Geology and Ground-Water Resources of the Lower Yellowstone River Valley, Between Glendive and Sidney, Montana

By ALFRED E. TORREY *and* FRANCIS A. KOHOUT

With a section on

CHEMICAL QUALITY OF THE WATER

By HERBERT A. SWENSON

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By Alfred E. Torrey and Francis A. Kohout

WITH A SECTION ON THE CHEMICAL QUALITY OF THE WATER

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ABSTRACT

The geology and ground-water conditions of the lower Yellowstone River valley in northeastern Montana between Glendive and Sidney were studied during the summer of 1949. The purpose of this investigation was to evaluate the recharge, discharge, storage, and direction of movement of the ground water, and to correlate these factors with present and potential irrigation problems.

Most of the area described in this report consists of flat to gently sloping terraces that border the flood plain of the Yellowstone River. The flood plain and the lower terraces were formed by the river after the melting of the last ice sheet that advanced into the area in late Pleistocene time. The higher terraces were formed before glaciation of the area. In places, the higher terrace deposits and the bedrock are mantled by glacial drift. Bedrock exposures are numerous on both sides of the river between Glendive and Intake, and on the southeast side of the river downstream from Intake. The Fort Union formation of Tertiary (Paleocene) age and the Hell Creek formation of Late Cretaceous age are the only bedrock formations cropping out in the area.

Moderate to large amounts of water can be obtained from the surficial deposits of sand and gravel that underlie the flood plain and the lower terraces. The higher terrace deposits and the glacial drift are sources of small amounts of water. The two exposed bedrock formations and the Fox Hills sandstone (Late Cretaceous age), which underlies the Hell Creek formation, yield small to moderate amounts of water. Almost all the water used in the area for domestic purposes and for stock is obtained from ground-water sources; a small amount of ground water is used for irrigating lawns and gardens.

The water contained in the unconsolidated surficial deposits is variable in chemical properties but generally is less mineralized and much harder than the water in the bedrock. Iron was present in objectionable amounts in many of the samples that were collected for analysis. As a rule the Fox Hills sandstone and the Hell Creek and Fort Union formations yield soft bicarbonate water containing 1,000 parts per million (ppm) or more dissolved solids. Significant amounts of fluoride were present in many of the samples from bedrock sources.

Water diverted from the Yellowstone River at Intake, about 14 miles downstream from Glendive, is used for the irrigation of valley lands downstream from that point. Additional lands proposed for irrigation in the report area are undergoing investigation and development. Most of the land now irrigated is effectively drained, but drainage problems are likely to result from the extension of irrigation in the area. Further and more detailed ground-water investigations are recommended as an aid toward the solution of these problems.

INTRODUCTION

LOCATION AND EXTENT OF AREA

Except for about 3 square miles in North Dakota, the area described in this report lies in the northeastern part of Montana along the lower course of the Yellowstone River and extends northeastward from Glendive in Dawson County to the north edge of T. 23 N., which is 6 miles north of Sidney in Richland County, and is only 14 miles from the confluence of the Yellowstone and the Missouri Rivers (figs. 1 and 2). The area is about 60 miles long and 10 miles wide and lies along both sides of the Yellowstone River. The outer boundaries for the most part coincide with the landward margin of the highest distinct terrace along the river.

Most of the downstream three-fourths of the area is included in the Intake and Lower Yellowstone irrigation projects, which use water diverted from the Yellowstone River at Intake. (The Lower Yellowstone Project extends to the confluence of the Yellowstone and Missouri Rivers, about 20 miles downstream from Sidney.) Additional units now under investigation or undergoing development by the United States Bureau of Reclamation, in downstream order, are: Stipek, 4,800 acres; Savage, 2,218 acres; Elm Coulee, 1,800 acres; Seven Sisters, 2,000 acres; and Sidney unit area 3, 2,450 acres (fig. 2). Water was made available for irrigation in the Savage unit in the spring of 1950.

PURPOSE AND SCOPE OF THE INVESTIGATION

The investigation on which this report is based is one in a series of studies being made by the United States Geological Survey in connection with plans for the development of ground-water resources in the Missouri River basin. The purpose of these studies is to evaluate ground-water recharge, discharge, and storage, especially in the areas that have been proposed for irrigation under the development program. During this study special consideration was given to the source and geologic occurrence of ground water, its direction of movement, the fluctuations of the water level in wells, the depth of the water table below the land surface, the water supply available for domestic and stock use, and the present and potential drainage problems in irrigated areas.

The field work on which this report is based was done between June and December 1949 under the general direction of A. N. Sayre, chief of the Ground Water Branch of the U. S. Geological Survey, and G. H. Taylor, regional engineer in charge of ground-water investigations in the Missouri River basin, and under the supervision of F. A. Swenson, district geologist for Montana and northern

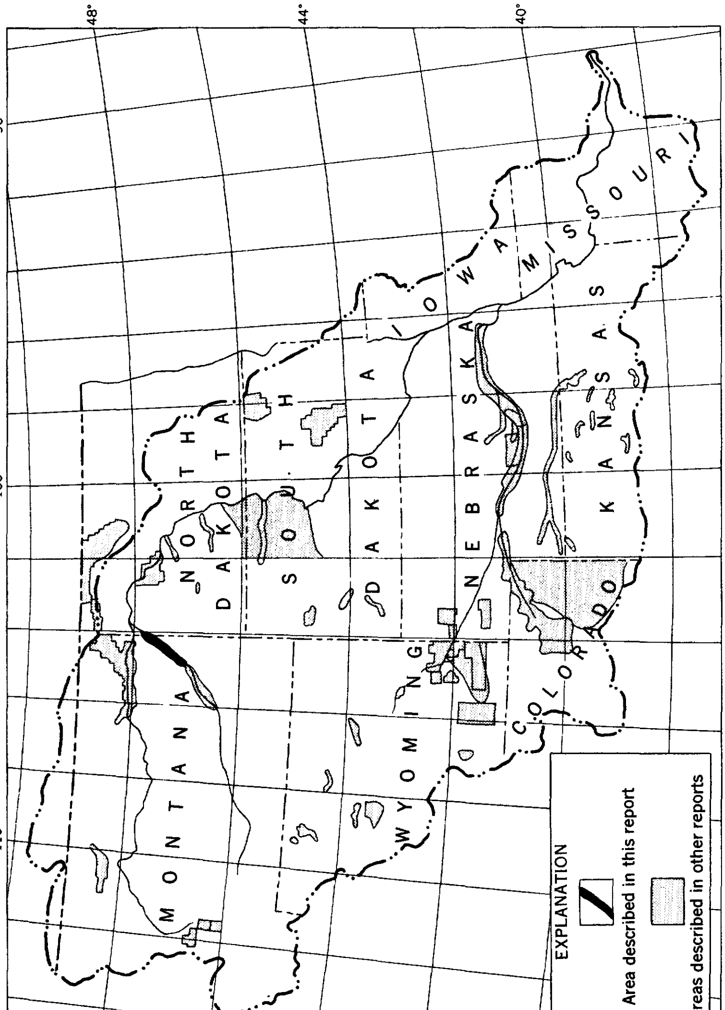

Figure 1. —Map of the Missouri River basin showing areas in which ground-water studies have been made under the program for development of the Missouri River basin.

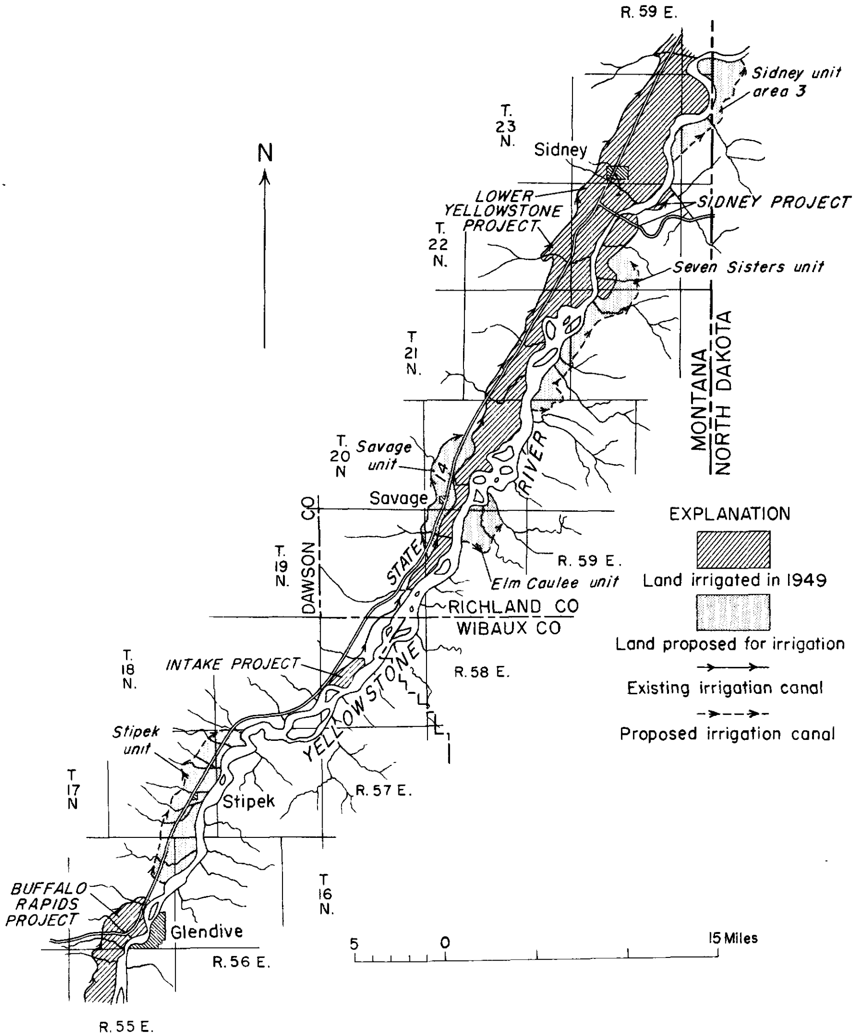

Figure 2. —Map showing area described in this report.

Wyoming. The quality-of-water study was under the general direction of S. K. Love, chief of the Quality of Water Branch, and under the supervision of P. C. Benedict, regional engineer in charge of quality-of-water investigations in the Missouri River basin.

The geology of the area was mapped on aerial photographs; the field data were transferred later to a base map by use of a sketchmaster. All wells (359) were inventoried to obtain available pertinent information. The altitude of the water level in 211 wells was determined by spirit level and a map showing the configuration of the ground-water surface was prepared from this information.

The water level in selected wells was measured monthly; these measurements are shown in table 3. Periodic measurements of the water level in observation wells were continued beyond the period of general field studies, in some through the 1952 calendar year.

PREVIOUS INVESTIGATIONS

The general geology of the area was described by Calvert and others (1912), and the glacial geology was described by Alden (1932). These publications have been used freely in the preparation of this report. Other publications that discuss the general regional geology and that were helpful in the preparation of this report were written by Parker (1936) and Thom and Dobbin (1924). This is the second report on the geology and ground-water resources of the lower Yellowstone River valley; the first report, which was written by A. E. Torrey and F. A. Swenson (1951), described the valley from Miles City to Glendive.

ACKNOWLEDGMENTS

The authors are indebted to many persons who contributed information and assistance, both in the field and in the preparation and review of this report. Axel Persson, former manager of the Lower Yellowstone Project, provided climatological data and pertinent information concerning the history of that project. Officials in the city water departments of Glendive and Sidney, owners and operators of industrial plants, and farm owners also provided valuable information.

WELL-NUMBERING SYSTEM

The wells are numbered according to their location within the U. S. Bureau of Land Management's survey of the area (fig. 3). The first numeral of the well number denotes the township, the second the range, and the third the section in which the well is located. Lowercased letters following the section number indicate the quarter section and the quarter-quarter section, respectively. These subdivisions of the section are lettered a, b, c, and d in a counterclockwise direction, beginning at the northeast quarter or quarter-quarter section. If two or more wells are located within the same quarter-quarter section, they are distinguished by numerals following the lowercased letters.

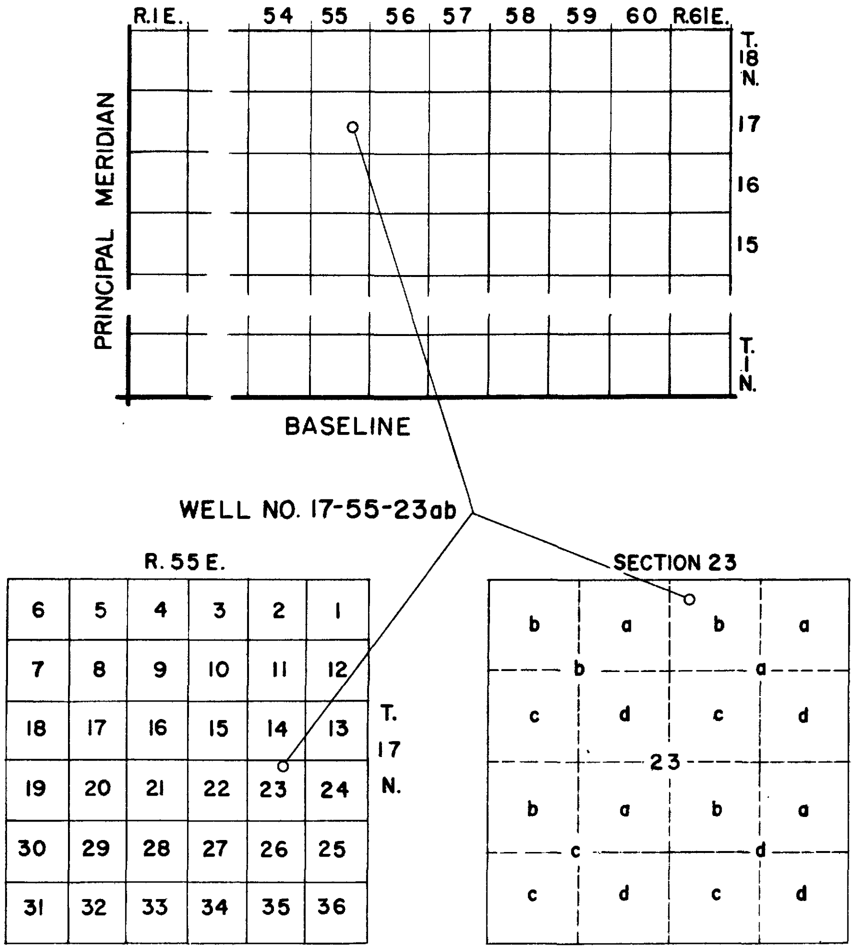

Figure 3.—Sketch showing well-numbering system.

HISTORY

The first white men who visited the region probably were French-Canadian trappers and fur traders who left little evidence of their wanderings. The first authentic records of the presence of white men in the area are those left by François Larocque who was leader of an expedition sent by the Northwest Company in 1804 to trade with the Indians along the Yellowstone River. During his travels, Larocque also explored the valleys of the Powder, Tongue, Little Big Horn, Big Horn, and Yellowstone Rivers.

In 1806 Capt. William Clark, coleader of the Lewis and Clark expedition, descended the Yellowstone River with a small party of men (Thwaites, 1904, p. 314–315). It is recorded that they camped in the vicinity of Glendive on the night of July 31, 1806, and on a small island, probably upstream from Sidney, the following night. The party was delayed for several hours at one locality by a large herd of buffalo crossing the river near a chain of rapids. Clark also reported the sighting of large numbers of elk, wolves, and other animals.

The settlement of the Yellowstone River basin was begun in 1807 with the establishment of a trading post at the mouth of the Big Horn River, and for many years trapping and hunting were the sole occupations of the few white men living in the basin. In 1828 Fort Union was established at the confluence of the Missouri and Yellowstone Rivers. The valley of Glendive Creek was a famous hunting ground in the early days. The creek was named by Sir George Gore, an Irish nobleman, who, with Jim Bridger, the celebrated frontiersman, hunted buffalo in the area in the winter of 1855–56 (Campbell and others, 1915, p. 64). The city of Glendive received its name from Glendive Creek.

Agriculture in the Yellowstone River valley began about 1870 with the establishment of large cattle ranches. In 1880 the main line of the Northern Pacific Railway was completed to Glendive. During the construction of the railroad, Glendive was the most important town between the Missouri River and Helena because supplies were transported from Bismarck, N. Dak., by boat on the Missouri and Yellowstone Rivers to Glendive, and from there construction of the railroad was carried on in both directions. However, when the road was completed and through travel to Helena was established, Glendive was made a division terminal of the railroad and lost much of its earlier importance. For a long time thereafter its growth was slow because the surrounding country was sparsely settled. In compliance with the enlarged Homestead Act of 1909, federally owned lands were divided into 320-acre tracts and many farmers moved into the area. The completion of the Lower Yellowstone Project also gave impetus to the settlement of the region.

The U. S. Geological Survey had previously made an investigation in the lower Yellowstone River valley to determine the feasibility of irrigation, and in 1904 the Secretary of the Interior authorized the construction of the Lower Yellowstone Irrigation Project. Work was begun in 1905 by the Reclamation Service of the U. S. Geological Survey and water was made available for irrigation in the spring of 1909. A dam was constructed 18 miles downstream from Glendive to divert water from the Yellowstone River into a canal on the west side of the river. The canal is 71.8 miles long and carries water as far as the confluence of the Yellowstone and Missouri Rivers.

Water rights have been filed on 1,200 cfs of water from the Yellowstone River. The water is distributed by 225 miles of laterals branching off the main canal; excess water from irrigation is drained from the land by 105 miles of drainage ditches. The project was operated by the U. S. Bureau of Reclamation (originally the Reclamation Service) until 1931; since that date it has been operated and maintained by a Board of Control.

Before irrigation was begun in the Yellowstone River valley, it was necessary to farm a minimum of 640 acres in order to derive an adequate livelihood. With the practice of irrigation, however, farmers have found it not only unnecessary but impractical to farm such a large acreage and the average farm in the area at present is about 100 acres. By law, water for irrigation cannot be delivered to more than 160 acres in one farm.

GEOGRAPHY

CLIMATE

The climate of northeastern Montana is semiarid; it is characterized by cold winters, by moderately warm summers that have a wide diurnal range in temperature, and by irregular precipitation. Data representative of the climate were obtained from the records of the following stations of the United States Weather Bureau: Glendive, at the southwest end of the area; Savage, near the middle; and Williston, N. Dak., 35 miles to the northeast. The records at Williston were selected in preference to those at Sidney, Mont., because they were more complete.

Climatological data have been recorded continuously at Glendive since 1890 (fig. 4). In 1916, the wettest year on record, the precipitation was 26.02 inches; in 1934, the driest year on record, the precipitation was 4.83 inches. The average annual precipitation at Glendive between 1890 and 1949 was 14.42 inches. The mean annual temperature for this period was 44.3°F. The mean January temperature was 14.0°F, and the mean July temperature was 73.7°F. As average dates of the last killing frost in the spring and the first killing frost in the fall are May 12 and September 25, respectively, the average frost-free growing season for the area is 136 days.

The weather records at the Savage station are complete after 1905 (fig. 5). In 1906, the wettest year recorded by this station, the precipitation was 27.11 inches; in 1934, the driest year, the precipitation was 5.93 inches. The average annual precipitation for the 43-year period of record was 13.38 inches. The mean annual temperature for this period was 43.4°F, the mean January

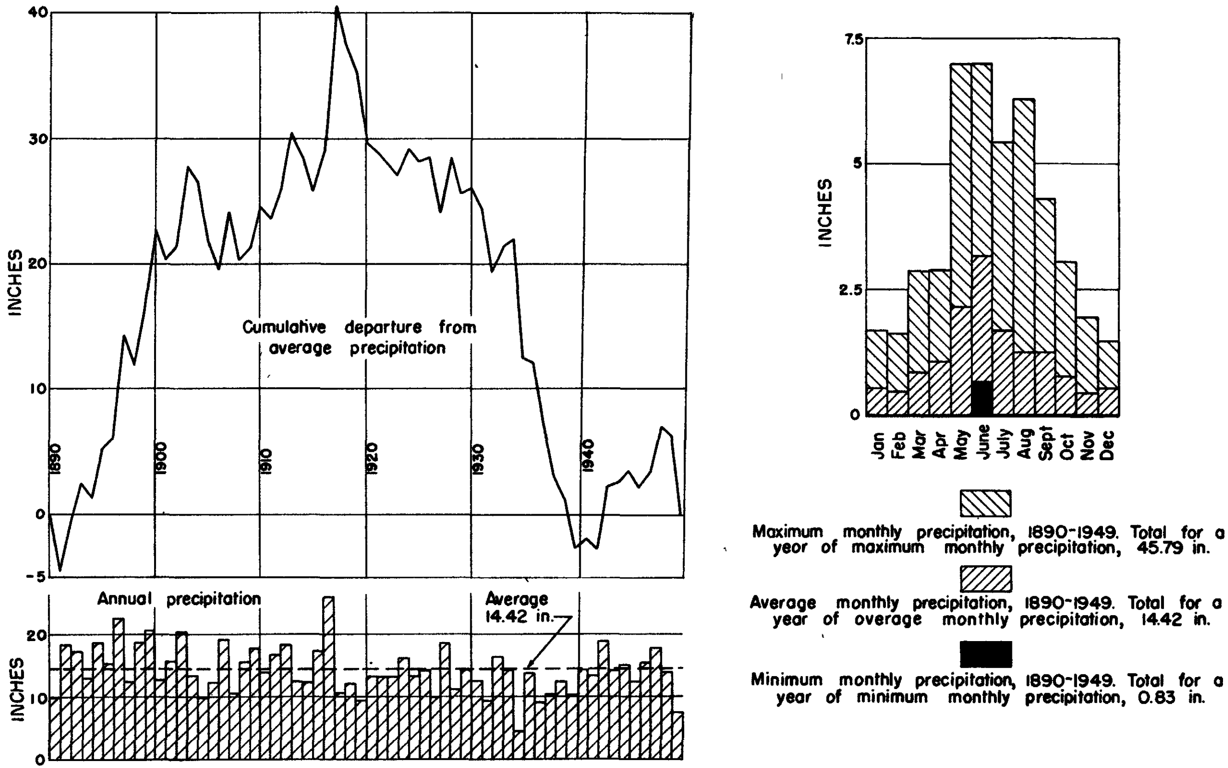

Figure 4.—Precipitation records at Glendive, Mont., 1890–1949 (from records of the U. S. Weather Bureau).

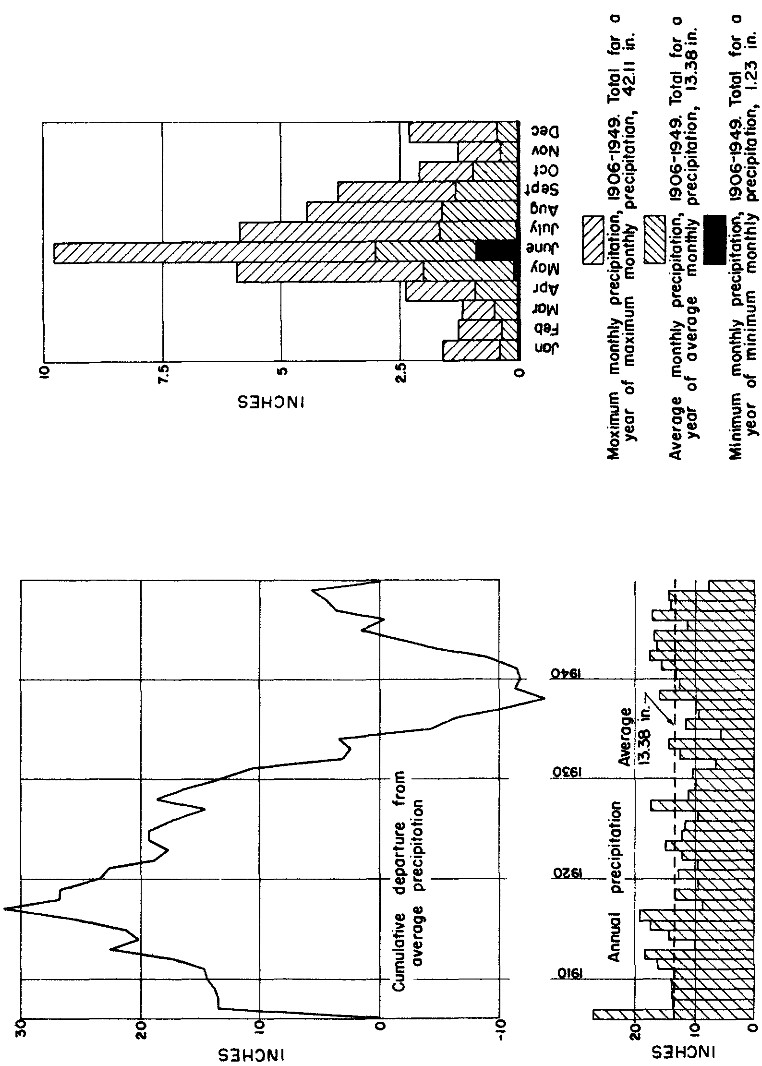

Figure 5. —Precipitation records at Savage, Mont., 1906–49 (from records of the U. S. Weather Bureau).

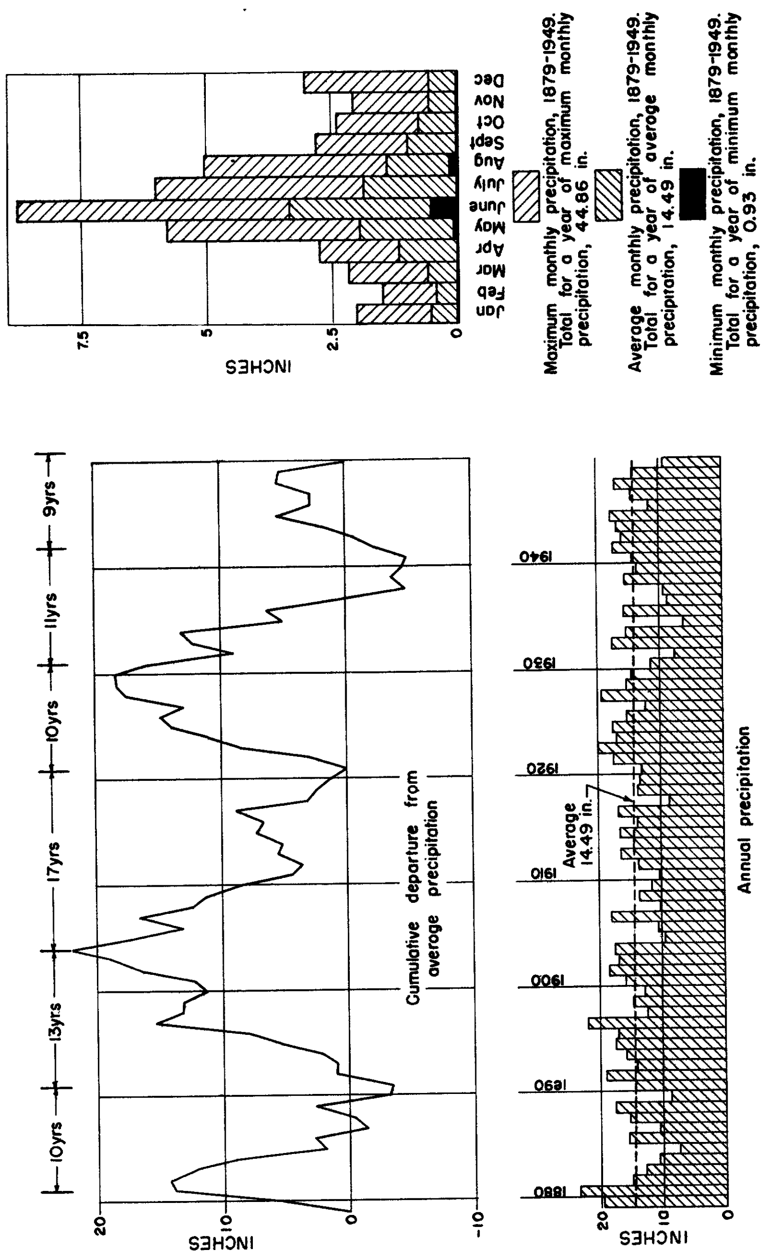

Figure 6. —Precipitation records at Williston, N. Dak., 1879–1949 (from records of the U. S. Weather Bureau).

temperature was 12.9° F, and the mean July temperature was 70.2° F. At the Savage station the average date of the last killing frost is May 17 and the average date of the first killing frost is September 24; hence the average frost-free growing season is 130 days.

Climatological data at Williston, N. Dak., 30 miles northeast of the area, are complete after 1878 and are the longest available records in the region (fig. 6). In 1880, the wettest year on record at this station, precipitation was 23.55 inches; and in 1934, the driest year, the precipitation was 6.13 inches. The average annual precipitation for the 71-year period (1879–1949) was 14.49 inches. During this period the mean temperatures for January and July were 8.0° F and 68.6° F, respectively, and the annual mean temperature was 39.7° F. The average date of the last killing frost is May 15, the average date of the first killing frost is September 23, and the average frost-free growing season is 131 days.

Graphs showing the cumulative departure from average precipitation at Glendive, Savage, and Williston (figs. 4, 5, 6) indicate the long-term excesses and deficiencies of precipitation. The periods of above-average rainfall are indicated by a rising line, and the periods of below-average precipitation are indicated by a declining line. In figure 6, the cumulative departure from average precipitation for Williston shows a marked reoccurrence of wet and dry periods. The dry periods were 1881–90, 1904–20, and 1931–41; the intervening years, 1891–1903, 1921–30, and 1941–49, were the wet periods. The average length of these periods is about 12 years.

The distribution of precipitation generally is uneven and several exceedingly dry months may be followed by months of heavy precipitation. This fact is not indicated in annual totals. For example, if all the wettest months in the 71-year period of record at Williston were to occur in the same year, the total annual precipitation would be 44.86 inches. Likewise, if the driest months in this period were to occur in any single year, the total annual precipitation would be only 0.93 inch. A similar analysis was made of the records at Glendive and Savage (figs. 4 and 5).

Although the monthly distribution of precipitation varies from year to year, it usually increases to a maximum in June and decreases to a minimum in the winter. About half the annual precipitation is received in May, June, and July.

AGRICULTURE AND INDUSTRY

The gross value of crops raised on the Lower Yellowstone Project in 1948 was $2,765,307. The average return per acre from the 48,909 cultivated acres was $56.54. The major crops and their gross returns were: sugar beets, $880,171; wheat, $573,037; and oats, $208,570. Other crops included hay, alfalfa, corn, beans, potatoes, and flax. The irrigated crops that yielded the greatest gross return per acre were: potatoes, $109.86; sugar beets, $95.72; and commercial beans, $55.38.

