	N	N	Tpf	.3	......	Dry	8- 3-49	
-31bd7	S. Stenett	D	33	1.25	P	Al	P,H	D	......	......	......	......	......	A
-31bd8	......do	Dr	8.1	1.25	P	Al	......	O	Tca	.2	......	6.52	8- 3-49	O
-31cb	J. Mann	Du	10.1	48	W	Al	Cy,H	D,S,O	Tcu	.2	......	7.30	8- 3-49	A
-31cd	......do	......	......	......	......	......	PP	......	......	......	......	......	......	
-31db	John Gravely	Dn	20	1¼	P	Al	E	D	......	......	......	6	9- 3-50	Ca
-31dc	G. Reider	D	10.9	1.25	P	Al	P,H	D	Tca	1.0	3,824.08	8.80	8- 1-49	A
-31dd1	U. S. Soil Cons. Serv.	D	7.6	1	P	Al	......	O	Tca	2.2	3,823.66	4.75	8- 9-49	O
-31dd2	L. Green	Du	25	30	W	Al	Cy,W	S	Tpf	.5	3,824.27	6.00	8-12-49	A
-32ab	U. S. Soil Cons. Serv.	Dr	13.6	1	P	Al	......	O	Tca	2.6	3,827.36	6.72	8- 9-49	O
-32ba1	J. Standley	D	18.2	1.25	P	Al	P,H	N	Tca	2.6	3,826.52	8.60	8-10-49	
-32ba2	U. S. Soil Cons. Serv.	Dr	6.6	1	P	Al	......	O	Tca	1.9	3,821.96	4.20	8- 9-49	O
-32bb	......do	Dr	13.7	1	P	Al	P,H	O	Tca	3.4	3,822.18	8.63	8-10-49	O
-32ca	J. Standley	D	11.6	1.25	P	Al	P,H	N	Tca	2.3	3,825.58	6.75	8- 9-49	
-32cb	U. S. Soil Cons. Serv.	Dr	14.1	1	P	Al	N	O	Tca	.6	3,825.66	3.15	8- 9-49	O
-32cd	......do	Dr	15	1	P	......	N	N	Tca	......	......	4.55	5-17-50	
-32da	......do	Dr	10.1	3	P	Al	N	O	Tca	.0	3,828.16	5.30	9-23-49	O
-33cd1	E. Dawson	D	20	1.25	P	Al	P,H	S	Tca	2.1	3,841.80	2.60	8- 1-49	A,Ca
-33cd2	......do	Dr	6.9	1	P	Al	N	O	Tca	.5	3,841.86	.8	8- 9-49	O
-33cd3	......do	Dr	7.5	4	M	Al	N	N	Tca	.5	3,843.19	3.45	8- 1-49	
-36db	Esther Stroh	Dn	16.2	1¼	P	Al	P,H	D,S	Tvs	3.0	......	10.10	5-23-50	
A7-3-14ad1	E. Clark	Dr	84.3	6	P	Tg	Cy,H	N	Tca	.5	......	62.98	7-20-50	
-14ad2	......do	Du	47.4	54	M	Tg	Cy,H	N	Tco	.3	......	32.48	7-20-50	
-14bd1	John Walters	Du	24.8	50	M	Tg	Cy,H	D	L	.0	......	10.5	7-20-50	
-14bd2	......do	Du	25	54	M	Tg	Cy,H	S	......	......	......	12	7-20-50	
-14bd3	......do	Du	25	54	M	Tg	Cy,G	I	......	......	......	10	7-20-50	
-14dd	Klopton	Dr	91.8	6	P	Tg	Cy,H	N	Tca	.5	......	81.28	7-20-50	
-15dd1	Emery Clark	Du	13.3	56	M	Tg	Cy,G	I	Tco	.4	......	8.58	7-20-50	
-15dd2	......do	Dn	20	1¼	P	Tg	Cy,E	D	......	......	......	9	7-20-50	
-24ab	Herbert Hoppe	Dr	130	5	P	Tg	Cy,E	D,S	......	......	......	116	7-20-50	

Table 5.—*Record of wells and springs*—Continued