Beet sugar, the chief product exported from the area, is processed in Sidney by a sugar-refining company, which controls the raising of sugar beets by allotting an acreage quota to each farmer. The erection of the beet sugar processing plant in 1925 stimulated the raising of sugar beets which have become the most valuable crop on the irrigation project. In 1948 the total value of the sugar-beet crop from the Lower Yellowstone Project amounted to almost one-third the gross value of all crops grown on the project.

The Lower Yellowstone Project is one of the principal areas in Montana for fattening livestock. Hay, alfalfa, corn, oats, and the tops of sugar beets provide excellent and diversified forage. Money from the sale of livestock makes up a large part of the gross income of the farmers. In the nonirrigated parts of the area, wheat, oats, native hay, alfalfa, corn, and flax are raised. Of these, flax seed and wheat are the most important exports. Although the yield from crops raised on nonirrigated land is lower than that from irrigated land, in recent years the high price of flax seed and of wheat have made these crops profitable.

The lignite of the Fort Union formation is mined commercially during the late fall and winter. The three most important mines in the area are the Clapp, which is 10 miles north of Glendive on State Highway 14, and the Theil and Sidney mines in sec. 19, T. 23 N., R. 60 E. The total output of all the mines is used locally. Although most mines are underground, a few strip mines are operated where the overburden is thin. Individual farmers mine fuel for their own needs from outcrops of the lignite, and more coal is mined in this way than is mined for commercial use.

During 1949 oil companies actively explored the area for possible oil structures along the northwestern extension of the Cedar Creek anticline. Since the discovery in 1951 of oil in commercial quantities in the Williston Basin of North Dakota, there has been a greatly expanded program of oil exploration in this general region, and several producing fields are located in or adjacent to the area described by this report.

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TRANSPORTATION

The area is served by four paved highways: State Highway 14 crosses the length of the area; the transcontinental U. S. Highway 10 enters the Yellowstone River valley from the east at Glendive and follows the valley upstream; State Highway 16 from the northwest joins State Highway 14 at Sidney; and State Highway 23 is paved from Sidney to the North Dakota State line. An excellent network of county roads has been constructed in the irrigated part of the area but few roads cross the rough terrain lying southeast of the river.

The main line of the Northern Pacific Railway passes through Glendive, and a branch line extends northeastward to Sidney. One branch line of the Great Northern Railway extends southward from Snowden, Mont., to Sidney, and 5 miles south of Sidney another branch line extends westward along the Fox Creek valley to Lambert and Richey. The Northern Pacific Railway has trackage rights on the Lambert-Richey spur.

Both Glendive and Sidney have airports, but to date the area is not served by a commercial airline.

PHYSIOGRAPHY

TOPOGRAPHY

The area described in this report is in the Northern Great Plains physiographic province (Fenneman, 1931, p. 63–65). The northern half has been glaciated and at least one of the continental glaciers advanced as far as the vicinity of Intake. Downstream from Intake gently rolling, boulder-strewn ground moraine mantles the upland and higher terraces on the northwest side of the Yellowstone River and small patches of ground moraine and glacial erratics occur along the sides of the valleys of tributaries flowing toward the Yellowstone River from the southeast. The mature topography and the scant evidence of glaciation southeast of the river indicate that glaciation may have been restricted to the stream valleys. If the glacier mantled the upland southeast of the river, certainly the period of glaciation was short and the ice mass was weak, as erosion has removed nearly all evidence of glacial deposits.

The ice mass advanced over a maturely dissected land surface. Broad stream terraces, ranging in height from 120 to 410 feet above the present river level, had been developed along the Yellowstone River before glaciation. On the northwest side of the valley, north of Intake, these terraces have been almost obliterated by the mantle of glacial deposits, but south of Intake the higher terraces have been preserved because they are south of the southernmost advance of the ice sheet.

Broad, gently sloping stream terraces, as high as 90 feet above the present river level and extending the length of the area, are believed to be of postglacial (though probably not post-Pleistocene) age because they have no glacial mantle and occur in both the glaciated and the unglaciated parts of the area. These relatively smooth surfaces differ from the undulating and more dissected higher terraces of early Pleistocene age.

Downstream from Savage the Yellowstone River valley is 4 to 5 miles wide and is characterized by broad lower terraces and a few small areas of badlands, the largest of which is across the river from Sidney. Upstream from Savage the valley is less wide and is characterized by narrow terrace remnants and numerous badlands.

Buttes capped by red clinker are a characteristic feature of the upland south and east of Intake. The red clinker, which consists of clay that was baked and fused into a hard, indurated mass by the burning of the underlying lignite beds, protects from erosion the softer underlying rocks of the Fort Union formation. Similar buttes are not present in the glaciated area north of Intake; it may be that during the period of glaciation the ice was thick enough to override and plane off the buttes. Except for small patches of ground moraine and isolated glacial erratics, that part of the area southeast of the Yellowstone River, almost as far north as Sidney, is topographically similar to that of the unglaciated area upstream from Intake.

The Yellowstone River meanders across its valley, and sheer cliffs rising 250 feet or more to the terrace level above have been formed where the river impinges directly against the valley wall. The steepest cliffs generally are on the southeast side of the river; consequently most of the irrigation projects are northwest of the river on the broad terraces extending downstream from Savage to a point about 5 miles north of Sidney, a distance of 25 miles.

The surface of the ground moraine overlying the highest terrace remnant, 3 miles west of Intake, is the highest point in the area. The altitude of this terrace ranges from 2,410 to 2,430 feet. The lowest point, where the river leaves the area to the northeast, is 1,872 feet. The maximum topographic relief is about 550 feet, and the maximum relief in any one township is about 450 feet.

PRESENT DRAINAGE

Before irrigation was begun in the area, the numerous intermittent tributaries of the Yellowstone River provided excellent drainage for the terraces along the river. However, small tracts of the flood plain were swampy, especially along the lower course of Morgan, Lower Sevenmile, Thirteenmile, Burns, Fox, and Pierre Creeks, which flow in valleys cut originally by larger streams that had been diverted by glacial action. After irrigation was begun many of the tributary streams became perennial in their lower course. Some of the creek channels have been straightened to increase their effectiveness as drains, but in many places they now are clogged by silt and weeds and normal storm flows generally result in flooding.

DRAINAGE IN PLEISTOCENE TIME

The advance of the ice sheets during Pleistocene time caused pronounced changes in the drainage of northeastern Montana. These changes are evidenced by conspicuous valleys that obviously were formed by streams that had a much greater flow than the streams now flowing in them (fig. 7).

Before the advance of the ice sheets in Pleistocene time, the ancestral Missouri River flowed in the valley occupied by the present stream between Nashua and Poplar, Mont. At Poplar the ancestral river turned northeastward toward Hudson Bay. As the ice mass advanced, this course was blocked and the river was forced to flow as an ice-marginal stream around the edge of the advancing ice mass (Alden, 1932). At the time of maximum extent of the ice sheet in northeastern Montana, the displaced Missouri River flowed about 25 to 30 miles south of its present course to a point about 25 miles west of Sidney, where it turned abruptly southward (Alden, 1932; Parker, 1936). (See fig. 7.) For a time the Missouri River flowed through the valley now occupied by Burns Creek, but the ice blocked this course also and the damming of the water caused the Missouri River to cross successively the divides between Burns, Thirteenmile, Morgan, and Lower Sevenmile Creeks. These latter stream valleys were used only during the relatively short time of maximum extent of the ice sheet. The blocking of the Yellowstone River valley by the ice sheet ponded the combined flows of the Missouri and Yellowstone Rivers until the water surface was raised to a level sufficiently high that the water could flow through one of the low places in the divide between the Yellowstone and Little Missouri Rivers. As the ice sheet melted, the ancestral Missouri River successively flowed through the valleys now occupied by Morgan, Thirteenmile, Burns,

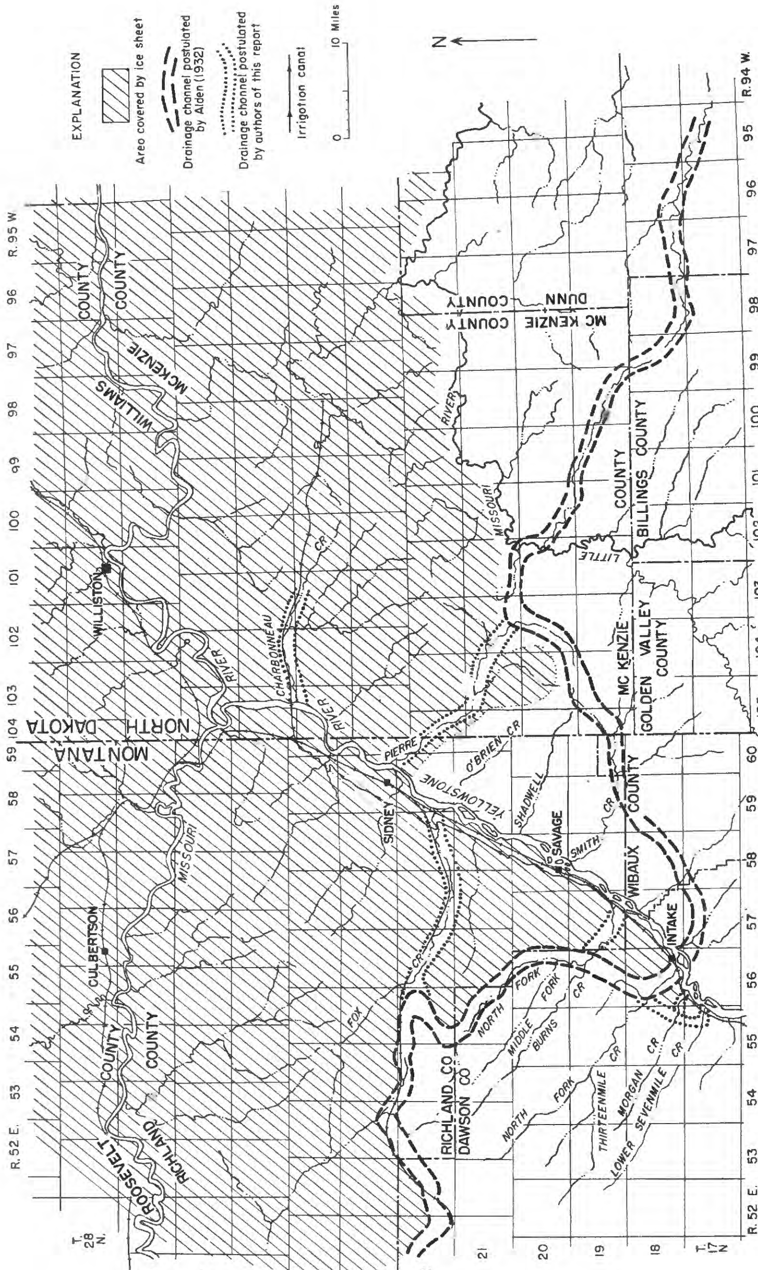

Figure 7. —Map showing drainage channels during Pleistocene time.

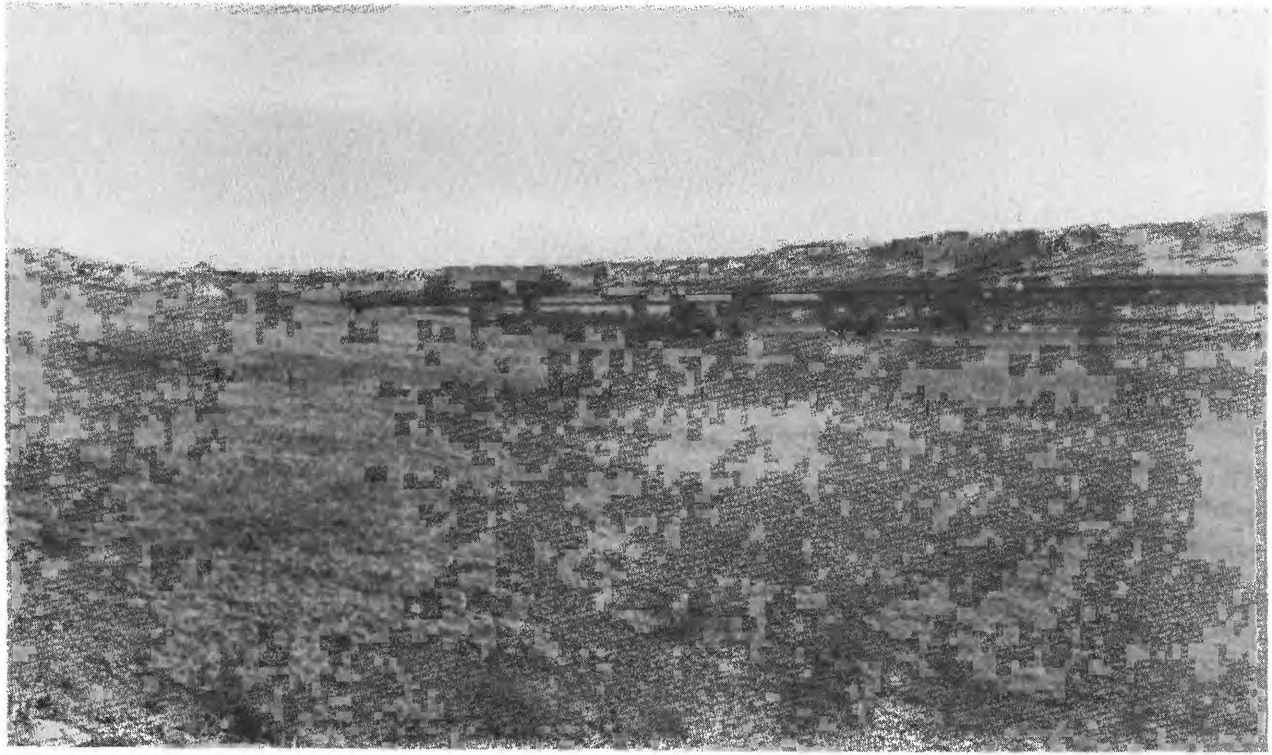

Figure 8.—View, looking eastward, of a channel occupied by the combined Missouri and Yellowstone Rivers during part of Pleistocene time (secs. 24 and 25, T. 147 N., R. 102 W., N. Dak.). The farther line of trees marks a creek flowing to the Little Missouri River, and the nearer line of trees marks a tributary to Pierre Creek, which flows into the Yellowstone River. The valley is about 1 mile wide and the altitude is about 2,200 feet. The floor of the channel is more than 300 feet higher than the present Yellowstone River at the mouth of Pierre Creek.

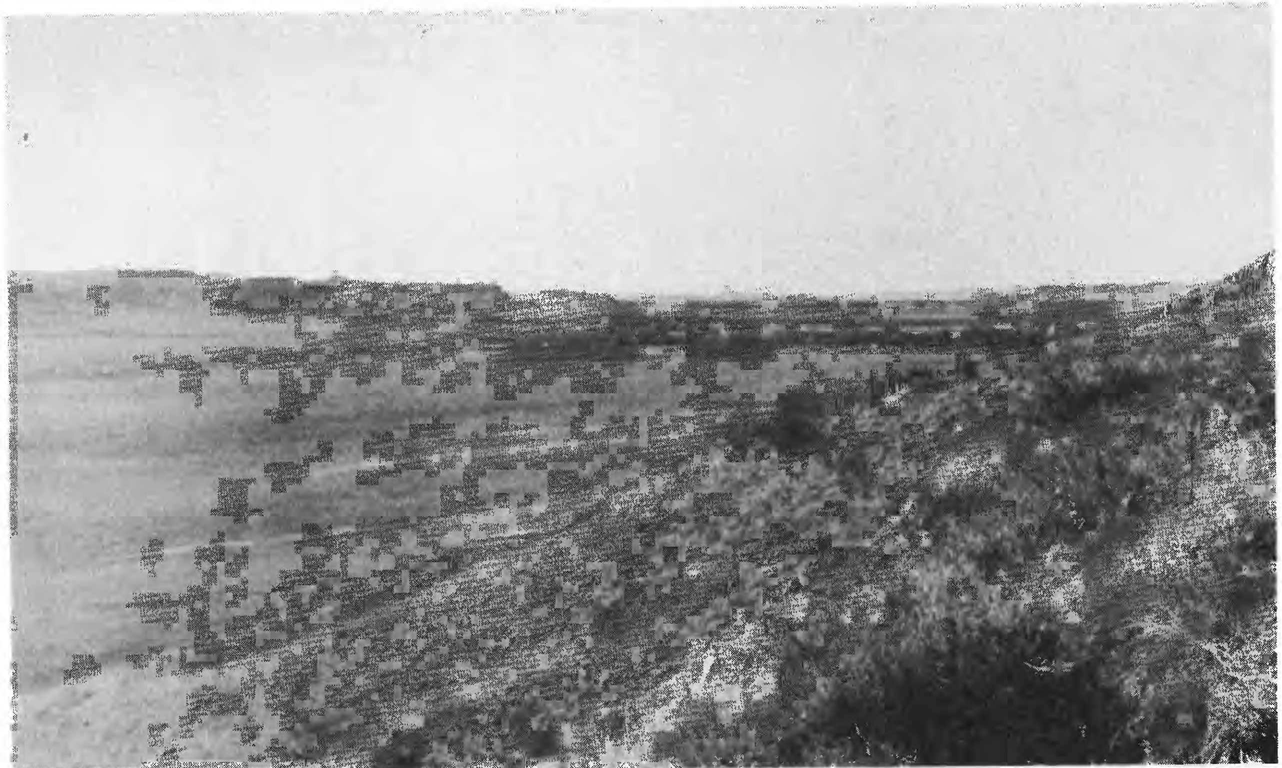

Figure 9.—View, looking westward, of a channel occupied by the combined Missouri and Yellowstone Rivers during part of Pleistocene time (same channel as shown in fig. 8). The line of trees marks a tributary to Pierre Creek, which flows into the Yellowstone River.

and Fox Creeks, and for a time the combined ancestral Missouri and Yellowstone Rivers may have followed the course suggested by Alden (1932) but later flowed across the divide at the head of Pierre Creek (figs. 7, 8, and 9). Further recession of the ice sheet allowed the combined ancestral Missouri and Yellowstone Rivers to flow through the channel now occupied by Charbonneau Creek, which occupies the largest of the abandoned glacial valleys in this region, to some undetermined point (fig. 7). Eventually these rivers adopted their present courses.

GEOLOGY

The rocks exposed in the area range in age from Late Cretaceous to Quaternary. The bedrock is flat lying except at the southernmost end where the consolidated rocks on the northeast limb of the Cedar Creek anticline dip as much as 3° to the northeast. The Cedar Creek anticline is a prominent geologic structure in southeastern Montana; it extends northwestward for 70 miles from near the Black Hills of South Dakota, and its axis crosses the Yellowstone River about 8 miles upstream from Glendive (Calvert and others, 1912, p. 19). The bedrock exposed in this area has been subdivided by earlier geologists into two formations, one of Late Cretaceous age and the other of early Tertiary age. The unconsolidated sediments of Quaternary age include terrace deposits, glacial drift, and alluvium (pl. 1 and table 1).

CRETACEOUS SYSTEM

UPPER CRETACEOUS SERIES

Fox Hills sandstone.— Although not exposed, the Fox Hills sandstone is important because it is the source of water yielded by the municipal-supply wells in Glendive. Outcrops of this formation on both sides of the Yellowstone River valley a short distance upstream from Glendive indicate that the formation is composed in its lower part of yellow shaly sandstone interbedded with gray silty sandstone and in its upper part of massive white to light-gray fine- to medium-grained friable sandstone. The formation is 150 to 220 feet thick where exposed and probably underlies the entire area. Although the Fox Hills sandstone also would yield copious supplies of water to wells downstream from Glendive, ample supplies for present requirements are obtained from overlying aquifers.

Hell Creek formation.—The belt of outcrop of the Hell Creek formation crosses the Yellowstone River valley in the vicinity of Glendive at

Table 1.—*Sedimentary rocks of the lower Yellowstone River valley and their water-bearing characteristics*

System	Series	Aquifer	Height of surface above Yellowstone River (feet)	Character and thickness	Water supply	Irrigation of surface
QUATERNARY	Recent	Alluvium	0–10	Mostly very fine to medium sand, silt, and clay. A small amount of gravel is scattered along the river bank. Thickness ranges from a featheredge to about 40 ft.	A reservoir for a large amount of ground water. The yield of wells tapping this aquifer is limited by the permeability of the water-bearing materials penetrated. Recharged by underflow from adjacent terrace deposits, by precipitation, and by the river during flood stage.	Not irrigated. Flood plain is heavily forested in most places.
	Pleistocene	Stream-terrace deposits underlying terrace *A*	14–17	Fine sand and silt overlying gravel. The thickness of the gravel probably is less than 10 ft.	Yield sufficient water for domestic and stock use. In some places, water is highly mineralized. Recharged principally by the infiltration of irrigation water.	Entirely irrigated north of Intake on the west side of Yellowstone River.
		Stream-terrace deposits underlying terrace *B*	20–25	Sand, silt, and clay overlying gravel. The gravel is 5 to 10 ft thick. The terrace extends the length of the area and its maximum width is 3 miles.	Yield sufficient water for domestic and stock use. On southeast side of Yellowstone River north of State Highway 16 water generally is unfit for human consumption because of high concentration of magnesium salts. Recharged principally by the infiltration of irrigation water.	About 95 percent irrigated north of Intake.
		Stream-terrace deposits underlying terrace *C*	40–46	Interbedded gravel, sand, silt, and clay. The combined thickness of the gravel layers is about 30 ft. The largest remnant of the terrace is in the vicinity of Sidney and is about 10 miles long and 3 miles wide.	Yield sufficient water for domestic and stock use, also for industrial and municipal use in Sidney. Quality generally is satisfactory. Recharged principally by infiltration of irrigation water.	About 90 percent irrigated. Development of Sidney unit area 3 will increase irrigated area.
		Stream-terrace deposits underlying terrace *D*	50–60	Interbedded gravel, sand, silt, and clay. The thickness of the gravel beds ranges from 10 to 20 ft. The town of Savage is situated on one of the remnants of this terrace.	Yield sufficient water for domestic and stock use. Recharged by infiltration of irrigation water and precipitation.	Partly irrigated. Development of the Savage unit will increase irrigated area.

Table 1.—*Sedimentary rocks of the lower Yellowstone River valley and their water-bearing characteristics*—Continued

System	Series	Aquifer	Height of surface above Yellowstone River (feet)	Character and thickness	Water supply	Irrigation of surface
QUATERNARY	Pleistocene	Stream-terrace deposits underlying terrace *E*	70–90	Gravel, sand, silt, and clay. The thickness of the gravel beds ranges from 15 to 25 ft. Remnants of the terrace have been preserved in several places along the length of the area. The slope of this terrace is greater than that of the lower terraces.	Yield sufficient water for domestic and stock use. Quality generally satisfactory, but in some places water may be highly mineralized. Recharged by infiltration of irrigation water and precipitation.	About 50 percent irrigated. Planned development will increase irrigated area.
		Glacial moraine	------------	Unsorted gravel, clay, silt, and clay; contains cobbles and boulders of granite, other crystalline rocks, and limestone. Present principally on the northwest side of the Yellowstone River. Thickness generally is less than 10 ft.	Yield sufficient water for domestic and stock use. Recharged by infiltration of precipitation. Zone of saturation generally thin.	Not irrigated.
		Stream-terrace deposits underlying terrace *F*	120–140	Sand, silt, and clay overlying layer of gravel 15 to 20 ft thick. Remnants of these deposits are near Fox Creek and on the west side of Yellowstone River about 5 miles upstream from Savage. Overlain in part by glacial moraine.	Yield sufficient water for domestic and stock use. Recharged by infiltration of precipitation.	Do.
		Stream-terrace deposits underlying terrace *G*	270–290	Mostly sand and silt overlying layer of gravel 30 ft thick. Identified only in unglaciated area upstream from Intake.	Yield sufficient water for domestic and stock use. Recharged by infiltration of precipitation.	Do.
		Stream-terrace deposits underlying terrace *H*	310–330	Sand and silt overlying layer of gravel 20 to 30 ft thick. Largest remnant is on southeast side of river near Sidney. A smaller remnant on northwest side of river about 4 miles upstream from Savage is mantled by glacial moraine.	Yield sufficient water for domestic and stock use. Recharged by infiltration of precipitation.	Do.

		Stream-terrace deposits underlying terrace *1*	410-430	Sand and silt overlying layer of gravel 25 to 30 ft thick. Only remnant in report area is between Morgan and Thirteenmile Creeks. Partly mantled by glacial moraine.	Yield sufficient water for domestic and stock use. Recharged by infiltration of precipitation.	Do.
TERTIARY	Paleocene	Fort Union formation	----------	Yellowish-gray to buff sandstone, shale, lignite, clay, and clinker beds. About 1,190 ft thick. Underlies entire area downstream from Glendive. Exposed principally on upland on southeast side of Yellowstone River, in valley walls of tributaries to the Yellowstone River, and in places in the escarpment between terraces.	Yield sufficient water for domestic and stock use. Generally water obtained from fractured lignite beds is soft, tastes of soda, and contains small amounts of combustible gas. Recharged by infiltration of precipitation.	Not irrigated.
CRETACEOUS	Upper Cretaceous	Hell Creek formation	----------	Brownish-gray clay, carbonaceous shale, gray silty mudstone, and lenticular beds of sandstone about 500 ft thick. Exposed only in vicinity of Glendive but underlies Fort Union formation in rest of area.	Yield sufficient water for domestic and stock use. Water generally highly mineralized. Where exposed, recharged by direct penetration of precipitation; elsewhere, by seepage of water from overlying beds.	Do.
		Fox Hills sandstone	----------	Massive, white to light-gray, fine to medium-grained sandstone in upper part; yellow shaly sandstone interbedded with gray silty sandstone in lower part. Thickness ranges from 150 to 220 ft. Not exposed but probably underlies entire area.	Source of part of municipal supply of Glendive. Wells yield soft, highly mineralized sodium bicarbonate water. Recharged by precipitation and by infiltration of water from overlying beds.	Do.

the southwest end of the area. The thickness of the formation is about 500 feet (Calvert and others, 1912, p. 14). The contact of the Hell Creek formation with the underlying Fox Hills sandstone is exposed along both sides of the valley for a short distance southwest of Glendive, and the contact with the overlying Fort Union formation of Tertiary (Paleocene) age is exposed on the northeast side of the Glendive Creek valley and on the northwest side of the Yellowstone River valley opposite Glendive. The upper contact is transitional and generally is poorly exposed.

The Hell Creek formation consists of brownish-gray sandstone interbedded with carbonaceous shale and gray silty mudstone. The carbonaceous shale, which in places grades into shaly lignite, is more characteristic of the upper part of the formation. Ironstone concretions, as much as 6 inches in diameter, are common. The concretions have a curious surficial pattern caused by the exfoliation of the outer coating of hematite. The soft rocks of the Hell Creek formation erode readily into badlands.

Small to moderate supplies of ground water can be obtained by wells penetrating the Hell Creek formation. Recharge to the formation is by the direct infiltration of precipitation that falls on the outcrops, by seepage from overlying beds, and by infiltration where the formation is crossed by streams. Although some of the deeper wells downstream from Glendive probably penetrate the Hell Creek formation, it generally is impossible to determine whether this or some shallower formation is the principal aquifer.

TERTIARY SYSTEM

PALEOCENE SERIES

Fort Union formation.— The only other bedrock formation exposed in the area north of the outcrop of the Hell Creek formation is the Fort Union formation. It is 1,190 feet thick and is essentially flat lying except near the south end of the area where it dips from 1° to 3° northeastward off the flank of the Cedar Creek anticline (Calvert and others, 1912, p. 10, 103).

The Fort Union formation was deposited in fresh water and consists of alternating beds of yellowish-gray to buff sandstone, clay, shale, lignite, carbonaceous shale, and red clinker. Because the beds interfinger and grade both laterally and vertically, a stratigraphic section measured at one place cannot be correlated closely with a section measured elsewhere. Some of the massive sandstone beds become cavernous on exposure to weathering. The lignite beds, which range up to 15 feet in thickness, are sometimes set on fire by lightning, by spontaneous combustion, or by man.

The heat from the burning lignite bakes and fuses the overlying clay and sandstone into red clinker.

Many of the domestic and stock wells obtain moderate supplies of water from the Fort Union formation. The water is obtained principally from fractured lignite, which is more permeable than the other materials. In places, the water is brownish, tastes of "soda" (sodium bicarbonate), and contains small amounts of combustible gas. The gas, which probably originates from the decomposition of coal, generally forms bubbles in the water of flowing wells. Some of the wells in the Fort Union formation are as much as 500 feet deep; however, most of the wells draw water from aquifers that are only 100 to 350 feet below the surface.

QUATERNARY SYSTEM

PLEISTOCENE SERIES

Higher stream-terrace deposits.— Prominent stream terraces border the lower Yellowstone River. The higher terraces, which range from 120 to 420 feet above the present stream, are probably of early Pleistocene age because in the northern two-thirds of the area they are mantled by glacial moraine and therefore are older than the glacier which deposited the moraine. The higher terraces have been designated *I*, *H*, *G*, and *F*, from oldest to youngest, respectively. The unconsolidated deposits underlying the four terraces consist of gravel, sand, silt, and clay. The gravel beds range in thickness from 15 to 30 feet and are composed principally of well-rounded pebbles and cobbles of quartzite or intrusive igneous rocks. Pieces of agate and petrified wood are common in the gravel. The combined area of the four terraces is about 10 square miles.

Although their origin is somewhat in doubt, terraces *I* and *F* have been mapped as stream terraces. They are flat tablelands bordered by glacial moraine on the upland side. Possibly they are remnants of more extensive terraces that were glaciated elsewhere but not here, or possibly they are surfaces from which the mantle of glacial deposits has been removed by erosion. The writers were unable to correlate these two terraces with unglaciated terraces farther south.

As no wells within the area are known to tap the water-bearing gravel underlying the higher terrace deposits, the amount of water obtainable from these deposits could not be determined without making further detailed investigations.

Glacial deposits.—Glaciation extended as far south as Intake. Although no terminal or recessional moraines are recognized in the area, extensive deposits of rolling ground moraine mantle the higher terraces and the upland on the northwest side of the Yellowstone River. Small patches of ground moraine and scattered boulders brought into the area by the ice sheet are present along the sides of tributaries on the southeast side of the Yellowstone River, but there is almost no evidence of glaciation of the upland on the southeast side of the river. Possibly two ice sheets advanced over the northern part of the area; the first was more extensive than the second, which was restricted to the northwest side of the Yellowstone River valley. It is possible also that only one ice sheet advanced into the area and that only a weak ice mass crossed the Yellowstone River from the northwest side and advanced in the form of lobes up the tributary valleys. The broad valley of the Yellowstone River and its high southeast wall may have prevented the advance of the ice sheet over the upland on the southeast side of the river.

The ground moraine, a matrix of clay and silt that encloses coarser debris, generally is less than 10 feet thick; consequently, it does not store large quantities of ground water. Only one well in the area is known to tap this deposit.

Lower stream-terrace deposits.—The lower, more recent stream terraces are wider and less dissected than the higher stream terraces; because of the absence of glacial debris on these surfaces, it is believed that they were formed subsequent to the melting of the last glacier. The unconsolidated sediments underlying the lower terraces are composed of materials similar to those underlying the higher terraces, but the materials generally are finer grained and the beds of gravel are thinner. The lower terraces have been designated *E, D, C, B,* and *A*, from oldest to youngest, respectively, and they range in height from 14 to 90 feet above the Yellowstone River.

Ground water in the terrace deposits is the source of supply for most wells. In some places relatively large yields can be obtained from these deposits if the wells are constructed properly and spaced so that mutual interference is minimized.

RECENT SERIES

Alluvium.—Underlying the flood plain of the Yellowstone River is alluvium consisting largely of medium to fine sand, silt, and clay. In places small amounts of gravel are scattered along the river bank. Several wells obtain water from the alluvium. The yield of wells tapping the alluvium generally is limited by the relatively low permeability of the water-bearing material.

GROUND WATER

Both the bedrock formations and the unconsolidated materials mantling the bedrock contain ground water and are the source of water for industrial and municipal use as well as for domestic and stock supply in several areas.

RECHARGE

Precipitation, which amounts to about 14 inches per year on the average, is the principal source of recharge to the bedrock formations, the higher terrace deposits, the lower nonirrigated terrace deposits, and the ground moraine. Recharge to these aquifers generally is greatest during the spring when the snow cover melts and the precipitation is heaviest. The bedrock formations are a source of perennial supply and most dryland farmers have one well or more that penetrates the bedrock. The zone of saturation in the higher terrace deposits and in the lower nonirrigated terrace deposits probably is relatively thin, but water supplies adequate for domestic and stock use probably could be obtained from the more extensive remnants of these deposits. Where terrace deposits are bounded on the upland side by higher terrace deposits or ground moraine, the supply of ground water is likely to be perennial because some recharge is effected by underflow from the higher lying unconsolidated deposits. In favorable locations a small supply of water for domestic and stock use can be obtained from the ground moraine at the present time, but a succession of dry years probably would almost completely dewater this material.

Infiltrating irrigation water diverted from the Yellowstone River is the principal source of recharge to the terrace deposits underlying the irrigated terraces. Additional sources of recharge are precipitation, infiltration of canal water, and underflow from higher terrace deposits and possibly from the bedrock. Because the amount of recharge to these deposits is much greater than that to the deposits underlying the nonirrigated terraces, the water table generally is closer to the land surface and the zone of saturation is thicker.

The alluvium along the Yellowstone River and its tributaries is recharged by the river, or tributary streams, during periods of high flow, by precipitation, and by underflow from the adjacent terrace deposits and bedrock.

MOVEMENT

The water table, or surface of the ground water, in the terrace deposits slopes toward the Yellowstone River because the ground water is moving in that direction. The slope of the water table generally is somewhat irregular rather than perfectly smooth and changes slightly from time to time depending on the conditions of recharge and discharge. The major irregularities are caused by differences in the slope of the bedrock on which the terrace deposits rest and by differences in the capacity of the terrace deposits to transmit the water. Localized recharge to ground-water storage causes temporary mounding of the water table, and localized discharge of ground water creates depressions in the water table.

The slope of the water table is shown by the two sets of contour lines on plate 2. One set is based on water-level measurements made in August 1949, when the water table was at its highest stage for that year, and the other set is based on water-level measurements made during December 1949, when the water table was at its lowest stage. The water table in August was comparatively smooth because at that time the rate of recharge exceeded the rate of discharge and the avenues of discharge by underflow were not reflected by depressions in the water table. On the other hand, the water table in December was uneven because the avenues of discharge by underflow were not masked either by recharge or by other types of discharge.

DISCHARGE

Ground water is discharged from the Fort Union formation by wells, by springs where water-bearing beds in the formation are exposed along valley sides, and by underflow into the terrace deposits and alluvium where they are in contact with water-bearing beds of the Fort Union formation. Ground water in the ground moraine and the higher terrace deposits is discharged by underflow into adjacent lower unconsolidated deposits, by vegetation and evaporation wherever the water table is shallow, and by springs where the water table intersects the land surface along the edge of a terrace. The lower terrace deposits are drained by ditches and streams, by underflow into adjacent deposits downgradient, by vegetation and evaporation in places where the water table is shallow, and by wells and springs. Ground water in the alluvium along the Yellowstone River is discharged by the transpiration of the many trees and other plants growing on the flood plain, by direct evaporation where the water table is shallow, by wells, and by outflow into the Yellowstone River. The river drains from the valley the excess ground water not discharged by other means.

All water wells in the area were visited during the course of the investigation and data pertaining to the wells were recorded. These data are assembled in table 4. The municipal water-supply systems of Sidney and Glendive represent the two greatest concentrations of artificial withdrawals of ground water. The public supply of Glendive is obtained in part from two wells that penetrate the Fox Hills formation and in part from the Yellowstone River. The public supply of Sidney is obtained wholly from three closely spaced wells that penetrate unconsolidated deposits of sand and gravel. Water consumption at Sidney is reported to range from about 200,000 to 1,000,000 gpd. Large industrial users of ground water at or near Sidney who have their own source of supply are a sugar refinery, a flour mill, and a frozen-food locker company.

WATERLOGGING

The capillary fringe is the zone in which ground water is held by capillarity, and land is said to be waterlogged when the capillary fringe above the water table extends to, or almost to, the land surface. Waterlogged land generally is unproductive because the air necessary in the soil for the growth of most plants has been displaced by water and because the concentration of salts in the water resulting from evaporation at the surface has exceeded the tolerance of most plants. Waterlogging is the result of inadequate subsurface drainage and occurs in areas of shallow water table where recharge is greater than the capacity of the water-bearing materials to transmit the excess ground water away. The infiltration of irrigation water, seepage from the canal and laterals, and water discharged by springs along the edge of higher lying terrace deposits are the principal causes of waterlogging on the Lower Yellowstone Project. Most of the problems resulting from waterlogging have been solved by the use of open drainage ditches, which generally have been well placed and have operated effectively. The waterlogging that has made small patches of land untillable on the Lower Yellowstone Project is almost entirely the result of ineffective drainage ditches. Other areas are likely to become waterlogged if the drainage ditches are not kept free of weeds and accumulated silt.

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FLUCTUATION OF THE WATER LEVEL IN WELLS

Measurements of the water level in wells were made periodically during the course of and for some time after this investigation. Hydrographs of the water level in three of the observation wells have been plotted in figure 10 to illustrate typical water-level fluctuations in the nonirrigated and irrigated parts of the area.

Well 18–56–25cb is situated in a nonirrigated area where the principal source of recharge is precipitation. The range of water-level fluctuation during the $4\frac{1}{2}$-year period of record was slightly more than 1 foot. The water level generally is highest in the spring when the snow is melting and precipitation is greatest. As the growing season advances, the water level gradually declines because the discharge from the aquifer exceeds the recharge. The first heavy frost in the fall usually is reflected by a sharp rise of the water level in the well because withdrawal of water from the aquifer by growing plants has been halted abruptly.

The record of water-level fluctuations in well 20–58–30db began before irrigation and extended into the period of irrigation. During the first year of record (1949) the water level was 5 to 6 feet below the land surface. During 1950 the area in which the well is situated was first irrigated and the water level in the well rose to a level of 2 to 3 feet below the land surface. The water level remained at this depth during 1951 except for a short time after the spring thaw when the water level in the well was 1 to 2 feet below the land surface. Topographically low places near the well became ponds, and deposits of salts on the land surface became evident in much of the area.

Well 23–59–11ba2 is in an area that has been irrigated for more than 40 years. During the 3 years of record, the water level in this well has fluctuated within a range of about 3 feet. The water level rises in the early spring as a result of recharge from the melting snow and from rainfall, declines during the late spring and early summer, rises again later in the summer as a result of the infiltration of irrigation water, and then declines again during the fall and winter. The downward trend of the water level indicates that waterlogging in the vicinity of this well is not imminent if the present ratio of recharge to discharge remains relatively constant.

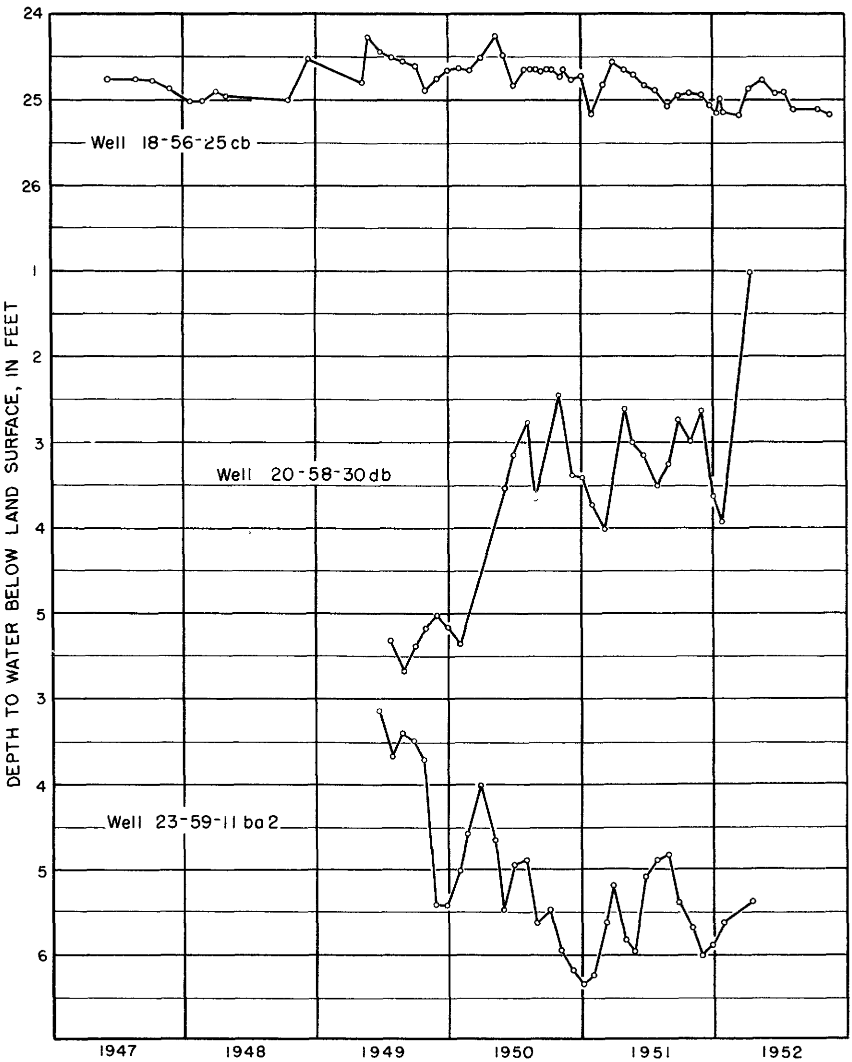

Figure 10. —Hydrographs of the water level in three observation wells.

CHEMICAL QUALITY OF THE WATER

By Herbert A. Swenson

The chemical character of the water in the area was determined from 30 analyses of water from ground and surface sources. These samples, collected from September 15 to December 29, 1949, are considered representative of water in the bedrock aquifers and surficial deposits and of water in irrigation canals and drainage ditches. The sources of these samples and the number analyzed from each source are shown below:

Water samples collected for chemical analysis

Aquifer or surface source	*Samples analyzed*
Fox Hills sandstone	1
Fort Union formation	6
Glacial drift	1
Terrace deposits	13
Alluvium	2
Blend[1]	1
Irrigation canal	3
Drainage ditch	3
Total	30

[1]Water from Fox Hills sandstone and Yellowstone River (Glendive municipal supply).

The main sources of ground water are the consolidated rocks of the Fort Union formation and the unconsolidated terrace and alluvial deposits. It is believed that a sufficient number of samples was collected to define the average chemical characteristics of the water in the aquifers. The municipal supply at Glendive was analyzed to show the effects of blending ground water from the Fox Hills sandstone with water from the Yellowstone River. Three samples were collected from the main irrigation canal for analysis. Drainage water from ditches was sampled during the irrigation season and after irrigation had ended to observe any changes in the salinity of the drainage water. The location of sampling points is shown in figure 11, and the results of chemical analyses appear in table 2. Typical analyses are represented graphically in figure 12, in which the height of the columns is proportional to the concentration of principal ions expressed in equivalents per million.

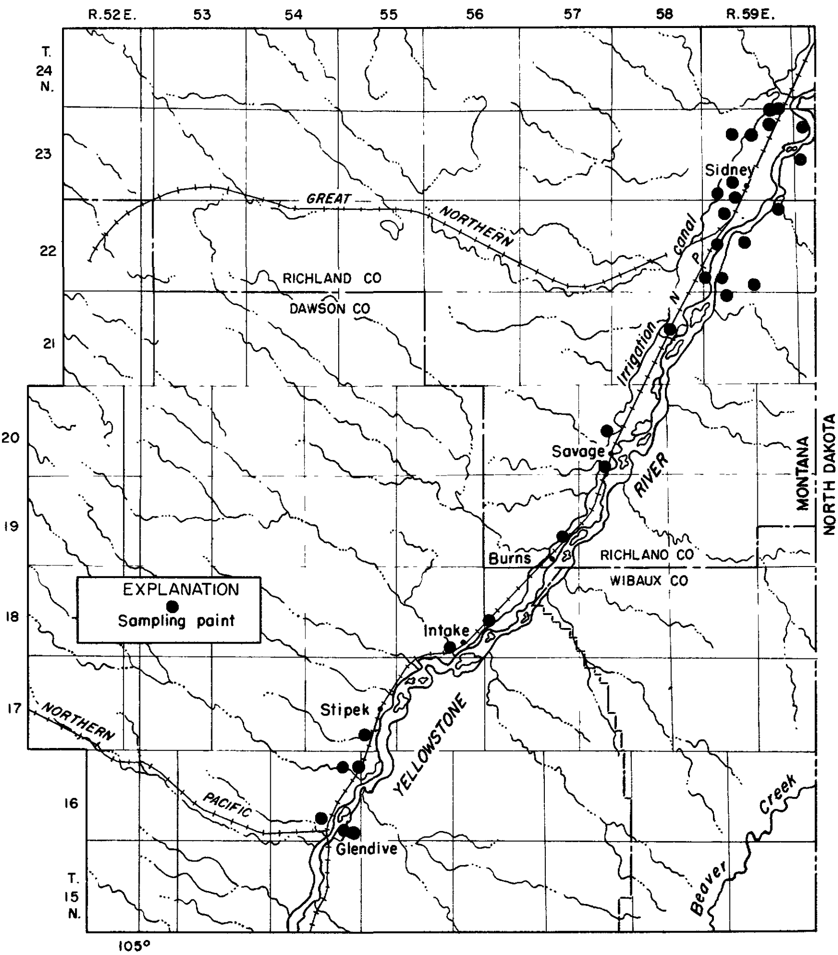

Figure 11.—Map of the lower Yellowstone River valley between Glendive and Sidney showing points at which water samples were collected for chemical analyses.

CORRELATION OF GROUND-WATER QUALITY WITH GEOLOGIC SOURCE

WATER IN THE FOX HILLS SANDSTONE

Well 16-55-35ab2 in the city of Glendive is 105 feet deep and is reported to penetrate the Fox Hills sandstone. The sample of water from this well contained sodium bicarbonate, was soft and highly mineralized, and was similar in chemical properties to water in the Fort Union formation.

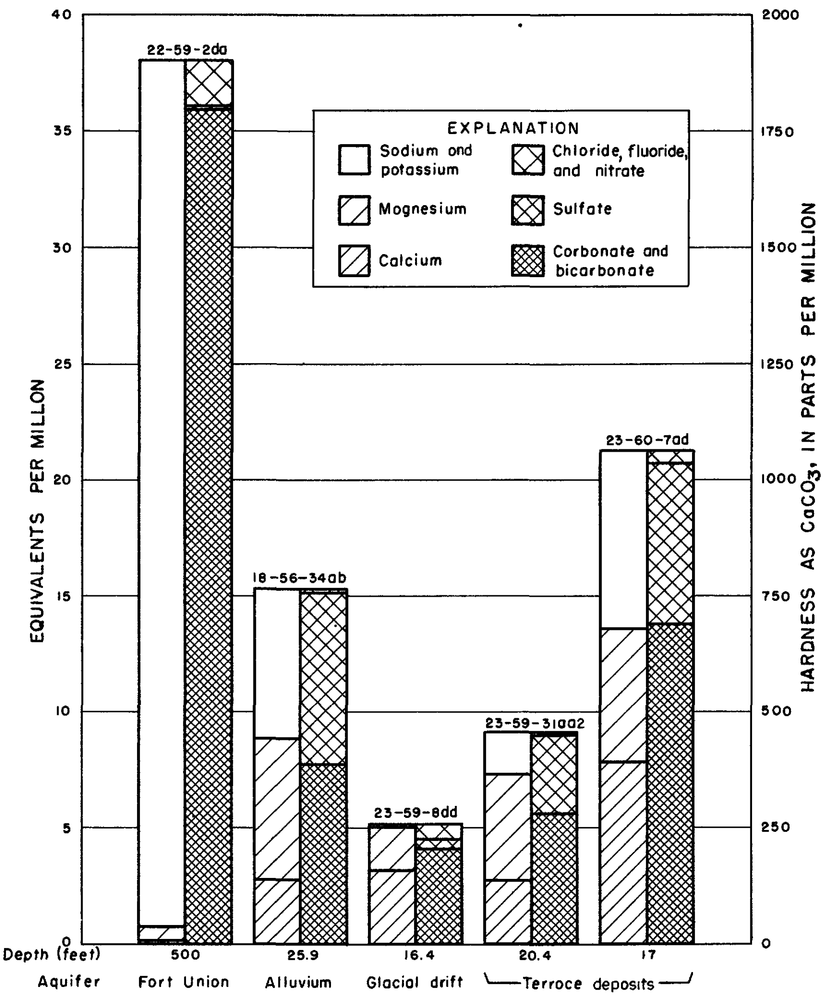

Figure 12.—Chemical analyses of ground water from several water-bearing formations.

WATER IN THE FORT UNION FORMATION

Samples of water for chemical analysis were collected from 6 wells penetrating the Fort Union formation. Five of the wells, which range in depth from 150 to 500 feet, yield water that contains more than 1,000 ppm of dissolved solids. The hardness of this water was uniformly low and ranged from 38 to 56 ppm as calcium carbonate ($CaCO_3$). Fluoride concentrations were significant in water from 4 deep wells and ranged from 1.8 to 3.2 ppm. Commonly present in the water from the Fort Union formation is a small amount of natural gas, which is liberated when the water

Table 2.—*Chemical analyses and related*

[Analytical results in parts per

Well no. or surface source	Depth of well (feet)	Date of collection (1949)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)
							Fox Hills sandstone		
16-55-35ab2	105	Sept. 15	17	0.14	2.0	6.1	478	0.8	852
								Fort Union	
16-55- 1dc	150	Oct. 4	16	0.04	10	5.2	424	2.4	746
22-59- 2da	500	3	16	.15	3.0	7.4	857	2.4	2,080
30bb	220	4	14	.06	6.0	6.6	602	10	1,490
34ca	100+	4	15	9.9	100	46	30	2.4	532
23-59- 2ab	190	3	10	1.0	6.5	6.0	578	7.2	912
32dd1	400	3	22	.40	6.0	10	891	.8	2,170
									Glacial
23-59- 8dd	16.4	Oct. 3	18	0.11	63	23	3.7	0.8	246
									Terrace
17-55-34ad	22.8	Oct. 4	17	5.0	39	59	448	10	444
19-57-26ad	22.0	4	25	.32	87	66	211	6.4	292
20-58-21bb	37.9	4	30	.17	98	90	218	2.4	694
32ac2	32.5	4	27	4.7	84	33	51	5.6	268
21-58-15db4	....	4	33	.06	61	75	69	8.0	464
59- 5ba	37.9	4	26	.06	50	74	695	14	852
22-59-16dc	16.1	4	18	.06	108	45	31	4.0	453
19ab	9.0	4	23	8.1	124	84	226	4.0	648
23-59-11ba2	8.2	3	24	.22	55	80	197	8.0	635
31aa2	20.4	3	19	.42	55	56	40	.8	342
32ad	75	Sept. 15	26	2.6	65	56	59	3.2	348
60- 7ad	17	Oct. 3	21	10	158	69	173	11	843
19ca1	21.7	3	22	8.4	103	69	940	14	1,020
		Alluvium							
16-55- 2dc	13.4	Oct. 4	21	0.22	107	60	400	7.2	682
18-56-34ab	25.9	4	17	.31	56	71	148	4.0	472
						Delivered water, Glendive			
Mixture of water from Fox Hills sandstone and from the Yellowstone River	....	Sept. 15	23	0.10	24	20	126	3.2	52
									Surface
Irrigation canal near Glendive	....	Oct. 4	9.8	0.12	42	28	86	3.2	116
Irrigation canal near Intake	....	4	16	1.0	65	31	80	.8	194
Irrigation canal north of Sidney	....	3	13	.12	65	25	70	7.2	190
Drainage ditch canal about 6 miles southwest of Sidney	....	4	22	.06	77	47	87	4.8	402
Drainage ditch canal about 2 miles southwest of Sidney	....	Dec. 29	24	1.0	124	110	193	14	540
Drainage ditch canal about 6 miles northeast of Sidney	....	29	20	.02	61	128	361	9.6	676

physical measurements of water

million except as indicated]

Carbonate (CO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Boron (B)	Dissolved solids: Residue on evaporation at 180°C	Dissolved solids: Sum	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Percent sodium	Specific conductance (micromhos at 25°C)	pH
(Glendive municipal well)												
59	216	14	2.4	3.8	1.15	......	1,230	30	0	97	1,770	8.6
formation												
49	176	39	......	2.0	0.96	......	1,090	47	0	95	1,610	8.7
57	1.6	71	2.0	.2	.40	......	2,060	38	0	98	2,960	8.3
89	10	17	3.2	.5	......	......	1,500	42	0	96	2,400	8.2
0	66	1.0	.2	.0	.20	530	......	439	3	13	803	7.5
28	436	12	1.8	2.4	.20	......	1,540	41	0	96	2,380	8.3
79	0	41	2.4	2.2	.25	......	2,140	56	0	97	3,050	8.3
drift												
0	16	10	......	25	0.40	270	......	252	50	3	447	7.6
deposits												
0	832	31	......	2.4	0.30	......	1,670	340	0	73	2,290	7.9
0	628	20	0.6	29	.76	......	1,220	489	250	48	1,630	7.7
0	456	8.0	.6	3.8	.76	......	1,250	615	46	43	1,720	8.0
0	204	10	......	.6	.30	566	......	345	125	24	778	7.4
0	224	9.0	.6	19	.30	774	......	461	81	24	1,060	7.8
0	1,180	9.8	1.2	.5	......	......	2,480	430	0	77	3,560	7.6
0	128	7.0	.4	2.4	......	562	......	455	84	13	873	7.0
0	588	13	.6	.0	.40	......	1,400	655	124	43	1,830	7.5
0	332	12	.8	2.2	.40	......	1,030	467	0	47	1,520	7.8
0	164	4.0	.2	2.8	.25	496	......	368	88	19	746	7.8
0	208	6.0	.2	.4	.30	600	......	393	108	24	847	7.6
0	332	19	.2	.0	......	......	1,200	678	0	35	1,810	7.3
0	1,660	18	.6	6.2	.25	......	3,350	541	0	79	4,180	7.7
Alluvium												
0	812	5.8	0.2	0.2	......	......	1,750	514	0	62	2,430	7.5
0	356	4.0	.4	.4	0.30	934	......	432	45	42	1,260	7.8
municipal supply												
39	284	13	0.6	1.8	0.30	546	......	143	36	65	790	9.6
waters												
0	272	12	0.4	1.0	0.25	538	......	220	125	45	746	7.5
0	264	11	.4	1.2	.30	626	......	290	131	37	824	8.1
0	248	10	.4	1.2	......	572	......	265	109	36	864	7.3
0	208	9.0	.6	1.8	.30	680	......	386	56	33	941	8.1
0	676	10	.2	.8	.60	......	1,420	762	319	35	1,970	7.7
0	860	9.6	.7	1.8	.40	......	1,790	679	125	53	2,490	7.7

reaches the surface. Well 22-59-34ca, which is 100 feet deep and penetrates a short distance into the Fort Union formation, furnished water that differed in chemical character from the water yielded by the other sampled wells in the same formation. This water contained 530 ppm of dissolved solids and had a hardness of 439 ppm. The concentration of fluoride was only 0.2 ppm. As the well is not tightly cased, hard water from the overlying terrace deposits probably enters the well. The mixing of water from the two sources may account for the difference between the chemical character of the water in this well and that of the other sampled wells in the Fort Union formation.

The soft water yielded by wells penetrating deeply into the Fort Union formation may be the result of natural softening (Renick, 1924) by minerals of the beidellite[1] group. These minerals are plentiful in the Fort Union formation and are capable of exchanging all or part of their sodium and potassium for other bases. The calcium and magnesium ions in the water in the upper part of the formation enter into ion-exchange reactions with these minerals and thereby reduce the hardness considerably. The minerals of the beidellite group are more abundant in some parts of the formation than in others.

WATER IN THE GLACIAL DRIFT

One sample of the water in the glacial drift was collected from well 23-59-8dd, 16.4 feet deep. The water was hard and had a relatively low mineral content that consisted principally of calcium and magnesium bicarbonates.

WATER IN THE TERRACE DEPOSITS

A wide range in chemical properties characterized the water from wells in the terrace deposits. The concentration of dissolved solids ranged from 496 to 3,350 ppm, and the hardness ranged from 340 to 678 ppm. The average for 13 analyses was 1,280 ppm of dissolved solids and a hardness of 480 ppm. Minimum and maximum values for iron were 0.06 and 10 ppm, respectively. The concentration of nitrate ranged from 0 to 29 ppm. The salinity of the water is independent of the well depth and, like the chemical composition of the water, is due to several factors, which include the following: the proportion and type of rock comprising the clay, silt, sand, and gravel in the aquifer; the rate and direction of ground-water movement through the aquifer; the amount, rate,

[1] Renick referred to this mineral as leverrierite, which name since has been discarded. See Ross, C. S., and Hendricks, S. B., 1945, Minerals of the montmorillonite group: U. S. Geol. Survey Prof. Paper 205-B, p. 26.

and chemical character of the recharge to the aquifer; and the rate of discharge from the aquifer.

WATER IN THE ALLUVIUM

Water in the alluvium from wells 16-55-2dc and 18-56-34ab, which are 13.4 and 25.9 feet deep, respectively, was similar in mineral content and hardness to water in the terrace deposits. Both wells penetrate the alluvium of tributaries to the Yellowstone River.

CHEMICAL CHARACTER OF IRRIGATION WATER

Three samples of water from irrigation canals were analyzed to obtain information on the quality of water that is applied to farmland in the valley. According to the standards of Wilcox (1948) the canal water is satisfactory for irrigation. The chemical and physical properties that affect the suitability of water for irrigation are shown below:

Properties of irrigation water

Sampling point	Specific conductance (micromhos at 25°C)	Boron (ppm)	Percent sodium
Near Glendive..........	746	0.25	45
Near Intake..............	824	.30	37
North of Sidney.........	864	....	36

CHEMICAL CHARACTER OF DRAINAGE WATER

The water in a drainage ditch about 6 miles southwest of Sidney was sampled on October 4, 1949, when water was flowing in the irrigation canal. The concentration of dissolved solids in the water was 680 ppm, and this salinity is the net result of the mixing of salt-laden seepage water with irrigation runoff from the fields. On December 29, after the flow in the canal had ceased, two water samples were collected from drainage ditches in the vicinity of Sidney. These samples of seepage water contained more than twice the amount of dissolved solids contained in the October sample. These results, though not necessarily indicative of average conditions for the whole irrigation season, do show the variable chemical character of the drainage water. The drainage water would be classified as permissible for reuse as an irrigation supply, according to the standards of Wilcox (1948).

The chemical analyses of both irrigation and drainage water are shown graphically in figure 13.

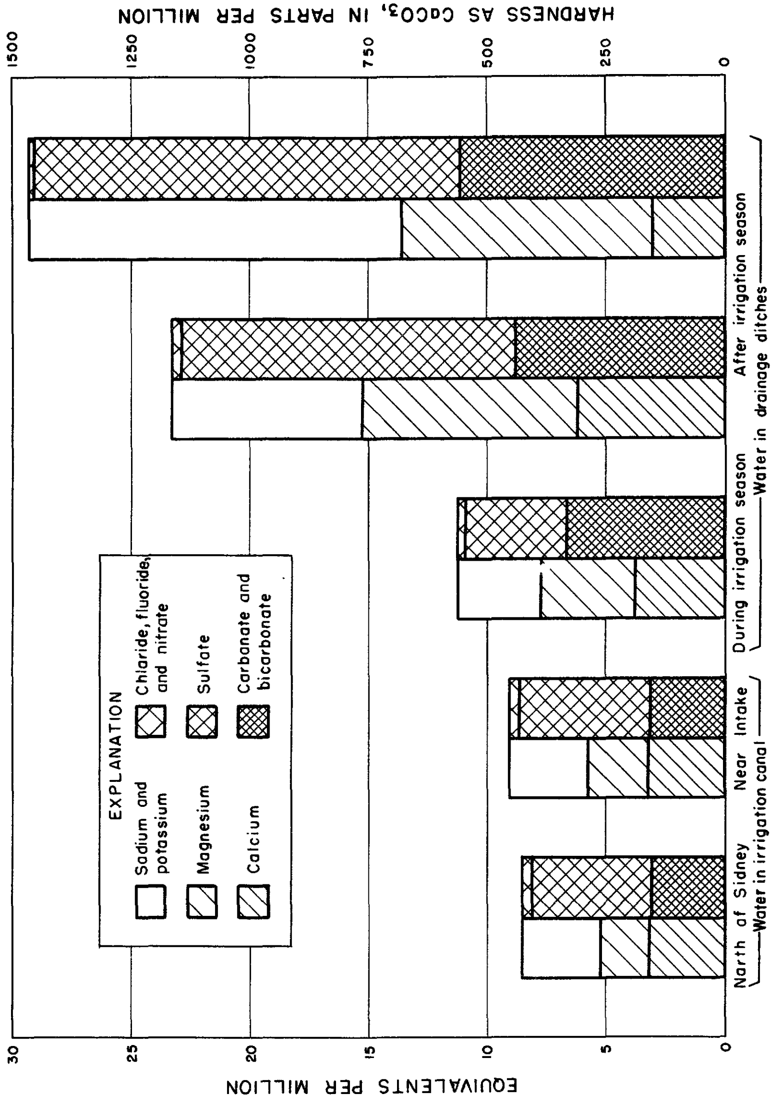

Figure 13. —Chemical analyses of irrigation and drainage water.