Well no.	Owner or tenant	Type of well	Depth of well (feet)	Diameter of well (inches)	Type of casing	Geologic source	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below(-) land surface (feet)	Measuring point: Height above mean sea level (feet)	Depth to water level below measuring point (feet)	Date of measurement	Remarks
A7-3-28cc	School District	Dr	51.8	4	P	Tg	Cy,H	N	Tca	1.0	....	36.55	5-25-50	
-28db	A. L. Ballard	Dr	153.1	4	P	Tg	N	N	Tca	1.0	....	64.97	5-25-50	
-28dc	L. Kickbush	Dn	15.5	1¼	P	Al	P,H	N	Tp	3.4	....	13.95	5-25-50	
-29cc	Edward Jacobson	Du	24	24	P	Al	PP,E	D	....	....	....	20	5-24-50	
-31bb1	W. T. Thompson Est.	Du	10.5	36	M	Al	N	N	Tpf	.20	....	6.44	5-24-50	
-31bb2	......do	Dn	23	1¼	P	Al	J,E	D	....	....	....	7	5-23-50	
-31bb3	......do	Dn	21	1¼	P	Al	P,H	S	....	....	....	6	5-24-50	
-32aa1	W. B. Ward	Dn	15	1¼	P	Al	PP,E	D,S	....	....	....	8	5-24-50	
-32aa2	......do	Dn	15	1¼	P	Al	P,H	S	....	....	....	8	5-24-50	
-33ba	A. L. Ballard	Dr	46	4	P	TG	P,H	D	....	....	....	20	5-25-50	
-34ba	L. Kickbush	Dn	15	1¼	P	Al	P,H	D	....	....	....	5	5-25-50	
A8-1-6bc1	Art Diehl	Du	19.7	54	M	Al	Cy,G	S	Tco	1.6	4,326.94	9.96	7-27-50	
-6bc2	......do	Du	40	48	M	Al	Cy,H,W	D	....	....	....	10	7-27-50	
-6bc3	......do	Du	16.3	48	M	Al	Cy,H	S	Tco	.4	4,318.68	8.11	7-27-50	
-6cb1	Bert Lanning	Du	16	56	M	Tg	PP,E	D	....	....	....	8	7-25-50	
-6cb2	Hugh Rogers	Du	10.5	48	M	Tg	N	N	Tco	.0	4,360.98	7.31	7-25-50	
-6cb3	Bill Diehl	Du	18.5	60	M	Tg	Cy,H	D	....	....	....	7	7-27-50	
-6cb4	Adam Stabler	Du	16	48	M	Tg	Cy,H	D	....	....	....	10	7-25-50	
-6cb5	Ray Reynolds	Du	6.2	54	M	Tg	N	N	Tco	.2	4,352.88	5.7	7-25-50	
-6cb6	Bill Johannsen	Du	16	56	W	Tg	Cy,H	D	....	....	....	10	7-25-50	
-6cb7	Harry Smith	Du	80	56	M	Tg	Cy,H	D	....	....	....	9	7-25-50	
-6cb8	Bill Diehl	Du	12	60	M	Tg	PP,E	D	....	....	....	8	7-25-50	
-6cb9	......do	Du	18.4	54	M	Tg	N,H	S	Tco	.0	4,358.32	7.02	7-25-50	
-6cb10	N. P. Railroad	Du	16	54	M	Tg	N	N	....	....	....	8	7-25-50	
-6cb11	H. M. Carmichael	Du	18	54	M	Tg	PP,E	D	....	....	....	6	7-26-50	
-6cb12	Ray Reynolds	Du	18.5	60	M	Tg	PP,E	D	....	....	....	6	7-25-50	
-6cb13	Leslie Miles	Du	22	54	M	Tg	Cy,H	D	....	....	....	6	7-25-50	

-6cb14	S. Grudisher	Du	29.8	56	M	Tg	Cy,H	D	Tpf	.4	4,367.72	5.27	7-26-50	
-6cb15	W. W. Harrington	Du	30	60	M	Tg	Cy,H	D				14	7-26-50	
-6cb16	J. Meyer	Du	16	54	M	Tg	Cy,H	D				8	7-26-50	