MUNICIPAL SUPPLIES

GLENDIVE

A sample of the municipal water supply at Glendive was collected from well 16-55-35ab2 (city well no. 2), and the analysis showed it to be a soft, highly mineralized sodium bicarbonate water. The mixing of the soft ground water from the Fox Hills sandstone (hardness, 30 ppm) with the river water (estimated hardness, 225 ppm) resulted in a delivered water that had a hardness of 143 ppm on September 15, 1949.

SIDNEY

City well no. 1 in Sidney yields a hard, highly mineralized water, which when sampled contained 2.6 ppm of iron. This well (23-59-32ad) is 1 of 3 city wells that supply water to Sidney.

Chemical analyses of water from the Glendive and Sidney supplies are shown graphically in figure 14.

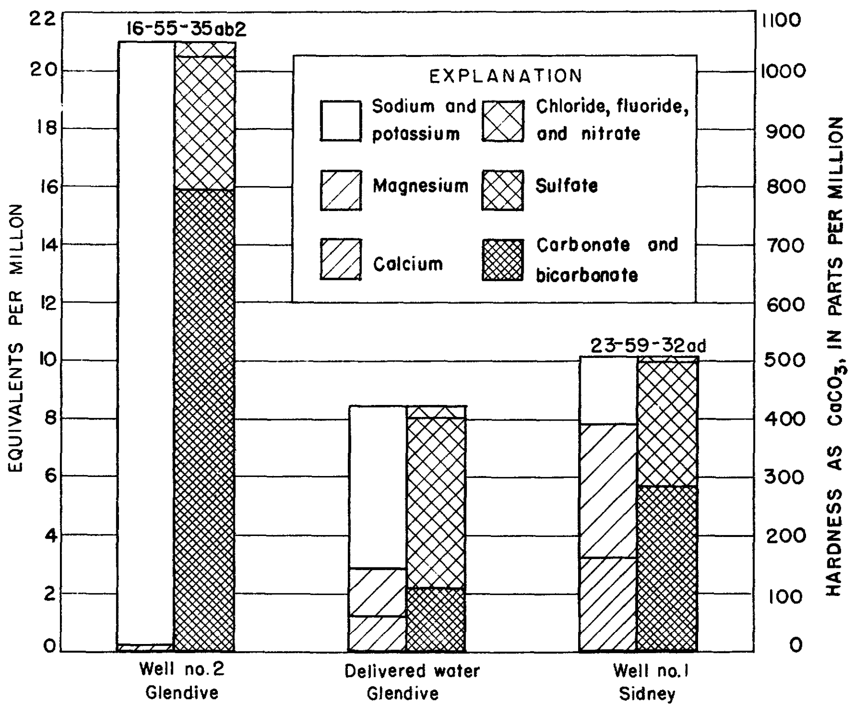

Figure 14. —Chemical analyses of municipal water supplies.

RELATION OF THE CHEMICAL CHARACTER OF GROUND WATER TO USE

Ground water in the valley at present is used almost exclusively for domestic and stock purposes. The results of analyses of ground water generally indicate that water from the bedrock aquifers is much softer than water in the surficial deposits. The bedrock water usually has a "soda" taste and in places contains undesirable amounts of fluoride. Highly mineralized water from the terrace deposits and alluvium is potable except the water that contains iron in excess of 0. 3 ppm. People who are accustomed to drinking water that contains more than 1, 000 ppm of dissolved solids generally consider less concentrated water unpalatable.

Ground water is not used for irrigation in the valley except for sprinkling lawns and small gardens. Water in the alluvium of small tributaries to the Yellowstone River may be suitable as irrigation water. Two analyses show that the water from the alluvium would be classified as "permissible to doubtful" for irrigation (Wilcox, 1948).

CONCLUSION

Bedrock of Late Cretaceous and early Tertiary age and unconsolidated deposits of Quaternary age are sources of ground-water supply. The bedrock aquifers generally are tapped only where no unconsolidated deposits are present or the water yielded by those deposits is insufficient in amount or poor in quality. The unconsolidated deposits of sand and gravel underlying the broad lower terraces on the northwest side of the Yellowstone River are the source of the water yielded by most of the wells in the area. Although the existing wells generally have a small yield, moderately large supplies probably could be developed where the infiltration of irrigation water is the principal source of recharge and the deposits of sand and gravel are relatively thick and permeable. Before drilling any wells from which a large yield is required, however, the water-yielding capacity of the aquifer at the proposed well site should be tested by drilling one or more test holes.

The Fox Hills sandstone and Fort Union formation generally yield soft sodium bicarbonate water containing 1, 000 ppm or more of dissolved solids in which fluoride is often present in significant amounts. Although variable in chemical properties, water contained in the surficial deposits generally is less mineralized but much harder than water in the bedrock. Many of the samples collected for analysis contained objectionable amounts of iron. The sodium bicarbonate content of the water from the deeper wells in the Fort Union formation in this region is thought to result from the action of minerals of the beidellite group which are capable of entering into ion-exchange reactions. Ground water is used almost exclusively for domestic and stock purposes and is satisfactory in most places for drinking.

Although a small amount of ground water is applied to lawns and gardens, only water diverted from the Yellowstone River is used for the irrigation of farmland. To what extent the chemical character of the ground water has been modified as a result of irrigation practices is not known.

Irrigation of the lower terraces along the Yellowstone River has greatly increased the recharge to the unconsolidated deposits underlying these terraces. As a result the water table has risen sufficiently to cause or threaten waterlogging of the topographically low areas. The construction of drains has lowered the water table in most of these areas, but unless the drains are kept free of vegetation and silt deposits their efficacy will be so reduced that the low areas will become waterlogged again. Detailed ground-water studies are needed in the few remaining waterlogged areas so that further attempts to drain them will be more effective. The extension of irrigation to new areas probably will result in a general rise of the water table beneath both those lands and adjacent lower-lying lands. By making periodic measurements of the depth to water in wells, areas threatened by waterlogging can be delineated. Detailed ground-water investigations in these areas before drainage is attempted will yield information that is essential for the planning of effective drains. The cost of such an investigation would be amply repaid if the construction of ineffective drains and the resultant losses attributable to waterlogging could be prevented.

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WATER-LEVEL MEASUREMENTS AND WELL RECORDS

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Table 3.—*Water-level measurements in observation wells*

[Feet below land surface]

Date	Water level	Date	Water level	Date	Water level
DAWSON COUNTY, MONT.					
16-55-2dc					
July 12, 1949	8.27	Nov. 30, 1949	10.25	May 31, 1950	7.55
Aug. 31	10.31	Dec. 29	10.59	June 30	7.73
Sept. 30	10.78	Jan. 31, 1950	10.70	July 31	8.98
Oct. 31	10.30	May 11	7.80	Aug. 30	9.93
16-55-13bd					
May 27, 1949	11.32	Oct. 31, 1949	12.52	May 31, 1950	11.63
June 29	12.06	Nov. 30	12.58	June 30	11.58
July 28	12.34	Dec. 29	12.68	July 31	12.12
Aug. 31	12.68	Jan. 31, 1950	12.46	Aug. 30	12.12
Sept. 30	12.68	May 11	11.70		
16-55-34aa2					
June 6, 1949	10.40	Feb. 2, 1951	9.60	Aug. 30, 1951	11.14
Sept. 30	12.02	Mar. 5	9.63	Sept. 26	11.48
Oct. 31	10.57	29	9.56	Oct. 30	10.66
Nov. 30	10.39	Apr. 30	10.17	Nov. 30	10.45
Dec. 29	10.43	May 25	11.14	Dec. 26	10.52
Nov. 2, 1950	10.75	June 28	9.33	Jan. 25, 1952	9.31
Dec. 5	9.72	July 30	10.24	Apr. 18	9.07
Jan. 2, 1951	9.40				
17-55-23ab					
July 13, 1949	16.45	Nov. 30, 1949	16.32	May 11, 1950	16.38
28	16.40	Dec. 29	16.42	31	16.42
Aug. 31	17.31	Jan. 31, 1950	16.39	June 30	16.32
Sept. 30	16.26	Feb. 28	16.46	July 31	16.38
Oct. 31	16.28	Mar. 31	16.34	Aug. 30	16.32
17-55-23bc					
June 24, 1949	37.10	Dec. 29, 1949	37.07	May 31, 1950	36.95
July 28	37.04	Jan. 31, 1950	36.93	June 30	37.06
Aug. 31	37.05	Feb. 28	36.98	July 31	37.20
Sept. 30	37.01	Mar. 31	37.02	Aug. 30	36.82
Oct. 31	36.99	May 11	37.02	Sept. 30	36.88
Nov. 30	36.99				
17-55-23da					
June 24, 1949	25.58	May 31, 1950	24.89	Apr. 30, 1951	24.54
July 28	25.58	June 30	25.12	May 25	24.65
Aug. 31	25.73	July 31	25.01	June 28	24.73
Sept. 30	25.95	Aug. 30	27.08	July 30	24.80
Oct. 31	25.49	Sept. 30	24.75	Aug. 30	24.59
Nov. 30	25.44	Nov. 2	24.42	Sept. 26	24.95
Dec. 29	25.51	Dec. 5	24.80	Oct. 30	24.60
Jan. 31, 1950	25.38	Jan. 2, 1951	24.66	Nov. 30	24.53
Feb. 28	25.16	Feb. 2	24.67	Dec. 26	24.51
Mar. 31	25.04	Mar. 5	24.64	Jan. 25, 1952	24.30
May 11	24.86	29	24.65	Apr. 16	24.42
17-55-23dd					
May 27, 1949	23.80	Aug. 31, 1949	23.97	Nov. 30, 1949	23.73
June 29	23.91	Sept. 30	23.92	Dec. 29	23.88
July 28	23.93	Oct. 31	23.80	Jan. 31, 1950	23.56

Table 3.—*Water-level measurements in observation wells*—Continued

DAWSON COUNTY—Continued

17-55-23dd—Continued

Date	Water level	Date	Water level	Date	Water level
Feb. 28, 1950	23.49	May 31, 1950	23.59	Aug. 30, 1950	23.67
Mar. 31	23.44	June 30	23.64	Sept. 30	23.56
May 11	23.46	July 31	23.71		

17-55-34ad

Date	Water level	Date	Water level	Date	Water level
June 24, 1949	15.51	May 31, 1950	15.42	Apr. 30, 1951	15.71
July 28	15.68	June 30	15.46	May 25	15.52
Aug. 31	15.77	July 31	15.47	June 28	15.65
Sept. 30	15.82	Aug. 30	15.53	July 30	15.75
Oct. 31	15.90	Sept. 30	15.54	Aug. 30	15.79
Nov. 30	15.95	Nov. 2	15.51	Sept. 26	15.73
Dec. 29	16.01	Dec. 5	15.57	Oct. 30	15.75
Jan. 31, 1950	16.05	Jan. 2, 1951	15.61	Nov. 30	15.83
Feb. 28	16.03	Feb. 2	15.66	Dec. 26	15.87
Mar. 31	16.02	Mar. 5	15.73	Jan. 25, 1952	15.92
May 11	16.03	29	15.73	Apr. 16	15.69

18-56-25cb

Date	Water level	Date	Water level	Date	Water level
June 5, 1947	24.77	Feb. 28, 1950	24.67	May 25, 1951	24.70
Aug. 26	24.77	Mar. 31	24.51	June 28	24.84
Oct. 3	24.79	May 11	24.25	July 30	24.87
Nov. 25	24.87	31	24.49	Aug. 30	25.08
Jan. 23, 1948	25.01	June 30	24.83	Sept. 26	24.95
Feb 25	25.01	July 31	24.65	Oct. 30	24.92
Mar. 31	24.90	Aug. 14	24.64	Nov. 30	24.95
Apr. 26	24.95	30	24.64	Dec. 26	25.05
Oct. 18	25.01	Sept. 13	24.67	Jan. 10, 1952	25.14
Dec. 10	24.51	30	24.65	25	24.99
May 5, 1949	24.79	Oct. 10	24.65	30	25.15
27	24.27	Nov. 2	24.72	Mar. 13	25.18
June 29	24.45	14	24.64	Apr. 8	24.89
July 28	24.50	Dec. 5	24.76	16	24.77
Aug. 31	24.55	Jan. 2, 1951	24.72	June 24	24.92
Sept. 30	24.61	Feb. 2	25.17	July 16	24.91
Oct. 31	24.89	Mar. 5	24.82	Aug. 11	25.12
Nov. 30	24.76	29	24.56	Oct. 21	25.12
Dec. 29	24.66	Apr. 30	24.66	Nov. 18	25.19
Jan. 31, 1950	24.63				

18-56-26dd1

Date	Water level	Date	Water level	Date	Water level
July 14, 1949	24.52	Dec. 29, 1949	24.79	May 31, 1950	24.57
Aug. 31	24.55	Jan. 31, 1950	24.81	June 30	24.62
Sept. 30	24.67	Feb. 28	24.85	July 31	24.67
Oct. 31	24.74	Mar. 31	24.70	Aug. 30	24.70
Nov. 30	24.78	May 11	24.53		

18-56-26dd2

Date	Water level	Date	Water level	Date	Water level
July 14, 1949	24.07	Dec. 29, 1949	24.50	May 11, 1950	24.24
Aug. 31	24.13	Jan. 31, 1950	24.52	31	24.10
Sept. 30	24.23	Feb. 28	24.55	June 30	24.23
Oct. 31	24.29	Mar. 31	24.36	July 31	24.36
Nov. 30	24.48				

18-56-34ab

Date	Water level	Date	Water level	Date	Water level
May 27, 1949	18.58	Aug. 31, 1949	21.57	Nov. 30, 1949	21.31
June 29	19.01	Sept. 30	22.10	Dec. 29	22.56
July 28	19.71	Oct. 31	21.91	Jan. 31, 1950	22.85

Table 3.—*Water-level measurements in observation wells*—Continued

DAWSON COUNTY—Continued

18-56-34ab—Continued

Date	Water level	Date	Water level	Date	Water level
Feb. 28, 1950	22.87	May 31, 1950	19.25	Aug. 30, 1950	19.55
Mar. 31	22.08	June 30	19.11	Sept. 30	19.45
May 11	19.21	July 31	20.03		

18-56-36bb

Date	Water level	Date	Water level	Date	Water level
July 14, 1949	42.21	Dec. 29, 1949	42.57	May 31, 1950	42.44
Aug. 31	42.33	Jan. 31, 1950	42.72	June 30	42.22
Sept. 30	42.30	Feb. 28	42.84	July 31	42.24
Oct. 31	42.36	Mar. 31	42.60	Aug. 30	42.22
Nov. 30	42.42	May 11	42.46	Sept. 30	42.28

18-57-4aa

Date	Water level	Date	Water level	Date	Water level
July 21, 1949	10.54	Dec. 29, 1949	11.61	May 31, 1950	10.23
Aug. 31	10.58	Jan. 31, 1950	11.69	June 30	9.65
Sept. 30	10.45	Feb. 28	11.72	July 31	10.10
Oct. 31	10.87	Mar. 31	11.37	Aug. 30	9.65
Nov. 30	11.29	May 11	10.70	Sept. 30	9.43

18-57-4cd

Date	Water level	Date	Water level	Date	Water level
July 15, 1949	4.92	Nov. 30, 1949	5.56	May 31, 1950	5.26
Aug. 31	5.91	Dec. 29	5.64	June 30	4.93
Sept. 30	4.85	Mar. 31, 1950	5.61	July 31	5.65
Oct. 31	5.35	May 11	5.54	Aug. 30	5.34

18-57-4dd

Date	Water level	Date	Water level	Date	Water level
July 15, 1949	8.67	Dec. 29, 1949	9.51	June 30, 1950	9.05
Aug. 31	9.40	Feb. 28, 1950	10.49	July 31	8.31
Sept. 30	9.10	Mar. 31	10.26	Aug. 30	8.92
Oct. 31	9.40	May 11	10.12	Sept. 30	8.65
Nov. 30	9.46	31	9.30		

18-57-10bb

Date	Water level	Date	Water level	Date	Water level
July 15, 1949	6.52	Sept. 30, 1949	6.77	Nov. 30, 1949	7.86
Aug. 31	7.02	Oct. 31	7.49	Dec. 29	8.42

18-57-17bd

Date	Water level	Date	Water level	Date	Water level
July 21, 1949	11.37	Dec. 29, 1949	11.61	June 30, 1950	11.05
Aug. 31	11.55	Feb. 28, 1950	11.87	July 31	11.45
Sept. 30	11.88	Mar. 31	11.46	Aug. 30	11.39
Oct. 31	11.24	May 11	11.35	Sept. 30	11.28
Nov. 30	11.23	31	11.16		

18-57-19ca

Date	Water level	Date	Water level	Date	Water level
July 14, 1949	22.35	Dec. 29, 1949	21.76	May 31, 1950	23.36
Aug. 31	21.34	Jan. 31, 1950	22.20	June 30	21.35
Sept. 30	20.79	Feb. 28	22.26	July 31	21.07
Oct. 31	20.75	Mar. 31	21.70	Aug. 30	18.74
Nov. 30	21.23	May 11	23.22	Sept. 30	18.31

Table 3.—*Water-level measurements in observation wells*—Continued

RICHLAND COUNTY, MONT.

19-57-13ab

Date	Water level	Date	Water level	Date	Water level
Aug. 1, 1949	15.65	July 31, 1950	14.69	May 25, 1951	14.58
Sept. 6	15.57	Aug. 30	14.49	June 28	14.48
Oct. 31	15.35	Sept. 30	14.17	July 30	12.55
Nov. 30	15.36	Nov. 2	14.07	Aug. 30	13.00
Dec. 29	14.99	Dec. 5	14.13	Sept. 26	12.96
Jan. 31, 1950	15.19	Jan. 2, 1951	14.26	Oct. 30	13.50
Feb. 28	15.32	Feb. 2	14.47	Nov. 30	13.51
Mar. 31	15.16	Mar. 5	14.72	Dec. 26	13.91
May 11	15.11	29	14.66	Jan. 25, 1952	14.03
31	15.15	Apr. 30	14.80	Apr. 16	14.60
June 30	14.88				

19-57-24ac

Date	Water level	Date	Water level	Date	Water level
Sept. 13, 1949	5.39	Mar. 31, 1949	7.19	May 31, 1949	7.44
Oct. 31	5.96	May 11	7.10	June 30	5.20
Nov. 30	7.13				

19-57-25bb

Date	Water level	Date	Water level	Date	Water level
July 30, 1949	10.65	Oct. 31, 1949	11.76	Dec. 29, 1949	14.13
Aug. 31	9.84	Nov. 30	13.62	Jan. 31, 1950	14.95
Sept. 6	9.84				

19-57-26ad

Date	Water level	Date	Water level	Date	Water level
Aug. 1, 1949	17.98	Nov. 30, 1949	20.58	May 11, 1950	19.20
Sept. 6	17.56	Feb. 28, 1950	21.37	31	21.20
Oct. 31	20.27	Mar. 31	20.16		

19-58-5ba

Date	Water level	Date	Water level	Date	Water level
July 29, 1949	29.90	May 31, 1950	29.77	July 31, 1950	30.42
Sept. 6	29.80	June 30	31.19	Aug. 30	29.42
Dec. 29	29.90				

19-58-5cd

Date	Water level	Date	Water level	Date	Water level
Sept. 8, 1949	5.77	Mar. 31, 1950	5.50	June 30, 1950	3.56
Oct. 31	6.52	May 11	4.78	July 31	4.53
Nov. 30	6.12	31	5.10	Aug. 30	4.63

19-58-6ba

Date	Water level	Date	Water level	Date	Water level
Aug. 2, 1949	20.10	Jan. 31, 1950	20.25	June 30, 1950	19.86
Sept. 6	20.10	Feb. 28	20.33	July 31	18.45
Oct. 31	20.16	Mar. 31	20.11	Aug. 30	19.46
Nov. 30	20.19	May 11	20.02	Sept. 30	19.41
Dec. 29	20.20	31	20.00		

19-58-7bd1

Date	Water level	Date	Water level	Date	Water level
Aug. 2, 1949	19.37	Feb. 28, 1950	21.12	July 31, 1950	18.99
Sept. 6	19.31	Mar. 31	20.21	Aug. 30	18.99
Oct. 31	19.23	May 11	19.00	Sept. 30	19.42
Nov. 30	19.24	30	19.07	Nov. 2	18.88
Dec. 29	20.45	June 30	19.03	Jan. 2, 1951	18.76

Table 3.— *Water-level measurements in observation wells*— Continued

RICHLAND COUNTY, MONT.— Continued

19-58-7bd1—Continued

Date	Water level	Date	Water level	Date	Water level
Feb. 2, 1951	18.80	June 28, 1951	18.82	Nov. 30, 1951	18.80
Mar. 5	18.68	July 30	18.89	Dec. 26	18.67
29	18.61	Aug. 30	18.81	Jan. 25, 1952	18.48
Apr. 30	18.65	Sept. 26	18.73	Apr. 16	18.52
May 25	18.73	Oct. 30	18.70		

19-58-8ad

Date	Water level	Date	Water level	Date	Water level
Sept. 9, 1949	12.11	Jan. 31, 1950	12.99	May 31, 1950	11.95
Oct. 31	12.52	Feb. 28	13.03	June 30	10.62
Nov. 30	12.95	Mar. 31	12.64	July 31	9.80
Dec. 29	12.89	May 11	11.49	Aug. 30	11.25

19-58-8bc

Date	Water level	Date	Water level	Date	Water level
Sept. 9, 1949	7.15	May 31, 1950	9.00	Mar. 5, 1951	6.71
Oct. 31	7.48	June 30	8.08	29	7.78
Nov. 30	8.15	July 31	7.23	Apr. 30	7.87
Dec. 29	8.70	Aug. 30	6.36	May 25	7.89
Jan. 31, 1950	8.96	Sept. 30	5.25	June 28	7.22
Feb. 28	9.30	Nov. 2	6.12	July 30	6.89
Mar. 31	9.25	Dec. 5	6.95	Aug. 30	6.79
May 11	9.20	Jan. 2, 1951	7.13	Sept. 26	7.54

19-58-18ad

Date	Water level	Date	Water level	Date	Water level
Sept. 9, 1949	7.03	July 31, 1950	5.02	May 25, 1951	7.79
Oct. 31	8.16	Aug. 30	5.90	June 28	7.68
Nov. 30	9.32	Sept. 30	6.40	July 30	8.03
Dec. 29	10.21	Nov. 2	8.08	Aug. 30	7.98
Jan. 31, 1950	10.86	Dec. 5	8.92	Sept. 26	8.43
Feb. 28	10.91	Jan. 2, 1951	9.08	Oct. 30	9.50
Mar. 31	10.32	Feb. 2	10.13	Nov. 30	10.08
May 11	9.60	Mar. 5	10.68	Dec. 26	10.62
31	8.66	29	10.65	Jan. 25, 1952	11.20
June 30	6.90	Apr. 30	10.55	Apr. 16	9.56

19-58-18ba

Date	Water level	Date	Water level	Date	Water level
Aug. 2, 1949	23.15	June 30, 1950	23.15	Apr. 30, 1951	21.92
Sept. 6	23.13	July 31	22.60	May 25	20.98
Oct. 31	23.19	Aug. 30	21.12	June 28	20.75
Nov. 30	23.21	Sept. 30	21.41	July 30	18.00
Dec. 29	23.25	Nov. 2	21.56	Aug. 30	17.47
Jan. 31, 1950	23.98	Dec. 5	21.60	Sept. 26	17.66
Feb. 28	24.06	Jan. 2, 1951	21.90	Oct. 30	18.10
Mar. 31	23.90	Feb. 2	21.67	Nov. 30	18.44
May 11	23.45	Mar. 5	22.04	Dec. 26	18.70
31	23.25	29	21.85	Apr. 16, 1952	15.27

19-58-18dc

Date	Water level	Date	Water level	Date	Water level
Sept. 13, 1949	8.21	Mar. 31, 1950	7.91	Sept. 30, 1950	5.78
Oct. 31	7.80	May 11	6.40	Nov. 2	6.50
Nov. 30	7.83	31	6.72	Dec. 5	6.92
Dec. 29	8.18	June 30	5.82	Jan. 2, 1951	7.13
Jan. 31, 1950	10.04	July 31	6.75	Feb. 28	7.42
Feb. 8	9.33	Aug. 30	6.98	Mar. 5	7.61

Table 3.—*Water-level measurements in observation wells*—Continued

RICHLAND COUNTY, MONT.—Continued

19-58-18dc—Continued

Date	Water level	Date	Water level	Date	Water level
Mar. 29, 1951	7.41	July 30, 1951	7.08	Nov. 30, 1951	[a]8.14
Apr. 30	6.53	Aug. 30	8.03	Dec. 26	[a]8.14
May 25	6.48	Sept. 26	8.13	Apr. 16, 1952	4.85
June 28	7.12	Oct. 30	8.12		

[a]Dry.

20-58-2ab

Date	Water level	Date	Water level	Date	Water level
July 13, 1949	9.60	Dec. 31, 1949	11.12	June 2, 1950	10.95
Aug. 31	8.51	Feb. 2, 1950	11.52	30	10.16
Sept. 30	9.44	Mar. 1	11.92	Aug. 1	9.78
Oct. 29	10.16	31	12.05	29	9.20
Nov. 30	10.68	May 5	11.76		

20-58-2ad

Date	Water level	Date	Water level	Date	Water level
July 18, 1949	13.29	Nov. 30, 1949	13.34	Mar. 31, 1950	15.10
Aug. 31	10.95	Dec. 31	13.89	Apr. 26	14.16
Sept. 30	10.83	Feb. 2, 1950	14.40	June 2	14.62
Oct. 29	12.52	Mar. 1	14.83		

20-58-2cd

Date	Water level	Date	Water level	Date	Water level
July 15, 1949	9.19	Sept. 30, 1949	8.48	Nov. 30, 1949	10.15
Aug. 31	9.22	Oct. 29	8.81		

20-58-2dc

Date	Water level	Date	Water level	Date	Water level
July 15, 1949	7.65	Nov. 30, 1949	7.60	Mar. 31, 1950	9.69
Aug. 31	7.01	Dec. 31	8.19	Apr. 26	9.07
Sept. 30	6.55	Feb. 2, 1950	9.60	June 2	8.64
Oct. 29	7.09	Mar. 1	10.32		

20-58-2dd

Date	Water level	Date	Water level	Date	Water level
July 15, 1949	11.62	June 2, 1950	12.42	May 25, 1951	11.88
Aug. 31	8.03	30	11.54	June 28	9.89
Sept. 30	8.69	Aug. 2	10.79	July 30	8.92
Oct. 29	9.41	29	9.96	Aug. 30	9.15
Nov. 30	10.41	Nov. 2	10.14	Sept. 26	9.70
Dec. 31	11.05	Dec. 5	10.80	Oct. 30	10.97
Feb. 2, 1950	11.79	Jan. 2, 1951	11.39	Nov. 30	11.46
Mar. 1	12.21	Feb. 5	11.49	Dec. 26	11.95
31	12.28	Mar. 29	13.70	Jan. 25, 1952	12.23
Apr. 26	12.27	Apr. 30	11.92	Apr. 16	12.55

20-58-3cc

Date	Water level	Date	Water level	Date	Water level
July 15, 1949	8.25	Mar. 29, 1950	10.48	Jan. 2, 1951	9.88
Aug. 31	7.25	Apr. 26	10.50	Feb. 5	10.17
Sept. 30	7.94	June 2	10.13	Mar. 5	10.41
Oct. 29	8.47	30	9.49	29	10.36
Nov. 30	9.23	Aug. 2	9.17	Apr. 30	10.48
Dec. 31	9.62	29	8.63	May 25	10.56
Feb. 2, 1950	9.92	Nov. 2	9.29	June 28	9.11
Mar. 1	10.27	Dec. 5	9.61	July 30	8.40

Table 3.— *Water-level measurements in observation wells*— Continued

RICHLAND COUNTY, MONT. —Continued

20-58-3cc—Continued

Date	Water level	Date	Water level	Date	Water level
Aug. 30, 1951	8.97	Nov. 30, 1951	9.89	Jan. 25, 1952	10.20
Sept. 26	9.37	Dec. 26	10.10	Apr. 16	8.27

20-58-9dd1

Date	Water level	Date	Water level	Date	Water level
Aug. 30, 1949	2.62	June 30, 1950	[c]1.52	May 25, 1951	[a]7.4
Sept. 30	4.00	Aug. 2	[c]1.74	June 28	5.35
Oct. 29	4.25	29	1.99	July 30	5.30
Nov. 30	4.47	Nov. 2	2.79	Aug. 30	5.35
Dec. 31	4.80	Dec. 5	3.93	Sept. 26	[a]7.4
Feb. 2, 1950	5.10	Jan. 2, 1951	4.68	Oct. 30	[a]7.4
Mar. 1	[b]5.50	Feb. 5	4.50	Nov. 30	[a]7.4
29	5.40	Mar. 5	[b]4.98	Dec. 26	[a]7.4
Apr. 26	5.63	29	[b]5.25	Apr. 16, 1952	[a]7.4
June 2	5.08	Apr. 30	[a]7.4		

[a]Dry. [b]Frozen. [c]Above land surface.

20-58-10ba

Date	Water level	Date	Water level	Date	Water level
July 15, 1949	7.02	Aug. 30, 1949	6.87		

20-58-11aa

Date	Water level	Date	Water level	Date	Water level
July 18, 1949	11.03	Nov. 30, 1949	11.50	Mar. 31, 1950	12.78
Aug. 31	9.59	Dec. 31	12.89	Apr. 26	12.74
Sept. 30	9.71	Feb. 2, 1950	12.42	June 2	12.73
Oct. 29	10.89	Mar. 1	12.67		

20-58-11bc

Date	Water level	Date	Water level	Date	Water level
July 19, 1949	5.21	Nov. 30, 1949	5.40	Mar. 1, 1950	7.12
Aug. 31	2.31	Dec. 31	5.99	Apr. 26	6.31
Sept. 30	3.57	Feb. 2, 1950	6.80	June 2	4.47
Oct. 29	4.68				

20-58-11cb

Date	Water level	Date	Water level	Date	Water level
July 19, 1949	6.59	Oct. 29, 1949	4.96	Mar. 1, 1950	8.32
Aug. 31	4.01	Nov. 30	5.60	June 2	4.72
Sept. 30	4.23	Dec. 31	6.14		

20-58-11cc1

Date	Water level	Date	Water level	Date	Water level
July 19, 1949	7.73	June 2, 1950	8.50	May 25, 1951	7.73
Aug. 31	5.31	30	7.28	June 28	7.07
Sept. 30	6.33	Aug. 2	6.67	July 30	7.15
Oct. 29	7.00	29	6.37	Aug. 30	7.40
Nov. 30	8.63	Nov. 2	6.91	Sept. 26	8.11
Dec. 31	8.23	Dec. 5	7.86	Oct. 30	8.63
Feb. 2, 1950	9.02	Jan. 2, 1951	8.41	Nov. 30	8.98
Mar. 1	9.47	Feb. 5	9.05	Dec. 26	9.33
29	9.66	Mar. 29	9.47	Jan. 25, 1952	9.66
Apr. 26	9.73	Apr. 30	9.51	Apr. 16	9.82

Table 3.— *Water-level measurements in observation wells*— Continued

RICHLAND COUNTY, MONT. —Continued

20-58-11cc2

Date	Water level	Date	Water level	Date	Water level
July 19, 1949	6.28	Nov. 30, 1949	6.18	Mar. 29, 1950	7.79
Aug. 31	5.12	Dec. 31	6.57	Apr. 26	7.65
Sept. 30	6.00	Feb. 2, 1950	7.22	June 2	7.15
Oct. 29	5.66	Mar. 1	8.60		

20-58-11dc

Date	Water level	Date	Water level	Date	Water level
July 19, 1949	12.27	June 30, 1950	12.87	May 25, 1951	12.56
Aug. 31	11.61	Aug. 2	12.43	June 28	11.92
Sept. 30	11.08	29	11.69	July 30	11.24
Oct. 29	11.75	Nov. 2	12.12	Aug. 30	10.31
Nov. 30	12.34	Dec. 5	12.68	Sept. 26	11.65
Dec. 31	12.75	Jan. 2, 1951	12.49	Oct. 30	12.16
Feb. 2, 1950	13.21	Feb. 5	12.80	Nov. 30	12.65
Mar. 1	13.40	Mar. 5	12.93	Dec. 26	13.04
31	13.57	29	12.95	Jan. 25, 1952	13.31
Apr. 26	13.43	Apr. 30	12.92	Apr. 16	13.27
June 2	13.34				

20-58-12bc

Date	Water level	Date	Water level	Date	Water level
July 18, 1949	12.44	Nov. 30, 1949	14.35	Mar. 31, 1950	14.08
Aug. 31	13.10	Dec. 31	13.92	Apr. 26	13.95
Sept. 30	13.42	Feb. 2, 1950	14.60	June 2	14.20
Oct. 29	14.56	Mar. 11	14.18		

20-58-14bb

Date	Water level	Date	Water level	Date	Water level
July 22, 1949	5.08	Oct. 29, 1949	6.85	Apr. 26, 1950	8.97
Aug. 31	7.64	Nov. 30	7.42	June 2	8.71
Sept. 30	8.76	Dec. 31	7.85		

20-58-15ad

Date	Water level	Date	Water level	Date	Water level
July 22, 1949	8.25	Oct. 29, 1949	6.55	Dec. 31, 1949	7.63
Aug. 31	6.31	Nov. 30	7.23	Feb. 2, 1950	8.22
Sept. 30	5.53				

20-58-15cd1

Date	Water level	Date	Water level	Date	Water level
July 25, 1949	4.07	Dec. 31, 1949	4.89	June 2, 1950	5.96
Aug. 31	3.10	Feb. 2, 1950	4.93	30	4.70
Sept. 30	3.50	Mar. 1	5.32	Aug. 2	4.22
Oct. 29	3.98	29	5.55	29	4.40
Nov. 30	4.57	Apr. 26	5.33		

20-58-15cd2

Date	Water level	Date	Water level	Date	Water level
July 25, 1949	8.80	Sept. 30, 1949	7.97	Nov. 30, 1949	9.11
Aug. 31	7.18	Oct. 29	9.06		

20-58-16ba

Date	Water level	Date	Water level	Date	Water level
July 19, 1949	8.77	Nov. 30, 1949	8.37	Mar. 29, 1950	9.66
Aug. 31	6.40	Dec. 31	9.03	Apr. 26	9.52
Sept. 30	6.85	Feb. 2, 1950	9.35	June 2	9.73
Oct. 29	7.67	Mar. 1	9.56		

Table 3.—*Water-level measurements in observation wells*—Continued

RICHLAND COUNTY, MONT.—Continued

20-58-16bb

Date	Water level	Date	Water level	Date	Water level
July 21, 1949	20.64	June 2, 1950	21.92	Apr. 30, 1951	22.94
Aug. 31	20.32	30	20.02	May 25	20.68
Sept. 30	21.24	Aug. 2	19.37	July 30	18.51
Oct. 29	22.02	29	20.09	Sept. 26	18.64
Nov. 30	21.23	Nov. 2	20.68	Oct. 30	19.16
Dec. 31	21.82	Dec. 5	21.45	Nov. 30	19.45
Feb. 2, 1950	22.02	Jan. 2, 1951	21.16	Dec. 26	19.72
Mar. 1	21.85	Feb. 5	21.66	Jan. 25, 1952	19.43
29	21.66	Mar. 5	21.60	Apr. 16	20.28
Apr. 26	21.56	29	21.00		

20-58-16bc

Date	Water level	Date	Water level	Date	Water level
July 21, 1949	13.37	June 30, 1950	13.98	May 25, 1951	13.28
Aug. 31	13.48	Aug. 2	13.82	June 28	12.10
Sept. 30	12.72	29	13.75	July 30	12.58
Oct. 29	13.38	Nov. 2	14.16	Aug. 30	12.63
Nov. 30	14.11	Dec. 5	14.30	Sept. 26	12.67
Dec. 31	14.49	Jan. 2, 1951	14.37	Oct. 30	13.45
Feb. 2, 1950	15.49	Feb. 5	14.48	Nov. 30	13.92
Mar. 1	14.75	Mar. 5	14.58	Dec. 26	14.08
29	14.51	29	14.24	Jan. 25, 1952	14.21
Apr. 26	14.88	Apr. 30	14.47	Apr. 16	13.88
June 2	14.04				

20-58-19ad

Date	Water level	Date	Water level	Date	Water level
July 26, 1949	23.06	Nov. 30, 1949	24.67	Mar. 29, 1950	24.74
Aug. 31	23.41	Dec. 31	24.69	Apr. 26	24.78
Sept. 30	24.25	Feb. 2, 1950	24.58	June 2	23.16
Oct. 29	24.53	Mar. 1	24.73		

20-58-20aa

Date	Water level	Date	Water level	Date	Water level
July 21, 1949	26.63	June 30, 1950	27.82	May 25, 1951	28.26
Aug. 31	23.94	Aug. 2	26.65	June 28	27.52
Sept. 30	22.95	29	25.46	July 30	25.94
Oct. 29	21.82	Nov. 2	24.27	Aug. 30	23.76
Nov. 30	22.69	Dec. 5	24.73	Sept. 26	23.52
Dec. 31	23.70	Jan. 2, 1951	25.38	Oct. 30	24.03
Feb. 2, 1950	24.68	Feb. 5	26.09	Nov. 30	24.76
Mar. 1	25.71	Mar. 5	26.87	Dec. 26	25.45
29	26.61	29	29.37	Jan. 25, 1952	26.18
Apr. 26	27.32	Apr. 30	27.87	Apr. 16	28.05
June 2	28.06				

20-58-20ab

Date	Water level	Date	Water level	Date	Water level
July 21, 1949	10.87	Nov. 30, 1949	12.16	Mar. 1, 1950	12.41
Aug. 31	11.47	Dec. 31	12.27	29	12.10
Sept. 30	11.79	Feb. 2, 1950	12.21	Apr. 26	12.42
Oct. 29	12.00				

20-58-20ca

Date	Water level	Date	Water level	Date	Water level
July 26, 1949	10.47	Nov. 30, 1949	9.16	Mar. 29, 1950	10.55
Aug. 31	9.72	Dec. 31	7.68	Apr. 26	9.05
Sept. 30	8.83	Feb. 2, 1950	8.74	June 2	8.83
Oct. 29	8.88	Mar. 1	10.12		

Table 3.—*Water-level measurements in observation wells*—Continued

RICHLAND COUNTY, MONT.—Continued

20-58-20dd

Date	Water level	Date	Water level	Date	Water level
July 26, 1949	27.26	Aug. 2, 1950	29.07	July 30, 1951	27.26
Aug. 31	25.96	29	28.18	Aug. 30	27.26
Sept. 30	25.31	Nov. 2	27.11	Sept. 26	26.90
Oct. 29	25.45	Dec. 5	27.99	Oct. 30	27.17
Nov. 30	26.43	Jan. 2, 1951	28.33	Nov. 30	28.03
Dec. 31	27.38	Mar. 29	29.84	Dec. 26	28.58
Apr. 26, 1950	30.05	Apr. 30	30.17	Jan. 25, 1952	29.32
June 2	30.32	May 25	30.26	Apr. 16	30.40
30	29.62	June 28	28.31		

20-58-21ad

Date	Water level	Date	Water level	Date	Water level
July 25, 1949	12.21	Dec. 31, 1949	13.12	June 2, 1950	11.97
Aug. 31	11.03	Feb. 2, 1950	13.28	30	11.58
Sept. 30	11.06	Mar. 1	13.30	Aug. 2	11.15
Oct. 29	12.17	29	13.26	29	11.75
Nov. 30	12.83	Apr. 26	12.56		

20-58-21bb

Date	Water level	Date	Water level	Date	Water level
July 22, 1949	27.08	Oct. 29, 1949	21.28	Apr. 26, 1950	27.02
Aug. 31	23.71	Nov. 30	23.78	June 2	28.34
Sept. 30	23.53	Dec. 31	24.67		

20-58-22da

Date	Water level	Date	Water level	Date	Water level
July 22, 1949	10.26	Nov. 30, 1949	11.70	Mar. 1, 1950	12.50
Aug. 31	9.24	Dec. 31	12.02	Apr. 26	12.02
Sept. 30	10.17	Feb. 2, 1950	12.45	June 2	12.36
Oct. 29	11.07				

20-58-28ba

Date	Water level	Date	Water level	Date	Water level
July 25, 1949	6.63	Nov. 30, 1949	8.24	Mar. 29, 1950	[a]8.25
Aug. 31	6.50	Dec. 31	8.20	Apr. 26	[a]8.25
Sept. 30	6.95	Feb. 2, 1950	[a]8.25	June 2	6.73
Oct. 29	7.64	Mar. 1	[a]8.25		

[a]Dry.

20-58-28bd

Date	Water level	Date	Water level	Date	Water level
July 25, 1949	15.49	Nov. 30, 1949	16.10	Mar. 29, 1950	16.24
Aug. 31	14.83	Dec. 31	16.32	Apr. 26	15.90
Sept. 30	15.44	Feb. 2, 1950	16.49	June 2	15.04
Oct. 29	15.76	Mar. 1	16.32		

20-58-29aa

Date	Water level	Date	Water level	Date	Water level
July 22, 1949	8.50	Mar. 29, 1950	10.76	Jan. 2, 1951	9.07
Aug. 31	6.90	Apr. 26	10.43	Feb. 2	9.90
Sept. 30	6.73	June 2	9.94	Mar. 29	10.52
Oct. 29	7.25	30	8.48	Apr. 30	9.85
Nov. 30	8.39	Aug. 2	7.65	May 25, 1951	8.85
Dec. 31	9.16	29	6.82	June 26	7.11
Feb. 2, 1950	10.01	Nov. 2	7.91	July 30	6.34
Mar. 1	10.47	Dec. 5	8.74	Aug. 30	6.00

Table 3.— *Water-level measurements in observation wells*— Continued

RICHLAND COUNTY, MONT. — Continued

20-58-29aa—Continued

Date	Water level	Date	Water level	Date	Water level
Sept. 26, 1951	6.69	Nov. 30, 1951	8.51	Jan. 25, 1952	10.58
Oct. 30	8.33	Dec. 26	9.32	Apr. 16	10.35

20-58-29cd

Date	Water level	Date	Water level	Date	Water level
June 8, 1949	18.69	Sept. 30, 1949	17.78	Apr. 26, 1950	30.55
July 31	18.09	Oct. 29	17.73	June 2	22.17
Aug. 31	18.20	Nov. 30	29.35		

20-58-29dc

Date	Water level	Date	Water level	Date	Water level
July 27, 1949	13.86	Oct. 29, 1949	13.27	Apr. 26, 1950	17.57
Aug. 31	12.39	Nov. 30	14.40	June 2	17.35
Sept. 30	11.75				

20-58-29dd

Date	Water level	Date	Water level	Date	Water level
July 27, 1949	10.68	Dec. 31, 1949	12.70	June 2, 1950	13.57
Aug. 31	9.72	Feb. 2, 1950	13.40	30	12.02
Sept. 30	9.37	Mar. 29	14.21	Aug. 2	11.48
Oct. 29	11.15	Apr. 26	14.29	29	9.97
Nov. 30	12.08				

20-58-30db

Date	Water level	Date	Water level	Date	Water level
July 26, 1949	5.32	Aug. 2, 1950	2.77	June 28, 1951	3.16
Aug. 31	5.68	29	3.68	July 30	3.51
Sept. 30	5.39	Nov. 2	2.45	Aug. 30	3.25
Oct. 29	5.19	Dec. 5	3.39	Sept. 26	2.74
Nov. 30	5.02	Jan. 2, 1951	3.41	Oct. 30	3.00
Dec. 31	5.16	Feb. 2	[b]3.72	Nov. 30	2.63
Feb. 2, 1950	[b]5.37	Mar. 3	[b]4.02	Dec. 26	3.65
June 2	3.54	Apr. 30	[b]2.60	Jan. 25, 1952	3.96
30	3.14	May 25	3.02	Apr. 16	1.01

[b]Frozen.

20-58-32aa

Date	Water level	Date	Water level	Date	Water level
July 29, 1949	20.60	June 30, 1950	21.98	May 25, 1951	22.34
Aug. 31	18.96	Aug. 2	19.67	June 28	20.41
Sept. 30	18.73	29	19.55	July 30	19.36
Oct. 29	19.45	Oct. 2	18.74	Aug. 30	18.45
Nov. 30	20.31	Nov. 21	19.75	Sept. 26	19.15
Dec. 31	20.98	Dec. 5	19.65	Oct. 30	19.94
Feb. 2, 1950	22.55	Jan. 2, 1951	20.92	Nov. 30	20.58
Mar. 1	23.06	Feb. 2	21.43	Dec. 26	21.00
29	23.22	Mar. 5	21.89	Jan. 25, 1952	21.50
Apr. 26	22.62	29	21.17	Apr. 16	22.25
June 2	22.85	Apr. 30	22.39		

20-58-32ab

Date	Water level	Date	Water level	Date	Water level
July 27, 1949	13.33	Nov. 30, 1949	14.11	Mar. 29, 1950	[a]14.35
Aug. 31	11.81	Dec. 31	[a]14.35	Apr. 26	[a]14.35
Sept. 30	11.52	Feb. 2, 1950	[a]14.35	June 2	[a]14.35
Oct. 29	13.12	Mar. 1	[a]14.35		

[a]Dry.

Table 3.— *Water-level measurements in observation wells*— Continued

RICHLAND COUNTY, MONT. —Continued

20-58-32ac1

Date	Water level	Date	Water level	Date	Water level
July 28, 1949	14.78	Sept. 30, 1949	11.00	Nov. 30, 1949	15.12
Aug. 31	13.20	Oct. 29	14.36	June 2, 1950	17.30

20-58-32ac2

Date	Water level	Date	Water level	Date	Water level
July 29, 1949	16.22	Nov. 1, 1949	15.20	July 31, 1950	15.90
Aug. 31	14.55	30	15.96	Aug. 30	14.44
Sept. 30	14.60	Dec. 3	15.96	Sept. 30	14.60
Oct. 31	15.20	June 30, 1950	17.52		

20-58-32ad

Date	Water level	Date	Water level	Date	Water level
July 28, 1949	20.62	Aug. 31, 1949	18.43		

20-58-32bb1

Date	Water level	Date	Water level	Date	Water level
July 27, 1949	12.22	Dec. 31, 1949	12.38	June 2, 1950	12.15
Aug. 31	12.27	Feb. 2, 1950	12.48	30	12.10
Sept. 30	12.28	Mar. 1	12.30	Aug. 2	12.01
Oct. 29	12.25	29	12.13	29	12.06
Nov. 30	12.36	Apr. 26	12.02		

20-58-33ba1

Date	Water level	Date	Water level	Date	Water level
July 29, 1949	8.84	Dec. 31, 1949	11.05	June 2, 1950	10.98
Aug. 31	8.32	Feb. 2, 1950	11.35	30	9.42
Sept. 30	7.67	Mar. 1	11.75	Aug. 2	7.59
Oct. 29	9.40	29	12.10	29	7.97
Nov. 30	10.25	Apr. 26	10.92		

20-58-33ba3

Date	Water level	Date	Water level	Date	Water level
Aug. 2, 1949	11.59	Sept. 30, 1949	11.85	Nov. 30, 1949	13.61
Aug. 31	11.40	Oct. 29	12.68	Dec. 31	14.20

20-58-33bc

Date	Water level	Date	Water level	Date	Water level
July 28, 1949	20.02	Oct. 29, 1949	18.66	Apr. 26, 1950	22.22
Aug. 31	18.22	Nov. 30	19.04	June 2	19.19
Sept. 30	18.19				

21-58-1aa

Date	Water level	Date	Water level	Date	Water level
June 23, 1949	1.95	Oct. 29, 1949	1.19	Feb. 28, 1950	3.33
July 31	1.54	Nov. 29	1.84	May 5	2.96
Aug. 30	.84	Dec. 31	2.73	June 1	3.14
Sept. 30	.50	Feb. 2, 1950	3.01		

21-58-2ad

Date	Water level	Date	Water level	Date	Water level
Sept. 2, 1949	7.83	Dec. 31, 1949	9.45	Mar. 30, 1950	9.88
30	7.97	Feb. 2, 1950	9.69	May 5	9.82
Oct. 29	8.56	28	9.90	June 1	9.83
Nov. 30	9.06				

Table 3.—*Water-level measurements in observation wells*—Continued

RICHLAND COUNTY, MONT.—Continued

21-58-2dd

Date	Water level	Date	Water level	Date	Water level
July 7, 1949	10.35	Nov. 30, 1949	9.63	June 30, 1950	10.12
Aug. 30	6.66	Dec. 31	10.22	Aug. 1	9.52
Sept. 30	9.02	Feb. 2, 1950	10.68	30	9.22
Oct. 29	9.10	Mar. 31	10.70		

21-58-10dc

Date	Water level	Date	Water level	Date	Water level
July 11, 1949	10.11	June 2, 1950	14.44	May 25, 1951	14.41
Aug. 30	8.01	30	12.70	June 28	11.55
Sept. 30	8.22	Aug. 1	10.02	July 30	10.52
Oct. 29	10.20	30	10.14	Aug. 30	9.77
Nov. 30	12.59	Nov. 2	13.02	Sept. 26	10.67
Dec. 31	14.02	Dec. 5	13.15	Oct. 30	12.52
Feb. 2, 1950	15.42	Jan. 2, 1951	14.34	Nov. 30	14.24
28	14.74	Feb. 5	15.14	Dec. 26	15.98
Mar. 31	14.68	Mar. 29	16.03	Jan. 25, 1952	17.05
May 5	14.59	Apr. 30	16.06	Apr. 16	15.53

21-58-11bb

Date	Water level	Date	Water level	Date	Water level
Aug. 31, 1949	18.64	Dec. 31, 1949	17.91	Mar. 31, 1950	21.17
Sept. 30	14.27	Feb. 2, 1950	18.98	May 5	22.17
Oct. 29	14.47	28	20.23	June 1	22.55
Nov. 30	16.28				

21-58-11bd

Date	Water level	Date	Water level	Date	Water level
July 18, 1949	35.70	Nov. 30, 1949	32.50	Mar. 31, 1950	35.14
Aug. 30	33.16	Dec. 31	33.15	May 5	35.71
Sept. 30	32.85	Feb. 2, 1950	33.90	June 2	36.12
Oct. 29	31.93	28	34.14		

21-58-14db

Date	Water level	Date	Water level	Date	Water level
Sept. 6, 1949	12.82	Nov. 30, 1949	12.16	Feb. 28, 1950	11.27
30	12.05	Dec. 31	11.37	June 2	10.58
Oct. 29	11.83	Feb. 2, 1950	11.55		

21-58-15ca1

Date	Water level	Date	Water level	Date	Water level
July 11, 1949	8.06	Nov. 30, 1949	8.34	Feb. 28, 1950	9.98
Aug. 30	7.18	Dec. 31	9.05	Mar. 31	10.15
Sept. 30	7.62	Feb. 2, 1950	10.02	June 2	9.82
Oct. 29	7.58				

21-58-15dc

Date	Water level	Date	Water level	Date	Water level
Sept. 6, 1949	16.86	June 30, 1950	22.43	June 28, 1951	21.82
30	16.58	Aug. 1	21.76	July 30	20.15
Oct. 29	17.23	29	18.70	Aug. 30	18.42
Nov. 30	19.25	Nov. 2	20.85	Sept. 26	19.15
Dec. 31	21.14	Dec. 5	22.33	Oct. 30	20.73
Feb. 2, 1950	22.66	Jan. 2, 1951	23.19	Nov. 30	21.90
28	23.55	Mar. 5	24.95	Dec. 26	22.74
Mar. 31	24.25	29	25.07	Jan. 25, 1952	23.63
May 5	24.72	Apr. 30	25.32	Apr. 16	24.48
June 2	24.81	May 25	25.56		

Table 3.—*Water-level measurements in observation wells*—Continued

RICHLAND COUNTY, MONT.—Continued

21-58-15db1

Date	Water level	Date	Water level	Date	Water level
July 11, 1949	15.59	Nov. 30, 1949	19.02	Mar. 31, 1950	[a]19.00
Aug. 30	13.27	Dec. 31	18.25	May 5	[a]19.00
Sept. 30	16.11	Feb. 2, 1950	18.40	June 2	[a]19.00
Oct. 29	17.09	28	[a]19.00		

[a]Dry.

21-58-16bb

Date	Water level	Date	Water level	Date	Water level
July 12, 1949	9.68	Oct. 29, 1949	9.23	May 5, 1950	7.58
Aug. 30	10.02	Nov. 30	9.06	June 2	8.09
Sept. 30	9.61	Dec. 31	9.15		

21-58-20aa

Date	Water level	Date	Water level	Date	Water level
July 28, 1949	56.19	Oct. 29, 1949	55.82	Feb. 28, 1950	56.27
Aug. 30	57.21	Nov. 30	56.11	May 5	56.12
Sept. 30	56.77	Dec. 31	56.15	June 2	55.93

21-58-21ac

Date	Water level	Date	Water level	Date	Water level
July 13, 1949	10.72	Nov. 30, 1949	10.36	Mar. 31, 1950	9.62
Aug. 30	7.51	Dec. 31	12.04	May 5	15.09
Sept. 30	7.27	Feb. 2, 1950	13.77	June 2	14.54
Oct. 29	8.35	Mar. 1	14.61		

21-58-21db1

Date	Water level	Date	Water level	Date	Water level
July 14, 1949	21.31	Dec. 31, 1949	23.95	June 2, 1950	24.45
Aug. 31	21.12	Feb. 2, 1950	25.23	30	21.99
Sept. 30	20.90	Mar. 1	25.72	Aug. 1	21.17
Oct. 29	21.06	31	25.36	29	20.81
Nov. 30	22.91	Apr. 26	24.93		

21-58-21db2

Date	Water level	Date	Water level	Date	Water level
July 14, 1949	13.84	Nov. 30, 1949	14.52	Mar. 31, 1950	[a]14.90
Aug. 31	12.38	Dec. 31	[a]14.90	Apr. 26	[a]14.90
Sept. 30	12.90	Feb. 2, 1950	[a]14.90	June 2	[a]14.90
Oct. 29	12.85	Mar. 1	[a]14.90		

[a]Dry.

21-58-22da

Date	Water level	Date	Water level	Date	Water level
Sept. 6, 1949	5.51	Feb. 2, 1950	6.22	June 2, 1950	5.38
20	6.11	28	5.89	30	4.31
Oct. 29	6.45	Mar. 31	5.10	Aug. 1	4.00
Nov. 30	6.73	May 5	6.20	30	4.07
Dec. 31	6.32				

21-58-27bb

Date	Water level	Date	Water level	Date	Water level
Sept. 12, 1949	16.71	Dec. 31, 1949	16.20	Apr. 26, 1950	16.63
30	16.28	Feb. 2, 1950	16.55	June 2	14.38
Oct. 29	16.08	Mar. 1	16.43	June 30	13.60
Nov. 30	16.84	31	14.92	Aug. 2	13.08

Table 3.—*Water-level measurements in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
RICHLAND COUNTY, MONT.—Continued					
21-58-27bb—Continued					
Aug. 30, 1950	15.56	Apr. 30, 1951	16.87	Oct. 30, 1951	16.27
Nov. 2	16.37	May 25	15.35	Nov. 30	16.71
Dec. 5	14.95	June 28	13.60	Dec. 26	16.43
Jan. 2, 1951	15.63	July 30	12.99	Jan. 25, 1952	16.62
Feb. 5	15.51	Aug. 30	14.19	Apr. 16	15.98
Mar. 29	15.04	Sept. 26	15.41		
21-58-27cc					
Sept. 8, 1949	12.20	Feb. 2, 1950	12.83	June 2, 1950	12.16
30	12.40	Mar. 1	12.82	30	10.98
Oct. 29	12.84	31	12.63	Aug. 1	9.87
Nov. 30	13.25	Apr. 26	11.95	30	11.74
Dec. 31	13.78				
21-58-32ab					
July 15, 1949	32.17	Oct. 29, 1949	29.79	Mar. 31, 1950	32.53
Aug. 31	30.54	Nov. 30	30.35	May 5	33.16
Sept. 30	29.32	Dec. 31	31.02	June 2	32.81
21-58-32cd					
July 14, 1949	17.19	Oct. 29, 1949	16.34	Mar. 31, 1950	16.94
Aug. 31	15.88	Nov. 30	16.69	May 5	16.93
Sept. 30	15.63	Dec. 31	16.80	June 2	16.66
21-58-33bb					
July 15, 1949	20.76	Dec. 31, 1949	19.90	June 2, 1950	21.25
Aug. 31	18.09	Feb. 2, 1950	20.25	30	20.83
Sept. 30	18.01	Mar. 1	20.72	Aug. 1	20.17
Oct. 29	18.47	31	21.03	29	19.38
Nov. 30	20.16	May 5	21.08		
21-58-33dd					
July 13, 1949	9.71	Nov. 30, 1949	13.72	Mar. 31, 1950	14.50
Aug. 31	11.54	Dec. 31	14.03	Apr. 26	13.54
Sept. 30	12.15	Feb. 2, 1950	14.20	June 2	10.97
Oct. 29	13.12	Mar. 1	14.23		
21-59-5ba					
July 6, 1949	11.90	Dec. 30, 1949	18.70	June 1, 1950	9.65
Aug. 30	10.71	Feb. 1, 1950	16.55	30	8.83
Sept. 29	11.64	28	16.68	Aug. 1	8.36
Oct. 28	15.79	Mar. 31	12.11	30	10.26
Nov. 29	15.25	May 5	8.87		
21-59-8aa					
July 7, 1949	9.85	Sept. 29, 1949	10.65	Nov. 25, 1949	10.08
Aug. 30	10.53	Oct. 28	10.27		

Table 3.—*Water-level measurements in observation wells*— Continued

RICHLAND COUNTY, MONT.—Continued

21-59-8bb

Date	Water level	Date	Water level	Date	Water level
July 7, 1949	13.60	Oct. 28, 1949	15.21	May 5, 1950	11.77
Aug. 30	13.88	Nov. 29	14.61	June 1	11.74
Sept. 29	15.34	Dec. 30	14.52		

22-58-1dd

Date	Water level	Date	Water level	Date	Water level
June 16, 1949	14.90	Oct. 28, 1949	14.77	Feb. 28, 1950	13.36
July 30	14.70	Nov. 28	13.44	Mar. 30	12.61
Aug. 29	14.61	Dec. 30	12.94	May 4	12.83
Sept. 29	14.86	Feb. 1, 1950	13.25	June 1	12.37

22-58-24cd

Date	Water level	Date	Water level	Date	Water level
Aug. 18, 1949	8.41	Nov. 29, 1949	8.42	Mar. 30, 1950	8.47
30	7.81	Dec. 30	9.05	May 5	7.93
Sept. 30	7.90	Feb. 2, 1950	8.85	June 1	8.13
Oct. 29	8.20	28	8.85		

22-58-36aa

Date	Water level	Date	Water level	Date	Water level
June 23, 1949	1.60	Feb. 28, 1950	3.32	Dec. 5, 1950	2.59
July 30	1.69	Mar. 30	3.12	Jan. 2, 1951	2.75
Aug. 30	2.15	May 5	2.35	Feb. 5	[b]3.10
Sept. 30	1.51	June 1	2.31	Mar. 5	[b]3.10
Oct. 29	1.77	30	1.48	29	3.02
Nov. 29	2.35	Aug. 1	1.15	Apr. 30	[b]2.98
Dec. 30	2.81	30	1.44	May 25	2.68
Feb. 2, 1950	3.14	Nov. 2	2.01		

[b]Frozen.

22-58-36bb

Date	Water level	Date	Water level	Date	Water level
Sept. 2, 1949	2.35	Dec. 30, 1949	4.15	Mar. 30, 1950	4.12
30	3.20	Feb. 2, 1950	[d]4.23	May 5	3.92
Oct. 29	3.69	28	[a]4.5	June 1	3.32
Nov. 29	4.11				

[a]Dry. [d]Mud.

22-59-3aa1

Date	Water level	Date	Water level	Date	Water level
Aug. 5, 1949	9.70	Nov. 28, 1949	9.67	Feb. 27, 1950	11.19
29	8.95	Dec. 29	[b]10.22	Mar. 30	11.12
Sept. 29	8.48	Jan. 31, 1950	[b]10.15	May 4	11.08
Oct. 28	9.04				

[b]Frozen.