-6cb17	C. E. Prince	Du	50±			Tg		D						Ca
-6cc1	Bill Diehl	Du	25.9	50	M	Tg	N	S	Tpf	.5	4,375.81	5.78	7-27-50	
-6cc2	Winston School	Dr	80	6	P	Tg	Cy,H	D				15	7-26-50	Ca
-18ca	Guxley	Du	61.4	50	M	Tg	N	N	Tco	1.8	4,409.31	51.24	7-26-50	
-21ba		Sp				Tg	Cy							
-21bd		Sp				Tg								
-28ad		Sp				Tg								
A8-2-3dc1	Bert Plymale	Du	44.2	54	M	Tg		O	Tpf	1.0	4,056.78	27.49	7- 5-50	
-3dc2	......do	Dr	40	5	P	Tg	J,E	D,S				28	6-29-50	
-3dd	Laird Plymale	Dr	72	6	P	Tg	J,E	D				50	6- 5-50	
-6ac	W. D. Rankine	Du	16.3	60	M	Al	N	O	Tco	.0	3,778.79	8.86	7-19-50	
-6db1	W. Daniels	Du	40	50	C	Al(?)	PP,E	D				22	7-18-50	
-6db2	......do	Du	30	54	M	Al(?)	Cy,G	S				22	7-18-50	
-7aa1	W. Haegle	Dr	35.4	6	P	Al(?)	Cy,H	O	Tca	.2	3,774.70	25.33	7- 7-50	
-7aa2	......do	Dr	32.9	6	P	Al(?)	Cy,H	D,S	Tca	.2	3,772.12	23.12	7- 7-50	
-8ca	Paul Plymale	Du	85.9	6	T	Tg	Cy,G	S,O	Tco	1.0	3,834.46	59.65	7- 7-50	Ca
-9bc	Bert Plymale	Du	10.8	54	M	Al	H	D,O	Tco	2.5	3,868.45	7.98	7- 5-50	
-10aa	Duck Creek School	Dr	54.8	6	P	Tg	N	O	Ttp	-2	4,074.26	38.01	7- 6-50	
-11ab	Fred Plymale	Dr	142	6	P	Tg	J,E	D				120	7- 5-50	Ca
-14bb	Lyle Chamberlain	Dr	10.7	5	P	Tg	Cy,E	D,S,O	Tca	-6	4,085.09	85.57	6-30-50	Ca
-17bb	Bert Plymale	Dn	30	2	P	Al	Cy,H	D				20	6-29-50	
-18ad	W. Rankine	Dn	6.5	2	P	Al	P,H	D	Tca	3.5	3,752.48	6.05	7- 5-50	
-20aa	Bert Plymale	Du	32.6	24	P	Al	Cy,H	N	Tco	.6	3,786.36	28.81	6-29-50	
-20cd1	Curt Plymale	Du	3.9	40	M	Al	P,H	S,O	Tco	.0	3,761.05	1.76	6-26-50	
-20cd2	......do	Dn	15	1¼	P	Al	P,H	D				2	6-26-50	
-21ca	Bert Plymale	Dn	18.5	2½	P	Al	N	S,O	Tca	.0	3,769.29	2.97	6-27-50	
-21cd	J. T. Meyer	Dr	25	6	P	Al	PP,E	D,S				12	6-27-50	
-23cc1	Royal Smith	Du	17.8	42	M	Al	N	O	Tco	1.2	3,974.78	11.11	6-27-50	
-23cc2	......do	Dr	39	6	P		Cy,H	D				12	6-27-50	Ca
-23cc3	......do	Dr	12.2	6	P	Al	N	N	Tca	.5	3,970.55	7.91	6-27-50	
-28ac1	Walter Horn	Du	45.8	48	M	Al(?)	Cy,E	D	Tco	.3	3,804.61	30.13	6-20-50	
-28ac2	......do	Dr	84	6	P	Tg	Cy,E	S				34	6-20-50	
-28cb	John Pennington	Du	14.9	24	M	Al	Cy,G	S	Tco	.5	3,777.00	7.84	7- 6-50	
-28cd	School dist. 5	Dr	28.1	6	P	Al	Cy,H	O	Tpp	1.5	3,793.83	16.99	6-20-50	

Table 5.—*Record of wells and springs*—Continued