22-59-3aa2

Date	Water level	Date	Water level	Date	Water level
June 15, 1949	7.48	Oct. 28, 1949	7.61	Jan. 31, 1950	9.08
July 30	7.61	Nov. 28	8.30	May 4	8.87
Aug. 29	6.31	Dec. 29	7.70	31	9.01
Sept. 29	8.23				

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Table 3.—*Water-level measurements in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
		RICHLAND COUNTY, MONT.—Continued			
		22-59-3bb			
Aug. 5, 1949	10.24	Dec. 29, 1949	10.63	May 31, 1950	11.51
29	7.86	Jan. 31, 1950	11.18	June 29	10.94
Sept. 29	8.28	Feb. 27	11.35	Aug. 1	10.09
Oct. 28	8.21	Mar. 30	12.00	30	4.57
Nov. 28	9.88	May 4	12.20	Oct. 2	5.52
		22-59-4ad			
June 16, 1949	10.37	Oct. 28, 1949	11.10	Feb. 27, 1950	11.67
July 30	11.05	Nov. 28	11.35	Mar. 30	11.58
Aug. 29	9.72	Dec. 29	11.65	May 4	9.95
Sept. 29	11.24	Jan. 31, 1950	11.65	31	10.32
		22-59-4bc1			
July 6, 1949	7.24	Oct. 28, 1949	7.28	Feb. 28, 1950	9.75
30	7.90	Nov. 28	8.12	Mar. 30	9.77
Aug. 29	4.53	Dec. 30	8.87	May 4	9.04
Sept. 29	5.69	Jan. 31, 1950	9.51	31	7.67
		22-59-5aa			
July 6, 1949	7.43	Oct. 28, 1949	7.50	Feb. 27, 1950	9.04
30	7.68	Nov. 28	8.09	Mar. 30	9.00
Aug. 29	7.80	Dec. 29	8.59	May 4	7.92
Sept. 29	6.77	Jan. 31, 1950	8.93	31	8.07
		22-59-5ba			
July 6, 1949	12.10	Sept. 29, 1949	10.86	May 4, 1950	15.20
30	12.10	Oct. 28	11.83	31	14.01
Aug. 30	10.43				
		22-59-5cc			
June 16, 1949	9.04	May 4, 1950	9.74	Mar. 29, 1951	9.70
July 30	9.00	31	9.34	Apr. 30	9.12
Aug. 29	8.22	June 29	8.74	May 25	9.22
Sept. 29	8.58	Aug. 1	8.42	June 28	8.15
Oct. 28	9.02	30	8.93	July 30	8.18
Nov. 28	9.27	Oct. 2	8.95	Aug. 30	7.92
Dec. 30	9.50	Nov. 2	9.21	Sept. 26	8.70
Jan. 31, 1950	10.19	Dec. 5	9.30	Oct. 30	8.93
Feb. 28	9.88	Jan. 2, 1951	9.51	Nov. 30	9.35
Mar. 30	9.95	Mar. 5	9.69	Feb. 26, 1952	9.55
		22-59-6dc			
July 29, 1949	8.26	Nov. 28, 1949	8.44	Mar. 30, 1950	11.36
Aug. 29	4.50	Dec. 30	9.26	May 4	11.27
Sept. 29	5.57	Jan. 31, 1950	11.37	June 1	8.48
Oct. 28	7.36	Feb. 28	11.09		

Table 3.—*Water-level measurements in observation wells*—Continued

RICHLAND COUNTY, MONT.— Continued

22-59-6dd1

Date	Water level	Date	Water level	Date	Water level
July 29, 1949	6.96	Nov. 28, 1949	7.37	Mar. 30, 1950	9.02
Aug. 29	5.20	Dec. 30	7.92	May 4	8.55
Sept. 29	5.52	Jan. 31, 1950	8.92	31	7.99
Oct. 28	6.72	Feb. 28	8.85		

22-59-7cd

Date	Water level	Date	Water level	Date	Water level
June 16, 1949	15.19	Oct. 28, 1949	13.46	Feb. 28, 1950	18.91
July 31	15.43	Nov. 28	15.26	Mar. 30	19.56
Aug. 29	10.12	Dec. 30	16.65	May 4	19.69
Sept. 29	11.72	Feb. 1, 1950	17.95	June 1	19.05

22-59-8ad1

Date	Water level	Date	Water level	Date	Water level
July 5, 1949	7.14	Nov. 28, 1949	7.57	Mar. 30, 1950	8.01
Aug. 29	6.88	Dec. 30	7.90	May 4	7.61
Sept. 29	6.82	Feb. 1, 1950	8.12	June 1	7.31
Oct. 28	7.36	28	8.15		

22-59-8cd

Date	Water level	Date	Water level	Date	Water level
July 5, 1949	3.69	Oct. 28, 1949	5.27	Feb. 28, 1950	6.70
31	5.05	Nov. 28	6.39	Mar. 30	6.82
Aug. 29	3.00	Dec. 30	6.25	May 4	6.00
Sept. 29	4.69	Feb. 1, 1950	6.59	June 1	5.67

22-59-8da1

Date	Water level	Date	Water level	Date	Water level
July 5, 1949	4.18	Nov. 28, 1949	[a]5.5	Mar. 30, 1950	[a]5.5
Aug. 29	3.32	Dec. 30	[a]5.5	May 4	3.66
Sept. 29	4.88	Feb. 1, 1950	[a]5.5	June 1	3.23
Oct. 28	3.98	28	[a]5.5		

[a]Dry.

22-59-8dd

Date	Water level	Date	Water level	Date	Water level
Aug. 29, 1949	5.43	Aug. 1, 1950	5.59	May 25, 1951	7.84
Sept. 29	6.49	30	5.42	June 28	6.59
Oct. 28	7.06	Oct. 3	5.90	July 30	6.11
Nov. 28	7.50	Nov. 2	6.80	Aug. 30	6.32
Dec. 30	7.91	Dec. 5	7.41	Sept. 26	6.79
Feb. 1, 1950	8.25	Jan. 2, 1951	7.77	Oct. 30	7.35
28	8.41	Feb. 2	7.50	Nov. 30	7.80
Mar. 30	8.37	Mar. 5	8.33	Dec. 26	7.98
May 4	7.73	29	7.96	Jan. 25, 1952	8.25
June 1	7.25	Apr. 30	8.20	Apr. 16	6.18
29	6.27				

22-59-9aa

Date	Water level	Date	Water level	Date	Water level
Aug. 22, 1949	6.80	Nov. 28, 1949	[a]6.5	Mar. 30, 1950	[a]6.5
29	6.47	Dec. 29	[a]6.5	May 4	[a]6.5
Sept. 29	5.38	Jan. 31, 1950	[a]6.5	31	[a]6.5
Oct. 28	7.02	Feb. 27	[a]6.5		

[a]Dry.

Table 3.—*Water-level measurements in observation wells*—Continued

RICHLAND COUNTY, MONT.—Continued

22-59-11cd

Date	Water level	Date	Water level	Date	Water level
June 17, 1949	26.96	Nov. 29, 1949	25.60	May 4, 1950	24.79
July 31	22.65	Dec. 30	27.87	June 1	25.30
Aug. 29	23.55	Feb. 1, 1950	26.13	30	23.61
Sept. 29	24.09	28	26.29	Aug. 1	21.90
Oct. 28	25.04	Mar. 30	25.79	30	23.18

22-59-15bd

Date	Water level	Date	Water level	Date	Water level
Aug. 10, 1949	22.13	Oct. 28, 1949	22.19	Mar. 30, 1950	23.09
29	22.38	Nov. 29	22.54	May 4	22.62
Sept. 29	22.39	Dec. 30	24.23	June 1	23.40

22-59-16aa

Date	Water level	Date	Water level	Date	Water level
Aug. 15, 1949	13.68	Oct. 28, 1949	14.10	Feb. 1, 1950	14.37
29	9.07	Nov. 29	14.51	28	14.16
Sept. 29	11.23	Dec. 30	14.07	June 1	13.25

22-59-16dc

Date	Water level	Date	Water level	Date	Water level
Aug. 15, 1949	9.75	Nov. 29, 1949	8.75	Mar. 31, 1950	9.02
29	8.11	Dec. 30	9.01	May 5	8.80
Sept. 29	8.31	Feb. 1, 1950	9.24	June 1	9.07
Oct. 28	8.30	28	9.11		

22-59-17aa

Date	Water level	Date	Water level	Date	Water level
July 5, 1949	6.49	Nov. 28, 1949	7.59	Mar. 30, 1950	10.10
Aug. 29	6.36	Dec. 30	7.65	May 4	7.92
Sept. 29	6.89	Feb. 1, 1950	8.25	June 1	7.64
Oct. 28	7.20	28	8.95		

22-59-17ba1

Date	Water level	Date	Water level	Date	Water level
July 5, 1949	5.86	Nov. 28, 1949	8.12	Mar. 30, 1950	9.25
Aug. 29	5.10	Dec. 30	8.55	May 4	8.35
Sept. 29	6.79	Feb. 1, 1950	8.97	June 1	8.03
Oct. 28	7.44	28	9.20		

22-59-18ab

Date	Water level	Date	Water level	Date	Water level
Sept. 3, 1949	5.80	Oct. 28, 1949	8.36	Dec. 30, 1949	9.10
29	7.51	Nov. 29	8.84		

22-59-18bc

Date	Water level	Date	Water level	Date	Water level
June 21, 1949	8.30	Oct. 28, 1949	5.69	Mar. 3, 1950	[a]9.30
July 31	7.93	Nov. 29	7.94	May 5	[a]9.30
Aug. 30	4.65	Dec. 30	9.10	June 1	[a]9.30
Sept. 29	4.82				

[a]Dry.

Table 3.—*Water-level measurements in observation wells*—Continued

RICHLAND COUNTY, MONT.—Continued

22-59-18ca

Date	Water level	Date	Water level	Date	Water level
Aug. 9, 1949	8.77	Nov. 29, 1949	9.14	Mar. 31, 1950	10.83
30	6.21	Dec. 30	9.25	May 5	11.05
Sept. 29	7.29	Feb. 1, 1950	10.31	June 1	10.74
Oct. 28	7.11	28	10.66		

22-59-19ab

Date	Water level	Date	Water level	Date	Water level
Aug. 23, 1949	3.30	Feb. 1, 1950	6.03	June 1, 1950	4.48
Sept. 30	3.98	28	3.88	30	4.05
Oct. 28	5.36	Mar. 31	5.71	Aug. 1	3.82
Nov. 29	6.08	May 5	4.81	30	3.76
Dec. 30	6.32				

22-59-19bb

Date	Water level	Date	Water level	Date	Water level
Aug. 23, 1949	4.97	June 30, 1950	2.11	June 28, 1951	3.38
Sept. 30	1.63	Aug. 1	1.82	July 30	[a]4.05
Oct. 28	.67	30	2.80	Aug. 30	1.59
Nov. 29	1.33	Oct. 2	.79	Sept. 26	1.08
Dec. 30	1.26	Nov. 2	1.59	Oct. 30	1.35
Feb. 1, 1950	[b]1.80	Dec. 5	2.91	Nov. 30	1.50
28	[b]1.85	Jan. 2, 1951	[b]1.18	Dec. 26	[b]1.35
Mar. 31	[b]1.82	Mar. 29	[b]1.00	Jan. 25, 1952	[b]1.40
May 5	.31	Apr. 30	.80	Apr. 16	.64
June 1	2.84	May 25	3.43		

[a] Dry. [b] Frozen.

22-59-19cc

Date	Water level	Date	Water level	Date	Water level
Sept. 12, 1949	4.75	Dec. 30, 1949	6.10	June 30, 1950	4.76
30	3.57	Feb. 1, 1950	6.32	Aug. 1	3.96
Oct. 28	4.58	28	6.30	30	4.20
Nov. 29	5.56	June 1	5.30		

22-59-20bc

Date	Water level	Date	Water level	Date	Water level
Sept. 12, 1949	15.25	Nov. 29, 1949	15.54	Feb. 28, 1950	14.04
Oct. 28	15.09	Dec. 30	14.15	June 1	13.64

22-59-21bb

Date	Water level	Date	Water level	Date	Water level
Aug. 25, 1949	11.48	Dec. 30, 1949	11.57	Mar. 31, 1950	11.66
Sept. 29	11.41	Feb. 1, 1950	11.70	May 5	11.18
Oct. 28	10.96	28	11.89	June 1	11.59
Nov. 29	11.46				

22-59-28cc

Date	Water level	Date	Water level	Date	Water level
June 8, 1949	16.38	Nov. 29, 1949	15.75	May 5, 1950	15.79
July 30	16.03	Dec. 30	16.09	June 1	15.80
Aug. 29	15.60	Feb. 1, 1950	16.52	30	15.13
Sept. 29	15.06	28	16.83	Aug. 1	14.56
Oct. 28	15.18	Mar. 31	16.82		

22-59-30cd

Date	Water level	Date	Water level	Date	Water level
Sept. 2, 1949	8.19	Oct. 29, 1949	8.61	Dec. 30, 1949	8.72
30	8.25	Nov. 29	8.76	June 1, 1950	6.59

Table 3.—*Water-level measurements in observation wells*—Continued

RICHLAND COUNTY, MONT.—Continued

22-59-31cb

Date	Water level	Date	Water level	Date	Water level
June 23, 1949	4.95	Oct. 29, 1949	4.67	Feb. 2, 1950	5.82
July 31	4.72	Nov. 29	5.22	May 5	5.45
Aug. 30	3.88	Dec. 31	5.47	June 1	5.27
Sept. 30	3.99				

22-59-31cc

Date	Water level	Date	Water level	Date	Water level
June 23, 1949	9.25	Oct. 29, 1949	8.66	Feb. 28, 1950	[a]10.50
July 31	9.08	Nov. 29	9.33	Mar. 30	[a]10.50
Aug. 30	8.53	Dec. 31	9.70	May 5	[a]10.50
Sept. 30	8.31	Feb. 2, 1950	10.23	June 1	[a]10.50

[a]Dry.

22-59-31dd

Date	Water level	Date	Water level	Date	Water level
June 23, 1949	10.22	Aug. 30, 1949	10.71	Oct. 29, 1949	11.87
July 31	10.88	Sept. 30	11.08		

22-59-32da

Date	Water level	Date	Water level	Date	Water level
July 7, 1949	15.43	Aug. 29, 1949	9.28	Sept. 29, 1949	11.11

22-59-32dd

Date	Water level	Date	Water level	Date	Water level
July 7, 1949	2.38	Dec. 30, 1949	2.10	June 1, 1950	2.40
Aug. 29	2.08	Feb. 1, 1950	2.20	30	2.20
Sept. 29	1.57	28	2.17	Aug. 1	1.95
Oct. 28	1.50	May 5	1.80	30	2.03
Nov. 29	1.86				

22-59-34ca

Date	Water level	Date	Water level	Date	Water level
Aug. 10, 1949	73.18	Nov. 29, 1949	73.37	May 5, 1950	72.76
Sept. 29	72.94	Dec. 30	75.10	June 1	72.89
Oct. 28	72.79				

22-59-34cb

Date	Water level	Date	Water level	Date	Water level
Aug. 10, 1949	63.02	Nov. 29, 1949	63.88	May 5, 1950	63.80
Sept. 29	63.31	Dec. 30	65.34	June 1	63.62
Oct. 28	63.44				

23-59-1ab

Date	Water level	Date	Water level	Date	Water level
June 28, 1949	5.31	Oct. 27, 1949	4.29	Feb. 27, 1950	5.60
July 30	4.69	Nov. 25	4.72	Mar. 30	5.76
Aug. 29	4.36	Dec. 29	5.02	May 4	5.73
Sept. 28	3.91	Jan. 31, 1950	5.36	31	5.58

23-59-1cc

Date	Water level	Date	Water level	Date	Water level
June 28, 1949	11.82	Sept. 28, 1949	10.82	Dec. 29, 1949	11.93
July 30	11.85	Oct. 27	11.15	Jan. 31, 1950	12.08
Aug. 29	10.65	Nov. 25	11.65	Feb. 27	12.37

Table 3.—*Water-level measurements in observation wells*—Continued

Date	Water level	Date	Water level	Date	Water level
		RICHLAND COUNTY, MONT.—Continued			
		23-59-1cc—Continued			
Mar. 30, 1950	12.51	June 29, 1950	11.26	Aug. 30, 1950	10.96
May 4	12.21	Aug. 1	10.89	Oct. 2	11.04
31	12.02				
		23-59-1dc			
June 24, 1949	8.48	Oct. 27, 1949	8.11	Feb. 27, 1950	9.12
July 30	8.22	Nov. 25	8.81	Mar. 30	8.88
Aug. 29	7.95	Dec. 29	8.85	May 4	7.83
Sept. 28	7.72	Jan. 31, 1950	8.81	31	8.07
		23-59-2ca			
June 27, 1949	6.99	Oct. 27, 1949	9.19	Feb. 27, 1950	9.21
July 30	6.00	Nov. 25	9.50	Mar. 30	8.80
Aug. 29	5.74	Dec. 29	9.47	May 4	9.97
Sept. 28	7.73	Jan. 31, 1950	9.19	31	10.11
		23-59-2cc			
June 27, 1949	9.92	Sept. 28, 1949	6.13	Nov. 25, 1949	9.00
July 30	8.43	Oct. 27	7.38	May 4, 1950	14.67
Aug. 29	7.26				
		23-59-2dd1			
June 24, 1949	6.38	Oct. 27, 1949	4.32	Feb. 27, 1950	7.10
July 30	6.22	Nov. 25	5.59	Mar. 30	7.12
Aug. 29	5.46	Dec. 29	6.68	May 4	6.86
Sept. 28	5.70	Jan. 31, 1950	6.88	31	6.41
		23-59-2dd2			
June 8, 1949	7.04	Oct. 27, 1949	5.75	Feb. 27, 1950	[a]9.60
July 30	6.19	Nov. 25	6.49	Mar. 30	[a]9.60
Aug. 29	4.48	Dec. 29	7.15	May 4	[a]9.60
Sept. 28	4.72	Jan. 31, 1950	Dry	31	[a]9.60

[a] Dry.

Date	Water level	Date	Water level	Date	Water level
		23-59-8dd			
June 14, 1949	8.75	Oct. 27, 1949	11.06	Mar. 30, 1950	12.48
July 30	10.09	Nov. 25	10.85	May 4	8.42
Aug. 29	11.29	Dec. 29	12.77	31	7.93
Sept. 28	11.38				
		23-59-11aa1			
June 8, 1949	6.65	Aug. 29, 1949	4.36	Oct. 27, 1949	6.01
July 30	6.49	Sept. 28	4.80		
		23-59-11ab			
June 24, 1949	7.24	Oct. 27, 1949	7.67	Feb. 27, 1950	7.85
July 30	7.27	Nov. 25	7.98	Mar. 30	8.05
Aug. 29	6.89	Dec. 29	8.22	May 4	7.74
Sept. 28	7.08	Jan. 31, 1950	8.27	31	7.80

Table 3.—*Water-level measurements in observation wells*—Continued

RICHLAND COUNTY, MONT.—Continued

23-59-11ba1

Date	Water level	Date	Water level	Date	Water level
June 27, 1949	5.42	Sept. 28, 1949	3.79	May 4, 1950	7.22
July 30	2.90	Oct. 27	6.11	31	6.89
Aug. 29	3.10				

23-59-11ba2

Date	Water level	Date	Water level	Date	Water level
June 24, 1949	3.13	May 31, 1950	5.48	Apr. 30, 1951	5.84
July 30	3.69	June 29	4.96	May 25	5.98
Aug. 29	3.41	Aug. 1	4.90	June 26	5.10
Sept. 28	3.50	30	5.65	July 30	4.90
Oct. 27	3.71	Oct. 2	5.50	Aug. 30	4.84
Nov. 25	5.40	Nov. 2	5.96	Sept. 26	5.42
Dec. 29	5.42	Dec. 5	6.19	Oct. 30	5.70
Jan. 31, 1950	5.02	Jan. 2, 1951	6.33	Nov. 30	6.02
Feb. 27	4.58	Feb. 2	6.26	Dec. 26	5.92
Mar. 30	4.01	Mar. 5	5.64	Jan. 25, 1952	5.65
May 4	4.66	29	5.20	Apr. 16	5.40

23-59-11cc

Date	Water level	Date	Water level	Date	Water level
June 23, 1949	7.78	Sept. 28, 1949	7.42	May 4, 1950	8.45
July 30	7.70	Oct. 27	7.98	31	8.35
Aug. 29	7.19	Nov. 25	8.19		

23-59-12da1

Date	Water level	Date	Water level	Date	Water level
June 21, 1949	3.61	Sept. 28, 1949	4.04	Dec. 29, 1949	5.16
July 30	4.17	Oct. 27	4.41	May 31, 1950	4.14
Aug. 29	4.02	Nov. 25	4.81		

23-59-13aa

Date	Water level	Date	Water level	Date	Water level
Aug. 15, 1949	3.60	Dec. 29, 1949	6.11	May 31, 1950	5.19
29	4.98	Jan. 31, 1950	6.15	June 29	3.99
Sept. 28	4.93	Feb. 27	6.02	Aug. 1	3.62
Oct. 27	5.34	Mar. 30	5.46	30	5.92
Nov. 25	5.74	May 4	5.15		

23-59-13bc

Date	Water level	Date	Water level	Date	Water level
June 20, 1949	8.50	Oct. 27, 1949	9.62	Feb. 27, 1950	10.91
July 30	8.01	Nov. 25	10.86	Mar. 30	11.05
Aug. 29	7.22	Dec. 29	11.12	May 4	11.40
Sept. 28	10.67	Jan. 31, 1950	10.76	31	11.45

23-59-13cc

Date	Water level	Date	Water level	Date	Water level
June 20, 1949	9.89	May 31, 1950	12.39	May 25, 1951	13.20
July 30	10.53	June 29	11.43	June 28	10.78
Aug. 29	9.30	Aug. 1	10.14	July 30	10.52
Sept. 28	10.07	30	10.24	Aug. 30	9.57
Oct. 27	11.01	Oct. 2	10.59	Sept. 26	10.74
Nov. 25	11.63	Nov. 21	10.87	Oct. 30	11.26
Dec. 29	12.00	Dec. 5	11.34	Nov. 30	11.82
Jan. 31, 1950	11.89	Jan. 2, 1951	11.80	Dec. 26	12.03
Feb. 27	12.21	Mar. 29	12.48	Jan. 25, 1952	12.15
Mar. 30	12.42	Apr. 30	12.72	Apr. 16	12.60
May 4	12.78				

Table 3.—*Water-level measurements in observation wells*—Continued

RICHLAND COUNTY, MONT.—Continued

23-59-14ab

Date	Water level	Date	Water level	Date	Water level
June 21, 1949	7.92	Oct. 27, 1949	6.30	Jan. 31, 1950	9.09
July 30	7.07	Nov. 25	7.32	May 4	10.00
Aug. 29	4.85	Dec. 29	8.29	31	9.83
Sept. 28	4.99				

23-59-14cc

Date	Water level	Date	Water level	Date	Water level
June 20, 1949	8.19	Oct. 27, 1949	7.85	Feb. 27, 1950	9.62
July 30	8.86	Nov. 25	8.43	Mar. 30	9.80
Aug. 29	6.62	Dec. 29	8.94	May 4	9.59
Sept. 28	6.98	Jan. 31, 1950	9.51	31	9.71

23-59-14da

Date	Water level	Date	Water level	Date	Water level
June 20, 1949	7.69	Oct. 27, 1949	9.84	Feb. 27, 1950	8.95
July 30	7.24	Nov. 25	9.91	Mar. 30	8.93
Aug. 29	6.30	Dec. 29	9.27	May 4	9.21
Sept. 28	9.55	Jan. 31, 1950	8.71	31	8.73

23-59-15ab

Date	Water level	Date	Water level	Date	Water level
June 21, 1949	7.56	Oct. 27, 1949	8.18	Feb. 27, 1950	[a]10.0
July 30	7.20	Nov. 25	9.72	Mar. 30	[a]10.0
Aug. 29	6.53	Dec. 29	9.32	May 4	[a]10.0
Sept. 28	7.10	Jan. 31, 1950	9.60	31	7.98

[a]Dry.

23-59-15db1

Date	Water level	Date	Water level	Date	Water level
June 21, 1949	8.27	Sept. 28, 1949	8.29	May 4, 1950	8.81
July 30	8.45	Oct. 27	8.50	31	8.80
Aug. 29	7.90	Nov. 25	8.71		

23-59-15db2

Date	Water level	Date	Water level	Date	Water level
June 21, 1949	8.97	Mar 4, 1950	11.41	Apr. 30, 1951	11.20
July 30	8.46	31	10.78	May 25	11.16
Aug. 29	7.98	June 29	9.75	June 28	8.21
Sept. 28	8.53	Aug. 1	8.98	July 30	9.27
Oct. 27	9.24	30	9.09	Aug. 30	9.44
Nov. 25	9.87	Oct. 2	9.79	Sept. 26	10.17
Dec. 29	10.77	Dec. 5	10.69	Oct. 30	10.66
Jan. 31, 1950	10.62	Jan. 2, 1951	10.96	Nov. 30	10.96
Feb. 27	11.27	Feb. 2	11.21	Apr. 16, 1952	10.38
Mar. 30	11.51				

23-59-15dc

Date	Water level	Date	Water level	Date	Water level
June 21, 1949	5.34	Sept. 28, 1949	4.63	Mar. 30, 1950	6.65
July 30	4.35	Oct. 27	5.83	May 4	[a]7.40
Aug. 29	3.77	Nov. 25	6.97	31	[a]7.40

[a]Dry.

Table 3.—*Water-level measurements in observation wells*—Continued

RICHLAND COUNTY, MONT.—Continued

23-59-21ab1

Date	Water level	Date	Water level	Date	Water level
June 17, 1949	11.72	Sept. 28, 1949	9.09	Nov. 25, 1949	11.48
July 30	11.16	Oct. 27	10.32	May 31, 1950	14.60
Aug. 30	9.04				

23-59-21cd

Date	Water level	Date	Water level	Date	Water level
June 14, 1949	5.29	Oct. 27, 1949	5.47	Feb. 27, 1950	6.46
July 30	5.17	Nov. 25	6.72	Mar. 30	6.56
Aug. 29	4.98	Dec. 29	6.18	May 4	6.26
Sept. 28	4.89	Jan. 31, 1950	6.47	31	5.81

23-59-21db

Date	Water level	Date	Water level	Date	Water level
June 17, 1949	3.00	Oct. 27, 1949	4.70	Feb. 27, 1950	7.84
July 30	5.06	Nov. 25	5.46	Mar. 30	7.80
Aug. 29	4.38	Dec. 29	6.60	May 4	7.79
Sept. 28	5.63	Jan. 31, 1950	7.45	31	7.78

23-59-21dd

Date	Water level	Date	Water level	Date	Water level
June 15, 1949	4.42	May 31, 1950	6.45	Apr. 30, 1951	7.51
July 30	5.86	June 29	5.49	May 25	5.79
Aug. 29	5.10	Aug. 1	4.96	June 28	5.55
Sept. 28	5.65	30	5.86	July 30	4.76
Oct. 27	6.21	Oct. 2	6.58	Aug. 30	6.04
Nov. 25	6.91	Nov. 21	6.91	Sept. 26	6.54
Dec. 29	7.25	Dec. 5	7.34	Oct. 30	7.15
Jan. 31, 1950	7.59	Jan. 2, 1951	7.55	Nov. 30	7.48
Feb. 27	8.04	Mar. 5	8.62	Dec. 26	7.77
Mar. 30	7.81	29	3.07	Apr. 16, 1952	6.97
May 4	7.15				

23-59-22ab

Date	Water level	Date	Water level	Date	Water level
June 14, 1949	8.63	Sept. 28, 1949	5.86	Dec. 29, 1949	9.64
July 30	7.41	Oct. 29	7.52	May 4, 1950	11.13
Aug. 30	5.08	Nov. 25	8.94	31	10.75

23-59-22bc

Date	Water level	Date	Water level	Date	Water level
June 17, 1949	5.08	Oct. 27, 1949	5.01	Feb. 27, 1950	7.32
July 30	4.55	Nov. 25	5.51	Mar. 30	8.04
Aug. 29	4.62	Dec. 29	7.08	May 4	7.27
Sept. 28	4.42	Jan. 31, 1950	7.10	31	6.89

23-59-22cb

Date	Water level	Date	Water level	Date	Water level
June 17, 1949	7.01	Oct. 27, 1949	6.36	Feb. 27, 1950	9.44
July 30	6.49	Nov. 25	7.11	Mar. 30	9.66
Aug. 29	5.19	Dec. 29	9.37	May 4	9.26
Sept. 28	5.50	Jan. 31, 1950	8.98	31	8.59

23-59-22dd

Date	Water level	Date	Water level	Date	Water level
June 20, 1949	12.60	Aug. 29, 1949	11.04	Oct. 27, 1949	11.36
July 30	11.67	Sept. 28	10.77	Nov. 25	12.71

Table 3.—*Water-level measurements in observation wells*—Continued

RICHLAND COUNTY, MONT.—Continued

23-59-22dd—Continued

Date	Water level	Date	Water level	Date	Water level
Dec. 29, 1949	13.33	Feb. 27, 1950	14.08	May 4, 1950	13.89
Jan. 31, 1950	13.72	Mar. 30	13.96	31	13.69

23-59-23ba

Date	Water level	Date	Water level	Date	Water level
June 20, 1949	18.39	Dec. 29, 1949	19.28	May 31, 1950	20.58
July 30	18.70	Jan. 31, 1950	20.04	June 29	18.94
Aug. 29	15.10	Feb. 27	20.35	Aug. 1	17.53
Sept. 28	15.10	Mar. 30	20.55	30	16.32
Oct. 27	16.96	May 4	20.70	Oct. 2	16.80
Nov. 25	18.16				

23-59-23dc

Date	Water level	Date	Water level	Date	Water level
Aug. 28, 1949	8.33	Dec. 29, 1949	10.25	Mar. 30, 1950	[a]10.40
Sept. 28	8.62	Jan. 31, 1950	10.35	May 4	[a]10.40
Oct. 27	9.20	Feb. 27	[a]10.40	31	[a]10.40
Nov. 25	10.01				

[a]Dry.

23-59-24aa

Date	Water level	Date	Water level	Date	Water level
Aug. 24, 1949	14.47	Sept. 30, 1949	14.41		

23-59-24dc

Date	Water level	Date	Water level	Date	Water level
June 22, 1949	7.09	Sept. 29, 1949	9.24	Dec. 30, 1949	11.07
July 31	5.55	Oct. 28	9.00	May 4, 1950	10.74
Aug. 30	8.29	Nov. 29	10.69	June 1	11.01

23-59-26dd

Date	Water level	Date	Water level	Date	Water level
Aug. 10, 1949	6.35	Nov. 28, 1949	7.17	Feb. 27, 1950	[a]7.15
29	5.86	Dec. 29	7.11	Mar. 30	[a]7.15
Sept. 28	6.18	Jan. 31, 1950	[a]7.15	May 31	6.29
Oct. 28	6.77				

[a]Dry.