Well no.	Owner or tenant	Type of well	Depth of well (feet)	Diameter of well (inches)	Type of casing	Geologic source	Method of lift	Use of water	Measuring point: Description	Measuring point: Distance above or below (-) land surface (feet)	Measuring point: Height above mean sea level (feet)	Depth to water level below measuring point (feet)	Date of measurement	Remarks
A8-2-29ad	John Pennington	Du	20	24	M	Al	Cy,H	D				8	7- 6-50	
-29bd	Walter Gravely	Dn	14	1¼	P	Al	P,H	D				6	6-15-50	
-29dc1	W. J. Gaab	Du	9.1	48	M	Al	C,G	S,O	Tpf	0.0	3,773.42	2.61	6-19-50	
-29dc2	......do	Dn	30	1¼	P	Al	J,E	D				4	6-19-50	Ca
-29dd1	Joe Merritt	Du	15	30	M	Al	Cy,H	S				6	6-20-50	
-29dd2	......do	Dn	22	1¼	P	Al	PP,E	D				6	6-20-50	
-30cc	John Gravely	Dn	12	1¼	P	Al	P,H	D				4	6-20-50	
-32aa	Joe Merritt	Du	12.5	34	M	Al	Cy,H	O	Tco	.0	3,779.25	5.44	6-20-50	
-32ba1	W. T. Cotter	Du	9.7	30	M	Al	PP,G	S	Tco	1.0	3,772.85	2.62	6-20-50	
-32ba2	......do	Dn	20	1¼	P	Al	P,H	D				4	6-20-50	
-32ba3	......do	Dn	12	1¼	P	Al	P,H	N				4	6-20-50	
-32cd1	Bill Zabel	Dr	22	4	P	Al	J,E	D				6	6-19-50	
-32cd2	......do	Du	12.5	30	M	Al	Cy,H	S	Tpf	.8	3,781.00	4.04	6-19-50	
-32db1	Herb Gill	Du	12.1	30	M	Al	Cy,G	S,O	Tpf	1.0	3,779.22	5.21	6-19-50	
-32db2	......do	Dn	18	1¼	P	Al	PP,E	D				6	6-19-50	Ca
-33bc1	D. E. Mahoney	Du	19.1	60	M	Al	Cy,H	N	Tco	.2	3,785.22	8.47	6-20-50	
-33bc2	......do	Dn	20	1¼	P	Al	PP,E	D				9	6-21-50	
-33bc3	......do	Du	17.2	60	M	Al	Cy,G	S	Tco	.4	3,784.27	7.50	6-21-50	
-33da	U. S. Bur. of Reclamation	Dr	26	2	P	Al	N	O	Tca	.8	3,815.3	24.37	8- 9-50	
-33db1	Frank Wieferich	Dr	40	4	P	Al	J,E	D,S				18	6-23-50	
-33db2	......do	Dr	15.3	4	P	Al	Cy,H	N	Tca	.0	3,797.07	13.88	6-23-50	
-33db3	U. S. Bur. of Reclamation	Dr	11.9	2	P	Al	N	O	Tca	1.0	3,805.5	Dry	8- 9-50	
-34ba	Jimmy Gill	Dr	65	6	P	Al	J,E	D				30	6-21-50	
-34cb	U. S. Bur. of Reclamation	Dr	24	2	P	Al	N	O	Tca	.9	3,819.4	22.93	8- 9-50	
-34cd	Lonnie Merritt	Dr	63	4	P	Al(?)	J,E	D,S				40	6-23-50	
A8-3-30aa1	Harold Marks	Dr	46.3	6	P	Al(?)	N	S	Tca	.3		17.88	6-29-50	

-30aa2	......do......	Dr	41.8	6	P	Al(?)	N	S	Tca	.1		20.70	6-29-50	
A9-1-22db	Milton Beatty......	Dn	15	1¼	P	Al	PP,E	D				6	7- 4-50	
-22db2	School district......	Du	8.9	36	M	Al	Cy,H	D	Tco	.5	3,750.69	5.53	8- 4-50	
-22dc	Haddcock......	Du	20	48	M	Al	Cy,E	D				5	8- 4-50	
-25da	Bruce Estate......	Dr	100+	6	P	Tg	Cy,H	D,S	Tca	.1	3,846.65	74.61	8- 4-50	