23-59-27bb

Date	Water level	Date	Water level	Date	Water level
Aug. 29, 1949	2.79	Dec. 29, 1949	5.29	Mar. 30, 1950	7.88
Sept. 28	3.25	Jan. 31, 1950	7.33	May 4	7.39
Oct. 27	4.71	Feb. 27	7.72	31	6.43
Nov. 25	5.65				

23-59-27dc

Date	Water level	Date	Water level	Date	Water level
Aug. 8, 1949	8.18	Nov. 28, 1949	[a]9.70	Feb. 27, 1950	[a]9.70
29	7.82	Dec. 29	[a]9.70	Mar. 30	[a]9.70
Sept. 28	8.70	Jan. 31, 1950	[a]9.70	May 4	[a]9.70
Oct. 28	[a]9.70				

[a]Dry.

Table 3.—*Water-level measurements in observation wells*—Continued

RICHLAND COUNTY, MONT.—Continued

23-59-28ad

Date	Water level	Date	Water level	Date	Water level
July 23, 1949	7.00	Aug. 29, 1949	6.00		

23-59-28bb

Date	Water level	Date	Water level	Date	Water level
Aug. 29, 1949	4.81	Aug. 1, 1950	7.77	May 25, 1951	7.17
Sept. 28	5.48	30	6.25	June 28	5.83
Oct. 27	6.91	Oct. 2	6.87	July 30	4.86
Nov. 25	7.32	Nov. 2	7.62	Aug. 30	6.59
Dec. 29	8.24	Dec. 5	8.21	Sept. 26	7.31
Jan. 31, 1950	9.05	Jan. 2, 1951	8.57	Oct. 30	7.84
Feb. 27	9.43	Feb. 2	8.88	Nov. 30	8.24
Mar. 30	9.61	Mar. 5	9.45	Dec. 26	8.65
May 4	9.35	29	9.39	Jan. 25, 1952	9.10
31	8.55	Apr. 30	9.42	Apr. 16	9.27
June 29	8.13				

23-59-28cc

Date	Water level	Date	Water level	Date	Water level
June 14, 1949	5.21	Aug. 29, 1949	4.61	Sept. 28, 1949	4.52
July 30	5.54				

23-59-28db1

Date	Water level	Date	Water level	Date	Water level
June 14, 1949	5.27	Oct. 27, 1949	5.11	Feb. 27, 1950	7.74
July 30	5.03	Nov. 25	6.12	Mar. 30	7.65
Aug. 29	3.00	Dec. 29	6.79	May 4	6.98
Sept. 28	4.07	Jan. 31, 1950	8.41	31	5.71

23-59-31aa2

Date	Water level	Date	Water level	Date	Water level
June 14, 1949	18.68	Oct. 27, 1949	17.42	Feb. 27, 1950	20.10
July 30	18.69	Nov. 25	18.43	Mar. 30	[a]20.50
Aug. 29	18.68	Dec. 29	19.07	May 4	[a]20.50
Sept. 29	17.97	Jan. 31, 1950	20.35	31	20.05

[a]Dry.

23-59-32dd2

Date	Water level	Date	Water level	Date	Water level
June 14, 1949	9.04	Oct. 28, 1949	9.11	Mar. 30, 1950	11.42
July 30	10.09	Nov. 28	10.01	May 4	9.50
Aug. 29	8.46	Dec. 29	10.50	31	9.73
Sept. 28	8.37				

23-59-33ad

Date	Water level	Date	Water level	Date	Water level
June 15, 1949	10.60	Mar. 30, 1950	10.84	Apr. 30, 1951	9.61
July 30	10.35	May 4	10.68	May 25	10.66
Aug. 29	10.13	31	10.44	June 28	10.06
Sept. 29	10.03	Nov. 2	10.38	July 30	10.35
Oct. 28	10.20	Dec. 5	10.63	Aug. 30	10.08
Nov. 28	10.32	Jan. 2, 1951	10.47	Sept. 26	10.11
Dec. 29	10.45	Feb. 2	11.97	Oct. 30	10.43
Jan. 31, 1950	10.55	Mar. 5	10.82	Nov. 30	10.55
Feb. 27	10.86	29	10.53		

Table 3.—*Water-level measurements in observation wells*—Continued

RICHLAND COUNTY, MONT.—Continued

23-59-33db

Date	Water level	Date	Water level	Date	Water level
June 13, 1949	8.49	Dec. 29, 1949	9.15	May 31, 1950	8.95
July 30	8.97	Jan. 31, 1950	9.45	June 29	8.10
Aug. 29	8.55	Feb. 27	9.59	Aug. 1	7.27
Sept. 29	8.38	Mar. 30	9.57	30	8.60
Oct. 28	8.63	May 4	9.05	Oct. 3	8.49
Nov. 28	8.87				

23-59-33dc

Date	Water level	Date	Water level	Date	Water level
June 15, 1949	9.05	Aug. 29, 1949	7.59	Oct. 28, 1949	8.50
July 30	9.21	Sept. 29	5.75		

23-59-33dd

Date	Water level	Date	Water level	Date	Water level
June 13, 1949	8.76	Oct. 28, 1949	8.34	Feb. 27, 1950	10.10
July 31	8.37	Nov. 28	8.93	Mar. 30	[a]11.00
Aug. 30	7.76	Dec. 29	10.00	May 4	9.41
Sept. 29	7.54	Jan. 31, 1950	9.80	31	9.08

[a]Dry.

23-59-35bc

Date	Water level	Date	Water level	Date	Water level
Aug. 5, 1949	8.23	Sept. 29, 1949	7.78	Nov. 28, 1949	8.42
30	7.53	Oct. 28	7.93	Dec. 29	8.30

23-59-35dc1

Date	Water level	Date	Water level	Date	Water level
Sept. 2, 1949	9.91	Jan. 31, 1950	10.92	June 29, 1950	8.45
29	10.07	Feb. 27	10.82	Aug. 1	8.07
Oct. 28	10.28	May 4	10.02	30	9.30
Nov. 28	10.61	31	9.90	Oct. 2	10.06
Dec. 29	10.72				

23-60-6ca

Date	Water level	Date	Water level	Date	Water level
June 24, 1949	6.87	Sept. 28, 1949	7.82	Dec. 29, 1949	9.73
July 30	7.74	Oct. 27	9.07	May 31, 1950	8.74
Aug. 29	7.25	Nov. 25	9.37		

23-60-6dc

Date	Water level	Date	Water level	Date	Water level
June 23, 1949	3.48	Aug. 29, 1949	5.55	Oct. 27, 1949	6.07
July 30	4.77	Sept. 28	4.52		

23-60-8bc

Date	Water level	Date	Water level	Date	Water level
July 12, 1949	7.00	Nov. 25, 1949	7.52	Mar. 30, 1950	[a]7.54
Aug. 29	6.85	Dec. 29	7.50	May 4	[a]7.54
Sept. 28	6.76	Jan. 31, 1950	[a]7.54	31	[a]7.54
Oct. 27	6.55	Feb. 27	[a]7.54		

[a]Dry

23-60-18aa

Date	Water level	Date	Water level	Date	Water level
June 20, 1949	8.50	Sept. 28, 1949	10.54	Nov. 25, 1949	11.25
Aug. 29	10.78	Oct. 27	9.79	Dec. 29	11.94

Table 3.— *Water-level measurements in observation wells*— Continued

Date	Water level	Date	Water level	Date	Water level
RICHLAND COUNTY, MONT. — Continued					
23-60-18aa — Continued					
Jan. 31, 1950	11.61	May 31, 1950	10.36	Aug. 1, 1950	6.55
May 4	10.82	June 29	7.26	30	9.48
23-60-18bb					
Aug. 29, 1949	7.36	Dec. 29, 1949	8.89	Mar. 30, 1950	7.14
Sept. 29	7.02	Jan. 31, 1950	8.81	May 4	7.77
Oct. 27	8.31	Feb. 27	8.37	31	7.42
Nov. 25	8.66				
23-60-18dd					
Aug. 24, 1949	9.98	Nov. 29, 1949	10.94	Feb. 28, 1950	12.03
Sept. 29	10.32	Dec. 30	11.49	May 5	11.49
Oct. 28	10.03	Feb. 1, 1950	11.80	June 1	11.73
23-60-19bc					
Aug. 24, 1949	11.10	Nov. 29, 1949	12.75	Feb. 28, 1950	13.95
Sept. 29	11.49	Dec. 30	13.32	May 5	13.43
Oct. 28	11.90	Feb. 1, 1950	13.67	June 1	12.58
23-60-19ca1					
June 22, 1949	10.91	Nov. 29, 1949	13.67	May 5, 1950	15.14
July 31	12.17	Dec. 31	14.01	June 1	14.71
Aug. 30	8.96	Feb. 1, 1950	14.51	30	13.55
Sept. 29	13.17	28	15.62	Aug. 1	12.77
Oct. 28	11.50	Mar. 31	15.16	30	15.64
MCKENZIE COUNTY, N. DAK.					
149-104-5cb					
Aug. 10, 1949	13.58	Nov. 29, 1949	17.04	June 30, 1950	14.36
30	12.46	Dec. 30	15.99	Aug. 1	13.45
Sept. 29	15.42	May 5, 1950	15.49	30	14.75
Oct. 28	16.09	June 1	15.37		
150-104-32bc					
July 1, 1949	19.80	Oct. 28, 1949	23.67	Feb. 1, 1950	23.01
30	23.20	Nov. 29	24.07	May 5	23.21
Aug. 29	25.17	Dec. 30	24.02	June 1	21.40
Sept. 29	25.34				
150-104-32cd					
July 1, 1949	10.04	Aug. 30, 1949	17.41	Oct. 28, 1949	16.24
30	14.92	Sept. 29	17.08	Nov. 29	16.53

RECORD OF WELLS AND SPRINGS

Table 4.—*Record of wells and springs*

Well no.: See text for explanation of well-numbering system. Type of well: B, bored; DD, dug and drilled; Dn, driven; Dr, drilled; D, 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 or stone; N, none; P, pipe (iron or steel); T, tile; W, wood. Character of water-bearing material: G, gravel; L, lignite; S, sand; Ss, sandstone. Geologic source: Gm, ground moraine; Kfh, Fox Hills formation; Khc, Hell Creek formation; Qal, alluvium; Qtd, terrace deposits; Tfu, Fort Union formation. Type of pump: C, centrifugal; Cy, cylinder; J, jet; N, none; P, pitcher pump; R, reciprocating; T, turbine. Type of power: E, electric; F, natural flow; G, gas or gasoline; H, hand operated; N, none; W, wind. Use of water: D, domestic; I, irrigation; In, industrial; N, none; P, public supply; S, stock. Measuring-point description: Bp, base of pump; Tca, top of casing; Tco, top of cover; Tcu, top of curbing; Tp, top of pump; Tpf, top of platform. Remarks: Ca, sample collected for chemical analysis; F, natural flow (numeral indicates gallons per minute).

Well no.	Owner or tenant	Type of well	Depth of well (feet)	Diameter of well (inches)	Type of casing	Character of water-bearing material	Geologic source	Type of pump	Type of power	Use of water	Measuring point: Description	Measuring point: Distance above or below (-) land surface (feet)	Measuring point: Altitude above mean sea level (feet)	Depth to water level below measuring point (feet)	Date of measurement	Remarks
Dawson County, Mont.																
															1949	
16-55- 1dc	F. Peterson	Dr	150	3	P	Ss	Tfu?	N	F	D, S	----	-----	--------	-----	6- 2	F-2;Ca
1dd	L. Schloss	Dr	135	5	P	---	Tfu	N	F	D, S	----	-----	--------	-----	7-13	F-1, 25
2dc	Evens	D	13.4	24	W	G	Qal	Cy	H	D, S, O	Bp	0.60	2,108.21	8.87	7-12	Ca
12bb	Undum	D	25	36	C	G	Qal	Cy	W	D, S	----	-----	--------	-----	-----	
12bd	Charles Widman	D	25	36	W	G	Qal	Cy	W	D, S	----	-----	--------	-----	-----	
13bd		D	13.6	36	W	G	Qtd	Cy	H	O	Tpf	.5	2,060.65	11.82	5-27	
14ad	Schepens	Dr	90	4	P	---	-----	Cy	W	D, S	----	-----	--------	-----	-----	
23ac		D	49.6	6	P	---	-----	Cy	W	D, S	Tca	.4	2,051.05	12.22	8-31	
23cc	Carl Borg	D	23.5	36	W	G	Qal	Cy	H	D, S	Tpf	1.85	2,056.82	11.56	6- 6	
26bc	H. H. Hines	D	13.4	36	P	G	Qal	P	H	D	----	-----	--------	-----	-----	
27ac	R. S. Olmstead	Dr	60	5	P	---	Khc ?	Cy	H	D, S	----	-----	--------	-----	-----	
27db	Willard Kent	Dr	68	5	P	---	Khc ?	Cy	H	D, S	----	-----	--------	-----	-----	

34aa1	W. S. Engman	D	12.4	24	W	G	Qal	Cy	H	D	Tpf	.31	—	8.52	6- 6	
34aa2	Farmers Union	Dr	135	4	P	—	Khc ?	N	N	O	Tca	0	2,055.63	10.40	6- 6	
34da	Jack Skartved	D	15.7	36	W	G	Qal	Cy	H	D, S	Bp	.65	—	13.55	6- 6	
35ab1	City of Glendive	Dr	126	8.25	P	S	Kfh	T	E	P	—	—	—	—	—	
35ab2	do	Dr	105	8.25	P	S	Kfh	T	E	P	—	—	—	—	—	Ca
56- 6ca	Palmer Brown	Dr	100	4	P	—	Tfu	N	F	D, S	—	—	—	—	7-13	F-3
6db	Toby A. Richard	Dr	145	4	P	—	Tfu	N	F	D, S	—	—	—	—	7-13	F-5
20bb	Gorden Mullener	Dr	200	6	P	—	—	Cy	W	S	—	—	—	—	—	
17-55-13aa	Frank Peterson	B	40	18	P	G	Qal	Cy	H	D, S	—	—	—	—	—	
23ab	—	D	19.7	36	W	G	Qal	Cy	H	S, O	Tpf	.8	2,091.42	17.25	7-13	
23bc	Word	D	39.2	36	W	G	Qtd	Cy	H	D, S, O	Tpf	.65	2,059.38	37.75	6-24	
23da	—	Dr	69.6	3	P	—	—	Cy	H	O	Tca	.70	2,058.02	26.28	6-24	
23dd	M. Frelich	Dr	46.7	6	P	—	—	N	N	O	Tca	1.0	2,047.88	24.80	5-27	
30cc	O. Lausundum	D	52	36	P	L	Tfu	Cy	W	D, S	—	—	—	—	—	
34ad	A. Zintner	D	22.8	24	P	G	Qtd	Cy	H	S, O	Tca	1.3	2,095.76	16.81	6-24	Ca
34ca	W. Medtke	Dr	140	2	P	—	Tfu	Cy	W	D, S	—	—	—	—	—	
34dd1	A. Zintner	D	32	36	W	G	Qtd	Cy	H	D, S	—	—	—	—	—	
34dd2	do	Dr	193	2	P	—	Tfu ?	Cy	W	D, S	—	—	—	—	—	
35ab	M. J. Ballback	D	40	4	W	G	Qtd	Cy	E	D, S	—	—	—	—	—	
56- 4dc1	A. Suckow	Dr	300	6	P	—	—	Cy	W	D, S	—	—	—	—	—	
4dc2	do	Dr	170	6	P	—	Tfu	N	F	S	—	—	—	—	6- 7	F-7
4dc3	do	D	18.6	54	C	G	Qtd	N	N	N	Tca	.40	—	14.25	6- 7	
31cc	S. Selman	Dr	94.6	6	P	—	Tfu	Cy	W	S	Tca	1.0	—	28.57	6- 5	
57- 2dc	C. Temple	D	24.4	24	P	G	—	Cy	W	D, S	Tca	.72	—	6.98	7-16	
18-56-25cb	B. Stevenson	D	28.1	30	W	G	Qtd	N	N	O	Tcu	.75	2,068.39	25.52	*1947* 6- 5	
25db	L. Tague	Dr	29	4	P	G	Qtd	Cy	G	S	—	—	—	—	—	
26dd1	—	D	31.5	36	C	G	Qtd	N	N	O	Tco	1.35	2,068.70	25.87	*1949* 7-14	
26dd2	—	D	27.3	36	C	G	Qtd	N	N	O	Tca	.60	2,068.16	24.67	7-14	
34ab	C. Fletcher	D	25.9	36	C	G	Qal	Cy	H	D, S, O	Tpf	.75	2,024.69	19.33	5-27	Ca
36bb	Yellowstone Irrigation Project	D	59.5	24	C	—	—	Cy	H	D, S, O	Bp	.30	2,039.87	42.51	7-14	
57- 3ab	S. Bean	Dr	145	4	P	—	Tfu	N	F	D, S	—	—	—	—	7-30	F-1
4aa	Grant Johnson	D	18.9	24	P	G	Qtd	Cy	H	S, O	Tca	1.25	1,984.56	11.79	7-21	
4cd	School	D	13.7	24	W	G	Qtd	N	N	O	Tco	.7	1,979.96	5.62	7-15	
4dd	H. McPherson	D	12.9	24	W	G	Qtd	Cy	E	S, O	Bp	.7	1,982.47	9.37	7-15	
10bb	Tom McPherson	D	11.4	24	W	S	Qtd	Cy	E	S, O	Tpf	1.2	1,982.55	7.72	7-15	

Table 4.—*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	Character of water-bearing material	Geologic source	Type of pump	Type of power	Use of water	Measuring point: Description	Measuring point: Distance above or below (-) land surface (feet)	Measuring point: Altitude above mean sea level (feet)	Depth to water level below measuring point (feet)	Date of measurement	Remarks
Dawson County, Mont.—Continued																
															1949	
18-57-17bd	----------	D	17.7	36	W	G	Qtd	Cy	E	S, O	Tpf	0.3	2,038.74	11.67	7-21	
19ad	S. S. Tomalino	D	35	24	W	G	Qtd	Cy	E	D, S	----	----	----	----	----	
19ca	Elmer Lease	D	25.1	16	P	G	Qtd	N	N	O	Tca	1.1	2,006.30	23.45	7-14	
20bc	Wm. Ziller	Dn	17	1.25	P	S	Qtd	Cy	H	D, S	----	----	----	----	----	
Richland County, Mont.																
															1949	
19-57-13ab	John Miller	D	16.8	36	N	G	Qtd	N	N	O	Tpf	0.75	2,042.01	16.40	8- 1	
14bd	Larson	Dr	280	4	P	G	----	C	E	D, S	----	----	----	----	----	
24ac	Willis H. Wilson	Dn	11.3	30	W	S	Qtd	Cy	E	S, O	Tpf	.2	1,970.90	5.59	9-13	
25bb	C. Baroni	Dr	16.9	8	P	G	Qtd	Cy	E	D, O	Tca	0	1,966.06	10.65	7-30	
26ad	Roy Brose	D	22	36	M	G	Qtd	Cy	W	D, S, O	----	0	1,991.56	17.98	8- 1	Ca
26dd	Micheletto	Dn	18	1.25	P	G	Qal	Cy	E	D, S	----	----	----	----	----	
34cc	D. Davies	Dr	582	4	P	----	----	N	F	D, S	----	----	----	----	7-30	F-10
58- 5ba	----------	B	32.5	18	W	G	Qtd	Cy	W	S	Bp	.1	2,004.80	30.00	7-29	
5cd	John Mastuelten	B	10.1	48	W	S	Qal	Cy	E	S, O	Bp	.9	1,949.83	6.67	9- 8	
6ba	----------	D	28.2	24	W	G	Qtd	Cy	H	D, S, O	Tpf	1.4	2,025.97	21.50	8- 2	
7bd1	Glen Mitchel	D	23.9	24	W	G	Qal	Cy	W	D, S, O	Tpf	1.15	2,019.79	20.52	8- 2	
19-58- 7bd2	do	D	27.8	24	W	G	Qal	Cy	H	D, S	Bp	.55	----	18.78	8- 2	
8ad	----------	Dn	24.8	1.25	P	S	Qal	N	N	O	Tca	2.6	1,953.91	14.71	9- 9	
8bc	----------	B	12.1	2	P	S	Qtd	N	N	O	Tco	.3	1,955.05	7.45	9- 9	
18ad	----------	D	14.5	24	W	S	Qtd	N	N	O	Tca	1.5	1,958.54	8.53	9- 9	
18ba	H. Fisser	D	25.1	36	W	G	Qtd	Cy	E	D, S, O	Tpf	.75	2,016.63	23.90	8- 2	

18cc	G. Miller	Dr	29	1.25	P	G	Qtd	Cy	E	D, S	----	----	----	----	----	
18cd	M. J. Berg	Dn	17	1.25	P	G	Qtd	Cy	H	D, S	----	----	----	----	----	
18db	E. Meitzel	Dn	22	1.25	P	G	Qtd	Cy	H	D, S	----	----	----	----	----	
18dc	----	B	10.2	2	P	S	Qtd	N	N	O	Tca	.2	1,956.11	8.41	9-13	
20-57-13bd	B. Lalonde	B	81.5	36	W	G	Qal	Cy	W	S	Tpf	1.5	----	53.40	7-20	
22dd	do	B	60.3	24	W	Ss	Tfu	Cy	G	S	Tpf	1.5	----	31.60	7-27	
27dc	Carl Etzel	Dr	210	6	S	S	----	Cy	G	----	----	----	----	----	----	
58- 2ab	H. H. Kincade	D	13.9	48	W	S	Qtd	Cy	W	S, O	Tpf	1.0	1,931.66	10.60	7-13	
2ad	Sig Jonasen	Dr	24.7	10	P	G	Qtd	Cy	E	S, O	Tca	0	1,934.19	13.29	7-18	
2bb	Henry Peterson	Dn	29	1.25	P	G	Qtd	N	N	N	----	----	----	----	----	
2cd	Albert Hoffman	D	12.0	12	P	S	Qtd	Cy	H	D, O	Tpf	0	1,932.53	9.19	7-15	
2dc	Leo Kappel	D	15.5	30	W	S	Qtd	Cy	E	S, O	Tpf	1.0	1,933.17	8.65	7-15	
2dd	do	D	14.0	48	W	G	Qtd	Cy	N	O	Tpf	.1	1,932.56	11.72	7-15	
3cc	Wm. Pust	B	33.2	8	P	G	Qtd	N	N	O	Tpf	1.7	1,980.28	9.95	7-15	
3da	G. T. Millhouse	Dn	33.0	1.25	P	G	Qtd	Cy	E	D	Tca	4.7	----	27.86	7-18	
9dd1	U. S. Geol. Survey	B	9.9	1	P	G	Qtd	N	N	O	Tca	2.5	1,938.30	5.12	8-30	
9dd2	Curtis Rasmussen	Dn	14	1.25	P	G	Qtd	R	E	D	----	----	----	----	----	
10ba	Hans Dynneson	B	11.0	5	P	G	Qtd	Cy	H	S, O	Tca	1.0	1,976.59	8.02	7-15	
10dc	Mrs. G. Leivestad	Dr	389	4	P	----	Tfu	N	F	----	----	----	----	----	7-14	F-0.5
11aa	Jess Hart	B	19.7	24	W	G	Qtd	Cy	E	S, O	Tpf	.2	1,932.78	11.23	7-18	
11bc	Desi Vallejo	Dn	32.6	1.25	P	G	Qtd	P	H	D, O	Tca	2.2	1,935.09	7.41	7-19	
11cb	Allen Darnall	Dn	11.0	1.25	P	G	Qtd	P	H	D, O	Tp	3.5	1,938.28	10.09	7-19	
11cc1	Lawrence Brown	Dn	14.7	1.25	P	S	Qtd	N	N	O	Tca	-4.3	1,931.58	3.43	7-19	
11cc2	do	Dn	19.9	1.25	P	S	Qtd	P	H	D, O	Tca	2.5	1,936.38	8.78	7-19	
11dc	Fred Hamburg	B	21.4	24	W	S	Qtd	N	N	O	Tpf	.6	1,936.36	12.87	7-19	
12bc	H. H. Kincade	B	23.1	24	P	G	Qtd	Cy	E	D, S, O	Tca	.2	1,932.92	12.64	7-18	
14aa	O. L. Crumpacker	Dn	16	1.25	P	S	Qtd	Cy	E	S	----	----	----	----	----	
14bb	George L. Hagler	B	17.9	10	P	G	Qtd	Cy	E	S, O	Tca	.1	1,936.16	5.18	7-22	
15ad	Chet Gear	Dn	22.2	1.25	P	G	Qtd	P	H	D, O	Tca	3.1	1,939.30	11.35	7-22	
15cd1	Chris Bach	D	11.9	36	W	G	Qtd	Cy	E	S, O	Tpf	.7	1,932.62	4.77	7-25	
15cd2	do	Dn	16.2	1.25	P	G	Qtd	P	H	D, O	Tca	1.6	1,939.44	10.40	7-25	
16ba	Max Priebnow	D	23.6	18	C	G	Qtd	Cy	E	D, O	Tca	.2	1,984.19	8.97	7-19	
16bb	State of Montana	D	26.5	36	W	G	Qtd	Cy	H	D, S, O	Tpf	1.0	2,005.24	21.64	7-21	
16bc	Harold Wind	B	19.0	24	W	G	Qtd	P	H	D, O	Tpf	2.4	1,999.86	15.77	7-21	
16bd	Mrs. Mary Miller	B	49	12	P	G	Qtd	Cy	H	D, S	----	----	----	----	----	

Table 4.—*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	Character of water-bearing material	Geologic source	Type of pump	Type of power	Use of water	Measuring point: Description	Measuring point: Distance above or below (-) land surface (feet)	Measuring point: Altitude above mean sea level (feet)	Depth to water level below measuring point (feet)	Date of measurement	Remarks
	Richland County, Mont.—Continued															
															1949	
20-58-17dd	Harold Wind	B	33	24	W	G	Qtd	J	E	D	----	----	----	----	----	
18dd	Frank LaFreniere	B	32	24	W	L, S	Tfu	Cy	E	D, S	----	----	----	----	----	
19ad	Robert Seeve	B	32.6	20	W	L	Tfu	C	E	D, O	Tpf	0.7	2,052.65	23.76	7-26	
20aa	Bertle Wind	B	36.4	8	P	G	Qtd	N	N	O	Tca	.4	1,993.33	27.03	7-21	
20ab	do	D	16.2	24	W	G	Qtd	N	N	O	Tca	.5	2,004.03	11.37	7-21	
20ca	Francis Basso	B	16.7	32	P	G	Qtd	Cy	H	D, O	Tca	.9	2,008.45	11.37	7-26	
20dd	do	B	38.4	8	P	G	Qtd	N	N	O	Tca	1.0	1,995.79	28.26	7-26	
21ad	John Gear	D	21.6	24	P	G	Qtd	Cy	E	D, O	Tpf	.7	1,941.44	12.91	7-25	
21bb	Nels Conradson	B	37.9	24	W	G	Qtd	Cy	E	D, S, O	Tpf	.1	1,982.69	27.18	7-22	Ca
22da	Frank Bone	D	14.7	30	W	G	Qtd	Cy	H	D, S, O	Tcu	1.4	1,936.89	11.66	7-22	
28ba	J. Playle	D	9.5	27	W	S	Qtd	Cy	H	S, O	Tpf	1.2	1,938.73	7.83	7-25	
28bd	G. E. Hicks	D	19.3	36	C	G	Qtd	Cy	W	O	Tcu	.1	1,959.43	15.59	7-25	
29aa	Conrad Gabel	B	30.8	36	W	S	Qtd	Cy	E	S, O	Tpf	1.2	1,975.48	9.70	7-22	
29cd	Caneva	Dr	67	8	P	----	----	Cy	E	S, O	Bp	2.3	2,000.42	20.99	6-8	
29db	D. L. Howard	D	16	36	W	G	Qtd	Cy	E	S	----	----	----	----	----	
29dc	Mansfeldt	B	20.7	24	W	G	Qtd	Cy	H	D, S, O	Tcu	.8	1,980.00	14.66	7-27	
29dd	Olef Waag	B	22.8	24	W	G	Qal	Cy	E	D, S, O	Tpf	1.3	1,974.01	11.98	7-27	
30db	Toby Reiner	D	12.2	48	W	G	Qtd	N	N	O	Tpf	.8	2,015.20	6.12	7-26	
32aa	School Dist. No. 7	B	27.8	18	W	G	Qtd	Cy	H	O	Tpf	.4	1,977.87	21.00	7-29	
32ab	Mexican Labor House	D	15.3	48	W	G	Qtd	Cy	H	D, O	Tpf	.7	1,998.98	14.03	7-27	
32ac1	C. H. Gebhardt	D	19.3	36	P	G	Qtd	Cy	H	D, S, O	Tpf	.2	1,981.99	14.98	7-28	
32ac2	Ruth Johnson	B	32.5	18	W	G	Qtd	Cy	W	S, O	Tpf	.4	1,984.67	16.62	7-29	Ca

TABLE 4

32ad	Mrs. Caroline Jackson	D	27.8	18	P	G	Qtd	Cy	H	D, O	Tpf	1.0	1,977.24	21.62	7-28	
32bb1	Oscar S. Larson	D	13.0	30	T	G	Qtd	N	N	O	Tcu	.2	2,005.84	12.42	7-27	
32bb2		D	11.3	4	N	S	Qtd	N	N	N	Tca	-2.0		8.22	7-26	
32dd	Fred Meyer	Dn	18	1.25	P	G	Qal	Cy	H	D, S						
33ba1	Dave McConaha	D	13.0	24	W	G	Qtd	Cy	H	D, S, O	Tpf?	.5	1,948.86	9.34	7-29	
33ba2	Reclamation Camp	B	12.8	36	?	G	Qtd	Cy	E	D	Tpf	-10.5		4.63	7-29	
33ba3	Dave McConaha	B	20.1	8	P	G	Qtd	Cy	H	D, S, O	Tpf	.6	1,952.45	12.19	8- 2	
33bb	Edward Burau	Dn	30	1.25	P	G	Qtd	C	E	D						
33bc	Emil Caneva	B	32.7	15	P	G	Qtd	Cy	H	D, S, O	Tpf	.6	1,973.77	20.62	7-28	
33cb	Roy Beagle	B	28	15	P	G	Qtd	Cy	E	D, S						
35bc	Jack Eaton	D	21.7	8	P	G	Qal	N	N	N	Tca	1.8		18.86	8- 3	
59- 8bc	J. Gulbrea	D	25	48	W	Ss	Tfu	Cy	G	S	Tpf	.3		20.51	7- 7	
21-57-23aa	Eades	Dr	150	6	S		Tfu	Cy	W	N	Tca	0		126.7	7-12	
35cb	L. C. Bergsted	B	40	24	W	G		Cy	W	S						
58- 1aa		Dn	14.4	1.25	P	G	Qtd	P	H	D, O	Tca	2.1	1,910.93	4.05	6-23	
2ad	H. Christensen	Dr	40	2.50	P	G	Qtd	N	N	O	Bp	1.0	1,924.26	8.83	9- 2	
2dd		Dn	22.8	1.25	P	G	Qtd	P	H	D, O	Tca	2.3	1,928.19	12.65	7- 7	
8dd	Ted Sorenson	Dn	15	1.25	P	G	Qal	C	G	I						
10dc	Niels Nelson	B	42.3	24	W	L	Tfu	Cy	E	S, O	Tpf	1.0	1,963.78	11.11	7-11	
11bb	Carl Rien	Dn	35.4	1.25	P	G	Qtd	P	H	D, O	Tca	3.1	1,955.60	21.74	8-31	
11bd	E. A. Brown	B	46.6	36	W	G	Qtd	Cy	H	S, O	Tpf	2.0	1,956.90	37.70	7-18	
11dc	M. Bakken	Dn	23	1.25	P	S	Qal	Cy	E	D, S						
14bb	Adam Buxbaum	D	7.4	36	W	S	Qtd	Cy	E	S	Tpf	.9		6.33	7-11	
14db	Sorenson	B	16.5	2	P	S	Qal	N	N	O	Tca	1.1	1,915.59	13.92	9- 6	
15ac	J. M. Roberts	Dn	24	1.25	P	G	Qtd	Cy	E	S						
15ca1	Herbert Larson	Dn	15.9	1.25	P	G	Qal	P	H	S, O	Tca	1.7	1,950.63	9.76	7-11	
15ca2	J. Wright	Dr	140	6	P		Tfu	J	E	D, S						
15da	George Lzicar	Dn	14	1.25	P	G	Qtd	Cy	H	D						
15db1	J. Roberts	Dn	21.4	1.25	P	S	Qtd	N	N	O	Tca	1.2	1,963.52	16.79	7-11	
15db2	do	D	15	42	C	G	Qtd	C	E	S						
15db3	Fount Fred	Dn	22	1.25	P	G	Qtd	Cy	H	D						
15db4	J. Roberts	Sp		2	P	G	Qtd	N	F	S						F-20;Ca
15dc		Dn	38.2	1.25	P	G	Qtd	N	N	O	Tpf	1.0	1,942.20	17.86	9- 6	
16bb	Dan Wyman	D	12.6	36	W	G	Qal	Cy	W	S, O	Tpf	0	2,020.75	9.68	7-12	
18dc	Nels Larson	Dr	160	6	P	Ss	Tfu	Cy	W	D, S						

Table 4.—*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	Character of water-bearing material	Geologic source	Type of pump	Type of power	Use of water	Measuring point: Description	Measuring point: Distance above or below (-) land surface (feet)	Measuring point: Altitude above mean sea level (feet)	Depth to water level below measuring point (feet)	Date of measurement	Remarks
	Richland County, Mont.—Continued														1949	
21-58-20aa	Dan Wyman	B	72	18	W	---	----	Cy	W	S, O	Tpf	1.0	2,079.56	57.19	7-28	
21ac	D. Stuart	D	25.9	48	C	G	Qtd	N	N	O	Tpf	.8	1,932.67	11.52	7-13	
21bd	Hans Sorenson	Dn	12.0	1.25	P	G	Qtd	Cy	E	D, S	Tpf	.1	--------	11.50	7-12	
21db1	C. Gattield	B	36.4	24	W	G	Qtd	Cy	H	S, O	Tpf	.2	1,937.09	21.51	7-14	
21db2	----------	D	16.3	36	W	G	Qtd	Cy	E	S, O	Tpf	1.4	1,931.34	15.24	7-14	
22cb	H. J. Nielson	Dn	30	1.25	P	G	Qal	Cy	E	D, S	----	-----	--------	-----	-----	
22da	----------	B	9.1	2	P	S	Qal	N	N	O	Tca	.5	1,912.99	6.01	9- 6	
27bb	----------	B	19.5	1	P	S	Qtd	N	N	O	Tca	.7	1,925.05	17.41	9-12	
27cc	Ted Huber	D	15.5	48	W	S	Qtd	Cy	E	D, S, O	Tca	0	1,922.98	12.20	9- 8	
29bb	E. Struckman	Dn	13	1.25	P	S	Qtd	Cy	H	D, S	----	-----	--------	-----	-----	
32ab	H. L. Moran	B	38.9	18	P	G	Qtd	Cy	H	D, S, O	Tpf	1.0	1,961.89	33.17	7-15	
32bc	State of Montana	Dn	10	1.25	P	G	Qtd	N	N	N	----	-----	--------	-----	-----	
32ca	C. Genther	Dn	20	1.25	P	G	Qtd	Cy	H	S	----	-----	--------	-----	-----	
32cd	C. Bouchard	Dr	33.6	6	P	S	Qtd	Cy	H	D, O	Tca	.5	1,969.61	17.69	7-14	
32da	L. Bakken	Dr	215	6	P	L	Tfu	Cy	W	D, S	----	-----	--------	-----	-----	
33ad	G. A. Nollmeyer	Dn	21	1.25	P	S	Qtd	C	E	D	----	-----	--------	-----	-----	
33bb	Fred Peterson	B	24.5	12	C	G	Qtd	Cy	E	S, O	Tpf	1.0	1,950.32	21.76	7-15	
33dd	G. Nollmeyer	Dn	15.7	1.25	P	S	Qtd	P	H	D, O	Tca	2.6	1,932.92	12.31	7-13	
59- 3cc	Roy Williams	D	15.4	36	W	S	Qal	P	H	D	Tpf	-6.0	--------	14.77	7- 6	
5ba	R. W. Kreiss	B	37.9	24	W	S	Qtd	Cy	E	S, O	Tpf	1.0	1,925.62	12.90	7- 6	Ca
8aa	W. Albert	D	12.3	30	P	G	Qal	Cy	G	S, O	Tpf	.6	1,952.06	10.45	7- 7	
8bb	S. McCarten	D	17.5	48	W	G	Qal	Cy	E	S, O	Tpf	1.0	1,920.45	14.60	7- 7	

8db	Pat Mac Grady	Dr	171	2	P	--	Tfu	Cy	W	D, S	--	--	--	--	--	
18cd	Ben Simonson	Dr	62	2	P	Ss	Tfu	Cy	W	D, S	--	--	--	--	--	
22-58- 1dd	R. E. Shilling	D	19.6	36	W	G	Qtd	Cy	W	S, O	Tpf	.7	1,966.25	15.60	6-16	
23da	D. Ricket	Dr	300	4	P	L	Tfu	N	F	D, S	--	--	--	--	6-22	F-1
24cd		B	16.1	2	P	S	Qal	N	N	O	Tca	2.2	1,931.17	10.61	8-18	
36aa	Joe Rios	Dn	20.8	1.25	P	G	Qtd	P	H	D, O	Tca	1.7	1,909.93	3.30	6-23	
36bb		Dr	11.2	2	P	S	Qtd	N	N	O	Tca	1.0	1,922.49	3.35	9- 2	
59- 2da	Peter Storholm	Dr	500	4	P	Ss	Tfu	N	F	--	--	--	--	--	6-22	F-1;Ca
3aa1	E. B. Hardy	D	12.3	36	P	S	Qtd	N	N	O	Tpf	0	1,904.38	9.70	8- 5	
3aa2	do	Dn	19.9	1.25	P	G	Qtd	N	N	O	Tca	2.5	1,902.81	9.98	6-15	
3bb	Mrs. Conrad Strasheim	D	16.8	36	W	G	Qtd	Cy	E	S, O	Tpf	.5	1,921.06	10.74	8- 5	
3cc	Lester Moore	Dn	26	1.25	P	G	Qtd	Cy	E	S	--	--	--	--	--	
4ad	Becker	D	12.9	36	M	G	Qtd	Cy	H	D, S, O	Tpf	.3	1,923.21	10.67	6-16	
4bc1	Cemetery	Dn	19.9	1.25	P	G	Qtd	N	N	D, O	Tca	3.15	1,938.90	10.39	7- 6	
4bc2	Arnold Digie	DD	8.7	24	W	S	Qtd	Cy	E	D, S	Tca	-4.3	--	2.77	7- 6	
5aa	F. Creis	Dn	14.2	1.25	P	S	Qtd	P	H	S, O	Tca	2.8	1,941.15	10.23	7- 6	
5ac	Julian Varhesselt	Dn	15	2	P	S	Qtd	Cy	H	S	--	--	--	--	--	
5ba	Eldrshy Petterson	Dr	70.2	3	P	--	--	J	E	D, O	Tcu	0	1,952.15	12.10	7- 6	
5cc	Cris Digie	D	12.4	30	W	G	Qtd	Cy	E	S, O	Tca	.6	1,938.93	9.64	6-16	
5dd	Mrs. Morril	Dr	160	2	P	--	Tfu	N	F	D, S	--	--	--	--	7- 6	F-1
6ba	R. Anderson	Dr	35	1.25	P	G	Qtd	Cy	E	D, S	--	--	--	--	--	
6dc	Gregorio DeLuna	Dn	38.1	1.25	P	G	Qtd	N	N	O	Tca	2.3	1,950.14	10.56	7-29	
6dd1	Cris Digie	Dn	21.3	1.25	P	G	Qtd	P	H	D, O	Tca	2.8	1,944.94	9.76	7-29	
6dd2	do	D	8.8	24	W	G	Qtd	N	N	N	--	0	--	7.33	6-16	
7cd	Manual Buxbaum	Dr	30.9	1.50	P	G	Qtd	P	H	D, O	Tca	2.1	1,959.09	17.29	6-16	
8ad1	Paul Wodtkey	D	7.8	42	M	G	Qtd	--	--	I, O	Tcu	0	1,926.30	7.14	7- 5	
8ad2	Charles Kelley	Dn	18	1.25	P	G	Qtd	Cy	E	D	--	--	--	--	--	
8bb	Buxbaum	D	6.4	24	W	--	Qtd	Cy	E	D, S	Bp	0	1,937.26	5.50	7- 6	
8bc1	H. Lorenz	Dn	12	1.25	P	S	Qtd	Cy	E	S	--	--	--	--	--	
8bc2	do	Dr	300	4	P	L	Tfu	N	F	D, S	--	--	--	--	6-21	F-1
8cd	Henry Scheetz	Dn	12.4	1.25	P	G	Qtd	P	H	S, O	Tca	1.9	1,929.38	5.59	7- 5	
8da1	Henry Buxbaum	D	5.9	80	M	G	Qtd	C	G	I, O	Tpf	0	1,923.27	4.18	7- 5	
8da2	Henry Hamburg	D	14.7	48	W	G	Qtd	Cy	H	D	Tcu	.3	--	7.77	7- 5	
8dd	John Schmidt	D	10.5	36	W	S, G	Qtd	Cy	E	S, O	Tpf	1.3	1,926.48	6.73	8-29	
9aa		B	9.3	2.50	P	S	Qtd	N	N	O	Tca	1.3	1,907.48	8.10	8-22	
9ab	Ed Mindt	Dn	23	1.25	P	G	Qtd	Cy	E	D	--	--	--	--	--	

Table 4.—*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	Character of water-bearing material	Geologic source	Type of pump	Type of power	Use of water	Measuring point: Description	Measuring point: Distance above or below land surface (feet)	Measuring point: Altitude above mean sea level (feet)	Depth to water level below measuring point (feet)	Date of measurement	Remarks
Dawson County, Mont.—Continued															*1949*	
22-59- 9ba	H. V. Faucet	Sp	----	----	---	G	Qtd	---	---	D, S	----	----	----	----	----	
11cd	Joe Strack	D	30.1	43	W	G	Qtd	Cy	E	S, O	Tpf	0.4	1,912.81	27.36	6-17	
15bd	----	B	29.7	24	W	G	Qtd	N	N	O	Tpf	1.4	1,916.80	23.53	8-10	
16aa	C. J. Woodruff	Dn	23.3	1.25	P	S	Qtd	P	H	S, O	Tca	3.2	1,898.00	16.88	8-15	
16ac	Alex Scheetz	Dn	28	1.50	P	S	Qtd	P	H	D	----	----	----	----	----	
16da	Alex Raa	Dr	1,000	4	P	----	----	N	F	D, S	----	----	----	----	7- 5	F-10
16dc	Phillip Scheetz	Dn	16.1	1.25	P	S	Qtd	P	H	S, O	Tca	2.0	1,904.91	11.75	8-15	Ca
17aa	John Stip	D	11.3	48	W	G	Qtd	C	E	In, O	Tpf	.5	1,926.86	6.99	7- 5	
17ba1	Ernest D. Voorhees	Dn	18.1	1.25	P	G	Qtd	N	N	O	Tca	1.8	1,930.93	7.66	7- 5	
17ba2	Albert Obergfeld	D	10.8	40	W	G	Qtd	N	N	N	Tpf	.8	----	10.55	7- 5	
18ab	Albert Groskinsky	Dn	20.6	1.25	P	G	Qtd	P	H	D, O	Tca	4.4	1,944.35	10.20	9- 3	
18bc	George Hafner	D	10.1	36	P	S	Qtd	Cy	E	D, S, O	Tpf	.8	1,946.52	9.10	6-21	
18ca	A. Rodriguez	Dn	23.5	1.25	P	G	Qtd	P	H	D, O	Tca	3.0	1,944.89	11.77	8- 9	
18cc	M. Simonson	Sp	----	36	---	G	Qtd	N	F	D	----	----	----	----	6-21	F-10
19ab	Merrien Simonson	D	9.0	36	W	S	Qtd	Cy	E	S, O	Tpf	.8	1,905.63	4.10	8-23	Ca
19bb	do	B	7.0	2.50	P	S	Qtd	N	N	O	Tca	.25	1,918.90	5.22	8-23	
19cc	O'Brien	B	11.6	1	P	S	Qtd	N	N	O	Tca	3.2	1,910.59	7.95	9-12	
19cd	do	Dr	190	4	P	---	Tfu	N	F	D, S	----	----	----	----	6-21	F-4
20bc	----	Dn	18.4	1	P	S	Qtd	N	N	O	Tca	1.5	1,909.44	16.75	9-12	
20da	Jake Marker	Dr	312	4	P	---	Tfu	N	F	D, S	----	----	----	----	6- 3	F-4

21ab	Ray Smart	Dn	26	1.25	P	S	Qtd	R	E	D, S						
21bb		B	13.6	2.50	P	S	Qtd	N	N	O	Tca	.3	1,905.64	11.78	8-25	
21bc	Joe Tapp	Dr	18	1.25	P	G	Qtd	Cy	H	D, S						
28cc		D	25.0	36	W	G	Qtd	Cy	H	O	Tpf	.8	1,932.17	17.18	6- 8	
28dc	A. J. Mercer	Dr	172	4	P	L	Tfu	Cy	W	D, S						
30bb	Sam Simard	Dr	220	4	P		Tfu	N	F	D, S					6-23	F-25;Ca
30cd		B	11.8	2	P	S	Qtd	N	N	O	Tca	.3	1,910.18	8.49	9- 2	
31cb	Albert Odenbach	Dn	20.2	1.25	P	G	Qtd	P	H	D, O	Bp	1.6	1,912.90	6.55	6-23	
31cc	do	D	11.0	36	W	S	Qtd	Cy	W	O	Bp	.5	1,915.93	9.75	6-23	
31dd	Bert Pust	Dn	27.9	1.25	P	G	Qtd	P	H	O	Tca	2.3	1,915.63	12.52	6-23	
32aa	John Verhasselt	Dr	49	5	P	L	Tfu	Cy	G	D, S						
32cd	Ruben Hamburg	Dn	34	1.25	P	G	Qtd	Cy	G	S						
32da	H. H. Kincade	D	31.9	24	W	S	Qtd	Cy	H	S, O	Tpf	.8	1,937.52	16.23	7- 7	
32dd	Lewis Albert	Dn	12.9	1.25	P	S	Qtd	P	H	D, O	Tca	3.4	1,943.97	5.78	7- 7	
34ca		B	100+	24	P	L	Tfu	Cy	H	O	Tpf	.8	2,067.42	73.98	8-10	Ca
34cb		Dr	65.5	4	P			Cy	W	O	Tca	.3	2,042.01	63.32	8-10	
60- 7cc	Sterling Swigart	Dr	361	5	P	L	Tfu	N	F	S					6-22	F-10
23-58-22cc	John Cundiff	B	53.1	36	C	S	Qal	Cy	W	S	Tcu	1.0		41.68	7- 8	
59- 1ab	Mexican Labor House	Dn	20.1	1.25	P	G	Qtd	P	H	D, O	Tca	3.0	1,900.71	8.31	6-28	
1ba	Tony Pominville	Dn	8.2	1.25	P	G	Qtd	N	N	N	Tca	-5.2		2.90	6-28	
1bc	Oscar Johnson	Dr	96	6	P	L	Tfu	Cy	E	D, S						
1cc	Marie Sorenson	D	15.1	20	P	G	Qtd	C	E	D,S,O		0	1,907.55	11.82	6-28	
1dc	Ruben Nelson	Dn	14.4	1.25	P	G	Qtd	N	N	O	Tca	-4.4	1,893.42	4.08	6-24	
2ab	U. S. Bur. of Reclamation	Dr	190	6	P		Tfu	Cy	E	D						Ca
2ca	Iverson	Dn	14.4	1.25	P	G	Qtd	P	H	O	Tca	2.3	1,922.91	9.29	6-27	
2cc	Jay Gibbs	D	11.9	48	M	G	Qtd	C	E	D, S, O	Tcu	-7.5	1,930.46	2.42	6-27	
2db	A. Breiting	Dn	10	1.25	P	G	Qtd	Cy	H	S						
2dd1	Mexican Labor House	Dn	16.6	1.25	P	S	Qtd	P	H	D, O	Tca	2.8	1,906.90	9.18	6-24	
2dd2	Ridgelawn School	D	10.2	45	W	G	Qtd	Cy	H	O	Tpf	.6	1,906.74	7.64	6- 8	
8dd	Lloyd Flom	D	16.4	31	W	G	Gm	Cy	H	D, S, O	Tcu	1.8	2,141.99	10.55	6-14	Ca
10bd	Margaret Leo	Sp					Gm									
11aa1		Dn	13.2	1.25	P		Qtd	N	N	O	Tca	1.6	1,908.64	8.25	6- 8	
11aa2	J. A. Reynolds	Dn	21	1.25	P	G	Qtd	Cy	E	D, S						
11ab	Wm. Hammes	B	10.7	4	P	G	Qtd	P	H	D, O	Tca	1.9	1,910.30	9.14	6-24	
11ba1	Chris. A. Iversen	Dn	15.8	1.25	P	G	Qtd	P	H	D, O	Tca	2.8	1,919.06	8.22	6-27	
11ba2	Radio Station KGCX	D	8.2	24	W	G	Qtd	R	E	O	Tca	.1	1,913.77	3.23	6-24	Ca
11cc	Mexican Labor House	Dn	17.7	1.25	P	G	Qtd	P	H	D, O	Bp	2.1	1,915.55	9.88	6-23	

Table 4.—*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	Character of water-bearing material	Geologic source	Type of pump	Type of power	Use of water	Measuring point: Description	Measuring point: Distance above or below (-) land surface (feet)	Measuring point: Altitude above mean sea level (feet)	Depth to water level below measuring point (feet)	Date of measurement	Remarks
									Richland County, Mont.—Continued							
															1949	
23-59-11cd	L. S. Schermerhorn	D	12.3	48	W	S	Qtd	Cy	H	D, S	Tpf	0.4	----	6.33	8-28	
12ac	John Sallaberry	Dr	36	1.50	P	S	Qtd	Cy	E	S	----	----	----	----	----	
12da1	W. Lewis	D	8.2	36	W	S	Qtd	N	N	O	Tpf	.30	1,894.39	3.91	6-21	
12da2	F. Markle	Dn	37	1.25	P	S	Qtd	C	E	D, S	----	----	----	----	----	
13aa	----	B	9.0	2	P	S	Qtd	N	N	O	Tca	3.4	1,898.13	7.00	8-15	
13ba	E. A. Maslowski	Dn	24	1.50	P	G	Qtd	R	E	D	----	----	----	----	----	
13bc	P. Storholm	Dn	22.8	1.25	P	G	Qtd	P	H	D, O	Tca	2.8	1,915.24	11.30	6-20	
13cc	J. Hundtoft	D	15.8	34	C	S	Qtd	Cy	W	S, O	Tpf	.5	1,916.45	10.39	6-20	
14aa	L. Sorensen	Dn	13	1.25	W	G	Qtd	Cy	E	S	----	----	----	----	----	
14ab	T. Christoferson	D	11.4	48	W	G	Qtd	Cy	H	S, O	Tpf	.9	1,913.11	8.82	6-21	
14cc	J. L. Larson	D	10.3	48	W	G	Qtd	Cy	H	S, O	Tpf	.3	1,917.48	8.49	6-20	
14da	G. Joslin	Dn	15.0	1.25	P	G	Qtd	P	H	D, O	Tca	.9	1,912.53	8.59	6-20	
15ab	R. Hass	D	10.2	36	W	G	Qtd	Cy	W	S, O	Tpf	.2	1,921.57	7.76	6-21	
15db1	W. J. Hardy	D	12.4	36	W	G	Qtd	Cy	E	S, O	Tpf	.5	1,925.34	8.77	6-21	
15db2	E. Nevins	B	15.4	6	P	G	Qtd	Cy	H	D, O	Tpf	0	1,923.61	8.97	6-21	
15db3	P. Steffens	D	14	30	W	G	Qtd	R	E	D, S	----	----	----	----	----	
15dc	N. C. Anderson	D	8.4	20	P	G	Qtd	Cy	H	S, O	Tpf	1.0	1,921.35	6.34	6-21	
20da	J. M. Smith	Dn	32	1.25	P	G	Qtd	Cy	E	D	----	----	----	----	----	
21ab1	S. Peterson	D	19.5	48	W	G	Qtd	Cy	H	O	Tpf	.4	1,942.80	12.12	6-17	
21ab2	----	D	4.7	48	W	G	Qtd	Cy	H	D	Tpf	0	----	2.52	6-17	
21ad	C. Peterson	Dn	12	2	P	G	Qtd	J	E	D, S	----	0	----	6.88	6-17	
21cc	H. Henderson	Dn	18	1.25	W	G	Qtd	Cy	E	S	----	----	----	----	----	

21cd		Dn	11.3	1.25	P	G	Qtd	P	H	D, O	Bp	3.0	1,931.97	8.29	6-14	
21db	Nels Bach	D	11.4	20	W	G	Qtd	P	H	O	Bp	2.1	1,928.68	5.10	6-17	
21dd	Gunnar Hansen	D	12.2	40	W	G	Qtd	Cy	E	S, O	Tpf	.9	1,929.06	5.32	6-15	
22ab	E. H. Robinson	Dn	12.4	1.25	P	G	Qtd	P	H	D, O	Tp	1.1	1,921.19	9.73	6-14	
22bc	Nels Anderson	D	9.9	1.50	T	G	Qtd	P	H	O	Tpf	.6	1,925.15	5.68	6-17	
22cb	Lars Peterson	D	15.1	36	W	G	Qtd	Cy	H	D, O	Tpf	.5	1,926.74	7.51	6-17	
22dd	Nels Bach	Dn	17.8	1.25	P	G	Qtd	P	H	D, O	Tp	1.9	1,923.39	14.50	6-20	
23ad	Glen Hall	D	8.5	24	W	G	Qtd	Cy	H	D	Tpf	.5	—	7.82	6-20	
23ba	do	Dn	48.0	1.25	P	G	Qtd	Cy	—	D, O	Tca	-10.1	1,915.12	8.29	6-20	
23dc		B	14.9	2	P	S	Qtd	N	N	O	Tca	1.7	1,901.84	10.03	8-28	
24aa		Dn	25.7	1.25	P	S	Qtd	P	H	D, O	Tca	3.5	1,900.93	17.97	8-24	
24bb	C. G. Mayer	Dn	20	1.50	P	G	Qtd	Cy	H	D, S	—	—	—	—	—	
24db	Ken Lynde	Dn	20	1.50	P	S	Qtd	P	H	N	—	—	—	—	—	
24dc	Ernie Eilertsen	Dn	21.0	1.25	P	S	Qtd	P	H	D, O	Bp	2.1	1,898.54	9.19	6-22	
25aa	Ray Thiel	Dn	33	1.50	P	S	Qtd	Cy	G	D, S	—	—	—	—	—	
26ab	William Lewis	Dr	165	5	P	S	Tfu	R	E	D, S	—	—	—	—	—	
26ba	Hiller K. Fisser	D	13	36	W	G	Qtd	Cy	E	S	—	—	—	—	—	
26cc	Conrad Strasheim	Dn	15	1.50	P	G	Qtd	Cy	E	D, S	—	—	—	—	—	
26dd		B	10.0	2	P	S	Qtd	N	N	O	Tca	0	1,894.28	6.35	8-10	
27aa	Adolph Kaiser	D	15	40	W	G	Qtd	Cy	H	D	—	—	—	—	—	
27bb	Art Hansen	D	10.1	48	W	S	Qtd	Cy	E	O	Tpf	.2	1,925.68	2.99	8-29	
27dc		D	10.1	24	W	G	Qtd	P	H	D, O	Tpf	.4	1,926.08	8.58	8- 8	
28ad	W. Nelson	Dr	34.4	5	P	G	Qtd	P	H	D, O	Tca	1.4	1,928.74	8.40	7-23	
28bb		Dn	13.9	2	P	G	Qtd	N	N	O	Tca	2.9	1,941.49	7.71	8-29	
28cc	A. Harper	Dn	17.4	1.25	P	G	Qtd	P	H	O	Tca	1.8	1,941.25	7.01	6-14	
28db1	Vox	Dn	19.6	1.50	P	G	Qtd	P	H	D, O	Bp	1.2	1,931.56	6.47	6-14	
28db2		Dn	19.6	1.50	P	G	Qtd	P	H	D	Bp	1.7	—	9.41	6-13	
29cc		D	12.7	64	W	G	Qtd	Cy	H	N	Tpf	.9	—	10.03	6-13	
29dd		Dn	14	1.25	W	G	Qtd	Cy	H	D	—	—	—	—	—	
30aa		D	26	36	W	G	Qtd	Cy	W	D, S	—	—	—	—	—	
31aa1	Sidney Golf Club	B	57.6	18	P	—	—	N	N	N	Tco	1.0	—	56.80	6-14	
31aa2	do	D	21.0	36	C	—	Qtd	Cy	H	D, O	Bp	.6	1,966.66	19.28	6-14	Ca
32ad[1]	City of Sidney	Dr	75	10	P	G	Qtd	T	E	P	—	—	—	—	—	Ca
32cd	J. Micheletto	Dn	37	1.25	P	G	Qtd	Cy	E	D, S	—	—	—	—	—	
32dd1	I. J. Peterson	Dr	400	2	P	—	Tfu	N	F	D	—	—	—	—	6-14	F-0.75;Ca
32dd2	do	Dn	23.4	1.25	P	G	Qal	P	H	D, O	Tp	3.8	1,945.93	12.84	6-14	

Table 4.—*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	Character of water-bearing material	Geologic source	Type of pump	Type of power	Use of water	Measuring point: Description	Measuring point: Distance above or below (-) land surface (feet)	Measuring point: Altitude above mean sea level (feet)	Depth to water level below measuring point (feet)	Date of measurement	Remarks
Richland County, Mont.—Continued															1949	
23-59-33ac	Sidney Locker Co	D	21	24	W	G	Qtd	C	E	In						
33ad	Occident Flour Mill	D	11.3	72	C	G	Qtd	C	E	In, O	Tca	0	1,932.63	10.60	6-15	
33db	J. Campbell	Dn	23.1	1.50	P	G	Qtd	P	H	D, O	Bp	2.2	1,931.42	10.69	6-13	
33dc	H. Willegt	Dn	20.2	1.25	P	G	Qtd	P	H	D, O	Tp	3.9	1,936.17	12.95	6-15	
33dd	J. Kling	D	11.5	30	W	G	Qtd	Cy	E	S, O	Tpf	.5	1,929.39	9.26	6-13	
34ba1	W. M. Rozell	Dn	18	2	P	G	Qtd	Cy	E	D						
34ba2	Holly Sugar Co	D	23.2	1.50	P	G	Qtd	C	E	In						
35bc	R. Propp	Dn	18.7	1.25	P	G	Qtd	P	H	D, O	Tca	1.8	1,903.52	10.03	8-5	
35dc1		B	12.5	1	P	S	Qtd	N	N	O	Tca	.6	1,898.98	10.51	9-2	
35dc2	A. Jackson	Dn	26	1.25	P	S	Qtd	Cy	E	S						
60- 6ca	Elmer Ward	Dn	30	1.25	P	S	Qtd	P	H	D, O	Tca	1.8	1,893.09	8.67	6-24	
6cd	Bill Petersen	Dn	21	1.25	P	S	Qtd	Cy	H	D						
6dc	R. N. Erps	Dn	27.6	1.25	P	S	Qtd	P	H	S, O	Tp	3.0	1,892.46	6.48	6-23	
7ad	T. Nordmark	Dn	17	1.50	P	S	Qtd	Cy	H	S						Ca
7cd	Forest Markle	Dn	19	1.25	P	S	Qtd	R	E	D						
8bc		B	8.5	2	P	S	Qtd	N	N	O	Tca	0	1,891.25	7.00	7-12	
18aa	Peter Storholm	Dn	18.6	1.25	P	G	Qal	N	N	O	Tca	2.8	1,895.47	11.30	6-20	
18bb		Dn	21.0	1.25	P	S	Qtd	P	H	D, O	Tca	1.6	1,895.24	8.96	8-29	
18dd	Peter Storholm	Dn	28.0	1.25	P	G	Qtd	N	N	O	Tcu	0	1,894.45	9.98	8-24	
19aa	J. C. Moore	Dn	38.0	4	P	G	Qtd	Cy	W	S	Tpf	.1		9.59	6-30	
19bc		Dn	27.9	1.25	P	S	Qtd	P	H	D, S, O	Tca	1.9	1,900.44	13.00	8-24	
19ca1	John Christensen	D	21.7	36	W	S	Qtd	Cy	G	D, S, O	Tpf	1.6	1,903.31	12.51	6-22	Ca
19ca2	Peter Storholm	Dn	24	1.50	P	S	Qtd	Cy	H	D, S						

McKenzie County, N. Dak.

149-104- 5cb	--------------------	Dr	25	4	P	S	Qtd	N	N	O	Tca	-1.6	1,909.33	11.98	1949 8-10	
6ad	Peter Storholm----------	Dr	22	1.25	P	S	Qtd	Cy	G	S	----	------	--------	------	------	
150-104-32bc	--------------------	D	26.1	50	W	S	Qtd	N	N	O	Tpf	.6	1,901.58	20.4	7- 1	
32cd	Walla----------------	Dr	36.0	4	P	G	Qtd	Cy	G	S, O	Tpf	1.2	1,894.95	11.24	7- 1	

[1] Three closely spaced wells at this location.

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