-26dc1	Art Donavan......	Du	12.1	42	M	Al	Cy,H	N	Tco	1.6	2,724.90	9.13	8- 4-50	
-26dc2	......do......	Dn	16	1¼	P	Al	P,H	D				8	8- 4-50	
-26dc3	......do......	Dn	16	1¼	P	Al	Cy,G	S				8	8- 4-50	
-27aa1	D. Devans......	Dn	15	1¼	P	Al	Cy,E	S				8	8- 4-50	
-27aa2	......do......	Dn	15	1¼	P	Al	P,H	D				8	8- 4-50	
-31bc	Al Allbright......	Du	21.4	54	M	Al	Cy,H	D	Tco	.0	4,218.74	13.69	8- 2-50	
-31db1	Bill Diehl......	Du	40	56	M	Tg(?)	J,E	D				25	7-27-50	
-31db2	......do......	Dr	55	8	P	Tg(?)	Cy,H	S				6	7-27-50	
-34aa	C. E. Foster......	Du	44.3	54	M	Al(?)	N	N				Dry	8- 4-50	
-35cb1	......do......	Dn	26	1¼	P	Al	P,H	D				18	8- 4-50	
-35cb2	......do......	Dn	26	1¼	P	Al	Cy,E	S				17	8- 4-50	
-36da1	Charles Bruce......	Du	32	56	M	Al(?)	Cy,H	D				12	8- 4-50	
-36da2	......do......	Du	9.4	36	P	Al	Cy,H	S				Dry	8- 4-50	
A9-2-6dd	Gordon Gravely......	Dr	400	4	P	Tg	Cy,E	D,S				22.5	4-30-49	Ca
-19da1	Alex Sandru......	Dr	74	6	P	Tg	J,E	D				20	6-19-50	
-19da2	......do......	Du	11.4	60	M	Al	Cy,H	S,O	Tco	.6	3,965.34	2.98	6-19-50	
-20db	Cora Henries......	Du	23	54	M	Al	Cy,H	D,S,O	Tco	.4	4,006.09	4.49	6-19-50	
-29cb	Geo. Christie......	Dr	72	4	P	Tg	Cy,H	D				40	6-18-50	
-31da	W. D. Rankine......	Du	47.6	54	M	Tg	Cy,N	O	Tco	2.2	2,832.76	37.5	6-18-50	
-33cd	Schultz......	Dr	60.5	6	P	Tg	Cy,H,W	S,O	Tco	.9	3,990.88	49.19	6- 7-50	Ca
A10-1-28ad	Jake Burkart......	Du	100+	36	W	Tg	Cy,W,G	D,S	Tpf	.50		91.55	4-29-49	Ca
B8-1-2aa	C. R. Masola......	Du	20	54	M	Al	Cy,H	D				4	6-27-50	
B9-1-22ad	J. McMaster......	Du	79	72	M	Tg	J,E	D,S				47	6-28-50	
-22cd	......do......	Du	26	60	M	Al(?)	Cy,G	S	Tcp	-3.3	4,441.29	.76	6-28-50	
-26ad1	Ned George......	Du	15.1	40	M	Al	N	I	Tco	1.2	4,331.98	6.04	8- 2-50	
-26ad2	......do......	Du	16	48	M	Al	Cy,E	D				5	8- 2-50	
-26ad3	......do......	Du	17	56	M	Al	Cy,G	S				5	8- 2-50	
-26dd1	W. Riis......	Dr	110	6	P	Tg	J,E	D				20	8- 1-50	
-26dd2	......do......	Dr	85	6	P	Tg	Cy,H	S				20	8- 1-50	
-33ab	L. McMullan......	Du	10.5	60	M	Al	Cy,H,W	S	Tpb	1.0	4,736.78	2.42	6-28-50	
-35dd1	R. S. Lokowitch......	Du	10.5	15	P	Al	N	S	Tca	.9	4,370.19	3.44	6-27-50	
-35dd2	......do......	Du	20	15	P	Al	PP,E	D				4	6-27-50	
-36ca	M. Wells......	Du	8	50	M	Al	Cy,H	D				4	6-27-50	
-36dd	Francis Apple......	Du	12	60	M	Al	Cy,H	D				9	6-27-50	

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